TECHNICAL REPORT

Phase II Supplemental Sediment Investigation and Ecological Studies (SSIES) Report

Northwest Wetland
York Oil Superfund Site
Moira, New York

May 2001

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1. Introduction

1.1 Overview

This Phase II Supplemental Sediment Investigation and Ecological Study (SSIES) Report presents the results of supplemental sediment toxicity testing that was conducted by Blasland, Bouck & Lee, Inc. (BBL) for the York Oil Superfund Site located in Moira, New York. The Phase II SSIES was conducted by BBL to address agency concerns regarding the potential toxicity of sediment from the Northwest Wetland, and to supplement previous sediment toxicity tests which were conducted as part of the initial SSIES.

The initial SSIES was performed in response to the requirements of the December 31, 1998 Unilateral Administrative Order (UAO) and accompanying Statement of Work (SOW)(USEPA 1998a) issued to Alcoa by the United States Environmental Protection Agency (USEPA). Specifically, the USEPA (1998b) Record of Decision (ROD) for OU2 requested design-phase studies to determine if lead and/or PCBs in sediments in the Northwest Wetland (NW) pose a potential ecological threat. These design-phase studies were described in the December 3, 1998 draft Pre-Design Work Plans for OU2, and Alcoa's January 7, 1998 response to comments on the draft Work Plans.

The original SSIES focused on the evaluation of potential ecological risks due to lead and PCBs in sediment in the NW. Specifically, the evaluation consisted of a variety of different studies, including habitat evaluation, sediment/soil sampling and analyses, sediment toxicity testing, and whole-body and target organ biota tissue residue sampling and analysis. Results of the SSIES were presented in the *Supplemental Sediment Investigation and Ecological Study (SSIES) Report* (BBL, 2000). Collectively, the results of these evaluations were used to determine that sediments in the NW do not pose a "significant threat" to the environment, and that remediation of the NW is not required.

The NYSDEC and USEPA provided comments on the SSIES Report, and raised some issues with the laboratory protocol and bioassay techniques that were used in the SSIES. Specifically, the agencies asserted that the tests should be repeated because some of the tests did not achieve acceptable survival or growth in sand control samples. Subsequent response letters by BBL acknowledged the sand control results, but disagreed that the results were invalid and unusable, because other control samples (i.e., sediments from reference locations) achieved acceptable survival and growth and provided a suitable basis for evaluating NW sample results. Regardless, it was agreed that an additional round of sediment sampling and toxicity testing would be performed. The second round of sediment sampling and analysis and sediment toxicity testing is the focus of this report.

1.2 Report Organization

This Phase II SSIES Report is organized into five sections, with accompanying tables, figures and appendices. Section 1 provides a brief introduction to the project activities, and a description of the site and the sampling locations. Section 2 describes the results of sediment sampling and analysis, and Section 3 describes the results of sediment toxicity testing. Section 4 presents the summary and conclusions of the Phase II SSIES. Section 5 include the references cited in the report.

1.3 Site Background

A Remedial Investigation (RI) was conducted by BBL for OU2 in 1993. The RI involved an environmental media investigation (i.e., ground water, surface water, sediment, and soil sampling) and an ecological investigation (i.e., wetlands identification, flora/fauna surveys, and biota sampling). The NW was considered a "secondary" area during the RI, and was not subject to detailed ecological investigations. The results of the RI were reported in the *Interim Ecological Investigation Report* (BBL, 1994) and the *Contamination Pathways Remedial Investigation Report* (BBL, 1998a). The USEPA used the RI data to evaluate potential human health and ecological risks in the baseline risk assessment (RA) report (USEPA, 1995).

Based on these evaluations, the SOW (USEPA, 1998a) and the ROD (USEPA, 1998b) required that additional investigations be conducted to further evaluate potential ecological risks at the NW. In response, BBL performed the ecological investigation that was reported in the SSIES Report (BBL, 2000). The ecological studies included habitat evaluation, sediment/soil sampling and analyses, sediment toxicity testing, and biota tissue residue sampling and analysis. Collectively, the results of these evaluations indicated that sediments in the NW do not pose a "significant threat" to the environment, and remediation of the wetland is not required (BBL, 2000).

According to the ROD, based on the results of the ecological studies in the NW, "the prediction of a significant reduction in survival or growth or a significant impact to higher trophic level receptors would indicate the need to remediate the sediments." However, the need for remediation would be weighed against the magnitude of the physical impacts associated with remediating the NW. As discussed in the ROD, the NW is a forested wetland, and its restoration would be difficult (it has been estimated that it would take 50 to 60 years for the forested habitats of the NW to be restored).

1.4 Site Description

The NW is located northwest of OU1 (see Figure 1). The wetland is densely vegetated with a mixture of coniferous and hardwood trees and a variety of herbaceous ground cover. The drainage channel flowing through the wetland is generally less than 1 to 2 feet wide, and the water is approximately 2 to 4 inches deep. The channel is often difficult to follow, given its relatively small size and the dense vegetative undergrowth. There is an old beaver pond in the lower portion of the NW. The water in the abandoned beaver pond is less than 1 foot deep, and there is no evidence of recent beaver activity. Apparently, the beaver pond is in the process of succession into a scrub-shrub type wetland. A more recent beaver dam exists at the very lower end of the NW.

1.5 Sample Locations

Sediment characterization sampling and sediment toxicity sampling were conducted at the same locations as the initial SSIES. Five sampling locations were selected in the NW to represent the range of lead and PCB concentrations detected in the NW during the RI. Three reference locations were also sampled. Each of the sample locations are described below.

NW-1 This sampling location coincides with RI sediment sample location SD-23, which is approximately 1,200 feet downstream of North Lawrence Road. Previous RI sampling at this location indicated a relatively high lead concentration (408 mg/kg) and a relatively low PCB concentration (0.78 mg/kg).

NW-2 This sampling location coincides with RI sediment sample location SD-24, which is approximately 3,000 feet downstream of North Lawrence Road. Previous RI sampling at this location indicated a moderate lead concentration (142 mg/kg) and the highest detected PCB concentration (4.0 mg/kg).

NW-3 This sampling location coincides with RI sediment sample location SD-24B, which is approximately 3,600 feet downstream of North Lawrence Road. Previous RI sampling at this location indicated the highest detected lead concentration (423 mg/kg) and a relatively low PCB concentration (0.65 mg/kg).

NW-4 This sampling location coincides with RI sediment sample location SD-24D, which is in the vicinity of the abandoned beaver pond, approximately 1500 feet upstream of Savage Road. Previous RI sampling at this location indicated a relatively moderate lead concentration (162 mg/kg) and a relatively low PCB concentration (0.27 mg/kg).

NW-5 This sampling location coincides with RI sediment sample location SD-24F, which is approximately 400 feet upstream of Savage Road, in the vicinity of the more recent beaver pond. Previous RI sampling at this location indicated a relatively low lead concentration (8.7 mg/kg) and non-detectable levels of PCBs.

REF-1 Reference Area 1 is located approximately 2 miles southeast (upstream) of the site along a tributary to Lawrence Brook (Figure 1).

REF- 2 Reference Area 2 is located approximately 10 miles northwest (downstream) of the site at the confluence of Lawrence Brook with the Deer River (Figure 1).

REF-3 Reference Area 3 is located approximately 2.5 miles southwest (upstream) of the site along Lawrence Brook.

1.6 Sediment Characterization

Sediment samples were collected from the NW and the reference wetlands for laboratory analyses of target compound list (TCL) and target analyte list (TAL) constituents, total petroleum hydrocarbons, total organic carbon, pH, grain size, and oil/grease. These data were used to characterize chemical concentrations in sediments and to assist in the interpretation of sediment toxicity test results. A more complete description of the sediment characterization task is presented in Section 2.

1.7 Sediment Toxicity Testing

Sediment toxicity tests were conducted to confirm the conclusion of the initial SSIES tests that PCBs or lead do not affect the survival or growth of benthic invertebrates. Sediment toxicity tests were conducted by an independent laboratory using sediments from the NW and the reference wetlands. The test species were *Hyalella azteca* and *Chironomus tentans*. The tests were conducted using the same general procedures as those used in the initial phase of the SSIES, with the exception that additional control sediment samples were used. Additional details regarding the sediment toxicity testing (and the use of the additional control samples) are discussed in Section 3.

2. Sediment Characterization

2.1 General

The objective of the sediment sampling program was to characterize chemical concentrations in sediment samples from the NW and reference locations, specifically to interpret the results of the laboratory toxicity tests. The sediment sampling targeted the upper 6 inches of sediment as the biologically active zone. The sampling procedures and analytical methods, described below, were consistent with the initial SSIES.

2.2 Sampling Procedures

Sediment samples were collected in July, 2000, following methods outlined in the Field Operations Plan (FOP) (BBL, 1993a) and the Quality Assurance Project Plan (QAPP) (BBL, 1993b). Samples were collected using Lexan tubing, and were collected in general accordance with ASTM *Standard E 1391-90 Standard Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing*, and USEPA (2000) *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates*. QA/QC samples were collected as specified in the QAPP (BBL 1993b). Following collection, samples were preserved on ice, and sent to EnChem Laboratories of Madison, Wisconsin for analysis.

2.3 Laboratory Analysis

As specified in the SOW (USEPA 1998a), sediment samples were analyzed for TCL and TAL constituents, total petroleum hydrocarbons, TOC, pH, percent solids, and oil/grease.

2.4 Results

The results of the laboratory analyses of NW sediment samples are presented in Table 1. As shown, the only organic constituents detected above the detection limit were PCB Aroclor 1254 (0.37 mg/kg to 1.0 mg/kg) and PCB Aroclor 1260 (0.38 mg/kg to 0.43 mg/kg), and the common laboratory contaminants 2-butanone (maximum 0.12 mg/kg) and acetone (maximum 0.49 mg/kg). No semivolatile organic compounds (SVOCs) or pesticides were detected in any of the sediment samples.

Several inorganic constituents were detected in the sediment samples, as would be expected because these constituents are naturally occuring. To evaluate the potential significance of the observed levels, sediment concentrations were compared to New York State DEC (1999) screening values. Several of the inorganics (cadmium, copper, lead, manganese, mercury, and zinc) exceeded lower screening values. Two inorganics exceeded the higher screening values. These were lead at sediment sampling locations NW-1 (220 mg/kg) and NW-2 (120 mg/kg), relative to a screening value of 110 mg/kg, and manganese at NW-3 (2,000 mg/kg), relative to a screening value of 1,100 mg/kg.

The sediment sampling results from the Phase II SSIES are generally consistent with the results from the 1993 RI sediment sampling and the 1999 SSIES sampling. A comparison of the total PCB and lead data for the NW sediment samples is presented in Figure 2. If anything, the data indicates that both lead and PCB concentrations detected during the Phase II SSIES sampling are less than in previous years. The highest lead concentration previously detected in the NW was 450 mg/kg (detected at NW-2 in 1999). The highest lead concentration detected during the Phase II SSIES was only 220 mg/kg (detected at location NW-1). Similarly, the highest PCB concentration previously detected was 4.0 mg/kg (detected at NW-2 in 1993). The highest PCB concentration detected during the Phase II SSIES was only 1.38 mg/kg (detected at NW-1).

3. Sediment Toxicity Testing

3.1 General

Sediment toxicity testing was performed to evaluate the potential effects of sediment constituents on benthic invertebrates. Sediment samples were sent to the Lake Superior Research Institute (LSRI) for toxicity testing. As requested by the agencies, the sediment toxicity tests were conducted with two test organisms: *Hyalella azteca* and *Chironomus tentans*. The sediment for the toxicity tests included sediment from five NW locations (NW-1, NW-2, NW-3, NW-4, and NW-5), and three reference sediment samples.

3.2 Sampling Procedures

The sediment samples were collected in general accordance with ASTM *Standard E 1391-90 Standard Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing*, and USEPA (2000) *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates*. Sediment samples were collected using indirect methods (shovel, trowel or auger), placed in decontaminated 3-gallon plastic buckets, and shipped to the laboratory for toxicity testing.

3.3 Laboratory Procedures

Sediment toxicity tests were performed by LSRI. The *Hyalella azteca* 28-day Survival Test for Sediments was performed in accordance with USEPA Method 100.4 (USEPA, 2000). The *Chironomus tentans* 10-day Survival and Growth Test for Sediments was performed in accordance with USEPA Method 100.2 (USEPA, 2000). Tests were conducted as intermittent renewal, with eight replicate analyses for each sediment sample *(i.e.*, 5 samples from the NW, 3 reference samples, and 3 control samples). The control samples used in the tests included a sand control, an artificial sediment, and a sample from West Bearskin Lake. Minnesota. The artificial sediment control sample was created by the lab using the method described in USEPA (2000). Similarly, the West Bearskin Lake control sample was used because samples from this lake are routinely used as a control by the USEPA-Duluth sediment testing laboratory.

Toxicity test data were analyzed by the LSRI using the statistical software package SYSTAT®. Analyses included one-way analysis of variance and the Bonferonni *t*-Test ($p \leq 0.05$ and below) for determination of significant differences of means between the treatment groups and the reference sediment and/or the control samples.

Additional details regarding the test methods are presented in the laboratory report, which is included as Appendix A.

3.4 Results

As required by the SOW, sediment toxicity tests were conducted with two species of test organisms (*Hyalella azteca* and *Chironomus tentans*) with endpoints of survival and growth. Evaluation of test results included comparison of mean percent survival data to both the reference samples and the control samples. The results of each of the tests are described in the attached laboratory report (Appendix A) and summarized below.

Hyalella azteca

The results of the *Hyalella azteca* tests are presented in Table 2. Survival in the control samples was 97.5% for the sand control, and 90% for the formulated sediment and West Bearskin Lake sediment. These survival rates are all above the USEPA (2000) required minimal survival rate of 80%. Survival in reference samples REF-1, REF-2, and REF-3 were 68.75%, 81.25%, and 67.5%, respectively. The percent survival for the NW sediment samples ranged from 15% in sample NW-5 to 95% in samples NW-3. Only one of the sediment samples from the NW (NW-5) exhibited survival significantly ($p \leq 0.05$) lower than the reference sediments and/or the control sediments.

Growth of *Hyalella azteca* was measured as mg/kg (dry weight) of the test organisms at the end of the exposure period. Organism weights in the control samples were 0.39 mg for the sand control, 0.52 mg for the formulated sediment, and 0.35 mg for the West Bearskin Lake control. The USEPA (2000) toxicity testing manual does not give specific growth criteria for test acceptability. According to LSRI, the increased growth rate for organisms from the formulated sediment may be attributed to a fungus-like growth which occurred on the surface of the formulated sediment, and may have served as an added food source for the test organisms. Organism weights from reference sediments REF-1, REF-2, and REF-3 were 0.35 mg, 0.30 mg, and 0.44 mg, respectively. Organism weight from the NW samples ranged from 0.36 mg (NW-5) to 0.56 mg (NW-1). Sediment samples from locations NW-2 and NW-5 exhibited organism weights significantly ($p \leq 0.05$) lower than the formulated sediment (which had an unusually high growth rate); however, the sample weights from these two locations were not significantly different from those for the reference sites and the other two control samples. 150-30→120

These data for *Hyalella azteca* indicate no apparent relationship between sediment lead or PCB concentrations and organism survival or growth. Only one of the NW samples (NW-5) exhibited survival significantly lower than the reference samples and/or the control samples. Given the fact that sample location NW-5 had the lowest detected lead concentration (6.7 mg/kg) and was non-detect for PCBs, the observed toxicity of this sample is not related to site related contaminants. Similarly, for organism growth, the only significant differences were for NW-2 and NW-5 compared to the formulated sediment (which had an unusually high growth rate). However, these samples were not significantly different from the other two control samples (sand and West Bearskin Lake) or the reference samples.

Chironomus tentans

The results of the *Chironomus tentans* tests are presented in Table 3. The survival of *Chironomus tentans* in the control samples was 87.5% for the sand control and the formulated sediment, and 81.2% for the West Bearskin Lake sediment. Percent survival for each of the controls exceeded the USEPA (2000) requirement of 70%. Survival in the samples from reference sites REF-1, REF-2, and REF-3 were 98.7%, 93.7%, and 93.7%, respectively. Survival in NW samples ranged from 88.8% in sample NW-1 to 97.5% in sample NW-3 and NW-5. None of the sediment samples from the NW exhibited survival significantly ($p \leq 0.001$) lower than the control sediments or the reference samples.

Growth of *Chironomus tentans* was measured as both mg dry weight and mg ash-free dry weight of the test organisms at the end of the exposure period. Organism weight (ash-free) in the control samples was 0.54 mg for the sand control, 0.42 mg for the formulated sediment, and 0.57 mg for West Bearskin Lake. The USEPA (2000) growth requirement is 0.48 mg. Organism growth for the formulated sediment was only 0.42 mg, however, according to LSRI, the reduced growth rate in the formulated sediment may be attributed to the presence of sulfide in the sediment. Regardless, growth rates for the other two control samples (sand and West Bearskin Lake) did meet the USEPA (2000) requirement. Organism weight from reference sites REF-1, REF-2, and REF-3 were 0.66 mg, 0.67 mg, and 0.70 mg, respectively. Organism weights from the NW samples ranged from 0.66 mg (NW-4) to 0.92 mg (NW-1). None of the sediment samples from the NW exhibited growth significantly ($p \leq 0.005$) lower than the control sediments or the reference samples.

