

Corona Avenue Vortex Facility Performance Evaluation

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Overview

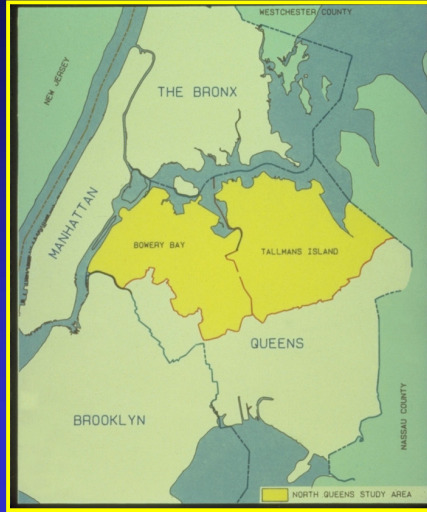
- Purpose and Objectives
- Testing Program
- Performance Results
 - Floatables
 - Solids, BOD, O&G
- Conclusions



*Corona Avenue Vortex Facility
Operating Floor*

Purpose and Objectives

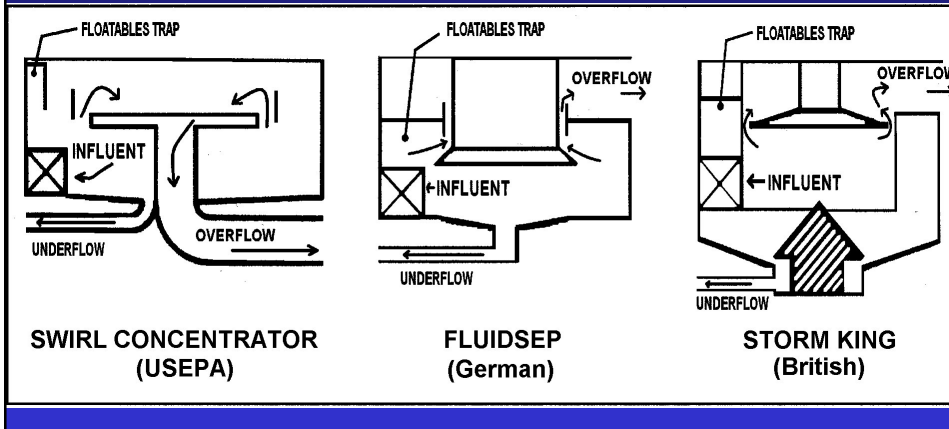
- Flushing Bay Watershed Facility Plan identified:
 - Low Dissolved Oxygen
 - Sediment Mounds
 - Pathogens
 - Floatables
- Causes:
 - CSOs
 - Limited Natural Flushing
- Solution Proposed: Vortex at up to 9 outfalls
 - CSO floatables
 - CSO solids



Flushing Bay & Surrounding Area

Purpose and Objectives

- Some installations in the US and internationally
- Various available vortex technologies available, limited tests, particularly for floatables



Purpose and Objectives

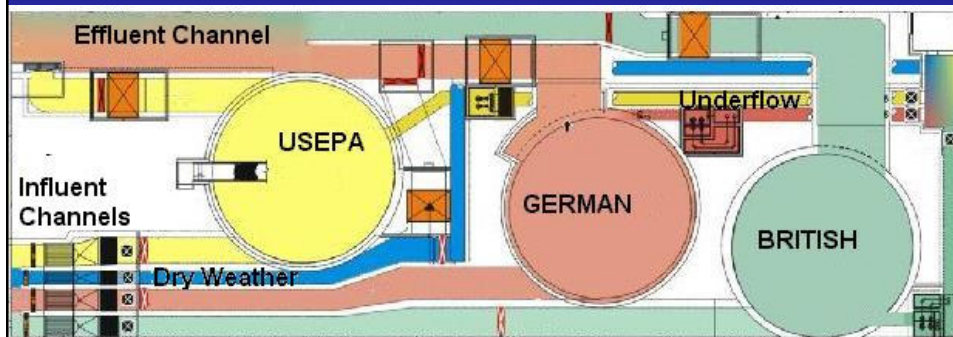
- Prior to proceeding with vortex, conduct full-scale testing for:
 - Floatables Removal
 - Solids, BOD, O&G Removal
 - O&M
 - Differences between vortex technologies
- Corona Avenue Vortex Facility



Construction of CAVF

Testing Program Overview

- CAVF Design:
 - Number of Vortex Units: 3
 - Diameter of Vortex Units: 43 ft
 - Sidewater Depth: 10.5 to 18.3 ft
 - Peak Flow: 130 MGD (each)
- Testing:
 - HydroQual: Floatables
 - URS/B&C: Hydraulics
 - URS/LMS: Solids, BOD, O&G
 - March 2000 – October 2002
 - Successfully sampled 22–24 events



