Retention:
Permanent

Chronic Zinc Screening Water Effect Ratio for the H-12 Outfall, Savannah River Site

Daniel P. Coughlin, Brian B. Looney and Margaret R. Millings

JANUARY 12, 2009

Savannah River National Laboratory
Savannah River Nuclear Solutions
Aiken, SC 29808

Prepared for the U.S. Department of Energy Under Contract Number DE-AC09-08SR22470

SRNL
SAVANNAH RIVER NATIONAL LABORATORY

Printed in the United States of America

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REVIEWS AND APPROVALS

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LIST OF ACRONYMS

BML	Biotic Ligand Model
DOC	Dissolved Organic Carbon
NPDES	National Pollutant Discharge Elimination System
SRNL	Savannah River National Laboratory
SRS	Savannah River Site
WER	Water Effects Ratio

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Executive Summary

In response to proposed Zn limits for the NPDES outfall H-12, a Zn screening Water Effects Ratio (WER) study was conducted to determine if a full site-specific WER is warranted. Using standard assumptions for relating the lab results to the stream, the screening WER data were consistent with the proposed Zn limit and suggest that a full WER would result in a similar limit. Addition of a humate amendment to the outfall water reduced Zn toxicity, but the toxicity reduction was relatively small and unlikely to impact proposed Zn limits. The screening WER data indicated that the time and expense required to perform a full WER for Zn is not warranted.

1.0 Introduction

To support National Pollutant Discharge Elimination System (NPDES) permit development at the Savannah River Site (SRS), limits for Zn were proposed based on a simplified "recalculation" method. The recalculation was performed in 2007 resulting in a proposed limit for Zn of 153.2 µg/L. The recalculation procedure simplifies data requirements, focusing on a few dominant mechanisms that reduce toxicity in outfalls and surface water (U.S. EPA 1985). A WER has the capability to account for a broader array of potential detoxifying processes in the outfall water and can help refine discharge limits. Due to the high cost and extended timeframe required for a full WER, a screening WER is usually performed first to determine if the WER is likely to substantively alter the limits developed using recalculation.

The screening WER is performed similarly to a full WER except that it is based on a single sample rather than samples collected over time to represent the varying real-world conditions. This particular WER study was also modified to include a preliminary assessment of the impact of dissolved organic carbon (DOC) amendment on Zn toxicity. SRS is currently designing a DOC amendment system to mitigate copper toxicity in the H-12 outfall. The screening WER was performed in accordance with the *Interim Guidance on Determination and Use of Water-Effect Ratios for Metals* (U.S. EPA 1994); a determination that the expense and time required for a full site-specific WER is warranted is dependent on a screening WER result that would indicate the potential for modifying (increasing) the proposed permit limits for Zn while assuring environmental protection requirements are met.

2.0 Method

Outfall H-12 is located near the junction of Road 4 and Road E at the Savannah River Site. It flows south for approximately 750 ft where it merges with an unnamed tributary that also receives discharges from the H-08 outfall. The combined stream flows freely for a distance of about 1500 ft to an extension of the Four Mile Branch (FMB) swamp.

On August 5, 2008 20 liters of raw H-12 effluent was collected directly from the NPDES H-12 sampling platform (Figure 1). A peristaltic pump with the siphon suspended in the channel's water column was used to prevent the collection or disturbance of sediment. The sample collection corresponded with a release of the H-Area Segregated Cooling Basin (281-5H). The sample was immediately chilled and transported to the Savannah River National Laboratory (SRNL) where half of it was treated with 3.39 mg/L organic carbon using a commercially available potassium humate solution (Huma K©, Land and Sea Organics, Modesto CA). The DOC treatment used in this study was intended to mimic the operation of the carbon injection system soon to be built for the mitigation of copper toxicity at the H-12 outfall (Millings et al., 2008). The quantity of amendment added to the treated samples was determined using the Biotic Ligand Model (BLM) Windows Interface Version 2.2.1 (Hydroqual, 2007); the amendment interacts with the copper and reduces chronic toxicity for copper levels up to 25 ug/L. The results of the BLM indicated that the quantity of Huma K© amendment required is a function of pH and the simplified equation for required dose is:

$$C_{target} = \{(9.465\text{x}10^{11})(H^+)^2 + (1.690\text{x}10^7)(H^+) + 1.108\} / 0.96$$
$$= \{(9.465\text{x}10^{11})(10^{-pH})^2 + (1.690\text{x}10^7)(10^{-pH}) + 1.108\} / 0.96$$

Where:
C_{target} is the desired amendment concentration in the treated wastewater (mg DOC/L)
C_{stock} is the amendment concentration in the storage tank (mg DOC/L)

This equation was the basis for the amendment dose (3.39 mg/L organic carbon) at a pH of 6.9, as measured in the August 5, 2008 sample of H-12 effluent.

A chronic Zn screening WER was conducted by ETT Environmental, Inc. in Greer, SC (Appendix A). This study evaluated the toxicity of both the raw H-12 sample and the amended H-12 sample relative to standard laboratory water. For each type of water, the test organism *Ceriodaphnia dubia* was exposed to varying levels of added Zn. Based on the reproduction of *C. dubia* at the different Zn levels, a maximum Zn concentration that met a predetermined toxicity target was determined for each water type and adjusted to a constant hardness. The ratio of the result for each test water to the result for the laboratory standard water (water effects ratio) provides a measure of the non-hardness biogeochemistry in the tested water that reduces (or increases) toxicity. WER values greater than 1 indicate that zinc exhibits less toxicity in the tested water than in the laboratory water. As the screening WER result increases, zinc toxicity decreases in the test water. A sub-sample of the untreated water was analyzed for copper at the Environmental/Bioassay Laboratory on the Savannah River Site (Appendix B).

Figure 1. NPDES H-12 sampling station

3.0 Results

The study determined the untreated effluent has a WER value of 5.35 while the DOC treated water has a WER value of 7.24. That is a 1.34 fold reduction in Zn toxicity for the DOC treated effluent at the laboratory standard water hardness of 50 mg/L. Applying the screening WER outcomes to the outfall conditions (e.g., flow rates, hardness, etc.) results in an approximate average permit limit of 122 μg/L Zn for the untreated effluent and 168 μg/L Zn limit for the DOC treated discharge. A full site specific WER using multiple samples over time, representing a range of outfall conditions, would be needed to support a WER-based permit limit. The copper concentration of the H-12 water used in this study was < 25 μg/L and not likely to have affected the results of the Zn screening WER, particularly for the carbon amended sample.

4.0 Discussion

A proposed average permit limit for Zn in the H-12 outfall, 153.2 μg/L, was previously developed based on a standard recalculation procedure (Appendix C). A central goal of the standard recalculation procedure was to provide a reasonable and technically defensible approach for estimating permit limits, and an approach that can be applied cost effectively so that a full WER is not required for every outfall. The recalculation procedure simplifies the data requirements and focuses on some of the dominant mechanisms that reduce toxicity in outfalls and surface water. *Prima facie* differences between the outcome for the recalculation procedure and the outcome from a WER are the result of differences/simplifications in standardized assumptions (e.g., hardness is treated differently in the two approaches and suspended solids are emphasized in the recalculation). Importantly, the WER has the capability to account for a broader array of potential detoxifying processes in the outfall water – processes such as the impact of the DOC amendment. Due to the high cost and extended timeframe required for a full WER, many sites apply a stepwise decision process in which: 1) a recalculation procedure is performed, 2) (if there is a potentially significant unquantified detoxification process) perform a screening WER to determine if the recalculation procedure has adequately represented the water chemistry, and 3) perform a full WER only if the results of the screening WER and the recalculation procedure are significantly different.

5.0 Conclusions

While the DOC amendment reduced Zn toxicity, the screening WER results do not warrant performing a full WER. The proposed H-12 Zn limit of 153.2 μg/L is bounded by the results of the screening WER of 122 μg/L and 168 μg/L for untreated and treated waters, respectively. The data suggest that the recalculation procedure provides a reasonable and appropriate basis for developing a Zn limit and that a full WER would result in a similar limit and would require significant time and expense to perform.

6.0 References

HydroQual, Inc, 2007. User's Guide and Reference Manual for Biotic Ligand Model, Windows Interface, Version 2.2.1, February 2007.

Millings, M. R., B. B. Looney, N. V. Halverson and R. L. Nichols. 2008. Detoxification of Copper in Surface Water Discharges Using Soluble Humic Acid Amendment: Technical Summary of Results. Washington Savannah River Company report WSRC-STI-2008-00105.

U.S. EPA. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. PB85-227049. National Technical Information Service, Springfield, VA.

U.S. EPA. 1994. Interim Guidance on Determination and Use of Water-Effect Ratios for Metals. EPA-823-B-94-001 or PB94-140951. National Technical Information Service, Springfield, VA.

Appendix A

ETT Screening WER Report for H-12 Outfall

ETT environmental, Inc.
(864) 877-6942 . FAX (864) 877-6938
P.O. Box 16414, Greenville, SC 29606
Craftsman Court, Greer, SC 29650

Screening Tests to Determine the Feasibility of Conducting a Water Effect Ratio for Adjustment of Zinc Limits

Outfall: WSRC H-12

Metal: Zinc

Test Type: Chronic Survival and Reproduction Test

Test Species: ***Ceriodaphnia dubia***

September 2008

Amended 9/22/08

1.0 Introduction

In response to the anticipated proposed limits in the draft permit, screening studies were initiated to determine whether a Site Specific / WER studies would be likely to significantly increase permit limits for zinc. A screening WER was conducted for untreated H-12 effluent and H-12 effluent which was spiked with Dissolved Organic Carbon (DOC). This report presents the result of the screening studies.

2.0 Methods

A WER involves comparing the toxic level of a metal in laboratory water to the toxic level of a metal in site water. In this study Diluted Mineral Water (DMW) at a hardness of 50 mg/L was used as the "laboratory water". Because laboratory water contains no natural chelating agents which can bind aquatic metals and make them less biologically available, metals such as zinc tend to be toxic at lower concentrations than they are in natural site waters. Downstream water is typically a mixture of effluent and upstream water. In this study 100% effluent was used as site water, because it is the In-Stream Wastewater Concentration (IWC).

2.1 Preparation of Test Solutions

2.1.1 *Laboratory Water*

Due to an adequate database of test results of zinc in laboratory water which has been developed at ETT Environmental, no additional tests were needed. Existing data was used.

