US EPA (Region 4) and
NC Division of Environmental Health (Public Water Supply Section)

Area Wide Optimization Program
"AWOP"

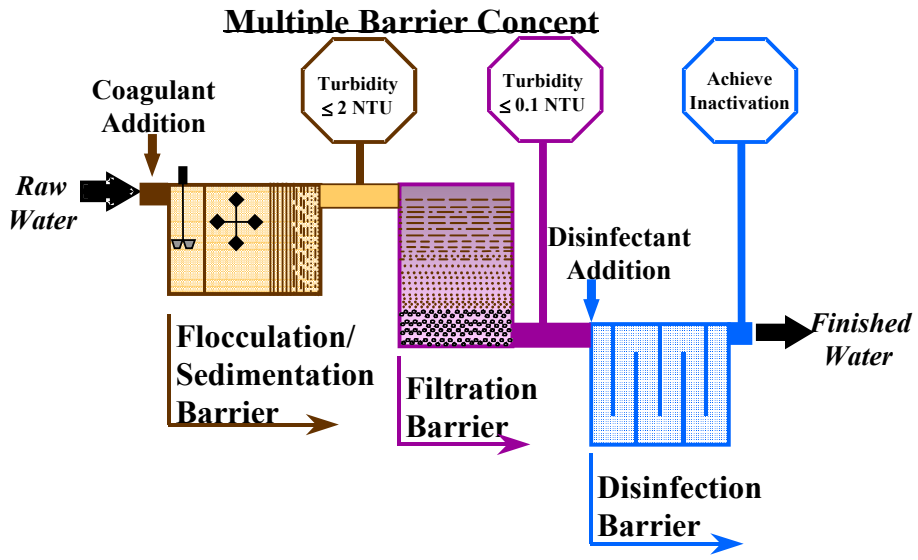
The Multi-State Pilot Program was established by EPA/Region 4 in response to requests for information and training for Comprehensive Performance Evaluations (CPE) of water treatment facilities that failed to meet turbidity performance requirements of the Interim Enhanced SWTR. The CPE, along with Comprehensive Technical Assistance (CTA) is a part of the Composite Correction Program (CPP) as identified in the '96 amendments to the SWTR. The Center for Drinking Water Optimization ({w/Process Applications Inc.} (Boulder, CO), along with EPA's Technical Support Center (Cincinnati, OH) are the principal authors and coordinators of the program. Several other states have individually begun this approach to performance enhancement, but this is the first group effort. Initial members of the R4 program (established in '98) were South Carolina, Georgia, Alabama, Kentucky and EPA's/ R4 staff. North Carolina shares these interests and joined the group in August 2000.

The goals of AWOP are to eliminate or reduce fluctuations in water quality and treatment facility performance with particular attention to turbidity removal and optimization and are similar to those of the Partnership for Safe Water sponsored by AWWA, USEPA, ASDWA, et.al.

Conventional surface water treatment is based on the multi-stage barrier concept (illustrated in Figure 1):

- Select the best source water available (and protect that source),
- Provide flocculation & sedimentation barrier to allow particulates to settle, thereby reducing the work load for filters,
- Provide filtration barrier to physically remove particles that may harbor microbial contaminants,
- Provide disinfection barrier, with adequate contact time, to inactivate microbial contaminants.

Figure 1



Many utilities operate water treatment facilities and equipment that were in service during the 1970's, when turbidity standards were 5.0 JTU. Others may have made minor improvements to comply with the 1980's & '90's standards of 1.0 NTU, and a few have new facilities or major renovations to meet the 0.5 NTU standard of the late 1990's. It's now up to the operators to enhance the performance of their respective facilities.

Specific performance goals for NC's surface water treatment facilities are:

Sedimentation/Clarification

- Settled water turbidity of less than 2 NTU 95 percent of the time where average annual raw water turbidity is greater than 10 NTU.
- Settled water turbidity of less than 1 NTU 95 percent of the time where average annual raw water turbidity is less than or equal to 10 NTU.

