The Metropolitan

Water Reclamation District

of Greater Chicago

WELCOME
TO THE JUNE EDITION
OF THE 2017
M&R SEMINAR SERIES

BEFORE WE BEGIN

- SAFETY PRECAUTIONS
  - PLEASE FOLLOW EXIT SIGN IN CASE OF EMERGENCY EVALUATION
  - AUTOMATED EXTERNAL DEFIBRILLATOR (AED) LOCATED OUTSIDE
- PLEASE SILENCE CELL PHONES OR SMART PHONES
- QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION
- PLEASE FILL EVALUATION FORM
- SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ Reports ⇒ M&R Data and Reports ⇒ M&R Seminar Series ⇒ 2017 Seminar Series)
- STREAM VIDEO WILL BE AVAILABLE ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ MWRDGC RSS Feeds)

CARLA D. DILLON, Ph.D., PE

Current: **Engineering Supervisor,** Orange County Sanitation District (OCSD), Fountain Valley, California

Experience: Lead teams responsible for research, interagency coordination, easements/right-of-way, annexations, sewer transfers, etc.; Planning Director of Emergency Operation Center, when active; As Engineer, Senior Engineer with OCSD, responsible for process engineering and optimization of plant odor control systems, optimized treatment processes to minimize odor generation, etc.; Prior to OCSD, as project engineer for Braun Intertec Corporation, 3M Company, CA Regional Water Quality Control Board

Education: Ph.D. (Public Administration), University of La Verne, La Verne, CA
M.S. (Civil Eng w/ minor in Public Health), Univ of Minnesota, Minneapolis, MN
B.S (Envir Eng), California Polytechnic State University, San Luis Obispo, CA

Professional: Licensed Professional Engineer in C;, Certified Water Treatment Operator; Committee Chair of WEF; Committee member of WE&RF

Award: 2012 Jennings Randolph International Fellow, AWWA

Volunteerism: City of Long Beach, Sustainable City Commission

U.S. President's Volunteer Service Program

Odor Control at the Orange County Sanitation District

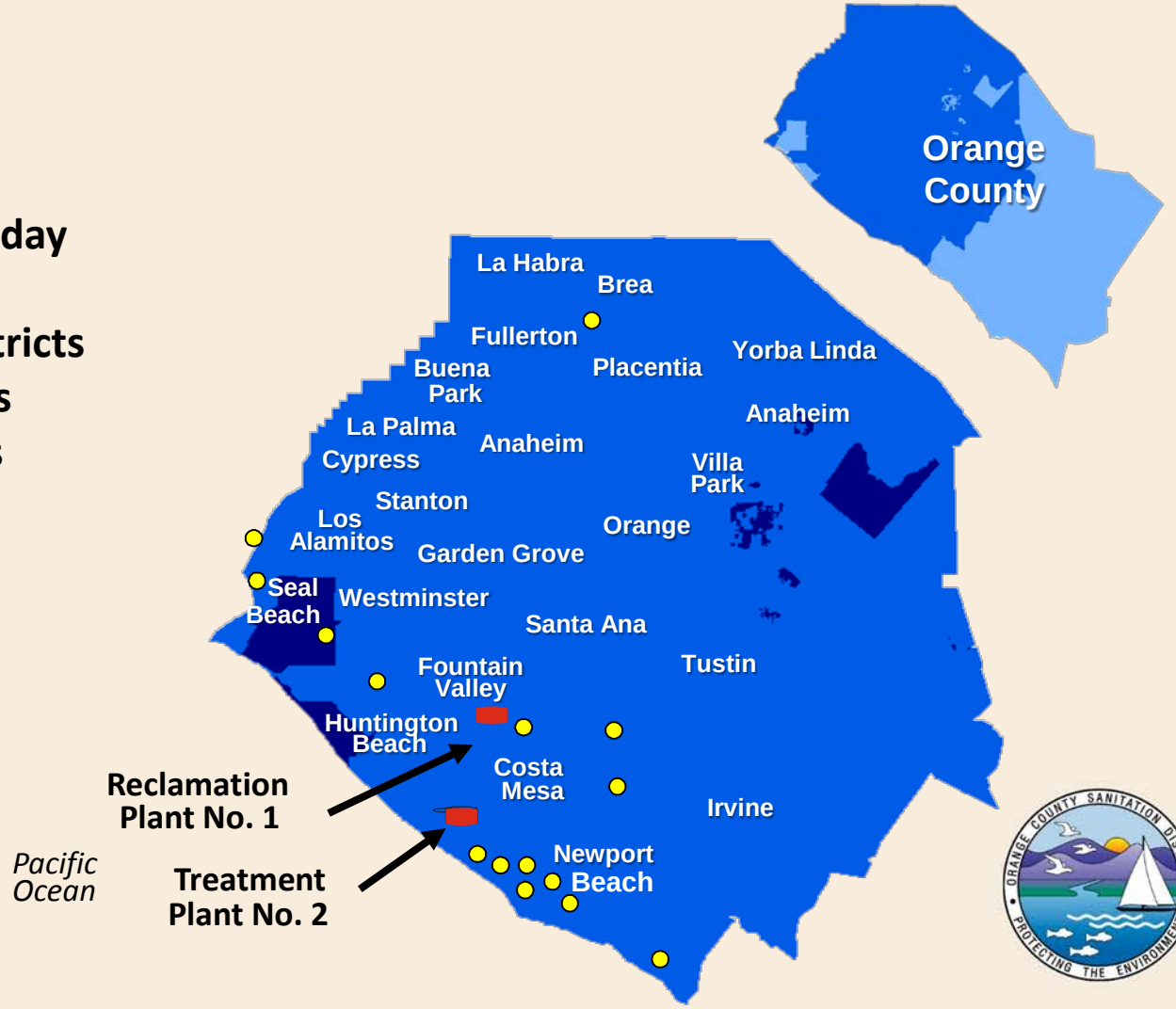
Dr. Carla D. Dillon, P.E.
Engineering Supervisor
Orange County Sanitation District

Outline

- OCSD Overview
- Collection System Odor Control
- WRRF/Plant Odor Control
- Complaint Process
- Odor Control Master Plan
- Other odor-related Research

OCSD Service Area

396 miles of sewers
471 square miles
185 million gallons per day
2.6 million population
20 cities, 4 special districts
15 pumping stations
2 treatment plants



Governance

25 Member Board

- 20 City Council Representatives
- 2 Sanitary District Representatives
- 2 Water District Representative
- 1 Member of the Orange County Board of Supervisors

Committees

- Steering
- Administration
- Operations
- Legislative & Public Affairs

Reclamation Plant No. 1

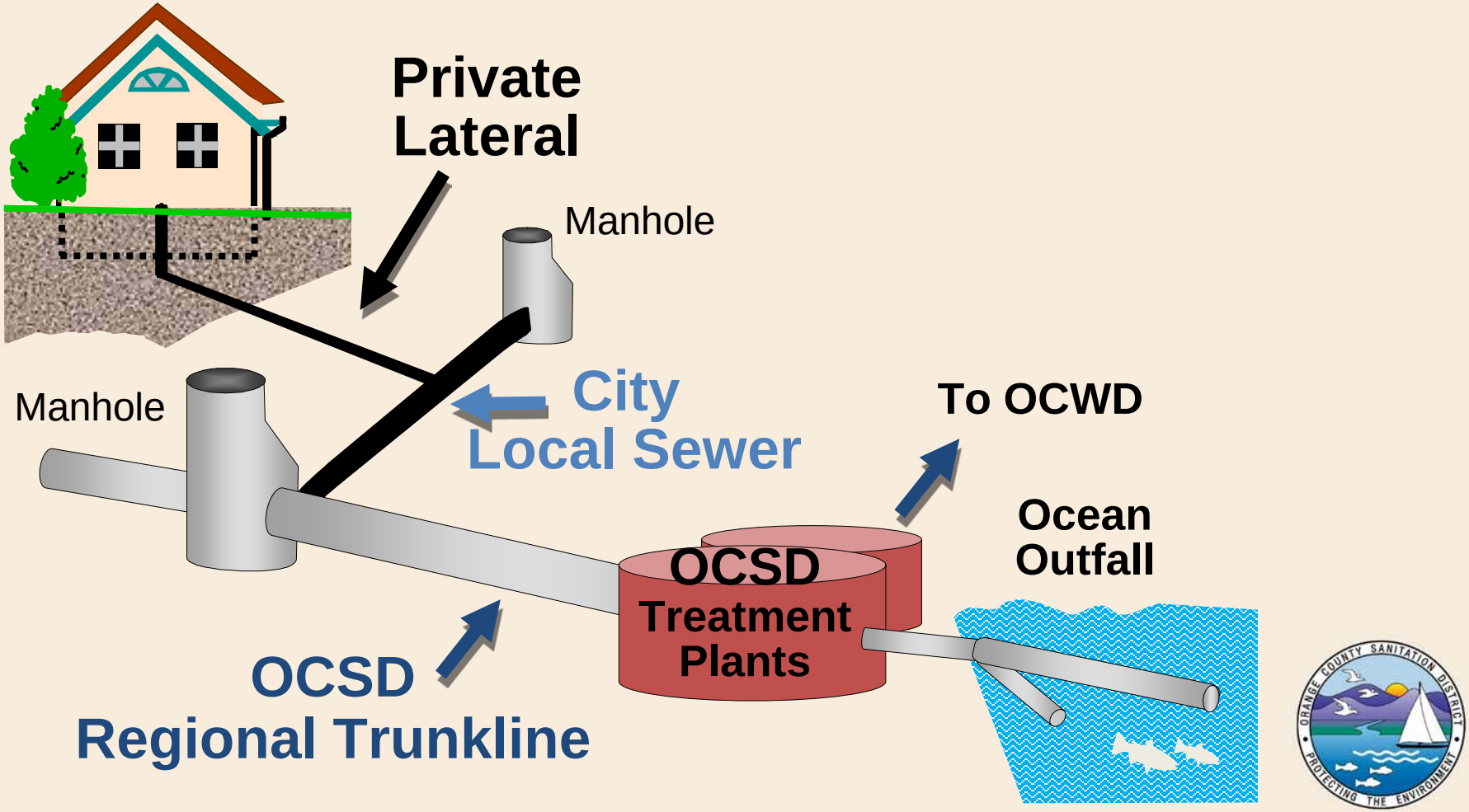
Fountain Valley

Treatment Plant No. 2

Huntington Beach

Collection System Odor Control

Wastewater Collection System



OCSD Odor Control Chemical Dosing Locations

- **Ferrous Chloride** –
  Used in Gravity Trunks
- **Magnesium Hydroxide** –
  Used in Force Mains
- **Calcium Nitrate** –
  Used in Force Mains
- **Caustic (Sodium Hydroxide)** –
  Used for batch dosing

Westside Pump Station (Los Alamitos)

Critical 1-hour response

SARI Facilities in Yorba Linda

SARI Gate

Yorba Linda Spur Odor Control

SAVI Ranch

ta Ana River

SARI Metering Station

Gysum Canyon

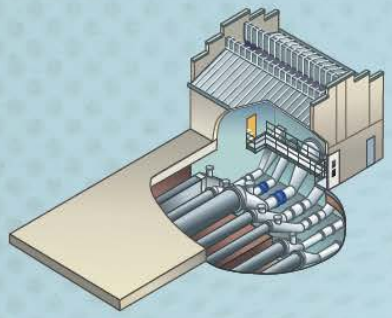
Collection System Dosing

- Multi-chemical
  - Iron
  - Magnesium Hydroxide
  - Calcium Nitrate
  - Sodium Hydroxide
- Quality assurance of chemicals
- Real time testing
- Dynamic program to allow for quick change
- ≤ 25 ppm H_2S headspace
- ≤ 0.5 ppm dissolved sulfides