2.1.2 *Simulated Downstream Water*

Simulated downstream water was 100% effluent. Zinc was spiked into untreated effluent and effluent spiked with DOC at a series of seven test concentrations. It was spiked from a stock solution of 50 mg/L of zinc sulfate $ZnSO_4$ $7H_20$ (11.37 mg/L as Zn). The volumes of stock solution added were as follows;

Test Concentration	mL Stock Soln.	Total Volume (mL)
0 ug/L (Control)	0	1400
34.3 ug/L	4.22	1400
49 ug/L	6.03	1400
70 ug/L	8.62	1400
100 ug/L	12.31	1400
143 ug/L	17.51	1400
204 ug/L	25.12	1400

2.2 Metal Analyses

Total and dissolved zinc were measured in each test concentration at the beginning of the test. Zinc was measured by an atomic absorption spectrophotometer using method 3111B (Standard Methods 18th Ed.).

2.3 Toxicity Testing

Chronic Survival and Reproduction tests with the test organism *Ceriodaphnia dubia* were conducted with each zinc treatment level. The methodology is summarized as follows;

1. Temperature:	25°C ✂ 1
2. Light:	100 ft-cd; 16 hr lt/8 hr dk
3. Test Chamber Size:	30 mL plastic cup
4. Test Solution Volume:	15 mL
5. Renewal:	Daily
6. Age of Test Organisms:	<24 hours
7. No. of Neonates / Test Chamber	1
8. No. Replicates / Dilution	10
9. Feeding:	Daily with 0.05 mL Selenastrum and 0.1 mL YAT
10. Cleaning of Test Chambers:	None
11. Aeration:	None
12. Dilution Water	N/A
13. Effluent Concentrations:	as noted in 2.1.2
14. Dilution Factor:	0.7
15. Test Duration:	7 days / 3 broods
16. Test End Point	EC50 (using non-linear regression)

3.0 Results

3.1 Laboratory Water

Data from previous testing has indicated that zinc is chronically toxic in the 50 mg/L hardness laboratory water at approximately 66.5 ug/L (LC_{50} at a hardness of 50 mg/L).

3.2 Untreated Effluent

The results for the tests with zinc spiked into untreated H-12 effluent are summarized as follows.

Nominal Test Concentration	Measured Test Concentration	Mean Reproduction Untreated Effluent
0 ug/L (Control)	27.6 ug/L T-Zn	19.5
34.3 ug/L	80 ug/L T-Zn	20.6
49.0 ug/L	85 ug/L T-Zn	17.2
70.0 ug/L	95 ug/L T-Zn	2.9
100 ug/L	124 ug/L T-Zn	0.0
143 ug/L	202 ug/L T-Zn	0.0

EC_{50} = 89.9 ug/L T-Zn

3.3 DOC treated Effluent

The results for the tests with zinc spiked into treated H-12 effluent are summarized as follows.

Nominal Test Concentration	Measured Test Concentration	Mean Reproduction Untreated Effluent
0 ug/L (Control)	27.6 ug/L T-Zn	21.0
49.0 ug/L	77 ug/L T-Zn	20.4
70.0 ug/L	85 ug/L T-Zn	19.8
100 ug/L	120 ug/L T-Zn	11.0
143 ug/L	170 ug/L T-Zn	4.3
204 ug/L	208 ug/L T-Zn	0.0

EC_{50} = 123.8 ug/L T-Zn

4.0 Determination of Water Effect Ratio

4.1 Adjustment of Laboratory Water Result to Hardness of Site Water

In order to determine a WER the EC_{50} values for the laboratory water must be adjusted to the same hardness as the effluent. This is done using the following equation;

(H-12 Untreated) Adjusted EC50 = $(\text{Site Hardness/Lab Water Hardness})^{0.8545}$ *Original EC_{50}

$= (10/50)^{0.8545} * 66.5$ ug/L

= 16.8 ug/L Zn

(H-12 DOC Treated) Adjusted EC50 = $(\text{Site Hardness/Lab Water Hardness})^{0.8545}$ *Original EC_{50}

$= (10.2/50)^{0.8545} * 66.5$ ug/L

= 17.1 ug/L Zn

4.2 Calculation of WER

The WER is calculated as follows; Effluent LC_{50} / Adjusted Laboratory Water LC_{50}

Untreated Effluent WER = 89.9 / 16.8 = 5.35

DOC Treated Effluent WER = 123.8 / 17.1 = 7.24

NOTE: Hardness of the DOC treated effluent was measured as 16 mg/L by the titrimetric method. However, based on measured concentrations of calcium and magnesium in the DOC, the hardness should have been 10.2 mg/L. According to Standard Methods (20^{th} Ed.) suspended or colloidal organic matter may interfere with the end point for the titrimetric method. For the purposes of the calculations in this report the hardness used is 10.2 mg/L.

5.0 Predicted Site Specific Limits for Zinc

The Site Specific Limits for Zinc are calculated as follows;

$$\frac{[(\text{EPA Water Quality Criterion}) \times (\text{WER}) \times (\text{Downstream Flow})] - [(\text{Upstream Flow}) \times (\text{Upstream Zn Conc.})]}{(\text{Effluent Flow})}$$

Untreated Effluent

The EPA Water Quality Criterion (Maximum) for Zinc at the Site Hardness of 10 mg/L (for untreated effluent) = 17.03 ug/L. Incorporating the results of the Recalculation Procedure the EPA Water Quality Criterion for Zinc at a Site Hardness of 10 mg/L is adjusted to 22.88 ug/L.

The WER is 5.35

Downstream flow = effluent flow.

The 7Q10 upstream flow is 0 mgd = 0 cfs.

The default upstream zinc concentration to be used 0 mg/L.

Using the formula above, the **Predicted Average Site Specific Limit** is **0.122 mg/L Zn.**

DOC Treated Effluent

The EPA Water Quality Criterion (Maximum) for Zinc at the Site Hardness of 10.2 mg/L (for untreated effluent) = 17.32 ug/L. Incorporating the results of the Recalculation Procedure the EPA Water Quality Criterion for Zinc at a Site Hardness of 10.2 mg/L is adjusted to 23.27 ug/L.

The WER is 7.24

Downstream flow = effluent flow.

The 7Q10 upstream flow is 0 mgd = 0 cfs.

The default upstream zinc concentration to be used 0 mg/L.

Using the formula above, the **Predicted Average Site Specific Limit** is **0.168 mg/L Zn.**

6.0 Conclusion

If a full chronic Water Effect Ratio for Zinc is conducted, it is predicted that the new **average** permit limit will be **0.122 mg/L** for untreated H-12 effluent and **0.168 mg/L** for DOC treated effluent. As compared to the current permit limit of 0.100 mg/L, it may be predicted that a Zinc WER will raise permit limits for untreated effluent. However, a Zinc WER will be more effective to raise permit limits if the effluent is treated with DOC. SCDHEC has the authority to arbitrarily reduce the limit based upon their determination of “what is needed”.

Attachment

Bench Sheets for Screening WER

WER Chronic Multi-Concentration

Client: WSRC #42A			Metal
Sample ID: DMW or Downstream (circle one)			Upstream
Start Date: 3/6/08	End Date: 3/13/08		
Start Time: 1430	End Time: 1130		Effluent
Started By: BB	Ended By: BB		320

Test Organism: Ceriodaphnia dubia

Neonates born on ______ between ______ and ______

Broods	A,I	B,J	C,K	D,L	E,M	F,N	G,O	H,P
3/7-25	W4	D10	W5	W10	U4	E4	D4	E2

Temperature 24-26 C Light: 16 h L/8 h dark 50-100 ft-candles

Water Renewal and Feeding*

Day	0	1	2	3	4	5	6	7
fed	✓	✓	✓	✓	✓	✓	✓	
renew	X	✓	✓	✓	✓	✓	✓	X
time	1430	1115	1445	1430	1020	1445	1445	
Init	BB	BB	AC	KC	JM			
Incubator #1								

*DO for water batches and form batches in separate record.

Conc.	rep	1	2	3	4	5	6	7	8	Total	Mean
Nominal Conc. 0 ug/L	A			0	12	6	9			17	21.0
	B			3	0	6	11			20	Std.D.
	C			0	4	10	0	11		25	4.52
	D			4	0	8	13			25	
	E			2	0	9	0	12		23	
	F			3	0	8	9			20	
	G			0	3	10	0	10		13	
Measured Conc.	H			2	0	7	8			17	
	I			0	4	10	8			22	
	J			0	6	9	0	13		28	
	K										
	L										
	M										
	N										
	O										
	P										
	Q										
	R										
	S										
	T										
Nominal Conc. 44	A			0	0	5	0	8		13	Mean
	B			3	0	6	9			18	20.4
	C			0	3	10	0	12		25	Std.D.
	D			4	0	9	9			22	4.70
	E			0	4	8	12			24	
	F			0	4	8	0	10		22	
	G			0	4	4	10			18	
Measured Conc.	H			0	6	8	0	12		26	
	I			0	5	7	0	11		23	
	J			0	3	10	0	0		13	
	K										Mean
	L										
	M										Std.D.
	N										
	O										
	P										
	Q										
	R										
	S										
	T										

Conc.	rep	1	2	3	4	5	6	7	8	Total
Nominal Conc. 70	A			0	3	8	0	10		21
	B			3	0	9	12			24
	C			0	2	7	9			18
	D			0	3	6	8			17
	E			0	3	8	0	10		21
	F			0	4	7	7			18
	G			0	5	7	9			21
Measured Conc.	H			3	0	8	8			19
	I			0	4	6	0	9		19
	J			3	0	8	9			20
	K									M= 19.8
	L									SD= 5.04
	M									
	N									
	O									
	P									
	Q									
	R									
	S									
	T									

Test solution volume: ... test vessels: 1 oz. plastic cups. Test boards ... per SOP. X = dead organism ...

