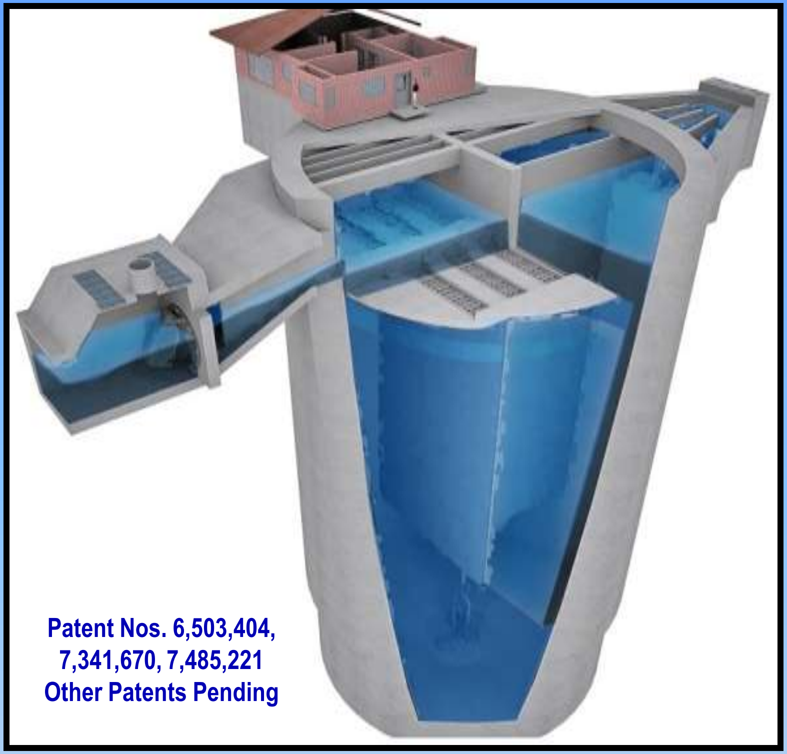
TREATMENT SHAFT TECHNOLOGY PRESENTATION

INDIANA
Water
Environment
Association

Presented by:

Applied Engineering Technologies, Inc.
Process Wastewater Technologies, Inc.
Public Works Consulting, LLC

TREATMENT SHAFT TECHNOLOGY

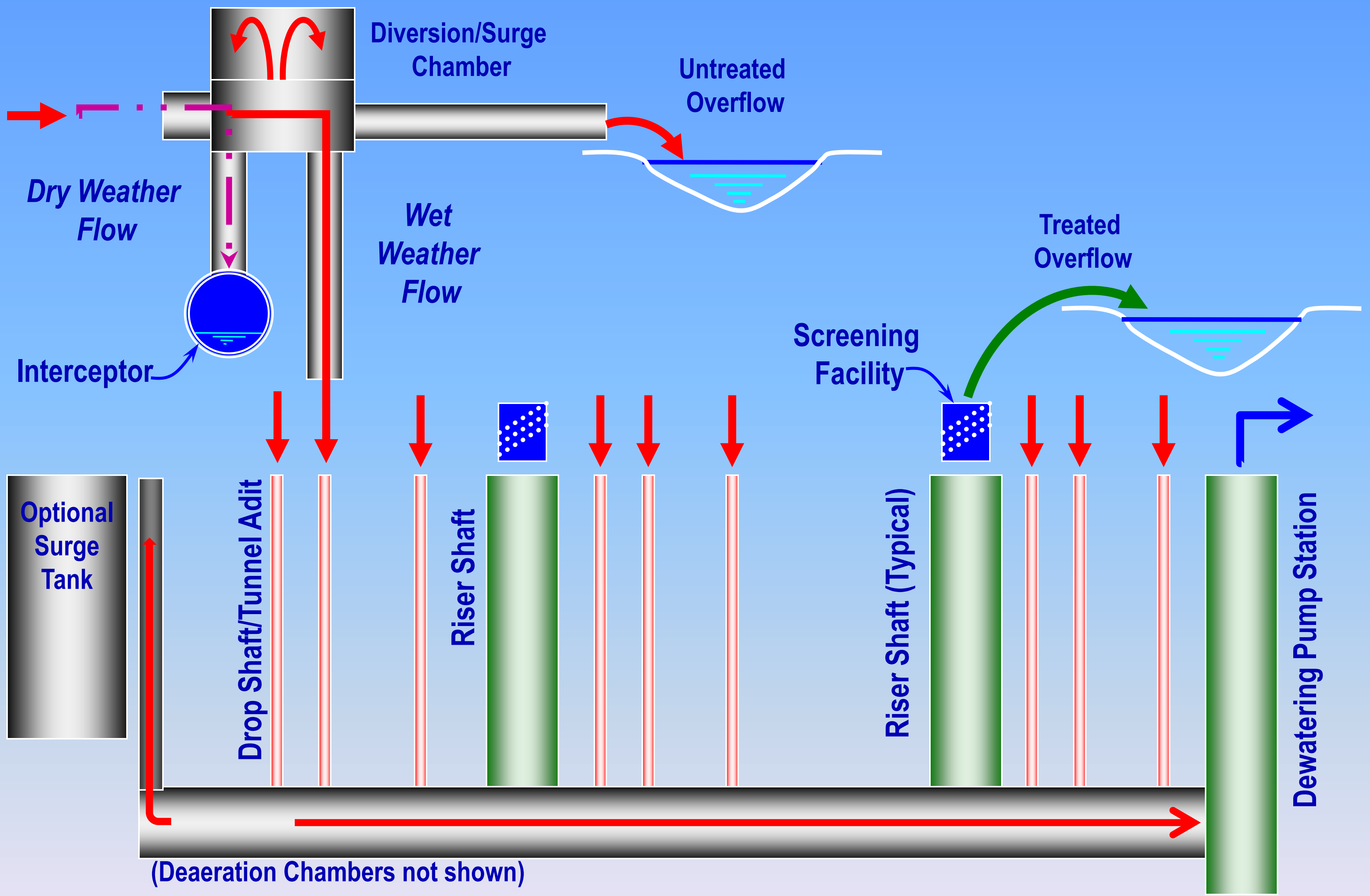


Innovative Alternative for
Large CSO Control Projects

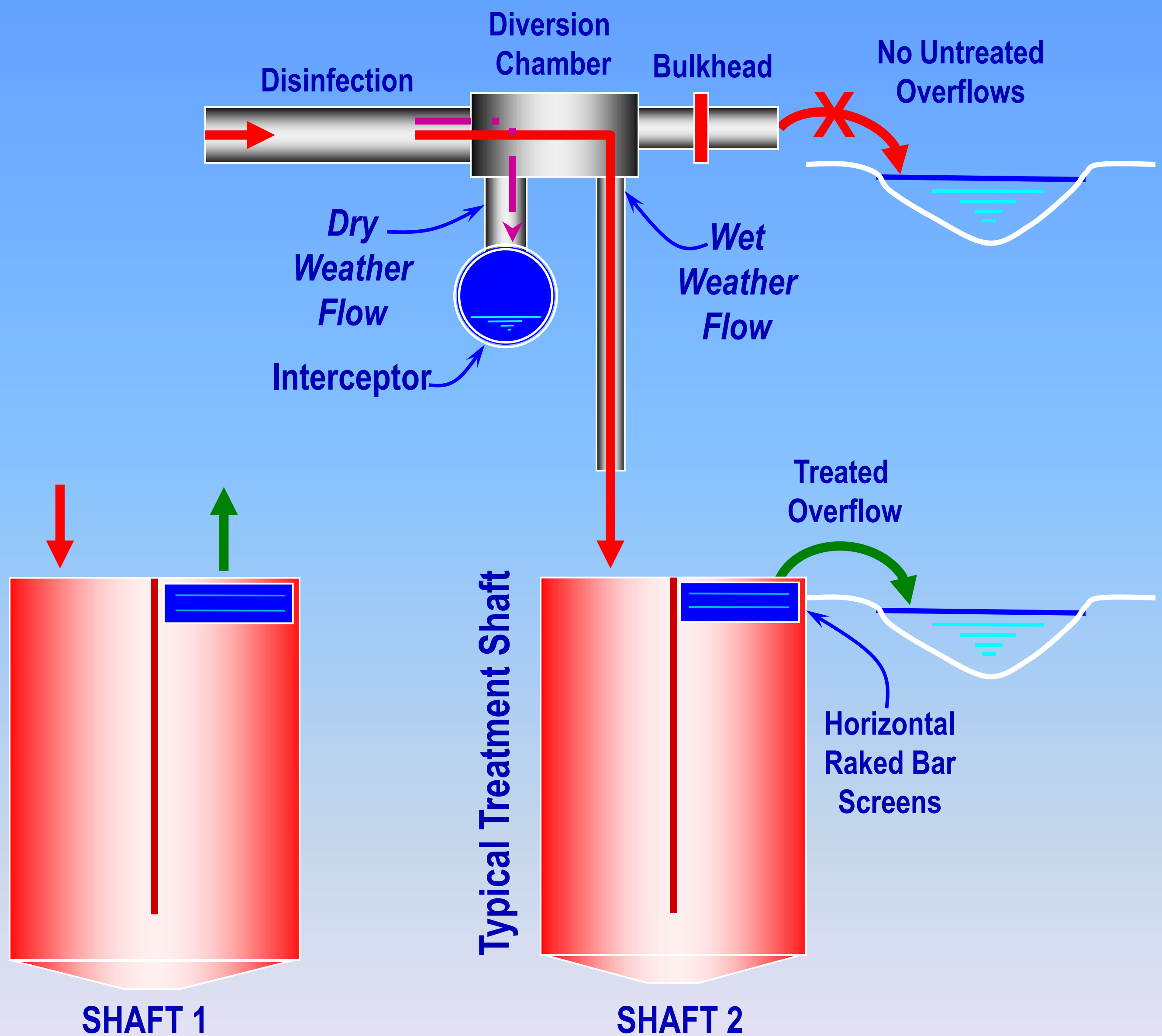
Improved Performance and
Lower Cost Compared to
Tunnels or Basins

OVERVIEW: TREATMENT SHAFT TECHNOLOGY

1. System Components and Processes
2. Cost Savings
3. Construction Options
4. Operational Advantages
5. Regulatory Compliance

