Public Act 12-155 Workgroup 3

BACKGROUND

In 2010 the United States Environmental Protection Agency (EPA) objected to two permits written by Connecticut Department of Environmental Protection (DEP) with an interim strategy of technology-based phosphorus limits.

DEP (now known as Connecticut Department of Energy and Environmental Protection or DEEP) shifted the strategy to one based on best available science with the intention that the strategy may be modified based on future findings from studies of the nutrient dynamics found in freshwater streams in Connecticut. This interim best available science based strategy was accepted by EPA.

A coalition of municipalities objected to the new strategy and entered into negotiations with DEEP concerning the new strategy and the resulting permit limits. Permits have since been issued to the coalition facilities with timetables requiring immediate treatment to at least 0.7 mg/l and implementation of final limits as defined by the interim strategy in seven and a half to nine years.

Public Act 12-155 put in place a collaborative program for the State of Connecticut Department of Energy and Environmental Protection (DEEP) and affected municipalities to evaluate and make recommendations regarding the DEEP interim nutrient management strategy for reducing phosphorus loading in inland non-tidal waters so as to meet current standards:

> *Section 1. The Commissioner of Energy and Environmental Protection, or the commissioner's designee and the chief elected officials of the cities of Danbury, Meriden and Waterbury and the towns of Cheshire, Southington and Wallingford, and the chief elected official of any other municipality impacted by the state-wide strategy to reduce phosphorus, or such chief elected officials' designees, shall collaboratively evaluate and make recommendations regarding a state-wide strategy to reduce phosphorus loading in inland nontidal waters in order to comply with standards established by the United States Environmental Protection Agency. Such evaluation and recommendations shall include (1) a state-wide response to address phosphorus nonpoint source pollution, (2) approaches for municipalities to use in order to comply with standards established by the United States Environmental Protection Agency for phosphorus, including guidance for treatment and potential plant upgrades, and (3) the proper scientific methods by which to measure current phosphorous levels in inland nontidal waters and to make future projections of phosphorous levels in such waters.*

The DEEP and affected communities assigned each of the numbered tasks to a workgroup for evaluation and recommendation. A coordinating committee was put in place to guide the workgroups.

CHARGE

The charge for Work Group 3 comes from Section 1 of PA 12-155:

> *". . .(2) approaches for municipalities to use in order to comply with standards established by the United States Environmental Protection Agency for phosphorus, including guidance for treatment and potential plant upgrades, . . ."*

Workgroup 3 is led by Co-Chair Dennis Waz, Director of Public Utilities for the City of Meriden and Co-Chair Rowland Denny, Senior Sanitary Engineer for the Municipal Facilities Section of the Water Bureau at DEEP. Numerous municipal officials, scientists, consulting engineers and environmental group representatives contribute to this workgroup.

Workgroup 3 developed and adopted the following scope of work:

> Review and make recommendations for use of technologies, methods, or a mix of approaches that can be applied to individual basins to reduce phosphorus to various levels. Consider technologies effective in removal of emerging contaminants. Identify tools that exist, prioritize methods and approaches to be employed, prioritize methods and approaches by cost/pound of total phosphorus removed/day.

The objective of Workgroup 3 is to provide a way of comparing the cost of various methods and approaches so municipalities can select the most cost-effective path for complying with the standards that Workgroup 2 is evaluating. The results of Workgroup 1 are to be integrated into this report as their report encompasses phosphorus non-point source controls and cost-effectiveness. This is intended to allow for a direct cost-effective comparison between point and non-point methods.

DATA COLLECTION

Two interns, Demetri Athanasiou and Judi Meunier, working for DEEP made contact with facilities in an attempt to gain information on performance capabilities, capital costs and operation and maintenance (O&M) costs of their phosphorus removal projects. They utilized a questionnaire developed by the workgroup to maximize the quality of data retrieved. Included were Ansonia, Bristol, Beacon Falls, Canton, Cheshire, Danbury, Killingly, Litchfield, Meriden, Naugatuck, Plainville, Southington, Wallingford and Windham, Connecticut, and Concord, Marlborough Easterly, Marlborough Westerly and Webster, Massachusetts.

Demetri and Judi searched for reports covering phosphorus removal project performance and costs.

Members of consulting engineering firms serving on the workgroup made information available concerning performance and costs of phosphorus removal projects that they were involved in. This included Bristol, Cheshire, Manchester and Plainville, Connecticut; Hudson, Marlborough Westerly and North Attleboro, Massachusetts; and Warwick, Rhode Island.

