Ewart Avenue Stormwater

iPond

Controlling Runoff in the Cloud

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Executive Summary

The iPond is an intelligent stormwater management project, developed in response to a persistent problem of roadway flooding and property damage in Beckley, West Virginia. Beckley Sanitary Board (BSB) partnered with Opti RTC to retrofit BSB's existing stormwater detention facility with Opti's interactive monitoring and control system. The data-driven system is controlled through an online platform where forecasted rainfall is balanced with real-time pond storage capacity. The adaptive control system responds to the forecast by detaining and releasing stormwater runoff from a 263-acre urban watershed (12% impervious). The iPond has been highly effective in reducing roadway flooding, and has provided additional benefits to downstream channels, water quality, and the community.

Project Synopsis

Location: Beckley, West Virginia – Part of an approximately 500-acre watershed

Overview: In February 2017, a passive detention pond was retrofitted with Continuous Monitoring and Adaptive Control (CMAC) technology. Data analysis, optimization, and site operations are ongoing.

Timeline: Oct 2012 – Passive Detention Pond construction begun

Oct 2013 – Passive Detention Pond completed

July 2016 – CMAC Project development begun

February 2017 – CMAC Pond "iPond" goes online

April 2017 – Pond weir retrofitted, nearly doubling capacity of pond storage

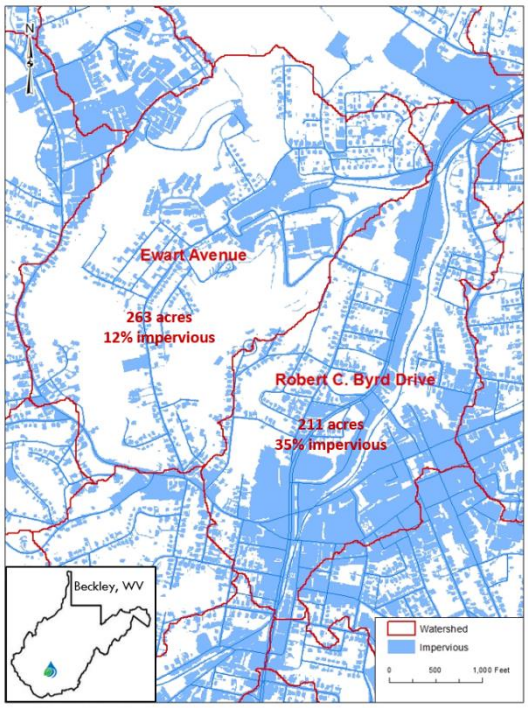
Ongoing – iPond is generating helpful data and serving a great purpose. Opti and BSB continue to monitor iPond to optimize its performance.

BECKLEY SANITARY BOARD

Project Background

The Beckley Sanitary Board partnered with other state and federal agencies (West Virginia Department of Highways, Southern Conservation District, West Virginia Conservation Agency) to address an issue of flooding along State Rt. 16 at the confluence of two urban watersheds, the Robert C Byrd Dr. watershed (211 acres, 35% impervious) and Ewart Avenue watershed (263 acres, 12% impervious). Roadway flooding was a longstanding issue that occurred 4-5 times per year. Flooding incidents resulted in complete closure at the roadway, deployment of emergency personnel, and damage to vehicles and infrastructure.

Initial planning considered improvement of the existing stormwater conveyance system in the flood-prone intersection itself, but soon revealed such a project would incur a cost of approximately $2.5 million. When the engineer's report determined that upgrading existing infrastructure was costlier and more structurally extensive than expected, an alternative solution was considered. After careful analysis and collaboration, it was determined that constructing a detention pond on City property to capture and detain runoff from the Ewart Avenue watershed during significant rain events would reduce the quantity of water flowing into the flood-prone area. The detention pond was completed in 2013 and reduced but did not eliminate flooding, as it was not equipped to detain runoff from smaller storms. As such, more performance was required and BSB needed to meet other water quality/TMDL objectives as well. In the interest of learning how flood control (detention) facilities could be used to improve water quality through short-term retention, BSB partnered with Opti in 2016 to evaluate Continuous Monitoring and Adaptive Control (CMAC) technology for this detention basin.



