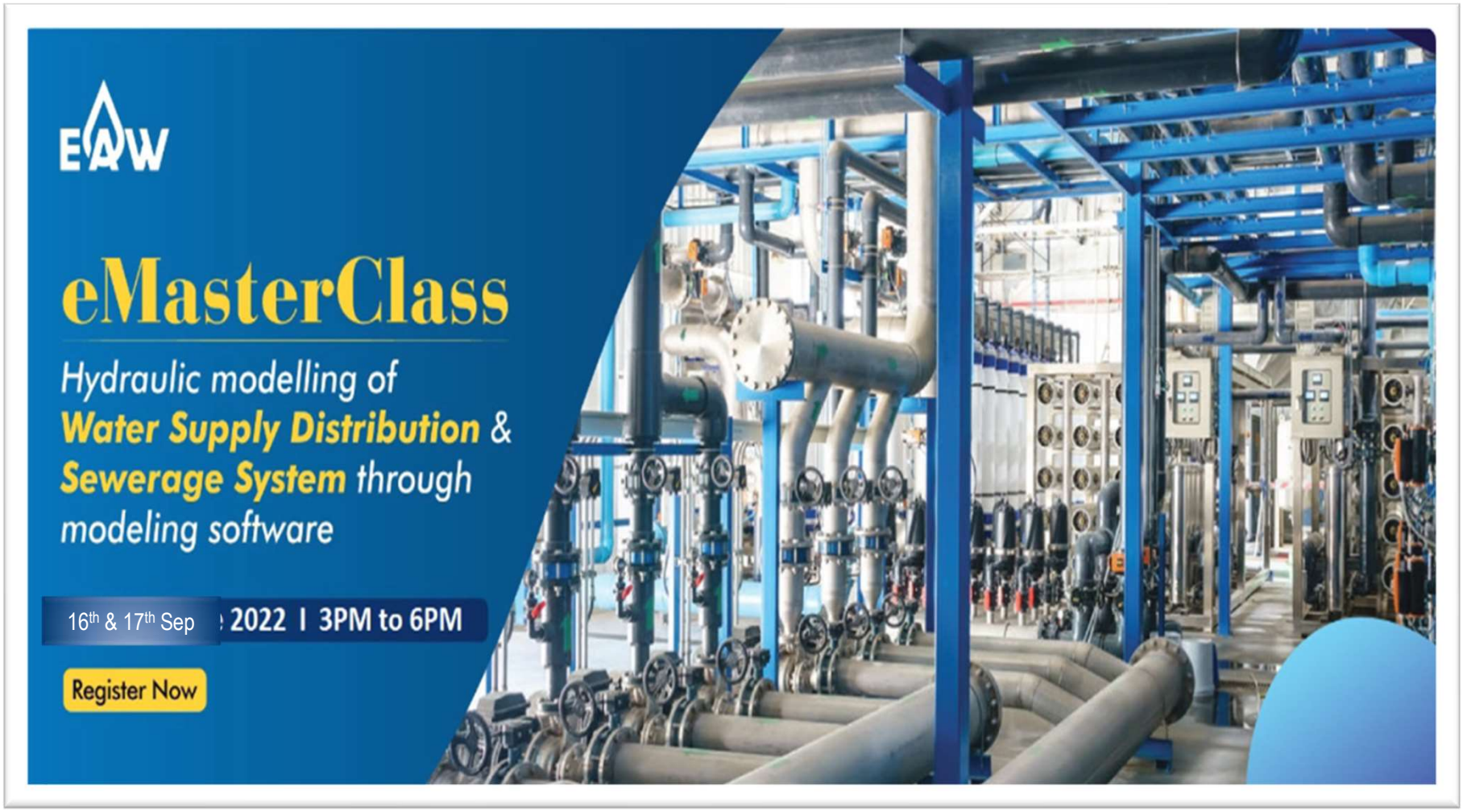
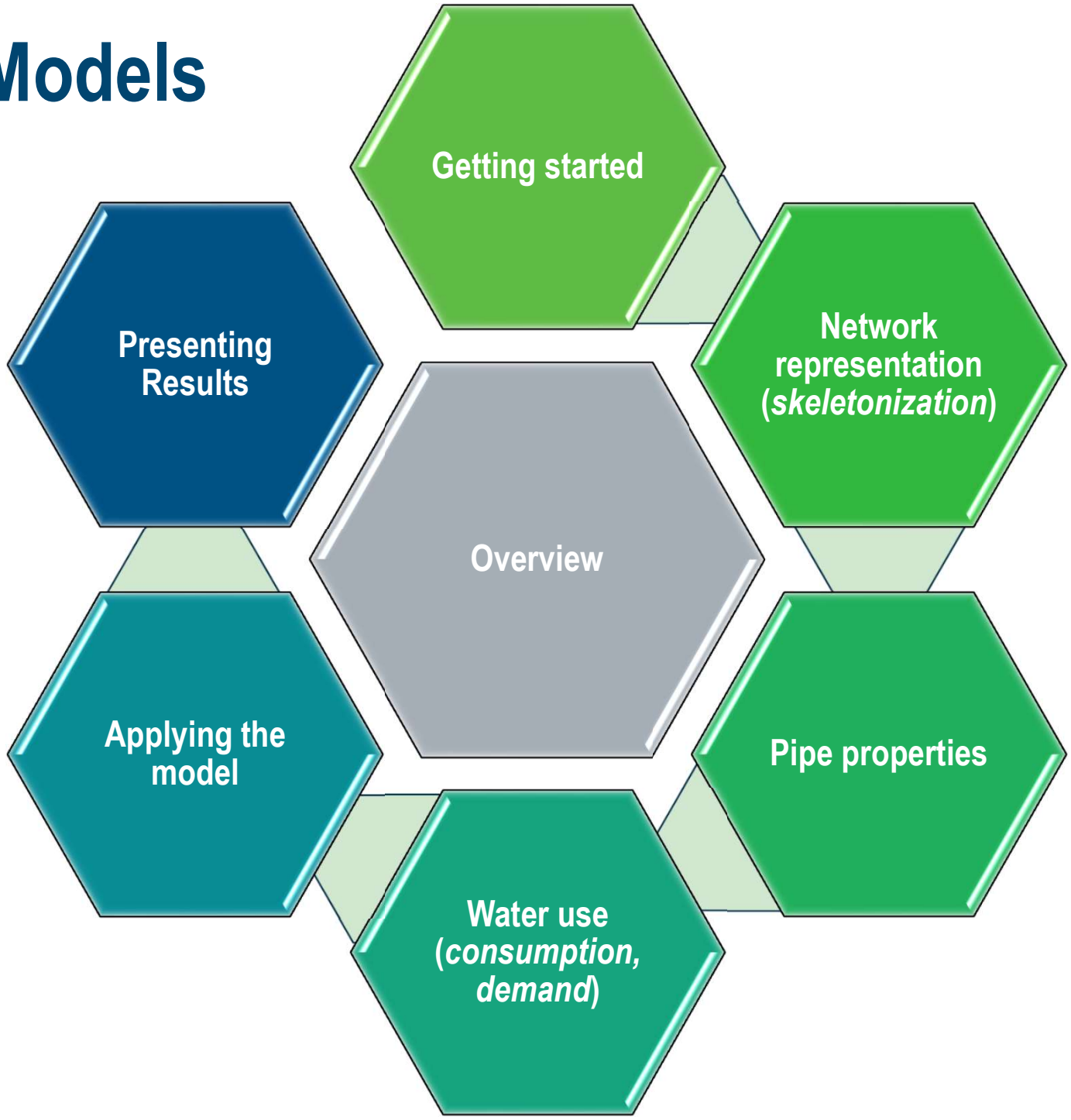
Hydraulic modelling of Water supply Distribution system through modelling software



