Appendix G:
EXAMPLE OF A STANDARD OPERATING PROCEDURE FOR CONDUCTING A ROUTINE FILTER INSPECTION

This appendix contains an example of a standard operating procedure (SOP) based on an SOP developed by the staff at a surface water treatment plant (SWTP) in Texas. The SOP was developed during an on-site technical-assistance visit conducted as part of a TCEQ pilot project.

IMPORTANT

Do not use the example SOP until you have:

- reviewed the document
- customized the SOP to fit your specific plant;
- ensured that the SOP conforms with the existing standard operations, maintenance, and safety requirements of the water system;
- documented approval; and
- distributed it to plant staff.

City of Aguaville Surface Water Treatment Plant (SWTP)
EXAMPLE Standard Operating Procedure SOP No. 7
ROUTINE FILTER INSPECTIONS

Date Adopted: September 23, 1999

Date Revised: January 7, 2012

Background: This example standard operating procedure (SOP) is Number 7 in a coordinated series of SOPs for operating the City of Aguaville SWTP. SOPs 1 through 6 would cover topics such as:

- Routine filter backwash procedure
- Turbidity monitoring
- Disinfection level monitoring

Every SWTP should have SOPs that are kept up to date. All the operators should use the SOPs. That is how you can ensure that things are done the same way each time.

Reason for Revision: To reformat the SOP and add a pre-backwash filter-inspection step, and some additional safety precautions, and insert Equation 7.3.

Summary: This SOP contains the procedures for conducting a routine filter inspection. The procedures for conducting a variety of special filter studies are found in other SOPs. The process for conducting a routine filter inspection requires at least two staff members and involves a series of steps:

1. preparing a filter diagram;
2. partially draining the filter and measuring the filtration rate;
3. observing the (pre-backwash) condition of the filter media surface;
4. looking for any unusual conditions during a routine filter backwash;
5. draining the filter;
6. observing the (post-backwash) condition of the filter media surface;
7. making several filter bed measurements, including
    a. the levelness of the filter media surface,
    b. the depth of the filter media, and
    c. the levelness of the support gravel and underdrain;
8. excavating the media to identify any unusual filter conditions;
9. backwashing the filter again to
    a. restratify the media and
    b. measure the bed expansion and backwash water flow rate at the maximum backwash rate; and
10. returning the filter to service.

IMPORTANT

Use **extreme caution** to ensure operator safety, especially in the case of the large filters at Plant No. 2 where confined spaces and high backwash water flow rates exist. In addition, **extreme caution** is also required to prevent damage to the washwater troughs, filter underdrain and support gravel, and filter media.

Filter evaluations require a team of at least two licensed water works operators. At least one of the operators must hold a valid Class C Surface Water license.

Failure to comply with the requirements of this SOP is grounds for disciplinary action up to and including termination.

Equipment Needed:

One filter probe
One 1-inch wide tape measure or a 1-inch wide yardstick
Four 2 ft × 2 ft pieces of ¼-inch plywood
One 2 ft × 3 ft piece of ⅜-inch plywood
One stopwatch
One 8 ft to 10 ft length of 2 × 4
One 1 ft × 1 ft × 2.5 ft (H) plexiglass excavation box
One 2-inch diameter PVC filter-coring tool will be needed if special studies will be conducted following the routine inspection

Procedure:

Step 1—Prepare a Filter Diagram

Prepare a diagram of the filter showing the location of the filter inlets, outlets, and backwash trough. Although the diagram does not have to be exactly to scale, it is helpful if the diagram is drawn as large as possible and looks like the filter.

Step 2—Partially Draining the Filter and Measuring Filtration Rate

1. Close the filter influent valve completely.
2. Leave the filter effluent valve open.
3. Record the filtered-water flow rate from the filter's flowmeter.
4. Measure and record the amount of time that it takes for the water level to fall 6 inches. If possible, make this measurement while the water level is at least 6 inches above the top of the backwash trough. If the water level is not at least 6 inches above the top of the backwash trough, wait until the water level is below the top of the trough to begin the measurement.
5. Leave the filter effluent valve open until the water reaches the surface of the filter media.

