Whole Effluent Toxicity

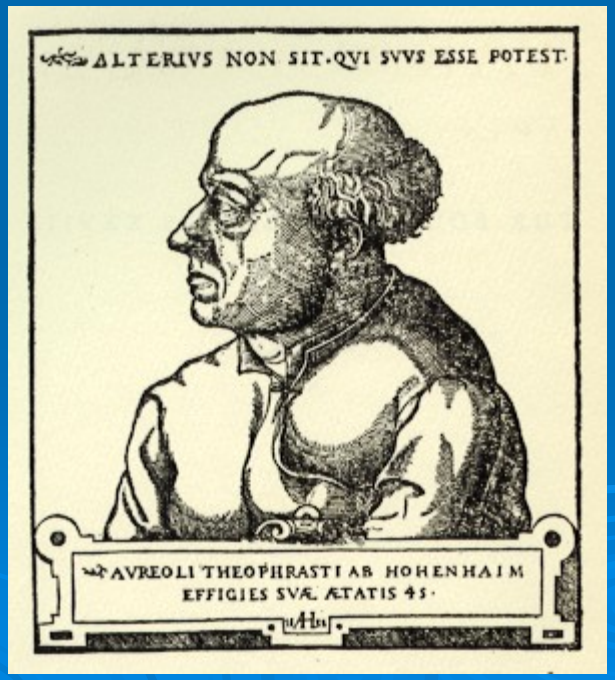
Pretreatment and TIE/TREs

Toxicology

Toxicology is defined as “the study of the adverse effects of chemical, physical or biological agents on living organisms and the ecosystem”

All substances are poisons: there is none which is not a poison. The right dose differentiates a poison and a remedy”

-Paracelsus (1493-1541)



History of Toxicity Testing

In the early 1800's there was an increase in synthetic chemical production and an increase in concern about what the chemicals were doing to people.

In the early 1920s, the LD50 idea was proposed by a British pharmacologist, J.W. Trevan. The LD50 represented the dose that would kill half the animals exposed to it.

This type of comparative toxicity index offered instant appeal to government regulators and has been used to this day.

WET Program History

- Early 1980's - Acute monitoring and limits used on a routine basis
- 1989 - Began use of chronic monitoring and chronic limits
- 1995 - Group permit challenge on chronic WET
- 1998 - Settlement and initial chronic WET program revisions

Settlement Agreement Requirements

- Variability Guidance Document
- Method Guidance Document
- Interlaboratory Variability Study
- Rulemaking actions

Conclusions

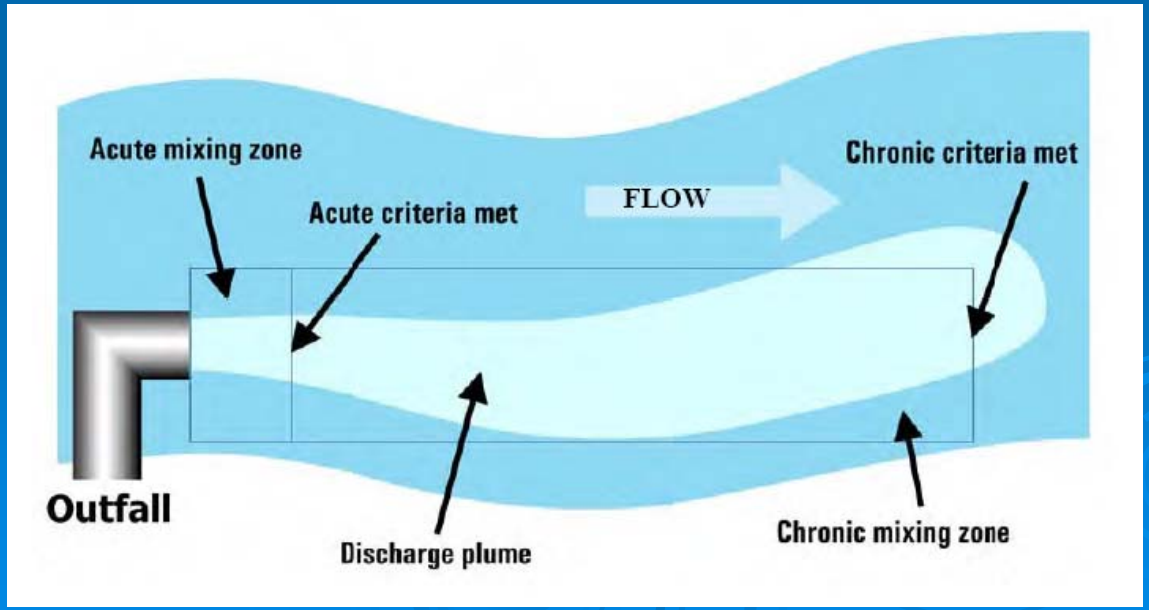
- WET Variability Study results confirmed EPAs conclusions that WET methods provide sufficient precision and can be reliably used in permits
- In September 2001, EPA proposed to ratify its previous approval of the methods evaluated in the study
- 2002 Methods manuals revised

