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Saving It for a Dry Day: Storage of Wet Weather Flows

Thursday, December 13, 2018

1:00 - 3:00 PM ET

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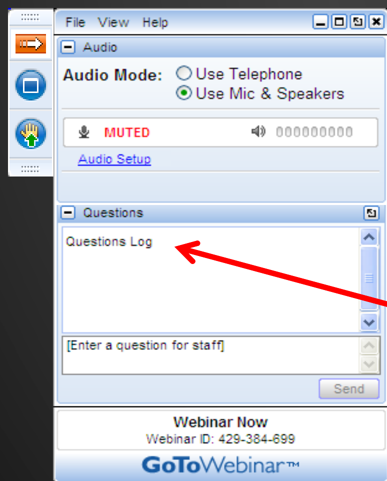
How to Participate Today



- **Audio Modes**
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- **Submit your questions using the Questions pane.**
- **A recording will be available for replay shortly after this webcast.**

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Today’s Moderator

Maureen Durkin, PE
Metropolitan Water Reclamation District of Greater Chicago

Today’s webcast is brought to you by WEF’s Collection Systems Committee

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Today's Speakers

- **Design Considerations for Off-Line Storage Tanks**
  - Greg Heath, PE
- **Reducing Basement Backups Through Intergovernmental Cooperation and Design-Build**
  - Brigitte Berger-Raish, PE
  - Michael Young, PE
- **In-System Wet Weather Storage; an Innovative Solution to Manage Plant Expansion**
  - P.S. Arora, PE
  - Brant Miller, PE

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Our Next Speaker

Greg Heath

Vice President, Americas
Wet Weather Treatment
Practice Leader

AECOM

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Design Considerations for Off-Line Storage Tanks

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Introduction

- Facilities planning:
  - storage tank = box on a map
- Balance sufficient detail vs. over-engineering at planning/concept level
- Sometimes concept needs more development to get public buy-in

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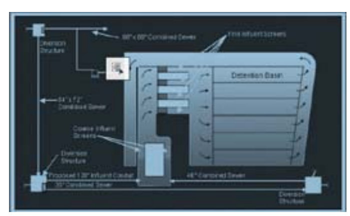
Topics

- Tank Layout and Configuration
- Tank Flushing
- Tank Dewatering
- Ventilation and Odor Control
- Influent Facilities



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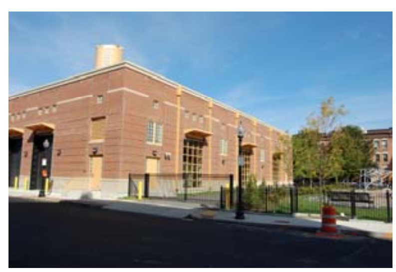
Tank Layout and Configuration

- Circular vs. Rectangular
- Elevation vs. Grade
- Depth/area Relationship
- Internal Configuration
- Materials of construction
  - Pre-cast, Cast-in-Place, Steel

Rectangular Tanks

- Support above-grade structures
- More common arrangement to facilitate flushing
- Easier to provide multiple bays



Circular Tanks

- Cost-effective where site allows
- Typically open configuration (no internal bays)

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Tank Elevation vs. Grade

- Function of system hydraulics and siting
- Pumping vs excavation trade-off
- Potential for dual-use if below-grade

MWRA Union Park Detention/Treatment Facility

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Tank Elevation vs. Grade

Gardiner, ME Storage Facility

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Influent Pumping vs. Pumped Dewatering

Influent Pumping Considerations

- Larger, higher capacity pumps
  - Higher cost
  - More space required
- Less costly above-ground tank construction possible
- Vertical location of tank independent of system piping / hydraulics

Pumped Dewatering Considerations

- Smaller, lower capacity pumps
  - Lower cost
  - Less space required
- Avoids risk of pump failure during event
- With gravity in, vertical location of tank is dictated by system piping / hydraulics

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Water Surface to Roof Slab Clearance

- Internal walkway?
- Leave room for beams and ventilation ducts
- Minimize freeboard to minimize ventilation air volume

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Tank Depth vs. Area

- Shallow/Larger Footprint vs Deep/Smaller Footprint?
  - Available space
  - Rock vs. soil excavation
  - Trade off wall vs roof and base slab concrete
  - Consider tank flushing lengths

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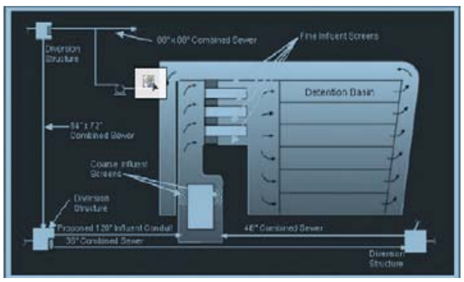
Internal Tank Configuration

- Bays vs. Open Configuration
- If Bays, how many?
  - Look at typical year storm volumes
  - For range of bay sizes, how often would bays fill?