Comments:

Test Method: Interim Guidance; EPA-823-B-94-001

Results Reviewed By:

WER Chronic Multi-Concentration Test

Continued: HRA | Log# 2019

Rep	1	2 (AE??)	3	4	5	6	7	8	Total	
A		D	0	0	1	0	0		1	Mean 11.0
B			3	0	6	13			22	Std.D.
C		D	0	2	8	0	7		17	6.42
D		D	3	0	7	9			19	
E			0	1	7	10	0		8	
F		D	0	3	7	2			12	
G		D	0	0	0	0	0		0	
H	D								0	
I			0	4	6	9			19	
J			0	1	6	5	0		12	
K										
L										
M										
N										
O										
P										
Q										
R										
S										
T										
A		D							0	Mean 4.3
B			0	0	2	0	0		2	
C		D							0	Std.D 6.85
D		D							0	
E			0	0	2	9	0		11	
F		D							0	
G		D							0	
H		D							0	
I			4	0	5	10	0		19	
J			0	3	0	8	0		11	
K										Mean
L										
M										Std.D.
N										
O										
P										
Q										
R										
S										
T										

Preparation of Downstream Water:

% Effluent: 100	Volume Effluent	Prep Date
% Upstream	Volume Upstream	Prep. By:

Preparation of DMW: Date Prepared:

Type (Circle one)	Volume DMW	Total Volume
25 mg/L Hardness DMW		
50 mg/L Hardness DMW		
	Volume MHSF	Total Volume
25 mg/L Hardness Synthetic		
50 mg/L Hardness Synthetic		

Metal Spiking Metal salt used: $ZnSO_4$

Stock Solution conc. 1137 mg/L

Nominal Conc.	mL of Stock Solution	Volume prepared	Prepared by
[illegible]	—	mL	[illegible]
49	6.43	~~[illegible]~~ 1400 mL	
70	8.62		
100	12.31		Prep. Date:
143	17.51		8/6/[illegible]
204	25.12		

Conc.	rep	1	2	3	4	5	6	7	8	Total
Nominal Conc.	A	D								
	B		D							
	C	D								
204	D		D							
	E	0								
	F	0								
	G	0								
Measured Conc.	H	D								
	I	D								
	J		D							
	K									
	L									
	M									
	N									
	O									
	P									
	Q									
	R									
	S									
	T									

WER Chronic Multi-Concentration

Client: WSRC H-12 B			
Sample ID:	DMW or Downstream (circle one)		
Start Date: 8/6/08		End Date: 8/13/08	
Start Time: 1900		End Time: 1430	
Started By: GB		Ended By: GB	

Test Organism: Ceriodaphnia dubia

Neonates born on 8/5/08 between 1700 [illegible]

Blocks	A,I	B,J	C,K	D,L	E,M	F,N	G,O	H,P
7/25-7/29	W4	S10	W5	W6	U4	E7	D4	E2

Temperature 24-26°C Light; 16 hr light/8 hr dark; 50-100 ft-candles

Water Renewal and Feeding*

Day	0	1	2	3	4	5	6	7
fed	✓	✓	✓	✓	✓	✓	✓	
renew	X	✓	✓	✓	✓	✓	✓	X
time	[illegible]	1115	1434	0800	0140	1330	1430	
Ind.	[illegible]	GB	[illegible]	[illegible]	AM	[illegible]	[illegible]	

Incubator #1

*Dilution water batches and food batches in separate record.

	rep	1	2	3	4	5	6	7	8	Total	
Nominal	A			0	6	8	0	11		25	Mean 14.5
Conc.	B			3	0	8	9			20	Std.D.
	C			0	3	10	0	12		25	7.20
	D			0	3	6	9			18	
0 mg/L	E			0	2	8	0	10		20	
	F			0	4	8	11			23	
	G			0	5	9	7			21	
Measured	H			0	3	8	10			21	
Conc.	I		D							0 X	
	J			0	3	7	12			22	
	K										
	L										
	M										
	N										
	O										
	P										
	Q										
	R										
	S										
	T										
Nominal	A			0	4	8	0	12		24	Mean
Conc.	B			0	4	6	9			19	20.6
	C			0	4	7	0	11		22	Std.D.
34.3	D			0	2	7	13			22	2.50
	E			0	4	8	0	11		23	
	F			0	3	6	10			19	
	G			0	1	7	8			16	
Measured	H			0	2	7	9			18	
Conc.	I			3	0	8	10			21	
	J			0	4	8	0	10		22	
	K										Mean
	L										
	M										Std.D.
	N										
	O										
	P										
	Q										
	R										
	S										
	T										

Conc.	rep	1	2	3	4	5	6	7
Nominal	A			1	8	5	0	8
Conc.	B			0	2	8	9	
	C			0	4	5	0	7
	D			0	3	6	12	
49	E			0	5	D		
	F			0	4	6	10	
	G			0	4	5	12	
Measured	H			0	3	8	13	
Conc.	I			0	1	6	8	
	J			0	2	6	8	
	K							
	L							
	M							
	N							
	O							
	P							
	Q							
	R							
	S							
	T							

Test solution volume: 15 mL. Test vessels: 1 oz. plastic cups. Test board randomized per SOP. X = dead organism. Lethal organism. Transfer volume 0.05 ml

Comments:

Test Method: Interim Guidance; EPA-823-B-94-001

Results Reviewed By:

WER Chronic Multi-Concentration Test

Continued: #12 | Log# 32050

	rep	1	2	3	4	5	6	7	8	Total	
Nominal	A			0	3	0	0	0		3	Mean
Conc.	B		D							0	2.9
	C		D							0	Std.D.
	D			0	0	2	7	0		9	5.11
70	E			D						0	
	F			D						0	
	G			0	0	0	D			0	
Measured	H			D						0	
Conc.	I			2	0	D				2	
	J			0	1	6	8	0		15	
	K									--	
	L										
	M										
	N										
	O										
	P										
	Q										
	R										
	S										
	T										

	rep	1	2	3	4	5	6	7	8	Total	
Nominal	A			D							Mean
Conc.	B		D								0
	C	~~X~~ D									Std.D.
	D		D								
100	E		D								
	F	0									
	G		D								
Measured	H		D								
Conc.	I		D								
	J			0	D						
	K										Mean
	L										
	M										Std.D.
	N										
	O										
	P										
	Q										
	R										
	S										
	T										

Preparation of Downstream Water:

% Effluent 100%	Volume Effluent	Prep Date:
% Upstream	Volume Upstream	Prep By:

Preparation of DMW: Date Prepared.

Type (Circle one)	Volume DMW	Total Volume
25 mg/L Hardness DMW		
50 mg/L Hardness DMW		
	Volume MHSF	Total Volume
25 mg/L Hardness Synthetic		
50 mg/L Hardness Synthetic		

Metal Spiking

Metal salt used: $ZnSO_4$

Stock Solution conc. 1137 mg/l

Nominal Conc µg/L	mL of Stock Solution	volume prepared ml	Prepared by:
34.3	4.22	~~500~~ 1400	BB
49	6.03	↓	
70	8.62	↓	Prep. Date.
100	12.31	↓	8/6/08
143	17.51	↓	

Conc.	rep	1	2	3	4	5	6	7	8	Total
Nominal	A	0								D
Conc.	B	0								
143	C	0								
	D	0								
	E	0								
	F	0								
	G		D							
Measured	H		R							
Conc.	I		D							
	J		D							
	K									
	L									
	M									
	N									
	O									
	P									
	Q									
	R									
	S									
	T									

Appendix B

H-12 WER Sample Metal Analysis

(Environmental/Bioassay Laboratory)

Savannah River Site's
Analytical Laboratories
Environmental/Bioassay Laboratory

NPDES
CERTIFICATE OF ANALYSIS

SC DHEC Certification: 02550001 QC/QA Officer: Jay Hutchison, Jr. Signature: ____________

Bldg 735-B Tech Support: Robin Utsey Signature: ____________

Customer ID: H-12 WER **SRS Sample ID: 0880153100** **Laboratory ID: 200090507** % Liquids: 100

Collection Location: MISCELLANEOUS ON-SIT Sample Collection Date 09/09/2008 Sample Collection Time 12:00 AM

Analyst: Robin Utsey Extraction Date: 09/24/2008 Extraction Time: 11:00 AM

Analyte		Result	PQL	Units	Extraction Method:	Analysis Method:	Analysis Date	Analysis Time
Ca		2.3617	0.25	mg/L	EPA200.8	EPA200.8	09/24/2008	11:57 AM
Cu	<	0.0250	0.025	mg/L	EPA200.8	EPA200.8	09/24/2008	11:57 AM
K		0.6688	0.03	mg/L	EPA200.8	EPA200.8	09/24/2008	11:57 AM
Mg		0.3095	0.25	mg/L	EPA200.8	EPA200.8	09/24/2008	11:57 AM
Na		9.9021	0.15	mg/L	EPA200.8	EPA200.8	09/24/2008	11:57 AM

Appendix C.

Report on Recalculation Procedure for Zinc: NPDES Outfall H-12

ETT environmental, Inc.
(864) 877-6942 . FAX (864) 877-6938
P.O. Box 16414, Greenville, SC 29606
Craftsman Court, Greer, SC 29650

RECALCULATION PROCEDURE
for
ZINC

NPDES Outfall H-12

Conducted for Westinghouse Savannah River Company
Contract # 383922N

August 2007
Amended 1/9/08 (Rev. 4)