Test Design Basics

Test Design

- Acute
- 24 hr, 48 hr, 96 hr
- Endpoint lethality

- Chronic
- 4 days or 7 days
- Endpoint lethality, growth and reproduction



WET Requirements

- Established after reasonable potential for WET is determined.
- Permit limits are based on the IWC for the facility and the WQS for the receiving stream.
- Existence of a pretreatment program or significant contributions from industrial users.

Acute Limit LC50 = 100%

Typical dose response where mortality increases as the concentration of effluent in the mixture increases.

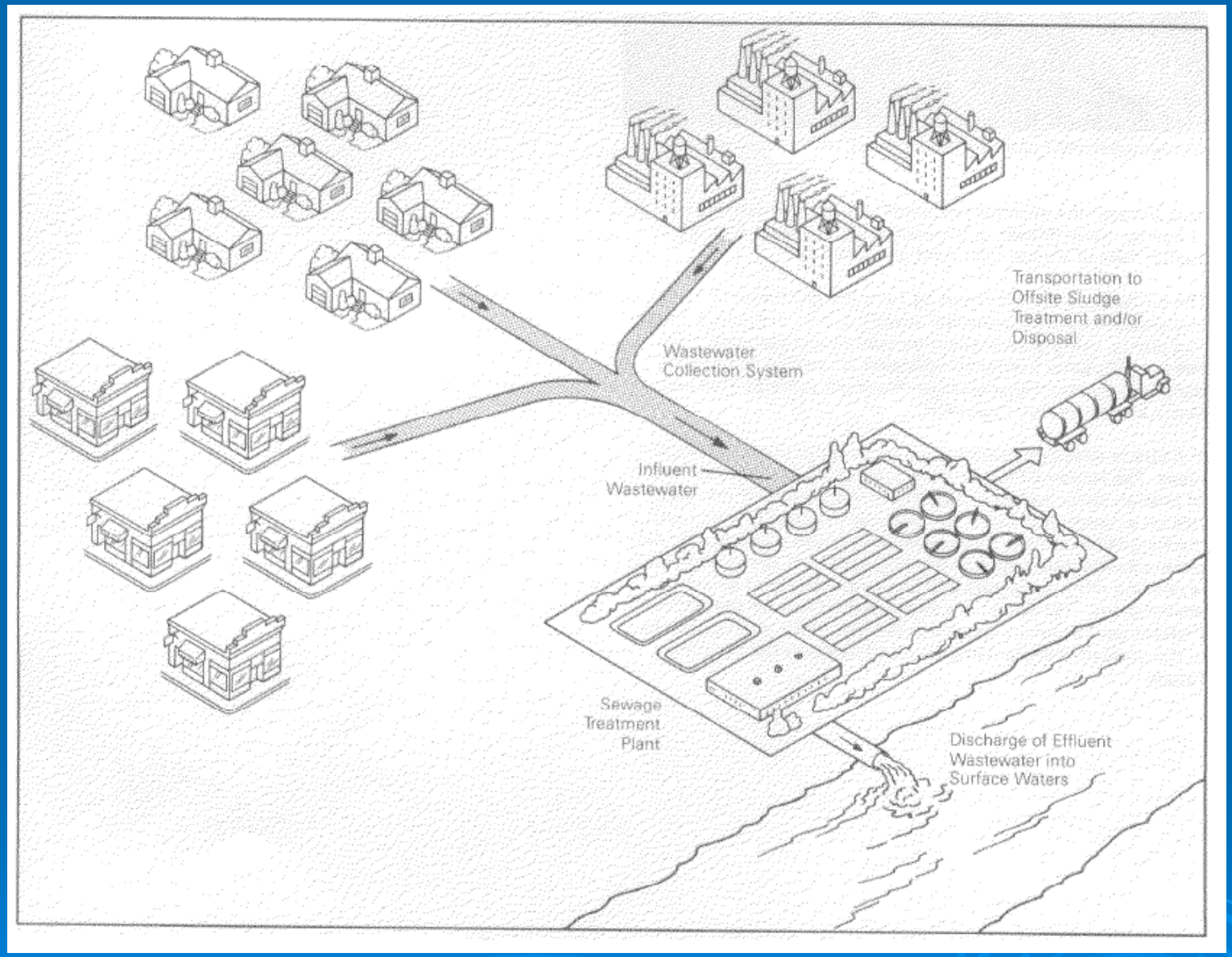
LC50 would be somewhere between 50% effluent and 75% effluent.

