Keeping the Storm Water Asset Backbone Strong to Avoid Disaster

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On September 5, 2017, Hurricane Irma reached Category 5 as it whipped the eastern Caribbean with force not seen before in the Atlantic. The operators at the emergency operations center of the South Florida Water Management District (SFWMD or the District) were busy implementing the measures they had just practiced during their hypothetical Hurricane Freddy exercise a few months earlier - pump water out to sea and drain all storage as much as possible to make room for the deluge to follow in just a few days.

As they sped through their carefully practiced routine, they knew they were leaning heavily on the backbone of South Florida's storm water control capabilities, the $2B system of over 1000 pump stations, locks, spillways, weirs, canals, and levees that cover the southern tip of the Florida peninsula.

Figure 1. A spillway in the South Florida Water Management District's system of more than 1000 pump stations, weirs, locks, culverts, canals, and levees.

Two years earlier, the operations and maintenance team (O&M) knew they needed a higher budget to maintain the system. But they didn't how much higher. Each asset in the system had a lifespan, and a need for regular capital investment to refurbish or replace. For the larger assets like the $80M S-3 pump station, these projects could cost millions of dollars and take many years to design and implement. One project could totally exhaust the entire capital improvement budget if the SFWMD team let it.

The team needed a way to look far into the future, at the full scope of all their assets, and quantify a budget to ensure they weren't digging themselves into a hole by letting assets deteriorate faster than they could be maintained. With the fiscal year rapidly

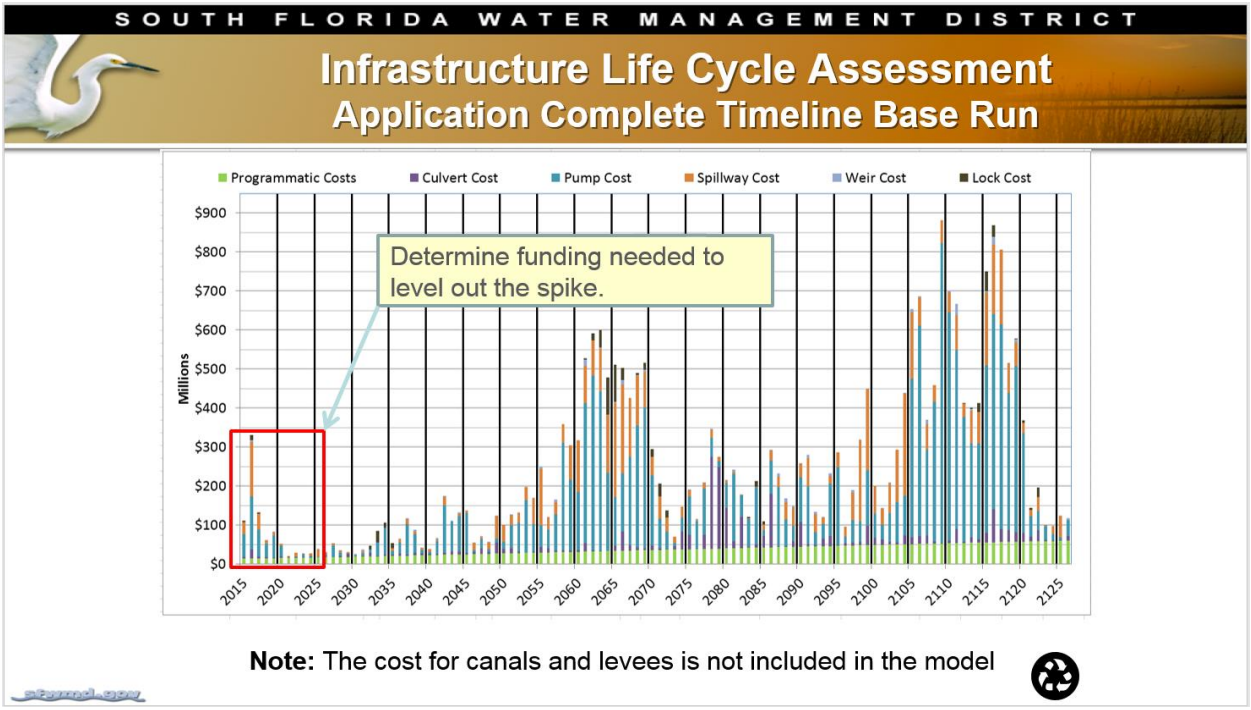
progressing, they knew they needed an answer quickly, so they could request their budget increase with research and real numbers to back them up.

