# Step 1: Model Selection

- EPA SWMM because it is free, open source and user friendly

  https://www.epa.gov/water-research/storm-water-management-model-swmm

# Step 2: Catchment Delineation

- Use contour maps, ArcGIS Watershed tool, ArcHydro or StreamStats: streamstats.usgs.gov
  - Delineate the catchment boundary (save as JPG)

    **Put in SWMM:** View > Backdrop > Load

    Click on  , and draw a catchment based on the backdrop
  - Calculate the catchment area (acers)

    **Put in SWMM:** Right click on catchment > Properties > Area (ac)
  - Measure the catchment slope (%)

    **Put in SWMM:** Right click on catchment > Properties > %Slope
  - Measure the longest flow path (feet)

# Step 3: Data Collection

- First, find your manual: Stormwater standards part 1: Appendix G

  https://www.sandiego.gov/sites/default/files/sws_part_1_nov_2017_edition.pdf
- Precipitation:
  - Find the closest precip station and download it from Project Clean Water website

    www.projectcleanwater.org/download/rainfall-data/
  - Format the data in Excel using =DATE() function so that you have:

One column for date (MM/DD/YY); One column for time (HH:MM); One column for depth (inch)

- **Put in SWMM:** On the Project window on the left, click on "Time Series", and hit  to add a Time Series. Put a name and paste the precip data from Excel.
- **Put in SWMM:** Click on  , and put a Rain Gage anywhere on the Study Area Map. Edit the information and type the time series name under TIME SERIES.
- **Alternatively**, you can format an external *.dat file as below and link to SWMM:

| *Gage_name* | *Year* | *Month* | *Day* | *Hour* | *Minute* | *Data* |
|---|---|---|---|---|---|---|
| SD_Airport | 2011 | 1 | 1 | 9 | 30 | 0.02 |

- Evapotranspiration
  - For monthly values of Potential Evapotranspiration, use Figure G.1-2 and Table G.1-1
  - **Put in SWMM**: Climatology > Evaporation > Source of Evaporation Rates = Monthly Averages

You can now run the model to test. You need to have an outlet: click on  , then edit the Catchment properties, and put the outlet name. Also, put the correct dates based on precip data: Options > Dates

## Step 3: Data Collection (continued)

- To calculate catchment Width, find Subcatchment area divided by the length of longest flow path from Streamstats report (**Put in SWMM:** Double click on catchment > Width)
- To calculate catchment Slope, find Relief divided by the length of longest flow path from Streamstats report (**Put in SWMM:** Double click on catchment > %Slope)
- Use Stormwater Standards Table G.1-4 to find N-imperv, N-Perv, Dstore-Imperv, Dstore-Perv and %ZeroImperv (**Put in SWMM:** Double click on catchment)
- Download Hydrologic Soil Group (HSG) data from rdw.sandag.org (under Geology category). Find the HSG for the site and refer to Table G.1-4 to obtain the Green-Ampt parameters.
  **Put in SWMM**: Options > General > Infiltration Model: Green-Ampt
  **Put in SWMM**: Double click on catchment > Infiltration Data > Click on "…"
- Map the land uses from rdw.sandag.org to estimate the imperviousness in each subcatchment (alternatively Streamstats can give an estimate on average imperviousness from NLCD datset)
  **Put in SWMM**: Double click on catchment > %Imperv
- Map stormdrain nodes/conduit: rdw.sandag.org (under Stormdrain category), as-built, visits etc.
  **Put in SWMM**: To add nodes for inlet and outlets of conduits: Hydraulics > Nodes > Junctions
  **Put in SWMM**: To add conduits: Hydraulics > Links > Conduits

## Step 4: Run 

- Save what you have created so far as the "Post-Developed" condition, and hit Run.
- Copy the model and save as "Pre-Developed". For this model try to mimic the catchment before urbanization. This requires research, but the first thing to start is reducing the imperviousness to open space. Then, hit Run. **Plot Time Series:**  > Object: Outfall, Variable: Total Inflow
- To create **flow-duration** curves: Report > Statistics, and then set Object: Outfall, Variable: Total Inflow, Event Time: Event-Dependent, Statistics: Peak

## Step 5: Design

- The ultimate goal is match the runoff to pre-development condition, such that we can manage the hydromodification caused by urbanization (occurring in the $Q_2$ to $Q_{10}$ range).
- Save a copy of the "Post-Developed" model and name it as "Mitigated". Now, we need to add Detention Basin and/or Low Impact Development (subject of future lectures).