Trench Type Wet Well Designs

MINIMIZE YOUR FOOTPRINT AND YOUR MAINTENANCE HEADACHES

April 16, 2019
Presentation Objectives

- Introduction to Trench Type Wet Wells
- Introduction to Self Cleaning Operation
- Case Studies
  - Return Activated Sludge Pump Station
  - WWTP Influent Pump Station
  - WTP Pump Station
  - Lift Station
- Would the design be right for you?
Trench Type Wet Well

• Invented by D.H. Caldwell in 1964
• Improved by Dr. Robert Sanks, Ph.D., P.E.
  – 1:1 scale model of portion of trench floor
    • Result: >5 fps requirement
  – 1:3.3 scale model of the Kirkland Pump Center
    • Result: Only a small portion of the sand was ejected at pump down equilibrium.

• 1998 Breakthrough
  – 2nd Edition of Pumping Station Design
  – ANSI/HI 9.8 Pump Intake Design

Transition from circular to rectangular recommended

See Section 9.8.3.2.1

Plan

ANTI-rotation baffle (protude as far as practical)

0.3 m/s (1.0 ft/s) max velocity above trench

4 ft/s max

Sluice gate

Min. level

VANE

Hydrocone

Longitudinal section

\( r \geq 2.33 \times \text{head on sluice gate} (2D \text{ min}) \)

\( \varepsilon \geq 45^\circ \) for smooth surface (plastic lining)

\( \varepsilon \geq 60^\circ \) for concrete

\( S \geq (1+2.3F_D)D \)
ANSI/HI 9.8 Pump Intake Design (2012)

PLAN

SECTION A-A

Flow splitter

Fillet - 45°

0.3 m/s (1.0 ft/s) max above trench

SECTION B-B

Flow splitter

Fillet - 45°

45-63°

0.38D

NOTES
1. Flow splitter and fillets may be omitted in a trench less than 1.0 m (39 in.) wide.
2. \( r_1 \geq 2.33 \times \frac{v^2}{2g} \) where \( v \) = velocity at top of ramp (2D min), \( r_2 > 1.25D, 45° \) tangent between \( r_1 \) and \( r_2 \).
3. 1.2 m/s (4 ft/s) max wet pit pumps, 1.0 m/s (3 ft/s) max dry pit pumps
4. \( e \geq 45° \) smooth surface (plastic lining)
5. \( e \geq 60° \) concrete surface
6. \( S \geq (1+2.3F_0)D \)
7. See Appendix D for details and tutorials
Trench Type Wet Well

- Suitable for Design Flows > 3 MGD
- Pump Intakes, Confined in a Deep, Narrow Ditch
- Pump Intakes, Substantially Lower Than Upstream Inlet Pipe
Trench Type Wet Well

- Suitable for Different Pump Types/Arrangements
  - Wet Pit or Dry Pit/Wet Pit
  - Pumps
    - VTSH
    - Submersible
    - Non-Clog Centrifugal

- Suitable for Different Fluids
  - Clean Water
  - Activated Sludge
  - Raw Wastewater

Dallas Water Utilities Central WWTP Influent Pump Station
(335MGD initial capacity, 425MGD ultimate capacity)
Advantages
- Superb Hydraulic Environment for Pump Intakes
- Minimum Footprint Size
- Small Floor Area (Minimum accumulation of sludge or grit)
- Ease and Quickness of Cleaning

Disadvantages
- Compact, Minimal Storage Capacity
- Increased Depth
- Clogging if Pumps Not Used
Section Views

- Trench
- Water Guide
- Sloping Walls
- Flow Splitter
- Fillet
1 fps max above trench

4 fps (wet pit)
3 fps (dry pit)

Illustrative Section of Trench Type Wet Well Pump Station – Normal Operation
Self Cleaning Cycle

Mixes sludge and scum into a mass that is ejected by the last pump.
Illustrative Section of Pump Station – Cleaning Cycle (Pump Down)
Cleaning Ramp

Illustrative Section of Pump Station – Cleaning Cycle (Pump Down)
Cleaning Ramp

Illustrative Section of Pump Station – Cleaning Cycle (Pump Down)
Cleaning Ramp

Illustrative Section of Pump Station – Cleaning Cycle (Pump Down)
Case Study #1

• Trinity River Authority
  – CRWS Treatment Plant

• Design and Construction of Pump Station 13B

• Fluid of Interest: Return Activated Sludge (RAS)
  – Final Clarifiers – Traveling Bridge Suction Clarifiers
  – Thin Sludge

• RAS Firm Capacity – 200 MGD for WWTP
  – New PS-13B – 50 MGD (North Plant, Trains 4-6)
    • 3 pumps (200HP)
    • 30-inch diameter columns
    • 36-foot overall shaft length
  – Downrated PS-13 – 50 MGD (North Plant, Trains 1-3)
  – Uprated PS-13A – 100 MGD (South Plant, Trains 7-12)
Pump Station Evaluation

• Dry-Pit/Wet-Pit
  – Horizontal Non-Clog Centrifugal Pumps
    • PS-13 and PS-13A
  – Vertical Non-Clog Centrifugal Pumps
    • PS-6 and PS-6A

• Wet-Pit
  – Vertical Turbine Solids Handling Pumps (VTSH)
Vertical Non-Clog Centrifugal Pumps

