

## XP Software – On-Site Detention (OSD) Example

Step 1 Open xpswmm2010 program

Or from Start menu – select “Programs” – “XPS” - then select “xpswmm2010”

Select “Create From Template”



Save file, e.g. “Filename.xp”

The program will jump to Templates folder - click on Malaysia folder

Select file MalaysiaTimeArea.xpt



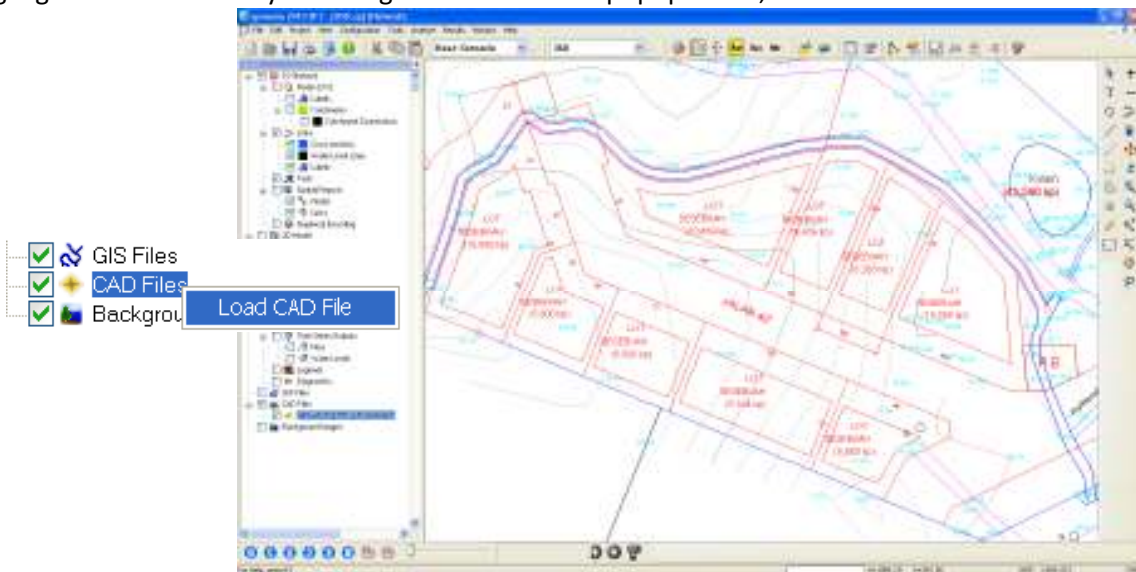
This loads a preset standard set of data appropriate for Malaysian modeling projects.

Check model layer

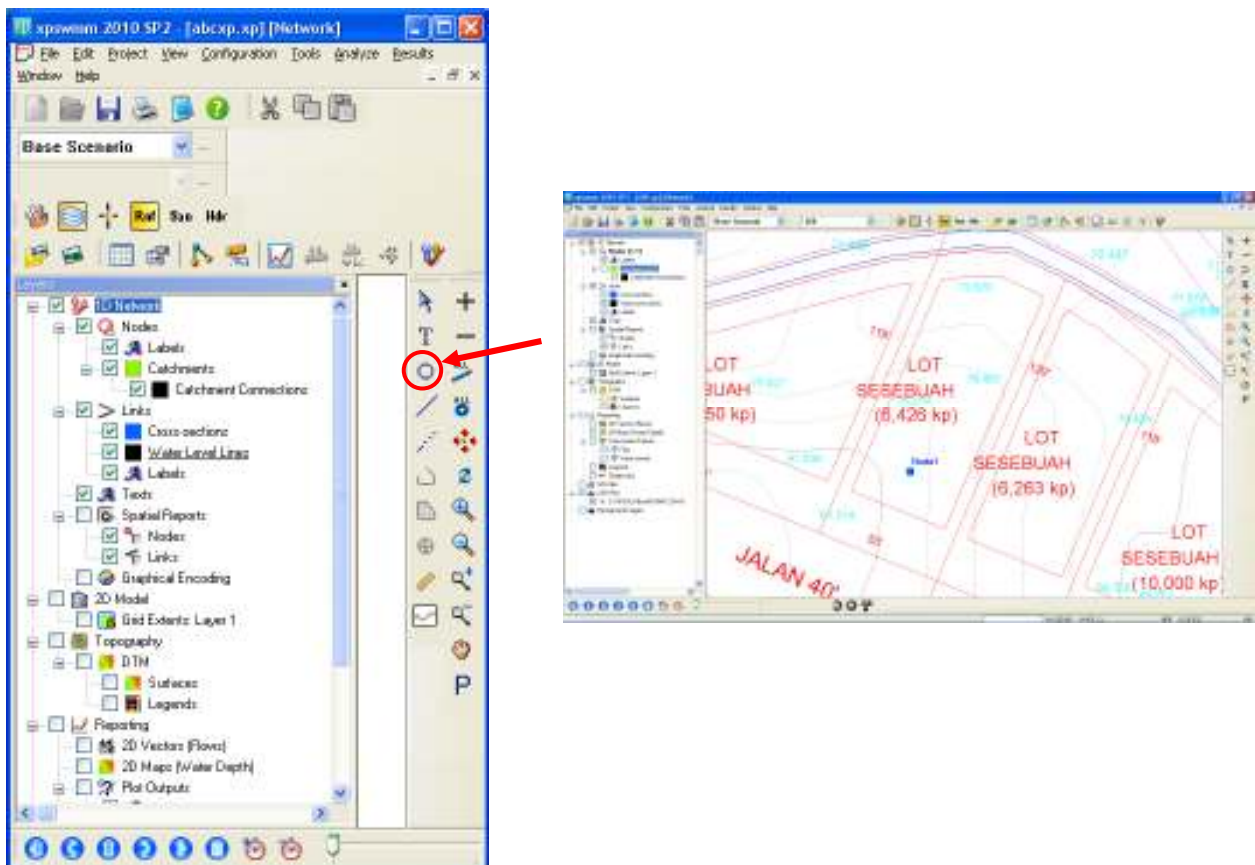
Select **RNF** button to enter Runoff layer



Add CAD layer as background. On the Layer Control Panel, check the visible box for **CAD Files**. Highlight the CAD Files layer and right click. From the popup menu, select **Load CAD File**.



Select Node button from tool strip – With left mouse button place node at the center of the lot. This node represents the outlet of a catchment for a development site.



Change “Node 1” name to your desire name (OSD) using attributes menu or right mouse click Properties or select Node (highlighted) & double click on text.

As the Malaysia Master Time Area.xpt template file contains most of the data necessary to run any drainage system in Malaysia it is only necessary to add the local sub-catchment and connecting hydraulic links, rainfall pattern and intensity plus soil infiltration data.

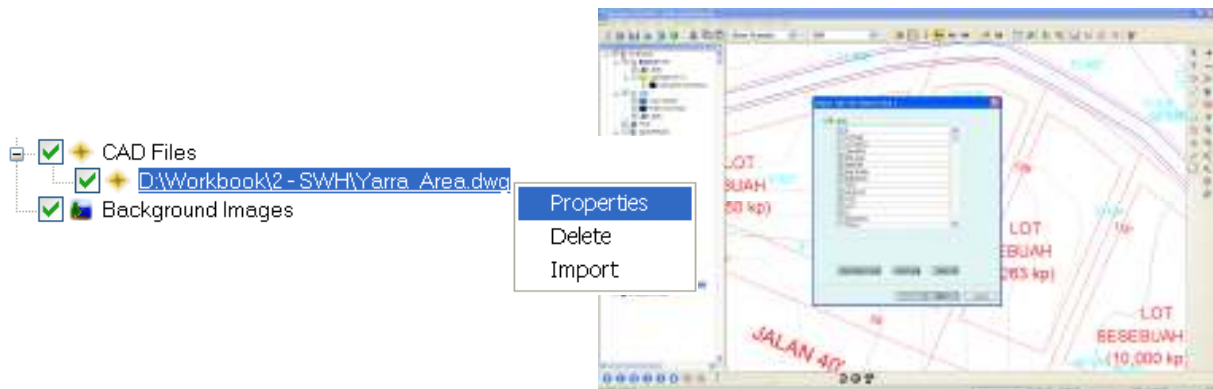
## Pre development flow

At RNF layer, enter sub-catchment (Development contributing area) data to node OSD

