

Pipe Design Bypass Method

Introduction

This command is used to set the way Bypass is treated with respect to Pipe flow. There are three (3) methods, along with the ability to change the method on existing networks.

Bypass flows have always been calculated for pits and are reportable items.

The **Top Pits Only** option, forces all catchment runoff into the downstream pipe, with the exception for Top Pit, where the pipe flow is based on the Pit Inflow. In others words bypass flows are ignored when designing pipes.

The two (2) other options are provided to better treat these bypass flows - **Linear** and **Exact**. These methods are the same, expect for the time calculations. For larger networks, **Linear** should produce faster results as the User can enter the time interval.

The two different options can best be portrayed with the following figures.

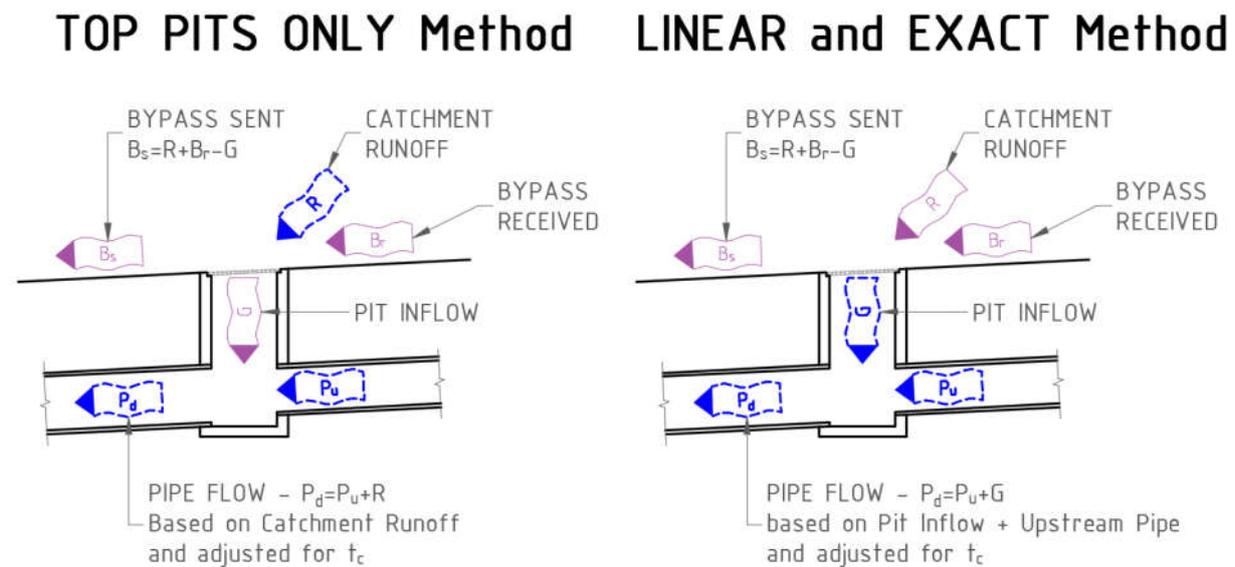


Figure 1

Where P_u equals the sum of all upstream catchment runoff.

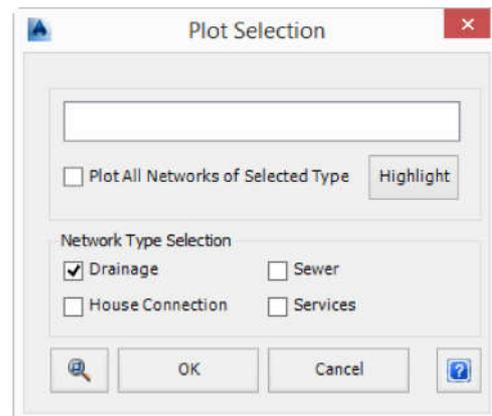
Figure 2

Where P_u equals the sum of all upstream pipe flow.

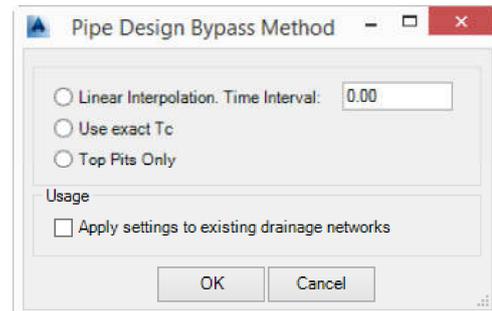
The critical information from this document has been included in the ARD Pipe Help system.