Creation Of Models

Date of Training : 16.09.2022

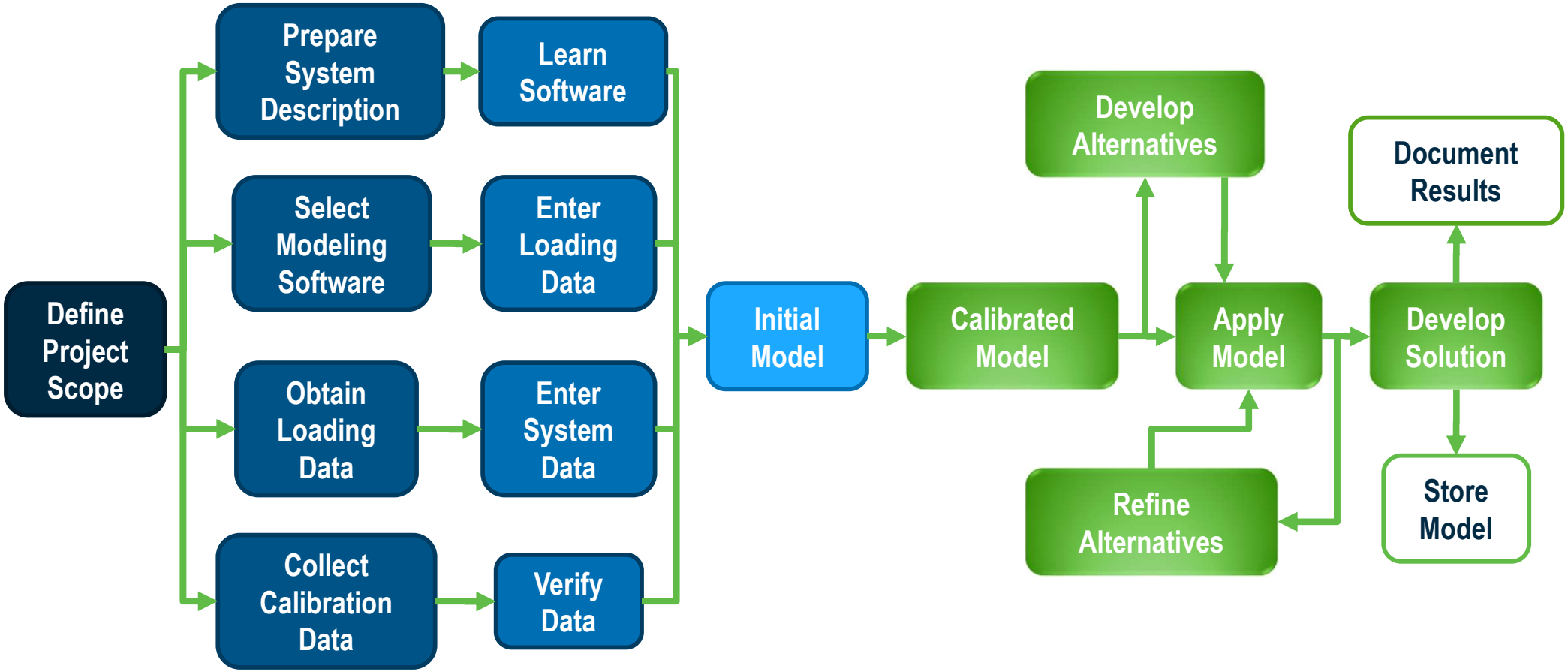
Using Models



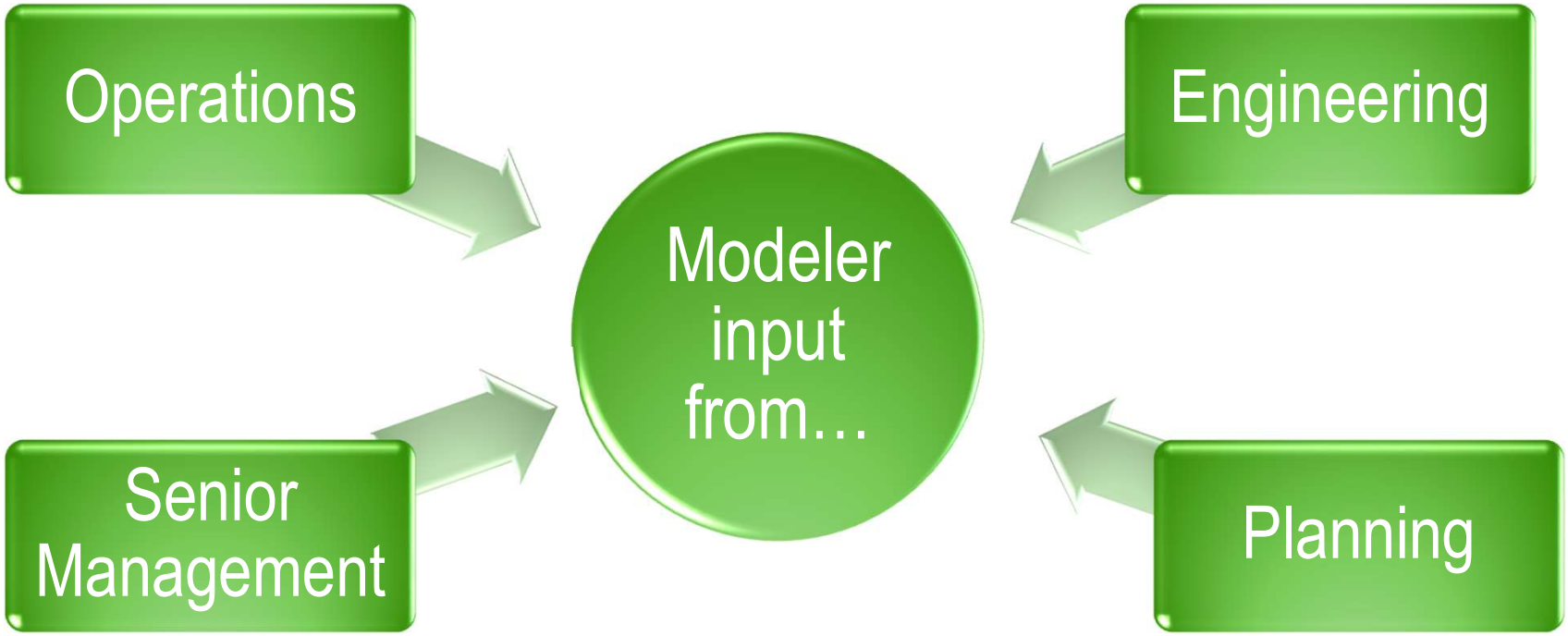
Overview

- Model = Software + Data
- Model = Approximation of real world
- Approximation is no more accurate than the data provided
- GIGO: Garbage In = Garbage Out
- Most work involves data collection/checking
- Always check results to make sure they are reasonable

The Modeling Process



#1 Define the Scope



Do you have these parties identified?

#2 Select the Software

- Most software packages work
- Selection criteria:
  - technical features
  - support
  - user interface (look and feel of the software)
  - quality of manuals
  - integration with other software AKA=Interoperability
  - Required effort and time to build the model

#3 Learn how to best utilize the value

- Work tutorials
- Ask knowledgeable users
- Training
- Use the Software
- Ongoing: OnDemand & Hydraulics & Hydrology Community

#4 Build the Data Model

Model Sources

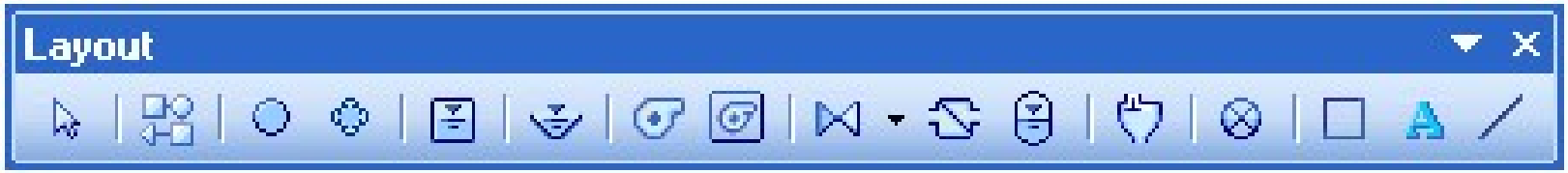
- Maps basis for representing system
- Use CAD/GIS drawings if available
- Use the latest available maps
- Verify maps with as-built drawings
- Verify with field personnel

#5 Construct the Hydraulic Network

- Convert maps to model
- Manual or automated using CAD / GIS
- Assign node/link identifiers (e.g. numbers or labels)
  - Naming conventions
  - Automatic labeling
  - Auto prompting

