Data Management with Continuous Monitoring and Adaptive Control

Seth Bryant, OptiRTC, Inc
Data Utilized by CMAC

- Water level
- Valve / pump status
- Weather forecasts
- Site metadata
  - Drainage area hydrology
  - Stage-storage relationship
  - Stage-discharge relationship

- Collected on a minutely basis
- Used to inform / update control decisions
- Stored as a historic record
Traditional Flow of Information

On-Site    Remote

Opti Cloud

.CSV
Integrations with External Data Sources

Communication options include:

- Modbus
- Digital and analog IO
- API

Allows for integration with majority of commercially available monitoring sensors
Case Study: Ormond Beach

Existing Pump System

3 Distributed Monitoring Stations
Case Study: PLC Integration at Ormond Beach

- Opti hardware communicates via modbus, read and write access to city’s PLC
- 4 monitoring locations, 1 control

### Real-Time System Status

<table>
<thead>
<tr>
<th>Pump 1 Status 48hr</th>
<th>Pump 2 Status 48hr</th>
<th>Opti/PLC Operation Modes 48hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote/Local Override</td>
<td>Remote/Local Override</td>
<td>Opti Operation Mode</td>
</tr>
<tr>
<td>100.0% Remote</td>
<td>100.0% Remote</td>
<td>100.0% Automatic</td>
</tr>
<tr>
<td>0.0% Local</td>
<td>0.0% Local</td>
<td>0.0% Manual Override</td>
</tr>
<tr>
<td>Run Status</td>
<td>Run Status</td>
<td>0.0% Opti FailSafe</td>
</tr>
<tr>
<td>50.3% Off</td>
<td>58.8% Off</td>
<td>0.0% Opti FailSafe</td>
</tr>
<tr>
<td>49.7% Run</td>
<td>41.2% Run</td>
<td>0.0% Opti FailSafe</td>
</tr>
<tr>
<td>Fault Status</td>
<td>Fault Status</td>
<td>PLC Operation Mode</td>
</tr>
<tr>
<td>100.0% Normal</td>
<td>100.0% Normal</td>
<td>100.0% Opti</td>
</tr>
<tr>
<td>0.0% Fault</td>
<td>0.0% Fault</td>
<td>0.0% Operator</td>
</tr>
</tbody>
</table>

### Monitoring and Control Datastreams

- Hammock Lane
- Bennett Lane Pump Station

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Ormond Beach - 2017 Hurricane Irma

Central Park Lakes (View Only)

Storm Status
24-hour Forecast Precipitation (in)
09/10/2017 04:26
7.1

24-hour Forecast Runoff Volume (ac-ft)
09/10/2017 04:26
94.5

Currently In
09/10/2017 04:26
Wet Weather

Storage Available (ac-ft)
09/10/2017 04:26
56.5

Target Valve Percent Open (%)
09/10/2017 04:26
0.0

Pump 1 Status
Past 48 Hours
Remote/Local Override
100.0% Remote | 0.0% Local

Run Status
31.1% Off | 68.9% Run

Fault Status
99.9% Normal | 0.1% Fault

Precipitation Forecast
Future 48 Hours

Water Volume in Active Storage

Opti Connectivity
Past all Hours
92.4% Online | 7.6% Offline

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Goals

- Enable engineers to understand performance of stormwater infrastructure
- Make connections on a watershed scale
- Provide feedback for new infrastructure
- Optimize existing infrastructure
Event Analysis

- Many stormwater analyses use events rather than time as a basis
- Data to delineate events already exists for Opti installations
Event Explorer

Timeline of events within the last year

<table>
<thead>
<tr>
<th>Event start</th>
<th>Event Definition</th>
<th>Duration (hr)</th>
<th>Precipitation Depth (in)</th>
<th>Runoff Volume (ft^3)</th>
<th>Maximum Precipitation Intensity (in/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>05/11/2019 19:07</td>
<td></td>
<td>86.3</td>
<td>1.09</td>
<td>8.76e+4</td>
<td>0.0800</td>
</tr>
<tr>
<td>05/10/2019 16:04</td>
<td></td>
<td>24.0</td>
<td>0.910</td>
<td>7.31e+4</td>
<td>0.360</td>
</tr>
</tbody>
</table>

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Event Specific IDs

- Available in all data exports
- All for grouping in custom analyses
- Can be matched to Event Explorer exports
Advanced Data Export

- Summarize data on a set time interval
- Aggregate as:
  - Mean
  - Median
  - Sum
  - Max / min
  - Latest value
- Fill null data by:
  - Next / previous value
  - Linear interpolation
- Create and save template downloads
Power BI Integration

- Operation Mode: Manual Override, FailSafe, Automatic Mode
- Online Status: Offline
- Fraction Online: 0.98
- Inflow (CF): 2.27M
- Wet Weather Outflow (CF): 952.12K
- Average Retention Time (hrs): 106.06
- Wet Weather Flow Volumes:
  - Sum of InflowVolume, Wet Weather Outflow, Wet Weather Outflow Retained: 2.7M
- Storage Volume (CF) Time Series:
  - Overflow
  - Data Points:
    - Oct 2018: 0.02
    - Nov 2018: 0.02
    - Dec 2018: 0.02
    - Jan 2019: 0.02
    - Feb 2019: 0.02
- Total: 3.21
Integration with EPA SWMM

- Use monitoring data as inputs to SWMM models
- Formatted in .dat SWMM format
- Enable time series inputs of measured data for calibration
Export Data

**Basic:** A snapshot of your data as it is stored on the OptiPlatform

**Export as:**
- **Comma-Separated Values (CSV)**
  The CSV format is a general purpose text format that can be easily imported into spreadsheet software and data analysis tools.

**Advanced:** Task oriented views of your data

**Export as:**
- **Preprocessed Comma-Separated Values (CSV)**
  This option offers preprocessing that summarizes your data on regular time intervals. The CSV format is a general purpose text format that can be easily imported into spreadsheet software and data analysis tools.
- **SWMM5 Rain Gauge File (.txt)**
  This option transforms data from one or more of your rain gauges into a SWMM5 Rain Gauge file that can be linked from a SWMM5 input file (.txt).
- **SWMM5 Time Series File (.dat)**
  This option creates a generic SWMM5 time series file (.dat) that can be imported into any SWMM5 time series object. This format only supports one datastream per file, but can represent rainfall, flows, or water level.
Example: Calibration of Hydrologic Model

![Time Series of Measured Data and Outlet Valve States](image)

- Water Elevation
- Overflow
- Underdrain
- Model Elevation
- Model Runoff
Takeaways

- A variety of hydrologic data sources already exist in disparate places
- Many methods exist for data warehousing with the cloud
- Combining data with analysis tools allows for
  - Optimizing performance of existing infrastructure
  - Better design and selection of new infrastructure
  - Better understanding of watersheds
Questions & Contact Info

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