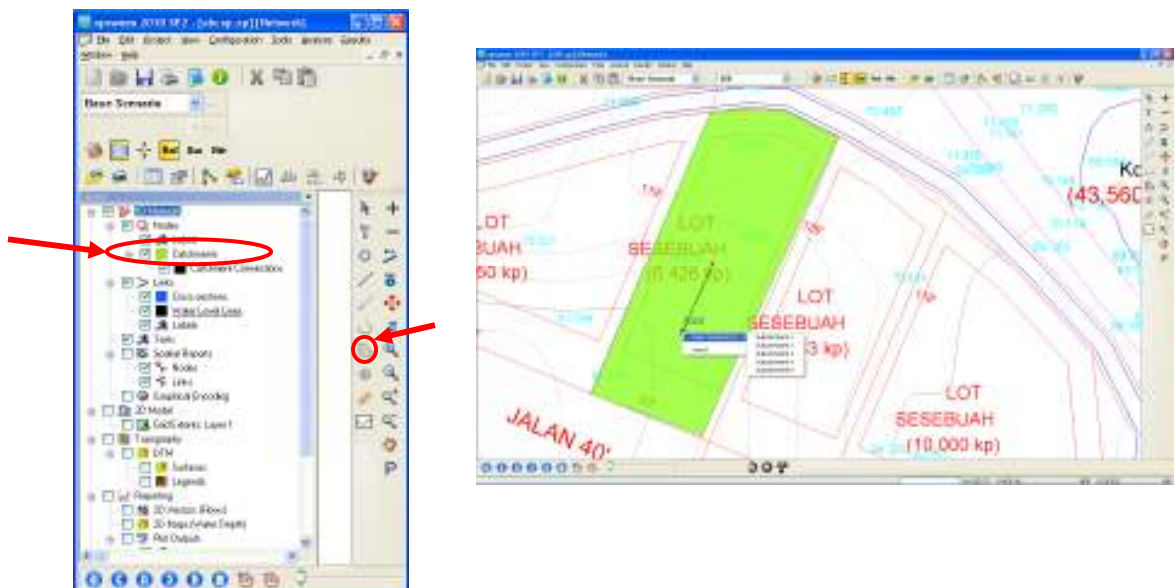


Users can

1. Import the catchment area from CAD file (if the catchment area is already drawn in CAD file). Right click the CAD file at the left hand panel. Select CAD property equivalent to catchment area – click **Next** – Select **Catchment** – click **Finish**



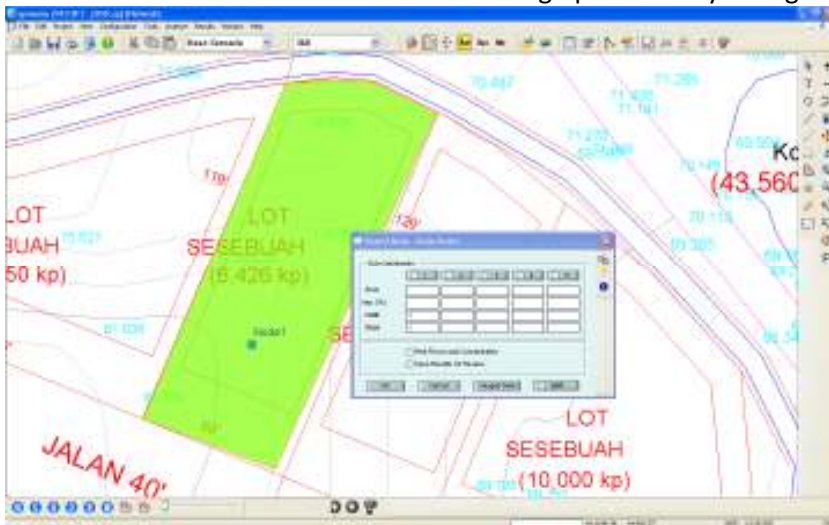
2. Draw catchment area using Polygon tool at right hand panel. Highlight "Catchment" & use polygon tool to draw the catchment area,



Link the catchments to the nodes. Select a catchment. Move the cursor over the centroid. The cursor will appear as shown above. Hold the left button down and draw a line to node OSD. The cursor will appear as a cross. Release the left button and a popup menu will appear. Designate the area as Subcatchment 1 for Node OSD.

3. Enter the data directly

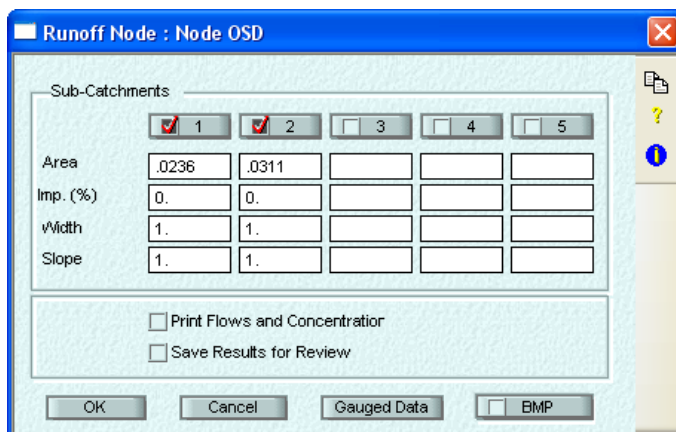
Double left mouse click on node OSD to bring up data entry dialogue .

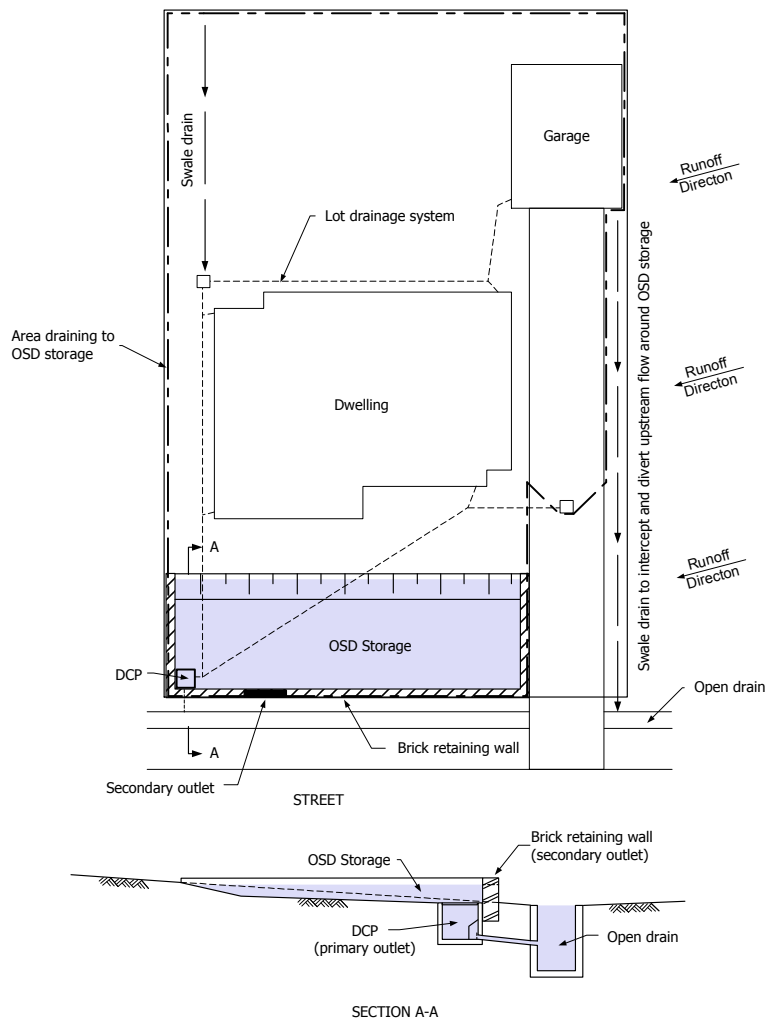


Note: Used **Ruler tool** to measure catchment area



Enter data for first column (Impervious sub-area) and second column (pervious sub-area)





Impervious area:

- Dwelling = 115.7 m<sup>2</sup>
- Garage = 30.2 m<sup>2</sup>
- Driveway = 40.6 m<sup>2</sup>
- Surface paving and paths = 49.5 m<sup>2</sup>
- Total = **236 m<sup>2</sup> (0.0236ha)**

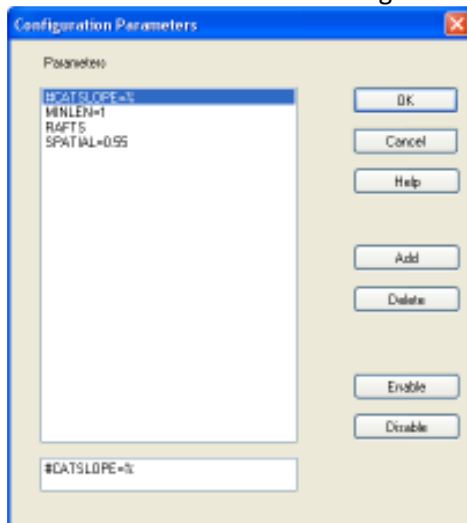
Pervious area:

- Lawns and Gardens = **311 m<sup>2</sup> (0.0311ha)**

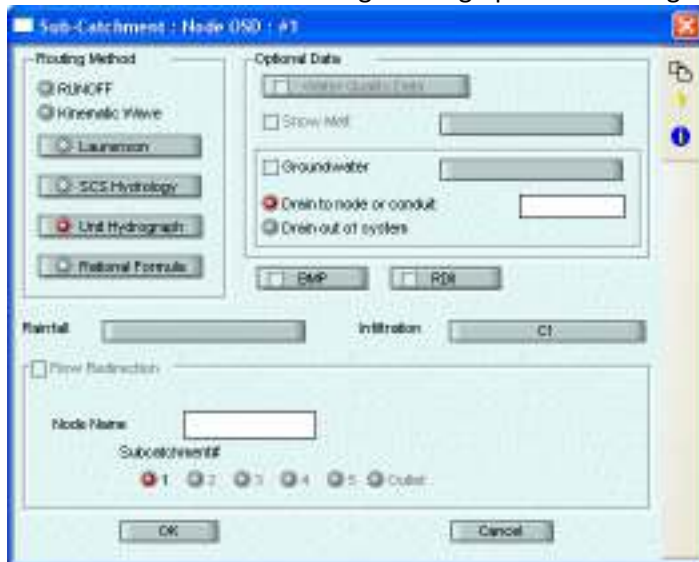
As Time Area hydrology method is being used; *width of catchment & Slope* are NOT used so default value of 1 is used.

