CHAPTER 15

Designing Pressure Pipe Networks

Now that you have studied gravity pipe networks, it's time to move on to a different type of pipe design: one that involves pipes under pressure. If you're unfamiliar with pipe design, you may be surprised to discover that the design process for gravity and pressure systems is quite different. For this reason, the AutoCAD® Civil 3D® software provides two unique tool sets: one for gravity pipe design and one for pressure pipe design.

Pressure pipe design most commonly refers to water supply lines but it can also apply to natural gas and sanitary sewer lines. These pipelines provide valuable utility services to the new residents of the land you're developing and must undergo extensive design to ensure that they function as intended and integrate well with surrounding features, whether new or existing.

In this chapter, you'll learn to:

- **Understand pressure pipe networks**
- **Create pressure pipe networks**
- **Edit pressure pipe networks**

Understanding Pressure Pipe Networks

Gravity system designs and pressure system designs are quite different and must be addressed using different tools. For a pressure pipe network design to be a success, it must meet the following basic requirements:

- The bends and curves must be constructed according to industry-standard fittings and allowable joint deflections.
- The pipes must be sized according to specific flows and pressures.

- The pipes must be far enough underground to avoid being damaged by freezing or by activities on the site.
- The pipes must not be so far underground that it is cost prohibitive to install them.
- Appurtenances such as valves and hydrants must be included in the design to allow the lines to be controlled, accessed, and maintained.

These requirements relate to three basic types of pressure pipe design components: fittings, pipes, and appurtenances. This chapter describes these components as well as their relationship to each other when represented in a Civil 3D pressure network.

Understanding Fittings, Angles, and Appurtenances

Pressure pipe fittings serve two purposes. The first, like structures in gravity systems, is to enable two or more pipes to connect. For example, a tee or wye fitting provides a connection for three pipes, and a crossing fitting provides a connection for four. The second purpose of a fitting is to create a bend in the direction of the pipeline, the angle of which is typically dictated by manufacturing standards. For example, elbows are commonly available in 90°, 45°, 22.5°, and 11.25° versions. For this reason, bend angles are a big part of pressure pipe design.

In addition to bend angles, a slight amount of deflection is allowed within connections. This deflection angle is part of the design and varies depending on how the pipes or fittings have been manufactured. This allowable deflection also enables a series of pipes to form a curve by providing a little deflection at each joint but without bending the pipes. Therefore, pressure pipes can be laid out on a curve, with the radius determined by the allowable deflection.

Another factor that can be incorporated into the design is the allowable bending radius of the pipes. Bending the pipes is another way a system can be laid out along a curve. The allowable bending radius is a function of the size, material, and manufacturer specifications of the pipe.

Because of available fittings, allowable deflection angles, and allowable bend radius, each bend in a pressure pipe is a design in itself. As a designer, you'll be required to choose the right combination of fitting, deflection angle, and bend radius to make each bend in the pipeline.

Appurtenances are another component of pressure pipe designs. The challenge with appurtenances is that they usually require consideration for human access. For example, a fire hydrant must be properly located at ground level so that firefighters or maintenance personnel can access it.

Understanding Pressure Pipes

Like gravity pipes, pressure pipes are used to convey a substance, but the main difference, of course, is that the substance is moved by pressure rather than gravity. For this reason, elevations aren't nearly as important to ensure adequate flow. They are important, however, to ensure that the pipeline has adequate cover to prevent freezing or physical damage and that it avoids underground obstacles, including other pipes. In the event of a conflict, because pressure pipe flow isn't dependent on elevation, a designer will typically bend a pressure pipe to avoid a gravity pipe rather than the other way around. As discussed previously, the required bends are a design challenge because of the limitations of available fittings and deflection angles.

Exploring the Pressure Network

Civil 3D enables you to create objects that represent fittings, pipes, and appurtenances. It also establishes relationships between these components as well as relationships with other important design elements such as surfaces, alignments, profiles, and profile views. The pipes, fittings, and appurtenances and their associated relationships are referred to as a Civil 3D *pressure network*. In Figure 15.1, a few pipes and fittings are shown in plan view on the left, profile view in the center, and 3D view on the right.