Step 2—Partially Draining the Filter and Measuring Filtration Rate, continued

6. When the water reaches the surface of the filter media, take one of the two following actions:
    A. At Plant No. 1 (which does not have filter-to-waste facilities), leave the filter effluent valve open for three minutes after the water level reaches the surface of the filter media, and then completely close the valve.
    B. At Plant No. 2 (which does have filter-to-waste facilities):
        i. Completely close the filter effluent valve.
        ii. Open the filter-to-waste valve for eight minutes.
        iii. Completely close the filter-to-waste valve.
7. Determine and record the wetted surface area of the filter.
    A. If the drawdown was measured above the wash water trough, calculate the surface area of the filter.
    B. If the drawdown was measured below the top of the trough, determine the total area between the troughs.
8. Calculate the filtration rate using Equation 7.1 shown on the following page.
9. Compare the calculated filtration rate with the filtration rate shown on the filtered water flowmeter.

Equation 7.1: Calculating the filtration rate

$$\text{Filtration rate (gpm)} = \frac{\text{drawdown (inches)} \times \text{surface area (ft}^2\text{)} \times \left[\frac{\text{ft}}{\text{12 in}}\right] \times \left[\frac{\text{7.48 gal}}{\text{ft}^3}\right]}{\text{time (minutes)}}$$

$$= \frac{\text{drawdown (inches)} \times \text{surface area (ft}^2\text{)} \times 0.6233}{\text{time (minutes)}}$$

IMPORTANT

This part of the filter evaluation requires an operator to climb down into the filter. **Operators must take the following precautions to avoid injury and filter damage.**

1. At least two licensed operators must be present any time that an operator enters a filter. One of the operators must carefully enter the filter and make the measurements while the other remains outside the filter to record the data. Class D operators **may not** enter the filter.
2. Filter surfaces are often wet and slippery. Any operator who enters the filter must wear slip-resistant shoes.
3. We have designated all of the filters at Plant No. 2 as "confined spaces" because they are very deep filter boxes and some of them are partially covered. Consequently, any operator who enters those filters must:
    a. have a signed Confined Space Entry Request form prior to entering the filter,
    b. wear a safety harness, and
    c. be secured by a safety rope whenever he or she is inside the filter.
4. Operators are encouraged to take identical precautions when entering the filters at Plant No. 1.
5. Operators **must not** stand or walk in the fiberglass backwash troughs at Plant No. 1 because the troughs can be severely damaged.
6. The ¼-inch plywood boards **must** be used to distribute and support the weight of the operator whenever they are walking or standing on the filter media.

1. Lower the ladder into the filter using one of the following procedures:
    A. At Plant No. 1 (which uses lightweight fiberglass backwash troughs), the troughs **will not** support the weight of an individual. Consequently, the following procedure **must** be used on Filters No. 1–4:
    B. Lower the ⅜-inch plywood into the filter and place it directly on the filter media near the wall where the operator will enter. This board will then be used as the support footing for the ladder.
    C. Lower the ladder into the filter and center its feet on the piece of plywood.
    D. At Plant No. 2 (which has concrete backwash troughs), the troughs will support the weight of an individual. Consequently, when inspecting Filters No. 5–8, operators can either use the procedure described in item A above, or they can lower the ladder so that its feet are securely positioned directly in the backwash trough.