Default unit for Slope of sub-areas is in m/m. Check unit by placing cursor close to the input box, the unit information will popup.

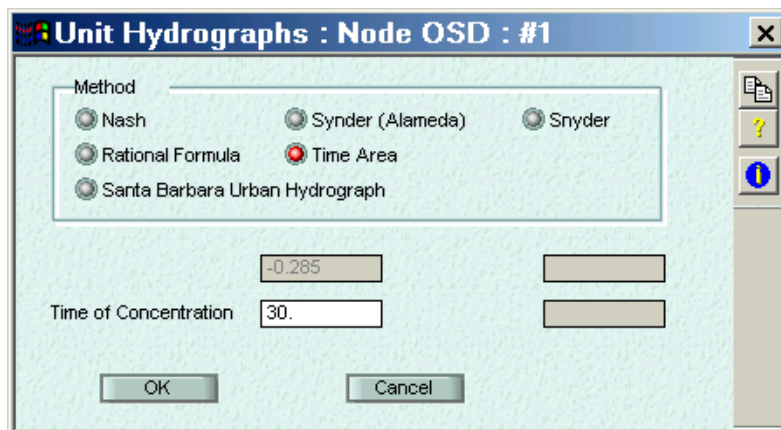
Users may change the catchment slope unit from m/m to % using Configuration Parameter. Users can **Enable** or **Disable** the configuration.



Click on first column 1 heading to bring up further dialogue



Select **Unit Hydrograph**



Select **Time Area** and input a 30 min time of concentration. Select **OK**

## Rainfall Intensity Estimation

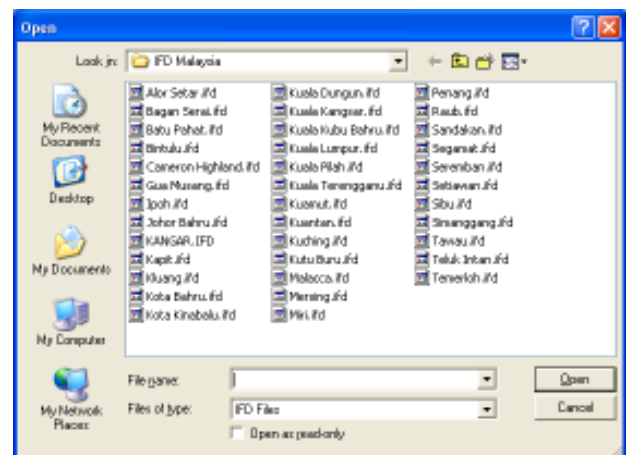
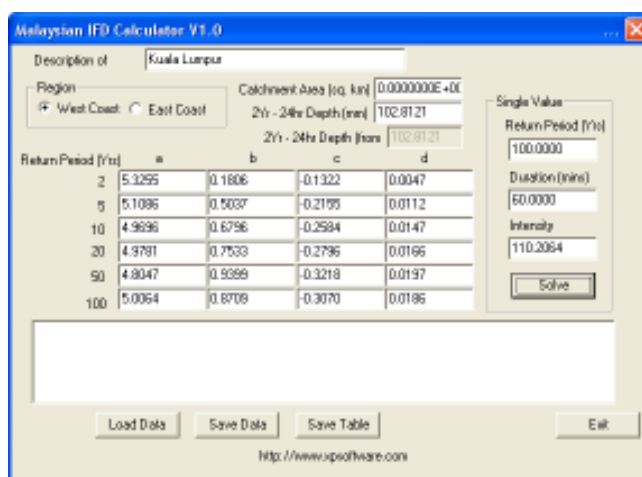
Intensity-Duration-Frequency (IDF) relationship is given in MSMA Table 13.A1 for 36 major cities throughout Malaysia. For intensities with a TC less than 30 min, MSMA Equation 13.3 and Table 13.3 (Fd values) can be used.

A utility is included with xpswmm to calculate the IFD (intensities). Using MSMA equation 13.4, the rainfall depth can be calculated from the intensity by multiplying the intensity by the storm duration (in hours).

The total depth is entered in xpswmm as a multiplier for temporal patterns in MSMA Tables 13.B1 and 13.B2.

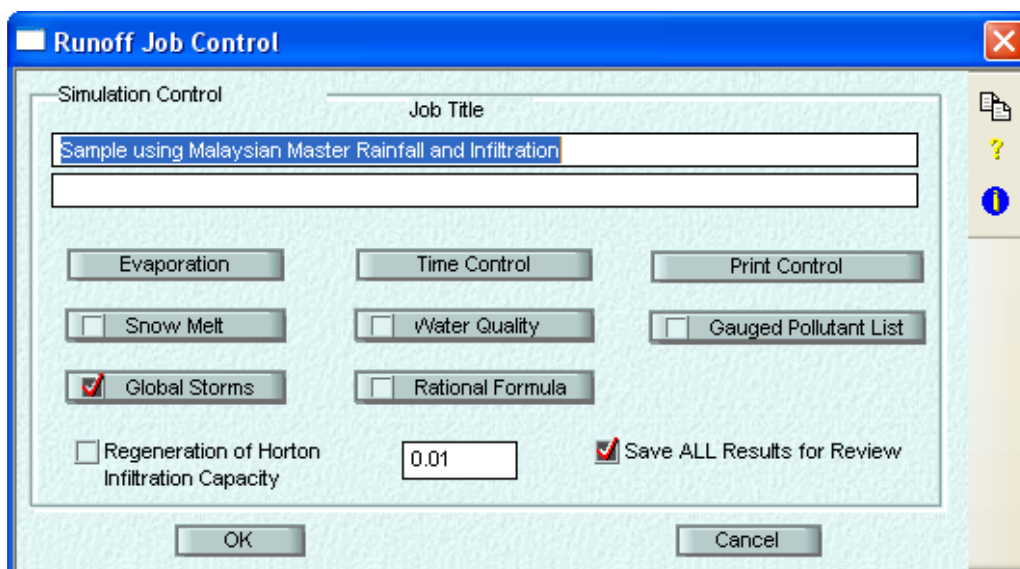
### Go to **Tools – Launch Application**

Open **MalaysiaIFD.exe** calculator

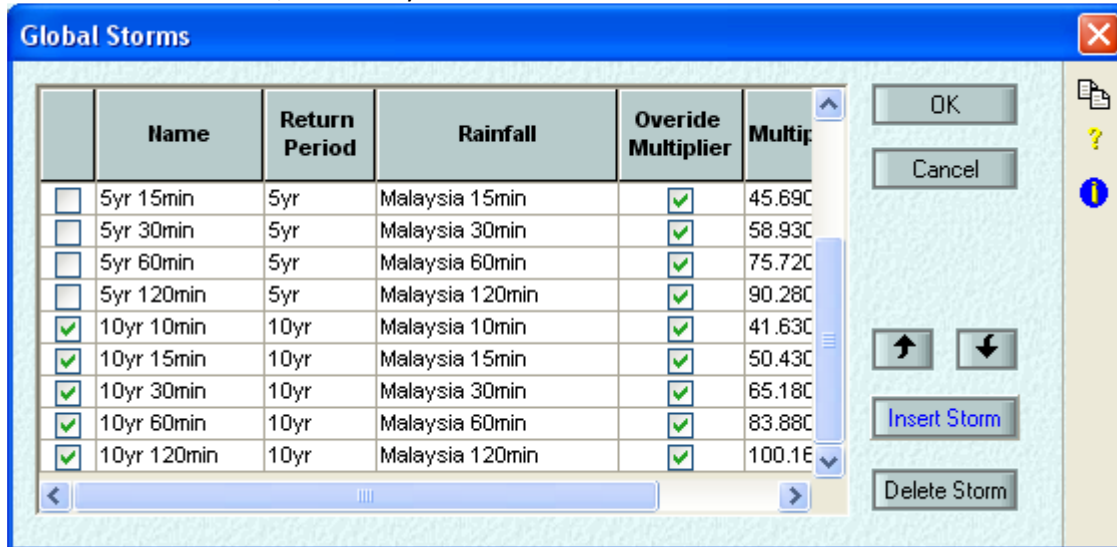


Load city closest to your project location to obtain the design rainfall

### Go to RNF layer **Job Control**



Click on **Global Storms**, select 10 years storms.

