Drinking Water Operator Certification Training Instructor Guide

Module 9: Cross-Connection Control and Backflow Prevention

This course includes content developed by the Pennsylvania Department of Environmental Protection (Pa. DEP) in cooperation with the following contractors, subcontractors, or grantees:

The Pennsylvania State Association of Township Supervisors (PSATS)
Gannett Fleming, Inc.
Dering Consulting Group
Penn State Harrisburg Environmental Training Center

A Note to the Instructor

Dear Instructor:

The primary purpose of *Module 9:Cross-Connection Control and Backflow Prevention* is to provide an overview of the concepts of cross-connection and backflow as well as an understanding of the techniques and equipment used to protect cross-connections and to prevent backflow. These concepts are essential for the protection of the public water supply and for compliance with PADEP regulations. This module has been designed to be completed in approximately 3 hours, but the actual course length will depend upon content and/or delivery modifications and results of course dry runs performed by the DEP-approved sponsor. The number of contact hours of credit assigned to this course is based upon the contact hours approved under the DEP course approval process. To help you prepare a personal lesson plan, timeframes have been included in the instructor guide at the Unit level and at the Roman numeral level of the topical outline. You may need to adjust these timeframes as necessary to match course content and delivery modifications made by the sponsor. Please make sure that all teaching points are covered and that the course is delivered as approved by Pa. DEP.

Web site URLs and other references are subject to change, and it is the training sponsor's responsibility to keep such references up to date.

Delivery methods to be used for this course include:

- Lecture
- Discussions
- Exercises/Activities

To present this module, you will need the following materials:

- One workbook per participant
- Extra pencils
- Laptop (loaded with PowerPoint) and an LCD projector **or** overheads of presentation and an overhead projector
- Screen
- Flip Chart
- Markers

Icons to become familiar with include:

Participant Workbook	Instructor Guide
Exercise/Activity	Same icons for Participant Workbook apply to the Instructor Guide.
Case Study	**Ans:** Answer to exercise, case study, discussion, question, etc.
Discussion Question	PowerPoint Slide
Calculation(s)	Overhead
Quiz	Flip Chart
Key Definition(s)	Suggested "Script"
Key Point(s)	

Instructor text that is meant to be general instructions for the instructor are designated by being written in script font and enclosed in brackets. For example:

[Ask participants if they have any questions on how to read the table. Answer any questions participants may have about how to read the table.]

If your module includes the use of a PowerPoint presentation, below are some helpful controls that you may use within the Slide Show.

PowerPoint Slide Show Controls

You can use the following shortcuts while running your slide show in full-screen mode.

To	**Press**
Advance to the next slide	N, ENTER, or the SPACEBAR (or click the mouse)
Return to the previous slide	P or BACKSPACE
Go to slide <number>	<number>+ENTER
Display a black screen, or return to the slide show from a black screen	B
Display a white screen, or return to the slide show from a white screen	W
Stop or restart an automatic slide show	S
End a slide show	ESC
Return to the first slide	Both mouse buttons for 2 seconds
Change the pointer to a pen	CTRL+P
Change the pen to a pointer	CTRL+A
Hide the pointer and button temporarily	CTRL+H
Hide the pointer and button always	CTRL+L
Display the shortcut menu	SHIFT+F10 (or right-click)
Erase on-screen annotations	E
Go to next hidden slide	H
Set new timings while rehearsing	T
Use original timings while rehearsing	O
Use mouse-click to advance while rehearsing	M

INTRODUCTION OF MODULE: 5 minutes

Display Slide 1—Module 9: Cross-Connection Control and Backflow Prevention.

[Welcome participants to "Module 9 – Cross-Connection Control and Backflow Prevention." Indicate the primary purpose of this course is to provide an overview of the concepts of cross-connection and backflow as well as an understanding of the techniques and equipment used to protect cross-connections and to prevent backflow. These concepts are essential for the protection of the public water supply and for compliance with PADEP regulations.]

[Introduce yourself.]

[Provide a brief overview of the module.]

