

City of Los Angeles LA Sanitation



Collection System Odor Control Master Plan 2017



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Table of Contents

1. EXECUTIVE SUMMARY	1
1.1 PURPOSE	5
1.2 OBJECTIVE	5
1.3 CONTRIBUTING FACTORS	7
2. TASK DESCRIPTIONS.....	9
3. ODOR CONTROL MEASURES	11
3.1 INTRODUCTION	11
3.2 ODOR COMPLAINT RESPONSE AND INVESTIGATION.....	11
3.3 ROUTINE SEWER MAINTENANCE	12
3.4 CHEMICAL CONTROL TECHNOLOGIES.....	14
3.5 AIR WITHDRAWAL, TREATMENT AND MANAGEMENT	18
3.5.1 Carbon Adsorption.....	20
3.5.2 Air Treatment Facilities (ATF)	22
3.5.3 Trap Maintenance Holes.....	23
3.5.4 Hydraulic Flow Management.....	23
3.5.5 Air Curtains.....	24
3.6 SEWER CONSTRUCTION AND REPAIR	24
3.7 MONITORING	25
4. ANNUAL FY 2016/17 ODOR COMPLAINT REPORT	29
COLLECTION SYSTEM ODOR CONTROL PROGRAM	
4.1 INTRODUCTION	29
4.2 RESULTS	30
4.3 DISCUSSION	32
5. AREAS OF CONCERN AND AREAS OF STUDY	35
5.1 AOC-1 - EAST NOS AND NEIS CORRIDOR.....	37
5.2 AOC-2 - LA CIENEGA/SAN FERNANDO CORRIDOR - 2017	43
5.3 AOC-3 - SOUTH LOS ANGELES AREA - NOS/MAZE-ECIS-SLAIS-2017.....	48
5.4 AOC-4 - BALDWIN HILLS/CULVER CITY - NORS-ECIS-NOS-NCOS-WLAIS-WRS-2017	53
5.5 AOC-5 - EAST VALLEY AREA - AVORS-EVRS-VORS-NHIS-NOS-2017.....	58
5.6 AOS -1 - WEST VALLEY AREA-VORS-AVORS-EVIS-2017	62
5.7 AOS -2 - VENICE/PLAYA DEL REY-CIS-LNOS - 2017	62
6. SUMMARY OF RECOMMENDATIONS.....	64
6.1 AOC-1 EAST NOS AND NEIS/ECIS CORRIDOR	64
6.2 AOC-2 LA CIENEGA SAN FERNANDO CORRIDOR – LCSFVRS-WHIS	64
6.3 AOC-3 SOUTH LOS ANGELES AREA – NOS/MAZE-ECIS-SCAIS	64
6.4 AOC-4 BALDWIN HILLS/CULVER CITY – NORS-ECIS-NOS-NCOS-WLAIS-WRS	64
6.5 AOC-5 EAST VALLEY AREA – AVORS-EVRS-VORS-NHIS-NOS	65
7. ODOR RELATED STUDIES/ACTIVITIES/PROJECTS	66
7.1 THIOGUARD ADDITION – NOS (EAST LA).....	66
7.2 MISSION AND JESSE AIR TREATMENT FACILITY – FOUL AIR BALANCE - 2017	66
7.3 MLK/RODEO AND NORS/ECIS CARBON SCRUBBER REPLACEMENT PROJECT – TO BE COMPLETED IN 2017	67

7.4 BTF PILOT TEST	68
7.5 AFRAS RADIAL CARBON SCRUBBER STUDY 2017	68

1. EXECUTIVE SUMMARY

INTRODUCTION

The Los Angeles Sanitation (LASAN) has prepared the 2017 Collection System Odor Control Master Plan. The master plan is an annual review and evaluation of the City's on-going collection system odor control program and efforts. A proactive plan to manage and address the sewer odors is developed. The City continues to control and mitigate foul sewer odors through the implementation of the master plan. 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. However, the 5-years of drought conditions and the mandatory water conservation have created a unique situation and challenge for the collection system. Due to reduced wastewater flows and lower velocities to move debris downstream, odor complaints and odor levels have increased. Nevertheless, a multitude of odor control and response measures are in place to address the on-going challenges of protecting the collection system infrastructure from corrosion and protect public health and the environment from nuisance causing sewer odors. These measures include:

- On-going sewer air pressure and odor monitoring;
- Air management and migration control through hydraulic flow adjustments, air curtains and trap maintenance holes;
- Air treatment utilizing carbon scrubbers and state of the art air treatment facilities which include bio-trickling and carbon scrubber systems;
- Sewer cleaning and maintenance;
- Chemical addition for hydrogen sulfide control;
- Sealing sewer maintenance holes to control unintended emissions;
- Sewer construction repair, relief, and replacement; and
- Sewer Odor Hotline response and investigation

These odor control measures have produced a successful odor control program in the City of Los Angeles. As a result, sewer odors and odor complaints will continue to be addressed. A more detailed description of the City's collection system odor control measures is presented, that includes special studies, investigations, and activities to proactively mitigate and control sewer related odors.

EVALUATION OF THE COLLECTION SYSTEM

The LASAN has identified and studied key areas of the wastewater collection system based on the frequency of odor complaints and targeted these areas for detailed monitoring and analysis. These areas are categorized as "Areas of Concern (AOC)" and "Areas of Study (AOS)". Sewer air pressure measurements and hydrogen sulfide (H₂S) concentrations were taken in these areas to quantify the characteristics that could cause odors in the collection system. The Odor Master Plan presents an assessment of the odor generation of each of the identified areas and recommends a strategy for addressing and controlling odors.

The five (5) Areas of Concern (AOC) with an unusually high frequency of complaints in the collection system are identified as odor hot spot areas in the City. They are:

- AOC-1 East NOS and NEIS/ECIS Corridor
- AOC-2 La Cienega San Fernando Corridor – LCSFVRS-WHIS-LCIS
- AOC-3 South Los Angeles Area – NOS/Maze-ECIS-SCAIS
- AOC-4 Baldwin Hills/Culver City – NORS-ECIS-NOS-NCOS-WLAIS-WRS
- AOC-5 East Valley Area - AVORS-EVRS-VORS-NHIS-NOS

There are two (2) Areas of Study (AOS) as well which are normally under negative pressure, but potentially could cause odor issues depending on the flow dynamics and scrubber conditions. They are:

- AOS-1 – West valley Area- VORS-AVORS-EVIS
- AOS-2 – Venice/Playa Del Rey- CIS-LNOS-COS-NCOS-NORS

SUMMARY OF RECOMMENDATIONS

AOC-1 East NOS and NEIS/ECIS Corridor

- Continue to monitor pressure and hydrogen sulfide levels on an annual basis
- Continue to implement current odor control measures. Determine the need for additional odor control measures including chemical addition and/or additional air treatment
- Evaluate the effectiveness of magnesium hydroxide to the NOS via the Valley Bl. Relief Sewer (Implemented Sept. 2017)
- Evaluate air flow dynamics after completion of the Mission NOS emergency repair, adjustment of the inlet damper at Mission and Jesse ATF and refurbishment of the Mission and Jesse Air Curtain.
- Evaluate air flow dynamics by manipulating sewage flow throughout the various diversion structures
- Evaluate air flow dynamics of 6th Street sewer tributary to the NOS after air curtain installation.
- Evaluate long term need for the Enterprise Siphon
- Evaluate up-sizing of Humboldt and Richmond carbon scrubbers to 15,000 cfm

AOC-2 La Cienega San Fernando Corridor – LCSFVRS-WHIS-LCIS

- Continue to monitor pressure and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor the H₂S levels to evaluate the effectiveness of magnesium hydroxide addition for the collection system odor control on an annual basis
- Continue to seal all maintenance holes where needed in the area to minimize odor release

- Continue to implement on-going odor control measures
- Re-evaluate the system after the installation of the up-sized Genesee carbon scrubber to 10,000 cfm

AOC-3 South Los Angeles Area – NOS/Maze-ECIS-SCAIS

- Continue to monitor pressure and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor the H₂S levels on an annual basis to evaluate the effectiveness of caustic shock dosing
- Continue to seal all maintenance holes where needed in the area to minimize odor release
- Continue to implement on-going odor control measures
- Reevaluate the system after the planned CIP improvements, including Martin Luther King (MLK) carbon scrubber replacement, NOS, Slauson Sewer, and Normandie Sewer Replacement rehabilitation projects.
- Evaluate alternative odor control chemical addition technologies

AOC-4 Baldwin Hills/Culver City – NORS-ECIS-NOS-NCOS-WLAIS-WRS

- Continue to monitor pressure and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor H₂S levels on an annual basis to evaluate the effectiveness of chemical addition
- Continue to seal all maintenance holes where needed in the area to minimize odor release
- Continue to implement on-going odor control measures
- Reevaluate the system after the planned CIP improvements, including NORS/ECIS carbon scrubber replacement and WLAIS rehabilitation
- Evaluate up-sizing of NOTF carbon scrubber to 15,000 cfm

AOC-5 East Valley Area – AVORS-EVRS-VORS-NHIS-NOS

- Continue to monitor pressure and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor H₂S levels on an annual basis in order to evaluate the effectiveness of chemical addition
- Continue to seal all maintenance holes where needed in the area to minimize odor release
- Continue to implement on-going odor control measures
- Reevaluate the system after the planned CIP improvements, including Radford carbon scrubber replacement

The purpose of the Collection System Odor Master Plan is to present an assessment of odor issues within each area of concern and area of study and develop a strategy for proactively addressing and managing sewer odors in the City of Los Angeles. The goal is to protect the public health safety and be a good neighbor for the surrounding community.

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1. INTRODUCTION

The Odor Control Master Plan is an annual review and evaluation of City's on-going collection system odor control program and efforts. It is a proactive plan to manage and address the sewer odors within the sewer collection system. The City continues to control and mitigate foul sewer odors through the implementation of the master plan.

1.1 PURPOSE

The purpose of the Odor Control Master Plan is to be both educational and functional. This document will provide a background of the odor issues in the City's wastewater collection system 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 efforts 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.

1.2 OBJECTIVE

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 responding to odor complaints;
- Operating and maintaining odor control scrubbers and air treatment facilities;
- Chemically treating sewers to reduce hydrogen sulfide (H₂S) generation;
- Investigating and pilot testing 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 investigation of odor character throughout the collection system and evaluates the current operation and maintenance policies and practices.

The effort to monitor the sewer system involves 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 conducting wastewater sampling to determine the odor-causing characteristics of sewage such as total sulfide, dissolved sulfide, dissolved oxygen, BOD and pH. After sufficient amounts of 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 already has a developed system in place for documenting and responding to odor complaints and will continue this effort in order to work with the residents to address their concerns promptly and effectively.

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 treatment facilities, the implementation of chemical injection technologies that will inhibit the generation of hydrogen sulfide gas within the wastewater collection system, construction/installation of trap maintenance hole, house connection traps and air curtains.

The City has embarked on efforts to identify and evaluate new technologies to mitigate and resolve odor issues. New technologies will be implemented where appropriate, through either the operation and maintenance program or the capital improvement program. When implemented, the City will optimize the operation of the technologies by monitoring and adjusting the systems to ensure maximum effectiveness.

The overall strategies and goals are to implement a community-supported odor control program that will keep the public informed at various levels, to inform and advise the Board of Public Works and the City Council at every stage of the program, and to protect the public health and safety of the community.

1.3 CONTRIBUTING FACTORS

Although a long list of potential odorous compounds can be released from sanitary sewer collection systems, sewer odor complaints generally result from the presence of hydrogen sulfide. The occurrence of hydrogen sulfide in untreated wastewater begins with the biochemical reduction of inorganic sulfates to liquid sulfide. A combination of several environmental and physical conditions determines the rate at which this occurs.

- **Dissolved Oxygen (DO)**

When the DO level is below about 1 mg/L, as it is in most municipal waste streams, surface reduction to liquid sulfide will occur. Bacteria residing in the slime layer that lies beneath the wastewater surface on the inside wall of the sewer pipe or wet well cause the sulfate reduction.

- **Wastewater pH**

The reduced sulfate exists as sulfide and bisulfide ions and hydrogen sulfide in varying concentrations, depending on wastewater pH.

- **Temperature**

The bioactivity of the sulfate-reducing bacteria in the slime layer increases as wastewater temperature rises, thus odor generation will tend to accelerate during the warmer months.

- **Liquid stream velocity**

A lower wastewater velocity causes an increase in total liquid sulfide. When the velocity is less than scouring velocity, solids deposition will occur, which tends to provide a site for sulfate reduction if DO is low.

- **Surface area**

As wastewater flow depths increase, the surface area of the slime layer increases. This occurs in flat gravity sewers, force mains, and wet wells. These typically are the locations of high liquid-sulfide production in a sanitary sewer system.

- **Detention time**

As wastewater detention times increase in pipe systems and wet wells, oxygen consumption increases. This reduces DO and creates conditions favorable for sulfate reduction.

- **Wastewater turbulence**

When flows are turbulent, the wastewater's surface area increases. The partial pressure of the hydrogen sulfide above the surface of waste stream is reduced slightly by this condition. To maintain equilibrium, hydrogen sulfide is stripped from the solution to the atmosphere. Turbulent conditions are created at drops, sharp bends, and slope reductions in the system.

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2. 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 analyze wastewater samples to determine the characteristics of the sewage.
- 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 technology 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.

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3. ODOR CONTROL MEASURES

3.1 Introduction

Municipalities face daily challenges in their efforts 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, treatment, and management;
- 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.

3.2 Odor Complaint Response and Investigation



The LASAN, Wastewater Collection Systems Division (WCSD) responds to various odor complaints from the public. However, the 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 and 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 H₂S levels and evaluating the data
 - requesting repair of trap maintenance holes or other sewer structures by an on-call contractor
 - Proposing capital improvement projects (CIP) such as hydraulic relief pipes, air treatment facilities, chemical addition, etc.

The City continues to pursue odor remediation measures to reduce complaints. On-going measures include: cleaning and maintaining sewers, upgrading and/or installing trap maintenance holes, installing house connection traps and air curtains, optimizing the air dampers at the inlet of ATFs, continued operation of the carbon scrubbers and ATFs, addition of odor control chemicals in the collection system and rehabilitation and replacement of aging and hydraulically deficient sewers. Overall, the implementation of the projects mentioned above and continued maintenance have made a marked improvement to the reduction of the sewer related odor complaints.

All sewer related odor complaints were properly investigated and addressed, while non-sewer related odors were referred to the appropriate City department or other government agencies.

3.3 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.



3.3.1 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.

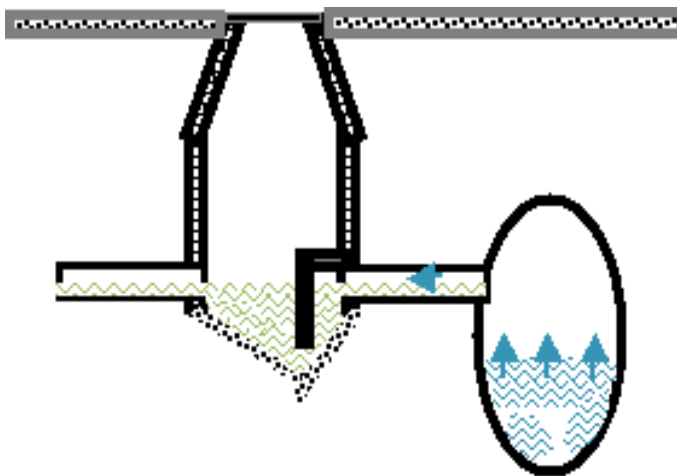
Rodding – A continuous or sectional rod with a blade at the end is inserted into the pipe and rotated. This action breaks-up grease deposits, cuts roots, and loosens debris.

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 7,000 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 350 miles of sewers are treated annually.

