WATER QUALITY MONITORING REPORT
FOR
ROUTINE MONITORING EVENTS
AT
CHICAGO AREA CONFINED DISPOSAL FACILITY
FOR THE YEAR
(NOVEMBER 03 - NOVEMBER 04)

PREPARED BY:

U.S. ARMY CORPS OF ENGINEERS, CHICAGO DISTRICT
111 NORTH CANAL STREET
CHICAGO, ILLINOIS 60606

December 2004

TABLE OF CONTENTS

APPENDICES (Provided on Compact Disk)

LIST OF TABLES

LIST OF FIGURES

1 Purpose

The purpose of this report is to analyze and summarize the water quality data from samples collected at the Chicago Area Confined Disposal Facility (Chicago CDF) and at the Calumet River and Harbor by the U.S. Army Corps of Engineers (USACE), Chicago District, during the Year 2004 monitoring period from November 2003 to November 2004. The report includes data from routine monitoring events that were conducted on May 18, August 23 and November 8 of 2004, and it provides discussions of the sampling procedures, laboratory testing and data quality for these events. The trimester routine monitoring events are conducted to determine if the Chicago CDF is having an adverse impact on the water quality of the Calumet River or Harbor.

2 Background

The Chicago Area CDF is a diked facility for the disposal and containment of contaminated dredged materials from deep-draft (18 feet or greater) federal navigation projects in Chicago, Illinois, particularly the Calumet River federal project. The Chicago CDF was constructed between 1982–1984, and it is located at the mouth of the Calumet River (Figure 1). The Chicago CDF was constructed by, and is operated and maintained by, the USACE, Chicago District, under authority of the River and Harbor Act of 1970 (Public Law 91-611, Section 123). The Chicago Regional Port Authority and the Chicago Park District have adjoining interests for this project. The facility is roughly triangular in shape, it has a surface area of approximately 43 acres, and it has a capacity of about 1.3 million cubic yards of dredged material. As shown in Table 1, the total amount of dredged sediment that has been placed into the facility since its inception is about 1,038,100 cubic yards. This table also shows that the Chicago CDF has been used for ten different dredging and disposal events, each of which used mechanical dredging operations. Separate reports have been prepared for nine dredging events, and these reports should be consulted for details on the sampling and analyses performed for the dredging operations. Due to the relatively small volume of material dredged during the obstruction removal event in 2002, a modified program of water and sediment quality monitoring was conducted and a separate dredging report was not prepared.

Table 1: Historical Dredging and Disposal Events for Chicago Area CDF

Year of Disposal Operation	Location of Dredging	Volume of Dredged Material	Dredging By
Oct. – Dec. 1984	Calumet River	100,000 yd^3	USACE
July – Sept. 1985	Calumet River	108,000 yd^3	USACE
May – June 1986	Chicago Harbor & Chicago River	62,000 yd^3	USACE
April – June 1989	Calumet River	70,000 yd^3	USACE
May 1991	Calumet River	3,100 yd^3	KCBX Terminals Co.
December 1994	Calumet River	62,000 yd^3	USACE
Aug. 2000 – Apr. 2001	Calumet River & Harbor Breakwater	206,000 yd^3	USACE
Sept. – Dec. 2001	Calumet Harbor	291,000 yd^3	USACE
June 2002	Calumet River Obstruction Removal	1,000 yd^3	USACE
Sept. – Dec 2003	Calumet River	135,000 yd^3	USACE
Total		1,038,100 yd^3	

3 Sampling and Analytical Procedures

3.1 Water Quality Monitoring Plan

USACE obtained its most recent water pollution control permit (in compliance with the Section 401 certification requirements of the Clean Water Act (CWA)) for the Chicago CDF from the Illinois Environmental Protection Agency (IEPA) under Permit # 2001-EA-4691. This permit was issued on December 7, 2001 and it is valid until December 1, 2006 (Appendix A). Under "Special Condition 2," the permit stipulates that the monitoring shall be conducted in accordance with the Corps of Engineers report entitled "Water Quality Monitoring at the Chicago Area Confined Disposal Facility, Calumet Harbor, IL." Thus, this report was integrated into the permit and it provides the details of the current monitoring plan, including the routine monitoring as well as the more rigorous monitoring that is conducted during dredging events. The report also explains the rationale for changing from the previous monitoring plan to the current monitoring plan.