Testing Program

Floatables

- Evaluate Vortex Floatables-Removal Efficiency, *overall and with respect to:*
 - Floatables characteristics
 - Hydraulic loading rate
 - Individual vortex technology
- Characterize Inf/Eff Floatables
 - Concentration/composition
 - Identify materials/items effectively removed
 - Identify materials/items not removed
- Issues associated with Vortex types
 - Practical and Operational Issues



Floatables Testing Program

Definitions

- Floatables-Removal Efficiency (FRE)

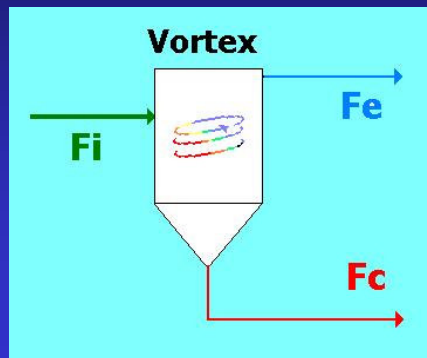
Mass Balance:

$$F_i = F_c + F_e$$

$$FRE = F_c / F_i$$

but cannot sample F_c

$$= (F_i - F_e) / F_i$$

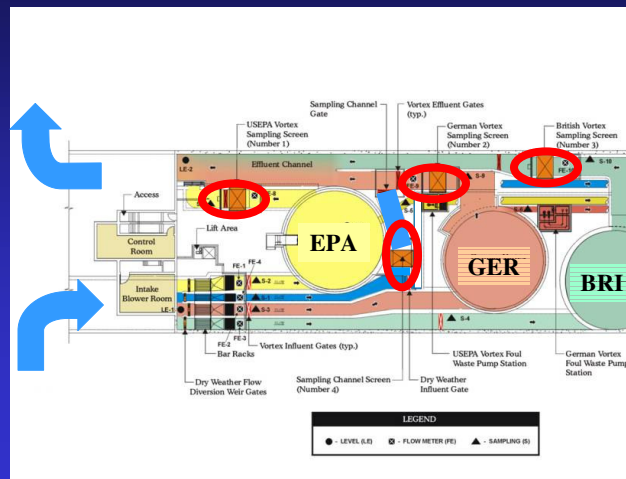


Floatables Testing Program Approach

- “Parallel” Sampling Approach:
 - “Seeded-Matrix” Sampling
 - “Combined-Sewer (CS) Floatables” Sampling

Floatables Testing Program Approach

- Sampling Equipment
 - Screens: ½ inch open spacing
- Locations:
 - Influent:
 - ISC
 - Effluent:
 - EPA
 - German
 - British



Floatables Testing Program *Overview of Testing*

- Sampling Period: Mar 2000 – Oct 2002
 - Successful Mobilizations: 22 + 2 special tests
 - But, not 3 units simultaneously
 - | | <u>USEPA</u> | <u>German</u> | <u>British</u> | <u>ISC</u> | |
|------------------|--------------|---------------|----------------|------------|---------------------------|
| – Flow Routing: | 13 | 12 | 12 | 20 | |
| – Matrix Tests: | 9 | 9 | 7 | NA | |
| • Flow Data: | 7 | 7 | 5 | NA | |
| – CS Floatables: | 11 | 10 | 10 | 20 | Collected 4,812 lbs total |
| • Lab: | 9 | 9 | 8 | 17 | |
| • Flow Data: | 7 | 7 | 5 | 17 | |

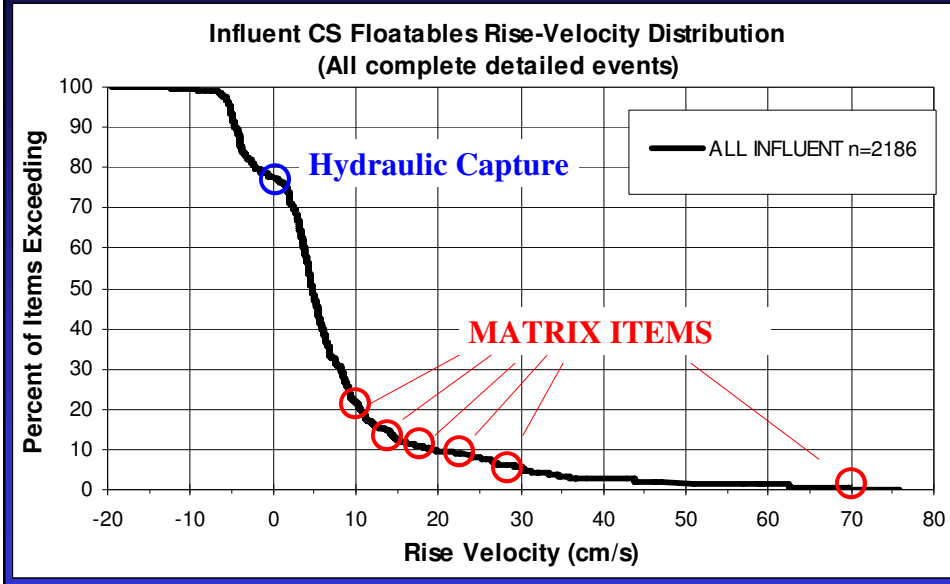
Floatables Testing Program *Seeded-Matrix Sampling*

