TROUBLE WITH CHRONIC TOXICITY

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The Bernards Township Sewerage Authority operates a 2.5 mgd wastewater treatment plant with core treatment facility consisting of 2 oxidation ditches & 2 secondary clarifiers followed by 2 polishing ponds and chlorination /dechlorination facilities. In 1993 the plant received a whole effluent chronic toxicity limit for *Ceriodaphnia dubia* of 93%, which in 2001 was modified to 56%. Due to the occasionally borderline results reported by the contract bioassay laboratory, the Authority in 2000 performed a split sample testing with another NJDEP-certified laboratory. The test results were quite different, 34% (present lab) and 74% (alternative lab), which is more than a two-fold difference in sample toxicity, corresponding to 2- fold difference in concentration of a hypothetical toxicant. Based on that disparity, the Authority switched to the alternative laboratory for future work. However, the whole effluent toxicity results continue to be occasionally marginal, which prompted the Authority to conduct additional testing and investigations aimed at identifying a possible source of this apparent toxicity or a method of its removal.

The work included the following sample manipulations and treatments followed by comparative, screening bioassays:

- Evaluation of potential toxicity from polymer used in the sludge dewatering operations by adding a range of polymer doses to activated sludge, aerating it overnight and testing supernatants for toxicity.
- Testing of grab samples collected at the same time (with a delay corresponding to the average hydraulic retention time) from various in-plant locations: clarifier effluent, stabilization pond effluent, chlorine contact tank effluent and dechlorinated final effluent.
- Parallel testing of final effluent sample and laboratory-filtered final effluent sample.
- Treatment of final effluent with a coagulant (alum) in a manner similar to potential use of alum for phosphorus removal.
- Aeration of the final effluent overnight.

None of the sample manipulations (treatments) resulted in identification of a source of toxicity or an effective method to reduce the apparent toxicity. The results from each series of tests were typically quite similar. On some occasions all samples (effluent and manipulated samples) showed similar toxicity, on others there was no toxicity detected in any sample. As only relatively mild toxicity, with IC25 no lower than 56% (permit limit!), was recorded in the period 2001-2003, no further measures were taken to address this low levels of apparent toxicity occasionally reported by the contract laboratory.

However, the results of an IC25 of 33.4% from February 2004 violated the plant permit limit. Due to the suspect pattern of toxicity revealed during the review of the test report, the Authority requested from NJDEP a review of the bioassay test in question, claiming laboratory error. The Department, after the review by the Office of Quality Assurance, rejected the claim of laboratory error. Subsequently, the Authority has experienced another apparent failure and several near-failures of its bioassay tests, as reported by the contract laboratory (laboratory A) – see Table 1. To address this problem, BTSA contracted with an independent toxicology laboratory (laboratory B) to conduct a Toxicity Identification Evaluation (TIE) procedure. In order to timely identify a toxic sample for the TIE study, the independent laboratory conducted a parallel screening test on an exact split sample of the January 2005 official DMR test conducted by laboratory A. While the test conducted by the regular laboratory failed again, the independent laboratory found no toxicity in that sample.

As a result, the subsequent February 2005 DMR test conducted by the regular laboratory A was accompanied by three bioassays using an exact split sample conducted by the independent laboratory B and two other qualified, NJDEP-certified laboratories (C and D). While the test from regular laboratory A again resulted in an apparent serious violation, all three other tests resulted in an IC25 >100% (Table 1).

It should be noted that the tests by laboratories B, C and D were non-compliance tests, as only nine organisms for each dilution were used. This was done to avoid the situation experienced by the Authority in the past, when averaging of the bioassay results was not allowed by the NJDEP and any single failed test would result in a notice of violation. Consequently, performing more than one compliance test could have increased the Authority's exposure to a permit limit violation. The non-compliance tests, while not being used for DMR reporting, are nevertheless performed utilizing the same procedures as the compliance test and the lack of toxicity observed in all these tests is unquestionable.

At this point the Authority has contracted a bioassay expert to perform detailed evaluation of the information contained in the apparently failed chronic toxicity reports from the regular laboratory A. That evaluation identified several deficiencies or potential deficiencies in laboratory A reports and test protocol. The most serious of them appears to be uncertainty concerning the number of broods taken into account in calculating test results. Review of the past chronic toxicity reports from laboratory A, including all four recorded permit limit violations, indicate similar deficiencies, including a pattern of counting the young.

In view of the dramatic differences in the test results between the NJDEP-certified, contract laboratory A and all other labs, the Authority requested that a detailed re-evaluation of the laboratory A test protocol, organisms quality control and calculation methods be performed by the NJDEP, including but not limited to the issues raised in the evaluation by the independent expert. That submittal included extensive documentation of the unacceptable differences in test results between the NJDEP certified laboratories and the apparent deficiencies in the test protocol for at least one of the laboratories involved.

Data in Figure 1 were also brought to NJDEP's attention. That Figure correlates the reported effluent IC25 results from Bernards' DMRs and screening tests (performed by laboratory A) in the span of two years with the Standard Reference Toxicant (SRT) test results from the corresponding month (where available). The graph indicates that the Bernard's plant bioassay failure or passing score is almost always predicted by the SRT test result. It is also noted that the most recent SRT control limits (70 to 280 mg/L of KCl, or potassium chloride) developed by laboratory A, span a 4-fold concentration range, which is apparently still acceptable.