These results of the *Chironomus tentans* tests indicate no significant differences in percent survival or growth of the test organisms in comparison to control and/or reference samples. Collectively, these results clearly indicate that concentrations of lead and PCBs in NW sediment are not sufficient to affect the growth or survival of aquatic organisms.

4. Summary and Conclusions

4.1 Summary

The Phase II SSIES for the NW involved chemical analyses of soils and sediment and sediment toxicity tests. Collectively, these data were used to re-affirm the conclusions of the initial SSIES, and further evaluate potential ecological risk using a weight-of-evidence approach consistent with USEPA (1997) guidance.

Analytical data from the Phase II SSIES were generally comparable to earlier data from the 1993 RI sampling and the 1999 SSIES sampling. The Phase II SSIES data indicated a range of lead and PCB concentrations in sediment and soils of the NW. During the Phase II SSIES PCBs were only detected in two of the NW sediment samples, and at a maximum concentration of only 1.38 mg/kg. Lead concentrations in the NW sediment ranged from 6.7 mg/kg to 220 mg/kg.

The potential significance of the lead and PCB concentrations with respect to potential for causing direct toxicity were evaluated using sediment toxicity tests. A total of eight sediment samples (five samples from the NW and three samples from reference locations) were used to conduct the sediment toxicity tests. The tests included 10-day tests with *Chironomus tentans* and 28-day tests with *Hyalella azteca*. Results from the laboratory toxicity tests were comparable to the results of earlier sediment toxicity tests reported in the initial SSIES (BBL, 2000), and demonstrate that NW sediment do not cause statistically significant concentration-related effects on survival or growth of aquatic invertebrates.

4.2 Conclusions

According to criteria specified in the ROD (USEPA 1998b), remediation of the NW is not warranted. Based on the results of the activities conducted for the initial SSIES and the Phase II SSIES, a significant reduction in invertebrate survival or growth has not been observed in relation to lead concentrations in site sediments. In addition, the available tissue residue data from the initial SSIES (BBL, 2000) demonstrate that there is no significant impact to higher trophic level receptors. Moreover, as noted in the ROD (USEPA, 1998b), remediation of the NW would itself create significant ecological impacts. For example, the removal or capping of sediments in the wetland would drastically change both the physical and biological characteristics of the site, resulting in the loss of an established community, or the reversal of natural succession from a forest community to a scrub/shrub wetland. The re-development of a forested wetland similar to that currently present in the NW has been estimated to take 50 to 60 years to reestablish the vegetation (USEPA, 1998b).

*Based on these considerations, no remediation of the NW is recommended.

5. References

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Table 1

Phase II SSIES Report

York Oil Superfund Site
Moira, New York

Sediment Data Summary

Sample ID: / Date Collected:	Units	NW-1 07/10/00	NW-2 07/10/00	NW-3 07/10/00	NW-4 07/10/00	NW-5 07/10/00	REF-1 07/10/00	REF-2 07/11/00	REF-3 07/11/00
Volatile Organics									
1,1,1-Trichloroethane	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
1,1,2,2-Tetrachloroethane	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
1,1,2-Trichloroethane	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
1,1-Dichloroethane	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
1,1-Dichloroethene	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
1,2-Dichloroethane	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
1,2-Dichloroethene, total	ug/Kg	ND(61) F	ND(66) F	ND(80) F	ND(23)	ND(18)	ND(32) F	ND(16) F [ND(28)]	ND(18)
1,2-Dichloropropane	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
2-Butanone	ug/Kg	ND(61) F	ND(66) F	120 F	ND(23)	26	ND(32) F	ND(16) F [ND(28)]	ND(18)
2-Hexanone	ug/Kg	ND(61) F	ND(66) F	ND(80) F	ND(23)	ND(18)	ND(32) F	ND(16) F [ND(28)]	ND(18)
4-Methyl-2-pentanone	ug/Kg	ND(61) F	ND(66) F	ND(80) F	ND(23)	ND(18)	ND(32) F	ND(16) F [ND(28)]	ND(18)
Acetone	ug/Kg	89 F	ND(66) F	490 F	460	83	41 F	ND(16) F [ND(28)]	30
Benzene	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Bromodichloromethane	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Bromoform	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Bromomethane	ug/Kg	ND(61) F	ND(66) F	ND(80) F	ND(23)	ND(18)	ND(32) F	ND(16) F [ND(28)]	ND(18)
Carbon disulfide	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Carbon tetrachloride	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Chlorobenzene	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Chlorodibromomethane	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Chloroethane	ug/Kg	ND(61) F	ND(66) F	ND(80) F	ND(23)	ND(18)	ND(32) F	ND(16) F [ND(28)]	ND(18)
Chloroform	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Chloromethane	ug/Kg	ND(61) F	ND(66) F	ND(80) F	ND(23)	ND(18)	ND(32) F	ND(16) F [ND(28)]	ND(18)
cis-1,3-Dichloropropene	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Ethylbenzene	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Methylene chloride	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Styrene	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Tetrachloroethene	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Toluene	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
trans-1,3-Dichloropropene	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Trichloroethene	ug/Kg	ND(31) F	ND(33) F	ND(40) F	ND(11)	ND(9.1)	ND(16) F	ND(8.0) F [ND(14)]	ND(9.1)
Vinyl chloride	ug/Kg	ND(61) F	ND(66) F	ND(80) F	ND(23)	ND(18)	ND(32) F	ND(16) F [ND(28)]	ND(18)
Xylene, total	ug/Kg	ND(92) F	ND(99) F	ND(120) F	ND(34)	ND(27)	ND(48) F	ND(24) F [ND(43)]	ND(27)
PCBs									
Aroclor 1016	ug/Kg	ND(310)	ND(330)	ND(400)	ND(110)	ND(91)	ND(160)	ND(80) [ND(140)]	ND(91)
Aroclor 1221	ug/Kg	ND(310)	ND(330)	ND(400)	ND(110)	ND(91)	ND(160)	ND(80) [ND(140)]	ND(91)
Aroclor 1232	ug/Kg	ND(310)	ND(330)	ND(400)	ND(110)	ND(91)	ND(160)	ND(80) [ND(140)]	ND(91)
Aroclor 1242	ug/Kg	ND(310)	ND(330)	ND(400)	ND(110)	ND(91)	ND(160)	ND(80) [ND(140)]	ND(91)
Aroclor 1248	ug/Kg	ND(310)	ND(330)	ND(400)	ND(110)	ND(91)	ND(160)	ND(80) [ND(140)]	ND(91)
Aroclor 1254	ug/Kg	1000	370	ND(400)	ND(110)	ND(91)	ND(160)	ND(80) [ND(140)]	ND(91)
Aroclor 1260	ug/Kg	380	430	ND(400)	ND(110)	ND(91)	ND(160)	ND(80) [ND(140)]	ND(91)
Total PCBs	ug/Kg	1380	800	ND(400)	ND(110)	ND(91)	ND(160)	ND(80) [ND(140)]	ND(91)
Semivolatile Organics									
1,2,4-Trichlorobenzene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
1,2-Dichlorobenzene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
1,3-Dichlorobenzene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
1,4-Dichlorobenzene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
2,2'-oxybis(1-Chloropropane)	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
2,4,5-Trichlorophenol	ug/Kg	ND(10000)	ND(5500)	ND(6700)	ND(1900)	ND(1500)	ND(2600)	ND(1300) [ND(2400)]	ND(1500)
2,4,6-Trichlorophenol	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
2,4-Dichlorophenol	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
2,4-Dimethylphenol	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
2,4-Dinitrophenol	ug/Kg	ND(10000)	ND(5500)	ND(6700)	ND(1900)	ND(1500)	ND(2600)	ND(1300) [ND(2400)]	ND(1500)
2,4-Dinitrotoluene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
2,6-Dinitrotoluene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
2-Chloronaphthalene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
2-Chlorophenol	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
2-Methylnaphthalene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
2-Methylphenol	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
2-Nitroaniline	ug/Kg	ND(10000)	ND(5500)	ND(6700)	ND(1900)	ND(1500)	ND(2600)	ND(1300) [ND(2400)]	ND(1500)
2-Nitrophenol	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
3,3-Dichlorobenzidine	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
3-Nitroaniline	ug/Kg	ND(10000)	ND(5500)	ND(6700)	ND(1900)	ND(1500)	ND(2600)	ND(1300) [ND(2400)]	ND(1500)
4,6-Dinitro-2-methylphenol	ug/Kg	ND(10000)	ND(5500)	ND(6700)	ND(1900)	ND(1500)	ND(2600)	ND(1300) [ND(2400)]	ND(1500)
4-Bromophenyl phenyl ether	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)

Table 1

Phase II SSIES Report

York Oil Superfund Site
Moira, New York

Sediment Data Summary

Sample ID: Date Collected:	Units	NW-1 07/10/00	NW-2 07/10/00	NW-3 07/10/00	NW-4 07/10/00	NW-5 07/10/00	REF-1 07/10/00	REF-2 07/11/00	REF-3 07/11/00
4-Chloro-3-methylphenol	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
4-Chloroaniline	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
4-Chlorophenyl phenyl ether	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
4-Methylphenol	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
4-Nitroaniline	ug/Kg	ND(10000)	ND(5500)	ND(6700)	ND(1900)	ND(1500)	ND(2600)	ND(1300) [ND(2400)]	ND(1500)
4-Nitrophenol	ug/Kg	ND(10000)	ND(5500)	ND(6700)	ND(1900)	ND(1500)	ND(2600)	ND(1300) [ND(2400)]	ND(1500)
Acenaphthene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Acenaphthylene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Anthracene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Benzo(a)anthracene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Benzo(a)pyrene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Benzo(b)fluoranthene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Benzo(g,h,i)perylene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Benzo(k)fluoranthene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
bis(2-Chloroethoxy)methane	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
bis(2-Chloroethyl)ether	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
bis(2-Ethylhexyl)phthalate	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Butylbenzylphthalate	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Carbazole	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Chrysene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Di-n-butylphthalate	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Di-n-octylphthalate	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Dibenzo(a,h)anthracene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Dibenzofuran	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Diethylphthalate	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Dimethylphthalate	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Fluoranthene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Fluorene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Hexachlorobenzene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Hexachlorobutadiene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Hexachlorocyclopentadiene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Hexachloroethane	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Indeno(1,2,3-cd)pyrene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Isophorone	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
N-Nitroso-di-n-propylamine	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
N-Nitrosodiphenylamine	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Naphthalene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Nitrobenzene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Pentachlorophenol	ug/Kg	ND(10000)	ND(5500)	ND(6700)	ND(1900)	ND(1500)	ND(2600)	ND(1300) [ND(2400)]	ND(1500)
Phenanthrene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Phenol	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Pyrene	ug/Kg	ND(4100)	ND(2200)	ND(2700)	ND(760)	ND(610)	ND(1100)	ND(530) [ND(950)]	ND(610)
Pesticides									
4,4'-DDD	ug/Kg	ND(31)	ND(33)	ND(40)	ND(11)	ND(9.1)	ND(16)	ND(8.0) [ND(14)]	ND(9.1)
4,4'-DDE	ug/Kg	ND(31)	ND(33)	ND(40)	ND(11)	ND(9.1)	ND(16)	ND(8.0) [ND(14)]	ND(9.1)
4,4'-DDT	ug/Kg	ND(31)	ND(33)	ND(40)	ND(11)	ND(9.1)	ND(16)	ND(8.0) [ND(14)]	ND(9.1)
Aldrin	ug/Kg	ND(15)	ND(16)	ND(20)	ND(5.7)	ND(4.6)	ND(7.9)	ND(4.0) [ND(7.1)]	ND(4.6)
alpha-BHC	ug/Kg	ND(15)	ND(16)	ND(20)	ND(5.7)	ND(4.6)	ND(7.9)	ND(4.0) [ND(7.1)]	ND(4.6)
alpha-Chlordane	ug/Kg	ND(15)	ND(16)	ND(20)	ND(5.7)	ND(4.6)	ND(7.9)	ND(4.0) [ND(7.1)]	ND(4.6)
beta-BHC	ug/Kg	ND(15)	ND(16)	ND(20)	ND(5.7)	ND(4.6)	ND(7.9)	ND(4.0) [ND(7.1)]	ND(4.6)
delta-BHC	ug/Kg	ND(15)	ND(16)	ND(20)	ND(5.7)	ND(4.6)	ND(7.9)	ND(4.0) [ND(7.1)]	ND(4.6)
Dieldrin	ug/Kg	ND(31)	ND(33)	ND(40)	ND(11)	ND(9.1)	ND(16)	ND(8.0) [ND(14)]	ND(9.1)
Endosulfan I	ug/Kg	ND(15)	ND(16)	ND(20)	ND(5.7)	ND(4.6)	ND(7.9)	ND(4.0) [ND(7.1)]	ND(4.6)
Endosulfan II	ug/Kg	ND(31)	ND(33)	ND(40)	ND(11)	ND(9.1)	ND(16)	ND(8.0) [ND(14)]	ND(9.1)
Endosulfan sulfate	ug/Kg	ND(31)	ND(33)	ND(40)	ND(11)	ND(9.1)	ND(16)	ND(8.0) [ND(14)]	ND(9.1)
Endrin	ug/Kg	ND(31)	ND(33)	ND(40)	ND(11)	ND(9.1)	ND(16)	ND(8.0) [ND(14)]	ND(9.1)
Endrin aldehyde	ug/Kg	ND(31)	ND(33)	ND(40)	ND(11)	ND(9.1)	ND(16)	ND(8.0) [ND(14)]	ND(9.1)
Endrin ketone	ug/Kg	ND(31)	ND(33)	ND(40)	ND(11)	ND(9.1)	ND(16)	ND(8.0) [ND(14)]	ND(9.1)
gamma-BHC (Lindane)	ug/Kg	ND(15)	ND(16)	ND(20)	ND(5.7)	ND(4.6)	ND(7.9)	ND(4.0) [ND(7.1)]	ND(4.6)
gamma-Chlordane	ug/Kg	ND(15)	ND(16)	ND(20)	ND(5.7)	ND(4.6)	ND(7.9)	ND(4.0) [ND(7.1)]	ND(4.6)
Heptachlor	ug/Kg	ND(15)	ND(16)	ND(20)	ND(5.7)	ND(4.6)	ND(7.9)	ND(4.0) [ND(7.1)]	ND(4.6)
Heptachlor epoxide	ug/Kg	ND(15)	ND(16)	ND(20)	ND(5.7)	ND(4.6)	ND(7.9)	ND(4.0) [ND(7.1)]	ND(4.6)
Methoxychlor	ug/Kg	ND(150)	ND(160)	ND(200)	ND(57)	ND(46)	ND(79)	ND(40) [ND(71)]	ND(46)
Toxaphene	ug/Kg	ND(1500)	ND(1600)	ND(2000)	ND(570)	ND(460)	ND(790)	ND(400) [ND(710)]	ND(460)

