Treatment Challenges of Leachate for Lined Landfills

BURNS McDONNELL

Michael Cook, PE

October 2018 -- RAM/SWANA 23rd Annual Conference

Presentation Outline

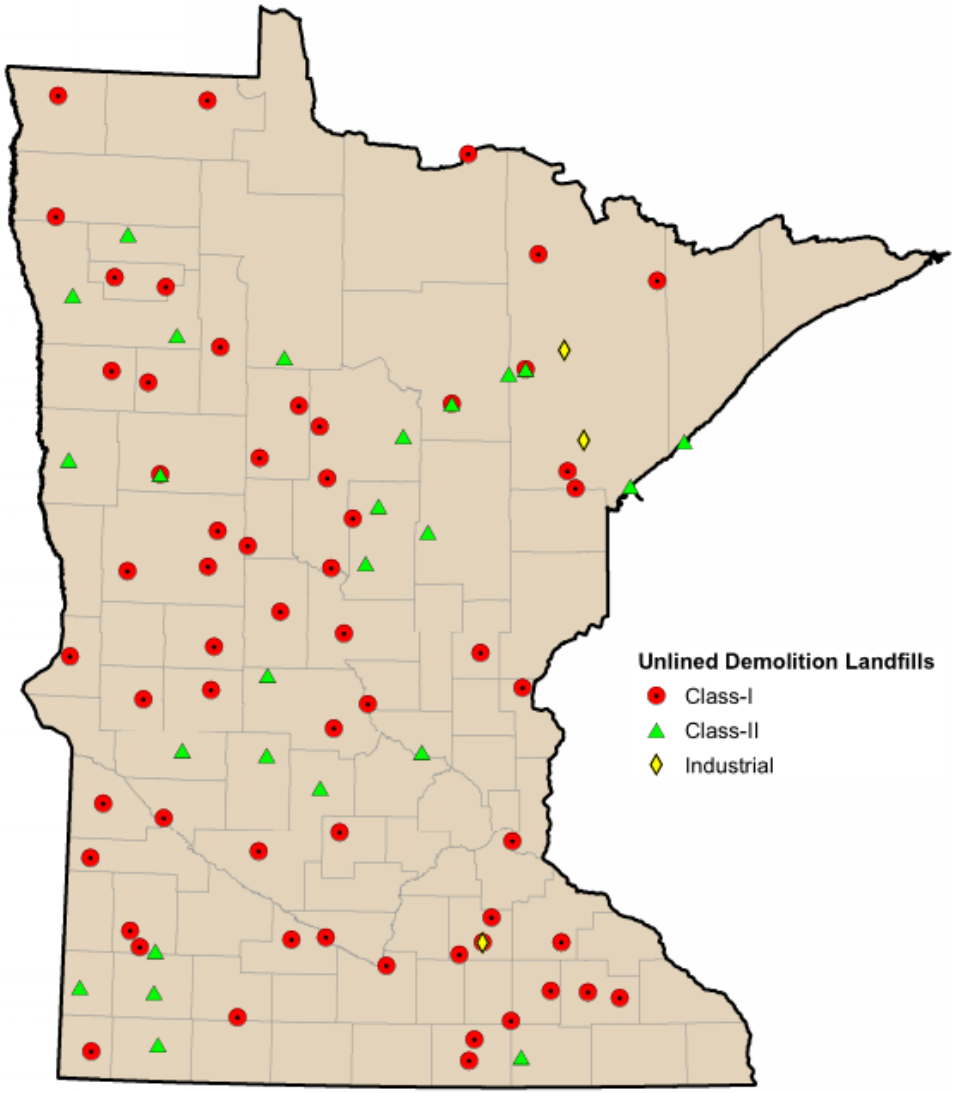
- Minnesota's Landfill Landscape
- Managing Leachate in Operation
- Leachate Treatment Solutions

Minnesota's Landfill Landscape

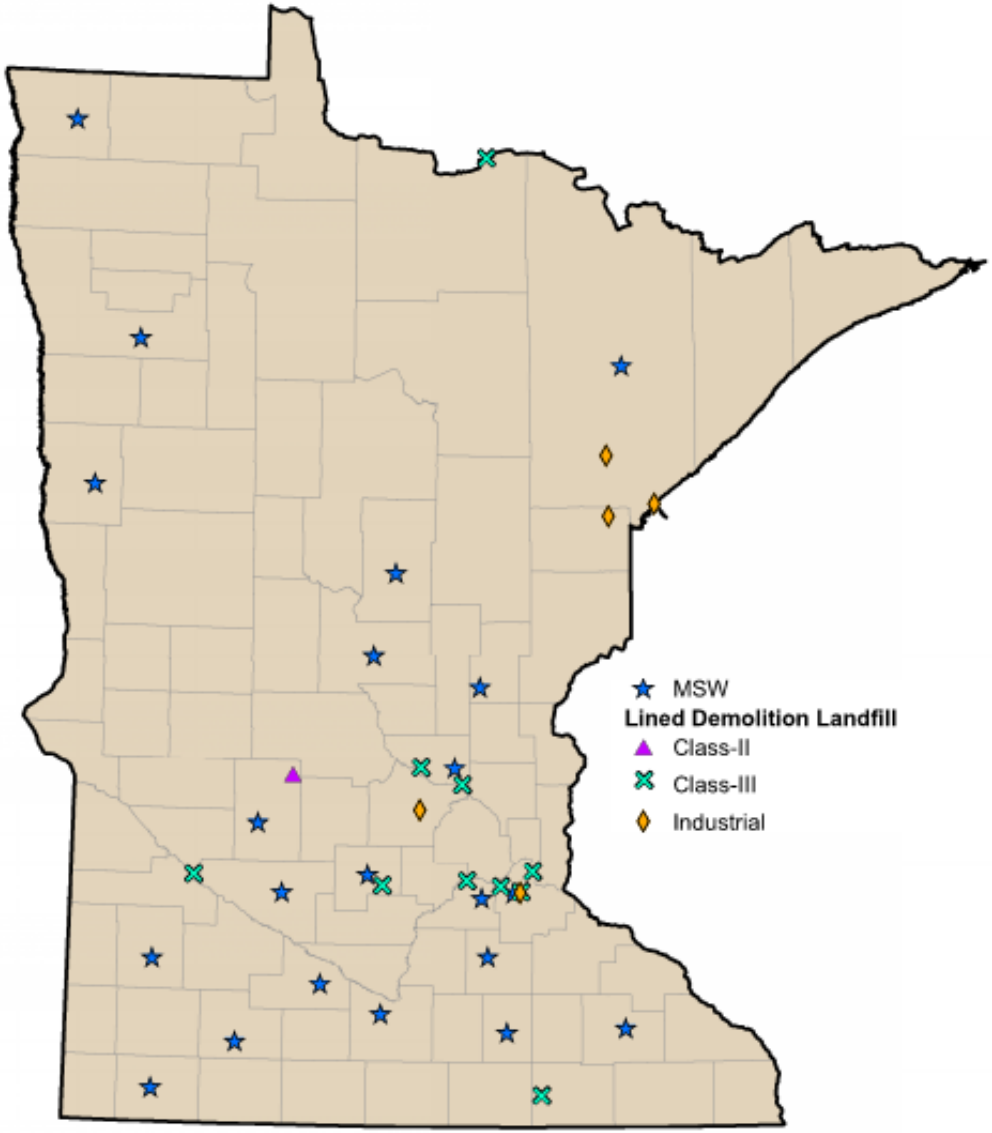
Types of Permitted Landfills in MN

1. Industrial Solid Waste Landfill
   - Captive, or monofill: waste from specific corporation(s) [23]
     - May be lined or unlined
   - Merchant: open to many industries [7]
     - Liner likely required
2. Demolition Debris Landfill
   - Class 1: strict waste list, unlined [66]
   - Class 2: strict waste list + packaging + limited demo-like industrial waste; liner evaluation required [26]
   - Class 3: more diverse waste list; liner evaluation required [10]
3. Municipal Solid Waste (MSW) Landfill [21]
4. MSW Combustor Ash Landfill [8]

