City of San José

San José/Santa Clara Water Pollution Control Plant Master Plan

TASK NO. 5
PROJECT MEMORANDUM NO. 5
ODOR TREATMENT ALTERNATIVES

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in association with

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CITY OF SAN JOSÉ

SAN JOSÉ/SANTA CLARA WATER POLLUTION CONTROL PLANT MASTER PLAN

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GLOSSARY OF ACRONYMS AND TERMS

AB	Assembly Bill
AC	Acre
ACH	Air Changes per Hour
AD	Air Drying
ADAF	Average Day Annual Flow (Average daily flow or loading for an annual period)
ADC	Alternative Daily Cover
ADMMF	Average Day Maximum Month Flow (Peak month for each year)
ADMML	Average Day Maximum Month Load
ADWF	Average Dry Weather Flow (Average of daily influent flow occurring between May - October)
ADWIF	Average Dry Weather Influent Flow (Average of five consecutive weekday flows occurring between June - October)
ADWL	Average Dry Weather Load
AES	Advanced Energy Storage
ANSI	American National Standards Institute
ARWTF	Advanced Recycled Water Treatment Facility
BAAQMD	Bay Area Air Quality Management District
BAB2E	Bay Area Biosolids to Energy
BACWA	Bay Area Clean Water Association
BAF	Biological Aerated Filter
BC	Brown and Caldwell
BCDC	Bay Conservation and Development Commission
BNR	Biological Nutrient Removal
BNR1	Formerly Secondary Facilities
BNR2	Formerly Nitrification Facilities
BOD	Biochemical Oxygen Demand
BTUs	British Thermal Units
CAG	Community Advisory Group

CAL OSHA	California Occupational Safety and Health Administration
CAMBI	Vendor name for a pre-processing technology
CARB	California Air Resources Board
CCB	Chlorine Contact Basin
CEC	California Energy Commission
CECs	Contaminants of Emerging Concern
CEPT	Chemically Enhanced Primary Treatment
CEQA	California Environmental Quality Act
CFM	Cubic feet per minute
CH_4	Methane
CH_3SH	Methyl mercaptan
CIP	Capital Improvement Program
City	City of San José
CL	Covered Lagoons
CO	Catalytic Oxidation
CO_2	Carbon Dioxide
CO_2E	Carbon Dioxide Emissions
CSI	California Solar Incentive
DAFT	Dissolved Air Flotation Thickener
DO	Dissolved Oxygen
DG	Digester Gas
DPH	Department of Public Health
D/T	Dilutions to threshold
EBOS	Emergency Basin Overflow Structure
EDCs	Endocrine Disrupting Compounds
EEC	Environmental Engineering and Contracting, Inc.
e.g.	For example
EIR	Environmental Impact Report
ELAC	Engineering, Legal, and Administrative Costs

EPA	United States Environmental Protection Agency
EQ	Equalization
ESB	Environmental Services Building
ESD	Environmental Services Department
etc	etcetera
Fe_2O_3	Ferric Oxide
Fe_2S_3	Ferric Sulfide
FIPS	Filter Influent Pump Station
FOG	Fats, Oils, and Grease
fps	foot per second
FRP	Fiberglass Reinforced Plastic
FWS	Food Waste Separation
GC/SCD	Gas Chromatograph/Sulfur Chemiluminescence Detector
GHG	Greenhouse Gas Emissions
gpd/ft^2	Gallons per Day per Square Foot
GWP	Global Warming Potential
H_2S	Hydrogen Sulfide
H_2SO_4	Sulfuric Acid
HOCl	Hypochlorous Acid
HP	Harvest Power
HRT	Hydraulic Residence Time
HVAC	Heating Ventilation and Air Conditioning
HW	Headworks
IMLR	Internal Mixed Liquor Return
IWA	International Water Association
ISCST3	Industrial Source Complex Short-Term 3
ITC	Investment Tax Credit
JEPA	Joint Exercise of Power Authority
L	Liter

LFG	Landfill Gas
LHV	Lower Heating Valve
MAD	Mesophilic Anaerobic Digestion
MBR	Membrane Bioreactor
MD	Mechanical Dewatering
MG	Million Gallons
mgd	Million Gallons per Day
mg/L	Milligrams per Liter
MLE	Modified Ludzack - Ettinger
MLSS	Mixed Liquor Suspended Solids
MM	Million
MOP	Manual of Practice
MSW	Municipal Solid Waste
MW	Mega Watt
NAS	Nitrifying Activated Sludge
NBB	Nitrification Blower Building
NFPA	National Fire Protection Association
NG	Natural Gas
NH_3	Ammonia
N_2O	Nitrous Oxide
NPDES	National Pollutant Discharge Elimination System
O&M	Operations and Maintenance
ORP	Oxidation-Reduction Potential
OUR	Oxygen Uptake Rate
PE	Primary Effluent
PG&E	Pacific Gas and Electric
PEPS	Primary Effluent Pump Station
PHWWF	Peak Hour Wet Weather Flow (Peak hour flow resulting from a rainfall event)
PM	Project Memorandum

PMP	Plant Master Plan
PPA	Power Purchase Agreement
ppbv	Parts per billion by volume
PPCD	Pounds per capita per day
ppmv	Parts per million by volume
PPP	Public Private Partnerships
PS	Primary Sludge
PV	Photovoltaic
QA/QC	Quality Assurance/Quality Control
RAS	Return Activated Sludge
RO	Reverse Osmosis
ROAP	Regional Odor Assessment Program
RPS	Renewable Portfolio Standard
RSM	Residual Solids Management
RSPS	Raw Sewage Pump Station
SBB	Secondary Blower Building
SBR	Sequencing Batch Reactor
SBWR	South Bay Water Recycling
SC	Santa Clara
SCAQMD	South Coast Air Quality Management District
SCR	Selective Catalytic Reduction
SJ	San Jose
sf	Square Feet
SGIP	Self-Generation Incentive Program
SOM	Skidmore, Owings, and Merrill
SOTE	Standard Oxygen Transfer Efficiency
SRT	Solids Residence Time
SS	Suspended Solids
SSPS	Settled Sewage Pump Station

SVI	Sludge Volume Index
TAD	Thermophilic Anaerobic Digestion
TAG	Technical Advisory Group
TBL	Triple Bottom Line
TM	Technical Memorandum
TN	Total Nitrogen (organic & inorganic forms which are ammonia, nitrates, nitrite)
TSS	Total Suspended Solids
TWAS	Thickened Waste Activated Sludge
UV	Ultraviolet
VFDs	Variable Frequency Drives
VOC	Volatile Organic Compound
VSL	Volatile Solids Loading
WAS	Waste Activated Sludge
WEF	Water Environment Federation
WPCP	Water Pollution Control Plant
WWTP	Wastewater Treatment Plant

ODOR TREATMENT ALTERNATIVES

1.0 INTRODUCTION/SUMMARY

1.1 Introduction

The purpose of this project memorandum (PM) is to present an assessment of odor generation and to develop a long-term strategy for addressing and controlling odors for the San José/Santa Clara Water Pollution Control Plant (WPCP) as part of completion of the Plant Master Plan (PMP). This PM provides identification, analysis, preliminary evaluation, and projected costs of appropriate on-site odor control options that have been developed to meet the City's goals with respect to being a good neighbor to the surrounding community.

Part of the WPCP 2040 PMP vision is to be a good neighbor with respect to odor, noise, and aesthetics. With this strategic vision, the WPCP can develop policies that proactively mitigate odor emissions. The reduction and control of odors can be achieved through on-site (treatment plant) and/or collection system measures. The PMP considers not only plant-related odor control options but also the potential regional impacts of potential off-site odor generation. Additionally, without a comprehensive data collection effort and modeling of current and future odor impacts, recommendations for odor-related capital improvements cannot be optimized nor their success verified following installation. Therefore, in addition to a preliminary evaluation of plant odor control needs and solutions, this PM presents a conceptual scope of work for completion of a comprehensive regional odor assessment program (ROAP). The ROAP would provide a refinement of the findings presented in this PM through the use of additional odor testing, modeling, and technology analyses. This information would be used to update the capital improvements program (CIP) presented herein.

In this PM, plant odor control alternatives have been assessed from a conceptual perspective for their effectiveness, engineering feasibility, cost, and land-use requirements. This assessment will allow City staff to develop potential solutions that are best suited for the WPCP. Further detailed analysis developed as part of the ROAP is recommended before finalizing a detailed approach for addressing any specific odorous process area.

1.2 Summary

This PM summarizes existing odor control needs at the WPCP given assumptions regarding the potential development of adjacent currently uninhabited areas in the planning period. However, final recommendations for odor control improvements should be made in conjunction with the conclusions of the ROAP. Following are recommended actions with respect to data needs:

- As part of completing the ROAP, collect odor data (specific compounds and total odor as measured by an odor panel) reflective of current emissions from odorous process units at the WPCP, including data indicating approximate sulfide loads from the collection system.

- As part of completing the ROAP, conduct liquid-phase treatment sampling, analysis, and potentially pilot testing with the goal of reducing sulfide loads to the WPCP to optimal, cost-effective levels.

- As part of completing the ROAP, conduct dispersion modeling to assess current and future off-site odor impacts, and use the calibrated baseline model to predict the effectiveness of new odor control technologies and the best means of meeting the City's odor control goals.

- As part of completing the ROAP, conduct and update technological analyses for gas-phase treatment of odorous processes and implement optimal solutions.

- For the purposes of completing the PMP, this PM recommends solutions and provides approximate budgetary costs. These proposed solutions and costs would be updated during completion of the ROAP.

- Recommended interim odor control improvements include hydrogen peroxide (or other chemicals) addition to the various influent junction boxes, East Primary inlet structure, and the Primary Effluent Pump Station (PEPS) at the influent to primary effluent EQ basin. Pending results of the ROAP, covering and odor scrubbing of the primary clarifier launders/discharge channels could also be included in the interim measures.

- Recommended long-term PMP odor control improvements include the following: (1) installation of a permanent iron salt feed station at the Emergency Basin Overflow Structure (EBOS); (2) cover, ventilate and treat air from Headworks 2 facilities (including the various inlet junction structures); (3) cover, ventilate and treat air from the East Primary Clarifier facility; (3) cover, ventilate and treat air from the Dissolved Air Flotation (DAFT) facilities; (4) cover and collect gas from future storage lagoons and (5) cover, ventilate and treat air from future mechanical dewatering and greenhouse drying facilities. These improvements would also include repair and/or coating of the concrete structures that are to be covered.

- Update the PMP recommendations as appropriate to reflect the results of the ROAP and ongoing field analyses.

2.0 BACKGROUND

This section provides detail on the potential triggers related to odor control, sensitive odor receptors that serve as drivers for increased odor control, and the City's goals related to keeping odors contained within plant property.

2.1 Planning Triggers

Six categories of potential triggers for PMP projects include the following:

- **Condition (Rehabilitation/Replacement)** – A *condition trigger* is assigned if the process or facility has reached the end of its economic useful life. This trigger is established based on the need to maintain that facility as operationally sufficient to meet mission critical reliability and performance requirements.
- **Regulatory Requirement** – A *regulatory trigger* is assigned when the need is driven by local, state or national regulatory requirements.
- **Economic Benefit** – An *economic benefit trigger* is assigned when a positive a reduction in life-cycle costs (considering capital and O&M) can be achieved.
- **Improved Performance Benefit** – An improved *performance benefit trigger* is assigned when there is a benefit in improved operations and maintenance performance related to overall reliability and/or reduced operational and safety-related risks.
- **Increased Flows/Loads** – An *increased flow and load trigger* is assigned when the need is based on an increase in capacity to accommodate increases in flows or loads into the WPCP.
- **Policy Decision** – The *policy trigger* is assigned when the reason is based on a management and/or political decision from the policy-makers.

Odor control improvements are typically driven either by regulatory or policy decision triggers. A regulatory trigger would be imposed by the local air district, in this case the Bay Area Air Quality Management District (BAAQMD). Actions to be taken by the City would be those necessary to meet total odor levels at the plant property line for a certain percentage of the year. The BAAQMD provides these criteria on a case-by-case basis. Regulatory involvement typically is triggered following a period of odor complaints and subsequent violations imposed onto the utility.

The more desirable approach is to develop a strategic vision and supporting policies in which the City is proactive in meeting odor emissions limitations, whereby complaints are kept to a minimum and regulatory action is avoided altogether. Other facilities that use this approach use elements of the ROAP process to identify odor control needs, with the goal of meeting requirements of the nearby adjoining properties.

2.2 Odor Impacts

Odor control should be initiated at the WPCP for two reasons: (1) mitigation of on-site impacts (e.g., safety, maintenance, and worker comfort considerations), and (2) mitigation of potential off-site impacts (e.g., odor complaints).

2.2.1 On-Site Impacts

On-site (within the confines of the WPCP) considerations generally relate to maintenance of existing assets and worker safety and comfort. The maintenance considerations predominantly concern hydrogen sulfide (H_2S) concentrations within confined areas and the potential for H_2S to be converted to sulfuric acid, which will accelerate corrosion of concrete or metal surfaces of existing facilities. This is of particular concern with liquid-phase treatment processes near the head of the plant, such as the headworks facility and primary clarifiers.

Furthermore, odorous emissions are a nuisance to WPCP employees, operators and other staff that work on-site. Odor control provides a more pleasant work atmosphere for those individuals. Odorous emissions can also be elevated to safety concerns when H_2S concentrations are exceedingly high, as H_2S is a toxic gas and even short periods of exposure to very high concentrations can be fatal. This is especially important in confined space areas where H_2S is typically found, such as pump station wet wells. Besides H_2S there are numerous other reduced sulfide compounds, e.g. mercaptans, that could be produced in downstream processes that must be mitigated as part of the overall odor control program.

2.2.2 Off-Site Considerations

Background. The feasibility of developing property adjacent to or near the WPCP is impacted by potential odor emissions from the WPCP. This issue resulted in a settlement agreement between the City of San José and the McCarthy property owners in which the City purchased a 50-year deed restriction (through 2048) on 140 acres of McCarthy Ranch property. This deed restriction excludes the development of “odor sensitive uses” which were defined as residential, lodging or other such overnight uses. The City's purchase also included a 6-acre strip of land located along Coyote Creek, which is located within 500 feet of the WPCP's biosolids drying beds and included a house located on that property. The purchase price for the entire transaction was $6 million. The current property zoning with the deed restrictions allows the development of such uses as commercial, retail and industrial uses. Additional background material on the McCarthy deed restriction can be found in Appendix A. Currently, all the undeveloped property surrounding the WPCP continues to provide a buffer area between the various plant processes and the nearest sensitive receptors.

If this property should be developed, additional odor control measure would likely be needed due to the closer proximity of neighbors to the existing treatment processes at the WPCP. The nearest residential property is currently approximately 3,200 ft from the plant fence line (the boundary between WPCP property and off-site areas not owned by the City). Potential residential development at McCarthy Ranch would result in the nearest residential unit being located approximately 500 ft from the fence line. As a result of inquiries from McCarthy Ranch regarding a modification of the settlement agreement, a preliminary financial analysis was performed in November 2008 to determine the potential costs to mitigate off-site odor impacts from the current WPCP treatment facilities. Since no field sampling data was available, estimated air generation quantities and qualities were assumed (based on similar facilities) to prepare a dispersion model to determine off-site odor impacts. Three scenarios were developed to "bookend" the range of control and treatment alternatives: (1) maximum improvements; (2) high priority improvements and (3) do nothing. The estimated capital and operating costs for the mitigation alternatives were significant and therefore, further detailed analysis as part of the PMP was deemed appropriate.

As noted earlier, the BAAQMD regulates air quality and as such, is the monitoring agency for all odor complaints. The WPCP is part of BAAQMD's rapid notification system and as a result, the staff follows up on any odor complaints that may be attributable to the plant operations. Based on a review of five years (2005-2009) worth of BAAQMD's complaints, only one confirmed odor complaint was registered due to WPCP related operation. Using the BAAQMD's database of complaints, a series of aerial plots were prepared which summarize the location of each complaint by month. Based on prevalent wind patterns, it appears that most of the complaint locales are not associated with the operation of the WPCP. However, the most accurate estimation of the WPCP off-site impacts would be to collect odor sampling data and use that data to perform a more rigorous odor dispersion modeling effort.

Current Best Practices. Over the last six to seven years, the staff at the WPCP have had an ongoing program to modify or upgrade various operating procedures to reduce off-site odors. These are described in a standard operating procedures document entitled *Best Management Practices,* which can be found in Appendix B.

These best management practices include the following: (1) contracting with a chemical supplier to add hydrogen peroxide at several key locations in the liquids process; (2) careful monitoring of atmospheric conditions during the operation of the drying beds; and (3) modifying the truck loading procedures and transport schedule for the dried biosolids.

Regional Odor Considerations. As part of ongoing discussions with interested stakeholders, particularly the City of Milpitas, it became apparent that the odor issues in the region were not limited to the WPCP operations. As a result, field investigations were completed in late 2010 to potential sites in the area surrounding the WPCP, which included the following: (1) Newby Island, (2) Zanker Resources; (3) Milpitas Pump Station, and (4) various locations in the City's sewerage collection system (see summary information in Appendix C). As is the case with the WPCP, all of these operations have implemented odor mitigation measures over the last several years (see details in Appendix C). These efforts have been recognized by the City of Milpitas in their *June 2008 Odor Control Action Plan* (refer to Section 2.2 in Appendix D).

These field investigations resulted in the following preliminary findings:

Collection System. It appears that operating a fewer number of interceptors along Zanker Road has reduced the septicity of the sewage entering the WPCP. The major source of sulfides appears to be coming from the Santa Clara tie-in at Junction Structure C (high levels of hydrogen sulfide were observed). Caustic soda addition at the current ten locations will continue.

Milpitas Pump Station. The pump station was completely upgraded two years ago. Current design has a covered wetwell which is ventilated, but the air is not treated. Pump station could have been a source of off-site odors prior to this upgrade. However, no obvious odor issues were observed at the time of the site visit to the pump station.

Two force mains pump raw sewage to the Milpitas Structure at the WPCP. There is a surge tower on one of the force mains that is located in the RSM area, but because of its height, difficult to determine if there are odor issues. High localized sulfide levels were measured at the Milpitas Structure (160 ppm of hydrogen sulfide), which also receives supernatant from the storage lagoons.

Zanker Materials Processing Facility. Facility does not handle putrescible waste material because of odor issues. Yard waste was composted on-site for a number of years, but now that is performed at a facility in Gilroy (strongest odors were from composting leaf piles). Eliminating the composting took care of their major odor issues. They currently limit onsite storage of green wastes to three days or less to manage potential odors. No obvious odor issues were observed at the time of the site visit.

Republic Newby Landfill. Major sources of odors are the stockpiled WPCP biosolids, the food/green waste grinding operation, the landfill tipping face and the composting operation. They operate several fogging stations, which utilize an odor neutralizing agent, that are located strategically around the site. The food grinding operation will move to the compost area and will eventually be covered. The tipping face is maintained at less than one acre and is covered up at the end of the day (5 pm). They perform dust suppression on the WPCP biosolids and use best practices when breaking the stored piles. The compost operation, which is located in the western-most area of the site and operates year around, is comprised primarily of green wastes with a small fraction of food wastes (five percent). Odors were very strong off the compost operation.

WPCP Operations. Odors were detected in the Emergency Basin Overflow Structure (EBOS), headworks area (especially at the junction structures), primary clarifiers, dissolved air flotation (DAFT) units, and grease room. All odors measured were low level except for the launder area of the primary clarifiers. No odors were detected at the primary effluent equalization basins, but it was noted that some low levels of odors are sometimes detected when these basins are at their lowest operating levels. Observed the filling operation of the lagoons – localized low level odors. No odors noted around the dredging operation. Observed the filling operation for one of the drying beds – no odors were noticed. Based on the site visit, it appears that off-site odor potential is greatest for primary clarifier launder area (especially during the warmer months) and for the sludge drying operation once the beds are being turned during the summer and early Fall.

Based on these preliminary findings, it was concluded that the primary regional sources of odors in the area are the WPCP facilities and the Newby Island landfill operation. The offsite odors from the WPCP appear to be more seasonal in nature, while the offsite odors from Newby Island appear to be more independent of season, which is consistent with the BAAQMD odor complaint data previously presented. This preliminary investigation confirmed the need to perform a more detailed data collection and dispersion analysis to more accurately develop specific recommendations for long-term odor mitigation measures.

This additional data collection and odor dispersion analysis would be completed as part of regional odor assessment program and would potentially involve all the potential odor site in the area surrounding the plant. The benefits to the WPCP of a more detailed assessment include: (1) providing a more scientific analysis of the WPCP's contribution to odor in the region; (2) helps to identify the extent of odor control required at each source, and (3) helps to optimize the treatment technologies selected and implemented. This would translate to savings in both capital and O&M costs.

2.3 Establishing Odor Control Goals

Revised use of plant lands and development of nearby properties will make odor control a priority within the PMP time horizon. As use of the plant lands change, and public access moves closer to the treatment processes, the definition of "fence line" will change. This will require that more stringent odor control limitations be considered as a long-term policy direction.

For the purpose of this PM, "odors" as used in the preceding statement shall be defined as any plant-related odor detectable by an average individual. There are a number of different approaches that are commonly used in the U.S. to regulate odors (see article in Appendix E). The use of ambient air limits for individual compounds (i.e., hydrogen sulfide) does not address the existence of the various odorous compounds that can be generated by the WPCP and other local odor sources. What has generally been accepted is the use of off-site limits based on levels predicted by dispersion modeling and the use of a dynamic olfactometry approach which utilizes odor units (OU) or dilutions to threshold (D/T). California's South Coast Air Quality Management District states that at 5 D/T, people become consciously aware of the presence of an odor and at 10 D/T the odors are strong enough to evoke a complaint. For the purposes of this memo, it will be assumed that the WPCP operations will be managed to limit the odor discharges to 5 D/T at the plant fence line.

Adherence to the 5 D/T requirement can be established using dispersion modeling, conducted as part of the recommended ROAP (see Section 3.0). This goal will be confirmed in the ROAP and translated into dispersion modeling terms and into the final recommended odor control requirements for key plant processes discussed herein.

The odor goal stated above was used as the basis for odor control alternatives discussed in this PM. Meeting the goal will potentially require operational changes, liquid-phase treatment, gas-phase treatment, or (most likely) some combination of those modifications. Though preliminary odor treatment alternatives are discussed in Section 4.0 for liquid-phase treatment and Sections 5.0 through 11.0 for gas-phase treatment, recommended courses of action should not be finalized without completing an ROAP. This approach has been used successfully for multiple similar utilities and has resulted in the implementation of a thorough CIP which was tailored to meet specific odor control goals.

3.0 REGIONAL ODOR ASSESSMENT PROGRAM

A regional odor assessment program (ROAP) would be used by the City to establish odor-related goals, collect data, model off-site impacts, and develop a CIP specific to meeting odor control goals for the WPCP and collection system. This section summarizes the projected main task items in the ROAP.

3.1 ROAP Scope

Table 1 provides an initial breakdown of the major tasks projected to be included in the recommended ROAP scope.

For Task 2 Regional Odor Assessment, further information on the project sampling and analysis program is provided in Appendix F. It is anticipated that as many as 20 to 25 locations could be sampled as part of the regional odor assessment. An odor advisory panel would be assembled to peer review the overall approach, data collection, analysis and recommendations developed as part of the ROAP.

Table 1	Regional Odor Assessment Program - Scope Summary San José/Santa Clara Water Pollution Control Plant Master Plan City of San José
Scope Item	**Description and Key Task Components**
Task 1: Goal Setting	Set odor control goals for all potential odors emissions.
Task 2: Regional Odor Assessment	Comprehensive odor assessment of all major regional odor generating processes or systems, including seasonal sampling of odor emissions, which are needed to identify emissions variations in some sources.
Task 3: Odor Dispersion Modeling	Conduct modeling of the major odor sources, determine offsite impacts, and link impacts with the critical odor sources.
Task 4: Technology Analysis and Alternatives Evaluation	Develop final prioritization of odor sources and develop optimal means of odor control for each source, or combination of sources.
Task 5: ROAP Report and CIP	Update the strategic plan for capital improvements and operational modifications related to odor control
Task 6: Stakeholder Meetings	Develop a list of key stakeholders that are or will be impacted by the identified regional odor emissions.
Task 7: Public Outreach	Engage in a public outreach program to inform local residents about the origin and development of the project.

4.0 PRELIMINARY ASSESSMENT: LIQUID-PHASE TREATMENT ODOR CONTROL

4.1 Current Considerations

Various chemicals could potentially be injected for sulfide control at the head of the WPCP, or further upstream in the collection system. Jar testing and pilot testing are recommended for verification of success potential at full scale. This section reviews what is currently known with respect to liquid-phase treatment at the WPCP, and also lists data needs that would be beneficial in completion of the ROAP.

4.2 Chemical Injection Potential Locations

Chemicals or oxygen could be injected at various locations within the wastewater collection system and WPCP, with a goal of minimizing sulfide concentrations in the liquid stream. Following are potential liquid-phase treatment locations (note a combination of these locations could be used):

- Within the collection system: injecting a chemical (or oxygen) upstream in the collection system has the dual benefit of lowering the sulfide loading to the WPCP and lowering corrosion potential in the collection system. A reasonable sulfide concentration target for the influent to the plant after dosing a chemical into the collection system is 0.5 mg/L.

