The Dell at the University of Virginia – Charlottesville, VA
Methodology for Landscape Performance Benefits

Environmental

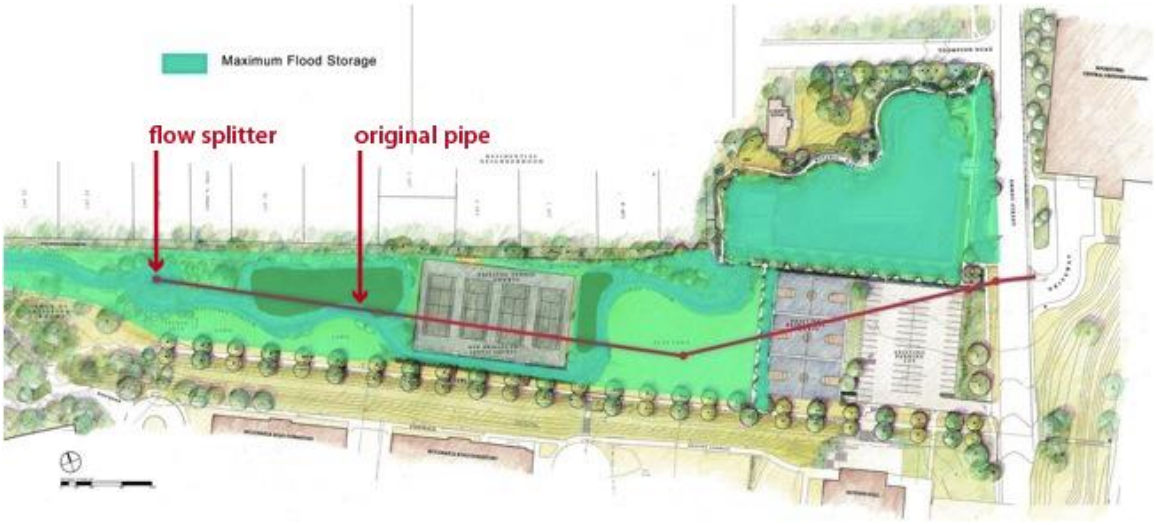
- ***Daylights and restores a 1,200 linear foot section of piped stream to a more naturalized profile with meanders and vegetated stream banks.***

This information comes from project design and construction documents. One of the primary goals of the Dell design was to restore Meadow Creek to a more ecologically productive and daylit condition.

- ***Manages runoff from up to a 2-year storm event, with excess runoff diverted through the original underground pipe to a storwater treatment facility located 0.75 miles downstream.***

A student research team made bathymetric measurements in the Dell Pond. The shape and depth of the pond bed was estimated by creating quadrangles in AutoCAD from these bathymetric measurements. The average depth of each quadrangle was calculated and multiplied by its area to find the incremental volume. By summing these incremental volumes, the total storage volume of the pond was found to be approximately 194,000 cubic feet. Actual volume is dependent upon the volume of captured sediment present in the system's catchment forebay.[1]

Runoff that enters the stream channel and exceeds the designed capacity of the Dell is diverted through the "flow splitter", which was installed in the upper northwestern zone of the site, upstream from the Dell Pond. The excess stormwater is then redirected to the John Paul Jones Arena stormwater treatment facility, 0.75 miles downstream (see previous map) through the original underground pipe that once fully contained the now daylit Meadow Creek.