TABLE OF CONTENTS

1.0 Introduction

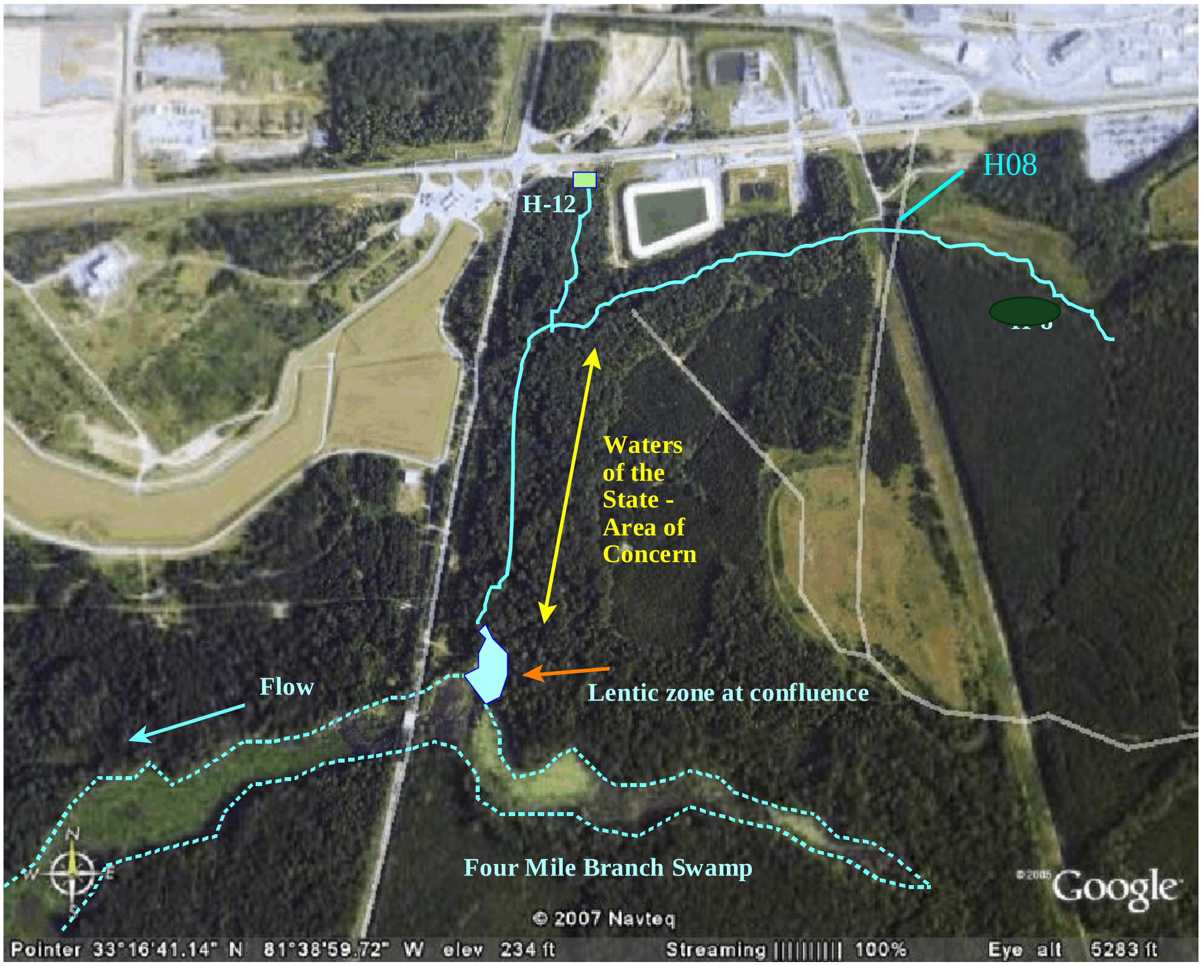
As permitted under the NPDES permit, a *Recalculation Procedure* was conducted for Zinc at WSRC Outfall H-12. The methodology used included *Interim Guidance on Determination and Use of Water-Effect Ratios for Metals* (EPA-823-B-94-001 Appendix B) and *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses* by Stephan et al.

2.0 Site Description

Outfall H-12 is located near the junction of Road 4 and Road E at the Savannah River Site. It flows south for approximately 750 ft where it merges with the unnamed tributary that also receives from the H-08 outfall and originates approximately 2/3 mile ESE of the H-12 Outfall. The unnamed tributary is a water of the state. The combined stream flows freely for a distance of about 1500 feet to where it enters a swampy lentic zone, which forms an extension of the Four Mile Branch (FMB) swamp. For the purposes of this study, this area is not considered to be part of the stream. Four Mile Branch is a second-order stream with a low flow of approximately 1.5 cfs.

The upper sections of the H-12/H-08 stream reach are deeply eroded, with a largely hard-clay stream bed (Figure 1). There are no rocks but the stream bed is littered with chunks of hard clay forming continuous riffle. The depth is only a few inches and the width of the stream is about ten feet. The steep banks are 10-15 feet high, at the top of which deciduous forest predominates. Near the point at which the stream reaches the swamp, the stream cuts less deeply into the ground and the height of the banks decreases to only 3-5 feet. In this section there is some silt benthic habitat and a slower flow.

AERIAL VIEW OF SITE



3.0 Determination of Species Present at the Site

According to the *Recalculation Procedure*, all species in the National Database for a particular metal which occur at a site must be retained in the list. Species which occur at a site are defined as 1) species which are usually present at the site, 2) species present only seasonally, 3) species present intermittently due to range fluctuations, 4) species known to be present in the past but are no longer present due to habitat degradation, and 5) species present in nearby bodies of water and would be expected to be present in the absence of habitat degradation.

Studies of the aquatic fauna, both fish and aquatic macroinvertebrates, have been conducted.

The following species of fish were collected in the stream during sampling in September 2005 (data provided by Michael Paller of WSRC).

<u>Family Cyprinidae</u>		
	Nocomis leptocephalus	Bluehead Chub
	Notemigonus chrysoleucas	Golden Shiner
	Notropis lutipinnis	Yellowfin Shiner
<u>Family Ictaluridae</u>		
	Ameiurus natalis	Yellow bullhead
	Noturus insignis	Margined Madtom
	Noturus leptacanthus	Speckled Madtom
<u>Family Esocidae</u>		
	Esox americanus	Redfin Pickerel
	Esox niger	Chain Pickerel
<u>Family Aphredoderidae</u>		
	Aphredoderus sayanus	Pirate Perch
<u>Family Centrarchidae</u>		
	Lepomis auritus	Redbreast Sunfish
	Lepomis gulosus	Warmouth
	Lepomis punctatus	Spotted Sunfish

In addition to the species actually collected in the stream, there are a number of species collected in Four Mile Branch which might also might be expected to occur in the stream or might have occurred in the stream in the past. These species include;

Family Anguillidae		
	Anguilla rostrata	American Eel
Family Cyprinidae		
	Notropis cummingsae	Dusky Shiner
	Notropis hudsonius	Spottail Shiner
	Notropis petersoni	Coastal Shiner
	Pteronotropis hypselopterus	Sailfin Shiner
	Semotilus atromaculatus	Creek Chub
Family Catostomidae		
	Erimyzon oblongus	Creek Chubsucker
	Minytrema melanops	Spotted Sucker
Family Percidae		
	Etheostoma olmstedi	Tessellated Darter
	Percina nigrofasciata	Blackbanded Darter

The following species of aquatic macroinvertebrates were collected in the stream during sampling on June 2007 (sampling by ETT Environmental, Inc.).

Order Trichoptera (Caddisflies)

Hydropsyche betteni

Order Megaloptera (Hellgrammites)

Nigronia serricornis

Order Coleoptera (Beetles)

Dineutus sp. (whirligig beetle)

Stenelmis sinuata (elmid beetle)

Order Diptera

Ablabesmyia mallochi (midge)

Chironomus sp. (midge)

<u>Order Diptera (cont'd)</u>

Labrundinia pilosella (midge)

Limnophila sp. (crane fly)

Meropelopia sp. (midge)

Paratendipes albimanus (midge)

Phaenopsectra flavipes (midge)

Rheotanytarsus exiguus gp. (midge)

Stenochironomus sp. (midge)

Tipulidae (cranefly pupa)

It was evident from the sample collection that the stream is currently supportive of only a reduced diversity of aquatic macroinvertebrates. One reason is undoubtably the hard clay benthic substrate which is not conducive to macroinvertebrate colonization. In addition to the species actually collected in the stream, there are numerous taxa of aquatic macroinvertebrates which would be expected in a stream of this size at the Savannah River Site. Some of the expected taxa would include;

Mayflies Family Baetidae genera; *Acentrella, Acerpenna, Baetis, Pseudocloeon*
Mayflies Family Ephemerellidae genera; *Ephemerella, Eurylophella*
Mayflies Family Heptageniidae genera; *Stenonema, Stenacron*
Mayflies Family Isonychiiidae genera; *Isonychia*
Stoneflies Family Capniidae genera; *Allocapnia*
Stoneflies Family Leuctridae genera; *Lecutra*
Stoneflies Family Nemouridae genera; *Shipsa*
Stoneflies Family Perlidae genera; *Acroneuria, Paragnetina*
Stoneflies Family Perlodidae genera; *Clioperla, Isopela*
Stoneflies Family Taeniopterygidae genera; *Taeniopteryx*
Caddisflies Family Calamoceratidae genera; *Hetroplectron*
Caddisflies Family Hydroptilidae genera; *Hydroptila, Ochrotrichia*
Caddisflies Family Hydropychidae genera; *Cheumatopsyche, Diplectrona*
Caddisflies Family Leptoceridae genera; *Oecetis, Triaenodes*
Caddisflies Family Lepidostomatidae genera;

Lepidostoma
Caddisflies Family Limnephilidae genera; *Pycnopsyche*
Caddisflies Family Philopotamidae genera; *Chimarra*

Caddisflies Family Polycentropodidae genera; *Phylocentropus*
Caddisflies Family Sericostomatidae genera: *Agarodes*
Hellgrammites Family Corydalidae genera; *Nigronia*, *Corydalus*
Damselflies Family Coenagrionidae genera; *Enallagma, Argia*
Damselflies Family Calopterygidae genera; *Calopteryx*
Dragonflies Family Aeshnidae genera; *Boyeria*
Dragonflies Family Gomphidae genera; *Gomphus, Ophiogomphus, Progomphus*
True Bugs Family Gerridae genera; *Gerris*
True Bugs Family Veliidae genera; *Rhagovelia*
Beetles Family Dytiscidae genera; *Hydroporus*,
Beetles Family Elmidae genera; *Ancyronyx, Dubiraphia, Macronychus, Stenelmis*
Beetles Family Gyrinidae genera; *Dineutus*
Beetles Family Hydrophilidae genera; *Sperchopsis*
Flies Family Ceratopogonidae genera; *Bezzia, Palpomyia*
Flies Family Chironomidae genera; *Ablabesmyia, Conchapelopia gp., Labrundinia, Brillia, Corynoneura, Cricotopus, Eukiefferiella, Nanocladius, Orthocladius, Parametriocnemus, Rheocricotopus, Thienemanniella, Tvetenia, Unniella, Cryptochironomus, Dicrotendipes, Polypedilum, Stenochironomus, Tribelos Rheotanytarsus, Tanytarsus*
Worms Family Naididae genera; *Nais*
Family Tubificidae genera; *Peloscolex*
Snails Family Menetidae genera; *Micromenetidae*
Crustaceans Family Decapoda genera; *Cambarus, Procambarus*
Family Amphipoda genera; *Hyallela, Crangonyx*

The following comments are provided with regard to species in the National Dataset and their potential for being present at the site;