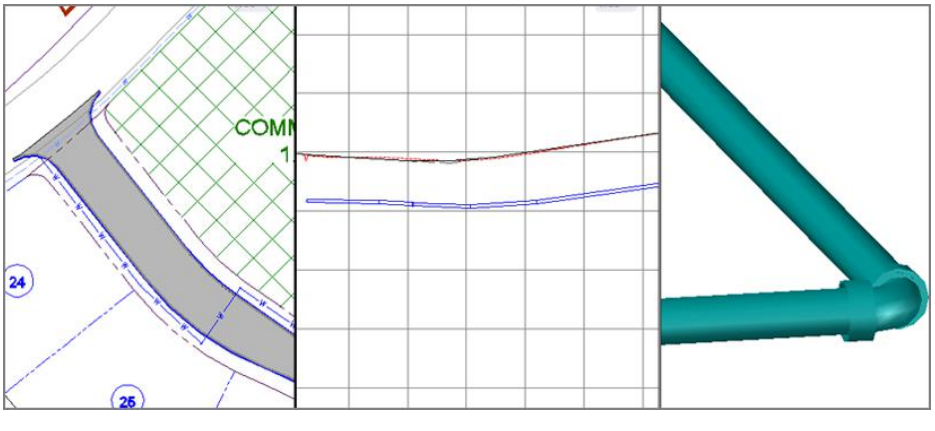


FIGURE 15.1 A pressure network shown in plan view (left), profile view (center), and 3D view (right)

Each component of a pressure network is shown in Prospector beneath the Pressure Networks node. From here, you can right-click each component to access various context commands for it. You can also use the item view at the

bottom of Prospector to edit information about each component. Figure 15.2 shows the contents of a pressure network in Prospector.

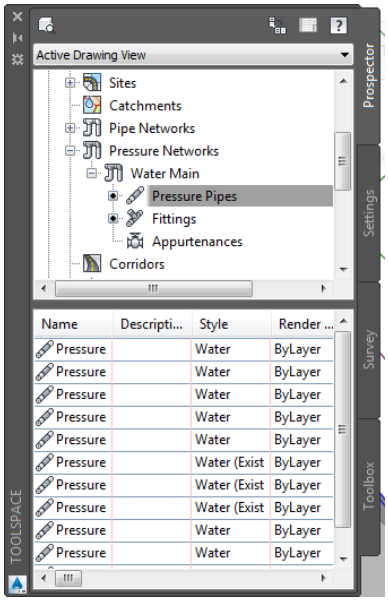


FIGURE 15.2 A pressure network shown in Prospector

Just as in gravity networks, the shape, dimensions, and behavior of a pressure network component are determined by the *part* that represents it. Pressure networks have their own parts lists, separate from gravity networks. Most companies have several parts lists, each one containing parts for a certain type of system such as water, sanitary, or natural gas.

Creating Pressure Pipe Networks

Certification Objective

As with gravity networks, pressure networks can be created in one of two ways. The first is to lay out the pressure network using basic AutoCAD® entities such as lines or polylines and then convert those objects to a pressure network. Another is to create the pressure network using layout tools. One difference with pressure networks is that the layout tools are housed in the ribbon rather than on a toolbar. The specialized ribbon tab (see Figure 15.3) is launched by using the Pressure Network Creation Tools command.

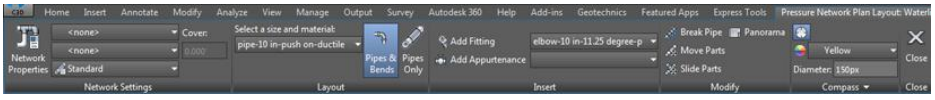


FIGURE 15.3 The specialized ribbon tab for pressure network layout

Creating a Pressure Network from Objects

At times, you'll find it easier to start with AutoCAD commands to sketch your pressure network using basic entities. This approach works quite well because Civil 3D provides a command that converts these basic entities to pressure networks: the Create Pressure Network From Object command. This command creates pipe networks from Civil 3D alignments and feature lines as well. One disadvantage of this method is that the same parts are used for pipes and fittings throughout the entire network.

If you haven't already done so, download and install the files for Chapter 15 according to the instructions in this book's Introduction.

Exercise 15.1: Create a Pressure Network from Objects

In this exercise, you'll create a waterline pressure network along Madison Lane by converting objects in the drawing. You'll also draw that pressure network in profile view.

1. Open the drawing named `Creating Pressure Networks from Objects.dwg` located in the `Chapter 15` class data folder.
2. In the left viewport, note the heavy blue polyline along Madison Lane labeled with W, indicating a schematic location for a proposed waterline.
3. On the Home tab of the ribbon, click Pipe Network ➢ Create Pressure Network From Object.

4. Click the heavy blue polyline, and press Enter to accept the default direction assumed by the command.
5. In the Create Pressure Pipe Network From Object dialog box, do the following:
   a. For Network Name, enter **Madison Lane Water**.
   b. For Network Parts List, select Water Supply.
   c. For Size And Material, select 4 INCH (100mm) DUCTILE IRON.

You may notice that the storm system has been changed to red in the example drawings for this chapter. This is to make it easier to differentiate the storm pipes from the water pipes you'll be creating.

d. For Surface Name, select Road FG.

e. For Alignment Name, select Madison Lane.

f. For Depth Of Cover, verify that 3.000' (1.000m) is the value currently applied.

g. Check the box next to Erase Existing Entity.

h. Click OK.