Table 1

Phase II SSIES Report

York Oil Superfund Site
Moira, New York

Sediment Data Summary

Sample ID: Date Collected:	Units	NW-1 07/10/00	NW-2 07/10/00	NW-3 07/10/00	NW-4 07/10/00	NW-5 07/10/00	REF-1 07/10/00	REF-2 07/11/00	REF-3 07/11/00
Metals									
Aluminum	mg/Kg	4600	3700	3600	9400	2300	5900	14000 [17000]	2700
Antimony	mg/Kg	ND(7.1)	ND(7.2)	ND(7.6)	ND(2.5)	ND(1.8)	ND(3.6)	ND(2.3) [ND(1.9)]	ND(1.7)
Arsenic	mg/Kg	ND(7.1)	ND(7.2)	ND(7.6)	ND(2.5)	ND(1.8)	ND(3.6)	ND(2.3) [3.2]	ND(1.7)
Barium	mg/Kg	230	260	200	150	30	120	200 [190]	37
Beryllium	mg/Kg	ND(0.71)	ND(0.72)	ND(0.76)	0.37	0.19	0.53	1.0 [1.2]	0.28
Cadmium	mg/Kg	2.1	2.0	1.6	0.99	ND(0.18)	0.85	0.73 [0.41]	0.18
Calcium	mg/Kg	27000 N	26000	32000	12000	1900	6500	6900 [6200]	2200
Chromium	mg/Kg	9.7	7.3	7.1	11	3.8	12	17 [20]	3.8
Cobalt	mg/Kg	ND(3.6)	ND(3.6)	ND(3.8)	2.2	1.4	ND(1.8)	2.8 [3.2]	1.1
Copper	mg/Kg	36	41	45	14	ND(3.6)	16	13 [9.1]	4.2
Iron	mg/Kg	6800	9000	7300	8300	7200	4100	8100 [12000]	4300
Lead	mg/Kg	220	120 E	21	16	6.7	17	9.5 [9.7]	6.8
Magnesium	mg/Kg	2700	2500 E	2700	1600	500	1200	2200 [2500]	520
Manganese	mg/Kg	520 N	540	2000	480	300	64	78 [95]	170
Mercury	mg/Kg	0.29 H(21)	0.48 H(21)	0.60 H(21)	0.25 H(21)	0.051 H(21)	0.37 H(21)	0.55 H(21) [0.43 H(21)]	0.047 H(21)
Nickel	mg/Kg	8.6	8.8	8.4	4.2	1.9	4.3	12 [11]	2.2
Potassium	mg/Kg	ND(710)	ND(720)	ND(760)	470	ND(180)	520	670 [740]	ND(170)
Selenium	mg/Kg	ND(7.1)	ND(7.2)	ND(7.6)	ND(2.5)	ND(1.8)	ND(3.6)	ND(2.3) [ND(1.9)]	ND(1.7)
Silver	mg/Kg	ND(3.6) *	ND(3.6)	ND(3.8)	ND(1.3)	ND(0.91)	ND(1.8)	ND(1.2) [ND(0.96)]	ND(0.87)
Sodium	mg/Kg	ND(1400)	ND(1400)	ND(1500)	ND(500)	ND(360)	ND(720)	ND(470) [ND(380)]	ND(350)
Thallium	mg/Kg	ND(7.1)	ND(7.2)	ND(7.6)	ND(2.5)	ND(1.8)	ND(3.6)	ND(2.3) [ND(1.9)]	ND(1.7)
Vanadium	mg/Kg	15	14	10	11	8.4	12	12 [14]	6.7
Zinc	mg/Kg	170	95 E	81	70	29	31	61 [44]	28
Miscellaneous									
Oil & Grease, total recoverable	%	0.67	0.51	0.48	ND(0.11)	ND(0.091)	0.20	ND(0.080) [ND(0.14)]	ND(0.091)
TPH-IR - soil	mg/Kg	340	1200	ND(160)	ND(46)	ND(37)	ND(63)	ND(32) [ND(57)]	ND(36)
pH, measured in water	pH Units	6.8	6.9	6.9	6.8	7.1	6.2	6.5 [6.6]	6.5
Solids, percent	%	16.3	15.2	12.5	43.8	54.7	31.5	62.4 [35.1]	54.8
TOC replicate 1	%	16	22	26	4.6	1.3	9.5	4.7 [5.2]	2.8
TOC replicate 2	%	18	15	26	6.8	1.3	7.6	5.1 [4.8]	2.7
TOC replicate 3	%	20	20	25	7.6	1.5	9.6	5.4 [4.0]	3.4
TOC replicate 4	%	16	16	25	7.3	1.5	7.7	5.2 [4.1]	3.8
TOC average of rep 1-4	%	18	18	26	6.6	1.4	8.6	5.1 [4.5]	3.2

Table 2

Phase II SSIES Report

York Oil Superfund Site
Moira, New York

Results of the 28-day *Hyalella azteca* Sediment Toxicity Tests

Site	Percent Survival Mean (± s.d.)	Dry Weight (mg) Mean (± s.d.)
Sand Control	97.5 (± 4.63)	0.39 (± 0.11)[b]
Formulated	90.0 (± 9.26)	0.52 (± 0.06)
West Bearskin	90.0 (± 11.95)	0.35 (± 0.01)[b]
Ref 1	68.75 (± 17.27)[a]	0.35 (± 0.06)[b]
Ref 2	81.25 (± 8.35)[e]	0.30 (± 0.03)[bc]
Ref 3	67.5 (± 11.65)[a]	0.44 (± 0.04)
NW-1	87.5 (± 16.69)	0.56 (± 0.06)
NW-2	93.75 (± 5.18)	0.39 (± 0.03)[b]
NW-3	95.0 (± 7.56)	0.43 (± 0.05)
NW-4	92.5 (± 7.07)	0.51 (± 0.04)
NW-5	15.0 (± 10.69)[ad]	0.36 (± 0.15)[b]

Notes:

a Significantly reduced (($p \leq 0.05$) relative to all three control sites by one-way ANOVA and the Bonferroni T-test.

b Significantly reduced ($p \leq 0.05$) relative to formulated sediment by one-way ANOVA and the Bonferroni T-test.

c Significantly reduced ($p \leq 0.05$) relative to reference site 3 by one-way ANOVA and the Bonferroni T-test.

d Significantly reduced ($p \leq 0.05$) relative to all reference sites by one-way ANOVA and the Bonferroni T-test.

e Significantly reduced ($p \leq 0.05$) relative to the sand control by one-way ANOVA and the Bonferroni T-test.

Table 3

Phase II SSIES Report

York Oil Superfund Site
Moira, New York

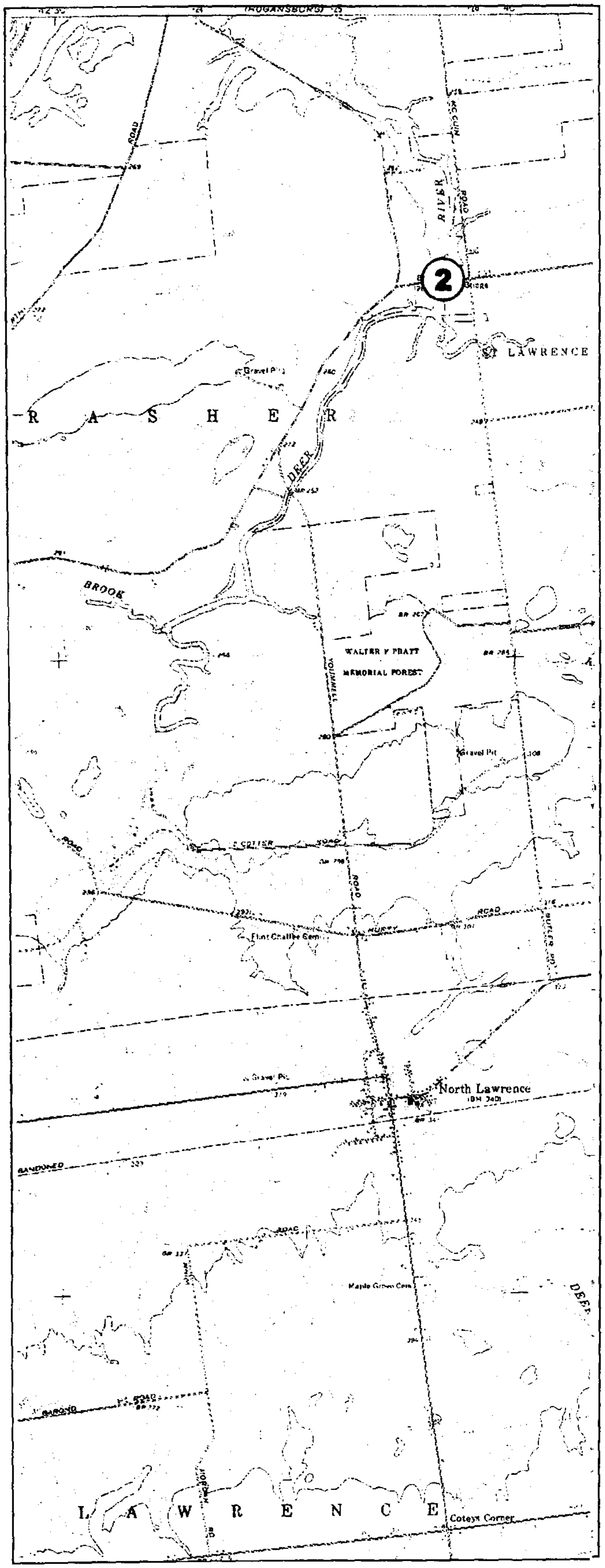
Results of the 10-day *Chironomus tentans* Sediment Toxicity Tests

Site	Percent Survival Mean (± s.d.)	Dry Weight (mg) Mean (± s.d.)	Ash free Dry Weight (mg) Mean (± s.d.)
Sand Control	87.5 (± 12.8)	0.64 (± 0.12)[a]	0.54 (± 0.11)
Formulated Sed	87.5 (± 11.6)	0.57 (± 0.37)[ab]	0.42 (± 0.23)
West Bearskin	81.2 (± 15.5)	0.89 (± 0.24)	0.57 (± 0.12)
Ref 1	98.7 (± 3.5)	0.80 (± 0.07)	0.66 (± 0.06)
Ref 2	93.7 (± 5.2)	0.84 (± 0.13)	0.67 (± 0.11)
Ref 3	93.7 (± 10.6)	0.87 (± 0.06)	0.70 (± 0.06)
NW-1	88.8 (± 14.6)	1.04 (± 0.11)	0.92 (± 0.10)
NW-2	96.2 (± 10.6)	0.78 (± 0.14)	0.68 (± 0.13)
NW-3	97.5 (± 4.6)	0.78 (± 0.12)	0.70 (± 0.11)
NW-4	96.2 (± 5.2)	0.79 (± 0.12)	0.66 (± 0.10)
NW-5	97.5 (± 4.6)	0.86 (± 0.15)	0.72 (± 0.12)

Notes:

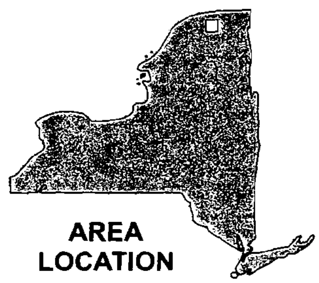
[a] Significantly reduced ($p<0.05$) relative to W. Bearskin Sediment by one-way ANOVA and the Bonferroni T-test

[b] Significantly reduced ($p<0.05$) relative to Reference Sediment 3 by one-way ANOVA and the Bonferroni T-test



LEGEND

(1) = REFERENCE AREA



4000' 0 4000'

Approximate Scale: 1" = 4000'

REFERENCE: BASE MAP SOURCE USGS 7.5 MINU

03/01 SYR-D54-LBR MRC
10420001/10420n03.cdr

YORK OIL SUPERFUND SITE
PHASE II
SUPPLEMENTAL SEDIMENT INVESTIGATION AND ECOLOGICAL STUDIES (SSIES) REPORT

REFERENCE SITES AND SITE LOCATION

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 1

LEGEND:

- - - - 10' CONTOURS

——— WATER

═══ ROADS

NW-5 ▪ SEDIMENT SAMPLE LOCATION

SAMPLE LOCATION I.D.

TOTAL PCBs & LEAD CONCENTRATION IN mg/Kg

NW-1			
Date	Sample I.D.	Total PCBs	Lead
1993	Y2-SD23-01	0.78 J	408
1999	NW-1	4.2	400
2000	NW-1	1.38	220

NOTES:

1. BASE MAP CONSTRUCTED FROM NORTH LAWRENCE, NEW YORK (1964, PHOTOINSPECTED 1980) AND BRUSHTON, NEW YORK (1964) U.S.G.S. 7.5 SERIES QUADRANGLES.
2. WETLAND AREAS AS IDENTIFIED IN EBASCO OCTOBER 1991 WORK PLAN.
3. DRAINAGE CHANNEL (ZONE 3) IS ASSUMED TO BE 5 FEET WIDE.

600' 0 600'

SCALE: 1" = 600'

YORK OIL SUPERFUND SITE

PHASE II SUPPLEMENTAL SEDIMENT INVESTIGATION AND ECOLOGICAL STUDIES (SSIES) REPORT

NORTHWEST WETLAND SURFICIAL SEDIMENT PCB AND LEAD DATA (ppm)

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE **2**

L: ON=*, OFF=REF
P: STD/BL
3/26/01 SYR-54-DMW YCC DCC PGL
10420001/10420C05.DWG

Appendices

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Appendix A

Sediment Toxicity Test Laboratory Report

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Evaluation of Aquatic Sediments from the Northwest Wetlands of the York Oil Company Site for Toxicity to *Chironomus tentans* and *Hyalella azteca*

By

Mary D. Balcer, Larry T. Brooke,
Thomas P. Markee,
and Dianne L. Brooke

Lake Superior Research Institute
University of Wisconsin-Superior
Superior, WI

February 4, 2001

Final Project Report

To

Blasland, Bouck & Lee, Inc.
2000 Regency Parkway
Suite 375
Cary, NC
(David Rigg, Project Officer)

INTRODUCTION

The University of Wisconsin-Superior's Lake Superior Research Institute (LSRI) contracted with Blasland, Bouck & Lee, Inc. to evaluate sediment samples from eight sites from the Northwest Wetlands region of the York Oil Company Site (three reference and five non-reference) for toxicity toward two species of benthic invertebrates. A ten-day acute exposure was conducted with larvae of the insect, *Chironomus tentans.* A 28-day exposure was performed with the crustacean amphipod, *Hyalella azteca.* The endpoints of survival and growth were examined in both studies.

METHODS

Sediment Collection and Preparation

Sediment was collected by staff from Blasland, Bouck & Lee on July 10 and 11, 2000, and was immediately shipped by air freight to LSRI in sealed 2.5 gallon polyethylene buckets contained in coolers with ice packs. The samples were designated as having been collected from either a reference site (Ref-1, Ref-2, and Ref-3) or a non-reference site (NW-1, NW-2, NW-3, NW-4, and NW-5). Upon arrival at LSRI, the sediment samples were refrigerated at 4 °C until they were homogenized, and then refrigerated again until used in the toxicity studies. Initial homogenization was for 15 minutes using a commercial drill equipped with a mortar paddle. At 5 minute intervals, the sediment was mixed manually with a stainless steel spoon to further ensure homogeneity. Immediately prior to placement of the sediment into the test chambers, the sediment was again homogenized for 5 minutes with the mortar paddle. All tests were initiated within 6 weeks of sample receipt and completed within 10 weeks.

Solid Phase Sediment Toxicity Tests

Chironomus tentans Acute Toxicity Test. A 10-day solid phase sediment toxicity test was performed with *C. tentans* following a specific LSRI test protocol (AT/21 Revision 2) that is based upon EPA Test Method 100.2 (EPA 2000). Eight replicates of each test sediment (NW-1 to NW-5), and reference sediment (Ref-1 to Ref 3) were used as well as 8 replicates of each of three laboratory performance control sediments. Our lab traditionally uses silica sand as a performance control to assess survival of the test organisms. For this experiment we also used a 19% sand and 2% organic carbon formulated sediment (Kemble et al 1999) that is recommended by EPA (2000) for use as a control sediment. In addition, we used sediment from West Bearskin Lake, near Grand Marais, MN which has been routinely used as a control sediment at EPA-Duluth.

One day prior to test initiation, approximately 100 mL of sediment was placed into each 300-mL screened test beaker. For each sediment, a set of eight replicate beakers were filled and placed into a single glass aquarium which received the renewal water. The aquaria in turn, were randomly placed within large, shallow water baths set to maintain the desired test temperature of 23 °C. The beakers contained two screened holes about two-thirds of the distance up the beaker walls to allow for water exchange between the beaker and the aquarium in which it was placed.

The test was initiated with larvae from the LSRI culturing laboratory that were 9 to 10 days old. Based on measurements of four replicates of 10 animals each, the mean (± s.d.) individual dry weight was 0.106 ±0.011 mg and individual ash-free dry weight was 0.090 ±0.005 mg at the start of the test. Measurements of the head capsule width revealed that 90% of the larvae were in the third instar (0.26 to 0.36 mm) and 10 % were second instars (0.16 to 0.20 mm). A 48-hr reference toxicant toxicity test with KCl and animals from the laboratory culture performed on July 21, 2000, yielded an LC50 value of 4,389 mg/L. This value is within the normal range of LC50 values for our laboratory, (3,851 to 7627) as determined from a control chart containing reference toxicant tests performed over the past five years.

The tests were performed at a nominal water temperature of 23 °C, and the overlying water was regularly and automatically renewed throughout the test. The overlying water was dechlorinated municipal water from the City of Superior, WI, which had passed through an ion exchange resin to remove trace metals. The source of this water supply is a series of shallow wells located in the strata underlying the western tip of Lake Superior, resulting in a soft water with basic characteristics of hardness, alkalinity and pH similar to the water of Lake Superior. The overlying water was exchanged within the aquaria housing the screened exposure beakers two times daily at a flow rate of 32 mL/min for one hour that resulted in two volume renewals per day. The water in the aquaria housing the exposure beakers was aerated. A 16L:8D photoperiod was maintained throughout the exposure period.

Ten larvae were randomly distributed to each replicate beaker at the start of the test. The replicates were provided with equal volumes of food daily, consisting of 1.5 mL of a 4 g/L suspension of Tetrafin®. (Feeding was reduced to only 0.75 mL in all chambers on day 7 due to concern over decreasing oxygen levels). At the end of the 10-day exposure period, sediment from each beaker was sieved through a No. 45 (335 um mesh opening) sieve, rinsed into a clean glass pan, placed over a light table, and the surviving organisms retrieved. They were cleaned of debris, placed into dried, pre-weighed weighing pans, and oven-dried at approximately 60 °C for 24 hr to obtain dry weight measurements. Dry weights were measured to 0.01 mg for all survivors combined at each replicate following the cooling of dried animals in a desiccator. The test organisms were then dried at 550 °C for an additional 24 hr and then weighed again for determination of ash free dry weight.