  The City currently operates the Downer Canoas Station which was constructed as a ferrous chloride dosing operation. The station, which is located in southern San Jose on Blossom Hill Road west of Route 85, was constructed in 1987 and was recently rehabilitated in 2008. This station is located too far upstream in the collection system to have any impact on sulfide loadings at the WPCP. In 2009 the City initiated a demonstration project at Structure E along Zanker Road which included a dosing station for a hydrogen peroxide/iron salt solution. However, it was determined that chemical dosing at this location was not effective at controlling downstream sulfides.

- Upstream of the raw equalization basin (when used): other project memoranda (PMs) note that providing 10 million gallons (MG) of raw sewage equalization would limit peak influent flow to the WPCP to 400 million gallons per day (mgd). Because this facility is not expected to be used very frequently, covering the basin is not considered a viable option. It would be recommended that when this facility is fully upgraded, provision for the use of chemicals or oxygen treatment should be provided. A chemical or oxygen could be injected into the influent flow rather than into the full basin, which would improve the chemical or oxygen distribution into the raw wastewater.

- Just upstream of the WPCP headworks: this is the most common location for liquid-phase treatment that provides odor control at a wastewater treatment facility. Chemicals (or oxygen) injected into the influent flow provide turbulence and typically enough reaction time to reduce odor emissions in the headworks facility, typically a location of higher odors. The WPCP staff have already made trials using iron salt injection at the EBOS facility, primarily for sulfide control in the digester gas (with the side benefits of odor mitigation). The City currently has an ongoing contract with a hydrogen peroxide vendor to seasonally dose at the Milpitas structure as well.

- Just upstream of the WPCP primary clarifiers: sulfides are typically formed in primary clarifiers, along with sulfides flowing from upstream facilities into the quiescent tanks. Several chemicals are applicable for upstream of primary tanks, with pilot testing needed to identify the optimal choice. Note that iron salt addition would provide the beginnings of chemically enhanced primary treatment (CEPT), which precipitates sulfides and also forms a material that aids in solids and biochemical oxygen demand (BOD) removal in the plant. The City uses that same hydrogen peroxide vendor to seasonally dose at the primary influent control structure.

- Within primary effluent equalization facilities: primary effluent should be less odorous than wastewater in upstream areas (headworks and primary settling tanks) therefore covering these large basins is undesirable. Because of this, odor control at this source may be provided by incorporating chemical injection into a holding area downstream of the primary tanks. The City uses that same hydrogen peroxide vendor to seasonally dose the primary effluent at the discharge of the primary effluent pump station just upstream of the equalization basin.

4.3 Additional Data Needs and Collection System Assessment Steps

To best evaluate liquid-phase treatment alternatives for odor control at the WPCP, the following steps should be taken (further details would be included in the ROAP):

- Collect wastewater grab samples from the plant influent at various times of day and measure the total and dissolved sulfide concentrations. This test can be conducted in the field. Other water quality characteristics such as temperature, pH, BOD, and dissolved oxygen should also be taken. Samples should be taken throughout the day to account for diurnal variations typically seen in sulfide levels in the influent to a wastewater treatment facility (sulfide levels are often highest at lowest flows).

- Collect wastewater samples from the influent to the headworks, primary clarifiers, BNR facility, and upstream in the collection system and perform a similar analysis as indicated above.

- Pilot test chemical and/or oxygen addition at locations determined to be most beneficial for odor control. Based on the pilot testing, identify the optimal dose rate for reduction of total sulfides at the location under consideration for liquid-phase treatment. The point of optimization may be a dose rate that lowers sulfide levels to non-detect, or a point of diminishing returns beyond which additional sulfide removal is cost-prohibitive.

- At various chemical and/or oxygen dose rates, measure H_2S levels in the gas phase within the headspace of the odorous process being treated. In the case of injection into the plant influent, measure sulfides in the headspace above the headworks facilities. These measurements should be compared to H_2S levels before liquid-phase treatment was initiated.

4.4 Preliminary Recommendations

The collection system assessment steps listed in Section 4.3 identify the means of determining the optimal liquid-phase treatment system, which will be determined as part of the ROAP final recommendations. However, for the purposes of completing this PM and incorporating budgetary estimates into the PMP, the City can assume a $1 million construction cost for a permanent iron salt dosing facility located at the EBOS structure, which would be used to lower sulfide concentrations to below 0.5 mg/L.

5.0 TECHNOLOGICAL ASSESMENT

The following sections provide preliminary assessments of odor control needs for the headworks, primary settling tanks, dissolved air flotation thickeners, and future dewatering building at the WPCP. These processes were selected as “high priority” based on the initial dispersion modeling efforts performed in November 2008. An updated odor prioritization process would be performed as part of the ROAP.

The technologies presented include those commonly used in the wastewater industry (either in North America or Europe), along with technologies that are considered innovative and are undergoing further improvements/development. These technologies must also exhibit promising features and have examples of full-scale experience at facilities similar to the WPCP. Processes that are at the research stage of development were not included in the alternative analysis or in the costs for the recommended implementation plan presented in this PM, since it is premature to determine if these processes are suitable at the scale of the WPCP.

However, many of the recommendations presented herein will not be implemented for a number of years. Therefore, an updated technological assessment, which could include pilot testing, should be performed as part of the early implementation stages of each project before final selection of a process or equipment is made.

6.0 PRELIMINARY ASSESSMENT: HEADWORKS ODOR CONTROL

6.1 Design Projections

This section includes a preliminary assessment of odor control needs for the headworks facility at the WPCP. This assessment has been completed so that budgetary costs can be estimated. Note that the calculations and projections made in this section are based on assumptions on air requirements and odorous compound concentrations. These assumptions will be confirmed or improved upon during completion of the ROAP.

6.2 Foul Air Collection

For production of odor control alternatives, it is assumed that Headworks 1 will be decommissioned and Headworks 2 will be expanded to a capacity of 400 million gallons per day (mgd). This expansion would include a duplication of the existing infrastructure (three bar screens and bar screen channels, three vortex grit basins, and three 80-mgd capacity pumps inside the raw sewage pump station). Odor control is projected for these three process areas. The following are projected ventilation rates:

- The volume of the room enclosing the screening channels and bar screens would be contained and ventilated at a rate of 12 air changes per hour (ACH). This rate is appropriate for foul air removal in an occupied space and also for minimization of corrosion potential. A volumetric air-flow rate of 13,000 cubic feet per minute (cfm) is calculated for this process area.

- The vortex grit chambers would be ventilated by installation of foul air ducting at the top of the units. Air removal would be at a rate of 6 ACH, a lesser rate than the bar screen process area since these are not occupied spaces. Doing so would produce an air-flow requirement of approximately 1,400 cfm.

- The wet well of the raw sewage pump station would be ventilated, which is also an unoccupied space and also projected to be ventilated at 6 ACH. Approximately 1,600 cfm is calculated for appropriate odor removal and corrosion minimization.

The total air flow in the Headworks 2 exhaust would be 16,000 cfm. If the upgraded headworks facility is essentially a duplication of Headworks 2, the projected total air flow requirement for the future headworks facility would be 32,000 cfm.

There are a number of junction structures which are part of the influent piping network to the EBOS and Headworks 2 facilities (i.e., Milpitas, Santa Clara, etc). These structures would need to be included as part of the final odor control plan. In addition, there may be some odors associated with the filter backwash equalization and treatment system directly adjacent to the headworks facilities, which may also have to be included in the final odor control plan.

6.3 Odor Control Alternatives

The following gas-phase odor control technologies were considered for the headworks:

- Packed tower scrubbing followed by carbon adsorption: This two-stage system is projected to sufficiently remove odors in the foul air such that offsite impacts are minimal. Hydrogen sulfide concentrations are expected to be high in the headworks foul air, therefore the packed tower scrubber would utilize sodium hypochlorite and sodium hydroxide (caustic) to target H_2S and other lower molecular weight acidic sulfurous compounds. The carbon system would target other odorous compounds that are not sufficiently controlled by the wet scrubber. Advantages of this system include reliability and a proven track record at similar facilities. Disadvantages of this system include a higher degree of operational attention and costs associated with chemical handling and carbon replacement.

- Bioscrubbing followed by carbon adsorption: In this case, this system is similar to the packed tower / carbon system described above in that the first stage serves to remove H_2S and other lower molecular weight compounds while the second stage adsorbs compounds that are not sufficiently removed by the bioscrubber. The bioscrubber media requires a higher contact time than the chemical scrubber packing (approximately 10 seconds versus about 1-2 seconds), which will require a larger bioscrubber to treat a comparable air flow; however, a bioscrubber has the advantage of not using any chemicals, which is an operationally less expensive and greener approach. Bioscrubbers are a newer technology than packed tower scrubbers; however, suppliers have made good advancements in the technology in recent years, and they are now in service at many facilities throughout the world.

- Bulk media biofilter: Of the three options, only this is a single-stage system. This can be accomplished due to the larger contact time associated with bulk media biofilters (typically ranging between 30 and 60 seconds for organic media and one to two minutes for soil media), which promotes greater odor removal of a broad range of contaminants. Furthermore, several biofilter manufacturers supply their own inorganic media that has been shown in case studies to provide very good (greater than 90 percent) odor removal at a wide variety of loadings, and sometimes requiring less contact time. The greatest disadvantage of the biofilter is the footprint requirement for odor treatment and achieving the increased contact time, in comparison to packed tower scrubbers and activated carbon adsorption vessels.

More conceptual design detail, projected footprint requirements, and possible odor control unit locations are provided in Appendix G. Further descriptions of the above technologies are provided in Appendix H.

6.4 Cost Comparison

Planning level cost estimates for the evaluated odor control improvement projects are presented in Table 2, including capital (construction plus engineering, administration, and overhead costs), O&M costs (yearly labor, electricity, chemicals, and carbon replacement), and life-cycle costs. A more detailed breakdown of costs is provided in Appendix F.

Table 2 Summary of Planning-Level Cost Estimates for Headworks Odor Control Improvements Options
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Option	Capital Cost	O&M Yearly Cost	Life-Cycle Cost
Packed Tower Scrubber + Activated Carbon	$5,700,000	$170,000	$8,400,000
Bioscrubber + Activated Carbon	$12,000,000	$173,000	$14,800,000
Biofilter	$6,700,000	$85,000	$8,000,000

The life cycle (present worth) cost is determined using a 20-year life and a discount rate of 3 percent. As noted in Appendix F, several cost items are reflective of percentages of other items, and a contingency is built into the estimates reflective of the planning-level nature of this PM and the PMP. Costs listed in this and other similar tables in this PM should be assumed to be accurate within -50%/+100%.

Note that Table 2 indicates a lowest capital cost for the packed tower scrubber / activated carbon two-stage system, but the life-cycle cost of the biofilter is lowest due to its lower O&M yearly cost (no chemicals or carbon replacement is necessary). However, it is anticipated there will be more stringent requirements for air toxic emissions in the future. Therefore, the packed tower and activated carbon system was selected as the preferred option because of this system's flexibility to deal with these potential future emission requirements.

The costs for providing odor control infrastructure at a number of junction structures upstream of the headworks are not included in this analysis. These structures are (1) EBOS, (2) Intertie Junction Box (Pie Structure), and (3) the Inlet Control (Milpitas) Structure. Since it is anticipated that the ROAP modeling effort will show they are required, an additional project cost of $8 million has been assumed for budgetary purposes. Due to the uncertain odor impact and longevity of the filter backwash treatment system, however, no cost has been budgeted for odor mitigation for these facilities.

7.0 PRELIMINARY ASSESSMENT: PRIMARY CLARIFIERS ODOR CONTROL

7.1 Design Projections

This section includes a preliminary design assessment of odor control needs for the primary clarifiers at the WPCP. Note that the calculations and projections made in this section are based on assumptions of air requirements and odorous compound concentrations. These assumptions will be confirmed or improved upon during completion of the ROAP.

7.2 Foul Air Collection

The primary clarifier system is currently divided into the East Primary Clarifiers and the West Primary Clarifiers. If they remained in service, both sets of tanks would require structural rehabilitation and corrosion-prevention measures within the master planning period. However, the West Primary Clarifiers are projected to be abandoned.

The East Primary Clarifiers have a hydraulic/process capacity of 330 mgd. Since the headworks has a capacity of 400 mgd, during peak flow events, 70 mgd of headworks effluent could bypass the primaries for direct discharge to the secondary treatment system. To ensure the reliability of the East Primary Clarifiers for the duration of the master planning period, they will receive the necessary structural rehabilitation and corrosion-prevention measures, during which time the City projects that odor control will also be provided.

For the East Primary Clarifiers, a total approximate foul air-flow requirement to be treated by an odor control unit is 17,000 cfm. This assumes installation of tight, flat covers on the primary settling tanks with 1 ft of headspace under the cover and above the water level to be ventilated.

7.3 Odor Control Alternatives

The following gas-phase odor control technologies are considered for the primary clarifiers (note that the same three are considered for the headworks):

- Packed tower scrubbing followed by carbon adsorption: This two-stage system is projected to sufficiently remove odors in the foul air such that offsite impacts are minimal. Though not as high as in the headworks, H_2S concentrations are expected to be elevated, therefore a packed tower scrubber with hypochlorite and caustic targeting H_2S is appropriate. The scrubber would also remove some other lower molecular weight acidic sulfurous compounds. The second stage carbon system would target other odorous compounds that are not sufficiently controlled by the wet scrubber. Advantages and disadvantages of these odor control technologies are listed in the previous section.

- Bioscrubbing followed by carbon adsorption: This system is similar to the one discussed in the previous section with the same advantages and disadvantages.

- Bulk media biofilter: This is the single-stage odor control option with similar characteristics, advantages and disadvantages as described for the headworks.

More conceptual design detail, projected footprint requirements, and possible odor control unit locations are provided in Appendix F.

7.4 Cost Comparison

Planning level cost estimates for the evaluated odor control improvement projects are presented in Table 3. A more detailed breakdown of costs is provided in Appendix F. Costs should be assumed to be accurate within -50%/+100%.

Costs for odor control for this process unit are much higher than the headworks, owed to the large surface area of tanks and the need to install a large number of covers. Note that the capital cost and life-cycle costs are very similar for the packed tower/carbon and biofilter options. Based on anticipated air toxics emission requirements noted earlier, the packed tower and activated carbon systems were selected as the preferred alternative for PMP budgeting purposes. The ROAP may determine that only the launder area and discharge channels must be covered, ventilated and treated, which would significantly reduce the capital and O&M costs for this process.

Table 3	Summary of Planning-Level Cost Estimates for Primary Clarifiers Odor Control Improvements Options San José/Santa Clara Water Pollution Control Plant Master Plan City of San José		
Option	**Capital Cost**	**O&M Yearly Cost**	**Life-Cycle Cost**
Packed Tower Scrubber + Activated Carbon	$33,100,000	$269,000	$37,500,000
Bioscrubber + Activated Carbon	$36,700,000	$267,000	$41,000,000
Biofilter	$33,800,000	$215,000	$37,400,000

The costs associated with providing odor control infrastructure at (1) the Raw Sewage Flow Distribution (California) Structure, (2) the junction structure upstream of the East Primaries, and (3) the Grease Room, as well as wash-down modifications at the primary effluent equalization basin, are not included in this analysis. However, it is anticipated that the ROAP modeling effort will show they are required. For budgetary purposes, therefore, an additional project cost of $6 million is assumed.

8.0 PRELIMINARY ASSESSMENT: DISSOLVED AIR FLOTATION THICKENER ODOR CONTROL

8.1 Design Projections

This section includes a preliminary design assessment of odor control needs for the dissolved air flotation thickeners (DAFTs) at the WPCP. Note that the calculations and projections made in this section are based on assumptions on air requirements and odorous compound concentrations. These assumptions would be confirmed or improved upon during completion of the ROAP.

8.2 Foul Air Collection

The DAFTs are currently uncovered and do not include odor control; however, the existing DAFTs treat waste activated sludge (WAS) only. In the future, the DAFTs would be converted to treat WAS and primary sludge. This shift to co-thickening would increase odors significantly and odor control would be needed, especially to meet a future City goal that minimizes odors at the fence line.

Gas-phase odor treatment of the DAFTs would include affixing flat tight covers on the existing DAFTs and ventilating foul air at an air change rate of 6 ACH. Aluminum or fiberglass reinforced plastic (FRP) covers are assumed, as they are both commonly used in wastewater treatment foul air containment. Preliminary calculations project that 3,000 cfm would need to be ventilated from this process area, significantly less than that which would be required for the primary clarifiers because of the smaller surface area.

8.3 Odor Control Alternatives

The following gas-phase odor control technologies are considered for the DAFTs (note that the same three are considered for the headworks and primary settling tanks):

- Packed tower scrubbing followed by carbon adsorption: This two-stage system is projected to sufficiently remove odors in the foul air such that offsite impacts are minimal. Hydrogen sulfide concentrations are expected to fluctuate, therefore at high H_2S levels an appropriately sized wet scrubber is an appropriate odor removal device. The carbon system would target other odorous compounds that are not sufficiently controlled by the wet scrubber. Advantages and disadvantages of these technologies are listed in the previous sections.

- Bioscrubbing followed by carbon adsorption: This system is similar to the one discussed in the previous section with the same advantages and disadvantages. The bioscrubber would be used to knock down H_2S concentrations and reduce the load on the second-stage carbon adsorption system, which would target non-H_2S odorous compounds.

- Bulk media biofilter: the single-stage odor control option with similar characteristics, advantages, and disadvantages as described above. If H_2S concentrations are found to fluctuate (determined in the ROAP process), this option could suffer from not having a second stage and odor fence line goals may not be met. This would be confirmed using dispersion modeling.

More conceptual design detail, projected footprint requirements, and possible odor control unit locations are provided in Appendix F.

8.4 Cost Comparison

Planning level cost estimates for the evaluated odor control improvement projects are presented in Table 4. A more detailed breakdown of costs is provided in Appendix F. Costs should be assumed to be accurate within -50%/+100%. Costs for odor control for the DAFTs are much less than those projected for the primary settling tanks, due to the smaller surface area of tanks and the lower number of covers needed to contain the foul air.

Note that the capital cost and life-cycle cost are lowest for the biofilter option. Given that the biofilter is also a green option, this makes the biofilter preferred at this level of analysis if it is determined to provide acceptable treatment as a single stage. However, because DAFT processes often have a variety of odorous compounds (more than just H_2S) and because of anticipated future air toxics emission requirements noted earlier, the packed tower and activated carbon systems were selected as the preferred alternative for PMP budgeting purposes.

Table 4	Summary of Planning-Level Cost Estimates for DAFTs Odor Control Improvements Options San José/Santa Clara Water Pollution Control Plant Master Plan City of San José		
Option	**Capital Cost**	**O&M Yearly Cost**	**Life-Cycle Cost**
Packed Tower Scrubber + Activated Carbon	$7,400,000	$73,000	$8,600,000
Bioscrubber + Activated Carbon	$8,200,000	$73,000	$9,400,000
Biofilter	$6,800,000	$48,000	$7,600,000

9.0 PRELIMINARY ASSESSMENT: DEWATERING BUILDING ODOR CONTROL

9.1 Design Projections

This section includes a preliminary design assessment of odor control needs for a future dewatering building at the WPCP. Note that the calculations and projections made in this section are based on assumptions on air requirements and odorous compound concentrations.

9.2 Foul Air Collection

The PMP is evaluating belt filter presses versus centrifuges for mechanical dewatering (replacing the existing lagoon and air-drying bed system). Either means of dewatering would be housed within a new building. Though relatively confined enclosures could be constructed around process areas such as a group of new centrifuges, this analysis conservatively assumes ventilation of the proposed main room which would contain the centrifuges and truck load out area at 12 ACH. This would produce an approximate air flow rate of 63,000 cfm of foul air to be treated.

9.3 Odor Control Alternatives

The following gas-phase odor control technologies are considered for controlling odors from a foul air stream exhausted from a future dewatering building:

- Packed tower scrubbing followed by carbon adsorption: This two-stage system is projected to sufficiently remove odors in the foul air such that offsite impacts are minimal. The packed tower scrubbing technology specifically applied to this process, however, would be different from the technology proposed for the headworks, primary settling tanks, and DAFTs, as the odorous compounds of greatest concern in the building are likely to be ammonia and other nitrogen-containing compounds such as amines. Therefore, the packed tower scrubber solution to be used would be sulfuric acid, which would effectively remove those compounds. The carbon system would target other odorous compounds that are not sufficiently controlled by the wet scrubber, including H_2S, which would be present in low enough quantities that virgin carbon can be used. Advantages and disadvantages of this system are listed in the previous sections.

- Bulk media biofilter: the single-stage odor control option with similar characteristics, advantages, and disadvantages as described above. If odor levels are found to fluctuate, this option could suffer from not having a second stage and odor fence line goals may not be met.

9.4 Cost Comparison

Planning level cost estimates for the evaluated odor control improvement projects are presented in Table 5. A more detailed breakdown of costs is provided in Appendix F. Costs should be assumed to be accurate within -50%/+100%.

Table 5 Summary of Planning-Level Cost Estimates for Dewatering Building Odor Control Improvements Options
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Option	Capital Cost	O&M Yearly Cost	Life-Cycle Cost
Packed Tower Scrubber + Activated Carbon	$6,200,000	$220,000	$9,700,000
Biofilter	$8,700,000	$100,000	$10,200,000

Note that the capital cost is higher for the biofilter option, but the life-cycle cost is only slightly higher due to the significantly lower yearly cost (no chemicals or carbon change out requirements). Because the first option provides a two-stage system, thus greater redundancy and reliability, and because the projected life-cycle cost is lower, the packed tower scrubber/carbon option will be listed as the current recommendation in the PMP. However, because dewatering processes often have a variety of odorous compounds, it is critical to conduct an appropriate sampling program and calibration of an odor dispersion model to confirm the solutions as optimal prior to construction.

10.0 PRELIMINARY ASSESSMENT: EXISTING SOLIDS PROCESSES ODOR CONTROL

10.1 Digesters

Odorous emissions are a concern for the digesters because of the existing floating covers, which can be a source of fugitive H_2S emissions. This odor problem is typically minimized upon installation of fixed covers. This is a recommendation within the PMP and is the most efficient means of providing sufficient odor control to meet the City's goals.

10.2 Sludge Lagoons

The existing sludge lagoons have a very large surface area, therefore gas-phase treatment and even liquid-phase treatment is not appropriate from a cost perspective. In similar facilities, ammonia is the odorous compound of greatest concern, with some sulfurous compounds providing impacts to a lesser degree. Ammonia is pungent and very noticeable to a receptor, but its odor does diffuse quickly with distance from the source. Therefore, provided that sensitive receptors are located an appropriate distance away (preferably with buffer lands in between), City odor control goals can be met for this source with appropriate levels of lagoon maintenance. Following are recommended actions:

- Minimize overloading any one lagoon. Overloading tends to disrupt the biology of the lagoon and could lead to an upset.
- Maintain a water cap of at least 6 inches to 1 foot. The water cap is represented by a layer of liquid that has a dissolved oxygen concentration that is significant enough to produce a barrier against emission of volatile (potentially odorous) compounds.
- Provide aerators throughout the lagoon surface that impart some dissolved oxygen but more importantly keep the water moving, thus allowing for a greater level of natural oxygen transfer to the liquid.
- Monitor the lagoon color, especially during the spring and fall turnover periods, when upsets tend to occur. The onset of darker colors could be an indication of a pending upset.

10.3 Air Drying Beds

Ammonia emissions, as well as other amine compounds and some sulfides (to a lesser degree), are the main concerns with respect to odorous emissions from the air drying beds. A potential near-term upgrade to this process that could lower odorous emissions would involve improving the drainage system. This would require that the beds be lined with concrete (which would help remove liquid from the sludge more readily). This would potentially reduce the drainage time when odors are the biggest concern. Because of the relatively high cost and minimal amount of odor improvements associated with this upgrade, no lining costs will be included in the CIP.

Note that the air drying beds involve very large process areas that are proximate to the City of Milpitas and the McCarthy Ranch development area. For this reason, these processes will be discontinued to maintain good neighbor status.

11.0 POTENTIAL FUTURE SOLIDS PROCESSES ODOR CONTROL

11.1 FOG and Food Waste Receiving Station

Fats, Oils, and Grease (FOG) and food waste receiving stations could be installed at the WPCP within the PMP planning period. If this is done, odor control would be necessary, as both of these waste streams are highly odorous. The foul air contains a variety of odorous compounds, which makes a combination of biofiltration and carbon an appropriate choice. Packed tower scrubbing, which tends to target one compound in each stage of treatment, would not be the best solution. Additionally, the iron oxide (iron sponge or SulfaTreat™) technology has been identified as appropriate for control of H_2S spikes (as high as 1,000 parts per million or higher) that would not be well controlled in a biofilter. These spikes could occur in a new FOG facility's emissions, depending upon the content of the feedstock being received.

11.2 Covered Storage Lagoons

This future installation downstream of the anaerobic digesters would also require odor control. Odorous compounds of concern would include moderate amounts of H_2S, high concentrations of organic sulfur compounds, and nitrogen-containing compounds. For this large process area, a flexible fabric cover and gas collection facilities would be appropriate.

