Brown AND Caldwell

Raleigh, NC

Capturing the Right Quantity of Foul Air for Treatment: Odor Control Theory, Application, and North Carolina Case Studies

November 2016

Common Wastewater Conveyance and Treatment Facility Odor Control Issues

COLLECT BEFORE YOU TREAT!

- Identifying air ventilation needs
- Capturing all of the foul air
- Capturing the right amount of foul air

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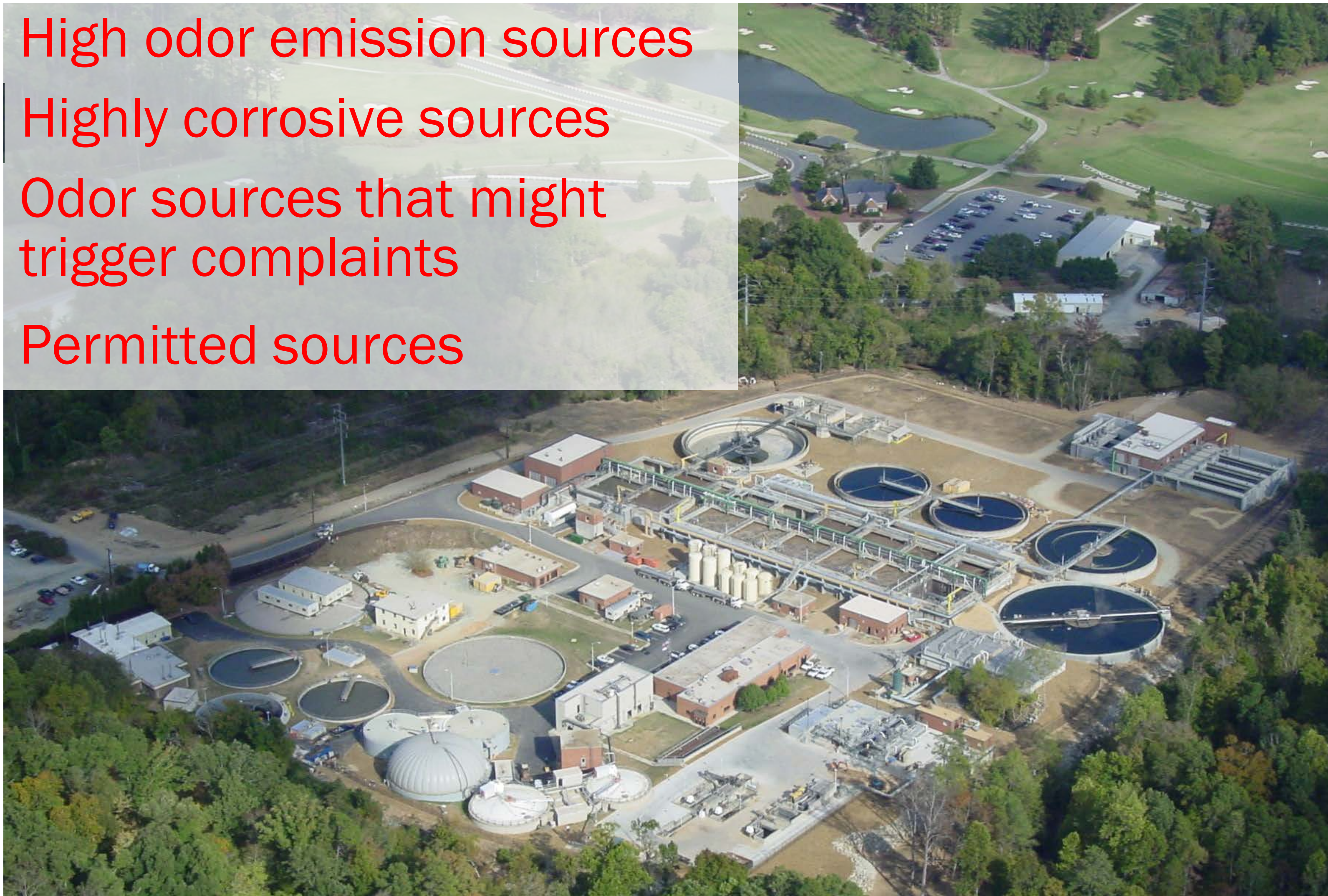
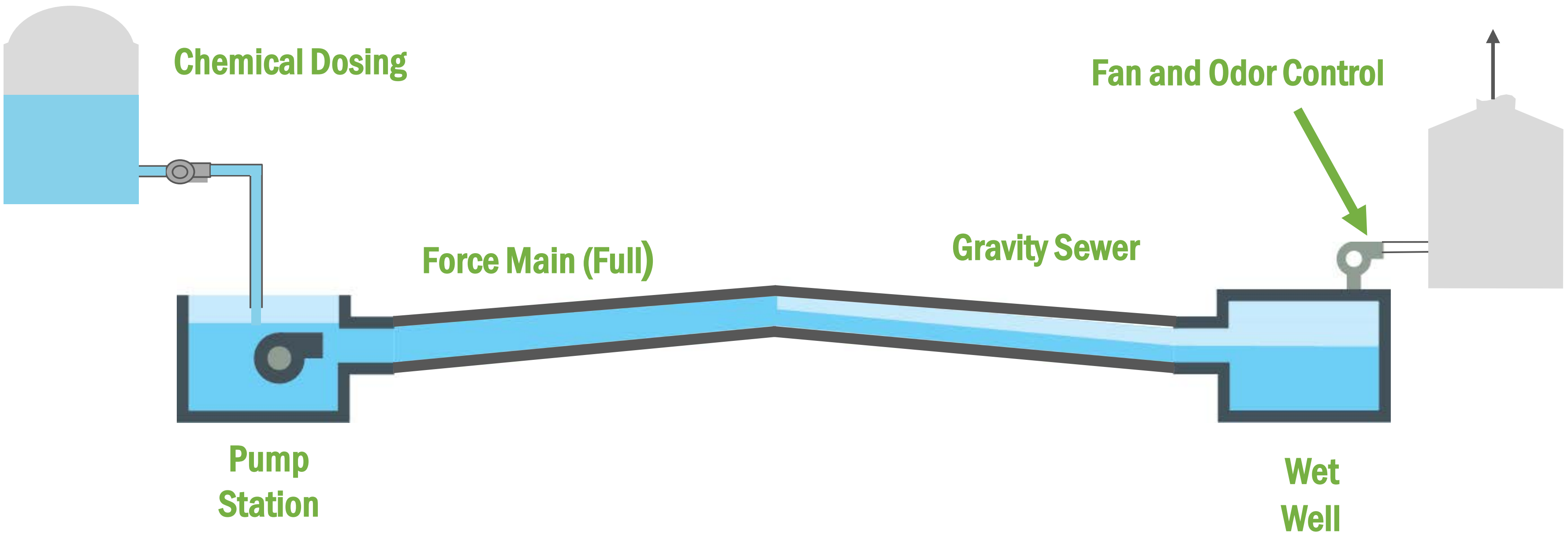
Which odor sources should be controlled?