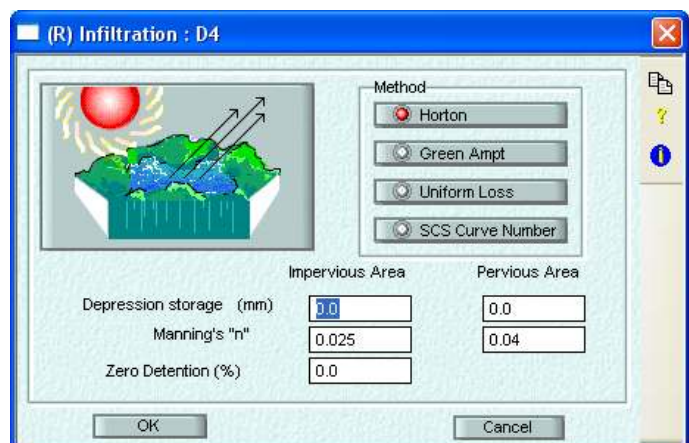
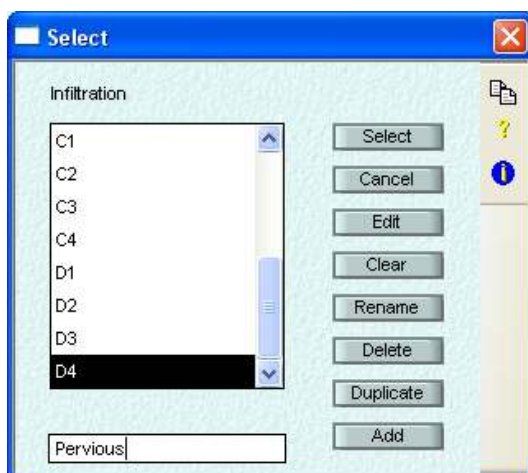


xpswmm uses its Global Storms feature to analyse multiple storm durations to determine which event will be the critical design storm for a given ARI. For this example, the total rainfall depth data for Kuala Lumpur will be entered into the Global Storms.

The **Insert Storm** and **Delete Storm** buttons are used to add and delete lines. The up and down arrows are used to arrange the storms in the list.

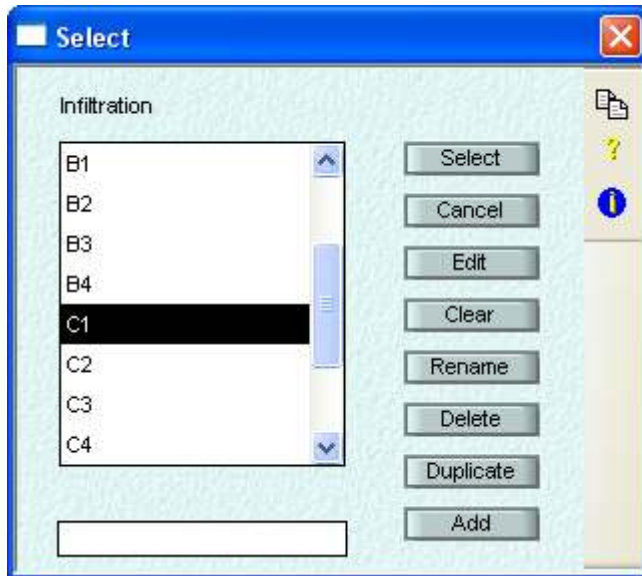
### Setting up the loss model.

Users can set up their own loss models. Click on the **Infiltration** button in the subcatchment hydrology dialogue box. Now you will see the infiltration global database dialogue (Alternatively you may access this dialogue box through configuration Menu/Global data). Example: Type in "Pervious" and click on **Add**, now click on **Edit** and select the **Horton** method.

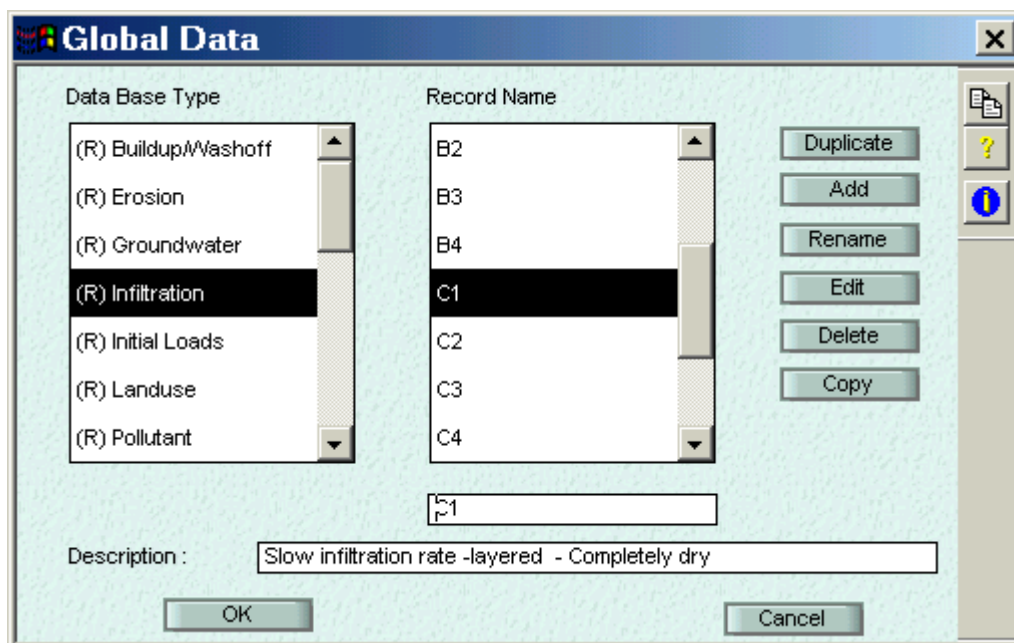


This example started from the template file, so we have a list of infiltration to be selected from **Global Database**.

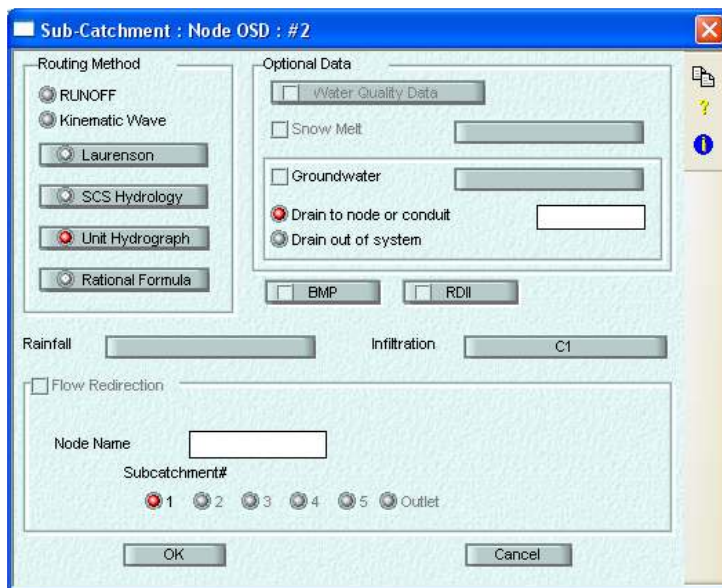
Click on **Infiltration** button, select "C1" for Pre Dev model. For Post Development model select D4 to represent impervious roofs and paths



Go to **Global Data** under **Configuration** Menu to see descriptions of preset **Infiltration** types A1 to D4

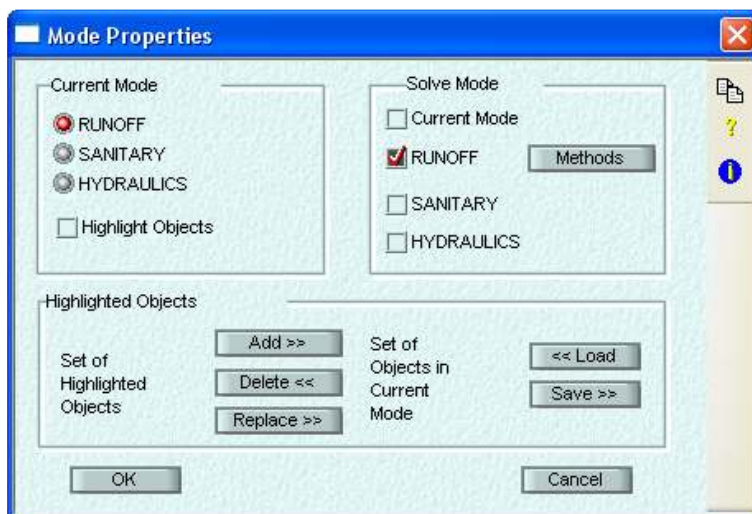


Select C1 infiltration for second sub-area.

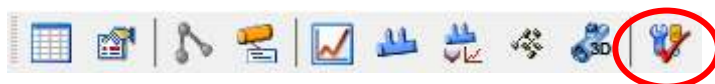


Return to network window by selecting **OK** buttons

Before running the model, go to **Mode Properties** (Under Configuration). If running only **RNF** layer, check **RUNOFF** mode only



Click on **“Solve Icon”** button far right of tool bar to **Solve** the selected modes.