Filtration Performance Criteria

- Filtered water turbidity of less than 0.1 NTU 95 percent of the time (excluding 15 minute period following backwashes).
- Maximum filtered water turbidity of 0.3 NTU.
- Particle counts $\leq$10 / ml in the 2-18 micron sizes (if available)
- Filtered water turbidity <0.1 NTU within 15 minutes following backwash

Water Quality Criteria

- Finished water pH and disinfectant residual should be maintained as consistent as possible, and should be site specific for each facility

Distribution System Performance

- Maintain a complete, systematically performed flushing program with storage tanks inspected at least annually and cleaned as necessary.
- Maintain water quality throughout the distribution system to exert the least disinfectant demand possible.
- Manage water quality in the distribution storage facilities through frequent water turnover.

These **performance goals are focused on turbidity removal**, largely based on the correlation that reducing finished water turbidity from 0.3 to 0.1 NTU is the equivalent of an additional log removal of giardia and cryptosporidium. Water treatment facilities that meet these performance goals will provide higher quality drinking water to the customers, and further protect the public health by reducing the risk of microbial contamination that may pass through the filtration process.

Changes to the Environmental Protection Agency's (EPA) Surface Water Treatment Rule (IESWTR) have established that at no time can turbidity (cloudiness of water) go above 5 nephelometric turbidity units (NTU); systems that filter must ensure that the turbidity go no higher than 1 NTU (0.5 NTU for conventional or direct filtration) in at least 95% of the daily samples in any month. For surface water systems serving greater than 10,000 people, effective January 1, 2002, turbidity may never exceed 1 NTU, and must not exceed 0.3 NTU in 95% of

daily samples from the combined filter effluent in any month. This same standard will apply to those serving less than 10,000 people during January 2005.

Additionally, **performance "triggers**" have been established to make the water system more aware of the treatment facility operation. These are not violations, but excursions that require follow up actions by the utility, and are described in Table 1.

Table 1

Turbidity Excursion	**Required Action**
(1) > 1.0 NTU in 2 consecutive measurements	1. Record filter number, turbidity value & date 2. Produce filter profile w/in 7 days (or obvious reason for high turb.) 3. Report w/in 10 days after end of the month
(2) > 0.5 NTU in 2 consecutive measurements at the end of 4 hours of operation after back-washing or taking offline	1. Record filter number, turbidity value & date 2. Produce filter profile w/in 7 days (or obvious reason for high turb.) 3. Report w/in 10 days after end of the month
(3) > 1.0 NTU in 2 consecutive measurements in 3 consecutive months	1. Record filter number, turbidity value & dates 2. Perform self-assessment of filter w/in 14 days ➢ Assessment of filter performance ➢ Prepare filter profile ➢ ID/prioritize factors limiting filter's performance ➢ Assessment of corrections ➢ Preparation of report
(4) > 2.0 NTU in 2 consecutive measurements in 2 consecutive months	1. Record filter number, turbidity value & dates 2. Comprehensive Performance Evaluation ➢ Scheduled w/in 30 days ➢ Completed & final report submitted to State w/in 90 days

Comprehensive Performance Evaluations, along with filter profiles and assessments are actions required if a facility does not meet individual filter performance requirements specified in the IESWTR. It is the intent of the CPE to identify areas within the treatment plant that affect turbidity removal and performance, whether the problem is administrative, management, operations or maintenance derived. Additionally, performance limitations may not be design or structure related.

It is <u>not</u> the intent of a CPE to identify specific remedies, or "troubleshoot" performance items for the plant staff and management, but allow staff to determine the best course of action. The

follow-up segment to a CPE is the CTA, which is executed through Performance Based Training (PBT). This PBT usually involves operations and management staff from several treatment facilities that have been through the CPE process, and allows them the opportunity to review problem areas of treatment together, work collectively to determine solutions, and take this knowledge to their respective plants for implementation.

In 2001, **a priority ranking system** was introduced for surface water systems in North Carolina that reviews twelve month's turbidity information in an effort to anticipate facilities that may need CPE's. An abbreviated listing of systems' results for calendar year 2000 is indicated on Table 2 with a copy of the rating form on Table 3. We will be asking for these annually from each facility.