- Advantages:
 - Known number of influent items
 - Control item characteristics
 - Easy to sample
- Disadvantages:
 - Items are not actual CSO floatables
 - Need to introduce items over course of storm
- Items selected to mimic actual floatables
 - Critical characteristic: rise velocity
 - Secondary characteristic: size
 - Other factors minimized (example: shape held constant)



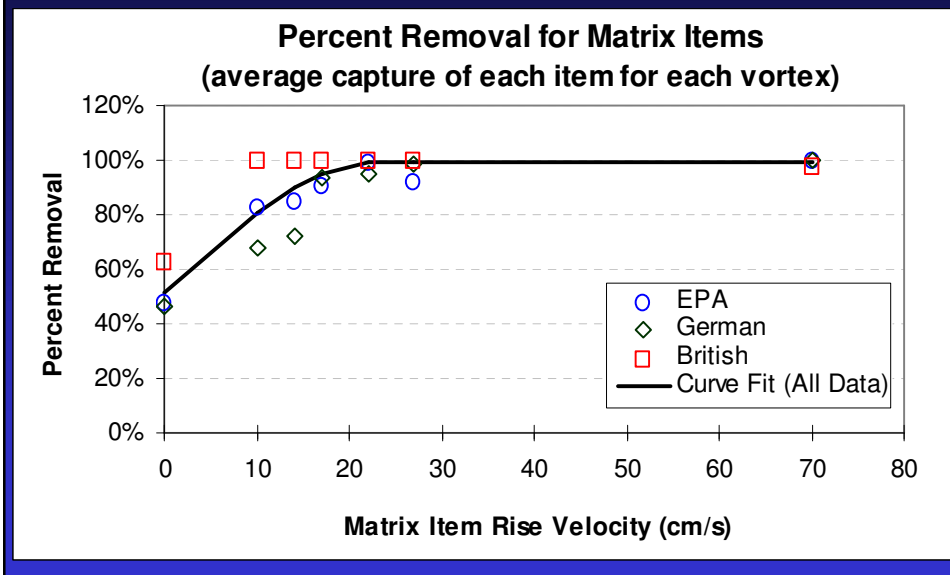
Floatables Testing Program

Seeded-Matrix Testing



Floatables Testing Results

Seeded-Matrix Sampling



Floatables Testing Results *Seeded-Matrix Sampling*

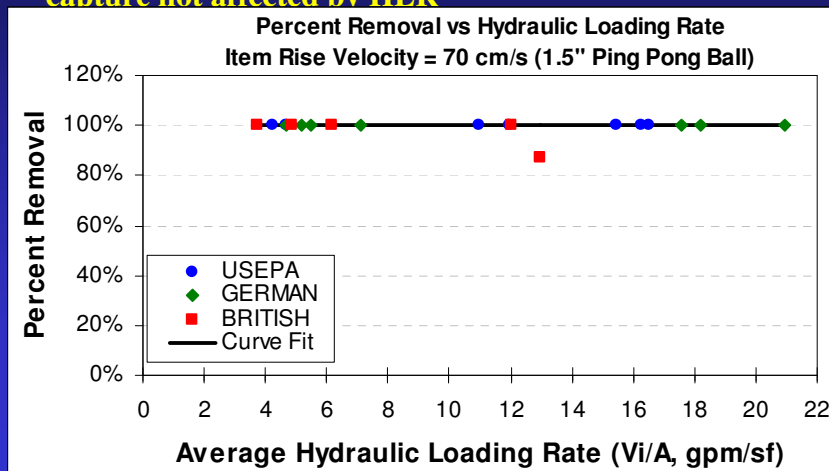
Hydraulic Loading Rate (HLR)

- Design Peak: 62 gpm/sf (~48 gpm/sf avg for typical storm)
- Actual Event-Averaged HLRs:
 - EPA: 4 to 16 gpm/sf (peak: 27 gpm/sf)
 - German: 5 to 21 gpm/sf (peak: 36 gpm/sf)
 - British: 4 to 13 gpm/sf (peak: 22 gpm/sf)
- Do not have coverage of entire HLR design range
- Different units tended to have different HLR ranges
- Now view effect of HLR on removals...