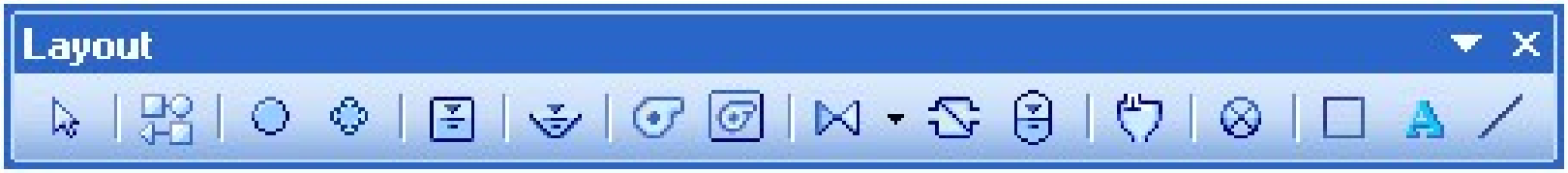
Hydraulic Element Types

- Pipe
- Junction
- Fire Hydrant
- Tank
- Hydropneumatic Tank
- Reservoir
- Pump
- Variable Speed Pump Battery
- Valves
  - PRV, PSV, PBV, FCV, TCV, GPV
  - Isolation Valve
  - Check Valve
  - Air Valve



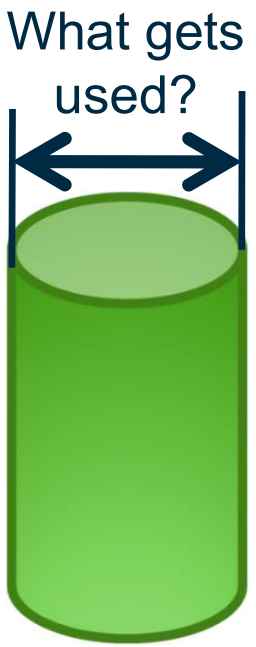
Transient Element Types

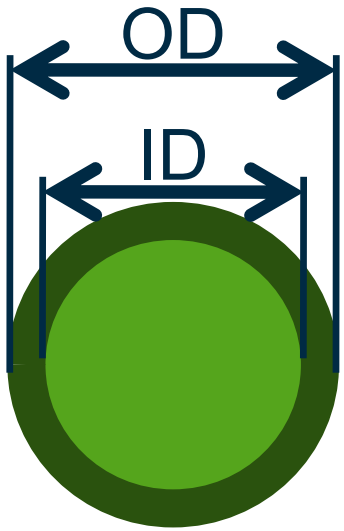
- Turbines
- Periodic Head-Flow
- Surge Tank
- Rupture Disk
- Discharge To Atmosphere
- Orifice Between Two Pipes
- Valve With Linear Area



Diameter Representation

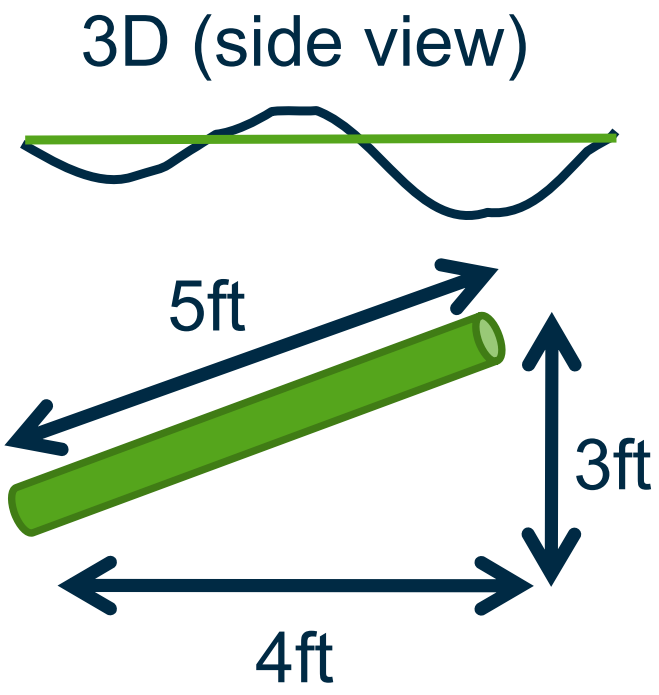
- Nominal diameters vs. Actual diameters
- Most important in water quality modeling
- Important in small sizes (e.g. sprinklers)





Diameter	ID	OD	Area-Nm	Area-ID	Area-OD
6” DI 50	6.40”	6.9”	28.27 in^2	32.17 in^2	37.39 in^2
6” DI 56	6.04”	6.9”	-	28.65 in^2	32.17 in^2
48” DI 50	49.78”	50.8”	1809.56 in^2	1946.25 in^2	2026.83 in^2
48” DI 56	48.94”	50.8”	-	1881.13 in^2	2026.83 in^2