It may not appear that much has happened, but the polyline has been converted to a 3D model of a waterline, complete with pipes and bends. You can zoom in to the newly created waterline model in the 3D view to examine the result.

6. Click the Modify tab of the ribbon. Then expand the Design panel, and select Pressure Pipe Network.

7. Click Draw Parts In Profile on the ribbon. Click one of the new waterline parts, and press Enter to indicate that you would like to draw the entire network.

8. Click one of the grid lines of the Madison Lane profile view in the top-right viewport. The waterline parts are displayed in the profile view, as shown in Figure 15.4.

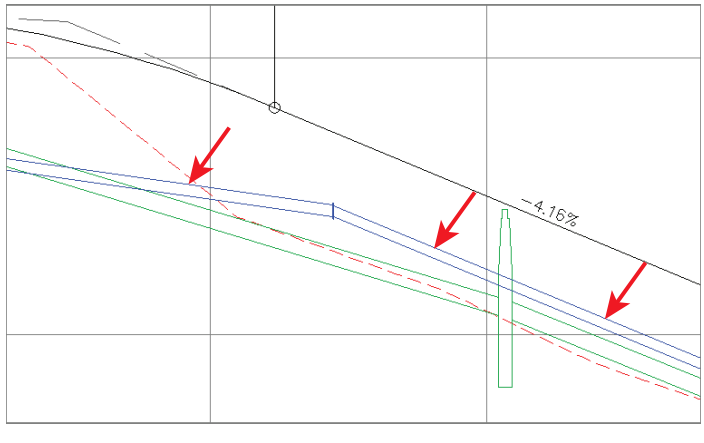


FIGURE 15.4 Pressure network parts (indicated with red arrows) shown in profile view along with other profile information

9. Save and close the drawing.

You can view the results of successfully completing this exercise by opening `Creating Pressure Networks from Objects - Complete.dwg`.

Pressure Networks from Feature Lines

You may have noticed the Use Vertex Elevations option in the Create Pressure Pipe Network From Object dialog box. If you create a pressure network from a feature line, you can use this option to set the elevations of the pipes and fittings based on the elevations of the feature line. You can also choose the reference point that is used when assigning elevations such as Outside, Top, Crown, Centerline, and so on. This is an effective way to convert a rough 3D sketch of a pressure pipe design into a full-fledged 3D pressure network model.

Creating a Pressure Network by Layout

Another way to create pressure networks is using the Pressure Network Creation Tools command. When you launch this command, you will see a specialized ribbon tab (as shown previously in Figure 15.3) that contains tools for pressure network layout. From this specialized ribbon tab, you can choose the pipes, fittings, and appurtenances from the parts list and use the commands on the ribbon to insert those parts into the drawing. You can change parts at any time and apply different types and sizes as you go.

To guide your design, Civil 3D provides a *compass* (see Figure 15.5), which displays the bend angles and deflections available at a given point, based on information stored in the parts list. The compass automatically "snaps" your cursor to an available bend angle to prevent you from laying out a nonstandard bend in the pipeline.

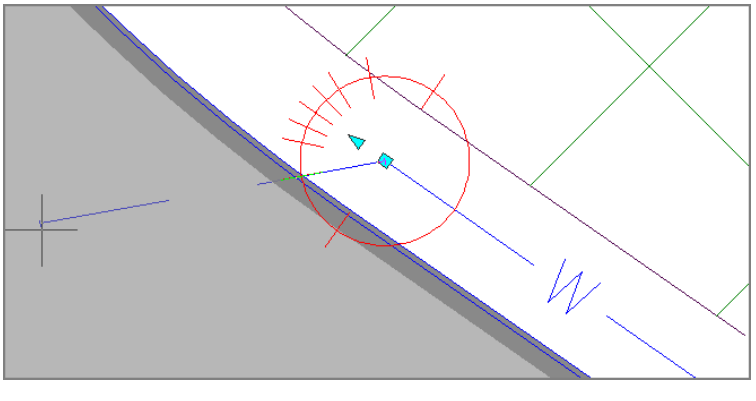


FIGURE 15.5 The compass (the red circle) shows the available bend angles and deflections.

Another fundamental difference with pressure network layout is that you provide a value for *cover*, and Civil 3D automatically sets the elevation at each end of a pipe according to that value. You can change the cover value as you design.

Cover refers to the distance from the top of the pipe to the surface of the ground.

Exercise 15.2: Create a Pressure Network by Layout

In this exercise, you'll use layout tools to begin designing the waterline pressure network along Jordan Court.

If you haven't already done so, download and install the files for Chapter 15 according to the instructions in this book's Introduction.

1. Open the drawing named `Creating Pressure Networks by Layout .dwg` located in the `Chapter 15` class data folder.

2. On the Home tab of the ribbon, click Pipe Network ➢ Pressure Network Creation Tools.

In this drawing, red circles have been provided to indicate the locations of bends.

