Slide 1

HRG
Herbert, Rowland & Grubic, Inc.
Engineering & Related Services
AN EMPLOYEE-OWNED COMPANY

MATERIAL MATTERS, Inc.

UNIVERSITY AREA JOINT AUTHORITY

University Area Joint Authority
Spring Creek Pollution Control Facility

Odor Control Study
Part 2 - Alternatives Evaluation

PMAA 2016 Annual Conference and Trade Show: August 29, 2016

Presented by:

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Project Manager
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Basis for Alternative Development

- 95% Odor Reduction at the Dewatering Facility and the Compost Facility would result in less than five (1-hour) off-site odor events (D/T > 7) in a five year period.
- Ventilation Rates (NFPA 820 and WEF Manual of Practice No. 8)
  - Dewatering Facility – 24,000 cfm
    (12 AC/h in Building; 4 AC/h in tanks)
  - Compost Facility – 131,000 cfm
    (12/h AC in Compost Bay Area)

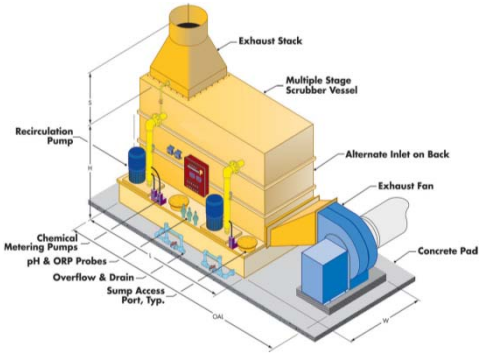
Odor Control Technologies

- Chemical Scrubber
- Photoionization
- Carbon Adsorber
- Bio-trickling Filter
- Liquid Sludge Treatment
- Ionization
- Biofiltration

Chemical Scrubber

Treatment Description

- Three Stage System for H_2S and NH_3 removal.
- Absorption of H_2S into alkaline liquid (NaOH)
- Oxidation of H_2S in solution (NaOCl)
- Absorption of NH_3 into water
- Chemical reaction of NH_3 with sulfuric acid (H_2SO_4)
- Oxidation of organic odorants with NaOCl



Chemical Scrubber

Advantages

- Simple and stable operation
- 99.5% removal of H_2S
- Adaptable to changes in pollutant loading
- Small footprint
- Relatively low profile
- Relatively low capital cost
- Not dependent on maintaining a biomass
- Periodic operation

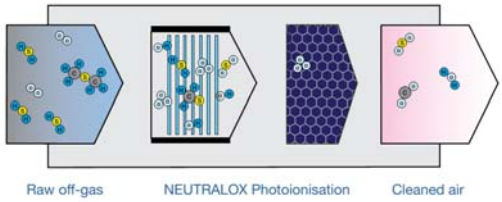
Disadvantages

- Storage and handling of NaOH, NaOCl, H_2SO_4
- Limited effectiveness on organic-based odorants
- Water consumption (would require softening if not Reclaimed Water)
- Blowdown to treatment plant
- Particulate Matter can cause media plugging
- Freeze concerns with exterior applications

Photoionization

Treatment Description

- UV light and a catalyst breakdown odorants.
- UV light creates oxidizing agents (O^{-2}, OH^-, O_3, activated O_2 and other free radicals)
- Untreated compounds are trapped in the catalyst and broken down.



Photoionization

Advantages

- >95% odor reduction
- Simple operation and maintenance
- Adaptable to changes in pollutant loading
- Small footprint
- Not dependent on maintaining a biomass
- No water or chemical usage
- Periodic operation
- Possibility of heat recovery
- Low back pressure (2 to 3 in WC)
- Wide temperature range (-30 °C to 70 °C)

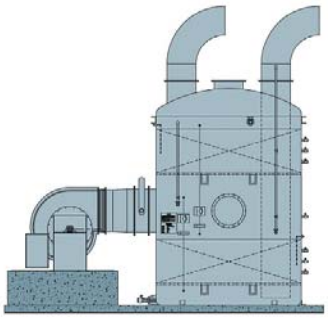
Disadvantages

- Limited installations in North America
- Relatively high capital cost
- Consumables (UV lights and catalyst)
- Ozone generation (captured by catalyst?)