Daphnidae	Water fleas.	Daphnids are associated with lentic (still water) habitats, which are not naturally present in this stream. Among the daphnids in the national dataset only *Ceriodaphnia reticulata* might be found in a lentic habitat at the Savannah River Site. Of the other species in the national dataset it may be noted that 1) *Daphnia magna* is found only in the north and midwest - associated with harder water, 2) *Daphnia pulex* is found in the north and west but not the Ohio Valley or Southeast, 3) *Ceriodaphnia dubia (=affinis)* is generally a more northern species. Species of *Daphnia* which are or would be expected to be present in lentic habitats at the Savannah River Site include *Daphnia ambigua*, *Daphnia catawba,*and *Daphnia laevis*. The H12/H08 stream does not have the type of lentic habitat which would be necessary for the presence of daphnids- therefore daphnids are determined not to be present.
Morone saxatilis	Striped Bass	Not present. A coastal species that does not enter small streams.
Agosia chrysogaster	Longfin Dace	Not present. Occurs in Arizona.
Oreochromis mossambica	Tilapia	Non-native species.
Salmonidae	Trout,Salmon	*Onchorhynus, Salvelinus, Salmo.* Not present. Salmonids are cold-water fish and do not occur in the lower Piedmont and Coastal Plain of South Carolina.
Limnodrilus hoffmeisteri	Worm	Widespread in distribution and expected to be found in this stream.
Pectinatella magnifica	Bryozoan	Not present. A northern species
Physella heterostropha	Snail	Expected to be present in the stream.
Physella gyrina	Snail	Widespread in distribution. Not reported from Savannah River Site.
Helisoma campanulatum	Snail	Not present. A northern species. = *Planorbula*.
Plumatella rostrata	Bryozoan	Status undetermined.
Jordanella floridae	Flagfish	Not present. Found only in Florida.
Lophopodella carteri	Bryozoan	Reported only from the northern United States and Canada
Lirceus alabamae	Isopod	Not present. Not known from the Savannah River Site.
Pimephales promelas	Fathead Minnow	Not present. A northern and midwest species..
Xiphophorus maculates	Southern Platyfish	Not present. Not found at the Savannah River Site.
Corbicula fluminea	Asiatic Clam	Non-native species. Present at site.
Catostomus commersonii	White Sucker	Not present. Not found at Savannah River Site.
Notemigonus crysoleucas	Golden Shiner	This species has been collected in the stream.
Poecilia reticulata	Guppy	Non-native species.
Ptychocheilus oregonensis	Northern Pikeminnow.	Not present. Found in NW North America
Cyprinus carpio	Carp	Non-native species
Gammaridae	Amphipod	There are no species of *Gammarus* present

		at the site, although species of the closely related *Crangonyx* are likely present, or may have been in the past.
Caecidotea sp.	Isopod	This genus likely occurs in the stream. *bicrenata* occurs in the Tennessee Valley.
Lumbriculus variegatus	Worm	Widespread. Likely found at site.
Carassius auratus	Goldfish	Non-native species.
Lepomis macrochirus	Bluegill	Likely to be present at the site.
Lepomis gibbosus	Pumpkinseed	Likely to be present at site.
Anguilla rostrata	American Eel	Found in Four Mile Branch. May enter the site.
Amnicola sp.	Snail	*Amnicola limosus* likely to be present at site.
Fundulus diaphanus	Banded Killifish.	Not present. Not found in Savannah River Drainage
Nais sp.	Worm	Species in this genus may be present.
Crangonyx pseudogracilis	Amphipod	Not present. A northern species.
Argia sp.	Damselfly	The species *Argia sedula* occurs in the stream.
Xenopus laevis	African Clawed Frog	Not present. Introduced in SW US

4.0 Corrections to the National Dataset

A listing of the National Dataset is provided in Appendix A (Includes 1995 Update). No corrections to the National Dataset are made in this Recalculation Procedure.

5.0 Additions to the National Dataset

No additions to the National Dataset are made in this Recalculation Procedure.

6.0 Deletions from the National Dataset

Based upon the deletion process as described in the *Recalculation Procedure*, the following species are deleted from the National Dataset (See Appendix B);

Daphnid	*Ceriodaphnia reticulata*
Daphnid	*Ceriodaphnia dubia*
Daphnid	*Daphnia pulex*
Daphnid	*Daphnia magna*
Chinook Salmon	*Onchorhynchus tshawytscha*
Sockeye Salmon	*Onchorhynchus nerka*
	Coho Salmon
	Onchorhynchus kisutch
Rainbow Trout	*Onchorhynchus mykiss*
Atlantic Salmon	*Salmo salar*
Snail	*Physella gyrina*
Tilapia	*Oreochromis mozambica*
Brook Trout	*Salvelinus fontinalus*
White Sucker	*Catostomus commersonii*
Bryozoan	*Lophopodella carteri*

7.0 Minimum Data Requirements

The primary Minimum Data Requirement is that after the Deletion Process there must be at least eight families of aquatic invertebrates, amphibians, and fishes at the site. In this Recalculation Procedure there were 12 families of aquatic invertebrates retained and 5 families of fishes after the deletion process was completed.

There are additional requirements regarding the eight families needed for the Minimum Data Requirement. These additional requirements include,

A. The Family Salmonidae must be included

B. A second family of Osteichthyes (bony fish) must be included - preferably a commercially important species.

C. A third family in Phylum Chordata must be included.

D. A planktonic crustacean must be included

E. A benthic crustacean must be included

F. An aquatic insect must be included

G. A family in a phylum other than Arthropoda or Chordata must be included

H. A second aquatic insect family or another Phylum not represented in the other 7 families.

Each of these requirements are addressed as follows;

A. Family Salmonidae

There are no species of the family (or the Order Salmoniformes) which occur or would be expected to occur at the site. However, there are species in the same class (Osteichthyes) in the National Dataset, and there are more than three families of Osteichthyes. Therefore one of the other families of Osteichthyes can substitute - for example Ictaluridae.

B. Second Family of Osteichthyes

There are five families of bony fish.

C. Third Family of Chordates

There are five families of fish.

D. A Planktonic Crustacean.

This requirement is inappropriate for an aquatic site without lentic habitat. Because no species in the Order Cladocera are found at the site, a species in the same class (Crustacea) can substitute - for example *Gammarus sp.* (Amphipod).

E. Benthic Crustacean

The amphipod species *Crangonyx pseudogracilis* fulfills the requirement.

F. Aquatic Insect

The damselfly species *Argia sp.* fulfills the requirement.

G. A Family in A Phylum Other Than Arthropoda or Chordata

The bryozoan species *Plumatella rostrata* fulfills the requirement.

H. A Second Insect Family or a Family in Another Phylum

The worm species *Lumbriculus variegatus* (Phylum Annelida) fulfills the requirement.

8.0 Calculation of Final Acute Value (FAV) and Final Chronic Value (FCV)

Calculations are shown in Appendix D. The four genera with the lowest GMAV values were; *Morone, Agosia, Physa,* and *Limnodrilus*.

Using the Site Specific Dataset, the new FAV is 178.9406 ug/L Zn.
Using the Site Specific Dataset, the new FCV is calculated by dividing the Site Specific FAV by the FACR (Final Acute-Chronic Ratio) of 2.0 (the national value). The calculated FCV is 89.4703 ug/L Zn.

9.0 Calculation of Site Specific CMC and Site Specific CCC

Calculations are shown in Appendix D.

The new Site Specific CMC is calculated as one-half of the FAV but must be adjusted for the site hardness

CMC = 89.4703 ug/L Zn
(at a hardness of 50 mg/L).
= 49.7297 ug/L Zn
(At a hardness of 25 mg/L)

The new Site Specific CCC is the same as the FCV

CCC = 89.4703 ug/L Zn
(at a hardness of 50 mg/L).
= 49.7297 ug/L Zn
(At a hardness of 25 mg/L)

The CCC=CMC, therefore only the CMC is used**.**

10.0 Calculation of Site Specific Limits for Zinc for Outfall H-12

Using the *Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria (October 1993)* and *Technical Guidance Manual for Performing Waste Load Allocations Book II, Rivers and Streams (EPA/440/484/022)* the Site Specific Limits for zinc can be calculated to take into account the partitioning of the metal in dissolved versus total form.

The calculations use the following input data.

CCC (Site Specific) = 49.7297 ug/L Zn (25 mg/L hardness)
CMC (Site Specific) = 49.7297 ug/L Zn (25 mg/L hardness)
DF_1 = 1.0
CF_{CCC} = 98.6
CF_{CMC} = 97.8
$k_{po} = 1.25 \times 10^6$
Background TSS = 1 mg/L
Effluent TSS = 6 mg/L (from upcoming NPDES 2C Application data)
a = -0.7038

The final limits are as follows;

Site Specific Maximum Zinc Limit: 153.2 ug/L

APPENDIX A (for recalculation procedure report)

National Dataset for Zinc

1995 UPDATE:

Freshwater Aquatic Life Criterion for Zinc

The new acceptable acute data for zinc are given in Table O1; no new acceptable chronic data were found. These data were used with those given in Tables 1 and 2 of the criteria document for zinc (U.S. EPA 1987) to obtain the values given in Table O2. Because the toxicity of zinc is hardness-dependent, all acute values in Table O2 have been adjusted to a hardness of 50 mg/L.

Criterion Maximum Concentration (CMC)

The Final Acute Value (FAV) was calculated using the four lowest Genus Mean Acute Values in Table O2, resulting in an FAV of 133.2 ug/L at a hardness of 50 mg/L. This value did not need to be lowered to protect a commercially or recreationally important species. The CMC was calculated by dividing the FAV by 2, resulting in a CMC of 66.6 ug/L, as total recoverable zinc, at a hardness of 50 mg/L. The CMC was related to hardness using the slope of 0.8473 that was derived in U.S. EPA (1987):

$$CMC = e^{0.8473(\ln hardness) + 0.884}$$

Criterion Continuous Concentration (CCC)

Insufficient chronic toxicity data were available to calculate a Final Chronic Value (FCV) using the eight-family procedure. Sufficient chronic data were available to calculate a FCV by dividing the FAV by the Final Acute-Chronic Ratio (FACR). SMACRs were available for seven species (Table O2), but three were for resistant species and one was a "less than" value. The other three were within a factor of 10.4. The FACR was calculated as the geometric mean of the three SMACRs and was 1.994. According to the methodology, the FACR cannot be less than 2. The FCV = FAV/FACR = (133.2 ug/L)/(2) = 66.6 ug/L at a hardness of 50 mg/L. This value did not need to be lowered to protect a commercially or recreationally important species. Thus the CCC was 66.6 ug/L, as total recoverable zinc, at a hardness of 50 mg/L and equals the CMC. The CCC was related to hardness using the slope of 0.8473:

$$CCC = e^{0.8473(\ln hardness) + 0.884}$$

%
%

%
%

When it equals the CMC, the CCC is irrelevant because the CMC has a shorter averaging period.

The Criterion

The procedures described in the methodology indicate that, except possibly where a locally important species is very sensitive, freshwater aquatic organisms should not be affected unacceptably if the one-hour average concentration of zinc does not exceed the numerical value (in ug/L) given by the equation

$$CMC = e^{0.8473(\ln \text{hardness}) + 0.884}$$

more than once every three years on the average.