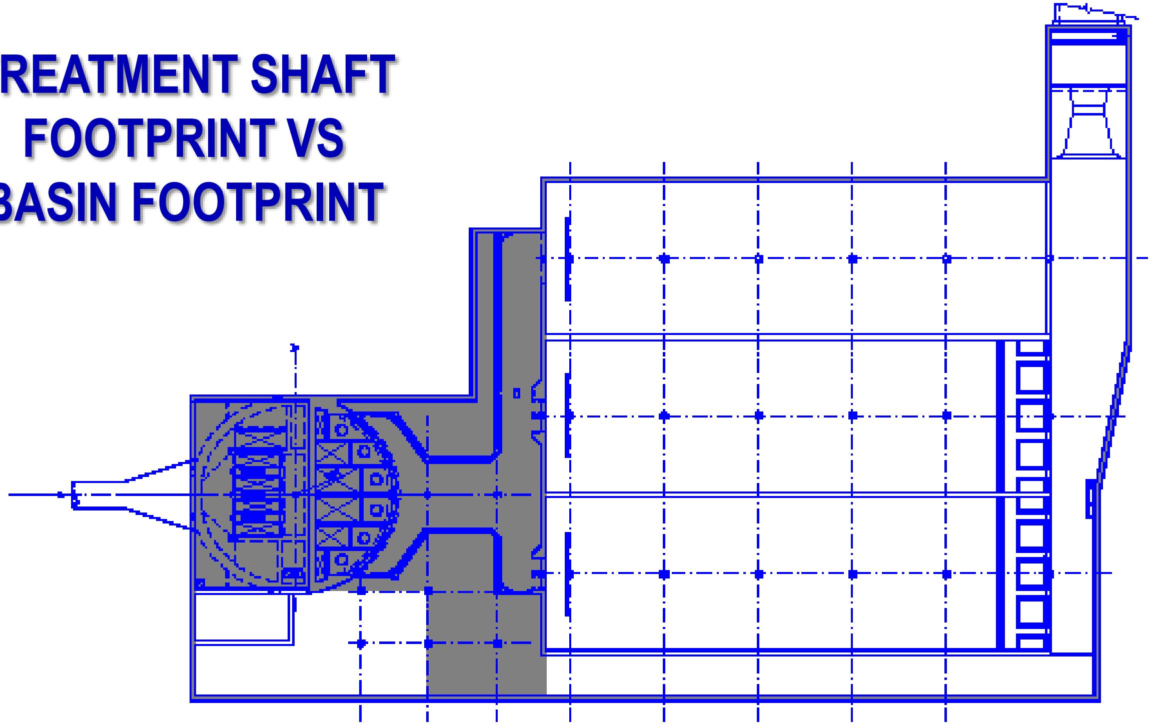


Flow Through Tunnel Concept



Treatment Shaft Concept

TREATMENT SHAFT FOOTPRINT VS BASIN FOOTPRINT

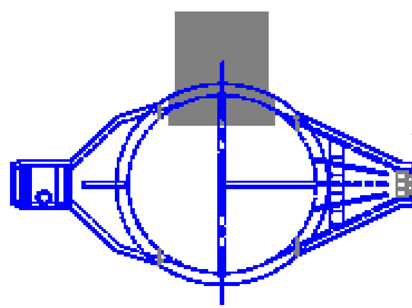


EXAMPLE BASIN
Volume = 3.1 MG
Peak Flow: 500 cfs
Constructed: 1994
Cost in 2008$: $37.1M
Pump Station: YES

INKSTER BASIN
VOLUME = 3.1 MG

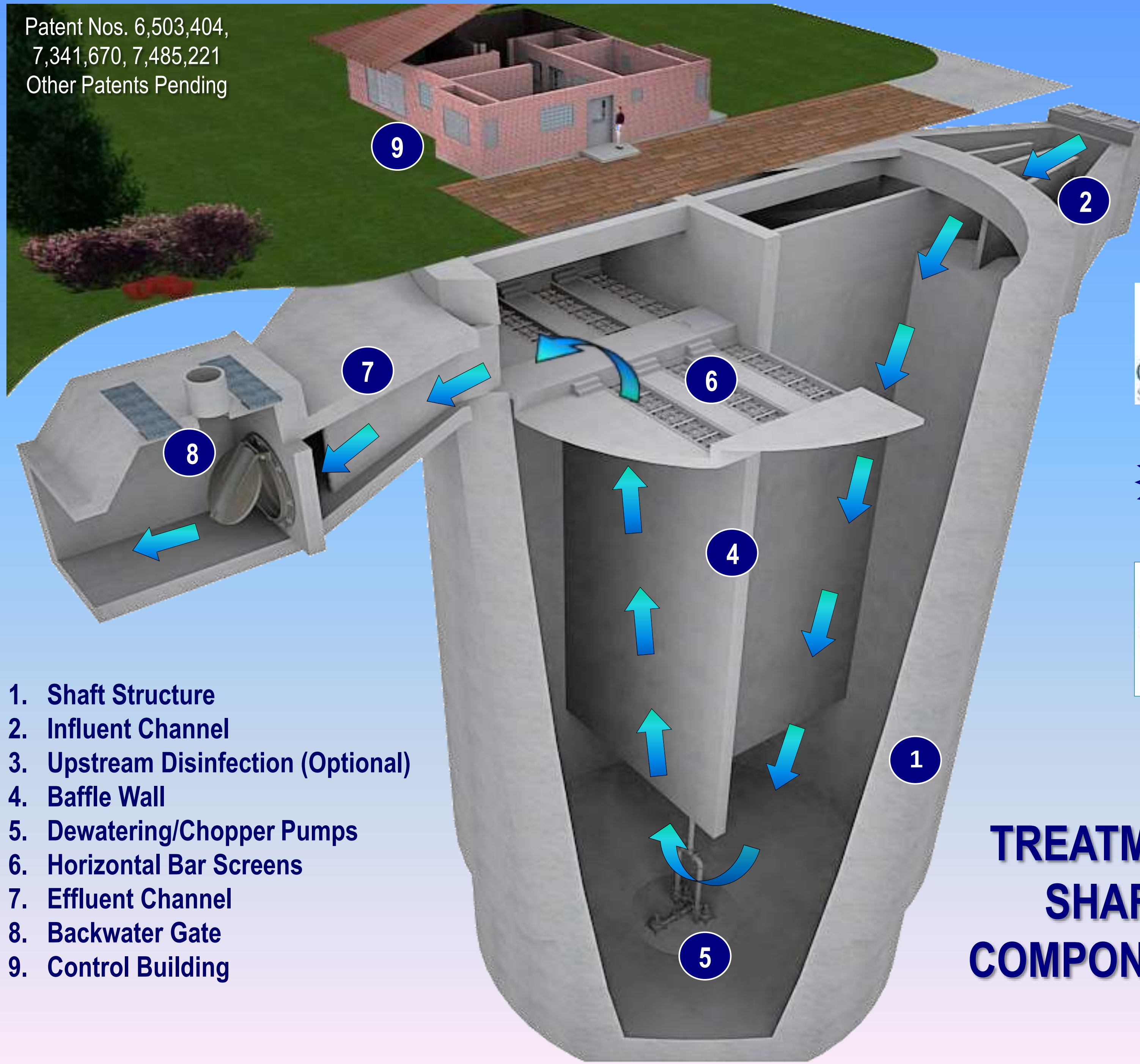
TREATMENT SHAFT IS 15% OF BASIN FOOTPRINT

EXAMPLE SHAFT
Volume = 3.3 MG
Peak Flow: 575 cfs
Under Construction
Cost in 2008$: $23.5M
Pump Station: NO



DEARBORN CSO 016
VOLUME = 3.3 MG

LEGEND
BUILDING



1. Shaft Structure
2. Influent Channel
3. Upstream Disinfection (Optional)
4. Baffle Wall
5. Dewatering/Chopper Pumps
6. Horizontal Bar Screens
7. Effluent Channel
8. Backwater Gate
9. Control Building

