12d Solutions Pty Ltd

Civil and Surveying Software

Course Notes

CIVIL AND

SURVEYING SOFTWARE

THE 12D PERSPECTIVE

12dModel

ADVANCED STORMWATER DESIGN

12d Advanced Stormwater Course Notes

These course notes assume that the trainee has the basic 12d Model skills usually obtained from the "**12d Model Training Manual**"

These notes are intended to cover basic Stormwater Design. For more information regarding training courses contact 12d Solutions Training Manager.

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COURSE NOTES

ADVANCED STORMWATER DESIGN

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COURSE NOTES

ADVANCED STORMWATER DESIGN

1.0 Advanced Stormwater Design - Introduction

The **Stormwater Design Course Notes** and this manual, the **Advanced Stormwater Design Course,** describe the functions and processes of the 12d drainage module.

The **Stormwater Design Course Notes** contain**:**

- s set drainage defaults and layout a drainage network,

- s use the powerful 12d drainage network editor to avoid service clashes, grade pipes, align obverts, minimise depth and many other design tools,

- s automatically assign names to the pit/pipes in the network,

- s designate catchment areas and produce catchment plans,

- s transfer data to and from electronic spreadsheets to enable the user to easily review the data and add user defined data to the 12d pipe network. This data may include such data as pipe bedding types and trench width,

- s create pit layout schedules to export to spreadsheets or word processors for final formatting.

- s produce long section drainage profiles including HGL data, flows, invert levels, service crossings

- s create plan drawings with pipe sizes, flows, manhole symbols, linestyles for pipe sizes, design parameters for manhole and pipes and user defined data

- s locate pits/manholes at exact chainage and offset locations

This manual, the **Advanced Stormwater Design Course,** is intended to describe the more advanced features 12d model drainage and discuss the customisation of the package. This will include

- s drainage trench excavation volume calculations

- s pipe and manhole quantity calculation

- s customising the drainage.4d file

- s design or evaluate the drainage system using 12d Drainage or create input files for the XP SWMM/RAT2000, Micro drainage, Drains and PCdrain drainage design packages,

- s read the output from the drainage design packages (automatic if using 12d Drainage), update the drainage network and store the hydraulic data, such as hgl (hydraulic grade line) levels, peak pipe flows and pipe capacities,

- s pit inlet capacity calculations and over land flow

- s flooded width analysis

- s surcharge volumes at SAG pits

- s and detailed drainage plan labelling

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2.0 Setup Files and Their Locations

The drainage module consists of the optional 12d Drainage engine, utilities, startup configuration files for RAT2000, XP SWMM and the 12d drainage configuration file (drainage.4d). Demonstration versions of Drains, RAT2000 and PCdrain have been included on the CD along with a copy of the ILSAX hydrology package. Manuals for the ILSAX program may be obtained from the Civil Engineering Department at the University of Technology Sydney.

All setup files have been configured for the training version. However, when you start working on real projects you may want customise the drainage module. **More - Customising the drainage module**

The **drainage.4d** file contains pipe types (RCP, Class 2 etc.) and example pit inlet capacity tables for RTA (NSW Road and Traffic Authority) standard pits. Detailed pit type descriptions and internal pit dimensions can be included in this file to be inserted into your pit schedules. For PCdrain users there is a routine to read your gully pit file and include these pit types in 12d **More**.

See "The drainage.4d file" on page 62.

REVIEW THIS DATA CAREFULLY! A detailed description of the pit inlet capacity tables in this file is given in "Pit Inlet Capacities" on page 63. The **drainage.4d** file may be customised for any additional inlet capacity data you may have.

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3.0 Starting with a Basic Drainage Network

These course notes assume that you have completed the Stormwater Design Course and that you have experience creating 12d model drainage networks with catchments areas. This course will begin with a completed drainage design found in the directory

\12djobs\courses\7.00\drainage\local road complete

4.0 Excavation Quantities

Sample templates are included in the courses section of 12djobs (\12djobs\courses\7.00\drainage\pipe template.tpl). The templates from this template library may be added to your project using

Design=>Templates=>Utilities=>Input.

This routine uses 12d templates to calculate the excavation volume for all of the drainage strings in a model. An option to create section for a tin on top of the pipe is also available so that the drainage long sections can include hatching between the obvert of the pipe and the design tin under roads.

Templates with names set to the pipe diameters (times 1000) are used for the calculations, thus trench shapes can be customised and over excavation for bedding materials can be included. Net area calculations to exclude pipe area are not supported.

Key points

1. One template for each pipe size (mm)

2. If obvert templates are used, add the prefix "obvert " to the pipe size

3. Carefully consider the tin selected.

A template must exist for each pipe size in the model (pipe size x 1000). For example a 0.3m pipe will require a template to exist named 300. A 0.5ft pipe would require a template named 500. Sample templates are included in the courses section of 12djobs (\12djobs\courses\7.00\drainage). These may be copied to your *.project directory and then added to your project using **Design=>Templates=>Utilities=>Add=>All all to project.**

The templates are run along the strings and the total volumes are reported. Volumes for each strings are given in the report file. An example follows.

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```
-------------------------- BEGIN APPLY TEMPLATE REPORT ----------------------------

 apply template to string report -

   string        E
   tin           design
   separation        10.000
   left template 375
   right template 375
   cut volumes and areas are negative
   fill volumes and areas are positive


chainage- ------sectional  information------  ------intermediate  information----   ---------accumulative  information-------
          ---------- ---cut area --fill area ----------- ----cut vol ---fill vol   -cut volume-- -fill volume- ---balance---

    0.000              -1.434      0.000                                              0.000         0.000        0.000
                                                            -0.771      0.000
    0.550              -1.367      0.000                                             -0.771         0.000       -0.771
                                                           -14.222      0.000
   10.000              -1.642      0.000                                            -14.992         0.000      -14.992
                                                           -15.293      0.000
   20.000              -1.416      0.000                                            -30.286         0.000      -30.286
                                                            -1.845      0.000
   21.313              -1.393      0.000                                            -32.130         0.000      -32.130
                                                            -0.794      0.000
   21.863              -1.493      0.000                                            -32.924         0.000      -32.924

   total cut                     -32.924
   total fill                      0.000
   balance                       -32.924
   ie excess of cut over fill     32.924


-------------------------- END APPLY TEMPLATE REPORT ----------------------------
```
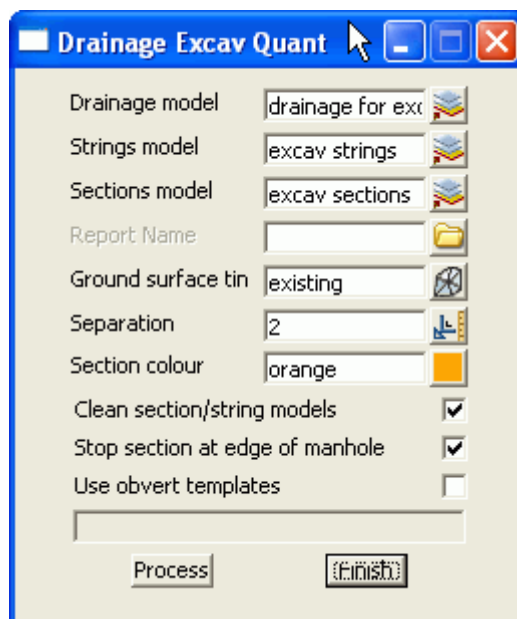
If a tin is created from these strings then volumes by depth can be determined using **Design=>Volumes=>Exact=>Tin to tin**

Usage

Access this panel from the menu selection

Design => Drainage => Reports => Excavation Quantities

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The fields and buttons used in this panel have the following functions.

Field Description	Type	Defaults	Pop-Up

Drainage model   input box

Model to contain all of the pit and pipe network to be worked on.

Strings model   model box

Strings generated from the templates will be stored in this model

Sections model   model box

Sections generated from the templates will be stored in this model

Report name   input box

cut and fill volumes will ne sent to this report

Ground Surface Tin   tin box

tins from which the volumes will be calculated

Separation   real box

distance between the sections

Sections colour   colour box

Sections generated from the templates will be assigned this colour (strings colours are defined in the templates)

Clean section/strings model   tick box

Delete the strings in these models before processing.

Stop section at edge of manhole   tick box

Template are run from manhole centre to centre if this is not selected. The templates stop at the edge of the manhole if selected. This is often selected with the following option Use obvert templates.

Use obvert templates   tick box

Templates must be named with the prefix "obvert". i.e. obvert 300. The template is still run along the invert of the pipe but the user now has a section "set" of templates that can be used to create a tin on top of the pipe as well as below.

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5.0 Network Quantities Report

This panel is accessed from the menu selection

Design => Drainage Sewer => Reports=> Network Quantities

Key points

1. Items are counted/totalled by depth and optionally type.

1. The routine will not "double count" items even if the ranges overlap.

2. Types are case sensitive, types with spaces in the name must be enclosed in quotes and the wild card * may be used.

3. Use vertically offset tins and "banded" depth ranges to get quantities under roads, foot paths etc. This is discussed later in detail.

4. Erase count file fields if the items are not to be counted.
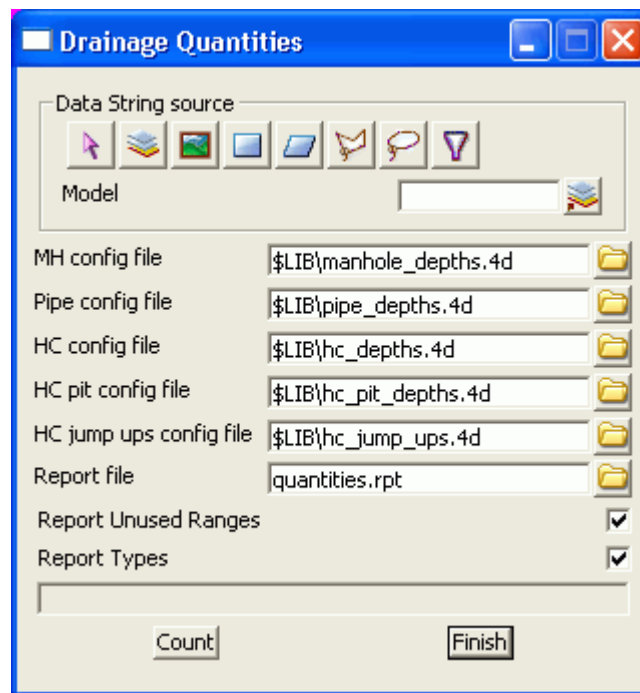
The fields and buttons used in this panel have the following functions.

Field Description	Type	Defaults	Pop-Up
Data String Source	Choice		

usually the entire model is selected but view is also available for combining models

MH config file	file box		

This file specifies the types and depth ranges for the manholes. Details of this file are contained below.

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Pipe config file   file box

This file specifies the types and depth ranges for the pipes. Details of this file are contained below.

HC config file   file box

This file specifies the types and depth ranges for the house connections. Details of this file are contained below.

HC pit config file   file box

This file specifies the types and depth ranges for the HC pits. Details of this file are contained below.

HC jump ups file   file box

This file specifies the types and depth ranges for the house connections jump ups. Details of this file are contained below.

Report file   file box

a sample report file is given below.

Report unused ranges   tick box

the depth ranges for the manhole/pipe/house connections are defined in the *.4d files. Selecting this option will cause the depth ranges in the file to be printed even if there are no manhole/pipe/house connections in these depth ranges (zero quantity values will be shown).

Report types   tick box

Selecting this option will cause the manhole/pipe/house connection types used in the model types to be listed (even if quantities are not requested in the *.4d files). Since this is a complete of the type used in the model, the list informs the user what types have not been included in the quantity calculation.

Count   button

executes the option.

Finish   button

removes the dialogue from the screen

The *.4d files listed above are contained in the 12d **library** directory. Each line is the file performs a count (count lines). No items are counted twice. Therefore, if an item is counted its type and then a count line is found the wild card is used for the type, the type already counted will not be included in the count.

The format for a count line is three or four values (space delimited) per line. Size is optional.

```
<type (from drainage.4d)>  <size> <starting depth>   <ending depth>
```

Notes:

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All **types** with spaces in the name must be enclosed in quotes The wild card * may be used.

The **size** is optional and if omitted the all sizes will be counted in this group (do not use the * for a wild card).

The **starting depth** and **ending depth** are required for all count lines.

Quantities Under Roads and Footpaths

By creating super tins with vertically offset sections, quantities under roads, footpaths etc. can be determined. for example.

Offset your road design tin up by 1000m (**Tins->Utility->Translate/Copy)** and then use the depth range 1000-1999 for pipes under roads.

Create a tin from the footpaths only, null by angle length with a small length to remove the road and then offset it vertically by 2000m. the depth range 2000-2999 is not the quantities under the footpath.

Sample count lines

```
// sum concrete cover manholes is various ranges

"CONC COVER" 0.0 1.6
"CONC COVER" 1.5 3.0
"CONC COVER" 3.0 999.9  // this is expected to be zero
"CONC COVER" -999.0 0.0 // trap errors

// any that are not Concrete cover will be counted here

* 0.0 1.6
* 1.6 3.0
* 3.0 999.9
```

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```
Manhole Quantities
====================================

CONC COVER          0.00    1.60    13      16.506
CONC COVER          1.60    3.00     1       1.510
CONC COVER          3.00   999.9     0       0.000
CONC COVER        -999.0     0.0     0       0.000

*                   0.00   1.60      0       0.000
*                   1.60   3.00      0       0.000
*                   3.00  999.9      0       0.000

   total length = 18.016


   Types Used
   ----------

   CONC COVER

   Diameters Used
   ----------

   1.100
```
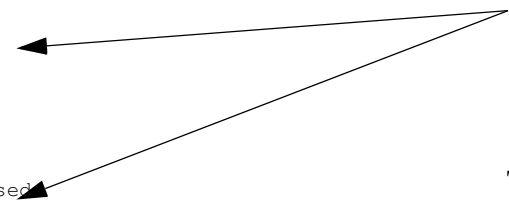
Since the **Report unused ranges** tick box was selected, these lines were printed even though there were no manholes in the data ranges.

This data results from selecting the **Report types** tick box.

Sample count lines for pipes follow.

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```
// sum class 2 pipes by diameter and for various ranges

// count 375

2 0.375 0.0 2.0
2 0.375 2.0 5.0
2 0.375 5.0 999.

// count 450

2 0.450 0.0 2.0
2 0.450 2.0 5.0
2 0.450 5.0 999.

// count 525

2 0.525 0.0 2.0
2 0.525 2.0 5.0
2 0.525 5.0 999.

// count pipe sizes that were missed

2 * 0.0 2.0
2 * 2.0 5.0
2 * 5.0 999.