# Bays	Vol./Bay (MG)	# Storms < Bay Vol.
1	2.0	50
2	1.0	30
3	0.67	20

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Tank Construction

- Cast-in-Place is typical
- Pre-cast can be cost-effective alternative
  - CIP base slab
  - Pre-cast wall sections thinner than CIP
  - Pre-cast or CIP roof slab
  - Post-tensioning cables/grout joints
  - Pre-cast box sections
- Floatation
  - Rock anchors
  - Thick base slab
  - No PRVs!

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Tank Construction

- Steel tanks
  - Above grade (influent pumping)
  - Lower tank cost
  - Tank cost savings may be partially offset by influent pumping cost
  - Likely shorter lifespan than concrete

Image courtesy of Jackson Twp., NJ

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Tank Flushing

- Manual water cannons (monitor nozzles)
  - Manual operation
  - Can be hard to reach corners
  - Need personnel access to tanks

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Tank Flushing

- Automated monitor nozzles
  - Eliminate need for tank access / operations staff
  - Suitable for circular tanks

Image courtesy of Akron Brass

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Tank Flushing

- Flushing Gates
  - Automatic operation
  - Reservoir fills during storm
  - Knee walls separate flushing lanes

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Tank Flushing

- Center flushers
  - Automatic operation
  - Center ring raises to release flush


Image courtesy of GNA CSO


Image courtesy of GNA CSO

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Tank Flushing

- Tipping Buckets
  - Automatic operation
  - Reservoir fills with clean water
  - Knee walls separate flushing lanes

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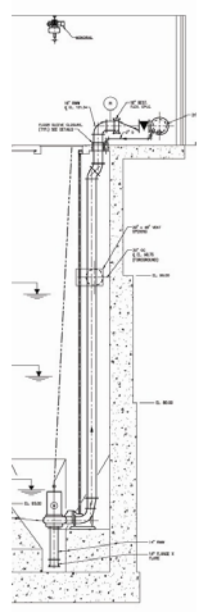
Tank Dewatering

- Submersible pumps well-suited
- High-rate rapid dewatering pumps and lower-capacity trash pumps
- Dewatering rate controlled by interceptor/WWTP capacity



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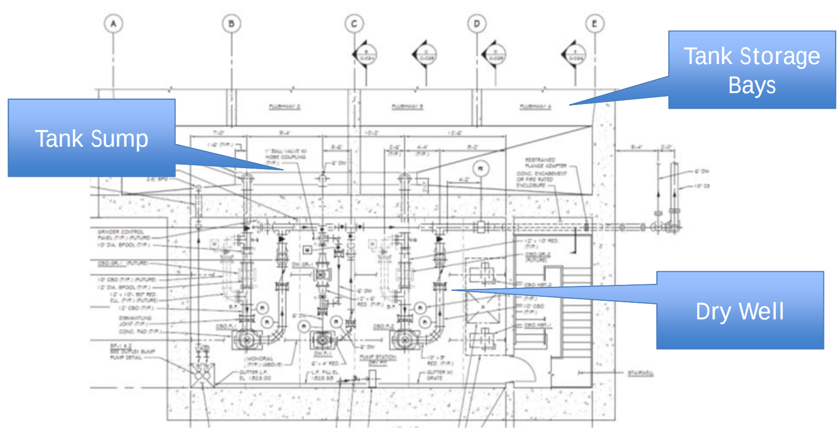
Tank Dewatering

- Dry well pumps offer easier access for maintenance if space permits



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Ventilation / Odor Control

- To ventilate or not to ventilate…
  - Recommend ventilating to control H_2S
- How many ACH?
  - 30 ACH intermittent
  - 12 ACH continuous
  - <12 ACH?

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Ventilation / Odor Control

- Activated carbon
  - Common for CSO applications
- Wet scrubbers
  - More complex, more equipment/chemicals
- Biofilters
  - Not well-suited for intermittent operation

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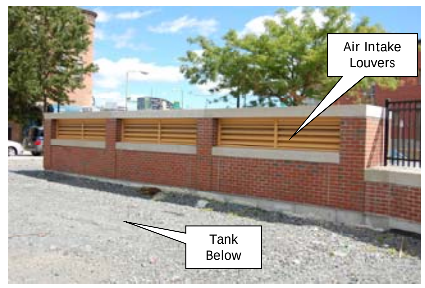
Air Intake Structure

- Draw air from one end of tank, and exhaust from the other
- Air intake will be an above-grade feature
  - Incorporate into stair head house or other structure
  - Provide architectural treatment



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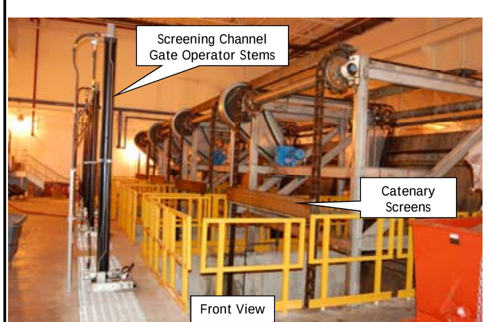
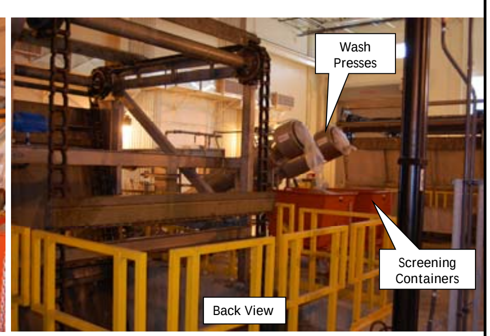
Influent Facilities

- Isolation gates
- Influent screens





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Questions?