2. Secure the top of the ladder to the top of the filter or the filter railing using a strong rope or chain.
3. If a safety harness is being used, secure the end of the lanyard to the filter railing at a location where the operator standing outside the filter can reach it.
4. The operator who will be making the measurements must **carefully** enter the filter. The operator who will be recording the data **must** remain outside the filter as a safety precaution.
5. Lower the tape measure, the ¼-inch plywood pieces, the straight 2 × 4, and other equipment into the filter.
6. Observe the surface of the filter media for the following media conditions.
    A. **Thickness of the floc mat:** Measure the thickness of the floc mat at several locations throughout the filter.
    B. **Distribution of floc mat:** Specifically, look for areas where the floc has accumulated to an unusual depth or has not accumulated to the same degree as in the rest of the filter.
    C. **Mudballs:** Specifically, look for areas where mudballs appear to be accumulating on the surface of the media.
    D. **Significant media mounds or depressions:** Specifically, look for areas where the depressions or mounds exceed 1½ inches in depth or height.
    E. **Filter cracks:** Specifically, look for cracks that are more than 6 inches long, more than ¼-inch wide, or more than ½-inch or so deep. Some small cracks may form as the filter dewaters, but larger cracks suggest that the filter media has been coated with an excessive coagulant layer.
    F. **Separation from filter wall:** Specifically, look for areas where the media has separated from the wall more than ¼ inch, the length of the separation exceeds 6–8 inches, or the separation is more than 1 inch deep. Some separation from the filter wall may occur as the filter dewaters, but separations that exist before the filters dewater suggest that the filter media has been coated with an excessive coagulant layer.
7. On the filter diagram, record the location of any unusual conditions seen on the media surface and describe the condition in detail on a separate sheet of paper.
8. Remove any equipment that was taken into the filter.
9. Exit the filter and remove the ladder and the ¼-inch plywood piece if it was used.

Step 4—Looking for Unusual Conditions during a Backwash Cycle

1. Make sure that none of the equipment used while observing the filter media surface during Step 3 remains in the filter.
2. Open the filter backwash valve **slightly** and allow that water to rise to 6–8 inches below the bottom of the backwash-water trough.

Step 4—Looking for Unusual Conditions during a Backwash Cycle, continued

3. Complete a routine backwash of the filter following the backwash procedure in the City's other SOPs describing routine filter backwash procedures. During the backwash cycle, observe the condition of the filter for the following unusual backwash conditions:
    A. **Levelness of the backwash trough:** Specifically, look at the top of the backwash water troughs to determine if water flows over some sections of the trough sooner than others.
    B. **Trough flooding:** Specifically, look for areas where flooding is occurring in one or more of the troughs.
    C. **Media boils and jets:** Specifically, look for areas where the backwash is producing a significantly more vigorous rolling action in the media. Pay particular attention to areas along the filter wall.
    D. **Media loss:** Specifically, look for media carryover into the backwash water troughs. Pay particular attention to areas where the carryover appears to be localized.
    E. **Lack of media agitation:** Specifically, look for areas where the media is moving very little. Again, pay particular attention to the areas along the filter wall and in the corners of the filter.
4. Record the location of any undesirable backwash conditions on the filter diagram, and describe the condition in detail on a separate sheet of paper.
5. Record the turbidity level of the spent backwash water at the end of the backwash cycle.

Step 5—Draining the Filter

1. Make sure that the influent and filter backwash are completely closed.
2. Open the filter effluent valve and wait approximately 45 minutes to allow the filter to completely discharge to the clearwell.
3. At Plant No. 2 (which is equipped with filter-to-waste facilities), open the filter-to-waste valve after 15 minutes.

Step 6—Observing the (Post-Backwash) Surface of the Filter Media

1. Repeat the filter-surface-inspection process described in Step 3.
2. Using the filter diagram, record the location of any unusual conditions seen on the media surface, and describe the condition in detail on a separate sheet of paper.

Step 7—Filter-Bed Measurements

IMPORTANT

Avoid injury; be safe. This part of the filter evaluation requires an operator to climb down into the filter. Operators must take the following precautions to avoid injury and filter damage.

1. At least two licensed operators must be present any time that an operator enters a filter. One of the operators must carefully enter the filter and make the measurements while the other remains outside the filter to record the data. Class D operators may not enter the filter.
2. Filter surfaces are often wet and slippery. Any operator who enters the filter must wear slip-resistant shoes.
3. We have designated all of the filters at Plant No. 2 as "confined spaces" because they are very deep filter boxes and some of them are partially covered. Consequently, any operator who enters those filters must:
   a. have a signed Confined Space Entry Request form prior to entering the filter,
   b. wear a safety harness, and
   c. be secured by a safety rope whenever he or she is inside the filter.
4. Operators are encouraged to take identical precautions when entering the filters at Plant No. 1.
5. Operators **must not** stand or walk in the fiberglass backwash troughs at Plant No. 1 because the troughs can be severely damaged.
6. The ¼-inch plywood boards **must** be used to distribute and support the weight of the operator whenever they are walking or standing on the filter media.