// count all other missed pipes

* 0.0 999.
```

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6.0 Exporting to Drainage Design Software Packages

12d contains most of the data required for your drainage design packages. However, each packages has specific design variables that 12d does not have access too. The design process is intended to export your data from 12d to the design package, design the drainage system and then read the results back into 12d for your long sections.

If pits/pipes are to be added/deleted from your network during the design process you are safest to add/delete the pit/pipe to 12d and to your design package separately.

Not recommended and as a poor alternative, you have the option of reading the results back into 12d, adding/deleting the pits/pipes and then exporting the data to a new drainage project in your drainage design software. **As 12d does not have access to all of the data in the design packages this method is not recommended!**

Some of the drainage design programs offer a third option that allows you to import data "on top of" an existing project thereby merging and over writing the existing data. Be sure to contact the drainage software supplier to obtain exact details of how the merging process is performed.

The interface is run by selecting **Import/Export** from the **Drainage Network Editor**

> **Design->Drainage-Sewer->Network Editor**

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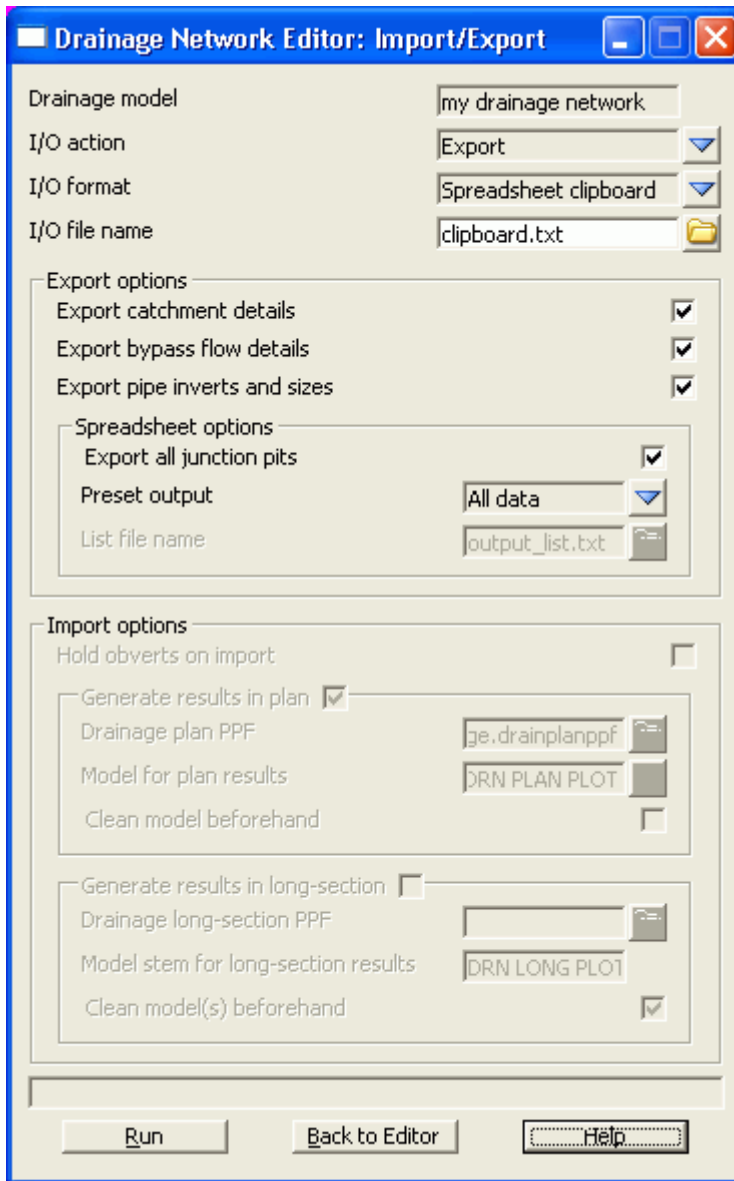
The **Drainage model** is the model currently being edited. The **I/O action** determines if data is exported or imported and enables/disables many of the fields below.

The **I/O format** selects which external program the 12d is interfacing with. Some programs use the windows clipboard and others use files. If the clipboard is used the data will also be written to a file by 12d in case you need to take the data to another computer.

The **Export options** have slightly different effects depending on the **I/O format** (program) selected above. Therefore they will be discussed later with the various formats.

Export pipe diameters and inverts is generally select for existing systems only. If your design program will set invert levels and pipe sizes then turn this tick box off for new systems.Some design programs will require initial inverts and pipe sizes. In this case this box should be selected on the first export.

Export default catchment/pit parameters is generally selected for the first export. For subsequent exports turn this selection off and then only the catchment areas (if the model is supplied above) will be exported.

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7.0 Drainage Data Input and Output to Spreadsheets

Spreadsheets are an effective method to manage the numerous variables urban drainage designers create in the modelling process. Spreadsheet data can be transferred to and from 12d in tab delimited files and stored within 12d as "user definable attributes". These attributes are linked to the pit and pipes within a network. Drainage long section plots can display the pipe attributes in the "arrows" data area and pit attributes in the bubbles area. Drainage plan drawing can also show these pit and pipe attributes.

Drainage strings will be created if they do not exist in the model but manholes cannot be added to existing strings.

See also

> 12d to spreadsheet transfers
>
> Spreadsheet to 12d update and create
>
> Spreadsheet options

7.1 12d to spreadsheet transfers

This interface is accessed the **Import/Export** button on the Drainage **Network Editor**.

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Select **Export**

Select **Spreadsheet clipboard**

These options are not used for spreadsheet export.

Usually leave this off! Select to export the junction pit at the end of all drainage lines (very rarely needed).

You may also select to limit the output if desired. If you like using spreadsheets for data entry, the PCdrain data and ILSAX data formats are useful for adding data for the first time for either program.

Select **Run** to place the data on the clipboard.

7.1.1 Options
The **Spreadsheet Options** section allows the user to define the amount of data exported.

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Export all junction pits when selected will repeat the data for the junction pit at the end of each branch line.

Preset Output this choice box offers the following choices:

All Data: All of the 12d drainage string data and the user defined attributes will be exported to the clipboard in a tab delimited format. The 12d data names and the user defined attribute names will appear at the top of the spreadsheets columns.
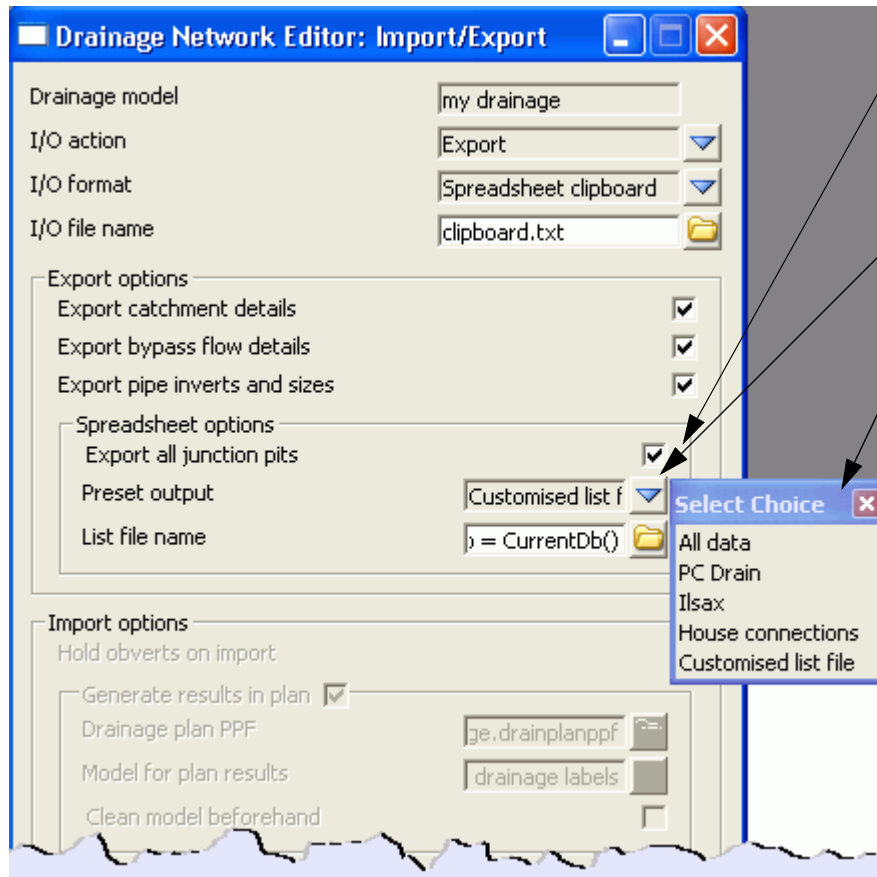
ILSAX: For the ILSAX program, the spreadsheet column headings will change depending on the pipe and catchment indicators (P2 card) and the inlet type (P3 card). Therefore, use the ILSAX pipe editor macro to set up one pit/catchment for the type of data you wish to enter. Now when you export the pipe network data the column headings will include the names of the relevant parameters.

User defined below: The **Customised list file name** is used to define the drainage values, their order and format you desire.

The **customised list file** is a text file where each line contains a drainage variable or a spreadsheet IO command (blank lines are ignored unless preceded by the header command). The spreadsheet IO commands available are:

header	to define a line of text to be exported
blank	to leave a blank column in the output
pipe data	to specify the following user defined attributes are pipe data
pit data	to specify the following user defined attributes are pit data.
variable name	a 12d drainage variable names
factor	the following variable is multiplied by this factor

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The simplest way to create your own customised tab delimited file is to set the **Preset Output** field to **All data** and leave the **customised list file name** field blank. Selecting **Set**, **Finish** and then **Copy** from the main dialogue. The data will be placed on the clipboard and a **customised list file**, named **output_list.txt** will be created containing the names of all of the drainage variables in the 12d model. Use a text editor to add/or delete the variable names, change their order and/or add spreadsheet IO commands. **Save the file with a new name!** The **output_list.txt** file is overwitten on every export.

A listing of a customised list file follows. Note the words in the header file have a "tab" between them so that they will be spaces across the spreadsheet columns.

```
                    header
                Pipe Details
                        header
                        Name Length   U/S IL   D/S IL   Slope(%)   Class   Dia I.D.   Rough   Pipe Is   No. Pipes

                        pit data
                        *pit name

                        pipe data
                        *length
                        low ch invert
                        high ch invert