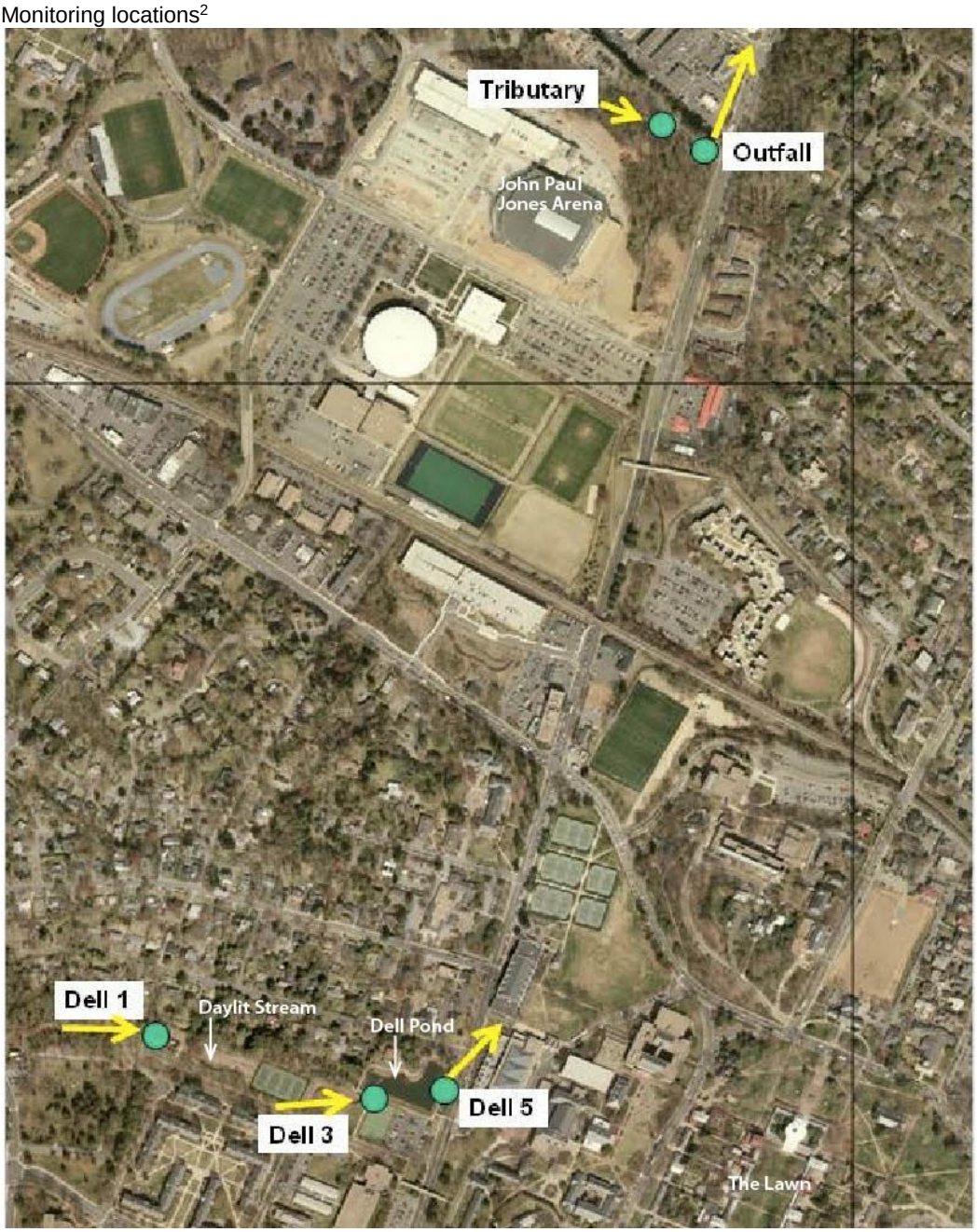


- ***Reduces and delays peak stormwater discharge, as evidenced by monitoring data. This results in less flash flooding, less bank erosion, and more opportunities for sediment to settle.***