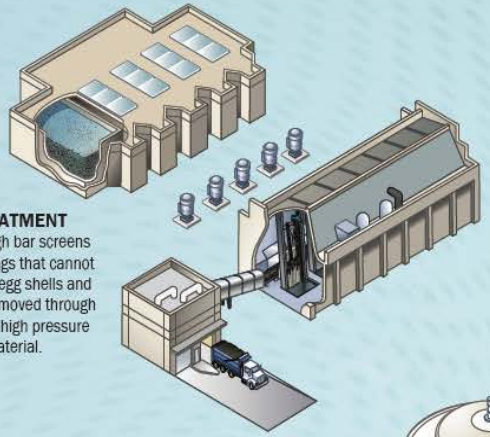
Water Resource Recovery Facilities
Odor Control

Orange County Sanitation District

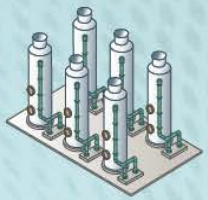
Wastewater Treatment Process



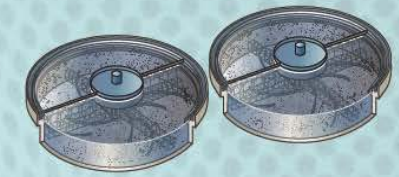
1. METERING AND DIVERSION
Wastewater enters our plant at 2.5 - 5 mph through pipes up to 10 feet in diameter. High tech equipment monitors the temperature, pH, conductivity, and flow of the incoming wastewater.



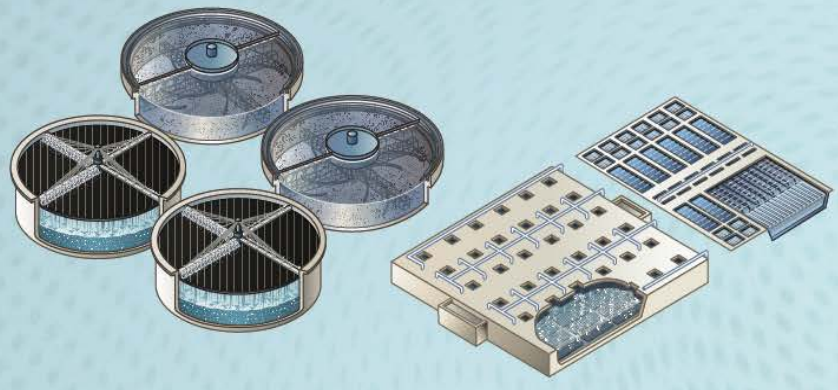
2. PRELIMINARY TREATMENT
Raw sewage passes through bar screens that trap large items like rags that cannot be recycled. Materials like egg shells and coffee grounds are then removed through the grit chamber that uses high pressure air to separate the gritty material.



3. AIR SCRUBBER
Hydrogen Sulfide (foul air) is captured throughout the process and funneled into large silos. It passes through a plastic medium and mixes with caustic soda and bleach. Causing the odorous compounds to be neutralized.

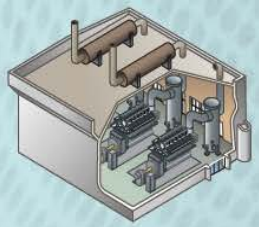


4. PRIMARY TREATMENT
Primary clarifiers or settling basins, slow the water down to let the solids that are within the water settle out, separate and float to the surface. Scrapper arms that move along the top and bottom remove up to 80% of the solids. Solids are then sent to digesters for processing.



5. SECONDARY TREATMENT
Trickling filters and aeration basins are used to further clean the water. In trickling filters the water is sprayed over a honeycomb type material upon which aerobic bacteria grow. As the water trickles down, the microorganisms consume the solids that were not removed through primary treatment. Aeration tanks use a combination of oxygen and microorganisms, (activated sludge) that consume the remaining organic solids. Treated water is then sent to the Orange County Water District for recycling, or discharged into the ocean.

6. BIOSOLIDS
Solids captured from primary and secondary processes are batch loaded into anaerobic digesters where they are heated to about 98 degrees and treated for 18-21 days. They enter de-watering where water is squeezed out using belt presses. The nutrient rich biosolids are trucked off to farms where they are recycled for direct land application, and composting. The digestion process produces methane gas.



7. CENTRAL GENERATION
Methane gas that is captured from digesters is compressed and used to fuel engine-generators that produce electricity, supplying about 60% of our energy needs.

ORANGE COUNTY SANITATION DISTRICT • PROTECTING THE ENVIRONMENT •

PA 07/2014

WRRF Odor Control – Plant No. 1

Process Area	Existing Treatment
Headworks	Packed bed chemical scrubbers operated in caustic-bleach mode plus trunkline roughing biofilter
Primaries	Packed bed chemical scrubbers operated in bleach-only mode

WRRF Odor Control – Plant No. 1

Process Area	Existing Treatment
Activated Sludge (AS-1 & AS-2)	None
Trickling Filters	None
DAFT	Packed bed chemical scrubbers operated with plant water only

WRRF Odor Control – Plant No. 1

Process Area	Existing Treatment
Truckloading/Dewatering	Packed bed chemical scrubbers operated with plant water only
Wastehauler Station	Biorem Biofilter (demolished)

WRRF Odor Control – Plant No. 2

Plant 2	Existing Treatment
Headworks	2-sec. EBGRT bioscrubber (recirculating) followed by chemical scrubbers operated in caustic-bleach mode plus trunkline roughing bioscrubbers
Primaries (NSC & SSC)	Packed bed chemical scrubbers operated in bleach-only mode

WRRF Odor Control – Plant No. 2

Plant 2	Existing Treatment
DAFTs	Biofilter
Trickling Filters	Carbon
Trickling Filters Contact Basins	None
Truckloading	None

Odors

- Compliance
- Complaint Process
- Internal Goals

SCAQMD Rule 402 – Nuisance

Prohibits discharge from any source
air contaminants which cause nuisance
or annoyance or which endanger the comfort, health
or safety of any number of persons or the public

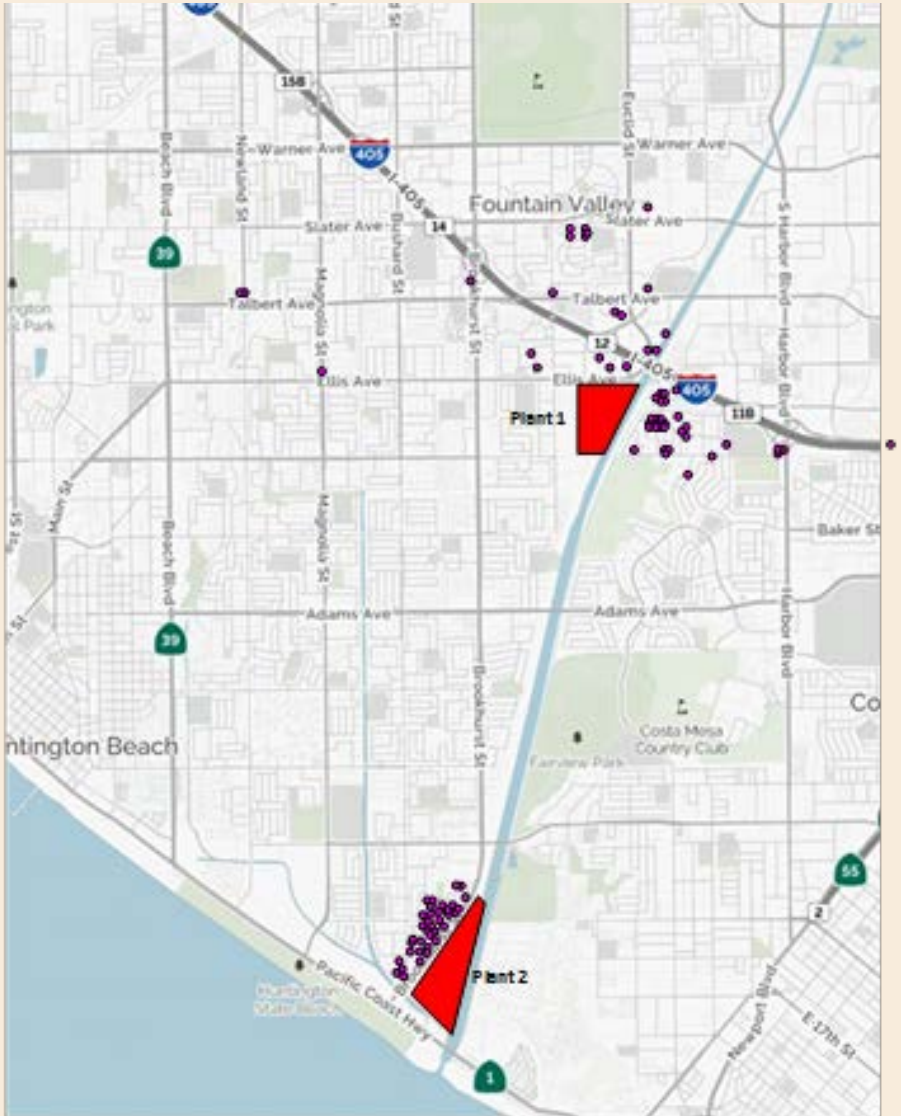
All Complaints Processed Online

- Logged in by anyone receiving complaint into call center
- Everyone shares and tracks information

Prior Goals for Odor Control

- Design all new projects to retain odor within property boundaries (10 D/T)
- No off-site odors from WRRF's during normal operations
- 12 complaints per year in Collection System
- Respond to WRRF odor complaints within 1 hour
- Respond to Collection System odor complaints within 1 day
- Respond to spills within 1 hour