3.3.2 Trap Maintenance Hole Inspection and Cleaning

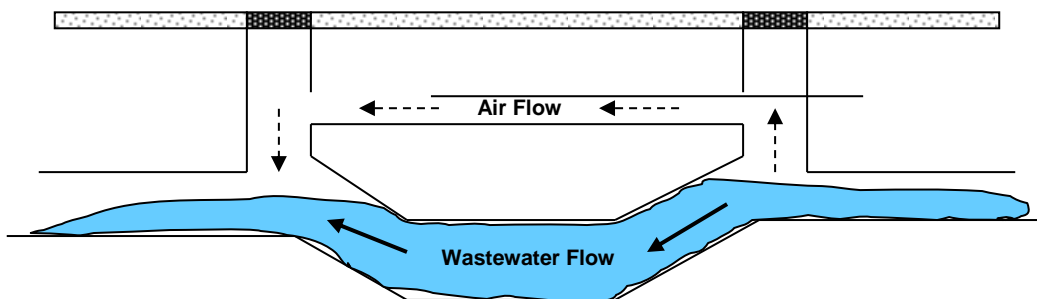
Trap maintenance holes are inspected and cleaned on a quarterly basis. These structures are used to prevent the migration of sewer gases throughout the collection system. They are typically located where small sewers, 6-inches to 15-inches, connect to large interceptor and outfall sewers since high gas 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.



3.3.4 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 H₂S 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 H₂S 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. This action impedes 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.

3.3.5 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.



3.4 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 H₂S 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 H₂S 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.

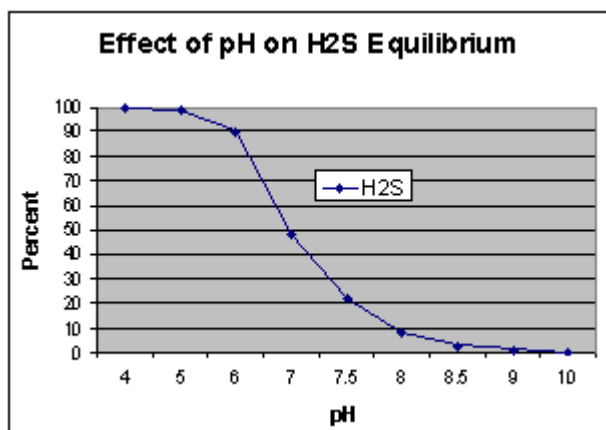
Although there are theoretical formulas and rules regarding the dosing requirements for each liquid phase treatment process, it is not an exact science. Field analysis of the results and subsequent adjustments are required. Therefore, trial and error applications are common until an adequate dose level is achieved. Continuous monitoring is necessary to determine a cause-and-effect relationship of each treatment. Monitoring for H₂S 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.

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.

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, 74th Street Sewer and Hollywood Main Sewer. These sewers are tributary to the Maze. Caustic shock dosing is also performed on the WLAIIS. Higher H₂S concentrations are a result of high dissolved sulfide generation caused by solids deposition in the large diameter sewer.

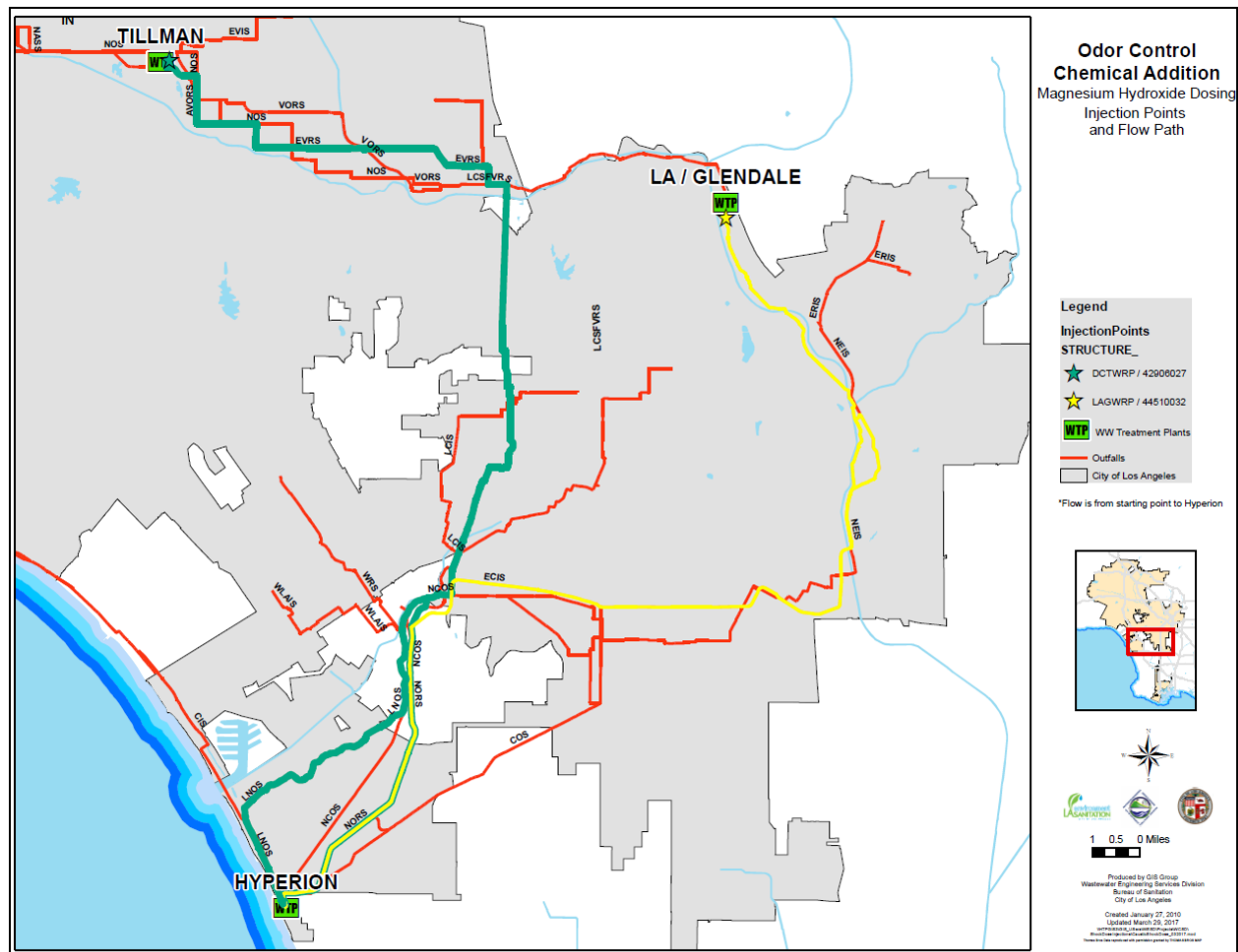
As a safety precaution, all chemical applications are scheduled in advance and announced to all collection system personnel to avoid accidental contact with the chemical as it passes down the sewer system. Additionally, the treatment plant is notified prior to application. A shock dose schedule bulletin 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 soda to be added to the collection system.

3.4.2 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 its pH to within a range of 7.5 and 8.6. As the graph on the left shows, at a pH of 7, approximately 50% of all sulfides exist as H₂S gas. At pH 8, that number falls to 10% and at pH 8.6, only 3% of sulfides exist as H₂S 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 H₂S produced and thus emitted into the atmosphere. Consequently, maintaining a high pH provides effective odor control.

The City has been using 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 the following figure for the chemical flow path. This benefits both the Studio City area, Hollywood and Mid-City areas. In July 2013, Thioguard application on the NOS from LAGWRP started to address the high concentration of H₂S resulting from the release of biosolids back to the NOS from the LAGWRP.



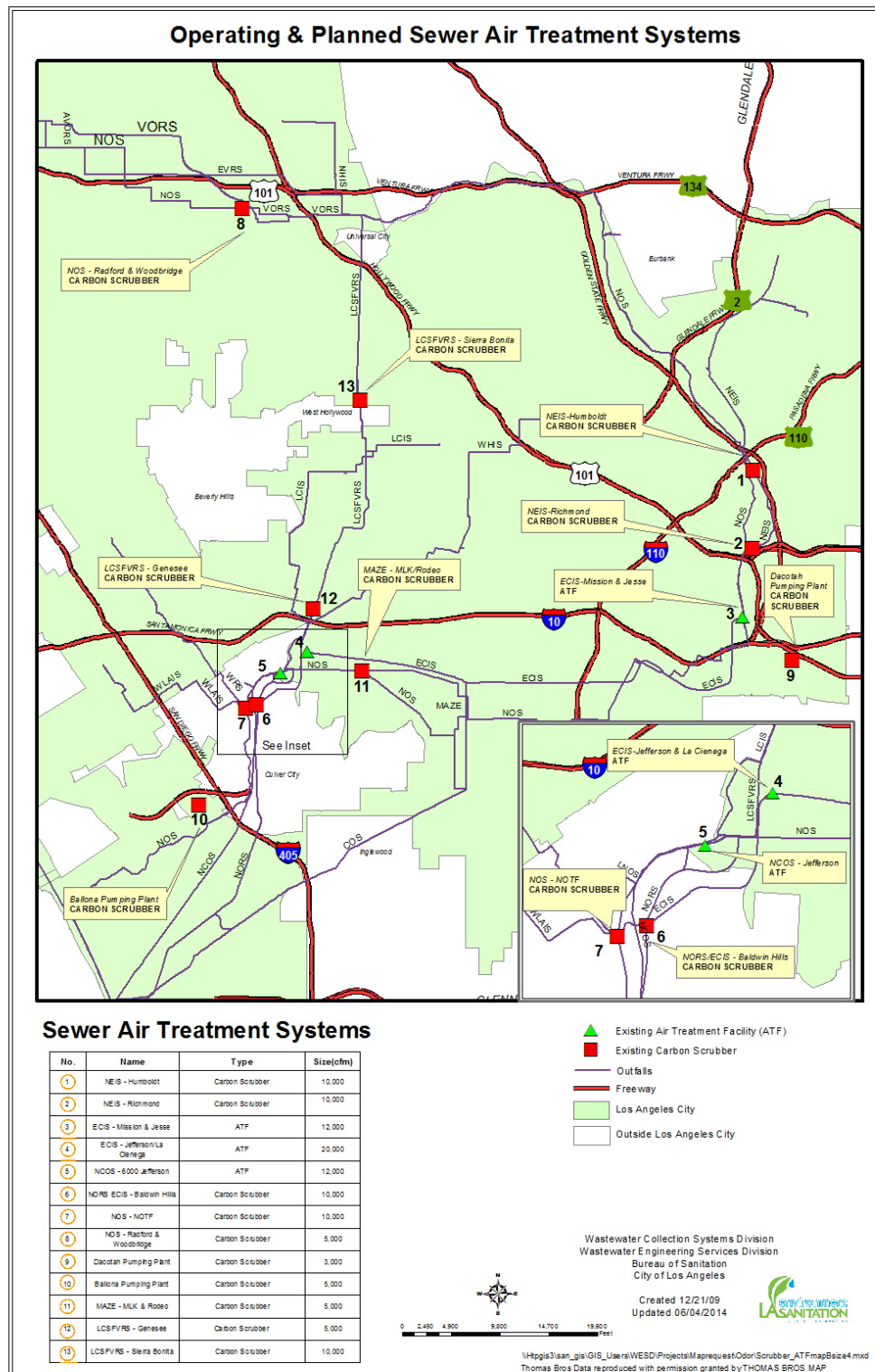
3.5 Air Withdrawal, Treatment and Management

The City has conducted multiple studies of sewer gas pressure and odors. The studies have identified distinct high pressure zones in sewers including:

- North Outfall Sewer (NOS)
- Maze Area Sewer System (Maze)

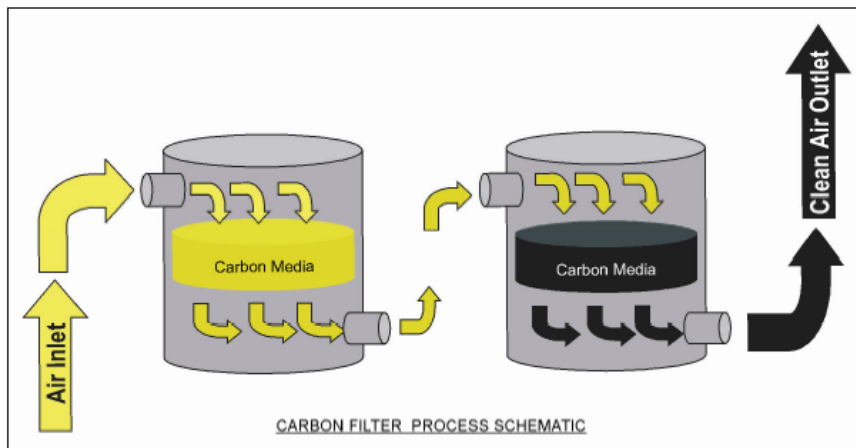
- La Cienega San Fernando Valley Relief Sewer (LCSFVRS)
- North Outfall Replacement Sewer (NORS)
- West Los Angeles Interceptor Sewer (WLAIS)
- Westwood Relief Sewer (WRS)

To address the high pressure zones and localize odor hot spots in the collection system, carbon scrubbers and permanent air treatment facilities were constructed to alleviate and mitigate the odor emissions from the collection system. See the following figure:



3.5.1 Carbon Adsorption

Conventional carbon 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 a 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 ten 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 ranges from monthly to quarterly to bi-annually depending on the contaminant loadings to the carbon scrubber.



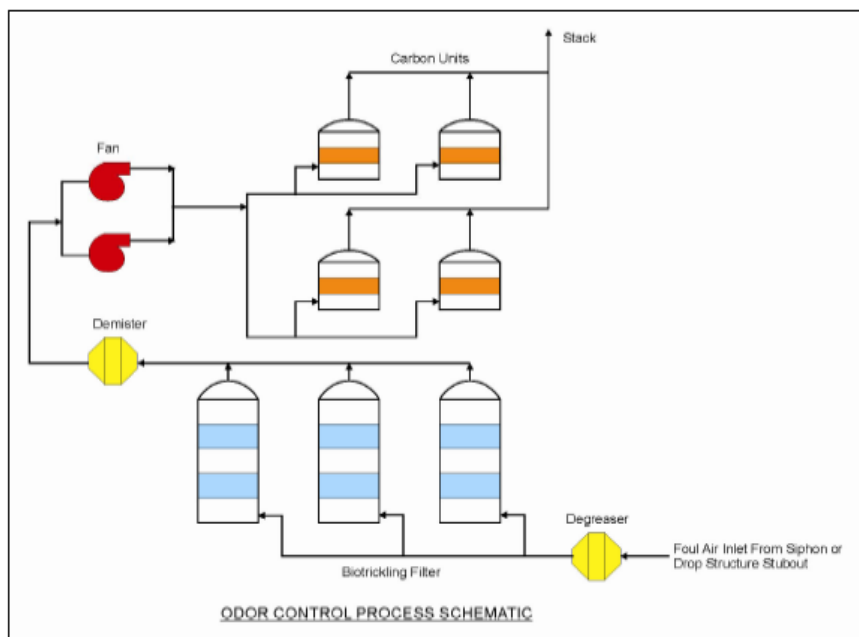
Ten carbon scrubbers are installed at sites to address localized odor hotspots within the collection system. They include:

1. NORS/ECIS Junction
2. NEIS Drop Structure - Humboldt and San Fernando Rd
3. NEIS - Richmond
4. LCSFVRS – Sierra Bonita
5. LCSFVRS Siphon – Genesee
6. NOS Siphon – Radford
7. Maze/NOS Junction – Rodeo and Martin Luther King
8. WLAI/NOS Junction – North Outfall Treatment Facility (NOTF)
9. Ballona Pump Plant
10. Dakota Pump Plant

These units have been in operation for 10 years and have reached their operational useful life. There are plans to upgrade existing units to insure continued operability.

3.5.2 Air Treatment Facilities (ATF)

The City has elected to use Air Treatment Facilities (ATF) using a 2-stage odor control system employing biotrickling filtration technology followed by a carbon adsorption polishing step.