                        factor
                        100
                        *grade

                        pipe type

                        factor
                        1000
                        diameter
```

After creating your customised list file, select **Options** again and change the **Preset Output** field to **User Defined below** and enter the new **customised list file** name that you saved above. Select **Set** then **Finish** and finally **Copy** to put the formatted data onto the clipboard.

The data can be pasted into a spreadsheet program for checking or additional formatting.

CUSTOM FORMATED DATA MIGHT NOT BE PASTED BACK INTO 12d!

The data must be in the "12d drainage spreadsheet" format to be read into 12d.

Caution with manhole names in the form 1-1 or 1/1. Some spreadsheets will interpret these values as dates. If you use these formats for your manhole names you will have to paste command them in once, format the columns that contain the manholes names as text data and then paste the information in again.

One final word on using the copy/paste commands in the Microsoft Excel program. The Paste Special command using the "Skip Blanks" option will allow you to copy a large block of 12d data (with blanks in it) on top your data so that your data is preserved where it coincides with the blanks. To use this option paste the data into a blank spreadsheet and then select copy again. The Paste special
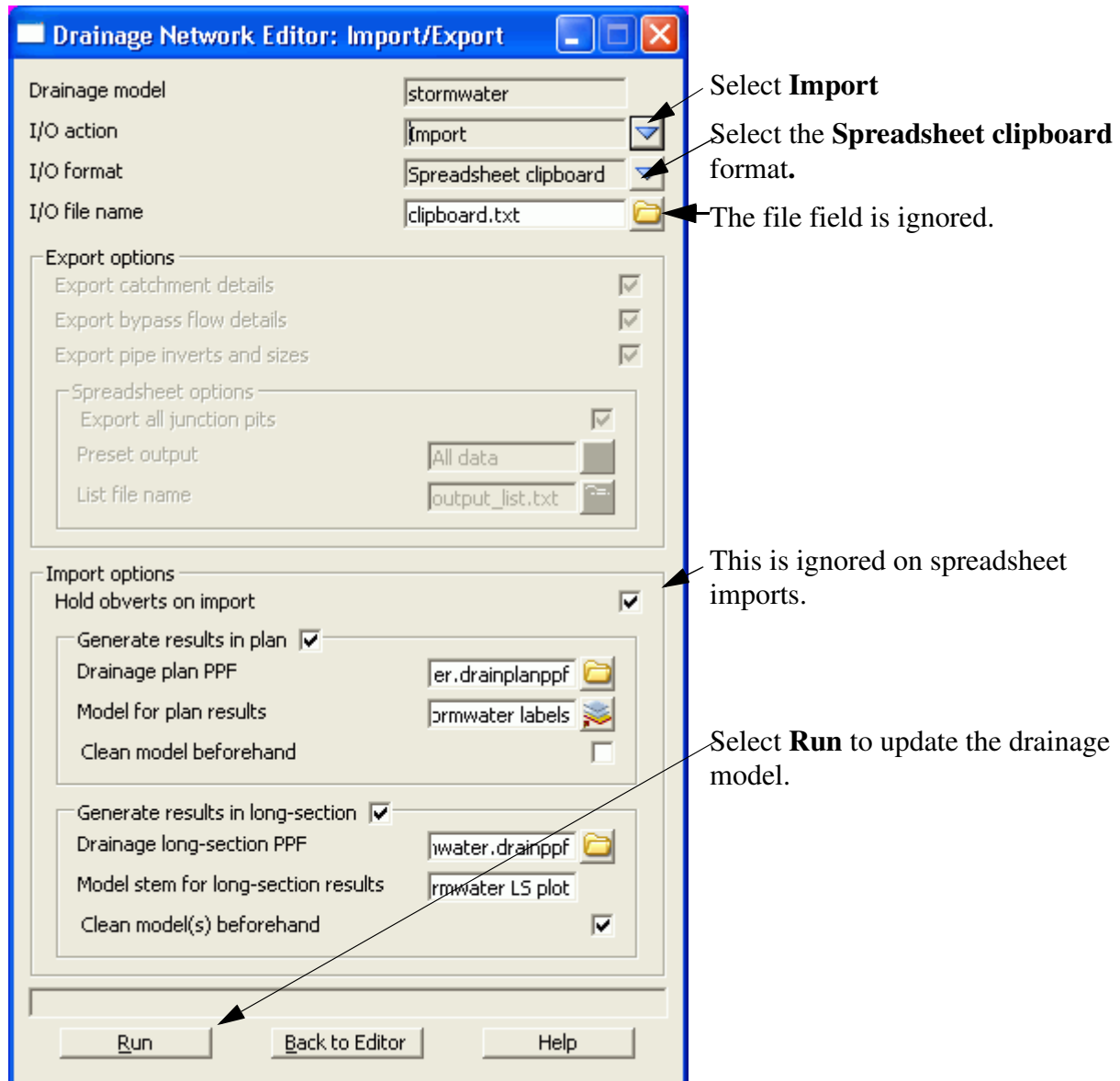
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option with "Skip Blanks" will now be available.

7.1.2 Spreadsheet to 12d transfers

This item is accessed from the **Import/Export** button on the **Drainage Network Editor**.

The following panel will appear.

Select **Import**

Select the **Spreadsheet clipboard** format**.**

The file field is ignored.

This is ignored on spreadsheet imports.

Select **Run** to update the drainage model.

Tab delimited, "12d drainage spreadsheet" format or "from to" format data must be on the clipboard in order to update a 12d drainage model or create a new model. These format are described below.

7.1.3 Updating an Existing Model

The data usually is generated by 12d using the **Export** option, pasted into a spreadsheet and then copied back to the clipboard so that 12d can be updated.

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When 12d exports the drainage model to a spreadsheet it includes a column for the unique string identifier and a unique manhole identifier (unique to the drainage model not the 12d project). The names of the strings and manholes may be changed via the spreadsheet if these columns are present at import time.

If the manhole id column is not present, 12d will search the drainage model for a matching manhole name. When the manhole is a junction between drainage lines, only the trunk line will be the data updated.

7.1.4 Creating a New Model

It is possible to create a new string or an entire drainage network using this format. However, manholes cannot be added to an existing string. The entire drainage string must be created at once. Two formats are available, the "from-to manhole" format and the "12d drainage spreadsheet" format.

At present the network editor must select a drainage string to become active. Therefore, if you are not adding strings to a network, you will have to great a drainage network with one "dummy" manhole. Select this one "dummy" manhole to activate the editor. After importing the data and the new drainage lines are created the "dummy" manhole may be deleted.

12d drainage spreadsheet Format

The top left cell in the clipboard data must be the text "12d" to specify this format. The minimum amount of data required to create a new string is the string name, manhole name, x and y coordinates. You can add as much additional data as you have available. This would include pipe diameters inverts etc. The manholes must be listed from upstream to downstream order. If the string is to join a trunk line, the junction manhole must be included for both the tributary and the trunk line.

An example file exists called **new_network.txt** is supplied in the library. Open this file in a spreadsheet or a text editor and copy it to the clipboard. Set the **I/O Action** to **Import** and select **Run**. The new drainage lines will exist in the model currently being edited.

From-to Manhole Format

The top left cell in the clipboard data must be the text "from to" to specify this format. The minimum amount of data required to create a new string is the upstream pit name "*pit name), the downstream pit name (*ds pit name) and the x(x location) and y(y location) coordinates of the upstream pit. If the string is to join a trunk line, the junction manhole must be included for both the tributary and the trunk line.

An optional column for the manhole cover elev (cover elev) may be specified. Once the network has been created additional pipe and manhole data may be added using the "12d drainage spreadsheet" format described above.

An example file exists called **new_from_to_network.txt** is supplied in the library. It is shown below. Open this file in a spreadsheet or a text editor and copy it to the clipboard. Enter a new model name in the **Drainage model** field and select paste. The new drainage model will now exist.

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from to	pit	pit	pit	pit
*pit name	*ds pit name	x location	y location	cover elev
text	text	real	real	real
E/1	A/3	5309.458	7336.935993	29.2173
D/1	A/4	5277.189	7336.935989	28.5071
C/1	B/3	5251.238738	7423.99485	31.5257
A/1	A/2	5354.629222	7336.935998	30.2115
A/2	A/3	5340.019987	7322.035996	29.89
A/3	A/4	5293.458002	7322.035991	28.8652
A/4	A/5	5250.182625	7322.035986	27.9127
A/5	A/6	5217.194202	7322.035983	27.1867
A/6	A/7	5183.458002	7322.035979	26.4442
A/7		5152.698693	7322.035975	25.7672
B/1	B/2	5289.42875	7422.289079	32.7197
B/2	B/3	5264.638564	7393.947083	30.7948
B/3	B/4	5249.738564	7384.207593	30.4187
B/4	B/5	5249.738564	7351.201545	29.1444
B/5	A/5	5233.426685	7336.935984	27.544

7.2 "12d drainage spreadsheet" Format

Each column of data is used for a 12d drainage variable or a user defined attribute. Each row represents a manhole and the downstream pipe (controlled by the direction of flow variable) within the drainage network. A sample is shown below.

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12d	pit	pit	pit	pit	pit	pit
*string Name	*pit name	pit type	pit low ch invert	pit high ch invert	pit id	string id
text	text	text	real	real	integer	integer
E	E/1	SA2	28.108	28.108	1	67389
E	A/3	SA2	27.7559	27.7559	2	67389
D	D/1	SA2	27.3961	27.3961	3	68100
D	A/4	SA2	26.8018	26.8018	4	68100
C	C/1	SA2	30.67	30.67	5	72072
C	B/3	SA2	29.563	29.563	6	72072
A	A/1	SA2	29.1026	29.1026	7	82469
A	A/2	SA2	28.7811	28.7311	8	82469
A	A/3	SA2	27.7652	27.7059	9	82469
A	A/4	SA2	26.8127	26.7518	10	82469
A	A/5	SA2	26.0867	26.0244	11	82469
A	A/6	SA2	25.3442	25.2942	12	82469
A	A/7	SA2	24.6672	24.6672	13	82469
B	B/1	SA2	31.2759	31.2759	14	192066
B	B/2	SA2	29.351	29.301	15	192066
B	B/3	SA2	29.123	29.073	16	192066
B	B/4	SA2	28.0444	27.8951	17	192066
B	B/5	SA2	26.3447	26.2947	18	192066
B	A/5	SA2	26.0744	26.0744	19	192066

Duplicate Definitions

Strings Variables such as "direction" are may be defined for numerous manholes on the same string. Searching in a top down direction through the file, the last definition found for the string will be set.

Invert levels may be set via pipe data or pit data or combined. It is recommended that the user only use one method and not combine them. Both are exported so delete the ones you are not going to use. The variables are processed from left to right, so if duplicate definitions of an invert level or found the right most data will be set.

The format definition

1. Row1, column 1 must contain either "12d", or "from to". Therefore, the first column must be a 12d drainage variable (cannot be a user defined attribute).

2. Row 1. The text <pit> at the top of the column indicates the column contains a user defined pit attribute and similarly <pipe> indicates a user defined pipe attribute.

3. Row 2. This row contains the names of the 12d drainage variable names and the pit/pipe attributes. All names are case sensitive so be careful where you use capital letters. A list of 12d drainage variables is found below.

   Names beginning with an asterix (*) will not be processed (except pit/string names when unique identifiers are present in the data). 12d drainage variables names beginning with an asterix indicate that this data was calculated at export time and cannot be read back into 12d (for example, pipe length, pipe grade and deflection angle).

Prefixing an user defined attribute name with "DELETE " (no quotes, note the space after the DELETE) will cause the attribute to be deleted from all pits/pipes within the model.

4. Row 3. The text in this row define the type of attribute to be stored within 12d. The only valid choices are;

> integer
> real
> text

If you want to change an attribute type you must delete the attribute and create it again. If you simply change the attribute type in the third row then that attribute will not be updated.

5. Blank lines may be inserted as desired.

6. You are not required to fill in all of the cells in the spreadsheets. Blank cells are ignored (you must use a space to remove all data from text attributes (the space will not be stored).

7. Pipe names are included in the data so that they can be changed but they are **not** used to identify the pipe. Pipe data will always be assigned to the pipe following the pit in the direction of **ascending** chainage. If flow directions is ascending then the pipe data will be for the downstream pipe. If the flow direction is descending then the pipe data will apply to the upstream pipe.

7.3 12d Drainage Variable Names

Manhole Variables	Pipe Variables	String Variables
*string Name	pipe name	direction
*pit name	pipe type	fs tin
pit type	low ch invert	ns tin
pit diameter	high ch invert	string id
pit low ch invert	diameter	
pit high ch invert	*length	
pit road chainage	*grade	
pit road name	low hgl	
*pit angle	high hgl	
*pit drop	pit hgl	
*pit depth	flow	
*pit chainage	velocity	
x location		
y location		
cover elev		
*fs elev		
*ns elev		
pit id		

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8.0 Bypass Flow

Bypass flow strings are used to trigger the bypass calculations in the network editor and are used as a centre line for flooded width calculations. The later requires unique names for the bypass flow strings.

Many of the design programs 12d exports to allow for bypass flow. Bypass flow involves the calculation of inlet capacity which is often based on the road grade upstream of the manhole.

Key Points

1. Set the manhole types to names that signify the inlet type in the program you are exporting to (**Type** on the **Pit->Main** tab).

2. Check that your grate level is correct (Setout z + **Setout to grate offset**)

3. Mark the manhole as a On grade or SAG inlet (**Inlet data** on the **Pit->Main** tab). On grade inlets capture the water as it passes the inlet while SAG inlet trap the water flowing in from all directions.

4. Draw an bypass flow string in the direction of flow so that it passes within 1 manhole diameter of the inlet. When bypass flow strings join they must join within 1 manhole diameter of a manhole. If flooded with calculations are to be done later, the bypass flow string must have a unique name and the string should located in the flow channel.

   Enter the model name in the **Bypass flow model** field on the **Global->Utility Models** tab.

5. Ensure a setout string is linked to the inlet so that the road grade may be calculated in its direction. If road crossfall is needed then the centre string is also required. These strings are specified using the **Road design file** on the **Global->Utility Models** tab.

6. Press the **Set Pit Details** button. Road grades, crossfalls, ponding depths and bypass pits will now be found in the **Inlet data** section on the **Pit->Main** tab. The bypass data may be verified on the **Pit-Main** tab of the **Network Editor**.

8.1 Drawing Bypass Flow Strings

The bypass flow string must be within 1. manhole diameter of the drainage pit in be considered on the bypass flow path. If the bypass flow string is to be used for flooded width calculations in the future, the string must also be drawn in the main flow area of the cross section.

Use the **CAD toobar** to create the bypass flow paths. A unique name is required if you plan to calculated flooded widths after the analysis is done.

To use the **CAD toolbar** go to the **CAD data bar** and enter a
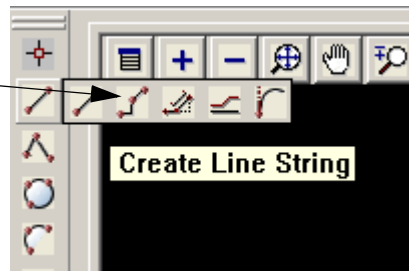string name and model name.   Select the line style (optional).

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DRAG the **Create line** button and release at the **Create Line String** button.

When finished drawing the string press **ESC.**

Starting at the upstream end. LB select an insertion point and MB or press return to accept the selection. Continue this until you reach the end of the flow path. The string will not be shown in the new linestyle until the screen is redrawn. Press **ESC** to finish drawing the string. MB on the plan view title area to redraw the screen. The correct linestyle will now appear.

If you reach a sag pit location you may terminate the string or continue defining the bypass flow path for a surcharging event out of the sag location.

8.2 Set Pit Details - Calculate the Bypass Flow Data

Once the first 4 steps above are complete you are ready to calculate the bypass flow data. Select **Set Pit Details** and then select a manhole on a bypass flow string. The downstream pit will now show in the **Bypass pit** field.

If **Pit on grade** is selected and a setout string was found, the **Road grade** will appear in grey. You may override this value by selecting the tick box beside the value and entering your own value. If a road centre string was selected, the **Road xfall** field will also have a value.

If **Sag pit** was selected and a catchment string was selected in catchment set 1, the **Pond depth** would be displayed. The catchment string is draped onto the finish surface tin and the low point located. The **Pond depth** is calculated as

Pond depth = min level - (setout level + setout to grate offset).

Negative Ponding Depths

Negative ponding depths are usually caused by two errors in input. The first may be that the grate level is too high. Often this happens when the setout point is on the top of the kerb and no **Setout to grate offset** has been entered.

The second is that the catchment string has not been drawn around the crest of the catchment. The lowest section of the catchment string must be drawn carefully because it is the lowest point on the string that determines the overflow elevation. If in doubt, profile the catchment string with the design tin shown in the section view. Double check were the low point is.

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12d adds verification strings in the **construction** model to confirm the locations where the road and crossfall have been measured. To check these strings add the **construction** model to the plan view. The following image shows a close up of the verification strings at a pit.
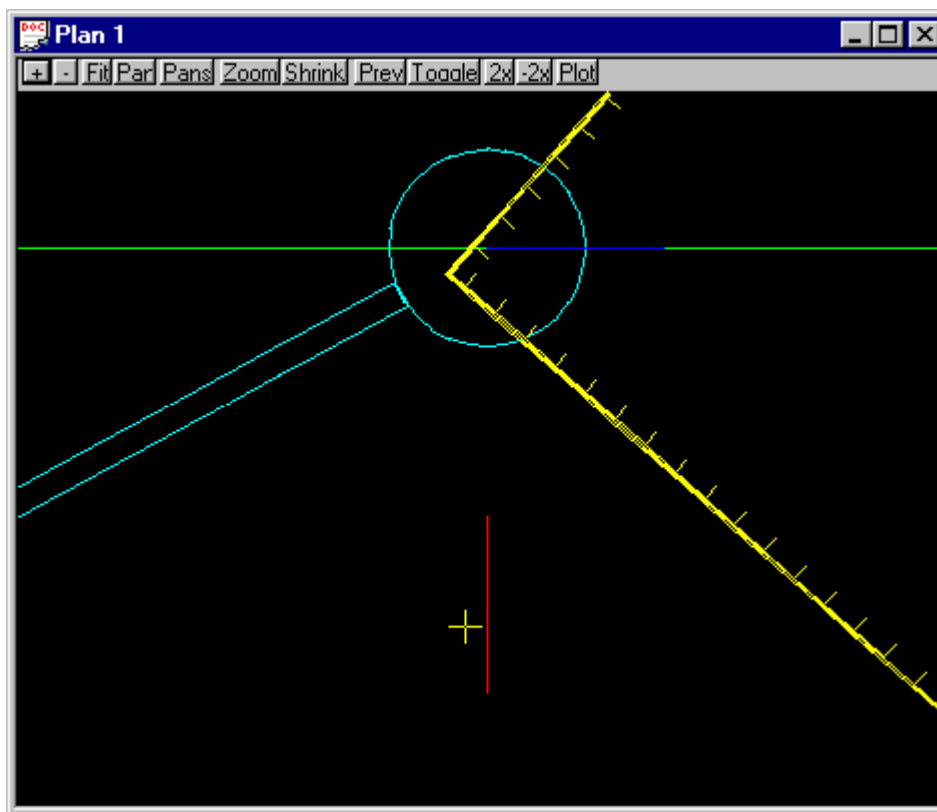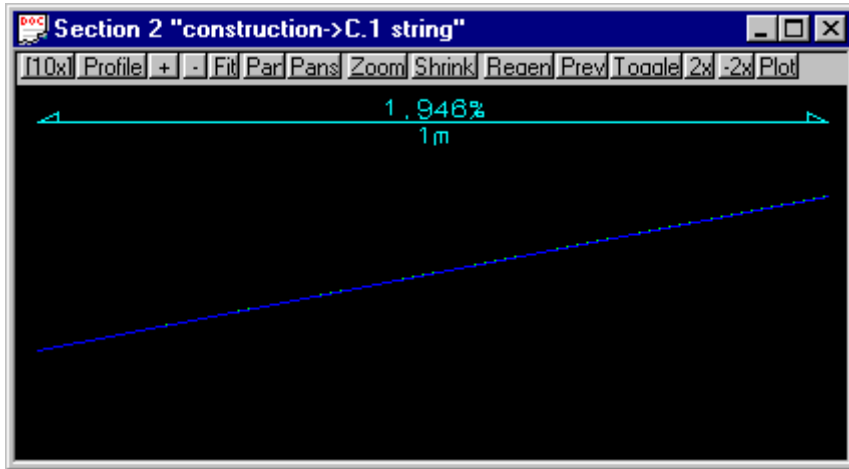

The blue line indicates where the road grade was measured and the red line indicates where the road cross fall was measured.

These are 3d super strings and therefore you may profile them in the section view. With the grades toggled on (check under **Toggle**) you can verify the slopes.

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Note in the **Section View Title area** that the string is named "C1->string". The work string indicates that was created from string data and not from the tin.

Important Notes

1. Pits with no pit type specified will not be processed by the overflow routine and the inlet capacity will be set to 100%.

2. For pits with no road design string specified, the inlet capacity will be set to 100%.

3. If no bypass flow string is supplied for a pit, the inlet capacity is set to 100%.

4. If you have a problem with the inlet capacity factors (Drains Version 1 and ILSAX), check the calculated crossfall and grade.

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9.0 Running PCdrain for Windows

Data is exchanged to and from PCdrain via the interchange (*.int) file. Gutter profiles and inlet type must be specified in PCdrain before the interchange file is read into PCdrain.

The data sent to PCdrain includes

- s   manhole names and types, easting and northing data with surface levels
- s   pipe deflection angles at manholes
- s   finished surface profile along the centre line of the pipes
- s   optional - crossing services - level, size and location along the pipes
- s   optional - bypass manholes, road grades and SAG inlet ponding depths
- s   optional - up to 2 catchment areas per manhole
- s   optional - default catchment characteristics, k values and overland travel times
- s   optional - pipe sizes and invert levels

9.1 PCdrain Requirements

Manhole names

The manhole name from 12d is assigned to both the structure and catchment name in PCdrain. These names cannot exceed 7 characters.