This module contains 4 units. On page i, you will see the topical outline for **Unit 1 – Overview of Cross-Connection Control and Backflow Prevention** and **Unit 2 – Backflow Prevention Methods**. Now turn the page to see the remainder of the outline.

On this page, you will find the outline for **Unit 3 – Detecting and Mitigating Backflow Occurrences** and **Unit 4 – Current Cross-Connection Control and Backflow Prevention Practices.**

[Continue to briefly review outline.]

UNIT 1: <u>60 minutes</u>

Display Slide 2 —Unit 1: Overview of Cross-Connection Control and Backflow Prevention.

At the end of this unit, you should be able to:

- Define cross-connection and backflow.
- List five examples of common cross-connections.
- Explain why cross-connection control and backflow prevention are necessary.

Display Slide 3 —Unit 1: Overview of Cross-Connection Control and Backflow Prevention.

The remaining learning objectives for Unit 1 are:

- Define backsiphonage and backpressure and list potential causes for each.
- Describe the conditions needed for backflow to occur.

INTRODUCTION: <u>35 minutes</u>

As was suggested by the learning objectives, we will begin this Unit by defining backflow and cross-connection.

Definitions

Backflow

Review definition listed in the workbook.

Backflow can be caused by many different conditions. Basically the reverse pressure gradient may be due to either a loss of pressure in the supply main called backsiphonage, or by the flow from a customer's pressurized system through an unprotected cross-connection, which is called backpressure. The term "backflow" covers both backsiphonage and backpressure.

Cross-Connection

Review definition listed in the workbook.

[Review bulleted list regarding cross-connections and be sure to point out that cross-connections are either direct or indirect.]

Display Slide 4 – A Direct Cross-Connection.

This graphic shows an example of a direct cross-connection. As you can see, the make-up water line is feeding a recirculation system and is therefore subject to backflow.

Common Cross-Connections

[Review information in the workbook.]

List some examples of common cross-connections that you can think of and be prepared to discuss them with the class.

Have participants give examples and record them on a flipchart. Listed below are some common cross-connections you can share with the participants. Review any items on this list that participants do not mention.

Ans: **Garden Hose –** Garden hose ends are often intentionally or accidentally submerged in fertilizer and/or pesticide solutions during gardening activities, in containers of soapy water during cleaning activities (such as vehicle washing), in wash basin/tubs, and in puddles of water on the ground. Each of these potential cross-connections involving a common garden hose represents opportunities through which backflow can occur.

Pressure Relief Valves – Pressure relief valves that vent to the atmosphere can provide a connection to atmospheric air, particles, and aerosols. A more serious potential cross-connection involving relief valves includes improperly installed relief valves in a pit or chamber that may become submerged, allowing external water to flow back into the drinking water system. Relief valves are included in some backflow prevention devices but must be properly installed and maintained so as to not be a potentially hazardous cross-connection.

Pipe/Joint Leaks – Common pipe and pipe joint leaks can also be considered a cross-connection. During periods of negative or sub-atmospheric pressure in the water system pipeline, groundwater or other contaminants from outside the pipe wall can be drawn through cracks in the pipe and pipe joint leaks into the water supply.

Pump By-pass Arrangements – Booster pumping applications are often arranged with a pump bypass line with a check valve. Leaking check valves can result in backflow into the system. A single check valve is not an effective backflow prevention device.

Plumbing Errors – Mistaken connections are often made to fire protection piping, process water piping, irrigation systems, or other non-potable water supply. These cross-connections can result in large amounts of contaminants entering the public water system.

Filling Tanker Trucks – Filling water trucks with either a submerged inlet or by allowing a hose end to be submerged in the tank represents a cross-connection and can result in backflow if the connection is unprotected by a backflow prevention device.

Importance of Cross-Connection Control and Backflow Prevention

Water Quality and Health/Safety

Now that we have discussed some common cross-connections, let's talk about the importance of cross-connection control and backflow prevention. The primary purpose of controlling-cross connections and preventing backflow is to protect the public health by ensuring that the water supply is safe.

[Review bulleted items in the workbook.]

Contamination Events

Your workbook lists several examples of backflow contamination events. Let's review these and then talk about other contamination events you may know about.

[Review the information in the workbook about the contamination events.]