11.3 Solar Greenhouses

This potential drying technology would consist of a number of modular greenhouses occupying a large amount of acreage. Main odorous compounds of concern are ammonia and nitrogen compounds. Ventilating these greenhouses to an odor control device is not desirable, as very large air volumes would be needed. Alternatively, venting the greenhouses directly to atmosphere would provide a vertical velocity component to the foul air removal, thus improving dispersion. In addition, because ammonia and amines disperse quickly with distance away from the odor source, this physical form of odor control may be acceptable with respect to meeting the City's goals. For the purposes of long-term PMP CIP planning, ventilation and treatment using biofilters has been assumed as part of the greenhouse implementation costs.

12.0 SUMMARY OF RECOMMENDATIONS

12.1 Preparation of a Regional Odor Assessment Program (ROAP)

Since odors have been identified as a significant issue that needs further analysis, staff should immediately proceed with the preparation of a scope for a regional odor assessment program, with a goal of completing this evaluation and providing updated odor implementation recommendations by the end of 2012.

Data Needs. Sections 4.0 through 11.0 provide general projected odor control needs for various processes within the WPCP. Projected order-of-magnitude costs provided in these sections are for general budgeting purposes only. Appropriate recommendations for odor control improvements at the WPCP cannot be made without undertaking additional steps within the confines of an ROAP. Following are recommended actions with respect to data needs:

- Collect plant data as prescribed in the ROAP.
- Conduct liquid-phase treatment sampling and analysis.
- Conduct gas-phase treatment sampling and analysis for H_2S and odor levels (analysis by an odor panel to determine total odor characteristics).

Dispersion Modeling Needs. After confirmation of the desired odor control goals, the existing extent of all the regional odor emissions and the impact of the future modifications can be determined by odor dispersion modeling. The ISCST3 model inputs odor data, plant parameters, and meteorological conditions to predict offsite odor impacts. This model can also determine whether planned odor control will be sufficient in reducing impacts such that odors are contained sufficiently to meet the City's goals.

12.2 WPCP – Interim Odor Mitigation Improvements

Because of the sensitivity to odors and the relatively long-term implementation schedule for some of the proposed odor improvements, a number of interim improvements have been identified for consideration by the WPCP staff. They include the following:

- Expand the use of hydrogen peroxide.
- Addition of an iron salts feed station.
- Temporary covers for certain influent junction boxes and ventilation to carbon scrubbers.
- Temporary covers with ventilation and treatment for the primary clarifier launder area.
- Improvements in the primary effluent EQ basin to better facilitate clean-up of debris.
- Modify feed piping into the existing lagoons and drying beds to provide submerged inlet pipes.
- Selected use of odor neutralizing chemicals (i.e., during the drying bed loading operation).

12.3 WPCP – Impact of Accelerating Odor Mitigation Improvements

An analysis was performed to evaluate the impacts of implementing interim improvements versus accelerating the installation of the proposed "permanent" odor mitigation improvements to provide for early mitigation of offsite odors. The accelerated project would involve installing the recommended odor improvements for the "high risk" facilities such as the headworks and primary clarifiers as a separate stand-alone project. This would be in lieu of implementing these odor improvements at the time of the facility upgrades, which was one of the original implementation assumptions. Accelerating these odor projects would require "work-arounds" during the facility upgrades, which would increase the overall cost of those upgrades.

The purpose of this analysis is to analyze the impact of the additional cost of accelerating the projects, versus implementing two interim solutions for early mitigation of the potential offsite odors.

The analysis was performed for the following three implementation scenarios:

- **Base Scenario.** This scenario represents an un-accelerated implementation plan which represents the following:
  - The proposed "permanent" odor mitigation improvements described in the PMP, which are planned for implementation at the same time as the improvements to the headworks and primary treatment facilities.
  - Until such time as these "permanent" improvements are in place, the City would continue to dose peroxide at the current three dosing locations, namely (1) the Inlet Control (Milpitas) Structure, (2) East Primary Inlet Structure, and (3) the Primary Effluent Pump Station (PEPS) pumping to the primary effluent EQ basin. Peroxide addition is assumed to expand to a total of six (6) months, compared to the four (4) months of application in 2010.
- **Base Scenario plus Expanded Peroxide Addition Scenario.** This scenario represents an un-accelerated implementation plan which represents the following:
  - The proposed "permanent" odor mitigation improvements described in the PMP as per the Base Scenario, i.e., no acceleration of the implementation schedule.
  - Interim odor mitigation would be provided by expanding the Base Scenario peroxide addition, as follows: (1) raw influent at all the various junction boxes would be dosed, not only at the Milpitas Structure, and (2) the six (6) month dosing period (Base Scenario) would be extended further to eight (8) months at all the dosing locations.

- Aside from the expanded peroxide addition, this scenario also entails covering the launders and discharge channels only of the primary clarifiers, and providing odor treatment facilities to suit.

- **Accelerated Scenario.** This scenario represents an accelerated implementation plan, which represents the following:
  - The proposed "permanent" odor mitigation improvements, described in the PMP, which would involve installing the recommended odor improvements for the headworks and primary clarifiers as a separate stand-alone project.
  - These accelerated "permanent" odor mitigation facilities would require modifications and/or "work-arounds" associated with upgrades planned for the headworks and primary facilities during the facility upgrades. This would increase the overall cost of those upgrades.
  - Acceleration would include covering certain junction structures which may not need to be covered as part of the overall final solution based on the un-accelerated implementation schedule currently included in the PMP, e.g. the Coffin Structure. These costs are unique to this scenario.
  - Hydrogen peroxide would be dosed as per the Base Scenario, except for a much-reduced dose at primary treatment, which would be covered and provided with odor mitigation improvements.

Details of the analysis are provided in Appendix I. Major assumptions used in the analysis included the following:

- The process facilities to be evaluated include (1) the headworks facilities (including EBOS, raw equalization and miscellaneous junction structures), and (2) primary clarifiers facilities. DAFT facilities were excluded since odor control is scheduled for the immediate future.
- No construction on the fast track or PMP recommended improvements can begin until the EIR work is completed in early 2013.
- The interim improvements described above could be implemented in parallel with the EIR process.
- Since the proposed "permanent" odor mitigation improvements to the headworks and primaries are scheduled to be complete by 2020, project and O&M costs were calculated for the alternatives only through 2019. After this point in time there is no cost difference between the alternatives.
- Project costs were escalated to midpoint of construction. An escalation of two (2) percent was assumed for both project and O&M costs.

The results of the cost analysis, which combines the capital and annual O&M for each alternative through 2019 are summarized in Table 6. This summary presents the following:

- Expanding the peroxide addition and covering the primary clarifier launders, over and above the base scenario, is expected to cost approximately nine (9) percent more than the base scenario. It should be noted that, while expanding the addition of chemicals will have a marked effect on odors at these facilities, the improvements are not expected to be as comprehensive as implementing capture and treat technologies.

- Accelerating the "permanent" odor mitigation improvements is anticipated to cost approximately 19 percent more through 2019, and includes improvements that are short term in their nature.

Table 6 Comparison of Odor Mitigation Project and O&M Costs
San José/Santa Clara Water Pollution Control Plant Master Plan
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Base Scenario	Base Scenario plus Expanded Peroxide Addition Scenario	Accelerated Scenario
$89± million	$96± million	$105± million

Based on the lack of specific data which identify any of the "high-risk" facilities as potential contributors to off-site odor emissions, it is recommended that the base scenario be implemented until the ROAP is completed.

12.4 Prioritization and Construction Phasing

Once recommendations are made and validated using the odor dispersion model, odor control projects can be prioritized through an odor control-specific capital improvements program (CIP). Project sequencing in the CIP can either indicate that less complex and low-cost projects should be constructed first, or higher-cost, larger impact projects constructed first. The strategy chosen may be based on development in the surrounding area.

Alternatively, given the situation where pending development and/or complaints are not driving odor-related capital improvements, the prioritization of construction projects will likely follow along with other upgrades to specific process areas. For example, odor control for foul air ventilated from a new solids dewatering building would be constructed at the same time as the building itself.

Liquid-phase treatment is typically installed and optimized at full-scale prior to completion of downstream gas-phase treatment processes. This is done so the facility can recheck odorous emissions in process headspaces to focus in on the exact nature of the planned gas-phase treatment unit. A shift in desired technology or potentially a shift away from gas-phase odor control altogether could occur.

Also before constructing gas-phase odor control systems, the City should be sure that new facility designs include ways to lower the potential for odorous emissions. This is most important at the head of the plant and upstream of primary treatment where volatilization of odorous compounds occurs most. Reducing free-fall drops and turbulence will reduce odorous emissions, and it is recommended to review designs for new wastewater treatment facilities with this in mind. In particular, this should be considered during construction of the new headworks facility.

12.5 Consideration of Future Developments and Trends

Other improvements and developments not directly associated with odor control will also impact the Strategic Plan as it relates to odor control. These future considerations and their project impacts are provided in Table 7.

Additionally, areas surrounding the WPCP may be converted to an alternate form of land use during the planning period. The current land uses are depicted in Figure 1. Potential land use changes include development of areas to the south and east of the WPCP, as shown in Figure 2. These areas are either downwind of the WPCP odor sources (such as the headworks and primary clarifiers), or are in close proximity to potentially odorous biosolids lagoons (to be replaced with mechanical dewatering in the future), and would require immediate implementation of improved odor mitigation measures at the WPCP to facilitate development.

Table 7 Odor Control Alternatives Summary: Future Considerations San José/Santa Clara Water Pollution Control Plant Master Plan City of San José	
Future Consideration or Trend	**Impact on Odor Control for Strategic Plan**
Raw influent peak hydraulic wet weather flow will increase to 455 mgd (including recycle flows).	Liquid-phase (chemical or oxygen) treatment upstream of the raw equalization basin becomes a greater priority, as odorous emissions pertaining to a larger surface area will increase. Also, consider lining the raw equalization basin to allow for rapid cleaning of collected solids after peak flow events.
Cost of chemicals will continue to rise and sustainable, greener solutions will be of greater interest to the City and to the public served by the WPCP.	Consider in the ROAP the tradeoff between liquid-phase treatment and capture-and-treat gas-phase technologies for odor control, both from an economic perspective and from the non-economic factors of sustainability and public perception. Also consider biological solutions.
Headworks 2 will be expanded and Headworks 1 will be phased out.	Odor control at Headworks 2 will be required. Foul air capture and appropriate ventilation must be appropriate for sufficient odor control and reduction of corrosion within the new facility.
The East Primary Clarifiers will be improved, and the aging West Clarifiers will be phased out.	Odor control at the East Primary Clarifiers will be required. Foul air capture and appropriate ventilation must be appropriate for sufficient odor control and reduction of corrosion within the improved facility.
Encroachment of commercial development on the southern and eastern side of the WPCP.	Odor control will need to be provided for the headworks, primary clarifiers, and DAFTs.
Implementation of alternative solids processing facilities such as FOG and food waste receiving.	Odor control needs to be a priority for these highly odorous systems. Dispersion modeling conducted as part of an ROAP should confirm no impacts at the WPCP fence line for their highly offensive odors following odor control implementation at these sources.
Current sludge storage and dewatering practices will be replaced by mechanical dewatering.	Some form of odor control needs to be incorporated into a new mechanical dewatering facility, with the approach for control dependent upon the type of dewatering technology chosen. Either ventilation of an entire building, a room, or the dewatering process itself will be needed, with foul air sent to an odor control system.

Figure 1 Current Land Use of Project Areas

Figure 2 Future Land Use Development

APPENDIX A – BACKGROUND MATERIAL – MCCARTHY PROPERTY DEED RESTRICTION

CITY OF SAN JOSE
CAPITAL OF SILICON VALLEY

Memorandum

TO: TREATMENT PLANT ADVISORY COMMITTEE

FROM: John Stufflebean

SUBJECT: McCARTHY PROPERTY

DATE: 12-03-09

Approved

Date

This memorandum responds to the request made by the Treatment Plant Advisory Committee at its October 2009 meeting for information regarding the Plant's interests in the McCarthy Property in Milpitas. Specifically, the Committee asked staff and the City Attorney's Office to respond to the following questions:

1. What rights did the Plant purchase and what was the purchase price? What would the rights be worth now if the Plant were to agree to release the rights?
2. What is the potential for monetary liability to homeowners for damages if development is allowed to occur before the solar drying operation is discontinued?
3. What is the impact on the water recycling project that we are trying to get done, if we try to move forward now with discontinuing the solar drying operation at the same time? Does there need to be prioritization, or can we do both? What are the potential rate increases associated with doing these projects separately at the same time?
4. Could an assessment district be formed on the McCarthy property to provide a funding source for all or a portion of the costs associated with discontinuing the solar drying operation? Is there some way to shift costs associated with that project to the developer or either the developer or the homeowners over time, for a portion of the cost, or must all of the costs be paid for through rates?

Written answers to questions 1 and 3 are provided below. The City Attorney's Office will provide verbal response at the TPAC meeting on questions 2 and 4.

Question 1. What rights did the Plant purchase and what was the purchase price? What would the rights be worth now if the Plant were to agree to release the rights?

As a result of a settlement agreement in 1998 between the City of San Jose and the McCarthy property owners, the City purchased a 50-year deed restriction (through 2048) on 140 acres of McCarthy Ranch property, to exclude "odor sensitive uses" (residential, lodging, or other such overnight uses.) The City's purchase also included a 6 acre strip of land located along Coyote Creek, and within 500 feet of the Plant's biosolids drying beds, including a house located on that property. The purchase price for the entire transaction was $6 million and required the house to be leased back to McCarthy for a term of five years at $800 per year for use by farm laborers working on McCarthy lands. The $6 million purchase price was budgeted and paid for out of

Treatment Plant funds. The house is currently planned for demolition at a cost of $200K due to its unsafe and poor condition. The current property zoning with the deed restrictions, allows the development of uses such as commercial, retail or industrial uses.

The City has not obtained an appraisal of the fair market value of the deed restriction or the 6 acre strip of land. However, the value of the deed restriction to the Plant is more than just the origiual $6 million paid, because any valuation must consider the cost impact to the Plant of allowing residential so close to the biosolids drying area, while it is still in operation. The deed restriction was purchased to prevent residential development in such close proximity to the current open air dewatering and drying operation and staff continues to believe that residential use of such property is incompatible with the Plant's interest, as long as the open air operation is in use.

Plant Master Plan work to date indicates that the earliest timeframe for permanently changing the biosolids drying process is 10 to 12 years. Until that time, the Plant would continue to use open air drying for its biosolids and reuse the material as Alternate Daily Cover at the nearby Newby Island Landfill, where the Plant has a contract for reuse for the next 10 years, and it is anticipated that, subject to renegotiation with Newby Island, the Plant could continue with landfill disposal until the landfill closes or regulatory changes prevent use for biosolids as Alternate Daily Cover. It should be noted that if the deed restriction remains in place, the Plant would not need to begin planning to change the biosolids process due to concern with conflicting residential uses for many years.

Current dewatering, drying and disposal of biosolids cost the Plant $3.5 million/year. The Plant Master Plan project has assumed that open air drying will be phased out over the next 30 years. Iu response to the request from TPAC members on what it would cost to accommodate the request to release property restrictions sooner than the Master Plan time frame, staff has worked with the Plant Master Plan consultants to develop an alternative approach to discontinue open air dewatering and drying operations in a shorter, three to four year, time frame. This approach, which consists of contracting out the solids dewatering operation, is estimated to cost the Plant $13 million per year for a period of 10 to 12 years. This approach represents a $9.5 million per year increase in biosolids processing and reuse. The cost to the Tributary agencies would be in proportion to their O&M cost share agreement. It should also be noted that this would be an interim solution that has a life expectancy of 12 years. The Plant Master Plan consultants have given initial estimates of over $500 million in capital costs alone to convert to a permanent alternative biosolids processing and disposal technology, with the earliest time frame for completing such conversion being 10 to 12 years.

Question 3: What is the impact on the water recycling project that we are trying to get done, if we try to move forward now with discontinuing the solar drying operation at the same time? Does there need to be prioritization, or can we do both? What are the potential rate increases associated with doing these projects separately at the same time?

As indicated above, the Plant Master Plan project has assumed that open air drying will be phased out over the next 30 years. Given that biosolids technologies are still evolving and many treatment plants in the Bay area and nation are facing significant and costly decisions regarding biosolids treatment and reuse options, a final cost analysis is not yet available for what future technologies may be needed. The current estimate for discontinuing open air solar drying is over $500 million in capital costs alone with significant increases in operating costs. Pilot testing will be needed in order to determine the most efficient and cost-effective treatment technologies. Based on the current operations (4 year cycle in the drying beds), need for environmental review of alternatives, need for pilot testing and the significant cost, it will take a minimum of 10 to 12 years to discontinue solar drying. Acceleration of the project would incur the costs described above to accomplish discontinuation of the open air drying operation sooner and therefore result in higher operations and maintenance costs sooner.

The funding for the Plant's share of the Advanced Water Treatment Project of $11 million has been allocated in the Plant's existing 5-year CIP. A new project to discontinue open air drying sooner than completion of the Plant Master Plan would need to be prioritized within the ongoing needs. Although San Jose does not set the sewer rates for the tributary agencies, the potential rate impact of the new project on San Jose rate payers would be significant and it is assumed the same would be true for the tributary agencies.

Staff will be prepared to respond to questions and concerns at the TPAC meeting on December 10, 2009. The City's Attorney Office will be verbally answering the legal questions on which the Committee requested information. For further information, please contact Dale Ihrke, Deputy Director, at 945-5198.

John Stufflebean
Director, Environmental Services

CITY OF
SAN JOSE
CAPITAL OF SILICON VALLEY

Memorandum

TO: TREATMENT PLANT ADVISORY COMMITTEE

FROM: John Stufflebean

SUBJECT: McCARTHY PROPERTY

DATE: 08-01-08

Approved *Christine J. Shippey* Date *8-4-08*

INFORMATION

This memorandum responds to committee members' request at the May TPAC meeting regarding the McCarthy Property in Milpitas. An information report on progress of meeting with McCarthy property owners was requested for the August 2008 TPAC meeting.

The following progress was made since the May TPAC meeting:

1. City Senior Staff met with the McCarthy Property Owners on May 22, 2008. City staff included John Stufflebean, Director, Environmental Services, Joseph Horwedel, Director of Planning, Building, and Code Enforcement, and Paul Krutko, Economic Development Director. The purpose of the meeting was to better understand the requests by the McCarthy property owners.
2. Dale Ihrke, Plant Manager, provided a tour of the biosolids processing area for Joe McCarthy and several of his associates on Tuesday, June 3rd. The tour included a brief overview of the treatment plant followed by an on-site tour of the biosolids drying operation with a special focus on odor issues. The steps involved in dewatering, drying and reuse the biosolids were discussed along with the time to complete each step. In addition, it was explained why the Plant will be using the current method of open air drying for at least the next 8 - 10 years, i.e. the length of treatment, need for thorough evaluation of alternatives through Master Plan, and time needed to finance any recommended changes and then implement.
3. John Stufflebean formally invited Mr. McCarthy to be a member of the Community Advisory Group for the Plant Master Plan process on June, 2008. Mr. McCarthy has accepted the invitation to the Community Advisory Group. The Community Advisory Group will consist of interested community members and provide input into the Master Planning process.

Conceptual alternatives for the technical and land use components of the Plan are expected by the end of the year, which will then be evaluated over the following year. We look forward to a collaborative process, leading to a successful Master Plan to guide the sustainable operation and upgrade of the Plant for the next 30 years.

Staff will be prepared to respond to questions and concerns at the TPAC meeting on August 14, 2008. For further information, please contact Dale Ihrke, Deputy Director, at 945-5198.

John Stufflebean
Director, Environmental Services

CITY OF
SAN JOSE
CAPITAL OF SILICON VALLEY

Memorandum

TO: TREATMENT PLANT ADVISORY COMMITTEE

FROM: John Stufflebean

SUBJECT: McCARTHY PROPERTY

DATE: 04-04-08

Approved Christine J. Shippey　　Date 4-4-08

INFORMATION

As a result of a settlement agreement in 1998 between the City of San Jose and the McCarthy property owners, the City purchased 6 acres of McCarthy's land in Milpitas and a 50-year deed restriction (through 2048) on the adjacent 140 acres that exclude "odor sensitive uses" (residential, lodging, or other such overnight uses) for $6 million. Letters from McCarthy property owners and City of Milpitas, Vice Mayor Bob Livengood indicate an interest in exploring a removal of the development restrictions to allow mixed use, including residential development, at the site adjacent to the biosolids processing area of San Jose/Santa Clara Water Pollution Control Plant (Plant). Specifically, the request is to study the feasibility of development alternatives for the property and the potential of moving the land use evaluation phase of the Plant Master Plan project ahead of the remainder of the tasks of the projects to accommodate the proposed development proposal.

Environmental Services staff has discussed this issue with City of San Jose Senior Staff and is presenting the following issues to consider in evaluating the McCarthy request:

- The Plant's current biosolids processing includes solar drying which has potential for generation of odor complaints within close proximity of this area. Such complaints could result in Bay Area Air Quality Management District citations and potential for mandated mitigation measures, which could be costly. This proposal would allow "odor sensitive uses" within 500 feet of the biosolids operation.
- Biosolids processing evaluation is one the critical tasks of the Plant Master Plan, because of the odor, land use and disposal issues associated with the current solar drying process. Addressing, the land use task out of sequence of other tasks would undermine the planning process, since typically, technological feasibility of alternatives and operational decisions drive land uses.
- Evaluating the land use issue, at this time, will divert staff time away from accomplishing the Plant Master Plan in a timely manner. The Plant Master Plan's primary goals are to address infrastructure repair and rehabilitation, while incorporating new technologies, and optimizing land use.

- The Plant Master Plan process will be complete by 2011. Implementation of the specific recommendations, if any, related to the biosolids processing would require an additional 5 to 10 years to complete.

Staff will be prepared to respond to questions and concerns at the TPAC meeting on April 10, 2008. For further information, please contact Dale Ihrke, Deputy Director, at 945-5198.

John Stufflebean
Director, Environmental Services

APPENDIX B - WPCP - BEST MANAGEMENT PRACTICES FOR ODOR CONTROL

CITY OF SAN JOSE
WATER POLLUTION CONTROL PLANT

BEST MANAGEMENT PRACTICES

In order to prevent odor emissions from sewage collection and process systems, the following are the best management practices employed by the City of San Jose as design and preventive measures to control odors:

- Preventing lagoon odors by covering the lagoons with a water cap(June –October)
- Neutralizing odors through oxidation with chlorine and hydrogen peroxide
- Activating the mobile odor neutralizing mister when necessary. (As needed basis)
- Utilizing Plant lands for buffers (Year around)
- Using soil bed scrubbing & ferrous chloride dosing on collection systems
- Selecting drying beds according to wind direction & population density(When practical)
- Reducing odors through extended solids stabilization and digestions (40 day digestion & 2 year lagoon storage)
- Adding a neutralizing chemical in water trucks for dust control(July-October)
- Enclosing process area and ventilation through scrubbing or dispersion stacks
- Aerating open channels and flushing of out of service process tanks

RESIDUAL SOLIDS MANAGEMENT (RSM) ODOR CONTROL

- An odor originating from the facultative lagoon operation gives a distinctive smell similar to ammonia or wet diaper. (A rotten egg smell is not related to this process) Filling or loading the lagoons is a year-round activity that produces odors locally. These odors typically have an organic ammonia smell and do not tend to drift offsite. **Lagoon surfaces are covered with a water cap to minimize odors.**

- Dredge operations begin in November and end in April. Minimal odors are associated with this activity. Very low flows to seasonal drying beds are not conducive to a large amount of odor production. **Operations staff always attempt to load drying beds away from Coyote Creek whenever possible.**

- Mixing and windrowing operations occur from May to September. Minimal odors are associated with this activity. The bio-solids in this treatment stage are aerated and intermixed and earthy soil odors are generally produced. Drying bio-solids have the consistency of thick mud and odors are generally localized.

- The stockpiling, hauling, and removal of bio-solids occurs between July and October. The City of San Jose Environmental Services Department has a commercial beneficial re-use contract to remove and use the biosolids. Odor impacts are the greatest during this process when piles are turned and loaded into trucks to be hauled. **A water truck is run 8-10 hours a day during hauling season to keep odors and dust at a minimum. Hauling is started by 7:00 a. m. daily and completed by 4:00 p. m. daily Monday through Friday. Odor neutralizing chemicals are also added to the water. It is found that these measures are effective. In addition, the mobile mister is also used to reduce odors.**

- Plant and lagoon odor observations are performed twice/week. When odors/dust become a nuisance on site, Operators are instructed to move loading to other piles until wind patterns are favorable.(June-September)

- A mobile misting unit for odor neutralizing agents has been purchased and is operational. This mister has the capability of dispensing approximately 1.8 gallons per minute of neutralizer through 24 high-pressured nozzles. The resulting mist discharges about 30 feet into the air and is able to deodorize large areas.(as needed basis)

PLANT ODOR CONTROL

Sources: The potential sources of odors are open channels, wet wells, and tanks. The release of hydrogen sulfide (H_2S) gas and other compounds, the general source of wastewater odors, are due to septic conditions or anaerobic decomposition of organic material in the wastewater. The Plant is monitored regularly for the presence of H_2S so that control measures can be immediately implemented.

Control Measures

- Hydrogen peroxide is applied to the wastewater stream at three locations in the Plant that have the greatest potential for odor emission. The application points currently include the pretreatment area where the raw wastewater enters the Plant, the Primary treatment area where there is a large surface area of open tanks, and the flow equalization facility. The wastewater is regularly tested for the presence of H_2S. The dosage rate of hydrogen peroxide is adjusted as needed to prevent the generation of odors.