Clean Water
State Revolving Fund

EPA PISCES AWARD WINNER

TREATMENT SHAFT COMPONENTS

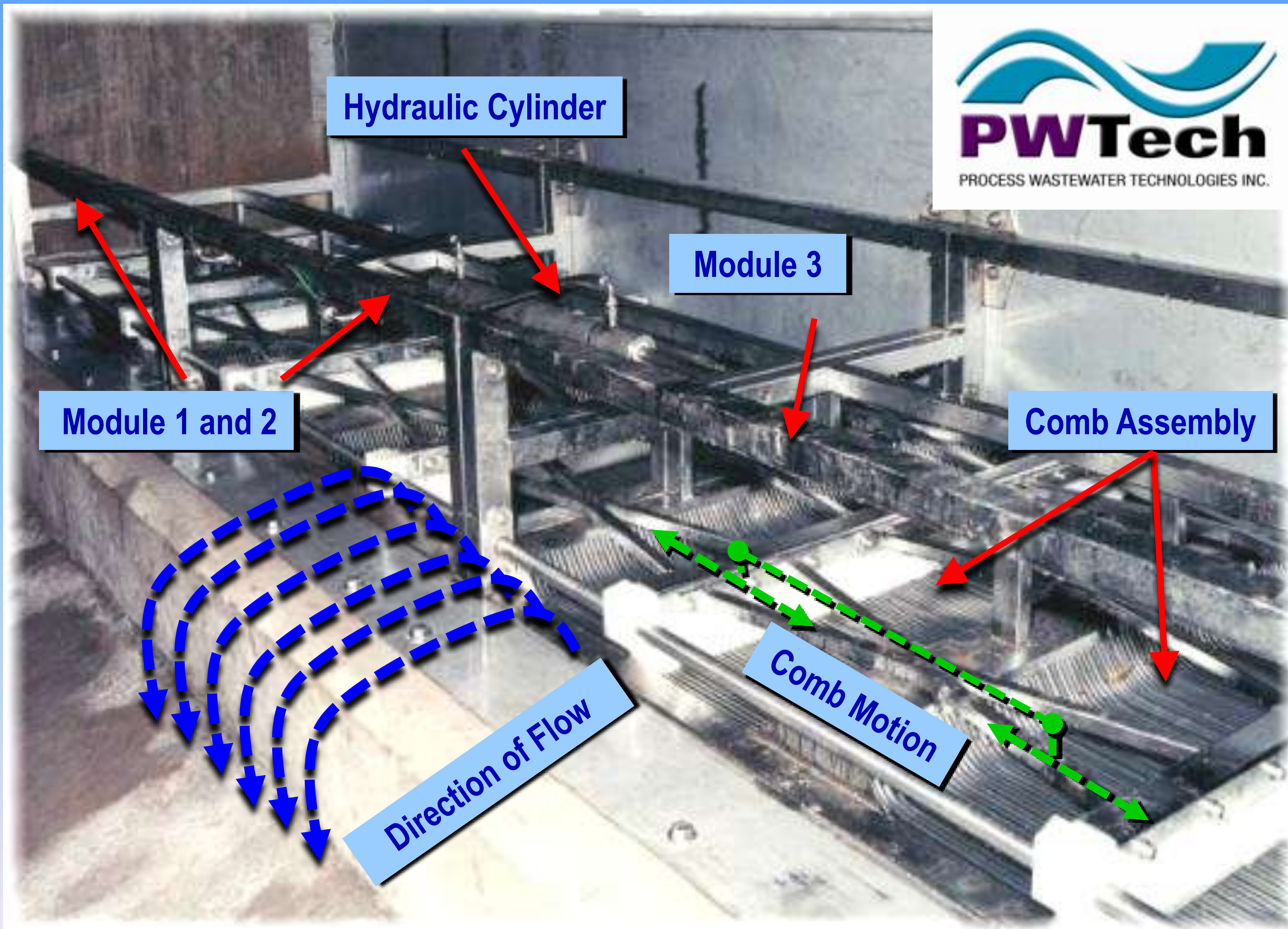
SUMMARY OF ADVANTAGES

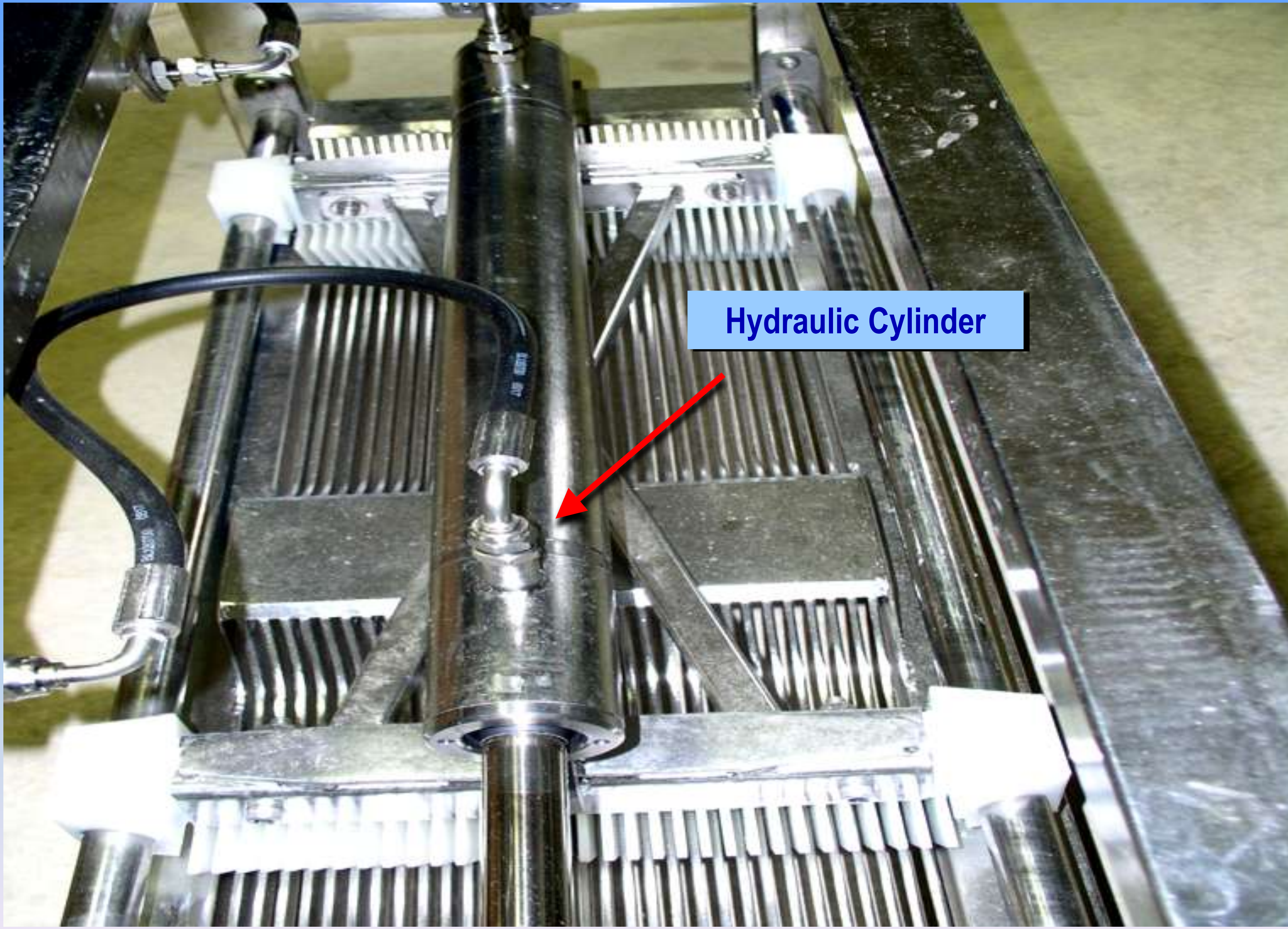
- Full capture of CSO for 90-95% of storm events
- Skimming, settling, screening, disinfection of any overflows
- Gravity operation eliminates large pump stations
- Compact structure with smaller footprint compared to basins
- Simple hydraulics with very low flow velocities (<0.1 ft/sec.)
- Very low head losses throughout entire facility (<0.5 ft)
- No surge analysis or protection as required with tunnels
- Screenings automatically sent to WWTP – no hauling required
- Control facilities (+/- 1,500 sq. ft.) may be located underground

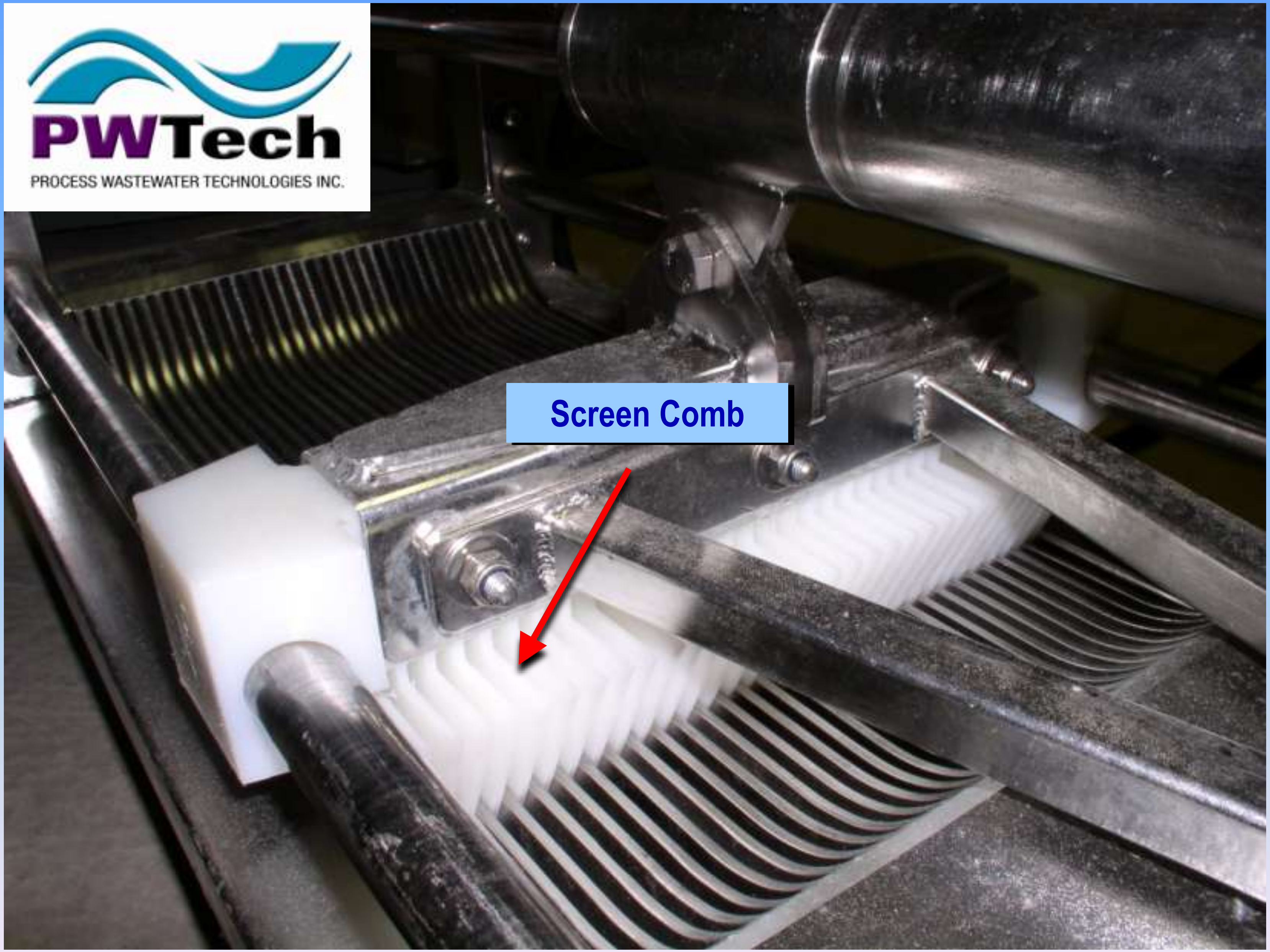
SCREENING AND HANDLING

- Self-cleaning, fine horizontal raked bar screens
- Numerous installations: Detroit pilot study – Leib & St. Aubin
- Screens achieve average of 98.5 mass reduction of floatables

  (EPA Combined Sewer Overflow Technology Fact Sheet, 1999)
- Screen bars are continually cleaned with self lubricating combs
- Uniform upward velocity through screens = low head losses
- Screens operate automatically based on level sensors
- Low power electric motors operate screen hydraulic packs
- Screenings fall to shaft bottom and are sent directly to interceptor by pumps (NO MANUAL HANDLING)


PWTech
PROCESS WASTEWATER TECHNOLOGIES INC.
Hydraulic Cylinder
Module 3
Module 1 and 2
Comb Assembly
Comb Motion
Direction of Flow

