

**DEPARTMENT OF ENVIRONMENTAL PROTECTION**  
**Bureau of Water Supply and Wastewater Management**

**DOCUMENT NUMBER:** 391-2000-021

**TITLE:** Field Data Collection and Evaluation Protocol for Determining Stream and Point Source Discharge Design Hardness

**EFFECTIVE DATE:** March 22, 1999  
Minor changes were made throughout (April 10, 2003)

**AUTHORITY:** Federal Clean Water Act, Pa. Code Title 25, Chapter 92, 93, and 95. The Clean Stream Law, 35 P.S. §§691.1 *et seq.*

**POLICY:** It is the policy of the Department of Environmental Protection (DEP) to use the best available data in the calculation or estimation of wasteload allocations and NPDES effluent limitations. This often involves the use of data that can only be collected in the field.

When data is not available or existing data is not adequate, other interested parties or dischargers are allowed to provide alternative data sources, or enough time is allowed for dischargers to accumulate the necessary data. In the absence of field data, DEP may use a default value or an empirical estimation of the data until the field data becomes available.

**PURPOSE:** The purpose of this document is to lay out the procedures recommended or used by DEP for field data collection and evaluation of such data. The procedures are not mandatory. DEP will consider the use of alternative procedures, which interested parties or dischargers believe are more appropriate than those presented in this document.

**APPLICABILITY:** DEP will use this guidance to provide technical details on how the program carries out various calculations and applies the evaluated results in preparing NPDES permits for discharges, based on water quality criteria published in Chapters 93 and 16 (Statement of Policy).

**DISCLAIMER:** The policies and procedures outlined in this guidance are intended to supplement existing requirements. Nothing in the policies or procedures shall affect regulatory requirements.

The policies and procedures herein are not an adjudication or a regulation. There is no intent on the part of DEP to give the rules in these policies that weight or deference. This document establishes the framework within which DEP will exercise its administrative discretion in the future. DEP reserves the discretion to deviate from this policy statement if circumstances warrant.

**PAGE LENGTH:** 6 pages

**LOCATION:** Volume 29, Tab 9

## 1.0 Purpose and Scope

Fish and aquatic life (FAL) water quality criteria for several toxic metals are expressed as functions of hardness.<sup>1</sup> In general, the criteria increase exponentially as hardness increases. It is DEP's policy to apply water quality criteria after mixing of the discharge with the stream. This protocol presents recommended field data collection and evaluation procedures for estimating stream and discharge design hardness.

The determination of design hardness requires that both design stream and discharge hardness be estimated. The draft version of this guidance recommended the calculation of a median value. This, however, does not consider the presence of any less than detection values that may appear in the data set. Section V, Design Hardness, *Design Conditions* rationale paper (March 1989) suggests the use of either the median or mean and recommends use of the median. Another statistical parameter must be used to establish design hardness values. The mean can better accommodate a data set containing less than detects and is recommended to calculate both design values derived from either representative in-stream measurements or historical records.<sup>2</sup>

### 1.1 Site-Specific Stream Data Collection

The primary method for estimating stream hardness is site-specific data collection. The data should be collected immediately above the point of the existing or proposed discharge, during critical low flow period (i.e. Q<sub>7-10</sub>). This is usually during the months of July through November. If the site upstream of the outfall is believed to be affected by one or more upstream point source discharges, an alternate sampling site is selected on the same stream either above the interfering discharge(s) or on a tributary stream that is not affected by point source discharges. The sampling site location is one which contributes a significant amount of the flow to the site where the discharger in question is located. Sampling should be performed on randomly selected days that are representative of normal operation, except that sampling on days immediately after a rainfall event should be avoided. A single mid-depth grab sample should be collected. A minimum of ten grab samples should be collected, with no more than one sample per week. The samples should be analyzed using the hardness by calculation method (Standard Methods 2340B). This method computes the hardness from the results of separate determinations of calcium and magnesium (using atomic absorption methods 3500-CaB and 3500-MgB). During 1998, DEP's Laboratory investigated a question concerning the accuracy of measured values for hardness compared to calculated values. It was determined the measured, colorimetric, method did, at times, underestimate hardness. The DEP laboratory began using the calculated method, above, during September 1998.