Please contact

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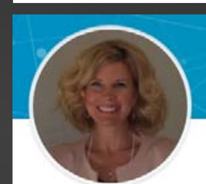
Reducing Basement Backups through Intergovernmental Cooperation and Design-Build

Presented by
Mike N. Young, PE

and

Brigitte Berger-Raish, PE



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Wilmette- Background

- North Shore Suburb of Chicago
- 5 Square Miles / Population 27,000
- Fully Developed
- East half Combined System
- West half Separate Storm System
- Sanitary Flows Treated by MWRDGC

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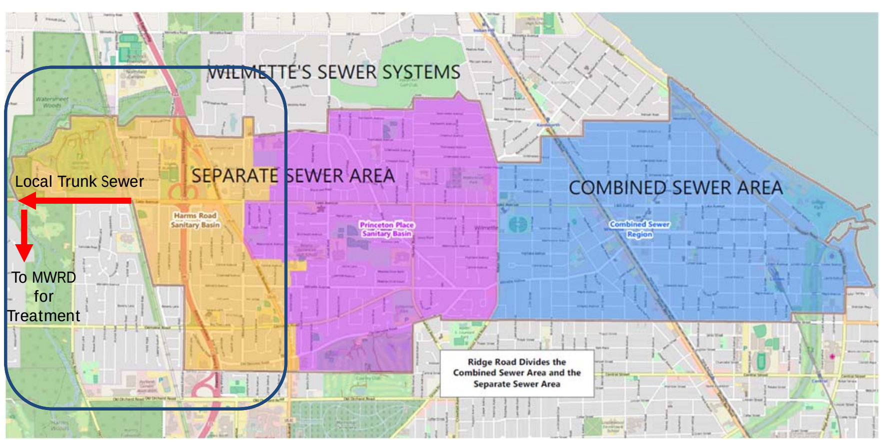
Wilmette Sewer System



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5 Major Storms of Record Past 5 Years

Village of Wilmette Water Plant
Storms of Record 1980-2017

Rank	Date	Location	Inches	Minutes	Hours	Inches/hour	Storm Freq, yrs
1	8/2/2001	WTP	4.11	80	1.33	3.08	100
2	7/12/1981	SWPS	3.60	120	2.00	1.80	100
3	8/7/1989	SWPS	4.20	150	2.50	1.68	100
4	8/13/1987	SWPS	9.80	1440	24.00	0.41	100
5	7/23/2016	SWPS	6.05	480	8.00	0.76	100
6	9/12/2008	SWPS	6.60	1200	20.00	0.33	70
7	9/12/2008	WTP	6.29	1200	20.00	0.31	70
8	8/22/2002	WTP	3.85	210	3.50	1.10	50
9	8/22/2002	SWPS	3.80	210	3.50	1.09	50
10	8/16/1995	WTP	2.71	90	1.50	1.81	25
11	7/23/2011	SWPS	4.48	300	5.00	0.90	25
12	6/24/1994	SWPS	4.10	600	10.00	0.41	25
13	4/17/2013	WTP	5.56	1440	24.00	0.23	25
14	4/17/2013	SWPS	5.00	1440	24.00	0.21	17
15	8/14/1981	SWPS	2.30	60	1.00	2.30	15
16	8/18/1990	SWPS	2.75	120	2.00	1.38	15
17	7/23/2011	WTP	3.39	300	5.00	0.68	10
18	7/24/2010	SWPS	4.20	810	13.50	0.31	10
19	7/24/2010	WTP	3.81	810	13.50	0.28	10
20	7/10/2004	SWPS	2.41	100	1.67	1.45	10

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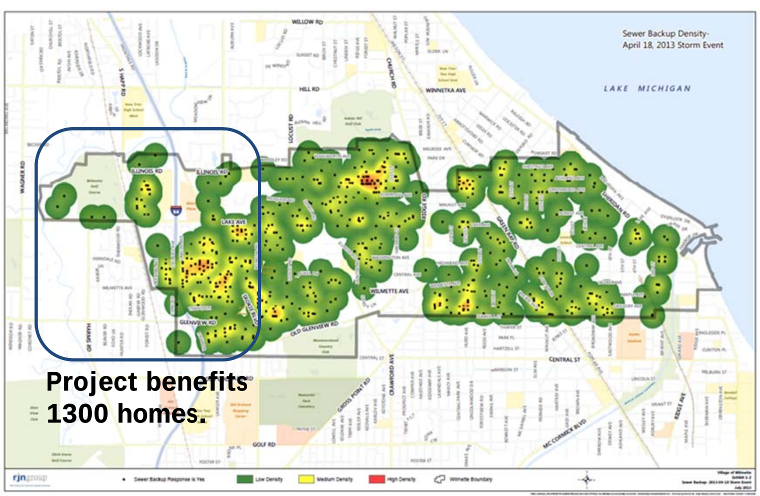
Resident Survey- Basement Backups