Bio-trickling 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 they are transferred directly from the gas to the biofilm, where they are oxidized biologically to odorless compounds. The oxidative by-products, namely sulfuric acid, are then removed through the trickling effluent. The treated effluent is then polished by carbon adsorption.

Three ATFs have been constructed and are in operation. They include the ATF at East Central Interceptor Sewer Siphon and LCSFVRS (Jefferson & La Cienega), the ATF at North Central Outfall Sewer Siphon (NCOS) and the ATF at Mission and Jesse. The ATFs were strategically placed to reduce the long standing odor issues in the South Los Angeles/Baldwin Hills area and in the Boyle Heights/East LA area. The ATF at ECIS is designed to ventilate and treat the ECIS at the siphon and the LCSFVRS to mitigate sewer gas emissions. The facility treats 20,000 cfm of foul air. 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. A third ATF at Mission and Jesse with a capacity to treat 12,000 cfm of foul began operation in June 2015. This ATF withdraws air from the ECIS/NEIS Junction and the NOS.



3.5.3 Trap Maintenance Holes

There are over 400 trap maintenance holes in the collection system. These structures are constructed at the downstream end of local sewers up to 15-inches in diameter prior to their connection to large diameter sewers. Large diameter sewers are the source of ventilation in the collection system. To prevent the migration of air from the large diameter pipes to the local sewers, the trap maintenance holes serve to block the migration of airflow from the large diameter pipe. Trap maintenance holes act similarly to p-traps used in residential plumbing by creating a water seal that blocks the sewer gases.



3.5.4 Hydraulic Flow Management

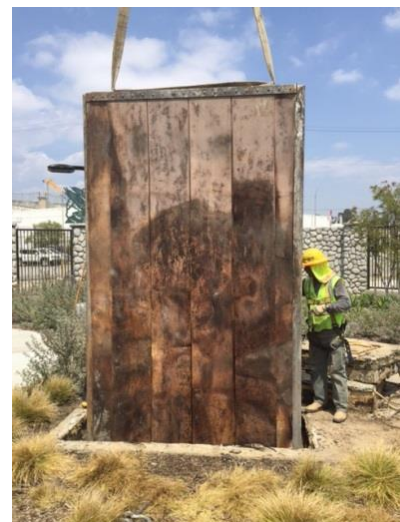
Flow management plays a major role in odor control, especially in the area of air dynamics and ventilation. Hydraulic flow has an influence on air movement. It is well documented that in major interceptor and outfall sewers, hydraulic flow will drag the air above it. As a result, air

moves within the pipe. Throughout the day, as part of the diurnal pattern of flow, the wastewater flow will rise and fall. When flows rise, air is pushed out the system. Conversely, when flows fall, air is pulled into the system. The air pressure is significant especially in sewers that are at or reaching capacity, meaning the hydraulic flow levels are high. Balancing flows in the system by splitting flows at diversion structures will relieve air pressure in the system.



3.5.5 Air Curtains

Air curtains proved to be effective tools in controlling the air movement in the sewers. The purpose of the air curtain is to isolate the air movement in the interceptor sewer and control movement of sewer air from entering other portions of the collections system. Air curtains are installed at major diversion structures. Air curtains have been installed at NORS Diversion Structures 1, 2, and 3; NOS/NCOS to LCSFVFRS diversion structure; 23rd and Trinity NOS to ECIS diversion structure and the NOS/ECIS diversion structure upstream of the Mission and Jesse ECIS drop structure; and most recently on the 6th Street Junction Sewer upstream of the NOS.



3.6 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. In special circumstances, the City will also install house connection traps on the private sewer lateral to control the migration of sewer gases from the City sewer to the private property. This requires consent from the property owner to install such a device on to their private lateral and agreement from the property owner to maintain the house connection trap.

Trap maintenance holes are inspected quarterly as part of an odor complaint investigation. The Bureau has identified all known problematic trap maintenance holes and has begun a program of replacing them on a systematic basis. The City is replacing existing trap maintenance holes with a new standard design. The new design will ensure a continuous seal and allow crews better accessibility to maintain the trap maintenance hole without compromising the seal. It is expected that these upgrades will significantly improve sewer odor releases where trap maintenance holes are located. The City will continue to upgrade and install trap maintenance holes where needed.

The City's program of constructing new and rehabilitating 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.

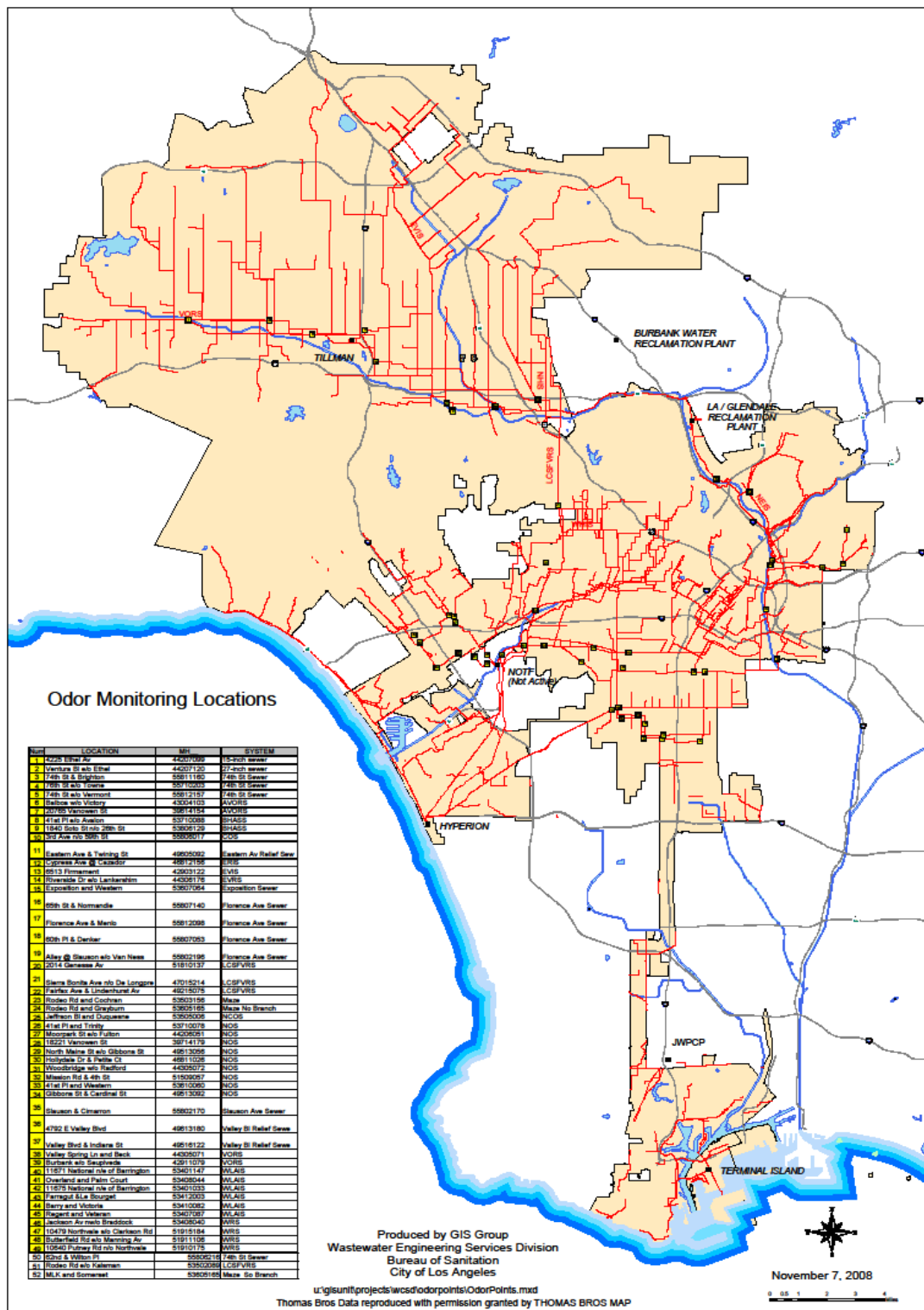
3.7 Monitoring

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 the following figure.

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

- Wastewater Characteristics – includes total and dissolved sulfides, pH, and temperature. These characteristics determine the potential for H₂S formation.
- H₂S Gas Concentration – determines potential for odor complaints if released.
- Air Pressure – determines potential sites of odor release.
- Sewer Odor Complaints – helps evaluate effectiveness of odor control measures and helps identify potential hotspots in the collection system.

Monitoring is conducted at least annually at designated points to gauge the 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 hotspot locations. This information is used as part of the annual odor master planning efforts.



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4. ANNUAL FY 2016/17 ODOR COMPLAINT REPORT

Collection System Odor Control Program

4.1 Introduction

The LA Sanitation receives odor complaints regarding possible sewer odors through the 24-hour Odor Hotline or other non-hotline sources. The Bureau investigates all the complaints received and determines whether they are sewer or non-sewer related odors. A brief overview of each element is as follows:

Hotline

- 24-hour Odor Complaint Hotline at 1-866-44SEWER or on-line at www.lasewers.org. All phone calls to the odor hotline are answered by operator.
- 3-1-1 City-Wide Call Center

Non-Hotline

- Direct contact from the public
- Council District Office or other referrals

The odor complaints are divided into four category types:

1. **Primary Sewer Ventilation** - Sewer related odors emitted due to positive pressure from maintenance holes, scrubbers, defective trap maintenance holes, diversion structures, treatment plants or other sewer structures.
2. **Septic Condition** - Sewer related odors due to septic conditions caused by blockage from grease, roots, and other debris or full, slow moving sewers.
3. **Other City Related Issues** - Non-sewer related odors from stormwater catch basin, debris basin or channel odors, dirty alley, and standing water. Typically these complaints are forwarded to the LA Sanitation's Wastewater Collection System Division Stormwater Section, Watershed Protection Division, Bureau of Street Maintenance, or other City Bureaus.
4. **Non-City Related Issues** - These are non-sewer related odors due to owner trouble, dead animal, other odors not involving city facilities, such as Los Angeles County Flood Control District and Sanitation Districts of Los Angeles County. This category also includes no odors detected at time of investigation.

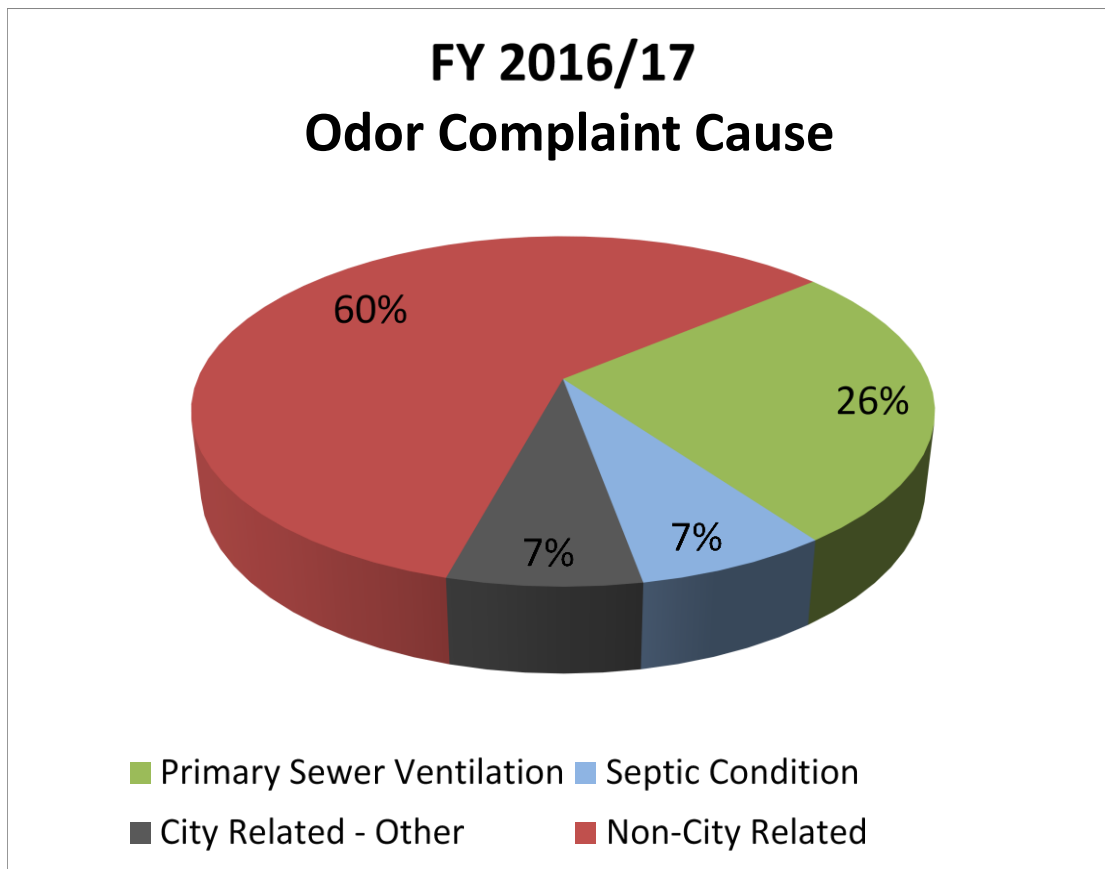


Figure 1 - Odor Complaint Cause

4.2 Results

Of the 352 odor complaints investigated in this fiscal year, 33% or 117 were related to the sewer system. 67% or 235 of the total odor complaints received were non-sewer sources (Figure 1) such as from storm water catch basins, dirty alleys, and standing water, owner trouble or no sewer odors detected. Figure 2 presents the location and cause of the odor complaints investigated this fiscal year.

Compared to last fiscal year, sewer related odor complaints decreased by 58% from 279 complaints in FY 2015/16 to 117 complaints in FY 2016/17 (Figure 3). Sewer ventilation is the primary cause of sewer related odor complaints. Foul odors venting out of the wastewater collection system attribute to 80% of the sewer related odor complaints received (Figure 4). Sewer ventilation is the forcible release and escape of foul sewer gases from various sources including outfall/interceptor sewers, leaking trap maintenance holes, direct connection house connections to large diameter sewers, emissions from air scrubbers and air treatment facilities, and odors from wastewater pumping plants and treatment plants. Septic sewer odors account for the remaining 20% of the sewer related odor complaints received. Septic conditions are caused

by sewer blockages caused by roots, grease, and/or other organic debris which create septic or anaerobic conditions in the pipe to cause foul odors.