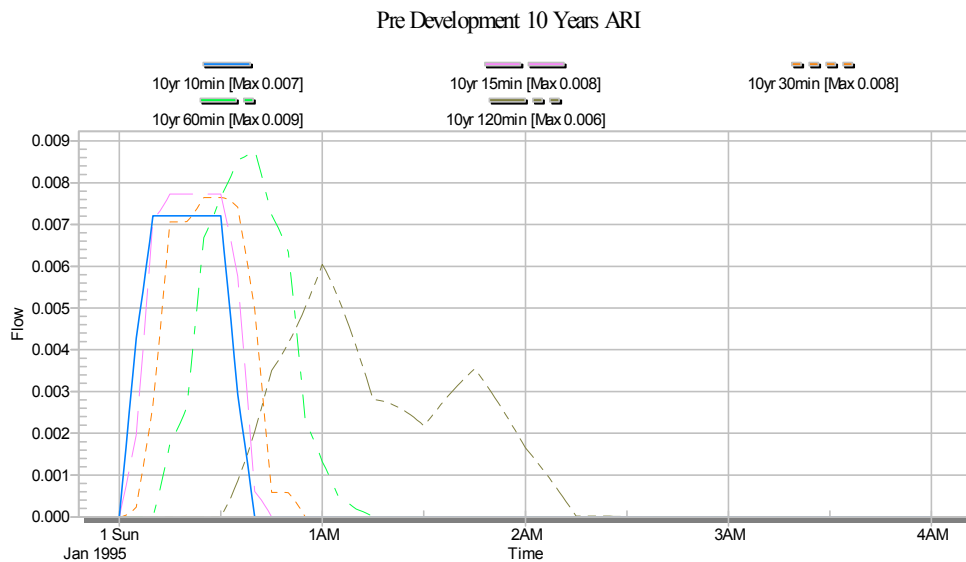


Save default output name

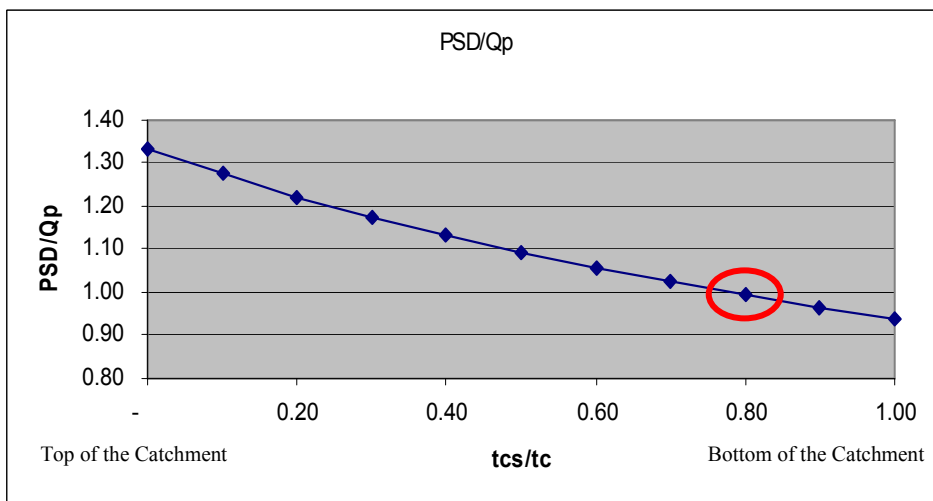
Single Click on **OSD** node and then press **Review Results** icon on tool strip to view hydrograph at development site outlet for 10 yr ARI storms. This is based on time-area hydrology with tc equal to 30 minutes.



Pre Dev 10 Years ARI - Peak Flow is 8.8 l/s. Critical storm is 60 min as it produces the highest peak flow.

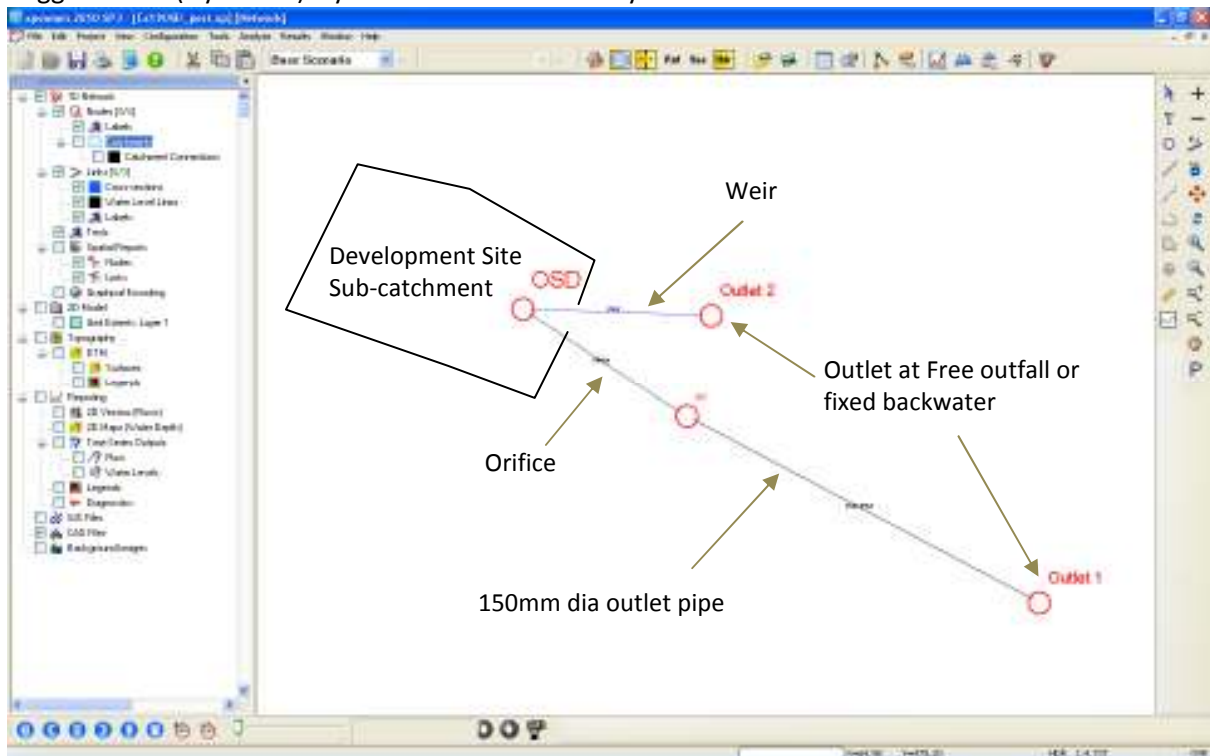


For this example, the site is conservatively taken as closer to the bottom of the catchment. From the chart below permissible site discharge (PSD) =  $Q_{pre}$



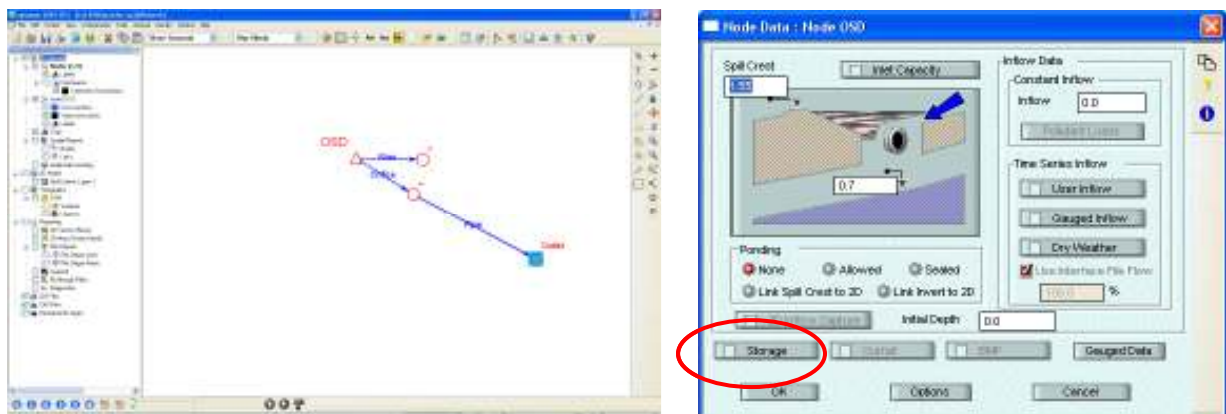
Run a Post Dev model with OSD on and allows it to be designed not to exceed PSD.

Toggle to Hdr (Hydraulic) layer and add the rest of hydraulic elements.



Orifice & Weir are represented by multi links. Select **Orifice link**, right click and choose **Multilink** from the popup menu. Double click on **Orifice link** to open the Multi Link dialog, right click & pick Multi links.