3. In the Create Pressure Pipe Network dialog box, do the following:
   a. For Network Name, enter **Water Main**.
   b. For Parts List, select Water Supply.
   c. For Surface Name, select Road FG.
   d. For Alignment Name, select Jordan Court.
   e. Click OK.
4. The Pressure Network Plan Layout ribbon tab opens. Do the following:
   a. In the Network Settings panel, enter **4.5 (1.5)** for Cover.
   b. Under Select A Size And Material, select 6 INCH (150mm) DUCTILE IRON.

Notice the compass that appears at point B, which shows the allowable deflection at the pipe joint and restricts the ability to draw the next pipe, to stay in that allowable deflection.

5. Click Pipes Only. Snap to the center of the circle marked A; then snap to the center of the circle marked B.
6. At the command line, click Curve to apply the Curve option. Snap to the center of the circle marked C.
7. At the command line, click Straight to apply the Straight option. Snap to the center of the circle marked D.

A new 90° fitting should be placed at the end of the pipe, but it curves in the wrong direction.

8. On the ribbon, to the right of Add Fitting, select 6 INCH (150mm) ELBOW 90 DEG. Click Add Fitting. Snap to the end of the last pipe you drew.

9. Press Esc to end the current command. In the lower-right viewport, zoom in to the area where you inserted the fitting so you can observe the development of the design in 3D.

10. In the left viewport, click the new fitting, and then click the northward-pointing arrow grip to flip the fitting so it curves toward the southwest. Press Esc to clear the selection of the fitting.

11. Click Pipes & Bends on the ribbon. In the left viewport, click the 90° elbow, and then snap to the center of the circle marked E.

Notice the difference in the compass, which now shows available bend angles rather than deflections. The available angles are based on the fittings listed in the parts list.

12. On the command line, click Curve to apply the Curve option. Click a point somewhere between circles E and F; then snap to the center of circle F. Press Esc to end the command.

    A new 90° elbow has been inserted, and a curved section of pipe has been drawn from circle E to circle F (see Figure 15.6).

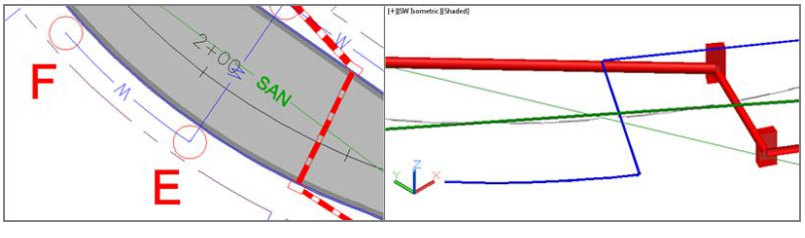


FIGURE 15.6 The newly drawn waterline, including the 90° elbow at circle E and the curved section of pipe between circles E and F

13. Save and close the drawing.

You can view the results of successfully completing this exercise by opening `Creating Pressure Networks by Layout - Complete.dwg`.

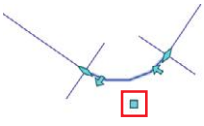
Editing Pressure Pipe Networks

Before editing a pressure network, it's best to display it in profile view so that you can analyze your design from more than one perspective. This is done using the Draw Parts In Profile View command, much as you did with gravity networks. And just like gravity networks, pressure networks can be edited using four basic approaches: grips, layout tools, properties, and Pipe Network Vistas. Of these four approaches, the grips and layout tools approaches differ

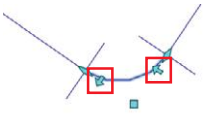
considerably from how they are applied in gravity systems. The sections entitled, "Editing Pressure Networks Using Grips" and "Editing Pressure Networks Using the Plan Layout Tools" explain the details of how these two approaches are applied to pressure networks.

Editing Pressure Networks Using Grips

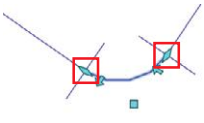
Grips are a great tool for making quick and simple graphical edits. Civil 3D provides the following specialized grips for pressure pipes and fittings:



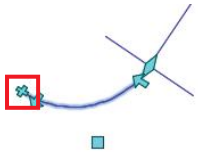
Fitting – Square Grip – Plan View This grip changes the location of the fitting without changing its rotation. As the fitting is moved, the ends of any pipes that connect to it will move with it.



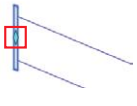
Fitting – Arrow Grip – Plan View This grip changes the direction of the fitting by flipping it around the axis of the connecting pipe.



Fitting – Diamond Grip – Plan View This grip slides the fitting along the pipe it's connected to without changing the rotation angle of the fitting.



