Design Priorities

Unfortunately, it is not always possible to automate a design that meets all desired constraints. With this in mind, there are certain priorities that are considered when the automated design is performed. These priorities are in place to try to minimize the effect on existing portions of the system while providing appropriate capacity in the designed pipes.

While this sequence does not go into complete detail regarding the design process, it does indicate the general priorities for the automated design. The priorities, of course, only deal with elements that are being designed. If a pipe has fixed inverts or is not to be designed at all, some or all of these criteria obviously do not apply.

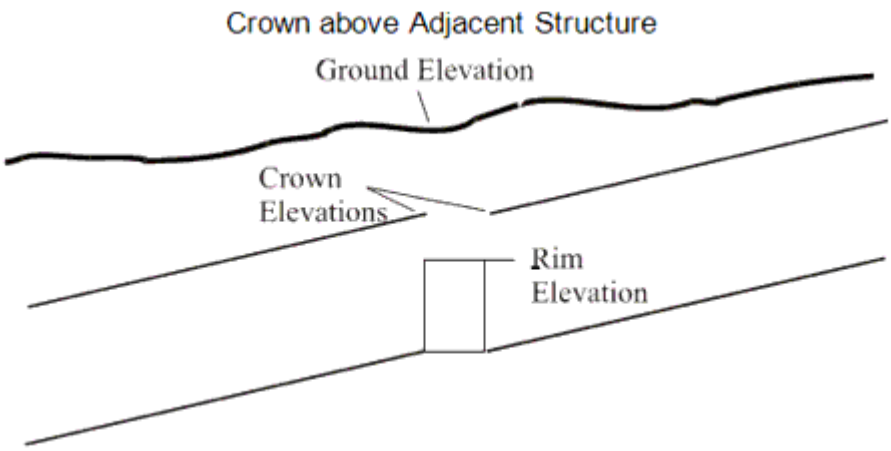
A Designed Pipe Should Fit within Adjacent Existing Structures

If a pipe connects to an existing structure, the pipe rise should be completely within the existing structure. The only time this may be violated is if there are no available section sizes that would not violate that condition (i.e., the existing structure height is so small that all available pipes have rises too big). In this very unlikely condition, the smallest available section size will be selected, with the invert elevation placed at the bottom of the structure.

A Designed Pipe Should Not Have a Crown Above an Adjacent Designed Structure

Where pipe inverts are fixed, it is possible that the required section size would cause the pipe crown to be higher than the top elevation of an adjacent designed structure. If all available pipe section rises are greater than the depth of the pipe invert, the smallest pipe size will be chosen.

Note: **This situation will only be encountered in situations where the structure's top elevation is set equal to the ground elevation - otherwise, the structure will be designed with a higher top elevation.**



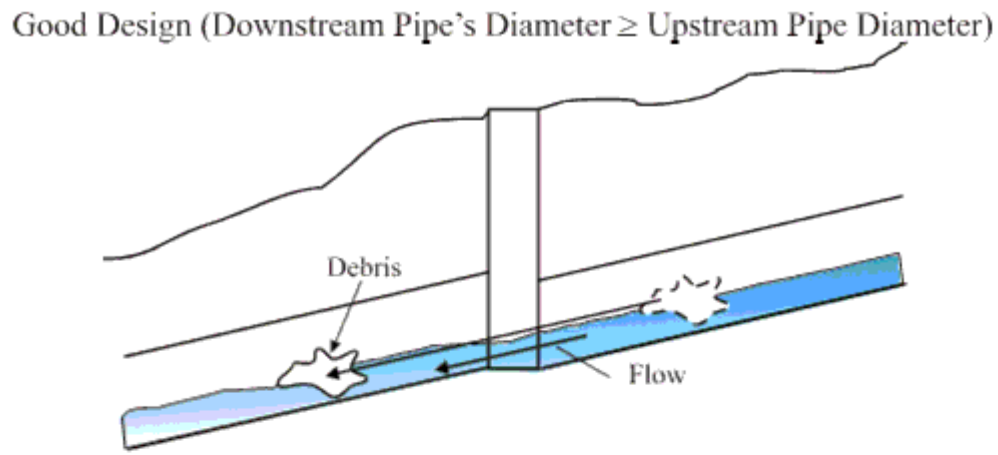
Pipe Capacity Should Be Greater Than the Discharge

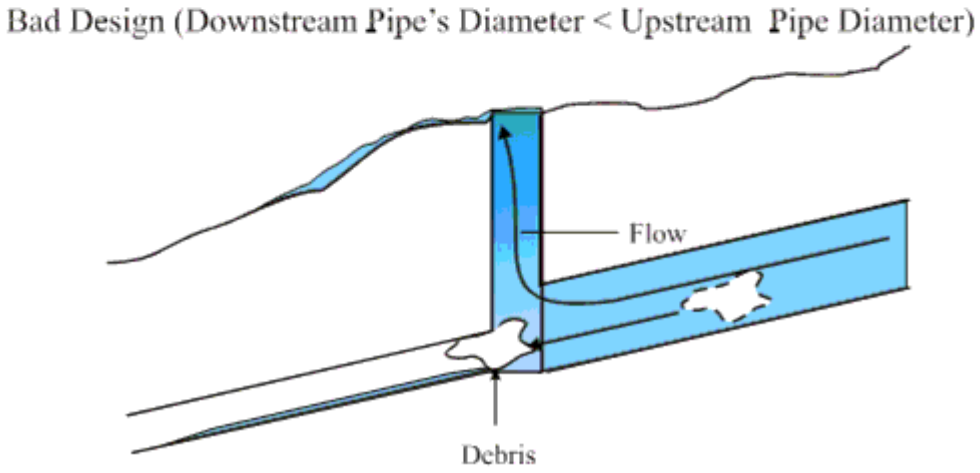
If the pipe is not limited by adjacent structures, the pipe should be sized such that the design capacity is greater than the calculated discharge in the pipe. The design capacity may be based on one or more pipes, flowing full or part-full, depending on user-set design options. If site restrictions or available section limitations result in a situation where no sections meet the required capacity, the largest available size and number of barrels will be chosen.