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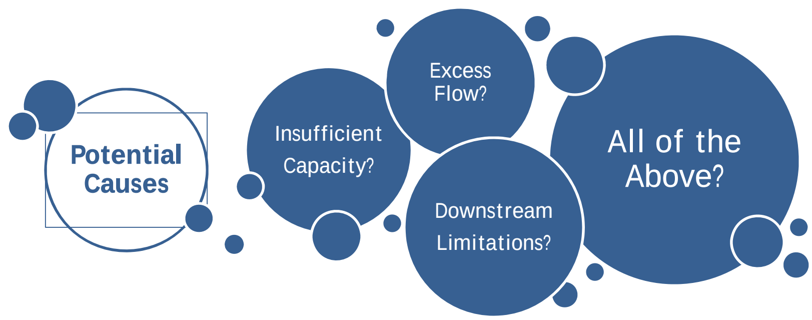
Basement Backups-Survey Results

- Regional and severe backups in major events
- Isolated backups in moderate events



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Engineering Study

- Village hired RJN to perform detailed evaluation of the Harms Basin
- Long Term Flow Monitoring
- Hydraulic Model
- Rim and Invert Survey of all Manholes

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Engineering Study

For decades, there was speculation that downstream control contributed to frequent basement backups, but the short term flow monitoring performed over many years did not capture this.

Until…

April 18, 2013

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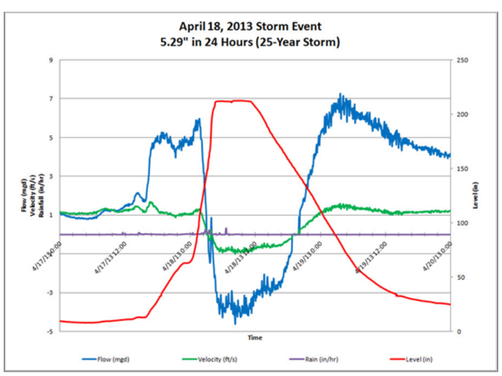
Flow study of 25-year storm



Flow data supports downstream control. Recorded 17 hours of reverse flow.

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Conclusions and Recommendations

Conclusions:

- Significant reverse flow from downstream MWRD interceptors
- Significant excess flow from I/I

Recommendations:

- Backflow prevention
- Pump over lift station
- Storage (optimal size of 5.5 MG)
- Flow reduction Program—on-going

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Project Approval

- Staff presented the conceptual recommendations and cost/benefit analysis to the Village Board and the community.
- There was broad support for the project.
- Next challenges:
  - Find location for the storage component
  - MWRDGC permitting

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Project Site—West Park

- Near the MWRD Interceptor
- Active athletic field
- Large enough to accommodate 5.5 MG tank

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MWRD Conceptual Approval

- Presented Flow Monitoring Data to secure backflow prevention
- Pump over lift station- limited to 150 gpcpd (approx. 1 mgd)
- 5.5 MG storage
- Flow Reduction Program

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Project Stakeholders

- Village Board
- Village Residents
- Park District-- for use of their land
- MWRDGC-- permitting agency

After numerous staff and public meetings, a partnership was formed with the Park District to build the underground storage reservoir under West Park.

Park District Coordination

- 1 year to complete the work
- New turf field (Village partially funded)
- Odor control system

The timing was such that RJN had just started preliminary engineering. Given the tight schedule, Village chose Design-Build construction delivery.

Guaranteed Maximum Price

- Set Prices
- Bid Sub Work
- Allowances
- Overhead and Profit
- Contingency
- Engineering
- General Conditions
- Original Contract Amount: $15 Million

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9-30-14 Groundbreaking

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Advantages of Design-Build

- Accelerated Schedule
- Guaranteed Maximum Price
- Early Cost Certainty
- Cost Containment
- Contractor Flexibility

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Keys to Design-Build

- Strong Project Manager
- Good Contractor Partner
- Open relationship with Owner (Village) and Park District
- Early and frequent communication with the Permit Agencies

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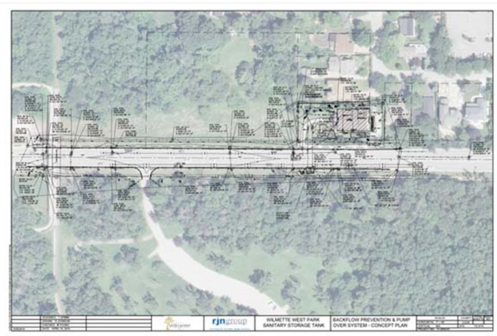
Backflow Prevention and Pump Over Lift Station

- Check Valve on 36" Interceptor
- 1 MGD Pump Station (Flow Set by MWRD)



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Excavation and Backfill

- Quotes from Three Qualified Subcontractors
- Start in October 2014
- 90,000 Cubic Yards Excavated
- 15,000 Cubic Yards Stockpiled
- Up to 500 Trucks Per Day
- Ramps to Lower Level
- Finished in December
- Mud Slab
- Start Backfill in June 2015
- Finish Backfill in August