Carbon Adsorption

Treatment Description

- Packed activated carbon vessels
- Adsorption – physical adherence of molecules to surface of media
- Activated carbon has very high surface area



Carbon Adsorbers

Advantages

- Simple and stable operation
- >95% odor reduction
- Handles changes in pollutant loading
- Small footprint
- Not dependent on maintaining a biomass
- No water or chemical usage

Disadvantages

- Higher pollutant loadings reduce bed life (higher frequency of media change out)
- Carbon bed replacement can be costly and labor intensive
- Spent carbon must be disposed of properly (landfill) for high capacity carbon
- Not effective at removal of ammonia
- Limited effectiveness at removal of amines

Bio-Trickling Filter

Treatment Description

- Natural metabolic actions of microorganisms degrade odorants
- Countercurrent flow of air and water through synthetic media

Bio-Trickling Filter

Advantages

- Minimal maintenance
- Synthetic media - long life (10 years)
- Programmable irrigation and nutrient control
- No chemicals

Disadvantages

- Requires water and sometimes nutrients
- Freeze concerns
- Must maintain biological activity
- Unable to handle odor spikes
- Difficult to maintain efficient removal of reduced sulfur organic compounds

Liquid Sludge Treatment

Treatment Description

- VX456 – Selective Oxidant with specificity to sulfides and related organic odorants

Liquid Sludge Treatment

Advantages

- Low capital cost
- Easy to pilot
- Controls odors in building space

Disadvantages

- Controls odors for 24-72 hours; concern of odor release downstream
- Chemical usage substantially increased when treating storage tanks
- Chemical is highly corrosive
- Fire hazard when allowed to dry

Ionization

Treatment Description

- Ionization systems supply highly ionized air with O^{2+} and O^{2-} ions to the application areas
- Ions form molecular ion clusters with high oxidizing power.

Ionizer Mounting Rack

Engineered Ion Distribution Duct

Ionization

Advantages

- Improves indoor air quality
- Interior dust control
- Interior corrosion control
- Ion generators sized for each discrete space
- Potential for heat recovery
- Ion Generator serves as make-up air unit
- Low pressure drop systems
- Low footprint and low profile

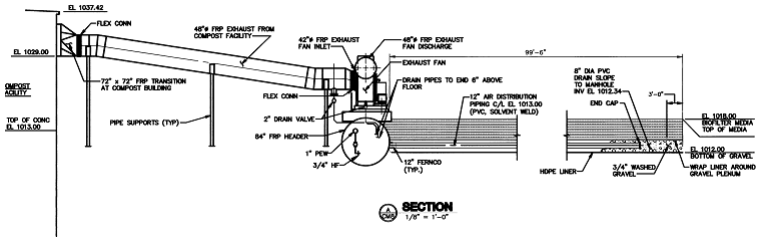
Disadvantages

- Relatively high capital cost
- ~90% H_2S and NH_3 reduction
- Consumables (ion tubes)
- Air distribution laterals in building space

Biofiltration

Treatment Description

- Natural metabolic actions of microorganisms degrade odorants
- Organic or mineral based media



Biofiltration

Advantages

- Low operation and maintenance costs
- 90-95% odor reduction
- No chemical usage
- Relatively high static pressures (5 – 9 in WC)
- Low profile
- Lowest life cycle costs for high ventilation rates (> 50,000 cfm)

Disadvantages

- Low to high capital cost depending on system sophistication
- Media replacement (3-5 years for organic media)
- High water consumption (humidification)
- Poor response to changes in pollutant loading
- Large footprint
- Background odor of media
- Short circuiting for traditional open bed filters

Opinion of Probable Project Costs

Assumptions

Cost for 25% Sodium Hydroxide	0.95	$/gal
Cost for 12.5% Hypochlorite	0.91	$/gal
Cost for 93% Sulfuric Acid	3.53	$/gal
Cost for Water (Reclaimed)	0.00	$/gal
Cost for Electricity	0.0602	$/kWh
Consumables	Manufacturer's Input	
Technician labor rate	50	$/hr
Life Cycle	20	years
Interest rate	5.0%	per year
Contingency	15%	

