Filter Optimization

# Manage Filter Assets for Media Performance and Capital Planning

A filter asset management program can help any utility optimize operations and reduce costs.

Filters are a water treatment plant's last barrier for particulate and microbial contamination. Filter asset management can maximize filter service life, maintain optimal performance, and allow proactive budgeting

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MAINTAINING FILTER performance and continuously producing water that exceeds industry standards is every operator's goal. However, only a small percentage of US water filtration plants have filter asset management plans, and an even smaller subset follow the plan they have. Filter asset management includes underdrain design, filter media condition assessment, and filter media cleaning. Implementing a filter asset management program can help any utility optimize operations and reduce costs.

## UNDERDRAIN DESIGN CONSIDERATIONS

During a filter rehabilitation, the underdrain system will often require maintenance or replacement. Before your utility replaces its underdrain system, it's critical to clearly understand the role of an underdrain within a filter.

Filter media and an underdrain system drive filter performance, including water production, water quality, and maintenance and operating costs. Filtration is a batch process, so the effectiveness of each filter cycle depends on the effectiveness of each backwash.

An underdrain's purpose is threefold: collect the filtered water, prevent media from entering the effluent/backwash circuit, and maintain the filter media. Maintaining and cleaning the filter media is accomplished during the backwash cycle. During the backwash cycle, the underdrain should uniformly distribute backwash water and air scour to flush the accumulated solids from the filter media. To accomplish this, the underdrain should use the least amount of backwash water possible as constrained by media depth and collection trough location.

When the underdrain fails to properly perform any of its three purposes, the results can be any combination of the following:

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- Loss of filter media into the filter effluent
- Shortened filter cycle times
- Reduced quality of finished water
- Wasted backwash water
- Reduced plant capacity
- More frequent and/or more costly filter maintenance

If you have determined your existing underdrain needs to be replaced to correct one or more of these problems, your utility should consider how the existing basin configuration will challenge the replacement system. Foremost, consider where and how the backwash water enters the filter box. Backwash entrance location and the method by which the water is distributed to the underdrain will result in areas of high water velocity. The replacement underdrain system should be able to compensate for areas of high entrance and channel velocities to prevent lower backwash rates in these areas.

Many newer underdrain systems offer direct retention, which means they can prevent the loss of media into the filter effluent without the use of support gravel. Support gravel is often thought of as filter media; however, it's really a part of the underdrain system. Support gravel takes up volume that could be used for filter media. It can also mound and migrate over time, which reduces filter performance, so eliminating gravel should be a goal with any underdrain replacement.

## FILTER MEDIA CONDITION ASSESSMENT

Assessing the condition of filter media is an important first step in developing an effective filter asset management program. Laboratory analysis of filter media is an effective way to identify problems associated with system fouling, operation, and age degradation. Using the information from an analytical assessment, a utility can determine the most effective cleaning technology, the required operational changes, or the need for media replacement.

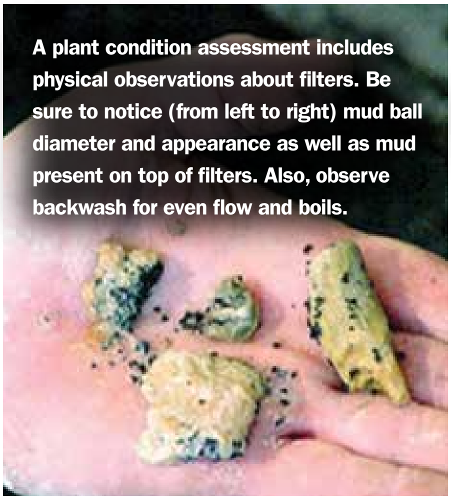
Filter problems such as head loss, media growth, reduced run times, and water quality can be attributed to deposit accumulation, both mineral and bacterial; media degradation; and operational issues such as excessive chemical feed. Bacterial deposits, referred to as biofilm, incorporate considerable volumes of polysaccharide slime that can reduce flow; promote mineral deposition; and, over time, harbor problematic organisms. Mineral deposits, which are a function of water chemistry, can smooth and round the media, reducing filtration effectiveness. Degraded media, displaying fractures and rounding, reduces filtration capacity.

## FILTER MEDIA CLEANING

The laboratory analysis should be designed to assess the presence of fouling deposits and the media's effectiveness. With this information, your utility can develop a cleaning program that targets the problems identified. A bacteriological analysis should cover the identity, quantity, and maturity of the biofilm to effectively evaluate potential issues. Mineral analysis can guide the potential cleaning process and identify operational issues such as excess coagulant or polymer. Sieve tests measure particle size and grain size distribution, identifying potential media loss and effects on filtration capacity. A laboratory bench-test study can evaluate the most effective cleaning chemistry and application procedures that target the problems identified in the analysis.