Odor Complaints



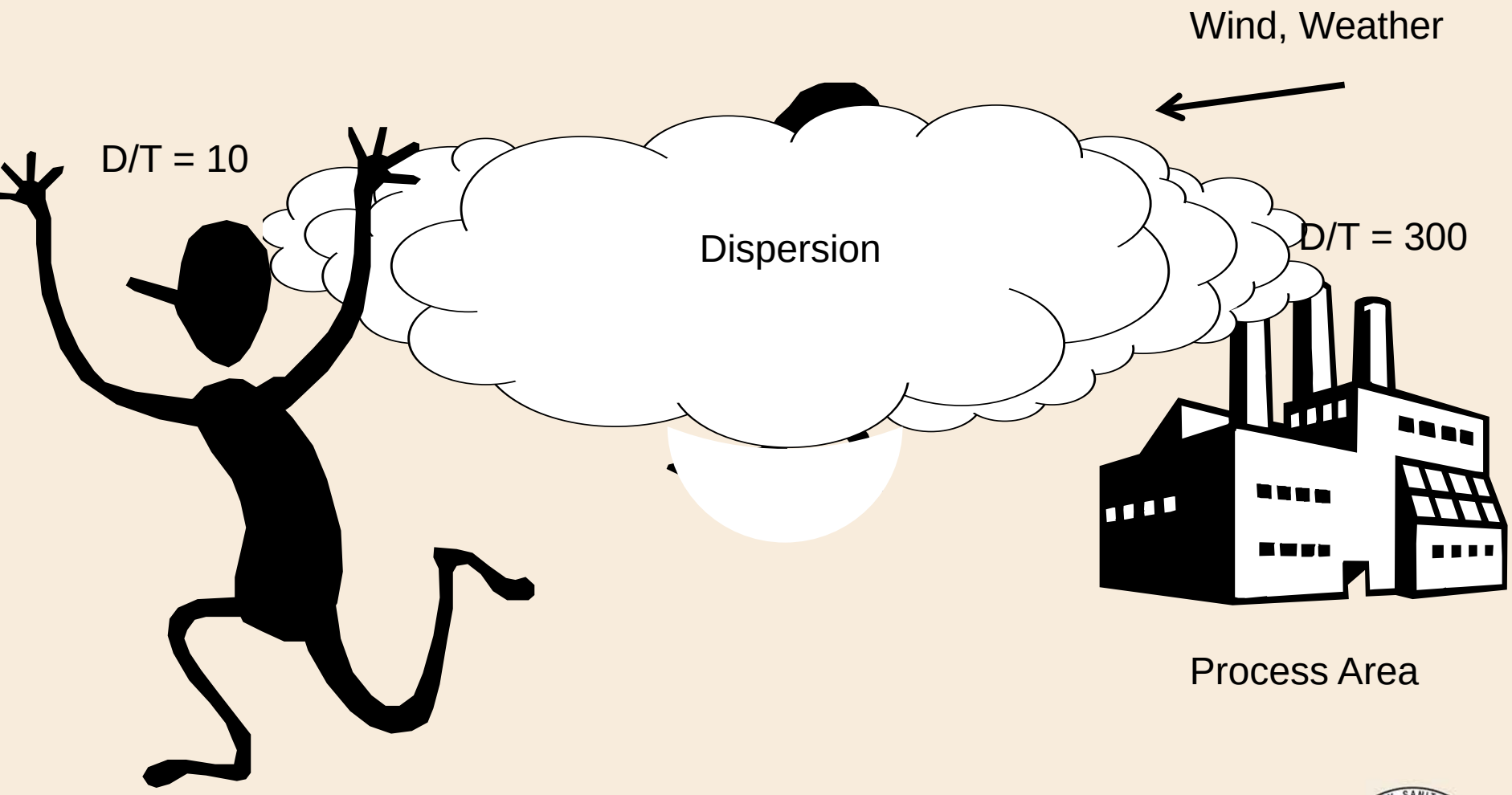
Odor Control Master Plan

- 2003 Master Plan – H2S based
- 2008 Master Plan – D/T based
- 2017 Master Plan –

2017 Odor Control Master Plan

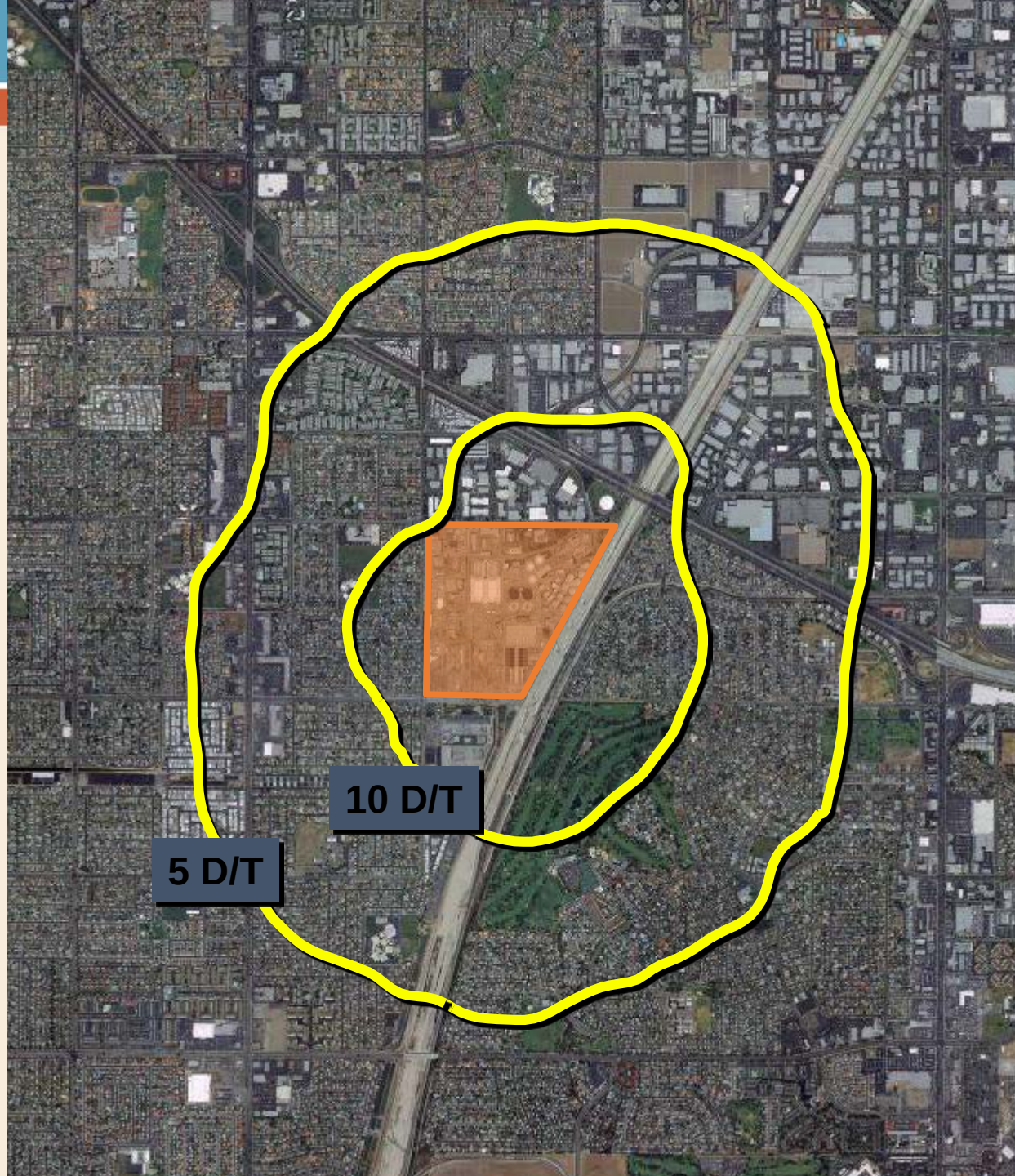
- Why initiate it
- Monitor
  - Chemical
  - OPM
  - D/T
- Pilot
- Model
- Recommended treatment