Summary of Alternatives for the Dewatering Facility

Alternative No. D1 - Chemical Scrubber

Alternative No. D2 - Photoionization

Alternative No. D3 - Carbon Adsorber

Alternative No. D4 - Bio-Trickling Filter

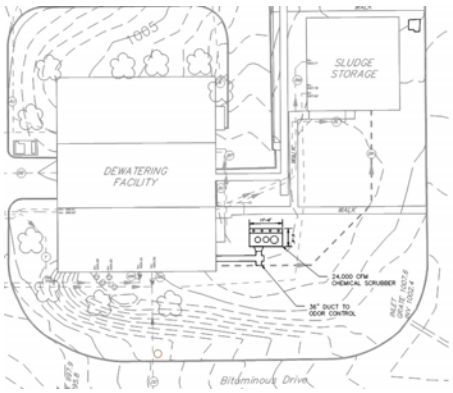
Alternative No. D5 - Liquid Sludge Treatment

Alternative No. D6 - Ionization

Dewatering: Alternative No. D1 – Chemical Scrubber

Opinion of Costs Summary

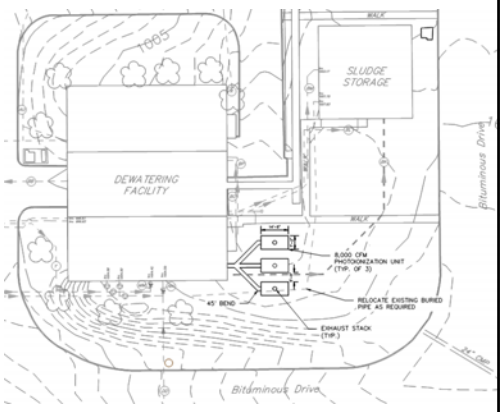
Construction Capital Cost:	$ 486,000
Engineering/Administrative:	$ 97,320
Contingency:	$ 87,590
Project Capital Cost:	$ 671,508
Annual Operating Cost:	$ 130,510
Annual Debt Service:	$ 53,884
Present Value:	**$2,297,945**



Dewatering: Alternative No. D2 – Photoionization

Opinion of Costs Summary

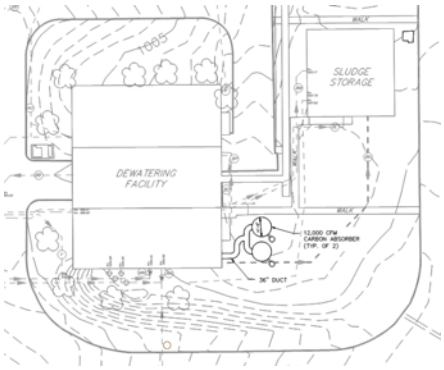
Construction Capital Cost:	$ 881,600
Engineering/Administrative:	$ 88,160
Contingency:	$ 145,500
Project Capital Cost:	$1,115,224
Annual Operating Cost:	$ 101,641
Annual Debt Service:	$ 89,488
Present Value:	**$2,381,897**



Dewatering: Alternative No. D3 – Carbon Adsorber

Opinion of Costs Summary

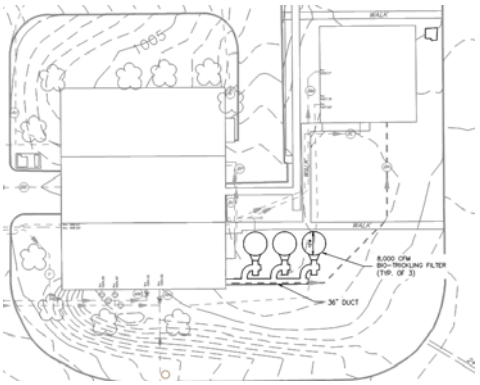
Construction Capital Cost:	$ 659,500
Engineering/Administrative:	$ 79,140
Contingency:	$ 110,800
Project Capital Cost:	$ 849,436
Annual Operating Cost:	$ 65,139
Annual Debt Service:	$ 68,161
Present Value:	**$1,661,206**