0% Mortality | 0% mortality | 20 % Mortality | 40% Mortality | 80% Mortality | 100% Mortality

R8 WET Test Failure

Should acute, chronic, acute and/or chronic toxicity occur in the second test following failure in the first test, the permittee shall initiate corrective actions

- Identify the source of toxicity
- submit a plan to eliminate toxicity
- complete steps identified in the plan
- return to compliance.



WET is protective of POTWs for pass-through and interference.

United States Environmental Protection Agency
Office of Wastewater Management Washington DC 20460
EPA/833B-99/002 August 1999

EPA

Toxicity Reduction Evaluation Guidance for Municipal Wastewater Treatment Plants

http://www.epa.gov/npdes/pubs/tre.pdf

Toxicity Identification Evaluation

The first step for the POTW is to identify the toxicant. In some cases, this may be known, in others a WET TIE will need to be initiated.

Typically done by contacting the WET laboratory and moving forward with identification procedures.

Toxicity Source Evaluation

The next step is to identify the source(s) of the toxicant(s).

This is where industrial users become primary suspects for toxicity.

Refractory Toxicity Assessment (RTA)

In situations where the TIE does not provide conclusive data on the effluent toxicants an RTA analysis can be performed.

Prior to toxicity analysis, sewer samples are subjected to the same type of treatment as is provided by the POTW for its influent wastewaters.

Toxicity Control Evaluation

Once the incoming toxicity is located, a POTW can now put limitations or controls on the industrial user.

Toxicity control evaluation involves assessing the potential control options and selecting the best option(s) for toxicity reduction based on technical and cost considerations.

Pretreatment Control Evaluation

Pretreatment control options can be developed by public works managers to prevent the pass-through of toxicants, toxicity, and inhibitory material that have been traced to indirect dischargers.

The primary advantages of pretreatment control of toxicity are that a smaller volume of waste can be managed by addressing individual sources and the costs are usually the responsibility of the industrial users.

Pretreatment requirements may involve a public education effort or the implementation of narrative or numerical limitations for POTW users.

Example Case Study

Toxicity Reduction Evaluation for the City of Reidsville, North Carolina, USA

Facility Background

The City of Reidsville was required by the North Carolina Department of Environment and Natural Resources (DENR), to conduct a TRE based on evidence of chronic effluent toxicity at its POTW.

In 1992–1994, monthly NOECs for Ceriodaphnia dubia averaged about 35% effluent and consistently exceeded the discharge permit NOEC limit of 90% effluent.

Description of treatment plant

- Influent wastewater 2.8 MGD
- Screened
- 2 activated sludge aeration basins
- Mechanical surface aerators
- 48hr contact time, then to final clarifiers
- Sand filtration
- Disinfection with chlorine gas
- Dechlorinated with sulfur dioxide
- Aerated prior to discharge

Refractory Toxicity Assessment (RTA) Procedure

The RTA procedure involves treating industrial wastewater samples in a bench-scale, batch simulation of the POTW and measuring the effluent toxicity.

The toxicity remaining after batch treatment, referred to as refractory toxicity, represents the toxicity that may pass through the POTW and into the effluent.

Tested Industrial Users

Acute and chronic toxicity tests were performed on raw (untreated) wastewater from the 7 permitted significant industrial users in the Reidsville collection system.

The industrial wastewater samples were tested at concentrations that reflected the average flow contribution of the industries to the POTW.

The results suggested that 5 of the 7 industries were contributing chronic toxicity to the POTW.

Table 6.68 Chronic toxicity of raw industrial wastewaters. Tests were conducted using industrial wastewater diluted according to its percent contribution to the total POTW influent.

	Ceriodaphnia dubia chronic result			
Industry	**May 1992**	**June 1992**	**July 1992**	**April 1993**
A	Fail	Fail	Fail	Fail
B	Fail	Not tested (NT)	Fail	Fail
C	Fail	Fail	Fail	Fail
D	Fail	NT	Fail	Fail
E	Pass	Pass	Fail	Fail
F	Pass	Pass	Pass	NT
G	Pass	Pass	Pass	NT

Table 6.69 Description of industries evaluated in the refractory toxicity assessment. Percentage flow based on maximum industrial flow and minimum publicly owned treatment works (POTW) influent flow, except for domestic which is based on average flow and minimum POTW influent flow.