3.1.1 *Current Routine Monitoring*

As explained in the permit, for routine monitoring, the sampling frequency is three times per year, and the approximate dates for routine monitoring events are March – May, June – August and September – December. For the Year 2004, the three routine monitoring events were conducted on May 18, August 23, and November 8, 2004.

3.2 Sampling Locations for Routine Monitoring Events

The sampling locations for routine monitoring events at the Chicago CDF are shown in Figure 2. The samples were collected from the following five distinctly different sampling environments for each of the routine monitoring events:

(a) Background – three background samples are collected from Lake Michigan about 1000 feet away from the dike (BACK-001, BACK-002, BACK-003)
(b) Near-Dike – three composite samples are collected in Calumet Harbor near the edge of the dike (ND-COMP-001, ND-COMP-002, ND-COMP-003)
(c) Calumet River – three samples are collected from the Calumet River; downstream, next to, and upstream of the filter cell effluent discharge point (RIV-001, RIV-002, RIV-003)
(d) CDF Pond – three samples are collected from within the CDF pond (CDF-001, CDF-002, CDF-003)
(e) Landing Well – one sample is collected from each of the monitoring wells in the Iroquois Landing area (CH-18-81, CH-19-81, CH-20-81)

The background samples are collected far enough away from the CDF so that the concentrations detected at these locations provide baseline contaminant levels in Calumet Harbor. The near-dike samples are composite samples that are collected in Calumet Harbor near the edge of the CDF dike wall. If the near-dike samples have parameter concentrations that are significantly higher than the respective concentrations in the background samples, then the CDF may be having an impact on the water quality in Calumet Harbor.

During dredging and disposal events, the volume within the CDF is reduced in proportion to the incoming sediment and water by pumping water out of the CDF settling basin. This water is subsequently passed through a filter cell and discharged into the Calumet River. To monitor the effluent from the filter cell during dredging and disposal operations, river samples are collected upstream, adjacent to, and downstream of the filter cell effluent discharge point. The sampling locations in the Calumet River are also monitored for routine monitoring events for comparison purposes and to reduce data variations that may occur due to changes in the sampling locations.

The CDF pond samples provide an indication of the quality of the water in contact with the sediments in the CDF. Depending on the parameter, the CDF pond samples may be expected to have relatively higher concentrations when compared to near-dike or background sample concentrations. Lastly, the landing well data provides an indication of groundwater quality adjacent to the CDF. It should be noted that a geotechnical investigation of the land area adjacent to the CDF prior to construction revealed that the soil was largely composed of fill consisting of silts, sands and clays with intermingled municipal and industrial wastes (Reference 11). This geotechnical investigation also found that the soil contained slag, cinders, ash, and foundry sand from the nearby steel mills as well as coal, wood, iron, and miscellaneous trash.

3.3 Laboratory Analyses for Water Quality Samples

The target parameters for routine monitoring events and the required detection limits for year 2004 are shown in Table 2. The detection limit for total Kjeldahl Nitrogen has been changed to 0.5 mg/L. The target parameters include three metals, three nutrients, and two general water quality parameters. The parameters were selected based on historical results, and they were chosen to provide a standardized and informative data set (Appendix A).

For the May, August, and November sampling events, Montgomery Watson Harza (MWH) subcontracted the laboratory analyses to Trace Analytical Laboratories, Muskegon, Michigan. The scope of work provided to MWH for the analytical testing is located in Appendix B. The Standard Operating Procedure (SOP) checklist is located in Appendix C.

