Based on material from
1. SWMM official documentation
2. CE572 material of Colorado state university.
3. Several other sources (cited)
SWMM is a distributed, dynamic rainfall-runoff simulation model used for single event or long-term (continuous) simulation of runoff quantity and quality from primarily urban areas.
SWMM's Process Models

- Precipitation
- Snowmelt
- Buildup
- Sanitary Flows
- Surface Runoff
- Overland Flow
- Washoff
- Channel, Pipe & Storage Routing
- Treatment / Diversion
- Evaporation / Infiltration
- Groundwater
- RDII
Hydrologic Modeling Features

- Time varying rainfall. Spatial variability can be mimicked.
- Infiltration, evaporation, depression storage, groundwater flow, snow.
- Kinematic-wave routing of overland flow.

Epa-SWMM represents catchments as single slope with kinematic wave routing. This has important consequences for application.
Drainage network analysis.

Various conduit shapes as well as irregular natural channels

Storage units, pumps, regulators

Allows external inflows from runoff, groundwater, RDII*, sanitary, DWF, etc.

Models various flow regimes: backwater, surcharging, reverse flow, and surface ponding

*Rainfall-derived infiltration and inflow
** Dry-Weather flow.
Pollutant buildup, reduction in build up by street cleaning.
Pollutant wash off by runoff
Reduction in wash off from SUD*s
Water quality routing through the drainage network
User-defined treatment functions

* Sustainable Urban Drainage (also known as BMPs – Best management practices in Americas)
Typical Applications of SWMM

- Design and sizing drainage system components including detention facilities
- Flood plain mapping of natural channel systems
- Control of combined and sanitary sewer overflows
- Generating non-point source pollutant loadings
- Evaluating SUDs and LID*’s for sustainability goals

* Low-impact development
Limitations of SWMM

- Not directly applicable to large-scale, non-urban watersheds.
- Not applicable to forested areas or irrigated cropland (e.g. No transpiration model)
- Cannot be used with highly aggregated (e.g., daily) rainfall data
- It's an analysis tool, not an automated design tool
- No Direct GIS interface (third party solutions available)
Structure of SWMM 5

Typically hidden from the (casual) user...
SWMM 5's Visual Objects

Diagram showing various visual objects including:
- Rainage
- Subcatchment
- Junction
- Conduit
- Divider
- Storage Unit
- Pump
- Outfall
- Regulator
Flow Routing Algorithms

- **Steady Flow**
  - simple hydrograph translation
  - applicable only to branched networks (no flow divergence)

- **Kinematic Wave**
  - gravity force balanced by friction force
  - attenuated & delayed outflow due to channel storage
  - applicable only to branched networks (exception: flow dividers – covered later)

- **Dynamic Wave**
  - solves full St. Venant eqns.
  - accounts for channel storage, backwater effects, pressurized (surcharged) flow, and reverse flow
  - applicable to any network layout
  - requires smaller time step
Conceptual Network Model
**Nodes**

- **Junctions:**
  - Mass balance: Sum of flows = change in storage
  - Geometric properties: Invert elevation, height to ground (max. Depth), Extra surcharge depth.
  - Computed values: Head, volume and flooding at each time step.

Invert: Lowest point of the channel inside a manhole or a pipe. Invert elevation: **elevation** of the point, above a datum.

**Source:** North-shore city, New Zealand
Outfalls:

Downstream boundary condition of the model.

Properties:

- invert elevation
- boundary condition type and stage description
- presence of a flap gate to prevent backflow through the outfall.
Remember: ponding is a very crude approximation of the real process - surface inundation.
Links:

- Mass balance: Inflow=Outflow
- Computed values: Flow-cross-section, discharge
- Geometric properties: Height offset from connecting manhole inverts. Shape & Dimensions
- Hydraulic properties: Friction
Orifices and Weirs
Orifices and Weirs

- Diagram showing orifices and weirs with labels for dry weather flow, connection to interceptor, receiving water, overflow weir, sump, combined sewer, and section views for sump with high outlet and weir with side outlet orifice.
Representation of Weirs

Schematic of a Weir Diversion

Conceptual Representation of a Weir Diversion
**Representation of Pump**

**Type 1**
an off-line pump with a wet well where flow increases incrementally with available wet well volume.

**Type 2**
an in-line pump where flow increases incrementally with inlet node depth.

**Type 3**
an in-line pump where flow varies continuously with head difference between the inlet and outlet nodes.

**Type 4**
a variable speed in-line pump where flow varies continuously with inlet node depth.

**Ideal**
An "ideal" transfer pump whose flow rate equals the inflow rate at its inlet node. No curve is required. The pump must be the only outflow link from its inlet node. Used mainly for preliminary design.
Offline detention is designed so that the peak flow will be diverted to the storage (e.g. via an overflowing weir). They reduce the peak effectively, but do not influence the rest of the hydrograph significantly. Online ponds typically have an orifice regulator that release water downstream. They start accumulating water from the early stages of the rising hydrograph, and therefore can be less effective in reducing the peak (compared to an equivalent volume offline pond).

Offline storages are often dry ponds, so that they could be used for other purposes during dry (or low flow) periods (e.g. parks). They also do not interfere with the aquatic life forms (e.g. upstream migrating fish).

Upstream off-line storages can often be less effective in regulating the flooding situations downstream.