As you can see, there are numerous examples of backflow contamination.

Other than the examples we just discussed, are there any other backflow contamination events you are aware of?

Record examples that participants share on a flipchart.

Statistics on Backflow and Related Outbreaks

The contamination events we just discussed are anecdotal so let's talk about some statistical data that has been compiled regarding backflow incidents.

[Review the CDC statistical information in the workbook.]

[Review the two studies listed in the workbook.]

These studies emphasize the point that backflow events do occur and that although many backflow events are not detected or not reported, a significant percentage of disease outbreaks are the result of water system contamination that may actually be due to backflow contamination.

CAUSES OF BACKFLOW: 25 minutes

Backsiphonage

To refresh your memory, we have already learned that backflow is the reverse flow of water or other substances into the potable water source. This can occur due to either backsiphonage or backpressure. For the next few minutes, we are going to talk about backsiphonage in more detail.

Review definition of backsiphonage in the workbook.

[Review bulleted items. Be sure to emphasize the following point:]

All that is required for backsiphonage to occur is a negative difference in pressure and a piece of tubing or pipe that is completely filled with fluid.

Potential Causes of Backsiphonage

Let's talk about some common events that can cause backsiphonage.

[Review bulleted list in workbook of backsiphonage examples.]

Display Slide 5—Backsiphonage.

The slide shows an illustration of hydraulic grade line reversal and backflow by backsiphonage through a submerged hose end (unprotected cross-connection) resulting from negative pressure in the water supply main. The negative pressure in the water supply main could be caused by high flow rates due to hydrant flushing, a main break, high demands, or inadequate supply capacity.

[Review remaining bulled list of backsiphonage examples in the workbook.]

Display Slide 6—Backsiphonage – Booster Pump.

Figure 1.3 shows two buildings, each connected to a common distribution main (black and white circle). The building on the right has a booster pump (B) that pumps to a tank on top of the building. It is possible, especially without a low pressure switch to turn off the pump in the event of low pump suction pressure, for the booster pump to draw the pressure on the suction side of the pump (distribution main and neighboring building) so low that negative pressures are experienced at taps in the adjacent building, potentially resulting in backflow. This condition is made even more critical by the elevation of the neighboring building. Point A would be first to experience potential negative pressures and potential backflow conditions due its high elevation.

Backpressure

Now that we have discussed backsiphonage, let's move the discussion to backpressure and what causes it.

Review definition of backpressure in the workbook.

[Review the two reasons why backpressure occurs].

[Review the two causes of backflow.]

Conditions Necessary for Backflow to Occur

This section talks about the three conditions that are necessary for backflow to occur. We have already discussed these concepts earlier in the unit, so this information is essentially a summary of what you have already learned. An important point for you to remember is that all three of the conditions listed in your workbook must happen simultaneously in order for backflow to occur. Does anyone have any questions about this information?

Key points for Unit 1 – Overview of Cross-Connection Control and Backflow Prevention

[Ask the participants to review the Key Points in their workbooks. Answer any questions that they have.]

Exercise for Unit 1 – Overview of Cross-Connection Control and Backflow Prevention.

1. The two basic types of cross-connections are __**direct**____ and ___**indirect**____.
2. Backflow is a flow condition caused by_____**differential**____ pressure.
3. The most common backflow contaminants are **bacteria** or **biological** although chemical and other physical contamination can also occur.
4. List three examples of common backflow contamination events:
   a. _**answers may vary**___
   b. _ **answers may vary** __
   c. _ **answers may vary** __
5. The normal hydraulic gradient slopes from the **higher elevation** to the **lower elevation**.

[Point out the references listed in the workbook.]

[Indicate that this is the end of Unit 1 and ask participants if they have any questions. Respond accordingly.]

UNIT 2: <u>55 minutes</u>

Display Slide 7—Unit 2: Backflow Prevention Methods.

At the end of this unit, you should be able to:

- List and explain three methods for backflow prevention.
- List seven types of backflow prevention devices and for each:
    - Identify its schematic.
    - Explain its operation.
    - List the advantages and disadvantages.
    - Describe its application(s).