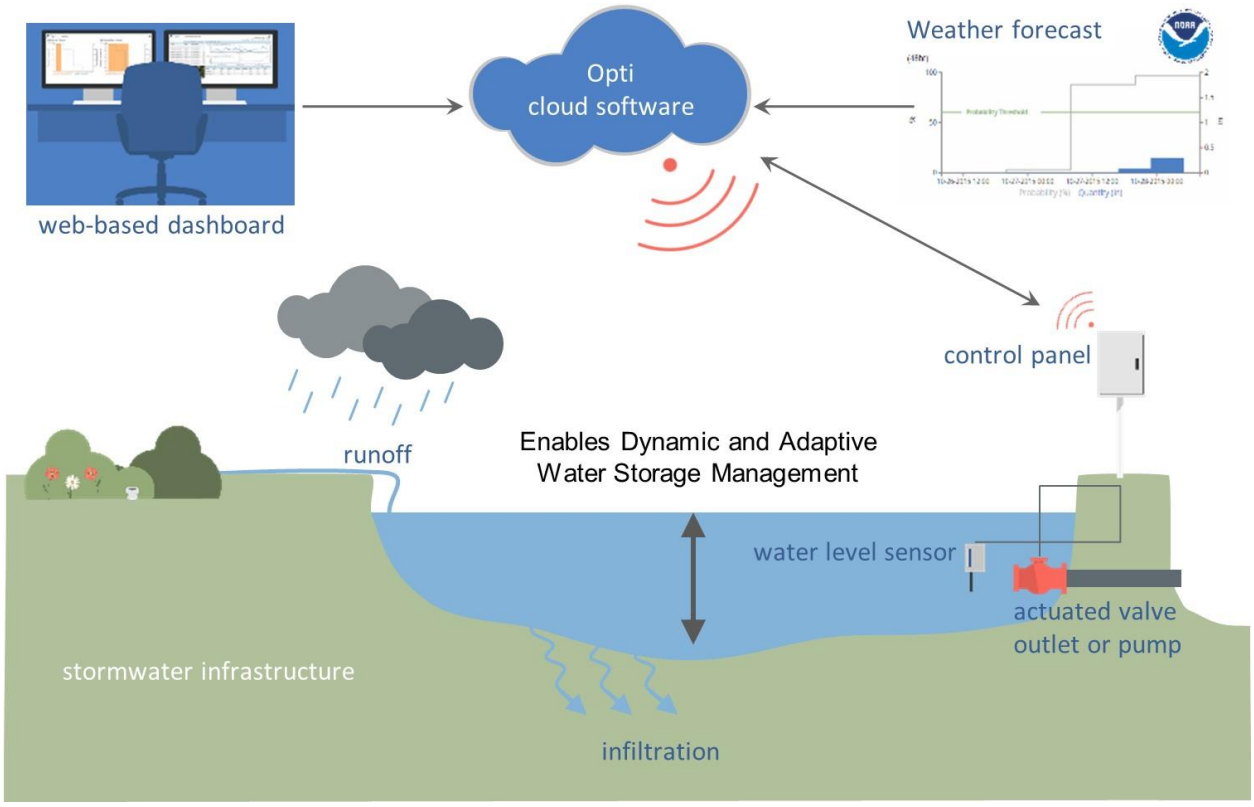
The convergence of two watersheds, Robert C Byrd & Ewart Ave, resulted in flooding 5-lanes wide due to the infrastructure not having the capacity to convey the stormwater during moderately intense rainfall. Flooding occurred 4-5 times per year and caused significant risk to vehicular traffic and damage to roadway and infrastructure.

Project Objectives

- *Reduce downstream flooding* by minimizing pond discharged during storm events.
- *Enhance water quality* of the downstream waterways.
- *Improve public safety* by collecting real-time data and automatic alerts.