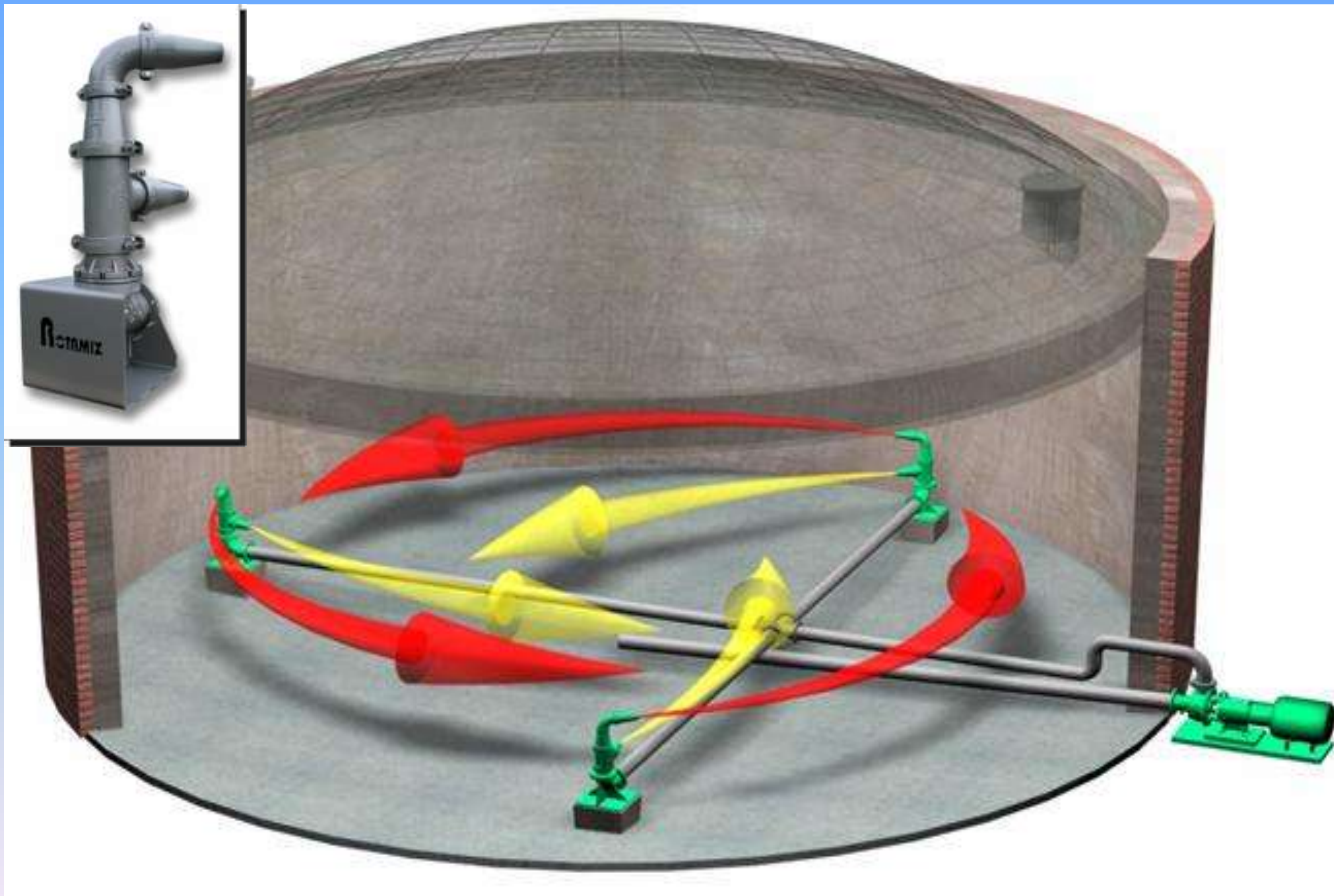

Hydraulic Cylinder


PWTech
PROCESS WASTEWATER TECHNOLOGIES INC.
Screen Comb

FLUSHING SYSTEM

- High velocity nozzles mix waste water at the shaft bottom
- Contents rotate as a unit in a vertical-axis vortex field of flow
- Re-suspended solids are dewatered to the WWTP interceptor using submersible dewatering/chopper pumps
- Flushing/Dewatering Chopper pumps activated at set level
- No extra handling of solids – no dumpsters – no hauling
- Odor problems minimized with effective flushing

Dual-Zone Mixing Pattern = Uniform Rotation and Vertical-axis Vortex



FLUSHING SEQUENCE

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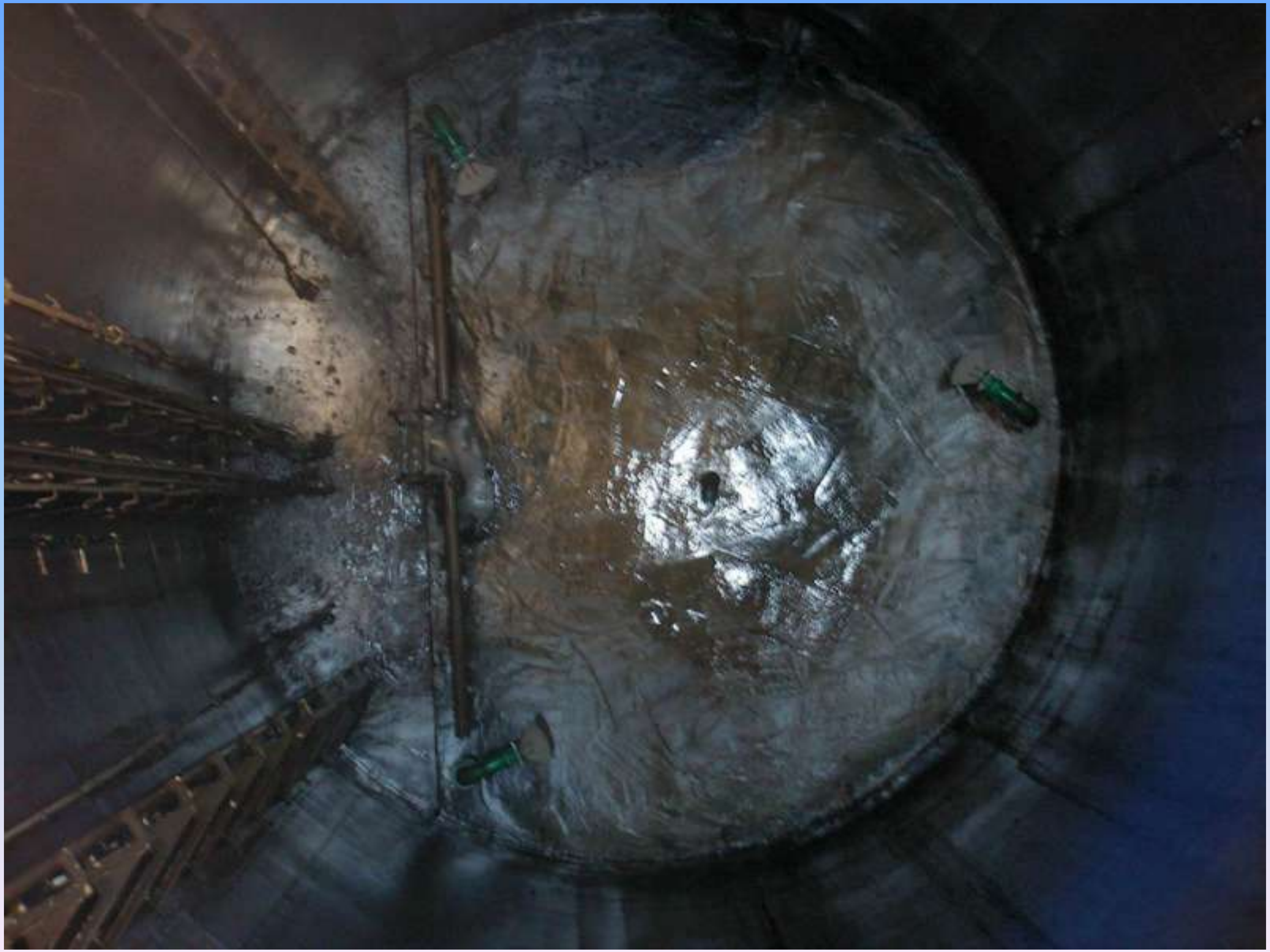

1/19 SCALE PHYSICAL HYDRAULIC MODEL

UNIVERSITY OF MICHIGAN – COLLEGE OF ENGINEERING

- University of Michigan Hydraulic Laboratory, Dr. Steven Wright, 2005
- Scale model simulates diameter of 95 feet; volume of 6.8 MG
- Based on 5 year, 24 hour, 5 minute peak flow rate of 1,867 cfs
- Tested for 10 year, 1 hour peak hourly flow rate of 1,205 cfs
- Head losses approximately 0.4 feet at peak flow rate
- Disinfection contact time greater than 11 minutes
- No impact issues on bottom due to plunge pool effect

PHYSICAL HYDRAULIC MODEL
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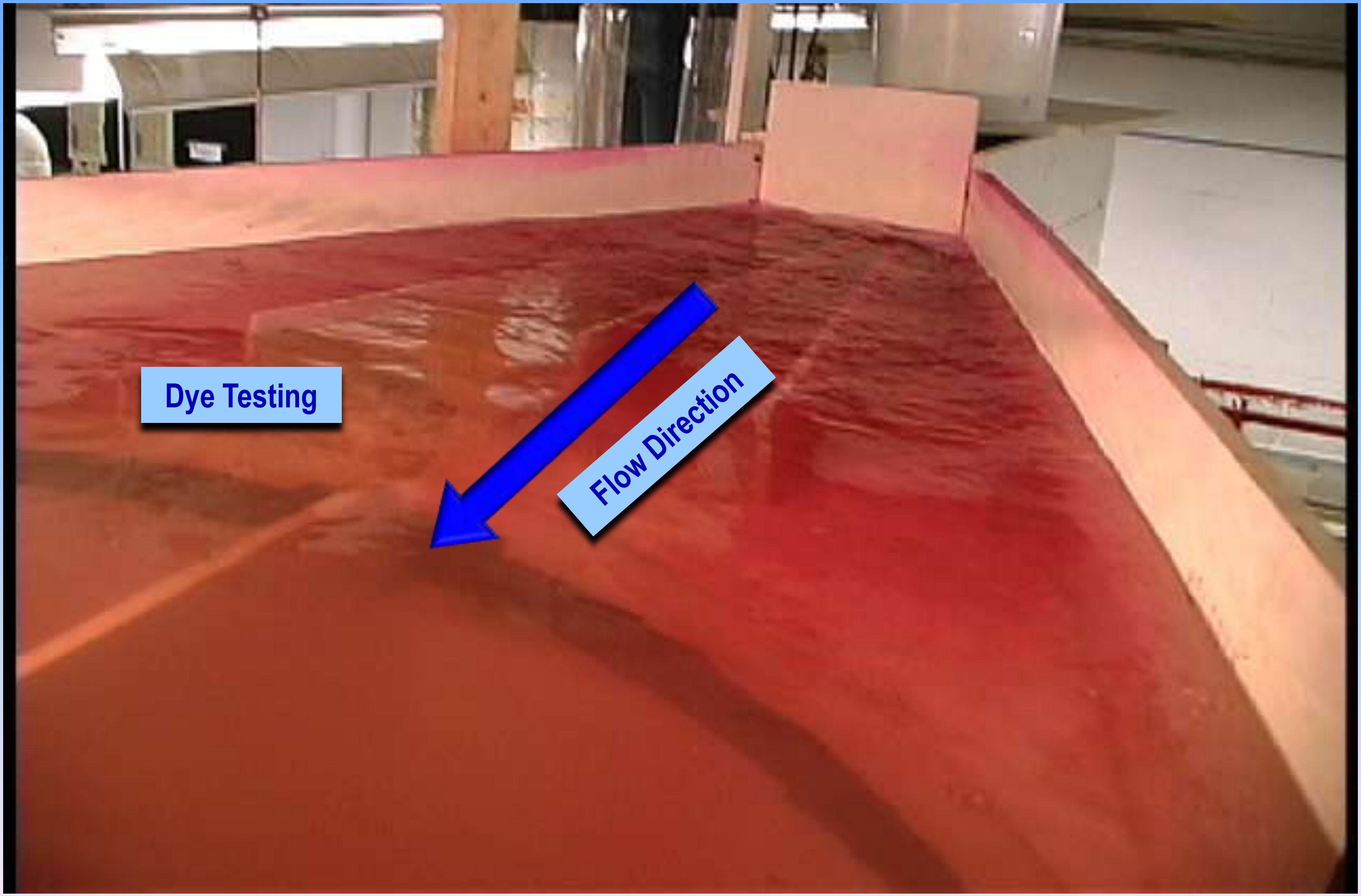