Fitting – Plus Grip – Plan View This grip creates a new pipe projecting from the end of the fitting, with the angle restricted to the allowable deflection at the joint. This grip doesn't appear in a location where a pipe is already connected.



Fitting – Diamond Grip – Profile View This grip changes the elevation of the fitting.

Pipe Endpoint – Square Grip – Plan View This grip changes the location of one end of the pipe without changing the location of the other. It's available only if neither end of the pipe is connected to a fitting.

Pipe Endpoint – Diamond Grip – Plan View This grip swings the pipe around a fitting at the opposite end. A graphic displays the allowable deflection but doesn't restrict movement to stay within it. This grip doesn't change the length of the pipe.

Pipe Endpoint – Plus Grip – Plan View This grip creates a new fitting and pipe projecting from the end of the pipe you've selected. The angle of the new pipe is restricted to the allowable angles as per the fittings in the parts list. This grip doesn't appear in a location where a fitting is already connected.

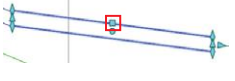
Pipe Endpoint – Triangular Grip – Plan View This grip changes the length of the pipe while maintaining the angle of the pipe and the location of the opposite end. If the pipe is curved, it maintains the radius of the pipe while extending it along its own curvature.

Pipe Midpoint Grip – Plan View For a straight pipe, this grip changes the location of the pipe without changing its rotation. It disconnects the pipe from any fittings it's attached to. For a curved pipe with a connection at both ends, this grip changes the radius of the curve without changing the location of either endpoint. If one or both of the ends aren't connected, it works the same as if it's a straight pipe.

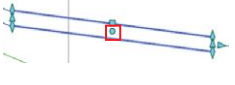
Pipe Endpoint Grips – Profile View These grips change the elevation of a pipe at its endpoint. The diamond-shaped grip at the top sets the crown (top of the inside wall) elevation. The diamond-shaped grip at the bottom sets the invert (bottom of the inside wall) elevation. The triangular grip sets the centerline elevation. These grips can be used in conjunction with the AutoCAD Dynamic Input feature to view the elevation or even type it in. They don't change the horizontal location of the pipe's endpoint.

Pipe Endpoint – Triangle Grip – Profile View This grip changes the length of the pipe while holding its slope.

Pipe Midpoint – Square Grip – Profile View This grip changes the elevation of the pipe without changing its slope. It doesn't affect the location of the pipe in plan view. It disconnects the pipe from any fittings or appurtenances it's connected to.



Pipe Midpoint – Circular Grip – Profile View This grip curves the pipe by holding the endpoints and forcing it to pass through the new location that you select for the grip. Movement isn't restricted based on allowable deflections.



Exercise 15.3: Edit a Pressure Network Using Grips

If you haven't already done so, download and install the files for Chapter 15 according to the instructions in this book's Introduction.

In this exercise, you'll make some adjustments to the layout of the waterline pressure network along Jordan Court. You'll use some of the specialized grips to make these adjustments in plan and profile.

1. Open the drawing named `Editing Pressure Networks Using Grips.dwg` located in the `Chapter 15` class data folder.
2. In the left viewport, zoom in to the circle marked D1, and click the 90° elbow fitting near its center. Click the fitting, and then click the square grip.
3. Snap to the center of the circle marked D2. The fitting moves to the new location along with the ends of the two pipes that are connected to it.

   The geometry of the fitting looks a bit odd at the moment because the fitting should be changed to a 45° elbow. This will be addressed in a later exercise.

The location of the next fitting will be outside the area covered by the Road FG surface, and it will therefore be based on EG surface elevations.

4. In the lower-right viewport, click the curved pipe between E and F1; then click the triangular grip at circle F1. Snap to the center of circle F2.
5. Click the plus-sign grip at circle F2. On the ribbon, select EG as the surface, and change the Cover value to 4.5 (1.5). Select 6 INCH (150mm) DUCTILE IRON as the pipe size, and snap to the center of circle G.

Notice how the end of the pipe isn't located at the elevation of the center of circle G, even though that's where you snapped. Civil 3D calculated the elevation based on the surface and the Cover value you specified.

6. Press Esc to end the current command and clear any selections in the drawing. Click the pipe between E and F2, and then click Draw Parts In Profile on the Pipe Networks: Water Main ribbon tab.
7. Click one of the grid lines of the Jordan Court profile view.

   The water pipe should appear in the profile view.
8. Press Esc to clear the current selection. Select all pipes and fittings from circle E to circle A; then use the Draw Parts In Profile command to add them to the profile view.

   The waterline should now appear in the profile view, as shown in Figure 15.7.