Methodology and Technology Overview

In 2016, the Ewart Ave detention pond was converted to an interactive, real-time, data-driven adaptive stormwater control structure through Opti's continuous monitoring and adaptive control (CMAC). CMAC technology continuously modulates the 18" control valve installed on the existing outlet structure's low flow orifice, based on the pond water level and the precipitation forecast.



The iPond operates at the command of a control system which sets the pond to a base flow condition during dry weather. In advance of wet weather, the pond's outlet structure control valve closes to 0% open, capturing storm runoff in the pond. If the forecasted runoff volume is larger than the available storage in the pond, the control valve allows the minimum flow rate required to avoid pond overflow. After a storm event, runoff is retained in the pond for 48 hours, then gradually released downstream over the following 12 hours. If another storm event enters the 24-hour forecast window during the retention period, the system responds by gradually emptying the pond earlier, as needed.

This image shows the pond and its operational equipment, with labels.

1. *Control box receives and sends data*
2. *Actuated butterfly valve controls the iPond volume and discharge rate*
3. *Pressure transducer measures the water level and determines the storage capacity of the iPond*
4. *Total Suspended Solids (TSS) sensor monitors water quality.*
5. *(Not pictured) Stream gauges monitor flow downstream used to alert First Responders.*

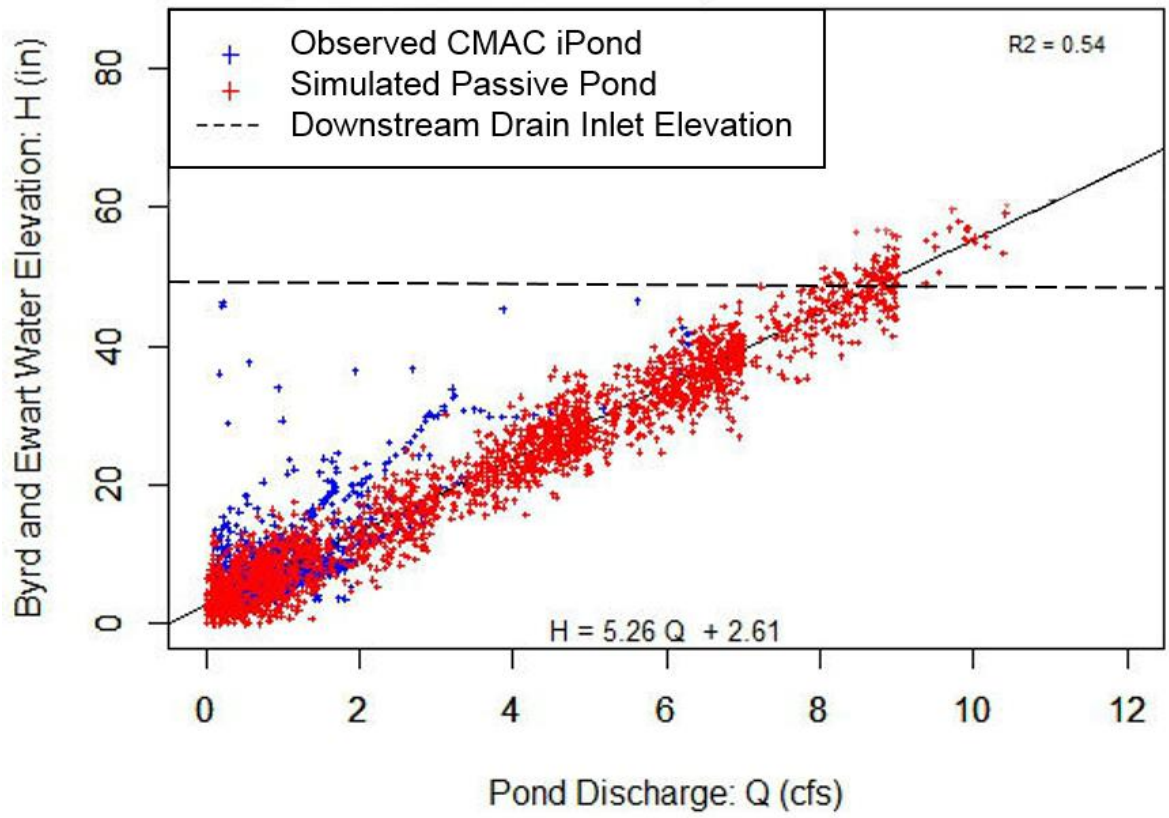
System Performance and Results

The iPond has been effective in accomplishing the goals of flood mitigation, water quality enhancement and public safety improvement. Comparison of the CMAC with a simulated passive system with the same watershed characteristics quantifies each of those benefits.