Previous Goal



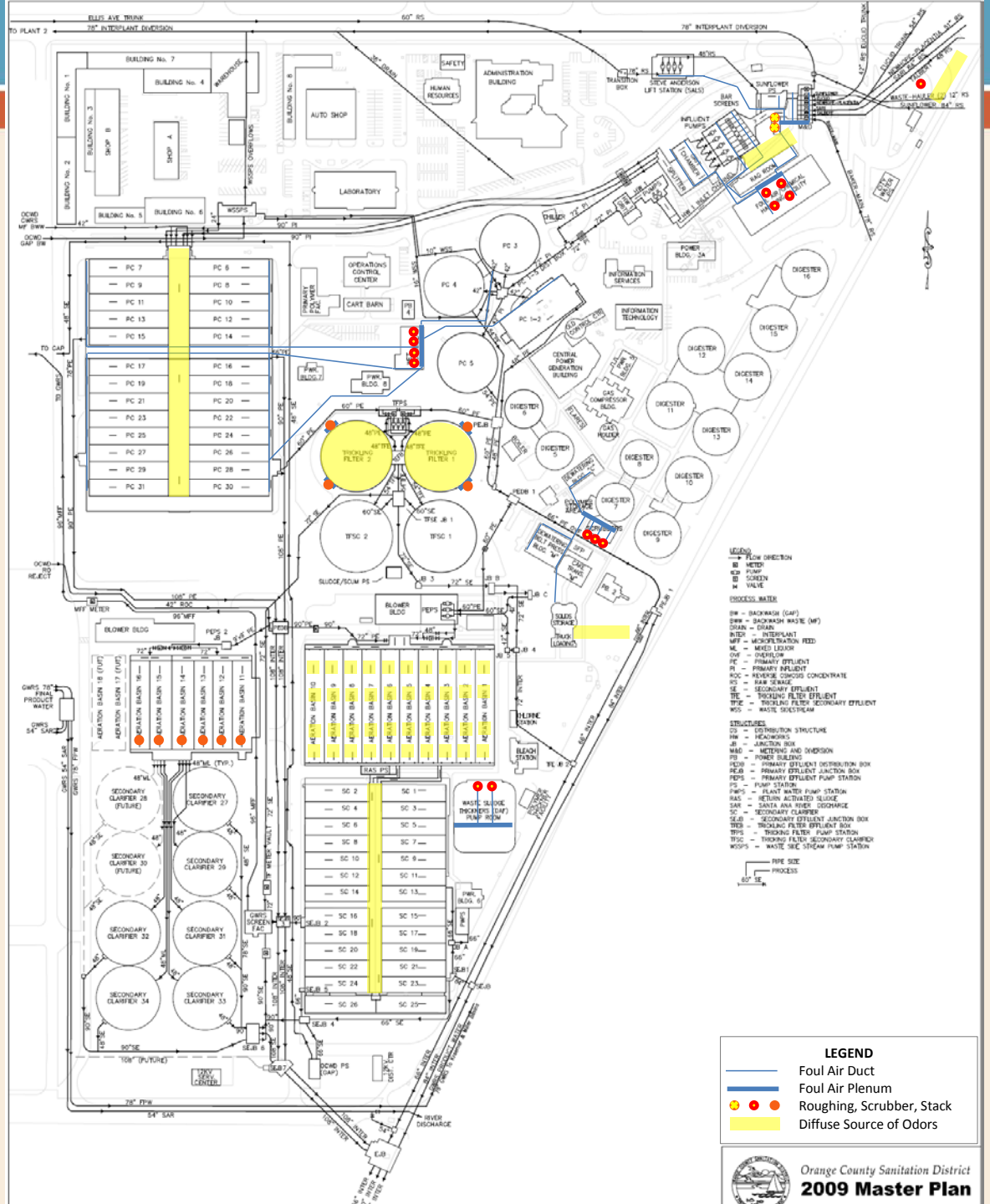
Odor Impact Modeling

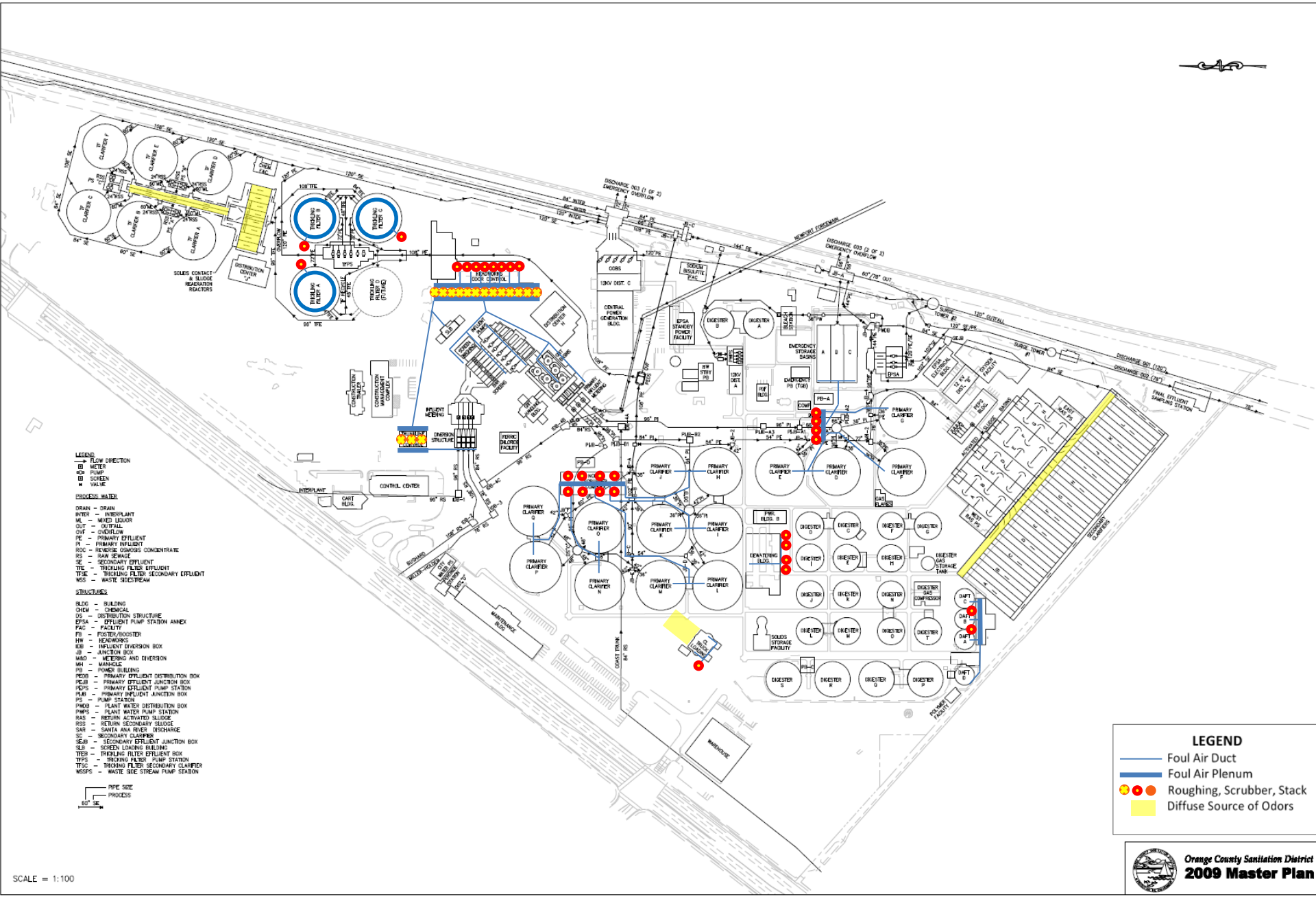
2008 Master Plan Approach



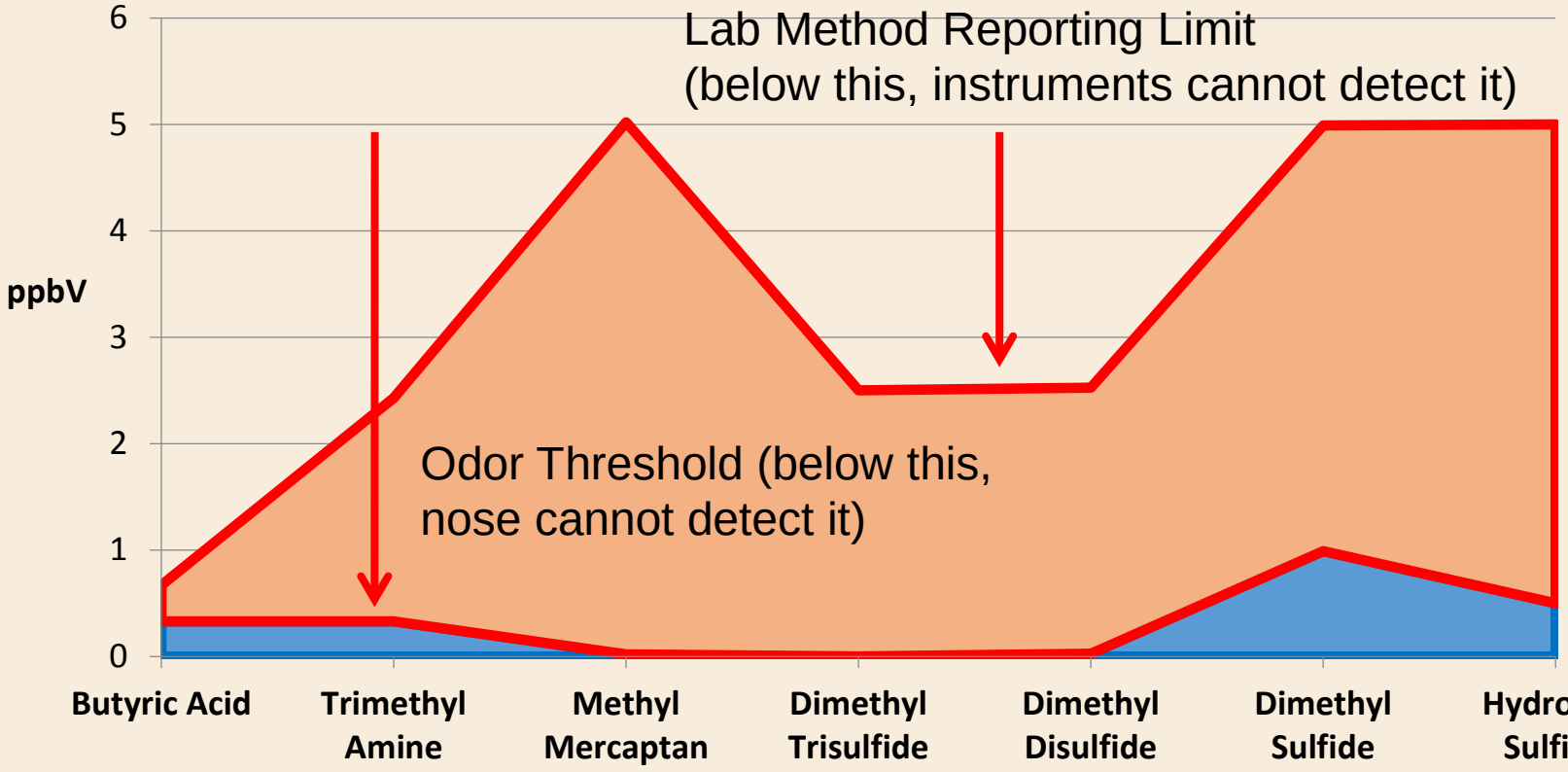
Master Plan Criteria

- Determine “most detected” odorant removal efficiency by OCSD treatment systems
- Determine which treatment technology is more effective at removing the combination of odorants identified based on three nuisance criteria:
    1. Current system (do nothing)
    2. Best single stage system
    3. Best multiple stage system
- Determine the odor impact at the fence line for each of the above nuisance criteria, which will become the new Level of Service options
- Determine costs associated with each LOS


LEGEND
Foul Air Duct
Foul Air Plenum
Roughing, Scrubber, Stack
Diffuse Source of Odors
Orange County Sanitation District
2009 Master Plan
ORANGE COUNTY SANITATION DISTRICT
PROTECTING THE ENVIRONMENT


LEGEND
Foul Air Duct
Foul Air Plenum
Roughing, Scrubber, Stack
Diffuse Source of Odors
SCALE = 1:100
Orange County Sanitation District
2009 Master Plan

Limitations of Analytical Methods

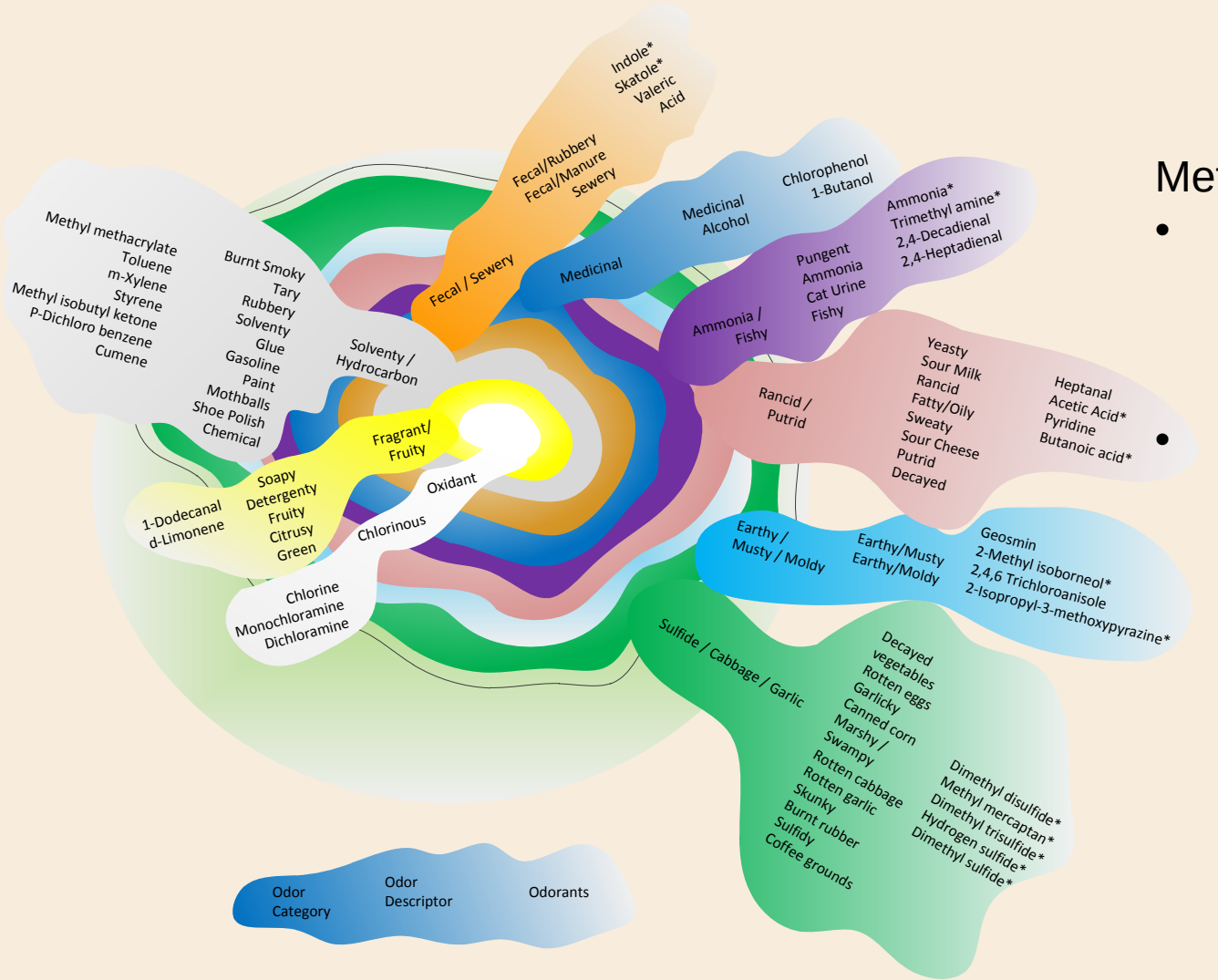


Odorants Detected at OCSD

Odorant	Odor Threshold (ppbV)	Odor Description	Method Reporting Limit (ppbV)
Acetic Acid	1,019	Sour, Vinegar	8.0 – 4.0
Butyric Acid	0.33	Sour, Sweaty	0.68 – 0.34
Ammonia	38.28	Pungent, Irritating	0.52 – 0.26
Trimethyl Amine	0.33	Fishy, Pungent	4.2 – 2.1
Skatole	0.000075	Fecal, Sewery	
2-Methyl Isoborneol	0.013	Earthy/Musty	
Methyl Mercaptan	0.020	Sulfidy, Rotten Vegetables	5.0
Carbonyl Sulfide	10.32	Sulfidy	5.0
Dimethyl Trisulfide	1.2	Rotten Garlic	2.5
Dimethyl Disulfide	0.026	Rotten Garlic	2.5
Dimethyl Sulfide	0.99	Canned Corn, Cabbage	5.0
Hydrogen Sulfide	0.50	Rotten Eggs	5.0