Table O1. New Acute Values for Zinc

Species	Method*	Hardness (mg/L as $CaCO_3$)	Acute Value (ug/L)	Adjusted Acute Value (ug/L)**	Reference
Frog, Xenopus laevis	S,M	100	34500	19176	Dawson et al. 1988
Cladoceran, Daphnia magna	S,U	300	1100	241	Berglind and Dave 1984

* S = Static, M = measured, U = unmeasured.
** Adjusted to a hardness of 50 mg/L using slope = 0.8473.

Table 02. Ranked Genus Mean Acute Values for Zinc.

Rank*	Genus Mean Acute Value (ug/L)**	Species	Species Mean Acute Value (ug/L)**	Species Mean Acute-Chronic Ratio
36	88560	Damselfly, *Argia* sp.	88960	-----
35	19800	Amphipod, *Crangonyx pseudogracilis*	19800	-----
34	19176	Frog, *Xenopus laevis*	19176	-----
33	18400	Worm, *Nais* sp.	18400	-----
32	17940	Banded killifish, *Fundulus diaphanus*	17940	-----
31	16820	Snail, *Amnicola* sp.	16820	-----
30	13630	American eel, *Anguilla rostrata*	13630	-----
29	10560	Pumpkinseed, *Lepomis gibbosus*	18790	-----
		Bluegill, *Lepomis macrochirus*	5937	-----
28	10250	Goldfish, *Carassius auratus*	10250	-----
27	9712	Worm, *Lumbriculus variegatus*	9712	-----
26	8157	Isopod, *Asellus bicrenata*	5731	-----
		Isopod, *Asellus communis*	11610	-----
25	8100	Amphipod, *Gammarus* sp.	8100	-----
24	7233	Common carp, *Cyprinus carpio*	7233	-----
23	6580	Northern squawfish, *Ptychocheilus oregonensis*	6580	-----
22	6053	Guppy, *Poecilia reticulata*	6053	-----

Table 02. (Cont.)

Rank*	Genus Mean Acute Value (ug/L)**	Species	Species Mean Acute Value (ug/L)**	Species Mean Acute-Chronic Ratio
21	6000	Golden shiner, Notemigonus crysoleucas	6000	------
20	5228	White sucker, Catostomus commersoni	5228	------
19	4900	Asiatic clam, Corbicula fluminea	4900	------
18	4341	Southern platyfish, Xiphophorus maculatus	4341	------
17	3830	Fathead minnow, Pimephales promelas	3830	5.644***
16	3265	Isopod, Lirceus alabamae	3265	------
15	2176	Atlantic salmon, Salmo salar	2176	------
14	2100	Brook trout, Salvelinus fontinalis	2100	2.335***
13	1707	Bryozoan, Lophopodella carteri	1707	------
12	1672	Flagfish, Jordanella floridae	1672	41.2***
11	1607	Bryozoan, Plumatella emarginata	1607	------
10	1578	Snail, Helisoma campanulatum	1578	------
9	1353	Snail, Physa gyrina	1683	------
		Snail, Physa heterostropha	1088	------
8	1307	Bryozoan, Pectinatella magnifica	1307	------
7	>1264	Tubificid worm, Limnodrilus hoffmeisteri	>1264	------

Table O2. (Cont.)

Rank*	Genus Mean Acute Value (ug/L)**	Species	Species Mean Acute Value (ug/L)**	Species Mean Acute-Chronic Ratio
6	931.3	Rainbow trout, *Oncorhynchus mykiss*	689.3	1.554
		Coho salmon, *Oncorhynchus kisutch*	1628	-----
		Sockeye salmon, *Oncorhynchus nerka*	1302	<6.074***
		Chinook salmon, *Oncorhynchus tshawytscha*	446.4	0.7027
5	790	Mozambique tilapia, *Tilapia mossambica*	790	-----
4	299.8	Cladoceran, *Daphnia magna*	355.5	7.26
		Cladoceran, *Daphnia pulex*	252.9	-----
3	227.8	Longfin dace, *Agosia chrysogaster*	227.8	-----
2	119.4	Striped bass, *Morone saxatilis*	119.4	-----
1	93.95	Cladoceran, *Ceriodaphnia dubia*	174.1	-----
		Cladoceran, *Ceriodaphnia reticulata*	50.70	-----

* Ranked from most resistant to most sensitive based on Genus Mean Acute Value.

** At hardness = 50 mg/L.

*** Not used in the calculation of the Final Acute-Chronic Ratio.

At hardness = 50 mg/L:

FAV = 133.2 ug/L

CMC = FAV/2 = 66.6 ug/L

As a function of hardness:

$$CMC = e^{0.8473(\ln \text{hardness}) + 0.884}$$

FACR = 1.994 but was raised to 2

At hardness = 50 mg/L:

$$FCV = FAV/FACR = (133.2\ \text{ug/L})/(2) = 66.6\ \text{ug/L} = CCC$$

As a function of hardness:

$$CCC = e^{0.8473(\ln \text{hardness}) + 0.884}$$

References

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APPENDIX B (for recalculation procedure report)

Deletion Process

Recalculation Procedure - Derivation of GMAV, FAV, FCV, CMC, and CCC
Metal - Zinc
Site - WSRC Outfall H-12

Rank	Phylum Class Order Family	Genus	species	Present at Site?	Occurrence at Site Genus	Family	Order	Class	Status	Retained/ Deleted	GMAV All Genera	Rank	GMAV With Deletions	P	sqrt P	ln GMAV	ln GMAV²
36	Arthropoda Insecta Odonata Coenagrionidae	*Argia*	*sp.*	present	yes	yes	yes	yes		R	88960	28	88960	0.9655			
35	Arthropoda Crustacea Amphipoda Crangonyctidae	*Crangonyx*	*pseudogracilis*	absent	yes	yes	yes	yes	species in same genus present	R	19800	27	19800	0.9310			
34	Chordata Amphibia Anura Pipidae	*Xenopus*	*laevis*	absent	no	no	yes	yes	species in same order preent	R	19176	26	18400	0.8966			
33	Annelida Oligochaeta Tubificida Naididae	*Nais*	*sp.*	present	yes	yes	yes	yes		R	18400	25	18400	0.8621			
32	Chordata Osteichthyes Cyprinodontiformes Fundulidae	*Fundulus*	*diaphanus*	absent	yes	yes	yes	yes	species in same genus present	R	17940	24	17940	0.8276			
31	Mollusca Gastropoda Mesogastropoda Hydrobiidae	*Amnicola*	*sp.*	present	yes	yes	yes	yes		R	16820	23	16820	0.7931			
30	Chordata Osteichthyes Anguilliformes Anguillidae	*Anguilla*	*rostrata*	present	yes	yes	yes	yes		R	13630	22	13630	0.7586			
29b	Chordata Osteichthyes Perciformes Centrarchidae	*Lepomis*	*gibbosus*	present	yes	yes	yes	yes		R							
29a	Chordata Osteichthyes Perciformes Centrarchidae	*Lepomis*	*macrochirus*	present	yes	yes	yes	yes		R	10560	21	10560	0.7241			
28	Chordata Osteichthyes Cypriniformes Cyprinidae	*Carassius*	*auratus*	absent	no	yes	yes	yes	genera in same family present	R	10250	20	10250	0.6897			
27	Annelida Oligochaeta Lumbriculida Lumbriculidae	*Lumbriculus*	*variegatus*	present	yes	yes	yes	yes		R	9712	19	9712	0.6552			
26b	Arthropoda Crustacea Isopoda Asellidae	*Caecidotea*	*bicrenata*	absent	yes	yes	yes	yes	species in same genus present	R							
26a	Arthropoda Crustacea Isopoda Asellidae	*Caecidotea*	*communis*	absent	yes	yes	yes	yes	species in same genus present	R	8157	18	8157	0.6207			
25	Arthropoda Crustacea Amphipoda Gammaridae	*Gammarus*	*sp.*	absent	no	no	yes	yes	order present not in dataset	R	8100	17	8100	0.5862			
24	Chordata Osteichthyes Cypriniformes Cyprinidae	*Cyprinus*	*carpio*	absent	no	yes	yes	yes	genera in the family present	R	7233	16	7233	0.5517			
23	Chordata Osteichthyes Cypriniformes Cyprinidae	*Ptychocheilus*	*oregonensis*	absent	no	yes	yes	yes	genera present not in dataset	R	6580	15	6580	0.5172			
22	Chordata Osteichthyes Cyprinodontiformes Poeciliidae	*Poecilia*	*reticulata*	absent	no	no	no	yes	species in family present	R	6053	14	6053	0.4828			
21	Chordata Osteichthyes Cypriniformes Cyprinidae	*Notemigonus*	*crysoleucas*	present	yes	yes	yes	yes		R	6000	13	6000	0.4483			
20	Chordata Osteichthyes Cypriniformes Catostomidae	*Catostomus*	*commersonii*	absent	no	no	yes	yes	genera in the order present	R	5228						
19	Mollusca Bivalvia Veneroida Corbiculidae	*Corbicula*	*fluminea*	present	yes	yes	yes	yes		R	4900	12	4900	0.4138			
18	Chordata Osteichthyes Cyprinodontiformes Poeciliidae	*Xiphophorus*	*maculatus*	absent	no	yes	yes	yes	genera in the family present	R	4341	11	4341	0.3793			
17	Chordata Osteichthyes Cypriniformes Cyprinidae	*Pimephales*	*promelas*	absent	no	yes	yes	yes	genera in same family present	R	3830	10	3830	0.3448			
16	Arthropoda Crustacea Isopoda Asellidae	*Lirceus*	*alabamae*	absent	yes	yes	yes	yes	species in same genus present	R	3265	9	3265	0.3103			
15	Chordata Osteichthyes Salmoniformes Salmonidae	*Salmo*	*salar*	absent	no	no	no	yes	species in same class present	D	2176						
14	Chordata Osteichthyes Salmoniformes Salmonidae	*Salvelinus*	*fontinalis*	absent	no	no	no	yes	species in same genus present	D	2100						
13	Bryozoa Phylactolaemata Plumatellida Lophopodidae	*Lophopodella*	*carteri*	absent	no	no	yes	yes	species in same order present	D	1707						
12	Chordata Osteichthyes Cyprinodontiformes Cyprinodontidae	*Jordanella*	*floridae*	absent	no	no	no	yes	species in family present	R	1672	8	1372	0.2759			
11	Bryozoa Phylactolaemata Plumatellida Plumatellidae	*Plumatella*	*rostrata*	absent	yes	yes	yes	yes	species in same genus present	R	1607	7	1607	0.2414			