PHYSICAL HYDRAULIC MODEL

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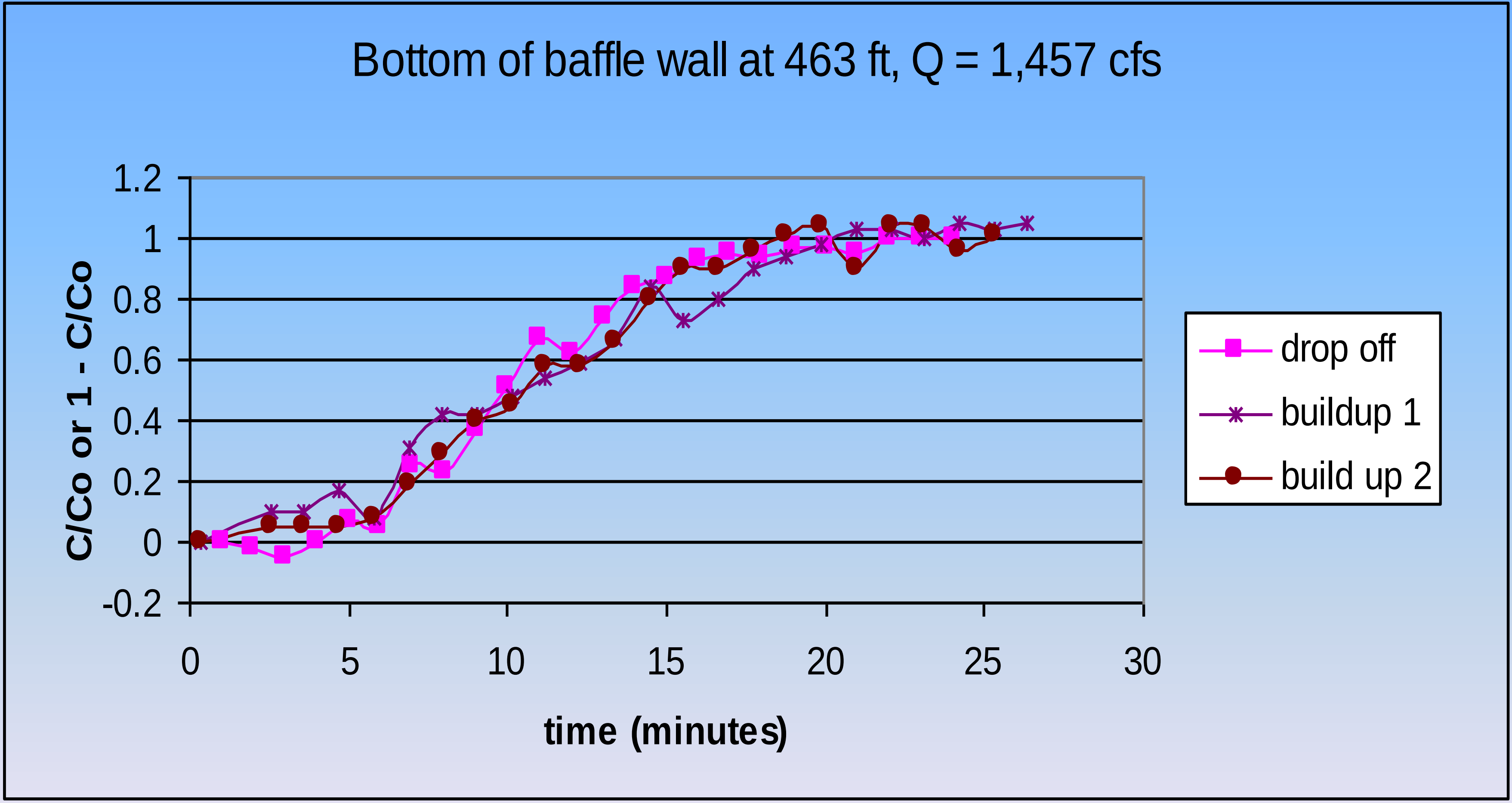

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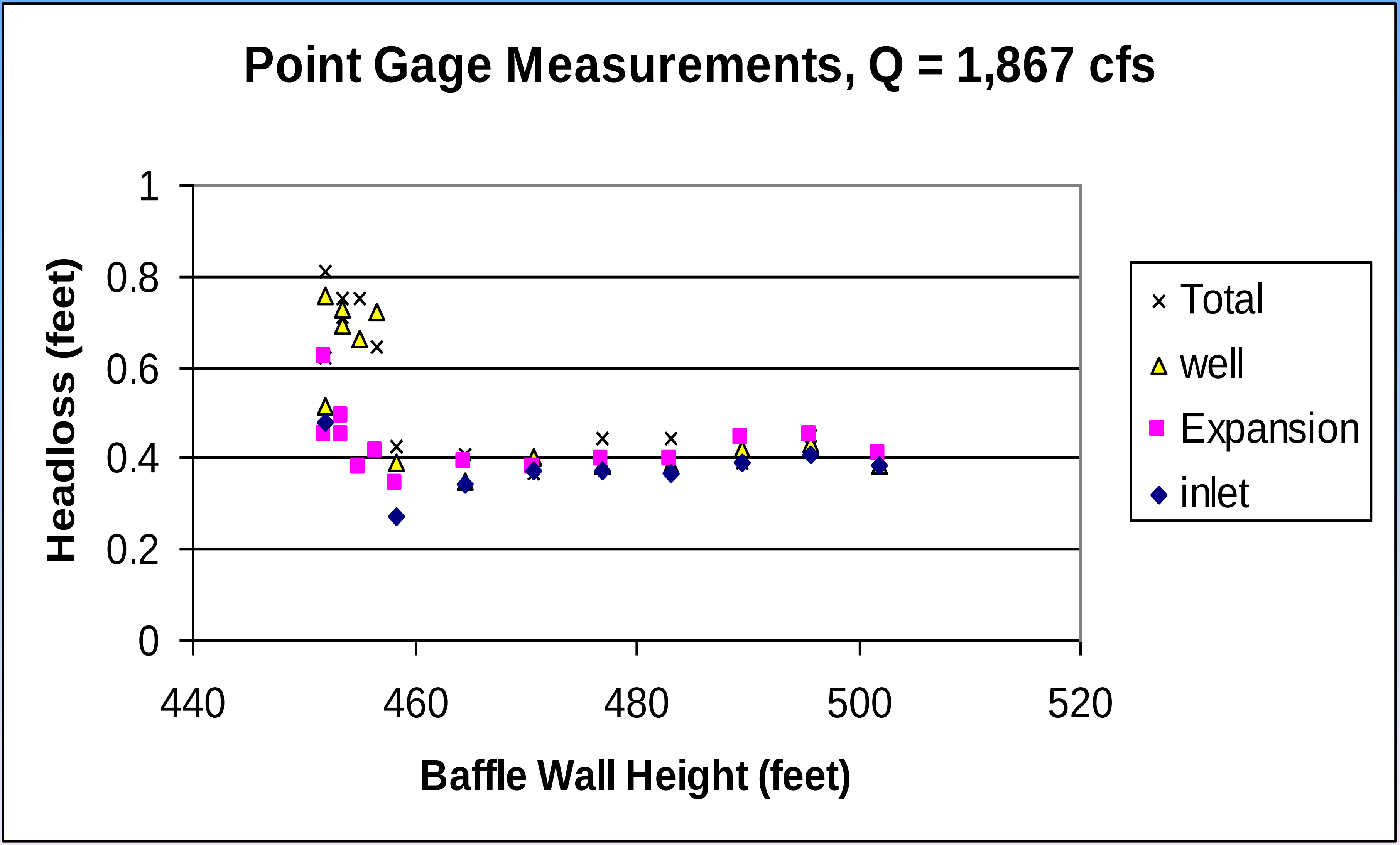
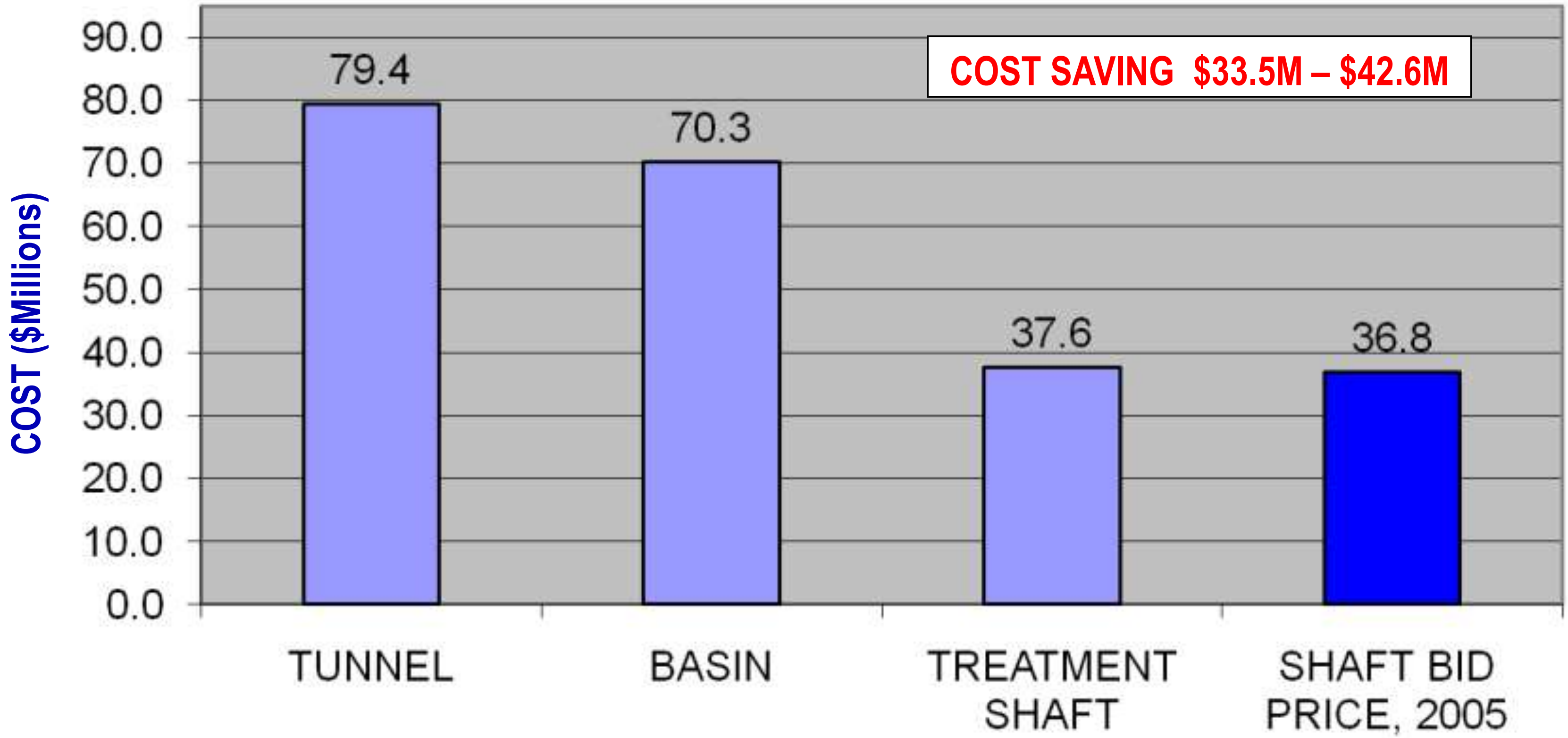


CURRENT PROJECTS

- Four Treatment Shafts are currently under construction
- First project completed Fourth Quarter of 2010
- Shafts range in volume from 3.3 to 7.7 MG
- Depth of shafts ranges from 138 to 161 feet below grade
- Shaft diameters range from 70 to 104 feet
- Peak flow treatment capacity ranges from 575 to 1867 cfs