Unlined Landfills in MN



Lined Landfills in MN



2016 MN Waste Disposal Data

Lined Tonnage	Tons
MSW	1,960,239
Industrial	2,223,602
Demo Class II Lined	50,121
Demo Class III Lined	785,696
Subtotal	**5,019,658 (91.5%)**
Unlined Tonnage	**Tons**
Industrial	81,567
Demo Class I [66]	236,159
Demo Class II [23]	146,497
Subtotal	**464,223 (8.5%)**
Total	**5,483,881**

2017 Leachate Disposal Data

MSW Landfills

- Wastewater Treatment Plants (11): 67,048,627 gallons
- Land Application (8): 31,255,071 gallons
- Recirculation (3): 5,534,286 gallons
- Total: 103,837,984 gallons

Merchant Industrial Landfills

- Wastewater Treatment Plants (6): 129,494,863 gallons
- Dust Control (1): 324,000 gallons
- Total: 129,818,863 gallons

2017 Leachate Disposal Data

Captive Industrial Landfills

- Wastewater Treatment Plants (6): 36,786,664 gallons
- Land Application (1): 6,700 gallons
- On-Site Storage (2): 6,280,900 gallons
- Total: 43,074,264 gallons

Construction & Demolition Landfills

- Wastewater Treatment Plants (5): 12,267,402 gallons
- On-Site Storage (1): 120,000 gallons
- Total: 12,387,402 gallons
- *Approximately 15 gallons of leachate per ton waste

2017 Leachate Disposal Data

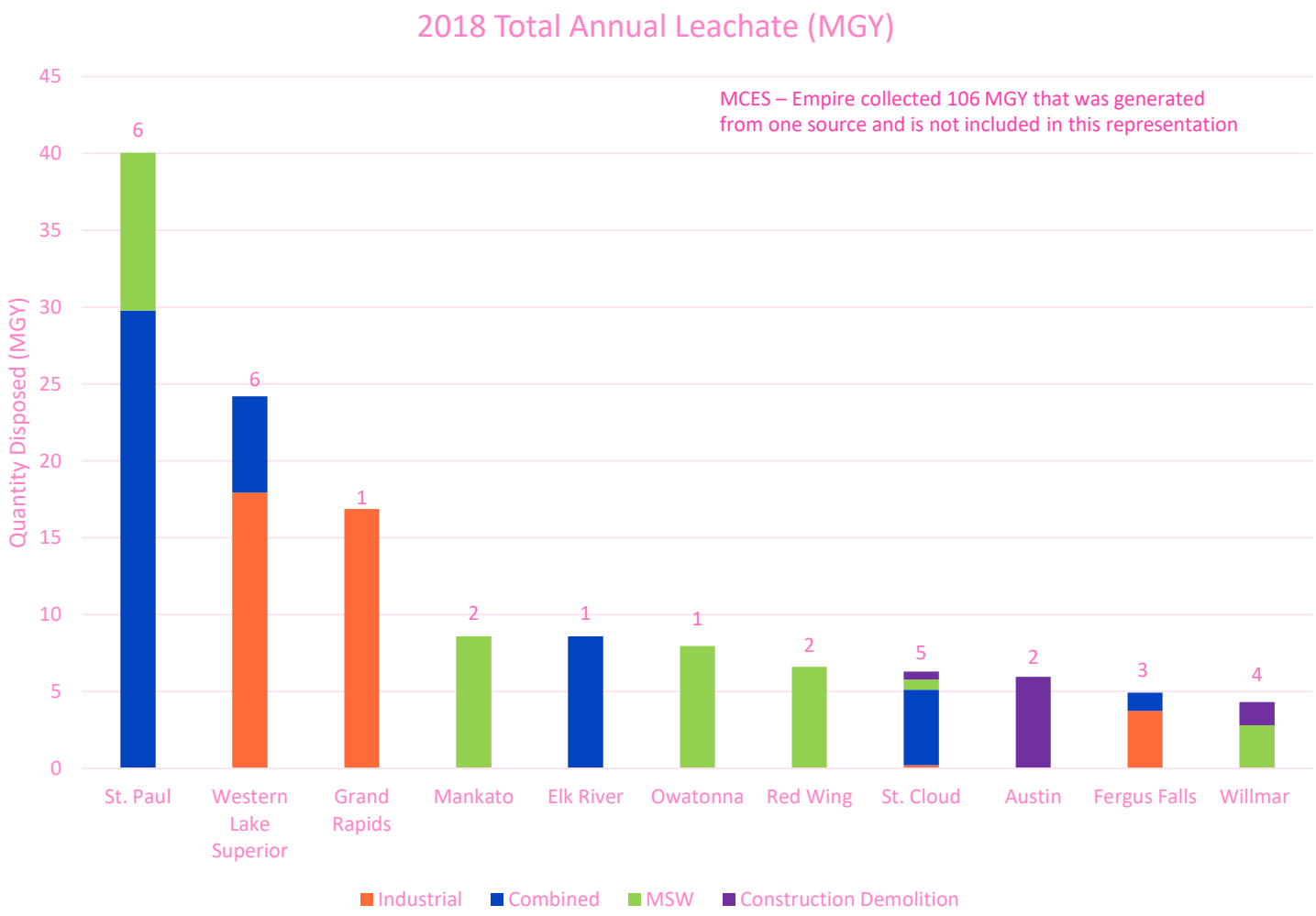
MSW/MSW Ash Landfills

- Wastewater Treatment Plants (8): 19,860,843 gallons
- Quench Water (2): 1,291,760 gallons
- Total: 21,153,603 gallons

2017 Leachate Disposal Data

Overall Total by Disposal Option

- Wastewater Treatment Plants: 265,458,399 gallons
- Land Application: 31,261,771 gallons
- On-Site Storage: 6,400,900 gallons
- Recirculation: 5,534,286 gallons
- WTE Ash Quench Water: 1,291,760 gallons
- Dust Control: 324,000 gallons
- Total: 310,271,116 gallons
- ➔Perspective: Rochester WWTP is 13 MGD average