The cleaning chemistries most effective on mineral deposits are generally acid reactions. Various acids, both mineral and

Before and after photos show how filter media can be cleaned and restored to its original specification provided it hasn't lost angularity.



A plant condition assessment includes physical observations about filters. Be sure to notice (from left to right) mud ball diameter and appearance as well as mud present on top of filters. Also, observe backwash for even flow and boils.

organic, have various effects on specific materials, underlining the need to know what your utility's cleaning process is targeting. However, solubility is common to all acids. As the acid is neutralized and pH increases, the solubility decreases, resulting in reprecipitation. To maintain solubilized mineral ions and prevent the organic biofilm from reforming, use dispersion polymers with the acid to prevent reprecipitation and enhance the cleaning process.

A comprehensive asset management plan entails monitoring your system by evaluating records, inspecting on-site processes and equipment, and analyzing media samples at a laboratory. Such a plan yields many benefits for your utility, including more efficient operations, early identification of potential problems, and effective maintenance or replacement protocols.

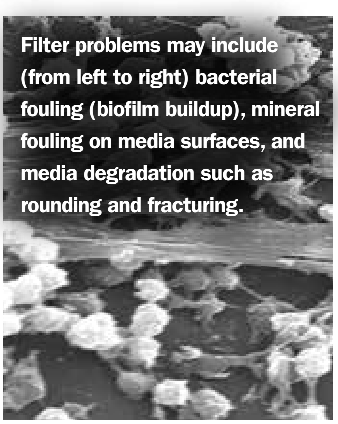
## FILTER ASSET MANAGEMENT

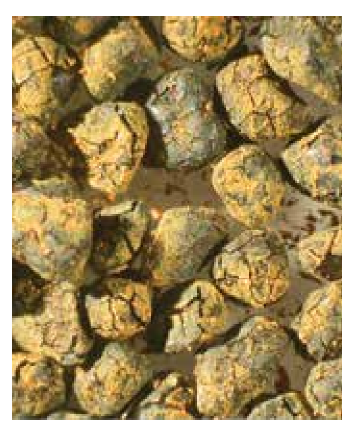
Filter asset management planning is a key component of maintaining a sustainable utility. The components of a filter asset plan should be reviewed and organized into a comprehensive asset management plan. Tools for developing a filter asset management plan include the following:

- Condition assessment
- Media sampling and analysis
- Renovation cost and life expectancy estimates

**Condition Assessment.** Condition assessment starts with a plant's overall condition and how well it meets the operating parameters of an optimized filtration plant. Filter run times for dual and multimedia filters should be 72–140 hr; for monomedia filters, run times should be 24–72 hr. Filtration rates should fall between 1.4 gpm/ft$^2$ and 4 gpm/ft$^2$. Filter effluent turbidity regulations require 0.3 ntu 95 percent of the time. Best practice for filter effluent turbidity is 0.1 ntu, with optimized, well-operated plants showing .03–.05 ntu below the filters.

Physical observations about the filters should be recorded before and during the backwash cycle. A filter report should identify the media surface condition with any cracks, mounds, craters, or the presence and location of mud balls. During the backwash cycle, observe the troughs; there should be even flow into and out of the troughs. Report uneven flow through the media and media boils as well as the condition and operation of the surface wash or air scour system.



Filter problems may include (from left to right) bacterial fouling (biofilm buildup), mineral fouling on media surfaces, and media degradation such as rounding and fracturing.

**A comprehensive asset management plan includes the cost of all filter room upgrades, planned media sampling, planned cleaning, and media replacement.**