Dissolved oxygen and temperature were measured daily prior to the water renewal periods in at least two replicates of each treatment. If oxygen levels were low, measurements were made again after the renewal period. Alkalinity, hardness, pH, conductivity, and ammonia were measured twice during the test, at the beginning and again near the end.

Hyalella azteca 28-Day Toxicity Test. A 28-day solid phase sediment toxicity test was performed with *H. azteca* according to Method 100.4 (EPA 2000). The test was ended after the 28-day sediment exposure phase and not continued for the additional 14 day reproduction phase. The exposures were performed in screened 300-mL beakers contained within aquaria set in a water bath, as described above for *C. tentans*. The exposures were of the flow-through type, with intermittent renewal of the overlying water to provide approximately two volume exchanges daily. The water in the aquaria housing the exposure beakers was aerated. A 16L:8D photoperiod was provided. As for the *C. tentans* exposures, we used three control sediments in addition to the 3 three reference sediments and five test sediments supplied by BBL.

Ten young *H. azteca* (7-8 days old) were randomly distributed to each replicate beaker at the start of the test. Three subsamples of forty organisms each were taken for determination of initial weight. The individual dry weight (± s.d.) of the subsample averaged 0.0269 (± 0.0023) mg. A 48-hr reference toxicity test with KCl was performed on August 1, 2000 with *Hyalella* from the laboratory culture. The LC50 value of 357 ± 37 mg/L is within the range of LC50 values for our laboratory (358 to 442 mg/L).

During the test each replicate received 1.0 mL of a 1,840 mg/L YCT (yeast, Cerophyll®, trout chow) diet daily. At the end of the 28-day exposure period, the sediment was sieved as described above, and the survivors were oven-dried for >24 hr at 100° C in pre-weighed aluminum weighing pans. The animals within a given replicate were weighed collectively to obtain a single dry weight for each replicate.

Measurements were made twice daily of dissolved oxygen and temperature prior to the renewal period. pH was recorded three times each week, conductivity was recorded once a week and Alkalinity, hardness, and ammonia at the beginning and end of the test period.

STATISTICAL ANALYSIS

Toxicity test data were analyzed using a SYSTAT® statistical software package (SPSS, Inc., 1997) that included a one-way analysis of variance and a suite of tests for comparison of treatment group means. Mean survival and mean dry weight values for each of the test sites were compared to the corresponding mean values for the three reference sites and the three performance control sediments using the Bonferroni t-test, with statistical significance set at a probability level of 0.05 and below.

RESULTS AND DISCUSSION

Chironomus tentans 10-Day Acute Toxicity Test.

According to EPA (2000) guidelines, average survival of C. tentans in the control sediment must be greater than 70% at the end of the test while the average size of the individual organisms must be at least 0.48 mg ash free dry weight (AFDW). Table 1 shows that our laboratory's sand control sediment and the West Bearskin Lake control sediment exceeded these requirements. Organisms tested in the formulated control sediment did not meet the guidelines for growth (average weight of only 0.42 mg). EPA (2000) notes that a critical component of formulated sediment is the source of organic carbon. We used alpha cellulose as the organic carbon source as recommended by Kemble et al 1999. EPA (2000) indicates that unpublished data suggests that using alpha cellulose may result in some generation of sulfide in the pore water. When we ended the 10 day exposures, we noted a hydrogen sulfide smell from several of the beakers containing the formulated sediment. What effect this may have had on growth of the test organisms is unknown. Since our sand control sediment does not contain any organic carbon it is only designed to assess survival. Therefore, growth and survival of the test sediments was compared only to growth and survival in the West Bearskin control and the Reference sediments.

Survival in all test sediments was high, (88.8 to 97.5%) (Table 1) and was not significantly different from that of any of the reference or control sediments. Growth in the test sediments (0.66 to 0.92 mg AFDW) was also similar to that in the reference and West Bearskin control sediment (0.57 to 0.70 mg AFDW). Raw data for survival and growth in each replicate are presented in the Appendix (Table A-1).

Measurements of water quality parameters that accompanied this test are presented in Tables A-2 to A-4 of the Appendix. Instantaneous water temperatures ranged from 22.1 to 23.6 °C while treatment averages ranged from 22.91 to 22.98 °C. On occasion oxygen levels in some of the individual beakers dropped as low as 0.9 ppm prior to renewal. However, the minimum daily averages for each treatment (3.4 to 4.9) were never lower than the recommended level of 2.5 ppm and overall average dissolved oxygen levels during the entire treatment period ranged from 4.9 to 5.9 ppm. The pH levels ranged from 6.6 to 8.0 during the experiment while conductivity ranged from 107 to 138 umho/cm. Water hardness averaged 47 to 58 ppm CaCO3 and alkalinity averages ranged from 45 to 58 ppm CaCO3. Ammonia levels varied from below detection to over 1.9 mg/L, with the highest levels occurring at the end of the test in sediments from test sites NW-2 and NW-5 .

Hyalella azteca 28-Day Toxicity Test.

EPA (2000) guidelines call for a minimum mean survival of 80% of the test organisms on day 28 for control sediments and indicate that a dry weight of over 0.15 mg/individual test organism has been achieved by over 66% of the labs that participated in a round-robin test of this method. All three of our control sediments achieved survival rates of 90% or above and average dry weights ranged from 0.35 to 0.52 mg per individual for these sediments (Table 2). Average survival in the three reference sediments ranged from 67.5% to 81.2% and in all cases was significantly lower than at least one of the control sediments. Average survival in sediments from sites NW-1, NW-2, NW-3 and NW-4 were not significantly lower than any of the control or reference sediments, ranging from 87.5 to 93.7%. Survival in test site NW-5 only averaged 15% and was significantly lower than in all control and reference sediments.

Growth in the formulated sediment (0.52 mg) was significantly greater than in either the sand control (0.39 mg) or the West Bearskin sediment (0.35 mg). Laboratory notes indicate that a fungus like growth occurred on the surface of the formulated sediment, which may have served as an added food source for the test organisms. *Hyalella* exposed to reference sediment 3 achieved an average dry weight of 0.44 mg while growth in the other two reference sediments (0.30 and 0.35 mg) was significantly lower than in the formulated sediment. Average dry weight of *Hyalella* in the five test sediments ranged from 0.36 to 0.56 mg. Growth in sediments NW-2 and NW-5 was significantly lower than in the formulated sediment but was not significantly reduced from that of the West Bearskin or Reference sediments. Data for survival and growth in each replicate of each treatment are provided in Appendix Table 5.

Because of previous experiences with the highly organic nature of some of the test and reference sediments, we watched the sediment closely for signs of hydrogen sulfide production as the organic materials decomposed during the 28-day test period. By the eighth day of the experiment we noticed that gas bubbles were appearing in the sediment from site NW-1 and that the sediment had begun to expand and rise. On day 11 the principal investigator used steel spatulas to gently "burp" all of the sediments. The spatulas were inserted into the sediment in each beaker and run once around the sides of the beakers and then in a figure X across the beaker. This released the gas bubbles that had begun to build up in the sediments from all of the reference and treatment sites. No gas bubbles were noted in any of the control sediments, although they were also treated in the same manner. After this action, all of the sediments subsided and remained at a level of less than 150 mL for the duration of the experiment.

Individual measurements of water quality parameters that accompanied this test are presented in Tables A-6 through A-9 of the Appendix. All values are within EPA guidelines with instantaneous temperatures ranging from 21.9 to 24.3° C and treatment averages of 22.6 to 22.8° C. Oxygen levels ranged from 2.4 to 7.9 ppm, and averaged 6.5 to 7.1 ppm for the individual treatments. The pH of the test chambers ranged from

6.8 to 8.1, and conductivity varied from 110 to 147 umho/cm. Hardness levels in the various treatments averaged 48.6 to 67.5 ppm $CaCO_3$, with alkalinity levels of 42 to 59 ppm $CaCO_3$. The ammonia concentrations ranged from less than detection (0.063 mg/L) to 2.1 mg/L.

REFERENCES

Kemble, N.E., Dwyer, F. J., Ingersoll, C.G., Dawson, T.D., and Norberg-King, T.J. 1999. Tolerance of freshwater test organisms to formulated sediments for use as control materials in whole-sediment toxicity tests. *Environ. Toxicol. Chem.* 18:222-230.

SPSS, Inc. 1997. SYSTAT® 7.0.1. SPSS, Inc., Chicago, IL.

U. S. EPA. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates. Second Edition. EPA/600/R-99/064. Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C. 20460.

TABLE 1. Mean Survival and Dry Weight of *Chironomus tentans* Larvae Following 10 Days of Exposure to Sediment from the Northwest Wetlands Portion of the York Oil Company Site in July 2000

Site	Percent Survival Mean (± s.d.)	Dry Weight (mg) Mean (± s.d.)	Ash free Dry Weight (mg) Mean (± s.d.)
Sand Control	87.5 (± 12.8)	0.64 (± 0.12)[a]	0.54 (± 0.11)
Formulated Sed	87.5 (± 11.6)	0.57 (± 0.37)[ab]	0.42 (± 0.23)
West Bearskin	81.2 (± 15.5)	0.89 (± 0.24)	0.57 (± 0.12)
Ref 1	98.7 (± 3.5)	0.80 (± 0.07)	0.66 (± 0.06)
Ref 2	93.7 (± 5.2)	0.84 (± 0.13)	0.67 (± 0.11)
Ref 3	93.7 (± 10.6)	0.87 (± 0.06)	0.70 (± 0.06)
NW-1	88.8 (± 14.6)	1.04 (± 0.11)	0.92 (± 0.10)
NW-2	96.2 (± 10.6)	0.78 (± 0.14)	0.68 (± 0.13)
NW-3	97.5 (± 4.6)	0.78 (± 0.12)	0.70 (± 0.11)
NW-4	96.2 (± 5.2)	0.79 (± 0.12)	0.66 (± 0.10)
NW-5	97.5 (± 4.6)	0.86 (± 0.15)	0.72 (± 0.12)

[a] Significantly reduced ($p<0.05$) relative to W. Bearskin Sediment by one-way ANOVA and the Bonferroni T-test

[b] Significantly reduced ($p<0.05$) relative to Reference Sediment 3 by one-way ANOVA and the Bonferroni T-test

TABLE 2. Mean Survival and Dry Weight of *Hyalella azteca* Following 28 Days of Exposure to Sediment Samples from the Northwest Wetlands Portion of the York Oil Company Site, August 2000

Site	Percent Survival Mean (± s.d.)	Dry Weight (mg) Mean (± s.d.)
Sand Control	97.5 (± 4.63)	0.39 (± 0.11)[b]
Formulated Sed	90.0 (± 9.26)	0.52 (± 0.06)
West Bearskin	90.0 (± 11.95)	0.35 (± 0.01)[b]
Ref 1	68.75 (± 17.27)[a]	0.35 (± 0.06)[b]
Ref 2	81.25 (± 8.35)[e]	0.30 (± 0.03)[bc]
Ref 3	67.5 (± 11.65)[a]	0.44 (± 0.04)
NW-1	87.5 (± 16.69)	0.56 (± 0.06)
NW-2	93.75 (± 5.18)	0.39 (± 0.03)[b]
NW-3	95.0 (± 7.56)	0.43 (± 0.05)
NW-4	92.5 (± 7.07)	0.51 (± 0.04)
NW-5	15.0 (± 10.69)[ad]	0.36 (± 0.15)[b]

[a] Significantly reduced (($p \leq 0.05$) relative to all three control sites by one-way ANOVA and the Bonferroni T-test.

[b] Significantly reduced ($p \leq 0.05$) relative to formulated sediment by one-way ANOVA and the Bonferroni T-test.

[c] Significantly reduced ($p \leq 0.05$) relative to reference site 3 by one-way ANOVA and the Bonferroni T-test.

[d] Significantly reduced ($p \leq 0.05$) relative to all reference sites by one-way ANOVA and the Bonferroni T-test.

[e] Significantly reduced ($p \leq 0.05$) relative to the sand control by one-way ANOVA and the Bonferroni T-test

Appendix Table 1. Survival and growth of Chironomus tentans in a 10-day test with sediments from the Northwest Wetlands site

Site/sediment	Rep	Percent Survival	Dry Weight mg/animal	Ash Free mg/animal
Sand	1	100	53.30	45.30
Sand	2	100	47.64	40.36
Sand	3	90	65.67	49.89
Sand	4	90	53.00	45.33
Sand	5	80	77.63	68.25
Sand	6	100	60.00	52.00
Sand	7	70	71.86	62.29
Sand	8	70	81.14	70.71
Formulated	1	70	58.29	43.57
Formulated	2	100	107.20	66.60
Formulated	3	90	123.00	84.67
Formulated	4	90	52.11	41.89
Formulated	5	90	38.25	31.75
Formulated	6	70	35.00	25.67
Formulated	7	90	19.88	15.25
Formulated	8	100	30.22	24.00
W. Bearskin	1	70	60.86	42.14
W. Bearskin	2	70	111.57	68.86
W. Bearskin	3	60	99.00	65.17
W. Bearskin	4	100	102.30	56.90
W. Bearskin	5	90	67.78	48.89
W. Bearskin	6	70	55.00	40.57
W. Bearskin	7	100	102.64	67.91
W. Bearskin	8	90	114.00	68.33
Ref 1	1	90	83.44	67.89
Ref 1	2	100	80.20	66.30
Ref 1	3	100	78.90	64.20
Ref 1	4	100	79.80	65.90
Ref 1	5	100	92.90	77.10
Ref 1	6	100	65.58	54.50
Ref 1	7	100	78.18	66.18
Ref 1	8	100	80.80	65.10
Ref 2	1	90	105.22	83.78
Ref 2	2	90	93.89	75.67
Ref 2	3	90	81.44	66.00
Ref 2	4	90	73.78	57.89
Ref 2	5	100	76.00	60.20
Ref 2	6	100	71.80	57.20
Ref 2	7	100	70.30	55.50
Ref 2	8	90	97.89	81.33
Ref 3	1	100	93.20	76.80
Ref 3	2	70	90.29	72.29
Ref 3	3	90	87.78	73.78
Ref 3	4	100	84.20	65.40
Ref 3	5	100	81.80	64.80
Ref 3	6	100	84.30	66.70
Ref 3	7	90	96.67	78.11
Ref 3	8	100	78.00	62.83

Site/sediment	Rep	Percent Survival	Dry Weight mg/animal	Ash Free mg/animal
NW 1	1	100	90.73	80.55
NW 1	2	60	101.17	89.33
NW 1	3	90	110.33	98.89
NW 1	4	100	104.70	91.70
NW 1	5	80	120.13	106.50
NW 1	6	100	87.40	76.50
NW 1	7	100	99.08	87.08
NW 1	8	80	115.50	102.25
NW 2	1	100	77.80	66.80
NW 2	2	100	64.40	56.30
NW 2	3	100	67.64	59.82
NW 2	4	70	72.29	61.14
NW 2	5	100	110.71	96.71
NW 2	6	100	82.50	72.90
NW 2	7	100	82.73	74.45
NW 2	8	100	69.50	59.58
NW 3	1	90	75.56	68.33
NW 3	2	100	65.18	59.00
NW 3	3	90	85.67	77.89
NW 3	4	100	78.40	69.80
NW 3	5	100	87.82	79.18
NW 3	6	100	97.80	87.90
NW 3	7	100	59.45	53.27
NW 3	8	100	75.00	66.50
NW 4	1	90	89.44	74.22
NW 4	2	100	72.10	60.60
NW 4	3	90	73.89	62.00
NW 4	4	100	57.27	49.18
NW 4	5	100	86.40	73.00
NW 4	6	100	79.80	66.70
NW 4	7	100	78.78	65.67
NW 4	8	90	96.44	81.78
NW 5	1	90	91.44	76.89
NW 5	2	100	101.64	86.18
NW 5	3	90	108.22	91.56
NW 5	4	100	85.44	69.00
NW 5	5	100	87.00	71.10
NW 5	6	100	74.73	64.36
NW 5	7	100	63.82	54.64
NW 5	8	100	72.36	62.36

Appendix Table 2. Water temperatures (C) for 10 day C. tentans exposure for York Oil Sites, July 2000