- High odor emission sources
- Highly corrosive sources
- Odor sources that might trigger complaints
- Permitted sources



Can foul air removal be balanced with upstream liquid-phase treatment?



Optimization of upstream chemical dosing can optimize, reduce reliance on, or eliminate downstream gas-phase odor control systems

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Fugitive emissions can defeat an otherwise good odor control strategy

Fugitive emissions may be problematic in:

- Buildings where doors are open or insufficient negative pressure is present
- Covered or enclosed sources where odor control is already present, but inadequately pulling foul air from the source

Building fugitive emissions: open doors

Potential Solutions:

- Keep the doors closed!
- Enclose or cover just the odorous process

Not a Potential Solution:

- Increase foul air removal (bigger fan)

Why increasing air flow won't prevent fugitive emissions if doors remain open…

$\Delta p = \rho/2\ (Q/C_f A_c)^2$

- Where:
  - Δp = differential pressure across flow path
  - ρ = density of air entering flow path
  - Q = volumetric flow rate
  - C_f = flow coefficient
  - A_c = area of flow path (cracks, openings)

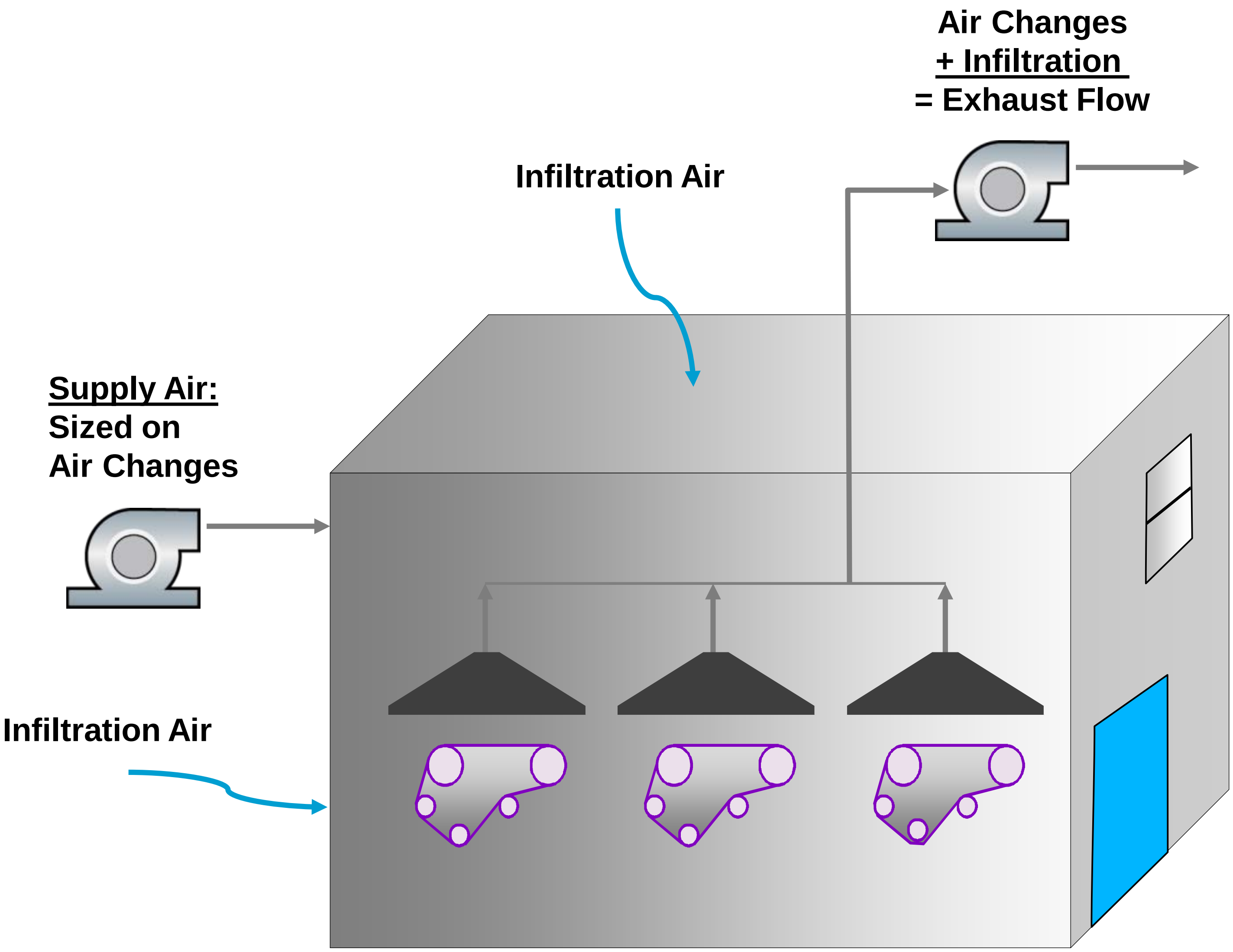
Using 0.65 as the coefficient C_f

- $V = 2610\ \Delta p^{1/2}$

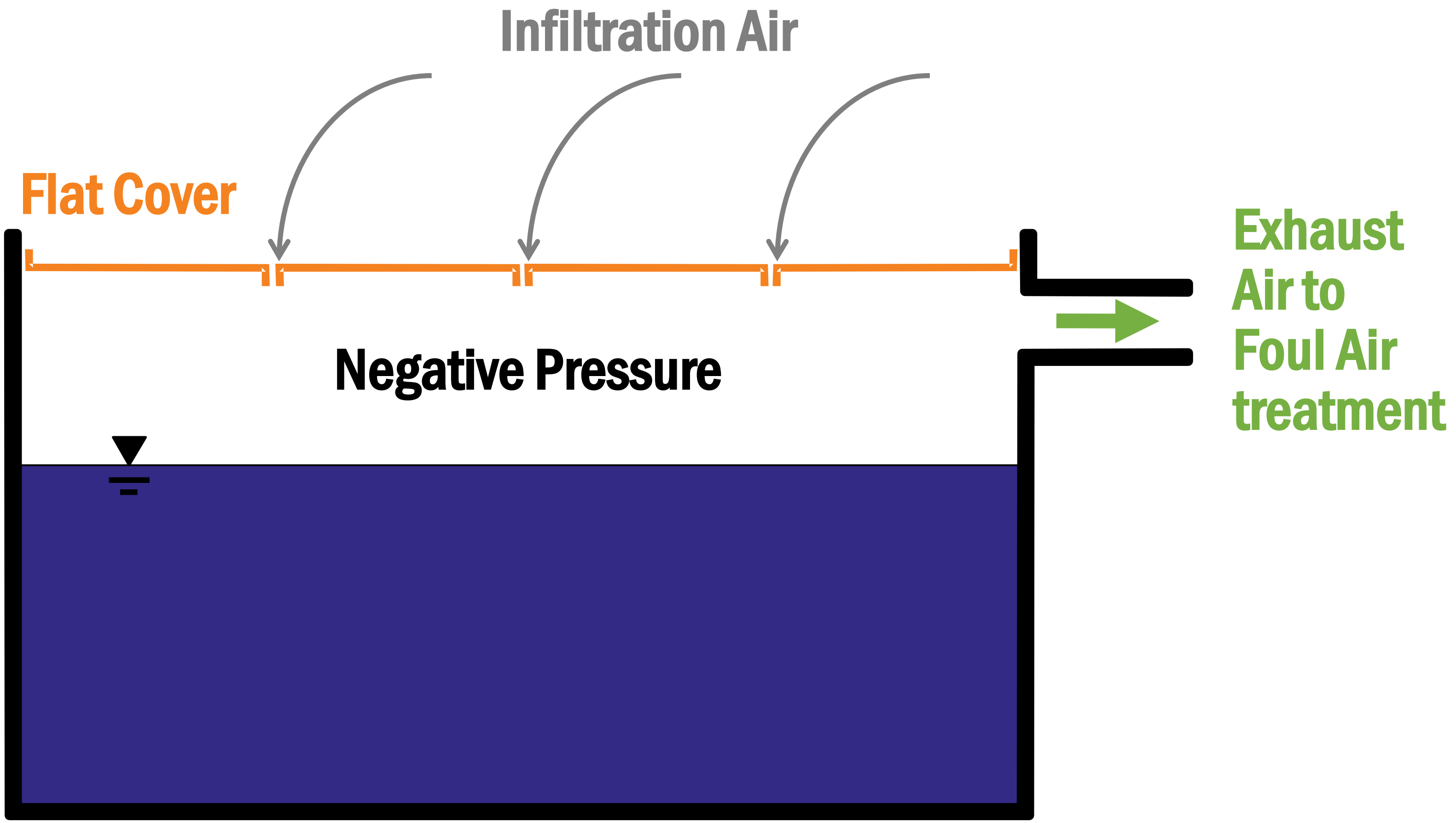
To obtain -0.1 in w.c. Δp

- V = 825 ft/min

Creating appropriate building ventilation



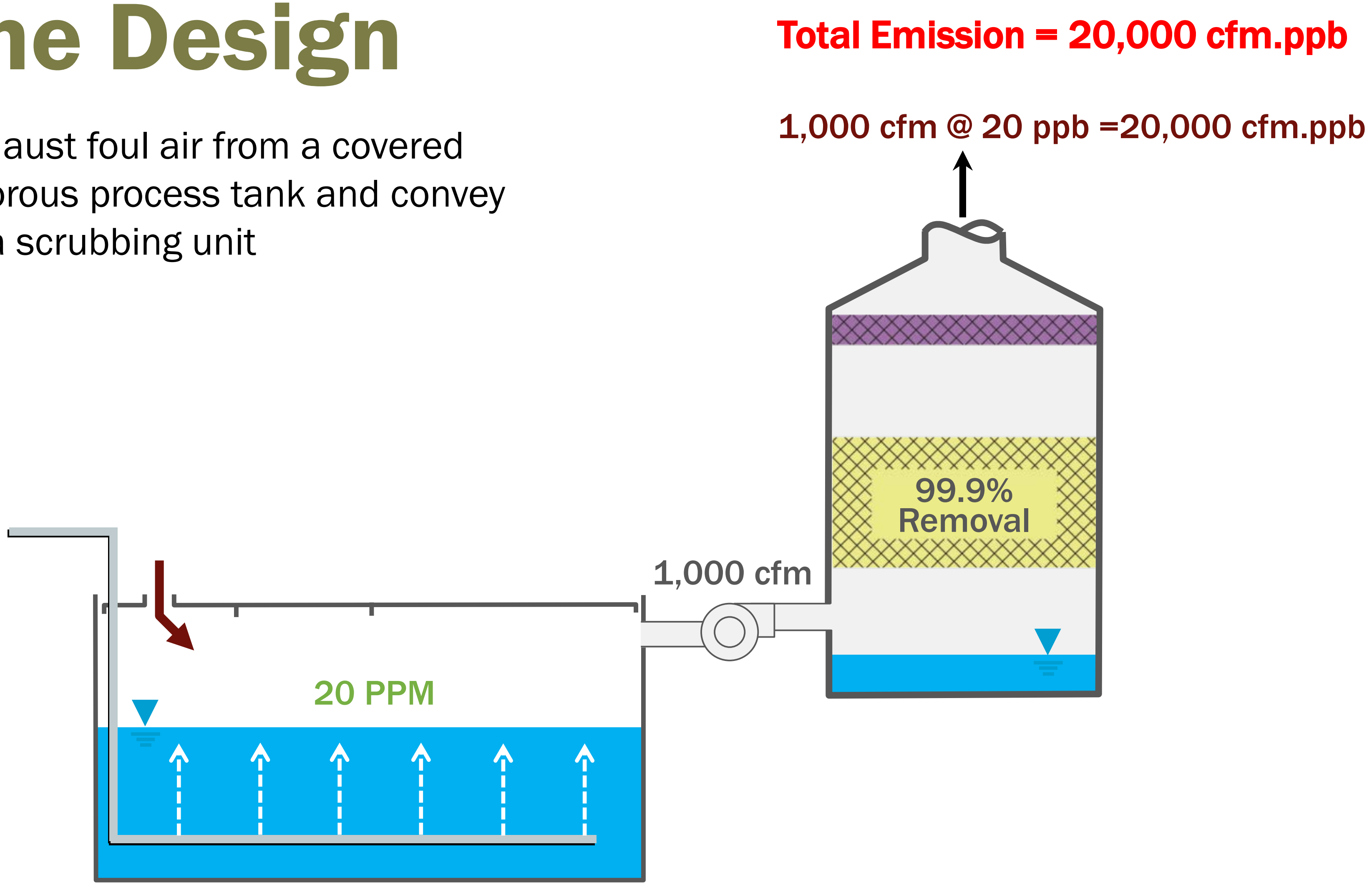
Preventing fugitive emissions from covered processes: maintain negative pressure