ELIMINATING CROSS-CONNECTIONS: 5 minutes

In Unit 1, we discussed some common cross-connections and we talked about the importance of backflow prevention and cross-connection control. In this unit, we will talk about specific methods for preventing backflow and we will review types of backflow prevention devices that can be used.

Cross-Connection Control Program

[Review the information in the workbook.]

Public Awareness

[Review the information in the workbook.]

MAINTAINING MINIMUM SYSTEM PRESSURE: <u>10 minutes</u>

As you can see, an effective cross-control program and public awareness play a role in preventing cross-connections. In addition to this, there are system requirements established by PA DEP. These requirements exist to reduce the chance of backflow.

[Review the information in the workbook.]

We will now discuss three means of maintaining minimum system pressure: distribution system capacity and maintenance, redundant equipment and pressure transient control.

Distribution System Capacity and Maintenance

[Review the information in the workbook.]

Redundant Equipment

[Review the information in the workbook.]

Pressure Transient (Surge) Control

[Review the information in the workbook.]

[After reviewing the first bullet item, point out the following:]

A common example of this phenomenon in the home is the rattling noises often observed in home plumbing when a faucet is slammed shut.

APPLYING BACKFLOW PREVENTION DEVICES: 40 minutes

Now that we understand the importance of eliminating cross-connections and maintaining minimum system pressure, the remainder of our discussion for this unit will focus on the application of various backflow prevention devices.

[Review the information in the workbook.]

Identification of Hazard Types

Before we apply a backflow prevention device, we must first know what type of hazard we are trying to prevent. For the next few minutes we will discuss hazard types before moving on to our discussion of specific backflow prevention devices.

[Review the information in the workbook.]

Hazardous Facilities

The first type of hazard is called a hazardous facility.

Review the defintion of hazardous facility in the workbook.

[Review the examples of hazardous facilities in the workbook.]

[Allow participants 2-3 minutes to answer the following question in their workbook and then ask them to share their answers with the class.]

What are additional examples of hazardous facilities?

Ans: The following is a list of additional examples of hazardous facilities. Be sure to review any that participants do not think of on their own.

Piers and other waterfront facilities.
Mortuaries
Laboratories.

The highest level of backflow prevention, which would be either an air gap or reduced pressure zone device, is required at these facilities. We will discuss these types of backflow prevention devices in further detail in a few minutes.

[Be sure to point out that additional examples can be found in the PA DEP Water Supply Manual, Part VII.]

Aesthetically Objectionable Facilities

The second type of hazard is known as an aesthetically objectionable facility.

Review the defintion of aesthetically objectionable facility in the workbook.

[Review the example of an aesthetically objectionable facility in the workbook.]

[Allow participants 2-3 minutes to answer the following question in their workbook and then ask them to share their answers with the class.]

What are additional examples of aesthetically objectionable facilities?

Ans: The following is a list of additional examples of aesthetically objectionable facilities. Be sure to review any that participants do not think of on their own.

Barber shops.
Beauty salons.
Supermarkets.

[Be sure to point out that additional examples can be found in the PA DEP Water Supply Manual, Part VII.]

Types of Backflow Prevention Devices

The basic types of backflow preventers include air gaps, barometric loops, vacuum breakers (pressure and atmospheric), double check valve assemblies, and reduced pressure principle devices. The operating principles, advantages, disadvantages, and applications of the primary types of backflow prevention devices will be discussed in this section. For more detailed specifications on any of the devices we discuss, you can refer to the literature supplied by the manufacturer.

Air Gap

The first type of prevention device we will review is an air gap.

Display Slide 8—Air Gap on a Tank.

This slide shows an air gap between a potable water supply and a non-potable water tank.

Operation of an Air Gap

Review the defintion of air gap listed in the workbook.

The air gap should be at least twice the diameter of the potable water supply pipe and not less than 1-inch.

Display Slide 9—Air Gap on a Lavatory.

This is an additional example of an air gap on a sink. Notice that the faucet opening is above the top of the sink, providing the required air gap.