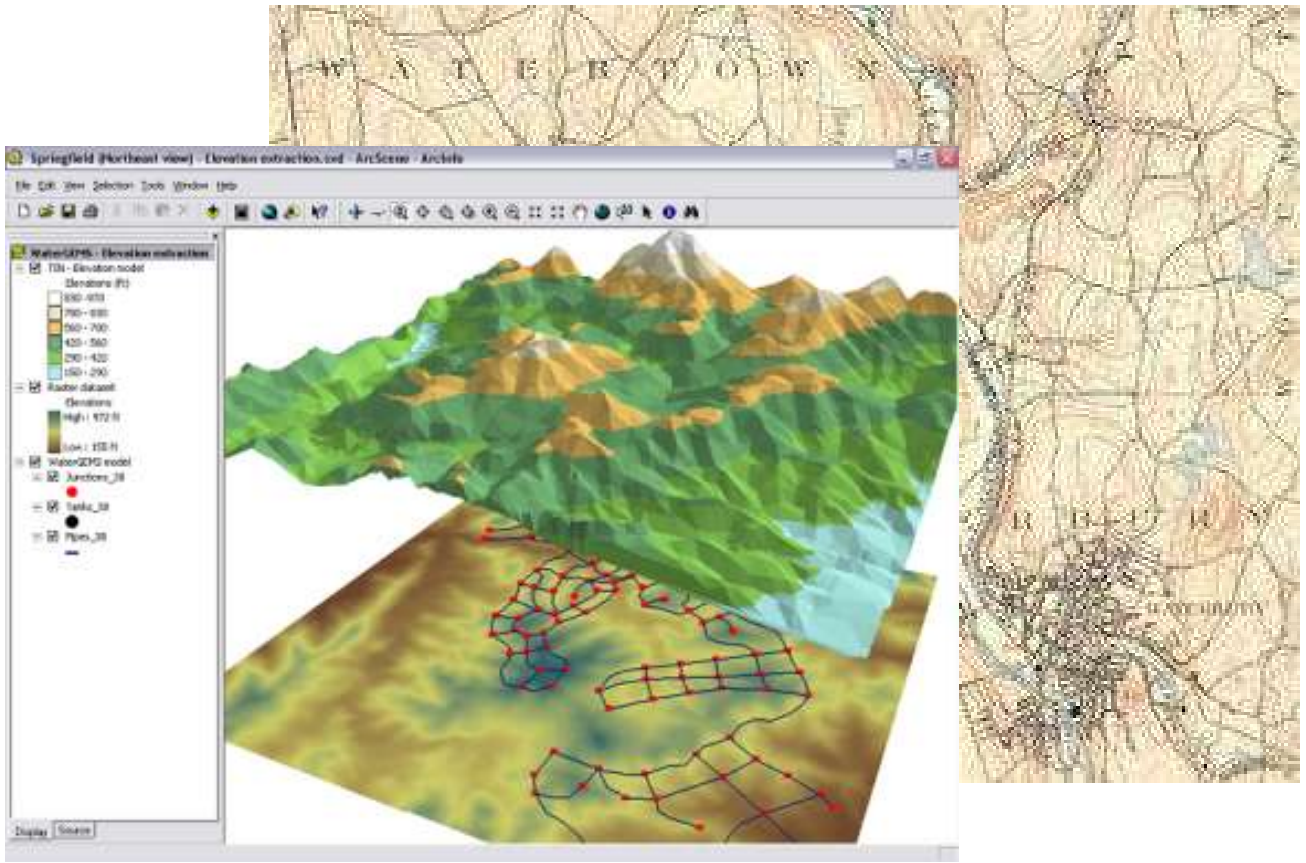
Length Representation



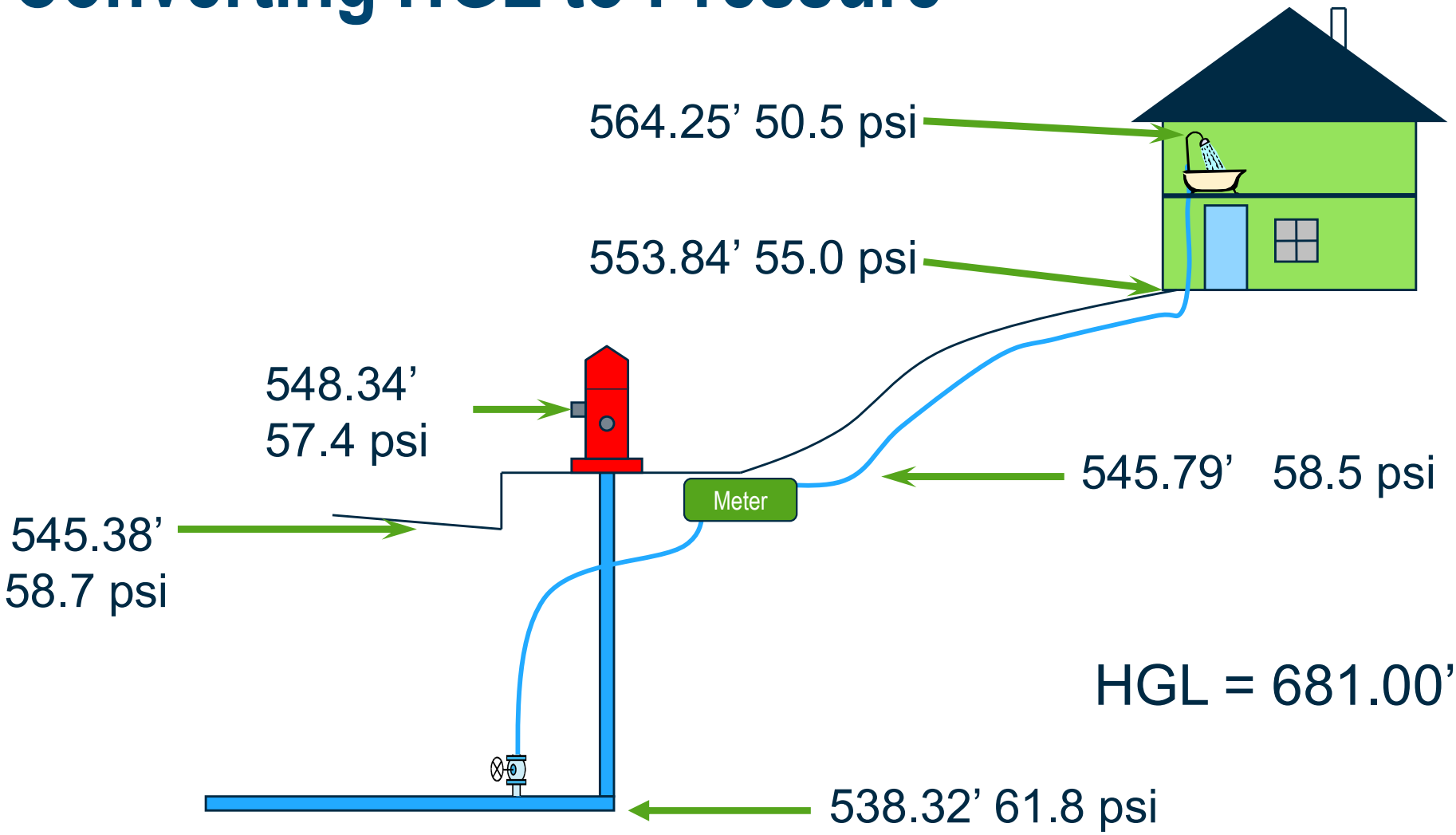
- Actual – not point-to-point
- Schematic vs. Scaled
  - Scaled - easier to use
  - Schematic - easier to build
- 3 Dimensional length
  - Tools > Options > Project > Use 3D Length
- User defined lengths

Elevation Representation

- Used to convert HGL to pressure
- What reference point do you use?
  - Ground?
  - Pipe?
  - Customer?
- Be consistent



Converting HGL to Pressure

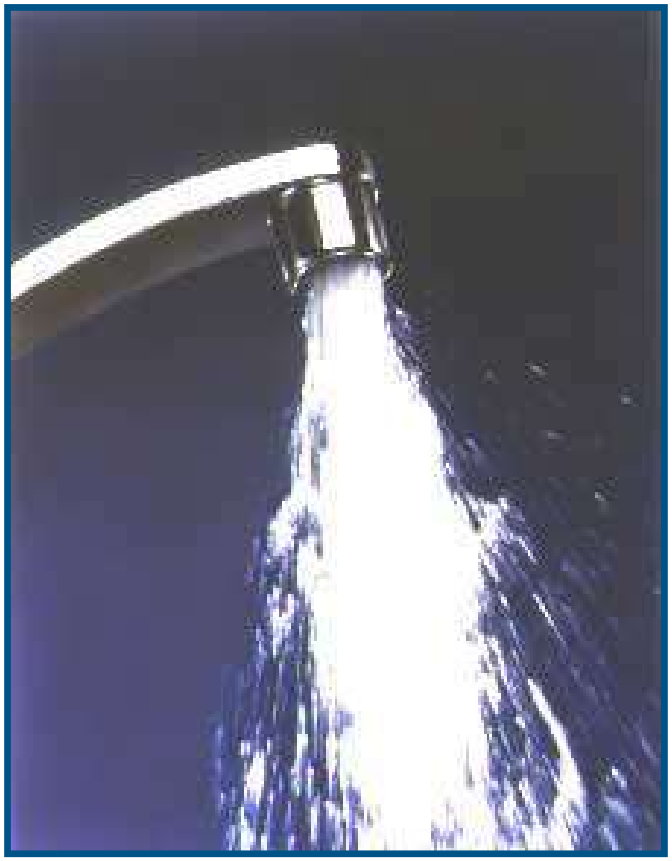


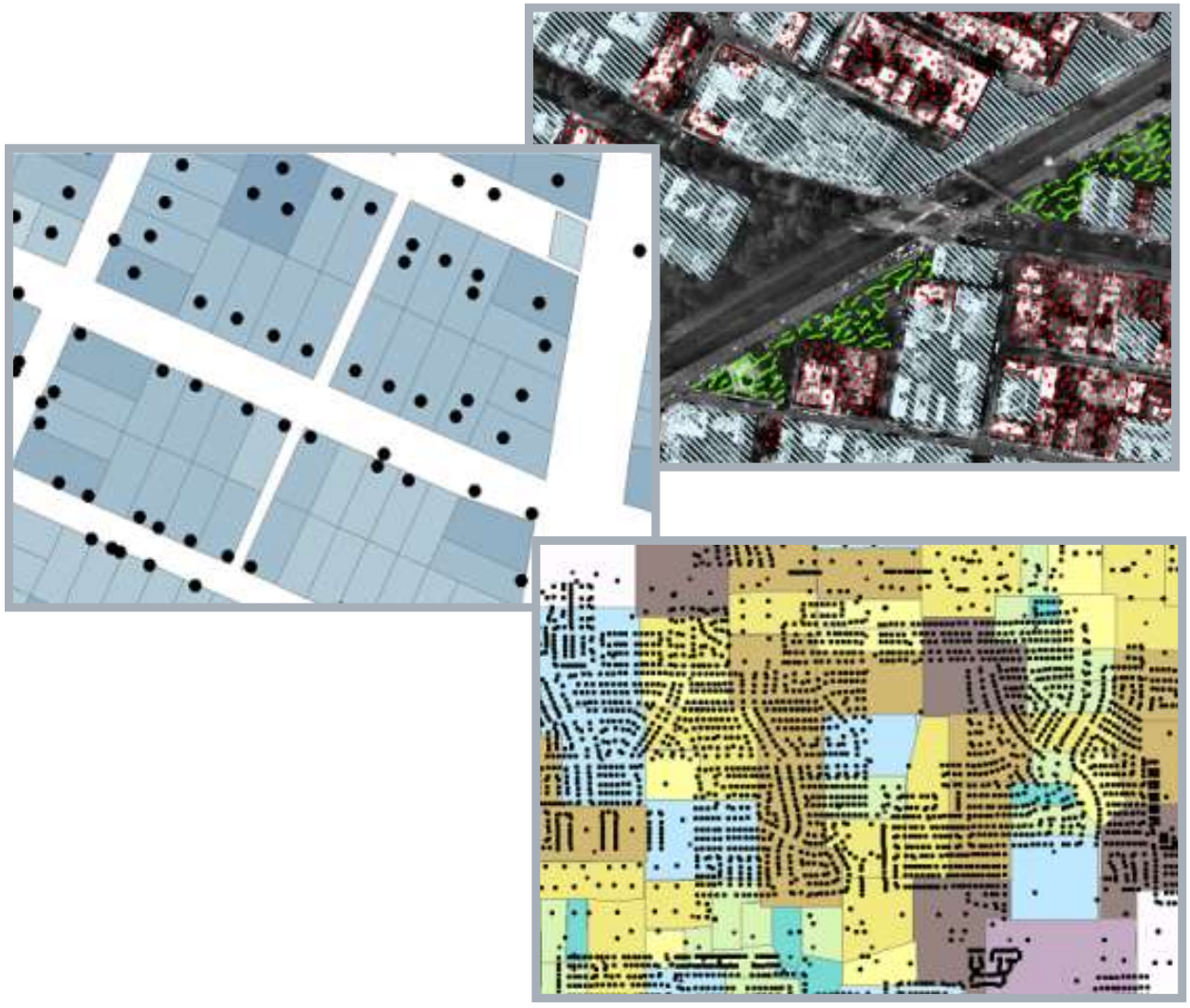
Which reference positions would you select?