2018 Total Annual Leachate (MGY)
MCES – Empire collected 106 MGY that was generated from one source and is not included in this representation
Quantity Disposed (MGY)
45
40
35
30
25
20
15
10
5
0
6
6
1
2
1
1
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5
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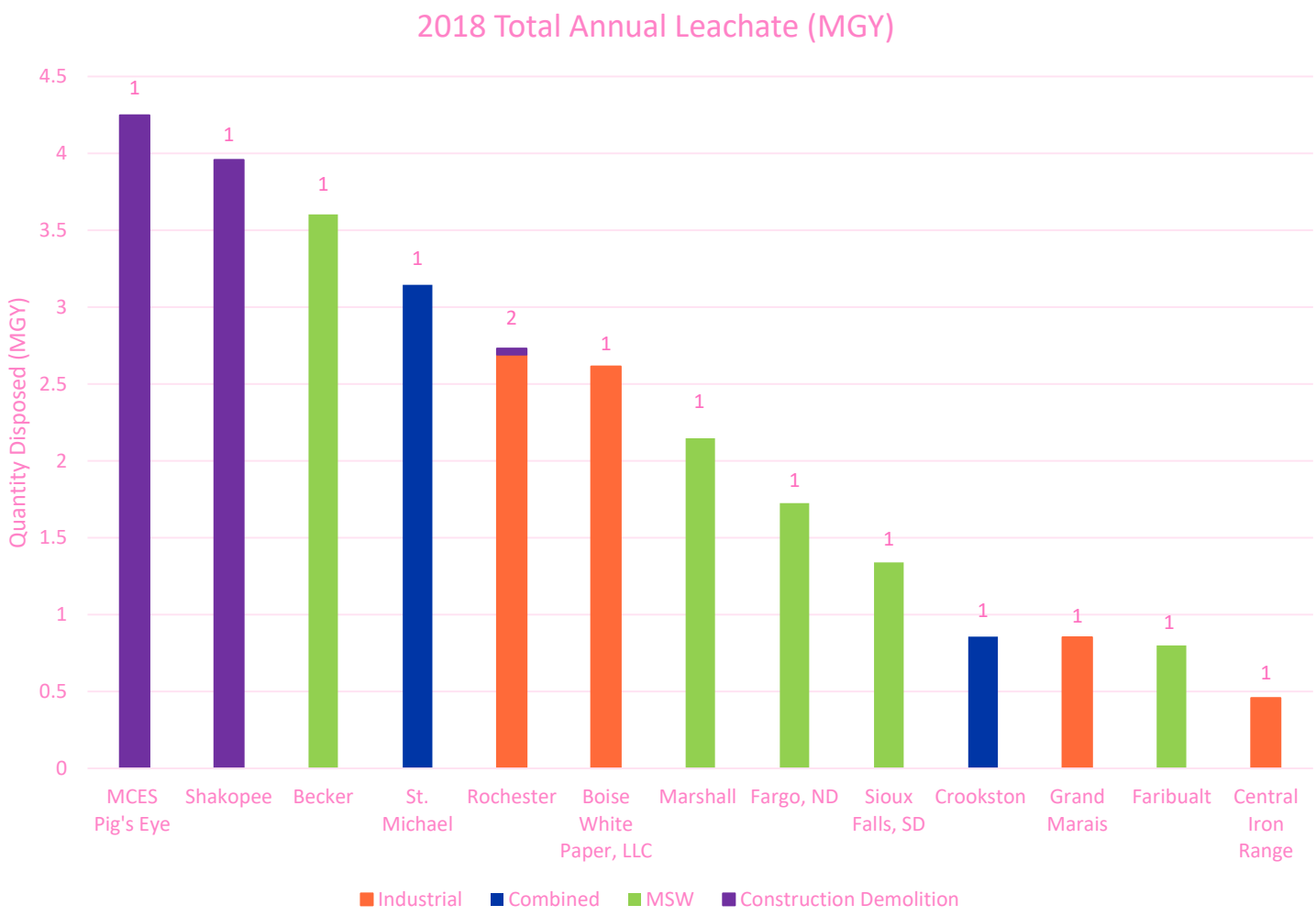
3
4
St. Paul
Western Lake Superior
Grand Rapids
Mankato
Elk River
Owatonna
Red Wing
St. Cloud
Austin
Fergus Falls
Willmar
Industrial
Combined
MSW
Construction Demolition


2018 Total Annual Leachate (MGY)
Quantity Disposed (MGY)
4.5
4
3.5
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MCES Pig's Eye
Shakopee
Becker
St. Michael
Rochester
Boise White Paper, LLC
Marshall
Fargo, ND
Sioux Falls, SD
Crookston
Grand Marais
Faribualt
Central Iron Range
Industrial
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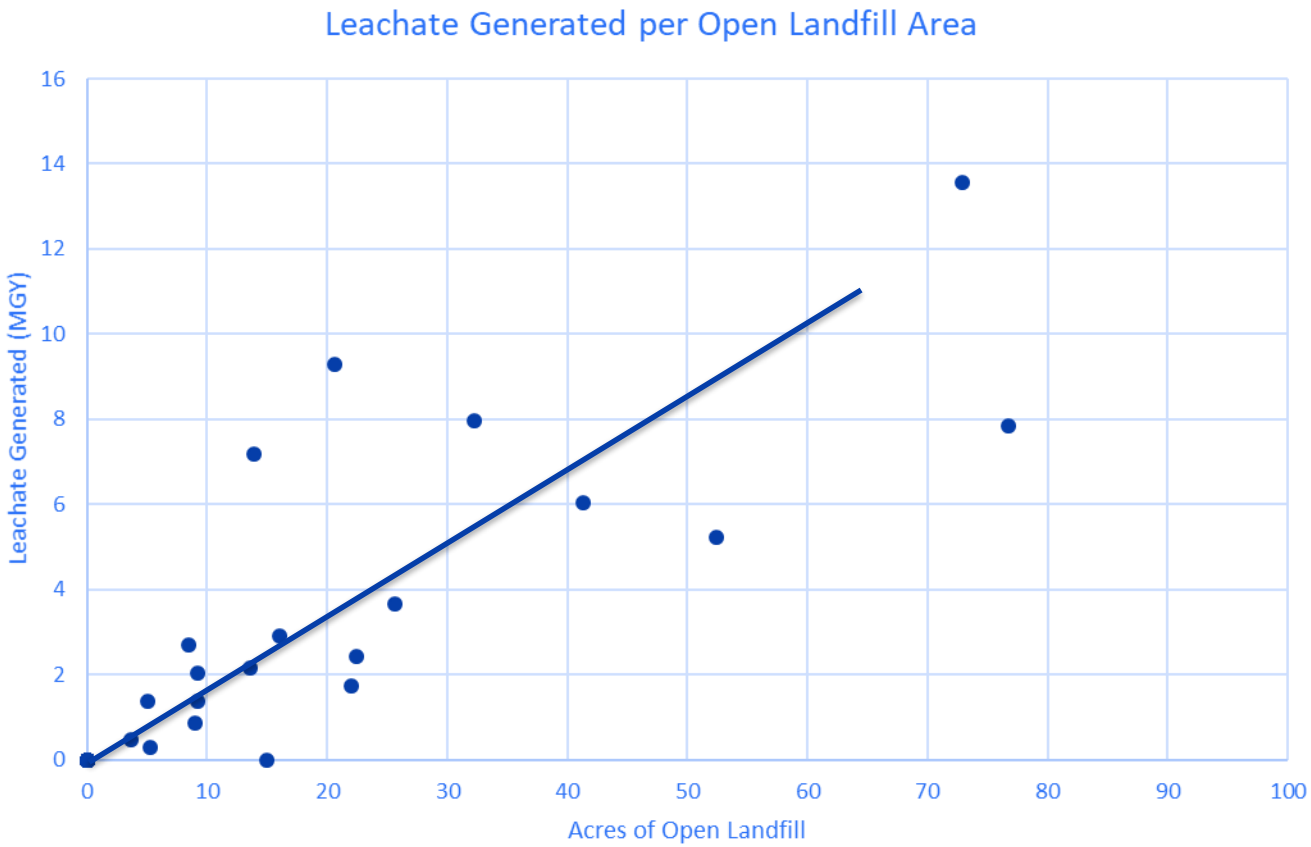
Construction Demolition