Table 2: Detection Limits for Routine Monitoring Parameters

Parameter	Required Detection Limit
Chromium (total)	0.005 mg/L
Manganese (total)	0.005 mg/L
Zinc (total)	0.005 mg/L
Total Phosphorus	0.01 mg/L
Ammonia as Nitrogen	0.01 mg/L
Total Kjeldahl Nitrogen	0.5 mg/L
Total Suspended Solids	5 mg/L
Total Dissolved Solids	5 mg/L
PH	1.0 – 14.0

4 Routine Water Quality Monitoring Events, Water Year 2004

4.1 Water Quality Data

The analytical data for the May 18, August 23, and November 8, 2004 monitoring events is provided in appendices D, E, and F respectively and this data is summarized in Tables 3A, 3B, and 3C, respectively. These tables provide the concentrations in mg/L for each of the target parameters at the fifteen sampling stations as well as the reporting limits achieved by the laboratory for each of the parameters. Parameter samples reported as "<" were below the reporting limit in Tables 3A, 3B, and 3C. Parameter samples designated with "J" were considered estimated. Total phosphorus samples designated with a "U J" were considered non detect down to the method detection limit of 0.010 mg/L. Means calculated did not include data designated in any of these three previously mentioned ways.

The analytical results are also shown graphically in Figures 3A-3H. Each figure shows a bar graph of the concentrations of a given target parameter by date for all fifteen of the sampling stations. The sampling stations are subdivided into (a) Background Samples (Back-001, 002, 003), (b) Near-Dike Samples (ND-Comp-001, 002, 003) (c) River Samples (Riv-001, 002, 003), (d) CDF Pond Samples (CDF-001, 002, 003), and (e) landing well samples (CH-18-81, CH-19-81, CH-20-81). For each of the stations, three concentrations are given, which correspond to the three monitoring events, and the reporting limit achieved by the laboratory is also provided. If no concentration is shown on the bar graph it means the analyte was non-detectable for that event and sample.

4.1.1 *pH and Temperature*

The field logs with the pH and temperature measurements are provided in Appendices D, E, and F. This data has been summarized in Table 4. This table shows that the pH measurements ranged from 7.39 to 11.75 and the greatest difference from neutral (pH = 7.0) occurred in the maximum pH measurements from the landing wells. Historically, the pH values have been particularly high for well CH-19-81, and this might be caused by the presence of waste or slag material in the soil adjacent to the well. The water temperature readings ranged from a low of 7.1°C in the CDF pond for the Nov-04 event to a high of 25.2°C in the CDF pond for the August-04 event (Table 4).

4.1.2 *Metals*

The monitoring results for total chromium, manganese and zinc are shown in Figures 3A, 3B and 3C, respectively. As observed in Figure 3A, the highest total chromium concentration (0.0084 mg/L) was measured in sample CH-18-81 which was acquired from the landing well for the May 2004 event. The next highest total chromium concentration (0.006 mg/L) was measured in sample CDF-002, which was acquired from the CDF pond sampling environment during the May 2004 event. For comparison, chromium was below the reporting limit for 42 of the remaining samples for all three monitoring events.

Table 3A: Analytical Data Summary for Chicago CDF Water Quality Monitoring, 18 May 2004