10	Mollusca Gastropoda Limnophila Planorbidae	*Helisoma*	*campanulatum*	absent	no	yes	yes	yes	genera in same family present	R	1578	6	1578	0.2069			
9b	Mollusca Gastropoda Limnophila Physidae	*Physa*	*gyrina*	absent	yes	yes	yes	yes	species in same order present	D	1683						
8	Bryozoa Phylactolaemata Plumatellida Pectinatellidae	*Pectinatella*	*magnifica*	absent	no	no	yes	yes	species in same family present	R	1307	5	1307	0.1724	sqrt P	ln GMAV	ln GMAV^2
7	Annelida Oligochaeta Tubificida Tubificidae	*Limnodrilus*	*hoffmeisteri*	present	yes	yes	yes	yes		R	1264	4	1264	0.1379	0.371	7.1420	51.00869
9a	Mollusca Gastropoda Limnophila Physidae	*Physa*	*acuta*	present	yes	yes	yes	yes		R	1088	3	1088	0.1034	0.322	6.9921	48.88941
6d	Chordata Osteichthyes Salmoniformes Salmonidae	*Onchorhynchus*	*mykiss gairdneri*	absent	no	no	no	yes	species in same class present	D							
6c	Chordata Osteichthyes Salmoniformes Salmonidae	*Onchorhynchus*	*kisutch*	absent	no	no	no	yes	species in same class present	D							
6b	Chordata Osteichthyes Salmoniformes Salmonidae	*Onchorhynchus*	*nerka*	absent	no	no	no	yes	species in same class present	D							
6a	Chordata Osteichthyes Salmoniformes Salmonidae	*Onchorhynchus*	*tschawytscha*	absent	no	no	no	yes	species in same class present	D	931.3						
5	Chordata Osteichthyes Perciformes Cichlidae	*Tilapia*	*mossambica*	absent	no	no	yes	yes	species in same order present	D	790						
4b	Arthropoda Crustacea Cladocera Daphnidae	*Daphnia*	*magna*	absent	no	no	no	yes	species in same class present	D							
4a	Arthropoda Crustacea Cladocera Daphnidae	*Daphnia*	*pulex*	absent	no	no	no	yes	species in same class present	D	299.8						
3	Chordata Osteichthyes Cypriniformes Cyprinidae	*Agosia*	*chrysogaster*	absent	no	yes	no	yes	genera in same family present	R	227.8	2	227.8	0.0690	0.263	5.4285	29.46827
2	Chordata Osteichthyes Perciformes Moronidae	*Morone*	*saxatilis*	absent	no	no	yes	yes	order present not in dataset	R	119.4	1	119.4	0.0345	0.186	4.7825	22.87211
1b	Arthropoda Crustacea Cladocera Daphnidae	*Ceriodaphnia*	*dubia*	absent	no	no	no	yes	species in same class present	D							
1a	Arthropoda Crustacea Cladocera Daphnidae	*Ceriodaphnia*	*reticulata*	absent	no	no	no	yes	species in same class present	D							
					Genus	Family	Order	Class						sum	sum	sum	sum
														0.3448	1.141	24.3451	152.2385

FAV Calculations			
S^2 =	212.2202	S =	14.5678
L =	1.9296		
A =	5.1871		
FAV =	178.9406		
CMC =	**89.4703**	at hardness of 50 mg/L	
CMC =	**49.7297**	at hardness of 25 mg/L	

FCV Calculations		
FACR =	2	national value
FCV =	89.4703	
CCC =	**89.4703**	at hardness of 50 mg/L
CCC =	**49.7297**	at hardness of 25 mg/L

APPENDIX C (for recalculation procedure report)

Site Specific Dataset and Calculations of FAV and FCV

METAL PARTITIONING CALCULATIONS									
Metal:	**Zinc**								
Outfall:	**WSRC H12**								
				Calculated Values					
Input Parameters				C_d=	48.635647	= S x CF for CMC			
S=	49.7297	= CCC		C_d=	49.033484	= S x CF for CCC			
S=	49.7297	= CMC		K_{pb}=	1250000	= K_{po} x $(TSS_b)^a$			
CF=	0.986	from Table for CCC		WQS_{al} =	110.32534	= Adjusted Water Quality Standard (CCC)			
CF=	0.978	from Table for CMC		WQS_{al} =	109.4302	= Adjusted Water Quality Standard (CMC)			
K_{po} =	1250000	from Table							
TSS_b =	1	eff. average		TSS_{avg} =	6				
TSSe =	6	eff. average		K_p=	354198.86				
a =	-0.7038	from Table		C_t =	153.23911	for CCC			
upst flow=	0.0%			C_t =	151.99579	for CMC			
eff flow=	100.0%								
DF_1 =	1			C_{aqlife} =	153.24	ug/L	Maximum effluent limit		
C_b =	0	background conc.		C_{aqlife} =	152.00	ug/L	Average effluent limit		

APPENDIX   D (for recalculation procedure report)

EPA Recalculation Procedure Protocol

Appendix B: The Recalculation Procedure

NOTE: The National Toxics Rule (NTR) does not allow use of the Recalculation Procedure in the derivation of a site-specific criterion. Thus nothing in this appendix applies to jurisdictions that are subject to the NTR.

The Recalculation Procedure is intended to cause a site-specific criterion to appropriately differ from a national aquatic life criterion if justified by demonstrated pertinent toxicological differences between the aquatic species that occur at the site and those that were used in the derivation of the national criterion. There are at least three reasons why such differences might exist between the two sets of species. First, the national dataset contains aquatic species that are sensitive to many pollutants, but these and comparably sensitive species might not occur at the site. Second, a species that is critical at the site might be sensitive to the pollutant and require a lower criterion. (A critical species is a species that is commercially or recreationally important at the site, a species that exists at the site and is listed as threatened or endangered under section 4 of the Endangered Species Act, or a species for which there is evidence that the loss of the species from the site is likely to cause an unacceptable impact on a commercially or recreationally important species, a threatened or endangered species, the abundances of a variety of other species, or the structure or function of the community.) Third, the species that occur at the site might represent a narrower mix of species than those in the national dataset due to a limited range of natural environmental conditions. The procedure presented here is structured so that corrections and additions can be made to the national dataset without the deletion process being used to take into account taxa that do and do not occur at the site; in effect, this procedure makes it possible to update the national aquatic life criterion.

The phrase "occur at the site" includes the species, genera, families, orders, classes, and phyla that:

a. are usually present at the site.
b. are present at the site only seasonally due to migration.
c. are present intermittently because they periodically return to or extend their ranges into the site.
d. were present at the site in the past, are not currently present at the site due to degraded conditions, and are expected to return to the site when conditions improve.
e. are present in nearby bodies of water, are not currently present at the site due to degraded conditions, and are expected to be present at the site when conditions improve.

The taxa that "occur at the site" cannot be determined merely by sampling downstream and/or upstream of the site at one point in time. "Occur at the site" does not include taxa that were once present at the site but cannot exist at the site now due to permanent physical alteration of the habitat at the site resulting from dams, etc.

The definition of the "site" can be extremely important when using the Recalculation Procedure. For example, the number of taxa that occur at the site will generally decrease as the size of the site decreases. Also, if the site is defined to be very small, the permit limit might be controlled by a criterion that applies outside (e.g., downstream of) the site.

Note: If the variety of aquatic invertebrates, amphibians, and fishes is so limited that species in <u>fewer than eight families</u> occur at the site, the general Recalculation Procedure is not applicable and the following special version of the Recalculation Procedure **must** be used:
1. Data **must** be available for at least one species in each of the families that occur at the site.
2. The lowest Species Mean Acute Value that is available for a species that occurs at the site **must** be used as the FAV.
3. The site-specific CMC and CCC **must** be calculated as described below in part 2 of step E, which is titled "Determination of the CMC and/or CCC".

The concept of the Recalculation Procedure is to create a dataset that is appropriate for deriving a site-specific criterion by modifying the national dataset in some or all of three ways:
a. Correction of data that are in the national dataset.
b. Addition of data to the national dataset.
c. Deletion of data that are in the national dataset.

All corrections and additions that have been approved by U.S. EPA are required, whereas use of the deletion process is optional. The Recalculation Procedure is more likely to result in lowering a criterion if the net result of addition and deletion is to decrease the number of genera in the dataset, whereas the procedure is more likely to result in raising a criterion if the net result of addition and deletion is to increase the number of genera in the dataset.

The Recalculation Procedure consists of the following steps:
A. Corrections are made in the national dataset.
B. Additions are made to the national dataset.
C. The deletion process may be applied if desired.
D. If the new dataset does not satisfy the applicable Minimum Data Requirements (MDRs), additional pertinent data **must** be generated; if the new data are approved by the U.S. EPA, the Recalculation Procedure **must** be started again at step B with the addition of the new data.
E. The new CMC or CCC or both are determined.
F. A report is written.

Each step is discussed in more detail below.

A. Corrections

1. Only corrections approved by the U.S. EPA may be made.
2. The concept of "correction" includes removal of data that should not have been in the national dataset in the first place. The concept of "correction" does not include removal of a datum from the national dataset just because the quality of the datum is claimed to be suspect. If additional data are available for the same species, the U.S. EPA will decide which data should be used, based on the available guidance (U.S. EPA 1985); also, data based on measured concentrations are usually preferable to those based on nominal concentrations.
3. Two kinds of corrections are possible:
   a. The first includes those corrections that are known to and have been approved by the U.S. EPA; a list of these will be available from the U.S. EPA.
   b. The second includes those corrections that are submitted to the U.S. EPA for approval. If approved, these will be added to EPA's list of approved corrections.
4. Selective corrections are not allowed. All corrections on EPA's newest list **must** be made.

B. Additions

1. Only additions approved by the U.S. EPA may be made.
2. Two kinds of additions are possible:
   a. The first includes those additions that are known to and have been approved by the U.S. EPA; a list of these will be available from the U.S. EPA.
   b. The second includes those additions that are submitted to the U.S. EPA for approval. If approved, these will be added to EPA's list of approved additions.
3. Selective additions are not allowed. All additions on EPA's newest list **must** be made.

C. The Deletion Process

The basic principles are:
1. Additions and corrections **must** be made as per steps A and B above, before the deletion process is performed.
2. Selective deletions are not allowed. If any species is to be deleted, the deletion process described below **must** be applied to all species in the national dataset, after any necessary corrections and additions have been made to the national dataset. The deletion process specifies which species **must** be deleted and which species **must not** be deleted. Use of the deletion process is optional, but no deletions are optional when the deletion process is used.
3. Comprehensive information **must** be available concerning what species occur at the site; a species cannot be deleted based

on incomplete information concerning the species that do and do not satisfy the definition of "occur at the site".