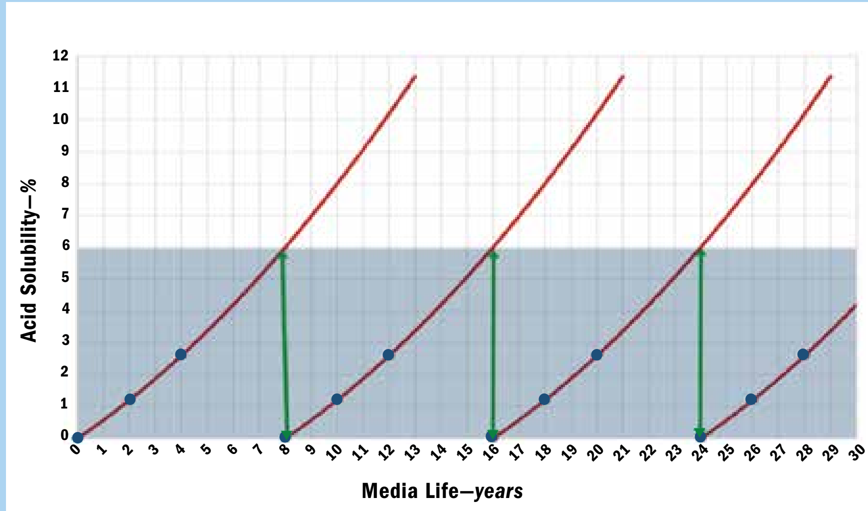
Record observations on the condition of the overall plant and building, including paint, electrical, lighting, heating, ventilation, air conditioning, flooring, instrumentation and controls, concrete, and windows and doors. The purpose is to identify anything and everything that needs to be part of a long-term plan to sustain filter operations.

**Media Sampling and Analysis.** Sampling filter media and tracking media degradation allow utilities to project when the media needs to be cleaned or replaced. Filter media can grow over time as a result of calcium carbonate, iron, manganese, and biological deposits. Media also wears out, or erodes, as it's backwashed and the grains collide, causing the media to round and lose size and uniformity. Media can last 20–30 yr if managed properly, or it may need to be cleaned or replaced in 4–10 yr in a depositing environment. Tracking media degradation through sampling every 2 yr in depositing and 4 yr in nondepositing conditions provides the information necessary for projecting media replacement and asset planning.

**Renovation Cost and Life Expectancy Estimates.** Regular periodic cleaning extends the life of media in a depositing environment. Media sample analysis results should include a laboratory's chemical, physical, and biological findings. Based on the laboratory recommendations, media can be cleaned and restored to its original specification provided it hasn't lost angularity (become rounded). Media should be cleaned before acid solubility reaches 10–12 percent. When it exceeds 10–12 percent, the media will require two or more chemical cleanings. Multiple-cleaning costs usually exceed replacement costs.

## Extending Media Life

**Regular periodic cleaning extends the life of media in a depositing environment.**




A comprehensive asset management plan includes the cost of all filter room upgrades, planned media sampling, planned cleaning, and media replacement. The life cycle used for predicting a scheduled media replacement can be based on historic replacement or projections of future needs. An asset management plan provides predictable fiscal budgeting and future cost estimates to help predict your utility's future financial needs.

### FINANCIAL BENEFITS

Developing and following a filter asset management plan can maintain, restore, and improve filter performance while extending asset life. Building a future-cost model will help identify the anticipated financial needs of your utility going forward and provide predictable budgeting into the future. Also, communicating the filter asset plan to utility managers and board members is critical to ensure accurate forecasts for short- and long-term capital funding.

## Develop a Financial Plan

**A filter asset management plan can maintain, restore, and improve filter performance while extending asset life.**
**Be sure to identify and price all necessary repairs and equipment life cycles.**

**Hypothetical Plant Asset Management Plan**

| | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Media | $ 2,000 | | $ 2,000 | | $2,000 | | $ 2,000 | | $2,000 | | $2,000 |
| Clean Media | | | | | | $ 30,000 | | | | | |
| Replace Media | $250,000 | | | | | | | | | | |
| Replace Surface Wash | $100,000 | | | | | | | | | | |
| Rehab Surface Wash | | | | | | | $10,000 | | | | |
| Epoxy Coat Filters Box | $300,000 | | | | | | | | | | |
| Rehab Underdrains | $ 60,000 | | | | | | | | | | |
| Replace Underdrains | | | | | | | | | | | |
| | $712,000 | $- | $ 2,000 | $- | $2,000 | $ 30,000 | $12,000 | $- | $2,000 | $ - | $2,000 |

| | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 |
|---|---|---|---|---|---|---|---|---|---|---|
| Sample Media | | $2,000 | | $ 2,000 | | $ 2,000 | | $ 2,000 | | $ 2,000 |
| Clean Media | $30,000 | | | | | $30,000 | | | | |
| Replace Media | | | | | | | | | | $ 250,000 |
| Replace Surface Wash | | | | | | | | | | $ 10,000 |
| Rehab Surface Wash | | | $ 10,000 | | | | | | | |
| Epoxy Coat Filters Box | | | | | | | | | | $ 300,000 |
| Rehab Underdrains | | | | | | | | | | |
| Replace Underdrains | | | | | | | | | | $ 400,000 |
| | $30,000 | $2,000 | $ 10,000 | $ 2,000 | $ - | $32,000 | $- | $ 2,000 | $ - | $ 962,000 |