[Review the information the workbook and then share the following:]

Air gaps are impractical where it is necessary to maintain pressure for customer end-use. For example, at the water supply point for a building, an air gap would be impractical because it would most likely require the water to be re-pumped to provide adequate pressure for the intended water use. Another example where an air gap would be impractical is a bottom feed tank where pressure is required to fill the tank.

Advantages and Disadvantages of an Air Gap

[Review the information in the workbook.]

Applications of an Air Gap

[Review the information in the workbook.]

Barometric Loop

Display Slide 10—Barometric Loop.

This slide shows a typical barometric loop.

Operation of a Barometric Loop

Review the defintion of barometric loop in the workbook.

A pressure of 14.7 psi is equivalent to a pressure head of approximately 34 feet; therefore, even if "full vacuum" conditions occur in the potable water system, water cannot be back-siphoned from the downstream side of the barometric loop into the potable water supply system.

Advantages and Disadvantages of a Barometric Loop

[[Review the information in the workbook.]

Applications of a Barometric Loop

[Review the information in the workbook].

Double Check Valve Assembly (DCVA)

Display Slide 11—Double Check Valve Assembly (DCVA).

This slide represents another type of backflow prevention device known as a Double Check Valve Assembly.

Operation of a Double Check Valve Assembly

Review the defintion of Double Check Valve Assembly in the workbook.

[Review the information in the workbook.]

Advantages and Disadvantages of a Double Check Valve Assembly

[Review the information in the workbook.]

Applications of a Double Check Valve Assembly

[Review the information in the workbook.]

Display Slide 12—A Typical DCVA Application.

This slide shows a typical application of a double check valve assembly protecting the public water supply from non-health hazard or aesthetically objectionable sources of potential backflow. The sources are pressurized (a pump from the non-toxic tank and a pressurized tank) which increases the likelihood of backflow and makes backflow protection very important.

Reduced Pressure Zone Device (RPZD)

Display Slide 13—Reduced Pressure Zone Device (RPZD).

This slide shows our next type of backflow prevention device, the reduced pressure zone device, or RPZD.

Operation of a Reduced Pressure Zone Device

Review the defintion of a Reduced Pressure Zone Device in the workbook.

[Review the information in the workbook.]

Advantages and Disadvantages of a Reduced Pressure Zone Device

[Review the information in the workbook.]

Applications of a Reduced Pressure Zone Device

[Review the information in the workbook.]

Display Slide 14—A Typical RPZD Application.

This slide shows a RPZD device preventing backflow from a hospital which is a health hazard. Note that since the RPZD only protects the supply system, not the customer system, from backflow contamination, atmospheric vacuum breakers (AVBs) are utilized to prevent backflow at each potential source, such as lab sinks, to protect the building plumbing from backflow contamination. The RPZD is an example of a containment device while the AVB is an example of an isolation device and is intended to keep potential contaminants out of the customer system. The concept of containment and isolation was discussed previously in this unit. AVBs will be discussed in more detail shortly.

Residential Dual Check Valve (RDCV)

Display Slide 15—Residential Dual Check Valve (RDCV).

The residential dual check valve is our next type of prevention device and it is shown in this slide.

Operation of a Residential Dual Check Valve

Review the definition of residential dual check valve in the workbook.

Advantages and Disadvantages of a Residential Dual Check Valve

[Review the information in the workbook.]

Applications of a Residential Dual Check Valve

[Review the information in the workbook.]

A modification of this valve, offering increased protection against backsiphonage, is the Double Check Valve with Intermediate Atmospheric Vent, which would provide improved protection against backsiphonage in the event of a check valve failure.

Display Slide 16—A Typical RDCV Application.

This slide depicts a typical residential dual check valve installed in a home, just downstream of the meter and prior to any water uses or pipe branches. Shutoff valves are often incorporated to facilitate service and/or replacement of the meter and replacement of the residential dual check valve.

Atmospheric Vacuum Breaker (AVB)

Display Slide 17—Atmospheric Vacuum Breaker (AVB).

The AVB, or atmospheric vacuum breaker, is our next type of prevention device.

Operation of an Atmospheric Vacuum Breaker

Review the defintion of atmospheric vacuum breaker in the workbook.

[Review the information in the workbook.]

