Example Flowchart Description, and Analysis Output

The example flowchart provided on the course website is intended to help you think through the processing for your project. Note that key steps are included, but you may need additional steps, e.g., additional operations may be required for variants of the identify and recode steps.

Data layers are depicted as rectangles, operations as ovals. Input data are shown with brown borders, approximately the data you've developed over the first 8 weeks of class, with the exception of the rainfall layer. This is simply a layer encompassing your study area and with an attribute that is the amount of rainfall for one of your storm events. As such, you'll actually have three rainfall layers, and the flowchart just illustrates one of the runs. You'll have to do a similar analysis for each rainfall level, substituting an appropriate rainfall layer into each analysis. Remember to convert the rainfall data to appropriate metric units, here meters, because you'll be reporting your output in cubic meters of water per grate.

I assume the buildings, soils, and canopy extent data are vector polygons layers, and the grates and sinks layer is a vector point layer. This grates/sinks layer is one that you may already have created, or will create in accordance with the videos and discussion provided over the past few weeks.

The DEM and the Rainfall data are assumed to be raster data layers in this depiction.

This flowchart assumes you will eventually convert the vector data, after processing, to raster data, before the combination steps shown in the right-most processing stream. The vector to raster conversions are noted with asterisks (*) within the late processing steps for the surface absorption and canopy interception layers. The explicit conversion step is not shown to save space, it simply would be another operation (vector to raster) and layer (e.g., raster Canopy interception) in the processing flow.

Note you don't have to conduct the analysis in raster. If conducting in vector, then you would create a vector rainfall layer, and you would convert the watersheds to vector polygons from the raster watershed delineation. You would then union the layers in the rightmost column of the flowchart, creating a table for the various combinations of canopy interception and surface absorption within your study area. You would subtract these from rainfall, calculate area and then runoff volumes for each runoff polygon, and then sum over the polygons that are in each watershed.

Once you have the surface water volume delivered to each grate/sink, you may export the surface water per grate/sink to a table.

You should organize your output table so that each storm sewer grate has a unique ID, corresponding to its watershed ID, with this ID listed first in the runoff volume table. The table will thus have a row for each grate, and the volume runoff at that grate.

You should also report sums for main sewer lines, identifying linear sequences of connected grates. You can do this summation manually, that is, identify the set of lines reaching a junction (two lines meeting, or a line exiting your study area), and summing grates along that line.

You will additional analysis reflecting your attempts to reduce runoff. You have to modify the landcover, canopy, buildings, and surface layers to try to eliminate the target storm runoff.

You can add new tree canopy by digitizing additional canopy polygons; graduate students may also change canopy to conifers, subject to the smaller canopy diameter for conifers. You may only "plant" trees in locations where it is possible, i.e., you can't plant trees in the middle of the road. You can plant in/adjacent to sidewalks, and assume when mature they overhang the road, but the crown radius of broadleaved trees is limited to 20 feet, and conifers to 10 feet. The process should involve digitizing new tree stem locations as points, and then buffering to an appropriate size limit.

You can modify surface permeability by converting parking lots and roads to permeable pavement, which raises surface absorption to the level of urban soils.

You can create new surface sink areas (e.g., rain gardens), basically catch basins, by modifying the landcover, converting a parking lot or other paved area to the equivalent of soil. The new sink has the surface absorption of the underlying soil. You can only put surface catch basins in areas that are currently not roads, sidewalks, or buildings. Parking lots and plazas are targets for conversion, but you must not reduce any one parking area by more than ½ the original size.

You can also reduce the amount of water by converting buildings to green roofs. This will absorb the first 2" rainfall. Green roofs can only be installed on flat-topped buildings.

Finally, you can specify underground storage, assuming you excavate an area, create a water storage chamber, and then replace the surface. This has the effect of assuming all water draining to that area infiltrates, because we assume the underground storage is deep enough to catch all water, and then eventually soaks down into the ground below. This has the effect removing that water from the network.

You will re-do the runoff analysis for your modified landscape, and create an additional runoff table, as above. Keep the same numbering for grates, so we can compare tables.

Use the following estimated costs for each of your modifications, and calculate the total cost for the realized reductions for each scenario:

$0.05 per square meter new tree canopy
$10 per square meter to add surface sinks
$40 per square meter converting parking lots and streets to permeable pavement
$200 per square meter for a green roof
$3600 per cubic meter of water for underground storage

You can calculate total costs by the surface areas of each of these modifications. Add these as a column to your table.