1. Close the filter effluent valve.
2. Lower the ladder into the filter using one of the following procedures:
   A. At Plant No. 1 (which uses lightweight fiberglass backwash troughs), the troughs **will not** support the weight of an individual. Consequently, the following procedure **must** be used at Plant No. 1:
      i. Lower the ⅜-inch plywood into the filter and place it directly on the filter media near the wall where the operator will enter. This board will then be used as the support footing for the ladder.
      ii. Lower the ladder into the filter and center its feet on the piece of plywood.
   B. At Plant No. 2 (which has concrete backwash troughs), the troughs will support the weight of an individual. Consequently, the operators can either use the procedure described in item A above, or they can lower the ladder so that its feet are securely positioned directly in the backwash trough.
3. Secure the top of the ladder to the top of the filter or the filter railing using a strong rope or chain.
4. If a safety harness is being used, secure the end of the lanyard to the filter railing at a location where the operator standing outside the filter can reach it.
5. The operator who will be making the measurements must **carefully** enter the filter. The operator who will be recording the data **must** remain outside the filter as a safety precaution.
6. Lower (do not drop) the filter probe, the straight 2 × 4, the ¼-inch plywood pieces, and other equipment into the filter.

Notes

1. Lay the straight 2 × 4 across the tops of adjacent troughs so that it spans the space between the troughs and provides a reference point for the measurements between the filter troughs.
2. Operators **must not** stand or walk directly on the surface of the filter media.
   a. At Plant No. 1 (which has fiberglass troughs), the operator **must** conduct the procedure while standing on the ¼-inch plywood pieces placed directly on the filter bed.
   b. At Plant No. 2 (which has concrete backwash troughs), the operator can either make the measurements while standing and walking in the troughs or by using the method described for plant No. 1 above. However, if the operator cannot reach the area between the troughs, the Plant No. 1 method must be used.

7. Keeping the probe perpendicular, probe the filter at two-foot intervals.
   A. Determine the levelness of the media surface by measuring the distance from the top of the filter trough to the surface of the media.
      i. Lower the probe until it just touches the top of the filter media.
      ii. Record the distance (to the nearest inch or less) directly on the filter diagram.
   B. Measure the depth of the media bed to the top of the gravel support layer or, if the filter uses a gravel-less underdrain, to the top of the underdrain.

IMPORTANT:
Do not push the probe into the gravel layer. Be **extremely** careful not to press the probe so far down that it damages the filter underdrain.

      i. Press the probe down into the media until a change in resistance is felt or until the sound of the probe passing through the media changes.
      ii. Record the depth (to the nearest inch or less) directly on the filter diagram.
8. Determine levelness of the support gravel/underdrain.
   A. Either:
      i. measure the distance from the top of the backwash trough to the surface of the support gravel or gravel-less underdrain; or
      ii. measure the depth of the media layer and the distance from the media surface to the top of the backwash trough and add the two readings.
   B. Record the result directly on the filter diagram.
9. Reduce the interval if significant differences are detected between adjacent measurements for either (1) the distance to the media surface, or (2) the media depth.
   A. If the distance or depth between adjacent measurements varies by more than 2 inches vertically, make an additional set of measurements at the midpoint of the two points.
   B. If the distance or depth continues to vary by more than two inches vertically, continue to measure at midpoints until the distance between the measurements is only three inches horizontally.
10. Probe the filter at each site where an undesirable filter backwash or media-surface condition was identified.

Step 8—Excavating the Filter

IMPORTANT:

Be safe. Operators must take some extremely important precautions to avoid injury and filter damage.