STATION	Chromium (mg/L)	Manganese (mg/L)	Zinc (mg/L)	TKN (mg/L)	Ammonia (mg/L)	Phosphorus (mg/L)	TDS (mg/L)	TSS (mg/L)
BACK-001	<0.005	0.0083	0.009	<0.50	0.054	0.009 J	210	5
BACK-002	<0.005	<0.005	<0.005	0.65	0.050	0.0085 J	150	<5.0
BACK-003	<0.005	<0.0066	0.016	<0.50	0.045	0.017	190	6.5
ND-Comp-001	<0.005	0.0071	0.014	<0.50	0.049	0.012 J	160	<5.0
ND-Comp-002	<0.005	0.0053	0.015	<0.50	0.052	0.014 J	170	<5.0
ND-Comp-003	<0.005	0.0078	0.0099	1.3	0.043	0.015	170	5.5
RIV-001	<0.005	0.0096	0.0056	<0.50	0.066	0.015	190	<5.0
RIV-002	<0.005	0.013	0.0084	0.53	0.065	0.013 J	190	5.5
RIV-003	<0.005	0.013	0.016	<0.50	0.06	0.018	200	5.5
CDF-001	0.0051	0.16	0.041	1.9	0.27	0.140	490	62
CDF-002	0.006	0.2	0.069	2.9	0.28	0.190	480	85
CDF-003	<0.005	0.16	0.038	1.7	0.28	0.130	490	54
CH-18-81	0.0084	0.1	0.029	1.5	0.160	0.092	500	58
CH-19-81	<0.005	0.06	0.015	6.1	5.1	0.039	560	16
CH-20-81	<0.005	0.12	0.015	0.53	0.060	0.058	900	<5.0
Detection limit	<0.005	<0.005	<0.005	<0.50	<0.010	<0.015	<5	<5.0

Parameter samples reported as "<" were below reporting limit

Parameter samples designated with " J" were considered estimated.

Phosphorus samples designated with "U J" were non-detect down to the method detection limit of 0.010 mg/L.

Table 3B: Analytical Data Summary for Chicago CDF Water Quality Monitoring, 23 Aug 2004

STATION	Chromium (mg/L)	Manganese (mg/L)	Zinc (mg/L)	TKN (mg/L)	Ammonia (mg/L)	Phosphorus (mg/L)	TDS (mg/L)	TSS (mg/L)
BACK-001	<0.005	0.0074	0.023	0.57	<0.010	U J	180	6
BACK-002	<0.005	<0.005	<0.005	0.61	<0.010	U J	170	10.0
BACK-003	<0.005	<0.005	0.009	0.58	0.045	<.013 J	170	<5
ND-Comp-001	<0.005	<0.005	<0.005	0.71	0.029	U J	170	<5
ND-Comp-002	<0.005	<0.005	<0.005	0.67	<0.010	U J	170	<5
ND-Comp-003	<0.005	<0.005	<0.005	0.72	<0.010	U J	180	<5
RIV-001	<0.005	0.014	<0.005	0.6	<0.010	U J	160	8
RIV-002	<0.005	0.019	0.0095	0.59	0.025	<.012 J	180	14
RIV-003	<0.005	0.012	<0.005	<0.5	<0.010	U J	170	9
CDF-001	<0.005	0.29	0.037	1.7	0.15	0.085	640	43
CDF-002	<0.005	0.26	0.025	2.1	0.17	0.079	650	24
CDF-003	<0.005	0.25	0.019	1.8	0.17	0.081	600	21
CH-18-81	<0.005	0.12	0.009	3.2	1.400	0.068	600	59
CH-19-81	<0.005	0.054	<0.005	6.4	4.8	0.035	530	23
CH-20-81	<0.005	0.15	0.0055	0.8	0.019	0.110	970	<5
Detection Limit	<0.005	<0.005	<0.005	<0.5	<0.010	<0.015	<5	<5

Parameter samples reported as "<" were below reporting limit.

Parameter samples designated with " J" were considered estimated.

Phosphorus samples designated with "U J" were non-detect down to the method detection limit of 0.010 mg/L.