Manhole type

The 12d manhole type is transferred to the structure type in PCdrain. These names must match those specified in the PCdrain Inlet charts selected (**Data=>Inlet charts**). Select the desired inlet charts BEFORE importing the interchange file.

12d manhole types with an "S" in the name are treated by 12d and PCdrain as a SAG inlet pit. 12d will strip off all characters after the "S" before adding the ponding depth. If a catchment string in set #1 is available for the SAG pit then the ponding depth will be calculated.The12d manhole type will remain unchanged. A typical example would be a manhole type "1TC" with the sag tick box on would become "1TC0.100" if a ponding depth of 0.1 was calculated.

Bypass Flow

When a catchment string is specified for the manhole, the maximum depth before bypass flow commences is calculated. The lowest point on the catchment string is determined by draping it onto the drainage strings tin. The maximum depth before bypass is calculated manhole setout level less the setout to grate offset less the lowest point on the catchment string.

PCdrain differentiates between manholes (no surface inflow) and gully pits via the 12d manhole type. The bypass flow strings can only be drawn within 1 manhole diameter of the gully pits. Keep the bypass flow strings away from the PCdrain manholes.

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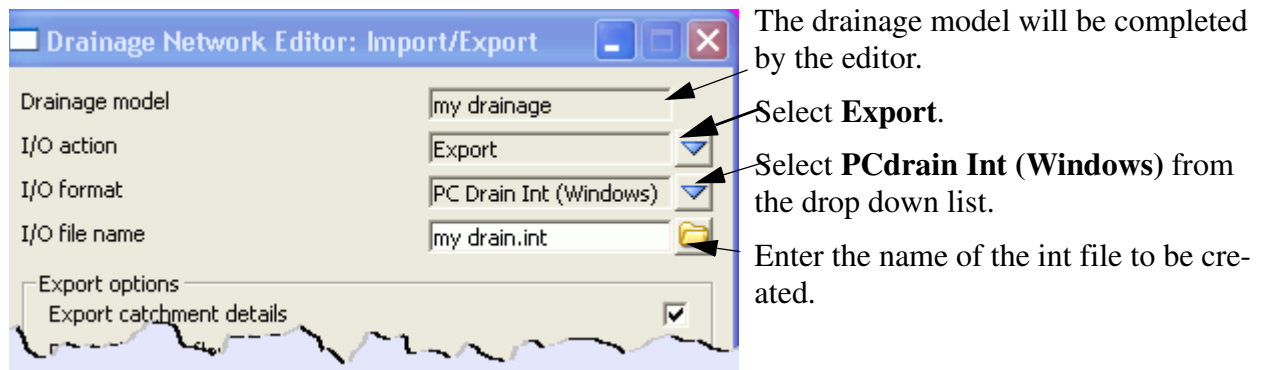***ADVANCED STORMWATER DESIGN***

Catchments

Again, since PCdrain differentiates between inlets and manholes (using the 12d manhole type), ensure that catchments are only drawn for gully inlet and NOT manholes.

9.2 12d to PCdrain

1. Export the data to PCdrain selected via the Network editor

<p align="center">Design=>Drainage-Sewer=>Drainage Network Editor</p>

After selecting the drainage network, select the **Import/Export** button and the following dialogue will appear.

The drainage model will be completed by the editor.

Select **Export**.

Select **PCdrain Int (Windows)** from the drop down list.

Enter the name of the int file to be created.

Select the **Run** button and the interface file will be created.

2. Launch the PCdrain for Windows program. If you have a project set up with the design parameters, rainfall data, inlet charts and gutter profiles then open it now and skip to step 8. Otherwise continue with step 5.

3. The Design Parameters can be set as desired with the menu selection
   Data=>Design Parameters.

4. Select the rainfall data using the **Data=>Rainfall** menu selection.

5. Select the inlet charts using the **Data=>Inlet Charts** menu selection. The manhole types specified in 12d must be included in these settings. **More - PCdrain to 12d pit converter**

6. At least one gutter profile in PCdrain needs to be defined. These are set through the menu selection **Data=>Gutter Profiles**. The default gutter section name (**Road ID**) from 12d is **4d** and therefore it is recommended you create a profile with this name and your own description. If you have changed the profile names in 12d (through the spreadsheet interface or the Attribute editor) these new profile names will have to exist in PCdrain.

7. Save this file now so that you can retrieve it later if required. It can be used as a starting template for new jobs.

8. **File=>Import** from the menu. Select the file exported in step 1. The information from 12d may be viewed by selecting **Data=>Network** and then selecting the desired tabs.

9. The HGL level and the pipe elevation at the outlet should be set using the menu selection

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Data=>Outlet.

10. If you have not exported pipe data then the pipe size must be determined. Use the menu selection **Process=>Select Pipe Sizes.**

PCdrain data values

Some PCdrain data values are not available in the 12d network editor. Prior to an import from PCdrain, **initial export values** are used. On the first **import** from PCdrain, 12d attributes are created to hold the PCdrain variables for subsequent exports to PCdrain. These data values are usually changed in the PCdrain menus but may by changed in 12d using the Attribute editor.

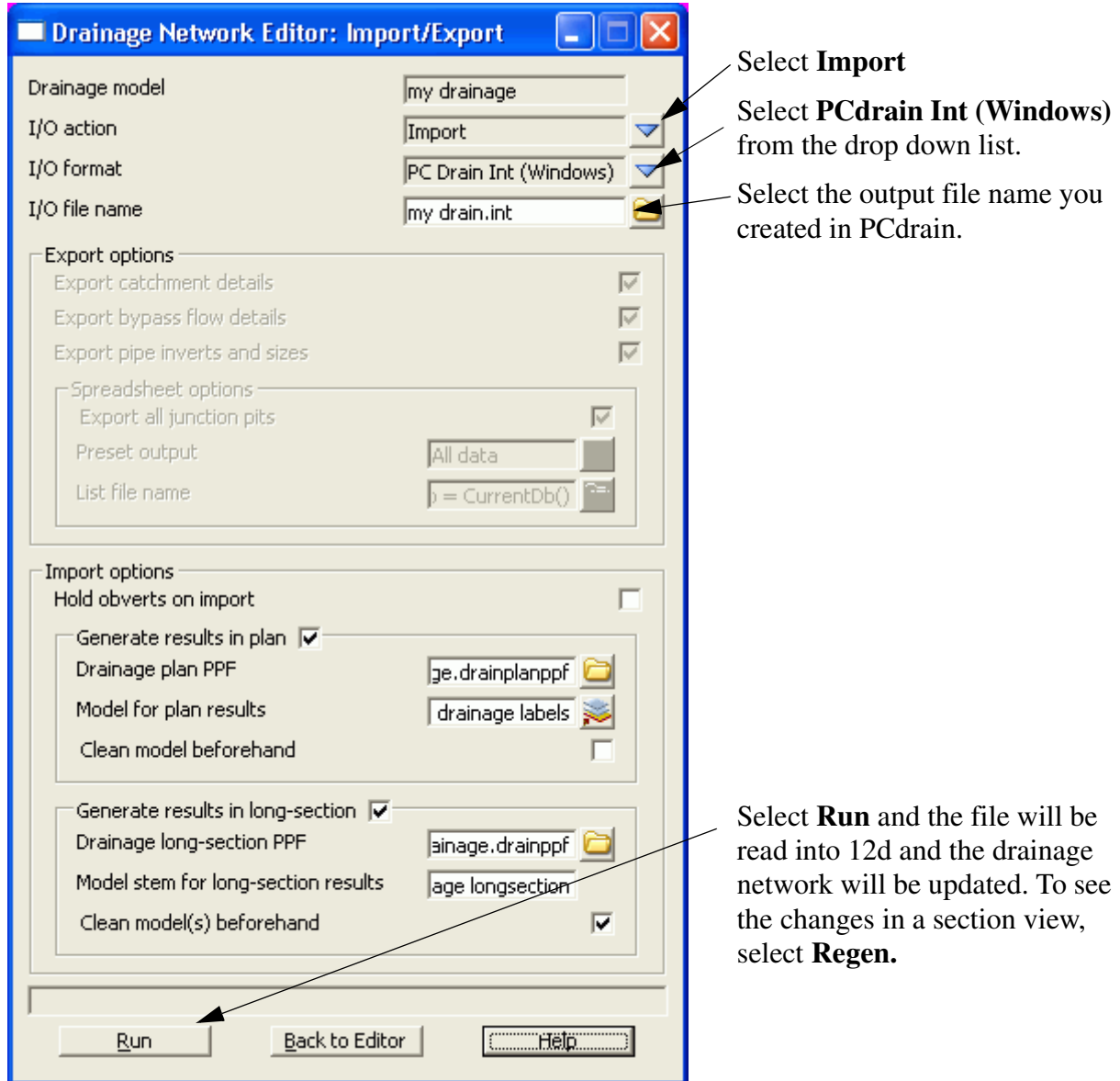| PCdrain	12d editor	12d attribute	initial export value
Kw	not available	kw	12d ku value
Minor Coef	Catch Set 1 - Pervious C (minor)	c minor pervious	default
Major Coef	Catch Set 1 - Pervious C (major)	c major pervious	default
Minor Coef2	Catch Set 2- Pervious C (minor)	c minor pervious2	default
Major Coef2	Catch Set 2- Pervious C (major)	c major pervious2	default
Tc overrider	Catch Set 1 - Pervious Tc (minor)	tc minor pervious	default
Length of overland flow	Catch Set 1 - Pervious length	catchment length pervious	default
Grade of overland flow	Catch Set 1 - Pervious slope (%)	catchment grade pervious	default
Length of gutter flow	Catch Set 1 - Impervious length	catchment length impervious	default
Grade of gutter flow	Catch Set 1 - Impervious slope (%)	catchment grade impervious	default
Road XSections left	not available	overland profile name	4d
Road XSections right	not available	overland profile name right	4d

9.3 PCdrain to 12d

Export the results to 12d using the **File=>Export** menu selection. Note the name of the interchange file you are creating as you will need to enter it inside 12d.

Return to 12d and select **Import/Export** from the network editor and the following dialogue will

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appear,

Select **Import**

Select **PCdrain Int (Windows)** from the drop down list.

Select the output file name you created in PCdrain.

Select **Run** and the file will be read into 12d and the drainage network will be updated. To see the changes in a section view, select **Regen.**

A listing of the data imported is stored on the 12d output window.

Manholes that have been specified as SAG inlets will have the ponding depth removed from the end of the PCdrain structure type before the data is stored as the12d manhole type.

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10.0 Running Drains - Version 2 onwards

Key Points

1. The Drains database (each project has its own) and the12d database (drainage.4d) must be synchronised (**More**).

2. For bypass flow, 12d selects pit families for Drains in the following way

   The users selects pit group in 12d and at export the pit group is scanned in the drainage.4d file using the road data to select the Drains pit families

3. Data is copied from 12d to the Windows clipboard and then pasted into Drains. 12d can not delete any objects in Drains, it can only add and update.

4. When updating 12d from Drains, always copy the DATA to 12d before the results. 12d will update the network but will not add or delete manholes.

Drains Interface Overview

The Drains program performs the rational and ILSAX hydrology calculations as well as hydraulic grade line calculations that determine pipe sizes and pipe invert levels.

The data sent to Drains includes

- s   manhole names and types, easting and northing data with surface levels
- s   finished surface profile along the centre line of the pipes
- s   **Headwalls** and their levels
- s   optional - bypass manholes, road grades/crossfalls and **SAG Inlet Calculations** (ponding volumes and depths). Pit family selection using road grade and crossfall data.
- s   optional - composite catchment area create from three12d areas per manhole
- s   optional - default catchment characteristics, k values and overland travel times
- s   optional - pipe sizes, type and invert levels

Data is copied from 12d to the Windows clipboard and then pasted into Drains (**Edit=>Paste data from spreadsheet**). 12d can not delete any objects in Drains, it can only add and update.

The Drains menu selection **Run=>Design** is used to design the network. Once the drainage network has been designed in Drains the updated design data (**Edit=>Copy data to spreadsheet**) and/or the hydraulic results (**Edit=>Copy results to spreadsheet**) are sent back to 12d via the clipboard.

Always copy the DATA to 12d before the results as the results are deleted inside 12d with every update of the data!

A demonstration version of the Drains program is included on the 12d distribution CD in the directory

        Other_Software\Drains

The version is limited in the number of pits allowed.

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10.1 Synchronising the Drains database and the drainage.4d file.

The Drains database and the 12d drainage.4d file must be synchronised as follows.

All Cases	
Drains database	**drainage.4d**
Pipe type	Pipe type entries
Only if bypass flow is required	
Drains database	**drainage.4d**
Pit famly	12d manhole group with road data
	to lookup Drains pit family
Overland route database	One default value set (not in drainage.4d)

Every Drains file begins with a default database and uses that database for the life of the project. This database must by synchronised with the **drainage.4d** file in 12d to ensure the Drains pit families, pit sizes, pipe types and overflow route types.

The following 5 steps will help ensure 12d is synchronised with Drains. More details are given in the sections below.

1)Export the Drains database from your Drains file

Inside Drains select **Project=>Overflow Route database**. Then select **OK** and then **YES**. This will cause Drains to export the database to the file "Drains Connection Data.txt".

2)Create a drainage.4d file from the Drains file

s   From the 12d menu select **Design->Drainage-Sewer->More->Drains to drainage.4d**.

s   Select **Read Drains database**,

s   review the Drains pit families list to identify the character (usually a comma or -) that separates the pit group from the road data and then enter it in the **Pit group separator** field.

s   Check the **12d pit groups** and if they are acceptable

s   select **Create drainage.4d.** The Drains database dump file is copied to the 12d working folder and a drainage.4d file is created in the 12d working folder.

s   **More details below**.

3)Edit the drainage.4d file

From the 12d menu select **Design->Drainage-Sewer->More->Edit drainage.4d**. Select **Find** then edit from the file **more info** button. Set the road grade and crossfalls for the 12d manhole groups.**More details below.**

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4)Restart 12d

From the 12d menu select **Project->Restart**.

5)Set the Overflow shape, Update Manhole and Pipe type.

A single global overflow route shape can be specified in 12d via the following routine and then it can be modified in the Drains program. The import operation of the interface will read modified values and store them so that the next export operation will export the modified values.

If the network has already been created, using manhole and pipe types that no longer exist in the drainage.4d file, they will have to be updated before the export to Drains can occur. You may update them using the drainage network editor or you may set **all** of the manhole and pipes types to **one value** using this routine.Later you may change them individually using the **Drainage network editor**

From the 12d menu select **Design->Drainage-Sewer->More->Drainage io defaults.**

More details below.

10.2 Drains to drainage.4d file

Position of option on menu: Design =>Drainage-Sewer =>More=>Drains to drainage.4d

On selecting the Drains to drainage.4doption, the Drains to drainage.4d panel is displayed.
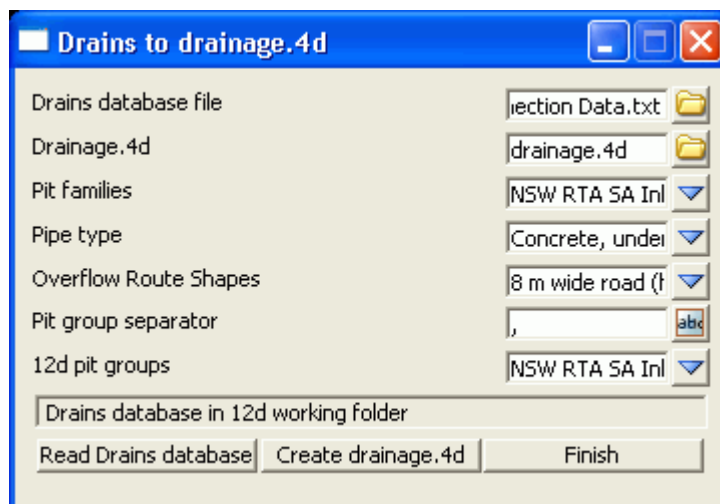
Key Points

1. Select **Read Drains database (12d will search the usual locations for the Drains database)**

2. Review the Drains pit families list to identify the pit group separator and then enter it in the **Pit group separator** field. **PRESS THE ENTER KEY!**

3. Check the **12d pit groups** and if they are acceptable select **Create drainage.4d.**

   The Details

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The Drains database dump file **Drains Connection Data.txt** is copied into the 12d working folder and read. The choices for the **Pit families, Pipe types** and **Overflow Route Cross Section** Shapes are loaded into the panel. The user must select a **Pit group separator** to separate the road grades and crossfalls from the pit family names. The resulting **12d Pit Groups** will be calculated and displayed in the choice box. **Create drainge.4d** will create a **drainage.4d** file that may then be edited to specify the road grade and crossfall threshold values. Once the file is created you may review/edit it by selecting the **More Info** icon then **Edit** on the **Drainage.4d** field. The **Overland route shapes** are not exported to the drainage.4d file and are presented for your information only.

YOU MUST RESTART 12D FOR THE NEW DRAINAGE.4D FILE TO BECOME ACTIVE!

Field Description Type   Defaults   Pop-Up

Drains database file file   Drains Connection Data.txt

You must update this file from Drains before each use of this panel. Inside Drains select Project=>Overflow Route database. Then select OK and then YES. This will cause Drains to export the database to the file "Drains Connection Data.txt".

*Selecting **Enter** in this field or selecting **Read Drains database** will cause the panel to search for the database dump in the folders **C:\Program Files\Drains\Program** and **C:\Program Files\Drains\Demo\Program**. If the Drains program is installed in another folder then you must browse for the file. After reading the file choice boxes below will be populated. Drains Connection Data.txt will be copied into the 12d working folder.*

Drainage.4d   file   drainage.4d

The drainage.4d will be created in the 12d working folder unless otherwise specified. It will only be used for 12d projects in this folder.

Pit families   choice   Drains pit families

These are the Drains pit families that will be exported to the drainage.4d file. The 12d pit groups will be created from this list.

Pipe type   choice   Drains pipe types

These are the Drains pipe types that will be exported to the drainage.4d file.

Overflow Route Shapes choice   Drains Route Shapes

These are the Drains Route Shapes *and are for information only.*

Pit group separator input

*These characters will be used to remove the road grade crossfall data from the **Pit families** above. The data before this character will become the **12d pit groups**. Press **Enter** or select **Read Drains database** to create a new list of **12d pit groups.***

12d pit groups   choice   12d pit groups

*These are created from the Pit family list above by deleting all text after the **Pit group separator**. This should delete all of the road grade and crossfall information from the pit group names.*

Read Drains database button

*Searches for the Drains database (see general description above) and populates the choices fields.*

Create drainage.4d button

Create a local copy of the drainage.4d file.

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10.3 Editing the Drainage.4d file

Position of option on menu: Design =>Drainage-Sewer =>More=>Edit drainage.4d

On selecting the Edit drainage.4d option, the Edit drainage.4d panel is displayed.
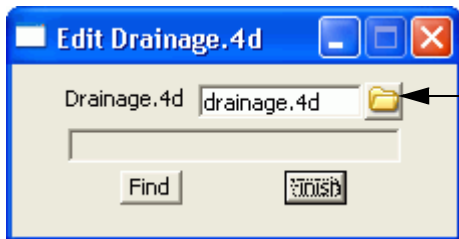
Select the **Find** button to search the 12d path for the current **drainage.4d** file. Select the **More info** button and then **Edit** to edit the file.

The drainage.4d file contains Manhole and Pipe commands. 12d also uses the Manhole commands to specify a manhole group by using the prefix "group". Details follow.

Headwalls

The manhole type "Headwall" (case sensitive for Drains) is reserved for the inlet headwall for a conduit. Drains does not use this for an outlet headwall.

If the inlet type is On Grade or there is no bypass pit, the setout z level + the setout to grate offset is exported as the Drains surface level. If the Inlet type is marked as a SAG pit then the surface level will be calculated from the low point on the catchment string (catchment set #1). The ponding depth will often be negative in this case. Also see **SAG Inlet Calculations**.

Pit Families and Manhole Groups

Version 2+ of the Drains clipboard interface uses a **pit family** to describe the kerb shape. Optionally, the Drains pit families also have the road crossfall and/or grade attached as a suffix to the name with a special character between them (pit group separator). Therefore there may be many pit families that have the same kerb shape but different road grades and cross falls. All of these pit families with the same prefix are brought together in 12d as a **manhole group**.

An example manhole group is the drainage.4d file is shown below. The 12d group is called **NSW RTA Pits** and 12d uses the road grade to select which pit family should be sent to Drains. In this example the road crossfall would not be used in selecting the pit family.

The **pit group separator** is a "-". This character separates the pit group from the road data.

It is up to the user to decide the grade when the next pit family should be used. In this case the threshold value for the gutter grade is set midway between the published values of the inlet curves. For example at a gutter grade of 2% 12d starts sending the ***NSW RTA Pits - 3% slope*** pit family.

This pit families listed on the right must match exactly with those in the Drains pit database.