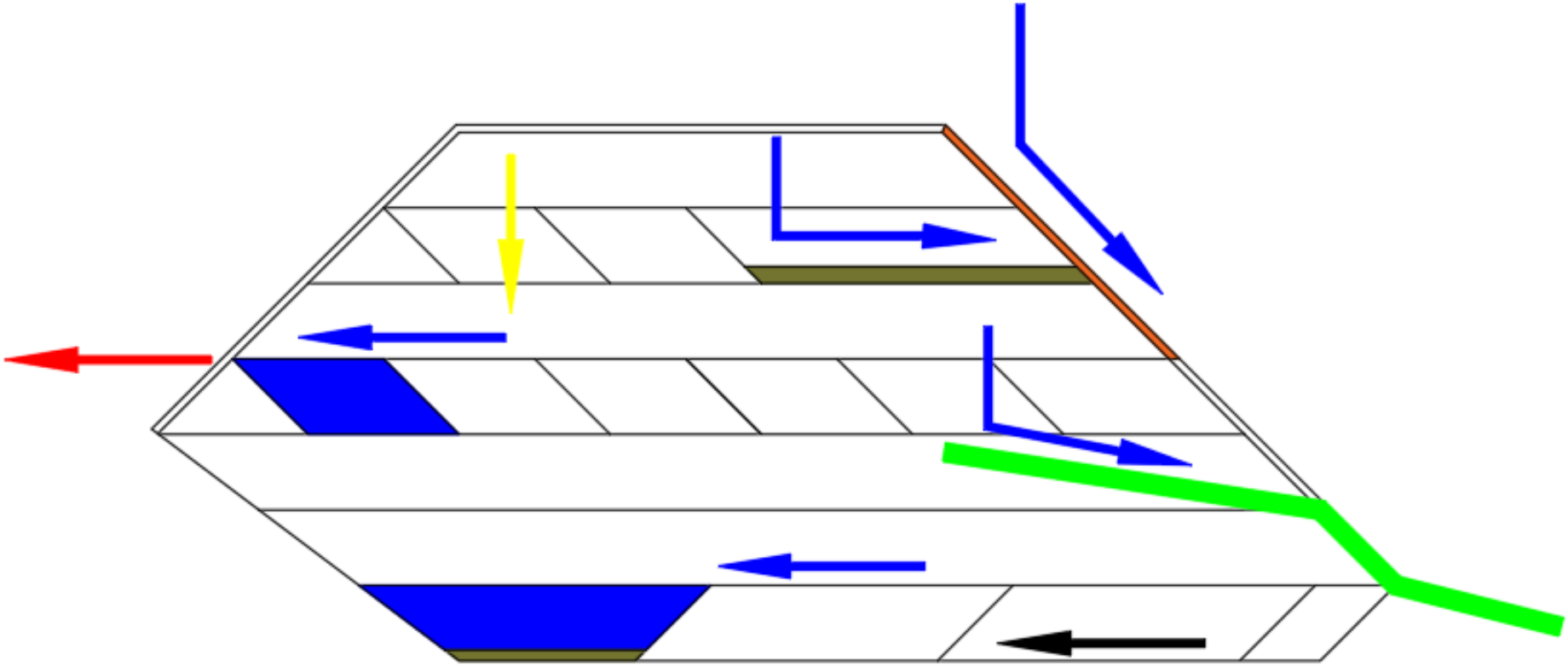
447 acres of open, active, lined landfill

Managing Leachate in Operation

MSW Placement Goals

- Airspace Utilization: >1,200 lb/cy
- Waste:Soil Ratio: >4:1
  - Minimize Soil Usage
  - Maximize Compaction
- Daily/Intermediate Cover ➔ ADC
- Minimize Litter
- Minimize Equipment/Fuel Costs
- Minimize Leachate Generation ★
  - Daily Cell Size
  - Open Lined Area
  - Manage Runoff

Landfill Cross Section



Controlling Stormwater

Takeaways

- Plan Cell Construction
- Minimize Contact Water
- Have Tight Final Intermediate Cover
- Keep the Leachate Collection System Open
- Don’t Trap Water…Do Promote Runoff
- Strip Daily/Intermediate Cover
- Remove Haul Roads
- Control Gas

Leachate Treatment Solutions

Leachate Disposal Hurdles

- Wastewater Treatment Plants
  - Volume Limits
  - Available Haulers
  - Metals Limits (arsenic, chromium, mercury)
  - Organics Loading (BOD, ammonia)

245 MGY

- Land Application
  - Hydraulic Loading (Moisture checkbook method)
  - Nitrogen Loading
  - Boron Loading
  - Metals Loading
  - Potential PFAS Groundwater Impacts

31 MGY

Options for Volume Reduction

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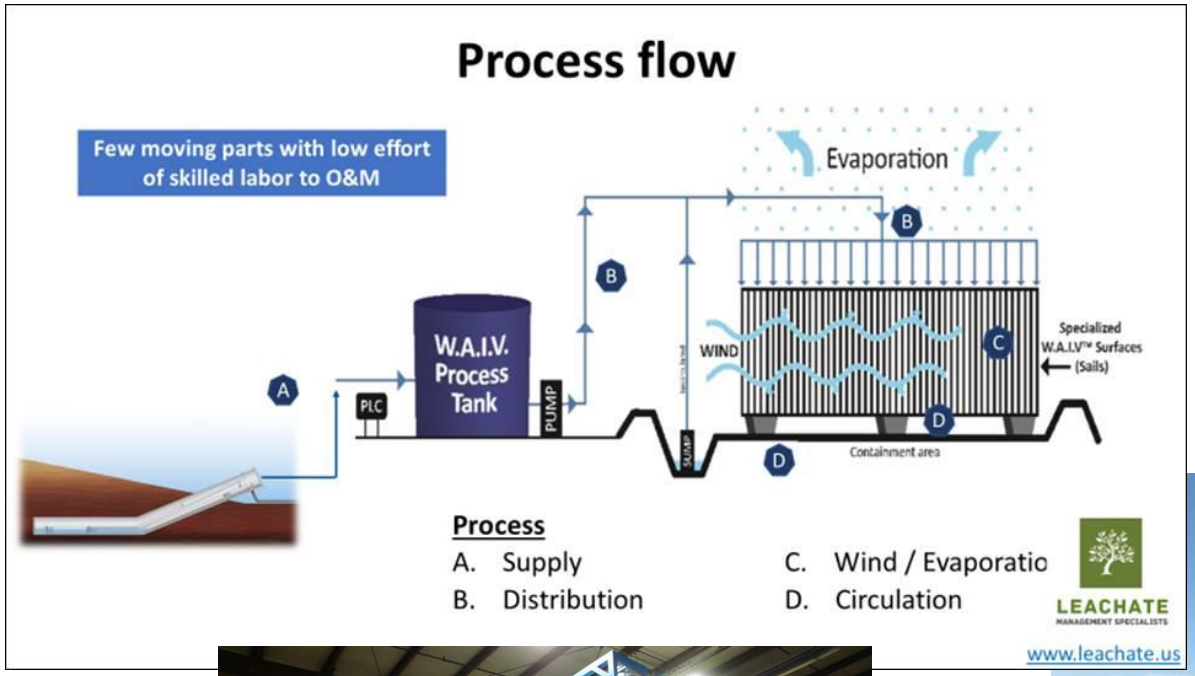
More Aggressive Evaporation



https://edocs.deq.nc.gov/WasteManagement/ElectronicFile.aspx?dbid=0&docid=98966&

https://twitter.com/enconevaporator

Recirculation (Storage)

