Project Status, August 2018: CS-175; Dynamic Collection System Control

Summary

The two areas of focus for the project CS-175; Dynamic Collection System Control are: analysis of dynamic control for the GDRSS system, and an operator decision support dashboard. Here we provide a review of progress made for each of these tasks and discuss future work.

Updates

Dynamic Control for the GDRSS

In July we added a flood elevation condition to the control decision algorithm and explored multiple market setups for the Conner Creek – Freud – Fairview complex. We observed that the three-marketplace setup performs better than the one and two-marketplace setups tried. However, work was still required to optimize the weighting and setpoint parameters to use during simulations.

With that in mind, in August we used a genetic algorithm technique to find a set of parameters that could reduce total CSO volumes and time of flooding. For this approach, several "individuals" (defined as a unique set of parameters,) were initially evaluated on their ability to minimize both CSOs and time of flooding. Individuals with the best performance by these metrics were chosen to continue into the next generation with minimal mutations. Other new individuals were made by crossing two different individuals from the previous generation, creating a group of offspring. Further still, the worst performing individuals were replaced entirely with randomly generated individuals. Doing this over multiple generations, we were able to test many different parameter settings and find a combination of parameters that best minimized CSOs and flooding. The best individual, or rather parameter set, from this optimization/calibration procedure resulted in a reduction of approximately 100 million gallons (or 77%) of CSO, a reduction in total volume to the treatment facility, and no increase in peak flows when compared to the no control, or baseline. These results can be found in Figure 1 below.

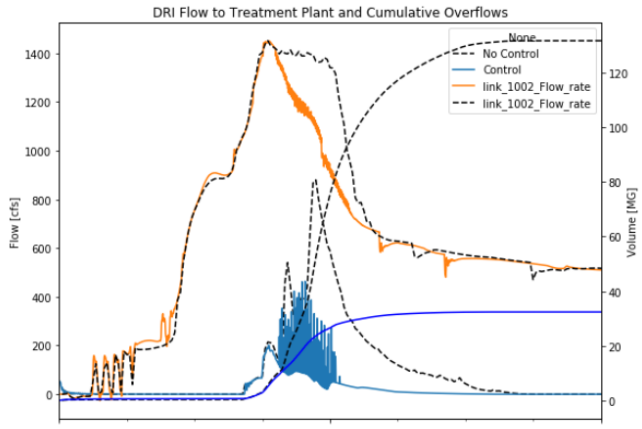

Figure 1 Comparison of results for the May 4, 2017 storm. The baseline, "No Control", case is seen in the dashed lines for inflow to the treatment plant, instantaneous CSO outflow (both left axis,) and total CSO volume for event (right axis.) Dynamic control for each of these measures is plotted using solid colored lines.

Using this calibrated parameter set we evaluated four different historical storms. The results from these simulations can be found in Table 1 below. All model outputs were compared against a baseline value calculated by running the same storm event with an unaltered version of the SWMM input file, which reflects current operating procedure. In three of four simulations we observed a reduction in total CSO, the best result being a reduction of 13% of CSOs (or 107 million gallons,) shown in Figure 2. Additionally, focusing on the inflow to the treatment plant, the recession limb trails off more quickly and maintains a constant value of approximately 500 cfs at the end of the storm event, indicating that we can quickly stabilize to an inflow setpoint. Similar results were observed for other storm events, with the exception of the 11-May-18 storm event listed in Table 1. We hypothesize that this is due to the identification of parameters via a genetic algorithm trained on a single storm event of certain characteristics. Note that the duration and total precipitation depth for these events are very different and thus the parameters identified by the genetic

Project Contacts:
Branko Kerkez
bkerkez@umich.edu

algorithm are not likely to be optimal for rain events of this nature. We intend to investigate this hypothesis in September.

Event Date	Event Type	Event Duration [hours]	Precipitation Depth [inches]	Total CSO Volume [Millions of Gallons]		
				Baseline	With Control	Reduction (%)
4-May-17	Calibration	16	1	130	30	77%
11-May-18	Evaluation	96	2.8	1666	1906	-14%
2-Jun-18	Evaluation	1	0.7	47	46	2%
31-Jul-18	Evaluation	8	1.3	1318	1274	3%
31-May-15	Evaluation	28	2.0	842	735	13%

Table 1. Comparison of outflow volumes for storm events using the current operation procedure, baseline, versus applying the team's dynamic control algorithm.

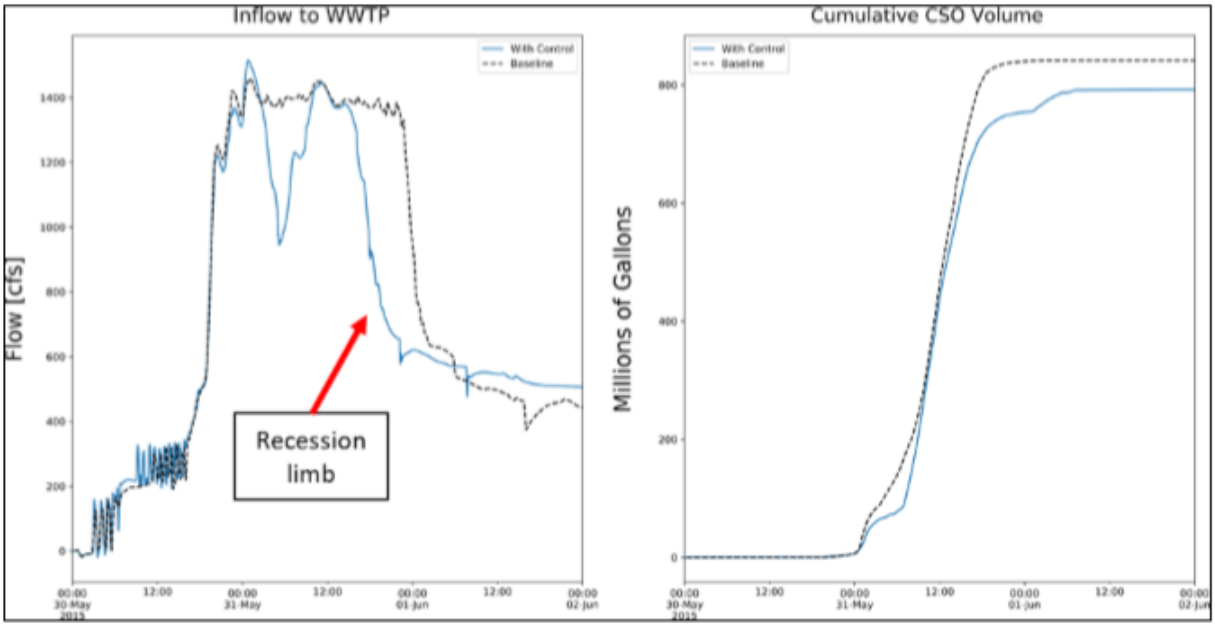

Figure 2. *Timeseries results for the May 30, 2015 storm event. Dynamic control resulted in a reduction of ~100 Million Gallons of combined sewer overflow as compared to baseline.*

Decision Support Dashboard

Two decision support dashboard prototypes were developed and shared with GLWA staff in August: one for ISDs and one for the Conner Creek – Freud – Fairview complex. Currently neither dashboard receives real-time data feeds. We are working with Joe Burchi of GLWA to begin to ingest and process real-time data. We anticipate this effort will be completed in September.

Future Work

What We Need: Schedule a meeting with GLWA stakeholders to discuss findings from this effort.

Reporting

We look forward to providing an update of our progress on September 30, 2018.

Project Contacts:
Branko Kerkez
bkerkez@umich.edu