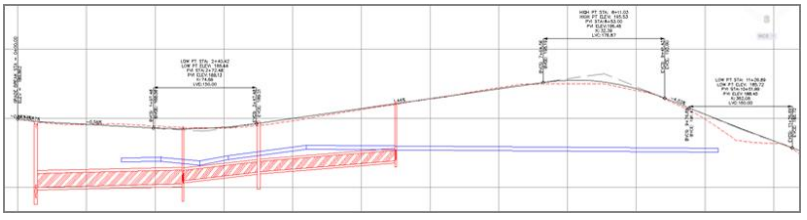


FIGURE 15.7 The water main pressure pipes and fittings shown in profile view

9. In the profile view, click the second fitting from the left, located near station 2+75 (0+080). Click the diamond-shaped grip. If Dynamic Input is turned off, turn it on by clicking the icon at the bottom of your screen.

10. Zoom out until you can see the Dynamic Input elevation value for the grip. Type 184 (55.45), and press Enter.

11. Pan to the right, and click the long pipe at the right end of the water main. Click the circular grip; then click a point slightly above the pipe.

12. Save and close the drawing.

The pipe curves upward so that it passes through the point you selected.

You can view the results of successfully completing this exercise by opening `Editing Pressure Networks Using Grips - Complete.dwg`.

Checking Design and Depth

Before performing any edits on a pressure network, you may find it helpful to use the Design Check and Depth Check commands to identify necessary edits. Both these commands are found on the Pressure Networks ribbon tab. The Design Check command checks for issues with deflection, mismatched pipe diameters, open connections, and radius of curvature. Depth Check finds issues with minimum and maximum cover.

If you haven't already done so, download and install the files for Chapter 15 according to the instructions in this book's Introduction.

Exercise 15.4: Check Design and Depth

In this exercise, you'll check the waterline along Jordan Court for deflection and depth issues.

1. Open the drawing named `Checking Design and Depth.dwg` located in the `Chapter 15` class data folder.

2. Click the pipe that runs from circle D2 to circle E. Then click Design Check on the ribbon.

The warning symbols are visible only in plan and profile view, not 3D view.

3. In the Run Design Check dialog box, uncheck all boxes except Deflection, and then click OK.
   Two warning symbols appear, one at each end of the pipe.
4. Zoom in to one of the warning symbols, and hover your cursor over it.
   The tooltip should indicate that deflection has been exceeded.
5. Press Esc to clear the current selection. Then, in the Jordan Court profile view, select the long water pipe that extends under the hill. Click Depth Check on the ribbon.
6. Select the same pipe again, and press Enter. In the Run Depth Check dialog box, check the box next to Maximum Depth Of Cover. Enter 4.5 (1.5) for Minimum Depth Of Cover and 10 (3) for Maximum Depth Of Cover. Click OK.

If you're having trouble getting the tooltips to appear, try zooming in and then running the REGEN command.

7. In the top-right viewport, notice the warning symbol that appears on the pipe directly below the high point of the hill. Hover over the warning symbol to reveal the tooltip, which states that maximum depth of cover has been exceeded.
8. Save and close the drawing.

You can view the results of successfully completing this exercise by opening `Checking Design and Depth - Complete.dwg`.

Editing Pressure Networks Using the Plan Layout Tools

One way to edit a pressure network is to use the Pressure Network Plan Layout ribbon tab, which is the same one you used initially to create the pressure network. To launch the ribbon in editing mode instead of creation mode, you select a component of the pressure network and then click Edit Network ➢ Plan Layout Tools (see Figure 15.8).

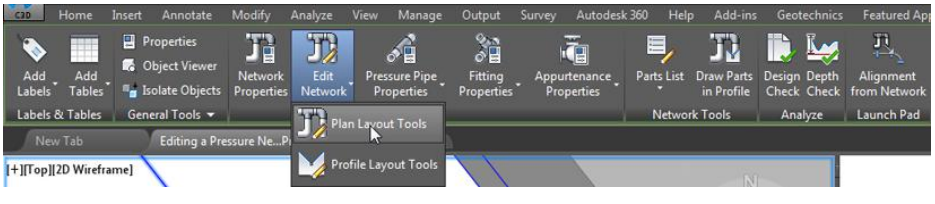


FIGURE 15.8 Launching the Pressure Network Plan Layout ribbon tab by clicking the Plan Layout Tools command

Exercise 15.5: Use the Plan Layout Tools

In this exercise, you'll use the Plan Layout Tools to change out several fittings and add a pipe to the end of the waterline network along Jordan Court.

If you haven't already done so, download and install the files for Chapter 15 according to the instructions in this book's Introduction.

1. Open the drawing named `Editing a Pressure Network Using Plan Layout Tools.dwg` located in the `Chapter 15` class data folder.
2. In the left viewport and the lower-right viewport, zoom in to circle D2. Click the elbow located near the center of the red circle at D2, and press the Delete key to delete it.
3. Click one of the pipes to display the Pressure Networks ribbon tab. Then click Edit Network ➢ Plan Layout Tools.

