EPA SWMM5 for Novice/Advanced Users
EWRI2025 Pre-Conference Workshop, May 17, 2025 (Anchorage AK)

Exercise 3-2: Investigate Conveyance Improvements

This is the second in a series of exercises that addresses flooding due to redevelopment within a residential neighborhood. This exercise uses the U.S. Environmental Protection Agency's Storm Water Management Model (SWMM5, 64-bit version of build 5.2.4) and is in U.S. customary units. It is assumed that you are sufficiently familiar with the SWMM5 user interface, so that only the key commands and input values are highlighted in bold.

This exercise set is intended to build skills in working with a neighborhood-scale pipe network model, comprised of the following exercises:

- ANC3-1: Update an existing system model to account for new development;
- ANC3-2: Investigate conveyance improvements; and
- ANC3-3: Investigate LID improvements.

Key Learning Objectives

1. Identify alternative pipe sizes in a capital improvement project.
2. Optimize proposed capital projects to provide the desired level of service for stormwater management.

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1 Set Up and Evaluate Option A: Maximum Pipe Capacity

The last two exercises in this set focus on investigating alternative structural measures that represent gray and green stormwater infrastructure. This exercise evaluates piped conveyance improvements to control runoff within the municipally-owned system. In the next exercise, low impact development (LID) controls that capture and treat runoff at its source, prior to discharge into the municipally-owned system, are evaluated. A typical study would also likely include a storage option (e.g., detention pond or tank) as well as a combination option (i.e., green + gray infrastructure) as part of the alternatives evaluation process.

There are many performance metrics that could be used to optimize improvement alternatives. The focus of this exercise set is on depth-based performance indicators, since the watershed goal is to eliminate all occurrences of surface flooding for the local 10-year design storm event.

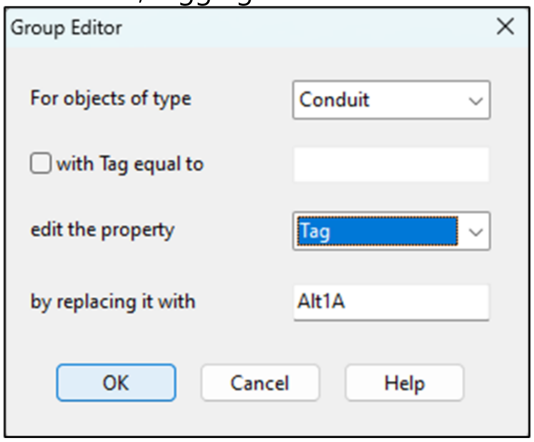
The first option investigates a "maximum pipe capacity" scenario. It is often helpful to begin the evaluation by testing the impact of the largest, technically feasible structural measure (e.g., maximum pipe/culvert capacity for conveyance controls, maximum pond/tank volume for storage controls, or maximum runoff retention for LID controls). Even if the proposed improvement is likely to be cost-prohibitive or presents permitting/construction challenges, such controls will bracket the upper limit of a solution set or at least demonstrate that a technical solution is possible.

1-1 **Unzip** the contents of the file "**ANC3-1_Uncontrolled_SW52.zip**" into an empty folder and **launch SWMM 5.2** (executable file "epaswmm5.exe", version 5.2.4, 64-bit edition, downloaded from the EPA website at https://www.epa.gov/water-research/storm-water-management-model-swmm).

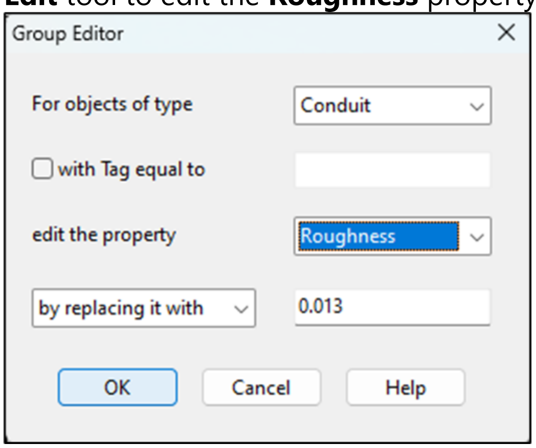
1-2 **Open** the project "**ANC3-1_Uncontrolled.inp**" in SWMM 5.2 and **Run** the simulation.