(Ruth, Jon H. “Odor Threshold and Irritation Levels of Several Chemical Substances: A Review” Am. Ind. Hyg. Assoc. J. (47). March 1986)

Determining Odors



Wastewater Odor

Methods:

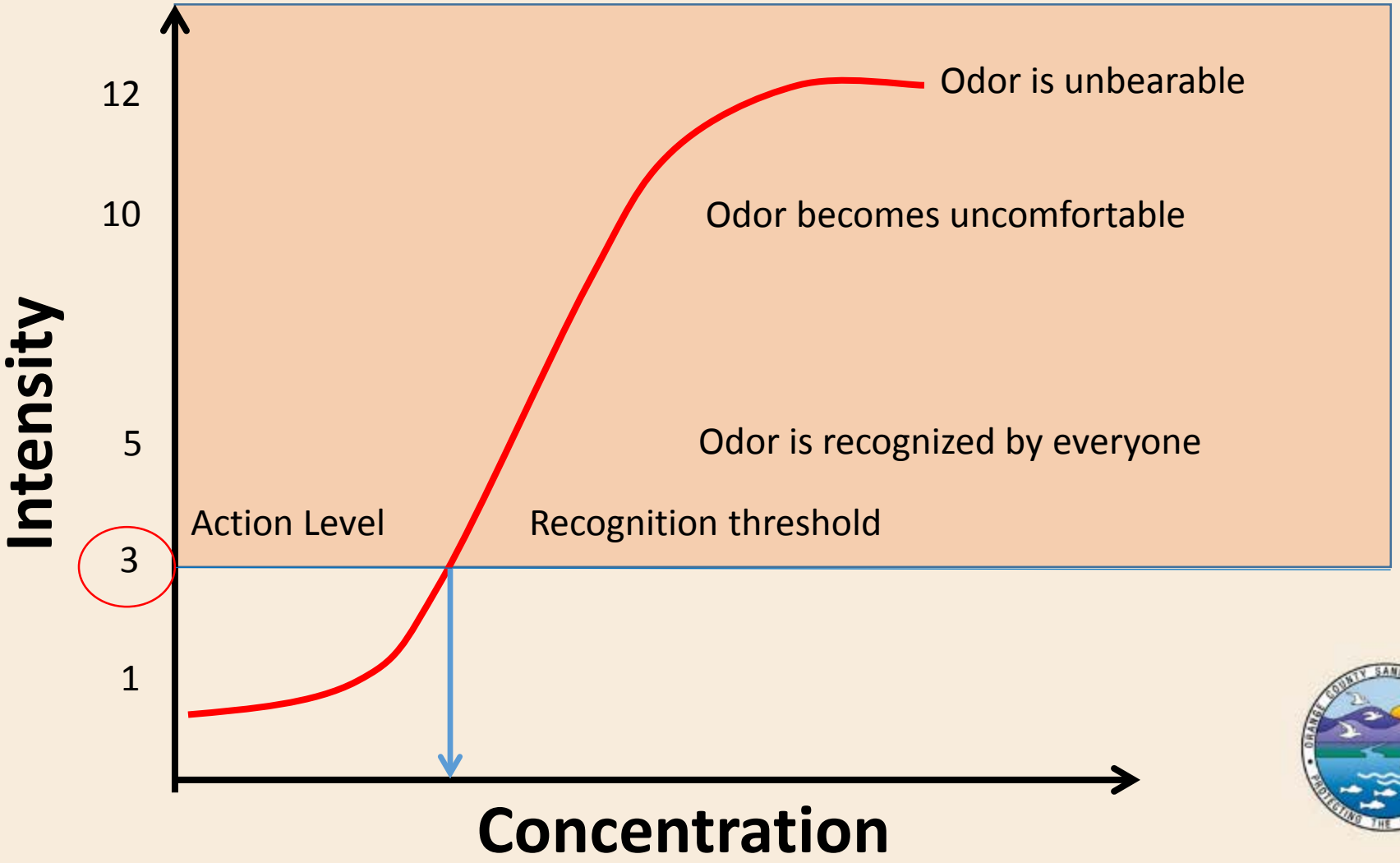
- Analytical
  - Amines
  - Carboxylic Acids
  - Reduced Sulfur
- Sensorial
  - D/T
  - OPM
    - GC/MS
    - GC/MS sniff

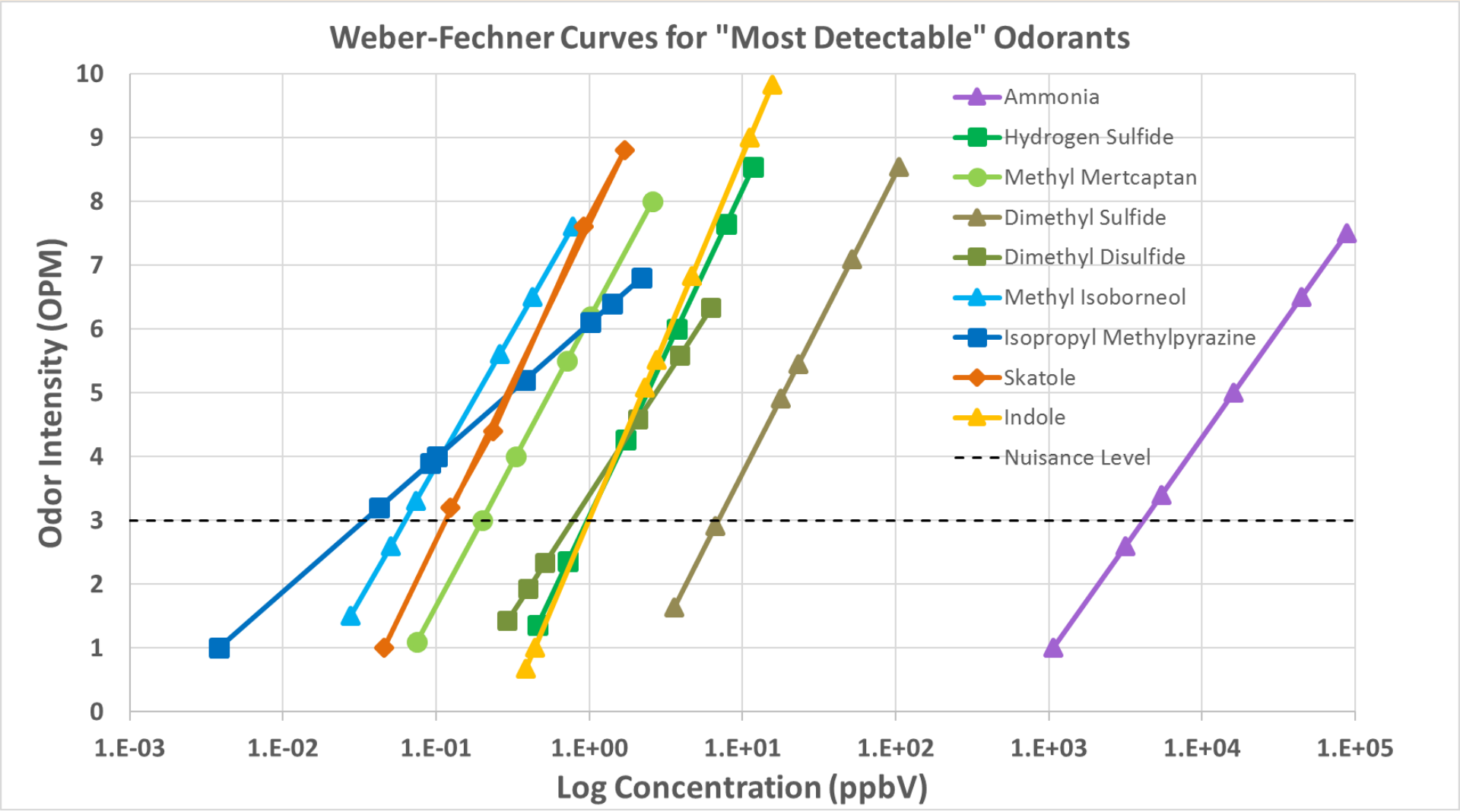
Odor Control Master Plan

Interim Milestones

- Develop standard analytical protocols for:
  - 2-Methyl Isoborneol (Earthy/Musty odors)
  - Skatole (Fecal odors) to determine its presence at all process areas
- Develop the Weber-Fechner curves for all 7 “most detectable” odorants:
  - Hydrogen Sulfide (H2S) – Rotten Egg
  - Methyl Mercaptan (MM) – Rotten Vegetable
  - Dimethyl Sulfide (DMS) – Canned Corn
  - Dimethyl Disulfide (DMDS) - Rotten Garlic
  - Ammonia - Pungeant
  - 2- Methyl Isoborneal (MIB) - Musty
  - 2-Isopropyl-3Methoxypyrazine (IPMP) - Musty
  - Indole - Fecal
  - Skatole - Fecal

Relating Odor Intensity with Concentration




Weber-Fechner Curves for "Most Detectable" Odorants
Odor Intensity (OPM)
10
9
8
7
6
5
4
3
2
1
0
1.E-03
1.E-02
1.E-01
1.E+00
1.E+01
1.E+02
1.E+03
1.E+04
1.E+05
Log Concentration (ppbV)
Ammonia
Hydrogen Sulfide
Methyl Mertcaptan
Dimethyl Sulfide
Dimethyl Disulfide
Methyl Isoborneol
Isopropyl Methylpyrazine
Skatole
Indole
Nuisance Level