- Chlorine solution can be introduced to the wastewater stream in other areas of the Plant as needed to quickly control odors.

- Some buildings and enclosed areas of the Plant such as wet wells and the Grease Thickening Facility may generate odors that could be released. Using a sodium hypochlorite scrubbing system on the building ventilation controls the odors. Some wet wells are now ventilated with elevated stacks that are designed to allow the diffusion of any odors above ground level to reduce the potential impact on neighboring areas.

- Good housekeeping is a major part of odor control. Wastewater tanks that are out of service are immediately drained and cleaned to reduce the potential for odor release.

- Aeration of wastewater is a significant tool to reduce the formation of odor compounds. Many open wastewater channels in the Plant are fitted with air diffusers along the entire length to mitigate odors as well as provide treatment.

OFF-SITE ODOR CONTROL

- **Canoas Creek Ferrous Chloride Dosing Station** – A ferrous chloride dosing station was constructed approximately eight years ago on Blossom Hill Road to eliminate odors originating in the collection system. Dosing at this location regulates odor control in downstream neighborhoods and continues to provide effective odor control.

- **Zanker Road Odor Control Facility** - This facility has been installed on Zanker Road near River Oaks Parkway to remove H_2S from the interceptor sewer. The facility is designed to strip the H_2S gas from the sewer using a soil bed design where gases are passed through a soil and wood chip media. The H_2S is stripped from the air and is consumed by the microbial activity in the media. The resulting clean air is then vented to the atmosphere.

Odor Control Using Administrative Protocol

- Odor complaints are investigated, documented and kept on file at the Plant. A review of our records for the past ten years indicates that we receive odor complaints at the rate of one to two per year. Citizen complaints may be reported by contacting the Plant, BAAQMD, or the City of San Jose.

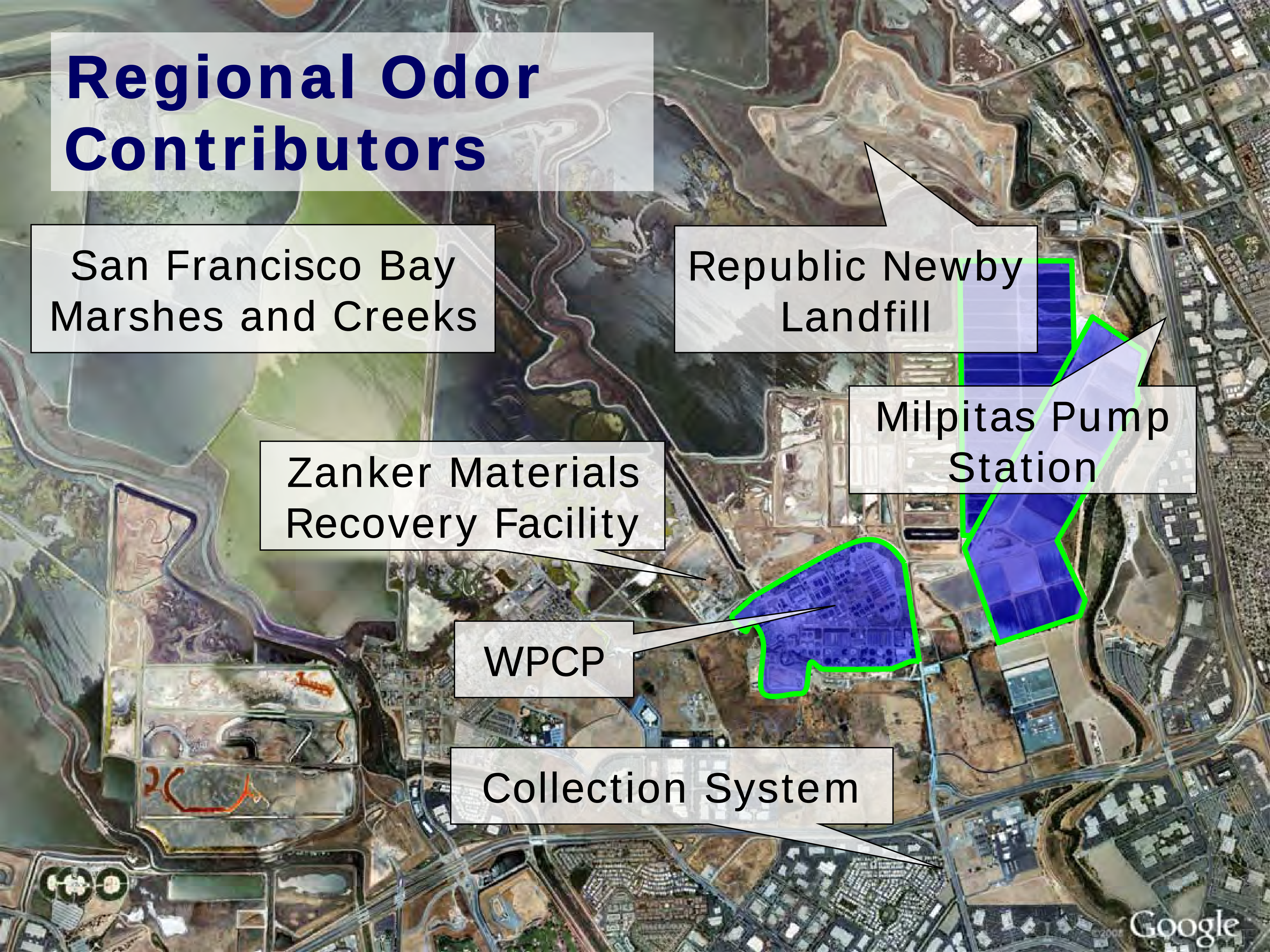
  - A new e-mail address for odor complaints, WPCP-Ops-Cntr@sanjoseca.gov has been provided to Milpitas and the BAAQMD to be used for immediate notification to the Shift Supervisors and San Jose/Santa Clara Treatment Plant Management in the events of any odor complaints.

  - RSM staff conducts routine odor observation around the area at least twice a week and will log and report any odor events they notice to the RSM management. (Year round)

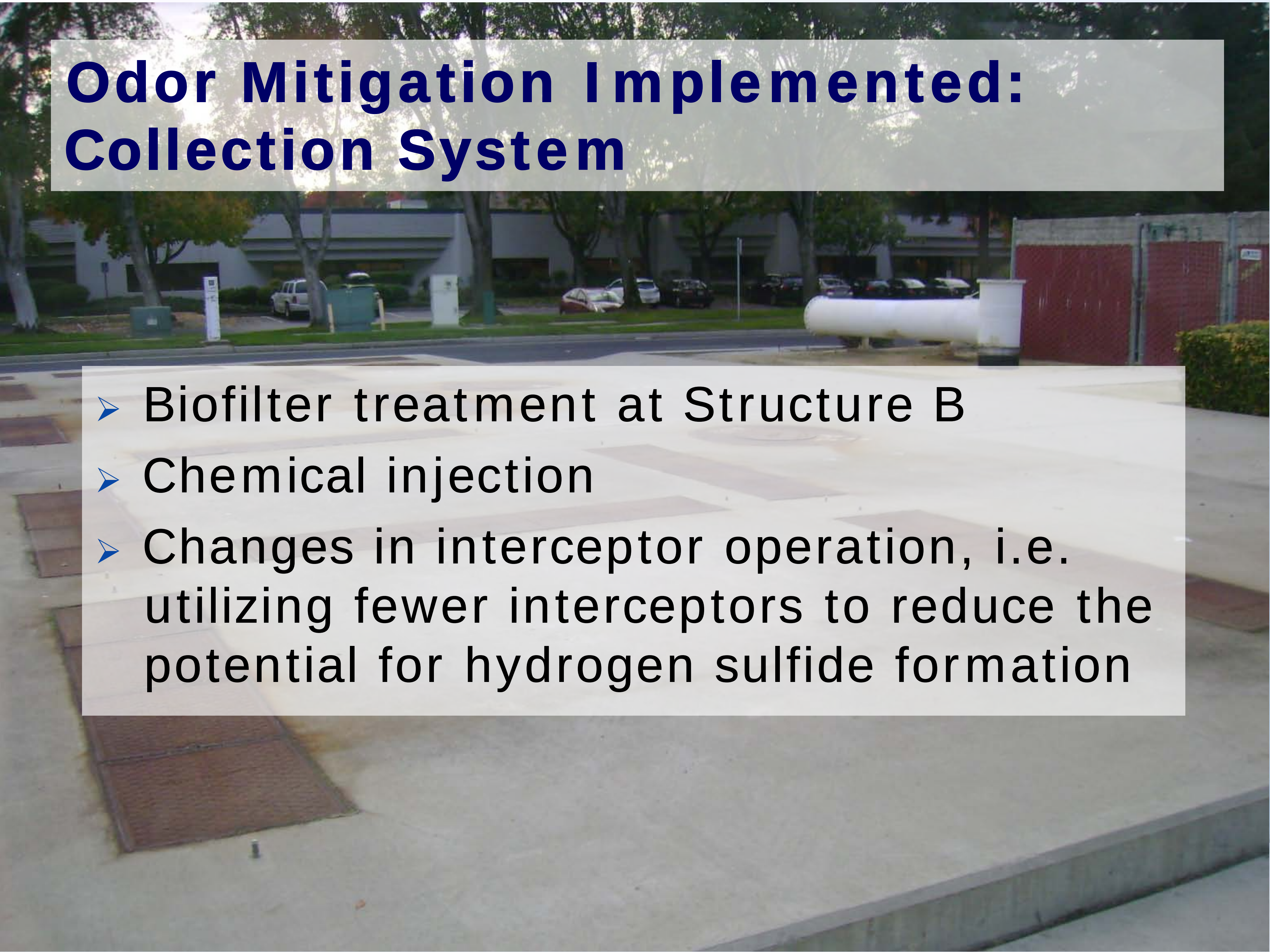
- Under the Plant's standard operating procedure, when an odor complaint is received directly from a citizen, in the absence of any Plant emergency and within reasonable distance from the Plant, a Plant Operations employee is sent to meet with the citizen at the location where odor is detected. Investigation includes wind direction, type of odor and other information that may allow staff to pinpoint the source. If the source is determined to be the Plant, mitigation steps are then taken and the citizen is informed of the outcome of the investigation of the mitigation steps taken. If the source is determined to be the collection system, then a referral to the corresponding department is made. (Where practical, year round)

APPENDIX C - REGIONAL ODOR CONTRIBUTORS AND IMPLEMENTED MITIGATION

Regional Odor Contributors



Odor Mitigation Implemented: Collection System



- Biofilter treatment at Structure B
- Chemical injection
- Changes in interceptor operation, i.e. utilizing fewer interceptors to reduce the potential for hydrogen sulfide formation

Odor Mitigation Implemented: Zanker

- Relocated composting operation to Gilroy
- No longer accept putrescible material (i.e. food waste)
- Limit on-site storage duration of green waste

Odor Mitigation Implemented: Milpitas Pump Station

In 2008, completed a pump station upgrade which included covering and containment of odors

Odor Mitigation Implemented: Republic (Newby) Landfill

- Have relocated the composting operation to their western-most boundary
- Have installed three odor neutralization fogging stations
- Limit the landfill open face to 1 acre
- Cover up their landfill open face daily

APPENDIX D - CITY OF MILPITAS ODOR CONTROL ACTION PLAN

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City of Milpitas

Odor Control Action Plan

Maintenance-Level Plan

Revised June 2008

1. INTRODUCTION

This maintenance-level odor action plan calls for the ongoing monitoring of odors and provides guidance for responding to excessive odor complaints exceeding baseline benchmarks established during the period of October 2003 to June 2008. The objective is to ensure that odor generators continue to maintain their best management practices and controls to keep odor incidents as low as practicable. The plan is a transition from the City's 2003 Odor Action Response Plan that reduced odor incidents to a baseline level through active stakeholder coordination. It continues many of the processes outlined the 2003 plan, including use of the Bay Area Air Quality Management District (BAAQMD) rapid notification process. Under this maintenance-level plan, staff will provide Council updates only an as needed basis and will continue to incorporate administrative changes in order to ensure that the processes and stakeholder contact information remains current.

2. BACKGROUND

On October 7, 2003, the City Council held a public hearing to receive testimony about chronic odor episodes within the City. Stakeholders including members of the community, regulatory agencies, and selected facilities attended. After receiving public comment, the Council directed staff to work with stakeholders to develop and implement an odor action plan. The objective was to reduce odor incidents by obtaining the cooperation and coordination of stakeholders and by simplifying the complaint reporting process.

Staff prepared the Odor Action Plan according to the following principles:

- Centralized Complaints Handling. Publicizing use of the BAAQMD Hotline (1-800-334-6367) would reduce confusion about how to submit complaints. It also reduces regulatory duplication.
- Timely Notifications. Quick feedback to potential sources about odor events would allow them to adjust or stop their odor generating processes. Sources identified this component as the most effective way to help them control odors from their sites.
- Prevention/Oversight Accountability. Development and implementation of best management practices at each potential source would yield consistent, responsive and effective odor control.

Staff implemented the plan upon Council's acceptance and provided Council quarterly status reports for the next three and one half years. At its June 19, 2007 meeting, Council reduced the reporting frequency from quarterly to annual. All other provisions of the action plan were to be continued, including the use of the BAAQMD odor hotline and the rapid notification process.

2.1 Stakeholders

Stakeholders consist of the members of the community, regulatory agencies, and potential odor sources that worked together to reduce the incidences of odor complaints. A history of stakeholder meeting is including in Appendix A.

Milpitas Community: The activities of the Milpitas community are adversely affected from odor incidents. It is the duty of the sources and the regulatory community to limit odor incidents to the maximum extent practicable. The community can assist this process by reporting odor incidents in a timely fashion and providing the BAAQMD investigator specific information about odors.

Regulatory Agencies:

California Integrated Waste Management Board (CIWMB) - This state agency is charged with developing and enforcing regulations for air quality. CIWMB oversees the performance of Local Enforcement Agencies (LEAs). CIWMB also shares permitting and environmental review at landfill, recycling, and compost facilities.

The Bay Area Air Quality Management District (BAAQMD) - BAAQMD is a special district charged with enforcing air quality regulations for stationary sources in the San Francisco Bay Area. It is the lead agency for investigation and control of odors. Upon receipt of a complaint, BAAQMD assigns a control number and sends an investigator to interview the complainant and locate the odor source. BAAQMD enforces when five or more odor events are verified by the investigator within a 24-hour period, and if the odor source site is identified. This process is undergoing a review and may include future revisions. The BAAQMD odor complaint process is shown in Figure 1.

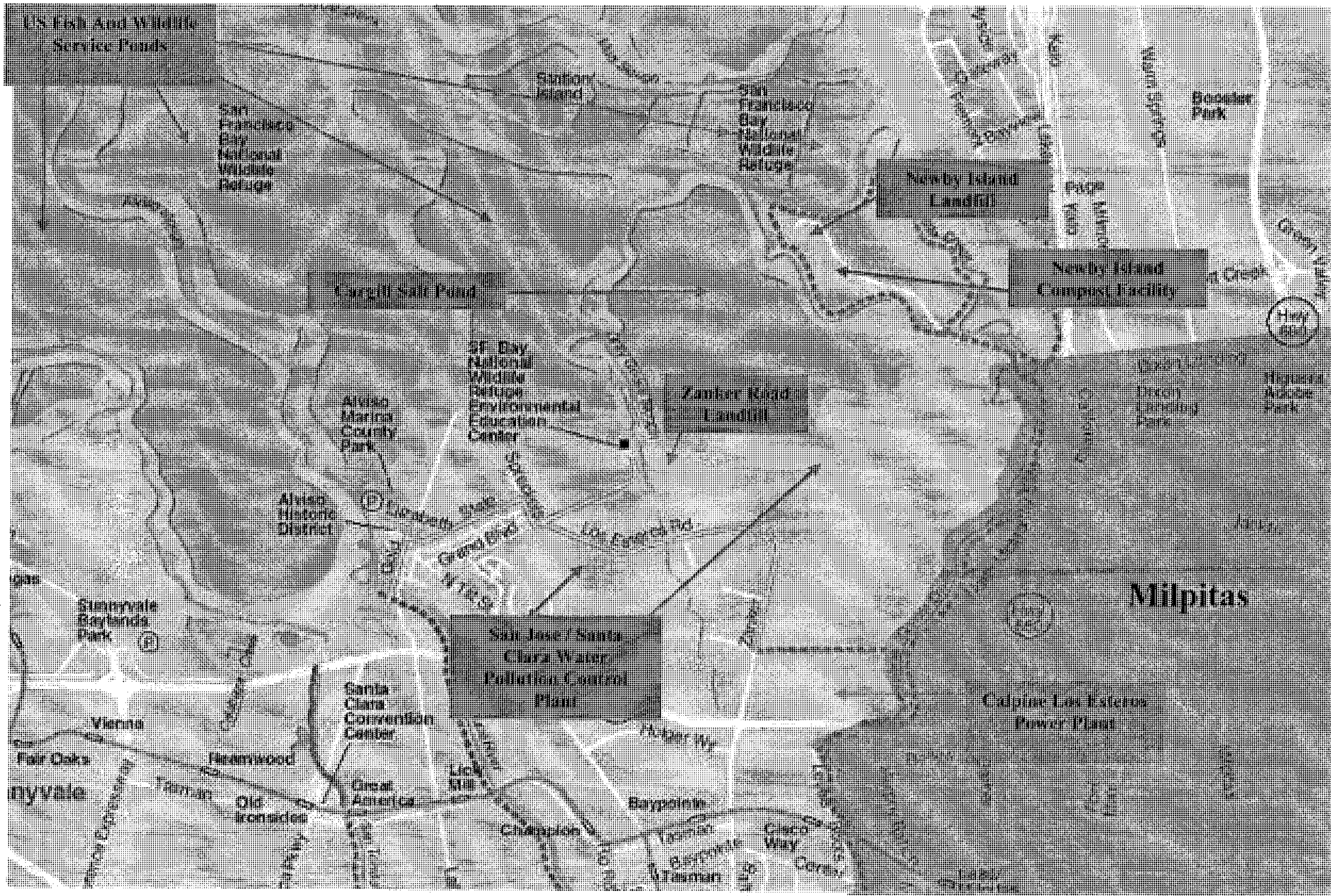
City of San Jose Local Enforcement Agency (LEA) - The 1989 California Integrated Waste Management Act charged Local Enforcement Agencies with monitoring, and enforcing odor emission from composting facilities. The local LEA is the Code Enforcement Section of the Planning Department of the City of San Jose. The LEA is responsible for permitting, inspecting, and enforcing regulations.

Potential Sources: Figure 2 shows the locations of potential odor sources, which are largely outside of the City of Milpitas. All sites were visited as part of a background review. Staff met with representatives from each site to discuss odor sources and methods to control odors.

City of Milpitas Sewage Collection System - The City's sewage collection system consists of laterals, sewers and pump stations. Odorous gases form from the decomposition of organic material. Odors are generated where sewage is detained and are released with turbulent flow. Such locations include the Main Sewer Lift Station located at the northwest corner of the city and the Venus Way Sewer Pump Station located near the corner of Capitol Avenue and Venus Way. The Main Sewer Lift station is currently undergoing a total reconstruction to be completed October 2008. During the design phase a comprehensive odor analysis was conducted that determined that specific odor control was not warranted. The Venus station is less likely to generate odors because it is relatively small and consists of submersible pumps within a covered, wet vault.

San Jose/Santa Clara Water Pollution Control Plant (WPCP) – This 50 year-old facility is located on Zanker Road a mile west of the City. The WPCP treats sewage from

Figure 2
Potential Odor Sources Locations



Milpitas, San Jose, Santa Clara, and other Santa Clara communities. Odors are generated in the sewage treatment and solids handling processes. The treatment process first separates solids and liquids. Solids are treated by anaerobic digestion for about 30 days, stored in open air lagoons for 3 to 4 years, and then air dried in open drying beds. Finally, the solids are hauled to the adjacent Newby Island landfill for use as alternative daily cover. Odor controls include the use of chemicals such as chlorine, hydrogen peroxide, ferric chloride, and odor-masking agents. The WPCP began a master planning effort in 2008 to guide the reconstruction of the facility to be conducted over the next 20 years.

Allied Waste – Newby Island Landfill - This landfill, located about one mile west of the City of Milpitas near Dixon Landing Road, was constructed in the 1930's and has an estimated life until 2023. Trash collected from Milpitas and other Santa Clara communities is disposed at this site. The facility covers approximately 350 acres and handles about 845,000 tons of solid waste each year. Disposal is into cells with daily cover applied each evening. Methane and other gases may be generated as a result of trash decomposition.

Allied Waste - Compost Facility - This facility is located about one mile west of the City of Milpitas boundary at Dixon Landing Road. The facility processes green and food waste into compost by aerobically decomposing the materials over about a 90-day period. Green wastes are shredded and dampened added prior to placement in windrows for decomposition. The windrows are aerated mechanically. Food wastes (including organics from the City of Milpitas) are placed into windrows that are covered with fabric and are aerated by means of negative pressure by fans.

Zanker Road Landfill/Compost Facility. This facility, located about 1.8 miles to the west of Milpitas, was constructed in 1985 and has an estimated life until 2023. It covers about 70 acres, with 46 acres of permitted disposal and the other 24 acres established as wetlands. Landfilling operations include processing and disposal of nonhazardous, noncompostable, inert mixed wastes, as well as recycling residuals from the on site resource recovery activities. It handles about 300,000 tons of material each year. The Landfill composts yard waste by conventional open-windrow composting. Windrows are watered and turned daily and the compost process is completed in twelve weeks. Each day about 100 tons of grass and leaves is composted.

The same company operates the neighboring Zanker Materials Processing Facility, with similar landfill operations. This second site is 70 acres and also handles about 300,000 tons of material each year. The resource recovery facility processes concrete, demolition debris, wood waste, glass, soil, and yard-waste and composting. There is no composting. Disposal includes daily cover of trash cells.

San Francisco Bay and Creeks). Natural decomposition of organic material occurs in the San Francisco bay wetlands west of Milpitas. During windy conditions, marsh sediments may be churned and odors released. Such events are more likely to occur during the spring and/or fall. Cargill formerly produced commercial salt by evaporating brine in a series of drying ponds on the bay fringe. In August 2002, a transfer pump at Cargill Salt Pond A18 failed, resulting in exposure and decomposition of pond bottom organic material. BAAQMD issued public nuisance citations. Cargill since installed gates on levees to allow gravity transfer of water between ponds. Portions of the Cargill holdings are now part of the South Bay Salt Pond Restoration Project.

2.2 Implementation of Best Management Practices (BMPs).

City staff and regulatory agencies completed site visits to each of the possible odor source facilities. Facility staff has shared information on their operation and details on odor control practices. The sites have best management practices (BMPs) to control odors. Among the practices noted are:

Allied – Compost Facility. Allied submits an odor minimization plan, required to be submitted by all compost facilities under Integrated Waste Management Board regulations, to the LEA each year. The plan includes odor-monitoring protocols, summary of meteorological conditions affecting migration of odors, and a complaint response procedure. Allied has improved various aspects of the plan over the years, including rapid response to odor complaints identifying Newby Island as the source.

Allied – Landfill. The landfill is contracted to the WPCP to accept and beneficially reuse Class A biosolids as alternate daily cover. Allied and WPCP staff monitor a weather station at the WPCP to forecast wind conditions and possible inversion layers which may adversely disperse odors during the loading and transportation of the biosolids. Allied and the WPCP found in 2005 that transporting biosolids from the drying beds windrows directly to the landfill without stockpiling reduced odor complaints. Allied has made several other operational changes reducing odor generation and dispersion, including:

- Increased monitoring of meteorological conditions at the facility and use of meteorological data to minimize potential impacts of odor beyond the site boundary.
- The conduct of a research and development program (test period from about February 2005 to March 2007) to assess the advantages and disadvantages of composting yard waste on the top of the landfill.
- Receiving dried sludge from the WPCP for disposal at the landfill during periods when meteorological conditions favor maximum odor dispersion and dispersion in a direction away from receptors.

Water Pollution Control Plant (WPCP). WPCP has implemented a BMP plan which includes extended solids stabilization enclosing process areas and ventilation through scrubbing or dispersion stacks, use of water trucks to control dust and completion of biosolids removal by each afternoon and use of mobile misting neutralizing chemicals, among others. An on-site weather station provides wind speed and direction data, which assists in making operational decisions. The WCPC implemented several changes to its practices to control generation of odors from the sludge drying and hauling operations, including:

- Increased monitoring of meteorological conditions at the facility and use of meteorological data that affect odor generating operations and, hence, minimize potential impacts of odor beyond the site boundary.

- More attention paid by plant personnel to hauling dried sludge during periods of the year and under meteorological conditions that were not conducive to odor dispersion and to dispersion over areas of high population density.

