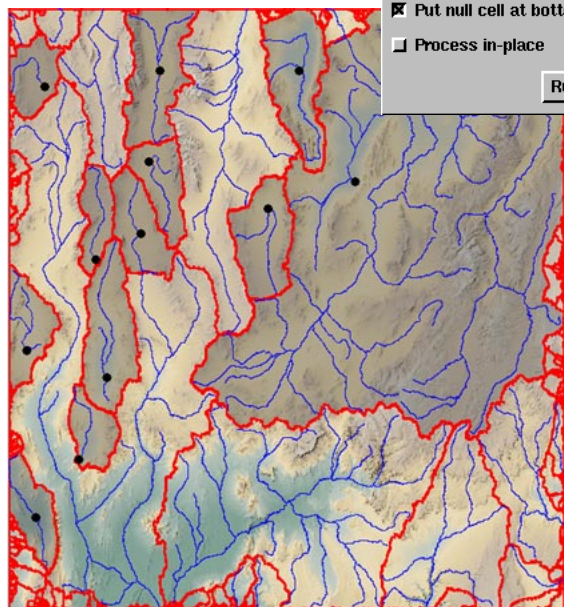# Fill or Drain Depressions in DEMs

In order for the TNTmips Watershed process (Terrain / Watershed) to create flowpaths from the source digital elevation raster (DEM), it must first create an adjusted elevation raster in which any depressions in the source DEM have been eliminated. TNTmips includes a fast and flexible depression-filling procedure as a preprocessing step in the Watershed process and as a separate standalone process (Terrain / Fill Depressions from the TNTmips menu). Each process provides settings that let you selectively fill depressions based on thresholds in their area (in number of raster cells), the number of null cells they contain, and their maximum depth. The depression-filling settings in the Watershed process are on the Depression tabbed panel of the Watershed Analysis window.

Small depressions in DEMs do not always accurately represent the corresponding natural landscape surface, but instead commonly result from errors in the DEM-creation process (local underestimation or overestimation of the ground elevation). Regional-scale DEMs with larger cell size (such as 30-meter NED or 90-meter SRTM datasets) may undersample intricately-sculpted landscapes, producing virtual blockages across nar-
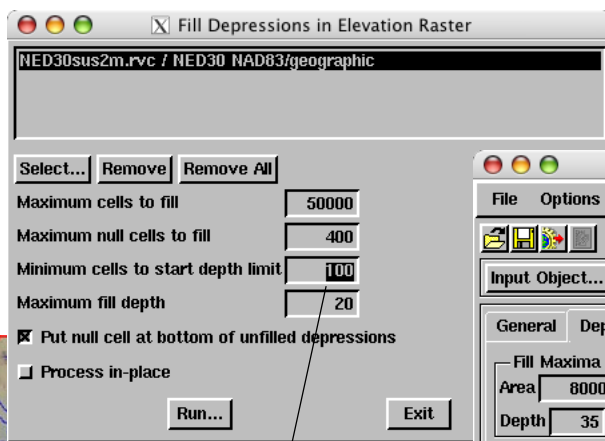
row stream valleys and canyons. Filling these spurious depressions allows the flow-routing procedures in the Watershed process to create continuous flowpaths past these obstacles.

However, depression-filling is not always the best solution for all DEM depressions. Some landscapes include large natural depressions; examples include closed lake basins and the large dry basins of the southwestern United States and East Africa. These large closed basins have their own internal drainage systems unconnected to adjacent watersheds. To handle such watersheds, the depression-filling procedure includes the option to automatically put a null cell at the bottom of depressions that are left unfilled according the specified filling limits (for example, depressions that exceed the size and /or depth limits). This null cell then serves as the flow outlet for the watershed when flowpaths are created, so that the internal drainage network is accurately modeled.
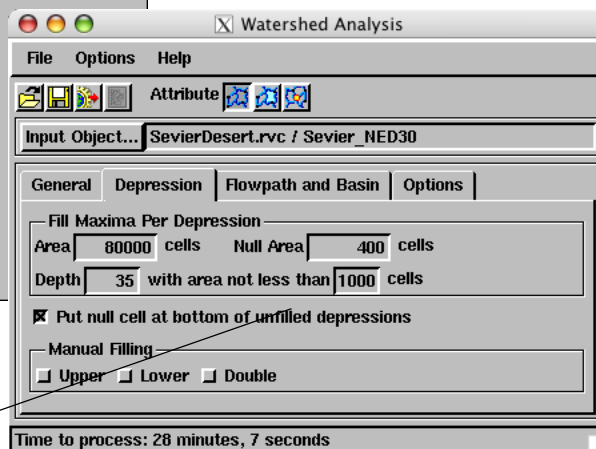
DEMs may also include small to large man-made depressions, such as those created by large dams. Earthen dams may be large enough to be represented