Floatables Testing Results *Seeded-Matrix Sampling*

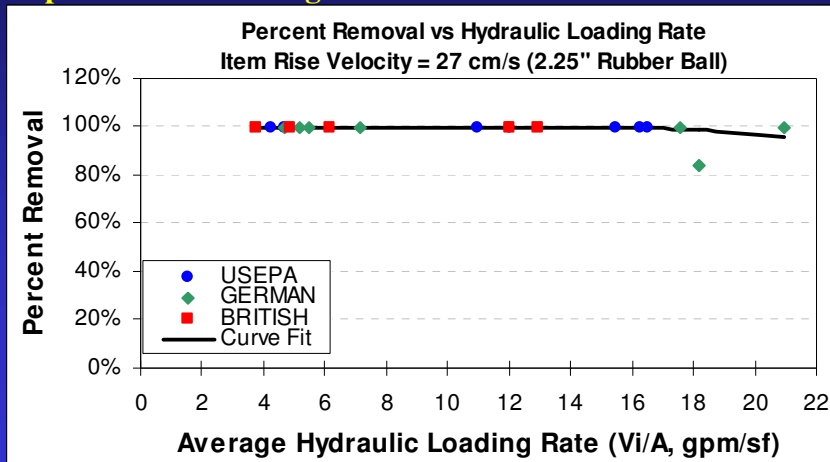
- **Highest Rise Velocity (70 cm/s)**

– capture not affected by HLR



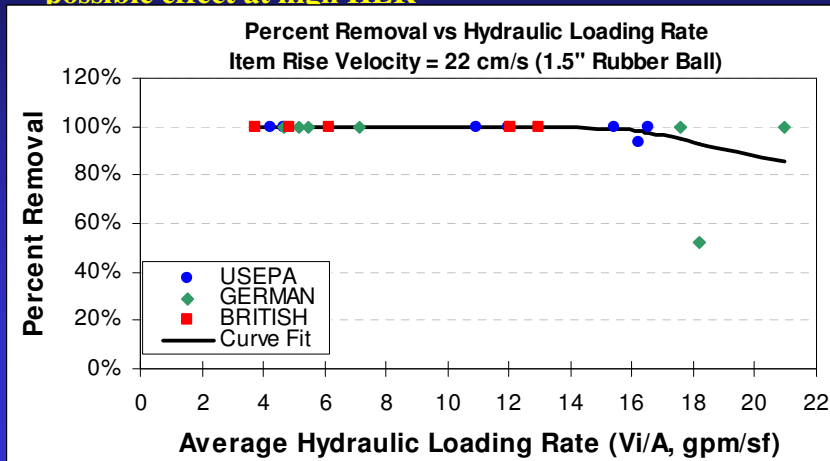
Floatables Testing Results *Seeded-Matrix Sampling*

- Rise Velocity = 27 cm/s
 - possible effect at high HLR



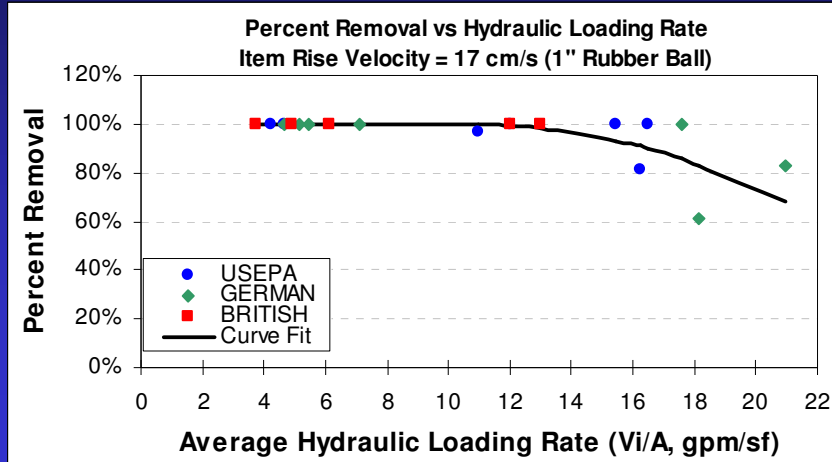
Floatables Testing Results *Seeded-Matrix Sampling*

- Rise Velocity = 22 cm/s
 - possible effect at high HLR



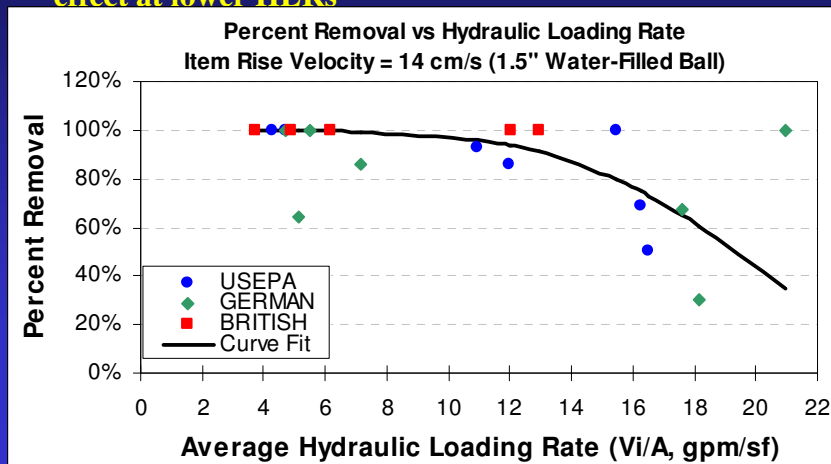
Floatables Testing Results *Seeded-Matrix Sampling*