Date	Day	time	rep	Sand	Form Sed	W. Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21-Jul-00	0	07:00	1	23	22.9	23	23.1	23	23	23.1	23	23.1	23.1	23.1
	0	07:00	2	23	23	23.1	23	23	23	23.1	23	23.1	23.1	23.1
	0	07:00	3	23	23	23.1	23	23	23	23	23.1	23.1	23.1	23.1
	0	07:00	4	23	23	23.1	23	23	23	23	23.1	23.1	23.1	23.1
	0	07:00	5	23	23	23.1	23	23	23	23	23.1	23.1	23.1	23.1
	0	07:00	6	23	23	23.1	23	23	23	23	23.1	23.2	23.1	23.1
	0	07:00	7	23	23	23.1	23	23	23	23	23.1	23.2	23.1	23.1
	0	07:00	8	23	23	23.1	23.1	23.1	23	23	23.1	23.2	23.1	23.1
	0	18:45	1	22.7	22.9	22.8	22.7	22.9	22.9	22.7	22.9	22.7	22.7	22.7
	0	18:45	4	22.8	22.8	23	22.7	22.9	22.9	22.7	22.9	22.7	22.7	22.6
22-Jul-00	1	07:50	4	22.4	22.4	22.4	22.4	22.4	22.3	22.3	22.4	22.6	22.6	22.6
	1	07:50	6	22.4	22.4	22.4	22.4	22.4	22.4	22.4	22.5	22.7	22.6	22.6
	1	16:30	4	23.1	23.1	23	23	23.1	22.9	23	23	23	23.1	23
	1	16:30	8	23.1	23.1	22.9	23	23.1	22.9	22.9	23	23	23	23
23-Jul-00	2	07:35	4	22.5	22.5	22.4	22.5	22.5	22.4	22.4	22.5	22.9	22.7	22.7
	2	07:35	5	22.5	22.5	22.4	22.5	22.5	22.4	22.4	22.5	22.9	22.9	22.9
	2	17:30	2	23.4	23.5	23.4	23.5	23.4	23.4	23.4	23.4	23.4	23.5	23.4
	2	17:30	4	23.6	23.5	23.4	23.4	23.4	23.3	23.4	23.4	23.4	23.5	23.4
24-Jul-00	3	06:50	4	23.1	23	23.1	23.1	23.1	23	23.1	23.1	23.1	23.1	23.1
	3	06:50	7	23.1	23	23	23	23.1	23	23	23.1	23	23	23
	3	15:15	3	22.4	23.2	23.1	23.1	23.2	23	23.1	23.2	23.2	23.2	23.1
	3	15:15	4	22.4	23.1	22.8	23.1	23.2	23	23.1	23.2	23.2	23.1	23.1
25-Jul-00	4	06:45	1	23	23	23	23	23	23	23	23.1	23	23	23.1
	4	06:45	4	23	23	23	23	23	23	23	23	23	23	23.1
	4	15:00	3	23.2	23	23.1	23	23.1	23.1	23	23.1	23	23.1	23.1
	4	15:00	4	23.1	23	23.1	23.1	23.1	23.1	23.1	23.1	23.2	23.2	23.1
26-Jul-00	5	06:45	4	23	22.9	23	23	23.1	23	23	23.1	22.7	22.7	22.8
	5	06:45	6	23	22.9	23	23	23.1	23	23	23.1	22.7	22.7	22.7
	5	16:00	4	23.6	23.2	23.1	23.4	23.2	23.4	23.4	23.6	23.4	23.3	23.2
	5	16:00	8	23.6	23.4	23.1	23.5	23.6	23.4	23.5	23.1	23.5	23.4	23.3
27-Jul-00	6	08:20	4	23.4	23.1	23.2	23.6	23.5	23.3	23.6	23.5	23.2	23.6	23.1
	6	08:20	5	23.5	23.2	23.2	23.6	23.6	23.5	23.6	23.6	23.2	23.1	23.4
	6	16:15	2	23	22.9	22.9	22.9	23	23	22.9	22.9	23.1	23	23
	6	16:15	3								22.1			
	6	16:15	4	23	22.9	23	22.9	22.8	23	22.9	22.8	23.1	23.1	22.9
	6	16:15	5		22.9						22.7			
	6	16:15	6		22.9						22.6			
	6	16:15	7		22.9						22.8			
	6	16:15	8		23						22.9			

Appendix Table 2 (continued). Water temperatures (C) for 10 day C. tentans exposure for York Oil Sites, July 2000

Date	Day	time	rep	Site D	Site A	Site B	Site F	Site G	Site C	Site E	Site H	Site K	Site I	Site J
28-Jul-00	7	08:15	1							23.1				
	7	08:15	3							23.1				
	7	08:15	4	23	22.9	22.9	23.1	23	23	22.9	23.1	23.5	23.5	23.1
	7	08:15	6							23				
	7	08:15	7	23.1	22.9	22.9	23.1	23	22.9	23	23.1	23.4	23.4	23.3
	7	16:00	1		22.8						22.9			
	7	16:00	2							23			22.7	
	7	16:00	3	22.9	22.8	22.8	22.9	22.9	22.9	22.9	22.8	22.6	22.6	22.9
	7	16:00	4	22.9	22.8	22.8	22.9	22.9	23	22.9	22.6	22.6	22.7	22.9
	7	16:00	6			22.8								
	7	16:00	7			22.8				22.9			22.7	
29-Jul-00	8	08:20	1							23.3	23.1		23	
	8	08:20	2								23.2		23.2	
	8	08:20	3											22.7
	8	08:20	4	23	22.9	23	23	23.1	22.9	23.1	23	22.8	23	22.7
	8	08:20	5										22.7	
	8	08:20	6	23	22.9	23	23	23	22.9	23	23	22.8	22.8	22.7
	8	08:20	7										22.7	
	8	08:20	8							23.2				
	8	15:45	1							23	23			22.6
	8	15:45	2		22.9									
	8	15:45	4	23	22.9	23	23	23.1	23.1	23.1	23	22.5	22.6	22.6
	8	15:45	5		22.9				23					22.6
	8	15:45	7							23				22.6
	8	15:45	8	22.9	22.9	23	23	23.1	23.2	23.1	23	22.6	22.6	22.6
30-Jul-00	9	08:35	1			23				23.1				
	9	08:35	2			23				23.1				22.7
	9	08:35	3											22.5
	9	08:35	4	22.9	22.9	22.9	23	22.9	22.9	23	22.9	22.6	22.7	22.6
	9	08:35	5			22.9								
	9	08:35	7	22.9	22.9	22.9	23	22.9	22.9	23	22.9	22.6	22.6	22.6
	9	16:30	1	23	22.9	22.9	23.1	23.2	23.1	23.2	23.1	23.1	23.2	23.1
	9	16:30	2				23.2		23.1	23.2			23.2	
	9	16:30	4	23.1	22.9	22.9	23.2	23.2	23.1	23.1	23.2	23.1	23.3	23.2
	9	16:30	6							23.2				
	9	16:30	7											23.1
31-Jul-00	10	07:00	1	22.7	22.7	22.7	22.6	22.6	22.6	22.7	22.6	22.7	22.7	22.7
	10	07:00	2	22.6	22.7	22.6	22.6	22.5	22.6	22.6	22.6	22.8	22.8	22.7
	10	07:00	3	22.6	22.6	22.6	22.6	22.6	22.6	22.7	22.5	22.7	22.9	22.7
	10	07:00	4	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.8	22.8	22.6
	10	07:00	5	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.7	22.9	22.7
	10	07:00	6	22.6	22.6	22.6	22.6	22.6	22.5	22.6	22.6	22.7	22.8	22.7
	10	07:00	7	22.6	22.7	22.6	22.6	22.6	22.6	22.6	22.6	22.8	22.9	22.7
	10	07:00	8	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.6	22.8	22.8	22.7
		average		**22.94**	**22.91**	**22.91**	**22.96**	**22.97**	**22.94**	**22.98**	**22.94**	**22.97**	**22.98**	**22.91**
		minimum		22.4	22.4	22.4	22.4	22.4	22.3	22.3	22.1	22.5	22.6	22.5
		maximum		23.6	23.5	23.4	23.6	23.6	23.5	23.6	23.6	23.5	23.6	23.4

Appendix Table 3. Dissolved Oxygen Levels (ppm) for 10 day C. tentans exposure for York Oil Sites, July 2000

Date	Day	time	rep	Sand	Form sed	W. Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21-July-00	0	07:00	1	7.3	7.5	6.1	7.1	6.9	7.2	5.1	7	6.7	6.1	5.7
	0		2	7.4	7.4	6	5.7	7.2	4.4	4.4	6	6.5	7	5.7
	0		3	7.3	7.5	6.2	7.1	6.2	4.4	3.9	7	5.9	6.1	5.2
	0		4	7.2	7.4	5.8	6.7	5.2	5.5	5.8	6	6.9	5	6.2
	0		5	7.2	7.3	6.1	7.3	7.2	4.6	6.5	6.7	6.3	7.1	5.3
	0		6	7.3	7.1	6	7.1	5.9	7	7	7.1	7.1	7	6.4
	0		7	7.2	7.2	6.4	5.6	7	4.1	5.8	5.4	7.3	6.8	5.8
	0		8	7.2	7	6.6	7.1	7.1	5.3	7	5.6	6.7	5.8	5.4
	0	18:45	1	7.3	7.1	6.6	7.3	6.7	6.8	6.1	6.8	7.1	7.1	5.9
	0		4	7.3	7	7.1	6.6	5.2	7.3	6.4	6.5	6.1	6.3	6.9
	0		7						6.7					
Daily average				7.27	7.25	6.29	6.76	6.46	5.75	5.8	6.41	6.66	6.43	5.85
22-July-00	1	07:50	4	7.2	7.4	6.5	7.1	5.3	7.1	6.8	5.2	7.1	6.7	7.1
	1		6	7.1	7.1	5.8	7.2	7	7.2	7	7	5.2	6.7	7.1
	1	16:30	4	6.6	5.7	7.1	6.8	4.1	6.5	6.3	3.9	5.2	6.3	6.1
	1		8	6.2	5.6	5.3	7.3	5.5	7.2	6.8	6.5	6.3	4.8	5.9
Daily average				6.78	6.45	6.18	7.10	5.48	7.00	6.73	5.65	5.95	6.13	6.55
23Jul-00	2	07:35	4	6.5	7.2	7	6.4	6.6	7	4.6	6.2	6.6	6.2	6.7
	2		5	6.1	7.3	6.9	6.9	5	7.1	4.3	7	6.9	6.8	7
	2	17:30	2	6.9	6.6	6.9	4.3	6.5	6.6	5.4	6.5	4	4.4	4.8
	2		4	5.3	5.3	6.8	5.9	6.3	6.9	4.7	6.6	3.2	6.4	4.8
Daily average				6.20	6.60	6.90	5.88	6.10	6.90	4.75	6.58	5.18	5.95	5.83
24-July-00	3	06:50 AM	4	5.3	5.5	6.1	5.9	6.1	6.3	6.2	6	2.6	5.8	5.4
	3		7	5.4	5.7	6.5	6.2	6.1	5.8	6	5.1	4.4	5.6	5.5
	3	08:00 AM	7									5.5		
	3	03:15 PM	3	6	5.1	4.9	3.8	5.2	3.7	3.3	5.3	5.8	6.1	4.1
	3		4	5.3	5.6	5	4.2	5.7	6.2	2.8	5.9	5.9	6.2	6.2
Daily average				5.50	5.48	5.63	5.03	5.78	5.50	4.58	5.58	4.84	5.93	5.30
25-July-00	4	06:45 AM	1	3.6	6.5	4.9	6.2	5.5	4.4	6.1	6.4	5	6.2	4
	4		4	4.9	4.6	5	6.1	5.5	4.3	6.4	6.3	5.1	6	5.4
	4	03:00 PM	1	3.2			5.5			6				
	4		3	4.3	6.4	6.3	5.6	6	2.3	4.1	4.3	3	5.9	3
	4		4	4.4	6.2	6.1	6	3.2	5.4	2.2	5.9	4.2	5.8	5.9
Daily average				4.08	5.93	5.58	5.88	5.05	4.10	4.96	5.73	4.33	5.98	4.58
26-July-00	5	06:45 AM	1	3.1										
	5		3						3.4					0.9
	5		4	3.3	6.8	6.4	5.5	3	6.1	3.9	3.1	5.1	6	6
	5		6	3.7	6.7	4.8	6.2	5.5	4.9	4.5	3.8	4	5.8	6.2
	5	10:30 AM	1	6.3										
	5		3						6.3					6.5
	5		4	5	6.6	5.5	5.5	5.4	5.1	6.3	6.1	4.6	6.6	6.6
	5		6			4.7		6		4	6.6	5.9	6.6	
	5	04:00 PM	1	5.6										
	5		3									4.2		6.8
	5		4	3.6	5.5	3.7	5.4	5.6	6.2	5.4	5.2	4.1	6.9	6.8
	5		8	5.8	5.4	7	6.9	4.7	6.9	4.3	6.9	6.6	6.3	5.4
Daily average				4.55	6.20	5.35	5.90	5.03	5.56	4.73	5.28	4.93	6.37	5.65
27-July-00	6	08:20 AM	1	3.5	3.4	6.1		6.9				3.1	5.7	6.7
	6		4	4.4	7.1	3.5	6.4	7	6.1	5.9	2.6	4.3	6.9	5.5
	6		5	4.4	6.1	7	6.8	6.1	7	6.3	6.7	5.1	7	7
	6	10:00 AM	1	6.3	4.8							4.6		
	6		4	6.5		6.1					4.9	5.1		
	6	04:15 PM	1	4.3	3.5						6.2			
	6		2	4.3	3.2	6.6	5.1	6.6	3.2	5.4	5.1	5.1	6.2	6.6
	6		3		5.4						3			
	6		4	5.1	5.8	5.9	5.3	6.3	5.4	4.3	2.3	4.3	6.3	6.5
	6		5		3.3						6.3			
	6		6		6.3						4.2			
	6		7		6						3.6			
	6		8		3.2						4.8			
Daily average				4.85	4.84	5.87	5.90	6.58	5.43	5.48	4.52	4.51	6.42	6.46

Appendix Table 3 (continued) Dissolved Oxygen Levels (ppm) for 10 day C. tentans exposure for York Oil Sites, Ju

Date	Day	time	rep	Sand	Form sed	W. Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
28-July-00	7	08:15 AM	1							6.1				
	7		3							6.5				
	7		4	3.9	4.5	6.3	6.3	3.5	3.7	6.8	4.4	5.3	6.3	6.4
	7		5							1.3				
	7		6							6.3				
	7		7	3.8	4.8	6.5	6.7	4.6	6.7	5.8	3.4	6.1	6.4	3.9
	7	04:00 PM	1		5.4						4.1			
	7		2							3			3	
	7		3	6.7	6.7	3.7	6.5	5	4	2.6	4.9	5.2	3.3	6.5
	7		4	6.5	3.8	6.8	4.5	4.5	6.4	3	3	6.1	3	8
	7		6			3.9								
	7		7			3.1				4.7			3.7	
Daily average				5.23	5.04	5.02	6.00	4.40	5.20	4.61	3.96	5.67	4.28	5.70
29-July-00	8	08:20 AM	1		4.1				3.1	5.7	2.7		5.3	
	8		2								1.5			
	8		3											5
	8		4	6.2	3.4	5	5.2	2.3	5.6	1.8	3.8	5.7	2.2	6.1
	8		5										6.5	
	8		6	6.9	6.7	4.5	3.8	4	5.9	6.5	2.2	3.8	6	5.3
	8		7										6.6	
	8		8							6.3				
	8	10:00 AM	2								2.6			
	8		4	6.3	3.8	6.5	4.6	6.5	3.4	3.9			3.6	
	8		6								4.7			
	8	01:45 PM	1							5.7	5.1			6.8
	8		2		6									
	8		4	6.4	3.4	6.5	5.6	5.1	3.4	3.7	3.5	4.8	4.1	5.7
	8		5		6.6				5.5					6.6
	8		7							1.8				2.4
	8		8	6.4	2.7	4.7	6.4	4.5	6	2.1	4.5	6.5	5.9	3
Daily average				6.44	4.59	5.44	5.12	4.48	4.70	4.17	3.40	5.20	5.03	5.11
30-July-00	9	08:35 AM	1			3.6				2.4				
	9		2			6.7				1.5				6.6
	9		3											5.7
	9		4	6.6	4.4	6.7	3.9	5.8	4.3	2.4	4.3	4.5	6.5	5.2
	9		5			3.4								
	9		7	6.6	4.1	2.7	4.2	6.7	5.3	5.2	4.5	4.5	5.4	1.9
	9	12:00 PM	1							6.3				
	9		2							4.3				
	9		4				3.6			4				
	9		7		3.2									2.4
	9	04:30 PM	1	6.3	4.2	4.5	6	6.3	4	4.9	6.2	5.3	6.5	6.5
	9		2				3.8		5.2	3.7			6.4	
	9		4	4.7	4.4	6.8	4.5	6.4	5.2	3.6	6.4	6.5	6.4	6.5
	9		6							6.2				
	9		7											6.4
Daily average				6.05	4.06	4.91	4.33	6.30	4.80	4.05	5.35	5.20	6.24	5.15
31-July-00	10	07:00 AM	1	7	3.9	5.9	6.6	6.2	1.4	4.6	5.1	4.4	6.5	6.4
	10		2	6.7	5.7	6.6	3.9	6.4	4.1	2.7	2.7	4.3	6.5	6.5
	10		3	6.8	2.7	5.8	6.4	5.9	2.6	5.9	5.7	4	5.5	4.9
	10		4	6.5	4.2	6.6	4.6	6.3	4.4	1.8	4.7	4.2	6.3	6.5
	10		5	6.6	2.5	6.5	5.1	4.7	5.2	3.8	4.9	5.2	6.4	6.3
	10		6	6.9	2.7	4.3	4.6	6.2	6.3	5	2.4	3.6	6.5	2.7
	10		7	6.8	3.9	4.8	5.7	6.4	6	5.7	2.8	5.7	5.9	6.2
	10		8	6.8	3.5	5.5	5.6	5.7	6.3	4.8	2	5.5	5.2	2.1
Daily average				6.76	3.64	5.75	5.31	5.98	4.54	4.29	3.79	4.61	6.10	5.20
Individual values		average		5.84	5.37	5.70	5.77	5.69	5.35	4.80	4.95	5.24	5.88	5.54
		minimum		3.1	2.5	2.7	3.6	2.3	1.4	1.3	1.5	2.6	2.2	0.9
		maximum		7.4	7.5	7.1	7.3	7.2	7.3	7	7.1	7.3	7.1	7.1
Daily values		grand average		5.79	5.46	5.72	5.75	5.60	5.41	4.92	5.11	5.19	5.89	5.58
		minimum		4.08	3.64	4.91	4.33	4.40	4.10	4.05	3.40	4.33	4.28	4.58
		maximum		7.27	7.25	6.90	7.10	6.58	7.00	6.73	6.58	6.66	6.43	6.55