Industry	**Type**	**Flow (MGD)**	**% Flow to POTW**
A	Textile	1.072	65
B	Tobacco products	0.308	28
C	Can making	0.085	10
D	Food processing	0.189	12
E	Metal finishing	0.031	2
Domestic			38

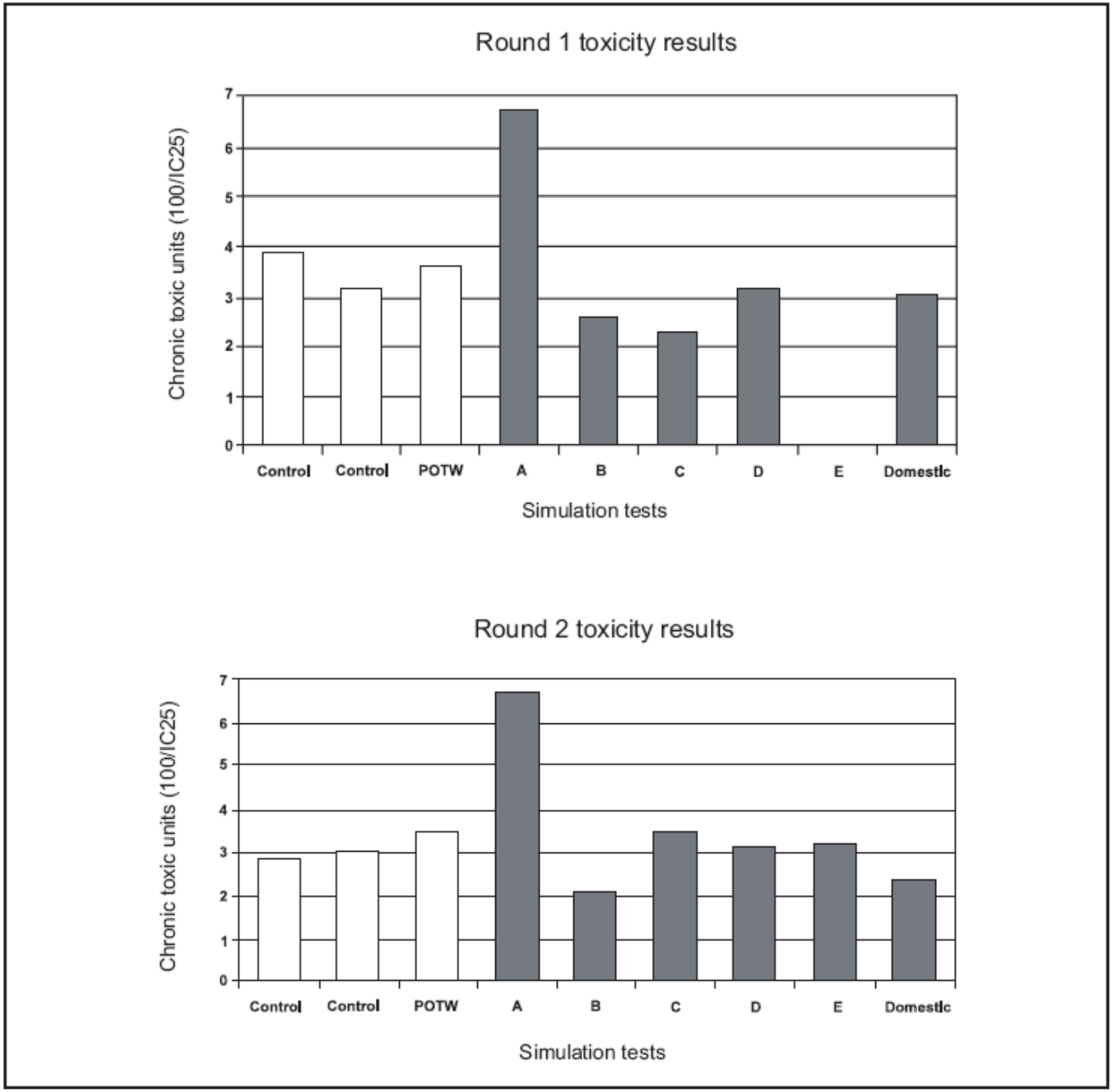


Figure 6.27 Results of refractory toxicity assessment: Rounds 1 and 2

The results of this study indicate that Industry A is a major contributor to chronic effluent toxicity at the Reidsville POTW. None of the other industries (B, C, D, and E) were found to discharge measurable toxicity even after the potential toxicity interference from Industry A was removed.