Obtain Elevation Data

- Topo Maps
- Surveying
- Digital elevation models (DEM)
- Global Positioning Systems (GPS)
- Altimeter
- Sewer / street maps
- As-builts

Assign Demands



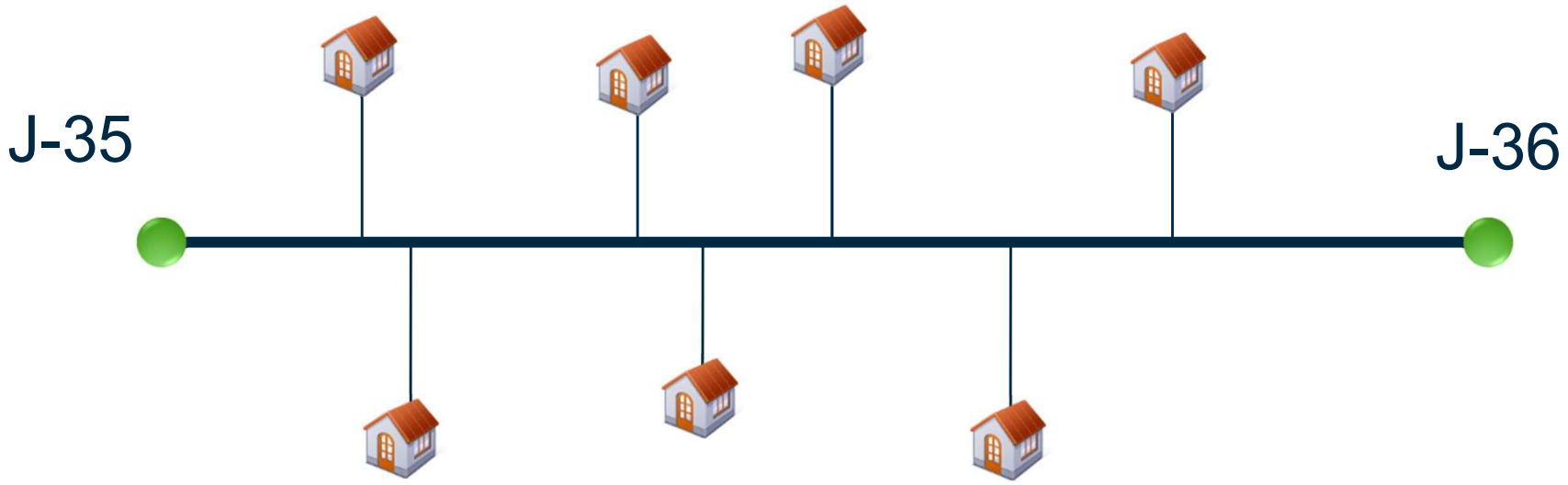


Consider all water use

- Referred to as:
  - Usage
  - Consumption
  - Demand
  - Loading
- Demands are assigned to nodes
- Unaccounted-for water use?

Place Demands at Nodes

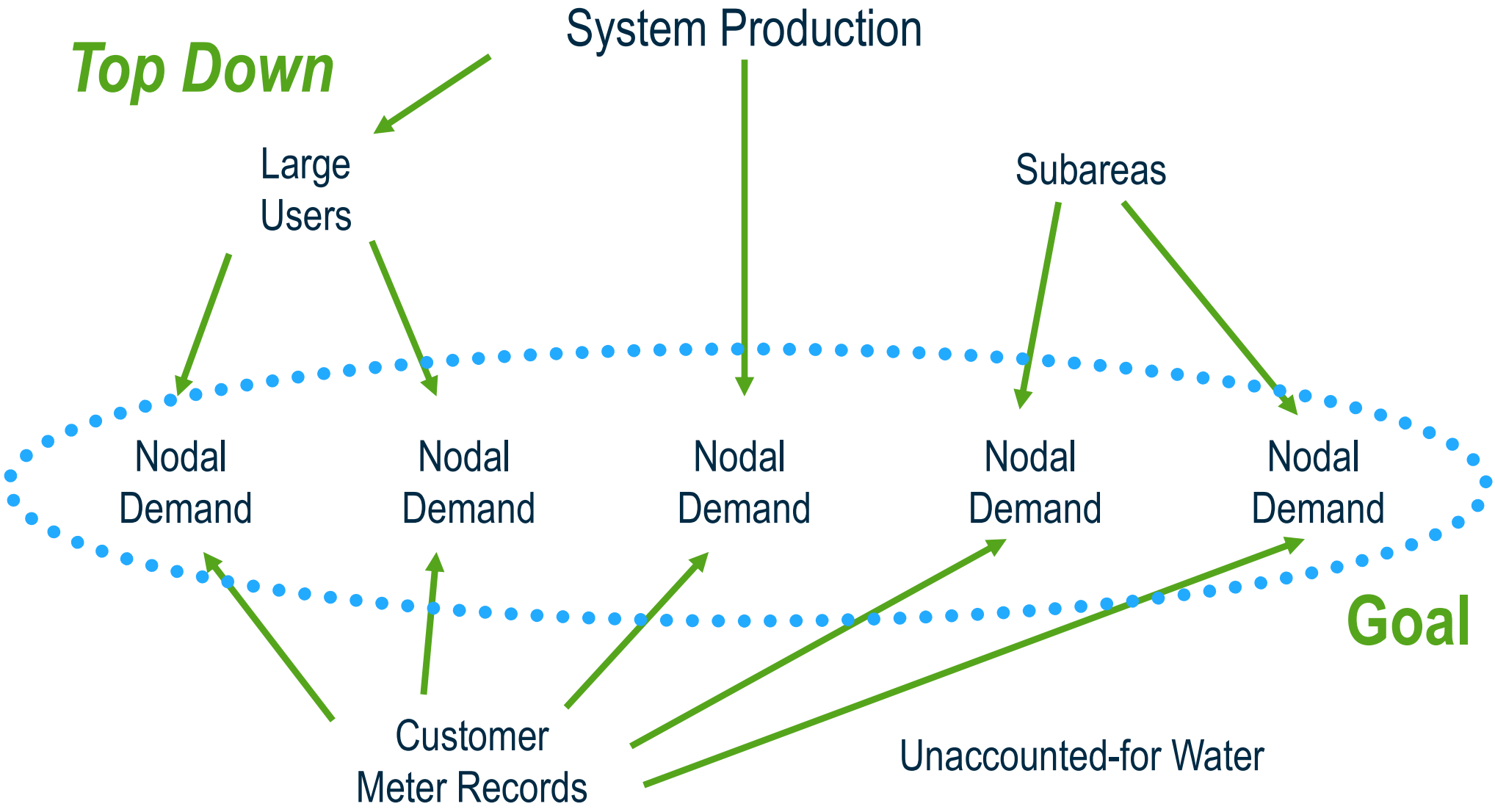
- If Q(use) << Q(in) then place demands at nodes
- If there is a significant demand add a node



Steps in Loading Model

1. Model at Current year daily average
2. Model at Peaking and temporal variations
3. Consider Fire flows
4. Consider unaccounted for water
5. Consider Projections – How do you predict the future?