Appendix Table 4. Water quality parameters for 10 day C. tentans for York Oil Sites, July 2000
(pH, Conductivity, Ammonia, Hardness, and Alkalinity)

PH

Date	Day	time	rep	Sand	Form Sed	W Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21-July-00	0	07:00	1	7.85	7.72	7.48	7.88	7.69	7.92	7.28	7.78	7.84	7.34	7.33
	0	07:00	4	8	7.05	7.45	7.56	7.3	7.82	7.42	7.36	7.89	7.37	7.63
	0	07:00	5	8.05	7.6	7.4	7.82	7.55	7.28	7.48	7.31	7.76	7.8	7.3
	0	07:00	8	8.06	7.01	7.43	7.85	7.64	6.9	7.92	7.2	7.84	7.32	7.48
31-July-00	1	07:00	1	7.66	6.81	7.78	7.69	7.56	6.93	7.61	7.49	7.69	7.71	7.74
	1	07:00	4	7.75	6.91	7.84	7.29	7.73	7.32	7.21	7.35	7.62	7.76	7.85
	1	07:00	5	7.81	6.63	7.86	7.56	7.43	7.37	7.24	7.48	7.68	7.81	7.87
	1	07:00	8	7.87	6.68	7.59	7.6	7.54	7.58	7.39	7.03	7.69	7.7	7.28
		minimum		7.66	6.63	7.4	7.29	7.3	6.9	7.21	7.03	7.62	7.32	7.28
		maximum		8.06	7.72	7.86	7.88	7.73	7.92	7.92	7.78	7.89	7.81	7.87

Conductivity (umho/cm)

Date	Day	time	rep	Sand	Form Sed	W Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21-July-00	0	07:00	1	108	111	107	109	117	103	136	110	117	116	118
	0	07:00	8	109	116	107	111	115	105	126	119	119	115	116
31-July-00	10	07:00	1	117	128	115	110	117	116	113	116	135	116	124
	10	07:00	8	116	135	115	110	118	117	114	113	134	117	138
		average		112.5	122.5	111.0	110.0	116.8	110.3	122.3	114.5	126.3	116.0	124.0

Ammonia (mg/L)

Date	Day	time	rep	Sand	Form Sed	W Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21-July-00	0	07:00	1	<.063	0.094	0.117	0.352	0.435	0.132	1.17	0.343	0.392	0.546	0.927
	0	07:00	8	<0.63	<.063	0.12	0.316	0.426	0.214	0.634	0.498	0.414	0.343	0.887
31-July-00	10	07:00	1	0.573	<0.63	0.506	0.729	0.435	0.975	0.279	1.164	0.942	0.084	1.137
	10	07:00	8	0.521	<0.63	0.634	0.697	0.426	0.587	0.208	1.459	0.97	0.078	1.914
		average		0.274	0.024	0.344	0.524	0.431	0.477	0.573	0.866	0.680	0.263	1.216

Hardness (mg/L CaCO3)

Date	Day	time	rep	Sand	Form Sed	W Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21-July-00	0	07:00	3	48	41.2	44.8	60.4	64.4		64	59.6	57.6	53.6	69.2
31-July-00	10	07:00	3	48.4	54.4	48.4	46.8	51.2	49.2	48	49.6	55.6	50.8	53.2
	10	07:00	5	49.6	54.4	48.6	44.8	44.8	48.4	48.8	48	56.4	49.6	52.4
		average		48.7	50.0	47.3	50.7	53.5	48.8	53.6	52.4	56.5	51.3	58.3

Alkalinity (mg/L CaCO3)

Date	Day	time	rep	Sand	Form Sed	W Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21-July-00	0	07:00	2	43.6	35.6	52.4	46.4	48.4	41.6	79.6	44.8	51.6	48.4	55.6
31-July-00	10	07:00	2	47.2	50	51.6	44.4	46.4	50.4	49.6	51.2	56	44.8	54.8
	10	07:00	6	46.4	54.9	48.8	44.4	45.2	45.2	44.4	46.8	56.8	45.6	54.8
		average		45.7	46.8	50.9	45.1	46.7	45.7	57.9	47.6	54.8	46.3	55.1

Appendix Table 5. Survival and growth of Hyalella azteca in a 28 day test with sediments from the Northwest Wetlands site, August 2000

Site/sediment	Rep	Percent survival	Dry Weight mg/animal	Site/sediment	Rep	Percent survival	Dry Weight mg/animal
Sand	1	100	0.641	NW 1	1	50	0.646
Sand	2	100	0.403	NW 1	2	100	0.590
Sand	3	90	0.343	NW 1	3	90	0.501
Sand	4	100	0.308	NW 1	4	90	0.547
Sand	5	100	0.321	NW 1	5	100	0.504
Sand	6	100	0.348	NW 1	6	80	0.640
Sand	7	90	0.416	NW 1	7	90	0.534
Sand	8	100	0.354	NW 1	8	100	0.533
Formulated	1	90	0.580	NW 2	1	100	0.396
Formulated	2	80	0.563	NW 2	2	90	0.398
Formulated	3	100	0.414	NW 2	3	90	0.392
Formulated	4	90	0.484	NW 2	4	90	0.394
Formulated	5	80	0.588	NW 2	5	100	0.343
Formulated	6	100	0.491	NW 2	6	100	0.360
Formulated	7	80	0.553	NW 2	7	90	0.396
Formulated	8	100	0.496	NW 2	8	90	0.460
W. Bearskin	1	90	0.358	NW 3	1	100	0.428
W. Bearskin	2	80	0.371	NW 3	2	90	0.447
W. Bearskin	3	80	0.344	NW 3	3	100	0.511
W. Bearskin	4	100	0.329	NW 3	4	100	0.453
W. Bearskin	5	70	0.343	NW 3	5	100	0.428
W. Bearskin	6	100	0.366	NW 3	6	90	0.419
W. Bearskin	7	100	0.335	NW 3	7	80	0.401
W. Bearskin	8	100	0.358	NW 3	8	100	0.344
Ref 1	1	60	0.370	NW 4	1	100	0.599
Ref 1	2	90	0.291	NW 4	2	90	0.510
Ref 1	3	80	0.431	NW 4	3	90	0.501
Ref 1	4	40	0.420	NW 4	4	100	0.491
Ref 1	5	80	0.301	NW 4	5	80	0.503
Ref 1	6	80	0.279	NW 4	6	90	0.521
Ref 1	7	50	0.390	NW 4	7	100	0.443
Ref 1	8	70	0.293	NW 4	8	90	0.497
Ref 2	1	80	0.290	NW 5	1	20	0.450
Ref 2	2	80	0.278	NW 5	2	20	0.450
Ref 2	3	80	0.299	NW 5	3	0	0.000
Ref 2	4	80	0.266	NW 5	4	30	0.397
Ref 2	5	80	0.283	NW 5	5	0	0.000
Ref 2	6	80	0.356	NW 5	6	20	0.170
Ref 2	7	100	0.306	NW 5	7	20	0.505
Ref 2	8	70	0.353	NW 5	8	10	0.180
Ref 3	1	80	0.456				
Ref 3	2	50	0.488				
Ref 3	3	80	0.406				
Ref 3	4	60	0.440				
Ref 3	5	60	0.450				
Ref 3	6	80	0.465				
Ref 3	7	60	0.445				
Ref 3	8	70	0.372				

Appendix Table 6. Water temperatures (C) for 28 day H. azteca exposure for York Oil Sites, August 2000

Date	Day	time	rep	Sand	Form Sed	W. Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21-Aug-00	0	06:45 AM	1	22.3	22.3	22.3	22.2	22.3	22.4	22.4	22.6	22.7	22.6	22.6
	0	06:45 AM	2	22.3	22.3	22.3	22.2	22.2	22.3	22.3	22.6	22.7	22.6	22.7
	0	06:45 AM	3	22.3	22.3	22.3	22.2	22.2	22.3	22.3	22.6	22.7	22.6	22.7
	0	06:45 AM	4	22.3	22.3	22.3	22.2	22.2	22.3	22.3	22.6	22.7	22.6	22.7
	0	06:45 AM	5	22.3	22.3	22.3	22.2	22.2	22.4	22.3	22.6	22.7	22.6	22.6
	0	06:45 AM	6	22.3	22.3	22.3	22.2	22.2	22.4	22.3	22.6	22.7	22.6	22.6
	0	06:45 AM	7	22.3	22.3	22.3	22.2	22.2	22.4	22.3	22.6	22.7	22.6	22.7
	0	06:45 AM	8	22.3	22.3	22.3	22.2	22.2	22.4	22.3	22.6	22.7	22.6	22.7
	0	03:30 PM	1	23.4	23.3	23.4	23.3	23.4	23.4	23.5	24.1	24	24	24
	0	03:30 PM	4	23.4	23.4	23.4	23.3	23.4	23.4	23.5	24.1	24	24	24
22-Aug-00	1	09:30 AM	4	22.8	22.7	22.7	22.7	22.7	22.8	22.8	23.5	23.3	23.4	23.3
	1	09:30 AM	6	22.8	22.7	22.8	22.7	22.7	22.8	22.8	23.4	23.3	23.4	23.3
	1	03:40 PM	4	23.2	23.2	23.1	23.2	23.2	23.1	23.2	23.1	23.1	23.1	23.1
	1	03:40 PM	8	23.2	23.2	23.1	23.2	23.2	23.1	23.3	23.1	23.1	23.1	23.1
23-Aug-00	2	09:15 AM	1			22.9								
	2	09:15 AM	4	22.9	22.8	22.9	22.8	22.9	22.9	22.9	22.9	23	22.9	22.9
	2	09:15 AM	5	22.9	22.8	22.9	22.9	22.8	22.9	22.9	22.9	23	22.9	23
	2	03:30 PM	2	23.4	23.4	23.4	23.4	23.4	23.4	23.5	23.2	23.2	23.1	23.1
	2	03:30 PM	4	23.4	23.4	23.4	23.4	23.4	23.4	23.4	23.2	23.2	23.1	23.2
24-Aug-00	3	09:15 AM	4	23.2	23	23.1	23.3	23	23.1	23.1	22.9	23	22.9	22.9
	3	09:15 AM	7	23.1	23.1	23.1	23	23.1	23.1	23.2	23	23	22.9	22.9
	3	03:45 PM	3	23.3	23.3	23.3	23.3	23.3	23.3	23.4	23.2	23.2	23.1	23.1
	3	03:45 PM	4	23.3	23.3	23.3	23.3	23.3	23.3	23.4	23.2	23.2	23.2	23.1
25-Aug-00	4	08:30 AM	1	23.4	23.4	23.4	23.4	23.2	23.4	23.4	23.2	23.2	23.1	23.1
	4	08:30 AM	4	23.4	23.4	23.4	23.2	23.2	23.4	23.4	23.1	23.1	23.1	23.1
	4	03:30 PM	3	23.2	23.2	23.2	23.2	23.2	23.2	23.2	22.9	23.1	22.9	22.9
	4	03:30 PM	4	23.2	23.2	23.2	23.2	23.2	23.2	23.2	22.9	23.1	22.9	22.9
26-Aug-00	5	08:00 AM	4	23.1	23.1	23.1	23	23	23.1	23.2	22.9	22.9	22.9	22.9
	5	08:00 AM	6	23.1	23.1	23.1	23	23	23.1	23.2	22.9	22.9	22.9	22.9
	5	04:45 PM	4	23.2	23.2	23.2	23.2	23.2	23.1	23.2	23.1	22.9	22.9	22.9
	5	04:45 PM	8	23.2	23.2	23.2	23.2	23.2	23.1	23.2	23.1	23	22.9	22.9
27-Aug-00	6	09:20 AM	4	23.1	23.1	23	22.9	22.9	22.9	23.1	22.9	22.9	22.9	22.9
	6	09:20 AM	5	23	23	23	22.9	22.9	22.9	23.1	22.9	22,9	22.9	22.9
	6	05:20 PM	2	23.2	23.2	23.2	23.2	23.2	23.1	23.2	23.1	22.9	22.9	22.9
	6	05:20 PM	4	23.2	23.1	23.2	23.2	23.2	23.1	23.2	23.1	22.9	22.9	22.9
28-Aug-00	7	09:00 AM	4	23.1	23.1	23.1	23	23.1	23.1	23.1	22.9	22.9	22.9	22.9
	7	09:00 AM	7	23.1	23.1	23.1	23	23.1	23.1	23.1	22.9	22.9	22.9	22.9
	7	03:15 PM	3	23.1	23	23.1	23.1	23.1	23	23.1	22.9	22.8	22.8	22.8
	7	03:15 PM	4	23.1	23.1	23.1	23.1	23.1	23	23.1	22.9	22.8	22.8	22.8
29-Aug-00	8	08:45 AM	4	22.4	22.4	22.4	22.5	22.3	22.3	22.4	22.8	22.8	22.7	22.7
	8	08:45 AM	6	22.4	22.4	22.4	22.3	22.3	22.4		22.8	22.8	22.7	22.7
	8	08:45 AM	8							22.5				
	8	03:30 PM	4	22.9	22.8	22.8	22.8	22.8	22.8	22.9	22.9	22.9	22.9	22.9
	8	03:30 PM	8	22.9	22.8	22.8	22.8	22.8	22.8	22.9	22.9	22.9	23	22.9
30-Aug-00	9	09:00 AM	4	22.9	22.9	22.9	22.9	22.8	22.8	22.9	22.9	22.9	22.9	22.8
	9	09:00 AM	7	22.9	22.8	22.9	22.9	22.8	22.8	22.8	22.9	22.9	22.9	22.8
	9	03:30 PM	1	22.4	22.4	22.4				22.5	22.4	22.5		22.4
	9	03:30 PM	2				22.5	22.3	22.4				22.4	
	9	03:30 PM	4	22.4	22.4	22.4	22.5	22.4	22.4	22.5	22.4	22.5	22.4	22.4
31-Aug-00	10	08:30 AM	4	23.2	23.1	23.2	23.2	23.1	23.1	23.1	23.1	22.9	23.2	22.9
	10	08:30 AM	5	23.2	23.2	23.2	23	23.1	23.1	23.1	23.1	22.9	23.2	22.9
	10	03:30 PM	2	23.3	23.2	23.2	23.3	23.2	23.2	23.3	23.3	23.2	23.4	23.2
	10	03:30 PM	4	23.3	23.3	23.2	23.3	23.2	23.2	23.3	23.3	23.2	23.4	23.2
01-Sept-00	11	08:30 AM	4	22.6	22.6	22.6	22.4	22.4	22.6	22.2	22.6	22.7	22.7	22.7
	11	08:30 AM	7	22.6	22.5	22.6	22.5	22.6	22.6	22.6	22.7	22.7	22.7	22.5
	11	03:50 PM	3	22.9	22.9	22.9	22.8	22.8	22.9	22.9	23.2	23.3	23.2	23.2
	11	03:50 PM	4	22.9	22.9	22.9	22.8	22.8	22.9	22.9	23.2	23.3	23.3	23.2

Appendix Table 6 (continued). Water temperatures (C) for 28 day H. azteca exposure for York Oil Sites, August 2000