COST COMPARISON EXAMPLE

DEARBORN CONTRACT NO. 6



ENGINEER'S ESTIMATE VERSUS ACTUAL BID

TREATMENT SHAFT PROCESS

CONSTRUCTION ADVANTAGES

- Flexible Construction: Slurry/Diaphragm Wall, Sinking Caisson, Tangent/Secant/Sheet Pile, Ground Freezing
- Lower risk than tunnel boring – less pre-grouting
- No tunnel adits or de-aeration chambers, shorter connector sewers, less surface disruption
- Ability to split/combine projects to enhance competition
- Small footprint reduces land acquisition costs
- Independent completion at each project site

TREATMENT SHAFT CONSTRUCTION: 95’ X 161’

VOLUME: 6.8 MG

VIEW FROM BASE SLAB

VOLUME: 6.8 MG

BASE AND CONTROL BUILDING

BAFFLE WALL CONSTRUCTION

VOLUME: 6.8 MG

PREPARING FOR COVER AND SCREENS INSTALLATION

COVER AND SCREENS INSTALLATION

COVER AND SCREENS INSTALLATION

COVER AND SCREENS INSTALLATION

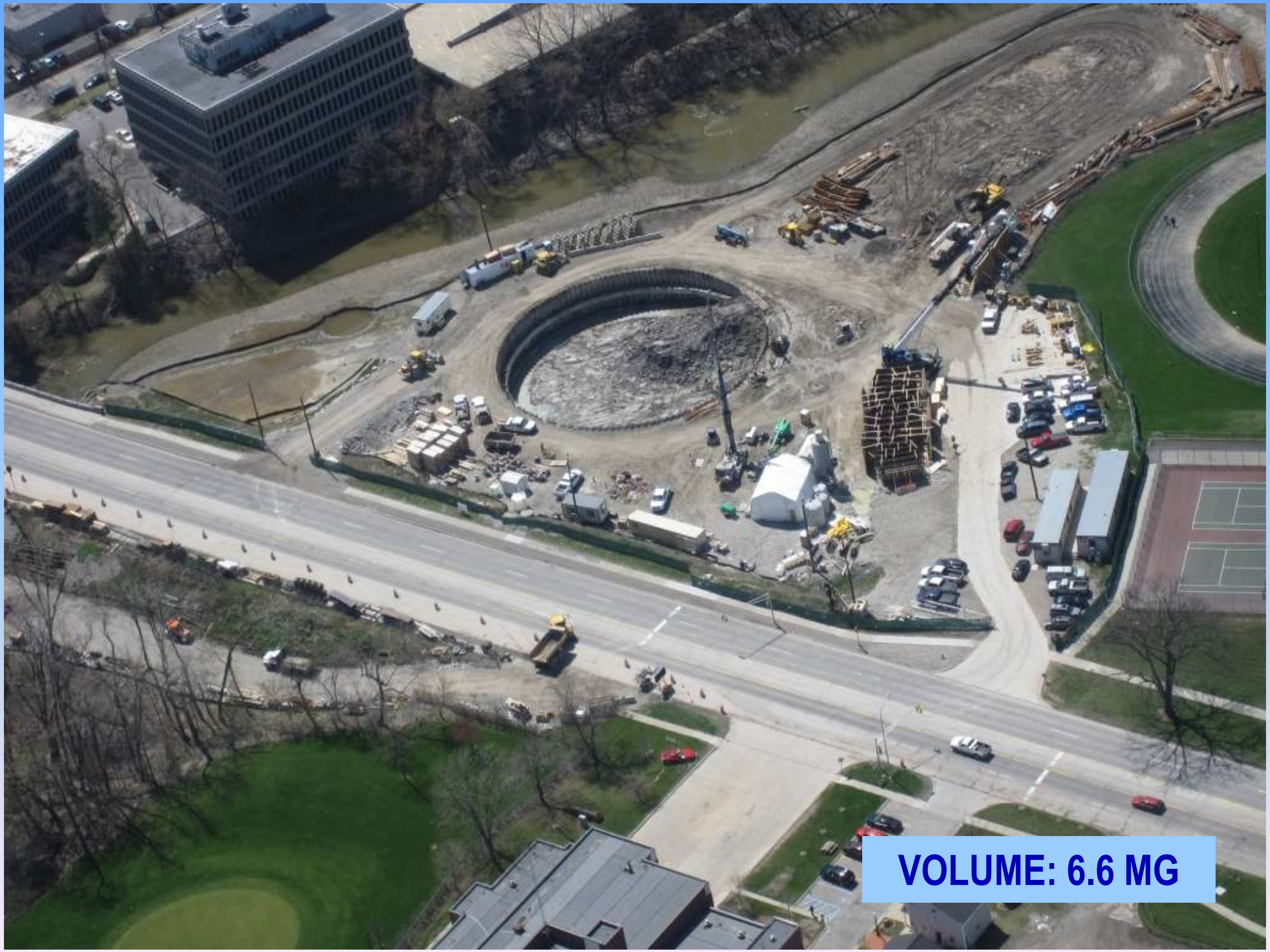
ALUMINUM COVER

ALUMINUM COVER

HORIZONTAL RAKED BAR SCREENS

HORIZONTAL RAKED BAR SCREENS

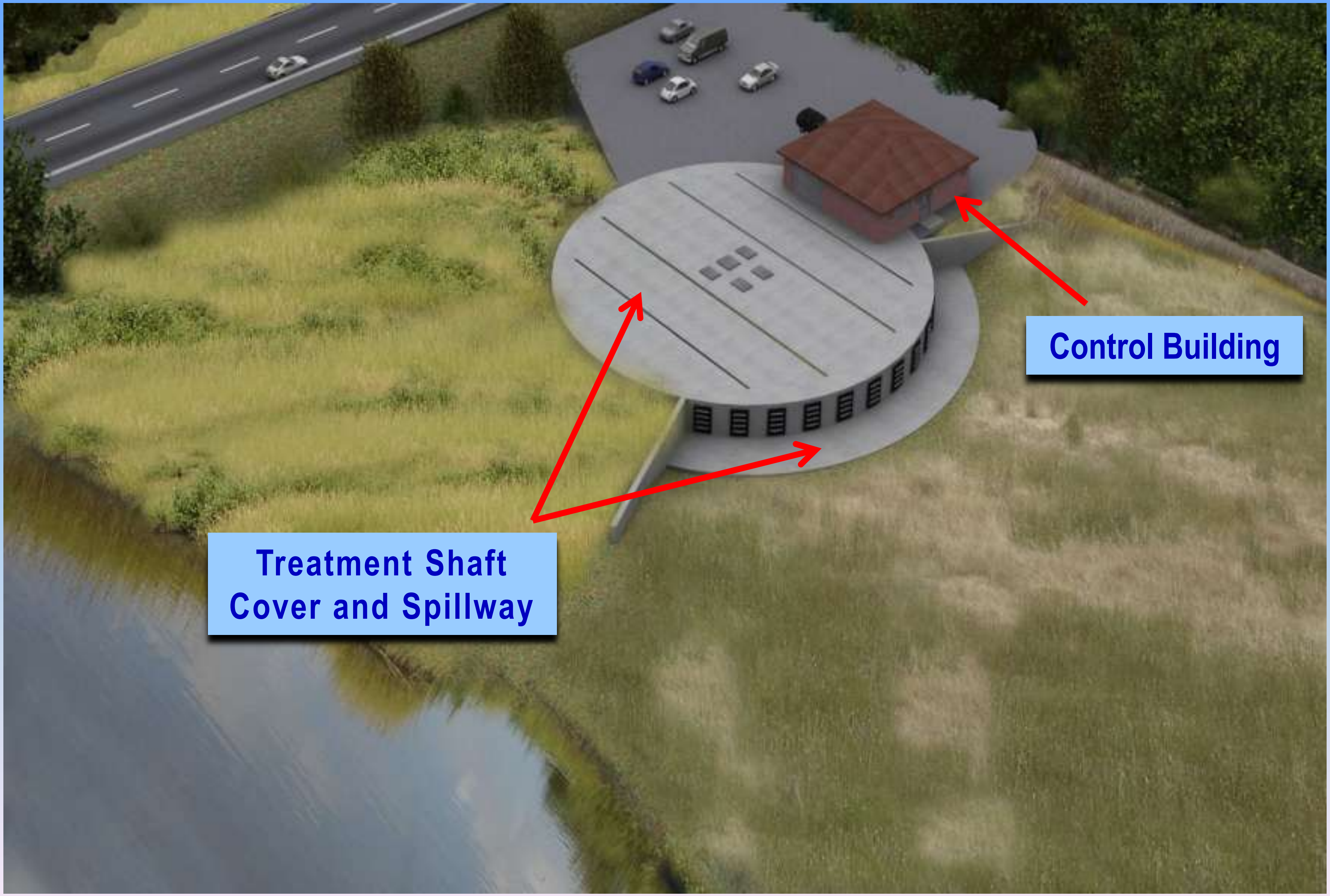
TREATMENT SHAFT CONSTRUCTION: 104’ X 134’



VOLUME: 6.6 MG

TREATMENT SHAFT CONSTRUCTION: 104' X 134'

COMPLETED PROJECT: CONTROL BUILDING ON SHAFT



TREATMENT SHAFT CONSTRUCTION: 104’ X 154’

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CONTROL BUILDING AWAY FROM SHAFT

OPERATIONAL ADVANTAGES

- Low risk of complete system failure – power back-up at each site
- Automatic screening, skimming, settling and disinfection
- Gravity operation – no booster pump stations
- All facilities can be located underground
- No costly surge controls or complex surge analysis
- No hauling – screenings removed automatically
- No untreated overflows