4. On the Pressure Network Plan Layout ribbon tab, do the following:
   a. Verify that Road FG is the selected surface.
   b. For Cover, enter 4.5 (1.5).
   c. Select 6 INCH (150mm) DUCTILE IRON as the pipe size.
   d. Select 6 INCH (150mm) ELBOW 45 DEG as the fitting.
5. Click Add Fitting; then, in the left viewport, click the end of either pipe in the D2 circle. Press Esc twice to end the command and clear the selection. If the fitting is turned the wrong way, click it and use the arrow grip to flip it in the right direction.

6. Click the pipe that isn't connected, to display its grips. Click the diamond-shaped grip; then click the new fitting to connect the pipe to the fitting. Press Esc to clear the selection of the pipe.
7. Delete the 90° fitting at circle E, and repeat steps 5 and 6 to replace it with a 45° fitting.
8. On the ribbon, select 6 INCH (150mm) TEE as the current fitting.
9. Delete the 90° fitting at circle F2, and repeat steps 5 and 6 to replace it with a 6 INCH (150mm) TEE.
10. In the plan view on the left, click the newly created tee; then click the northern plus-sign grip. Snap to the center of circle H to create a new pipe. Press Esc twice to end the command and clear the selection.
11. Save and close the drawing.

You can view the results of successfully completing this exercise by opening `Editing a Pressure Network Using Plan Layout Tools - Complete.dwg`

Editing Pressure Networks Using the Profile Layout Tools

As you may have noticed in Figure 15.8, there is also a *Profile Layout Tools* command. The editing tools available for pressure networks in profile view are a bit more numerous when compared to gravity networks. For example, with pressure networks, you can add new pipes, add fittings, extend pipes, and perform several other functions that aren't possible with gravity pipes. When you click the Profile Layout Tools command, the Pressure Network Profile Layout ribbon tab opens (see Figure 15.9); it provides many useful editing commands that are carried out in profile view.

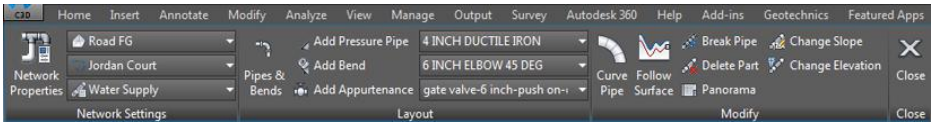


FIGURE 15.9 The specialized ribbon tab for pressure pipe layout in profile view

Exercise 15.6: Use the Profile Layout Tools

If you haven't already done so, download and install the files for Chapter 15 according to the instructions in this book's Introduction.

In this exercise, you'll use the Profile Layout Tools to design the portion of the Jordan Court waterline that connects to the existing water main. You'll add vertical bends as well as a valve.

1. Open the drawing named `Editing a Pressure Network Using Profile Layout Tools.dwg` located in the `Chapter 15` class data folder.

2. Click the new pipe that runs from circle H to circle F2 and the tee fitting at Circle F2. Click Draw Parts In Profile on the ribbon, and click one of the grid lines in the Jordan Court profile view.

   The new pipe and fitting are drawn in the profile view. Notice the tee connection and the short pipe stub located down from and to the left of the new pipe. This is the location where the new waterline will connect to the existing waterline.

3. With one of the pipes or fittings selected, select Edit Network ➢ Profile Layout Tools on the ribbon.

4. Next to Add Bend, select 6 INCH (150mm) ELBOW 45 DEG. Then click Add Bend.

5. In the upper-right viewport, place your cursor near the right end of the short pipe segment located just below the red circle. When the glyph appears, as shown in Figure 15.10, click the pipe. Click Counterclockwise on the command line.

A new 45° bend should appear. It may look odd in profile view because of the vertical exaggeration. If you zoom in to the new fitting in the 3D view, it will look more like you would expect.

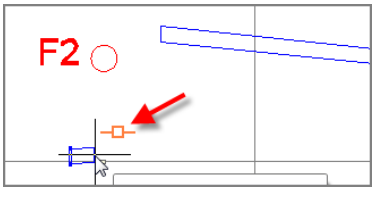


FIGURE 15.10 A glyph indicating the proper connection of a pipe to a fitting

6. Verify that 6 INCH (150mm) DUCTILE IRON is selected as the current pipe size, and click Add Pressure Pipe. When prompted for the part at the start of the range, click the newly created elbow.

7. When prompted for the part at the end of the range, click the pipe to the right of the red circle. Click Yes when asked if you want to continue.

8. Click the newly created elbow, and then snap to the center of the red circle located above the new bend.

9. Click Add Bend; then click the end of the newly created pipe, making sure the proper glyph is displayed, as previously shown in Figure 15.10. Click Clockwise on the command line to invoke the Clockwise option. Another 45° bend is created.