Details

Upon selecting this command, the User is prompted to select a (existing) drainage network. A single network can be picked from the screen or the list window or all Drainage networks can be picked from the list in the window provided the “Plot All” boxed is checked.

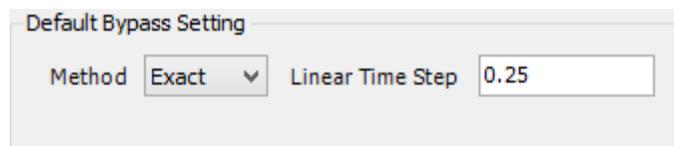


After a network has been selected the Pipe Design Bypass Method window will appear, the User then must select one (1) of the three (3) methods and choose whether to apply it to an existing network(s). After picking Okay, the Method chosen is then set for all **new** networks and if the apply Usage option was selected, then it will affect those ‘existing’ network(s) as well.



An explanation of each item is provided on the next page.

The Method can also be found on the Active Network Settings > Drainage > Design Settings tab, lower right on the form. This allows for the Method to be set prior to the creation of any drainage network.



Again, Pit flows are not affected by this command. This command only affects Pipe flows.

Method

Three (3) Methods of setting bypass are provided. **Linear** and **Exact** are essentially the same, with the only difference being the time calculation applied. Note once a method has been set by this command, the method chosen will be applied to all new drainage networks created. To change the method on existing networks, refer to the Usage section below.

Choosing between **Linear** and **Exact** will need to be considered on a job-to-job basis and is at the discretion of the User.

LINEAR INTERPOLATION

Selecting this method, the user is required to enter a Time Interval in minutes. The software will pre-calculate the bypass flows between the minimum and maximum times of concentration set, with the interval specified. As the bypass flows are pre-calculated, this method should produce faster results on larger stormwater networks.

USE EXACT T_c

When this method is used, the exact time of concentration is calculated each and every time it is needed. With complex bypass and pipe configurations, this could result in some performance issues. Should this 'lag' be considered excessive to the User, perhaps the **Linear** method should be used.

In both the **Linear** and **Exact** methods, downstream pipe flow is based on the Pit Inflow only plus any upstream pipe flow. Bypass flows are sent to the nominated pit and may enter the next pipe based on that pits rating curve.

TOP PITS ONLY

This method is the original method for treating bypass and was applied to all stormwater networks.

For the first (top) pipe of any branch that has surface flow only, without receiving any bypass flows, the pipe flow will match the pit inflow.

On any other pit, all of the surface flow (catchment runoff) excluding any bypass flow received, becomes the adopted pipe inflow. Should the pit generate a bypass flow, this bypass flow is passed onto the nominated pit, however this bypass flow is ignored and forced into the pipe. That is bypass flows are ignored from the pipe's point of view, but not from the pit calculations.

This may produce a conservative pipe size for some and undersized on others.

Usage

APPLY SETTINGS TO EXISTING DRAINAGE NETWORKS

This option allows the User to change the bypass method for existing network(s). The method selected above will be applied to those networks selected when the command was started.

OK

Select this to apply the method and usage selected.

Cancel

Select this to cancel out of the command.

Example

To demonstrate the difference in the three (3) methods, a simple network will be used.

Consider a linear system of pits and pipes, with bypass to the next downstream pit following the pipe, as shown in Diagram 1 below.