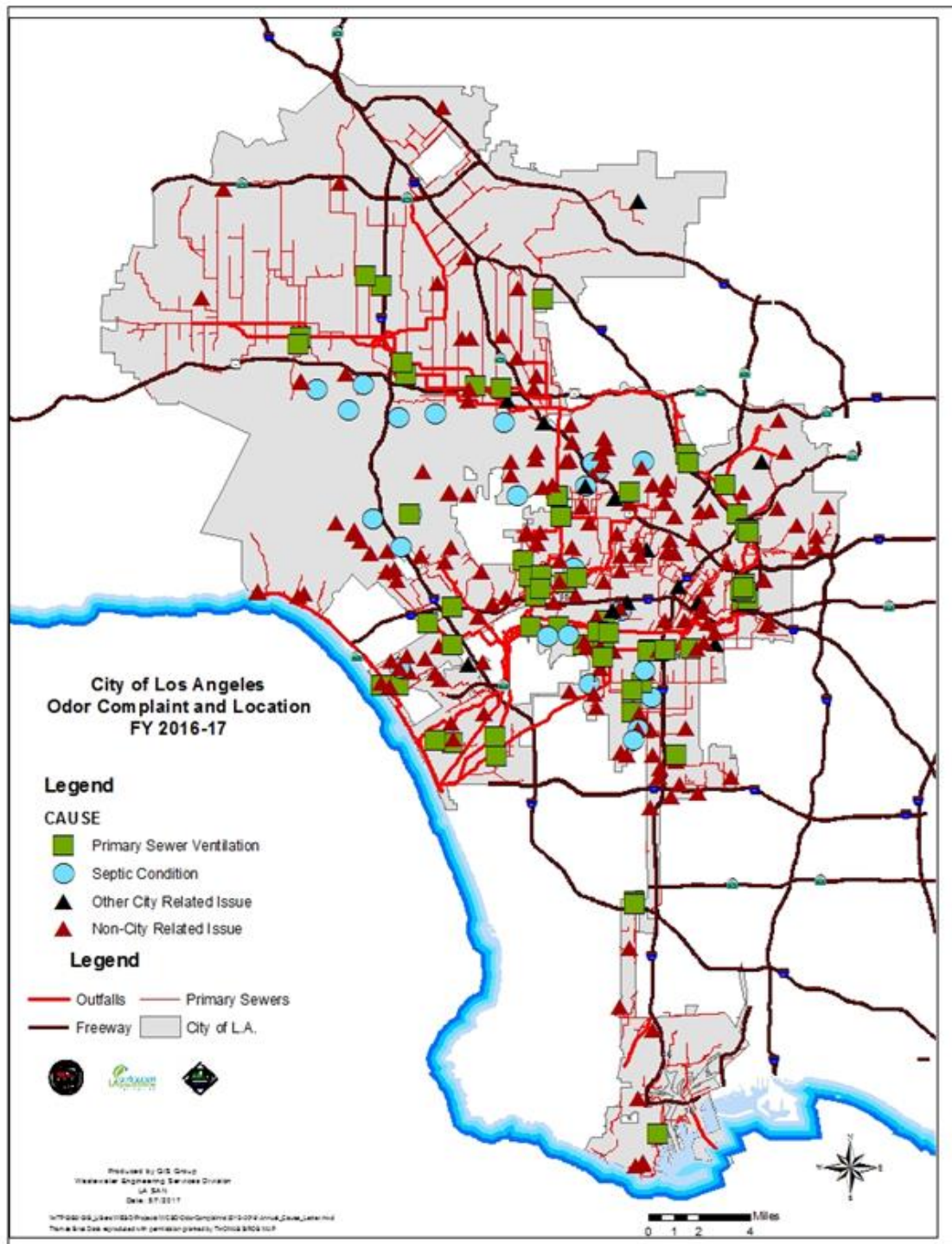


Figure 2 - Odor Complaint Location and Cause

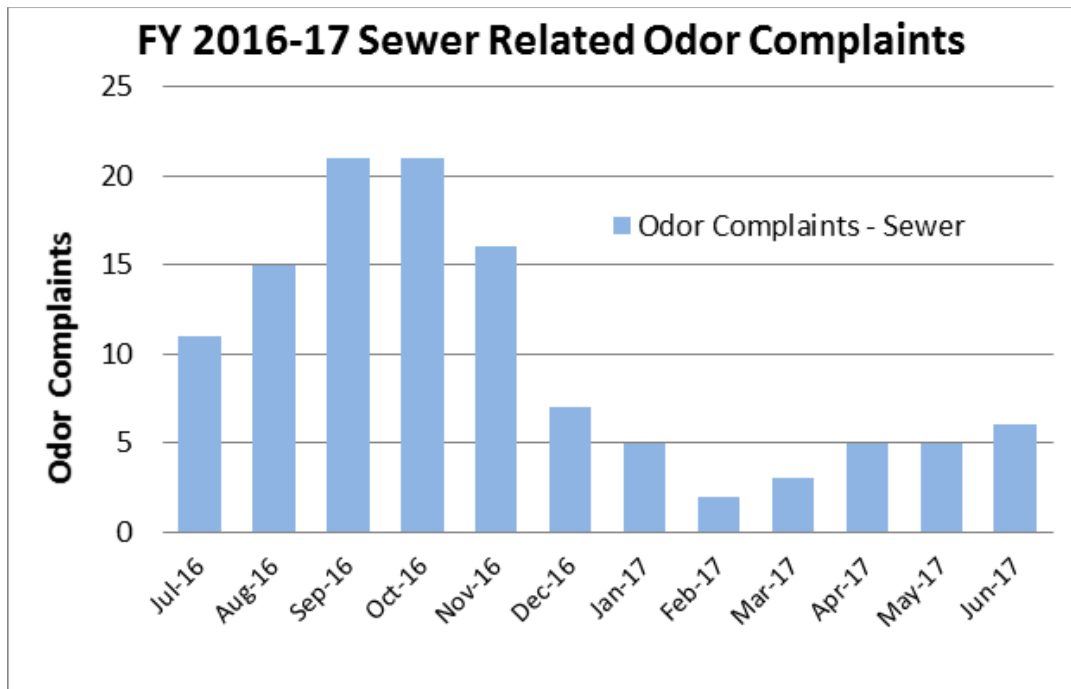


Figure 3 - Monthly Sewer Related Odor Complaints

4.3 Discussion

The City continues to address sewer related odor complaints by implementing its odor control program. Sewer odor control includes vapor phase and wastewater liquid phase treatment to address sewer odors. Vapor phase treatment consists of biotrickling filters and carbon adsorption scrubbers to reduce sewer ventilation along the major outfall and interceptor sewers and pumping plants. The three Air Treatment Facilities have been operating successfully and meeting designed treatment and air emission standards. The ten carbon adsorption scrubbers operating in the collection system have met or have exceeded their useful operating service lives. Capital improvement projects to replace and upgrade the existing aging units have been initiated. The LA Sanitation plans to upgrade and replace its 10 carbon adsorption scrubbers over the next 5 years. The first two carbon scrubber projects, NORS/ECIS scrubber and the Martin Luther King (MLK) scrubber, are currently in progress and nearing completion by the end of 2017. In the meantime, maintenance activities of these units have stepped up to ensure on-going operation of the units. After a successful pilot study, designs are underway to install a new radial type carbon scrubber vessel configuration with a suspended media bed. The initial installation will replace the Genesee scrubber. After installation, full scale testing will be conducted to determine treatment effectiveness and potential use for the remainder carbon scrubber sites.

Wastewater liquid phase treatment involves the use of odor controlling chemicals to reduce the concentration and the generation of hydrogen sulfide gases from forming in the collection

system. LA Sanitation uses caustic (sodium hydroxide) shock dosing along sewers subject to septic conditions and high sulfide generation caused by low velocity and surcharge conditions in the South Central Los Angeles Area Interceptor Sewer and West Los Angeles Interceptor Sewer Systems and a continuous addition of Thioguard (magnesium hydroxide) to control hydrogen sulfide levels in the collection system along the North Outfall Sewer, East Valley Relief Sewer and La Cienega San Fernando Relief Sewer.

The Bureau conducts periodic monitoring in the collection system to measure the effectiveness of the vapor phase and liquid phase treatment and to document the odor characteristics at designated points in the collection system in terms of potential odor generation and odor hot spots. On-going periodic monitoring of the collection system includes measuring hydrogen sulfide, air pressure and wastewater characteristics such as total and dissolved sulfides, pH and dissolved oxygen.

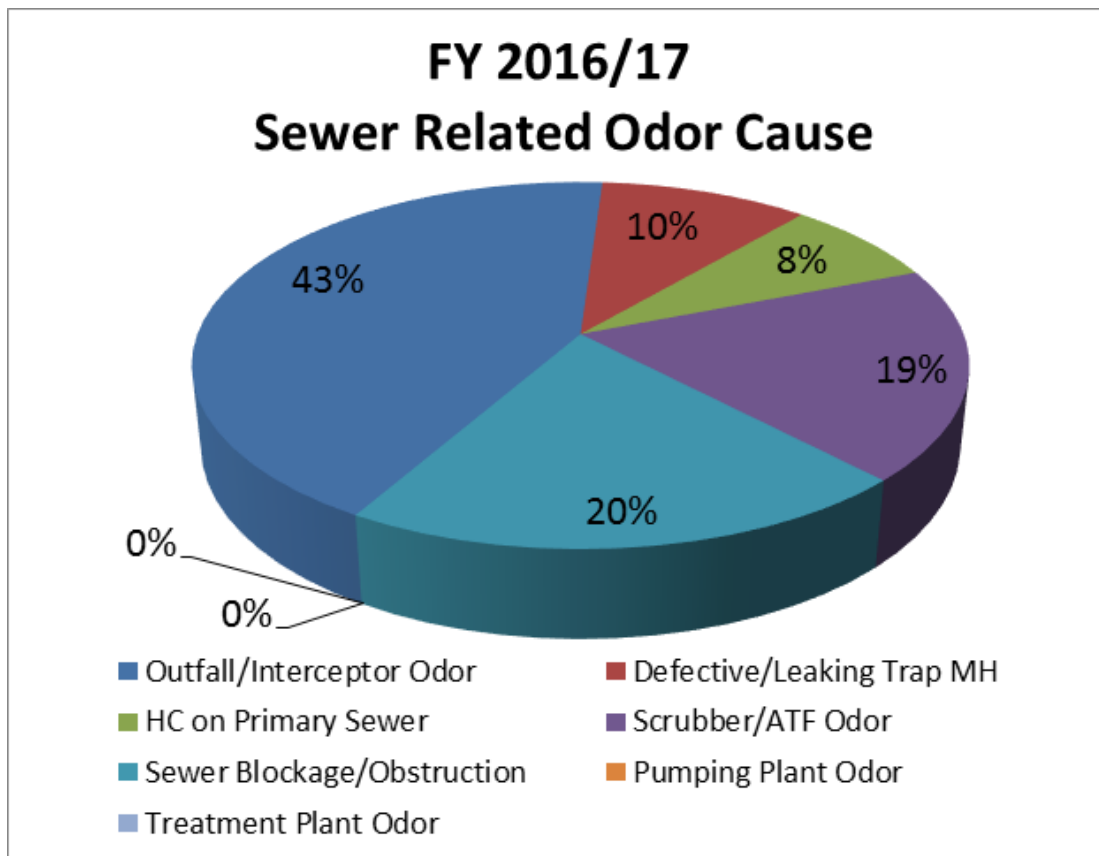


Figure 4 - Sewer Related Cause

Overall, the activities and projects mentioned above and the on-going maintenance activities will address sewer related odor complaints. The Bureau's collection system odor control efforts are geared toward maintaining the health, safety and quality of life for its constituents.

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5. AREAS OF CONCERN AND AREAS OF STUDY

The areas of concern and areas of study were selected based on the history and/or frequency of sewer related odor complaints, and the physical sewer characteristics that may potentially contribute to the generation and release of odors in the area. The following sections describe the locations of all odor complaints investigated during FY 2016/2017.

This section will provide an analysis for each of the five locations identified as Areas of Concern (AOC) and two locations identified as Areas of Study (AOS). Areas of Concern (AOC) are areas with a history and/or high frequency of odor complaints in the collection system. These areas are the odor hot spot areas in the collection system. Areas of Study (AOS) are areas that potentially can be areas of concern due to intermittent odor complaints that have developed. Further studies will be developed for these areas to understand the potential issues that may arise in the area.

The following figure identifies each of these areas on a map of Los Angeles. Monitoring locations within these areas were selected based on odor complaint history and a detailed review of the physical characteristics of the collection system that can contribute to odor generation and release. The physical sewer characteristics that may trigger odor generation or release include flat or severe pipe slopes, pipe diameter constriction, major junction structures, and proximity to an inverted siphon. Each AOC and AOS will contain an introduction, discussion and analysis, conclusion, and recommendations.

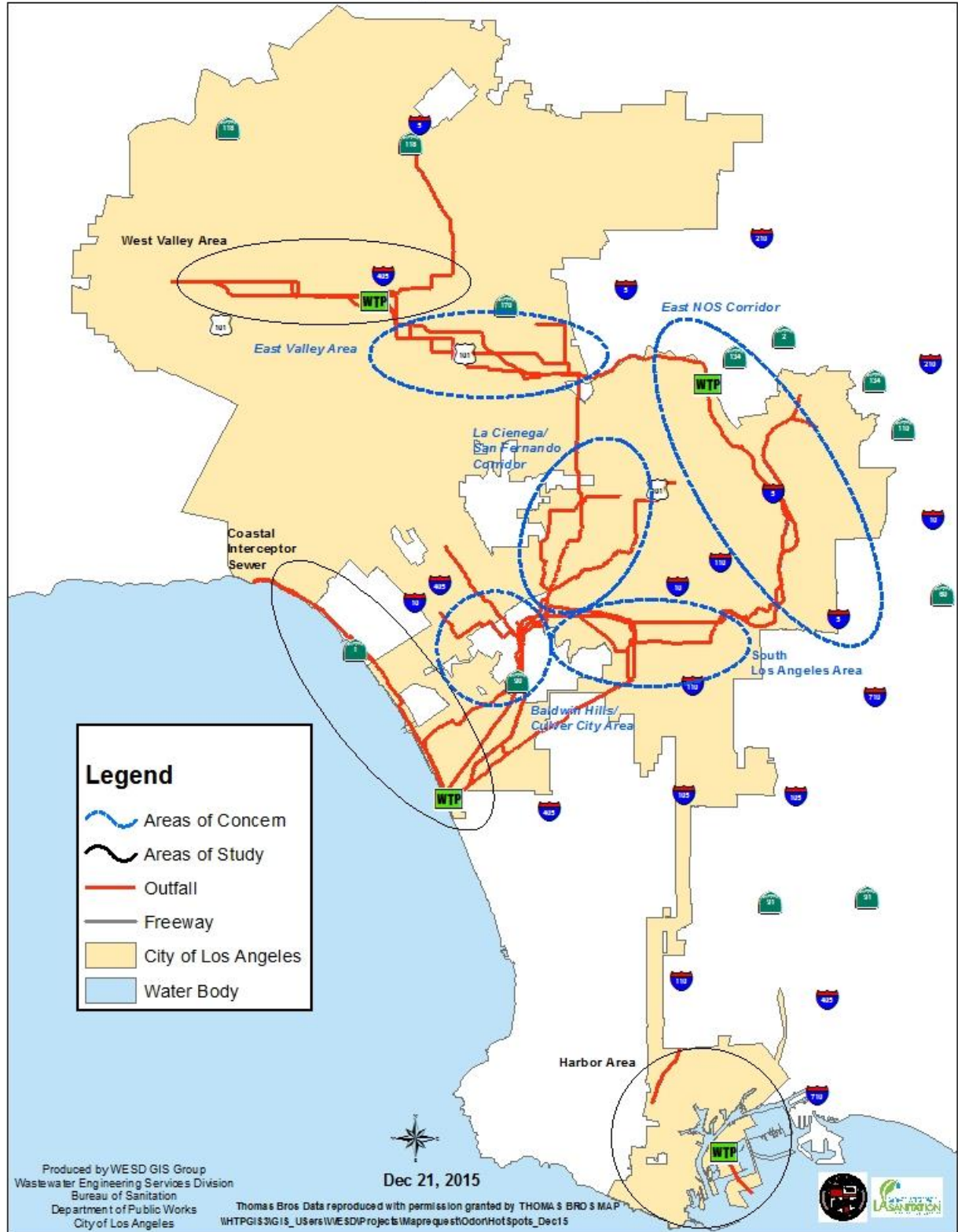
AOC - Areas of Concern

- AOC-1 – East NOS and NEIS/ECIS Corridor
- AOC-2 - La Cienega/San Fernando Corridor - LCSFVRS-WHIS-LCIS
- AOC-3 South Los Angeles Area – NOS/Maze-ECIS-SCAIS
- AOC-4 Baldwin Hills/Culver City – NORS-ECIS-NOS-NCOS-WLAIS-WRS
- AOC-5 East Valley Area - AVORS-EVRS-VORS-NHIS-NOS

AOS- Areas of Study

- AOS-1 – West valley Area- VORS-AVORS-EVIS
- AOS-2 – Venice/Playa Del Rey- CIS-LNOS

Collection System Odor Hot Spots



5.1 AOC-1 - East NOS and NEIS Corridor

INTRODUCTION

This section provides a discussion and analysis of the sewer characteristics that may contribute to collection system odors on major sewers along the eastern corridor of the North Outfall Sewer (NOS) system and the Northeast Interceptor Sewer (NEIS). The area of concern covers the NOS starting at the east side of the San Fernando valley near Toluca Lake area through the Los Angeles Glendale Water Reclamation Plant (LAGWRP) north of Atwater Village and moving southerly to the Enterprise Siphon located in the Boyle Heights area. The terminus of the Northeast Interceptor Sewer (NEIS) begins at San Fernando Rd north of Division St and moves southerly to Mission and Jesse where NEIS ends and the ECIS begins. The NOS receives returned biosolids from LAGWRP which makes it more susceptible to odor generation and odor complaints. In addition, there are several major sewer structures along this segment that may increase the potential for sewer air pressurization, migration, and release. The major sewer structures along the NOS and NEIS alignment include five siphons and three diversion structures and three drop structures. The siphons include Mariposa, Doran, Fletcher/Gilroy, Aliso/Mission, and Enterprise siphons. Portions of the NOS wastewater flow is diverted at major diversion structures including the Humboldt diversion to NEIS and Mission and Jesse diversion to ECIS. Both diversion points connect to drop structures conveying the NOS wastewater flows to NEIS and ECIS deep tunnel sewers, respectively. Flows from the Eagle Rock Interceptor Sewer are diverted to the Terminus of NEIS at the Division St diversion structure. In Early 2016 and through 2017, the majority of NOS flows were being diverted to the ECIS at Mission and Jesse to reduce flows to the NOS Sewer Rehabilitation Units 2 and 5 projects occurring downstream in the South Los Angeles area. In addition, the major collapse on the NOS in July 2017 near Mission and 6th forced upstream flows to be diverted to NEIS at Humboldt and to ECIS at the Mission and Jesse diversion structure. There were increased odor complaints during the emergency NOS repairs. The emergency construction project necessitated the need for additional odor control such as air treatment and chemical addition.

