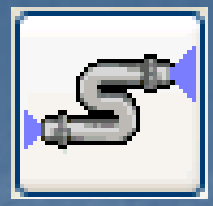
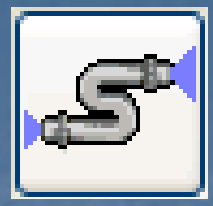
# Pipeline Modeling Enhancements

# Pipeline Hydraulics

- Enhanced the Pipeline object 
- Developed two new objects
  - Inline Pump 
  - Pipe Junction 
- Flows must be fully specified
- No network solution

# Pipeline 

- Existing Slots: Inflow, Outflow
- New category – Head Loss Calculations
  - No Head Loss
  - Hazen-Williams Head Loss

# Pipeline 

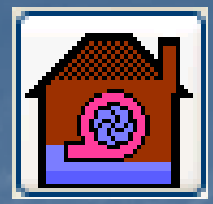
- Hazen-Williams Head Loss
  - Slots added: Inflow Head, Outflow Head, Diameter, Velocity, Length, C Value, Minor Losses

$$Velocity = k \cdot C \cdot (Rh)^{0.63} (S)^{0.54}$$

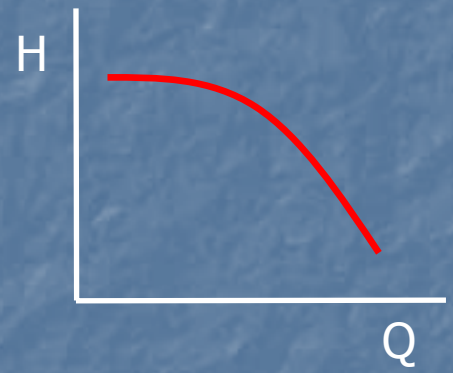
where $k = 1.318$, $Rh = \frac{D}{4}$, and $S = \frac{HeadLoss}{Length}$

  - Solve for Head Loss
  - Outflow Head = Inflow Head – Head Loss – Minor Losses
  - Inflow Head = Outflow Head + Head Loss + Minor Losses

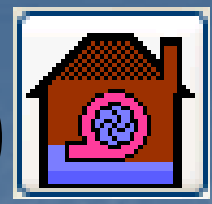
# Inline Pump



- General Slots: Inflow and Outflow
- New Category:
  - Hydraulic Calculations
    - No Hydraulics
    - Head Lookup
      - Slots added: Inflow Head, Outflow Head, Head Added, Minor Losses, Pump Curve Table, Pump Status
      - Head Added = f ( flow) using the Pump Curve Table
      - Outflow Head = Inflow Head + Head Added (or vice-versa)
      - Pump Status is used to specify whether the pump is on



# Inline Pump (continued)

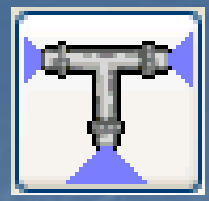


- Energy Calculations
  - No Energy
  - Energy Equation
    - Slots added: Power Consumed, Energy Consumed, Density of Water, Pump Efficiency

$$\text{Power Consumed} = \frac{(\text{Inflow})(\text{Density of Water})(\text{Gravity})(\text{HeadAdded})}{(1{,}000{,}000)(\text{Pump Efficiency})}$$

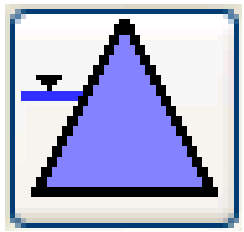
    - Energy Consumed = (Power Consumed)(Timestep Length)

# Pipe Junction

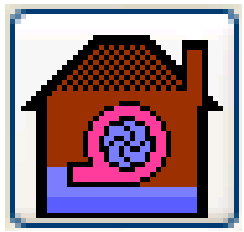


- General Slots:
  - Inflow, Outflow 1, Outflow 2
- New Category
  - Hydraulic Calculations
    - No Hydraulics
    - Propagate Head
      - Slots added: Inflow Head, Outflow 1 Head, Outflow 2 Head
      - Outflow 1 Head = Outflow 2 Head = Inflow Head
      - Can only input one of the three heads or RW aborts with an error

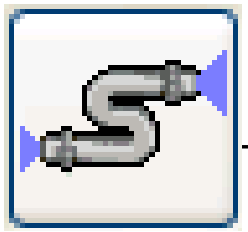
# Pipeline Hydraulics



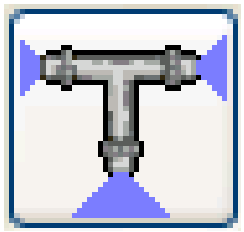
Reservoir



Inline Pump



Pipeline



Pipe Junction

Diversion

Pool Elevation

Previous Pool Elevation

etc ...

**Bold** text indicates values input or set by rules

Inflow

Outflow

Inflow Head

Outflow Head

**Pump Curve**

**Minor Losses**

Power

Energy

**Efficiency**

Head Added

Inflow

Outflow

Inflow Head

Outflow Head

**Diameter**

Velocity

**Length**

**C Value**

**Minor Losses**

Inflow

**Outflow 1**

Outflow 2

Inflow Head

Outflow 1 Head

Outflow 2 Head