Recirculation Benefits

- Waste/Leachate Stability
- Leachate Volume Storage/Reduction
- Additional Leachate Treatment
- Enhanced LFG/GHG Destruction
- Accelerated Waste Settlement
  - Airspace Recapture
  - Permit/Construction Savings
- Leachate Management Savings
- Reduced Long-Term Liability

Leachate Treatment Pond

- Aeration
  - Reduce VOC's/Organics
  - Promote Precipitation of Metals
  - Promote Nitrification of Ammonia
- Addition of Carbon and Denitrifying Bugs to Promote Anoxic Denitrification
- Significant Nitrogen Reduction
  - 500 to 800 mg/L ammonia-N to ND
- Metals Reduction
- Little Boron or PFAS Treatment

Reverse Osmosis

http://www.vsep.com/products/spiral-reverse-osmosis.html

Reverse Osmosis Demonstration

PFAS (ug/L)	Raw	Permeate	Concentrate
PFBS	0.714	ND	1.15
PFBA	1.46	ND	2.02
PFOA	1.05	ND	3.36
PFOS	0.13	ND	0.413

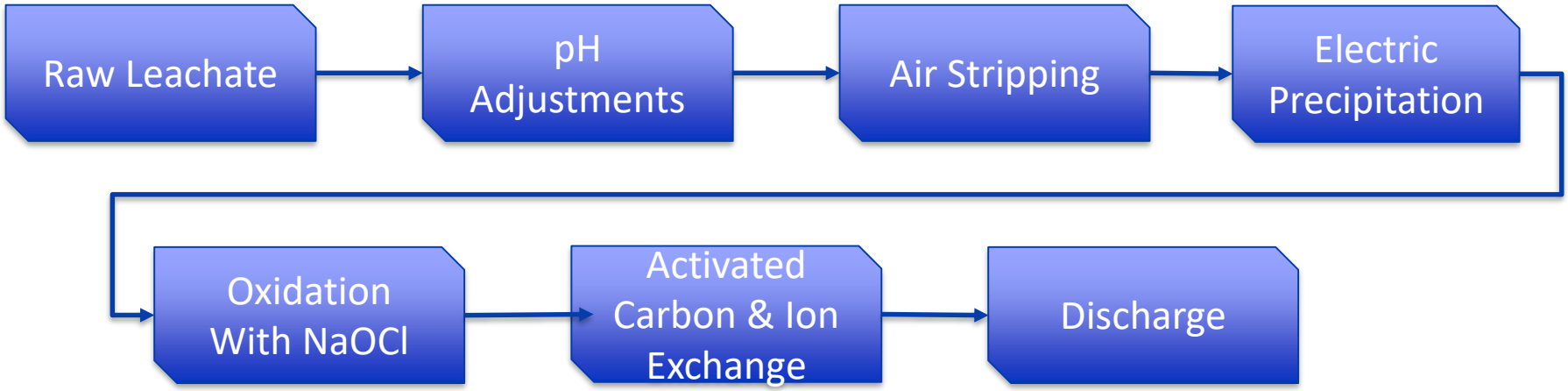
VOCs (ug/L)	Raw	Permeate	Concentrate
Tetrahydrofuran	66.5	21.2	126

Anions (mg/L)	Raw	Permeate	Concentrate
Chloride	1,160	88.1	3,880
Sulfate	26	ND	87.5

Nutrients (mg/L)	Raw	Permeate	Concentrate
Ammonia-N	158	30.4	481
NO3+NO2-N	189	57.5	747
TKN	172	31.6	533

Metals (ug/L)	Raw	Permeate	Concentrate
Arsenic	47.8	ND	141
Barium	214	3.39	445
Boron	8,430	5,620	14,700
Chromium	54.7	ND	175
Iron	6,460	105	13,000
Lead	0.585	ND	1.83
Manganese	992	ND	1,600
Nickel	192	ND	679
Silver	ND	ND	8.01
Zinc	30.5	76.4	100

Electro-Coagulation Demonstration



There's No Free Lunch

- Leachate generation is small, but 'intense'
  - Emerging contaminants
  - Regulations
- Minimizing leachate generation
  - Good planning
  - Good execution
- Leachate treatment
  - Multiple options
  - Treatment level vs. cost
  - Residuals management

Questions?