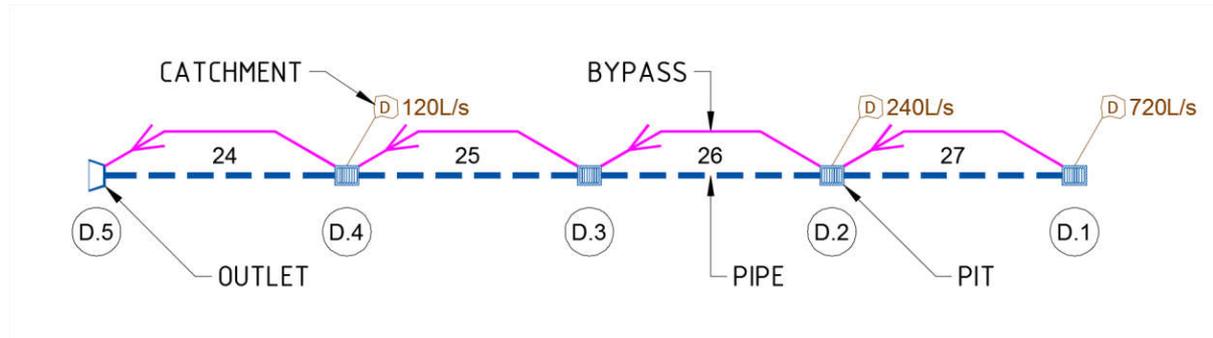


Diagram 1 – Network Configuration

The pits have been created with a capture rate of 50% and three (3) catchments have been applied with a total surface runoff of 1,080 L/s. A pipe size of 900 mm diameter at 2 % was set for all pipes and each pipe reach is 50 m long.

Pits and resultant bypass flows are as follows:

Pit	Runoff	Bypass From	Bypass Received	Total	Inflow	Bypass Sent	Bypass To
	L/s		L/s	L/s	L/s	L/s	
	[1]		[2]	[3]=[1]+[2]	[4]	[5]=[3]-[4]	
D.1	720			720	360	360	D.2
D.2	240	D.1	360	600	300	300	D.3
D.3	0	D.2	300	300	150	150	D.4
D.4	120	D.3	150	270	135	135	D.5
D.5	0	D.4	135	135			

Table 1 –Pit Hydrology – Runoff, Inflow and Bypass

This table can be produced by ARD and is the same for any Method selected.

It can be seen that the bypass is sent to the respective pit and the pit inflow is calculated from the combination of surface runoff and bypass received. *Note: The above table does not account for time of concentration effects.*

As mentioned, this new function affects the flow used in pipes based on the Method selected. Results from the three (3) methods are shown below.

Method	Unadjusted for t_c		Top Pit		Linear		Exact	
	Pipe Inflow	Sum of Pipe Flow	t_c	Flow	t_c	Flow	t_c	Flow
Pipe	L/s	L/s	min	L/s	min	L/s	min	L/s
27 (D.1-D.2)	360	360	5.00	360	5.00	360	5.00	360
26 (D.2-D.3)	300	660	6.51	931	6.51	640	6.51	640
25 (D.3-D.4)	150	810	7.09	920	7.35	772	7.35	772
24 (D.3-D.5)	135	945	7.68	1022	8.05	887	8.05	887

Table 2 – Pipe Hydrology – Results from 3 Bypass Methods.

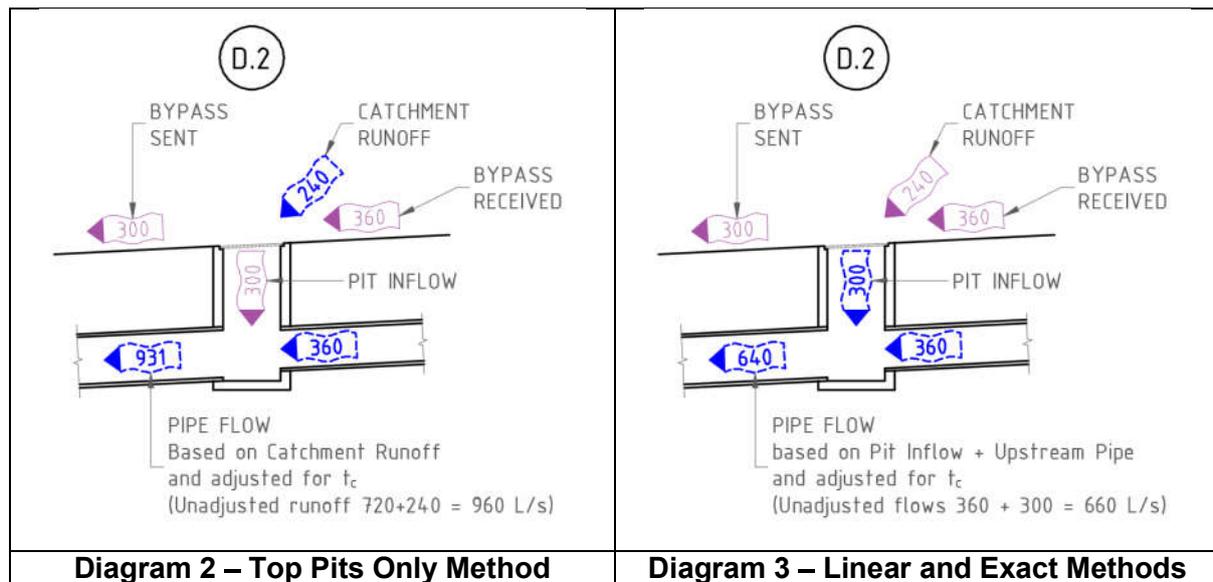
The **Unadjusted for t_c** group indicates what the expected flow is in each pipe, based purely on the pit inflow ignoring any time of concentration changes at all pits, from either catchment overland flow times or pipe travel time. This could be considered as the peak flow, and is shown here for ease of comparison purposes only and is not part of any method.