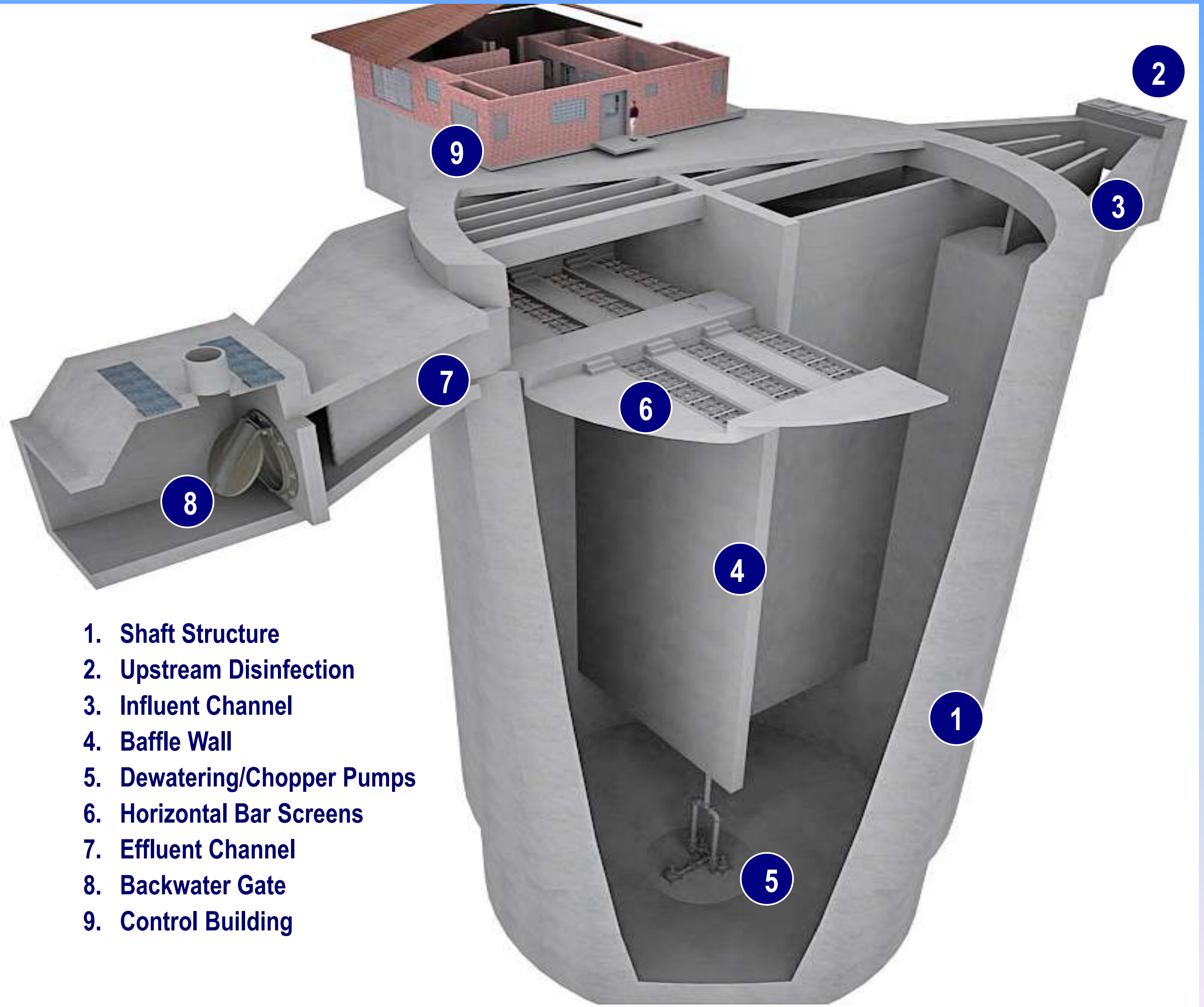
OPERATIONAL ADVANTAGES

TREATMENT SHAFT

COMPARED TO

TUNNEL ALTERNATIVE

TREATMENT SHAFT CONFIGURATION



1. Shaft Structure
2. Upstream Disinfection
3. Influent Channel
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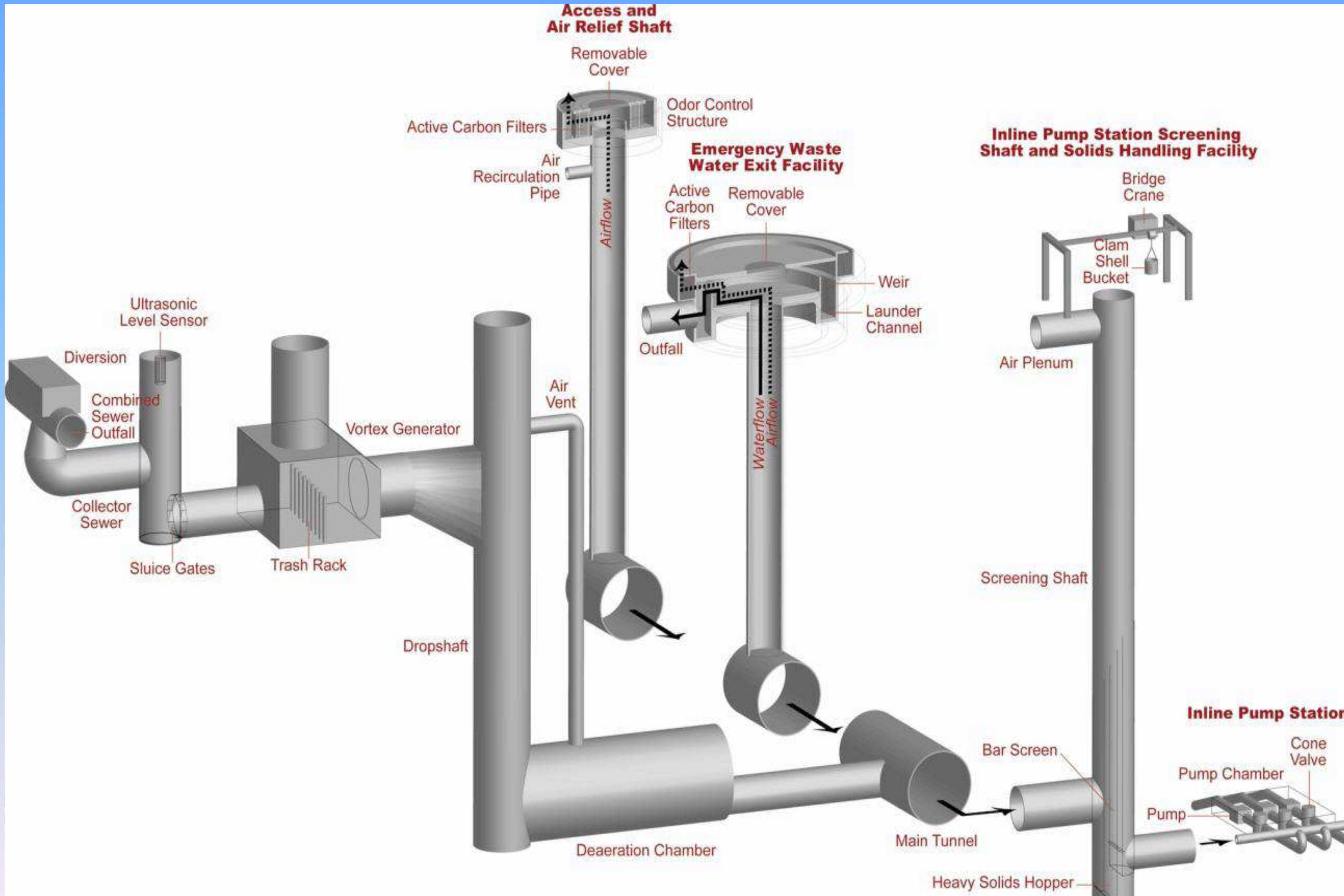
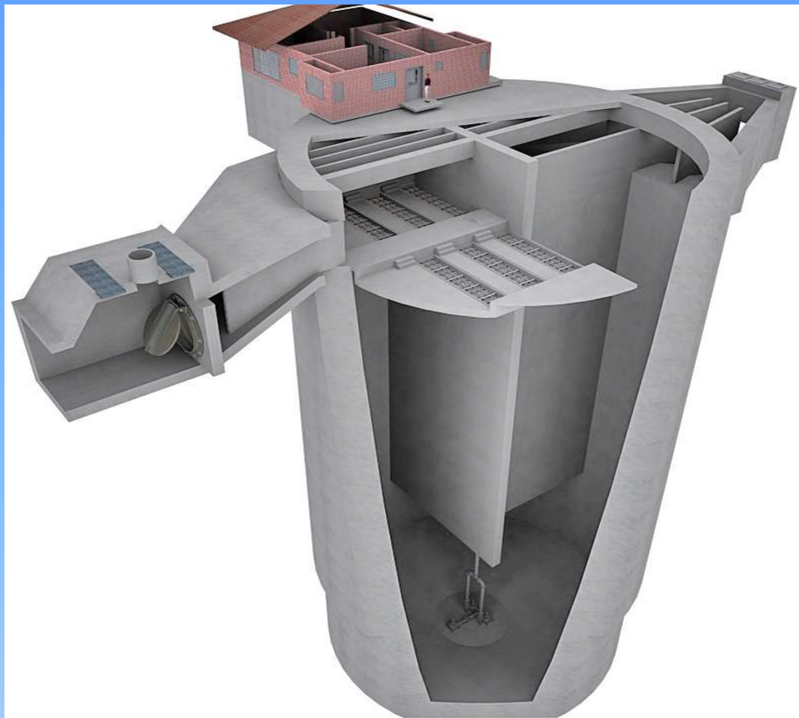
TUNNEL CONFIGURATION

DROP SHAFTS WITH DEARATION AND SURGE CONTROLS



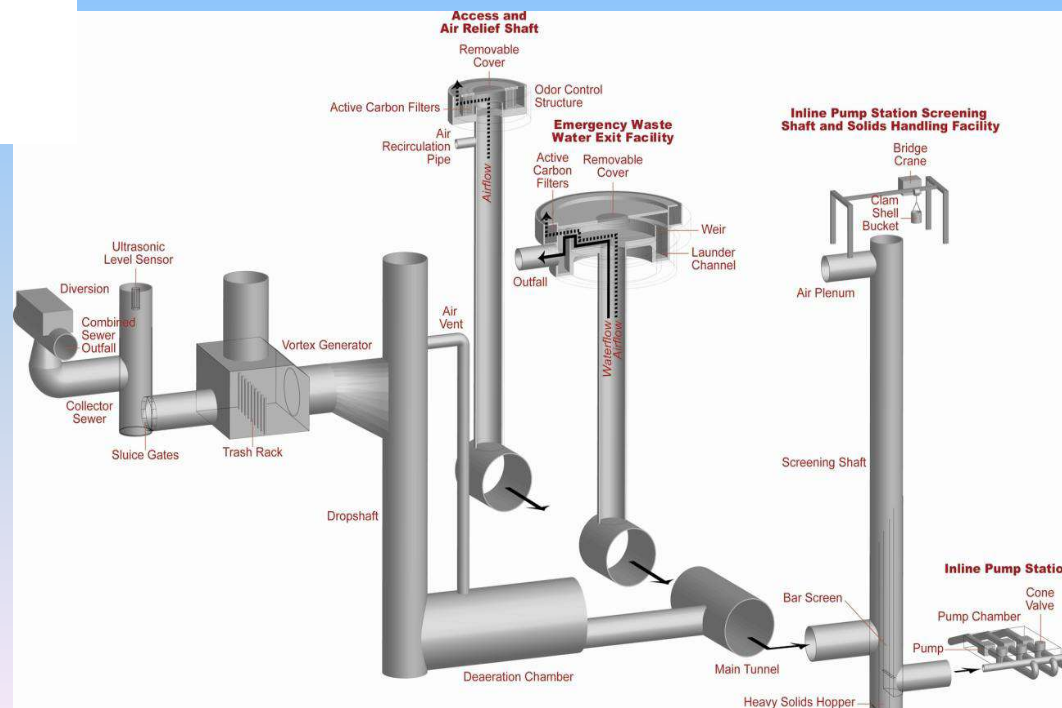


TREATMENT SHAFT

- Simpler Design
- Simpler Operation
- Automatic Cleaning
- Lower Cost
- Lower Risk

TUNNEL

- More Complex Design
- More Complex Operation
- Manual Cleaning
- Higher Cost
- Higher Risk