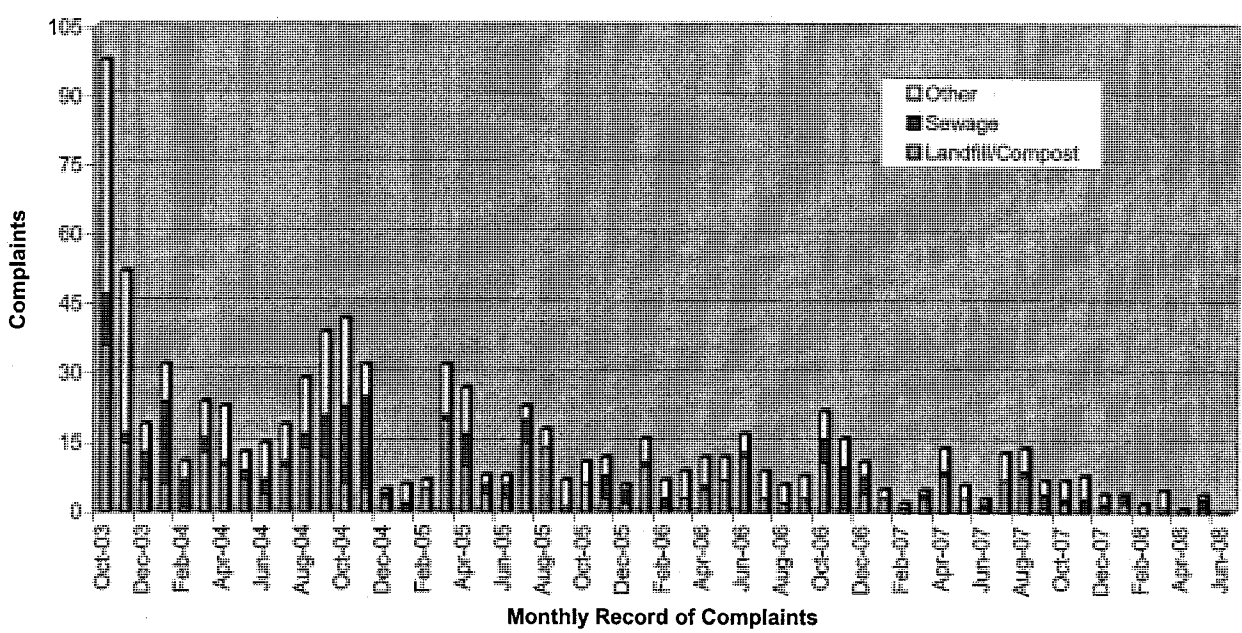
Odor Advice. The City employs a consultant to provide odor management advice. The scope of activities includes as-needed services for the odor outreach program, review of best management practices at potential odor sources, advice on legislative changes, and support at coordination and public sessions.

Additional Meteorological Stations and Monitoring. The City of Milpitas installed meteorological stations at: 1) the City's sewage pumping station located adjacent to the WPCP and Newby Island, and 2) the City's Public Works department. These stations allow a better understanding of local weather conditions affecting odor transport and help assess odor incidences. Data from the City's meteorological stations complement meteorological conditions monitored by Allied/BFI at the Newby Island Landfill location and by the WPCP at the wastewater treatment plant.

Over the course of the last three and one-half years, odor complaints have decreased and are now at a baseline level as shown in Figure 3. It is appropriate to transition to a maintenance-level odor control action plan that will continue the rapid notification and complaint tracking processes. The objective of this plan is to ensure that odor generators continue to maintain their BMPs and controls to keep odor incidents as low as practicable. The BAAQMD rapid notification process will remain in effect and staff will continue tracking complaints to ensure that they remain at the currently attained baseline level.

Figure 3

Oct 2003 - May 2008 Odor Complaint Summary



3. MAINTENANCE LEVEL ODOR ACTION PLAN

Due to the effectiveness of the City's odor management program, the City is transitioning to a maintenance-level plan consisting of on-going verification of proper operation of the rapid notification process and monitoring of alleged complaints to identify situations wherein the action (trigger) benchmarks are reached or exceeded. Components of the Maintenance-Level Odor Action Plan are as follows.

3.1 Streamlined Complaint Process. The Bay Area Air Quality Management District reporting hotline will continue as the centralize complaint receipt site. BAAQMD inspectors will now immediately investigate potential odor sources prior to interviewing complainant. The contact number is 1-800-334-ODOR or 1-800-334-6367. Outreach to advise the public of the number and what to provide is being implemented includes:

- Flyers placed at public counters
- Flyer as appears on www.ci.Milpitas.ca.gov
- Public Service Announcements – City Media (1510AM, KMLP15 – TV)
- Advertisement in "City Information Pages" of the May 2008 *Milpitas Yellow Pages*
- Flyers available at annual Celebrate Milpitas! Art & Wine Festival
- Flyers available at annual Family Day

3.2 Rapid Notification Plan. The rapid notification provides real-time information to regulatory agencies and stakeholders that may correlate to specific plant operations. It gives agencies and stakeholders the opportunity to take proactive steps to mitigate any potential odor impacts. Notifications are sent to the City of Milpitas and the City of San Jose LEA. Memorandums of understanding to receive complaint notifications have been completed between BAAQMD and Allied, Calpine, Cargill, WPCP and Zanker.

3.3 Triggers for Significant Incident Response Plan. Trigger levels of significant odor complaints are defined from experience gained over the past 36 months about the number of complaints indicating a potentially sustained problem. The triggers are at a level higher than the random baseline and indicate that action is needed to investigate and resolve the cause of odor. The trigger levels lower than regulatory levels because it is prudent to trigger City and facility (source) action before the BAAQMD is obligated to take regulatory action. The benchmarks or trigger levels to invoke the Significant Incident Plan are:

- 3 or more complaints per day from a single reporting location over 2 consecutive days, or
- 16 or more complaints from a single reporting location over a 30-day period.

If either of these trigger levels is exceeded, the City will implement Significant Incident Response Plan.

3.4 Significant Incident Response Plan

The following plan has been developed by CalRecovery, the City's consultant, to be implemented in the event of a "Significant Odor Incident" (SOI). A SOI is a condition wherein the frequency or intensity of odor complaints is above the baseline. Such a situation requires review and verification by City staff. Upon determination that a SOI may have occurred, city staff shall begin the following process:

Preliminary Investigation

1. Staff contacts sources of complaint calls to confirm if the odors are still being observed and alleged source of odors.
2. Staff contacts facility (ies) that are described in call complaints as the alleged sources of the odors to determine if, in the potential source's, opinion there is a reason for the odor complaints, or if there have been any changes in operations near the time of the complaints that could have been the reason for the odor complaints, etc.
3. Based on the results of the above contacts and a preliminary analysis of the situation, staff will decide if odor frequency indicates that facilities are not following best management practices (BMPs) and may proceed to the next step of the Plan.

Notifications. If staff concludes that BMPs are not being followed, staff will notify the following entities and to trigger all or part of the described actions, as appropriate:

1. Public Works Director (PWD) will be notified of the observations and premise that triggered the SOI,
2. Alleged Source(s) will be notified to implement their response plan (see Attachment 2),
3. Regulatory Agency (BAAQMD and/or LEA) may be contacted to verify their response and follow up investigation status,
4. Consultant may be asked to correlate meteorological and other factors to assist in verifying source(s), and assist as needed.
5. City Council will be notified in the weekly update that the number of complaints exceeded the benchmark and will be given information about the cause and response.

Staff Investigation. If the results of the preliminary investigation are inconclusive, City staff may tour the area of complaints and source(s) in conjunction with affected stakeholders. Depending on the results of this tour, staff sources implement their contingency plans, as described below. Staff may track and document corrective activities and results and brief PWD (and others as needed) of status.

<u>Allied Response Plan</u>

1. Facility receives report of SOI by City Staff.
2. Facility immediately examines operational activities and downloads information from on-site weather station to determine likelihood of being the odor-causing agent.
3. If possible odor-producing agent, facility implements the following options:
   - Immediately suspends the suspected odor-causing activity/operation(s) as allowed by law.
   - Implements odor control measures.
   - Implements additional damage control measures (i.e. drive to the odor incident area to witness the event and/or interview witnesses).
   - Review operation to determine causation and future preventative steps.
   - If unlikely odor-producing agent, facility continues operations but reviews possible odor-generating procedures to preclude potential incidents.
4. In both scenarios, coordination with BAAQMD inspector(s), LEA inspector(s) and City on findings applies.

WPCP Response Plan

1. Facility (computer room) receives report of SOI by City Staff.
2. Facility staff contact is alerted.
3. Facility immediately examines on-site activities and obtains weather satellite information to determine likelihood of being the odor-causing agent.
4. If possible odor-producing agent, facility implements the following options:
   - Immediately suspends the suspected odor-causing activity/operation(s) as allowed by law.
   - Implements odor control measures (i.e. mister device).
   - Implements additional damage control measures (i.e. drive to odor incident area to witness the event and/or interview witnesses).
   - Review operation to determine causation and future preventive steps.
5. If unlikely odor-producing agent, facility continues operations but reviews possible odor generating procedures to preclude potential incidents.
6. Provide finding to BAAQMD inspector(s), LEA inspector(s), and City on findings applies.

Debriefing. If needed, City staff will conduct debriefing on findings from alleged source and regulatory agencies to determine cause, and develop recommendations to prevent future recurrences.

1. A subsequent session with stakeholders may be conducted to share information and update plans to minimize future episodes.
2. All findings, actions and recommendations to be filed for use during any subsequent episodes.

APPENDIX A
Stakeholder Site Visit and Coordination Session Summary

Date	Activity
10-16-03	Stakeholder Coordination Kickoff Meeting
10-22-03	Regulatory Stakeholder Meeting
10-24-03	Water Pollution Control Plant (WPCP) Site Visit
10-28-03	Stakeholder Coordination Meeting
10-29-03	Review w/BAAQMD of complaint process
10-30-03	Cargill Coordination Meeting
10-30-03	Regulatory Stakeholder Meeting
10-31-03	BFI Compost Site Visit w/BAAQMD and LEA
11-12-03	Zanker Landfill Site Visit
11-14-03	Regulatory Stakeholder Meeting
11-14-03	Cargill Site Visit
11-17-03	CIWMB Conference Call Meeting
11-18-03	Calpine Los Esteros Power Plant Site Visit
11-18-03	Stakeholder Coordination Meeting
11-25-03	Regulatory Stakeholder Conf. Call
11-25-03	BFI D-Shape Parcel Review Meeting
12-01-03	Milpitas Sewage Pump Stations Site Visit
12-17-03	Regulatory Stakeholder Meeting
2-5-04	Stakeholder Coordination Meeting
2-10-04	Odor Consultant Kickoff Meeting
2-24-04	WPCP Best Management Practices Site Visit
3-29-04	Newby Island Best Management Practices Site Visit
5-11-04	Cargill Best Management Practices Site Visit
5-12-04	Zanker Best Management Practices Site Visit
5-25-04	Allied Site Visit with LEA/Cal Recovery
6-17-04	South Bay Salt Pond Tour
7-1-04	Odor Consultant Contingency Plan Meeting
7-12-04	Weather Station Meeting
7-21-04	BAAQMD Coordination Meeting
7-28-04	Allied Coordination Meeting
8-17-04	WPCP Odor Contingency Plan Meeting
8-17-04	Allied Odor Contingency Plan Meeting
12-15-04	Pond A-18 Comment Letter to City of San Jose
5-02-06	Odor Action Plan Update Meeting with WPCP
5-02-06	Odor Action Plan Update Meeting with Allied

APPENDIX B
SIGNIFICANT ODOR INCIDENT CONTACT LIST*

BAY AREA AIR QUALITY MANAGEMENT DISTRICT (BAAQMD):

Vicki Dvorak, Air Quality Program Manager (phone: 415.749.4764)
Steven Chin, Supervising Air Quality Inspector (phone: 415.749.4751, cell: 415.760.6345)
Jay Patel, Air Quality Inspector (phone: 415.749.6561)
Bob Delarno, Air Quality Inspector (phone: 415.749.5154)

CITY OF SAN JOSE, LOCAL ENFORCEMENT AGENCY (LEA):

Dennis Ferrier, Supervising Environmental Inspector (phone: 408.277.8725, cell: 408.888.8625)
Jamie Matthews, Administrator (phone: 408.277.4703)
Marty Pardun, Environmental Inspector (phone: 408.277.8724)
Rich Archdeacon, Environmental Inspector (phone: 408.277.8723)

CITY OF MILPITAS:

Elizabeth Koo, Administrative Analyst (408.586.3353)
Kathleen Phalen, Utility Engineer (408.586.3345)
Greg Armendariz, Director of Public Works/City Engineer (408.586.3317)

ALLIED WASTE SERVICES (ALLIED):

Gil Cheso, General Manager (phone: 408.635-1406, cell: 408.595.9716)
Mark Buntjer, BFI Recyclery (phone: 408-945-2801, cell: 925.980.5236)

CALPINE LOS ESTEROS POWER PLANT:

Allison Bryan, Compliance Manager (phone: 408.635.1308)

CARGILL:

Sean Riley, Environmental Manager (phone: 510.790.8625)

SAN JOSE/SANTA CLARA WATER POLLUTION CONTROL PLANT (WPCP):

Ken Rock, Operations Division Manager (phone: 408.945.5356)
Dale Ihrke, Deputy Director (phone: 408.945.5300)
Keith Creal, RSM Supervisor (phone: 408.945.5433)

ZANKER ROAD LANDFILL:

Scott Beall (phone: 408.263.2384)

*Bolded items indicate primary contact.

APPENDIX E - MEASUREMENT AND REGULATION OF ODORS IN THE USA

Measurement and Regulation of Odors in the USA

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Keywords
Regulations, United States, measurement

Abstract
This paper will present highlights of the current approaches used in the USA relative to odor regulations and guidelines. The issue of odor standardization has progressed significantly during the last few years. In the USA, the Air & Waste Management Association's EE-6 Odor Committee has forwarded its guidelines to the American Society of Testing Materials (ASTM) as a suggested replacement for ASTM Method E679-91. Among other things, the guidelines recommend a minimum flow rate of 3 liters per minute (lpm) for olfactometers. However a large number of odor laboratories in the USA have adopted the European Standard approach of a 20 lpm flow rate. The author asks whether current olfactometry based odor regulatory standards in the USA standards will now be inconsistent with the higher D/T (OU) levels that may be associated with the higher flow rates used as part of the European Standard approach?

1. Introduction

Odors are increasingly the cause of complaints to environmental regulatory agencies in the USA. One reason for this increase is the fact that more homes are being built near waste processing facilities such as wastewater treatment plants and landfills due to a lack of buildable land. Also as home prices have risen significantly in recent years, many residents have become less tolerant to even occasional odors or other nuisance conditions that are perceived to have an impact on property values. In addition, in agricultural areas of the USA there has been a dramatic increase in corporate large-scale confined animal feeding operations. Because most of these animal facilities do not really have significant odor treatment systems in place, there has been a significant increase in complaints and regulations relative to animal feeding operations in the USA.

2. Types of Odor Regulatory Approaches Used in the USA

There are generally a number of different approaches that are commonly used in the USA to regulate odors.

(1) The use of ambient air limits for individual compounds such as hydrogen sulfide as used in the state of Minnesota (see Table 1 below). The existence of so many different odorous compounds associated with WWTPs and particularly most

livestock operations creates serious potential problems when using individual compounds as the basis for assessing odors. In addition, detection and odor annoyance thresholds cited in the literature and in regulations vary widely for compounds such as hydrogen sulfide.

Table 1. Examples of Ambient Standards for Odor Causing Compounds
(all agencies listed are state agencies unless otherwise noted) *from Mahin, 2001 (1)*

Location	Compound	Ambient Odor Standard
California	Hydrogen sulfide	30 ppbv* (1-hour average)
Connecticut	Hydrogen sulfide Methyl mercaptan	6.3 ug/m^3 2.2 ug/m^3
Idaho	Hydrogen sulfide	10 ppbv (24 hour average) 30 ppbv (30 min. average)
Minnesota	Hydrogen sulfide	30 ppbv (30 minute average)** 50 ppbv (30 minute average)***
Nebraska	Total reduced sulfur	100 ppb (30 minute average)
New Mexico	Hydrogen sulfide	10 ppbv (1 hour avg.) or 30 - 100 ppbv (30 minute avg.)
New York State	Hydrogen sulfide	10 ppbv (14 ug/m^3) 1-hour average
New York City	Hydrogen sulfide	1 ppbv (for wastewater plants)
North Dakota	Hydrogen sulfide	50 ppbv (instantaneous, two readings 15 min. apart)
Pennsylvania	Hydrogen sulfide	100 ppbv (1 hour average) 5 ppbv (24 hour average)
Texas	Hydrogen sulfide	80 ppbv (30 minute avg.) - residential/commercial & 120 ppbv - industrial, vacant or range lands

* - parts per billion by volume
** - not to be exceeded more than 2 days in a 5-day period
*** - not to be exceeded more than 2 times per year

(2) General regulatory language that prohibits off-site nuisance or annoyance conditions as determined by field inspectors in response to complaints from the public. Some agencies have implemented procedures whereby inspectors rate the intensity of the odor in the field, based on an intensity scale. Six point scales are sometimes used with 1 = very weak, 2 = weak, 3 = distinct, 4 = strong, 5 = very strong and 6 = extremely strong. The advantage to this approach is its simplicity and the fact that it is not a theoretical value predicted by a model. One disadvantage for both this approach and the hydrogen sulfide hand-held meter approach is that odor nuisance conditions occur much more frequently in the evening and early morning when regulatory staff are usually not working.

(3) Off-site limits based on levels predicted by dispersion modeling and using the dynamic olfactometry approach with the criteria reported as odor units (OU),

OU/m^3 or dilutions/threshold (D/T). The terms D/T, OU/m^3 and OU will be used interchangeably in this paper since they all represent the same concept (see Table 2 below).

(4) Best available control technology (BACT) or similar approaches that specify required levels of odor treatment controls for new or upgraded large facilities.

(5) The American Society of Agricultural Engineering (ASAE) document Engineering Practice 379.1 “Control of Manure Odors” recommends setbacks from livestock facilities of 0.4 to 0.8 km for neighboring residences and 1.6 km to residential development (2).

Table 2 Examples of OU/m3 (D/T) Limits Used from Mahin (1)

Location	Off-site standard or guideline	Averaging times
Allegheny County Wastewater Treatment Plant (WWTP)	4 D/T (design goal)	2-minutes
San Francisco Bay Area Air Quality District	5 D/T	Applied after at least 10 complaints within 90-days
State of Colorado	7 D/T (Scentometer)	
State of Connecticut	7 D/T	
State of Massachusetts	5 D/T*	
State of New Jersey	5 D/T **	5-minutes or less
State of North Dakota	2 D/T (Scentometer)	
State of Oregon	1 to 2 D/T	15-minutes
City of Oakland, CA	50 D/T	3-minute
City of San Diego WWTP	5 D/T	5-minutes
City of Seattle WWTP	5 D/T	5-minutes

* draft policy and guidance for composting facilities
** for biosolids/sludge handling and treatment facilities

The European Committee for Standardization or CEN has developed a standard method for odor laboratory measurement using olfactometry. The standard, which is to be called “Air Quality – Determination of Odour Concentration by Dynamic Olfactometry” will be referred to in this paper as the “European Standard” (3). In the USA, several universities and WWTP districts follow the European standard’s basic tenets including: Duke University, Iowa State University, the University of Minnesota, Purdue University, the Los Angeles County Sanitation District and the Minnesota Metropolitan Council (4).

A study conducted for the California Air Resources Board (USA) included the review of six published studies that related to recognizability, unpleasantness and annoyance associated with a variety of unpleasant odors. The analysis concluded that for unpleasant odors the threshold of annoyance is at approximately five times the threshold of detection (5). California's South Coast Air Quality Management District's states that at 5 D/T (OU/m^3) people become consciously aware of the presence of an odor and that at 5 to 10 D/T odors are strong enough to evoke registered complaints (6)(7). It should be pointed out that there are questions as to whether these assumptions are still valid given the apparent increased sensitivity of the European Standard laboratory methods compared to ASTM Method E 679-91 (8). Given the background OU/m^3 levels commonly reported and because of the residual odor associated with Tedlar and similar bags, the olfactometric approach should not be used for ambient air odor analysis but rather for impact predictions using dispersion modeling.

3. Air & Waste Management Association Guidelines for Odor Sampling and Measurement

A subcommittee of the EE-6 Odor Committee of the Air and Waste Management Association (A&WMA) was formed to develop a set of guidelines or recommended practices for the standardization of odor sampling procedures and odor measurement techniques by dynamic dilution olfactometry. The A&WMA EE-6 Subcommittee on the Standardization of Odor Measurement prepared a document titled Guidelines for Odor Sampling and Measurement by Dynamic Dilution Olfactometry August 23, 2002 (9). The EE-6 Odor Committee has submitted the Guidelines to the ASTM as a more detailed odor testing replacement method for the current ASTM method E679-91 (Standard Practice for Determination of Odor and Taste Thresholds by a Forced-Choice Ascending Concentration Series Methods of Limits) (8).

The method accepts the use of forced choice or non-forced choice sample presentation method in an ascending concentration triangular method (one diluted odor sample and two blanks per presentation) or a binary method (one diluted odor sample and one blank per presentation). To reduce the variability obtained, the guidelines recommend that panelists also indicate their basis for the choice: pure guess, possible difference or recognize the presence of an odor.

The guidelines recommend that the flow rates of the olfactometer should be calibrated regularly using a primary volume-measuring device (i.e. soap bubble flow meter). To obtain consistent and accurate values, the flow rates of both the dilution (odor-free) air and the sample flows should be measured at all delivery settings several times and averaged to ensure stability.

The guidelines state that screening for detection of n-butanol and at least one other odorant should be conducted using aqueous solutions. Initially, a sub-threshold concentration of the selected odorant in distilled water is compared to two bottles containing only distilled, odor-free (triangular presentation) water. The candidate is asked to pick the bottle containing the odorant. A series of similar triangular presentations are made in an ascending series with the odorant concentrations doubling at each step.

The second screening procedure involves familiarization of the potential candidates with the olfactometric procedures and determines each individual's detection threshold for: a standardized concentration on n- butanol and an odor sample or prepared standard representative of the specific project.

The screening samples should be run in triplicate. To be accepted as a panelist, the geometric mean of the individual detection thresholds should be within 0.5 and 2 times the accepted reference value for the reference material used. After all panelists have evaluated a series of dilutions for the test sample, individual panelists' best estimate thresholds (BET) are determined. The BET for a panelist is the geometric mean of that dilution level (or equivalent concentration) at which the first point (highest dilution level) of a consistently correct series of (+) responses (with some degree of certainty) and the dilution level prior to this point. All responses indicated by the panelists as being guesses are disregarded.

3.1 Olfactometer Flow Rates

The guidelines state that the airflow rate from the olfactometer sniff ports must be regulated at a **minimum** of 3 liters per minute (lpm) to account for the variability of individual breathing/sniffing volumes and techniques during olfactory evaluations. The resultant face velocity at the cup face should be between 1 -10 cm/sec.

In the effort to reach international consensus on the standardization of odor measurement techniques, flow rate has probably been the most controversial issues (10). An earlier draft version of the EE-6 Odor Committee guidelines recommended a flow rate of 8 lpm (11). The final version includes a minimum flow rate but no maximum so that the 20 lpm flow rate used in the European Standard approach would still be consistent with the guidelines.

The guidelines also state that smelling chambers should be a cylindrical shape or an ergonomically shaped nasal mask and must be made out of a non-reactive, odor-free material (glass or Teflon). The cup design must allow for an even flow profile at the face of the cup. The diameter of the chambers must be between 5 and 10 cm to allow full insertion of the panelists' nose into the chamber and result in a face velocity that is barely perceptible by the panelists. Note: high flow rates and high face velocities may result in notable discomfort of the panelists.

3.2 Odor Sample Collection

The guidelines state that odor samples should be collected using a sampling line made of an odor-free, chemically inert and non-reactive material (i.e. Teflon or similar). The samples should be collected into gas sampling bags made of Tedlar. This material has been specified because it is the best at maintaining sample integrity and has the lowest background odor. New bags should be purged with odor-free air prior to use to ensure that there is no contamination due to manufacturing “bag” odor. This is especially critical with the collection of low level or ambient odor samples.

Re-use of sampling bags may be possible with low odor (i.e. less than 50 D/T) samples. Pre-used bags should be purged continuously with odor-free air for a minimum of 24 hours and tested to ensure that they are acceptable prior to re-use.

The sample bag must be half filled at least once and emptied prior to collecting the final sample in order to precondition the sampling line and the interior walls of the sampling bag. The guidelines state that if pre-dilution of the sample is necessary due to an excessively high odor level, high temperature, or high humidity of the sample gas, pre-conditioning of the sample bag with the diluted sample is also required.

The sampling train should allow for transfer of the gas through the sampling line directly into the sample bag without going through any potential sources of contamination such as rotameters, pumps etc. The recommended method for sample collection is the “evacuated drum” or “sampling lung” where the sample bag is placed within a rigid, leak-proof container. The air inside the container is evacuated using a pump, which causes the bag to fill with sample at a rate equal to the container evacuation rate. Pre-dilution of the sample may be required to prevent condensation in the bag if the sample gas contains a significant amount of moisture

4. Conclusions

- The issue of odor standardization has progressed significant during the last few years. The CEN European Standard has become the official olfactometry odor analysis approach for a number of countries. In the USA, the A&WMA EE-6 Odor Committee has forwarded its guidelines to the American Society of Testing Materials (ASTM) as a suggested replacement for ASTM Method E679-91. In addition, an interlaboratory comparison of seven olfactometry laboratories was conducted in Japan in late 2000 (12).
- The A&WMA guidelines are similar to the European Standard but they do allow quite a bit of flexibility in what olfactometer flow rates cab be used. This could potentially be a problem when attempting to compare data and results from different olfactometry laboratories.
- With the A&WMA guidelines now final, an important issue needs to be analyzed in the future. Current OU/m^3 (D/T) odor regulatory standards in the USA have traditionally been based on lower olfactometry flow rates used in the past. Will these regulatory standards now be inconsistent with what are believed by some to be the higher D/T (OU) levels associated with the higher olfactometric flow rates associated with the European Standard? There appears to be a need for studies in the future that would compare results from analysis of odor samples using varying olfactometry flow rates.