```
Manhole "group NSW RTA Pits" {
//     cross fall,  gutter grade,  cap1,  cap2,  cap3,  cap4pit family
//4d       0,           1,       0,     0,    0.0,   1.0         NSW RTA Pits - 1% slope
```

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//4d	0,	2,	0,	0,	0.0,	1.0	*NSW RTA Pits - 3% slope*
//4d	0,	4,	0,	0,	0.0,	1.0	*NSW RTA Pits - 5% slope*
//4d	0,	6,	0,	0,	0.0,	1.0	*NSW RTA Pits - 7% slope*
//4d	0,	8,	0,	0,	0.0,	1.0	*NSW RTA Pits - 9% slope*
}							

An example with crossfalls follows.

Manhole "group NSW RTA Pits" {

//   cross fall,   gutter grade, cap1, cap2, cap3, cap4

//4d *slope*	1,	1,	0,	0,	0.0,	1.0	*NSW RTA Pits - 1% crossfall, 1%*
//4d *slope*	1,	3,	0,	0,	0.0,	1.0	*NSW RTA Pits - 1% crossfall, 3%*
//4d *slope*	1,	5,	0,	0,	0.0,	1.0	*NSW RTA Pits - 1% crossfall, 5%*
//4d *slope*	1,	7,	0,	0,	0.0,	1.0	*NSW RTA Pits - 1% crossfall, 7%*
//4d *slope*	1,	9,	0,	0,	0.0,	1.0	*NSW RTA Pits - 1% crossfall, 9%*
//4d *slope*	3,	1,	0,	0,	0.0,	1.0	*NSW RTA Pits - 3% crossfall, 1%*
//4d *slope*	3,	3,	0,	0,	0.0,	1.0	*NSW RTA Pits - 3% crossfall, 3%*
//4d *slope*	3,	5,	0,	0,	0.0,	1.0	*NSW RTA Pits - 3% crossfall, 5%*
//4d *slope*	3,	7,	0,	0,	0.0,	1.0	*NSW RTA Pits - 3% crossfall, 7%*
//4d *slope*	3,	9,	0,	0,	0.0,	1.0	*NSW RTA Pits - 3% crossfall, 9%*
}							

The Drains pit family names must match the names in the last column EXACTLY!

Manhole Types and Pit Sizes

Each Drains **pit family** has several **pit sizes**. The Drains **pit sizes** link to the 12d manhole types and therefore all Drains **pit sizes** should exist in the 12d drainage.4d file.

The **pit size** will be read back from Drains into 12d as the **pit type** so that it can be placed on the drainage long sections and pit schedules.

Pipe Types

The pipe type selected in 12d must exist in the pipe database inside Drains. Simple "2" for class 2 or "RCP "do not exist in Drains.
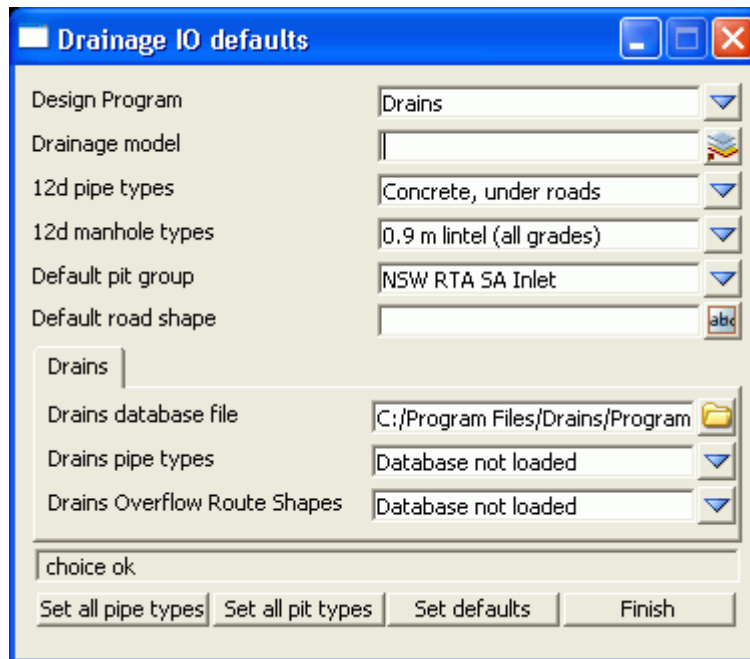
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10.4 Setting the Overflow Route, the Pit and Pipe types

Position of option on menu: Design =>Drainage-Sewer =>More=>Drainage IO Defaults

On selecting the Drainage IO Defaults option, the Drainage IO Defaults panel is displayed.

The routine changes ALL of your manhole and pipe types in a model to a single value. If you have changed your drainage.4d file after creating you drainage network, the manhole and pipe types you originally selected may no longer be valid (i.e. in the drainage.4d file).

Field Description	Type	Defaults	Pop-Up
Design Program	choice	Drains	Drains, PCdrain

The drainage model to be updated.

Drainage model   file

The drainage model to be updated.

12d pipe types	choice		values from drainage.4d

Set all pipe types *will set all pipes in the model to this value*

12d manhole types	choice		values from drainage.4d

Set all pit types *will set all manholes in the model to this value*

Default pit group	choice		values from drainage.4d

*manhole definitions in the drainage.4d file that have **group** as a prefix are included.*

Default road shape	choice		values from drainage.4d

*type the desired name or if using Drains select the desired shape from the **Drains Overflow route shapes**.*

Drains Tab

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Drains database filefile

pressing enter in this field will start a search for the Drains database dump. The search path is the specified folder, C:\Program Files\Drains\Program then C:\Program Files\Drains\Demo\Program. If the file is found the choice fields below are populated. **It is highly recommended that this file be in the 12d working folder.**

Drains pipe typeschoice   l   values from Drains file

the pipe types are retrieved from the last Drains database dump. Changing this value will update the **12 pipe types** *above.*

Drains Overflow Route Shapeschoice   values from Drains file

the overflow route shapes are retrieved from the last Drains database dump. Changing this value will update the **Default road shape** *above.*

Set all pipe types button

all pipe types in model are set to this value

Set all pit types   button

all pit types in model are set to this value

Set defaults   button

the defaults for the **Drains Overflow Route Shapes** *and* **12d pit group** *are set*

Finish   button

removes the panel

10.5 Drains Version 2+ Requirements

Manhole Names

The 12d manhole names cannot be more than 9 characters long. 12d uses 2 additional characters to the manhole name at export time create names for the pipes, overflow routes and catchments. For example manhole "A-1" will have a bypass route "F A-1", a catchment "C A-1" and a downstream pipe "P A-1".

Bypass Flow (Overland Flow Routes)

There are 3 requirements for Drains bypass flow.

1. Select **Default pit group** (Network editor->Defaults->Pits->Pit group). The Drains and 12d databases must be in sync.

2. Bypass strings in the **Bypass route model** specified (Network editor->Global->Utility Models->Bypass flow model. For more details see **Bypass Flow.**

3. Road grade and crossfall calculated (Network editor->Global->Utility Models->Road design file)

The overland flow strings are not allowed to pass through the outlet pit on the network.

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SAG Inlet Calculations

SAG inlets are manholes where the water ponds at the surface rather than flowing past. If a SAG inlet has a catchment string the overflow depth and volume are calculated. The catchment string from Set #1 is draped onto the design tin and the lowest point in found on the draped string (stored as a 12d pit attribute ***overflow level***. The storage volume inside the string up to this point is measured and stored as a 12d pit attribute ***overflow volume from level***. and are subtracted from the to determine

The Max Ponding Depth = lowest point on the catchment string -
(pit setout level + **Setout to grate offset)**

If the **manual flag** is selected for the "sag pit pond depth", 12d NOT calculate the value but will use the value entered by the user. 12d will check if a volume has been calculated before or imported from Drains. If the volume exists then it is exported. If it does not exist, this ponding depth will be used calculate the ponding level (setout z + depth + grate to setout offset) and this level will be used to calculate a ponding volume from the design tin and the catchment boundary.

If you want to manually delete this volume and force 12d to recalc to volume using the user defined level, delete the pit attribute, "overflow volume from level". To delete the attribute use Strings->Properties->Attributes, select the pit, go to the pit tab, right mouse select the row with this attribute and select delete).

Results

Drains exports the maximum data from all of the rainfall events analysed. Therefore, ensure you analyse only the rainfall events desired before coping the results to the clipboard. To verify the data that is being sent to 12d, copy the data into a spreadsheet so you can view it there first. The pit sizes selected in Drains will be stored in 12d as the manhole type. Therefore the pit sizes in Drains should exist as manhole types in the drainage.4d file. If pit families are changed in Drains the pit group in 12d will be updated by search for the pit family in the drainage.4d file.
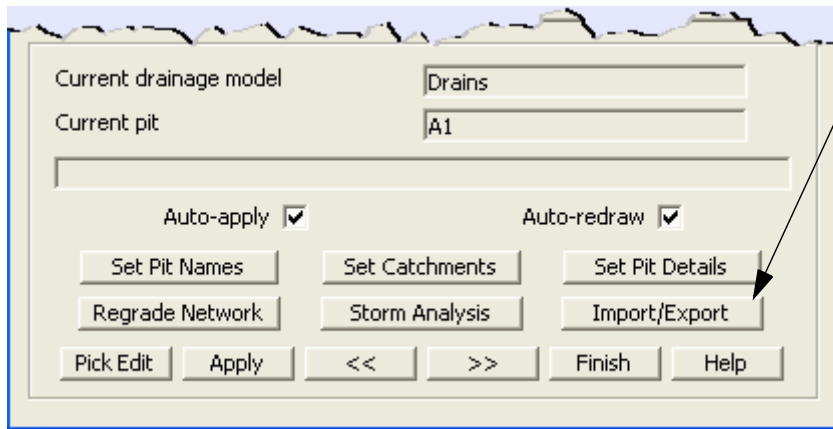
10.6 12d to Drains

Setup your drainage network models and ensure they have been assigned pit names.
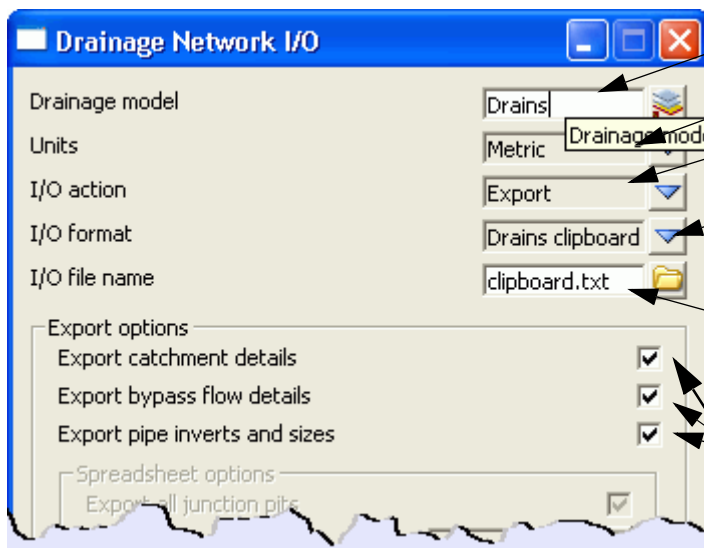
1. Copy the data to the clipboard

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From the Drainage network editor select the **Import/Export** button.

The following interfaces dialogues will appear.

This should be filled in from the editor.

Enter the units.

Select **Export.**

Select **Drains clipboard -Ver 5 Ilsax or Rational.**

Data is stored in this file as well as on the clipboard.

Not used by Drains

Use the **Run** button to copy to the clipboard.

2. From within the Drains program select **Edit =>Paste data from spreadsheet**. If you paste the data into a Drains project that has a hydrological model and rainfall data already defined the project will be ready to run.

3. Use the Drains Run=>Standard design to design your pipe sizes and invert levels. The Run=>Advanced Design will select the size of the manholes as well.

10.7 Drains to 12d Update

The following steps are required to update the 12d model with the Drains hydraulic results and changes to the pipe sizes and inverts.

1. To update the pipes and invert levels in 12d, select **Edit->Copy Data to Spreadsheet** from the Drains menu.

2. From within the 12d Drainage network editor select **Import/Export**.

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This should be filled in by the editor.

Not used on import.

Select **Import**

Select Drains clipboard - Version 5

Leave as clipboaard.txt

This will ignore the invert levels read from Drains and the current pipe obverts will remain fixed.

Plan and long section drawings may be created at the import time so that you can see the results on the drawings.

Select **Run** to update the drainage model. To see the changes in the section views you will have to select **Regen** on the section view toolbar.

To return to the network editor select **Edit**

IMPORTANT: THE DATA MUST BE PASTED BEFORE THE RESULTS!

12d erases the hydraulic and hydrology data when the physical data is updated. Therefore, always paste the data before the results.

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11.0 Running XPSWMM and RAT2000

The drainage design with all three of the XP software programs follows the same methodology. The process is substantially automated with the XP-SWMM program so that the XPX file is automatically read by XP-SWMM and automatically created when leaving XP-SWMM.

Drainage design with XP programs includes the following steps.

1. 12d creates an XPX file that is read by the XP programs.

2. The XP program is then run in the design mode to determine the pipe sizes and invert levels.

3. If bypass and overland flows are to be modelled then the inlet capacities need to be defined and then run the XP program in the Full Analysis Model.

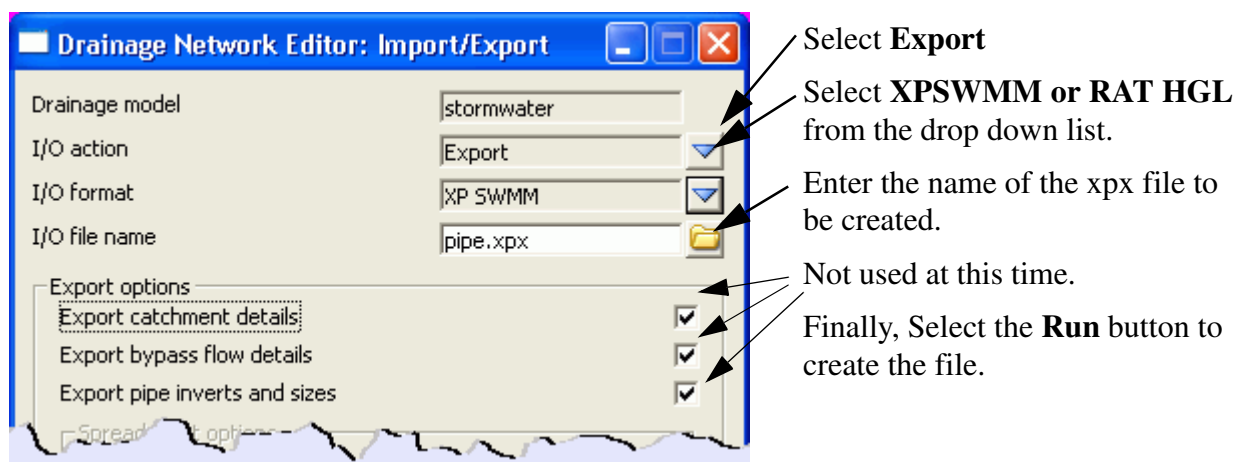4. The XP program creates an XPX file for 12d to import.

11.1 XP Program Requirements

11.2 12d to the XP Programs

The x,y pit layouts and the cover/surface levels are obtained from your drainage network while the catchment and overland flow data comes from the models specified in the drainage interface dialogue.

The steps required to transfer the data to the XP programs are as follows.

1. Setup your drainage network models.

2. To create the XPX file for XP programs start the Drainage Network Editor and select **Import/ Export**

The following interfaces dialogues will appear.

Select **Export**

Select **XPSWMM or RAT HGL** from the drop down list.

Enter the name of the xpx file to be created.

Not used at this time.

Finally, Select the **Run** button to create the file.

If exporting to RAT-HGL the following dialogue will appear.

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If you are using old versions of RAT-HGL (1996 or earlier) select use **Local** otherwise select **4D units** (eastings and northings).

Select process.

3. The XP SWMM program will automatically startup and load the XPX file.

   From within RAT-HGL, either select **File =>New** and follow the input prompt or load a file that contains all of the pit inlet rating curves, hydrological and design data without a pipe network. Many users have such RAT-HGL files setup so as to streamline the design process.

   The xpx file for RAT2000 will have the file startup.xpx added to it so that you may include all the startup global data that you require. The
   Fixed inlet capacities and rating curve names indicating road grade and crossfall may be set in the **drainage.4d** file. The format for these names is pit name-crossfall-road grade (ex SA2-3-4). These curves must exist in this file.

4. To read in the pipe file created above, select **Special =>Import Data** and select the xpx data file. Warnings will be given stating that several fields are inactive. This is expected as more data is sent to RAT-HGL than is needed at this time. Select the **Close Square** on the Help title area and the pipe network and catchments should now appear on the screen.

5. If you want RAT-HGL to redesign you network, change the analysis mode to Design mode by selecting **Special=>Job Control** and **S**elect Design mode. Do not do this if you want to analyse the network you layed out in 12d (used for existing systems).

6. Select the rainfall events to design/analyse and the **LB** (twice) on **OK** to return to the layout. Now select the outlet and enter the starting tailwater levels.

7. Now you can run RAT-HGL (**Special =>Solve**).

11.3 XP Programs to 12d

Once you have your design finished, the following steps are required to update your 12d model. Your design may contain several return periods in the analysis (Rp1 to Rp7) but 12d reads only the results from Rp1. The following table is taken from the RATHGL output file (*.out extension) and the results indicated are read back into 12d via the xpx file.

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```
HGL  PIPE  NETWORK  ANALYSIS  SUMMARY    RETURN PERIOD   5 YEARS
      PROJECT:12d DRAINAGE LAYOUT

     ----------------------------------------------------------
     |ITEM DIM| RESULT
     ----------------------------------------------------------
     RN     -    1     2     3     4     5     6
     NN     -    1-1   2-1   1-2   3-1   1-3   1-4
     DN     -    1-2   1-2   1-3   1-3   1-4   1-4
     MT     -    99    99    99    99    99    0
     DHGL   M  29.258 29.258 28.139 28.139 27.269   .000   DS HGL
     DD     M   .225  .375  .375  .300  .450  .000    Diameter
     DCTL       HGL   HGL   HGL   HGL   HGL
     DO     M   .225  .375  .375  .300  .450  .450
     QO   M3/S  .033  .181  .237  .075  .334  .353    Flow
     VELD M/S   .826  1.639 2.148 1.065 2.100  .000
     NORM   M   .106  .264  .271  .153  .289  .000
     CRIT   M   .152  .314  .345  .215  .396  .000
     KP     -   .00   .00   .00   .00   .00   .00
     SF   M/M  .0040 .0082 .0140 .0046 .0107 .0000
     LEN    M  45.93 18.44 54.65 31.31 49.91   .00
     HGLP   M  29.444 29.409 28.905 28.284 27.802   .000   US HGL
     DU     M   .225  .375  .375  .300  .450  .000
     VELU M/S   .826  1.639 2.148 1.065 2.100  .000   Velocity
     UCTL       HGL   HGL   HGL   HGL   HGL
     KU     -   1.50  1.50  1.50  1.50  1.50  .00   Ku
     KL     -   1.50  1.50  1.50  1.50  1.50  .00
     KR     -   1.50  1.50  1.50  1.50  1.50  .00
     KW     -   1.50  1.50  1.50  1.50  1.50  .00   Kw
     UHGL   M  29.496 29.615 29.258 28.370 28.139 27.269
     LHGL   M  29.496 29.615 29.258 28.370 28.139 27.269
     RHGL   M  29.496 29.615 29.258 28.370 28.139 27.269
     UWSL   M  29.496 29.615 29.258 28.370 28.139 27.269   HGL PIT
     MWSL   M  30.297 29.615 29.403 28.875 28.340 27.369
     AF   M3/S  .033  .207  .023  .094  .040  .000
     IF   M3/S  .033  .181  .023  .076  .023  .023
     IC   M3/S  .036  .227  .026  .076  .023  .023
     BF   M3/S  .000  .026  .000  .019  .017  .000
     ID     M   .000  .000  .000  .000  .000  .000
     ITW    M   .000  .000  .000  .000  .000  .000
     IVEL M/S   .000  .000  .000  .000  .000  .000
     IVD  M2/S  .000  .000  .000  .000  .000  .000
     FC     -         *           #     #     #
     ----------------------------------------------------------
```
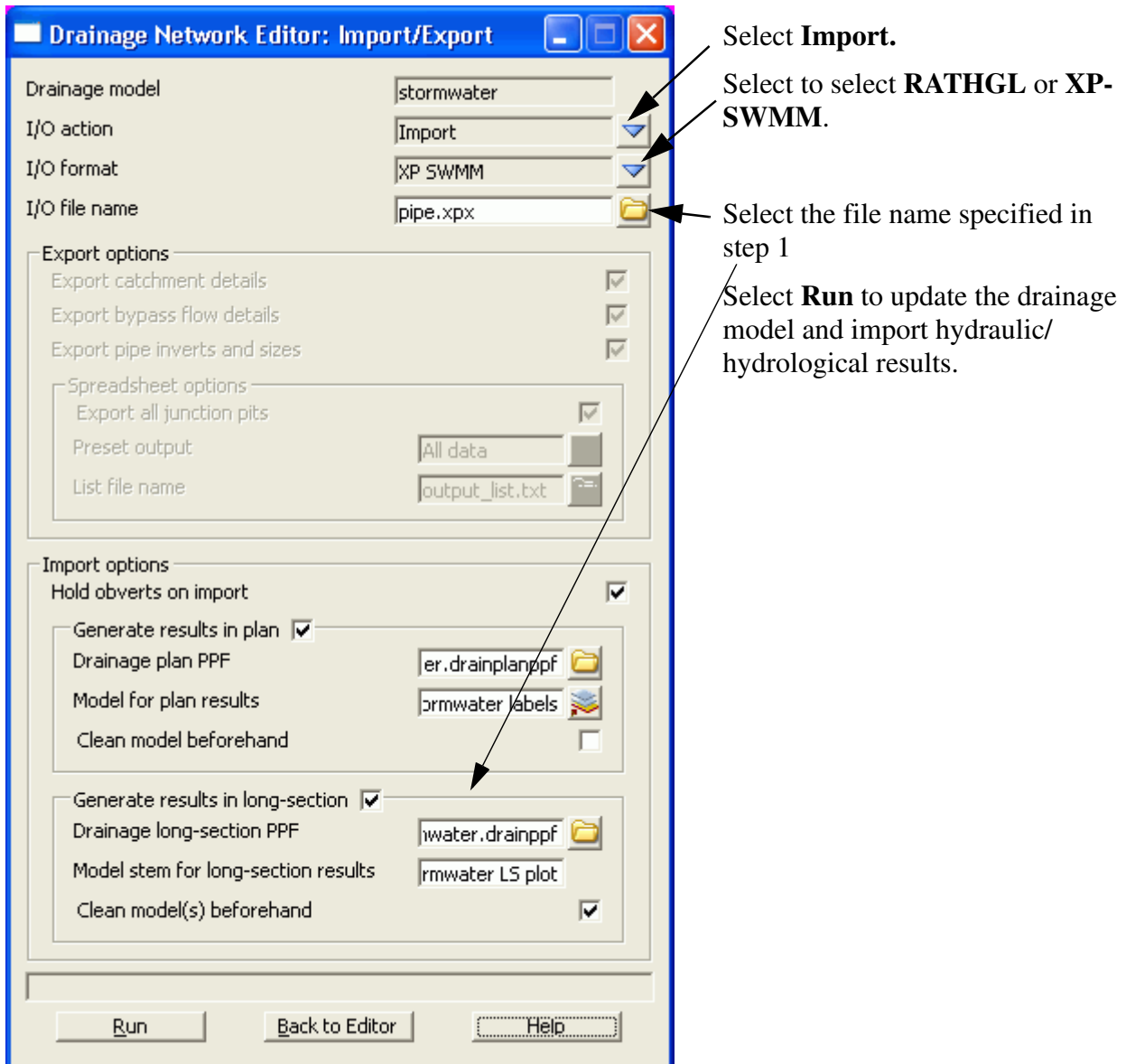
In addition to the results, the following input data is read back into the 12d model so that it may be exported back to RATHGL in the future (if required). 100% of your RATHGL data is not included in the XPX formats and the contents of the XPX file will depend upon your design mode. Therefore, use caution if you read an XPX file into an existing RATHGL model and check your data once inside RATHGL.