You can set a minimum depression size threshold for applying the maximum fill depth criterion.

Watersheds (red polygons) and flowpaths (blue lines) for an area of southeast Nevada and southwest Utah. The shaded watersheds have natural internal drainage. The DEM was run using the option to place a null cell at the bottom of unfilled depressions, so that flowpaths were generated to indicate the natural drainage patterns in these closed basins. The locations of these null cells are shown here by the filled black circles.
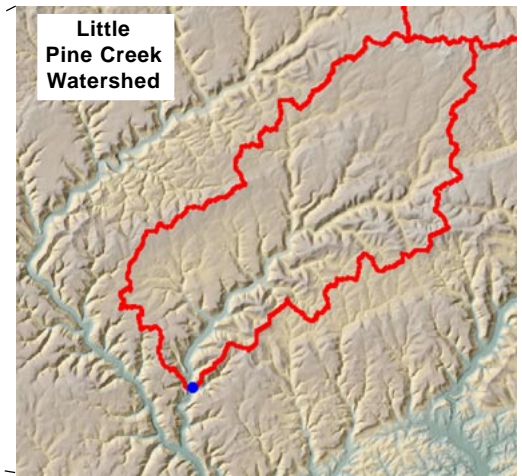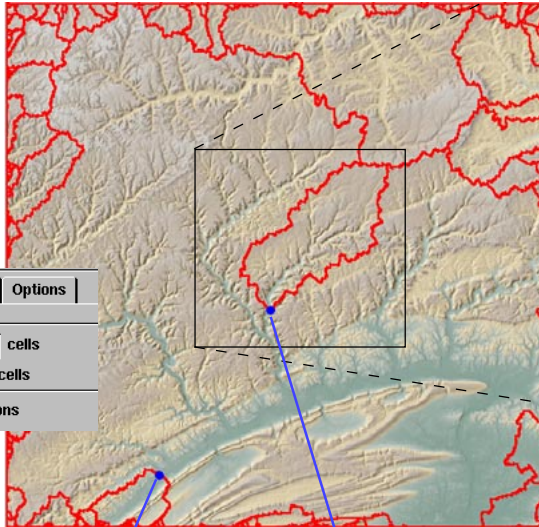
in the source DEM, and they typically impound reservoirs with water surfaces that are maintained well below the crest of the dam. In order to fill these man-made depressions, you will have to set a maximum depth limit for depression-filling that exceeds the height of the dam above the reservoir surface (see the example on the reverse side of this page). On the other hand, you might decide that the watersheds and flowpaths you create from the DEM should accurately represent the presence of this man-made feature. In the latter case you could set the depression-filling thresholds to automatically place a null cell at its bottom rather than filling it, thus generating local flowpaths that terminate somewhere in the reservoir area.

Note that if any depressions are left unfilled by a particular Watershed run, no flowpaths are generated. You should then analyze the results and determine how best to adjust the depression-filling settings before running the process again to eliminate remaining depressions and create the flowpath object.

Sample Effects of Depression Filling Settings

A Watershed process run to create watersheds and flowpaths left two watersheds with unfilled depressions (in illustration to right, watersheds with blue dots on their boundaries indicating pour point locations).

Watersheds (red polygons) from 1 arc-second (~30-m) NED DEM of central Pennsylvania.