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Storage Tank

- 5.5 MG Cast-In-Place Concrete Tank
- 310' Long x 168' Wide x 22' High
- 24" Base Slab – Checkerboard Pours
- Sloped to Center Trough
- 24" Walls – Poured in 20 Sections
- 98 Columns (14 x 7 Grid)
- Elevated 12" Drop Slab and 18" Top Slab
- Top of Tank – 4' Below Field Turf
- Account for Weight Above
- Sewer Overflow to Tank (No Mechanical / Electrical)

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Lift Station

- 24" Sewer Between Interceptor and Tank
- Lift Station Structures
  - –Manhole on 24" sewer
  - -Wet well and Valve vault
- Three Pump Station
  - –Pump out / Mixing / Flushing
  - –Add clear water in tank for final flush
- All Drains to Sump Pump in Wet Well

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Control Building

- Backup Generator
- Odor Control Unit
- System Controls
- Automatic Operation
  - –Odor control
  - –Mixing / Flushing
  - –Pump out
  - –Sump pump
- "Nuisance" Storms

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Original Site

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Excavation

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Excavation

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Mud Slab

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Storage Tank

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Storage Tank

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Storage Tank

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Storage Tank

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Backfill

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Backfill

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8-31-15 Substantial Completion

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Lift Station

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Control Building

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Odor Control

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Electrical Controls

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During construction

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Final Completion

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Final Cost

- Bid Sub Work
- Savings Returned to Village
- Allowances
- Increase in Lime Stabilization
- Decrease in Other Items
- Contingency
- Early Completion Bonus
- Final Payment Amount: $14,493,490
- Project Savings: $530,942

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Project Purpose

Address Basement Backups!

- Items Addressed
  - Stop reverse flow
  - Maximize allowable pump over
  - Store remaining Village excess flow
- Remaining Items of Concern
  - Excess flow
  - Capacity of sewers to convey flow to tank
- How Does It Work?

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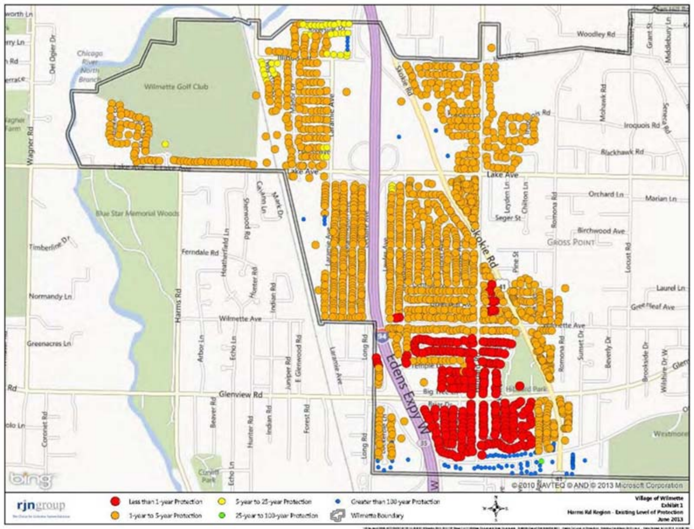
Original Level of Protection



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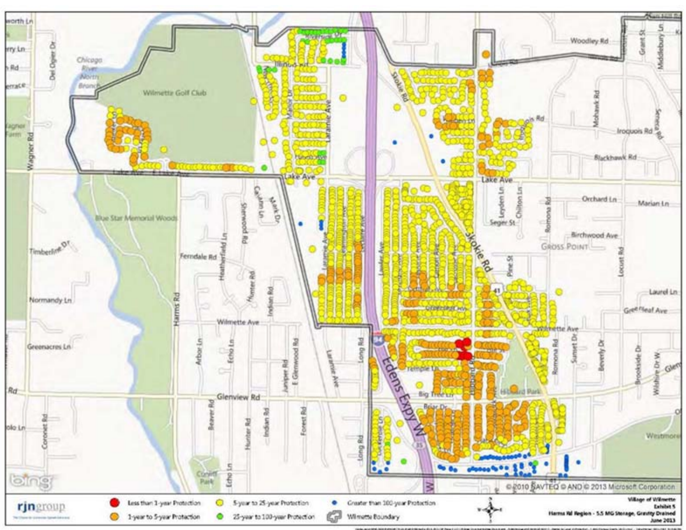
Updated Level of Protection



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First Test: July 23, 2016 Storm

- 6.05 inches in ~8 hours (100-year)
  - Two Waves
  - 2.91” in 1.25 hours
  - 3.14” in 4 hours
- Project Status
  - Pump over LS: Operated for 18 hours
  - Flow Into Storage: 10 Hours
  - Maximum Depth: 13 feet
  - Total Volume: 4.5 million gallons
  - Time to Empty Tank: 68 hours

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Project Performance

- Backup Calls to Village
  - Before project: 2013: 150 (25-year event)
  - After project 2016: 66 (100-year event)

Since operational 2 years ago:

- Check valve closed for 272 total hours
- Tank filled (various levels) 8 times
- Hundreds of fewer sewer backups

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Findings and Conclusions

- Backflow Valve and POLS: Operated as Designed
- Storage Tank: Operated as Designed
- Remaining Issues:
  - Flow exceed sewer capacity
  - Surface flooding
- Additional I/I Reduction Required

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Final Thoughts

- Flow Monitoring and Modeling
- Stakeholder Communication
- Consider Design-Build
- Use Storage with Flow Reduction

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Our Next Speakers

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CITY OF DENTON

Brandt Miller, PE
Process Leader (Texas and surrounding states)
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Hazen

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In-System Wet Weather storage; an innovative solution to manage plant expansion

P.S. Arora, PE and Brandt Miller, PE

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Agenda

- Introduction to in-system storage
- Background on City of Denton's situation
- City of Denton's in-system storage evaluation
- Designing for critical concerns

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In-system storage? Why?

