The Buck Creek Watershed

A watershed is the area of land that contributes runoff and streamflow to a given point downstream. A watershed can be subdivided into smaller watersheds. For example, Beaver Creek is a tributary to Buck Creek, so the Buck Creek watershed includes smaller watersheds, one of which is the Beaver Creek watershed. Smaller watersheds are often referred to as subwatersheds. Likewise, Buck Creek is a tributary of Mad River, so its watershed is part of a larger watershed that contributes runoff and streamflow to the Mad River. At the largest scale, runoff and streamflow from Buck Creek and Mad River watersheds flows into the Ohio and Mississippi Rivers, so the Buck Creek watershed is part of the even larger Mississippi River watershed. Watersheds are defined by watershed divides, high points or ridges in the landscape separating runoff between adjacent watersheds. The purpose of this factsheet is to provide information on the Buck Creek watershed, its subwatershed, and their characteristics, and some of the impacts these characteristics have on streamflow and water quality.

Understanding watersheds, watershed divides, and the direction and pathway of runoff and streamflow is critical in environmental studies. Excessive erosion occurs when land use promotes runoff. The eroded sediment is one of the principle pollutants in Ohio streams. Because watersheds define the point to which this water flows, a pollution problem can be traced to the watershed experiencing excessive erosion and mitigation of the problem can focus on that watershed. This same principle applies to nutrients, such as phosphorous, and other pollutants that adhere to and travel with the sediment. In addition, problems with the migration of freshwater fauna, some of which are invasive like Asian carp or the zebra mussel, can be addressed on a watershed basis.

Watershed area and morphologic properties of the watershed, like slope and length, are important variables because they control the amount of runoff and streamflow produced by a given rainfall event as well as the rate at which it flows off of surfaces within the watershed. Small, steep watersheds can produce excessive runoff and cause flash flooding. Runoff in larger watersheds with lower slopes travels more slowly and, while it can produce significant flooding, the floods are not flashy in character.

The Buck Creek Educational Corridor extends to just downstream of the Bechtle Avenue bridge over Buck Creek. The area of the watershed that contributes runoff and streamflow to
this point is 140 mi\(^2\). The highest elevation in the Buck Creek watershed, along the divide, is 1323 ft above mean sea level. The lowest elevation, at its outlet on Buck Creek, is 898 ft above mean sea level. Slopes in the watershed are as great as 34 percent, in the steeper areas nearer the divide, but average approximately 3 percent for the watershed as a whole. The Buck Creek watershed is composed of three smaller watersheds; the area draining into and from the C.J. Brown Reservoir on Buck Creek, upstream of its confluence with Beaver Creek, the area draining into Beaver Creek upstream of its confluence with Buck Creek, and the area draining into Buck Creek from the urbanized area of Springfield. Each of these areas impacts streamflow and water quality in Buck Creek differently.

**Buck Creek Upstream of Its Confluence with Beaver Creek**

The watershed draining to and from the C.J. Brown Reservoir on Buck Creek is 83 mi\(^2\) in area. More than 98 percent of this area is upstream of the reservoir. Land use and cover is dominated by agriculture, including row crops, hay, and pasture. Streamflow downstream of the reservoir is controlled by the U.S. Army Corps of Engineers (USACE). The dam and reservoir were constructed for flood control. This is especially critical during winter and spring months when the ground is frozen or saturated and much of the rainfall is converted to runoff and streamflow. During rainfall events, when runoff from the Beaver Creek watershed and the urbanized area of Springfield area are contributing to higher stages of streamflow in Buck Creek, runoff upstream of the reservoir is retained until flow stage on the lower Buck Creek has receded.

Hydrologists use a hydrograph to study streamflow in rivers. A hydrograph is a chart showing stream stage, or height of the water above an arbitrary datum over time. Stage normally rises during a rainfall event and begins to fall immediately after rainfall stops. The shape of the hydrograph in response to a rainfall event is somewhat triangular. Releases from reservoirs have a distinctly rectangular shape. At C.J. Brown Reservoir, the USACE adjusts the release from the reservoir daily after 6:00 am. Depending on the stage of flow, the release causes a rise in stage at the Plum Street gage approximately 3 to 4 hours later, and the rise continues for approximately 2 to 3 hours, after which the stage levels off again. If the release on a given day

<table>
<thead>
<tr>
<th>Watershed</th>
<th>Area (mi(^2))</th>
<th>Elevation (ft)</th>
<th>Slope (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buck Creek Watershed</td>
<td>140</td>
<td>898 to 1323</td>
<td>0.0 to 34.5, 3.4</td>
</tr>
<tr>
<td>Beaver Creek Subwatershed</td>
<td>39</td>
<td>948 to 1290</td>
<td>0.0 to 33.5, 3.2</td>
</tr>
<tr>
<td>Buck Creek Subwatershed above confluence with Beaver Creek</td>
<td>83</td>
<td>949 to 1322</td>
<td>0.0 to 31.3, 3.5</td>
</tr>
<tr>
<td>Buck Creek Subwatershed below confluence with Beaver Creek</td>
<td>18</td>
<td>898 to 1132</td>
<td>0.0 to 34.5, 3.3</td>
</tr>
</tbody>
</table>
is more than the previous day, this appears as a step up in stream level at the Plum Street gage, as the flood wave moves downstream. If the amount of the release is less than the day before, it appears as a step down in stream level.