At least one member of the workgroup visited phosphorus removal facilities to see what information was available on the capabilities of some facilities and the associated costs.

REPORTS

Reports on nutrient removal technology were collected and reviewed for performance and cost data. This included the following reports: "Estimation of Costs of Phosphorus Removal in Wastewater Treatment Facilities: Construction *De Novo*", F. Jiang, et. al. 2004, "Wastewater Treatment Performance and Cost Data to Support an Affordability Analysis for Water Quality Standards", Montana DEQ in 2007, "Municipal Nutrient Removal Technologies Reference Document" EPA in 2008, "EPA Nutrient Control Design Manual" from 2010, "Evaluation of Practical Technology-Based Effluent Standards for Phosphorus and Nitrogen in Illinois" from 2011 and the 2012 supplement, "Cost Estimate of Phosphorus Removal at Wastewater Treatment Plants" Ohio EPA in 2013, "Emerging Technologies for Wastewater Treatment and In-Plant Wet Weather Management" EPA in 2013, "Lake Champlain Phosphorus Removal Technologies and Cost for Point Source Phosphorus Removal" by Tetra Tech Inc. in 2014 and "Six Municipalities, One Watershed: A Collaborative approach to Remove Phosphorus in the Assabet River Watershed" by EPA in March 2015.

DATA COLLATION AND EVALUATION

Demetri and Judi spent a significant amount of time collating the data and Demitri spent additional time working with the data we collected and plotting it on graphs.

DISCUSSION

CAPITAL COSTS

Very little information on the real capital costs of phosphorus removal facilities was found. True capital costs are hard to come by as they are usually lost in a wholesale upgrade or expansion and upgrade. Most of the reports we reviewed were based on simulations. These simulations were set up using many assumptions that can lead to widely varying costs.

A review of numerous reports by EPA provided in "A Compilation of Cost Data Associated with the Impacts and Control of Nutrient Pollution" in May of 2015 highlights the dilemma. Figure IV-10 illustrates the capital costs ($/gallon treated per day or $/gpd) as they relate to the level of treatment required to meet a specific effluent concentration (mg/l or milligrams per liter).

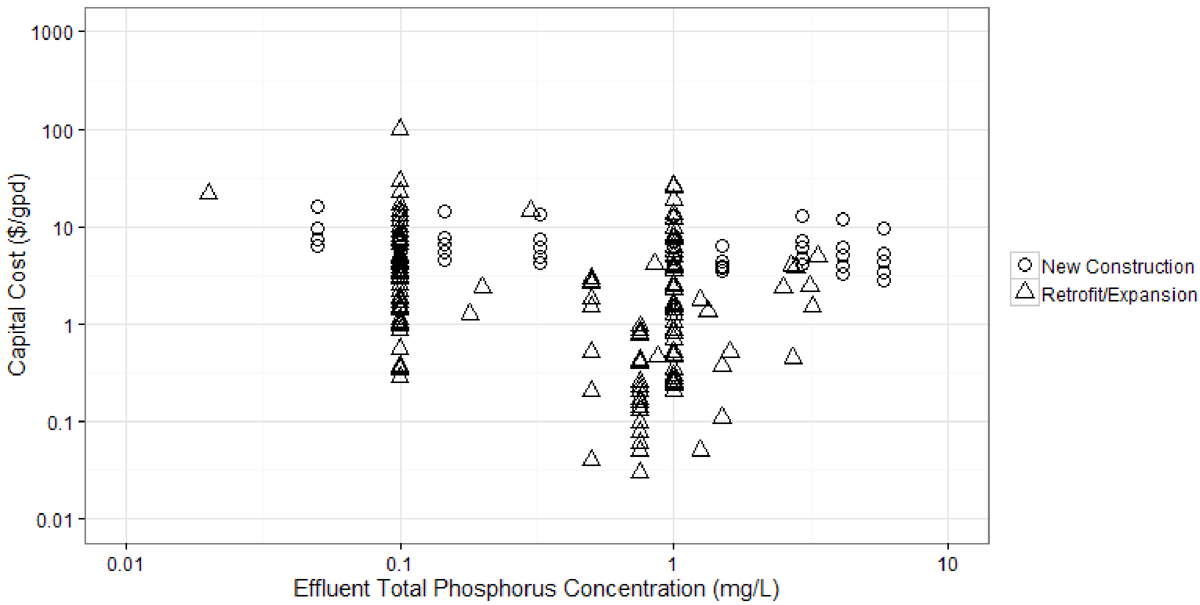


Figure IV-10. Capital cost and phosphorus effluent concentration for municipal WWTPs (2012$).