1-3 **Save** the current project and then **Save As "ANC3-2_Alt1A-Conveyance.inp"**. In the Title/Notes Editor, change the scenario description to read "Scenario: Future land use conditions + **Proposed** stormwater management system **(conveyance improvements)**", and then **OK**.

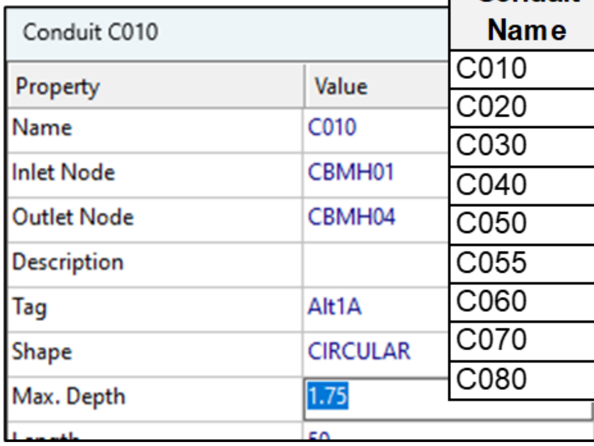
1-4 It is good practice to tag any proposed hydraulic entities (or annotate the description field), so that they can be readily distinguished from existing hydraulic entities for the purpose of estimating construction costs, further optimization, or for report writing. Use the **Group Edit** tool to edit the **Tag** property for all 9 conduits, tagging these with the text string **"Alt1A"**.



1-5 As a first attempt, all pipe diameters will be increased by one standard size (i.e., 3 inches or 0.25 ft). As an indicator of replacement pipes, a roughness factor of 0.013 will be applied to all proposed conduits (and note this contrasts with aged existing pipes with a roughness factor of 0.015 or higher). Use the **Group Edit** tool to edit the **Roughness** property for all 9 conduits, replacing them with a value of **0.013**.