To address odor issues along this portion of the NOS and NEIS, there are existing odor control facilities and mechanisms along the major sewers. They include a magnesium hydroxide chemical addition facility, two carbon scrubbers (Humboldt and Richmond), the Mission and Jesse air treatment facility, and trap maintenance holes on local sewers connected to the NOS. House connection traps on properties connected directly to the NOS were monitored with data logging instruments which measure sewer air pressure and hydrogen sulfide (H₂S).

MONITORING LOCATIONS-2017

Table 5.1.1 shows the list of maintenance holes tested along the East NOS/NEIS/ECIS Corridor from LAGWRP to the Enterprise Siphon at the Los Angeles River. Figure 8.1 displays a map of these locations.

ID	LOCATION	MH NO.	SEWER	JUSTIFICATION
1	4234 Elmer Avenue	443-06-135	NOS	Between Radford Siphon and NOS/VORS Diversion Structure @ Acama
2	10303 Valley Spring Lane	443-07-192	NOS	Between NOS/VORS Diversion Structure & Valley Spring Lane/Forman Diversion Str.
3	Valley Heart and Morningside Dr.	444-02-003	NOS	Upstream of Mariposa Siphon
4	Zoo Drive and Forest Lawn	444-03-004	NOS	Between Mariposa Siphon & Doran Siphon
5	Brazil St e/o San Fernando West	445-06-002	NOS	Between Doran Siphon & u/s of LAGWRP
6	Veselich Ave. sw/o Garden	468-02-027	NOS	Between LAGWRP & Los Feliz Blvd.
7	Fletcher / 2 Fwy	468-11-045	NOS	Siphon Pressure Effect
8	Blake & Oros	495-05-024	NOS	Slope Reduction
9	Mission & 6th	515-09-154	NOS	Drop Structure & Junction Structure Effect
10	Mission & 7 th Street	515-13-001	NOS	Drop Structure & Siphon Pressure Effect
11	Mission u/s Enterprise Siphon	515-13-003	NOS	Siphon Pressure Effect
12	Mission & Kearney	515-05-288	NEIS	Deep Tunnel Effect
13	Avenue 21 @ terminus	495-14-241	NEIS	Deep Tunnel Effect
14	NEIS @ Home Depot	495-14-144	NEIS	Deep Tunnel Effect
15	ERIS 48" drop to NEIS	468-12-156	ERIS/NEIS	Upstream of Drop Structure
16	66" drop to NEIS @ Humboldt	495-09-108	NOS/NEIS	Upstream of Drop Structure

MONITORING RESULTS AND ANALYSIS

Table 5.1.2 shows the sewer air pressure and/or H₂S monitoring results at the designated maintenance holes along the eastern corridor of the NOS/NEIS/ECIS. Where available, a comparison of air pressure results for the last two years and current year average H₂S monitoring is provided.

Table 5.1.2 - East NOS/NEIS/ECIS Corridor Monitoring Results							
ID	LOCATION	MH NO.	SEWER	Avg. Sewer Air Pressure (in. w.c.)			Avg. Hydrogen Sulfide (ppm)
				2017	2016	2015	Avg./High
1	Elmer & Acama	443-06-135	NOS	-0.11	-	-	22/35
2	Valley Spring Lane & Arcola	443-07-192	NOS	-0.14	-	-	3/6
3	Valley Heart and Morningside Dr.	444-02-003	NOS	0.06	-	-	4/19
4	Zoo Drive and Forest Lawn	444-03-004	NOS	0.05	-	-	-
5	Brazil St e/o San Fernando West	445-06-002	NOS	-0.06	-	-	10/34
6	Veselich Ave. sw/o Garden	468-02-027	NOS	0.12	-	0.13	5/36
7	Fletcher / 2 Fwy	468-11-045	NOS	0.13	0.28	0.13	2/14
8	Blake & Oros	495-05-024	NOS	-0.11	0.04	0.03	22/84
9	Mission & 6th	515-09-154	NOS	-0.04	0.33	0.33	219/349
10	Mission & 7 th Street	515-13-001	NOS	0.00	0.45	0.41	1/69
11	Mission u/s Enterprise Siphon	515-13-003	NOS	0.05	0.35	0.20	3/104
12	Mission & Kearney	515-05-288	NEIS	0.32	0.65	0.66	1/3
13	Avenue 21 @ terminus	495-14-241	NEIS	0.29	-	-	0/0
14	NEIS @ Home Depot	495-14-144	NEIS	0.24	-	-	0/0
15	ERIS 48" drop to NEIS	468-12-156	ERIS/NEIS	-0.49	-	-	-
16	66" drop to NEIS @ Humboldt	495-09-108	NOS/NEIS	-0.73	-	-	-

DISCUSSION AND ANALYSIS

Due to the aging of the NOS, odor testing was extended to include locations between Toluca lake area and LAGWRP. These central areas along the NOS included two locations: 4234 Elmer Ave. and 10303 Valley Spring lane. Collected data showed negative pressure and relatively moderate H₂S levels.

The eastern corridor of the NOS in the Atwater Village between LAGWRP and the Fletcher/Gilroy Siphon had a minimal odor complaints in comparison to past years. Although it was anticipated that sewer pressures would remain high due to the siphon back pressure effect from the Gilroy siphon, the implementation of odor control measures addressed the odor affecting the community. On average, sewer pressure ranged from 0.28 inches water column (in. w.c.) from the Fletcher/Gilroy Siphon to 0.04 in. w.c. just south of LAGWRP, respectively. The Fletcher/Gilroy siphon does not have an airline at the siphon to convey air downstream. The odor control measures implemented over the past few years include the installation of house connection gas traps on homes directly connected to the NOS, the installation and/or upgrade of trap maintenance holes on local sewers connected to the NOS, and sealing maintenance holes. The application of magnesium hydroxide, which started in July 2013, continues on the NOS from the LAGWRP to control sewer gas concentrations in the NOS.

Further downstream of the Fletcher/Gilroy Siphon, trap maintenance holes were constructed on local sewers just upstream of the NOS slope reduction at the LA River near Blake and Oros. Average sewer pressures along this portion of the NOS are either negative or about atmospheric levels with average H₂S at 22 ppm.

The NOS at the NOS/NEIS Humboldt Diversion Structure is not affected by the diversion of flow to the NEIS. This is indicated by the air pressures at Barranca and Avenue 18 on the NOS. The diurnal pressure measured at this location is an average of -0.08 in. w.c. The diversion of the NOS to NEIS shows that air is being pulled down the NEIS drop structure at Humboldt. The 10,000 cfm Humboldt carbon scrubber is located at this drop structure. This scrubber was running passively for the majority of time. However on May 20, 2016 this scrubber was turned on at its maximum capacity of 10,000 cfm in an effort to ventilate the high pressure and reduce odor in NOS near Mission and 6th.

The southerly area along the eastern NOS/NEIS/ECIS corridor in the Boyle Heights area is between the Mission & Kearny and the Enterprise Siphon. At this location lie the NOS/NEIS/ECIS diversion structure, the 12,000 cfm Mission and Jesse Air Treatment Facility (ATF) and the Enterprise Siphon. Significant air pressurization continues to exist on the NOS. This is where the air pressures and the H₂S levels are highest. The NEIS at Mission and Kearney has an average air pressure of 0.65 in w.c. with air pressure indicated over 1 inch of w.c. at maximum level. Directly upstream of this location is the 10,000 cfm Richmond Carbon scrubber, which is currently operating in the passive mode. The high volume of air in NEIS appears to be transferred to the Mission and Jesse NOS/ECIS drop structure and migrating back to the NOS from the NOS/ECIS diversion structure coupled with the fact that the Enterprise siphon downstream does not have an outlet for the air to get through. This is confirmed from the significant air pressures on the NOS upstream and downstream of the diversion structure, with an

average between 0.33 in. w.c. and 0.45 in. w.c. at Mission and 6th and Mission and 7th, respectively. Furthermore, the Enterprise siphon also contributes to the back pressurization upstream of the siphon due to lack of an airline. The pressures averaged at 0.35 in. w.c. and the H₂S levels were 200 ppm max with an average of 89 ppm. The high H₂S at this location is due to a lack of flow velocity in the Enterprise Siphon creating septic conditions and significant H₂S generation to address the high ventilation pressures. Several attempts were made to the Mission and Jesse ATF dampers to increase flow from NOS. The latest damper adjustments were made to open the dampers for NOS to a fully open position while the damper for ECIS was placed at fully closed position to mitigate the high level of odor in this area.

EMERGENCY WORK AT NOS COLLAPSE

On July 18, 2016, part of NOS along Mission Road, under the 6th Street Bridge, collapsed. An emergency contractor was assigned to repair this collapsed section. After several days, 3 other locations along the Mission road also collapsed up-stream of the NOS/ECIS Diversion Structure, causing a large sewage spill in this area. As an effort to control the spill, and repair the collapsed pipes several by-passes were installed to by-pass the NOS and other local sewers from Mission & 6th to the ECIS after NOS/ECIS diversion structure.

Due to several by-passes and diversions implemented during the repair work at these collapses, the dampers for Mission and Jesse ATF was adjusted several times to control the pressure and odor in this area during emergency repair work.

MITIGATIVE MEASURES

Followings steps were aggressively implemented to alleviate the foul odor:

- Reinstalled “Air Curtain” on NOS/ECIS diversion to block foul air from the deep tunnel back to a shallower NOS.
- Adjusted ATF dampers to be fully closed for the ECIS and a 100% open for the NOS
- Activated the 10,000 CFM Humboldt scrubber.
- A 10,000 CFM “Emergency scrubber” was installed at Mission and 6th, approximately 500 yards upstream from the Mission & Jesse ATF.
- A new “Air Curtain” was fabricated and installed on the local tributary sewer line along the 6th St. to block back pressure from the NOS.
- To address the high H₂S conditions on the NOS, thioguard (magnesium hydroxide) dose at the LAGWRP was increased to control the H₂S.
- New thioguard (magnesium hydroxide) addition is being pilot tested from Valley Blvd relief sewer to NOS for H₂S control.

The combination of all these measures resulted in creating negative pressure readings in the area.

CONCLUSIONS

The odor complaints along the NOS in the Atwater Village to Barranca and Avenue 18 have been significantly reduced and remained stable for the past two years by effectively

implementing odor control measures. However, downstream in the area of Mission and Kearny to Enterprise Siphon, air pressurization and high H₂S levels are occurring due to ventilation from the NOS/ECIS drop structure and back pressurization from the Enterprise Siphon which does not have an air jumper. Existing hydraulic conditions along the eastern NOS/NEIS/ECIS corridor are contributing to the significant air pressure and high H₂S occurring in the area of Mission and Jesse. Although the Mission and Jesse ATF is currently in operation, further studies will need to be performed after hydraulic conditions are restored back to original conditions along the NOS to determine if ventilation and H₂S conditions will be effected.

This reach along the NOS that starts from Mission and Kearny to Mission and Jesse ATF and the NOS towards the Enterprise Siphon will be closely monitored to alleviate the current ventilation issues.

RECOMMENDATIONS

- Continue to monitor pressure and hydrogen sulfide levels on an annual basis
- Continue to implement current odor control measures. However, determine the need for other methods including chemical addition and/or increased air treatment
- Evaluate the sewer system condition after flows have been restored back to the original configuration prior to the NOS Rehabilitation Units 2 and 5
- Evaluate air flow dynamics after the air curtain is re-installed at the Mission and Jesse NOS/ECIS diversion
- Evaluate air flow dynamics by manipulating sewage flow throughout the various diversion structures
- Determine the best hydraulic use of the Mission and Jesse
- Evaluate long term hydraulic rest for the Enterprise Siphon
- Evaluate the need for an additional carbon scrubber and/or activate the passive carbon scrubber at Richmond Avenue

5.2 AOC-2 - La Cienega/San Fernando Corridor - 2017

INTRODUCTION

This section provides a discussion and analysis of the sewer ventilation and the hydrogen sulfide characteristics that may contribute to collection system odors within the area of concern-2 on the major sewers along the La Cienega/San Fernando Corridor which include the La Cienega San Fernando Valley Relief Sewer (LCSFVRS), La Cienega Interceptor Sewer (LCIS) and West Hollywood Interceptor Sewer (WHIS). The upper portion of AOC-2 begins on the LCSFVRS at Valley Spring Lane Forman diversion structure. The lower portion of AOC-2 ends at Jefferson and Rodeo Rd. where the LCIS and LCSFVRS joins with the lower NOS. The LCSFVRS was constructed to relieve the NOS at the lower end of the San Fernando Valley and travels south through the Santa Monica Mountains to the West Hollywood area. The sewer continues south and travels through the Genesee Siphon and connects with the NOS near the intersection of Rodeo Road and Jefferson Boulevard in Baldwin Hills. The LCSFVRS can be diverted to the East Central Interceptor Sewer (ECIS) at Jefferson and La Cienega. The Wilshire- Hollywood Interceptor Sewer (WHIS), which conveys flow for the Wilshire/Hollywood area, is tributary to

the LCSFVRS at Washington and Fairfax. The LCIS begins at the intersection of Melrose and Alta Vista where it receives flows from the West Hollywood area. LCIS travels south and connects to the NOS near Rodeo and Jefferson. Along this route are two siphons, the Stearns Siphon, consisting of two 33-inch diameter pipes and the Burchard siphon, a 45-inch single barrel pipe. Additionally, the LCIS can be diverted to the LCSFVRS at the Clinton/Poinsettia diversion structure on the upper segment and at the Blackwelder diversion structure on the lower segment.

To address odor issues along the La Cienega/San Fernando Corridor several odor control measures have been implemented to address the historical odors stemming from sewer ventilation issues caused by severe slope changes, siphon back pressurization, and large diameter sewer air dynamics. Two carbon scrubbers operating on the LCSFVRS are the 10,000 cfm Sierra Bonita scrubber on the upper reach and the 5000 cfm Genesee scrubber on the lower reach at the Genesee Siphon. Further south, the 20,000 cfm La Cienega and Jefferson Air Treatment Facility pulls air from LCSFVRS and ECIS. A chemical addition program, implemented since 2005, continues with the injection of magnesium hydroxide on AVORS from the Donald C. Tillman Water Reclamation Plant (DCTWRP) to reduce hydrogen sulfide generation downstream from DCTWRP to the LCSFVRS.