- Rise Velocity = 17 cm/s
 - effect at lower HLRs



Floatables Testing Results *Seeded-Matrix Sampling*

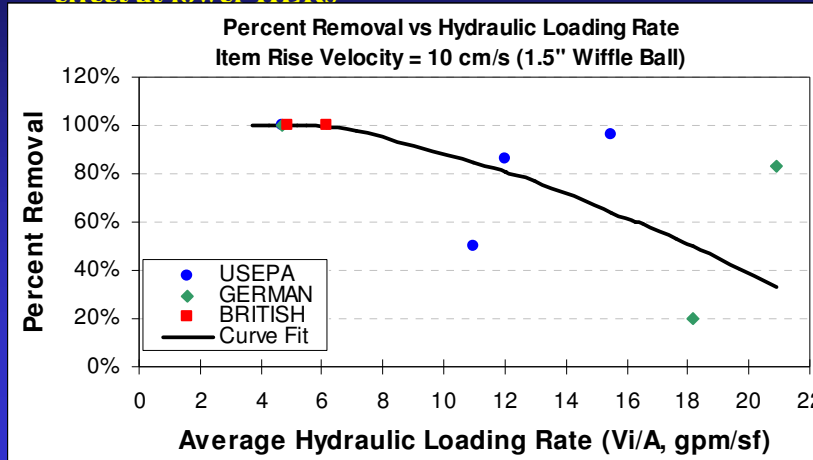
- Rise Velocity = 14 cm/s
 - effect at lower HLRs



Floatables Testing Results

Seeded-Matrix Sampling

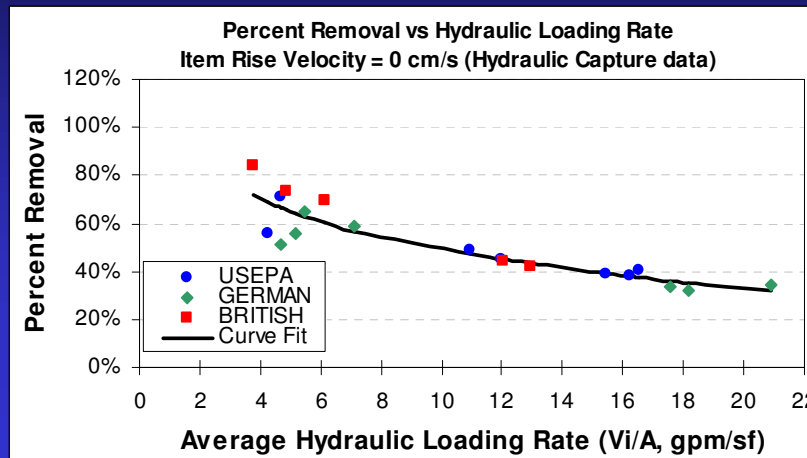
- Rise Velocity = 10 cm/s
 - effect at lower HLRs



Floatables Testing Results

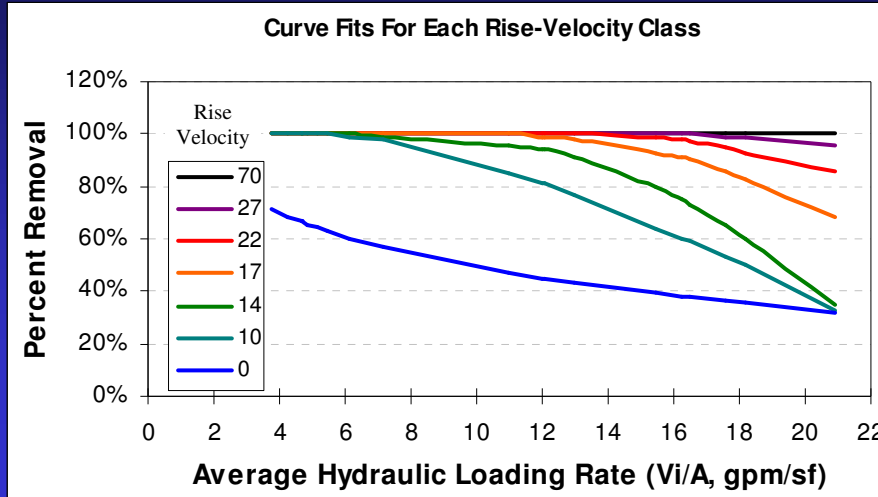
Seeded-Matrix Sampling

- Rise Velocity = 0 cm/s (Hydraulic Capture)
 - Surrogate for neutral buoyancy items