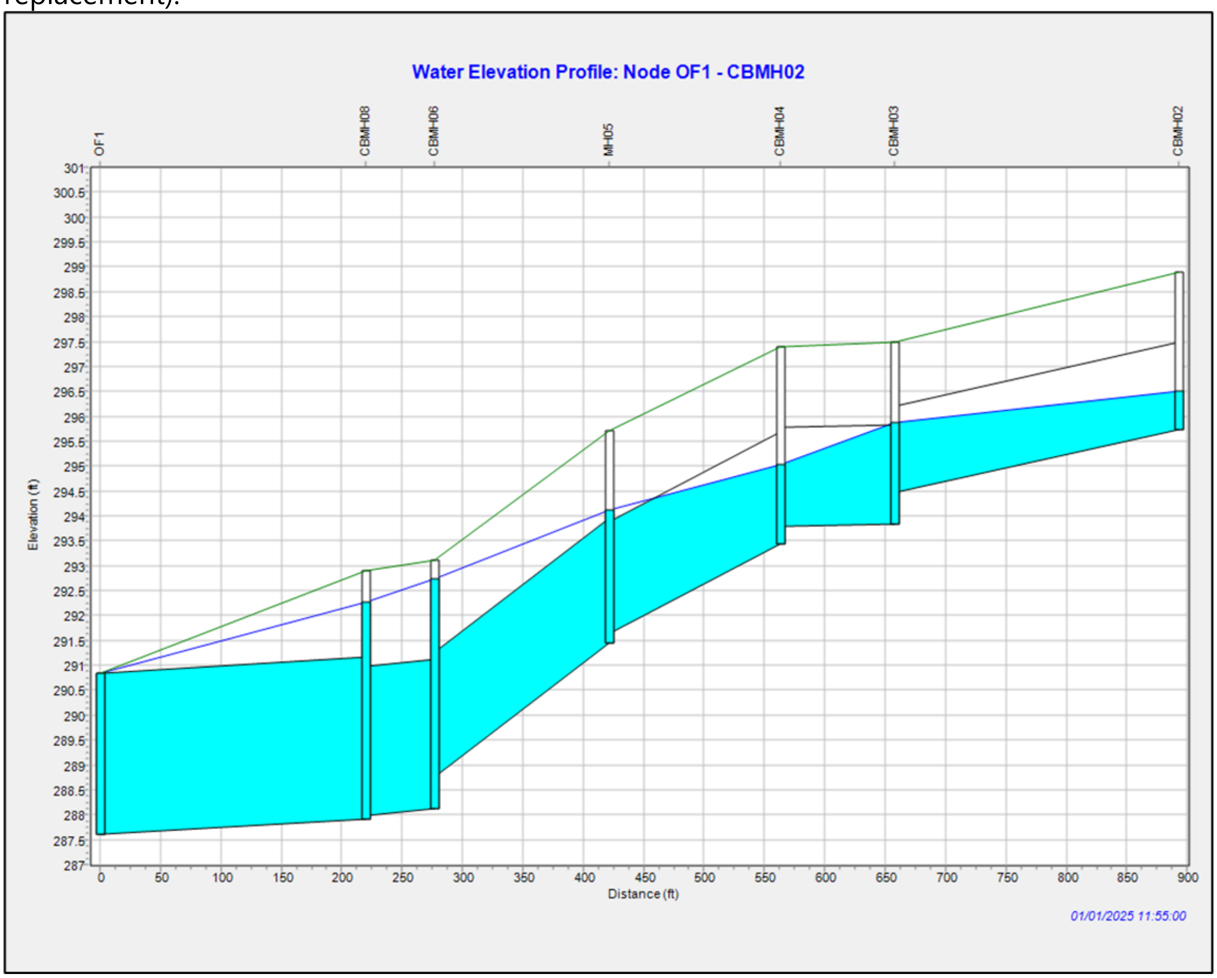


1-6 For each conduit, **increase the Max. Depth property by 0.25 ft**. These pipe diameter values are shown in the table below. Note that you can toggle between conduit entities by pressing **PgUp** or **PgDn**.



Conduit Name	Pipe Diameter (ft)	
	Existing	Proposed
C010	1.5	1.75
C020	1.5	1.75
C030	1.75	2
C040	2	2.25
C050	2.25	2.5
C055	1.75	2
C060	2.75	3
C070	1.5	1.75
C080	3	3.25

1-7 **Run** the simulation and **plot the profile** as was done previously, by entering **OF1 as the Start Node**, and **CBMH02 as the End Node** and plotting the HGL at **time 11:55:00**.. The increased conveyance capacity eliminates node flooding, confirming that a conveyance solution is technically feasible. However, this is not a valid capital improvement project, the solution set needs to be optimized – not all pipes need to be upsized. The profile plot also suggests a strategy for optimization. That is, larger pipes will be necessary at the downstream end (where surcharge is evident), whereas the existing system at the upstream end might be sufficient as-is (where there is no surcharge after the proposed pipe replacement).



2 Set Up and Evaluate Option B: Optimized Pipe Capacity

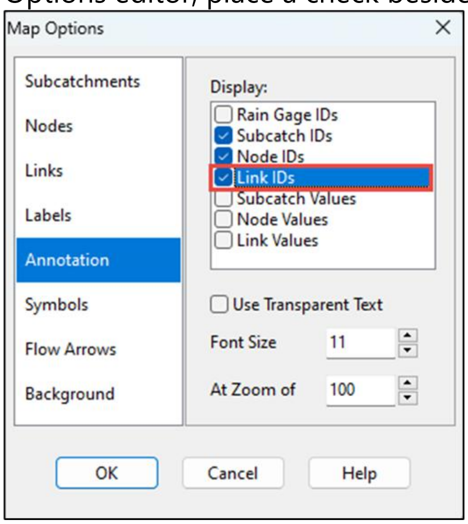
The second option investigates an "optimized pipe capacity" scenario. While the optimization process in this exercise appears somewhat arbitrary, it begins at the downstream end of the system and is guided by the impact of changes as one moves upstream (i.e., the incremental impact of a pipe replacement can suggest the next logical scenario to test).