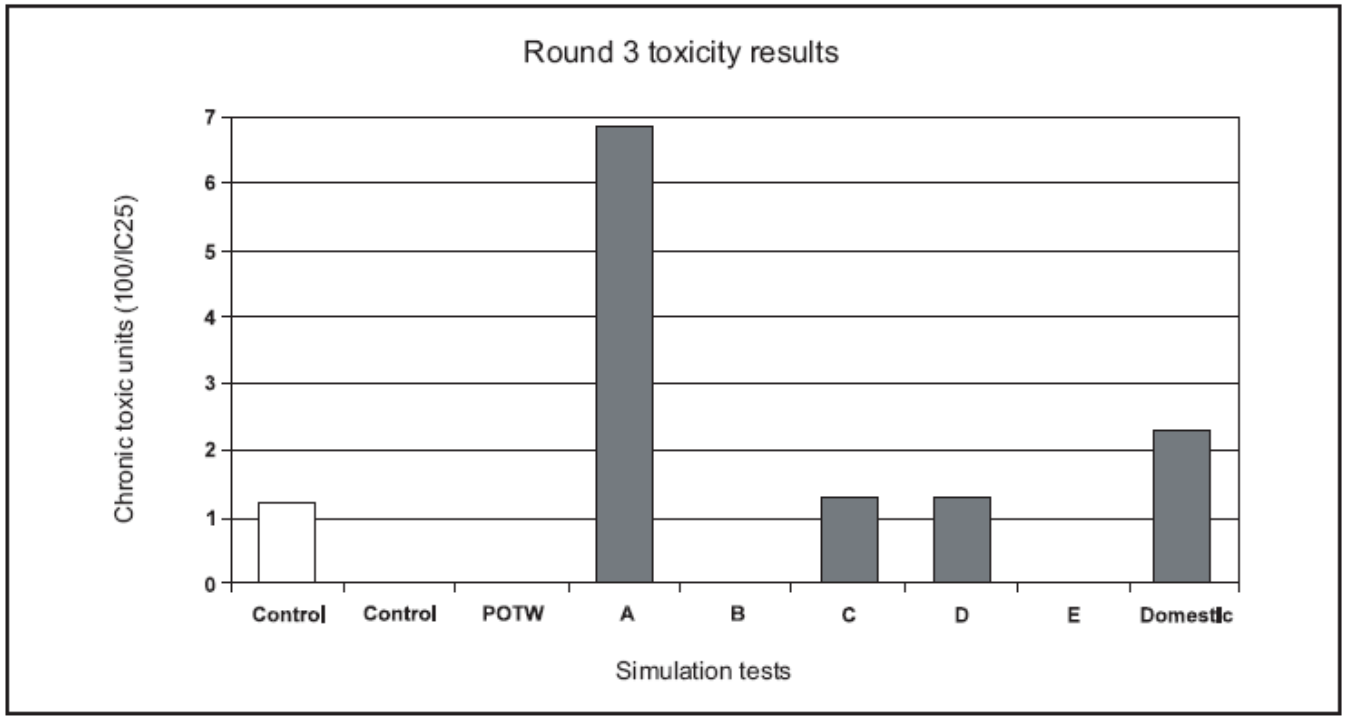


Figure 6.28 Results of refractory toxicity assessment: Round 3

Results

Although the RTA results indicated that Industry A is the major contributor of chronic toxicity, all of the city's permitted industrial users were requested to participate. The program involved the following:

1) an evaluation of current chemical usage and the selection of alternative materials of low toxicity, low inhibition potential, and high biodegradability; and

2) an on-site evaluation of waste minimization practices by the North Carolina Office of Waste Reduction.

BMP's

- Particular attention was given to surfactant products or chemicals with surfactant constituents, because the TIE indicated surfactants to be the principal toxicant in the POTW effluent.
- Industries were requested to maintain chronological records of changes in chemical usage, production, and house-keeping practices.
- These records were used to compare the timeline of industry modifications to results of chronic toxicity monitoring at the POTW.

After Identification and BMPs

- In 1995, occasional chronic effluent toxicity was again observed and the effluent became consistently toxic in 1997 (NOEC = 30% to 45%).
- Refractory toxicity testing again identified Industry A.
- The WWTP outfall was relocated in 1998 to achieve greater effluent dilution. The toxicity limit (NOEC) was reduced to the new instream waste concentration of 61%.
- Additionally, the consultant found that activated carbon could completely remove toxicity and the city implemented powdered activated carbon treatment at the WWTP in 1999.
- Since then, the city has achieved consistent compliance.

Conclusion

- WET testing works.
- WET protects against pass-through and interference.
- TREs can be implemented without a WET failure.
- Early identification by a facility is a recommended path to be proactive.

Thank You

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