When hardness correlates with flow, it does so in an inverse correlation (the higher the flow the lower the hardness). Hardness values are stream specific and correlation with flow is highly variable. If the discharger desires, flow may be optionally measured during sampling events and the design flow hardness may be determined through linear regression analysis. Before implementing this, submit a short narrative study plan to the local DEP field office addressing each step to be taken.

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<sup>1</sup> The affected substances are: Cadmium, Copper, Lead, Nickel, Silver, and Zinc (Chapter 16, Appendix A, Table 1.)

<sup>2</sup> Implementation Guidance Design Conditions, DEP ID: 391-2000-006

Obtain a representative sample in accordance with the water sample collection procedures above, taking care not to expose the sample or any sampling equipment or containers to contamination through contact with your skin or any of the following:

|                  |                    |                    |
|------------------|--------------------|--------------------|
| Rubber           | Cigarette Smoke    | Dust, Dirt or Soil |
| Metal Products   | Automobile Exhaust |                    |
| Painted Surfaces | Paper Products     |                    |

All equipment/containers that come into contact with the sample must be certified metals free from the supplier; or washed with 0.1% reagent grade hydrochloric acid and rinsed with metals free distilled or deionized water.

Remove the sample container cap, submerge the container below the surface of the water, move the container opening towards the upstream flow, and away from the collector. Hold the lower portion of the sample container making sure that water which contacts the hands cannot enter. Never touch the container opening or the inside of the container cap. Replace the cap after the container is filled with the appropriate quantity of water.

#### 1.1.1 Water Quality Network Data

Where site-specific stream data collection is not feasible, design stream hardness can be estimated using WQN data. The WQN station(s) that are used to make the estimate should be located in the same ecoregion as the site, and should display hydrologic and geologic characteristics that are similar to the site. The mean of the July through November WQN station(s) data set is used directly. This method, while acceptable, is not recommended.

### 1.2 Discharge Hardness

Discharge hardness may be different from stream hardness. This may be due to the nature of the wastewater or the result of hardness added during the treatment process.<sup>3</sup> Two methods for estimating discharge hardness are recommended here. The first requires the collection of discharge specific data, while the second makes use of a default value.

#### 1.2.1 Discharge Specific Data Collection

The best way to estimate discharge hardness is to measure it directly. The design discharge hardness is the mean hardness during the critical (low flow) design period. This is usually the months of July through November. Sampling should be performed on randomly selected days that are representative of normal operation, except that sampling on days immediately after a rainfall event should be avoided. A single mid-depth grab sample should be collected. A minimum of ten grab samples should be collected, with no more than one sample per week. The samples should be analyzed using the hardness by calculation method (Standard Methods 2340B).

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<sup>3</sup> While hardness may undergo change as a result of treatment, a discharger may not purposely alter effluent hardness to obtain a less stringent effluent limitation.

Obtain a representative sample in accordance with the water sample collection procedures above, taking care not to expose the sample or any sampling equipment or containers to contamination through contact with your skin or any of the following:

|                  |                    |                    |
|------------------|--------------------|--------------------|
| Rubber           | Cigarette smoke    | Dust, Dirt or Soil |
| Metal products   | Automobile exhaust |                    |
| Painted Surfaces | Paper products     |                    |

All equipment/containers that come into contact with the sample must be certified metals free from the supplier; or washed with 0.1% reagent grade hydrochloric acid and rinsed with metals free distilled or deionized water.

Remove the sample container cap, submerge the container below the surface of the water, move the container opening towards the upstream flow, and away from the collector. Hold the lower portion of the sample container making sure that water which contacts the hands cannot enter. Never touch the container opening or the inside of the container cap. Replace the cap after the container is filled with the appropriate quantity of water.

Dischargers with two or more substantially identical outfalls may request permission to sample and analyze only one outfall. Where permission is granted, the discharger may submit the results of the analysis as representative of the other substantially identical outfall(s).

Discharge samples should be collected from the center of the outfall flow channel where turbulence is at a maximum, or at a location specified in the NPDES permit.