Dewatering: Alternative No. D4 – Bio-Trickling Filter

Opinion of Costs Summary

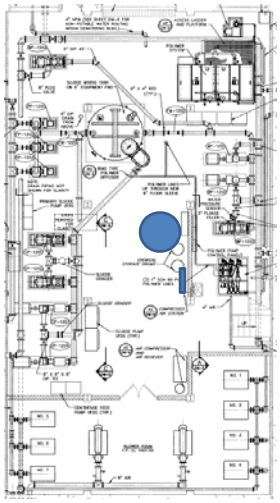
Construction Capital Cost:	$1,264,499
Engineering/Administrative:	$ 126,450
Contingency:	$ 208,642
Project Capital Cost:	$ 1,599,591
Annual Operating Cost:	$ 43,501
Annual Debt Service:	$ 128,355
Present Value:	**$2,141,707**



Dewatering: Alternative No. D5 – Liquid Sludge Treatment

Opinion of Costs Summary

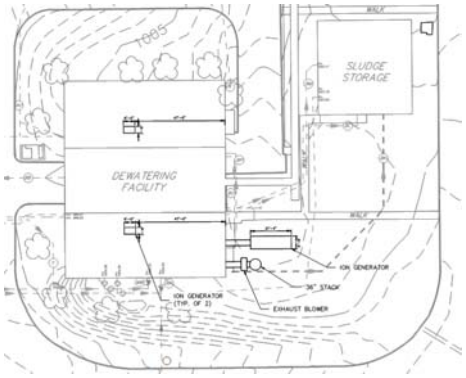
Construction Capital Cost:	$ 30,700
Engineering/Administrative:	$ 20,000
Contingency:	$ 7,605
Project Capital Cost:	$ 58,305
Annual Operating Cost:	$ 93,757
Annual Debt Service:	$ 4,679
Present Value:	**$1,226,721**



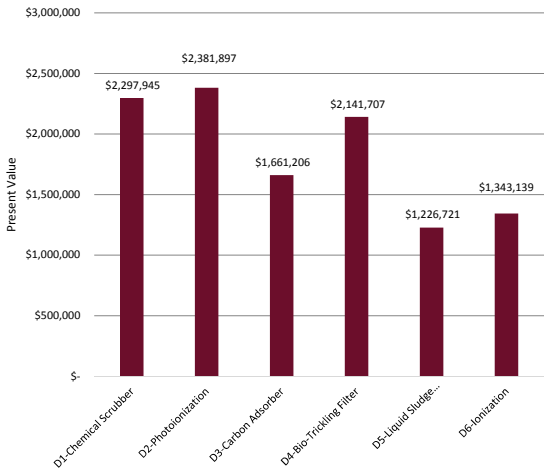
Dewatering: Alternative No. D6 – Ionization

Opinion of Costs Summary

Construction Capital Cost:	$	697,600
Engineering/Administrative:	$	104,640
Contingency:	$	120,340
Project Capital Cost:	$	922,576
Annual Operating Cost:	$	33,747
Annual Debt Service:	$	74,030
Present Value:		**$1,343,139**



Present Value Summary for Dewatering Alternatives



Summary of Alternatives for the Composting Facility

Alternative No. C1A – Existing Biofilter Support Gravel and Media Replacement

- Remove and replace gravel and biofilter media

Alternative No. C1B – Replace Existing Biofilter Media and Improve Flushing Access

- Remove and replace gravel and biofilter media
- Modify air distribution piping at end to facilitate cleaning

Alternative No. C1C – Existing Biofilter Upgrade

- Add humidifiers
- Replace air distribution piping with slotted open floor
- Replace media with root compost