Loading Method Approaches



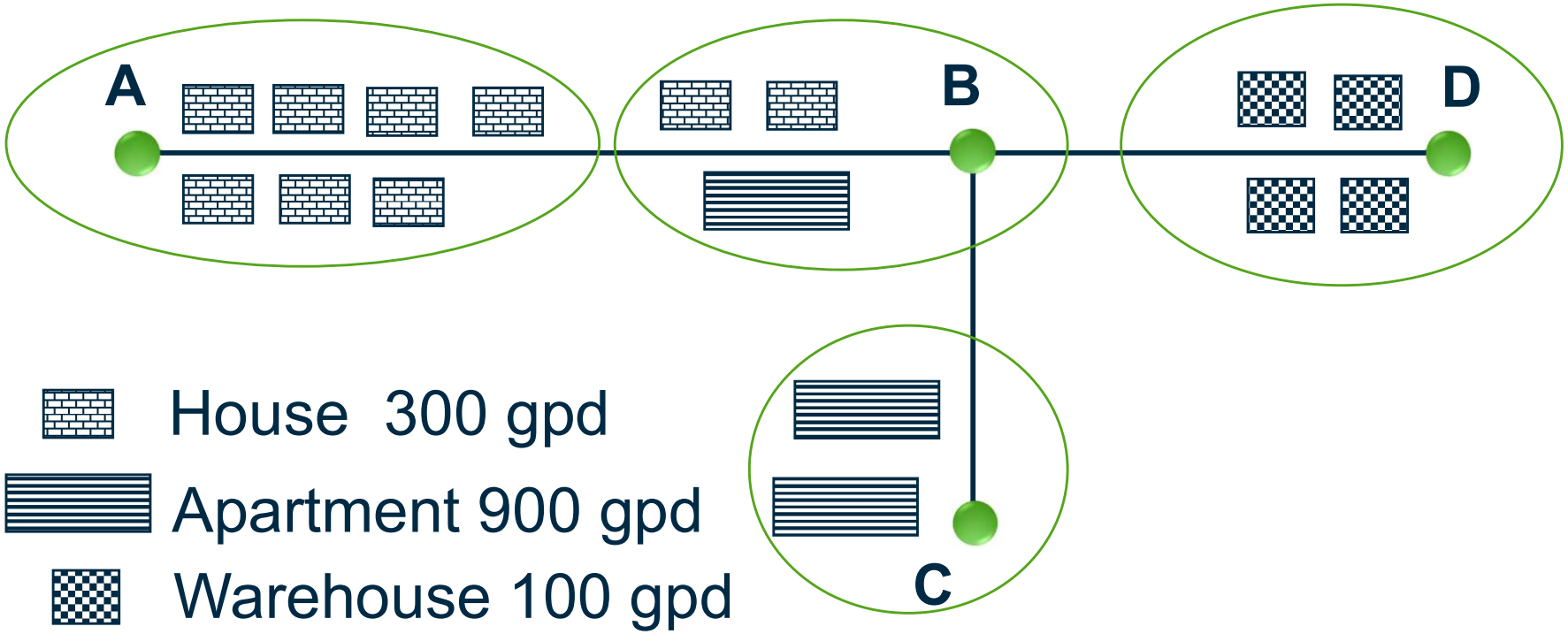
Which method is better?

Bottom Up

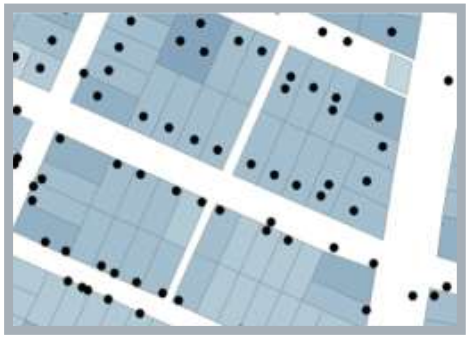
Assign Meters to Nodes

Nodes	Usage(gpd)
A	2100
B	1500
C	1800
D	400

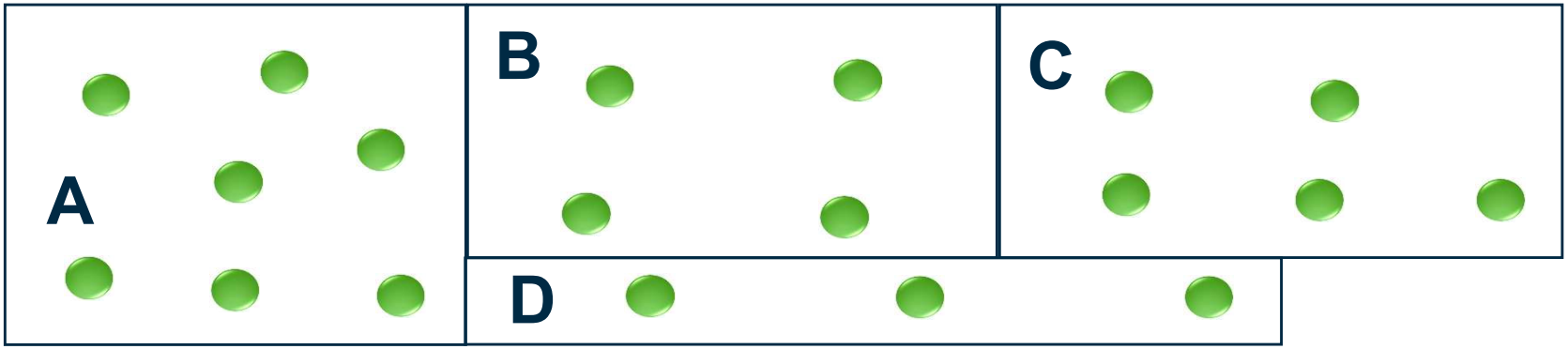
- Assign each meter to “nearest” node
- Automated using georeferenced meters
- Calculate water usage by directly accessing billing data
- Good for historical/current conditions



Distribute Areas to Nodes

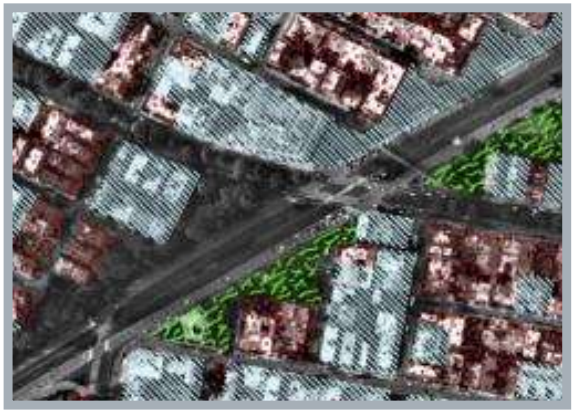


- Water usage can be estimated by areas such as census areas or meter routes
- Distribute areal water use evenly among nodes in area
- Assign large water users directly to a single node