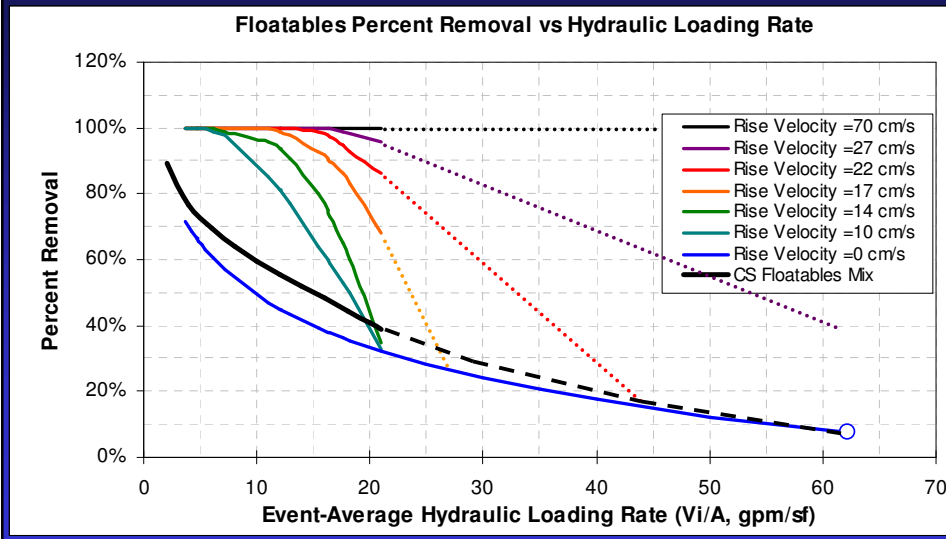


Floatables Testing Results *Seeded-Matrix Sampling*

- Show all curves together:



Floatables Testing Results *Seeded-Matrix Sampling*



Floatables Testing Program

CS-Floatables Sampling

- Advantage:
 - Actual CS Floatables
- Disadvantages:
 - Material handling
 - Cannot directly measure influent quantity
- Use “slip channel” to sample influent quantity
 - Influent Sampling Channel (ISC)
 - Will provide influent quantity if mixed laterally
 - Separate tests to verify that lateral distribution is uniform



Lab sorting CS items

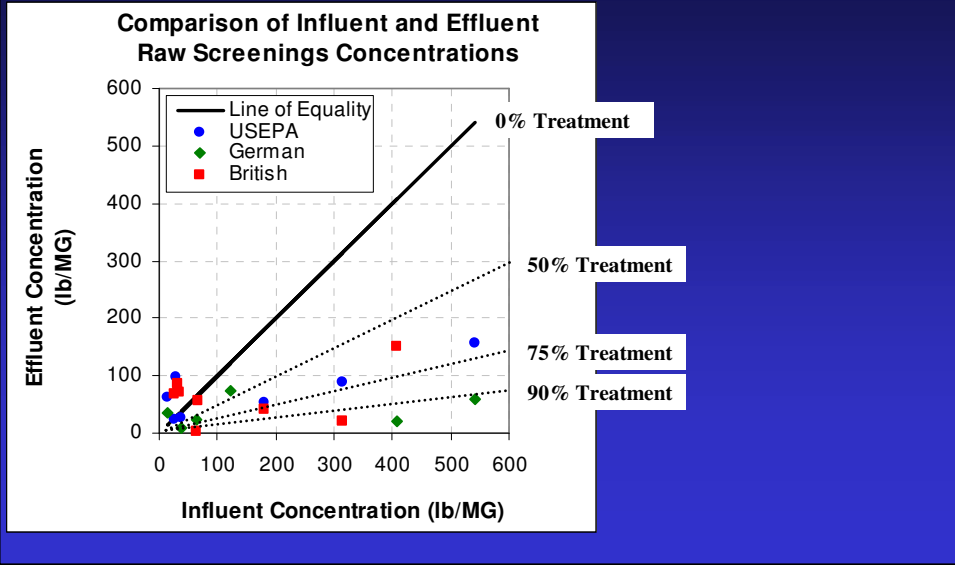
Floatables Testing Results

CS-Floatables Sampling

- *Cannot use CS-Floatables sampling as basis for FRE*
 - Floatables distribution between the individual vortex influent channels is not uniform – highly variable
 - ISC cant be used to predict floatables entering vortex units
- *Can use CS-Floatables sampling for “overall” or “qualitative” assessments*