Alternative No. C2 - Concrete Biofilter with Engineered Media

- Install a new Concrete Biofilter System with Engineered Media

Alternative No. C3 – Chemical Scrubber System

- Install five (5) two-stage chemical scrubbers with chemical storage building

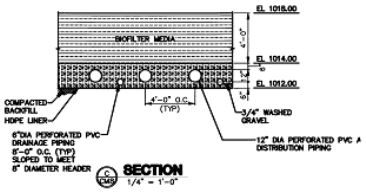
Alternative No. C4 – Ionization

- Ionization Generators

Composting: Alternative No. C1A – Replace Existing Biofilter Media

Opinion of Costs Summary

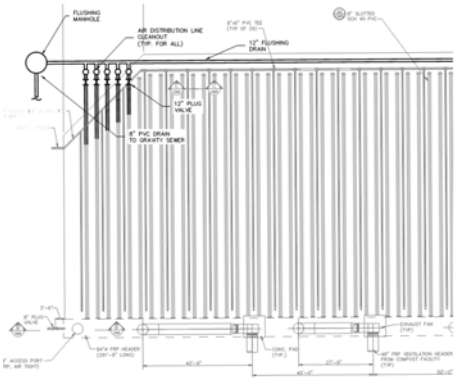
Construction Capital Cost:	$	432,876
Engineering/Administrative:	$	43,290
Contingency:	$	71,425
Project Capital Cost:	$	547,588
Annual Operating Cost:	$	187,072
Annual Debt Service:	$	43,940
Present Value:	**$**	**2,878,919**



Composting: Alternative No. C1B – Replace Existing Biofilter Media and Improve Flushing Access

Opinion of Costs Summary

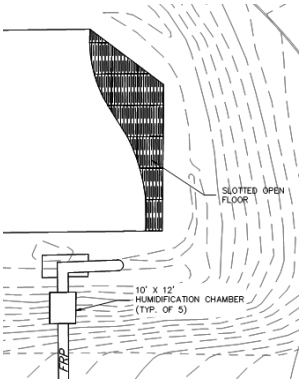
Construction Capital Cost:	$ 736,551
Engineering/Administrative:	$ 73,655
Contingency:	$ 121,531
Project Capital Cost:	$ 931,737
Annual Operating Cost:	$ 187,072
Annual Debt Service:	$ 74,765
Present Value:	**$3,263,068**



Composting: Alternative No. C1C – Existing Biofilter Upgrade

Opinion of Costs Summary

Construction Capital Cost:	$ 2,254,328
Engineering/Administrative:	$ 225,433
Contingency:	$ 371,964
Project Capital Cost:	$ 2,851,725
Annual Operating Cost:	$ 164,244
Annual Debt Service:	$ 228,830
Present Value:	**$ 4,898,572**

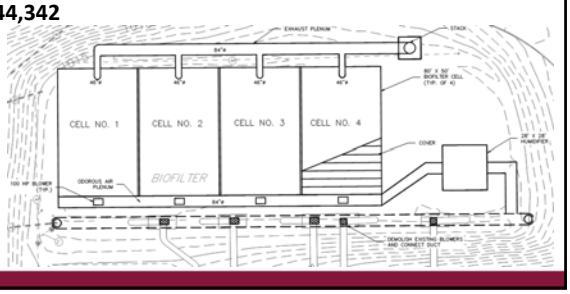


1. Coarse shredded, composted, tree root media
2. Water scrubber (humidifier) on each fan
3. Add Variable Frequency Drives
4. Secondary humidification system (grid of soaker hoses)

Composting: Alternative No. C2 – Concrete Biofilter with Engineered Media

Opinion of Costs Summary

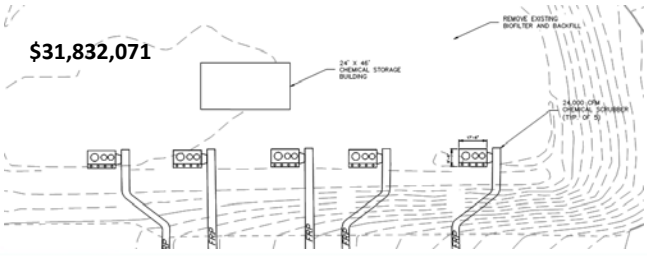
Construction Capital Cost:	$ 5,284,910
Engineering/Administrative:	$ 528,500
Contingency:	$ 872,010
Project Capital Cost:	$ 6,685,411
Annual Operating Cost:	$ 141,141
Annual Debt Service:	$ 536,455
Present Value:	**$ 8,444,342**