Date	Day	time	rep	Sand	Form Sed	W. Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
02-Sept-00	12	08:30 AM	1	22.8	22.6	22.8	22.6	22.8	22.7	22.8	22.1	22.1	22.1	22.1
	12	08:30 AM	4	22.8	22.7	22.8	22.6	22.7	22.8	22.8	22.1	22.2	22.1	22.1
	12	04:55 PM	4	23	22.9	23	22.8	22.8	22.9	23	22.7	22.8	22.8	22.8
	12	04:55 PM	5	23.1	22.9	23	22.8	22.8	22.9	23	22.8	22.8	22.8	22.8
03-Sept-00	13	09:30 AM	4	22.9	22.8	22.8	22.7	22.7	22.8	22.8	22.7	22.8	22.7	22.7
	13	09:30 AM	6	22.9	22.8	22.8	22.7	22.7	22.8	22.9	22.7	22.8	22.7	22.7
	13	03:55 PM	4	23.1	23	23.1	22.8	22.9	23	23.1	22.9	22.9	22.9	22.9
	13	03:55 PM	8	23.1	23	23.1	22.8	22.9	23	23.1	22.9	22.9	22.9	22.9
04-Sept-00	14	08:30 AM	1							22.4				
	14	08:30 AM	4	22.5	22.4	22.4	22.2	22.2	22.4	22.4	22.6	22.7	22.7	22.6
	14	08:30 AM	5	22.4	22.4	22.4	22.2	22.2	22.4	22.4	22.6	22.7	22.6	22.6
	14	04:00 PM	2	23.1	23.1	23.1	22.9	22.9	23.1	23.1	22.9	23.1	22.9	22.9
	14	04:00 PM	4	23.2	23.1	23.1	22.9	23	23.1	23.1	22.9	23.1	22.9	22.9
05-Sept-00	15	08:40 AM	4	22.8	22.6	22.7	22.6	22.5	22.7	22.7	22.6	22.7	22.6	22.7
	15	08:40 AM	7	22.8	22.6	22.7	22.6	22.5	22.7	22.7	22.6	22.8	22.6	22.7
	15	03:30 PM	3	23.2	23.1	23.1	22.9	22.9	23	23.2	23.1	23.2	23.1	23
	15	03:30 PM	4	23.2	23.1	23.1	22.9	23	23.1	23.2	23.1	23.2	23.1	23.1
06-Sept-00	16	08:35 AM	1	23.2	23.1	23.1	22.9	22.8	22.9	23.1	22.9	23	22.9	22.9
	16	08:35 AM	4	23.2	23.1	23.1	22.9	22.9	23	23.1	22.9	23	22.9	22.9
	16	03:00 PM	4	23.2	23.1	23.2	23.1	23.1	22.9	23.3	23	23	23	22.9
	16	03:00 PM	8	23.3	22.9	22.9	22.8	23.1	23	23.3	22.9	22.9	22.9	22.9
07-Sept-00	17	08:50 AM	4	23.2	23.1	23.1	23	22.9	23.1	23.3	22.9	23	22.9	22.9
	17	08:50 AM	6	23.2	23.1	23.1	22.9	22.9	23.1	23.2	22.9	23	22.9	22.9
	17	03:00 PM	4	23.3	23.2	23.3	23.1	23.2	23.2	23.3	23.1	23.2	23.2	23.2
	17	03:00 PM	8	23.3	23.2	23.3	23.1	23.2	23.2	23.3	23.2	23.2	23.2	23.2
08-Sept-00	18	09:00 AM	4	23.2	23	23.1	22.7	22.8	23.1	23.1	22.9	23	22.9	22.9
	18	09:00 AM	5	23.2	23	23.1	22.7	22.9	23.1	23.1	22.9	22.9	22.9	22.9
	18	03:30 PM	2	23.2	23.3	23.2	23.1	23	23.2	23.3	23	23	23	23
	18	03:30 PM	4	23.3	23.2	23.2	23	22.9	23.2	23.3	23	23	23	23
09-Sept-00	19	09:15 AM	4	23.4	23.4	23.4	23.3	23.4	23.4	23.4	24.1	24.3	24.2	24.2
	19	09:15 AM	7	23.4	23.4	23.4	23.3	23.4	23.4	23.4	24.2	24.3	24.2	24.2
	19	04:50 PM	3	23.4	23.5	23.5	23.2	23.3	23.4	23.3	23.4	23.3	23.3	23.3
	19	04:50 PM	4	23.4	23.5	23.5	23.2	23.3	23.4	23.3	23.4	23.3	23.3	23.3
10-Sept-00	20	09:30 AM	1	23.5	23.5	23.5	23.4	23.4	23.5	23.5	23.4	23.4	23.5	23.4
	20	09:30 AM	4	23.5	23.5	23.5	23.4	23.4	23.5	23.4	23.5	23.5	23.5	23.4
	20	05:00 PM	2	22.8	22.8	22.8	22.6	22.8	22.7	22.8	22.8	22.8	22.8	22.8
	20	05:00 PM	4	22.8	22.8	22.8	22.6	22.8	22.7	22.8	22.8	22.7	22.8	22.7
11-Sept-00	21	08:30 AM	4	23	22.9	23	22.9	23	23	23	23.4	23.2	23.3	23.2
	21	08:30 AM	6	23	23	23	22.9	23	23	23	23.3	23.2	23.2	23.1
	21	03:35 PM	4	22.9	22.8	22.9	22.9	22.9	22.9	22.9	22.9	22.9	22.9	22.8
	21	03:35 PM	8	22.9	22.8	22.9	22.9	22.8	22.9	22.9	22.9	22.9	22.9	22.9
12-Sept-00	22	08:20 AM	4	22.8	22.8	22.8	22.5	22.6	22.8	22.8	22.7	22.7	22.7	22.7
	22	08:20 AM	5	22.8	22.8	22.8	22.5	22.6	22.8	22.8	22.7	22.7	22.7	22.7
	22	03:15 PM	2	22.8	22.7	22.8	22.7	22.7	22.7	22.7	22.7	22.7	22.6	22.6
	22	03:15 PM	4	22.8	22.8	22.8	22.7	22.7	22.7	22.7	22.7	22.7	22.6	22.7
13-Sept-00	23	08:30 AM	4	22.8	22.9	22.9	22.7	22.8	22.8	22.9	22.7	22.7	22.7	22.7
	23	08:30 AM	7	22.9	22.9	22.9	22.7	22.7	22.9	22.9	22.7	22.8	22.7	22.7
	23	03:05 PM	3	22.9	22.9	22.9	22.8	22.8	22.9	22.9	22.8	22.8	22.8	22.8
	23	03:05 PM	4	22.9	22.9	22.9	22.8	22.8	22.9	22.9	22.8	22.8	22.8	22.8
14-Sept-00	24	08:35 AM	1	22.9	22.7	22.9	22.7	22.9	22.9	22.9	22.8	22.8	22.8	22.8
	24	08:35 AM	4	22.9	22.9	22.9	22.7	22.8	22.9	22.9	22.8	22.8	22.8	22.8
	24	03:15 PM	4	22.7	22.8	22.7	22.8	22.7	22.7	22.8	22.8	22.7	22.7	22.7
	24	03:15 PM	6	22.7	22.8	22.7	22.7	22.7	22.7	22.8	22.7	22.8	22.7	22.8

Appendix Table 6 (continued). Water temperatures (C) for 28 day H. azteca exposure for York Oil Sites, August 2000

Date	Day	time	rep	Sand	Form Sed	W. Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
15-Sept-00	25	09:00 AM	4	22.7	22.7	22.7	22.4	22.5	22.7	22.8	22	22	21.9	22
	25	09:00 AM	6	22.8	22.7	22.7	22.4	22.3	22.7	22.7	21.9	22	22	22
	25	03:15 PM	4	22.9	23	22.9	22.9	22.9	22.9	22.9	22.4	22.2	22.4	22.4
	25	03:15 PM	8	23	23	22.9	22.9	22.7	22.9	22.9	22.4	22.3	22.4	22.3
16-Sept-00	26	08:40 AM	4	22.8	22.7	22.8	22.4	22.5	22.7	22.8	22.5	22.6	22.5	22.6
	26	08:40 AM	5	22.8	22.8	22.8	22.5	22.4	22.7	22.7	22.6	22.6	22.5	22.6
	26	04:05 PM	2	23	23	23	22.9	22.9	23	23	22.2	22.2	22.2	22.2
	26	04:05 PM	4	23	23	23	22.9	22.9	23	23	22.2	22.2	22.1	22.2
17-Sept-00	27	09:00 AM	4	22.9	22.9	22.9	22.5	22.7	22.6	22.8	22.7	22.6	22.7	22.8
	27	09:00 AM	7	22.9	22.9	22.9	22.6	22.6	22.9	22.9	22.7	22.7	22.6	22.8
	27	03:30 PM	3	23.1	23.1	23.1	22.9	23	23	23.1	23.2	23.2	23.2	23.2
	27	03:30 PM	4	23.1	23.1	23.1	22.9	23	23	23.1	23.2	23.2	23.2	23.2
18-Sept-00	28	06:00 AM	1	23	23	23	22.8	22.8	23	22.9	22	22	22	22
	28	06:00 AM	2	23	23	23	22.8	22.8	23	22.9	22	22	22	22
	28	06:00 AM	3	23	23	23	22.8	22.8	23	22.9	22	22	22	22
	28	06:00 AM	4	23	23	23	22.8	22.8	23	22.9	22	22	22	22
	28	06:00 AM	5	23	23	23	22.8	22.8	23	22.9	22	22	21.9	22
	28	06:00 AM	6	23	23	23	22.8	22.8	23	22.9	22	22	22	22
	28	06:00 AM	7	23	23	23	22.8	22.8	23	22.9	22	22	21.9	22
	28	06:00 AM	8	23	23	23	22.8	22.8	23	22.9	22	22	21.9	22
		average		22.80	22.80	22.80	22.70	22.70	22.70	22.80	22.70	22.70	22.70	22.60
		minimum		22.3	22.3	22.3	22.2	22.2	22.3	22.2	21.9	22	21.9	22
		maximum		23.5	23.5	23.5	23.4	23.4	23.5	23.5	24.2	24.3	24.2	24.2

Appendix Table 7. Dissolved Oxygen (ppm) for 28d 10 day *H. azteca* exposure for York Oil Sites, August 2000

Date	Day	time	rep	Sand	Form Sed	W Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21-Aug-00	0	06:45 AM	1	7.6	7.8	7.6	7.6	5.1	3.8	5.5	7.5	6.3	7.4	5.6
	0		2	7.7	7.8	6.9	7.7	7.6	3	6.2	7.1	7.3	7.5	5.6
	0		3	7.7	7.6	7.7	7.3	4.4	3.9	6	5.8	7.5	7.3	6.4
	0		4	7.7	7.4	7.7	7.2	4.2	4.3	7.6	6.4	7.5	7.6	6
	0		5	7.8	7.4	7.5	7.2	5.8	3.9	6.2	7.6	6.9	6.9	5.2
	0		6	7.7	7.7	6.7	7.5	4.7	2.4	6.1	7.4	7.2	7.4	5.3
	0		7	7.7	7.7	6.6	7.5	6.4	6.9	6.1	7.6	7.6	7.4	6.6
	0		8	7.6	7.7	6.8	7.7	6.4	5.2	5.3	7.5	7.6	6.2	5
	0	03:30 PM	1	7.4	7.3	7.4	7	4	6.1	7.1	6.3	6	7	5.2
	0		4	7.4	7	7.3	5.3	7.3	7.2	7.1	6.9	6.5	7.1	6.5
22-Aug-00	1	09:30 AM	4	6.9	6.8	6.8	6.8	6.9	6.7	6.8	6.8	6.1	6.2	4.2
	1		6	6.9	7	6.7	7	5.5	6.7	6.9	6.3	6.3	6.4	4.2
	1	03:40 PM	4	6.7	6.3	6.3	6.7	6.6	6.4	6.6	6.4	6.3	6.5	5.1
	1		8	6.7	6.5	6.5	6.7	6.7	6.5	6.6	6.7	6.6	6.5	6.3
23-Aug-00	2	09:15 AM	2						5.3					
	2		4	6.6	6.4	6.5	6.5	6.6	5.8	6.5	6.6	6.2	6.5	5.3
	2		5	6.6	6	6.3	6.6	6.6	6.4	6.3	6.6	6.2	5.9	5.6
	2	03:30 PM	2	6.6	6.7	6.6	6.6	6.6	6.5	6.6	6.5	6.6	6.6	6.6
	2		4	6.7	6.6	6.5	6.6	6.7	5.9	6.6	6.1	5.9	6.6	4.9
24-Aug-00	3	09:15 AM	4	6.8	6.7	6.8	6.8	6.8	6.6	6.7	6.6	6.1	6.9	5.8
	3		7	6.8	6.1	6.8	6.8	6.7	6.7	6.6	6.7	6.7	6.7	6.6
	3	03:45 PM	3	6.6	6.7	6.3	6.6	6.4	5.9	6.3	6.2	5.3	5.8	6.5
	3		4	6.6	6.4	6.3	6.5	6.4	6.2	6.4	6.2	6.1	6.4	6.5
25-Aug-00	4	08:30 AM	1	6.7	5.9	6.7	6.6	6.3	4.7	6.5	6.6	6.7	5.9	6.2
	4		4	6.8	6.4	6.6	6.6	6.6	5.9	6.6	6.7	6.6	6	5.8
	4	03:30 PM	3	6.7	6.4	6.2	5.9	6.5	6.4	6.4	6.5	6	6.3	6.2
	4		4	6.7	6.1	6	6.4	6.6	6.4	6.5	6.4	6.5	6.3	6.6
26-Aug-00	5	08:00 AM	4	6.7	6.7	6.2	6.6	6.6	6.5	6.5	6.5	6.6	5.6	5.9
	5		6	6.6	6.6	5.6	6.6	5.9	6.5	5.9	6.6	6.3	6.3	5.5
	5	04:45 PM	4	6.7	5.6	6.2	6.1	6.4	5.9	6.5	6.5	6.3	6.5	5.2
	5		8	6.4	6.2	5.6	6.2	6.4	6.5	6	6.5	6.5	6.4	5.2
27-Aug-00	6	09:20 AM	4	6.7	6.8	6.6	6.7	6.6	6.4	6.5	6.6	6.4	6.2	5.8
	6		5	6.8	6.7	5.9	6.7	6.7	6.7	6.4	6.7	6.4	5.7	5.6
	6	05:20 PM	2	6.7	5.7	6	6.8	6.6	4.7	6.5	5.9	6.6	6.7	4.7
	6		4	6.8	6.1	6	6.7	6.7	5.8	6.6	5.7	5.9	6.6	5.8
28-Aug-00	7	09:00 AM	4	6.8	5.9	6.4	6.8	6.6	6	6.5	6	6.6	6	6
	7		7	6.8	5.6	6.7	6.8	6.7	6.3	6.6	6.3	6.7	6.1	6.6
	7	03:15 PM	3	6.8	6.3	6.5	6.1	6.6	4.7	5.9	6.1	5.9	6.6	6.6
	7		4	6.6	6.3	6.5	6.6	6.7	6	6.4	6.3	6.3	6.4	5.9
29-Aug-00	8	06:45 AM	4	7.1	6.8	7.1	6.9	6.9	7	6.9	6.6	6.8	6.7	6.8
	8		6	7.1	6.3	6.5	6.9	6.6	7.1		6.8	6.8	6.6	6.8
	8		8							6.8				
	8	03:30 PM	4	7.5	5.8	6.9	7.6	7.5	6.8	7.3	7.3	7.6	6.2	6.3
30-Aug-00	9	09:00 AM	4	7.5	6.6	7.1	7.1	7.3	6.8	7.1	7.3	7.2	7.1	7.1
	9		7	7.4	7	7.2	7.2	7.4	7.2	6.8	7.3	7.3	7.2	7.3
	9	03:30 PM	1	6.9	7.3	7.4				7.1	7.5	7.1		7.4
	9		2				7	6.5	7.3				7.4	
	9		4	7.4	7.2	6.8	7.4	7.3	7.4	6.5	7.3	7.4	7.3	7.5
31-Aug-00	10	08:30 AM	4	7.2	7.1	7.1	7	7.1	7	6.7	7.2	7.2	7	7
	10		5	7.1	6.4	6.4	7.1	7.1	7	4.3	7.3	7.2	6.2	7.1
	10	03:30 PM	2	6.9	5	6.8	6.7	6.9	6.8	5.9	7	7.2	6.8	7
	10		4	7.2	4.5	7.1	7.1	7	7	5.4	7	7.2	7	7.1
01-Sept-00	11	08:30 AM	4	7.6	6.1	7.4	7.3	7.4	7.3	6.3	7.2	7.9	6.8	6.9
	11		7	7.6	6.1	7.5	7.4	7.2	7.5	7.2	7.4	7	7	7.4
	11	03:50 PM	3	7.1	7	7.1	7.1	7.1	7.1	6.8	7	6.6	7.1	7.1
	11		4	7.3	7.1	7	7.2	7.1	7.1	6.8	7.1	6.9	7.1	6.2
02-Sept-00	12	08:30 AM	1	7.4	7.1	7.4	7.3	7.1	6.7	7.3	7.4	7.3	7.3	7.3
	12		4	7.3	6.8	7.3	7.3	7.3	7.3	7.1	7.3	7.2	7.3	7.1
	12	04:55 PM	4	7.3	5.4	6.8	7.1	7.1	7.1	6.8	7.1	7.1	6.4	6.8
	12		5	7.3	5.6	7.1	7.1	7.1	7.2	7	7.1	7.1	6.8	6.3