Based on an asset cost forecasting demonstration project Atkins had conducted previously, the District hired Atkins to help. The Atkins team started with a meeting of senior water managers at the District. The goal was to reach consensus on the approach and tools to be used; collaboration and inclusion of the broader water management team at this stage ensured that the results would be considered valid and relevant.

The determination from the workshop was to build a hybrid technological solution that merged the District's SAP asset databases and their additional databases on asset replacement cost and asset condition with two new tools; an Excel-based tool O&M would use for creating cost forecast scenarios and a web-based tool for communicating the scenarios to the larger organization.

Key design decisions included:

- Keeping the cost models simple and at the large asset level. Even an $80M pump station was counted as one asset.
- Leveraging past research on replacement cost and maintenance project costs for all assets in the system to ensure the projected costs were reasonable and as accurate as possible.
- Employing contingencies to account for unexpected costs arising from climate change, sea level rise, and shifts in construction/design costs.
- Apply a decay curve to each asset that forecasted the drop in condition of the asset over its lifespan. The condition is the trigger for replacement and refurbishment, so the decay curves were a critical element in the analysis.
- Developing a new analytics database dedicated to storing the simple models for all assets and to facilitating the analytics quickly.
- Relating the analytics database to the District SAP database, so that as the District's asset system evolved, so could the cost forecasting results.
- Developing an optimization algorithm that explored shifting the schedule of each refurbishment and replacement project in the future to force the maximum number of projects to be carried out while ensuring that no assets reached critically poor condition.



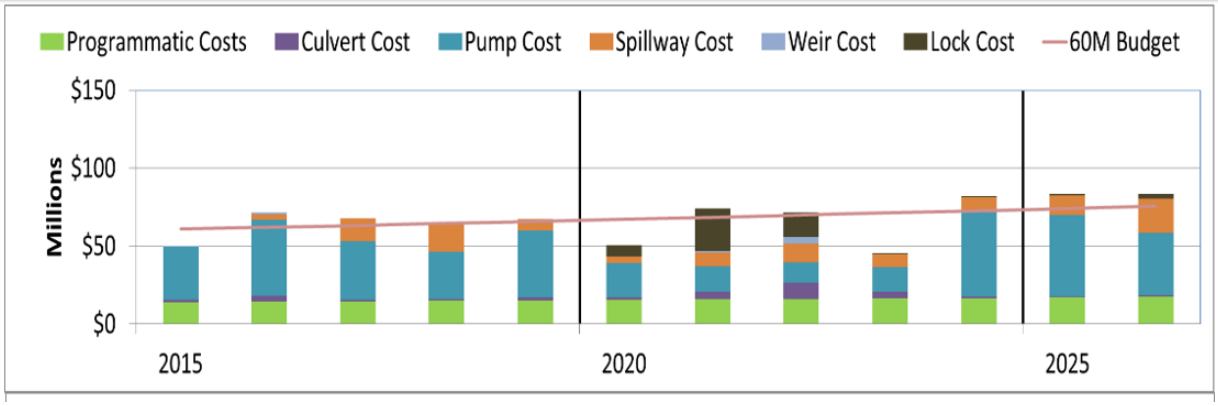


Figure 2. The SFWMD Cost Forecasting Tool presented the total cost of operations and maintenance from the current year to 2150. The upper panel shows the total cost if budget were unlimited. The lower panel shows a situation where a budget of $60M per year is forced. The tool has prioritized the most critical projects to ensure that no asset in the system moves to a worse condition while maintaining the required budget.

Over a period of just four months, the Atkins team worked with O&M to stock a database of replacement cost and cost forecasting model parameter for every asset in the system. At the end of the period, O&M conducted several assessments using the schedule optimization tools to arrive at a recommended budget that was approximately 20% higher than their current budget. Impressed by the research and the clear need for higher funding, the District governing board acknowledged that the current capital budget needed to be increased.

The flooding challenges in South Florida are huge. Rising sea levels are rendering coastal assets within the system less useful by the year, as gravity can be relied on less and less to drain dangerous storm water away. As the population continues to grow and housing and commercial real estate continues to fill the landscape, keeping the storm water system operational and effective is key. The District is collaborating with each community in the region to face these challenges, and is seeing impressive outcomes as a result.

Stephen Bourne serves as Project Director and R&D Chair at Atkins. A professional engineer, he has 17 years of experience in engineering and software development involving GIS, climate research, decision support system design, and software development and training.

Jack Hampson is Project Director, Life Cycle Asset Management, and has 25 years' experience in the application of technology for decision support. With a background in science, engineering, and technology he focuses on collaborative decision support to address a range of issues tied to resilient communities. This includes: asset management; life cycle cost forecasting; watershed management; risk communication; and, climate adaptation.