1. From within RAT-HGL, produce an XPX file for 12d to read by selecting **Special=>Export**

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Data and following the default prompts**.**

2. From within 12d, select the **Import/Export** button on the Drainage Network Editor.The following panel will appear.

Select **Import.**

Select to select **RATHGL** or **XP-SWMM**.

Select the file name specified in step 1

Select **Run** to update the drainage model and import hydraulic/ hydrological results.

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12.0 Reviewing, Changing and Creating User Defined Attributes

The catchment data is stored within 12d as user defined attributes. These attributes are automatically created by 12d when required but you are free to change them or add more as desired. The attributes may be exported to a spreadsheet and edited and then imported back into 12d. To work with the user defined attributes within 12d select

Design=>Drainage-Sewer=>More=>Top 10 Attribute Editor.

The following dialogue will appear.
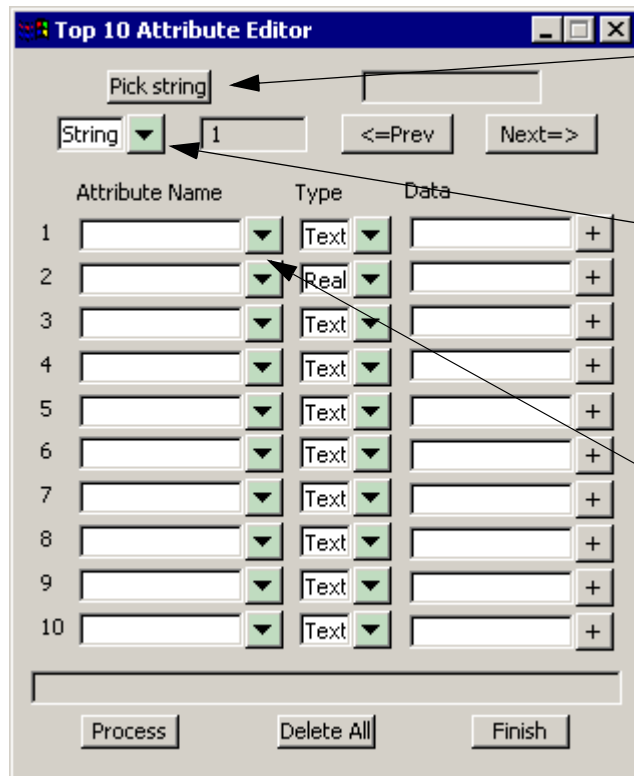
First **S**elect **Pick** to select the string that contains the user attributes (the drainage string). The strings will be highlighted in white when they are selected.

All catchment data is store with the pits in drainage strings. To access the pit attributes, select the drop down icon and then select **Pit**. A circle will be drawn around the pit selected. **Next** and **Prev** will now move you from pit to pit.

Select the drop down icon and then select the **Attribute Name** from the list of existing user defined attributes. These attributes include all of the attributes in the model that the string exists in.

They may not be defined for the pit you are editing. **Not found** will be displayed in the **Data** field if the pit does not have that attribute defined.

To change the value for the attribute enter the new value in the **data** field. If the attribute does not exist, deleting the **not found** text and adding data will create it. The message on the right will be displayed whenever you are creating a new attribute.
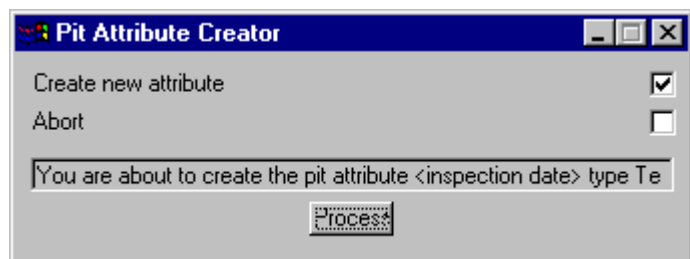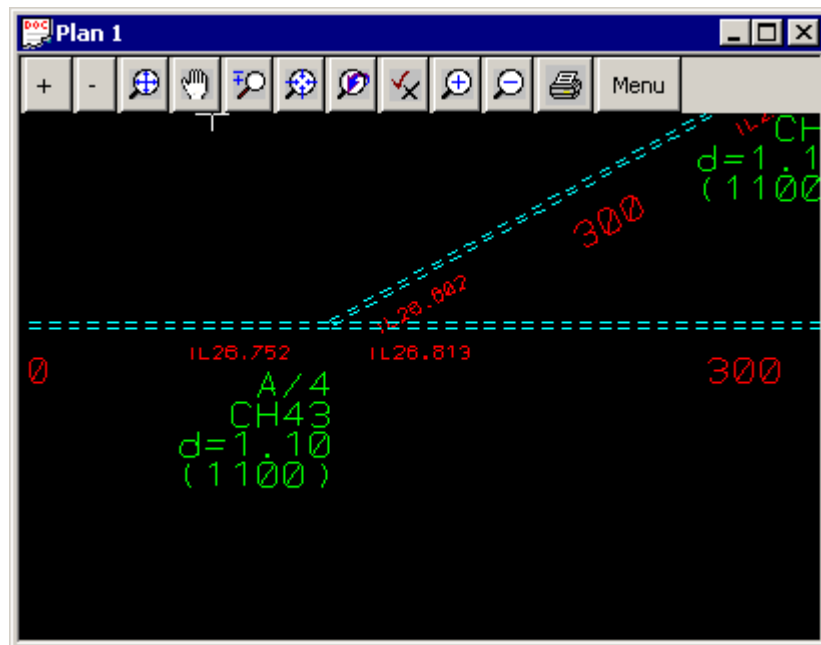
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13.0 Detailed Drainage Plan Drawing

12d drainage has the capability to create detailed drainage plan drawings with the following features:

screate symbols at the manholes and the type of symbol is controlled by the manhole type (given when you create the manhole).

screate text labels for manhole types and user defined pit attributes

sdraw lines with line styles and colours to represent pipe sizes

screate text labels for pipe diameters, inverts and user defined pipe attributes

screate text labels for house connection types, invert levels and chainages

sindicate direction of flow on pipes.

An example is shown below

Usage

This option is accessed from the menu selection

Design => Drainage-Sewer => Plots => Plan Annotations

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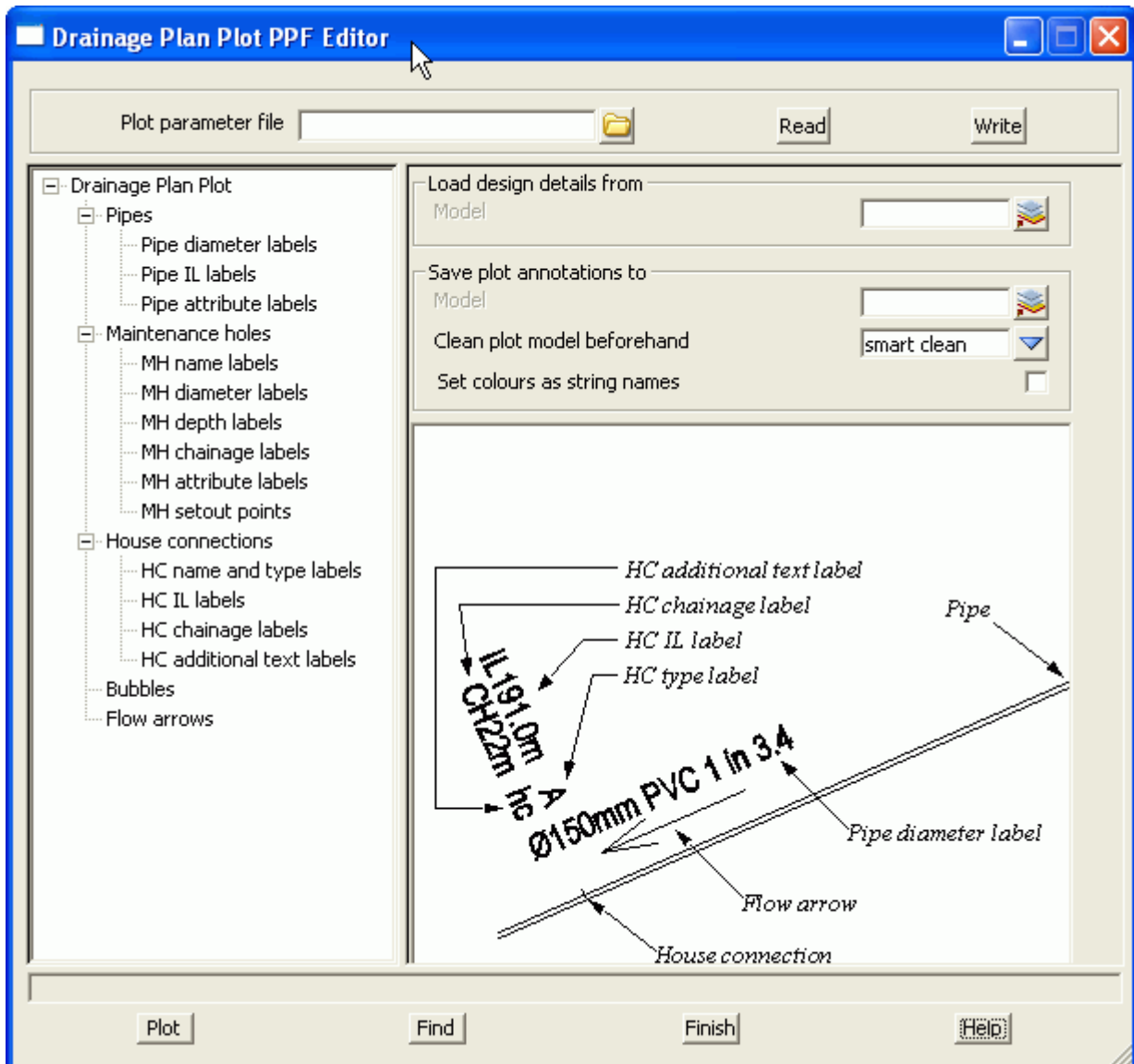
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The fields and buttons used in this panel have the following functions.

Field Description	Type	Defaults	Pop-Up

Plot parameter file   file box

Optional - no dpf is required. The default settings will create a schematic drainage drawing. A custom dpf may be selected if desired.

Load design details from   model box

data source for drainage strings to be labelled

Save plot annotations to modelmodel box

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labels to be created are stored here, Undo will remove the labels created

Clean plot model before hand choice box

smart clean will update text that has been moved and clean the rest. Full clean will all text from the plan annotations model.

Set colour as string name tick box

when selected the string colour will be used for the string name (to be used for DWG/DXF export using map files)

Plot button

Creates the labels in the model specified

Find button

used to locate plot parameter input boxes using Version 5 plot parameter names

IMPORTANT! to turn off any data change the text height to zero.

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14.0 Drainage Long Section Plotting - Hatching Under Roads

The drainage long section plotting has been discussed in the Intro Drainage Course. Here we will discuss the technique for hatching under roads and/or footpaths.

The following steps are required.

1. Run the Excavation volumes routine using the obvert templates to create sections and strings for a tin on top of the pipe (obvert tin). Select **Stop section at end of manhole** to prevent the manholes from being hatched

2. Create the obvert tin from the strings and sections then and null by angle length with a small length value so that the tin is nulled near the manholes.

3. Create a design tin that extends to the limit of the roads.

4. Use the hatching section of the drainage long section plot to select the hatching style.

14.1 Creating the Obvert sections and strings.

Run the Excavation volumes routine by selecting

Design->Drainage-Sewer->Reports->Excavation Quantaties
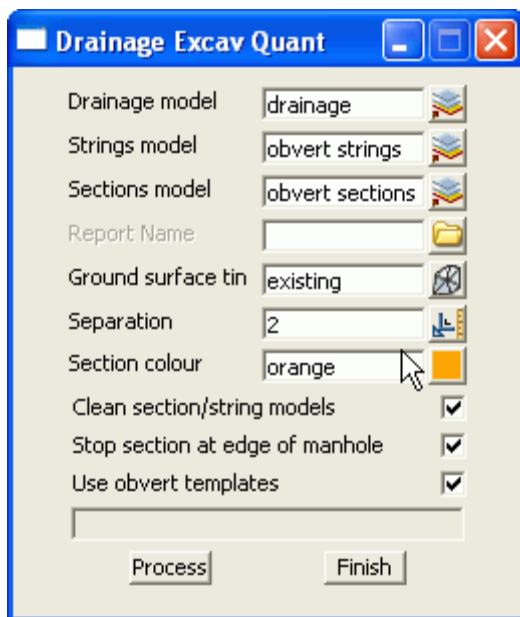
Select your **Drainage model.**

Enter new model names for the **strings model** and the **section models**.

No **Report name** is required.

The **Ground surface tin** need to be selected but it does not matter what it is as long as it exists for the drainage network.

Separation may be a large number as there will always be a section at each manhole. If the pipe is curved then you will want a smaller separation.

Stop section at edge of manhole will prevent sections from being created inside the manhole diameter. This will later stop the hatching from occurring on top of the manholes.