The widely varying costs encountered in their review of reports are well illustrated. For example, for an effluent total phosphorus concentration of 0.1 mg/l the costs range from $0.50 per gallon per day to $100 per gallon per day, a variation of 200 times.

As with many construction contracts at wastewater treatment facilities there are any number of local conditions that can affect the cost of a project. Some may have hydraulic limitations that require them to include pumping facilities, some may have limited area to add a new process that require them to use more expensive processes and/or construction techniques, some may be in high cost areas, some may be larger facilities that may gain an economy of scale. . . etc.

A continued review of the EPA report shows another limitation of reported data. In Table IV-3 below, there is an attempt to provide cost ranges (in $/gpd) as they relate to required treatment levels. The value of the reported data is lessened by the combining of treatment technology costs into three categories: two for treatment levels below 1 mg/l and one for those above 1 mg/l:

Effluent Quality (mg/L as P)	Removal Efficiency Range (%)	Capital Cost Range ($/gpd)[1]	Annual O&M Cost Range ($/gpd/year)[1]	Technologies
<1.0	75 – 99	0.03 – 22.17	<0.01 – 2.33	Chemical precipitation or any of a variety of BNR technologies - BNR frequently used in combination with tertiary filtration, ultrafiltration, and/or reverse osmosis.
<1.0	81 – 99	0.14 – 98.40	0.04 – 1.85	Lagoons and oxidation ditches capable of meeting this standard but at relatively higher unit costs.
>1.0	22 – 85	0.05 – 12.82	<0.01 – 1.55	Oxidation ditches, lagoons, and a variety of BNR systems.

[1] *All costs are in 2012$*

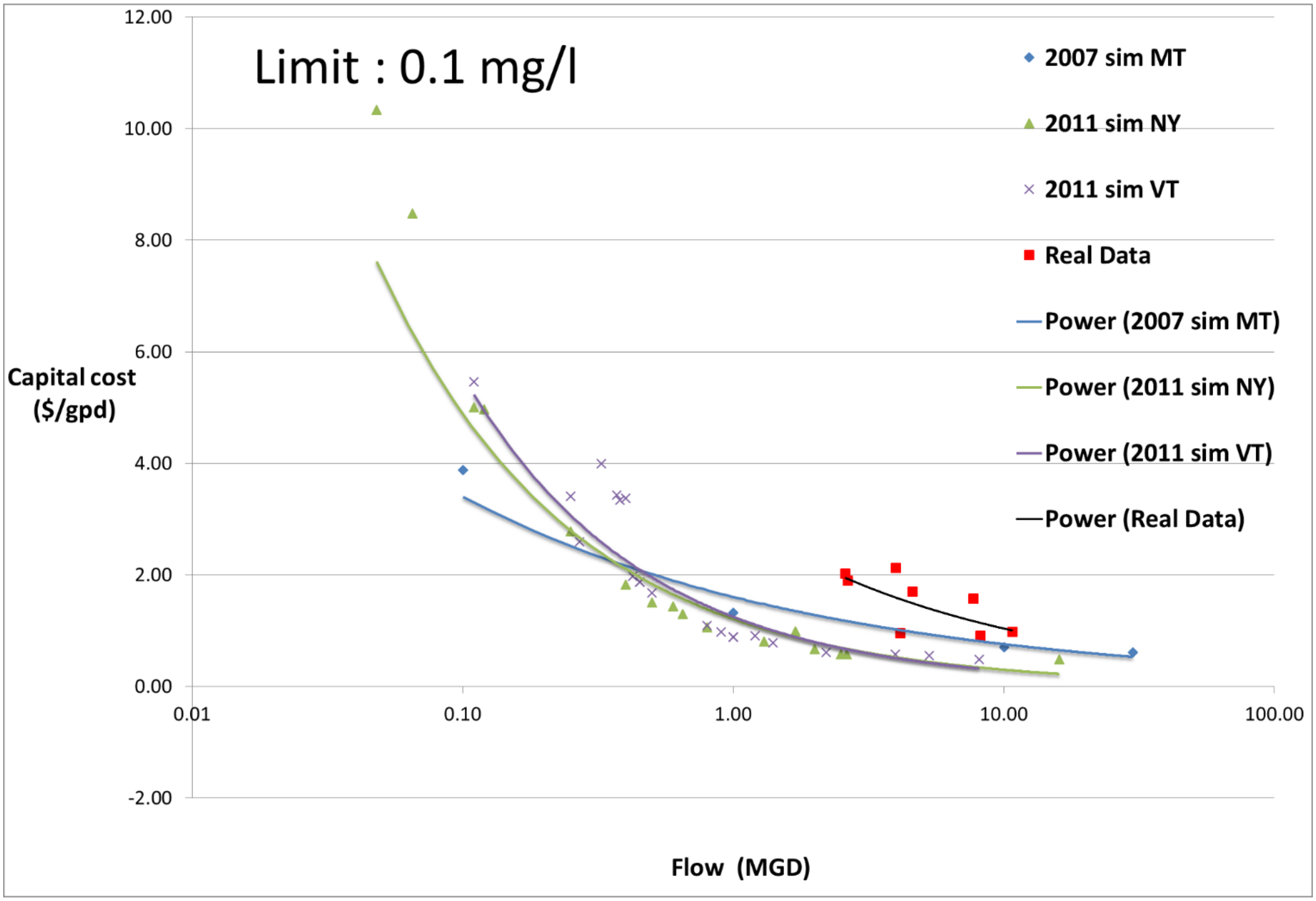
Table IV-3. Total Phosphorus Cost and Treatment Performance for Municipal WWTPs