- **In-system storage** – *holding tanks out in the collection system to dampen peak wet weather flows in strategic locations*
- Why?
  - Treatment plant capacity
  - Conveyance system capacity
  - Distance from treatment plant
  - Pipeline maintenance

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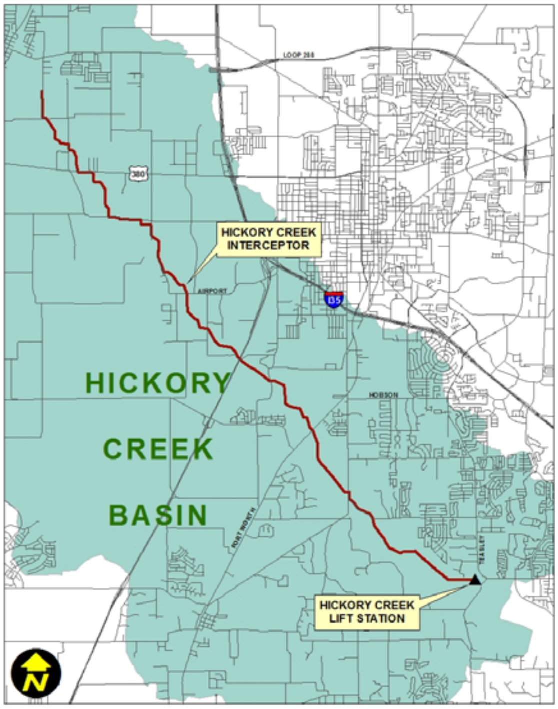

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Hydraulic Model for Capacity Assurance

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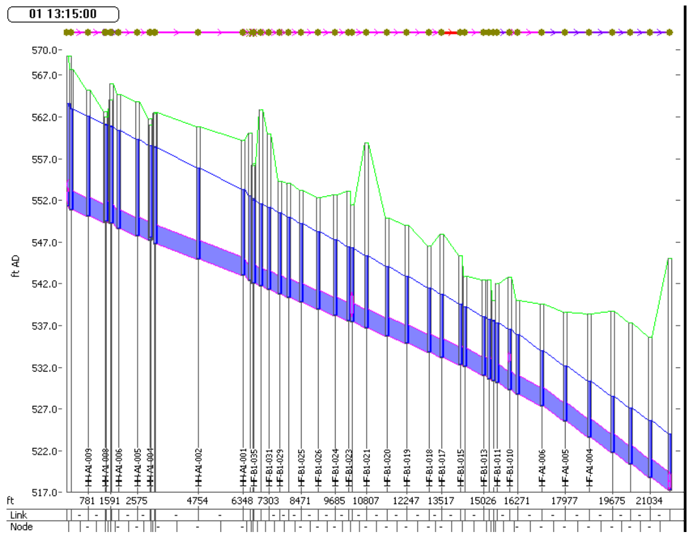
Current 5-Year 24 Hour W/O Storage



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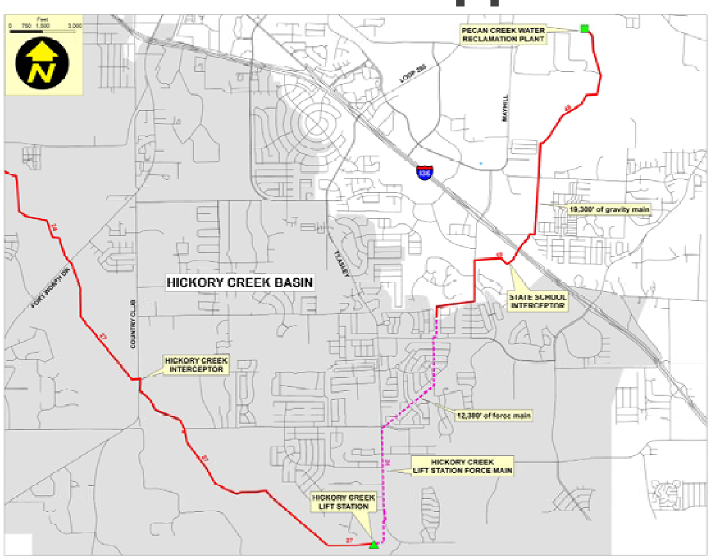
Conventional Approach