In some cases, it may be advantageous to conduct a more formal headloss analysis. In its simplest form, the analysis can calculate the difference in the maximum computed heads at the upstream and downstream ends of a conduit. The biggest hydraulic gradeline impact often results by upsizing conduits with the largest difference between upstream and downstream computed heads. Conversely, upsizing conduits in which the maximum upstream and downstream computed heads are approximately equal will generally not affect the hydraulic gradeline.

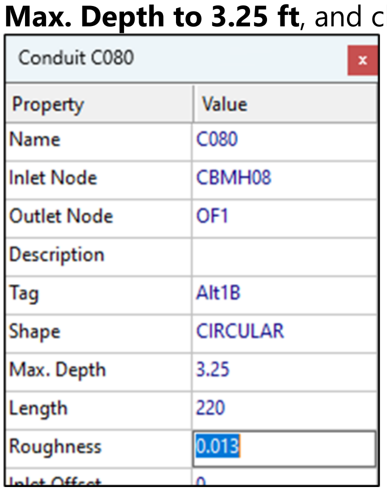
2-1 **Save** the current project and **Open** the previous project "**ANC3-1_Uncontrolled.inp**". The uncontrolled scenario will be used as the baseline model to derive a new conveyance option, this time optimizing the pipe sizes. **Save As "ANC3-2_Alt1B-Conveyance.inp"**.

2-2 In the Title/Notes Editor, change the scenario description to read "Scenario: Future land use conditions + **Proposed** stormwater management system **(conveyance improvements)**", and then **OK**.

2-3 To show the conduit names, **right-click in the Study Area Map** and select **Options…** In the Map Options editor, place a check beside the **Link IDs** and then **OK**.



2-4 Select **conduit C080**, the most downstream conduit in the system. Set the **Tag as "Alt1B"**, change the **Max. Depth to 3.25 ft**, and change the **Roughness to 0.013**.



2-5 **Run** the simulation and review the Node Flooding section of the **Summary Results**. This single intervention eliminates the flooding at junctions CBMH06 and reduces it at CBMH02. There is still significant surface flooding that needs to be resolved at CBMH03.

Summary Results

Topic: Node Flooding   Click a column header to sort the column.

Node	Hours Flooded	Maximum Rate CFS	Day of Maximum Flooding	Hour of Maximum Flooding	Total Flood Volume 10^6 gal	Maximum Ponded Depth Feet
CBMH02	0.01	0.98	0	11:52	0.000	0.000
CBMH03	0.13	5.21	0	11:54	0.009	0.000

2-6 Proceeding upstream in the profile, select **conduit C060**. Set the **Tag as "Alt1B"**, change the **Max. Depth to 3 ft**, and change the **Roughness to 0.013**.

2-7 **Run** the simulation and review the Node Flooding section of the **Summary Results**. Note the flooding persists at CBMH03.

2-8 Given the steep grades of the next two upstream pipes (C050 and C040), it could be assumed that the more significant capacity deficiency is further up the system (i.e., the two steep pipes do not need to be upsized). Select **conduit C030**, set the **Tag as "Alt1B"**, **Max. Depth as 2 ft**, and **Roughness as 0.013**.

2-9 **Run** the simulation and note the flooding persists at CBMH03. Additionally, a review of the hydraulic gradeline profile indicates that the next downstream junction (CBMH04) is now very close to flooding. This suggests that the steep conduits C040 and C050 will indeed need to be upsized.

2-10 Select **conduit C040**, set the **Tag as "Alt1B"**, **Max. Depth as 2.25 ft**, and **Roughness as 0.013**.

2-11 Select **conduit C050**, set the **Tag as "Alt1B"**, **Max. Depth as 2.5 ft**, and **Roughness as 0.013**.

2-12 **Run** the simulation and note that these interventions have eliminated all flooding occurrences.

2-13 To complete the optimization, undo the changes to conduit C030 by putting the existing pipe back in. Select **conduit C030**, **delete the "Alt1B" Tag**, set the **Max. Depth as 1.75 ft**, and **Roughness as 0.015**.

2-14 **Run** the simulation and confirm there are no flooding occurrences.

The conveyance improvements have been optimized. In this exercise, all the existing drops (i.e., conduit inlet/outlet offsets) have been retained. In an actual pipe design effort, these drops would be adjusted according to the local design standards.