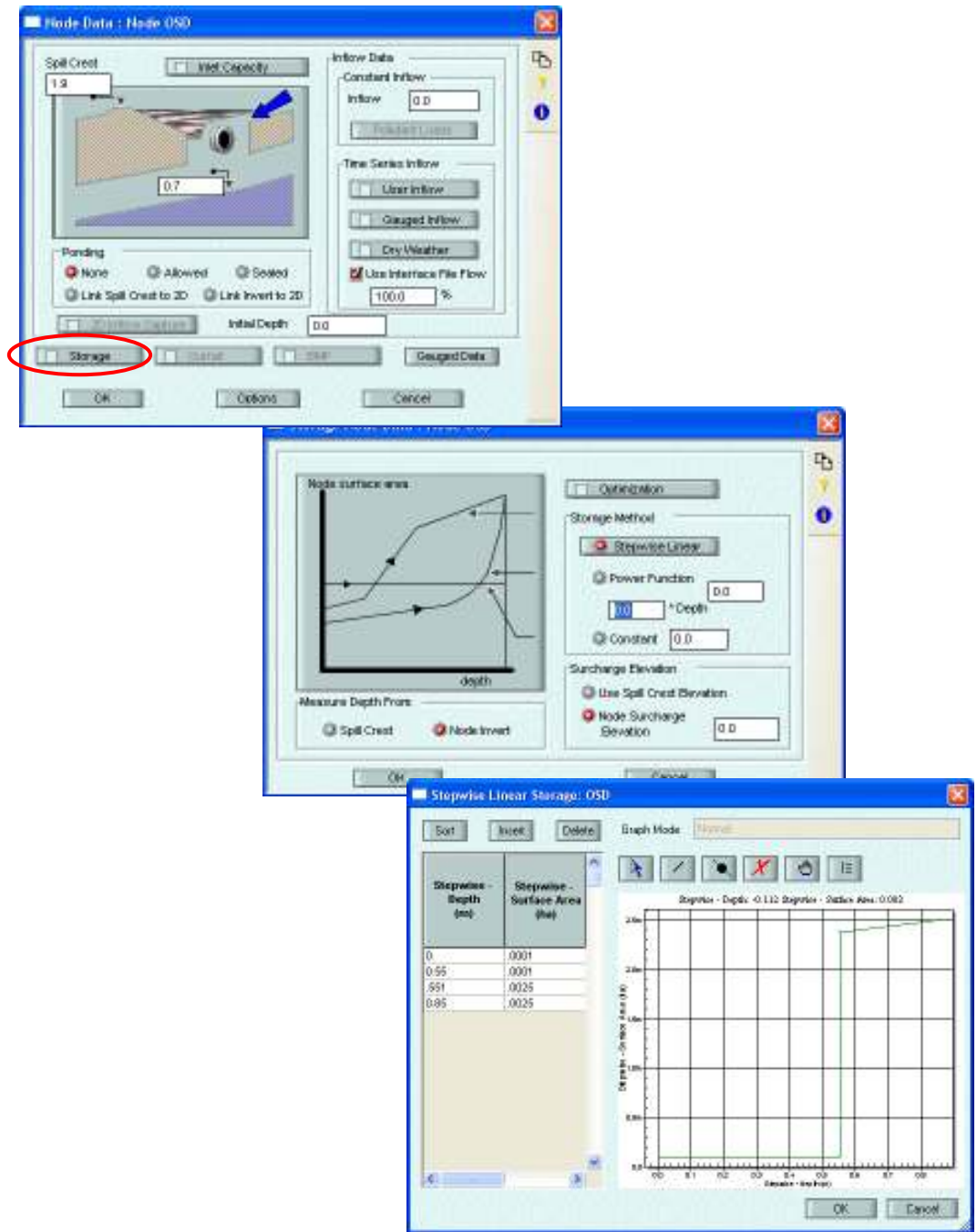
Multi Links are represented by broken lines.



Triangle shape for OSD node means storage function is on. If there is no storage at the OSD node, you can turn it off by **Unchecking** Storage in the Node dialogue.

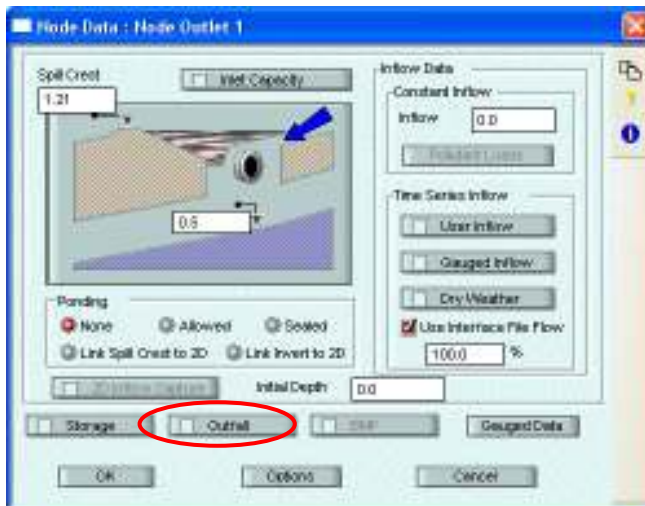
The OSD is to be sized to contain the 10 yr ARI storm

Double click at OSD node, input **Spill Crest, Invert & Storage** data.

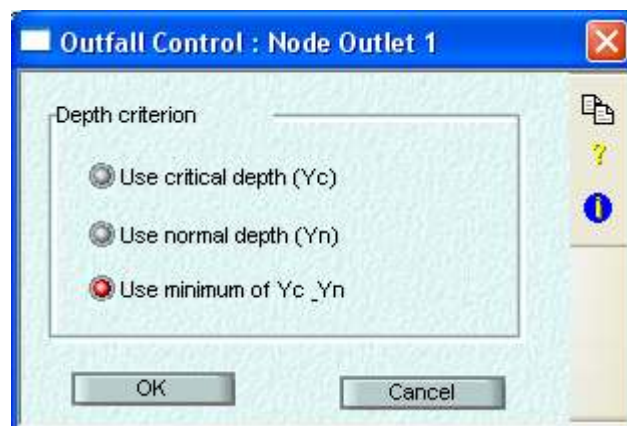
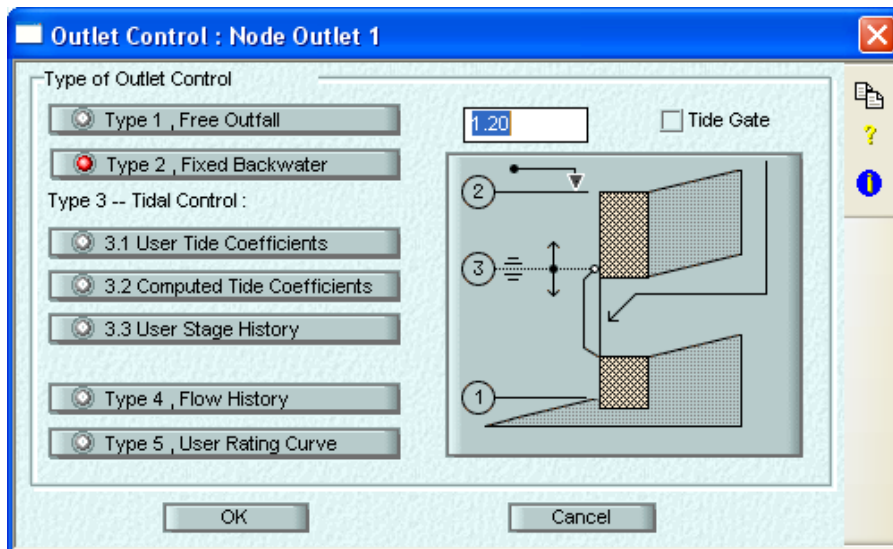


Area of (7.5 m<sup>3</sup>) storage at top water = 0.0025 ha, based on 0.3 deep rectangular storage with high early discharge

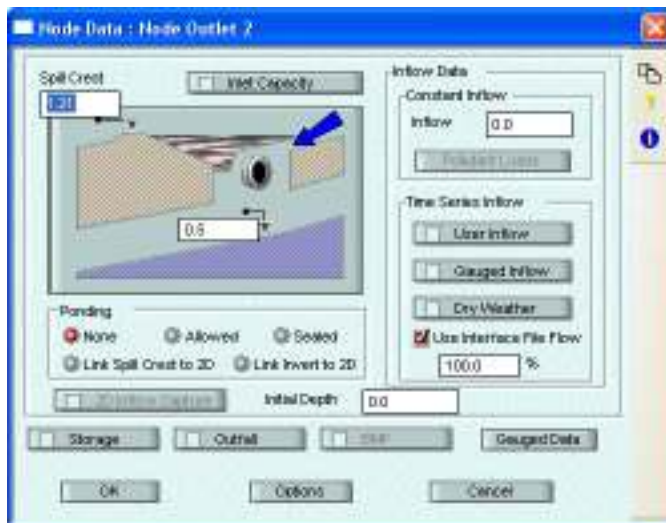
Input data to Outlet 1



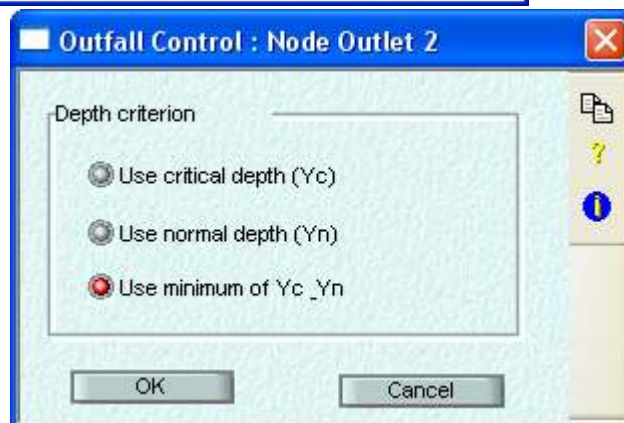
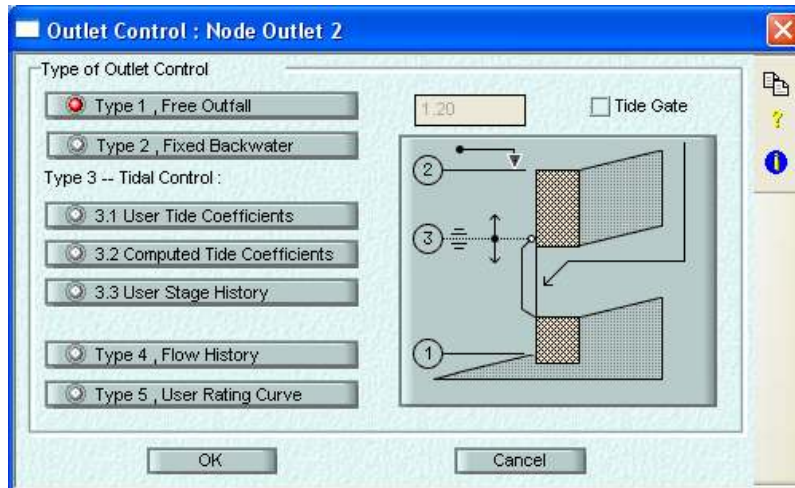
Click on **Outfall** button & set **Fixed Backwater** 1.2m as outlet control.