How fugitive emissions cause problems

The Design

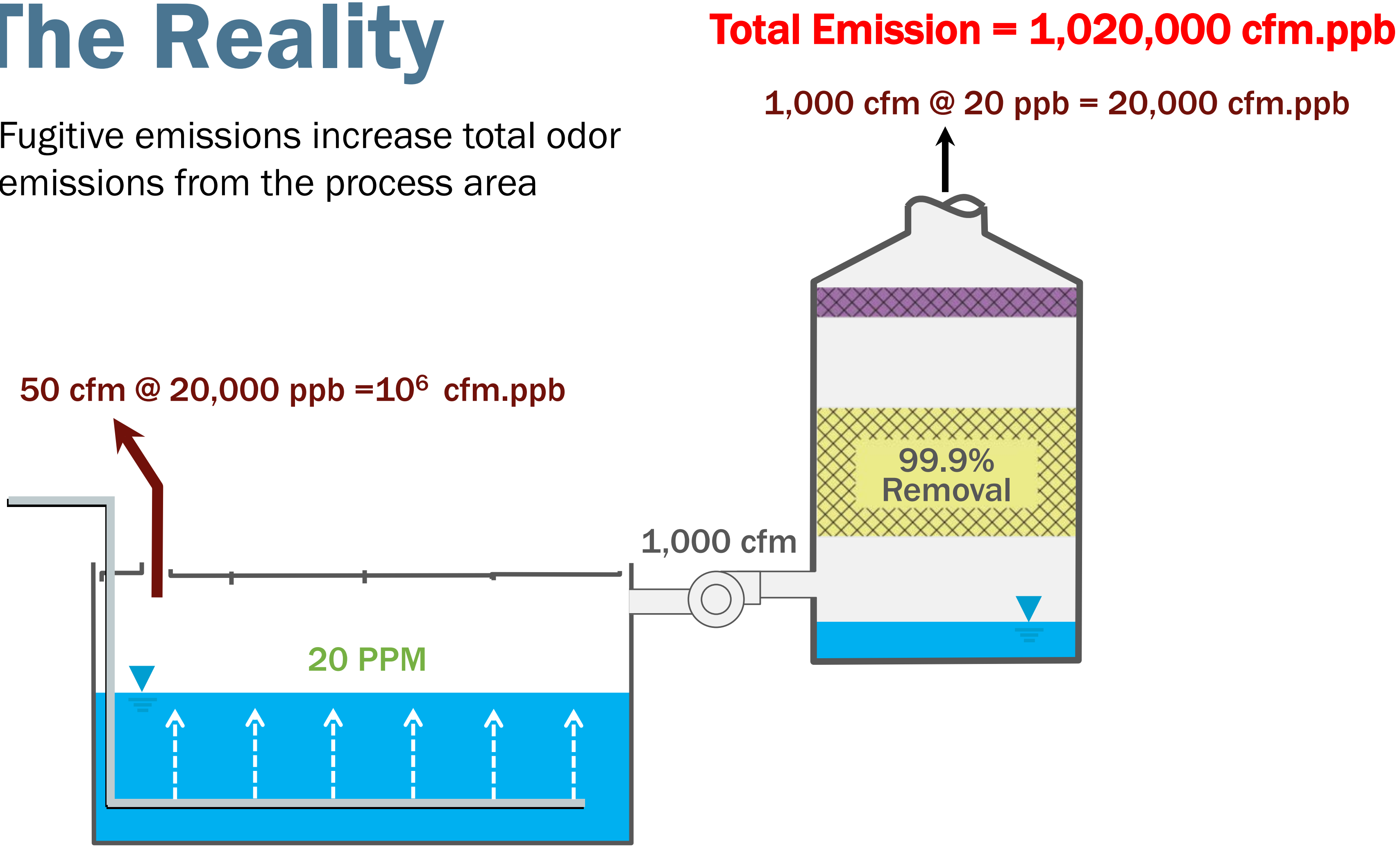
Exhaust foul air from a covered odorous process tank and convey to a scrubbing unit



How fugitive emissions cause problems

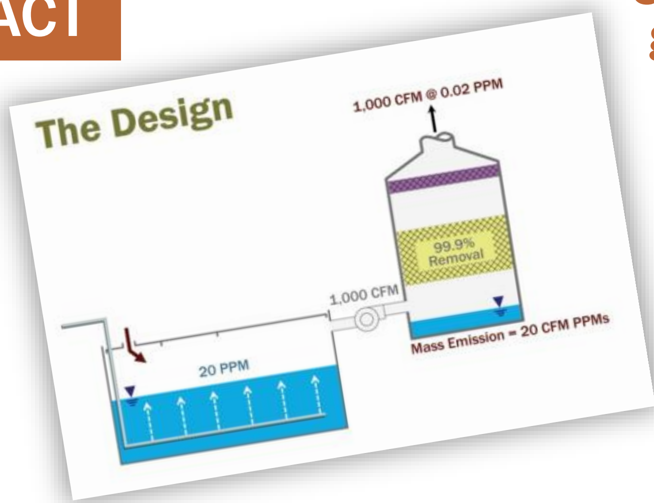
The Reality

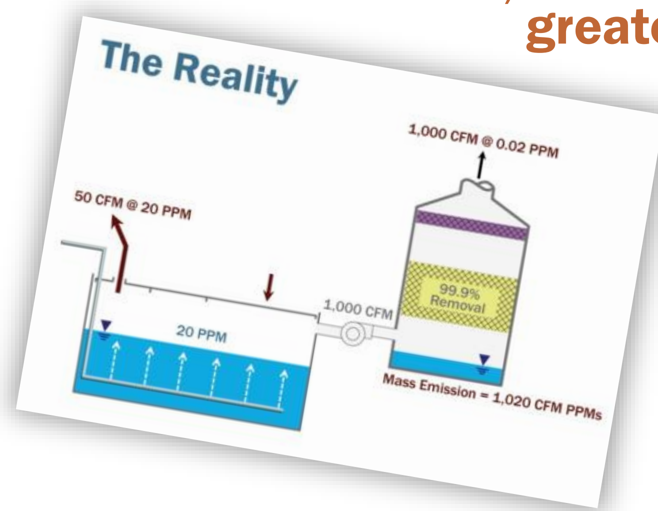
Fugitive emissions increase total odor emissions from the process area



Impact on overall emissions is significant

	Discharged Air cfm x ppb		Emission Rate cfm.ppb		Dilution to Fence Line		Offsite Impact
The DESIGN	1,000 x 20	=	20,000	/	500 [stack]	=	40
The REALITY	1,000 x 20	=	20,000	/	500 [stack]	=	40
	+		+				+
	50 x 20,000	=	1,000,000	/	20 [tank]	=	50,000
The IMPACT			51 times greater				1,000 times greater





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Collecting the right amount of air: Rooms

Dewatering Room (80 ft x 30 ft x 15 ft)

To achieve negative pressure:

$\Delta p = \rho/2\,(Q/C_f A_c)^2$

- $\Delta p = -0.1$ in w. A_c = c.
- $\rho = 1.2\ kg/m^3$
- Q = volumetric flow rate
- $C_f = 0.65$
- $A_c = (0.42 \times 10^{-3})$ * wall area
- $A_c = 1.01\ ft^2$

Q = 830 cfm

Air Change Method:

To achieve 12 ACH

NFPA 820

- Vol = 36,000 ft^3

Q = 7,200 cfm

To achieve 6 ACH

Q = 3,600 cfm

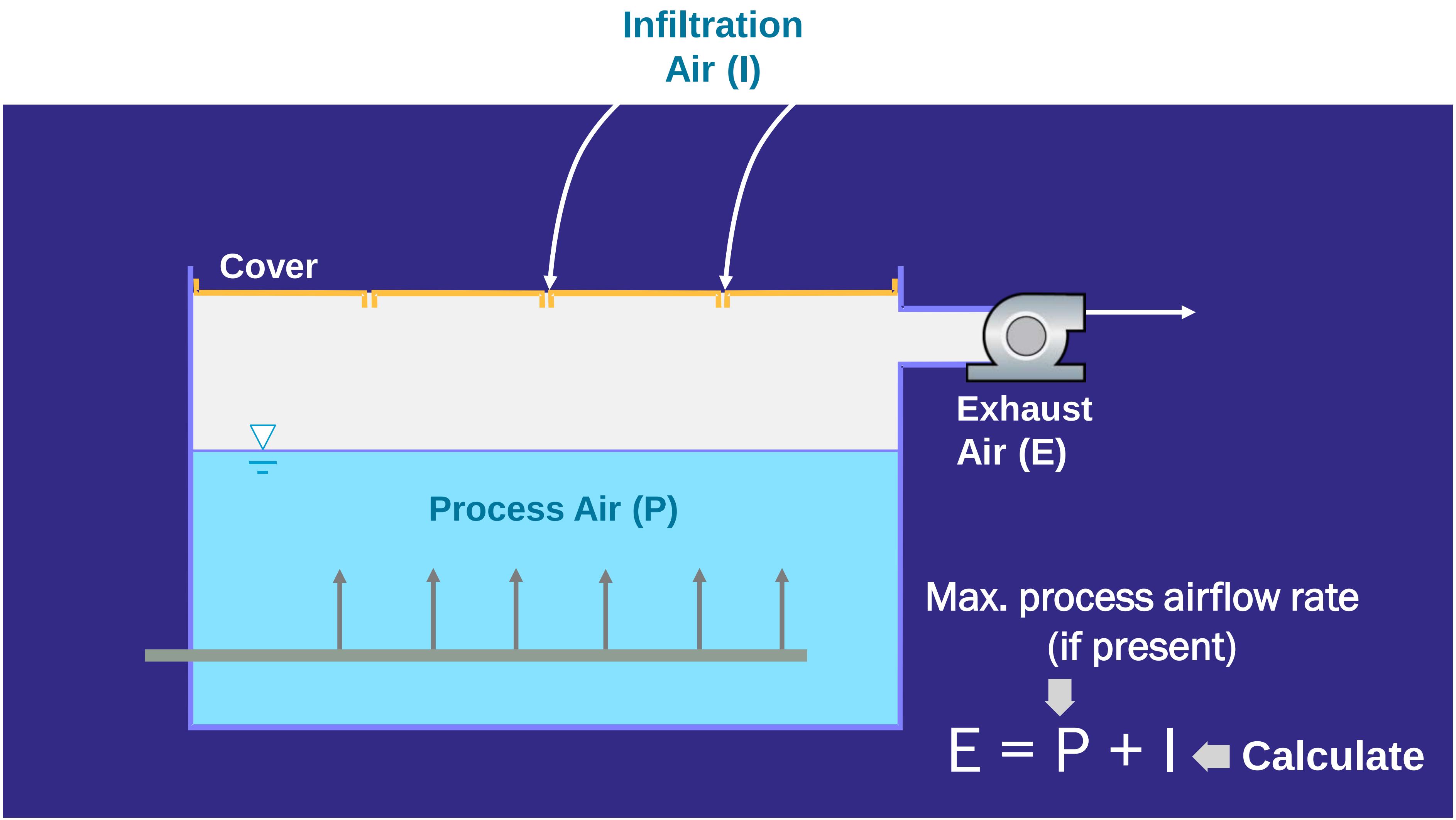
Dilute Odor
Less Occupied

To achieve 20 ACH

Q = 12,000 cfm

Strong Odor
Occupied

Collecting the right amount of air: Covered Tanks and Enclosed Processes



Collecting the right amount of air: Covered Tanks and Enclosed Processes

Known

Known

Unknown

$$\Delta p = \frac{\rho}{2}\left(\frac{Q}{C_f A_c}\right)^2$$

"A_c" is area of cracks, openings, gaps in cover:

- Problematic to measure
- Difficult to estimate accurately
- Can be empirically established

Pressures established under flat aluminum tank covers (pilot tests)

Test Number	Air Flux		Pressure established		Notes
	$m^3/s/m^2$	cfm/ft^2	Pa	Inches w.c.	
1	0.0076	1.5	12	0.05	Uncaulked
2	0.0076	1.5	25	0.10	Caulked at Perimeter
3	0.0061	1.2	50	0.20	Gasketed, uncaulked
4	0.0051	1.0	25	0.1	
5	0.0061	1.2	10	0.04	Ungasketed
6	0.0051	1.0	2	0.01	Ungasketed, many penetrations
7	0.0051	1.0	37	0.15	Perimeter gaskets

1,2 Pilot test, King County's East Section Wastewater Treatment Plant (WWTP), 1993
3 Sample covers test, King County's East Section WWTP, 1995
4 Sioux City, Iowa WWTP
5,6 City of Edmonton, 1996
7 Installed covers test King county's East Section WWTP, 1997

Ventilation Rate Guidelines (from empirical testing)

Enclosure Method	Ventilation Rate
Flat Covers	0.5 to 1.0 cfm/ft^2
Dome Covers	0.5 cfm/ft^2
Covered Dumpsters	1 to 2 cfm/ft^2
Enclosed Conveyors	25 to 50 cfm

Alternate Ventilation Calculation Methods: Covered Tanks and Enclosed Processes

Cake Storage Silo (35-ft dia, 25-ft tall)

Overcome Max Displacement:

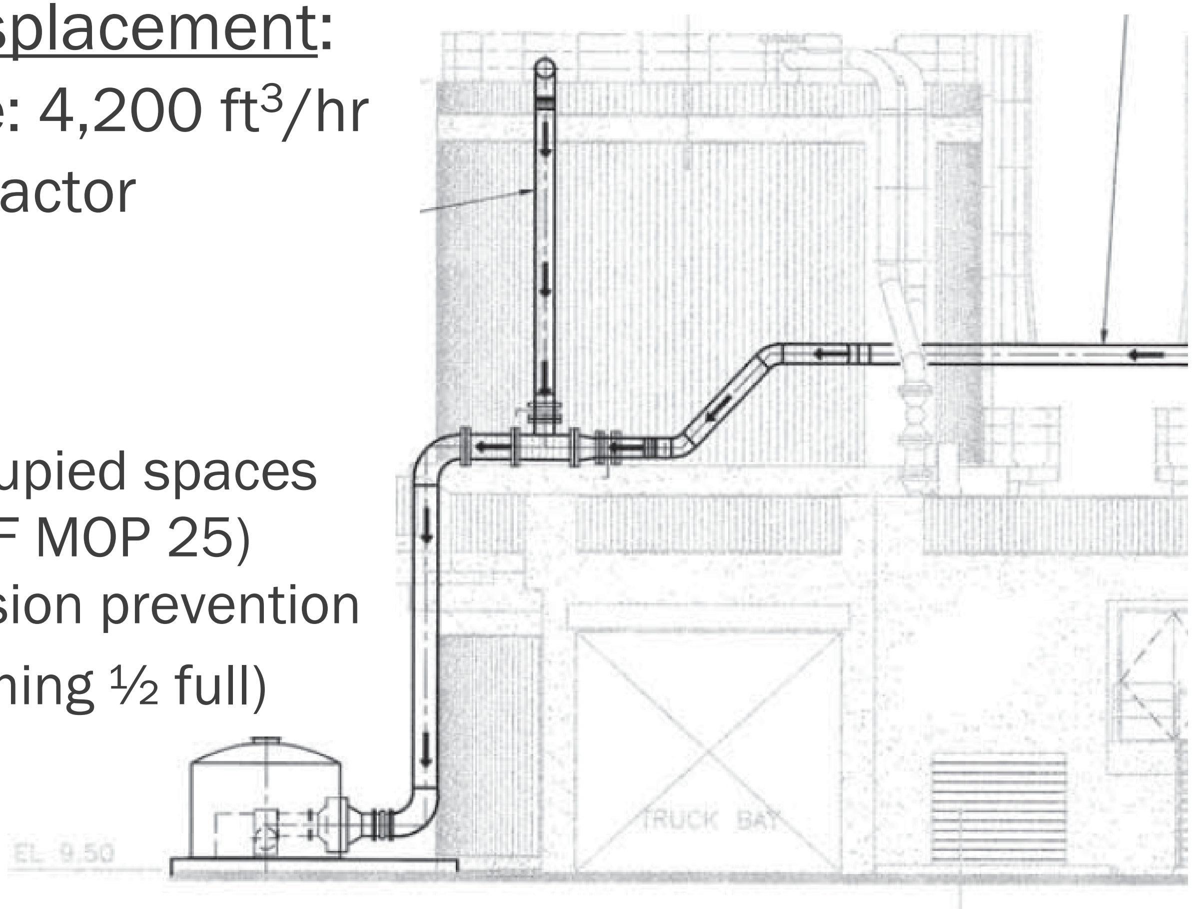
- Max cake fill rate: 4,200 ft^3/hr
- Add 20% safety factor

Q = 84 cfm

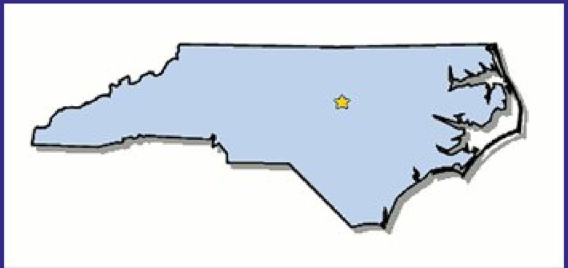
Air Changes:

- 4-6 ACH for unoccupied spaces (Guidance per WEF MOP 25)
- Primarily for corrosion prevention

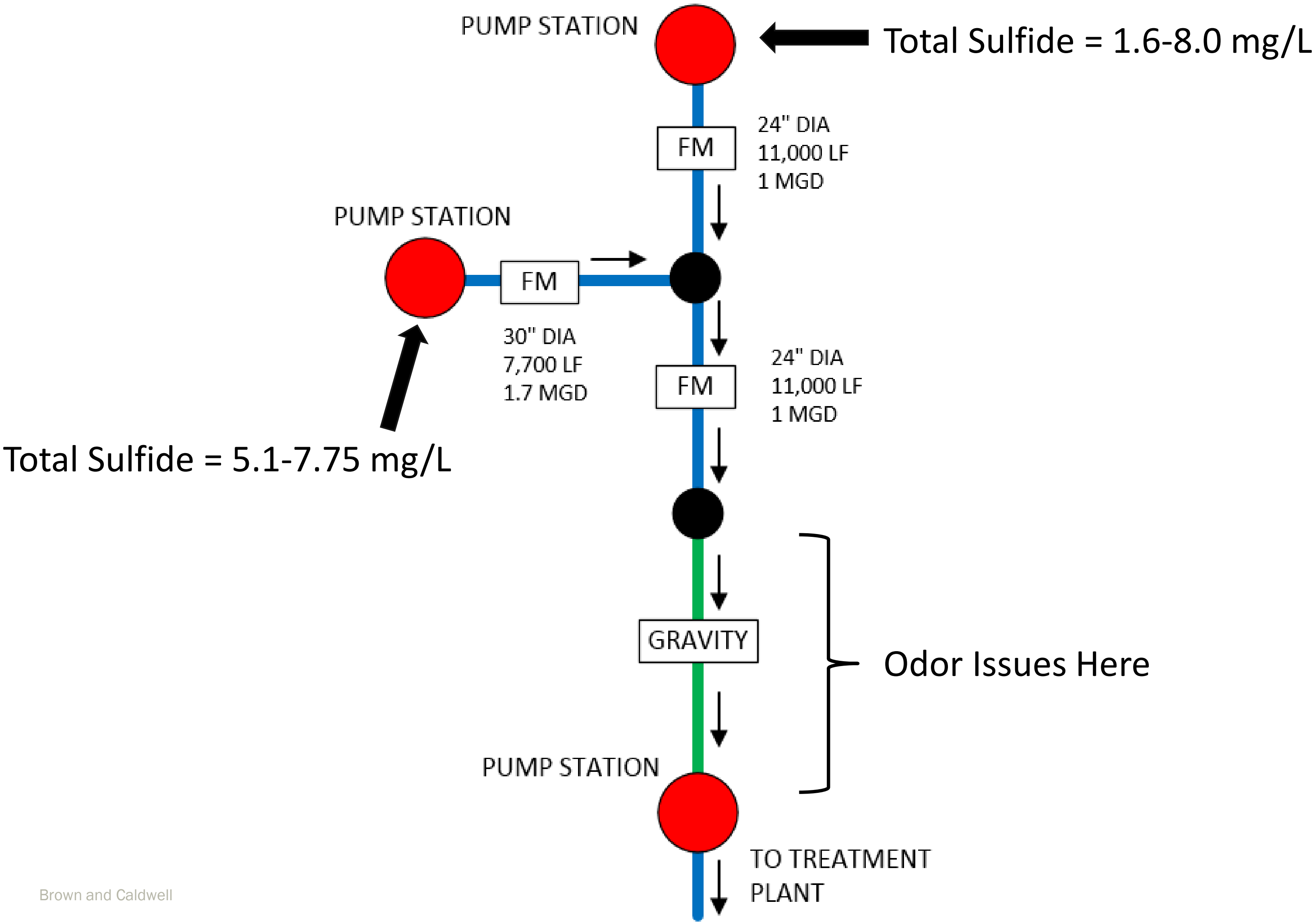
Q = 1,200 cfm (assuming ½ full)