4. Data might have to be generated <u>before</u> the deletion process is begun:
   a. Acceptable pertinent toxicological data **must** be available for at least one species in each <u>class</u> of aquatic plants, invertebrates, amphibians, and fish that contains a species that is a critical species at the site.
   b. For each aquatic plant, invertebrate, amphibian, and fish species that occurs at the site and is listed as threatened or endangered under section 4 of the Endangered Species Act, data **must** be available or be generated for an acceptable surrogate species. Data for each surrogate species **must** be used as if they are data for species that occur at the site.

   If additional data are generated using acceptable procedures (U.S. EPA 1985) and they are approved by the U.S. EPA, the Recalculation Procedure **must** be started again at step B with the addition of the new data.
5. Data might have to be generated <u>after</u> the deletion process is completed. Even if one or more species are deleted, there still are MDRs (see step D below) that **must** be satisfied. If the data remaining after deletion do not satisfy the applicable MDRs, additional toxicity tests **must** be conducted using acceptable procedures (U.S. EPA 1985) so that all MDRs are satisfied. If the new data are approved by the U.S. EPA, the Recalculation Procedure **must** be started again at step B with the addition of new data.
6. Chronic tests do not have to be conducted because the national Final Acute-Chronic Ratio (FACR) may be used in the derivation of the site-specific Final Chronic Value (FCV). If acute-chronic ratios (ACRs) are available or are generated so that the chronic MDRs are satisfied using only species that occur at the site, a site-specific FACR may be derived and used in place of the national FACR. Because a FACR was not used in the derivation of the freshwater CCC for cadmium, this CCC can only be modified the same way as a FAV; what is acceptable will depend on which species are deleted.

If any species are to be deleted, the following deletion process **must** be applied:

   a. Obtain a copy of the national dataset, i.e., tables 1, 2, and 3 in the national criteria document (see Appendix E).
   b. Make corrections in and/or additions to the national dataset as described in steps A and B above.
   c. Group all the species in the dataset taxonomically by phylum, class, order, family, genus, and species.
   d. Circle each species that satisfies the definition of "occur at the site" as presented on the first page of this appendix, and including any data for species that are surrogates of threatened or endangered species that occur at the site.

e. Use the following step-wise process to determine which of the uncircled species **must** be deleted and which **must not** be deleted:

1. Does the genus occur at the site?
   If "No", go to step 2.
   If "Yes", are there one or more species in the genus that occur at the site but are not in the dataset?
      If "No", go to step 2.
      If "Yes", retain the uncircled species.*

2. Does the family occur at the site?
   If "No", go to step 3.
   If "Yes", are there one or more genera in the family that occur at the site but are not in the dataset?
      If "No", go to step 3.
      If "Yes", retain the uncircled species.*

3. Does the order occur at the site?
   If "No", go to step 4.
   If "Yes", does the dataset contain a circled species that is in the same order?
      If "No", retain the uncircled species.*
      If "Yes", delete the uncircled species.*

4. Does the class occur at the site?
   If "No", go to step 5.
   If "Yes", does the dataset contain a circled species that is in the same class?
      If "No", retain the uncircled species.*
      If "Yes", delete the uncircled species.*

5. Does the phylum occur at the site?
   If "No", delete the uncircled species.*
   If "Yes", does the dataset contain a circled species that is in the same phylum?
      If "No", retain the uncircled species.*
      If "Yes", delete the uncircled species.*

* = Continue the deletion process by starting at step 1 for another uncircled species unless all uncircled species in the dataset have been considered.

The species that are circled and those that are retained constitute the site-specific dataset. (An example of the deletion process is given in Figure B1.)

This deletion process is designed to ensure that:
a. Each species that occurs both in the national dataset and at the site also occurs in the site-specific dataset.

b. Each species that occurs at the site but does not occur in the national dataset is represented in the site-specific dataset by all species in the national dataset that are in the same genus.
c. Each genus that occurs at the site but does not occur in the national dataset is represented in the site-specific dataset by all genera in the national dataset that are in the same family.
d. Each order, class, and phylum that occurs both in the national dataset and at the site is represented in the site-specific dataset by the one or more species in the national dataset that are most closely related to a species that occurs at the site.

D. Checking the Minimum Data Requirements

The initial MDRs for the Recalculation Procedure are the same as those for the derivation of a national criterion. If a specific requirement cannot be satisfied after deletion because that kind of species does not occur at the site, a taxonomically similar species **must** be substituted in order to meet the eight MDRs:

So do not have to meet MDRs in National Criterion

If no species of the kind required occurs at the site, but a species in the same order does, the MDR can only be satisfied by data for a species that occurs at the site and is in that order; if no species in the order occurs at the site, but a species in the class does, the MDR can only be satisfied by data for a species that occurs at the site and is in that class. If no species in the same class occurs at the site, but a species in the phylum does, the MDR can only be satisfied by data for a species that occurs at the site and is in that phylum. If no species in the same phylum occurs at the site, any species that occurs at the site and is not used to satisfy a different MDR can be used to satisfy the MDR. If additional data are generated using acceptable procedures (U.S. EPA 1985) and they are approved by the U.S. EPA, the Recalculation Procedure **must** be started again at step B with the addition of the new data.

If fewer than eight families of aquatic invertebrates, amphibians, and fishes occur at the site, a Species Mean Acute Value **must** be available for at least one species in each of the families and the special version of the Recalculation Procedure described on the second page of this appendix **must** be used.

E. Determining the CMC and/or CCC

1. Determining the FAV:
   a. If the eight family MDRs are satisfied, the site-specific FAV **must** be calculated from Genus Mean Acute Values using

the procedure described in the national aquatic life guidelines (U.S. EPA 1985).

b. If fewer than eight families of aquatic invertebrates, amphibians, and fishes occur at the site, the lowest Species Mean Acute Value that is available for a species that occurs at the site **must** be used as the FAV, as per the special version of the Recalculation Procedure described on the second page of this appendix.

2. The site-specific CMC **must** be calculated by dividing the site-specific FAV by 2. The site-specific FCV **must** be calculated by dividing the site-specific FAV by the national FACR (or by a site-specific FACR if one is derived). (Because a FACR was not used to derive the national CCC for cadmium in fresh water, the site-specific CCC equals the site-specific FCV.)
3. The calculated FAV, CMC, and/or CCC **must** be lowered, if necessary, to (1) protect an aquatic plant, invertebrate, amphibian, or fish species that is a critical species at the site, and (2) ensure that the criterion is not likely to jeopardize the continued existence of any endangered or threatened species listed under section 4 of the Endangered Species Act or result in the destruction or adverse modification of such species' critical habitat.

F. Writing the Report

The report of the results of use of the Recalculation Procedure **must** include:

1. A list of all species of aquatic invertebrates, amphibians, **and fishes that are known to "occur at the site", along with** the source of the information.
2. **A list of all aquatic plant, invertebrate, amphibian, and fish species that are critical species at the site, including all species that occur at the site and are listed as threatened or endangered under section 4 of the Endangered Species Act.**
3. **A site-specific version of Table 1 from a criteria document** produced by the U.S. EPA after 1984.
4. **A site-specific version of Table 3 from a criteria document produced by the U.S. EPA after 1984.**
5. **A list of all species that were deleted.**
6. **The new calculated FAV, CMC, and/or CCC.**
7. The lowered FAV, CMC, and/or CCC, if one or more were lowered **to protect a specific species.**

Reference

U.S. EPA. 1985. Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. PB85-227049. National Technical Information Service, Springfield, VA.

Figure B1: An Example of the Deletion Process Using Three Phyla

SPECIES THAT ARE IN THE THREE PHYLA AND OCCUR AT THE SITE

Phylum	Class	Order	Family	Species
Annelida	Hirudin.	Rhynchob.	Glossiph.	Glossip. complanata
Bryozoa	(No species in this phylum occur at the site.)			
Chordata	Osteich.	Cyprinif.	Cyprinid.	Carassius auratus
Chordata	Osteich.	Cyprinif.	Cyprinid.	Notropis anogenus
Chordata	Osteich.	Cyprinif.	Cyprinid.	Phoxinus eos
Chordata	Osteich.	Cyprinif.	Catostom.	Carpiodes carpio
Chordata	Osteich.	Salmonif.	Osmerida.	Osmerus mordax
Chordata	Osteich.	Percifor.	Centrarc.	Lepomis cyanellus
Chordata	Osteich.	Percifor.	Centrarc.	Lepomis humilis
Chordata	Amphibia	Caudata	Ambystom.	Ambystoma gracile

SPECIES THAT ARE IN THE THREE PHYLA AND IN THE NATIONAL DATASET

Phylum	Class	Order	Family	Species	Code
Annelida	Oligoch.	Haplotax.	Tubifici.	Tubifex tubifex	P
Bryozoa	Phylact.	---	Lophopod.	Lophopod. carteri	D
Chordata	Cephala.	Petromyz.	Petromyz.	Petromyzon marinus	D
Chordata	Osteich.	Cyprinif.	Cyprinid.	Carassius auratus	S
Chordata	Osteich.	Cyprinif.	Cyprinid.	Notropis hudsonius	G
Chordata	Osteich.	Cyprinif.	Cyprinid.	Notropis stramineus	G
Chordata	Osteich.	Cyprinif.	Cyprinid.	Phoxinus eos	S
Chordata	Osteich.	Cyprinif.	Cyprinid.	Phoxinus oreas	D
Chordata	Osteich.	Cyprinif.	Cyprinid.	Tinca tinca	D
Chordata	Osteich.	Cyprinif.	Catostom.	Ictiobus bubalus	F
Chordata	Osteich.	Salmonif.	Salmonid.	Oncorhynchus mykiss	O
Chordata	Osteich.	Percifor.	Centrarc.	Lepomis cyanellus	S
Chordata	Osteich.	Percifor.	Centrarc.	Lepomis macrochirus	G
Chordata	Osteich.	Percifor.	Percidae	Perca flavescens	D
Chordata	Amphibia	Anura	Pipidae	Xenopus laevis	C

Explanations of Codes:
- S = retained because this Species occurs at the site.
- G = retained because there is a species in this Genus that occurs at the site but not in the national dataset.
- F = retained because there is a genus in this Family that occurs at the site but not in the national dataset.
- O = retained because this Order occurs at the site and is not represented by a lower taxon.
- C = retained because this Class occurs at the site and is not represented by a lower taxon.
- P = retained because this Phylum occurs at the site and is not represented by a lower taxon.
- D = deleted because this species does not satisfy any of the requirements for retaining species.