Input data to Outlet 2



Click on **Outlet** button & set **Free Outfall** as outlet control.



Input Links data

Double click at **Orifice** link & input Orifice area

The image shows two overlapping software windows. The top window is titled "Multiple Link : OSD to 203" and contains a grid of link types: Conduit, Pump, Orifice, Weir, and Special. The Orifice link is selected. The bottom window is titled "Orifice Data : OSD to 203 : orifice 1" and contains the following fields:

- Orifice Type: Plan (selected), Section
- Name: orifice.1
- Orifice Area: 0.0028
- Discharge Coeff.: 0.62
- Vary with Time:
- Orifice Pipe:  Circular,  Rectangular
- Orifice Height: 0.0
- Orifice Invert Elev.: 0.79
- Bottom Outlet:  Bottom Outlet,  Side Outlet

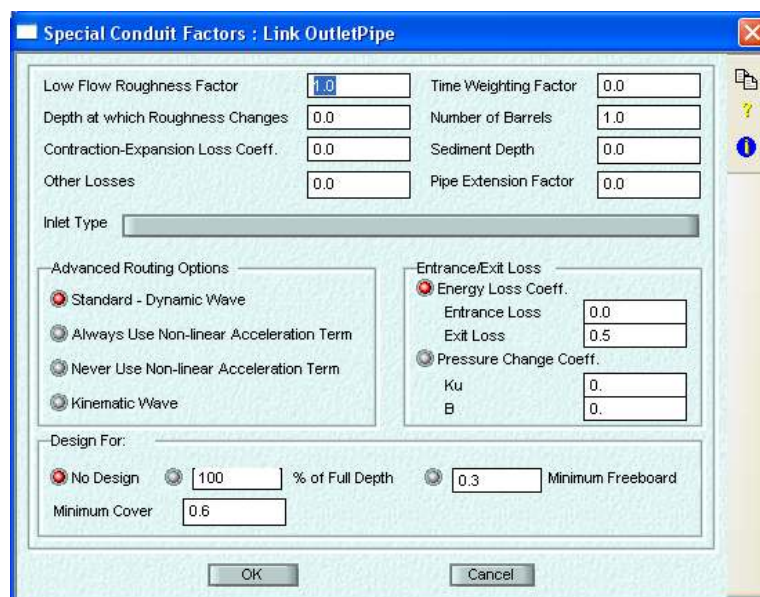
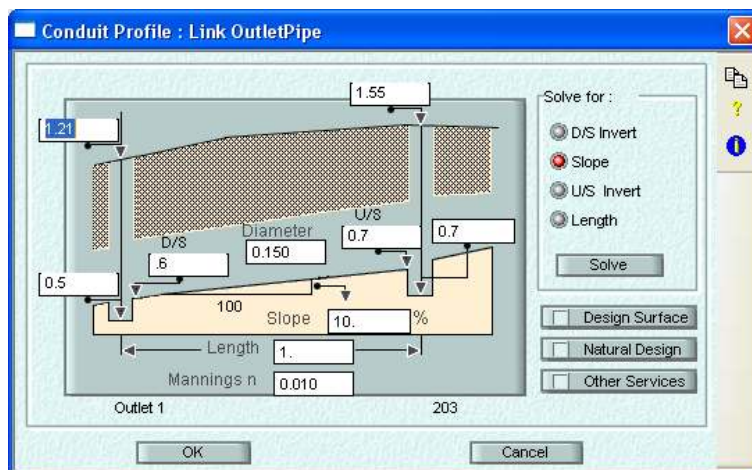
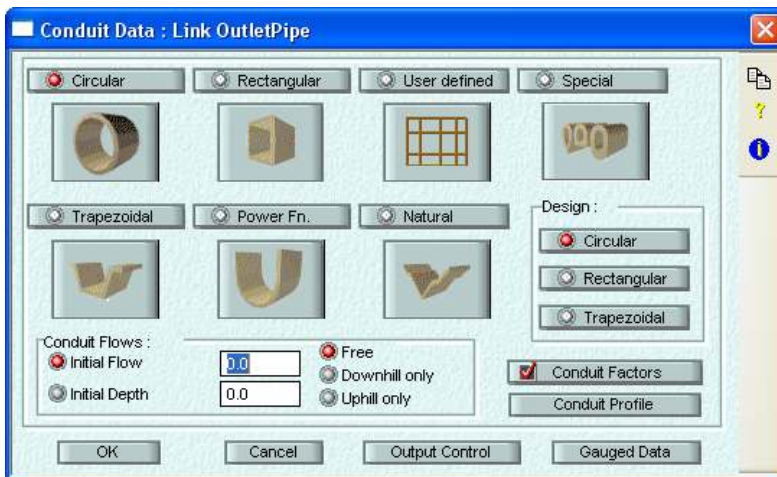
Orifice diameter = 60 mm.  
Area = 0.0028m<sup>2</sup>

Double click at **Weir** Link & input Weir data

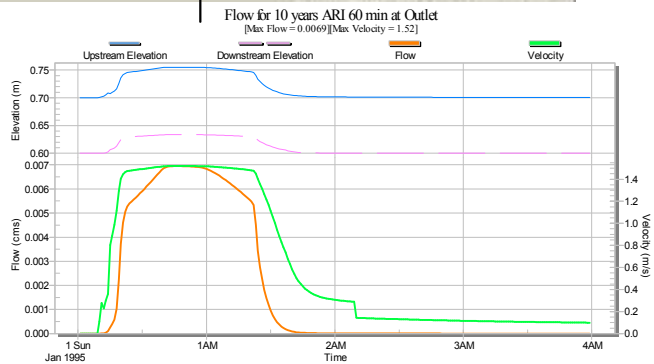
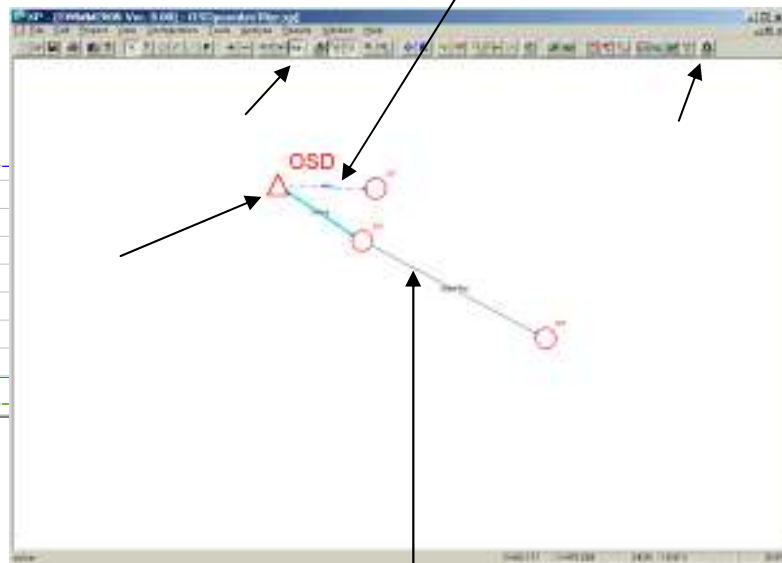
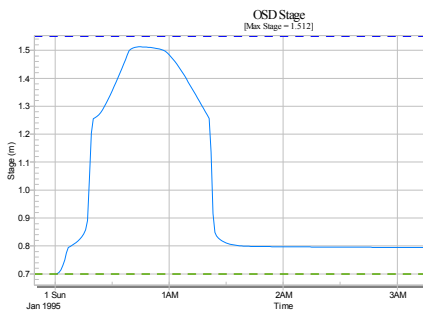
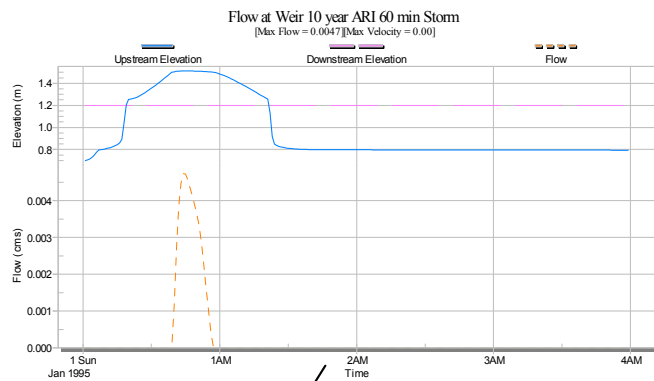
The image shows two overlapping software windows. The top window is titled "Multiple Link : OSD to Outlet 2" and contains a grid of link types: Conduit, Pump, Orifice, Weir, and Special. The Weir link is selected. The bottom window is titled "Weir Data : OSD to Outlet 2 : weir 1" and contains the following fields:

- Weir Type: Transverse Weir (selected), Section C-C, Side Weir
- Name: wosd
- Reverse Flow Eliminated Using Flap Gates:
- Discharge Coefficient: 1.7
- Crown: 1.9
- Crest: 1.55
- Weir Length: 2

Double click at OutletPipe Link & input conduit data



## Solve RNF & HDR layers



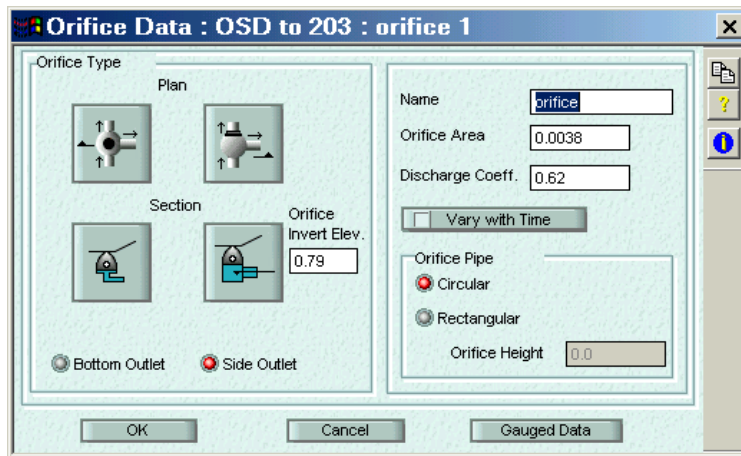
A storage of 7.5 m<sup>3</sup> with 60 mm diameter orifice results in a maximum water depth in storage of 0.812m. The primary outlet (orifice) has a discharge of 6.9 l/s and the discharge over the secondary weir outlet is 4.7 l/s.

A secondary outlet (Weir) is designed to direct access water from storms greater than 10 ARI to the drain.

The pond needs to be resized so that the secondary outlet has no flow for 10 ARI storm.

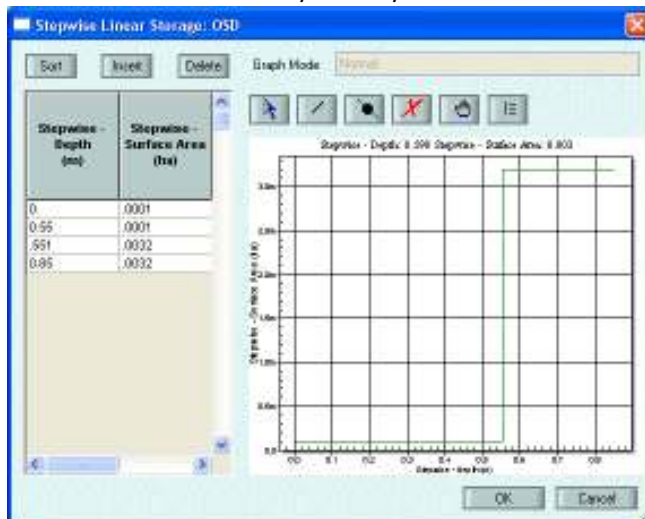
Based on a couple of trials, a storage volume of  $10.1\text{m}^3$  with a 70 mm diameter orifice satisfied the OSD requirements.

Change orifice area to  $3.1415927 * 0.035^2 = 0.0038\text{m}^2$

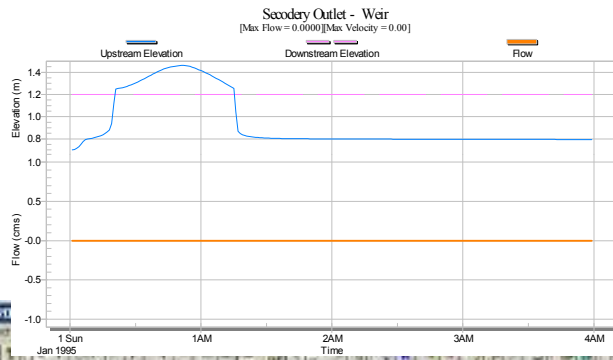


Change storage to  $10.1\text{m}^3$

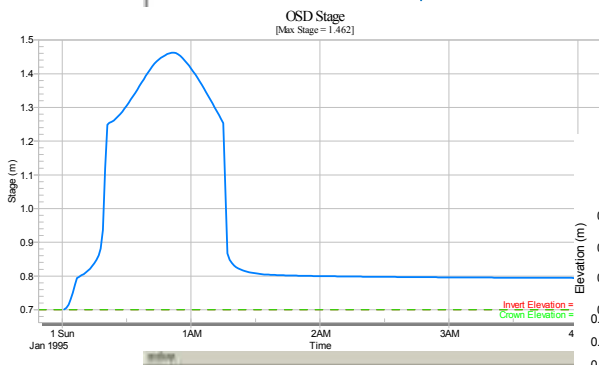
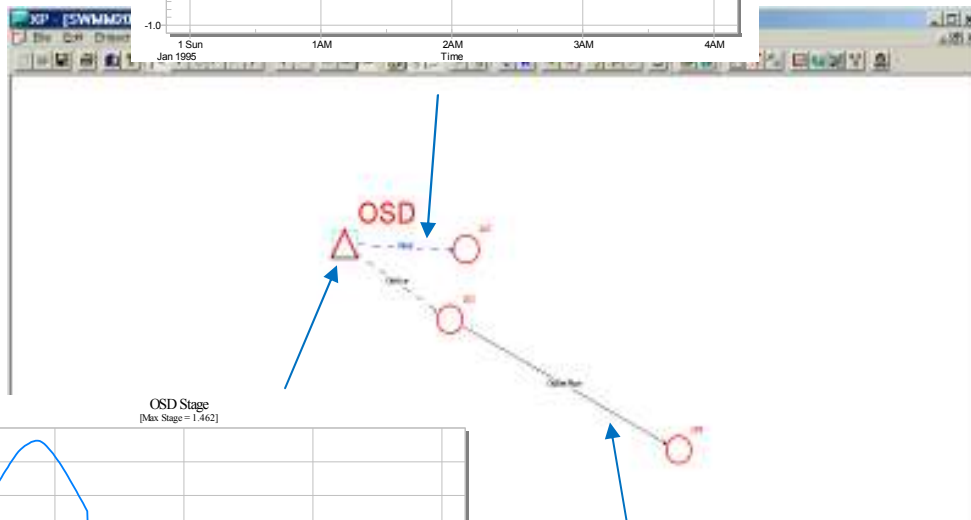
Surface area in ha =  $10.1/10000 / 0.300 = 0.0032\text{ha}$



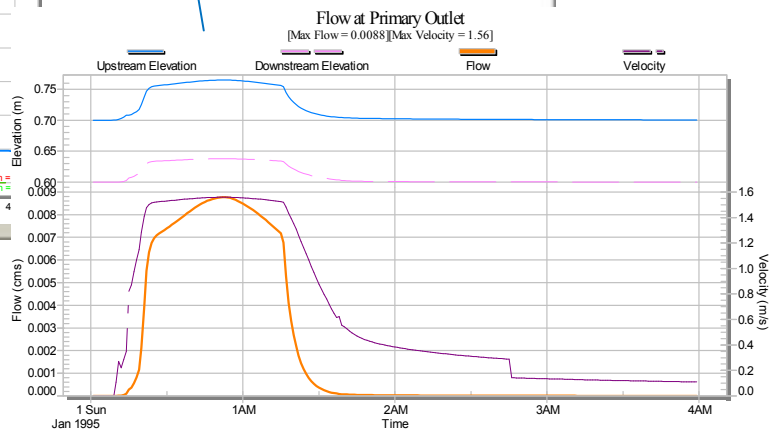
Re Solve model



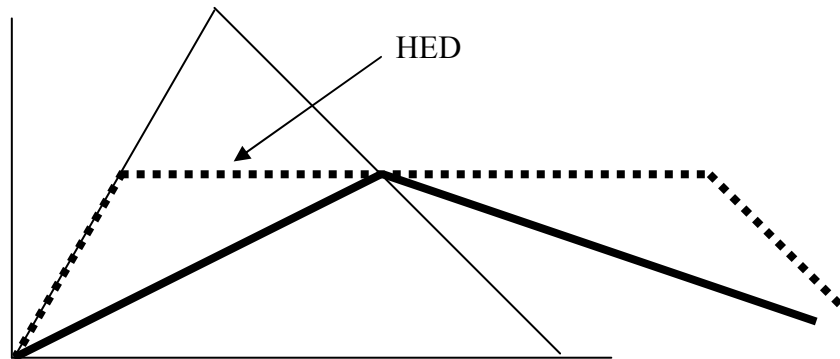
Weir has no flow for 10 years ARI storm



Outflow through orifice and pipe is 8.8 l/s ( $\leq$  PSD)



Storage with high early discharge (HED) control pits was adopted in this example. If a HED control is not used, the storage requirements will increase to meet the same PSD



Note that the above result is based on a rectangular tank type storage. If the storage is ultimately triangular in profile, then the storage stage will change.