Use obvert templates should be selected. This option allow required all templates to be prefixed with "obvert " before the pipe size (times 1000). An example template name would be "obvert 375" for a 375mm pipe. This allows the user to have one set of templates for the excavation volumes and another set for the obvert calcs. A completed set of templates for metric pipes should have been imported when you performed the excavation quantities calcs. If you skipped this sections then import the templates by selecting.
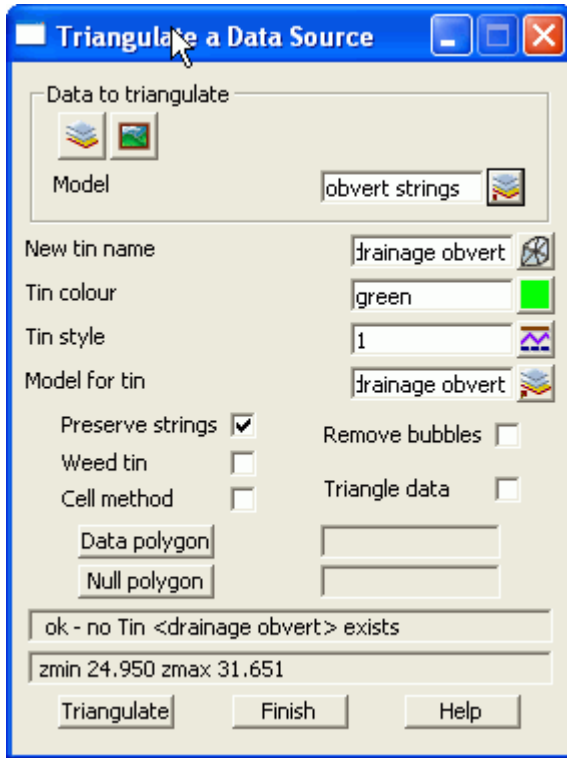
Design->Templates->Utilities->Input

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and import the file **PIpe templates.tpl.**

14.2 Create and Null the Obvert tin
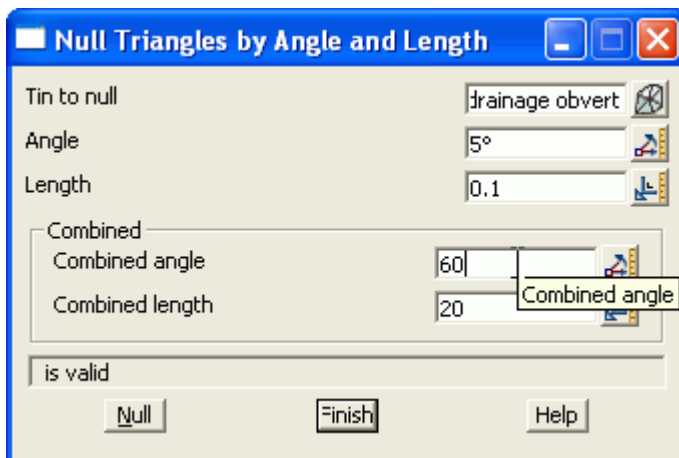
To create the obvert tin select.

Tins->Create->Triangulate Data

Select the obvert strings models created in step 1.

Enter a **New tin name** as desired.

Select **Triangulate**

Note that the sections are not used as they contain the hinge string that lies on the pipe invert.

Now select

Tins->Null->by angle/length

Select the tin created above for **Tin to null.**

Enter a small value for **Length.**

Select **Null.**

The tin will now only exist on top of the pipe and it is ready to use for hatching.
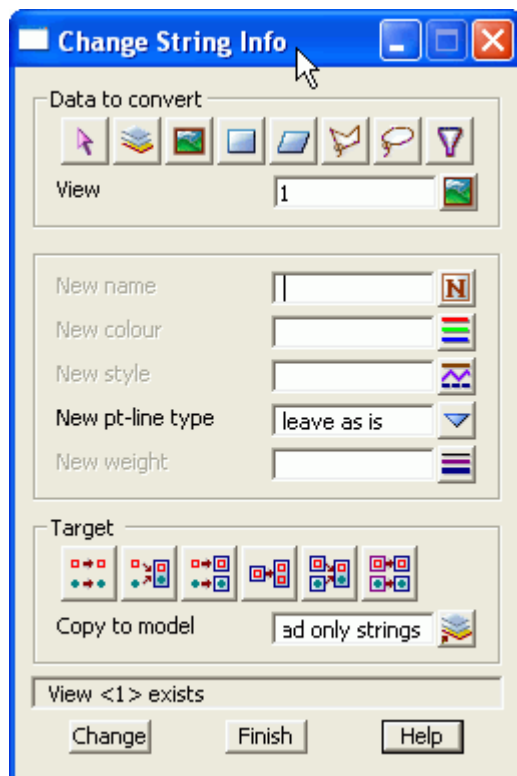
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14.3 Create a Roads Only Tin

The design tin is already nulled to remove the long triangles. If the footpaths were to be excluded from the tin then they should be removed from the road design strings. You could run a template that did not include the footpath and has a **Final Maximum slope width** of zero or just copy the desired road strings to one model and remove unwanted strings. We will use the later techniques.

Add all of the road string and kerb return models onto one view and then select

> **Utilities->A-G->Change**

View select the view that contains all of the road strings

Copy to model type the name of a model for all of the road strings.

Select **Change** copy the strings.

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Select the **Filter** icon at the end of the selection strip. Now select the **Model** tab and select the **Name** of the model that holds all of your road and kerb strings **road strings only** (tab not shown here).

Select the **String Info** tab and enter the name of the strings that you want to remove from the road only model. In this case it is **path.**
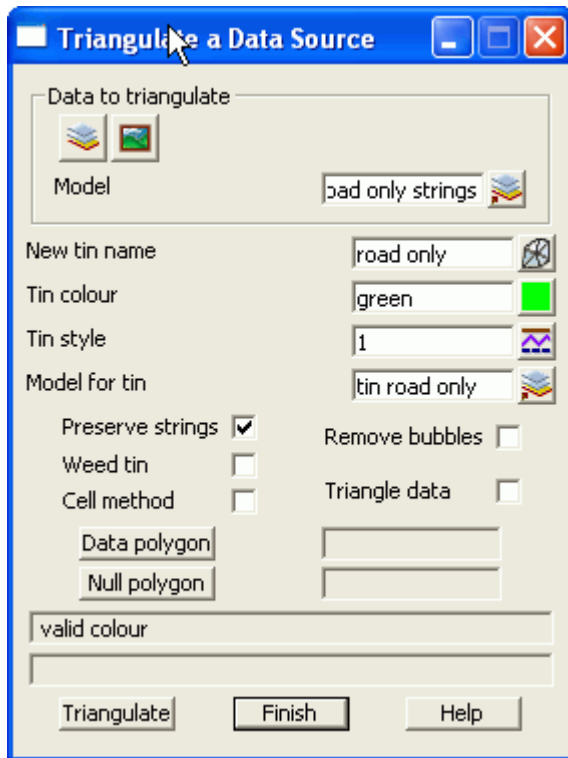
Select **Filter Select** to select these strings.

Select the second **Target** button **Move to model** and select the model **trash** and then select **Change**.

We are now ready to triangulate the road only tin.
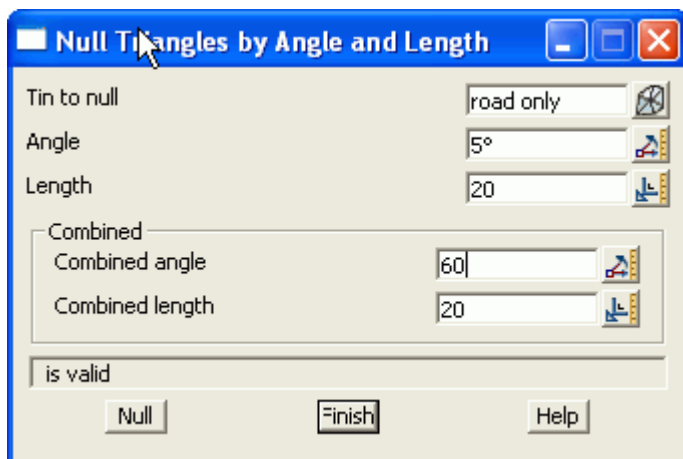
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Select **Tins->Create->Triangulate data**

Model - Select the model containing the road only strings.

New tin name Type a name for the road only tin.

Select **Triangulate**

Remove the long exterior triangle by selecting **Tins->Null->by angle/length**.

Tin to null select the road only tin.

Length select a value slightly greater than the road width (you may have to manually null a few triangles near the intersections)

select **Null.**

14.4 Use the Hatching Feature in Drainage Longsections

We are now ready to create the drainage longsection plots. Set up a section view with the a string in the drainage model profiled, the vertical exaggeration set, the desired tins displayed and the service models added. From the main menu select,

**Design->Drainage-Sewer->Plots->Longsections**

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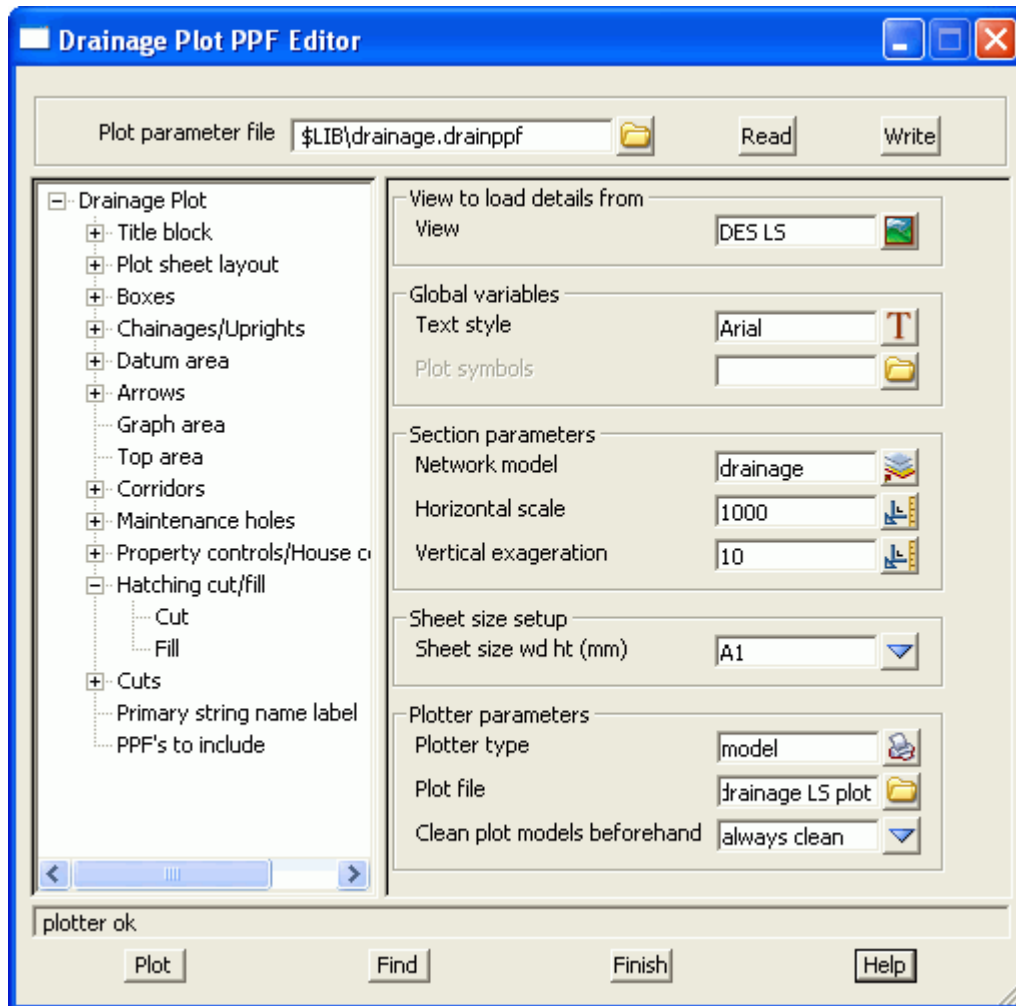
From the **Plot parameter file** field select a drainage longsection ppf from the library and then select **Read.**

In the **View to load details from** field select the section view you have setup for the drainage long section.

Now select **Hatching cut/fill**

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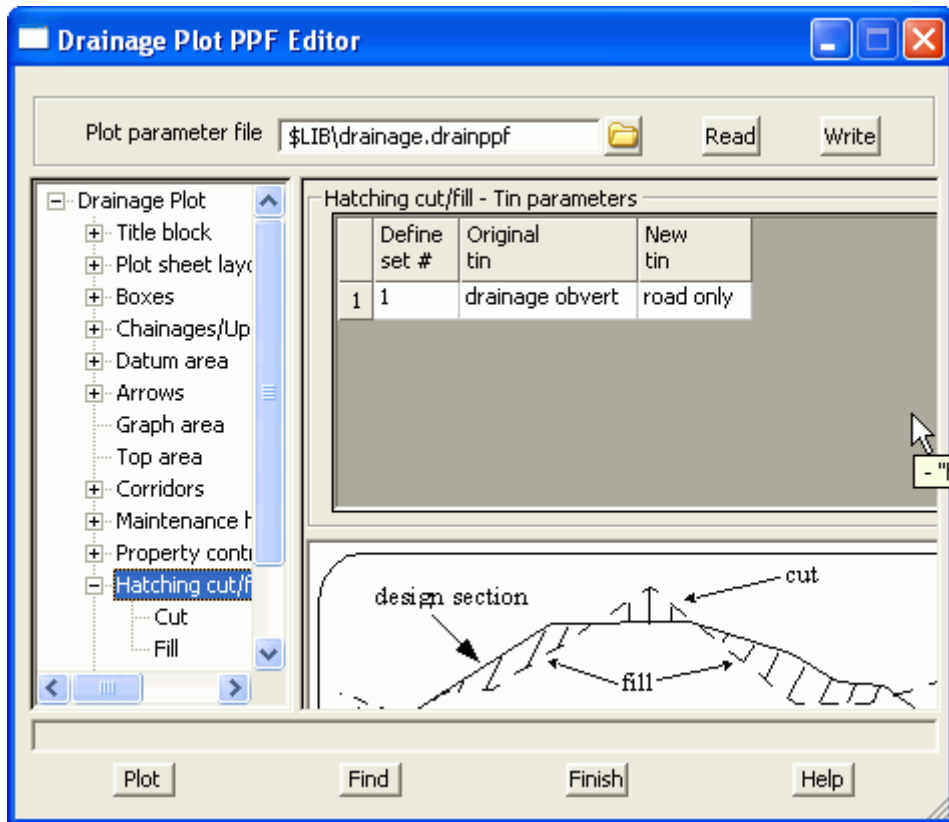
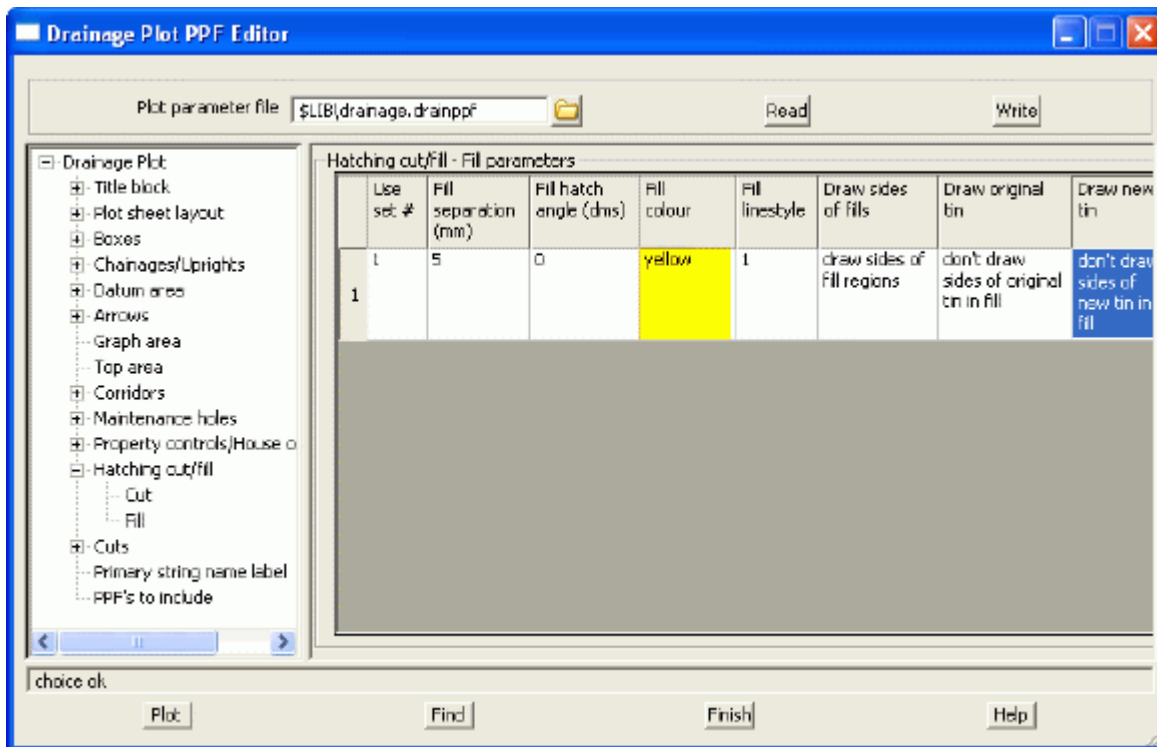**Define set** is set to 1.

Original tin is set to the obvert tin.

New tin is set to the road only tin.