Flood Mitigation

Based on local observations and reports, the intersection of Robert C Byrd Dr. and Ewart Ave has experienced no flooding since the implementation of CMAC at the iPond. The reduction of flooding is attributed to the iPond's ability to detain the necessary volume of water per individual storm events to

relieve the downstream intersection of the flow from the Ewart Ave watershed. The following figure shows the relationship between the discharge from the pond and downstream water level. Implementation of the CMAC retrofit enables the iPond to restrict flows to within the capacity of the existing stormwater infrastructure, thereby preventing flooding.



Temporally coincident iPond discharge (horizontal axis) and downstream water level at Robert C Byrd and Ewart Intersection (vertical axis). Blue is the observed CMAC relationship and red is the simulated passive relationship based on the developed correlation and the passive pond discharge model. Randomness was introduced to the passive model based on the mean and standard deviation of the observed residuals.

Enhanced Water Quality

The iPond serves to enhance water quality primarily by reducing downstream channel erosion and by providing a settling environment for suspended sediments. Prior to the iPond's construction, runoff from storm events contributed to downstream erosion as high flow volumes moved through the stormwater infrastructure and stream channels. This downstream erosion is being mitigated by reducing the discharge rate from the pond, more closely mimicking a natural hydrograph. While the passive structure offered little capability for governing the rate of discharge from the pond, the CMAC actuated valve regulates pond discharge preventing downstream channels erosion.