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APPENDIX F - FIELD SAMPLING AND LABORATORY ANALYSIS RECOMMENDED PROTOCOLS

APPENDIX F - FIELD SAMPLING AND LABORATORY ANALYSIS RECOMMENDED PROTOCOLS

A protocol for field measurement of odor levels and sampling will be compiled prior to commencement of the odor assessment tasks in the ROAP. This is projected to include the following components:

- ~~Liquid wastewater sampling and field testing~~: liquid samples will be taken from the WPCP influent point (upstream of the headworks) and other upstream collection system locations and tested in the field for total and dissolved sulfide concentrations. Various water quality parameters, potentially including pH, temperature, and dissolved oxygen will also be recorded. The goal of this portion of the field testing program is to identify approximate sulfide loads to the plant in the liquid phase. This will provide an indication of the odor emission potential in the collection system as well as for processes at the head of the plant such as the headworks and the primary settling tanks.

- ~~Field measurement of H_2S concentrations~~: two instruments will be used to measure H_2S in various odorous locations within the WPCP. Data loggers (OdaLogs) will be hung within the headspace of areas known to have high H_2S levels. These data loggers automatically measures gas-phase H_2S at regular intervals throughout a set time period (usually on the order of days). Because of this, these data loggers are often installed in locations where H_2S levels vary with time, such as with diurnal variations in flow. In addition, this field odor measurement item will include instantaneous measurements of H_2S using a Jerome 631-X handheld analyzer. The Jerome Analyzer has a working range of 1 to 50,000 parts per billion (ppbv) and will also detect other reduced sulfur compounds at about 10 percent of the sensitivity to H_2S. This unit can be used to measure odor levels at all odorous process units, and potentially at various locations within the same process unit (for example, above the quiescent surface and weirs of a primary settling tank) and in ventilated or occupied spaces with low odor concentrations.

- ~~Foul air sample collection~~: odorous headspaces within process units will be sampled by collecting 1L and 10L Tedlar bags of air. The most odorous locations within a process unit will be determined using Jerome Analyzer field measurements (see above), and those locations will be used for sample collection. A decompression lung vacuum chamber is used to collect air samples. Air samples are taken using a flux chamber, which isolates a volume of headspace above a given surface (for example, wastewater detained in a primary settling tank) and foul air is continuously withdrawn from the headspace and into the sample bags. A picture of a flux chamber above a water surface is shown in Figure I-1.

Figure F-1 Flux chamber used to collect air sample from an isolated headspace

Following collection of air samples from odorous points within the WPCP, laboratory analysis will be conducted to characterize odor emission levels. The following types of laboratory analysis are projected to be needed for the ROAP:

- Odor panel analysis: odor panel testing is described in ROAP Task 1 (Section 3.1). Detection threshold (effectively the "total odor" level of a sample) would be measured by the odor panel. The panel also provides a complete characterization of the odor level in the sample. Included in this is a measurement of hedonic tone, which indicates the odor's offensiveness on a 10-point scale: -5 being the most offensive odor the panelist has ever smelled, and +5 being the most pleasant. Hedonic tone is a helpful when reviewing multiple odor sources and considering the relative importance of odor control at each source, since a source that is highly detectable and also presents a very offensive odor to the average individual may be deemed more important than other sources for odor control. Additionally, odor "descriptors" can be provided that characterize the odor from a subjective perspective. Examples of odor descriptors noted in typical wastewater treatment plant studies include sour, rancid, garbage, earthy, vegetable and putrid. Odor descriptors provide another indication of the reaction of the average individual to the odors, beyond whether the odor is detectable or not.

- Reduced sulfur compound scan analysis: Anaerobic and anoxic processes in wastewater treatment form reduced sulfur organic compounds, in addition to the inorganic hydrogen sulfide. Most of these compounds have a very low human detection threshold concentration (the minimum concentration of the compound required for the average nose to detect its presence). For example, the detection threshold of H_2S is 0.5 ppbv and the detection threshold of the reduced sulfur organic compound methyl mercaptan (CH_3SH) is 1 ppbv. Reduced sulfur organic compounds are responsible for a range of unpleasant odors, frequently described as smelling like rotten vegetables and garbage. Therefore, the laboratory analysis plan for the ROAP will include measurement of 20 common reduced sulfur compounds as concentrations in collected air samples. All 20 of these compounds have the potential to contribute to wastewater-related odors. The laboratory analysis uses ASTM Testing Standard D 5504-01, which uses a gas chromatograph in conjunction with a sulfur chemiluminescence detector (GC/SCD). The analysis method involves directly injecting the air sample into the GC.

APPENDIX G - DETAILS ON ODOR TREATMENT OPTIONS AND COST ESTIMATES

APPENDIX G - DETAILS ON ODOR TREATMENT OPTIONS AND COST ESTIMATES

Following are layout figures showing additional details of proposed odor control systems at the WPCP headworks, primary settling tanks, DAFTs, and potential future dewatering building. Also included are more details on the planning-level odor control cost estimates produced for these processes.

Headworks Odor Control Options

Figure G-1 Headworks Packed Tower Scrubbers + Activated Carbon

Figure G-2 Headworks Bioscrubbers + Activated Carbon

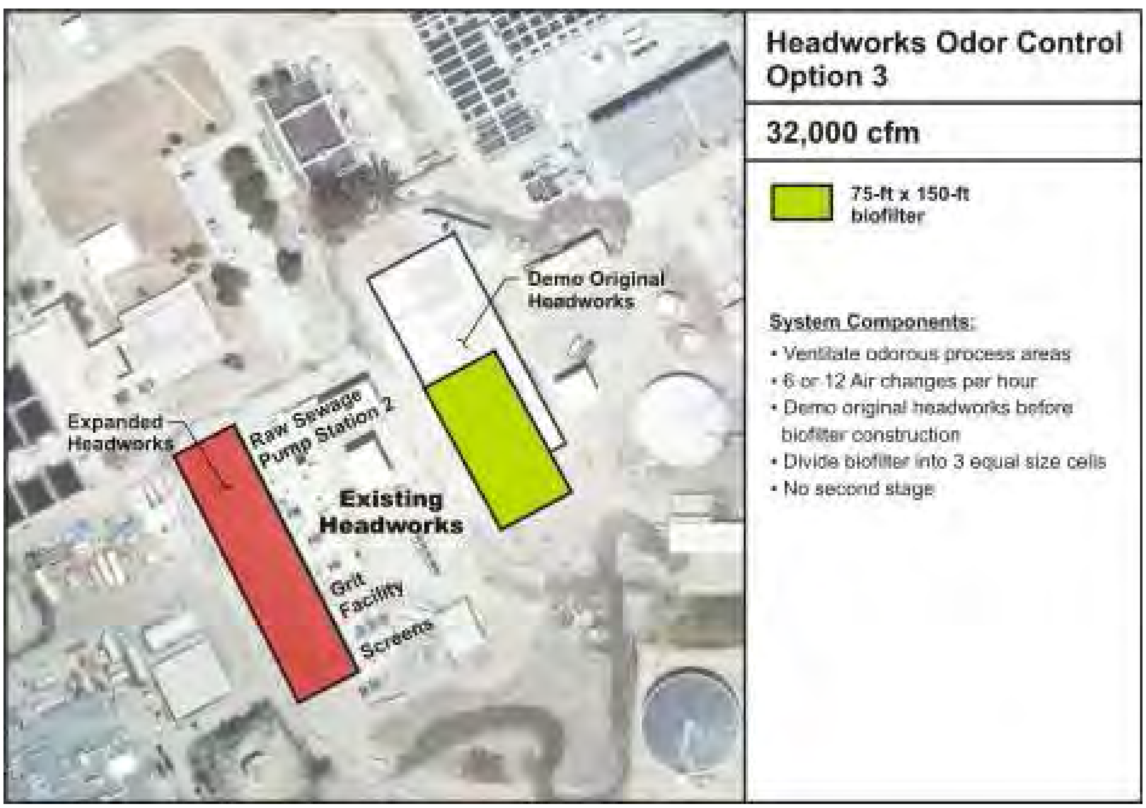

Figure G-3 Headworks Biofilter

Table G-1 Headworks Odor Control: Packed Tower Chemical Scrubbers + Activated Carbon (64,000 cfm)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Item	Element	Cost
1	Odor Control Equipment	$750,000
2	Odor Conveyance System	$280,000
	Equipment Cost Subtotal	**$1,030,000**
3	Installation, Start-Up, and Commissioning (60%)	$618,000
	BASE CONSTRUCTION COST ESTIMATE	**$1,648,000**
4	Demolition (10%)	$165,000
5	Yard Piping, sheeting, shoring, piles, coatings, other miscellaneous costs (15%)	$247,000
6	Electrical and Instrumentation (20%)	$330,000
	Subtotal	$2,390,000
7	Construction Contingency (15%)	$358,000
	Subtotal	$2,748,000
8	Escalation to Midpoint of Construction (0%)	$0
	Subtotal	$2,748,000
9	Construction Contingency (25%)	$687,000
	Subtotal	$3,435,000
10	Contractor Overhead and Profit (27%)	$927,000
	Subtotal	$4,363,000
11	Engineering, Legal, and Administration (30%)	$1,309,000
	TOTAL PROJECT COST	**$5,671,000**

~~**Yearly O&M Costs:**~~
Electricity: $84,000
Chemicals: $37,000
Labor: $31,000
~~Carbon: $17,000~~
Total: $169,000

Table G-2	Headworks Odor Control: Bioscrubber + Activated Carbon (64,000 cfm) San José/Santa Clara Water Pollution Control Plant Master Plan City of San José	
Item	**Element**	**Cost**
1	Odor Control Equipment	$1,900,000
2	Odor Conveyance System	$280,000
	Equipment Cost Subtotal	**$2,180,000**
3	Installation, Start-Up, and Commissioning (60%)	$1,308,000
	BASE CONSTRUCTION COST ESTIMATE	**$3,488,000**
4	Demolition (10%)	$349,000
5	Yard Piping, sheeting, shoring, piles, coatings, other miscellaneous costs (15%)	$523,000
6	Electrical and Instrumentation (20%)	$698,000
	Subtotal	$5,058,000
7	Construction Contingency (15%)	$759,000
	Subtotal	$5,816,000
8	Escalation to Midpoint of Construction (0%)	$0
	Subtotal	$5,816,000
9	Construction Contingency (25%)	$1,454,000
	Subtotal	$7,270,000
10	Contractor Overhead and Profit (27%)	$1,963,000
	Subtotal	$9,233,000
11	Engineering, Legal, and Administration (30%)	$2,770,000
	TOTAL PROJECT COST	**$12,003,000**

~~Yearly O&M Costs:~~
Electricity: $91,000
Chemicals: $0
Labor: $65,000
~~Carbon: $17,000~~
Total: $173,000

Table G-3 Headworks Odor Control: Biofilter (32,000 cfm)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Item	Element	Cost
1	Odor Control Equipment	$1,000,000
2	Odor Conveyance System	$210,000
	Equipment Cost Subtotal	**$1,210,000**
3	Installation, Start-Up, and Commissioning (60%)	$726,000
	BASE CONSTRUCTION COST ESTIMATE	**$1,936,000**
4	Demolition (10%)	$194,000
5	Yard Piping, sheeting, shoring, piles, coatings, other miscellaneous costs (15%)	$290,000
6	Electrical and Instrumentation (20%)	$387,000
	Subtotal	$2,807,000
7	Construction Contingency (15%)	$421,000
	Subtotal	$3,228,000
8	Escalation to Midpoint of Construction (0%)	$0
	Subtotal	$3,228,000
9	Construction Contingency (25%)	$807,000
	Subtotal	$4,035,000
10	Contractor Overhead and Profit (27%)	$1,090,000
	Subtotal	$5,125,000
11	Engineering, Legal, and Administration (30%)	$1,537,000
	TOTAL PROJECT COST	**$6,662,000**

~~Yearly O&M Costs:~~
Electricity: $49,000
Chemicals: $0
Labor: $36,000
~~Carbon: $0~~
~~Total: $85,000~~

Primary Settling Tanks Odor Control Options

Figure G-4 Primary Settling Tanks Packed Tower Scrubbers + Activated Carbon

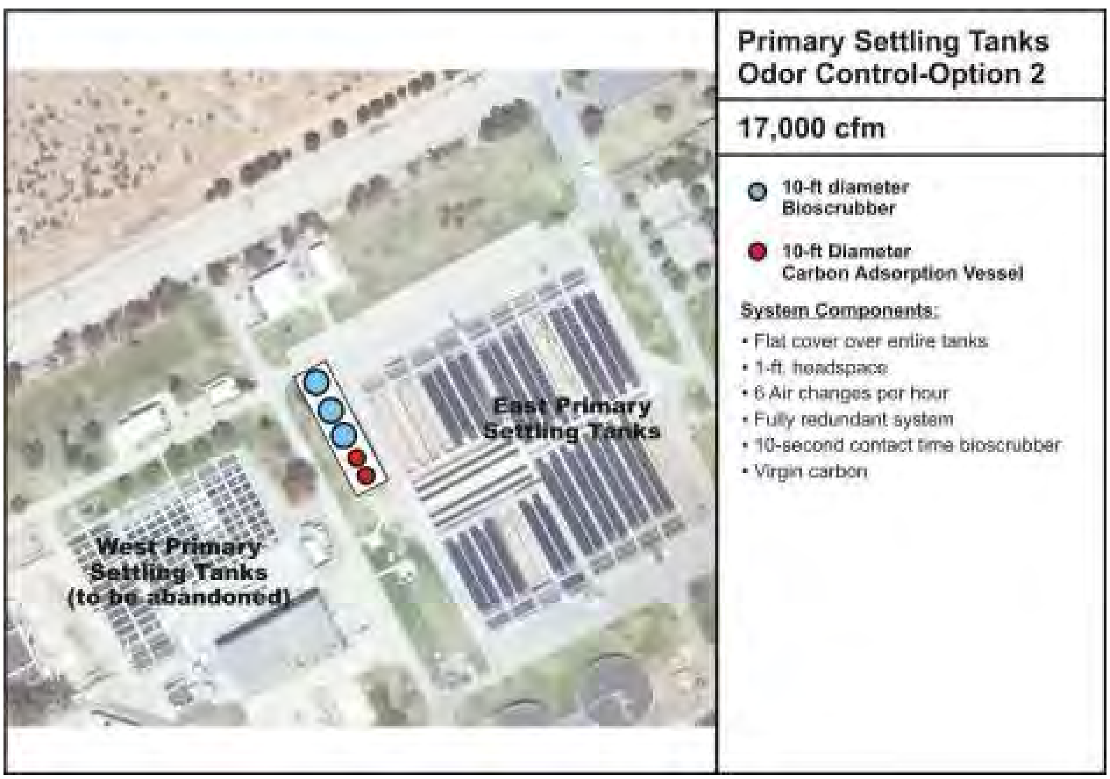

Figure G-5 Primary Settling Tanks Bioscrubbers + Activated Carbon

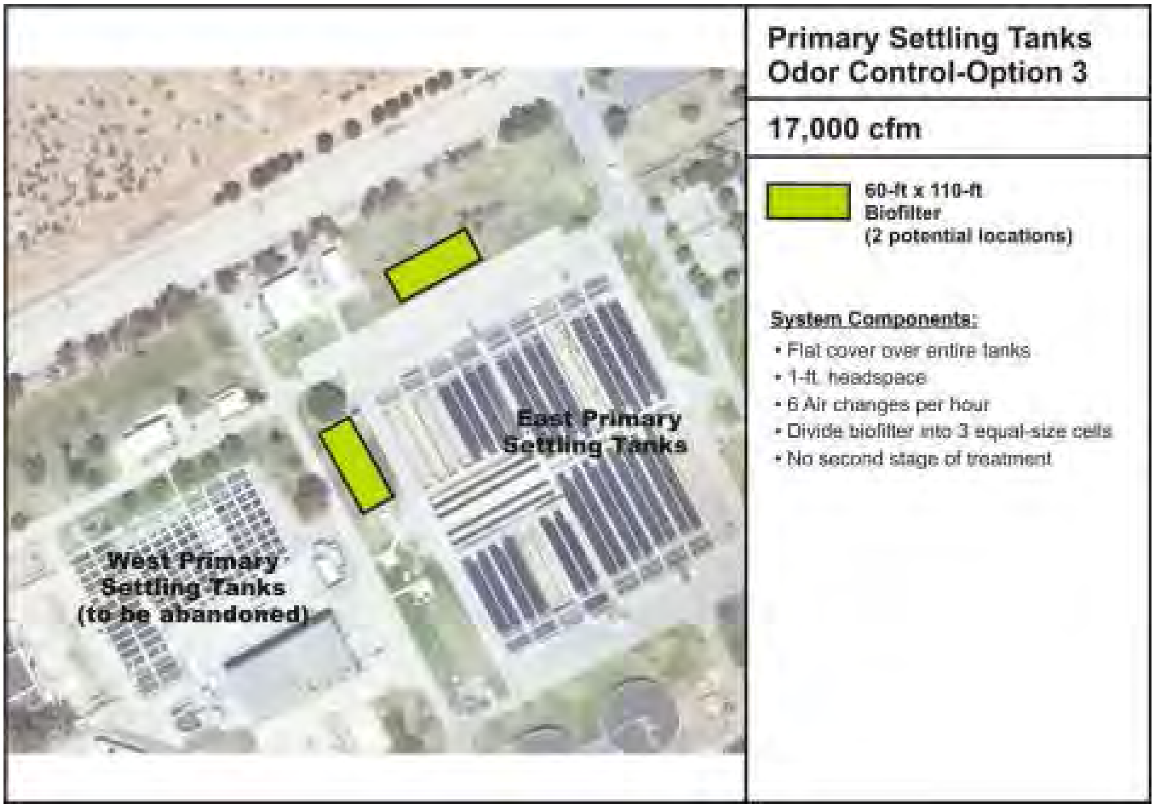

Figure G-6 Primary Settling Tanks Biofilter

Table G-4 Primary Settling Tanks Odor Control: Packed Tower Chemical Scrubber + Carbon (17,000 cfm treated flow with full redundancy)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Item	Element	Cost
1	Odor Control Equipment	$680,000
2	Odor Conveyance System	$5,338,000
	Equipment Cost Subtotal	**$6,018,000**
3	Installation, Start-Up, and Commissioning (60%)	$3,611,000
	BASE CONSTRUCTION COST ESTIMATE	**$9,628,000**
4	Demolition (10%)	$963,000
5	Yard Piping, sheeting, shoring, piles, coatings, other miscellaneous costs (15%)	$1,444,000
6	Electrical and Instrumentation (20%)	$1,926,000
	Subtotal	$13,961,000
7	Construction Contingency (15%)	$2,094,000
	Subtotal	$16,055,000
8	Escalation to Midpoint of Construction (0%)	$0
	Subtotal	$16,055,000
9	Construction Contingency (25%)	$4,014,000
	Subtotal	$20,069,000
10	Contractor Overhead and Profit (27%)	$5,419,000
	Subtotal	$25,487,000
11	Engineering, Legal, and Administration (30%)	$7,646,000
	TOTAL PROJECT COST	**$33,133,000**

~~**Yearly O&M Costs:**~~
Electricity: $57,000
Chemicals: $20,000
Labor: $181,000
~~Carbon: $11,000~~
Total: $269,000

Table G-5 Primary Settling Tanks Odor Control: Bioscrubber + Activated Carbon (17,000 cfm treated flow with full redundancy)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Item	Element	Cost
1	Odor Control Equipment	$1,320,000
2	Odor Conveyance System	$5,338,000
	Equipment Cost Subtotal	**$6,658,000**
3	Installation, Start-Up, and Commissioning (60%)	$3,995,000
	BASE CONSTRUCTION COST ESTIMATE	**$10,652,000**
4	Demolition (10%)	$1,065,000
5	Yard Piping, sheeting, shoring, piles, coatings, other miscellaneous costs (15%)	$1,598,000
6	Electrical and Instrumentation (20%)	$2,130,000
	Subtotal	$15,446,000
7	Construction Contingency (15%)	$2,317,000
	Subtotal	$17,762,000
8	Escalation to Midpoint of Construction (0%)	$0
	Subtotal	$17,762,000
9	Construction Contingency (25%)	$4,441,000
	Subtotal	$22,203,000
10	Contractor Overhead and Profit (27%)	$5,995,000
	Subtotal	$28,198,000
11	Engineering, Legal, and Administration (30%)	$8,459,000
	TOTAL PROJECT COST	**$36,657,000**

Yearly O&M Costs:
Electricity: $57,000
Chemicals: $0
Labor: $200,000
Carbon: $11,000
Total: $268,000

Table G-6 Primary Settling Tanks Odor Control: Biofilter (17,000 cfm)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Item	Element	Cost
1	Odor Control Equipment	$700,000
2	Odor Conveyance System	$5,448,000
	Equipment Cost Subtotal	**$6,148,000**
3	Installation, Start-Up, and Commissioning (60%)	$3,669,000
	BASE CONSTRUCTION COST ESTIMATE	**$9,836,000**
4	Demolition (10%)	$984,000
5	Yard Piping, sheeting, shoring, piles, coatings, other miscellaneous costs (15%)	$1,475,000
6	Electrical and Instrumentation (20%)	$1,967,000
	Subtotal	$14,262,000
7	Construction Contingency (15%)	$2,139,000
	Subtotal	$16,402,000
8	Escalation to Midpoint of Construction (0%)	$0
	Subtotal	$16,402,000
9	Construction Contingency (25%)	$4,100,000
	Subtotal	$20,502,000
10	Contractor Overhead and Profit (27%)	$5,536,000
	Subtotal	$26,038,000
11	Engineering, Legal, and Administration (30%)	$7,811,000
	TOTAL PROJECT COST	**$33,849,000**

Yearly O&M Costs:
Electricity: $30,000
Chemicals: $0
Labor: $184,000
Carbon: $0,000
Total: $214,000

DAFTs Odor Control Options

Figure G-7 DAFTs Packed Tower Scrubbers + Activated Carbon

Figure G-8 DAFTs Bioscrubbers + Activated Carbon

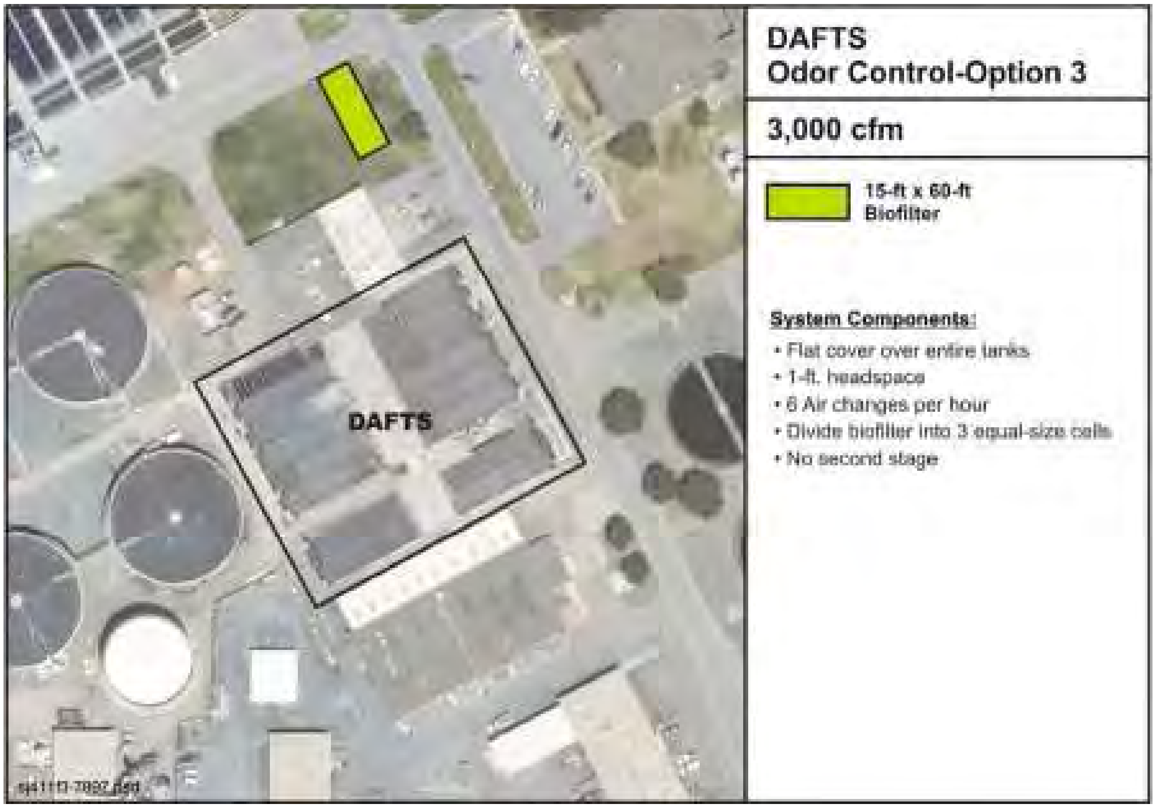

Figure G-9 DAFTs Biofilter

Table G-7 DAFTs Odor Control: Packed Tower Chemical Scrubber + Activated Carbon (3,000 cfm treated flow with full redundancy)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Item	Element	Cost
1	Odor Control Equipment	$390,000
2	Odor Conveyance System	$947,000
	Equipment Cost Subtotal	**$1,337,000**
3	Installation, Start-Up, and Commissioning (60%)	$802,000
	BASE CONSTRUCTION COST ESTIMATE	**$2,140,000**
4	Demolition (10%)	$214,000
5	Yard Piping, sheeting, shoring, piles, coatings, other miscellaneous costs (15%)	$321,000
6	Electrical and Instrumentation (20%)	$428,000
	Subtotal	$3,102,000
7	Construction Contingency (15%)	$465,000
	Subtotal	$3,568,000
8	Escalation to Midpoint of Construction (0%)	$0
	Subtotal	$3,568,000
9	Construction Contingency (25%)	$892,000
	Subtotal	$4,460,000
10	Contractor Overhead and Profit (27%)	$1,204,000
	Subtotal	$5,664,000
11	Engineering, Legal, and Administration (30%)	$1,699,000
	TOTAL PROJECT COST	**$7,363,000**