The value of such data would be greatly enhanced if the categories were matched up with technological capabilities. Removal of total phosphorus down to 0.4 and sometimes 0.3 mg/l does not always require advanced treatment technologies and therefore does not require significant capital investment while removal below that level typically does require advanced treatment. The reporting of the costs of various technological levels of treatment in one group does not provide a realistic range for reference or comparison to ones' own facility.

Further review of the data that we compiled from reports showed some of the cost data were skewed to an unrealistically low cost per gallon treated as some of the simulations were based on facilities already removing total phosphorus to very low levels (such as 0.132 or 0.233 mg/l). Since these facilities were already using advanced phosphorus removal systems, the cost to remove total phosphorus to a slightly lower level (0.1 or 0.2 mg/l) did not entail a capital project but did end up as an artificially low cost per gallon. These were not plotted on the chart.

The members of the workgroup decided that the 2004 DeNovo data should be excluded as it appears to be less representative of current cost data. This may be due to the age of the report or the assumptions utilized.

Our search for real data provided fairly well defined capital costs for six real projects and estimated capital costs for two real projects. In the chart shown below we have capital costs for treatment technologies able to meet a 0.1 mg/l maximum limit in dollars per gallon per day ($/gpd) versus the design flow of the facility in million gallons per day (MGD).



When the eight real projects are plotted on the chart above there appears to be some correlation but variability is still an issue. Instead of having a 200 times variation in costs (as shown in Figure IV-10 on page 4) we have a 4 times differential. While this is better it is difficult to utilize such results for determining what steps an individual municipality should take to mitigate phosphorus impacts.

O&M

While it is clear that there is little real data available on the capital costs of phosphorus removal treatment facilities it is even more difficult to get data on the O&M costs of those facilities. It might be related to some facilities not having the infrastructure to be able to break out O&M costs related to phosphorus removal activities.

Whatever the case is, real data was not found and simulated data had variability issues similar to capital cost simulations. Therefore, a meaningful chart was not able to be constructed.

CONCLUSION

The objective of this workgroup was ". . . to provide a way of comparing the cost of various methods and approaches so municipalities can select the most cost-effective path for complying with the standards that Workgroup 2 is evaluating."

The intent was to provide a cost per pound of total phosphorus removed for different levels of treatment. The reports we reviewed provided simulated cost per gallon treated data with little to no data to support a cost per pound scenario.

With the lack of data and with variability of simulated data being an issue it would appear that it would be best for each municipality to engage an engineering firm to conduct a planning study to better define the range of capital and O&M costs one should expect at the level of treatment needed for each individual project. This way individual local conditions can be factored into the analysis. Those costs could then be compared to the Workgroup 1 costs for non-point remediation projects to provide some direction for municipalities.