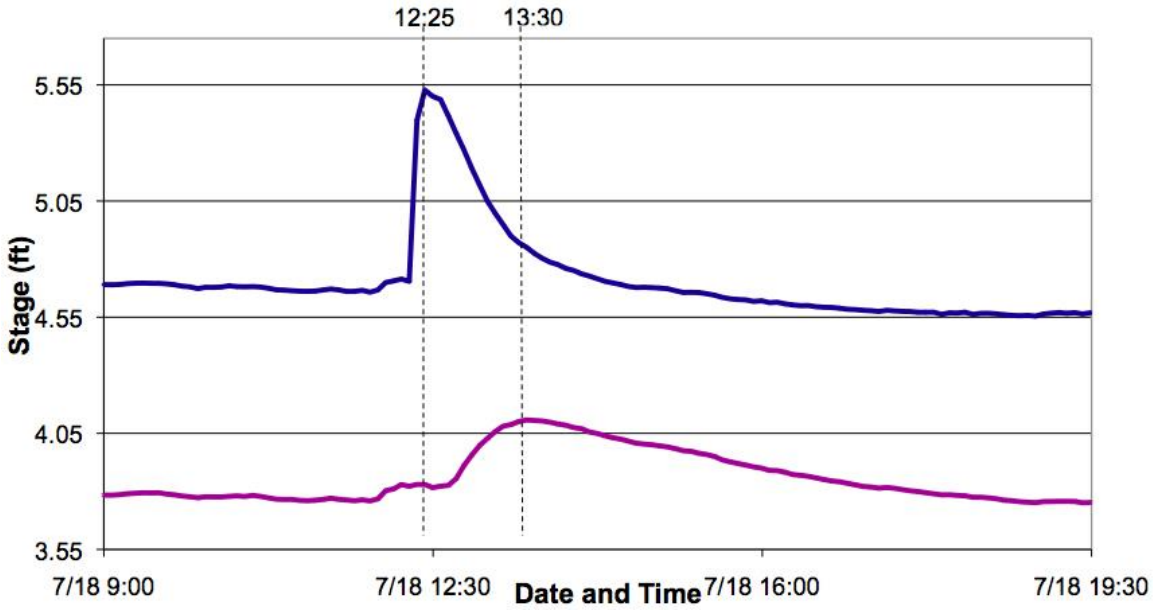
- ***Reduces sediment and nutrient loadings downstream, reducing total suspended solids by 30-92%, phosphate by 23-100%, and nitrate by -50-89% according to water sample data.***

A 2009-2010 student research team installed monitoring systems at nine locations in the Dell and measured water quality and quantity by establishing base flow conditions; examining conditions during and directly following storms; measuring Temperature, pH, Nitrates, Nitrites, Iron, Phosphates, Oxygen, Alkalinity, Conductivity, Turbidity and Flow. The team also involved a number of additional students in the monitoring and collection of data.

Monitoring locations[2]



For water quantity, the student research team used the following process:
"Monitoring the timing and magnitude of water discharge at various locations in response to rainfall was achieved through the installation of stilling wells in which were placed pressure transducers. After correcting for barometric pressure, total pressure was converted to height of water (stage). Measurements were recorded every 5 minutes." [2]



Water Quantity: Peak discharge is reduced and delayed at Dell Site 5 at Pond outlet relative to Dell Site 1 at upstream beginning of the meanders during a July 18, 2008 storm event. [3]