Referring to the **Top Pit** group, it can be seen that the first pipe flow has a flow of 360 L/s as expected. The second pipe though has a flow of 931 L/s, which is larger than the **Unadjusted** value of 660 L/s. This flow is based on the sum of upstream catchment runoffs of 720 and 240, or 960 L/s and when recalculated to the t_c for the downstream pipe drops to 931 L/s. Again, with the **Top Pit** method, all the pipes, other than from the Top Pit, are assumed to accept ALL the catchment runoff.

From both **Linear** and **Exact** groups it can be seen they produce similar results to each other, and the flows gradually increase going downstream. The increase being the attributed to the pit inflows, based on the runoff and bypass received at the respective pit. These flows are generally consistent with the Sum of Pipe Flow. The difference between these flows is due to the influence of the travel time within the pipes. This pipe travel time adds to the time of concentration and effects the pipe times only. Pipe travel time does not affect Pits. Again, with the **Linear** and **Exact** Methods the inflow to the pipe is based on the inlet capacities, which in this example is reducing the pipe flows. The missing flow in the last pipe (887 vs 1080) is mainly due to the bypass of 135 L/s from the last pit being directed to the outlet and time of concentration effects.

To better illustrate what occurs at the second pit “D.2” in each method, please refer to Diagrams 2 and 3. Please note that the flows show have not been adjusted to account for changes in times of concentrations. Hence the downstream pipe flow, do match the sum of upstream flows. Unadjusted flows are shown for comparison only.

It should be noted that these diagrams represent the typical scenario for all pits in a drainage network, except for the first pit. Should the first (top) pit on any branch just receive catchment runoff (that is no bypass flows), the downstream pipe flow equals the pit inflow flow. When the first (top) pit on any branch does receive bypass flows, it behaves similar to that shown in Diagrams 2 and 3, except there are no upstream pipe inflows to consider.



Note: The flows in the above diagrams do not account for time of concentration effects.

It can be seen that there is a slightly a different time of concentration for each method. The pipe travel time is based on the flow in the pipe. As the pipe size and grade have been fixed or set in this example, a smaller pipe flow results in a lower velocity and hence a slower travel time. *Note: Pipe travel times are also affected by the setting for velocity being calculated on Pipe Full or Partial (Flow) Area. In this example Pipe Full was set.*

This example is used for explanation purposes, in a typical subdivision, the large flows and bypassed shown should not be expected.

Conclusion

From the information provided and the example shown, it can be seen that the bypass methods result in different flows in the pipes. The purpose of this document is to provide information for the User to assess each method and therefore select their preferred method on a case-by-case basis. We would suggest that the **Exact** or **Linear** method better represents what is expected, compared to the **Top Pits** method.

Special Note – Specified Inflows

Specified Inflows are also affected by the Bypass Method selected. Specified inflows can be directed to Pipe Only, Pit and Pipe or Pit Only (No pipe flow). A simplex matrix of the interaction between them is shown in the table below.

	Top Pits Only	Linear or Exact
Pipe Only	Adds to Pipe	Adds to Pipe
Pit and Pipe	Adds to Pit and Pipe	Do Not Use
Pit Only (No Pipe)	Adds to Pit Flow, but NOT Pipe flow	Adds to Pit, then Pipe based on Pit Capacity

Diagrams of the above interaction can be found in the ARD Pipe Help system.