Advantages and Disadvantages of an Atmospheric Vacuum Breaker

[Review the information in the workbook.]

Applications of an Atmospheric Vacuum Breaker

[Review the information in the workbook.]

The reason the shutoff valves cannot be downstream is because shutoff valves downstream can cause a static pressure condition that can keep the air inlet disc in the closed position, potentially causing it to stick.

Display Slide 18—A Typical AVB Application.

This slide depicts an AVB functioning as an isolation device on an aspirator such as that used in a funeral parlor (which is a health hazard). AVBs are suitable for this application because the risk of backflow is from backsiphonage and the unit is not used continuously. Note that a containment device (a RPZD) would also be required in this situation.

Pressure Vacuum Breaker (PVB)

Display Slide 19—Pressure Vacuum Breaker (PVB).

This slide shows our next type of prevention device, a pressure vacuum breaker, or PVB.

Operation of a Pressure Vacuum Breaker

Review defintion of pressure vacuum breaker in the workbook.

[Review the information in the workbook].

Advantages and Disadvantages of a Pressure Vacuum Breaker

[Review the information in the workbook.]

Applications of a Pressure Vacuum Breaker

[Review the information in the workbook.]

Display Slide 20—A Typical PVB Application.

This slide shows a PVB being used to prevent backsiphonage from the tank. The PVB is used instead of an AVB because the pipe between the supply and the tank is under constant pressure, a condition under which the AVB cannot be used.

Hose-Bibb Vacuum Breaker (HBVB)

Display Slide 21—Hose-Bibb Vacuum Breaker.

This is our final type of prevention device, the Hose-Bibb Vacuum Breaker, or HBVB.

Operation of a Hose-Bibb Vacuum Breaker

Review the defintion of Hose-Bibbb vacuum breaker in the workbook.

The HBVB is a specialized version of the atmospheric vacuum breaker (AVB).

Advantages and Disadvantages of a Hose-Bibb Vacuum Breaker

[Review the information in the workbook.]

Applications of a Hose-Bibb Vacuum Breaker

[Review the information in the workbook.]

Testing and Maintenance of Backflow Prevention Devices

As with any type of equipment or devices, backflow prevention devices require testing and maintenance to ensure they are functioning properly. The remainder of this unit focuses on these two topics.

[Review the information in the workbook.]

Responsibility for Testing and Maintenance

[Review the information in the workbook.]

Schedule for Testing and Maintenance

[Review the information in the workbook.]

Key Elements of Testing

[Review the information in the workbook.]

Let's turn the page and review some key testing points regarding air gaps, RPZDs, DCVAs and PVBs.

Air Gap

[Review the information in the workbook.]

Reduced Pressure Zone Device

[Review the information in the workbook.]

Double Check Valve Assembly (DCVA)

[Review the information in the workbook.]

Pressure Vacuum Breaker (PVB)

[Review the information in the workbook.]

Key points for Unit 2 – Backflow Prevention Methods

[Have the participants read the Key Points for Unit 2. Answer any questions that they may have.]

☑ Exercise

For each of the following scenarios, explain what type of prevention device would be appropriate.

1. Restricted access military base

Ans: An air gap or RPZD should be installed since access for inspection of the water facilities and potential hazards is restricted.

2. Customer fire loop

Ans: If no chemical additives are used in the system, the hazard is stagnant water, tastes, and odors, which would require protection by a DCVA. If the fire system uses chemical conditioners, a RPZD or air gap would be required.

3. Water hauling trucks

Ans: Water hauling trucks can present cross-connections with tanks contaminated with toxic chemicals or other contaminants. Air gaps or RPZDs are typically required. Some water purveyors require water haulers to fill only at designated locations equipped with permanently established air gaps.

4. Single family residence

Ans: Residential dual check valves are generally recommended.

5. A hospital or medical building

Ans: Various hazards exist at medical facilities. Air gaps or RPZDs are required and other devices, such as AVBs, are often used concurrently at the highest hazard locations such as laboratories.

6. Commercial car wash

Ans: An RPZD or an air gap is recommended due to potential contamination by cleaning agents and recycled wash water.