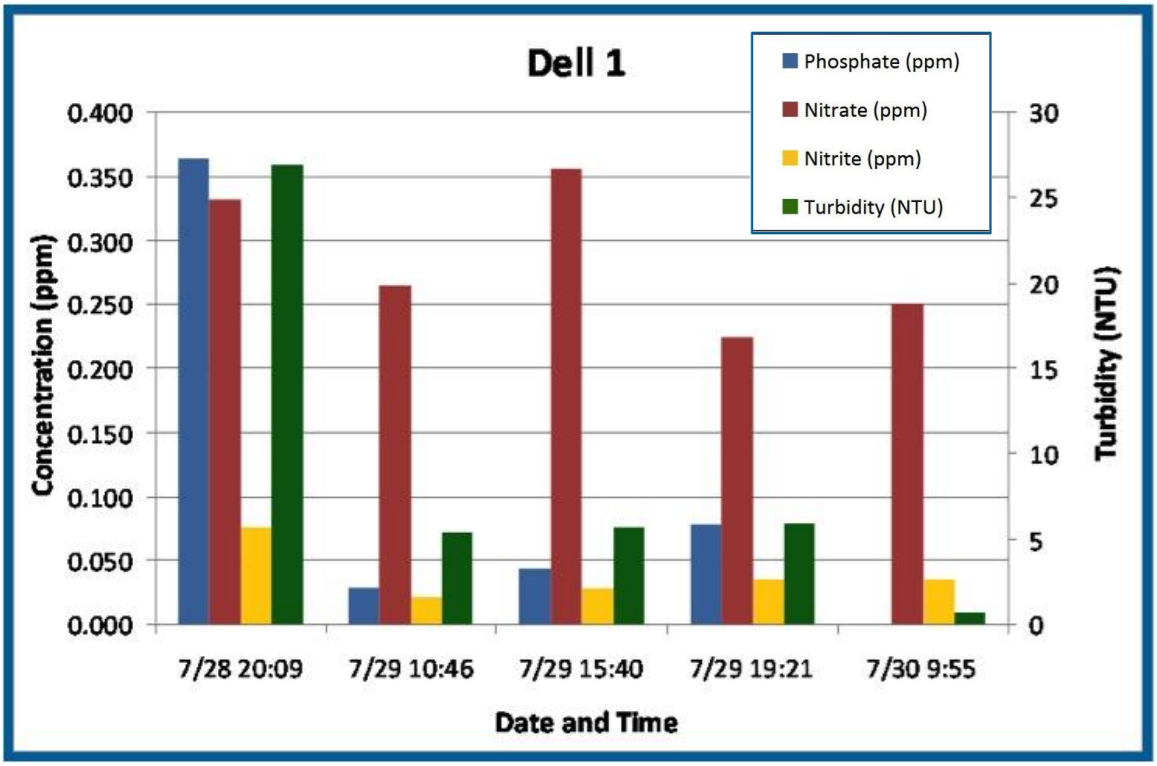
For water quality, the student research team used the following process:
"Water samples were collected in two ways both during and after a storm event. At some locations, water was collected by automatic samplers set to trigger for stage rise or for precipitation rate. At other locations, grab samples were collected by hand. Turbidity [was] measured first for each sample using an Oakton T-100 Portable Turbidimeter. Based on the trends in the turbidity data, the team decide[d] which samples to analyze for phosphate, nitrate, and nitrite. This nutrient analysis is performed using a CHEMetrics V-2000 Photometer."[4]

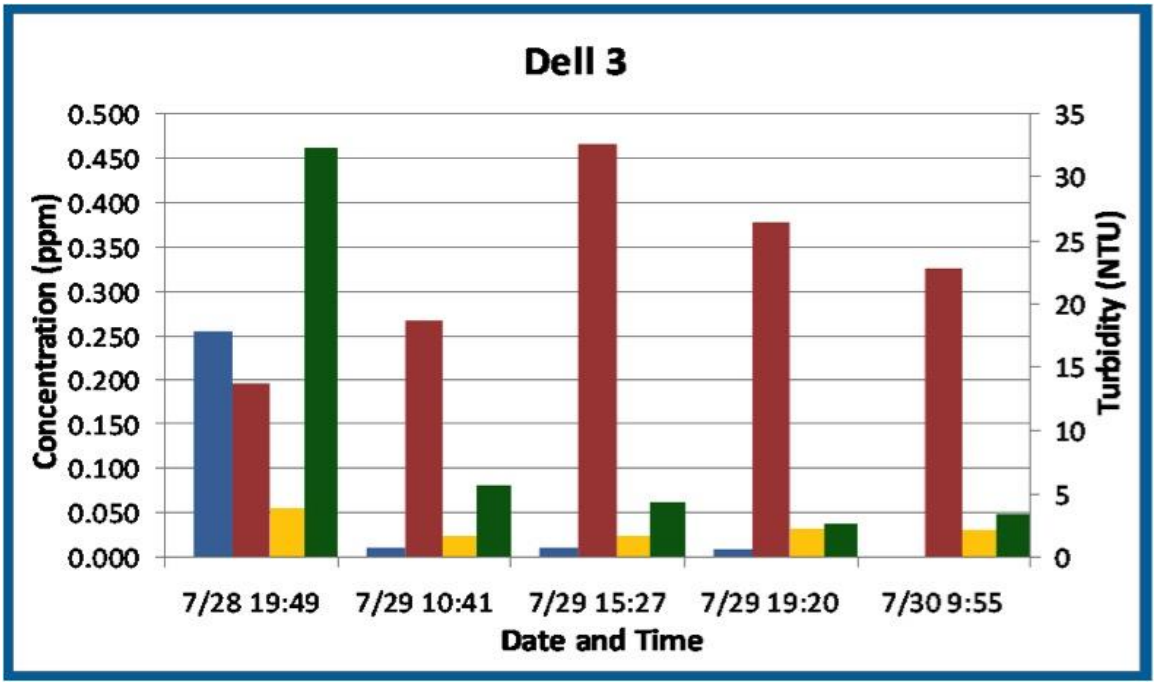
The student research team concluded that "sediment and phosphate drop out together along the vegetated meanders of the daylighted Meadow Creek and in the forebay of the Dell Pond",[5] as is evidenced by the following data:

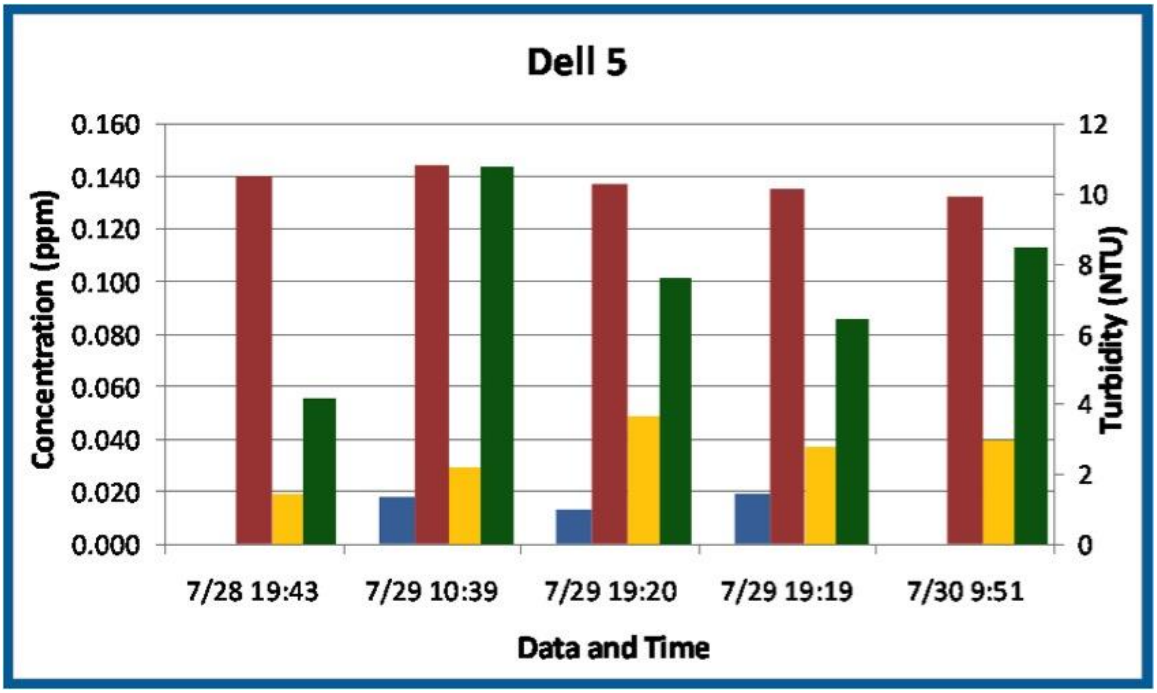
> *Reduces Total Suspended Solids loading downstream by 30-92%.*
> "Mitigation at the Dell Pond greatly reduces the amount of turbidity passing further downstream. During small storm events (2-year storm), very little turbidity ever arrives at the Pond outfall." [6]
>
> *Reduces Phosphate loading downstream by 23-100%.*
> "Phosphate concentrations are reduced in concert with the turbidity. Both phosphate and turbidity are reduced by as much as two orders of magnitude."[7]
> *Reduces Nitrate loading downstream by -50 to 89%.*
> "Nitrate concentrations are only reduced by a factor of two. Retention time in the Pond is not long enough for biological processes to fully mitigate the stormwater input."[8]

The following series of graphs illustrate the recorded Phosphate, Nitrate, Nitrite, and Turbidity

levels present in the upstream and subsequent downstream conditions during a storm event recorded from July 28th to July 30th, 2009. [9] Note that due to the substantial decrease in nutrient and suspended solids loads in downstream conditions, units are not uniform from graph to graph.