Composting: Alternative No. C3 – Chemical Scrubber System

Opinion of Costs Summary

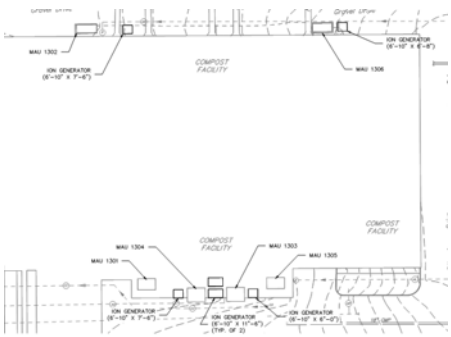
Construction Capital Cost:	$ 2,298,010
Engineering/Administrative:	$ 344,702
Contingency:	$ 396,410
Project Capital Cost:	$ 3,039,118
Annual Operating Cost:	$ 2,310,421
Annual Debt Service:	$ 243,867
Present Value:	**$31,832,071**



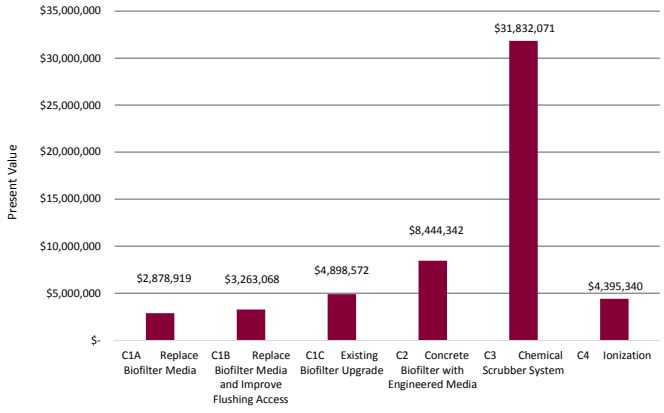
Composting: Alternative No. C4 – Ionization

Opinion of Costs Summary

Construction Capital Cost:	$ 2,429,300
Engineering/Administrative:	$ 364,395
Contingency:	$ 419,055
Project Capital Cost:	$ 3,212,749
Annual Operating Cost:	$ 94,894
Annual Debt Service:	$ 257,799
Present Value:	**$ 4,395,340**



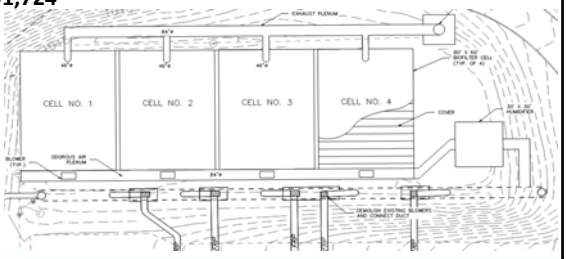
Present Value Summary for Compost Facility Alternatives



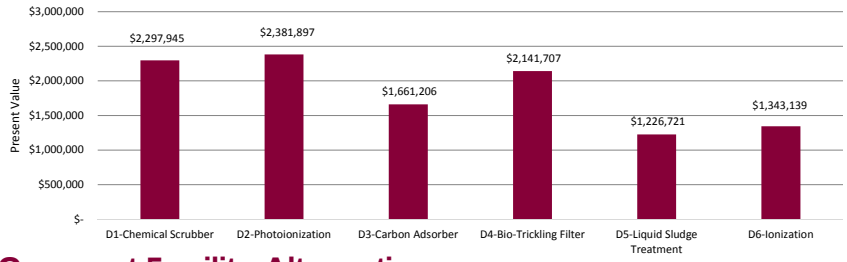
Dewatering and Composting: Alternative No. DC1 – Concrete Biofilter with Engineered Media

Opinion of Costs Summary

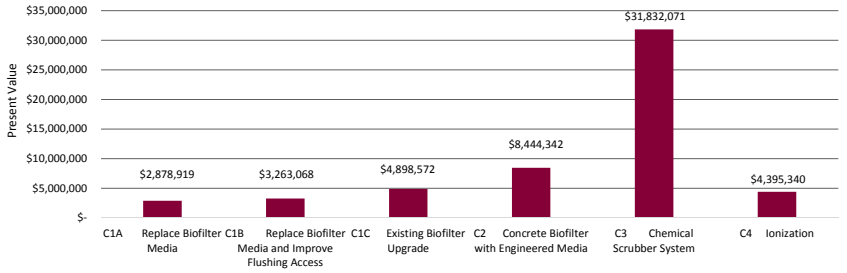
Construction Capital Cost:	$ 6,350,180
Engineering/Administrative:	$ 635,018
Contingency:	$ 1,047,780
Project Capital Cost:	$ 8,032,978
Annual Operating Cost:	$ 173,223
Annual Debt Service:	$ 644,587
Present Value:	**$10,191,724**