Large dams and reservoirs like C.J. Brown impound water, sediment, and much of the dissolved solids like salts and nutrients. As a result, water released from C.J. Brown Reservoir will generally have low turbidity. Other water quality parameters like temperature and dissolved oxygen can be controlled by the amount and depth at which water is released from the reservoir. The USACE manages the release in a way that minimizes the downstream impact on fish and other organisms living in Buck Creek.

**Beaver Creek Upstream of Its Confluence with Buck Creek**

The Beaver Creek watershed is 39 mi$^2$ in area. Nearly 80 percent of the watershed area is agricultural, comprised of row crops, hay, and pasture. There are no structural controls, such as a dam and reservoir, on flow is this watershed. A lowhead dam on Beaver Creek near its junction with Buck Creek does not control or regulate streamflow. Modifications are planned for this dam in fall, 2011, or spring, 2012.

Water quality in watersheds dominated by agricultural land use and cover is impaired by sediment and nutrients, from erosion and runoff from fertilized fields. Sediment decreases recreational value and reduces fishery habitat if it is deposited on spawning and feeding areas. Nutrients such as phosphorus may also be attached to sediment. Other nutrients, like nitrates, are dissolved in runoff and streamflow. They can cause excessive algae and aquatic growth, create toxicity problems for fish and humans, and impair recreational uses. When it rains in the Beaver Creek watershed, runoff into the streams causes the stream stage to rise. Because the runoff may carry sediment and nutrients related to agricultural use of the land, water quality downstream in Buck Creek will change. One of the parameters measured by the water quality instruments is turbidity, which is a measure of water clarity. Suspended sediment, from erosion will increase turbidity. When a storm passes over this watershed, stream stage and turbidity increase as water and sediment runoff from the Beaver Creek watershed enters Buck Creek. A gaging and water quality station on Beaver Creek records these and other changes above its confluence with Buck Creek.

**Buck Creek Downstream of its Confluence with Beaver Creek**

The Buck Creek watershed below the confluence with Beaver Creek includes the area of Springfield that drains to Buck Creek. The watershed area is 18 mi$^2$. City commercial and industrial areas and residential areas dominate this watershed; more than 50 percent of the area is classified as urban or built land use. Nearly 30 percent is also open space and water, primarily the parks, creek and ponds, and green space along the Buck Creek riparian corridor. The impervious surfaces in the urban or built areas (e.g., roads and roofs) have an obvious impact on the streamflow hydrograph. Impervious surfaces increase the amount of storm water runoff by 3-5 times the amount that would occur naturally. In Springfield, as in other communities throughout Ohio, run-
off from these surfaces is combined with sanitary and industrial wastewater from homes and businesses in sewers that carry the combined flow to treatment facilities.

During storm events the volume of storm water may exceed the capacity of the combined sewers or the treatment plant. When this happens in Springfield, combined sewers are designed to overflow into Buck Creek. Currently, there are 34 combined sewer overflows (CSOs) discharging wastewater directly to Buck Creek. With increased runoff from impervious surfaces and overflow into Buck Creek, streamflow hydrographs recorded on Buck Creek at the Plum Street bridge respond to runoff from the urban part of the Buck Creek watershed immediately. Flow from the Beaver Creek subwatershed generally takes longer to reach the Plum Street bridge, and flow from the upper Buck Creek subwatershed, above the confluence with Beaver Creek, is temporarily retained in the C. J. Brown Reservoir. The characteristic hydrograph will have an initial peak, representing the urban input of water, then a secondary peak, representing flow from Beaver Creek. Whereas the urban peak is narrow and sharp, rising and falling rapidly, the secondary peak is wider, rising and falling more slowly.

The watershed and subwatersheds, their area, morphology, and land use and cover, control the amount, rate, and quality of runoff. Data from the Buck Creek Educational Corridor can be used to assess short-term changes in water quality in response to rainfall events and water releases from C. J. Brown Reservoir as well as longer-term impacts due to changes in land use and cover.

The weather, streamflow, and water quality data used in this factsheet are available for your use. The data are collected every 15 minutes and downloaded every hour. Current and historical data are available at the following site:


Streamflow hydrograph from the Plum Street gaging station showing multiple peaks. The initial peak is runoff from impervious areas of the Springfield subwatershed, including input from combined sewer overflows. The second and third peak represent runoff from the Beaver Creek subwatershed.

Objectives of the Buck Creek Educational Corridor

- assess the environmental impact of in-stream and watershed changes on water quality over time;
- provide problem-based learning opportunities related to stream environments for area K-16 students; and
- provide current weather and water information to recreationists taking advantage of recreational amenities along the creek corridor.