Existing Average Odorant Removal Rates

Treatment System	H_2S (%)	MM (%)	DMS (%)	DMDS (%)	Ammonia (%)	MIB (%)	IPMP (%)	Skatole (%)	Indole (%)
PLANT 1 Treatment Systems									
Wastehauler Biofilter	99	99	24	0	0	-53	-53	78	78
Headworks Scrubbers	91	60	40	42	0	-30	-30	50	50
Primary Scrubbers	92	60	60	42	20	40	40	30	30
DAFT Scrubbers	0	0	0	0	0	0	0	0	0
Dewatering/Truckloading Scrubbers	0	0	0	0	0	0	0	0	0
PLANT 2 Treatment Systems									
Headworks Scrubbers	98	97	70	94	0	72	72	84	84
Primary Scrubbers North	85	64	27	0	20[b]	40	40	60	60
Primary Scrubbers South	85	64	27	0	20[b]	40	40	60	60
Trickling Filter Scrubbers	95	97	42	-158	0	65	65	75	75
DAFT Biofilter	90[a]	80[a]	50[a]	0	20[a]	0	0	43.5	43.5
Dewatering Scrubbers	0	0	0	0	0	0	0	0	0

Notes:

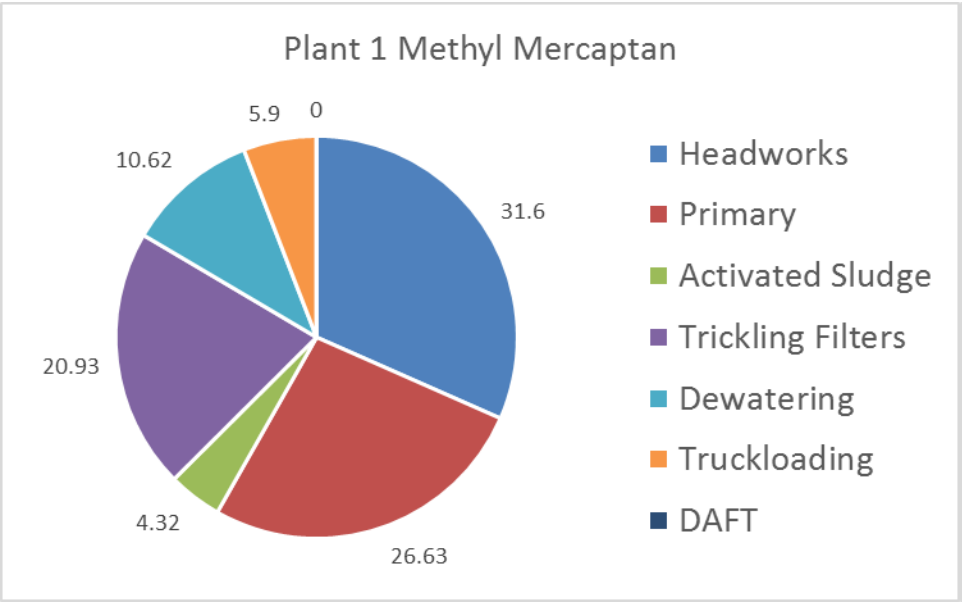
Negative numbers represent odor generation and are likely because of odorant transformation or conversion within treatment beds

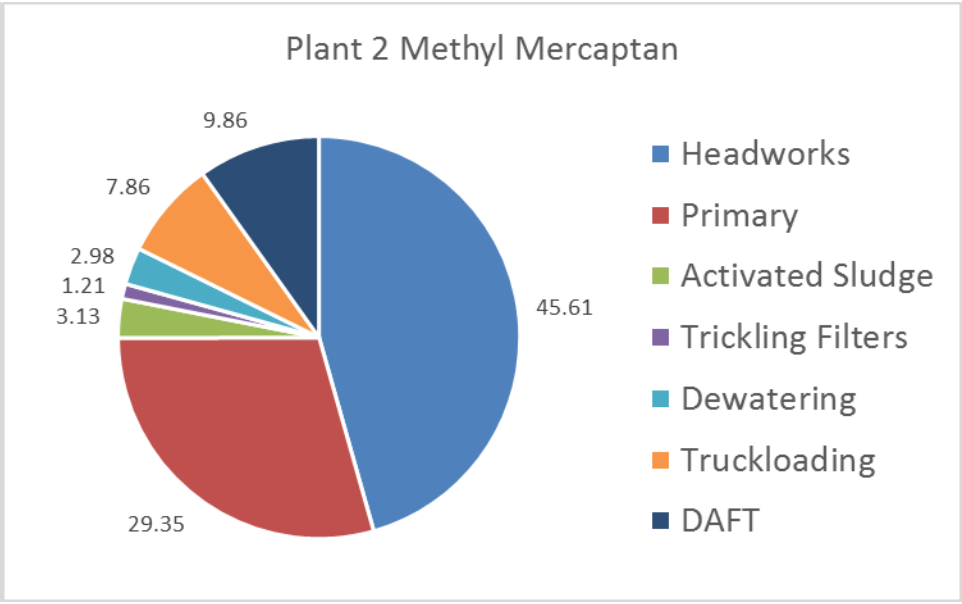
All removal rates are calculated strictly from treatment units and are not calculated based on receptor concentrations or fenceline concentrations

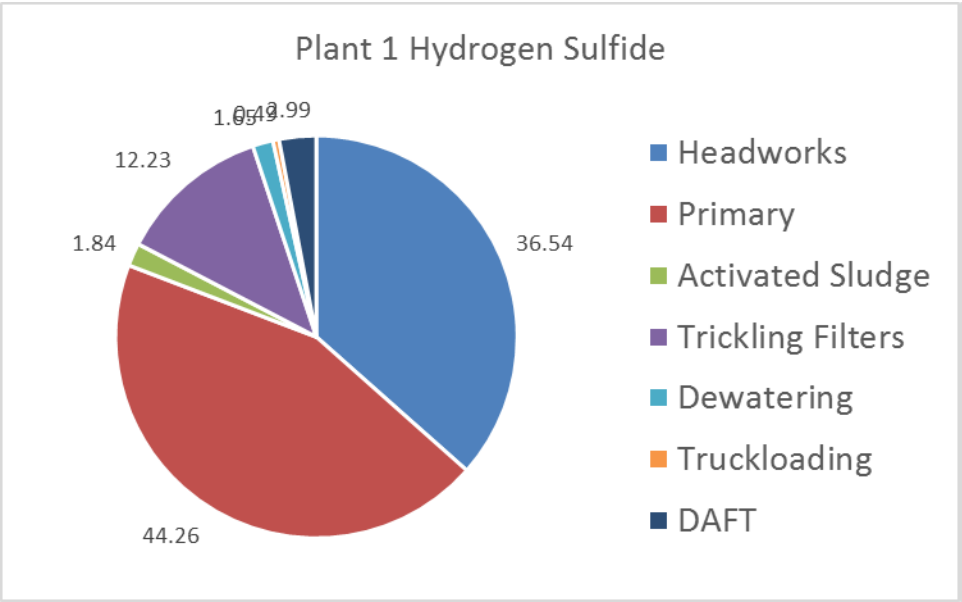
[a] Representative because no data provided.

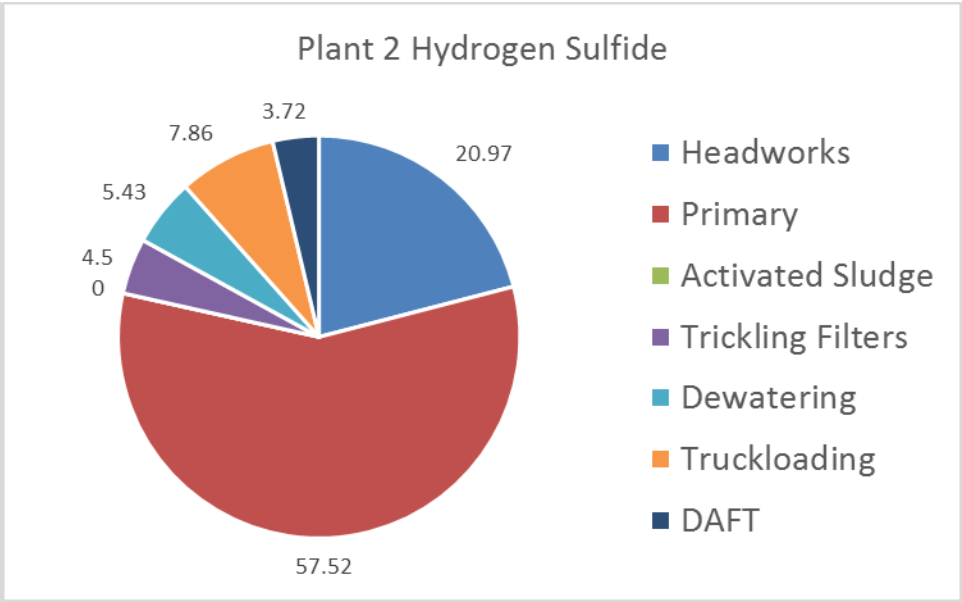
[b] Since nondetectable, used Plant No. 1 primary scrubber removal rate.

Current Emission Proportions









Pilot Testing Research

- Test additional treatment systems and/or pilot treatment unit to determine removal efficiency of “most detected”:
  - Chemical Scrubbers (using different chemical reactants)
  - Biofilters (using different natural media and EBRT’s)
  - Biotowers (using different synthetic media and EBRT’s)
  - Adsorbents (using different media)
  - Reaction Chambers (using ionized air, photo catalytic oxidation, ozone generators, etc.)
- Summarize results in a matrix with existing industry knowledge