Yearly O&M Costs:
Electricity: $27,000
Chemicals: $4,000
Labor: $40,000
Carbon: $2,000
Total: $73,000

Table G-8 DAFTs Odor Control: Bioscrubber + Activated Carbon (3,000 cfm treated flow with full redundancy)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Item	Element	Cost
1	Odor Control Equipment	$540,000
2	Odor Conveyance System	$947,000
	Equipment Cost Subtotal	**$1,487,000**
3	Installation, Start-Up, and Commissioning (60%)	$892,000
	BASE CONSTRUCTION COST ESTIMATE	**$2,380,000**
4	Demolition (10%)	$238,000
5	Yard Piping, sheeting, shoring, piles, coatings, other miscellaneous costs (15%)	$357,000
6	Electrical and Instrumentation (20%)	$476,000
	Subtotal	$3,450,000
7	Construction Contingency (15%)	$518,000
	Subtotal	$3,968,000
8	Escalation to Midpoint of Construction (0%)	$0
	Subtotal	$3,968,000
9	Construction Contingency (25%)	$992,000
	Subtotal	$4,960,000
10	Contractor Overhead and Profit (27%)	$1,339,000
	Subtotal	$6,300,000
11	Engineering, Legal, and Administration (30%)	$1,890,000
	TOTAL PROJECT COST	**$8,189,000**

~~Yearly O&M Costs:~~
Electricity: $26,000
Chemicals: $0
Labor: $45,000
~~Carbon: $2,000~~
~~Total: $73,000~~

Table G-9 DAFTs Odor Control: Biofilter (3,000 cfm)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Item	Element	Cost
1	Odor Control Equipment	$300,000
2	Odor Conveyance System	$933,000
	Equipment Cost Subtotal	**$1,233,000**
3	Installation, Start-Up, and Commissioning (60%)	$740,000
	BASE CONSTRUCTION COST ESTIMATE	**$1,973,000**
4	Demolition (10%)	$197,000
5	Yard Piping, sheeting, shoring, piles, coatings, other miscellaneous costs (15%)	$296,000
6	Electrical and Instrumentation (20%)	$395,000
	Subtotal	$2,861,000
7	Construction Contingency (15%)	$429,000
	Subtotal	$3,290,000
8	Escalation to Midpoint of Construction (0%)	$0
	Subtotal	$3,290,000
9	Construction Contingency (25%)	$823,000
	Subtotal	$4,113,000
10	Contractor Overhead and Profit (27%)	$1,110,000
	Subtotal	$5,223,000
11	Engineering, Legal, and Administration (30%)	$1,567,000
	TOTAL PROJECT COST	**$6,790,000**

~~Yearly O&M Costs:~~
Electricity: $11,000
Chemicals: $0
Labor: $37,000
~~Carbon: $0~~
Total: $48,000

Table G-10 Dewatering Building Odor Control: Packed Tower Scrubbers + Activated Carbon (63,000 cfm)
San José/Santa Clara Water Pollution Control Plant Master Plan
City of San José

Item	Element	Cost
1	Odor Control Equipment	$900,000
2	Odor Conveyance System	$300,000
	Equipment Cost Subtotal	**$1,200,000**
3	Installation, Start-Up, and Commissioning (60%)	$720,000
	BASE CONSTRUCTION COST ESTIMATE	**$1,920,000**
4	Demolition (0%) – NEW SYSTEM	$0
5	Yard Piping, sheeting, shoring, piles, coatings, other miscellaneous costs (15%)	$288,000
6	Electrical and Instrumentation (20%)	$384,000
	Subtotal	$2,592,000
7	Construction Contingency (15%)	$389,000
	Subtotal	$2,981,000
8	Escalation to Midpoint of Construction (0%)	$0
	Subtotal	$2,981,000
9	Construction Contingency (25%)	$745,000
	Subtotal	$3,726,000
10	Contractor Overhead and Profit (27%)	$1,006,000
	Subtotal	$4,732,000
11	Engineering, Legal, and Administration (30%)	$1,420,000
	TOTAL PROJECT COST	**$6,152,000**

~~**Yearly O&M Costs:**~~
Electricity: $101,000
Chemicals: $66,000
Labor: $36,000
~~Carbon: $17,000~~
Total: $219,000

Table G-11	Dewatering Building Odor Control: Biofilter (63,000 cfm) San José/Santa Clara Water Pollution Control Plant Master Plan City of San José	
Item	**Element**	**Cost**
1	Odor Control Equipment	$1,500,000
2	Odor Conveyance System	$190,000
	Equipment Cost Subtotal	**$1,690,000**
3	Installation, Start-Up, and Commissioning (60%)	$1,014,000
	BASE CONSTRUCTION COST ESTIMATE	**$2,704,000**
4	Demolition (0%) – NEW SYSTEM	$0
5	Yard Piping, sheeting, shoring, piles, coatings, other miscellaneous costs (15%)	$406,000
6	Electrical and Instrumentation (20%)	$541,000
	Subtotal	$3,650,000
7	Construction Contingency (15%)	$548,000
	Subtotal	$4,198,000
8	Escalation to Midpoint of Construction (0%)	$0
	Subtotal	$4,198,000
9	Construction Contingency (25%)	$1,049,000
	Subtotal	$5,247,000
10	Contractor Overhead and Profit (27%)	$1,417,000
	Subtotal	$6,664,000
11	Engineering, Legal, and Administration (30%)	$1,999,000
	TOTAL PROJECT COST	**$8,664,000**

Yearly O&M Costs:

Electricity: $45,000

Chemicals: $0

Labor: $51,000

Carbon: $0

Total: $96,000

APPENDIX H - DETAILED DESCRIPTIONS OF ODOR CONTROL TECHNOLOGIES

APPENDIX H - DETAILED DESCRIPTIONS OF ODOR CONTROL TECHNOLOGIES

Five gas-phase odor control technologies passed the fatal flaw criteria and were evaluated further in the production of the Plant Master Plan (PMP). These technologies are the following:

- Packed Tower Chemical Scrubbing
- Biofilters
- Bioscrubbers
- Activated Carbon Adsorption
- Iron Oxide Adsorption (Iron Sponge, SulfaTreat)

These technologies are discussed further below.

Packed Tower Chemical Scrubbing

Wet scrubbing has been used to control odors from wastewater treatment plants for several decades. Wet scrubbers use Henry's Law to drive odorous compounds from the foul air into a scrubbing solution. Packed tower scrubbers have historically removed H_2S from a foul air stream in excess of 95 percent, and in many applications they have been observed to remove H_2S in excess of 99 percent. Packed towers operate with high throughput rates (up to 600 ft/min) and low contact times (on the order of 1-2 seconds). Therefore, system footprints are small for large-capacity systems. Packed tower scrubbing is applicable for a wide range of air flow rates, an advantage over some technologies which are most efficient for lower air flow rates. Packed tower scrubbers can include single or multiple stages, can operate at a high or low pH, and may or may not use oxidants to aid in creating the driving force to reduce odorous compounds.

A packed tower wet scrubber removes odorous compounds from a foul air stream by the process of absorption into a liquid scrubbing solution, after which the compound may be eliminated by either chemical oxidation (by hypochlorite, for example), or disposal of the absorption medium. When acidic compounds (such as H_2S) are of greatest concern, a scrubbing solution with a high pH is typically required, generated by the use of caustic.

Two configurations are used for packed tower scrubbers: counter-current flow and cross flow. A schematic diagram of a typical counter-current packed tower scrubber is depicted in Figure K-1, which is taken from the Water Environment Federation (WEF) Manual of Practice (MOP) 25. In this configuration, the foul air enters at the bottom of the vessel, travels upward through packing, and contacts the scrubbing solution (the “scrubbant”), which is simultaneously flowing downward through the packing. The scrubbed air exits at the top of the tower. In cross-flow scrubbers, foul air enters from the side of the scrubber and flows horizontally through the scrubber media, while the scrubbant flows downward.

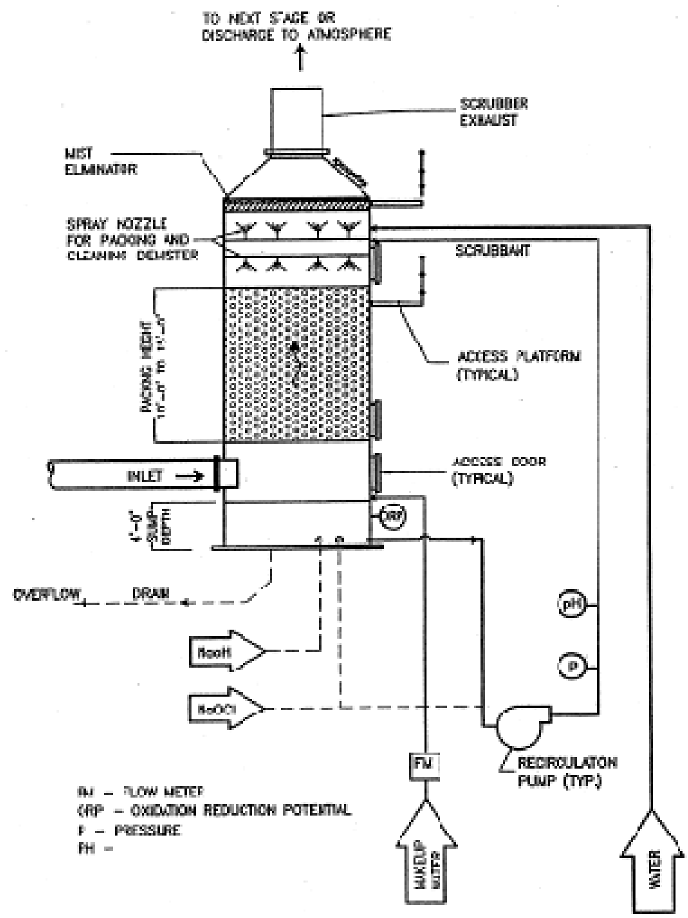

Figure H-1. Schematic of a counter-current flow packed tower scrubber (from WEF MOP 25).

In either configuration, the scrubbing solution that has passed through the packing is pumped from the sump back to the top of the tower by a recirculation pump. A make-up water stream is added continually to the tower, and a blowdown stream is removed continually. The pH and the oxidation-reduction potential (ORP) of collected liquid in the sump are continually monitored, with make-up water and blowdown flow rates modified to keep the scrubbing unit operating optimally.

The following are the typical components of a packed tower scrubber odor control system:

- **Scrubber vessel:** packed tower scrubber vessels are typically made of filament-wound fiberglass reinforced plastic (FRP). Fittings and other accessories are contact molded. The scrubber vessel typically is fabricated by a single manufacturer who builds the shell and installs the vessel internals.

- **Packing:** the scrubber manufacturer typically provides the packing, which are plastic pieces that are loaded into the scrubber vessel. Shapes are designed to maximize available surface area and minimize the pressure drop losses that fans must overcome to convey foul air through the vessel. Packing provides large interfacial contact area between the foul air and the scrubbing solution, which increases mass transfer of odorous compounds from the gas to the liquid phase.

- **Mist eliminator:** these components are located at the top of the scrubber vessel and are typically designed to remove 90 percent of all water droplets larger than 10 microns, and 99 percent of all water droplets larger than 40 microns.

- **Recirculation pump:** used to convey scrubbing liquid from the sump at the bottom of the vessel back to the top of the vessel to be distributed over the packing. Centrifugal pumps designed for highly corrosive environments are typically selected, constructed of steel or FRP and compatible with the scrubbing liquid.

- **Chemical feed system:** consists of metering pumps, feed piping and valves, storage tanks, and the necessary controls and appurtenances for maintaining the correct scrubbant mixture (for example, a mixture of hypochlorite, caustic, and water) in the vessel. Chemical feed is typically controlled automatically based on the measured pH or ORP of the scrubbing solution in the sump.

- **Blowdown:** Continuous withdrawal of scrubbing solution must be conducted to maintain the driving force from the gas to the liquid phase. In addition, the blowdown line minimizes build-up of solids and other contaminants removed from the gas phase during the absorption process.

- **Make-up water:** Water must be added to the scrubber to make up for blowdown and evaporation losses, the rate of which is controlled with a rotameter and valve or with a flow-control valve.

Biofilters

Biological odor control units rely on natural processes by bacteria to consume and oxidize odorous compounds in foul air streams. Where chemical scrubbers have been used for decades in municipal wastewater odor control, biological processes for odor control are relatively new, with proprietary designs becoming more prevalent only in the last decade. Advantages of biological odor control units include elimination of chemical costs (a negative associated with packed tower chemical scrubbers) and less frequent change-out of media (a negative associated with carbon adsorbers).

The industry distinguishes between “biofilters”, which involve bulk organic or inorganic media for odorous compound removal by bacteria, and “bioscrubbers”, in which the removal of odorous compounds occurs within a liquid that passes through media contained within a fabricated vessel. Bioscrubbers are discussed separately in the next section, though most of the odor removal principles of biofilters also apply to bioscrubbers.

Biofilters treat odorous compounds by a combination of adsorption, absorption, biological degradation, and chemical oxidation. Contaminants in the foul air stream are either adsorbed onto the surface of the biofilter media or absorbed by the thin liquid surrounding the media particles, referred to as the biofilm. Once the odorous compounds are trapped, they become the food source for the microorganisms living within the media and in the biofilm. An oxidation reaction releases energy within the cell structure of the microbes, which maintains cell material and growth.

During biological oxidation, organic and inorganic odorous compounds are degraded, ideally into carbon dioxide and water. If this degradation process is not completed, the result will be the production of a number of simpler organic compounds in the media and in the exiting treated air stream. If incomplete degradation occurs, a biofilter can appear to be generating odorous compounds, when in reality it has converted a more complex organic compound into less complex, but still odorous compounds. This highlights the importance of maintaining correct operating conditions and providing the correct amount of contact time.

Biofilters utilize organic media (such as mulch, wood chips, or compost), inorganic soil media, or manufactured inert media for odor removal. A moist filter media provides physical and chemical conditions appropriate for the transfer of the contaminants out of the gas phase, and supports biodegradation of the adsorbed and absorbed contaminants. The main differences between the media types are required contact times, expected life, and cost. Following is a general breakdown of these differences:

- Organic media required contact times are typically between 45 and 60 seconds. The cost is typically the lowest of the three general media types, and mixes of organic components such as wood chips and compost can be acquired directly. However, the expected life of organic media is the lowest of the three media types, with replacement being necessary typically in 2 to 5 years (replacement requirements vary with odor loading, composition, and maintenance provided).
- Inorganic media (soil) required contact times typically range between 60 and 120 seconds. The cost of soil media is slightly higher than organic media, in part because higher quantities are required. However, expected life is significantly higher, with life spans of 10 to 30 years reported.
- Proprietary inorganic media are manufactured by individual suppliers and are the highest cost. Required contact times are reported as low as 20 to 30 seconds. Most of these supplied media will come with a 10-year warranty from the manufacturer.

Figure K-2 depicts a simplified schematic diagram of a typical bulk media biofilter system. The main components of biofilters are the air distribution system, the media and media support structure, and a moisture control system. The foul air is distributed over the bottom of the unit and forced upward through the media. Simple air distribution systems consist of perforated pipe surrounded by gravel. Proprietary prefabricated biofilter systems have all components contained within a vessel, supplied by a manufacturer.

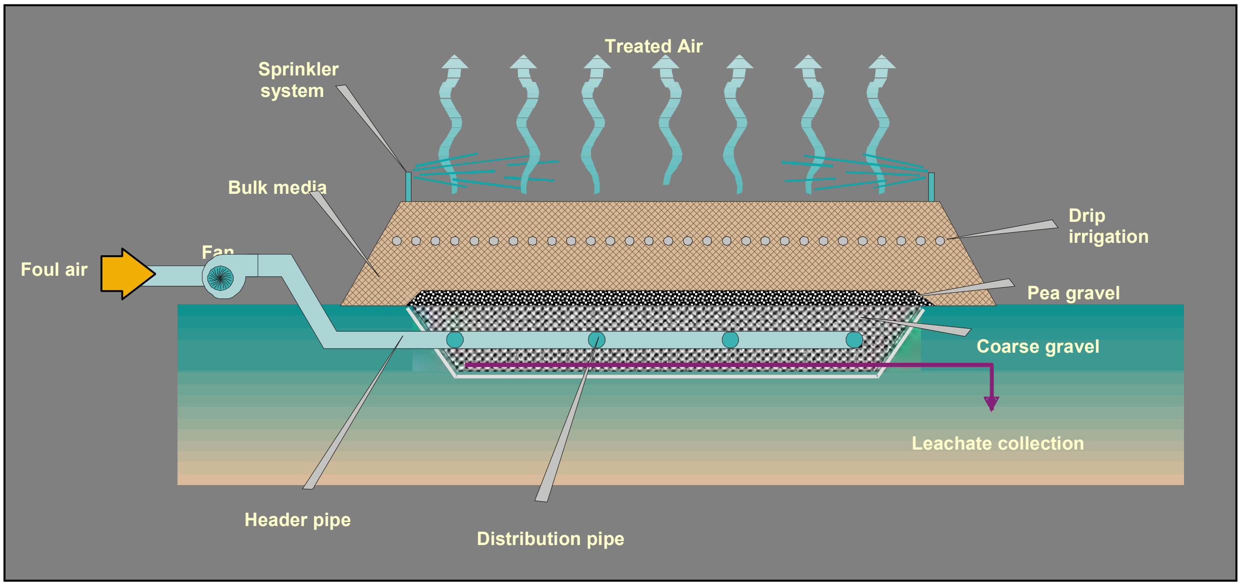

Figure H-2. Schematic of a typical bulk media biofilter.

The following operating parameters are critical for providing a suitable, stable environment to sustain the health of the microorganisms in a biofilter:

- **Media Moisture:** Media containing less than an adequate amount of moisture will not support a thriving microbial community necessary for optimum odor control. However, if the media is too wet, it can become too dense and compact, resulting in reduced porosity and high back-pressures that reduce airflow and create inactive odor treatment areas within the biofilter. Though the optimum moisture content varies by media choice, a general range of 40 to 70 percent moisture content is typical. This is typically accomplished using commercial sprinkler systems for larger open-vessel biofilters (shown in Figure K-2), or internal sprinkler systems for smaller, prefabricated biofilters.

- **Foul Air Prehumidification:** If the inlet air is well below 100 percent relative humidity, the incoming foul air will rapidly evaporate water from the media and dry it out, thus reducing media moisture and causing treatment issues. Prehumidification is typically accomplished using spray nozzles in the biofilter inlet air duct or a small water-only packed tower scrubber upstream of the biofilter. The relative humidity of the inlet air should be maintained higher than 90 percent as much as possible.

- **Temperature:** Temperature impacts the biological degradation rate of the microorganisms. A warmer biofilter generally supports more active organisms, and higher temperatures will result in higher treatment capacity. Biofilters operate effectively over a wide temperature range (40°F to 105°F), but a temperature range between 80°F and 100°F is considered optimal.

- **pH:** A biofilter that is targeting H_2S removal should operate at a lower pH (2 to 3), as autotrophic bacteria that break down H_2S tend to thrive under this pH range. The optimum pH range for removal of organic reduced sulfur compounds is neutral (7 to 8), as heterotrophic bacteria will dominate and break down these compounds and use the carbon for food. Oftentimes, these pH ranges can exist within the same biofilter, with different layers of media used to target different compounds.

Biofilters can remove H_2S with a relatively short contact time (on the order of seconds), and organic reduced sulfur compounds with more contact time. Removal efficiencies of H_2S have been reported as high as 99 percent in a number of installations. Removal efficiencies for the organic reduced sulfur compounds are much more variable, and can vary from one installation to the next. Field observations indicate that ammonia, amines, and other nitrogen-based compounds can be effectively removed with biofilters, something that a single-stage packed tower scrubber targeted for H_2S removal would not be able to accomplish. Finally, biofiltration is rightly claimed to be the most sustainable option of all the air treatment technologies and if space is available, is the least obtrusive, having a low or even no above-ground profile.

Bioscrubbers

Bioscrubbers include a reacting vessel containing an inert media, similar to some biofilters. However, bioscrubbers include either a constantly recirculating liquid through the media or an intermittent, once-through spray of the media. In either case, the liquid contains nutrients (such as trace organics, nitrogen, phosphorous, and potassium) for the biological system, as compared to biofilters in which the nutrients typically are in the media itself. Figure K-3 depicts a schematic diagram of a typical bioscrubber system.

The liquid flow rate in bioscrubbers is typically used to control the pH of the system. Doing this will therefore selectively target different types of microorganisms that remove different odorous compounds (similar to biofilters). The liquid used is often plant effluent, which in many cases contains the required nutrients for the bioscrubber. If plant effluent is not sufficient, then supplemental nutrients may be required.

Bioscrubbers retain an advantage over biofilters in requiring less contact time and occupying a smaller footprint. However, the lower contact time can make removal of organic reduced sulfur compounds less efficient. However, for four air streams whose odorous compounds are dominated by moderate to high concentrations of H_2S, a bioscrubber is a viable option and could be evaluated alongside a chemical scrubber.

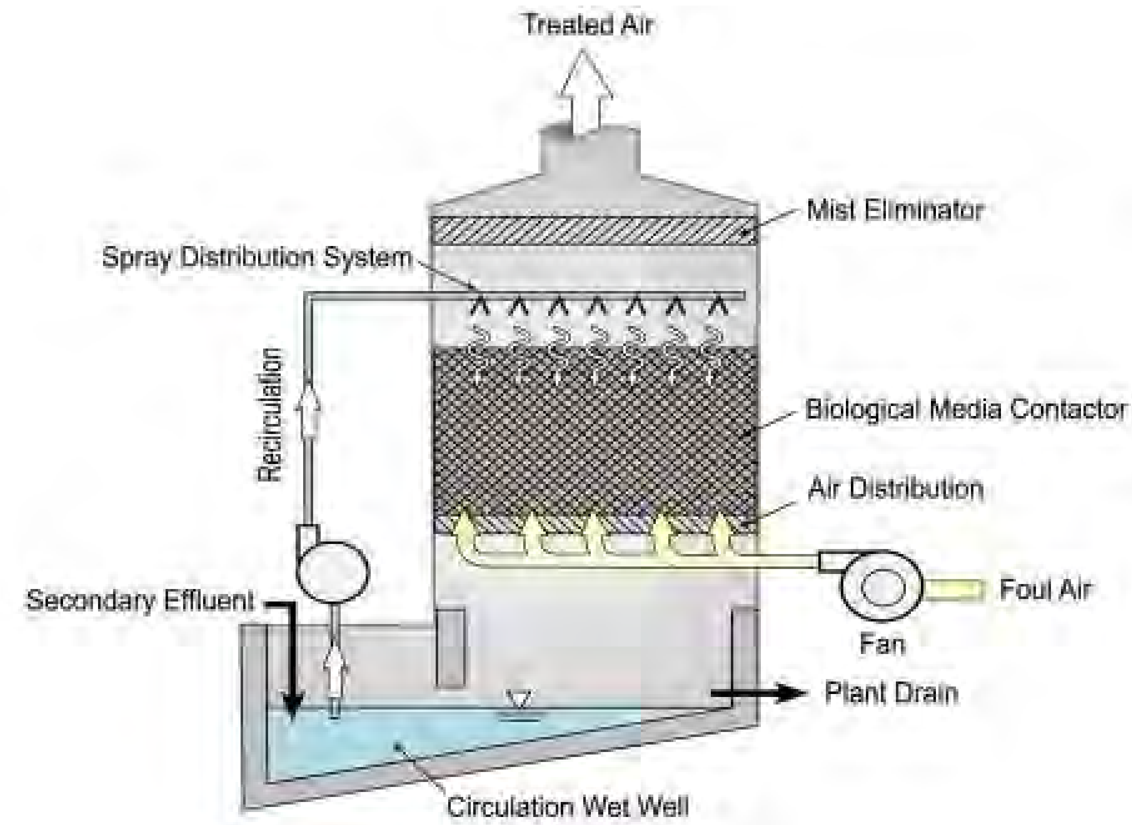

Figure H-3. Schematic of a typical bioscrubber.