MONITORING LOCATIONS

Table 5.2.1 shows the list of maintenance holes tested along the La Cienega/San Fernando Corridor.

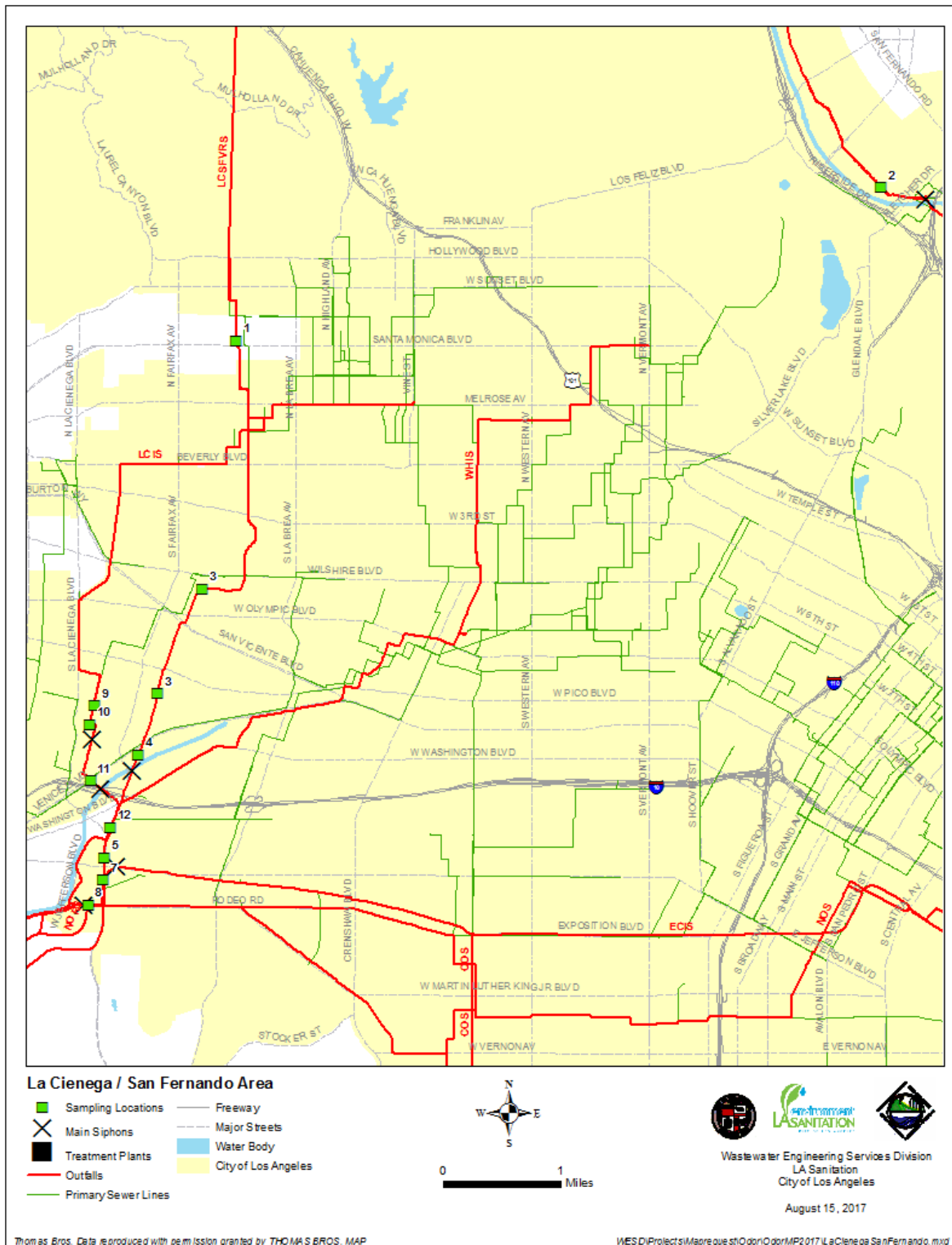
Table 5.2.1 – La Cienega/San Fernando Corridor Monitoring Locations				
ID	LOCATION	MH NO.	SEWER	JUSTIFICATION
1	Gardner n/o Santa Monica	492-04-109	LCSFVRS	Slope Reduction
2	Hauser and 3rd	468-11-026	LCSFVRS	Pipe Ventilation Drag
3	8th and Spaulding	518-03-209	LCSFVRS	Pipe Bend
4	1500 Genesee n/o Pickford	518-07-165	LCSFVRS	Siphon Pressure Effect
5	Genesee and Venice u/s Siphon	518-10-137	LCSFVRS	Siphon Pressure Effect
6	La Cienega n/o Jefferson (KLOS)	535-02-024	LCSFVRS	Pipe Ventilation Drag
7	La Cienega (See's Candy)	535-02-052	LCSFVRS	Upstream of Diversion Structure
8	Rodeo and Kalsman	535-02-089	LCSFVRS	Pipe Bend
9	Crescent Hts and Airdrome	518-06-235	LCIS	Pipe Diameter Change
10	18th and Crescent	518-10-247	LCIS	Pipe Bend and Siphon Pressure Effect
11	Burchard and Venice	518-10-199	LCIS	Siphon Pressure Effect
12	Fairfax and Smiley	518-14-122	LCIS	Upstream of Diversion Structure
13	Washington w/o Curson Ave	518-15-003	WHIS	Pipe Ventilation Drag & Diversion Effect

MONITORING RESULTS AND ANALYSIS

Table 5.2.2 shows the sewer air pressure and/or H₂S monitoring results at the designated maintenance holes along the eastern corridor of the LCSFVRS/LCIS/WHIS corridor.

* Indicates a handheld measurement.

Table 5.2.2 - La Cienega/San Fernando Corridor Monitoring Results							
ID	LOCATION	MH NO.	SEWER	Avg. Sewer Air Pressure (in. w.c.)			Avg. Hydrogen Sulfide (ppm)
				2017	2016	2015	Ave./High
1	Gardner n/o Santa Monica	492-04-109	LCSFVRS	-0.05	-0.28	-0.17	12/58
2	3rd and Hauser	468-11-026	LCSFVRS	0.04	-0.02	0.06	-
3	8th and Spaulding	518-03-209	LCSFVRS	-0.06	-0.10	0.05	2/21
4	1500 Genesee n/o Pickford	518-07-165	LCSFVRS	0.03	0.05	0.09	2/23
5	Genesee & Venice u/s Siphon	518-10-137	LCSFVRS	0.28	0.10	0.21	1/20
6	La Cienega n/o Jefferson	535-02-024	LCSFVRS	-0.15	0.08	0.13	1/7
7	La Cienega (See's Candy)	535-02-052	LCSFVRS	-0.18	0.10	-	5/13
8	Rodeo and Kalsman	535-02-089	LCSFVRS	0.01	0.01	-	4/16
9	Crescent Hts and Airdrome*	518-06-235	LCIS	0.00*	0.00	-	-
10	18th and Crescent*	518-10-247	LCIS	-0.02*	0.00	0.02	0/2
11	Burchard and Venice*	518-10-199	LCIS	-0.02*	0.03	0.21	13/32
12	Fairfax and Smiley	518-14-122	LCIS	-0.03	0.07	0.07	9/18
13	Washington w/o Curson Ave	518-15-003	WHIS	0.00*	0.00	-	11/26



DISCUSSION AND ANALYSIS

The LCSFVRS can be divided into an upper reach and lower reach in terms of odor and ventilation issues. The upper reach, which ends at 3rd and Hauser, is influenced by the significant slope and grade change of the LCSFVRS. Air is dragged into the steeply sloped LCSFVRS from the Valley Spring Lane and Foreman diversion structure as it travels through the Hollywood Hills. As flows reach the bottom of the Hollywood Hills, the sewer slope flattens causing a hydraulic jump; wastewater velocity decreases due to a flattening of the sewer slope and consequently causes air ejection and odor release. The upper reach average air pressures ranged from -0.05 in. w.c. at Santa Monica and Gardner to -0.06 inches at 8th and Spaulding. This area is treated by the 10,000 cfm Sierra Bonita scrubber. The addition of this scrubber significantly improved the ventilation issues caused by the pipe slope changes on the LCSFVRS. H₂S levels are 12 ppm average with a high close to 58 ppm. Odor complaints have subsided since the operation of the Sierra Bonita scrubber.

The lower reach is influenced by air continuously being dragged with the flow until it reaches the Genesee siphon. The Genesee siphon is not capable of conveying the air passed the siphon. Consequently air back pressure increased and impacted the area upstream of the siphon. The zone of influence caused by back pressurization reaches several miles with an average positive pressure of 0.18 in-wc. The positive ventilation at the MH just upstream of the siphon was recorded to reach 0.50 in-wc.

Currently the 5,000 cfm Genesee scrubber treats the air to address this issue. However this scrubber has reached the end of its life cycle and is slated for replacement and upgrade to a 10,000 cfm unit. The proposed carbon scrubber for this site will be using a new all-around flow carbon scrubber recently pilot tested at the Hyperion Water Reclamation Treatment Plant. Results showed a significantly longer carbon life at bench scale pilot testing compared to the vertical flow configuration. The new carbon vessel design utilizes larger surface area with smaller foot print and capability to separate the moisture from inlet air stream which results in longer carbon life.

The air downstream of the Genesee siphon, the tributary sewers, LCIS, WHIS, and a diversion structure that share headspace with the East Central Interceptor Sewer (ECIS) contribute to the air migrating to the LCSFVRS. Air pressures along the lower segment of the LCSFVRS range from -0.15 in. w.c. to 0.01 in. w.c. between La Cienega and Jefferson and Rodeo and Kalsman. This segment is treated by the 20,000 cfm ECIS ATF located at Jefferson and La Cienega Blvd. Approximately, 8000 cfm of the LCSFVRS and 12,000 cfm of the ECIS is treated by ATF.

The LCIS is affected by the confluence of the LCIS/LCSFVRS at the diversion structure at Clinton and Poinsettia. Air from the LCSFVRS migrates to the LCIS at this junction. Downstream on the LCIS, the Stearns siphon and the Burchard siphon contribute to the backpressure issues. As the flow continues downstream, the LCIS shares headspace with the LCSFVRS at the Blackwelder Diversion Structure. The air pressure in the lower reaches ranged from 0.00 in. w.c. to 0.10 in. w.c. respectively. The ongoing rehabilitation of the LCIS in FY 2016/17 through FY 2018/19 will improve the hydraulics in the system and therefore will

improve air dynamics. In addition, 48 direct house connections to the LCIS will be isolated to minimize odor migration to properties connected directly to the LCIS.

The WHIS is influenced by the junction to the LCSFVRS at Washington and Fairfax. The WHIS shares headspace with the LCSFVRS where air can migrate to the WHIS. The pressure on the WHIS is 0.00 in. w.c. measure with hand held instrument.

CONCLUSIONS

The majority of odor pressures were clustered along the lower reaches of the LCSFVRS upstream of the siphon. The siphon back pressure effect and the aging and decreased effectiveness of the Genesee scrubber contribute to the odor ventilation issues seen in this area. The planned replacement and upgrade of the Genesee scrubber in FY 2017/18 from 5000 cfm to 10,000 cfm will address the on-going ventilation issues in this area. In the interim, pressure levels will continue to be monitored. H₂S levels have been relatively low and steady due to the on-going addition of magnesium hydroxide to the collection system. The odor complaints along the upper portions of the LCSFVRS, LCIS and WHIS were relatively light due to the on-going odor control measures implemented. The operation of the 10,000 cfm Sierra Bonita scrubber has significantly improved the air dynamics in the upper reaches.

RECOMMENDATIONS

- Continue to monitor and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor the H₂S levels to evaluate the effectiveness of magnesium hydroxide addition for the collection system odor control on an annual basis
- Continue to seal all maintenance holes where needed in the area to minimize odor release
- Continue to implement on-going odor control measures
- Reevaluate the system after the planned carbon scrubber upgrades
- Monitor the performance of the Genesee carbon scrubber after the new carbon design system is installed to confirm unit performance and estimated carbon life at 10,000 cfm
- Evaluate the flow dynamics of the LCIS after the rehabilitation is complete

5.3 AOC-3 - South Los Angeles Area - NOS/Maze-ECIS-SLAIS-2017

INTRODUCTION

This section provides a discussion and analysis of the sewer ventilation and hydrogen sulfide characteristics that may contribute to collection system odors on the major sewers in the South Los Angeles Area. This area involves a very complex system of large diameter sewers that are interconnected through junction and diversion structures. Sewers have relatively flat slopes and the highest cluster of trap maintenance holes is located in this area. The alignment of the NOS known as the “Maze” has been historically an odor hot spot. The addition of the East Central Interceptor Sewer (ECIS) has relieved capacity on the NOS, improving the hydraulic conditions and thus improving ventilation. However, the drought conditions and the mandatory water use restrictions have created another challenge. Due to low water use, sewer flows have significantly decreased causing increased odor generation. The lower flow velocities caused by flat sewers and the gradual build-up of deposition in the pipe creates a higher potential for hydrogen sulfide

generation. The H₂S level in this area has increased and as a result, this area continues to be an area of concern.

The South Branch of the Maze/NOS picks up flow from the South LA Interceptor Sewers (SLAIS), namely the Florence Avenue Sewer, 74th Street Sewer and Slauson Avenue Sewer. The South Branch runs along Martin Luther King (MLK) to Rodeo Road where it intersects the North Branch of the NOS. The North Branch receives flow mainly from the NOS along 41st Place which conveys the flows from the Boyle Heights and East Los Angeles Area at 41st Place and Trinity. Most of the sewers that feed into the Maze South Branch have very flat slopes and barely meet the minimum 3 ft/sec scouring velocity. In this condition, sewers build up with debris and the system becomes anaerobic, resulting in increased H₂S production. The mandated water restrictions have exacerbated this process. To address ventilation occurring in the Maze area, a 5000 cfm carbon scrubber operates at the junction of the North and South Branch at the intersection of Rodeo Road and Martin Luther King (MLK). This scrubber has exceeded its operational life and is experiencing reduced performance. As a result, the carbon scrubber is in the process of being replaced for FY 2016/17. Currently this project is scheduled to be completed by the end of 2017. To address the H₂S generation occurring upstream in the South LA Interceptor Sewers, caustic shock dosing is conducted to control odors.