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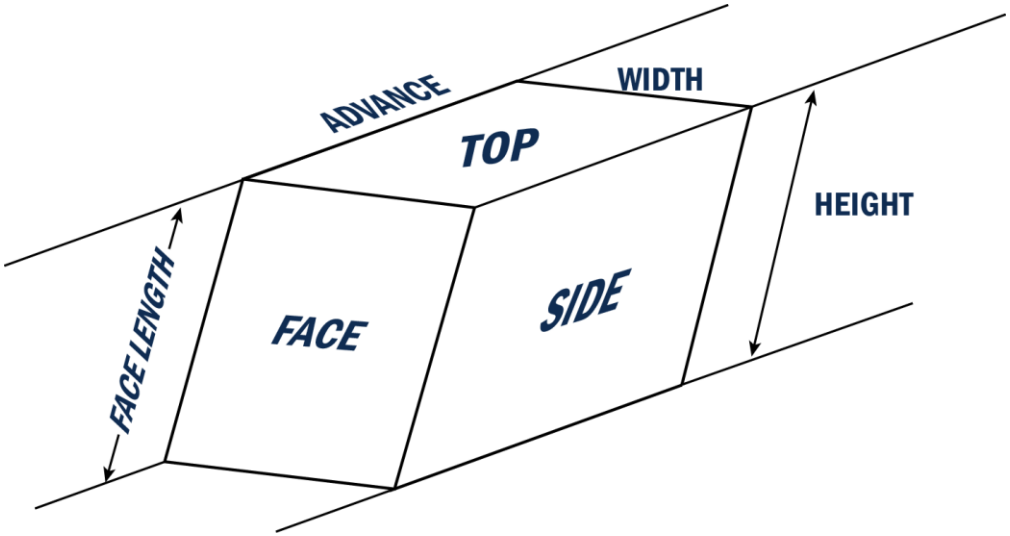
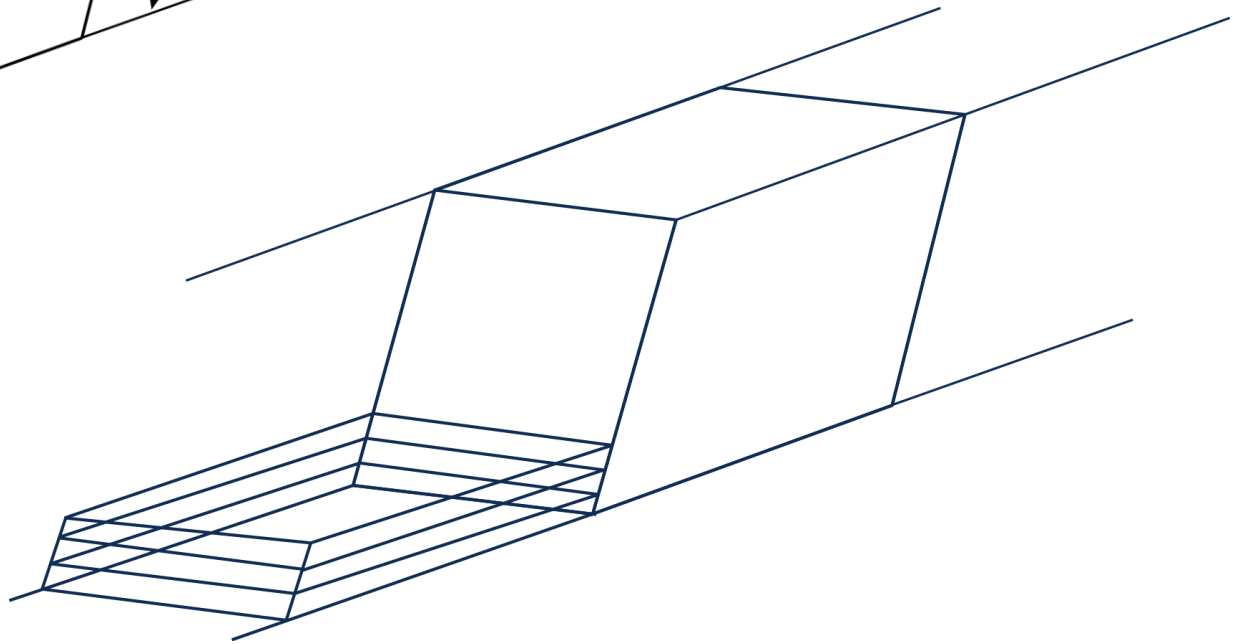
MSW Area Fill Working Face

Electrical Conductance Testing

Typical Daily Cell



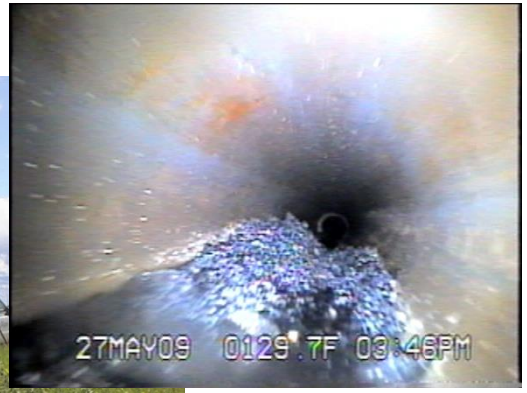


Leachate Rock Prevention

Leachate Rock (Cholesterol)

Pump Clogging

System Cleaning/Video

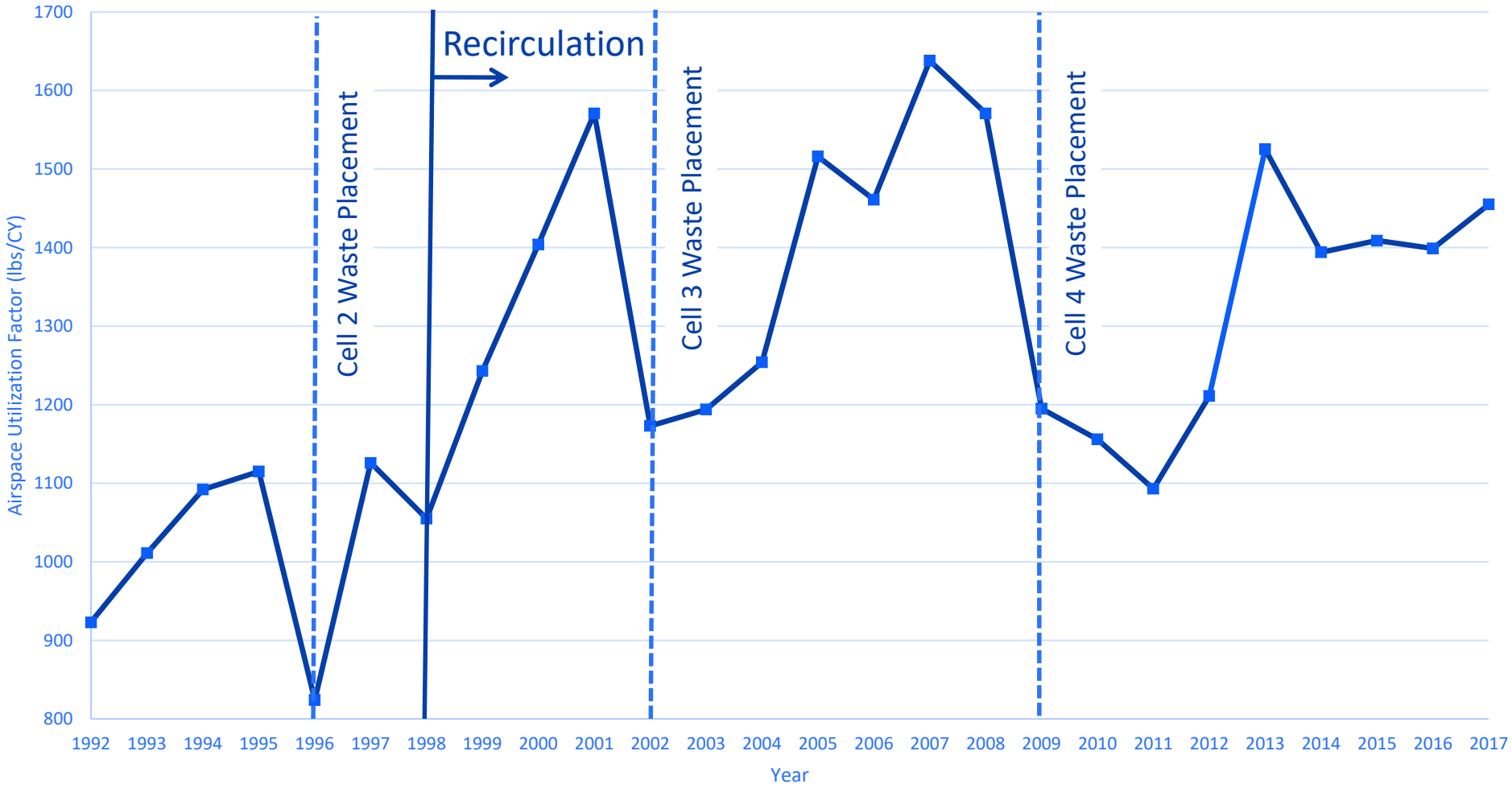


Takeaways

- Minimize Fines into Collection System
- Limit Air Intrusion
- Separate LFG Collection
- Reduce Pipe Weld Height
- Minimize Turbulence
- Avoid Stagnant Pipes
- Clean Pipes After Construction and Annually
- CLEANOUTS!