Based on the submittal of the above-outlined information, the NJ DEP granted an affirmative defense for each of the four failed bioassays in question based on the laboratory error in accordance with 7:14-8.3 (i).

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The underlying reasons for such unacceptable results, and the steps the NJDEP undertook or plans to undertake to minimize such, are of significant public interest. When the toxicology laboratory reports a failing whole effluent chronic toxicity test result, a number of cost generative responses are triggered. These include additional bioassay monitoring requirements and legal and engineering assistance to evaluate the cause and protect the discharger from enforcement action (fines) as may be appropriate. This can result in significant expenditure of public resources. Costs of routine and additional bioassay work performed by Bernards Township Sewerage Authority since 2000 are close to $50,000. Costs in staff's time and engineering, legal, administrative and additional analytical expenses easily doubled that amount. At least part of this is apparently a result of laboratory errors, which is why the Department approved the Affirmative Defense.

Since the Bernard's case clearly indicates that at least some of the apparent "non-compliance" problems encountered in chronic toxicity monitoring and control program in New Jersey could be a testing artifact, the following questions were asked the NJDEP Enforcement and Quality Assurance units.

1. What was the result of an audit of laboratory A presumably undertaken by the Department?
2. Are there any changes to the test procedure and/or quality control protocol being proposed/planned to prevent re-occurrence of similar problems at this or other laboratories?
3. Laboratory A is one of a few laboratories, which do the bulk of NJPDES toxicity testing in New Jersey. Has the Department reviewed other chronic toxicity tests performed by laboratory A in past several years, particularly any which yielded unfavorable results and resulted in enforcement actions?
4. As illustrated in Figure 1, the Standard Reference Toxicant (SRT) control limits for the laboratory A span a 4-fold concentration range, which is apparently still acceptable. This means that the margin of an acceptable test variability afforded to the laboratory encompasses the equivalent of a two-fold higher to two-fold lower concentration of the SRT above and below its average or "benchmark" IC25 concentration. This is contrasted with the strict enforcement actions in response to any apparent violation of the chronic toxicity limit reported by the lab. The accuracy of this test seems insufficient to properly establish compliance with the permit limit. Does the Department intend to address this issue?

Department's response could be summarized as follows (numbering preserved):

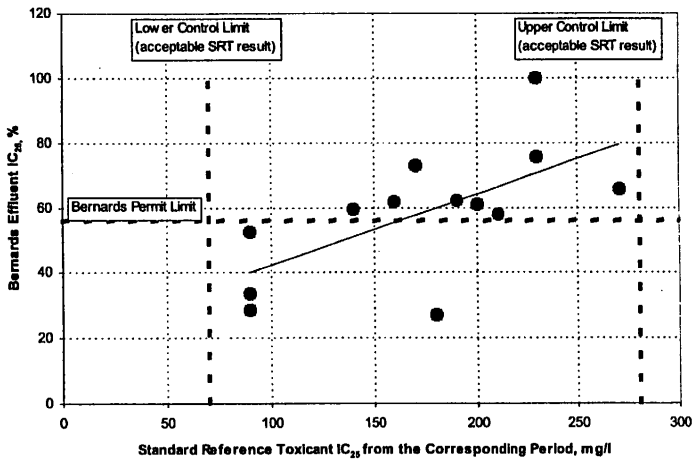
1. Numerous deficiencies were noted during the audit and the Department is following up on laboratory A's corrective measures.
2. There are no changes planned to the test method.
3. Review of all recent tests performed by laboratory A, which caused enforcement actions, indicated that not all of them were considered suspect.
4. In response to this question, the Department essentially restated whole effluent toxicity testing quality control measures already in place, and defended acceptability of large variability of Standard Reference Toxicant results.

Despite this reassuring response, it is our opinion that despite all the formal quality control measures and apparently scientifically defensible test protocols, the whole effluent chronic toxicity bioassay, as routinely performed by commercial laboratories is not a reliable test. This is a direct, common sense conclusion from the above-presented case study. Consequently, NJPDES permits should not include enforceable chronic toxicity numerical limits. Instead, the calculated limit should be an action level, whose exceedance would trigger additional testing or investigation.

Table 1. Chronic Toxicity (Ceriodaphnia dubia) Test Results Summary, IC25, %. Reportable, DMR Results are **boldfaced**. Permit Limit is 56%.

Date	Laboratory A Official (DMR) Lab Until 2/14/2005	Laboratory B	Laboratory C Official (DMR) Lab SINCE 3/15/2005	Laboratory D
2/16/2004	**33.4**			
3/15/2004	**57.9**			
4/19/2004	**61.6**			
5/17/2004	**>100**			
6/1/2004	**62.3**			
7/19/2004	**73.1**			
8/9/2004	**60.8**			
11/8/2004	**38.4**			
12/13/2004	**65.5**			
1/25/2005	**28.6**	>100		
2/14/2005	**18.4**	>100	>100	>100
3/15/2005	>100		**>100**	
4/19/2005	>100		**>100**	
6/14/2005			**>100**	
10/24/2005			**>100**	
1/17/2006			**93.8**	

Figure 1. Correlation Between Bernards Effluent IC25 and laboratory A Standard Reference Toxicant (SRT) Result from the Same Month Febr 2003 - Jan 2005



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