The pour points of these watersheds were found to coincide with large earthen dams with reservoir levels maintained well below the dam crests, creating man-made depressions in the NED DEM. Although the area of each depression is less than the upper area limit set for depression filling for this run, the
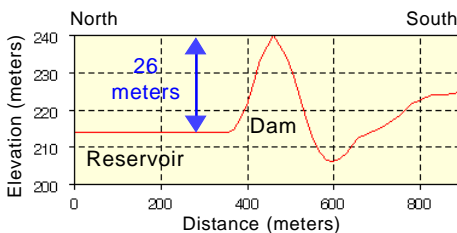

Sayers Dam (Birch Creek)   Little Pine Creek Dam

Little Pine Creek Watershed

Watershed polygon (red) encompassing the depression left unfilled behind the Little Pine Creek dam (at pour point location, blue dot); dam height (26 m) exceeds the depth threshold (20 m) set for filling depressions.
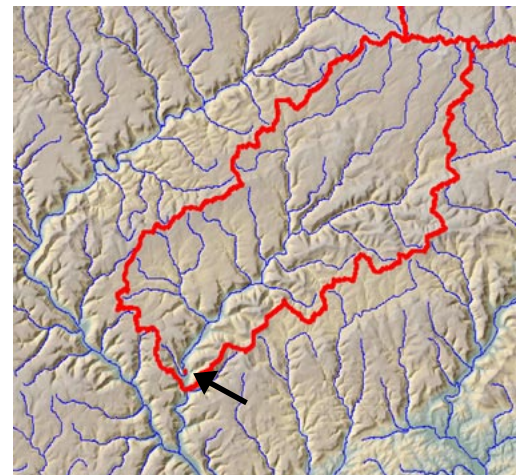
With a DEM cell size of 716 m², the larger depression area shown in the Depression Attributes listing is equivalent to about 21,000 raster cells, below the area threshold of 25,000 used in the first watershed run.

Depression Attributes

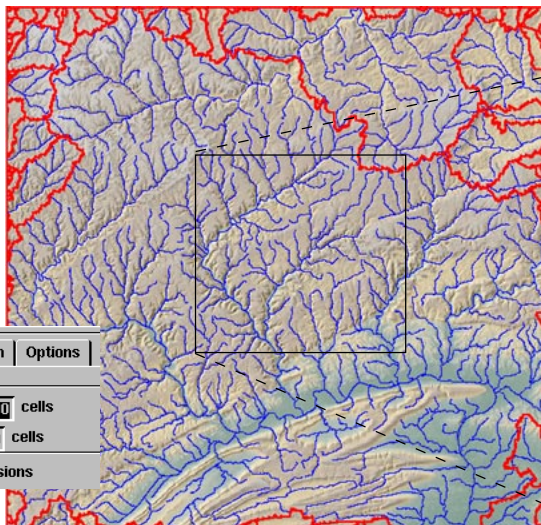| Watershed	Area	Volume
143	2036194	21462044
226	15024720	143155971

Depression — Total: 2, Active

Left, profile of NED DEM raster along a line crossing Little Pine Creek Dam (created using the GeoToolbox in the TNT Display process). Dam crest elevation is 240 m, reservoir surface is 214 m, so dam height is 26 m. Similar procedure for Sayers Dam yielded a height of 24 m. Both dam heights exceed the 20-m depth limit used in the first watershed run.

Alternative watershed result with option to put null cell at bottom of unfilled depressions turned on (other settings the same as for the result above). Flowpaths are generated, and Little Pine Creek flowpaths drain to the null cell created by the process (at red dot indicated by the arrow).

depth limit used proved to be lower than the height of either dam above its reservoir. Increasing the depth limit from 20 to 30 meters resulted in successful filling of both of these depressions and integration of their flowpaths into the regional stream network.

Depth limit increased to 30 m for second watershed run.

Result with depth limit for depression filling increased to 30 m. No watershed polygons remain for Little Pine Creek or Birch Creek, which now connect with the regional stream system.