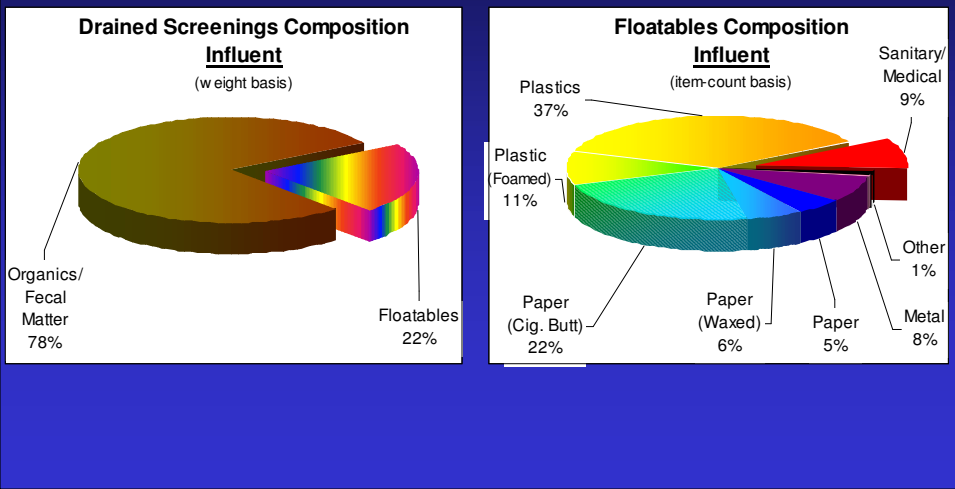
Floatables Testing Results

CS-Floatables Sampling



Floatables Testing Results

CS-Floatables Sampling



Floatables Testing Results

Summary

- Vortex floatables-removal efficiency (FRE) varies with
 - Item Rise Velocity
 - Best results for higher rise-velocity items (~100% for Styrofoam)
 - May also be good for “sinkers” (~100% for cigarette butts)
 - Not as good for near-neutral (condoms)
 - Most actual floatables are near-neutral
 - Hydraulic Loading Rate
 - Strong relationship – 40 to 90% during tests (better at low HLR), predict lower as approach design peak HLR
 - EPA vs German vs British
 - Insufficient data
- Vortex FRE: 60% overall during testing period
 - Matrix-based; backed up by raw CS screenings removal rates

Testing Program

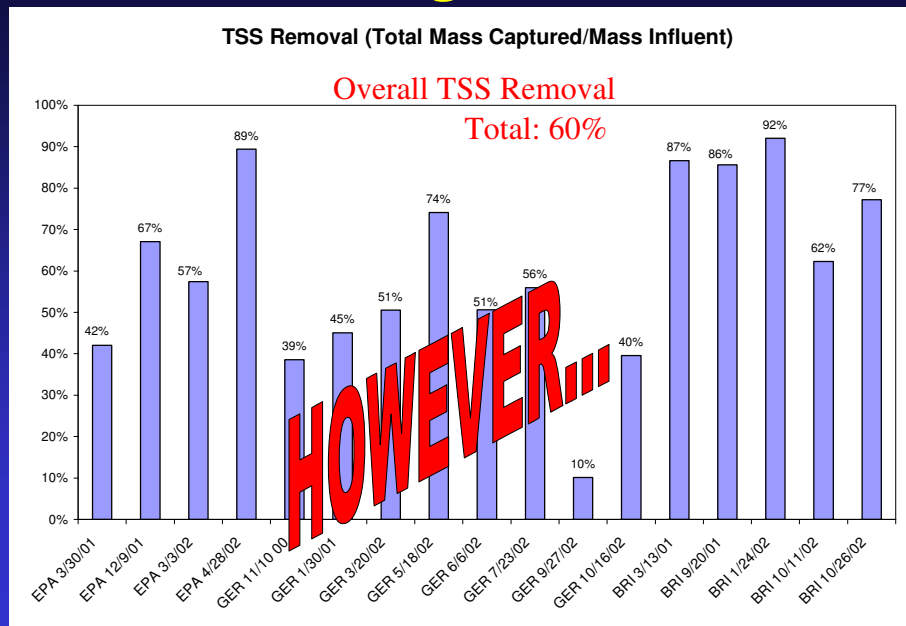
TSS/SS/BOD/O&G

- Evaluate Pollutant-Removal Efficiency with respect to:
 - Influent vs Effluent Concentrations
 - Influent vs Effluent Loading (Mass Balance)
 - Hydraulic loading rate
 - Individual vortex technology
- Sampling performed at influent, effluent, and underflow for most parameters using automatic sampler pumps
- No ability to perform “seeding” as in floatables testing

Testing Results TSS/SS/BOD/O&G

- Highly variable concentrations - influent and effluent
- Influent concentrations typically same (or lower) than effluent concentrations, though underflow concentrations were generally higher
- Mass-balance checks indicated that influent sampling was suspect:
 - Influent < Effluent + Underflow (all mass basis)
 - Computed Influent = Effluent + Underflow
 - Removal Efficiency = Underflow/Computed Influent
- Limited data
 - aggregated datasets for “overall” effectiveness