Table 2

NC Water Treatment Facilities

AWOP based Priority List - Limited listing

Year 2000

			Operational Data			**Total**
	Regulatory	Filtered Water	Settled Water	Raw Water	Plant	
PWS ID	Compliance	Turbidity	Turbidity	Turbidity	Score	
*******	20.0	1095.0	150.0	0.0	40.0	1305.0
*******	0.0	851.0	220.0	2.5	40.0	1113.5
*******	0.0	858.0	46.0	51.5	20.0	975.5
*******	0.0	87.0	685.0	163.0	0.0	935.0
*******	20.0	845.0	0.0	0.0	40.0	905.0
*******	0.0	545.0	0.0	0.0	0.0	545.0
*******	0.0	368.0	0.5	25.5	40.0	434.0
*******	20.0	237.0	49.0	59.0	20.0	385.0
*******	0.0	282.0	0.0	1.0	40.0	323.0
*******	0.0	29.0	146.0	139.0	0.0	314.0
*******	0.0	212.0	0.0	0.0	20.0	232.0
*******	0.0	113.0	8.0	9.0	0.0	130.0
*******	0.0	88.0	0.0	0.0	40.0	128.0
*******	0.0	10.0	0.0	77.0	20.0	107.0
*******	0.0	63.0	7.0	2.0	20.0	92.0
*******	0.0	7.0	2.0	44.0	0.0	53.0
*******	0.0	29.0	17.5	1.0	0.0	47.5
*******	0.0	1.0	0.0	0.0	20.0	21.0
*******	0.0	12.0	0.0	0.0	0.0	12.0
*******	0.0	1.0	1.0	0.0	0.0	2.0
*******	0.0	0.0	0.0	0.0	0.0	0.0
Mean	**2.3**	**144.9**	**43.4**	**23.1**	**19.1**	**232.8**

NOTE: Some systems didn't have data for the entire year for settled water turbidity

Table 3

Prioritization of NC Surface Water Systems for CPE Ranking

City of _____	System ID #		**0*-**-***
_____ WTP			
		Calendar Year	**2001**
Regulatory Compliance for the Past 2 Years			**Score**
# Acute MCL Violations	0	x 40 points=	0
# MCL Violations	0	x 20 points=	0
# Treatment Technique Violations	0	x 20 points=	0
# Monitoring and Reporting Violations	0	x 5 points=	0
	Subtotal		0
Operational Data Based on 1 year			
Filtered Water Turbidity			
# Days Max Filtered Turbidity >1 NTU	0	x 20 points=	0
# Days Max Filtered Turbidity >0.5 NTU	0	x 10 points=	0
# Days Max Filtered Turbidity >0.3 NTU	0	x 2 points=	0
# Days Max Filtered Water Turbidity > 0.1 NTU	0	x 1 point	0
	Subtotal		0
Settled Water Turbidity			
# Days Settled Turbidity >10 NTU	0	x 5 points=	0
# Days Settled Turbidity >5 NTU	0	x 2 points=	0
# Days Settled Turbidity >2 NTU	0	x 0.5 points=	0
	Subtotal		0
Raw Water Turbidity			
# Days RawTurbidity >250 NTU	0	x 5 points=	0
# Days RawTurbidity >100 NTU	0	x 2 points=	0
# Days RawTurbidity >50 NTU	0	x 1 points=	0
# Days RawTurbidity >25 NTU	0	x 0.5 points=	0
	Subtotal		0
Plant Score			
Is the Plant operated 24 hours per day?	yes	No = 20 points	0
Does the plant have more than one clearwell?	yes	No = 20 points	0
	Subtotal		0
TOTAL SCORE			**0**

