Columbus Collection and Treatment System
Real Time Wet Weather Operational Implementation

Presenters
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Existing Collection System

- SWWTP
- FDS
- JPWWTP
- WST
- Alum Creek
- Storm Tanks
- BIS
- Rhodes Park
- BBX
OARS Tunnel Addition

OARS Tunnel
- 23,000 feet long
- 20 ft diameter
- ~180 ft deep
- Four drop shafts
- 63MG storage

OARS Dewatering Pump Station
- Tunnel must be pumped empty to be ready for next wet weather event
- 9 pumps
- 4 level sensors
- Complex control circuits
Dewatering Pumps

- Two pumping zones to deal with depth of tunnel
- Zone 2 – 2 pumps, 4160V, 450HP, 20MGD each
- Zone 1 – 4 pumps, 4160V, 800HP, 15MGD each
- Grit Pumps – 2 pumps, 480V, 105HP, 1MGD each
- Mixing Pump – 1 pump, 480V
Many Items in Control Circuit

- Adjustable Frequency Drive
- Local Control Panel
- Pump Monitor
- Programmable Logic Controller
- Area Operator Touch Panel
- Plant Wide HMI System
Many Different Providers

Electrical sub responsible for all wires between them
Complex Control Strategy

- Each pump has an operating depth range.
- Tunnel can be completely filled and flow by gravity to JPWWTP which requires throttling of gates to control the flow.
- Speed of pumps must be varied with depth to maintain operation on favorable pump curve.
- Many pump protective interlocks.
Level Measurement Complexities

- 4 Hydrostatic level sensors
- 1 each grit sump
- 2 for dewatering pumps
  - Automatic failover
- Multiple local displays
- Must be correct to compare to other plant influent levels
- 0.25% accuracy is about ½ foot error

### Table

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<th>Unit</th>
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Local Control Panel
Display in AFD Room
Display in AFD Room

690 invert
Equipment Values

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Value</th>
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<tr>
<td>Zone 1 Pump, AFD, Rails &amp; Brackets</td>
<td>~$600,000 Each (4 total)</td>
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<tr>
<td>Zone 2 Pump, AFD, Rails &amp; Brackets</td>
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<td>Grit Pump, AFD, Rails &amp; Brackets</td>
<td>~$170,000 Each (2 total)</td>
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<tr>
<td>Mixing Pump, Starter, Nozzles</td>
<td>~$500,000</td>
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Testing must reduce risks due to equipment values.

“Press & Pray” is not a good method to manage risks
Something this complex doesn’t get “turned on” one day

40 people here and no one will stand next to the person who hits the start button the first time. Why?

**Answer:**
*It worked the first time, they didn’t have time to walk over*

The first pump start with sewage
Testing and Validation

- Live System Operation
- Wet testing with controlled fill events
- Pump bump testing
- Simulated tunnel filling/emptying
- Testing of interlocks
- Simulated motor start/stop with PLC
- Simulated motor start/stop with hardwired controls
- Equipment Monitoring Signals
- Process Monitoring Signals
Process Monitoring Signals

- Hydrostatic inside guide pipes: Grit 1
- Hydrostatic inside guide pipes: Grit 2
- Hydrostatic inside guide pipes: ODS 1
- Hydrostatic inside guide pipes: ODS 2

Tested by using smart instrument interface to force simulation.

Filling the tunnel just to test level sensors isn’t feasible.
Pump Operation Simulation

- Cannot operate pumps without sewage
- Medium voltage AFD has a motor simulation mode
- Allows for full testing of local and PLC circuits without starting the pump
- Testing without even having the pump attached was possible with a jumper to bypass the pump protection devices
- Many wiring issues fixed between the multiple vendor panels and electrical contractor. Several failed lights & indicators replaced.
- 480VAC pumps were simulated tested by removing motor leads from AFD
Every circuit issues was tracking individually. Microsoft Surface with OneNote was used as it could capture pictures, drawings and hold markups. Allowed for detailed notes in field with quick conversion to PDF to coordinate with Contractor, Construction Manager and Design Professional.
Simulated Tunnel Filling/Emptying

AFD Simulation Mode allowed for initial testing of automatic logic against the actual control circuits.

This uncovered some additional circuit issues on pump shutdown with restart delay timer effecting the “remote” status signal to the PLC.

Simulated testing occurred many months before pumps were installed in shaft.
Pump Bump Testing

First time medium voltage applied to pumps in field

Video of each pump spinning the correct direction. Pumps tested on surface before being lowered in. Allowed for easier inspection and troubleshooting.

Special submersible cables with plug terminations. One of them was not terminated correctly. Found during bump testing and fixed.
Wet Test with Controlled Tunnel Filling

- Test each pump by doing a volume draw down test over its operating range
- Tunnel holds ~60MG
- Utilize surface sewer to fill tunnel for pump testing
- Fill tunnel during dry weather ideally
- Repeat multiple times to test each pump

First tunnel filling test
Flow enters the dewatering pumps station
Wet Test with Controlled Tunnel Filling

- Invert of filling sewer is higher than overflow at end of tunnel
- Must manage the filling process with crews called in to stop the filling process
- Surface sewer flow is variable adding uncertainty to the procedure
- Pumps not tested yet so they can’t be used during first fill to slow the rate of filling
- Flow must be stopped or sent by gravity to Jackson Pike WWTP. Capacity must be available to receive it.
Wet Test with Controlled Tunnel Filling

- Filling projections done to aid the team in responding
- Flow calculated based on the volume change in the tunnel
- Far majority of tunnel volume is in the tunnel, not in the shafts. Notice rapid rise at end as shafts are filling
- Shafts can fill in 1 to 2 hours
- One fill test was filling shafts at 1 ft/min
Wet Test with Controlled Tunnel Filling

Common graphics at JPWWTP, SWWTP and SMOC to coordinate actions.
Pump Wet Testing Progressive Testing

- Pump flow rate estimated by drop in tunnel level and calculated tunnel volume
- Subsequent testing runs built on data from previous runs for each pumps baseline performance
- Due to testing of circuits before, equipment ran without control system issues.
Wet Testing Issues

- Pump 6 had a manufacturing issue that resulted in high bearing temperature shutdown after several hours of operation.
- Manufacturer pulled pump and repaired it.
- Internal pump monitoring only way to know what is going on under 100+ feet of sewage.
Wet Testing Success

All four Zone 1 pumps operation run including Pump 6. Notice change of speed with depth.
Preparing for Live Operation

- Wet testing helped establish interactions between tunnel pump station and surface sewers at JPWWTP
- Many graphic and automatic programming adjustments being made
- SOP being prepared with lessons learned from testing
- Final construction items being completed
Thank You to everyone who helped with all of the testing and issue resolutions
Will it be this nice out when its put on-line?
Questions?

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