Evaporation and Aeration

Annual Airspace Utilization Factor

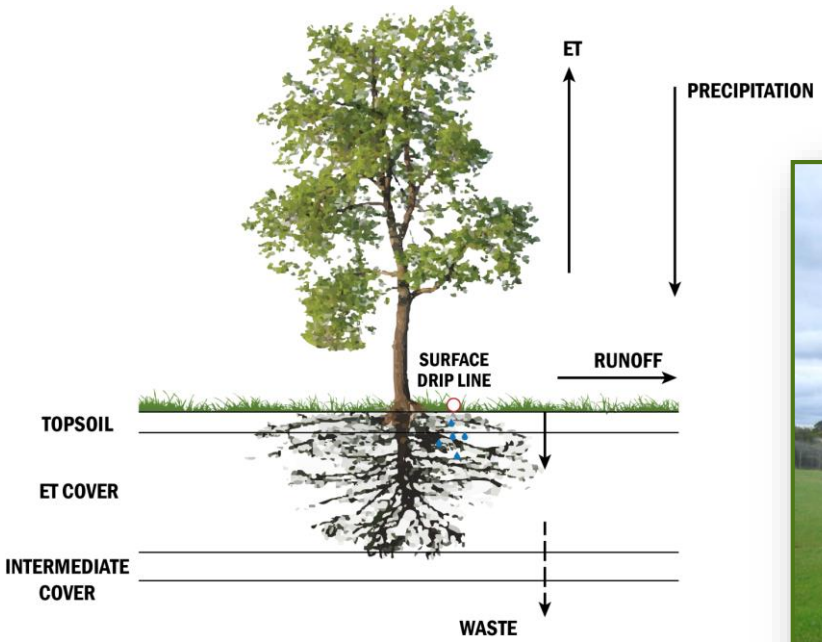


Source: Crow Wing County Landfill

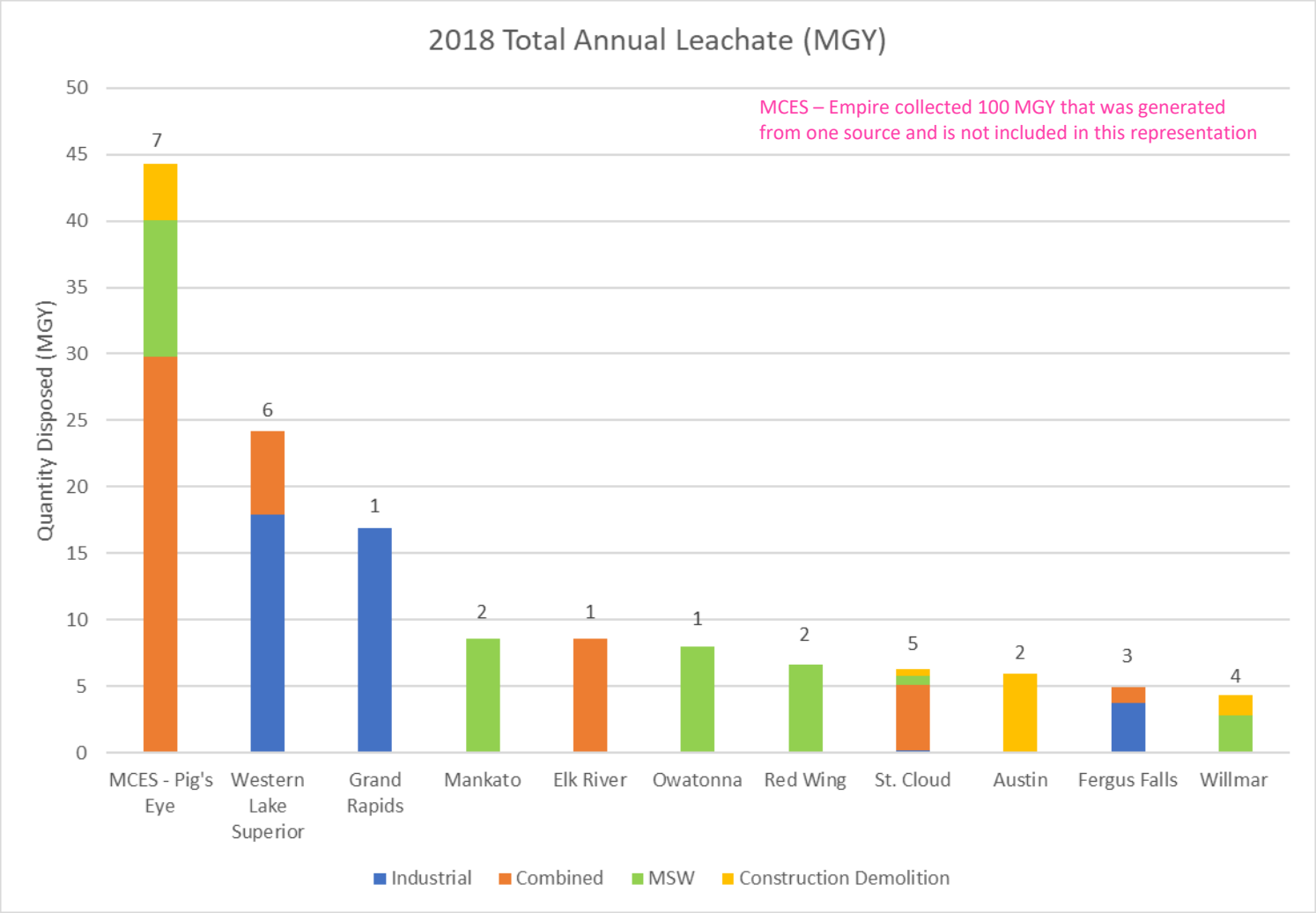
Long-Term Benefits

- Reduced Post-Closure Cost & Liability
  - Leachate Quality
  - Leachate Generation
  - Landfill Gas Generation
  - Settlement