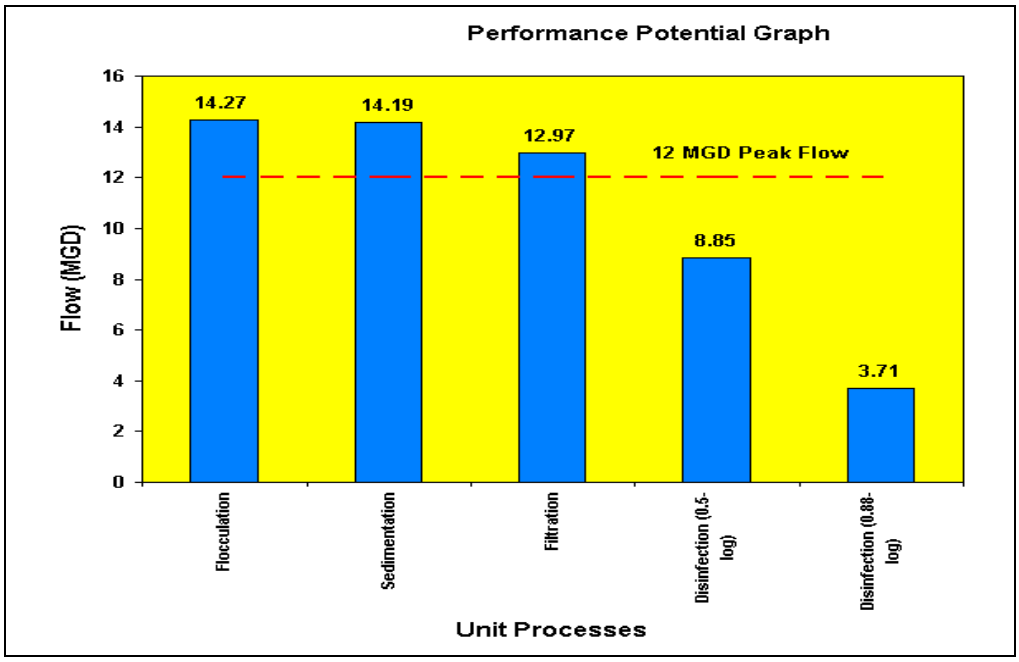
As reports are tabulated, it becomes apparent that the overall performance of a water treatment facility can be improved, simply by focusing the operating staff on a new goal. This can be seen in the change in system rankings as shown in Table 4. It should be noted, however that not all systems reported lower point totals, and a few actually increased significantly.

Table 4
Changes in Priority Ranking Point Totals

Plant	2000	2001
*******	128	94
*******	231.5	34
*******	410	303
*******	30	179

During the CPE, the **major treatment process units**, including flash mixers and flocculators, sedimentation basins, filters, and disinfection contact time can be evaluated for hydraulic capacity as shown on Figure 2. This graphically represents whether each unit is likely to meet performance expectations at a given flow rate, as indicated. This can be one of the evaluation tools to determine if the system is operating near it's capacity and for requests to increase flows through existing facilities, such as higher filter rates.

Figure 2



Filter assessments may be required and include media excavations and evaluation for uniform size, co-efficiency and accumulation of chemicals and /or "mudballs". During these evaluations, the media depth and surface configuration should be evaluated, (Figure 3) as well as the location and operational capabilities of air scours, surface sweeps, control valves and filter instruments. A filter profile should be performed to indicate performance through an entire filter cycle, including backwash (Figure 4). Many systems are currently addressing severe water shortages and may find this an appropriate investigation in order to reduce water usage, perhaps by reducing the length of filter backwash or increasing filter run times. Any modification to the

treatment process or equipment must be coordinated with the NC Public Water Supply Section on an individual basis.

Turbidity performance data collection is the initial step towards optimization and should be gathered from locations throughout the treatment facility. Spreadsheet software, developed by Process Applications, Inc., (available from NC PWSS) to assist the utility operators in monitoring turbidity through the treatment process. This has the capability to compile turbidity data raw water, each sedimentation basin and each filter, as well as the combined filter effluent; and generates graphs that visually indicate performance comparisons and efficiencies. This will be another means to evaluate plant performance as flow rates increase or water quality changes. It is especially apparent when turbidity "spikes" through the sedimentation process, and occasionally through the filters. This may also be effective to indicate if a particular basin or filter is not performing as expected, and will be support for the operations staff.

Figure 3