1. Operators must comply with all of the safety requirements described in Step 7.
2. Do not disturb the gravel support bed when excavating the media at each site.
   a. Excavation at each site must be stopped as soon as the operator detects small gravel (that is, ¼- to ⅛-inch gravel).
   b. The upper 75% of the filter bed can be excavated by hand or with a small shovel.
   c. The lower 25% of the filter bed **must** be excavated by hand.
3. Do not walk or stand directly on the filter media.
4. If the filter design does not allow the filter to be completely drained, do not attempt excavation below the remaining water level without an excavation box.

Notes:

1. During the filter excavation, note and record the following information:
   a. If mudballs are present, note their size and shape and how far they have penetrated into the media bed.
   b. If the filter contains more than one type of media, note how distinct the interface is between the different media layers, that is, the degree of stratification.
   c. If the filter contains more than one type of media, note how much intermixing of the media layers is present.
2. If the excavation cannot be completed because of the presence of subsurface standing water or other conditions that cause the walls of the excavation hole to collapse, it may be useful, or even necessary, to use the excavation box. **Do not force the excavation box so deep that it penetrates into the gravel layer.**

1. Make sure that all of the filter bed measurement activities required in Step 7 have been completed.
2. Place the ¼-inch plywood pieces on the filter media about a foot from the area to be excavated.
3. Clean a 3 ft^2 area on the opposite side of the excavation site by scraping off the top ¼-inch of filter media and placing it in a pile on one end of the scraped area.
4. Excavate a 6- to 8-inch diameter hole in the filter bed.
5. Excavate the top 3 to 6 inches of the media bed.
   A. If mudballs are present, note their size and shape and the depth of penetration.
   B. Place the excavated media in a pile at one end of the scraped area.
6. Excavate the remainder of the upper media layer.
7. If mudballs are present, note their size and shape and the depth of penetration. For example, “pancake-shaped mudballs with a diameter of ½ to ¾ inches have penetrated three inches into the anthracite layer.”
8. Place this layer of excavated media in a pile adjacent to the previous pile.

Step 8—Excavating the Filter, continued

9. If the filter contains multiple media materials, describe the interface between the layers. For example, "14 inches of clean anthracite is located above a 2-inch layer of intermixed sand and anthracite that contains about 40% sand and 60% anthracite."
10. If the filter bed contains more than one media layer, continue the excavation—that is, repeat step 5 until all the layers between the surface of the media and the upper gravel layer have been excavated and described.

IMPORTANT:
Stop the excavation as soon as the samples contain more than about 10% gravel; **do not** excavate the gravel layer.

11. Replace the media after completing the excavation.
    A. Return the media to the hole in the opposite order that it was removed. That means last out = first in.
    B. Pack each layer slightly by hand as it is replaced.
    C. If there is media left over after filling the excavation hole, spread it around in the general area of the excavation site and the cleared area.
12. Repeat steps 1–7 in each area where unusual backwash or media conditions were observed or noted during the media probing.
13. Collect "Core Samples" as described in the SWTP's other SOPs that describe how to perform special filter studies if any special studies are to be conducted on the filter media.
14. Remove the filter probe, tape measure, plywood squares, and any other equipment from the filter.
15. Close the filter-to-waste valve.

Step 9—Measuring Bed Expansion and Backwash Water Flow Rate

IMPORTANT

During the backwash process, large volumes of water are used and high water velocities exist in the backwash troughs and spent backwash water channel. Consequently, whenever possible, the evaluation team should collect the data required in this step without being in the filter during the backwash cycle. **However, if an operator needs to be in the filter during a backwash cycle, the following precautions must be taken to avoid injury.**

1. At least two licensed operators must present any time that an operator enters a filter. One of the operators must carefully enter the filter and make the measurements while the other remains outside the filter to record the data. Class D operators may **not** enter the filter.
2. Filter surfaces are often wet and slippery—any operator who enters the filter must wear slip-resistant shoes.
3. Any operator who is inside the filter box during a backwash procedure must wear a safety harness that is securely anchored to the filter wall or some other similarly immovable object. The lanyard, or safety rope, must be short enough to prevent the operator from becoming submerged in the filter bed, backwash trough, or spent backwash water channel.
4. Operators must stand at a location that will minimize the possibility of injury of filter damage.
    a. At Plant No. 1, the operators must stand on the top of the wall of the spent-backwash-water channel. Operators **must not** stand on the top of fiberglass backwash troughs at Plant No. 1 because they can be severely damaged.
    b. At Plant No. 2, the operator may either stand on the top of the wall of the spent-backwash-water channel or on the top of a backwash trough where it connects to the wall of the filter box.