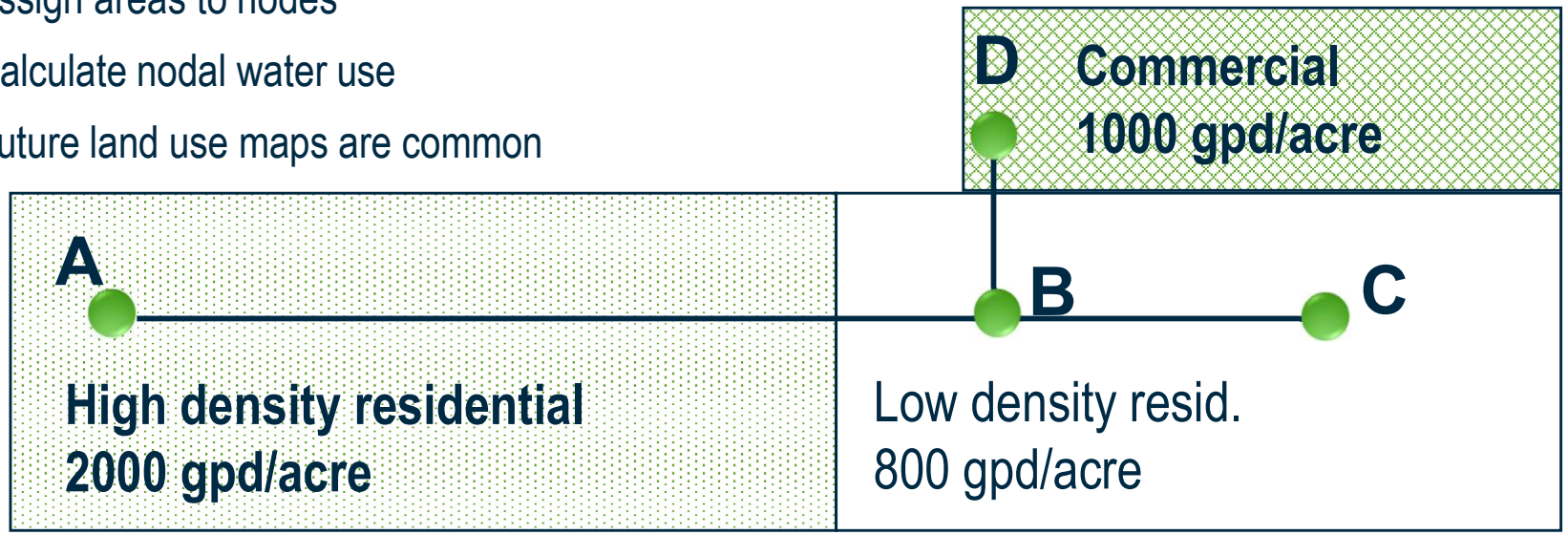


Area	Usage (GPD)	No. of Nodes	Usage/Node (gpd)
A	21000	7	3000
B	20000	4	5000
C	10000	5	2000
D	12000	3	4000

Water Usage by Land Use



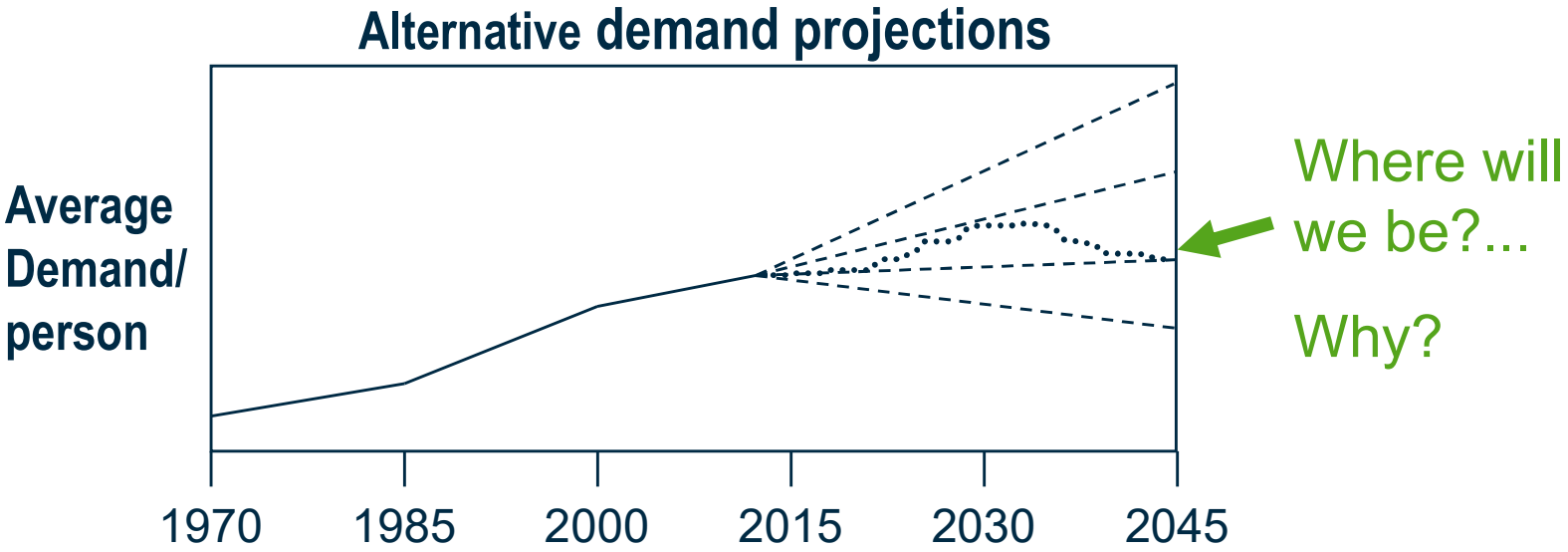
- Define water use/acre for each land use
- Define land use pattern
- Assign areas to nodes
- Calculate nodal water use
- Future land use maps are common



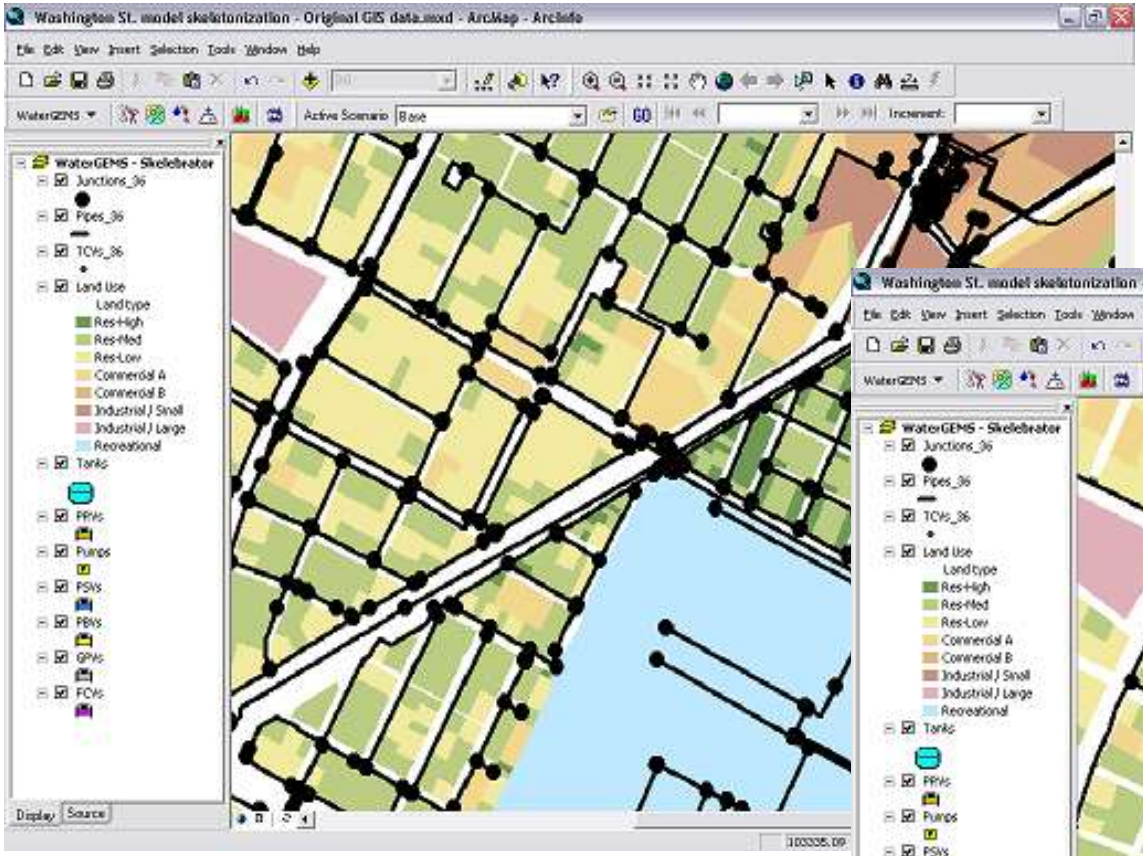
Acres in land use categories				Usage
Node	Low Den.	High Den.	Comm.	(gpd)
A	0	4	0	8000
B	3	3	0	8400
C	3	0	0	2400
D	0	0	6	6000

Demand Projections

- Spatial and temporal population projections
- Usually provided by city or regional planners
- Get others to “sign off” on population projections
- Where will high growth be? By whom?
- Future water conservation and per capita usage rates