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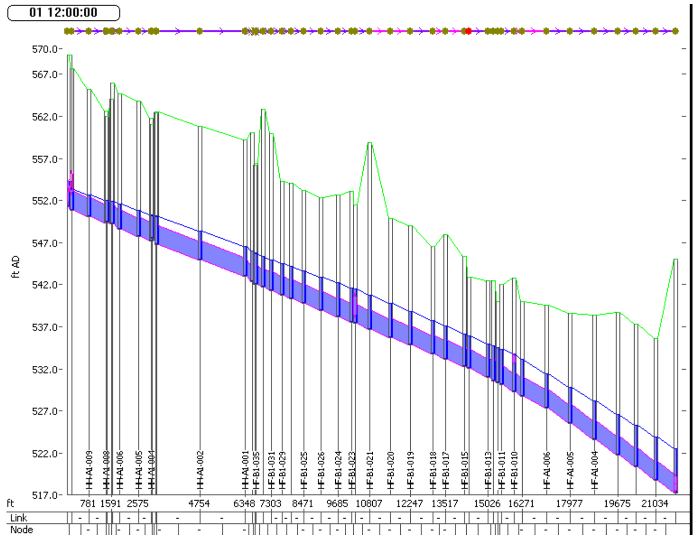
Current 5-Year 24 Hour With Storage



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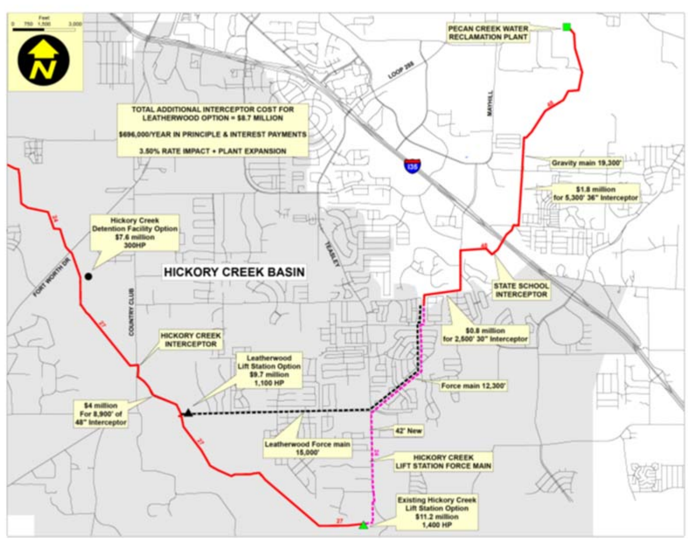
In-System Storage Approach



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How Citizen Concerns Were Addressed

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Planned facility location

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Photo 2 looking toward proposed detention facility site

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Photos of planned detention facility site

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Photo 5 looking toward proposed detention facility site

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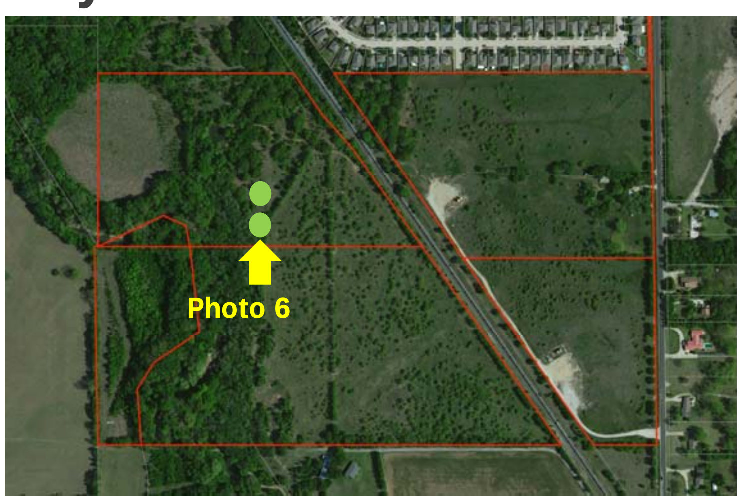
Photos of planned detention facility site



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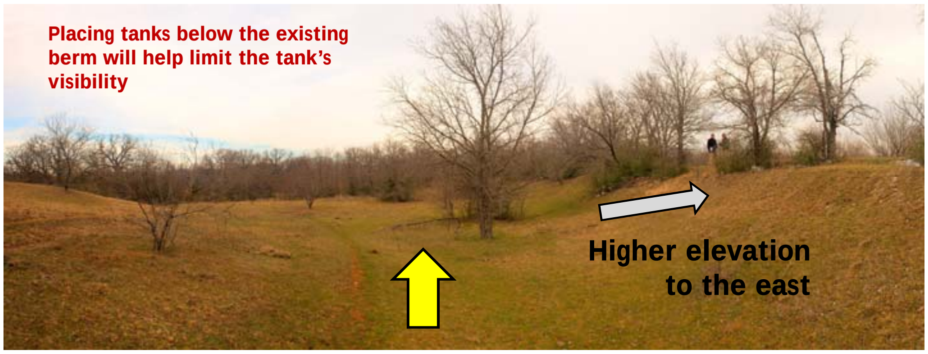
Looking north at proposed detention facility site



Hickory Creek (400 feet)

100 feet to proposed detention facility

Bent Creek Estates (1,000 feet)

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Looking north at proposed detention facility