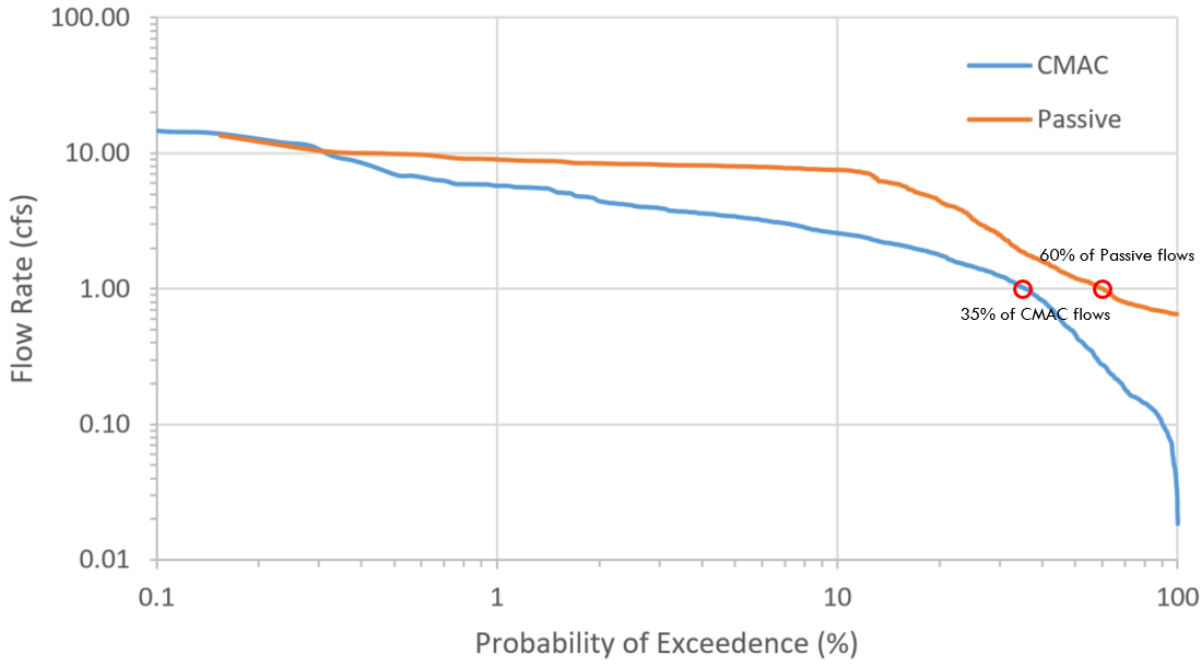
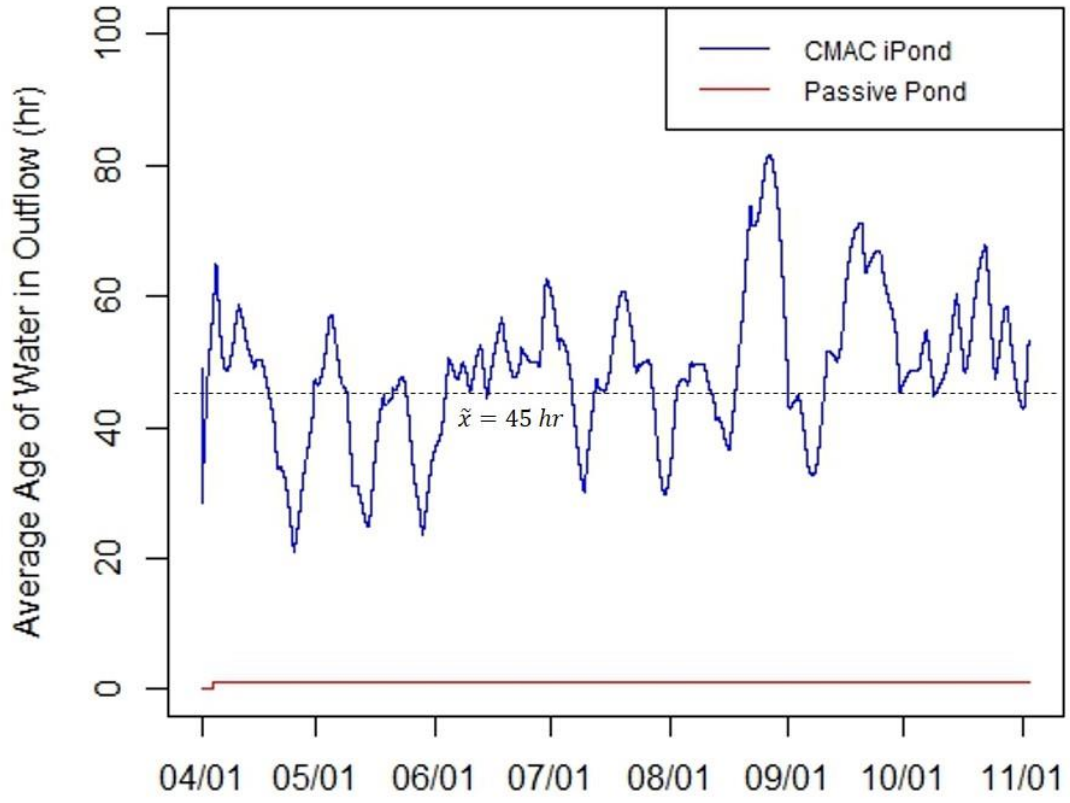