Now select the + beside the **Hatching cut/fill** and then select **fill.**
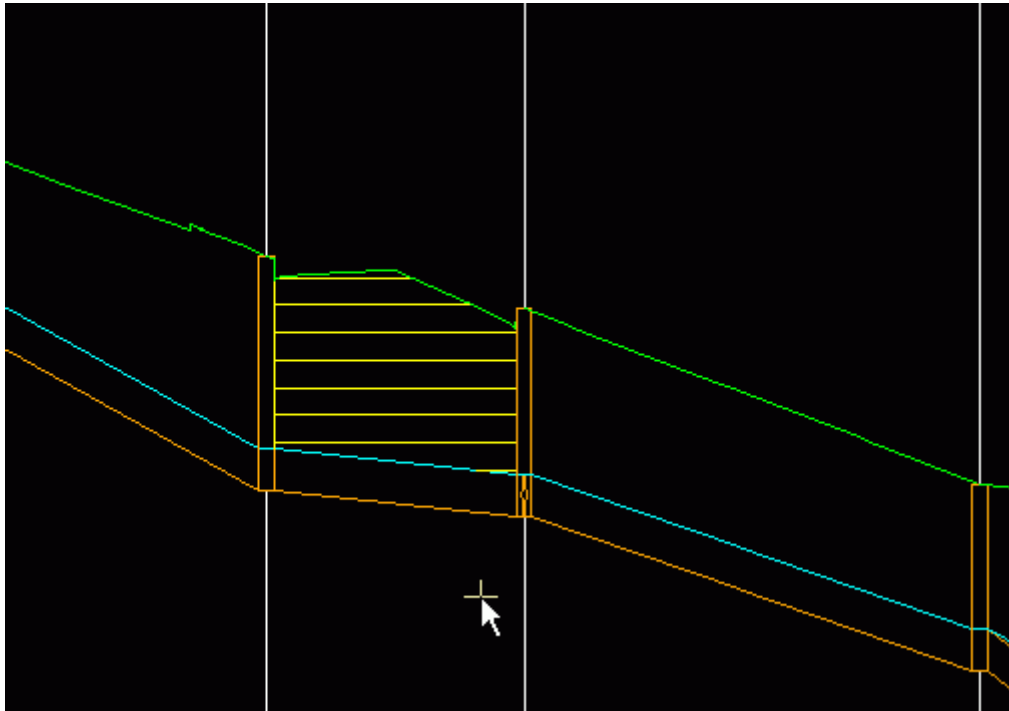
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Use set # is entered as 1. **Fill separation, hatch angle, colour and linestyle** selected as desired. **Draw sides of tin, Draw original tin** and **Draw new tin** are not required unless you want these extra line in the drawing.

Select **Plot** and add the plot model **drainage LS plot1** onto a PLAN view to preview the drawing.

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The hatching is shown to the left at a 2mm spacing with the tins and sides not drawn.

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15.0 The drainage.4d file

The drainage.4d file controls many of the settings for the pit and pipes types inside 12d. This section details the format of the drainage.4d file. Changes to this model take effect only after 12dmodel has been restarted.

The original **drainage.4d** file is found in the "program file\12d\12dmodel\7.00\set_ups" directory. **Do NOT** change this file. Copy it into "program file\12d\12dmodel\7.00\user" directory and edit it there. Files in the user directory are used by preference and they are never over written by a 12d update.

```
 Manhole "SA2" {// internal pit size data (width, length)
//SIZE   100, 200
//DESC  "2m lintel - grate and side entry"
// pit inlet capacities from Mathematical Description of Pit Entry Capacities Feb 1992
//     cross fall,  gutter grade,  cap1,  cap2,  cap3,  cap4
//4d      1,        1,       0,     0,    0.230, .621
//4d      1,        3,       0,     0,    0.225, .604
//4d      1,        5,       0,     0,    0.215, .577
//4d      1,        7,       0,     0,    0.200, .538
//4d      1,        9,       0,     0,    0.235, .593

//4d      3,        1,       0,     0,    0.495, .819
//4d      3,        3,       0,     0,    0.270, .568
//4d      3,        5,       0,     0,    0.290, .599
//4d      3,        7,       0,     0,    0.400, .727
//4d      3,        9,       0,     0,    0.330, .649

//4d      5,        1,       0,     0,    0.540, .793
//4d      5,        3,       0,     0,    0.480, .747
//4d      5,        5,       0,     0,    0.460, .744
//4d      5,        7,       0,     0,    0.450, .729
//4d      5,        9,       0,     0,    0.420, .704
```

The format of the entries is a follows.

1. All lines are to be blank or begin with //. This is not the normal 12d convention.

2. //SIZE indicates the values to be read and stored in the user defined pit attributes
   pit internal width and **pit internal length** when the pit schedule macro is run. A comma is used to separate the two values.

3. //DESC indicates that the following quoted text will be read and stored in the user defined pit attribute **pit type description** when the pit schedule macro is run.

4. The pit inlet capacity table data must begin //4d and commas are used to separate the data (comma delimited).

5. SAG pit names must begin with the 3 letters SAG.

6. The sample data provided is taken from the paper, "Mathematical Description of Pit Entry Capacities", Feb 1992, by Geoffrey O'Loughlin *et al.*

15.1 Pit Inlet Capacities

The pit inlet capacity tables contained within the **drainage.4d** file are used by the drainage design packages in different ways but with a common philosophy. An example entry may be found in the section "The drainage.4d file" on page 62

15.1.1 On grade pits

Crossfall data must never decrease moving down the table while the gutter grade data must increase for a constant crossfall. When the tables are being read, the next set of capacity factors will not be used until the crossfall and grade are equal to or exceed the values in the tables. The factors are not interpolated!

Drains and ILSAX

The cap1, cap2, cap3 and cap4 values are used to describe the inlet capacity of the pit as described in their user manuals.

RAT-HGL

If cap2, cap3 and cap4 are all equal to zero then a fixed inlet capacity equal to cap1 will be exported to RAT-HGL. If the sum of these three values is greater than zero then a pit type will be created in the format of **pit_type-crossfall-roadgrade**. For example SA2-3-2 for a SA2 pit with a road crossfall of 3% and a road grade of 2%. A rating curve with this name will have to exist inside RAT-HGL. 12d has no way of transferring the rating curve itself into RAT-HGL.

PC Drain

Similar to RAT-HGL, PC Drain has it own rating curves defined internally. The road grade is sent as a separate piece of data to PC Drain so that the pit inlet capacity may be determined.

15.1.2 SAG Inlets

Sag inlets always have a manhole type that begins with the three letters SAG or for PCdrain they end in a S. Sag pits contain only one line of data and an example follows.

```
Manhole "SAG3" {
// pit inlet capacities from Mathematical Description of Pit Entry Feb 1992
// if zeros are entered Sc1 and Sc2 then calculated crossfalls (if available) are used for Drains
and ILSAX
// Sc1 and Sc2 and the slope upstream on the overflow path is used for Sl1 and Sl2
//      Sc1 ,     Sc2    ,   Sl1  ,  Sl2 ,  lintel length,  max depth
//4d     3.0,          3.0,     0.5,    0.5,             3,       .150
}
```
Special conditions exist for each of the following programs.

Drains and ILSAX

RAT-HGL, RAT 2000 and XP SWMM

No direct means of specifying SAG pits has been established. A fixed inlet capacity before bypass

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begins can be calculated and entered with the format of an on grade pit. Cap1 would represent the inlet capacity with cap2,cap3 and cap4 being set to zero.

PC Drain

PC Drain places a suffix code in the pit type to specify that the pit is a SAG pit. For example an 9S0.03 indicates that pit type 9 is a sag pit and the maximum depth before bypassing is 30mm.

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16.0 Flooded Width Analysis and HEC RAS

The Calculate Flooded width procedure creates cross sections along the **bypass flow** paths and then calculates the flooded width at each section using Manning's normal depth calculations. A HEC-RAS project (same name as the bypass flow string) is also created for each line. The flooded width is indicated on each section as a blue line if it is less than a user defined width and a red line if the flooded width exceeds the limit. Details of the calculations such as the velocity, depth, wetted perimeter and slope can be exported to a spreadsheet for further analyse (velocity times depth calculations for example). The discharges imports from the urban stormwater design packages are shown in the following table.

Design Program	Discharge Event
PCdrain	Minor ARI
Drains	Maximum flow event analysed
ILSAX	Maximum flow event analysed
RAT HGL	First return period analysed

The user defines the length of these sections and the interval at which they are to be spaced. 12d calculates the normal flow depth interpolating the pit approach and bypass flows from the hydrology models (ILSAX, Drains, PC Drains or RAT HGL). The cross sections are taken perpendicular to the flow line and the slope is for the normal depth calculations is determined using the distance along the flow line and the change in elevation between the two lowest points in the primary flow channel. The flow line need not intersect the low points on the section but the flow line does mark the primary flow channel. If the depth of the flow exceeds the banks of the primary channel, then all adjacent flow channels will be considered as active flow area.

## 16.1 Limitations where overland flow lines join

Where overland flow lines converge at a manhole, 12d does not know the flow split between the 2 approaching paths. Therefore, 12d uses the total flow from all lines as the flow at the manhole for each line. This may overestimate the flooded width along the flow lines at these points.

16.2 Limitations at SAG pits

The flow width are not shown adjacent the sag inlets. The depth of flow due to ponding and the approach flow coming from several directions may overestimated flooded width in these areas. Therefore not flood depths are calculated approaching SAG inlets.

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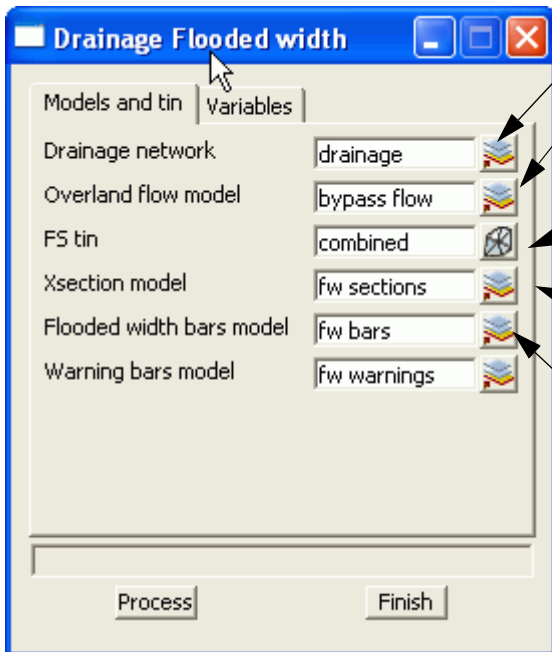
Enter the drainage network model.

Enter the bypass flow model.

Enter the model that will contain the actual flooded width lines.

Select the tin that will be used to create the cross sections.

Enter the model that will contain the cross sections. The calculated values such as velocity and slope are stored with these lines.

The flooded width will be drawn in blue in the **results model** when it is less than the **Max flooded width** (Variables tab). If the flooded width exceeds this value it will be drawn in red.

If warnings are give for a section a yellow bar will be placed in this model.
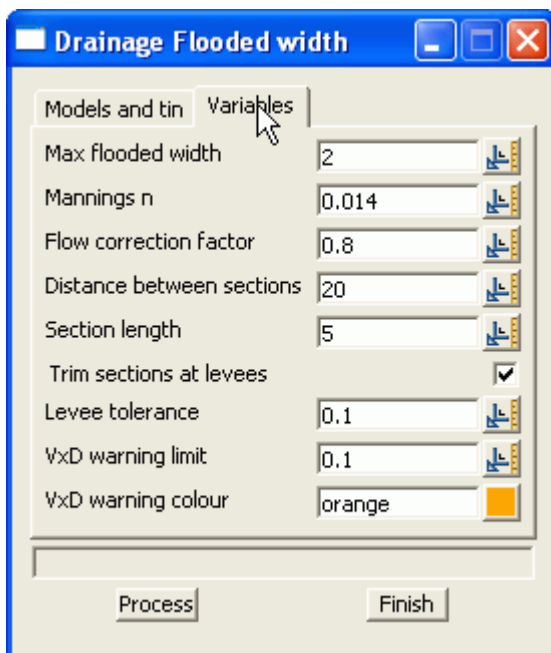
Max flooded width is the limit where the blue flooded width bars turn red.

Manning's n is the n value to be used in the normal depth calculations.

The **Flow correction factor** is the factor described in ARR 1987 for calculating depths of flow in gutter channels.

Distance between sections specifies the interval at which cross sections and therefore flooded width will be calculated along the flow path.

Section Length defines the length of each cross section. The cross section will be centred on the overland flow path.

Trim sections at levee is used to create a cross section that stops at the crest on either side of the flow channel. A levee point is the crest in the cross section found as you move away from the flow line location. If a levee point is encountered then the section is trimmed here.

Levee tolerance is the amount the cross section needs to drop as you move away from the centre line in order to call this local crest a levee.

VxD warning limit is the velocity times depth limit that when exceeded will cause a flooded width

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bar to be generated in the **warning bars model**.

VxD warning colour is the colour of the bars mentioned above.

Process will always clean the sections, string and warning bars model before process.

Summary Tables

The hydraulic calculations and warning messages are stored as string attributes on the flooded width bars. If these attributes are exported to a spreadsheet via the clipboard a summary table my be created. To copy these attributes to the clipboard select

File IO->User->String attributes-properties to/from clipboard
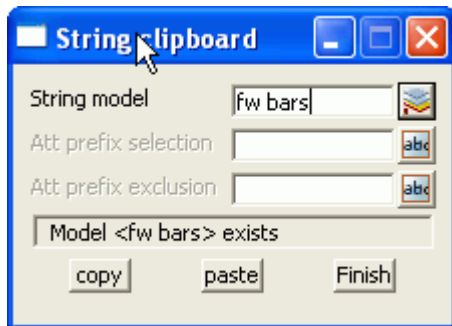
The **string model** may be either the flooded width bars or the warning bars. Both models of strings contain attributes on the strings.

The prefix selection and prefix exclusion are filters for reducing the number attributes that are exported to the clipboard.

16.3 Cross Sections, Discharges and Warnings

The analyse flooded width will proceed along each flow path and identify every pit on the line. Cross sections will be constructed in the model with the length and interval entered in the input dialogue. These cross sections may be plotted using the main menu selection
Plot=>X plot=>X plot. The **Sort Sections** must **not** be selected for these sections to be plotted.

Discharges will be determined for each cross section by linearly interpolating the discharge using distance between the pits. The bypass discharge (pit attribute - calculated bypass flow) will be taken from the upstream pit and the approach discharge (pit attribute - calculated approach flow) from the downstream pit.

The slope is calculated by subtracting the lowest points nearest to the centre line and dividing the cross section separation. The levee tolerance is NOT used for locating this point thus any rise in section moving away from the centre line marks the end of the low point search in that direction.

12d will give warning messages in the output window when it encounters the following conditions and these messages will be stored as string attributes on the flooded width strings. Descriptions of these messages follow.

Inverts do not go downhill

12d locates the lowest point (adjacent to the flow line without moving over a local crest) on each cross section to calculate the slope between the cross sections. This message indicates that the downstream minimum elevation is higher than the upstream minimum elevation.

Sometimes flow lines will go uphill. If you have specified an overflow from a SAG location then

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the flow line will go uphill until it crosses the overflow crest.

If the flow line is not supposed to be going uphill at this section, check to see where the flow line intersects the cross section located upstream of the one identified in the warning message. If it is in a local sag point that is not the lowest point on the section, move the flow line.

The program will use a slope of 0.5% to calculate a width at this location. This results in very wide flooded width sections to draw the user's attention to the problem area.

Vertical Walls Assumed at the Ends of the Cross Sections

If the depth of flow exceeds the ground surface elevation at the ends of the cross section a warning message the warning message shown above is shown. The cross sections causing the warning follows.

The vertical wall is placed at cross section chainage –20. Note that the flow line is always at chainage 0

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17.0 Drainage Overflow Areas from Volumes

This option is used to graphically display the overflow storage volume at a sag pit. The following pit attributes must exist for the flood extents to be calculated.

overflow volume	value greater than zero required.
sag pit	must be equal to 1.
catchment model id	set by labelling catchments
catchment string id	set by labelling catchments

The maximum storage volume is read from the drainage pit attribute "overflow volume". This may be entered manually using the **Attribute Editor** or it will be created when data is read from the drainage design programs Drains or XP SWMM design programs.

This routine locates the lowest point on the catchment string by draping the string on the tin specified and adds the overflow limit specified to this value. This becomes the **overflow limit.**

The volume at this level is calculated and the compared to the **overflow volume** read from the user defined attribute.If the overflow volume is less than the volume in the catchment then the routine iterates to find the flood level for the overflow volume.

If the overflow volume is greater than the volume in the catchment, the results depend on the **Use overflow limit** tick box.

If the box is selected, the **overflow limit** (calculated above) is reported at the flood level in the catchment.

If the tick box is not selected the routine iterates to find the flood level where the storage equals the **overflow volume** read. This option allows the user to see the maximum flood level should the catchment low point become blocked.
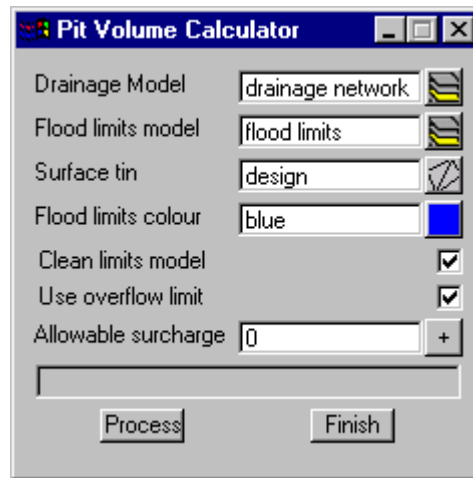
See Also

Drainage overview

Usage

This panel is accessed from the menu selection **Design => Drainage Sewer => More=>Calc pit overflow areas**

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The fields and buttons used in this panel have the following functions.

Field Description	Type	Defaults	Pop-Up

Drainage model — model box

all pits in this model that have a non zero "overflow volume" and "sag pit" set to 1 will be processed

Flood limits model — model box

flood limits strings will be created in this model

Surface Tin — tin box

ground surface tin used to calculate the volumes and flood limits

Flood limits colour — colour box

flood limits strings will be created using this colour

Clean limits model — tick box

*if selected all strings in the **Flood limits model** will be deleted before the calculations commence.*

Use overflow limit — tick box

*if the elevation calculated from the storage volume is higher than the lowest point on the catchment string then the **allowable surcharge** value below will be added to the lowest point on the catchment string and this elevation will be used to determine the flooding limits*

Allowable surcharge — real box

*this value is used only if **Use overflow limit** is ticked. Its purpose is described in the field above.*

Process — button

executes the option.

Finish — button

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removes the dialogue from the screen

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