As you know, backflow prevention is essential to ensuring a quality water supply. There are many devices available that prevent backflow, many of which we discussed. Each device is applicable in very specific situations, so it is essential that you are familiar with the various prevention devices and their applications. In our next unit, we will discuss detection and mitigation of backflow occurrences.

[Point out that the references for this unit are listed on this page.]

(This page was intentionally left blank.)

UNIT 3: <u>30 minutes</u>

Display Slide 22—Unit 3: Detecting and Mitigating Backflow Occurrences.

At the end of this unit, you should be able to:

- List and explain five indicators of backflow.
- Describe four methods for mitigating backflow events.

INDICATORS OF BACKFLOW: <u>15 minutes</u>

It is not practical for water system operators to continuously monitor the distribution system for the presence of contaminants that could indicate the occurrence of backflow events. Therefore, systems must rely on a combination of routine testing, pressure monitoring and customer input to indicate possible backflow occurrences and to initiate contamination mitigation. For the next few minutes, we will discuss some common indicators of backflow. Before looking at your workbook, tell me what you think some common indicators of backflow are.

Write participant answers on a flipchart.

We are going to discuss six different indicators: customer complaints, pressure reductions, loss of disinfectant residual, water meters running in reverse, total coliform detections and reported backflow events.

Customer Complaints

Customer complaints are usually a good indicator of a potential backflow event.

[Review the information in the workbook.]

Pressure Reductions

Monitoring distribution system pressures can indicate the potential for backflow events, such as when distribution system pressures drop. As described in the previous units, a reduction in system pressure increases the chance of backflow through unprotected cross-connections by both backsiphonage and backpressure.

[Review the information in the workbook.]

Loss of Disinfectant Residual

In addition to customer complaints and pressure reductions, a loss of disinfectant residual can also indicate a potential backflow occurrence.

[Review the information in the workbook.]

Water Meters Running in Reverse

Another indicator of backflow is when water meters are running in reverse.

[Review the information in the workbook.]

Total Coliform Detections

Changes in total coliform detections and heterotrophic plate count (HPC) results during distribution system monitoring can indicate that contaminants have entered the system from some source, potentially from a backflow event.

Review the definition of total coliform detections in the workbook.

Review the defintion of heterotrophic plate count in the workbook.

[Review the information in the workbook.]

Reported Backflow Events

The final indicator of backflow is the actual reporting of a backflow event. We discussed examples of backflow events in Unit 1.

[Review the information in the workbook.]

MITIGATING BACKFLOW EVENTS: 15 minutes

Once a backflow event is known to have occurred, water suppliers commonly employ several strategies to remove the contaminant and minimize the problems associated with the backflow event. We will now discuss some methods for mitigation of backflow events.

[Review the information in the workbook.]

Contaminated Area Isolation

Once a contamination event occurs, many systems attempt to isolate the contamination to prevent it from spreading over a larger area of the system. This approach is often employed regardless of the source of contamination. Isolation is accomplished by closing system valves surrounding the contaminated area.

[Review the information in the workbook.]

Public Notification

If the water system is contaminated, either by backflow or by other means, all system customers must be notified. The type, severity and extent of the contamination will dictate the type of notification provided.

[Review the information in the workbook.]

System Flushing and Cleaning

Once a contamination event is identified and the contaminant is isolated, water purveyors generally try to remove the contaminant by flushing water from the system.

[Review the information in the workbook.]

Pipeline Replacement

Pipeline replacement is another strategy for mitigating backflow occurrences.

[Review the information in the workbook.]

Identify and Correct the Source of Contamination

[Review the information in the workbook.]

Key points for Unit 3 – Detecting and Mitigating Backflow Occurrences

[Have the participants review the Key Points for Unit 3. Answer any questions that they may have.]

Exercise

1. List five indicators of backflow.

Ans: Five of any of the following: customer complaints, pressure reductions, loss of disinfectant residual, water meters running in reverse, total coliform detections and reported backflow events.

2. Describe four methods for mitigating backflow events.

Ans: contaminated area isolation, public notification, system flushing and cleaning, pipeline replacement and identify and correct the source of contamination.