10. Click the pipe just to the right of the newly created bend. Click the upright triangle grip at the left end of the pipe, and drag it toward the new bend. Click the newly created bend to connect the pipe to it.

You could have also done this step using the 3D view or the plan view.

In the 3D view, you can now see the complete design of the connection between the existing and proposed water mains (see Figure 15.11).

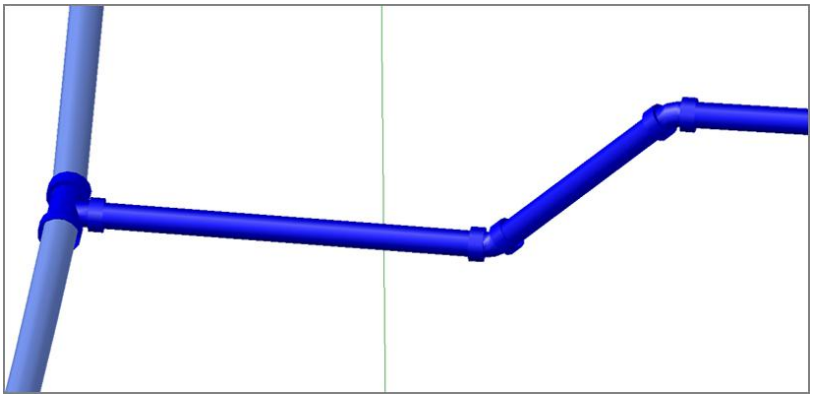


FIGURE 15.11 The connection of the proposed waterline to the existing waterline, shown in a 3D perspective

11. On the ribbon, click Break Pipe. Locate the two vertical red lines on the first pipe segment, and click where the red line on the left crosses the top of the pipe.
12. Repeat the previous step for the red line on the right.

13. On the ribbon, click Delete Part. Click the pipe segment between the red lines.

14. Click Add Appurtenance, and then click the left side of the gap created by deleting the pipe segment in the previous step.

A valve symbol should appear in the profile view.

15. Click the pipe on the right side of the gap to display its grips. Click the upright triangle grip, and drag it toward the new valve. Click when the glyph appears, indicating that a connection is going to be made. View the tee and valve assembly in the lower-right viewport (see Figure 15.12).

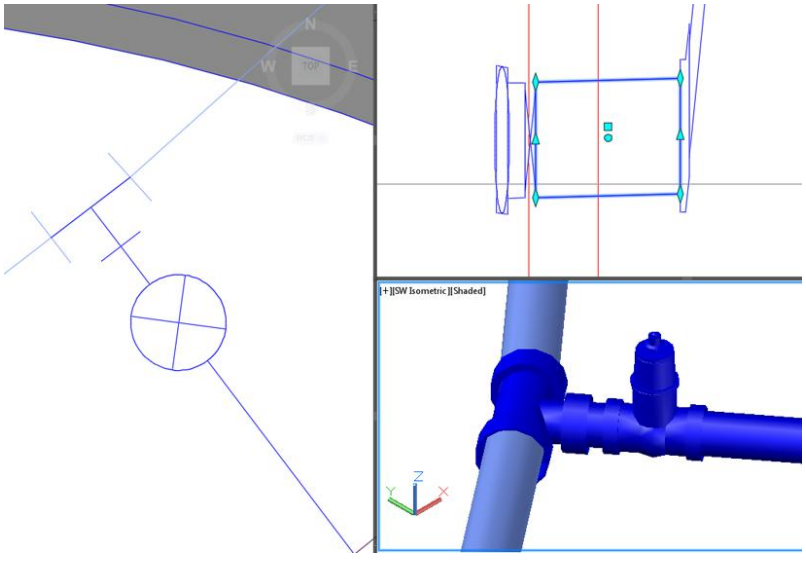


FIGURE 15.12 The connection of the proposed waterline to the existing waterline, shown in plan, profile, and 3D perspective

16. Press Esc to clear all the selections in the drawing. In profile view, pan to the right and select the long pipe. Click Follow Surface on the Pressure Network Profile Layout tab of the ribbon.

17. Press Enter; then type **4.5** (**1.5**) at the command line when prompted for the depth below the surface. Press Enter to complete the command.

18. Save and close the drawing.

The pipe has been broken into segments so that it can maintain a constant depth below the surface.

You can view the results of successfully completing this exercise by opening `Editing a Pressure Network Using Profile Layout Tools - Complete.dwg`.

Now You Know

Now that you have completed this chapter, you understand pressure networks and how they differ from gravity networks. You're able to create pressure networks by converting objects already in the drawing or by creating them from scratch using the layout tools. You know several methods for editing pressure networks, including the use of grips, Plan Layout Tools, and Profile Layout Tools.

You're ready to begin creating and editing pressure networks in a production environment.