Land Application Options



Raincoat Option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MCES - Pig's Eye
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Mankato
Elk River
Owatonna
Red Wing
St. Cloud
Austin
Fergus Falls
Willmar
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Combined
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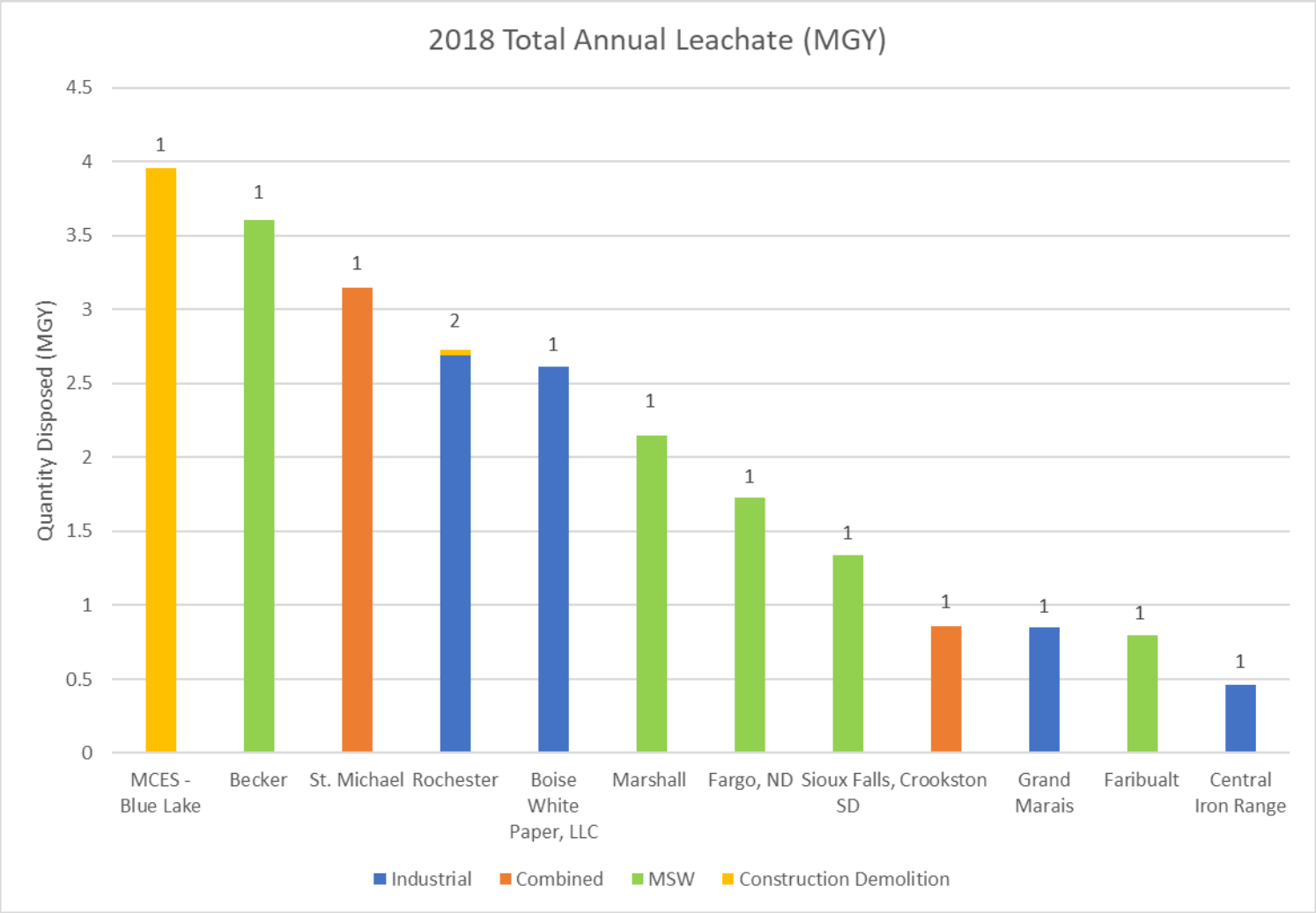
Construction Demolition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MCES - Blue Lake
Becker
St. Michael
Rochester
Boise White Paper, LLC
Marshall
Fargo, ND
Sioux Falls, SD
Crookston
Grand Marais
Faribualt
Central Iron Range
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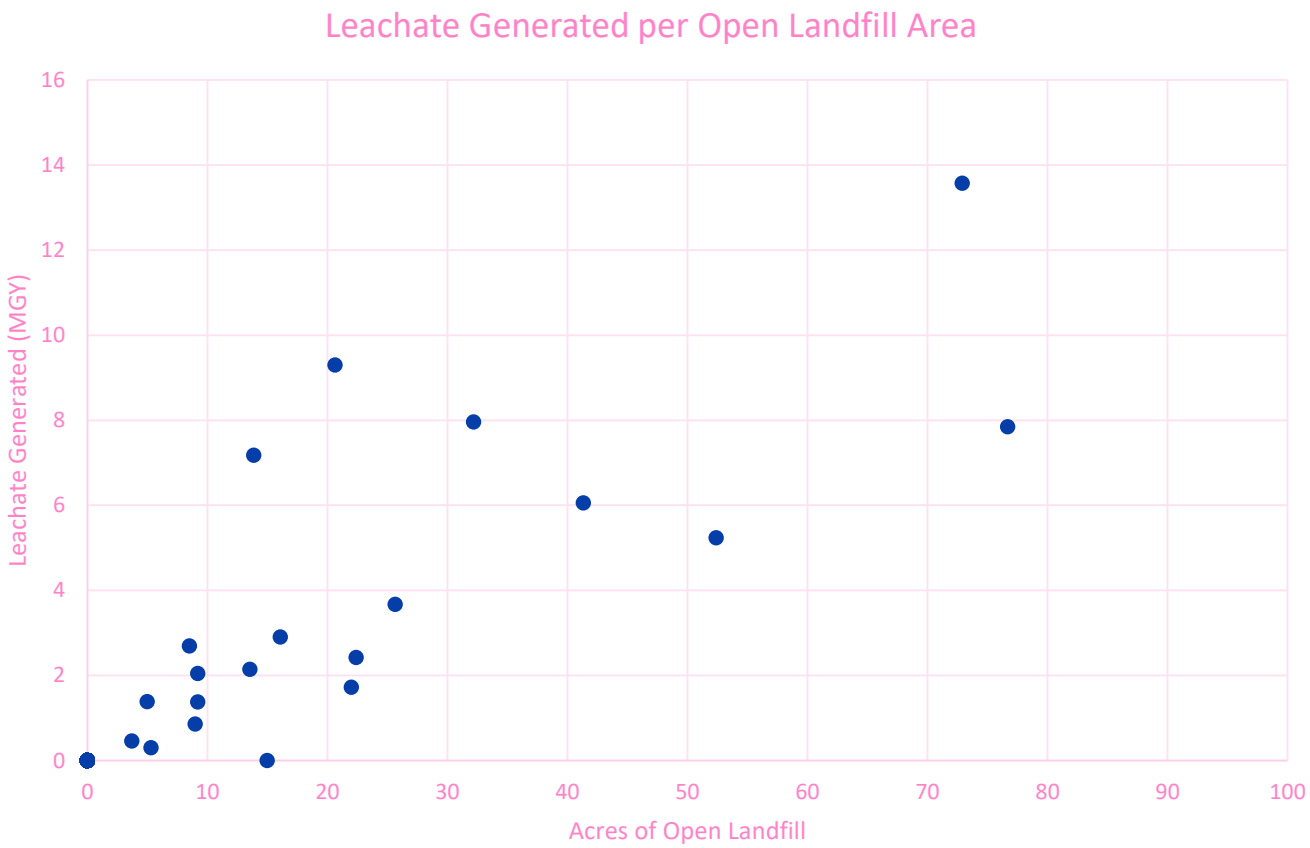

447 Acres of Open, active landfill and 28 acres of open, closed landfill

	MSW Landfills	Merchant Industrial LF's	Captive Industrial LF's	C&D LF's
WWTP	67,048,627	129,494,863	36,786,664	12,267,402
Land App	31,255,071		6,700	
Recirc	5,534,286			
Dust Control		324,000		
On-site Storage			6,280,900	120,000
Total	103,837,984	129,818,863	43,074,264	12,387,402
Tons	1,960,239	2,223,602		835,817
Gal/Ton	53.0	77.8		14.8
Tons/acre				
Gal/acre				
				***
Tons Unlined LF			81,567	382,656
Total gallons				5,671,234