Full details of the team's methodology and findings can be found in their final report, Stormwater Management: Validating Water Quality and Quantity: Final Report to the Vice-Provost for Academic Programs of the Community-Based Undergraduate Research Grant (CBURG) to Team Stormwater, 2009-2010.

- ***Provides habitat and sources of food for wildlife as evidenced by the dramatic increase in wildlife sightings that have occurred since the completion of the project.***

The success of the habitat created by the daylighting of the stream, the restoration of riparian edges, wetland thickets, and the construction of the Dell Pond can be measured by the dramatic increase in wildlife sightings that have occurred since the completion of the project. Species often observed, but that were not present prior to the construction of the Dell, include great blue heron, turtles, amphibians, fox, rabbits, fish, and a wide variety of birds. Many of the plants chosen also provide food for a variety of species and their presence has also encouraged the growth of a more diverse wildlife population.

Social

- ***Provides recreational opportunities for an estimated 10,000 users each year, including members of the University, the adjacent residential communities, and thousands of visitors each year.***

While the majority of the recreational facilities located at the Dell are designated as "drop-in" use fields, numerous tournaments, picnic, and field day events occur throughout the year alongside daily informal use. Records indicate over 3,000 people annually attend such special events. The Dell's location on Central Grounds in close proximity to the McCormick Road Residence Area (undergraduate dormitories), the University bookstore and Central Grounds Parking Garage, the Curry School of Education, Brown College, and an adjacent residential neighborhood, however, suggests that usage numbers likely exceed 10,000 visitors per year.

- ***Provides an educational resource and learning laboratory for students. The Dell has been the subject of thesis work, individual and group grant-funded research, academic design work, and is used as an outdoor classroom year-round.***

The Dell is an effective outdoor classroom and learning space for ecology and plant identification courses, has been the subject of graduate landscape architecture research and studio work, and is the subject of ongoing research undertaken by students in the Environmental Sciences, Civil, and Environmental Engineering Departments.

In 2009, a team of five University of Virginia students, Michael J. Downey, Andrew T. Smith, Robert S. Arthur, Kate E. Abshire, and Nathaniel C. Farrar, from the Environmental Sciences and Civil and Environmental Engineering Departments were awarded a Community-Based Undergraduate Research Grant (CBURG) to monitor and quantify the impact of the Dell Pond on water quality downstream. All field work, data collection and analysis was accomplished with the support and under the supervision of the University Environmental Health and Safety staff led by Jeff Sitler and Professors Janet Herman, Teresa Culver, and Joanna Curran. In addition to this effort, two members of the student team produced theses related to their initial research at on the Dell. Kate Abshire, who received additional funding for her research from Nitsch Engineering and the Boston Society of Architects, produced her thesis, Quantifying nitrate, phosphate, and total suspended solids loading and removal through measurement and analysis of stormwater events. Robert Arthur explored stormwater modeling tools and model validation, specifically the USEPA's Stormwater Management Model simulator, in his thesis, Stormwater Runoff Simulation Using SWMM: Evaluating Stormwater Management on the University of Virginia Grounds.

Much of the data and performance metrics available regarding the Dell are the direct result of both the aforementioned and ongoing student monitoring and research and were referenced in this document.

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[1] Michael J. Downey, Andrew T. Smith, Robert S. Arthur, Kate E. Abshire, and Nathaniel C. Farrar, Sustainable Stormwater Management: Validating Water Quality and Quantity: Final Report to the Vice-Provost for Academic Programs of the Community-Based Undergraduate Research Grant (CBURG) to Team Stormwater, 2009-2010, p6.
[2] Robert S. Arthur, Kate E. Abshire, Michael J. Downey, Joanna C. Curran, Theresa B Culver, and Janet Herman, Stormwater Management: Discharge Turbidity, and Nutrient Concentrations during Storm Events. From the poster presented at the Virginia Water Research Conference, October 16, 2009.
[3] Ibid, p5.
[4] Ibid, p4.
[5] Ibid, p6.
[6] Ibid, p5.
[7] Ibid, p5.
[8] Ibid, p6.
[9] Ibid, p10.