Testing Results

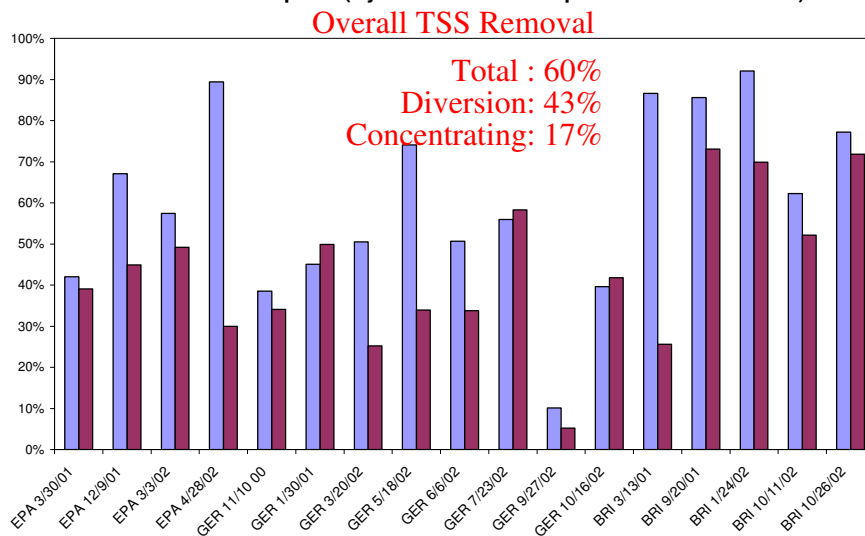


Testing Results TSS/SS/BOD/O&G

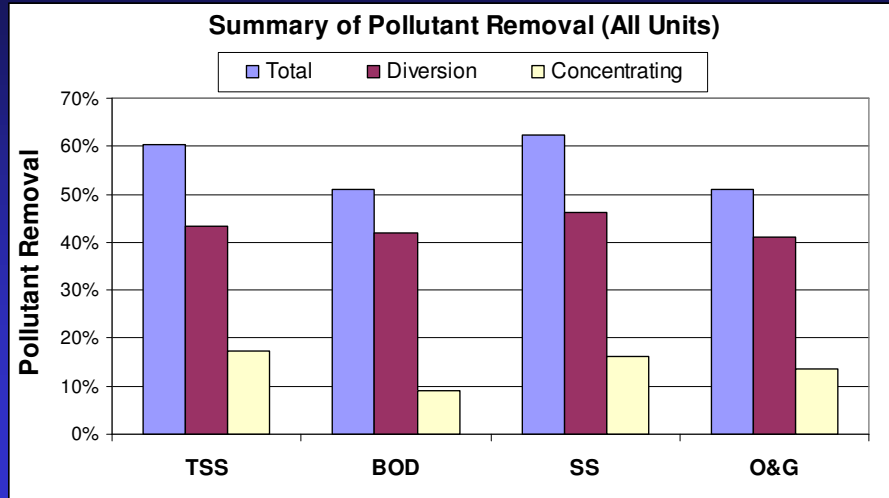
- These mass-balance calculations include
 - vortex “treatment” (concentrating of pollutants in the underflow) AND
 - “diversion” (hydraulic capture of flow volume)
- Any flow splitter provides “diversion capture”
- Vortex should also provide “concentration capture”
- Compare the total capture to the “diversion” capture
- The difference should represent the enhanced capture the vortex provides over a simple flow splitter (conventional regulator)

Testing Results

TSS Removal (Total Mass Captured/Mass Influent)
and Diversion Capture (Hydraulic Volume Captured/Volume Influent)



Testing Results TSS/SS/BOD/O&G



Summary of Testing Results TSS/SS/BOD/O&G

- Highly variable concentrations, and sampling problems
→ limit confidence in analysis of solids, BOD, and O&G
- Insufficient data to conclude whether one vortex type is more effective than another
- Insufficient data to conclude how HLR affects results
- Pooling available data enabled overall mass-balance analysis of pollutant removal
 - Result: vortex provided up to about 20% better effectiveness than a conventional regulator for solids, BOD, and O&G
 - Vortex treatment does not reduce effluent concentrations sufficiently to achieve compliance with applicable limits

Other Considerations

- NYC solids are relatively light compared to other cities – lighter solids are more difficult to treat with vortex
- Vortex hydraulic requirements will limit siting to locations with available head
- Vortex technology requires treatment of underflow: necessitates available conveyance capacity to WPCP and treatment capacity at WPCP
- The CAVF proved to require more O&M than anticipated
- Vortex treatment is not as cost effective as other available alternatives

Conclusions

- Vortex technology *not* selected for use in Flushing Bay or NYC
- More cost effective alternatives exist for floatables and solids

Thank You

Additional questions/comments, feel free to contact:

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