MONITORING LOCATIONS

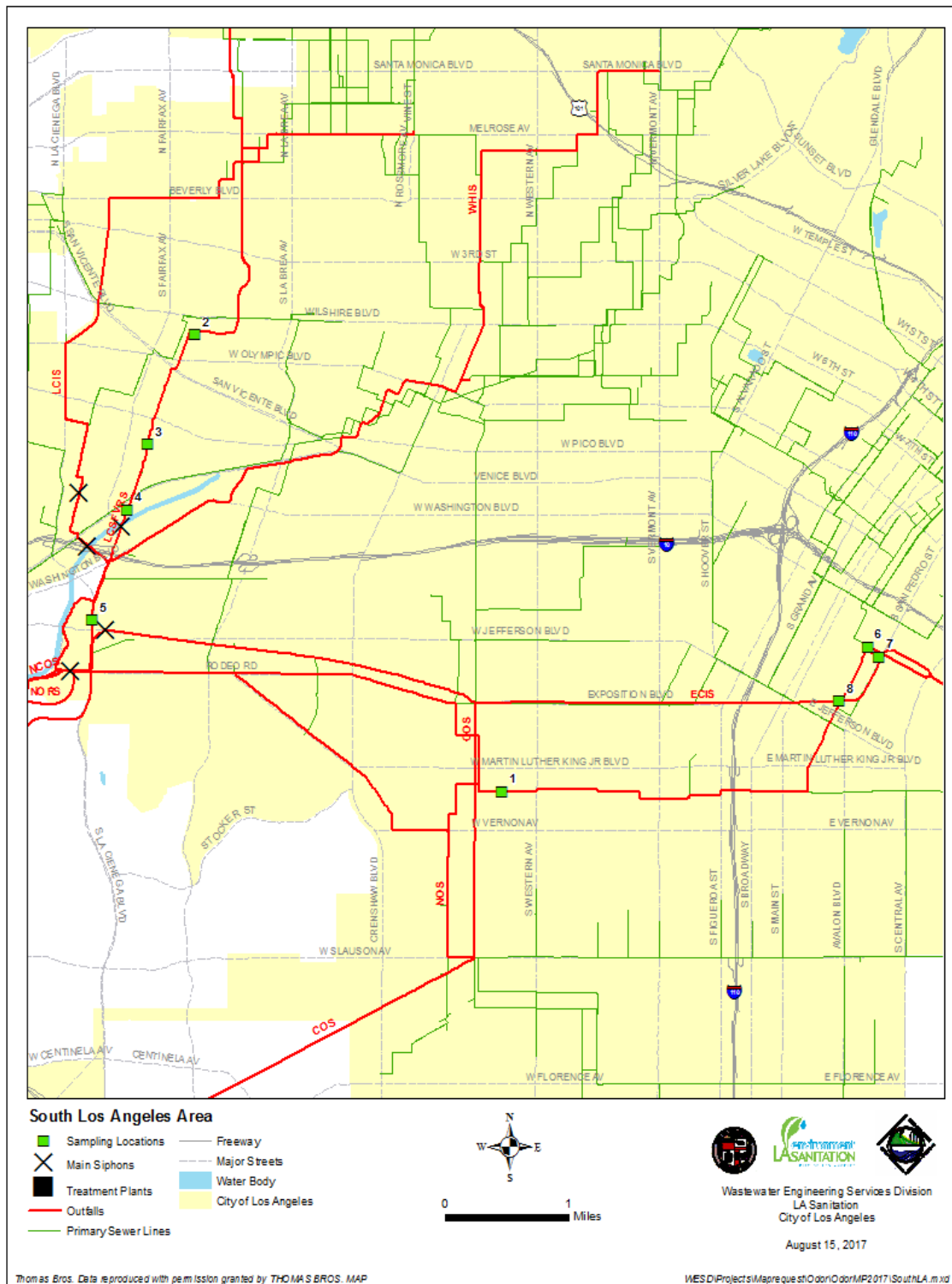
Table 5.3.1 shows the list of maintenance holes tested along South LA-NOS/Maze areas.

Table 5.3.1 – South Los Angeles Monitoring Locations				
ID	LOCATION	MH NO.	SEWER	JUSTIFICATION
1	41st Pl and Gramecy	536-10-118	NOS	Junction/Bend
2	Rodeo and Grayburn	518-03-029	Maze No Branch	Pipe Ventilation Drag
3	MLK and Somerset	518-07-165	Maze So Branch	Pipe Ventilation Drag
4	Rodeo and MLK	518-10-137	Maze Junction	Junction
5	Rodeo and Cochran	535-02-024	Maze/NCOS	Pipe Ventilation Drag
6	23 rd and San Pedro	537-02-084	CBD/NOS	CBD Junction to NOS
7	Alley @ 23 rd and San Pedro	537-03-199	NOS drop to ECIS	Drop Structure
8	31 st . St and Trinity	537-06-178	ECIS	Tunnel Pressure

MONITORING RESULTS AND ANALYSIS

Table 5.3.2 shows the sewer air pressure and/or the H₂S monitoring results at the designated maintenance holes in South Los Angeles area. Where available, a comparison of average air pressure results for the last two years against the current year, and the H₂S monitoring results for the current year are provided.

Table 5.3.2 - South Los Angeles Monitoring Results							
ID	LOCATION	MH NO.	SEWER	Avg. Sewer Air Pressure (in. w.c.)			Avg. Hydrogen Sulfide (ppm)
				2017	2016	2015	Ave./High
1	41st Pl and Gramercy	536-10-118	NOS	-0.17	-002	-	43/93
2	Rodeo and Grayburn	518-03-029	Maze Branch No	0.12	0.07	0.03	35/116
3	MLK and Somerset	518-07-165	Maze Branch So	0.01	0.06	0.02	142/235
4	Rodeo and MLK	518-10-137	Maze Junction	-0.15	0.07	0.05	100/247
5	Rodeo and Cochran	535-02-024	Maze/NCOS	0.01	0.06	0.06	59/126
6	23 rd and San Pedro	537-02-084	CBD/NOS	-0.13	-	-	-
7	Alley @ 23 rd and San Pedro	537-03-199	NOS drop to ECIS	-0.21	-	-	-
8	31 st St. @ Trinity	537-06-178	ECIS	0.30	-	-	-



DISCUSSION AND ANALYSIS

The odor complaints in the South Los Angeles area have significantly decreased this year compared to last year. This decrease is attributed to the low positive pressure levels in the sewer system although high H₂S concentration levels were recorded. The drought conditions and the mandatory water use restrictions have caused wastewater flows to decrease. A gradual build-up of sewer debris caused by flat sewers and lower flow velocities has created an ideal condition for the H₂S production in higher concentrations.

The H₂S levels in the approaching NOS and upstream of the Maze area remained unchanged averaging 200 ppm. Currently, rehabilitation projects for the NOS upstream of the Maze are in the final stage of completion (units 2 and 5). The projects will result in reduced odor generation due to improved wastewater flows. The North Maze area sewers had H₂S levels ranging from 43 ppm average to 100 ppm compared to 110 ppm to 317 ppm in 2016. The South Branch of the Maze had high levels of H₂S at 127 ppm compared to 180 ppm in 2016. Flows tributary to the South Branch are from the very flat sewers with a history of significant debris deposition issues. Odor control activities continue on tributary sewers. The tributary sewers to the South Branch are the 74th Street Sewer, Florence Ave Sewer and Slauson Avenue Sewer. Caustic shock dosing to control H₂S generation is performed weekly on the 74th Street Sewer and Florence Ave Sewer. Chemical pilot testing to evaluate new technologies is being planned in early 2018 to evaluate other odor control measures.

The rehabilitation project for Slauson Ave Sewer is currently in progress. This project is scheduled to be completed by May 2018. Shock dosing is continuing on the Hollywood Main Sewer as it has been since October 2015. The Maze North Branch has developed septic conditions due to the flat pipe slope. The 5000 cfm Martin Luther King (MLK) Carbon Scrubber at MLK and Rodeo will address the ventilation issues along the North and South Branch of the Maze. Florence Sewer and Slauson Sewer are currently undergoing construction and sewer rehabilitation. Once completed, the new sewer construction will improve sewer hydraulics and help reduce odor generation. The sewer construction is scheduled to be completed in May 2018 and December 2018 respectively. The 74th sewer rehabilitation will begin August 2018.

CONCLUSIONS

The odor complaints have decreased along the North and South Branch of the Maze due to decreased ventilation problems, even though the data shows increased hydrogen sulfide concentrations. The increased hydrogen sulfide concentrations are due to the water conservation efforts mandated by the drought conditions. The replacement and upgrade of the MLK scrubber in 2017 will address the on-going ventilation issues in this area. In the interim, pressure levels and H₂S levels will continue to be monitored. Caustic Shock Dosing activities will be evaluated to determine if more frequent dosing is required. Trap maintenance holes will continue to be cleaned and inspected on a quarterly basis to prevent odor migration. The continuing large diameter sewer cleaning program will also aid in addressing odors generating in the sewers.

RECOMMENDATIONS

- Continue to monitor and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor H₂S levels on an annual basis to evaluate the effectiveness of caustic shock dosing
- Continue to seal all maintenance holes where needed in the area to minimize odor release
- Continue to implement on-going odor control measures
- Reevaluate the system after the planned CIP improvements, including Martin Luther King (MLK) carbon scrubber replacement, NOS, Slauson Sewer rehabilitation and Florence Ave. rehabilitation.

5.4 AOC-4 - Baldwin Hills/Culver City - NORS-ECIS-NOS-NCOS-WLAIS-WRS-2017

INTRODUCTION

This section provides a discussion and analysis of the sewer ventilation and hydrogen sulfide characteristics that may contribute to collection system odors in the major sewers in the Baldwin Hills/Culver City. This area involves a very complex system of large diameter sewers that are interconnected through junctions and diversion structures. The sewers include the North Outfall Replacement Sewer (NORS), East Central Interceptor Sewer (ECIS), North Outfall Sewer (NOS), North Central Outfall Sewer (NCOS), West Los Angeles Interceptor Sewer (WLAIS) and Westwood Relief Sewer (WRS). The NORS, NOS, and NCOS have siphons and air lines that contribute to the air dynamics that characterize this system. However, due to high volume of air moving into this system, the airlines are unable to adequately convey air downstream past the siphon, thus causing back pressurization. The mile-long NORS siphon that extends underneath the 405 freeway is 150-inch with only four 18-inch inverted air lines along the crown/soffit of the pipe beginning at Green Valley Cir and Buckingham Pkwy. The NCOS has 2 siphons including a 90-inch with 36-inch inverted airline on the upstream at Jefferson and Lenawee and a 102-inch siphon with 48-inch inverted airline at Green Valley Cir and Bristol Pkwy on the downstream. The NOS has a 3-barrel, 78-inch siphon with a 42-inch airline at Fox Hills Drive and Green Valley Circle connecting to the NCOS Siphon Inlet at Green Valley Cir and Bristol Pkwy.

Historically, NORS has been the source of significant pressurization due to the undersized air lines at the NORS siphon. The interconnections of NORS with the major outfall sewers including the NOS, NCOS, WLAIS, WRS and ECIS have allowed air to migrate and travel to the upstream sewers. However, various odor control elements to control and manage the air migration have resulted in improved air dynamics in the Baldwin Hills/Culver City area. These elements include: wastewater flow management, balancing of flows between the NORS and the NOS, utilizing air curtains at the NORS diversion structures 1, 2, and 3 to control and isolate the NORS headspace from the other interconnecting sewers, operation of carbon scrubbers, which include the 10,000 cfm NORS/ECIS and 10,000 cfm North Outfall Treatment Facility (NOTF) and the 12,000 cfs NCOS Air Treatment Facility (ATF). The NORS/ECIS carbon scrubber addresses the ventilation issues at the NORS/ECIS junction. However this scrubber has reached the end of its life cycle and is currently under construction and scheduled to be completed by the end of 2017. The 10,000 cfm NOTF scrubber treats the WLAIS/WRS/NOS junction. The

12,000 cfs NCOS ATF treats air from the South LA sewer systems and addresses the high pressure caused by the NCOS siphon at Jefferson and Lenawee.

MONITORING LOCATIONS

Table 5.4.1 shows the list of maintenance holes tested in the Baldwin Hills/Culver City area. NOTF

Table 5.4.1 - Baldwin Hills/Culver City Monitoring Locations				
ID	LOCATION	MH NO.	SEWER	JUSTIFICATION
1	NORS/ECIS Junction	535-09-022	NORS/ECIS	Junction
2	La Cienega and Aladdin	535-06-116	ECIS	Tunnel Effect
3	Bristol Pkwy and Hannum	559-05-006	NORS	Siphon Pressure Effect
4	Culver City park	535-05-021	NORS	Pipe Ventilation Drag
5	West LA College	535-13-800	NOS	Pipe Ventilation Drag
6	Fox Hills Mall u/s Siphon	559-05-800	NOS	Siphon Pressure Effect
7	La Cienega and Rodeo	535-02-090	NCOS	Siphon Pressure Effect
8	Green Valley Cir and Bristol Pkwy	559-05-005	NCOS	Siphon Pressure Effect
9	Farragut and Le Bourget	534-08-044	WLAIS	Upstream of Diversion Structure
10	4100 Jackson Ave	534-08-042	WRS	Upstream of Diversion Structure

MONITORING RESULTS AND ANALYSIS

Table 5.4.2 shows the sewer air pressure and/or H₂S monitoring results at the designated maintenance holes in the Baldwin Hill/Culver City area.

Table 5.4.2 - Baldwin Hill/Culver City Monitoring Results							
ID	LOCATION	MH NO.	SEWER	Avg. Sewer Air Pressure (in. w.c.)			Avg. Hydrogen Sulfide (ppm)
				2017	2016	2015	Ave./High
1	NORS/ECIS Junction	535-09-022	NORS/ECIS	0.11	0.21	0.37	28/73
2	La Cienega and Aladdin	535-06-116	ECIS	0.12	-	-	-
3	Bristol Pkwy and Hannum	559-05-006	NORS	0.11	0.15	0.45	22/81
4	Culver City park	535-05-021	NORS	0.03	0.02	-	-
5	West LA College	535-13-800	NOS	-0.11	0.05	0.25	6/20
6	Fox Hills Mall u/s Siphon	559-05-800	NOS	0.09	-0.05	0.22	35/66

7	La Cienega & Rodeo	535-02-090	NCOS	-0.18	0.04	0.19	-
8	Green Valley Cir and Bristol Pkwy	559-05-005	NCOS	-0.12	-0.23	-0.17	37/98
9	Farragut and Le Bourget	534-08-044	WLAI	-0.11	0.00	0.17	8/27
10	4100 Jackson Ave	534-08-042	WRS	-0.04	0.04	0.20	3/11

DISCUSSION AND ANALYSIS

The Baldwin Hills/Culver City area has experienced a decrease in the average pressures. Average H₂S concentrations also experienced a decrease. H₂S ranges from 22 ppm to 38 ppm. The NCOS and the NOS had the highest levels.

Air treatment is the primary odor control component for the Baldwin Hills/Culver City area. Air pressures are fluctuating due to the 10,000 cfm NORS/ECIS scrubber reaching its useful life cycle resulting in decreased performance. The NORS is the highest pressurized sewer. Average pressures are ranging from 0.11 to high 0.50 in. w.c. The 10,000 cfm North Outfall Treatment Facility carbon scrubber (NOTF) treats the WLAIS, WRS and NOS. This scrubber is performing well under its current condition. The NOS pressure is averaging between - 0.11 to 0.09 in. w.c., but it can reach as high as 0.23 in. w.c. The WLAIS and WRS are both tributary to the NOS. Average pressures ranging from -0.11 to 0.04 in. w.c. respectively. These sewers are treated by the NOTF scrubber. This scrubber is scheduled for upgrade and replacement following the upgrade of Genesee scrubber in September 2019. The capacity of this scrubber is recommended to be increased to 15,000 cfm during the rehab.

The 12,000 NCOS Air Treatment Facility treats the NCOS upstream of the siphon at Jefferson and Lenawee. The pressures in the NCOS are significantly negative, ranging from -0.18 to -0.20 in. w.c. This is a result of reduced flows on the NCOS upon the activation of the East Central Interceptor Sewer and the operation of the 12,000 cfm NCOS ATF. The negative pressures in the NCOS may help to be a possible transfer point for air from the NOS to the NCOS.

Odor complaints are sporadic and minimal in this area due to the aggressive sealing of maintenance holes throughout the entire system. The air curtains installed on the NORS diversion structures have also been effective at controlling the NORS pressure migration.

CONCLUSIONS

H₂S concentrations are on the decline in this part of the collection system.

In addition, air pressures are considered moderate this year due to the 10,000 cfm temporary carbon scrubber at the site of NORS/ECIS junction. Odor complaints from this area have been low due to the effective odor control measures to isolate and control the migration and release of sewer gases, through the use of air curtains and maintenance hole sealing. The planned upgrade and replacement of the carbon scrubbers in the area will improve the increasing ventilation issues in the sewer. The evaluation of odor control chemicals are being planned for the upstream sewers tributary to this area.

RECOMMENDATIONS

- Continue to monitor pressure and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor H₂S levels on an annual basis to evaluate the effectiveness of chemical addition
- Continue to seal all maintenance holes where needed in the area to minimize odor release

- Continue to implement on-going odor control measures
- Reevaluate the system after the planned CIP improvements, including NORS/ECIS carbon scrubber replacement.
- Evaluate the possible transfer of air from the NOS to NCOS to take advantage of the negative (vacuum) air pressures in the NCOS.