Dewatering Facility Alternatives



Compost Facility Alternatives



Criteria	D1 Chemical Scrubber	D2 Photo-ionization	D3 Carbon Adsorber	D4 Bio-Trickling Filter	D5 Liquid Sludge Treatment	D6 Ionization
Number of Units	1	3	2	3	1	3
Unit Dimensions (L x W x H) or diameter x H	17.5 ft x 9.5 ft x 13.0 ft	14.4 ft x 7.2 ft x 10.5 ft	11 ft diameter x 16.75 ft (19.5 ft x 12 ft x 16.75 ft)	12.0 ft diameter x 32.0 ft (19.5 ft x 12 ft x 32.0 ft)	Not Applicable	(1) @ 21.3 ft x 6.7 ft (2) @ 6.0 ft x 3.5 ft
Overall Foot Print (ft^2)	238	311	468	702	100	185
Improves Indoor Odors	No	No	No	No	Yes	Yes
Reduces Indoor Particulates	No	No	No	No	No	Yes
Odor Reduction	95%	>95%	95%, limited with ammonia and amines	90-95%	Difficult to predict, specific to H_2S and organic sulfur compounds	90% reduction of H_2S and NH_3, less for other odorants
Confined Space Entry	When entering vessel, which may be required to clean media.	No	When entering vessel, which may be required during media replacement	When entering vessel, which may be required during media cleaning and replacement.	No	No
Industry Experience	Well established	Well established in Europe. Limited installations in the US, but notable installations in North America.	Well established	Well established	Well established	Moderately established
Media Handling	Periodic cleaning (if required based on air quality and water quality), media life expected to be 20 years	Not applicable	Carbon must be replaced when breakthrough occurs, requiring disposal of old media (6 months to 5 years depending on odorant concentrations)	Periodic cleaning if required. Replacement at 10 year intervals.	Not applicable	Not applicable
Consumables	Chemicals as required, Media at 20 years and Chemical meter pumps at 5 years.	UV Lamps and Catalyst with replacement every 14-18 months	Carbon media with replacement every five years.	Nutrients as required and media at 10 years.	Chemicals, Metering pumps at five years.	Air filters and ionization tubes at 18 months
Annual Maintenance Hours	260	130	416	156	260	164
Annual Water Usage (gallons)	131,626 minimum based on projected H_2S concentration, but could be 1,576,800 at typical replenishment rates	None	None	247,000 minimum based on projected H_2S concentrations, but could be 2,960,000 at typical design rates.	None	None
Chemicals	NaOH, NaOCl, H_2SO_4	None	None	Nutrients	Oxidants	None
Potential for Operational Upset	Medium (chemical adjustment)	Low	Low	High (biological process, temperature and pH ranges)	Medium (chemical adjustment)	Low
O&M Cost Stability with Varying Odorant Concentrations	Low – higher odorant loadings can increase chemical usage and O&M costs.	High – handles odorant concentration variability well without notable increases in O&M	Low – increased odorant concentrations can cause more frequent media replacement, increasing O&M costs.	High – subtle increases in odorant levels can be handled without increased O&M.	Low – higher sulfides in the liquid sludge and lower oxygen levels can require more chemical, resulting in higher O&M costs.	High - handles odorant concentration variability well without notable increases in O&M
Present Value Rank (1 lowest to 6 highest)	5 ($2,300,797)	6 ($2,465,664)	3 ($1,662,683)	4 ($2,143,047)	1 ($1,226,738)	2 ($1,344,060)