1. Make sure that all of the filter excavation activities required in Step 8 have been completed.
2. The operator who will be making the measurements must get the Secchi disk. The operator who will be recording the data **must** remain outside the filter as a safety precaution.
3. Find a place to stand that has good footing, and use the lanyard to secure the safety harness to the filter wall or other similarly immovable object.
4. Remove the ladder and the ⅜-inch plywood piece if it was used.
5. Complete a routine backwash of the filter following the backwash procedure in this example facility's SOP for routine filter backwash procedures.
6. Determine if there are still any unusual backwash conditions that were observed in Step 4. If there are, record their location on the filter diagram.
7. Measure the height of the expanded media bed at the maximum backwash flow rate routinely used during the backwash cycle.
    A. Lower a Secchi disk into the filter media until a small amount of filter media from the expanded bed begins collecting on the top of the disk.
    B. Measure the distance from the top of the filter wall to the surface of the fluidized (that is, expanded) media bed.
    C. Record the result on the filter diagram.

Step 9—Measuring Bed Expansion and Backwash Water Flow Rate, continued

8. Measure the maximum backwash-water flow rate routinely used to backwash the filters.
    A. At the maximum backwash-water flow rate, record the flow rate that is being shown on the backwash-water flowmeter.
    B. At the maximum backwash-water flow rate, close the backwash waste drain valve.
    C. Measure and record the amount of time that it takes for the water level to rise 6 inches.
    D. Open the backwash waste valve.
9. Complete the backwash cycle as described in the WSC's routine filter backwash SOP.
10. Return the filter to service using the procedure described in the WSC's routine filter backwash SOP.
11. Measure the height of the unexpanded filter bed using the same process as described in item 7.
12. Lower the ladder into the filter using one of the following procedures:
    A. At Plant No. 1 (which uses lightweight fiberglass backwash troughs), the troughs **will not** support the weight of an individual. Consequently, the following procedure **must** be used on Filters No. 1–4:
        i. Lower the ⅜-inch plywood into the filter and place it directly on the filter media near the wall where the operator will enter. This board will then be used as the support footing for the ladder.
        ii. Lower the ladder into the filter and center its feet on the piece of plywood.
    B. At Plant No. 2 (which has concrete backwash troughs), the troughs will support the weight of an individual. Consequently, when inspecting Filters No. 5–8, operators can either use the procedure described in item A above, or they can lower the ladder so that its feet are securely positioned directly in the backwash trough.
13. Secure the top of the ladder to the top of the filter or the filter railing using a strong rope or chain.
14. Take the Secchi disk, carefully exit the filter, and remove the ladder and the ⅜-inch plywood piece if it was used.
15. Calculate backwash water flow rate using equation 7.2.

Equation 7.2: Calculating the backwash water flow rate

$$\text{Backwash rate (gpm)} = \frac{\text{rise (inches)} \times \text{surface area (ft}^2\text{)} \times \left[\frac{\text{ft}}{12\ \text{in}}\right] \times \left[\frac{7.48\ \text{gal}}{\text{ft}^3}\right]}{\text{time (minutes)}}$$

$$= \frac{\text{rise (inches)} \times \text{surface area (ft}^2\text{)} \times 0.6233}{\text{time (minutes)}}$$

Step 9—Measuring Bed Expansion and Backwash Water Flow Rate, continued

Calculate the percent bed expansion using equation 7.3.

Equation 7.3: Calculating the percent bed expansion

$$\%\ Expansion = \frac{\text{“height” of unexpanded bed (inches)} - \text{“height” of expanded bed (inches)}}{\text{total depth of media bed (inches)}} \times 100$$

------ End of Example SWTP SOP No. 7—Routine Filter Inspections -----