North Carolina Case Studies
Foul Air Removal Optimization Efforts

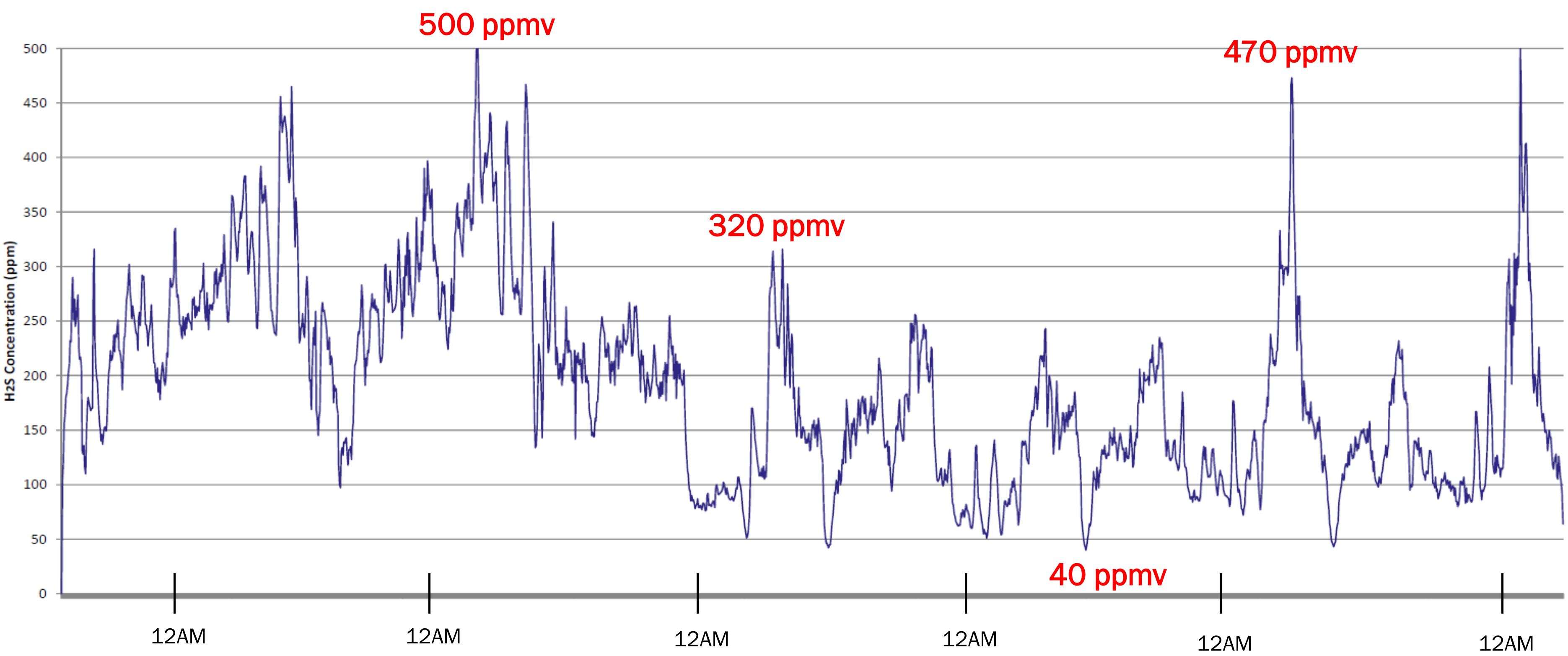


Cary, North Carolina:
Collection System Odor Control

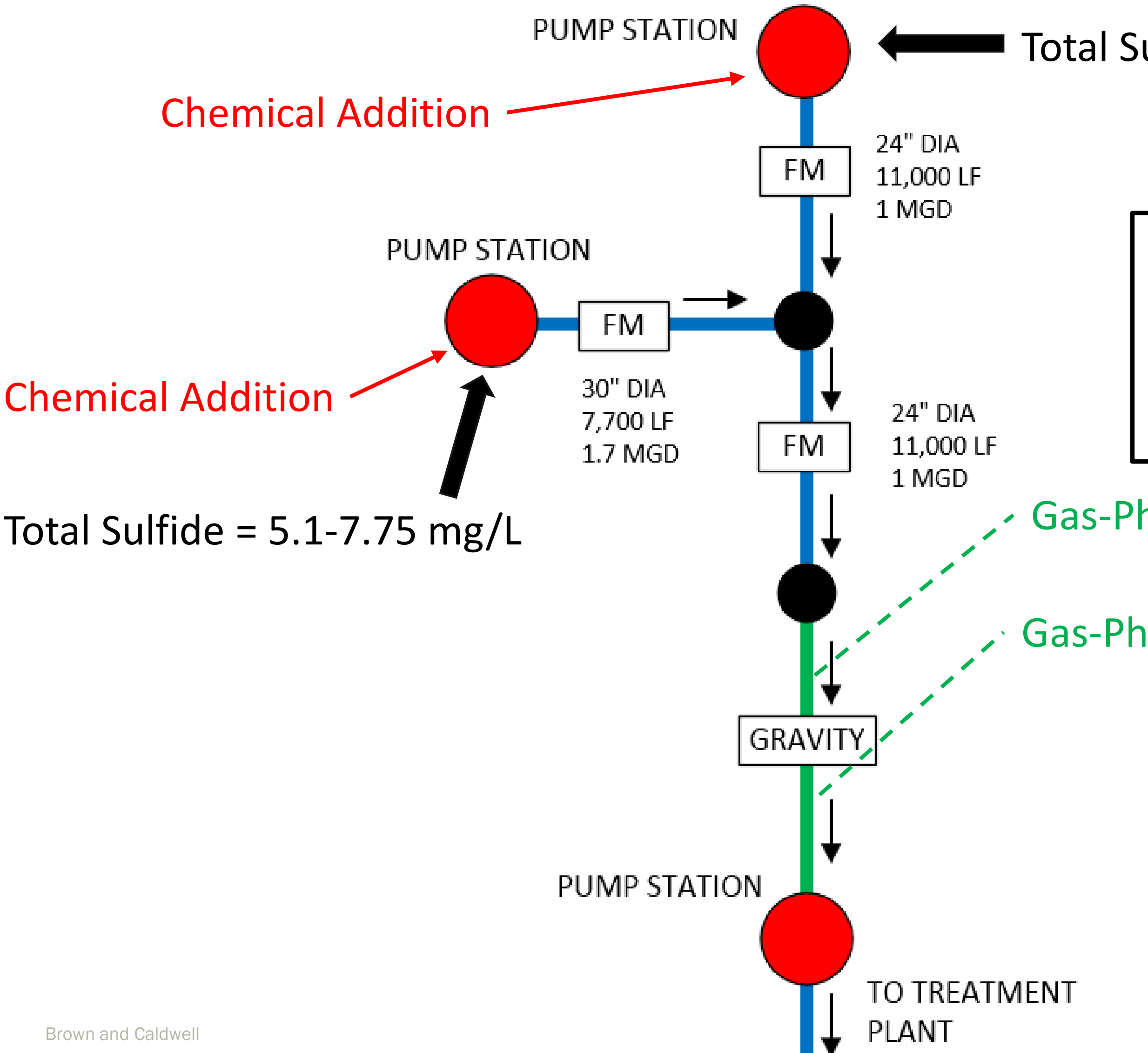


Cary, North Carolina: Collection System Odor Control

Force Main Discharge – H_2S Concentrations



Cary, North Carolina: Collection System Odor Control



<u>Odor Control Strategy</u>

Chemical Addition

Gas-Phase Treatment

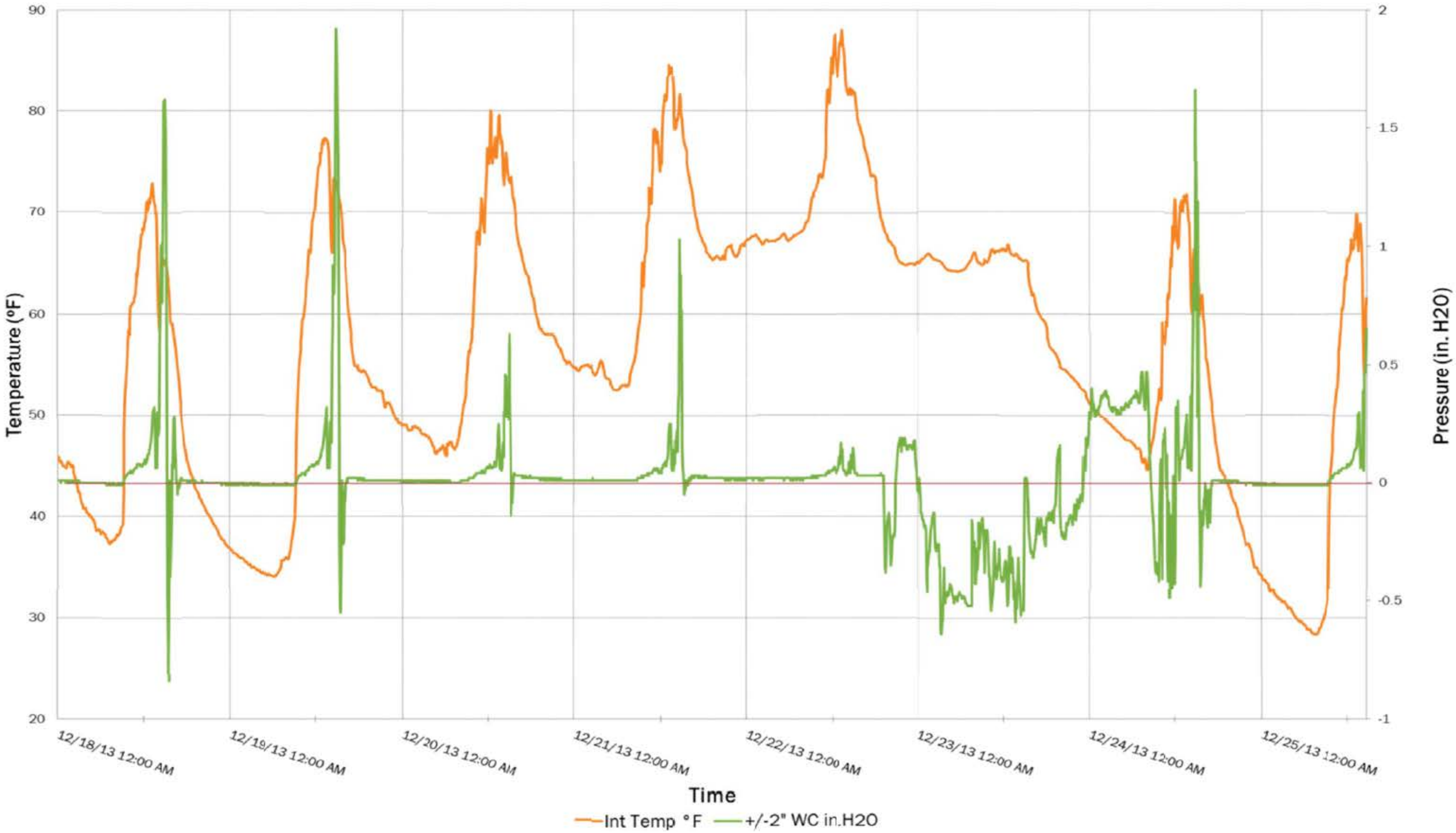
Cary, North Carolina: Collection System Odor Control

- Dual-strategy odor control approach
- Chemical Addition:
  - Iron salts chemical addition
  - 600 to 1,500 gallons per day
  - Dose dependent on time of day
- Gas-Phase Treatment
  - Biofilters (engineered media)
  - Recommended 3,600 and 5,000 cfm at buildout
- Field optimization of chemical dose rate

Cary, North Carolina
Fugitive Emissions from Covered Process Areas

- 2014 Investigation
- Treatment plant odor issues attributed to headworks screening & grit removal
- Odors were occasionally noticeable to plant staff and visitors
- Existing odor control (biofilter)
  - Treats influent flume headspace
  - Sized for 100 cfm (capacity)
  - Actual airflow rate not confirmed
  - Media was replaced twice in 10 years

Pressure Differential Measurements: Headworks



Cary, North Carolina
Fugitive Emissions from Covered Process Areas