Downstream Pipes Should Be at Least as Large as Upstream Pipes

Designs typically avoid sizing downstream pipes smaller than upstream pipes, regardless of differing slope and velocity requirements. One of the primary reasons for this is debris that passes through the upstream pipe could

become caught in the connecting structure, clogging the sewer.





Pipe Matching Criteria Downstream Should Be Met

Whenever possible, the designed pipe should have its downstream invert set such that the pipe meets the matching criteria, such as matching inverts or crowns. Note that because of higher design priorities, such as the pipe fitting within existing structures, the matching criteria may not always be met.

Minimum Cover Constraint Should Be Met

Pipe inverts should be set such that the upstream and downstream crowns of the pipe are below the ground elevation by at least the amount of the minimum cover. Note that higher design priorities, such as existing structure locations and matching criteria, may prevent the minimum cover constraint from being met.

Pipe Matching Criteria Upstream Should Be Met

The upstream invert of the designed pipe should be set to meet the matching criteria of the upstream structure. Higher design priorities, such as minimum cover constraints, may result in a pipe that does not match upstream as desired.

Maximum Slope Constraint Should Be Met

Wherever possible, the designed pipe should not exceed the desired maximum slope. In some situations, elevation differences across the system may result in a case where a drop structure can be used to offset pipes. This is used instead of a pipe that is too steep, or instead of upstream piping that would require much more excavation. Note that the maximum slope constraint may be violated if higher priority design considerations, such as existing structure location or pipe matching criteria, governs.

Other Constraints and Considerations

There are many degrees of freedom when designing a piping system. Several constraints that are not mentioned above, such as minimum velocity constraints and minimum slope constraints, may also result in adjustments to the designed pipe. Other constraints may be too limiting, such as maximum cover constraint and maximum velocity, resulting in designed pipes that could violate too many other constraints.

This wide range of choices and priorities emphasizes the need for careful review of any automated design by a professional. It is not always possible to meet every desired condition, so it is very much the responsibility of the engineer to make final judgments and decisions regarding the best design for the client.

Inlet Design

The length of any inlet can be automatically designed. The available design lengths (standard lengths) for a given inlet are defined in the inlet library, and can easily be changed. The design algorithm uses the same equations used in analysis to determine the minimum available inlet length that meets the design constraints.

Designing Inlets on Grade

Since gutter width and spread are independent of the inlet characteristics, inlets on grade are designed simply to meet the minimum efficiency. If the minimum efficiency cannot be met with any of the lengths, StormCAD will choose the largest of the available lengths.

Designing Inlets in Sag

When designing inlets in sag, the objective is to keep gutter spread and depth below desired maximum levels. StormCAD will choose the minimum available inlet length that meets these constraints. In a case where the constraints cannot be met with any of the available lengths, StormCAD will choose the largest inlet length possible.

Design Steps When Conduit Flow Travel Time Is Considered

After including conduit flow travel time in design (set in the Calculation Options), the design steps for one pipe in design from upstream to downstream will be the following:

a. Calculate flow travel time of non-design pipe if including flow travel time is selected
b. Conduit discharge calculation (Include flow travel time in system Tc calculation)
c. Get conduit minimum size
d. Get conduit maximum size
e. Adjust upstream invert to match upstream minimum cover
f. Adjust upstream invert to match upstream structure (to match matchline offset)
g. Adjust downstream invert to match downstream minimum cover
h. Adjust downstream invert to match minimum slope
i. Adjust downstream invert to match downstream fixed structure
j. Adjust upstream invert to match maximum slope

k. Adjust upstream invert to match fixed structure
l. Adjust downstream invert to match minimum slope
m. Adjust downstream invert to match fixed structure
n. Adjust conduit size for Capacity to match discharge (Calculate conduit flow travel time if including flow travel time is selected)
o. Adjust downstream invert to match minimum velocity
p. Adjust both ends to match Upstream structure(to match matchline offset)
q. Adjust both ends to match upstream minimum cover
r. Adjust downstream invert to match downstream minimum cover
s. Adjust upstream invert to match maximum slope
t. Adjust upstream invert to match fixed structure
u. Adjust downstream invert to match minimum slope
v. Adjust downstream invert to match fixed structure

After designing all pipes from upstream to downstream, we design all pipes from downstream to upstream. For each conduit, we run the following main steps:

a. Adjust downstream structure elevation to match conduit downstream invert
b. Adjust conduit downstream invert to match fixed structure
c. Adjust conduit upstream invert to match maximum slope
d. Adjust conduit upstream invert to match fixed structure