Additional Resources Used

[Point out that the resource information at the end of the unit.]

[Ask participants if they have any questions regarding Unit 3. Respond accordingly.]

UNIT 4: <u>35 minutes</u>

Display Slide 23—Unit 4: Current Cross-Connection Control and Backflow Prevention Practices.

At the end of this unit, you should be able to:

- Explain the regulatory basis for cross-connection control programs.
- Describe a typical backflow prevention program as outlined by the PA DEP Water Supply Manual.

REGULATORY BASIS OF CROSS-CONNECTION CONTROL PROGRAMS: <u>5 minutes</u>

Cross-connection control programs exist as a result of some specific regulatory requirements which we will briefly review. As you can imagine, these requirements are quite comprehensive and detailed, so we will only summarize those requirements in this unit.

PA Safe Drinking Water Act

[Review the information in the workbook.]

PA DEP Rules and Regulations

[Review the information in the workbook.]

TYPICAL BACKFLOW PREVENTION PROGRAM: 30 minutes

Now that you understand the regulatory basis of a cross-connection control program, let's talk about what a typical cross-connection control program entails.

PA DEP Public Water Supply Manual Part VII

The purpose of the *DEP Public Water Supply Manual, Part VII* is to provide basic information needed to develop and implement a cross-connection control and backflow prevention program. The information in your workbook is a general description of the various aspects of such a program.

[Review the information in the workbook.]

Step 1: Develop the Program

The first step is to develop the cross-connection control program. This involves several steps, the first of which is to ensure that you know and understand cross-connection control concepts.

Know and understand cross-connection control concepts.

[Review the information in the workbook.]

Establish the legal foundation.

Another important step in developing the cross-connection control program is to establish the legal foundation for the program. As previously described, a legal basis for program establishment is provided by DEP rules and regulations.

[Review the information in the workbook]

Establish a priority system.

When developing the cross-connection control program, it will be necessary to establish priorities.

[Review the information in the workbook.]

Estimate customer implementation costs.

The installation of backflow prevention devices is relatively expensive, especially for hazardous facilities, and may require customer budget planning. Customer implementation costs can affect implementation timetables.

[Review the information in the workbook.]

Develop a proposed implementation timetable.

Implementation of a cross-connection control program is not something that happens quickly; therefore, it is beneficial to develop an implementation timetable. Let's review a typical timetable as recommended by DEP.

[Review the 5-year timetable in the workbook.]

Review data and proposed procedures with governmental agencies.

Prior to initiating program implementation, the program as developed should be reviewed with the municipalities involved, the local health agencies, and DEP.

[Review the information in the workbook.]

Step 2: Implement the Program

Now that the cross-connection control program has been developed, implementation can begin. As with program development, there are multiple tasks involved in accomplishing this step. The first is to educate the public.

Educate the public.

[Review the information in the workbook.]

Notify affected customers.

The customers affected by the program must be notified.

[Review the information in the workbook.]

Monitor program progress.

As with any large project, it will be necessary to monitor the implementation of the program.

[Review the information in the workbook.]

Initiate testing requirements.

In Unit 2, we discussed the necessity for maintenance and testing of backflow prevention devices. Establishing testing requirements will be an important part of the implementation phase of the cross-connection control program.

[Review the information in the workbook.]

Key points for Unit 4 – Current Cross-Connection Control and Backflow Prevention Practices

[Have the participants review the key points for Unit 4. Answer any questions that they may have.]

☑ **Exercise**

1. PA DEP rules and regulations state "A public water system may not be designed or constructed in a manner which creates a **cross-connection.**"
2. Water suppliers are required to develop and implement a program to control **cross-connections** and prevent backflow of **contaminants** into the public water supply.
3. A reasonable timetable for implementing a backflow prevention program may take up to **five** years.
4. Important steps in implementing the backflow prevention program include **educating** the public and **notifying** the affected customers.

[Point out references information on this page].

We have completed the final unit of this module. Elimination of cross-connections and prevention of backflow is essential to maintaining the safety and health of the water supply. Based on the information covered in this module, you should have a good understanding of how you can accomplish these tasks.