Pilot Unit

Foam Cubes

Matala & Foam

Coated Pumice

Seashells

Lava Rock

Coal, Coconut, Permanganate Activated Carbon

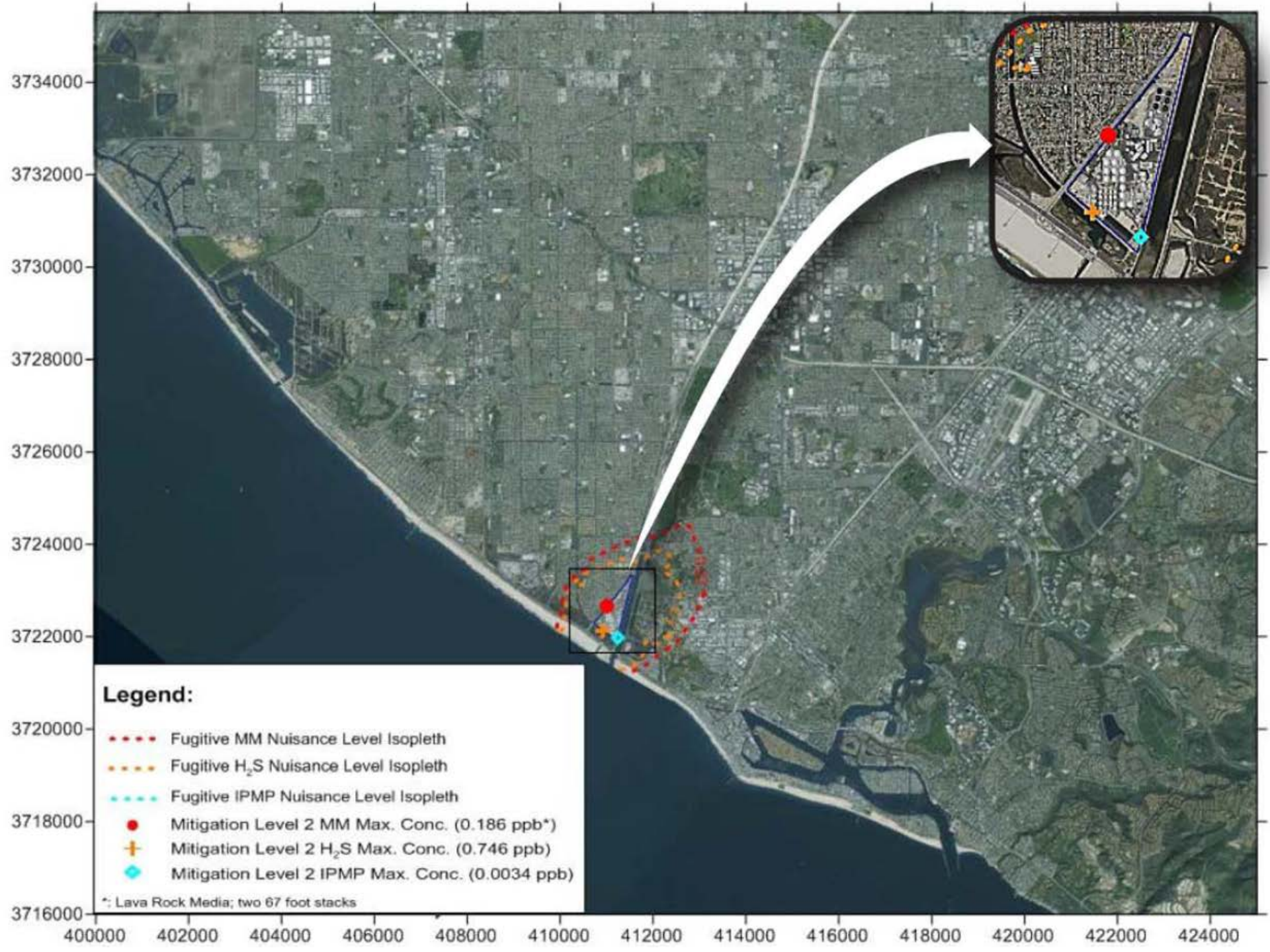
Figure ES-1. Odorant Nuisance Impacts, Baseline Existing Condition – Plant No. 1


3734000
3732000
3730000
3728000
3726000
3724000
3722000
3720000
3718000
3716000
400000
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
424000
Legend:
Baseline MM Nuisance Level Isopleth
Baseline H2S Nuisance Level Isopleth
Baseline IPMP Nuisance Level Isopleth
Baseline Skatole Nuisance Level Isopleth
Baseline DMS Nuisance Level Isopleth

Odorants Recommended for Mitigation

Plant No. 1 Summary of Sources Recommended for Mitigation				
	H_2S	MM	Musty	Fecal
Headworks Scrubbers	✓	✓		
Primary Scrubbers	✓	✓		
DAFT Scrubbers		✓		
Dewatering/Truckloading Scrubbers		✓		
Activated Sludge Basin Stacks		✓		
Activated Sludge Basins	✓	✓		✓
Trickling Filter Open Tops	✓	✓	✓	
Cake Truck Loading Door		✓		
Wastehauler Station	✓			


3734000
3732000
3730000
3728000
3726000
3724000
3722000
3720000
3718000
3716000
400000
402000
404000
406000
408000
410000
412000
414000
416000
418000
420000
422000
424000
Legend:
Fugitive MM Nuisance Level Isopleth
Fugitive H2S Nuisance Level Isopleth
Fugitive Skatole Nuisance Level Isopleth
Fugitive IPMP Nuisance Level Isopleth
Mitigation Level 2 MM Max. Conc. (0.176 ppb)
Mitigation Level 2 H2S Max. Conc. (0.62 ppb)
Mitigation Level 2 IPMP Max. Conc. (0.015 ppb)
Mitigation Level 2 SKAT Max. Conc. (0.0186 ppb)
Mitigation Level 2 DMS Max. Conc. (2.04 ppb)


3734000
3732000
3730000
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3716000
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412000
414000
416000
418000
420000
422000
424000
Legend:
Fugitive MM Nuisance Level Isopleth
Fugitive H_2S Nuisance Level Isopleth
Fugitive IPMP Nuisance Level Isopleth
Mitigation Level 2 MM Max. Conc. (0.186 ppb*)
Mitigation Level 2 H_2S Max. Conc. (0.746 ppb)
Mitigation Level 2 IPMP Max. Conc. (0.0034 ppb)
*: Lava Rock Media; two 67 foot stacks

Odorants Recommended for Mitigation

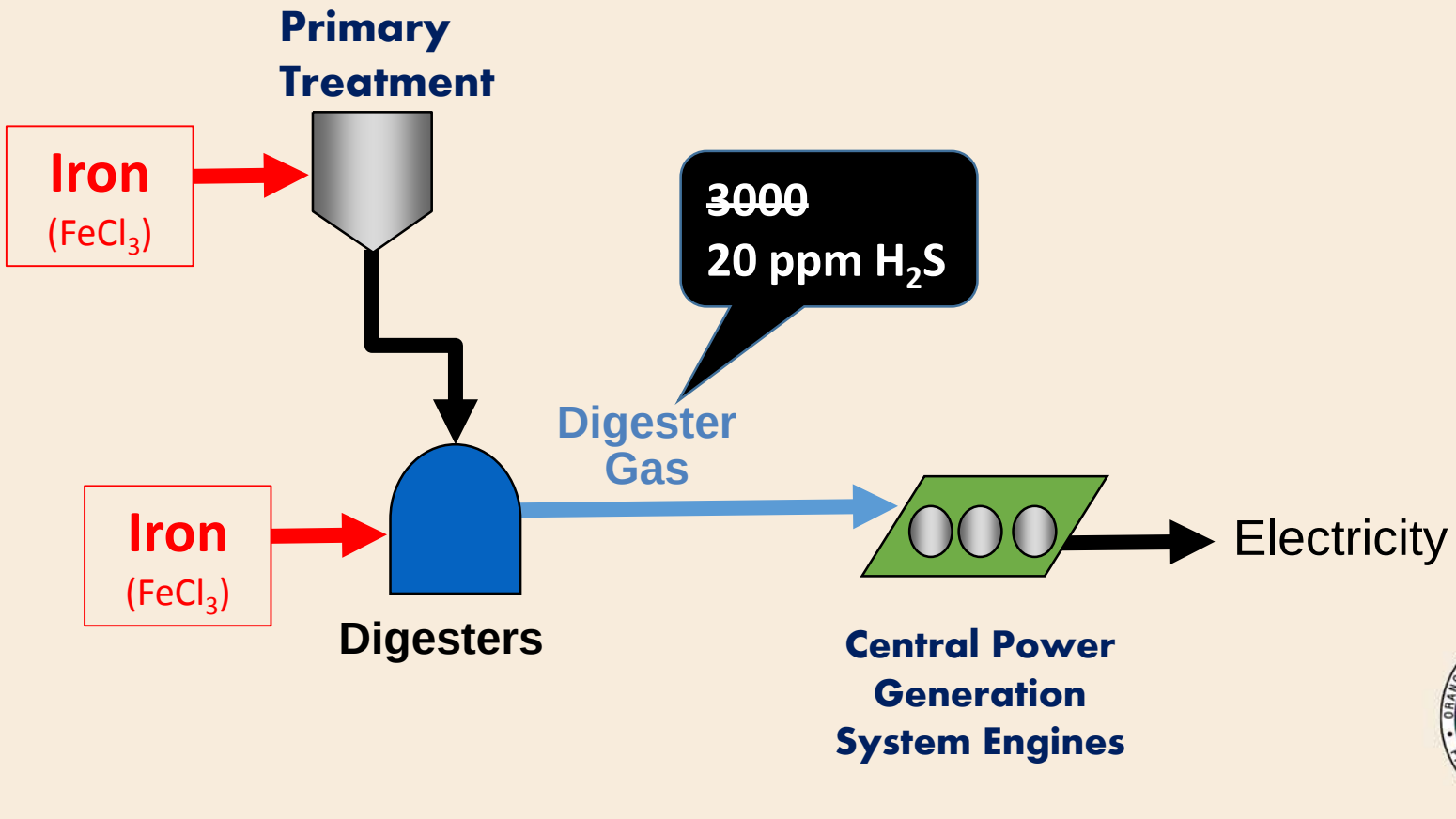
Plant No. 2 Summary of Sources Recommended for Mitigation			
	H_2S	MM	Musty
Headworks Scrubbers	✓	✓	
Primary Scrubbers North	✓	✓	
Primary Scrubbers South	✓	✓	
Trickling Filter Contact Basins		✓	✓
DAFT Biofilter		✓	
Truckloading Silos Fans		✓	
Cake Truck Loading Door		✓	

Process Area	Recommendation
Plant 1	
Headworks	45-sec. EBGRT biofilter (lava rock or engineered media)
Primaries	45-sec. EBGRT biofilter (lava rock or engineered media)
DAFT	Optimize existing chemical scrubbers operated in caustic-bleach mode
Truckloading/Dewatering	Optimize existing chemical scrubbers operated in caustic-bleach mode
Activated Sludge (AS-1 & AS-2)	Cover reactor basins and withdraw foul air through new chemical scrubbers
Trickling Filters	Cover towers and withdraw foul air through new chemical scrubbers operated in caustic-bleach mode
Plant 2	
Headworks	45-sec. EBGRT biofilter (lava rock or engineered media)
Primaries (NSC & SSC)	New chemical scrubbers operated in caustic-bleach mode
Trickling Filters Contact Basins	Cover reactor basins and withdraw foul air through new chemical scrubbers operated in caustic-bleach mode
Truckloading	Withdraw foul air through new chemical scrubbers operated in caustic-bleach mode