Criteria	C1A Replace Biofilter Media	C1B Replace Biofilter Media and Improve Flushing Access	C1C Existing Biofilter Upgrade	C2 Concrete Biofilter with Engineered Media	C3 Chemical Scrubber System	C4 Ionization
Number of Units/Cells	1	1	1	4	5	6
Unit Dimensions (L x W x H)	Not applicable	Not applicable	Not applicable	80 ft x 50 ft	17.5 ft x 9.5 ft x 13.0 ft	(2) @ 7.5 ft x 6.8 ft x 5.3 ft (2) @ 11.5 ft x 6.8 ft x 5.3 ft (2) @ 6 ft x 6.8 ft x 5.3 ft
Overall Foot Print (ft^2)	26,215	26,215	26,215	16,000	1,935 (including chemical building)	340 for IM and 600 for wet scrubbers (total = 940)
Improves Indoor Odors	No	No	No	No	No	Yes
Reduces Indoor Particulates	No	No	No	No	No	Yes
Odor Reduction	90-95%	90-95%	90-95%	90-95%	95%	<90%, 90% reduction of H_2S and NH_3, less for other odorants
Confined Space Entry	Yes (every one or two months for lateral flushing and nozzle exchange)	Yes (two to three months for nozzle exchange)	Yes, but only when evaluating dust build-up in open floor system	Yes, but only when cleaning top of filter	Yes, when entering vessel, which may be required to clean media.	No
Industry Experience	Well established	Well established	Well established	Well established	Well established	Moderately established
Air Distribution	Perforated lateral	Perforated lateral	Open floor	Open (down forced)	Not Applicable	Perforated lateral inside building
Media	Organic – wood chip and leaf compost	Organic – wood chip and leaf compost	Organic – composted tree roots	Mineral based	Synthetic	Not applicable
Media Replacement (years)	3-5	3-5	3-5	20	20	Not applicable
Consumables	Media	Media	Media	Media	Chemicals, Metering pumps at five years.	Air filters and ionization tubes at 18 months
Annual Maintenance Hours	514	514	130	130	260	164
Annual Water Usage (gallons)	3,153,600	3,153,600	3,153,600	2,241,100	718,000	None
Chemicals	None	None	None	None	NaOH, NaOCl, H_2SO_4	None
Potential for Operational Upset	High – biological process subject to variable environmental conditions.	High – biological process subject to variable environmental conditions.	High – biological process subject to variable environmental conditions.	Low-Medium	Medium (chemical adjustment)	Low
O&M Cost Stability with Varying Odorant Concentrations	High	High	High	High	Low – higher odorant loadings can increase chemical usage and O&M costs.	High
Present Value Rank (1 lowest to 6 highest)	1 ($2,888,194)	2 ($3,362,000)	4 ($4,904,275)	5 ($8,450,044)	6 ($13,348,373)	3 ($4,399,173)

Criteria	DC1 Concrete Biofilter with Engineered Media	DC2A Concrete Biofilter with Organic Media	DC2B Lined Biofilter with Organic Media
Number of Units/Cells	4	6	6
Unit Dimensions (L x W)	80 ft x 60 ft	70 ft x 74 ft	70 ft x 74 ft
Overall Foot Print (ft^2)	19,200 (80 ft x 240)	31,080 (440 ft x 70 ft)	31,080 (440 ft x 70ft)
Odor Reduction	90-95%	90-95%	90-95%
Confined Space Entry	Infrequently	Infrequently	Infrequently
Industry Experience	Well established	Well established	Well established
Air Distribution	Open, down forced	Open floor, upflow	Open floor, upflow
Media	Mineral	Organic – wood chip and leaf compost	Organic – wood chip and leaf compost
Media Replacement (years)	20	3-5	3-5
Consumables	Media	Media	Media
Annual Maintenance Hours	130	130	130
Annual Water Usage (gallons)	2,652,000	3,732,000	3,732,000
Chemicals	None	None	None
Potential for Operational Upset	Low-Medium	High – biological process subject to variable environmental conditions.	High – biological process subject to variable environmental conditions.
O&M Cost Stability with Varying Odorant Concentrations	High	High	High
Present Value Rank (1 lowest to 6 highest)	3 ($10,866,432)	2 ($9,122,615)	1 ($6,916,523)