Activated Carbon Adsorption

Adsorption using granular activated carbon is often incorporated into odor control systems for wastewater treatment facilities. The technology is typically used on air streams having relatively low H_2S levels and higher concentrations of more complex odorous compounds. With time, activated carbon becomes less effective as the adsorption sites become saturated. The spent carbon then must be replaced or regenerated. Carbon adsorption systems typically are easy to operate and are generally reliable. However, if high odor concentrations are treated they may require frequent media changes.

Physical adsorption is caused by intermolecular forces of attraction between the molecules of a solid and the adsorbed substance. When the intermolecular attraction forces between a solid and a gas are greater than the intermolecular forces of the gas itself, the compounds that comprise the gas will adsorb onto the surface of the solid. In an activated carbon adsorption system, carbon is the solid adsorbent. Granular activated carbon is processed such that it produces a large surface area on the carbon's internal pores, providing many sites for molecular adsorption in a relatively small volume.

Activated carbon is effective at removing odorous compounds and volatile organic compounds (VOCs) from air streams. Odorous compounds may be oxidized once adsorbed onto the carbon surface. Because activated carbon is non-specific, it tends to adsorb all trace vapors roughly in proportion to their concentrations until its sorptive capacity is reached. Therefore, capacity must be provided for those compounds that are not specifically targeted but will nevertheless be adsorbed. When the carbon's sorptive capacity nears saturation, more volatile compounds can desorb and be replaced by less volatile compounds, which can be a detriment for odor control.

The following types of granular activated carbon are typically used in odor control applications at municipal wastewater treatment facilities:

- **Virgin Carbon:** Virgin carbon is typically made by heating bituminous coal or coconut shells. This carbon adsorbs VOCs and many odorous organic compounds, but typically has a low sorptive capacity for H_2S, which makes virgin carbons a less effective first stage of odor treatment for many wastewater treatment odor sources. After the adsorption sites become essentially full, virgin carbon can be restored to nearly its original sorptive capacity by thermal reactivation, but typically this is not done and the carbon is simply replaced.

- **Impregnated Carbon:** Chemical additives can be injected into activated carbon to increase its sorptive capacity for H_2S and other odorous compounds with low boiling points. The most common chemical additive is sodium hydroxide (caustic), but potassium hydroxide or ammonia is also used. The reaction is an acid-base neutralization, where H_2S is reduced to sulfate and potentially to elemental sulfur, and then adsorbed onto the carbon sites. Onsite regeneration of impregnated carbon can be accomplished by washing the carbon with a caustic solution for several hours. This restores the adsorptive capacity of the carbon to approximately 80 percent of its former capacity, which ultimately after several regenerations can make regeneration less desirable than replacing the carbon altogether. An important disadvantage of impregnated carbons is that they have a lower ignition temperature than non-impregnated carbons, which means that temperature indicators within the carbon bed are required due to the risk of fire.

- **Catalytic Carbon:** Catalytic carbon has been modified to have finer pores, which gives it a higher density and enhances catalytic activity. The pores lead to a reaction between H_2S and oxygen, where H_2S is reduced to sulfate and adsorbed onto the pore sites. The advantage of catalytic carbon is that it can be partially regenerated using water washing only. However, a disadvantage seen at several wastewater treatment facilities is that catalytic carbons tend to have a low sorptive capacity for organic reduced sulfur compounds. Additionally, similar to impregnated carbons, there are a finite number of times that the carbon can be washed with water and its capacity partially restored before replacing the carbon is more cost-effective.

- **High-Capacity Carbon:** Several suppliers have developed a high-capacity carbon retains approximately 10 times the H_2S capacity of virgin carbon and twice that of impregnated carbon. This carbon is manufactured in a special process using additives to bituminous coal. This type of carbon has a recent good track record of success for treatment of higher H_2S content air streams, but there is some compromise in removal of organic reduced sulfur compounds and VOCs. There is no regeneration process for the high-capacity carbon.

The simplest type of carbon adsorption system is a fixed stationary bed with a 3-ft bed depth and an influent foul air face velocity of 50 to 70 ft/min. For higher air flow rates, dual-bed systems can be used to save cost and maintain a smaller footprint. Figure K-4 depicts a typical activated carbon adsorption system schematic. Note that the treated air outlet can be in the side or top of the vessel depending on the duct and stack configuration.

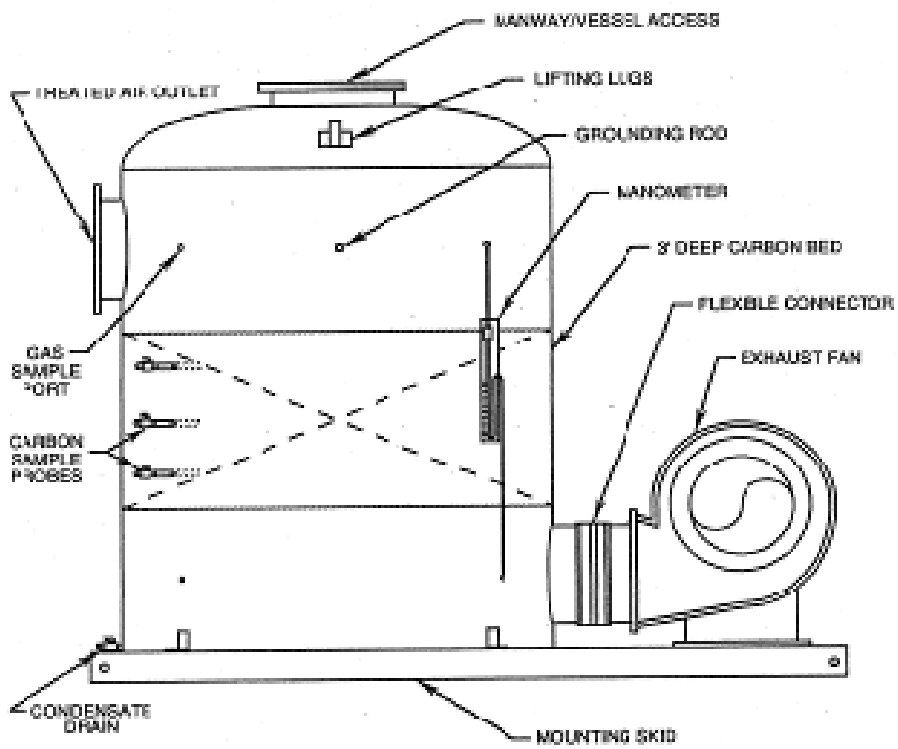

Figure H-4 Schematic of a typical activated carbon adsorber (from WEF MOP-25).

The following operating parameters are critical for providing an optimally functioning activated carbon adsorption system:

- **Contact time:** Ample contact time (mean bed residence time) must be provided between the foul air and the carbon bed to achieve effective removal efficiency. A typical mean bed residence time is 3 seconds.
- **Sorptive capacity:** An appropriate sorptive capacity ensures reasonable carbon bed life. A typical sorptive capacity for virgin carbon is 0.03 g H_2S/cm^3 of carbon; for caustic impregnated carbon is 0.14 g of H_2S/cm^3 of carbon; for catalytic carbon is 0.09 g of H_2S/cm^3 of carbon, and for high capacity carbon is up to 0.3 g of H_2S/cm^3.

- **Air flow:** Distribution of the foul air through the carbon media should be uniform to ensure complete use of the carbon. Resistance to gas flow within the media should also be reasonably low to conserve energy.

- **Foul air pretreatment:** Particulate matter, grease, and moisture should be removed prior to the foul air entering the carbon bed (foul air streams in wastewater treatment facilities typically have a high relative humidity). These components of the foul air would otherwise be retained on the carbon surfaces, thus reducing the carbon's adsorption capacity and potentially causing premature breakthrough. Moisture removal is particularly important when carbon is used as a second stage after a chemical scrubber or a bioscrubber.

- **Influent concentration:** When the average H_2S concentration in the foul air exceeds 5 to 10 parts per million by volume (ppmv), for virgin carbons regeneration or replacement is more frequent, generally on the order of months rather than years. This tends to be more frequent than most wastewater utilities would prefer. Therefore, with these influent H_2S concentrations, a high-capacity carbon is more appropriate, or selection of an alternative technology.

- **Face Velocity:** The face velocity is the ratio of air flow to the cross sectional area of the void space. Face velocity and bed depth define the bed pressure drop, and thus the power required to operate the system. The pressure drop varies exponentially with face velocity. The optimal face velocity is usually 45 to 55 ft/min.

Iron Oxide Adsorption

Adsorption using iron oxide as a media is sometimes incorporated into odor control systems, though it is more frequently used for high levels of H_2S removal from digester gas. Two iron oxide technologies are considered: iron sponge and SulfaTreat™.

The iron sponge technology is a dry system that is classified as a precipitation and scavenging process. In this approach, the foul air flows through a media of wood shavings coated with hydrated ferric oxide (Fe_2O_3), which also referred to as iron oxide. The wood shavings only serve as the carrier for the iron oxide powder. The media forms a "sponge" which is loaded into a vessel and supported on wooden pine trays. The sponge media absorbs H_2S and converts it to solid ferric sulfide (Fe_2S_3), which is also referred to as iron pyrite. The Fe_2S_3 can be regenerated using air to oxidize the Fe_2S_3 to Fe_2O_3 and elemental sulfur (S). The chemical reactions are as follows:

$$2\ Fe_2O_3 + H_2O + 6\ H_2S \rightarrow 2\ Fe_2S_3 + 7\ H_2O + \text{heat}$$

$$2\ Fe_2S_3 + 3\ O_2 \rightarrow 2\ Fe_2O_3 + 6\ S + \text{heat}$$

The regeneration reaction will proceed in the media until the accumulation of elemental sulfur and other reactions render the media ineffective. Hydrogen sulfide levels and pressure drop are continuously measured in the outlet of unit, and when maximum allowable concentrations of H_2S and pressure drop are beyond recommended levels, the media should be regenerated or replaced.

A schematic of an iron sponge system produced by Varec is depicted in Figure K-5.

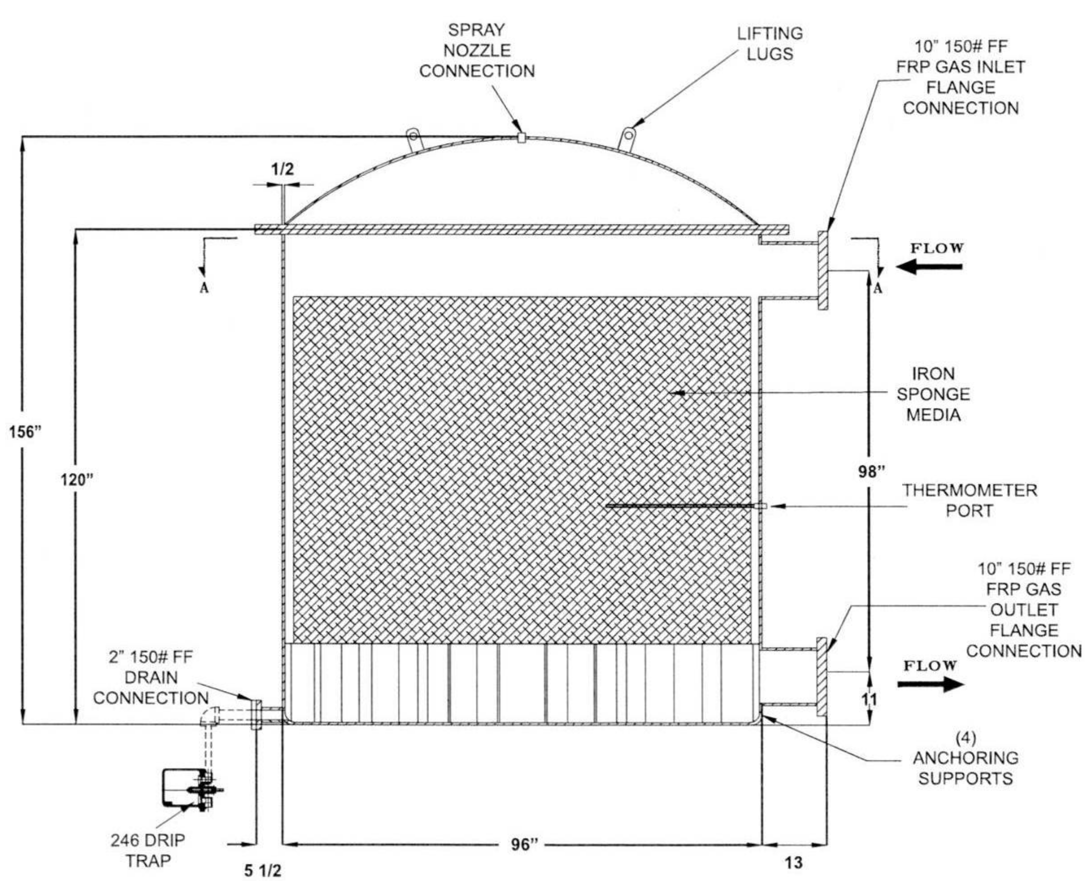

Figure H-5 Schematic of a typical iron sponge odor control system

A standard iron sponge design requires the media to be manually removed for replacement with new or regenerated media. Each time the media is batch-regenerated, the bed life will be approximately 70 percent or less than the previous bed life. Typically the media can be regenerated three times before it needs to be replaced. The regeneration process consists of removing the media and letting it sit in water for 10 days while the Fe_2S_3 is oxidized to iron oxide and elemental sulfur. The water is required to control the heat and prevent combustion due to the exothermic oxidation reaction.

SulfaTreat™ is a packed tower gas-phase treatment system similar to the iron sponge system that removes the H_2S from the gas phase. SulfaTreat™ is a dry system using black granular solid material containing iron oxide to absorb and convert H_2S in the foul air. SulfaTreat™ supplies the sorbent material and also offers various vessel sizes. Their typical recommended design consists of pairs of vessels in series, each containing SulfaTreat™ media. The gas enters the vessels and reacts with the SulfaTreat™ media to form iron pyrite. The spent material is treated as a non-hazardous waste and can typically be disposed of in a municipal landfill. SulfaTreat™ literature indicates that the product consumption is dependent only upon the amount of H_2S in the gas stream.

A basic schematic of a SulfaTreat™ vessel is provided in Figure K-6, which shows that the SulfaTreat™ media is packed into a vertical pressure vessel which is designed for a downward gas flow. Required immediately upstream of the SulfaTreat™ vessel is an inlet separator that removes excess liquids from the digester gas. Alternatively, a water-spray system may be required to saturate the inlet gas.

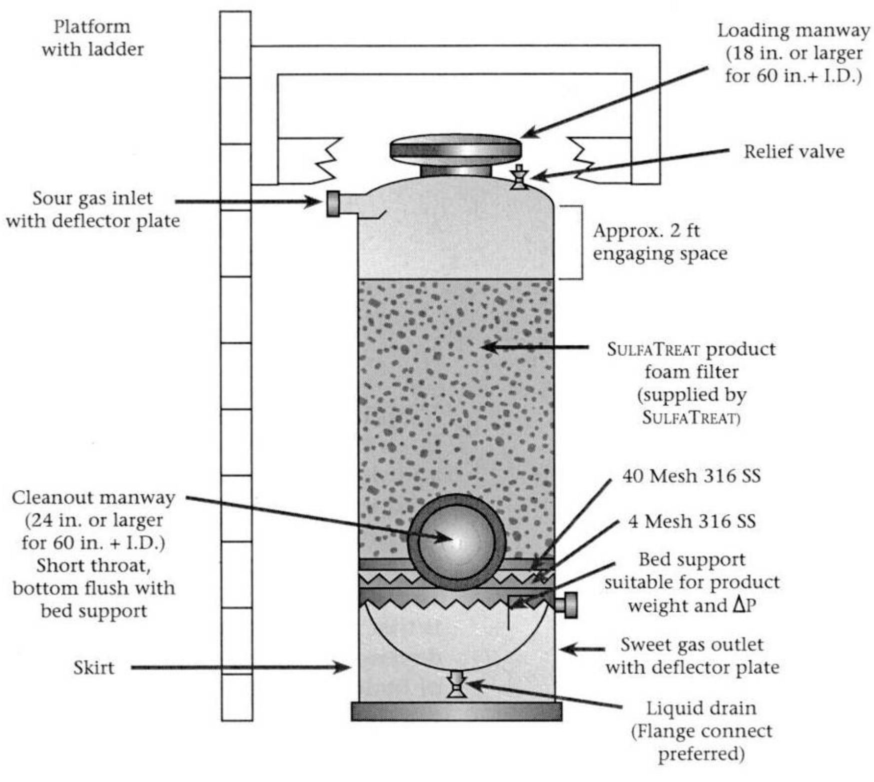

Figure H-6 Schematic of a typical Sulfatreat™ odor control system

The SulfaTreatTM literature states that their standard media has an H2S removal capacity of up to 12 percent by weight. The media density is listed as 70 lb/ft3, producing a maximum sulfur capacity of 8.4 lb of sulfur per cubic foot. Iron sponge manufacturers report a maximum sulfur capacity within a range of 6.3 to 21.3 lb of sulfur per cubic foot, thus the two technologies are reasonably similar with regard to reported efficiency of removing H2S.

Additionally, SulfaTreatTM provides a media called SulfaTreatTM 410 HP, which is produced for low-pressure applications and gas streams containing oxygen. The SulfaTreat literature states that it removes both H2S and light mercaptans odors (methyl mercaptan and ethyl mercaptan) from a foul air stream, and indicates that it is a popular media for odor control. The literature states that in the presence of oxygen, the reaction speed is higher, which allows for smaller equipment sizes. The 410 HP media has a listed H2S removal capacity of up to 25 percent by weight and the media density is 62 lb/ft3, producing a maximum sulfur capacity of 15.5 lbs of sulfur per cubic foot, higher than the standard media and still in the range of H2S removal efficiency reported by the Iron Sponge manufacturer.

APPENDIX I - INTERIM ODOR MITIGATION IMPROVEMENTS ANALYSIS

APPENDIX I - INTERIM ODOR MITIGATION IMPROVEMENTS ANALYSIS

An analysis was performed to evaluate the impacts of implementing interim improvements versus accelerating the installation of the proposed “permanent” odor mitigation improvements for the “high risk” facilities such as the headworks and primary clarifiers. This would involve installing odor improvements prior to beginning the major rehabilitation and upgrades to those particular facilities and then working around those odor improvements during the proposed facility upgrades.

Major assumptions used in the analysis included the following:

- The process facilities to be evaluated include (1) the headworks facilities (including EBOS, raw equalization and miscellaneous junction structures), and (2) primary clarifiers facilities.
- Improvements to the DAFT facilities are scheduled for implementation in the immediate future, including odor control improvements. Therefore, there are no additional interim odor mitigation improvements in this process area, and DAFTs were therefore excluded from the analysis.
- No construction on the fast track or PMP recommended improvements can begin until the programmatic EIR work is completed in early 2013.
- The interim improvements described above could be implemented in parallel with the programmatic EIR process.
- Since the proposed “permanent” odor mitigation improvements to the headworks and primaries are scheduled to be complete by 2020, project and O&M costs were calculated for the alternatives only through 2019. After this point in time there is no cost difference between the alternatives.
- Project costs were escalated to midpoint of construction. An escalation of 2 percent was assumed for both project and O&M costs.
- O&M costs for peroxide addition were based on the usage reported by the City’s vendor U.S. Peroxide during 2010. The records show peroxide was added over a four-month period during 2010.

Three implementation scenarios were analyzed for their project and O&M costs through 2019, and can be described as follows:

- **Base Scenario.** This scenario represents an un-accelerated implementation plan which represents the following:

- The proposed “permanent” odor mitigation improvements described in the PMP, which are planned for implementation at the same time as the improvements to the headworks and primary treatment facilities.

- Until such time as these “permanent” improvements are in place, the City would continue to dose peroxide at the current three dosing locations, namely (1) the Inlet Control (Milpitas) Structure, (2) East Primary Inlet Structure, and (3) the Primary Effluent Pump Station (PEPS) pumping to the primary effluent EQ basin. Peroxide addition is assumed to expand to a total of six (6) months, compared to the four (4) months of application in 2010.

- **Base Scenario plus Expanded Peroxide Addition Scenario.** This scenario represents an un-accelerated implementation plan which represents the following:

  - The proposed “permanent” odor mitigation improvements described in the PMP as per the Base Scenario, i.e., no acceleration of the implementation schedule.

  - Interim odor mitigation would be provided by expanding the Base Scenario peroxide addition, as follows: (1) raw influent at all the various junction boxes would be dosed, not only at the Milpitas Structure, and (2) the six (6) month dosing period (Base Scenario) would be extended further to eight (8) months at all the dosing locations.

  - Aside from the expanded peroxide addition, this scenario also entails covering the launders and discharge channels only of the primary clarifiers, and providing odor treatment facilities to suit.

- **Accelerated Scenario.** This scenario represents an accelerated implementation plan, which represents the following:

  - The proposed “permanent” odor mitigation improvements, described in the PMP, which would involve installing the recommended odor improvements for the headworks and primary clarifiers as a separate stand-alone project.

  - These accelerated “permanent” odor mitigation facilities would require modifications and/or “work-arounds” associated with upgrades planned for the headworks and primary facilities during the facility upgrades. This would increase the overall cost of those upgrades.

  - Acceleration would include covering certain junction structures which may not need to be covered as part of the overall final solution based on the un-accelerated implementation schedule currently included in the PMP, e.g. the Coffin Structure. These costs are unique to this scenario.

– Hydrogen peroxide would be dosed as per the Base Scenario, except for a much-reduced dose at primary treatment, which would be covered and provided with odor mitigation improvements.

The cost analysis of these three scenarios is summarized in the following Table L-1.

Expanding the peroxide addition and covering the primary clarifier launders, as well as implementing the base scenario, is expected to cost approximately nine (9) percent more than the base scenario alone. While expanding the addition of chemicals will have a marked effect on odors at these facilities, the improvements are not expected to be as comprehensive as implementing capture and treat technologies.

Accelerating the “permanent” odor mitigation improvements is anticipated to cost approximately 19 percent more through 2019, and includes improvements that are short term in their nature.

Table L-1: Comparison of Odor Mitigation Project and O&M Costs Through 2019.

Description	Base Scenario			Base Scenario plus Expanded Peroxide Addition Scenario			Accelerated Scenario		
	Project Cost	O&M Cost	Total Cost Through 2019	Project Cost	O&M Cost	Total Cost Through 2019	Project Cost	O&M Cost	Total Cost Through 2019
Headworks:									
EBOS: Coat, Cover & Scrub	$ 5,721,000	$ 18,000	$ 5,739,000	$ 5,721,000	$ 18,000	$ 5,739,000	$ 5,553,000	$ 43,000	$ 5,596,000
Raw EQ Basin: Line and spraydown equipment	$ 8,855,000	$ -	$ 8,855,000	$ 8,855,000	$ -	$ 8,855,000	$ 8,596,000	$ -	$ 8,596,000
Headworks 2: Coat, Cover & Scrub	$ 13,118,000	$ 402,000	$ 13,520,000	$ 13,118,000	$ 402,000	$ 13,520,000	$ 12,926,000	$ 688,000	$ 13,614,000
Headworks 1: Coat, Cover & Scrub	$ -	$ -	$ -	$ -	$ -	$ -	$ 11,294,000	$ 147,000	$ 11,441,000
Junction Structures: Coat, Cover & Scrub	$ 2,202,000	$ 6,000	$ 2,208,000	$ 2,202,000	$ 6,000	$ 2,208,000	$ 4,510,000	$ 32,000	$ 4,542,000
Peroxide Addition: Raw	$ -	$ 1,769,000	$ 1,769,000	$ -	$ 4,492,000	$ 4,492,000	$ -	$ 858,000	$ 858,000
Subtotal			**$ 32,091,000**			**$ 34,814,000**			**$ 44,647,000**
Primary Treatment:									
East Primaries: Coat Cover & Scrub	$ 49,063,000	$ -	$ 49,063,000	$ 52,838,000	$ 235,000	$ 53,073,000	$ 53,362,000	$ 1,132,000	$ 54,494,000
Junction Structures: Coat, Cover & Scrub	$ 2,492,000	$ 6,000	$ 2,498,000	$ 2,492,000	$ 6,000	$ 2,498,000	$ 2,492,000	$ 6,000	$ 2,498,000
Peroxide Addition: Primaries	$ -	$ 2,241,000	$ 2,241,000	$ -	$ 2,977,000	$ 2,977,000	$ -	$ 1,160,000	$ 1,160,000
PE EQ Basin: Washdown Modifications	$ 2,230,000	$ -	$ 2,230,000	$ 2,230,000	$ -	$ 2,230,000	$ 2,230,000	$ -	$ 2,230,000
Peroxide Addition: PE EQ Basin	$ -	$ 333,000	$ 333,000	$ -	$ 446,000	$ 446,000	$ -	$ 333,000	$ 333,000
Subtotal			**$ 56,365,000**			**$ 61,224,000**			**$ 60,715,000**
TOTAL			**$ 88,500,000**			**$ 96,100,000**			**$ 105,400,000**

Notes:
1. All costs include escalation at two (2) percent.