TUNNEL AND SHAFT COMPONENT COMPARISON

MAJOR COMPONENTS	TREATMENT SHAFT MODIFICATIONS	NOTES
Tunnel	Not Required	Shafts provide capture
Surge Controls	Not Required	Shafts control surging
Vent Shafts	Not Required	Shafts provide venting
Starter / Turning Shaft	Not Required	No boring machine used
Pump Station/Shaft	Not Required	Low head loss in shafts
Drop shafts	Enlarged	Convert to Treatment Shafts
Connector Sewers	Same or lower cost	Depends on shaft locations
Junction Chambers	Same	No change from tunnel
Bond, Insurance, Mobilization, GC	Lower cost	Tied to Construction Cost
Engineering / Construction Management	Lower cost	Simpler Design/Lower Cost

REGULATORY COMPLIANCE

- Flexible design can meet various regulatory criteria
- EPA PISCES award winner (Performance/Innovation)
- Full capture of most storms, plus flow-through treatment
- Approved by Michigan DEQ (now MDNRE)
- Presented to Ohio EPA and Indiana DEM
- Simple system expedites design, bidding and construction
- Facilities can be built sequentially or concurrently
- Facilities become operational as completed

CAPTURE / TREATMENT COMPARISON

QUALITY PARAMETER	TREATMENT SHAFT	CAPTURE TUNNEL	ACTIFLO / DENSADEG
ANNUAL CAPTURE / OVERFLOWS PER YEAR	85% 3 - 4 treated overflows/year	95% <1 untreated overflows/year	98% 5 year storm treat
DISINFECTION	Chemical	None	Chemical or UV
OVERFLOWS TO RECEIVING WATER			
- TSS	33% of 15% = 5%	100% of 5% = 5%	5% of 98%+2% = 7%
- PHOSPHORUS	100% of 15% = 15%	100% of 5% = 5%	2% of 98%+2% = 4%
- NITROGEN	67% of 15% = 10%	100% of 5% = 5%	50% of 98%+2% = 51%
- TOXINS	33% OF 15% = 5%	100% of 5% = 5%	10% of 98%+2% = 12%
- OXYGEN DEMAND	80% of 15% = 12%	100% of 5% = 5%	70% of 98%+2% = 71%
COST RATIO (WITH LIFE CYCLE)	$1 (base figure)	$1.5 to $2	$7 - $10
- DEARBORN PROJECT CASE	$35 million	$60 million	$150 million

WHY NOT A TUNNEL ?

- COST
  - CAPITAL = 1.5 - 2 X TREATMENT SHAFT

- WATER QUALITY
  - LACK OF DISINFECTION: MOST FREQUENT CAUSE OF FAILURE TO MEET INTENDED USE

WHY NOT CEPHRT ?

(chemically enhanced primary high rate treatment)

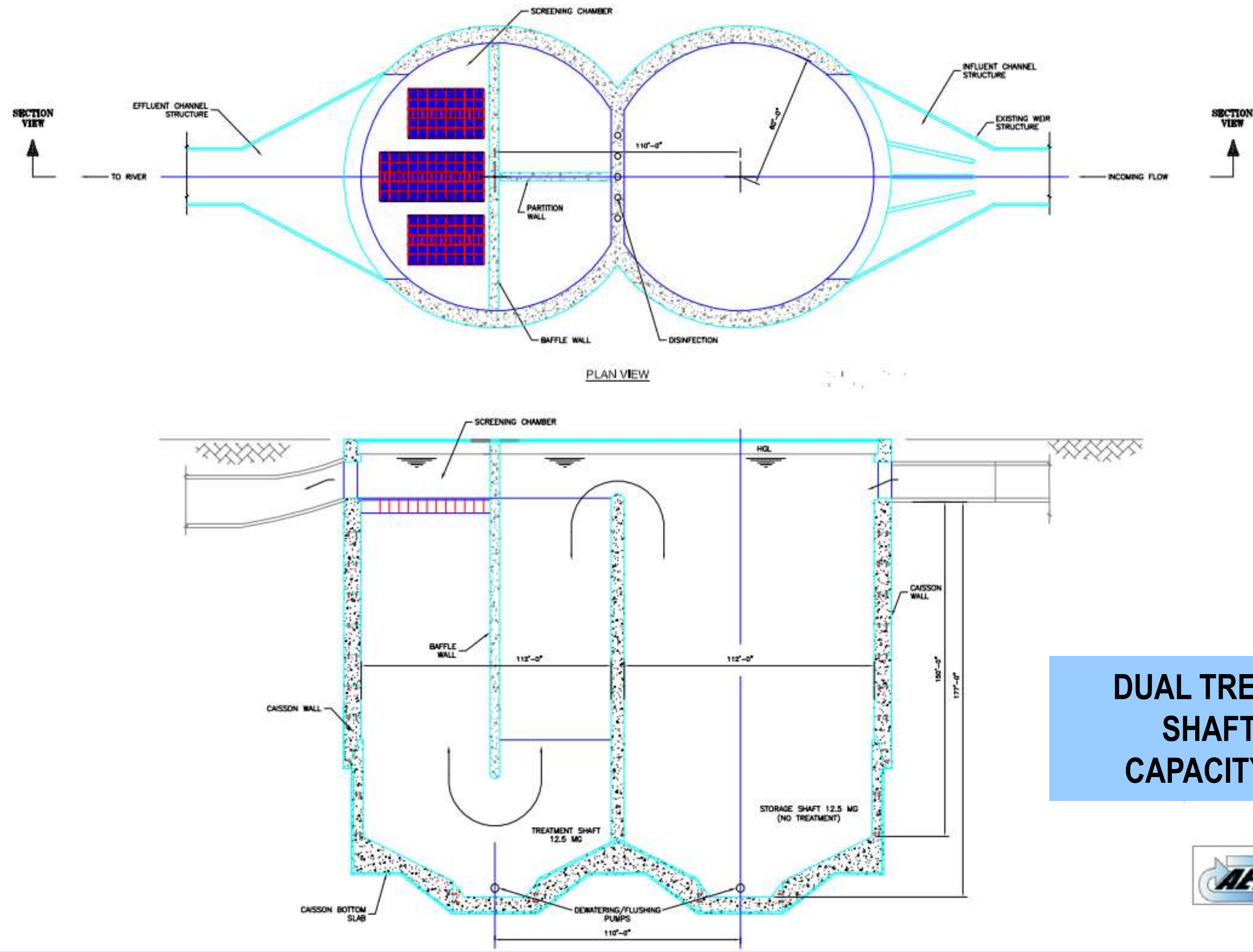
- COST
  - CAPITAL = 4 X TREATMENT SHAFT, 2 X TUNNEL
  - OPERATING
    - 5 X TUNNEL OR 7-10 X TREATMENT SHAFT
    - MORE THAN DOUBLES LIFE CYCLE COST

- WATER QUALITY
  - DISINFECTION: NO ADVANTAGE OVER TREATMENT SHAFT
  - NUTRIENT & O_2 DEMAND MUCH LESS EFFECTIVE

FUTURE DESIGN REFINEMENTS

- Consider removing divider wall
- Consider a thinner baffle wall
- Construct control building under shaft cover
- Addition of coagulants and/or flocculants
- Dual shaft configuration for larger first flush capture volume compared to disinfection volume

DUAL SHAFT

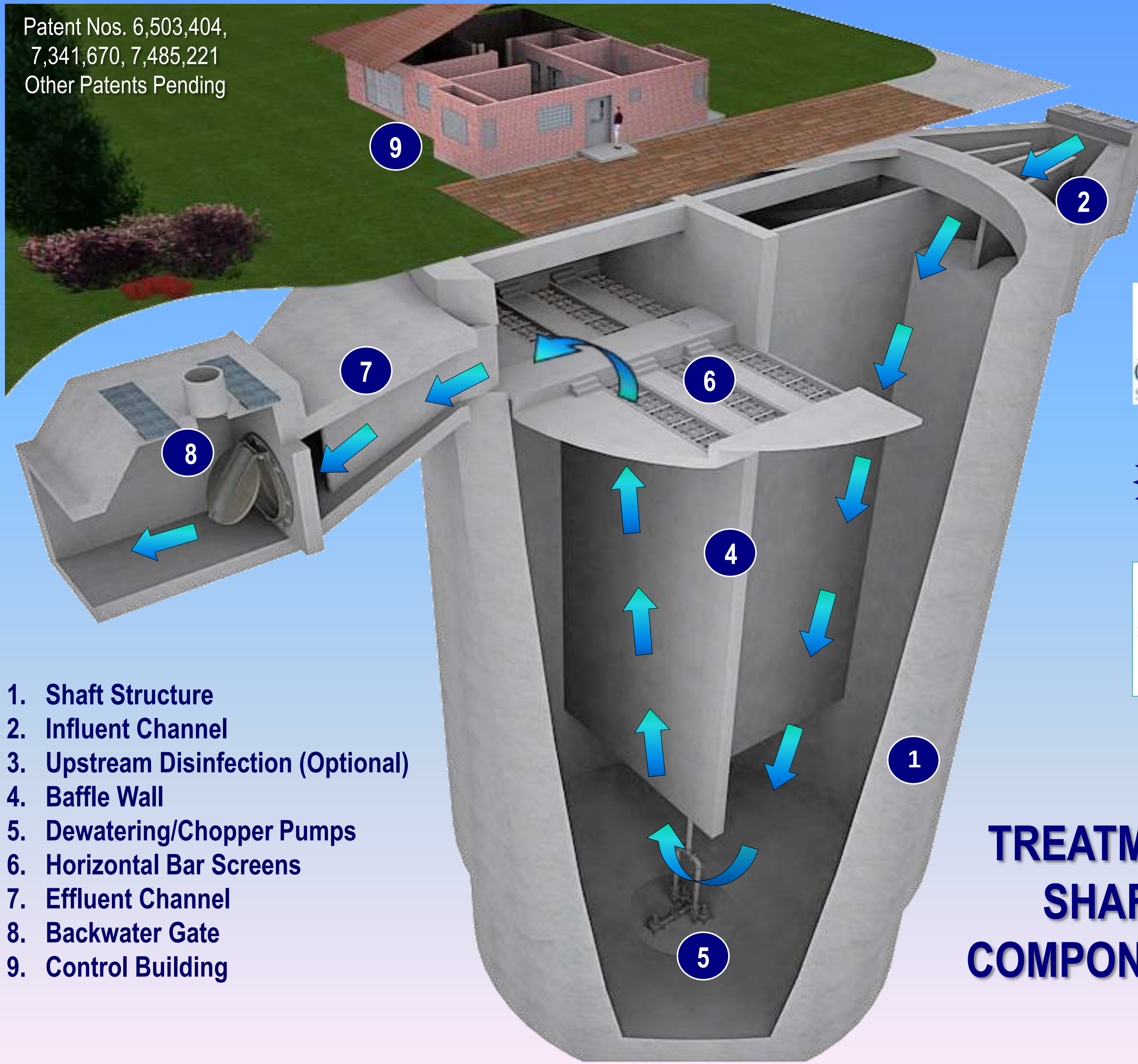


DUAL TREATMENT SHAFT FOR CAPACITY >15MG

CONCLUSION

- Thank you for your time and attention
- Questions and comments?
- Next steps?

Patent Nos. 6,503,404, 7,341,670, 7,485,221
Other Patents Pending



Clean Water
State Revolving Fund

EPA
PISCES
AWARD
WINNER

United States Environmental Protection Agency

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