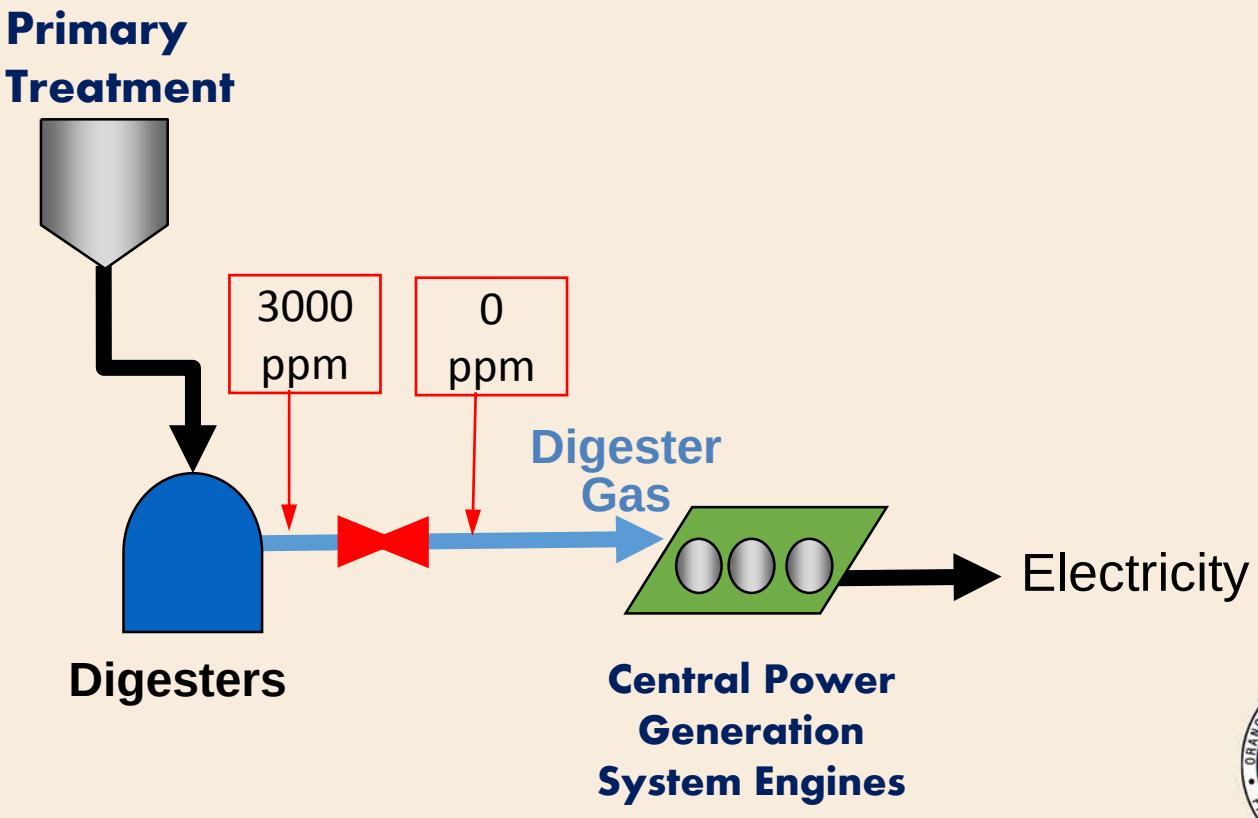
OCSD Research

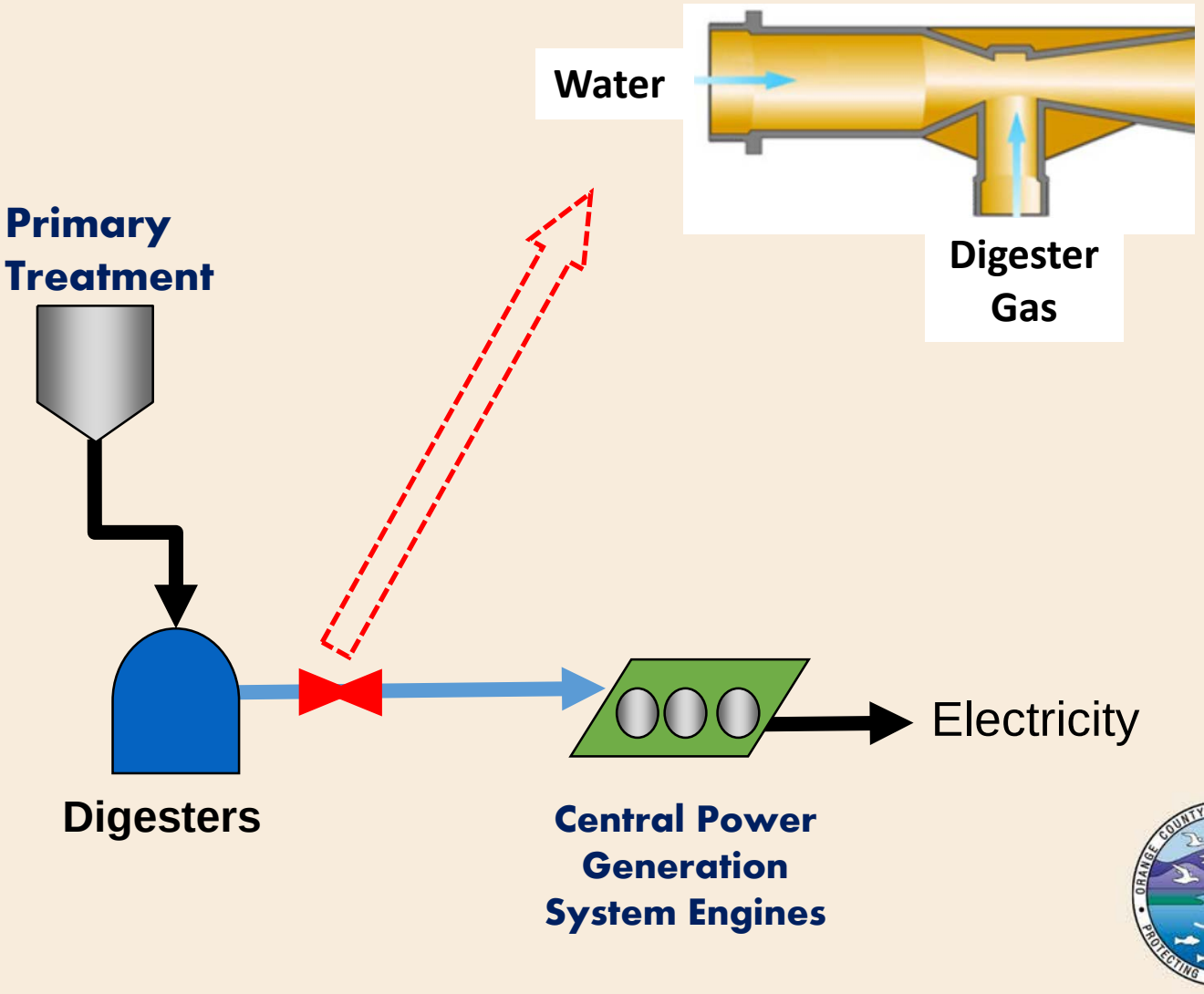
Business opportunity • Partnerships
New technology • Lower cost • Environmental stewardship

Current Digester Gas Treatment



Alternative Digester Gas Treatment




Water
Digester Gas
Primary Treatment
Digesters
Central Power Generation System Engines
Electricity

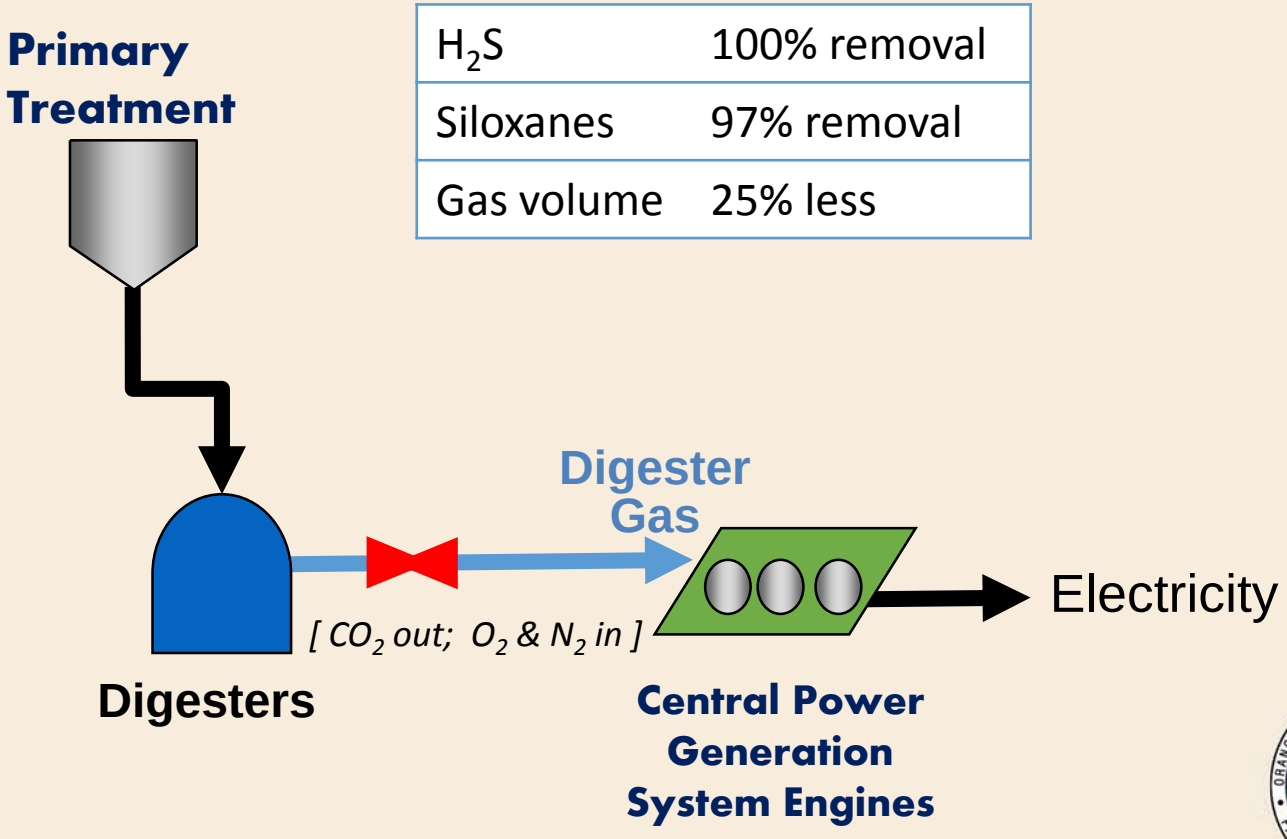
Why It Works

Compound	Solubility [1]	Ratio
CH_4 (methane)	4	-
H_2S (hydrogen sulfide)	300	73 : 1
CO_2 (carbon dioxide)	256	64 : 1

[1] ft^3 gas per 1000 gal water

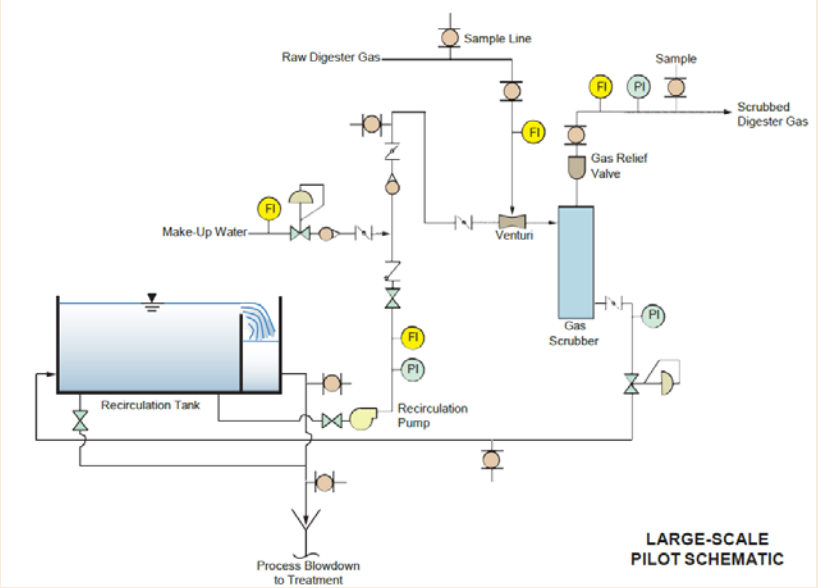
Alternative Digester Gas Treatment

H_2S	100% removal
Siloxanes	97% removal
Gas volume	25% less



Next Steps/Recommendation: Large-Scale Pilot Tests

- Construct instrumented test equipment (2” dia. venturi; 500 gal tank)
- Optimize process performance
- Reduce water usage
- Minimize methane loss
- Respond to changes in digester gas flow



Questions

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