5.5 AOC-5 - East Valley Area - AVORS-EVRS-VORS-NHIS-NOS-2017

INTRODUCTION

This section provides a discussion and analysis of the sewer ventilation and hydrogen sulfide characteristics that may contribute to collection system odors in the major sewers in the East Valley Area. The major sewers include the Additional Valley Outfall Relief Sewer (AVORS), East Valley Relief Sewer (EVRS), North Outfall Sewer (NOS), Valley Outfall Relief Sewer (VORS), and North Hollywood Interceptor Sewer (NHIS). The AVORS was installed to provide additional hydraulic relief to the NOS and the VOS pipelines in the east San Fernando Valley. The DC Tillman Water Reclamation Plant (DCTWRP) returns biosolids back to the collection system through the AVORS where it is conveyed to the various downstream systems including the EVRS, and the NOS at the Magnolia and Kester Ave Diversion Structure. EVRS was constructed to relieve flows from the AVORS and the NOS. Flows are routed to the Valley Spring and Foreman diversion structure where it can be routed to the NOS eastward towards the LAGWRP or south towards the LCSFVRS.

The VORS continues in an east to southeasterly direction across the San Fernando Valley and ends at the Acama Street and Vineland diversion structure where it is diverted to the LCSFVRS. The NHIS is a 69 to 78 inch sewer that was built to provide relief to the Cahuenga sewer and to provide an outlet for future sewers in the North Hollywood, Sunland and Tujunga areas. The NHIS ties into the EVRS at Riverside and Cahuenga.

Collection system odor issues are the result of biosolids being returned from the DCTWRP to the collection system which increases the susceptibility for odor generation and potential odor complaints. To address the H₂S concerns, a continuous dosing of magnesium hydroxide is added to the AVORS from the DCTWRP. In addition, the NOS at Radford and Woodbridge is susceptible to air pressurization due to the NOS Radford/Woodbridge siphon. The siphon has two 42-inch and one 18-inch pipes that convey flow under the Tujunga wash. It has no airline to transport sewer air across the siphon and consequently causes air to back up to the NOS. The 5000 cfm Radford scrubber was constructed to address the back pressurization along the NOS. The Radford scrubber has reached its useful life cycle and is scheduled for replacement in Sep 2019 after completion of Genesee carbon scrubber rehab project. Along the same NOS alignment, trap maintenance holes are placed on local sewers tied into the NOS to prevent air from migrating up the local sewers.

MONITORING LOCATIONS

Table 5.5.1 shows the list of maintenance holes tested along the East Valley area.

Table 5.5.1 - East Valley Monitoring Locations				
ID	LOCATION	MH NO.	SEWER	JUSTIFICATION
1	Riverside and Whitsett	442-03-172	EVRS	Siphon Pressure Effect
2	Riverside and Lankershim	443-06-176	EVRS	Pipe Bends
3	Magnolia w/o Lemona	429-15-062	AVORS	Pipe Ventilation Drag
4	Burbank and Kester	429-11-088	VORS	Upstream of Diversion Structure
5	Cahuenga and Huston	443-03-148	NHIS	Pipe Ventilation Drag
6	Sarah & Sunny Slope	442-02-114	NOS	Pipe Ventilation Drag
7	Woodbridge and Laurel Grove	442-08-090	NOS	Siphon Pressure Effect

MONITORING RESULTS AND ANALYSIS

Table 5.5.2 shows the sewer air pressure and/or H₂S monitoring results at the designated maintenance holes in the East Valley area. Where available, a comparison of air pressure results for the last two years and the current year average H₂S monitoring is provided.

Table 5.5.2 - East Valley Monitoring Results							
ID	LOCATION	MH NO.	SEWER	Avg. Sewer Air Pressure (in. w.c.)			Avg. Hydrogen Sulfide (ppm)
				2017	2016	2015	Ave./High
1	Riverside and Whitsett	442-03-172	EVRS	-	0.07	0.12	2/18
2	Riverside and Lankershim	443-06-176	EVRS	0.04	0.22	0.12	2/12
3	Magnolia w/o Lemona	429-15-062	AVORS	0.01	-	-	1/11
4	Burbank and Kester	429-11-088	VORS	0.08	-0.04	0.03	2/8
5	Cahuenga and Huston	443-03-148	NHIS	0.13	0.15	0.17	-
6	Sarah & Sunny Slope	442-02-114	NOS	0.02	-	-	5/11
7	Woodbridge and Laurel Grove	442-08-090	NOS	-0.11	0.04	0.02	5/11

DISCUSSION AND ANALYSIS

The odor complaints were mainly along the EVRS and the NOS. Most complaints were due to ventilation issues. The majority of the maintenance holes are sealed to minimize odor release; however, occasionally the seals break and odors are released.

The highest pressures were measured along the EVRS and the NHIS. EVRS pressures are caused by the siphon back pressure at the Whitsett siphon and the multiple 90 degree bends just downstream of Riverside and Lankershim. The bends cause air to slow down and consequently back-up and build pressure. The resulting pressure has migrated to the nearby interconnecting NHIS where the average pressure was 0.13 in. w.c. The air pressure upstream of the Radford siphon has been controlled by the 5000 cfm Radford carbon scrubber. The NOS air pressures were maintained at an average range of 0.02 in. w.c. The H₂S levels measured were moderate.

The continuous addition of magnesium hydroxide has been beneficial at controlling the H₂S in the area. Further evaluation of the chemical addition program will be made to determine a cost effective method to address the H₂S in the collection system. The section of NOS in this area showed two collapses during this year. The collapses were due to old age of sewer line in this area. Currently this section of NOS is being evaluated to rehab.

CONCLUSIONS

The continuous dosing of the collection system with magnesium hydroxide has controlled the levels of H₂S along EVRS. The NOS upstream of the Radford siphon is being controlled by the Radford scrubber. In addition, trap maintenance holes will continue to be cleaned and inspected on a quarterly basis to prevent odor migration.

RECOMMENDATIONS

- Continue to monitor pressure and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor H₂S levels on an annual basis to evaluate the effectiveness of chemical addition
- Continue to seal all maintenance holes where needed in the area to minimize odor release
- Continue to implement on-going odor control measures
- Reevaluate the system after the planned CIP improvements, including Radford carbon scrubber replacement
- Determine studies to address the H₂S generation from within the Venice Pump Plant force main and the LNOS
- Continue to seal all maintenance holes where needed in the area to minimize odor release
- Conduct H₂S characterization of the outfall sewers entering the HTP

5.6 AOS -1 - West Valley Area-VORS-AVORS-EVIS-2017

INTRODUCTION

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 Reclamation Plant (TWRP).

The following data was measured using an instantaneous hand-held instrument.

ID	Location	MH No.	System	Inst. Pressure, in-wc	H2S Reading, ppm
1	Burbank Blvd	429-11-079	VORS	0.01	0
2	18206 Victory Blvd	430-02-139	AVORS	0.02	5
3	6513 Firmament Ave.	429-03-121	EVIS	-0.11	2

DATA ANALYSIS

Overall, air ventilation was generally near or below atmospheric levels. There were no significant odor issue documented in the west Valley sewer system.

RECOMMENDATIONS

Continue to monitor this area for any pressure and hydrogen sulfide generations.

5.7 AOS -2 - Venice/Playa Del Rey-CIS-LNOS - 2017

INTRODUCTION

The Coastal Interceptor Sewer (CIS) serves the coastal area of Santa Monica Bay north of the Hyperion Treatment Plant in the Venice/Playa Del Rey Area. The CIS conveys wastewater collected from the areas north of the Marina Del Rey harbor to the Venice Pumping Plant, the largest pumping plant in the wastewater collection system. The wastewater is then pumped south across the Marina harbor entrance channel through the 48-inch Venice force main and discharged approximately 9057 feet downstream in the Playa Vista area to the 72-inch CIS. A diversion structure exists at the force main outlet to allow flow to be conveyed to the Lower

North Outfall Sewer (LNOS). The LNOS is a 126-inch semi-elliptical pipe that flows to the Hyperion Treatment Plant (HTP) headworks.

The HTP operates an 18,000 cfm influent scrubber to address odors at the headworks. The scrubber has an added benefit to the CIS, LNOS, COS, NCOS, and NORS.

The following data was measured using an instantaneous hand-held instrument.

ID	Location	MH NO.	System	Inst. Pressure In-wc	H2S Reading PPM
1	8366 Vista Del mar	563-09-303	NOS	-0.26	7
2	8366 Vista Del Mar	563-09-017	CIS	-0.44	16

DATA ANALYSIS

Overall, air ventilation was generally near or below atmospheric levels. There were no significant odor issue documented in the Venice/Playa Del Rey sewer system.

RECOMMENDATIONS

Continue to monitor this area for any pressure and hydrogen sulfide generations.

6. SUMMARY OF RECOMMENDATIONS

6.1 AOC-1 East NOS and NEIS/ECIS Corridor

- Continue to closely monitor pressure and hydrogen sulfide levels on a regular basis
- Continue to implement current odor control measures. Determine the need for additional odor control measures including chemical addition and/or additional air treatment
- Evaluate air flow dynamics after the emergency repair work at NOS collapse sites is completed
- Evaluate air flow dynamics by manipulating sewage flow throughout the various diversion structures
- Evaluate long term solution for the Enterprise Siphon by diverting the flow to ECIS

6.2 AOC-2 La Cienega San Fernando Corridor – LCSFVRS-WHIS

- Continue to monitor pressure and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor H₂S levels to evaluate the effectiveness of magnesium hydroxide addition for collection system odor control on an annual basis
- Continue to seal all maintenance holes where needed in the area to minimize odor release
- Continue to implement on-going odor control measures
- Re-evaluate the system after the installation of the up-sized Genesee carbon scrubber to 10,000 cfm

6.3 AOC-3 South Los Angeles Area – NOS/Maze-ECIS-SCAIS

- Continue to monitor pressure and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor H₂S levels on an annual basis to evaluate the effectiveness of caustic shock dosing
- Continue to seal all maintenance holes where needed in the area to minimize odor release
- Continue to implement on-going odor control measures
- Reevaluate the system after the planned CIP improvements, including Martin Luther King (MLK) carbon scrubber replacement, NOS and Slauson Sewer rehabilitation
- Evaluate alternative odor control chemical addition technologies

6.4 AOC-4 Baldwin Hills/Culver City – NORS-ECIS-NOS-NCOS-WLAIS-WRS

- Continue to monitor pressure and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor H₂S levels on an annual basis to evaluate the effectiveness of chemical addition

- Continue to seal all maintenance holes where needed in the area to minimize odor release
- Continue to implement on-going odor control measures
- Reevaluate the system after the planned CIP improvements, including NORS/ECIS carbon scrubber replacement and WLAIIS rehabilitation
- Evaluate up-sizing of NOTF carbon scrubber to 15,000 cfm

6.5 AOC-5 East Valley Area – AVORS-EVRS-VORS-NHIS-NOS

- Continue to monitor pressure and evaluate the air flow dynamics of the system on an annual basis
- Continue to monitor H₂S levels on an annual basis to evaluate the effectiveness of chemical addition
- Continue to seal all maintenance holes where needed in the area to minimize odor release
- Continue to implement on-going odor control measures
- Reevaluate the system after the planned CIP improvements, including Radford carbon scrubber replacement

7. ODOR RELATED STUDIES/ACTIVITIES/PROJECTS

The odor control program continues to proactively study, investigate and perform various activities to address on-going odor issues in the collection system. The following studies, activities and projects were performed in 2017:

7.1 Thioguard Addition – NOS (East LA)

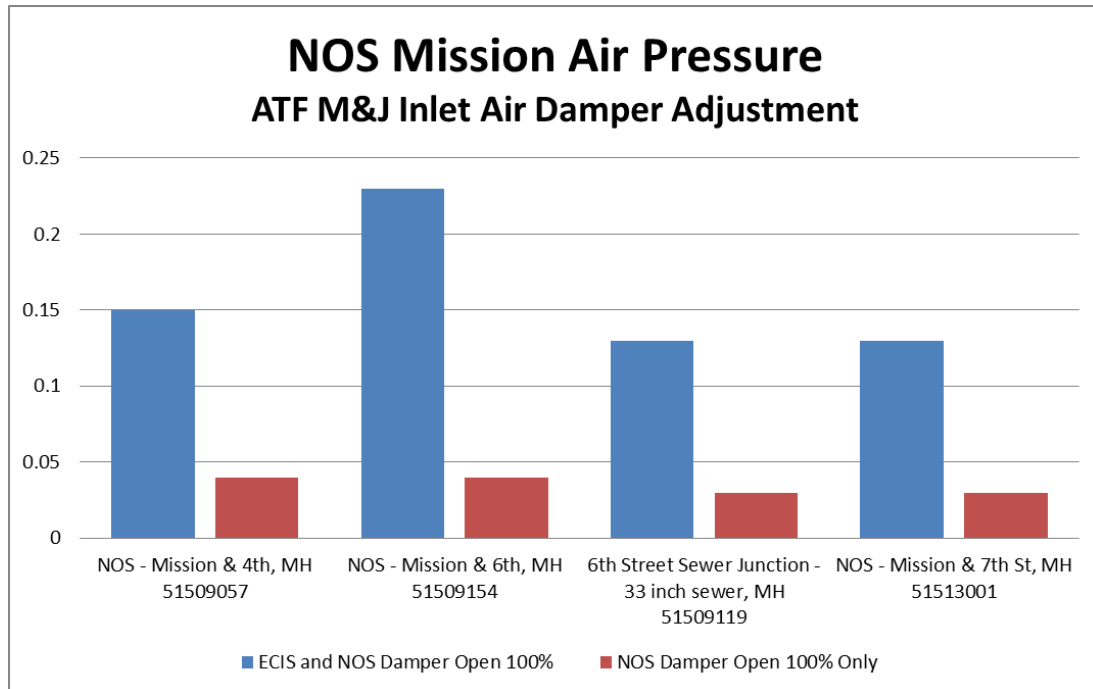
Thioguard addition to address odor along the NOS on Mission Road was implemented in September 2017. Preliminary results indicated 80% reduction in H_2S . Further monitoring and optimization are continuing to enhance odor reduction. After further optimization, H_2S concentrations were further reduced by 98%.

7.2 Mission and Jesse Air Treatment Facility – Foul Air Balance - 2017

The Mission and Jesse ATF was commissioned in June 2015. At the time of activation, 12,000 cfm was pulling air 100% open from the ECIS drop structure. The Mission and Jesse ATF foul air ventilation pipe is also connected to the NOS. The NOS was experiencing high pressures. To address the pressure, adjustments were made on the air dampers to pull more air from the NOS. These adjustments were finally adjusted after the emergency repair work at NOS collapsed site near Mission and Jesse ATF was completed in 2016. The final damper adjustment was made to open the dampers for NOS at fully open position while the damper for ECIS was to remain at fully close position.

The following graph shows that adjusting the Mission and Jesse inlet dampers so that they were 100% open to the NOS and completely closed to the ECIS significantly improved the NOS ventilation rate on Mission Rd. There was a 73% to 83% pressure reduction on the NOS.





7.3 Martin Luther King/Rodeo and NORS/ECIS Carbon Scrubber Replacement Project – To be completed in 2017

The capital improvement project will replace and upgrade the 5000 cfm and 10,000 cfm Martin Luther King (MLK)/Rodeo and NORS/ECIS scrubbers, respectively. The project is near completion and will be started up in late part of 2017. Replacement of these units will improve the air pressure in the Baldwin Hills/Culver City and South Los Angeles areas.



7.4 BTF pilot test

A pilot test was initiated in early 2017 to produce fresh water from primary tank at Hyperion by using a new water treatment equipment, to be used as the source of make-up water for a pilot-scale Bio-trickling filter installed near Primary Batter B at Hyperion. Three pilot-scale BTF were started up for this test. One will be using fresh water, one will be using plant effluent water and the last one will be using the water produced through a new technology under this test.



7.5 AFRAS Radial Carbon Scrubber Study 2017



The recently tested AfrasAir carbon scrubber will be used at Genesee carbon scrubber. This unit will be a 10,000 cfm vessel. The performance of the full-scale unit at Genesee will be evaluated once the installation is complete.