By using the natural topography and benching the site, the top of the tanks stay below the height of the existing tree line

Hickory Creek (400 feet)

Bent Creek Estates (1,000 feet)

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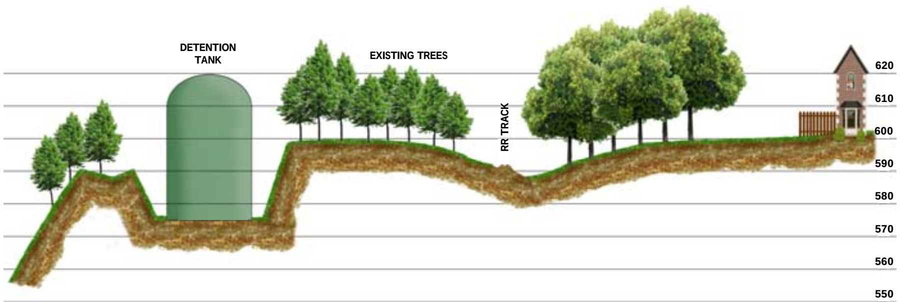
Local residents will not see the proposed facility due to the terrain and existing trees



Distortion: 1 foot vertical = 5 foot horizontal

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Proposed Hickory Creek Detention Facility is community-friendly

- Not visible from public roads
- Not visible from any residences
- Not visible from Bent Creek Estates
- Beneficial to the community at large, yet invisible to the community

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Benefits of the Proposed Project

- Permit requirement for the wastewater department to convey all flows to the wastewater treatment plant without overflows
- Proposed detention facility is in a remote location
- The tank is not visible from Country Club Road, Fort Worth Drive, or the Bent Oaks subdivision
- The land being used is not suitable for residential or commercial development due to access issues
- A pump station option would have required construction of parallel interceptor all the way to the wastewater plant using valuable land that is being used for business and commerce
- The plant capacity expansion will be needed
- And, the storage option is the least cost option

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I have some concerns…

Reliable operation when it's needed

Remote facility operation & maintenance

How and when to divert flow

Cleaning after draining

Odors

In-system storage is **innovative**, but not **new**.
An appropriate evaluation and design can address the concerns.

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Develop a philosophy and design around it

- Managing remote assets – where does the **man power** come from?
- Automation versus **man power**
- Exercising equipment
- Remote monitoring and communication methods
- **Electrical power** during the storm

It's all about power…

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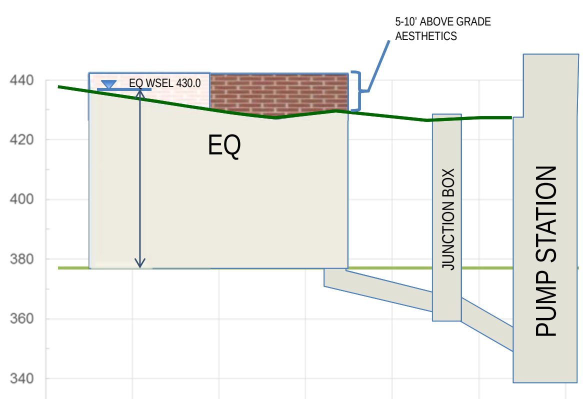
Flow diversion - keep it simple

- Static diversion weir(s)
- Gravity flow when possible
- Mitigate debris and floatables
- Level monitoring is critical



West Park, TN – gravity in, gravity out

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Buried tank - out of site, out of smell

North Olmsted, OH

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Cleaning and draining

Tank configuration impacts cleaning method

Jet wash

- Hose bibs
- Water cannons
- Floor mounted nozzles
- Ceiling mounted nozzles

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Cleaning and draining

Tank configuration impacts cleaning method

Wave flush - rectangular

Flushing Gates Connor Creek, Detroit, MI

Tipping Buckets

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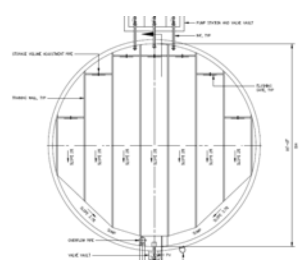
Cleaning and draining

Tank configuration impacts cleaning method

Wave flush - Circular

Photo of Gabriel Novak & Associates: HydroSelf Round



North Olmsted, OH

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Cleaning and draining

Tank configuration impacts cleaning method

Jet mix

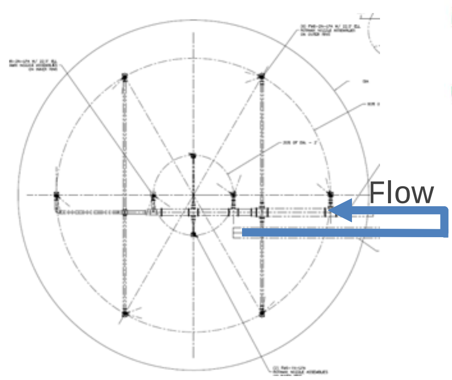

Photo of Vaughn Rotamix

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Odor control

Necessity depends on:

- Diversion method
- Proximity to public
- Anticipated storage time
- Cleaning practices

Absorption type odor treatment is the best suited technology

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Questions?

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