Findings:

- Influent flume significant contributor to perceived odors at plant
- Regular peaks of high positive pressure
- Measured H_2S concentrations (OdaLog)
  - 14 ppmv average
  - 160 ppmv peak (daily peaks > 50 ppmv)
- No need to change odor treatment
- Address gaps in existing flume covers:
  - Used 1 cfm/ft^2 for ventilation
  - Make checkerplate more air tight
  - Replace grating w/ air tight covers

Chapel Hill, NC
Mason Farm WWTP Odor Control Upgrades

Chapel Hill, NC
Mason Farm WWTP Odor Control Upgrades

- Appropriate airflow rate calculation was key in design:
  - Cost considerations
  - Limited footprint available
- Primary clarifier splitter boxes
  - Foul air from 2 boxes
  - Treated in carbon adsorber
- Intermediate pump station wet wells
  - Foul air from 2 wet wells
  - Treated in carbon adsorber

Chapel Hill, NC
Mason Farm WWTP Odor Control Upgrades

Location	Total Surface Area (ft^2)	Maximum Odor (D/T)	Airflow Rate (cfm)	Ventilation Rate (cfm/ft^2)
Splitter Boxes	720	11,500	700	0.97
IPS Wet Wells	440	62,400	700	1.59

- Higher ventilation rate provided to more odorous processes (intermediate pump station wet wells):
  - Better distribution of odor loading to carbon
  - Allowed for selection of identical carbon adsorbers

QUESTIONS?

it's about connecting

Brown AND Caldwell : essential ingredients®