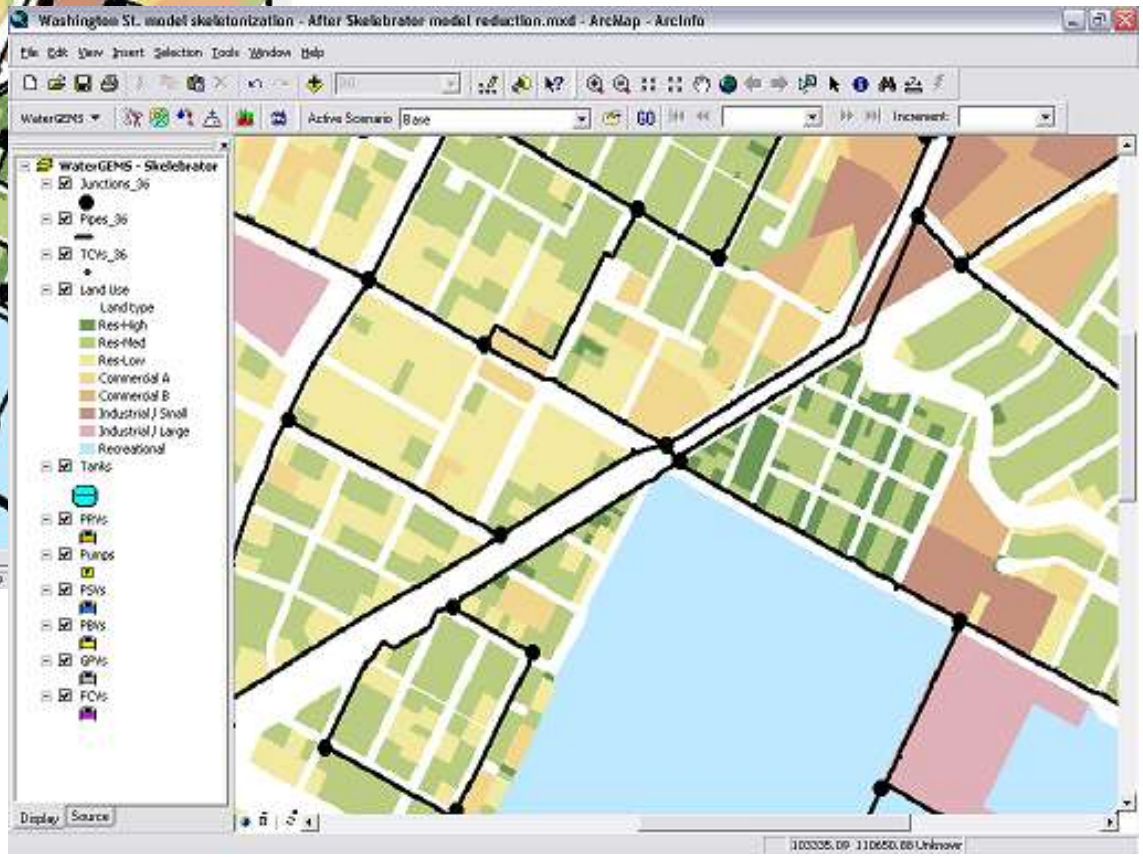


All Pipe Model vs. Skeletonized Model

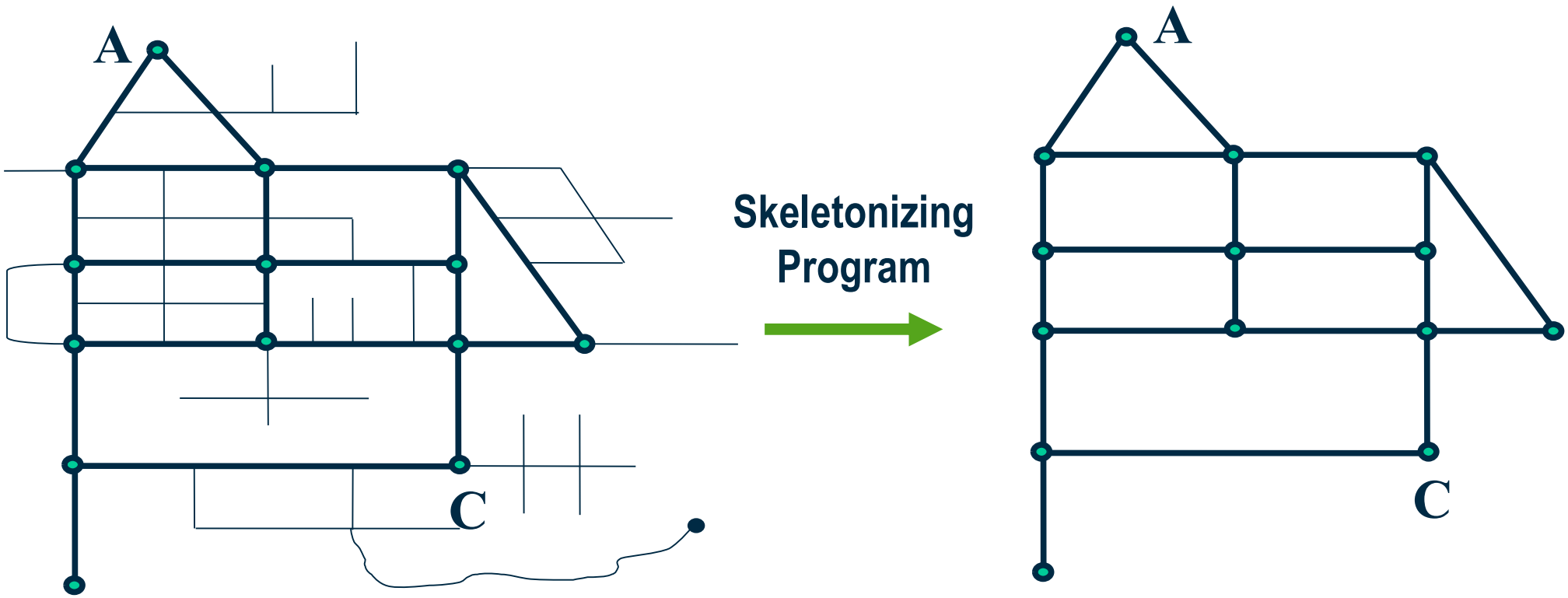


Original Model

Skeletonized Model



Accuracy in representing the processes in skeletonized model

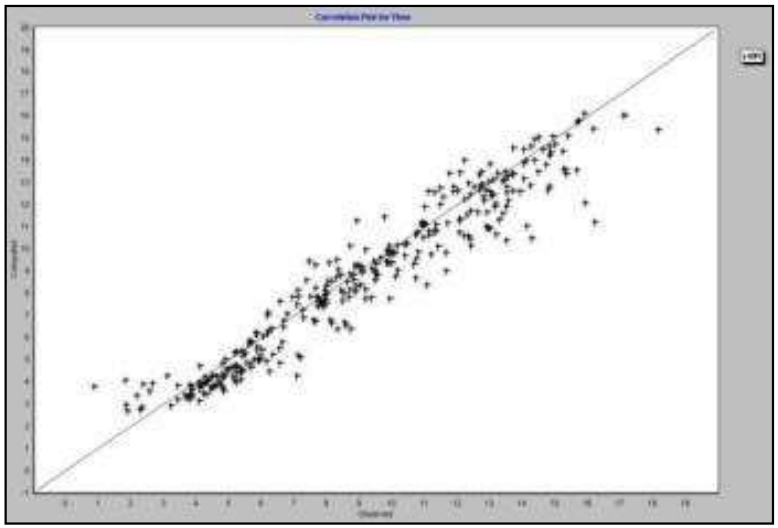


Does skeletonized model accurately predict behavior at nodes A and C?

Match the Model to the Application

- Applications that allow greater skeletonization
  - Master planning
  - Regional water quality studies
  - Energy studies
  - System head curves
- Applications that require more pipes
  - Design (in area of interest)
  - Designing flushing programs
  - Detailed water quality studies
  - Near fire flow nodes

#7 Calibrate, Calibrate, Calibrate



To fit the characteristics of the hydraulic model to the best representation of the real world

Measurement Devices (Data-Loggers)

Remotely piloted control stations

#8 Set up and Run the Model

- Steady State or EPS
- Pump Sizing
- Pipe replacement planning
- Calibration & Leakage
- Valve Criticality
- Pressure Dependent Demands
- Consider Interoperability Workflows with:
  - ArcGIS
  - Stand Alone
  - MicroStation
  - AutoCAD
- Much More…

Q & A ?

Thank You !