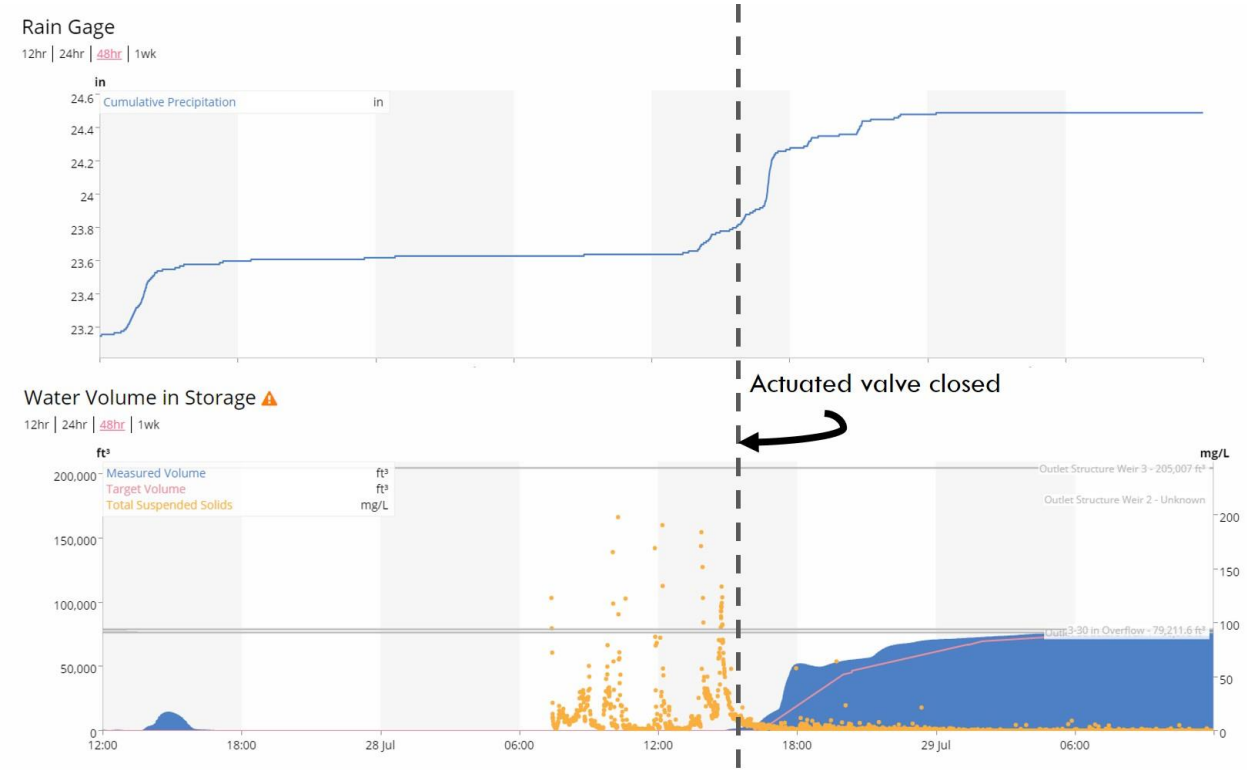