Appendix Table 7 (continued). Dissolved Oxygen (ppm) for 28d 10 day *H. azteca* exposure for York Oil Sites, August 2000

Date	Day	time	rep	Sand	Form Sed	W Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
03-Sept-00	13	09:30 AM	4	7.1	6.5	7.2	7.2	7.1	7.1	6.9	7.2	6.9	7.3	7.2
	13		6	7.1	6.6	7.1	7.3	7.2	7.1	7	7.2	7.1	7.2	6.7
	13	03:55 PM	4	7.4	6.2	7.2	7.2	7.3	7.2	7.2	7.3	7	7.2	7
	13		8	7.4	6.3	7.2	7.3	7.2	7.1	7.3	7.2	7.3	7.2	7.1
04-Sept-00	14	08:30 AM	1							7.3				
	14		4	7.5	6.6	7.4	7.4	7.4	7.4	7.3	7.3	7.1	7.2	7.3
	14		5	7.5	6.7	7.5	7.4	7.4	7.2	7.3	7.3	7.3	7.1	7.1
	14	04:00 PM	2	7.2	6.1	7.2	7.2	7.1	7.1	6.9	7	7.1	7.2	7
	14		4	7.3	6.3	7.2	7.3	7.2	7.2	7.1	7.2	7.1	7.2	7.2
05-Sept-00	15	08:40 AM	4	7.2	7.3	7.3	7.2	7.1	7.2	7.1	7.2	7	7.1	7.1
	15		7	7.2	7.1	7.3	7.1	7.1	7.1	7	7.1	7.1	7.1	7.1
	15	03:30 PM	3	7.3	6.7	7	7.1	7	7.1	7	7.1	6.9	7.1	7
	15		4	7.2	6.2	7.1	7.2	7.2	7.1	7	7.1	7	7.1	7.1
06-Sept-00	16	08:30 AM	1	7.2	6.6	7	7.1	7.1	6.9	7	7	7.1	6.9	6.8
	16		4	7.2	6.9	7.1	7.1	7	7.1	7.1	7	7	7	7.1
	16	03:00 PM	4	7.2	6.8	7	7.2	7	6.7	6.7	7	7	7.1	7
	16		8	7.3	6.9	6.9	7.2	7.1	7	6.8	7	7.1	7.1	7.1
07-Sept-00	17	08:50 AM	4	7.4	7.4	7.4	7.3	7.2	7.2	7.2	7.3	7.3	7.2	7.2
	17		6	7.3	7.2	7.2	7.1	7.2	7.2	7.2	7.3	7.3	7.3	7.2
	17	03:00 PM	4	7.4	7	7.4	7.4	7.5	7.4	7.5	7.4	7.2	7.1	6.6
	17		8	7.5	7.4	7.2	7.6	7.5	6.8	7.1	7.4	7.4	7.5	6.8
08-Sept-00	18	09:00 AM	4	7.2	7.2	7.1	7.3	7.3	6.1	7.2	7.1	7.1	7.1	7.2
	18		5	7.4	6.9	7.2	7.2	7.3	7.1	7.1	7.1	7.3	7.1	7.2
	18	03:30 PM	2	7.5	7.3	7.1	7.3	7.2	6.2	6.8	7.2	7.2	7.3	6.6
	18		4	7.6	6.4	7.3	7.3	7.3	7.2	6.4	7.1	7.2	7.1	6.2
09-Sept-00	19	09:15 AM	4	7.3	6.8	7.2	7.1	7.2	6.6	6.9	7	6.9	7	7
	19		7	7.3	7	7.3	7.2	6.5	7.2	7.2	7	7.1	7.1	7.1
	19	04:50 PM	3	6.7	6.4	6.7	6.8	6.6	6.6	6.7	6.7	6.6	6.8	6.8
	19		4	6.9	6.4	6.7	6.9	6.6	6.6	6.8	6.8	6.7	6.7	6.7
10-Sept-00	20	09:30 AM	1	7.1	6.8	6.8	6.8	6.5	6.4	6.6	6.6	6.8	6.8	6.6
	20		4	7	6.8	6.8	6.7	6.7	6.8	6.7	6.9	6.8	6.8	6.7
	20	05:00 PM	2	7.1	6.7	6.8	7	6.8	6.1	6.9	6.8	6.9	6.9	6.9
	20		4	7	6.7	6.9	7	6.9	6.6	6.8	6.9	7	6.8	6.9
11-Sept-00	21	08:30 AM	4	6.9	7.1	6.9	6.9	6.9	6.9	6.7	6.6	6.5	6.3	6.5
	21		6	7	7	6.8	6.8	6.8	6.8	6.8	6.6	6.5	6.6	6.4
	21	03:35 PM	4	7.5	7	7.1	7	7.1	6.9	7	7	7	7.2	7.1
	21		8	7.3	7.1	6.9	7.1	7	7	7	6.9	7.2	7	7.1
12-Sept-00	22	08:20 AM	4	6.9	6.8	6.9	6.9	6.7	6.9	6.7	6.8	6.9	7	7
	22		5	7	6.8	6.9	6.9	6.8	6.9	6.8	6.9	6.9	7	6.9
	22	03:15 PM	2	6.7	6.4	6.4	6.6	6.5	6.5	6.7	6.6	6.7	6.5	6.6
	22		4	6.7	6.2	6.3	6.6	6.6	6.5	6.3	6.5	6.6	6.7	6.6
13-Sept-00	23	08:30 AM	4	7.2	7	7.1	7	7	7	6.7	7	6.9	6.9	7.1
	23		7	7.2	7.1	7.1	7.1	6.9	7	6.8	6.8	6.8	7	7
	23	03:05 PM	3	7.2	7.1	7.1	7	6.9	6.6	6.9	6.2	6.9	6.8	6.8
	23		4	7.1	6.9	7	7.1	7	6.2	6.9	6	6.8	6.4	6.8
14-Sept-00	24	08:35 AM	1	7	6.7	6.8	7	6.6	6.7	6.8	6.8	6.6	6.9	6.8
	24		4	6.9	6.8	6.8	6.9	6.6	6.7	6.8	6.8	6.7	6.9	6.8
	24	03:15 PM	4	7.4	7.2	7.1	6.6	6.9	6.3	7	6.7	6.7	6.7	6.4
	24		6	7.4	7.1	6.9	6.7	6.9	7.1	6.9	6.9	6.8	6.9	6.4
15-Sept-00	25	09:00 AM	4	7	6.6	6.8	6.8	6.7	6.6	6.9	6.9	6.8	6.7	7
	25		6	6.9	6.7	6.9	6.9	6.7	6.8	6.9	6.9	6.9	7	7
	25	03:15 PM	4	7.2	7.2	7.2	7	7	6.9	7	6.9	6.9	6.9	6.9
	25		8	7.2	7	7.1	6.9	7	6.9	7	6.7	7	7.1	7
16-Sept-00	26	08:40 AM	4	7	6.9	6.9	6.7	6.7	6.5	6.6	6.6	6.8	6.7	6.7
	26		5	7	6.6	6.9	6.8	6.7	6.7	6.8	6.8	6.8	6.8	6.8
	26	04:05 PM	2	7.3	6.9	6.8	6.9	6.7	6.6	6.7	7	6.9	6.9	6.7
	26		4	7.1	6.7	6.9	6.9	7	6.7	6.9	6.7	6.8	7	6.9

Appendix Table 7 (continued). Dissolved Oxygen (ppm) for 28d 10 day H. azteca exposure for York Oil Sites, August 2000

Date	Day	time	rep	Sand	Form Sed	W Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
17-Sept-00	27	09:00 AM	4	7.3	7	7	7.2	7.1	6.9	7.2	6.8	7	7	6.8
	27		7	7.2	7.3	7.2	7.2	7.3	7.2	7.2	6.9	6.9	7.1	6.9
	27	03:30 PM	3	7	7	6.8	6.7	6.7	6.4	6.8	6.8	6.8	6.8	6.8
	27		4	7	6.7	6.9	6.8	6.8	6.6	6.8	6.8	6.8	6.7	6.7
18-Sept-00	28	06:00 AM	1	7.1	6.9	6.8	6.9	6.7	6.6	6.8	6.9	7	7	7
	28		2	7	6.8	6.8	6.8	6.7	6.6	6.7	6.9	7	7.1	7
	28		3	6.9	6.9	6.8	6.7	6.6	6.6	6.6	6.8	6.9	6.9	6.9
	28		4	7	6.9	6.9	6.8	6.7	6.6	6.7	6.9	6.8	6.9	6.8
	28		5	6.9	6.8	6.9	6.9	6.7	6.7	6.7	6.8	6.9	6.9	6.6
	28		6	7	6.6	7	6.9	6.6	6.7	6.7	6.9	7	7	6.8
	28		7	6.9	6.5	6.9	6.7	6.5	6.6	6.7	6.8	6.9	7	6.8
	28		8	7	6.6	6.8	6.7	6.6	6.5	6.7	6.9	6.9	7	6.7
			MEAN	7.11	6.70	6.88	6.95	6.77	6.52	6.72	6.85	6.84	6.83	6.55
			MIN	6.4	4.5	5.6	5.3	4	2.4	4.3	5.7	5.3	5.6	4.2
			MAX	7.8	7.8	7.7	7.7	7.6	7.5	7.6	7.6	7.9	7.6	7.5

Appendix Table 8. Measurements of pH for 28d *H. azteca* exposure for York Oil Sites, August 2000

Date	Day	time	rep	Sand	Form Sed	W.Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21-Aug-00	0	07:00 AM	1	7.91	7.73	7.98	7.8	7.49	7.11	7.38	7.91	7.69	7.88	7.59
	0		4	8.03	7.35	7.93	7.5	7.71	7.17	7.92	7.91	7.99	8	7.68
	0		5	8.05	7.32	7.79	7.48	7.7	7.19	7.58	7.94	8.02	7.96	7.44
	0		8	8.06	7.59	7.79	7.71	7.75	7.33	7.36	7.97	8.07	7.95	7.45
24-Aug-00	3	09:30 AM	4	7.68	7.49	7.54	7.59	7.77	7.58	7.66	7.77	7.14	7.72	7.79
	3		7	7.67	7.47	7.51	7.54	7.72	7.53	7.67	7.81	7.28	7.74	7.79
27-Aug-00	6	09:30 AM	4	8.03	7.96	7.99	7.97	8.02	8	7.94	8.03	8.04	7.92	8.06
	6		5	8.04	7.99	7.99	8	8.02	8	7.96	8.05	8.05	7.77	8.1
29-Aug-00	8	09:00 AM	4	6.8	7.75	7.93	7.93	8.01	7.89	6.8	7.95	7.99	8.04	8.06
	8		6	6.8	7.93	7.95	7.96	7.96	7.92		8.01	7.99	7.98	8.05
	8		8							6.8				
31-Aug-00	10	08:30 AM	4	7.88	7.83	7.8	6.8	7.9	7.83	7.82	7.99	7.96	7.74	7.88
	10		5	7.9	7.55	7.63	6.8	7.87	7.83	6.94	7.83	7.94	7.84	7.56
03-Sep-00	13	09:30 AM	4	8.01	7.81	7.83	7.99	8.02	7.93	7.92	8.02	8.03	8.01	8.01
	13		6	8.06	7.62	7.9	8.01	8.02	7.95	7.99	8.03	8.03	7.94	7.91
05-Sep-00	15	09:00 AM	4	7.53	7.31	7.43	7.48	7.56	7.48	7.52	7.55	7.53	7.56	7.56
	15		7	7.54	7.33	7.47	7.5	7.54	7.5	7.39	7.56	7.56	7.53	7.55
07-Sep-00	17	09:00 AM	4	7.71	7.42	7.56	7.71	7.71	7.63	7.71	7.67	7.74	7.68	7.71
	17		6	7.73	7.47	7.6	7.72	7.72	7.68	7.71	7.68	7.69	7.67	7.71
10-Sep-00	20	09:45 AM	1	8.02	7.9	7.94	7.94	7.98	7.89	7.8	7.98	8.01	7.99	7.98
	20		4	8.05	7.92	7.95	7.94	8	7.88	7.91	7.98	8.02	7.97	8.01
12-Sep-00	22	08:45 AM	4	7.89	7.74	7.84	7.87	7.91	7.83	7.9	7.93	7.91	7.93	7.92
	22		5	7.91	7.73	7.83	7.87	7.94	7.87	7.86	7.92	7.92	7.93	7.9
14-Sep-00	24	09:00 AM	1	8.1	7.53	7.86	7.99	7.98	7.9	8.05	8.04	8.05	8.05	8.06
	24		4	8.13	7.73	7.93	7.98	8.01	7.91	8.05	8.05	8.06	8.05	8.03
18-Sep-00	28	07:00 AM	1	7.98	7.83	7.93	7.93	7.99	7.92	7.96	7.99	7.97	7.96	7.98
	28		4	8.02	7.89	7.94	6.93	8.01	7.89	7.95	7.96	7.94	7.97	7.97
	28		5	8.03	7.9	7.94	7.94	8	7.9	7.93	7.97	7.95	7.96	7.92
	28		8	8.03	7.9	7.95	7.95	8.01	7.9	7.92	7.95	7.99	7.98	7.94
		minimum		6.8	7.31	7.43	6.8	7.49	7.11	6.8	7.55	7.14	7.53	7.44
		maximum		8.13	7.99	7.99	8.01	8.02	8	8.05	8.05	8.07	8.05	8.1

Appendix Table 9. Water Quality Parameters for 28d H. azteca exposure for York Oil Sites, August 2000
Conductivity, Ammonia, Hardness, and Alkalinity

Conductivity (umho/cm)

Date	Day	time	rep	Sand	Form Sed	W. Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21Aug-00	0	07:00 AM	1	116	127	119	107	132	120	137	124	153	128	141
	0		8	118	130	121	110	135	124	143	127	140	131	148
27Aug-00	6	09:30 AM	4	128	141	131	125	134	133	138	133	140	135	147
	6		5	129	141	134	125	135	133	138	134	140	138	146
3Sept-00	13	09:30 AM	4	126	136	124	121	121	124	124	126	133	127	132
	13		6	126	133	124	122	121	125	125	126	133	127	132
10Sept-00	20	09:45 AM	1	133	140	131	129	140	134	136	135	148	135	138
	20		4	133	140	131	129	140	135	136	134	138	136	138
18Sept-00	28	07:00 AM	1	109			107	120	113	112	110	113	109	110
	28		8	110			106	121	110	111	110	111	109	110
	average			122.8	136.0	126.9	118.1	129.9	125.1	130.0	125.9	134.9	127.5	134.2

Ammonia (mg/L)

Date	Day	time	rep	Sand	Form Sed	W. Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21Aug-00	0	07:00 AM	1	0.087	0.076	0.112	0.605	0.984	1.486	1.303	0.942	1.57	1.324	1.213
	0		8	<0.063	<.063	0.166	0.485	0.946	0.966	1.521	1.067	1.224	1.059	2.049
17-Sept-00	27	07:00 AM	1	<0.063	0.725	0.136	0.067	<0.063	0.093	0.197	2.104	<0.063	0.511	0.067
	27		8	<0.063	0.339	0.075	<0.063	<0.063	<0.063	0.099	0.525	0.065	0.142	0.133
	average			0.0218	0.285	0.12225	0.2893	0.4825	0.63625	0.78	1.1595	0.7148	0.759	0.8655

Hardness (mg/L CaCO3)

Date	Day	time	rep	Sand	Form Sed	W. Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21Aug-00	0	07:00 AM	3	47.6	44.4	48.8	53.2	60.4	74.8	71.2	57.2	62.8	62.8	64
	0		7	50.4	43.6	48.8	52	58.8	56	59.2	55.6	58.4	62.8	60
17Sept-00	27	05:00 PM	3	48	56	48.4	44.8	52.4	47.6	88.8	45.4	49.2	47.2	48.8
	27		7	48.4	52.4	50	47.6	54.4	48.8	50.8	45.6	49.6	47.6	51.2
	average			48.6	49.1	49	49.4	56.5	56.8	67.5	50.95	55	55.1	56

Alkalinity (mg/L CaCO3)

Date	Day	time	rep	Sand	Form Sed	W. Bear	Ref 1	Ref 2	Ref 3	NW-1	NW-2	NW-3	NW-4	NW-5
21Aug-00	0	07:00 AM	2	47.2	45.6	47.6	43	52.4	59.6	56.4	56.8	54	52.8	65.2
	0		6	43.2	36.4	48	40.8	64.4	55.8	63.6	49.6	55.6	52	78
17Sept-00	27	05:00 PM	2	45.2	50.4	44.4	41.2	49.2	46.4	44.4	43.2	46.8	45.2	46.8
	27		6	46.4	49.6	44.4	43.2	49.6	44.4	46.4	44.8	49.6	44.8	46.8
	average			45.5	45.5	46.1	42.05	53.9	51.55	52.7	48.6	51.5	48.7	59.2