Horizontal Non-Clog Centrifugal Pump

Pump Station 13-A
City of Phoenix, 23rd Ave. WWTP (36-inch VTSH Pumps)
Limitations at PS-13B Site

- 60-inch Final Clarifier Effluent Line
- 84-inch Primary Clarifier Effluent Line
- Electrical Duct Bank
- Caustic Soda Bank
- 2-inch to 12-inch lines
- 12-foot roadway
Relocated Caustic Soda Building

Relocated Pavement

Relocated 60-inch FCE Line

Footprint of Dry-Pit/Wet-Pit (Horizontal Non-Clog Pumps)
Footprint of Wet-Pit Wet Well (VTSH Pumps)

Existing Caustic Soda Storage Facility, 84-inch PCE Line, 60-inch FCE Line and Pavement Remains Unchanged
Dry Pit vs. Wet Pit

<table>
<thead>
<tr>
<th>Pump Station Type</th>
<th>Length/Width</th>
<th>Depth</th>
<th>Pump Cost ($)*</th>
<th>OPCC ($)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Non-Clog Centrifugal Pump Station (Wet-Pit/Dry-Pit)</td>
<td>67’/65’</td>
<td>26’</td>
<td>$915,000</td>
<td>$10.9 million</td>
</tr>
<tr>
<td>Vertical Non-Clog Centrifugal Pump Station (Wet-Pit/Dry-Pit)</td>
<td>59’/54’</td>
<td>~35’</td>
<td>$945,000</td>
<td>$11.4 million</td>
</tr>
<tr>
<td>VTSH Pump Station (Wet Pit)</td>
<td>49’/43’</td>
<td>29’</td>
<td>$1,718,000</td>
<td>$9.5 million</td>
</tr>
</tbody>
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*Total Pump Cost for Three (3) Pumps
**OPCC: Opinion of Probable Cost
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<td>$9.5 million</td>
</tr>
<tr>
<td>Trench Type Wet Well Pump Station</td>
<td>57’/18’</td>
<td>38’</td>
<td>$1,718,000</td>
<td>$8.5 million</td>
</tr>
</tbody>
</table>

* Total Pump Cost for 3 Pumps
** OPCC: Opinion of Probable Construction Cost
Site Plan – RAS Pump Station 13B
Construction Photos
Construction Photos
Construction Photos
Acknowledgements

• Trinity River Authority of Texas

• ANSI/HI (Hydraulic Institute) Pump Standards, 1998/2012

• *Pumping Station Design, 3rd Edition*
  – Editor-in-Chief: Garr M. Jones, P.E.
  – Co-Editors: Dr. Robert L. Sanks, Ph.D., P.E.
    Dr. George Tchobanoglous, Ph.D., P.E.
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• *Dr. Robert L. Sanks, Ph.D., P.E. (Quality Control)*

• Dr. Joel E. Cahoon, Ph.D., P.E., Montana State University
Case Study #2

- Dallas Water Utilities
  - Central Wastewater Treatment Plant

- Design and Construction of Influent Pump Station

- Fluid of Interest: Raw Sewage
  - Coarse screens upstream (1-inch spacing)

- Firm Capacity – 335 MGD (current), 425MGD (expanded)
  - 6 pumps (2, 1000HP and 4, 800HP)
  - 42-inch diameter columns
  - 62-foot overall shaft length
  - 20-80MGD range per pump (VFDs)
Case Study #2

[Images of industrial equipment and construction site]
Ten Years in the Making
Case Study #3

- City of Midlothian
  - Water Treatment Plant

- Design and Construction of New WTP

- Fluid of Interest: Partially Treated Water
  - Pumped water feeds membranes

- Firm Capacity – 9MGD (firm), 18MGD (ultimate)
  - 3 initial pumps (4.5MGD each)
  - 5 ultimate pumps
  - 20-foot depth
Case Study #4

- **City of Fort Worth**
  - Collection System

- **Design of Lake Arlington Lift Station**
  - Construction – November 2019
  - Completion – March 2022

- **Fluid of Interest: Raw Sewage**

- **Firm Capacity** – 40 MGD (firm), 80 MGD (ultimate)

- **Trench Type Wet Well**
  - Elimination of wet well reduces the size of the site
  - Self-cleaning design reduces maintenance costs
  - VFDs allow pumps to run efficiently through range of required flows
Is this the right design for you?

• Your Conditions
  – Limited on Space?
  – Solids/grit problem?
  – Tired of maintenance intensive cleaning?
  – Don’t prefer dry-pit/wet-pit?

• Pre-Design Evaluation
  – Cost Analysis (Life Cycle)
  – Benefits Analysis
  – Reference Calls
  – Site Visits
  – Comfort Level
Decision Making Examples
Case Studies #1 and #2

- **Client Concerns**
  - Lacking Comparable Size Installations
  - Staff Unfamiliar with Equipment

- **Increasing their Comfort Level with the Equipment**
  - Site Visits to Arizona and Kansas
  - Extended Warranty
  - Single Point of Responsibility
  - Witness Performance Testing
  - Contracted Maintenance (1st observe and learn)
  - Vibration Monitoring
  - Smith Pump Seminar

- **Largest Driver Tipping the Risk vs. Benefit Scale**
  - Significant Capital Cost Savings (Ex: DWU $16 Million over traditional design)
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