Chart shows a flow duration curve for both iPond as observed (CMAC) (blue) and for a simulated passive system (orange) with the same hydraulic and hydrologic conditions. We see the implementation of CMAC led to a decrease in the frequency of discharge rates below approximately 10 cfs, with higher flow rates primarily unchanged due to storms that overtopped the system. For medium and small storms, the CMAC system modulates the low flow valve to discharge at the slowest rate allowable to prevent overtopping. The observed CMAC system reduced peak flow rates relative to the simulated passive system (e.g., 60% of passive flows exceeded 1 cfs, whereas only 35% of CMAC flows exceeded 1 cfs). Flows of 0 cfs were omitted from this analysis.

Stormwater runoff often carries suspended sediment or other pollutants that are carried into streams. The iPond enhances the quality of stormwater by providing a settling environment for those suspended pollutants. The pond captures and holds the stormwater runoff, decreasing the water velocity and allowing sediments to settle out of the water column. As the detention time and the age of the water increases, more sediments are removed from the column, improving the water quality. The following figures show the age of the stormwater stored in the iPond and the resulting removal of suspended solids.

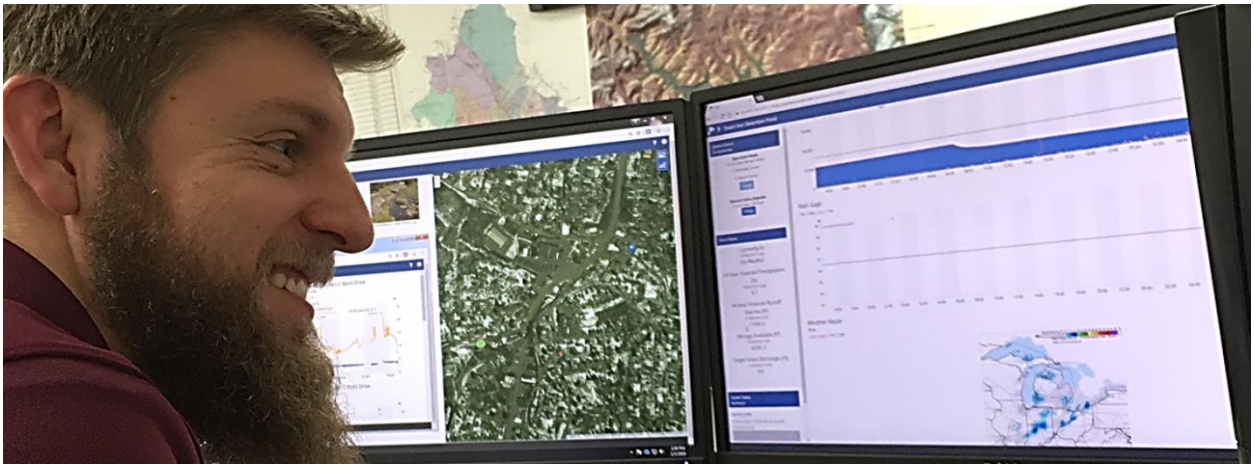


Age of water in the observed CMAC system (blue) and for a simulated passive pond (red). In the passive system, average water age is only one hour. In the iPond, the water's age ranges from 20 to 80 hours, with an average age of 45 hours. (Dry weather flows omitted from analysis.)



Online dashboard view of rainfall, water volume, and total suspended solids at the iPond during a 2017 summer storm. When the valve was closed to reduce flow, water volume increased and suspended solids began settling.

Community Benefits



Public Safety

The iPond project has served to protect both person and property in the city of Beckley. Flood mitigation has significantly reduced roadway flooding at a major 5-lane intersection, carrying approximately 25,000 vehicles per day. Early warning notifications to when the area may be at risk of

flooding enable First Responders to arrive on site more quickly to redirect traffic or correct any problems to prevent the area from flooding.

Financial Investment

The iPond provides a cost-effective solution to the ratepayers of the BSB's stormwater utility. Construction of the passive detention facility cost approximately $780,000, significantly less than the cost of upgrading drainage structures at the effected intersection. Implementation of the Opti CMAC system was even more affordable, at a total cost of about $23,000, originally—$13,000 after Opti in-kind funding. This low-cost solution protects Beckley rate-payers not only from a higher initial cost to fund a traditional grey infrastructure project, but from ongoing costs of roadway repairs and private property repairs from flood damage.

Environmental Protection

The iPond's enhancement of water quality and stream channel protection preserves the natural environment and the water for the community to use and enjoy now and in the future. Finally, the many successes of iPond aid in strategic planning of any future infrastructure upgrades by quantifying data so that more cost-effective upgrades can be performed.

Completed iPond, detaining runoff from the Ewart Ave subwatershed, thereby preventing flooding downstream at the convergence of watersheds.

iPond Project Partners:

OptiRTC is focused on improving water quality, preventing localized flooding, and reducing combined sewer overflows through Continuous Monitoring and Adaptive Control (CMAC) of stormwater infrastructure. Opti CMAC is a secure cloud-based solution that automatically controls the timing and rate of flow through stormwater storage systems, helping cities and businesses turn these assets into higher-performing, resilient systems at reduced cost and with less risk than existing alternatives.

The Beckley Sanitary Board (BSB) in the City of Beckley, West Virginia has been providing sanitary sewer collection and wastewater treatment for over 80 years. Since 2007, BSB has operated a stormwater utility to manage runoff in its urban watershed and is currently serving about 10,000 stormwater customers and 7,500 sewer customers.

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