#### 1.2.2 Default Discharge Hardness

The second method of estimating design discharge hardness is to use a default value. This is the method DEP uses where site-specific data is not available, and resources don't permit the use of the method described above. At the present time, DEP uses a default value of 100 mg/L for treatment plant discharge hardness. However, new dischargers may propose an alternative value, with appropriate justification.

### 1.3 Data Analysis and Reporting

Stream and discharge hardness data should be submitted using the attached Sample Data Report. The mean value is used in the determination of hardness. Appendix E, Lognormal Distribution and Permit Limit Derivations, from the TSD is used. The Lognormal distribution is used when the data set contains no nondetect values. When the data set contains nondetect values the Delta-lognormal distribution is used. DEP also will accept the report in electronic format (either ASCII, or Microsoft Excel).

## Lognormal

$$\mu_y = \frac{\Sigma(y_i)}{k}$$

$$\sigma_y^2 = \frac{\Sigma(y_i - \mu_y^2)}{(k-1)}$$

where:

$\mu_y$  = mean

$\sigma_y^2$  = variance

$y_i = \ln(x_i)$  for  $i = 1, 2, \dots, k$

$k$  = number of data points in the data set

$$E(x) = \text{mean (daily average)} = \exp\left(\mu_y + \frac{\sigma_y^2}{2}\right)$$

## Delta Log-normal

$$\mu_y = \frac{\Sigma(y_i)}{(k-r)}$$

$$\sigma_y^2 = \frac{\Sigma(y_i - \mu_y)^2}{(k-r-1)}$$

$$E(x) = \delta D + (1-\delta)\exp(\mu_y + 0.5\sigma_y^2)$$

where:

$D$  = detection limit

$r$  = number of nondetect values in sample

$$\delta = \frac{r}{k}$$

Attachment 1

Stream and Discharge Hardness Data Report

Stream: \_\_\_\_\_

Stream Code: \_\_\_\_\_

Name of Discharger: \_\_\_\_\_

NPDES Permit Number: \_\_\_\_\_

Discharger Location (RMI): \_\_\_\_\_

Stream Data

Discharge Data

|    | Date | Sample Conc. mg/l | Stream-Flow cfs |
|----|------|-------------------|-----------------|
| 1  |      |                   |                 |
| 2  |      |                   |                 |
| 3  |      |                   |                 |
| 4  |      |                   |                 |
| 5  |      |                   |                 |
| 6  |      |                   |                 |
| 7  |      |                   |                 |
| 8  |      |                   |                 |
| 9  |      |                   |                 |
| 10 |      |                   |                 |
| 11 |      |                   |                 |
| 12 |      |                   |                 |
| 13 |      |                   |                 |
| 14 |      |                   |                 |
| 15 |      |                   |                 |
| 16 |      |                   |                 |
| 17 |      |                   |                 |
| 18 |      |                   |                 |
| 19 |      |                   |                 |
| 20 |      |                   |                 |
| 21 |      |                   |                 |

|    | Date | Sample Conc. mg/l | Stream-Flow cfs |
|----|------|-------------------|-----------------|
| 1  |      |                   |                 |
| 2  |      |                   |                 |
| 3  |      |                   |                 |
| 4  |      |                   |                 |
| 5  |      |                   |                 |
| 6  |      |                   |                 |
| 7  |      |                   |                 |
| 8  |      |                   |                 |
| 9  |      |                   |                 |
| 10 |      |                   |                 |
| 11 |      |                   |                 |
| 12 |      |                   |                 |
| 13 |      |                   |                 |
| 14 |      |                   |                 |
| 15 |      |                   |                 |
| 16 |      |                   |                 |
| 17 |      |                   |                 |
| 18 |      |                   |                 |
| 19 |      |                   |                 |
| 20 |      |                   |                 |
| 21 |      |                   |                 |

Mean: \_\_\_\_\_

Mean: \_\_\_\_\_

Submitted By: \_\_\_\_\_

Date: \_\_\_\_\_

A topographical map showing the data collection points must be included with this Data Report (a copy is permissible).