Table 3C: Analytical Data Summary for Chicago Area CDF Water Quality Monitoring, 8 Nov 2004

STATION	Chromium (mg/L)	Manganese (mg/L)	Zinc (mg/L)	TKN (mg/L)	Ammonia (mg/L)	Phosphorus (mg/L)	TDS (mg/L)	TSS (mg/L)
BACK-001	<0.005	0.011	<0.005	<0.50	<0.010	<0.010	170	8
BACK-002	<0.005	0.013	0.0069	<0.50	0.060	<0.010	170	17
BACK-003	<0.005	0.016	0.0076	<0.50	<0.010	<0.010	170	17
ND-Comp-001	<0.005	0.0089	0.0052	<0.50	<0.010	<0.010	170	7
ND-Comp-002	<0.005	0.013	<0.005	<0.50	<0.010	0.011	170	11
ND-Comp-003	<0.005	0.020	0.010	<0.50	0.064	0.014	170	21
RIV-001	<0.005	0.021	0.0053	<0.50	0.020	0.011	210	11
RIV-002	<0.005	0.018	0.0055	<0.50	0.011	<0.010	200	13
RIV-003	<0.005	0.018	<0.005	<0.50	<0.010	<0.010	200	14
CDF-001	<0.005	0.097	0.021	1.5	0.370	0.068	570	24
CDF-002	<0.005	0.110	0.024	1.4	0.330	0.076	570	30
CDF-003	<0.005	0.100	0.020	1.5	0.360	0.058	580	26
CH-18-81	<0.005	0.120	0.014	0.96	0.220	0.064	570	43
CH-19-81	<0.005	0.098	0.0081	7.9	6.4	0.026	530	63
CH-20-81	<0.005	0.400	<0.005	0.52	0.049	0.024	970	<5
Detection limit	<0.005	<0.005	<0.005	<0.50	<0.010	<0.010	<5	<5

Parameter samples reported as "<" were below reporting limit.
Parameter samples designated with "J" were considered estimated.
Phosphorus samples designated with a "U J" were non-detect down to the method detection limit of 0.010 mg/L

Figure 3B shows that the highest manganese concentration (0.40 mg/L) was measured in sample CH-20-81 which was acquired from that well for the Nov 2004 event. The next highest manganese concentration (0.29 mg/L) was measured in CDF pond sample 001 for the August 2004 event. Compared to the CDF pond and landing well sampling environments, the river and near-dike samples all had manganese results that were considerably lower (0.021 mg/L or less), and the highest background manganese concentration that was measured was 0.016 mg/L.

As seen in Figure 3C, the highest zinc concentration (0.069 mg/L) was measured in sample CDF-002, which was collected from the pond for the May 2004 event. The next highest zinc concentration (0.041 mg/L) was measured in CDF pond sample 001 for the May event. The near dike and river samples from the three events showed zinc results that were slightly lower or much less than the August 2004 background sample, where the highest concentration of zinc in a background sample was measured to be about 0.023 mg/L.

4.1.3 *Nutrients*

The monitoring results for microbiological nutrients, including Total Kjeldahl Nitrogen (TKN), ammonia nitrogen, and total phosphorus, are shown in Figures 3D, 3E, and 3F, respectively. As shown in Figure 3D, the highest TKN concentration (7.9 mg/L) was measured in landing well sample CH-19-81 from the November 04 event, and the next

highest TKN concentration (6.4 mg/L) was measured in the sample from the August 04 event in the same landing well. TKN concentrations in the samples from the CDF pond

Table 4: Field pH and Temperature Summary Water Stations Water Year 2004

Parameter	PH			PH		
Statistical Measure	Minimum			Maximum		
Sampling Event	May	August	November	May	August	November
Location Group		(Station)			(Station)	
Background	7.45 (001)	8.22 (001)	8.29 (001)	8.34 (003)	8.37 (003)	8.62 (003)
Near Dike	7.84 (001)	8.22 (001)	8.34 (001)	8.0 (002-003)	8.28 (002)	8.56 (003)
River	7.42 (002)	8.13 (002)	7.38 (003)	7.7 (001)	8.17 (003)	7.72 (002)
CDF	7.4 (003)	8.02 (003)	8.34 (003)	7.63 (002)	8.20 (001)	8.52 (001)
Landing wells	7.55 (CH-18)	7.39 (CH-20)	7.43 (CH-20)	11.67 (CH-19)	11.13 (CH-19)	11.75 (CH-19)
	Temperature (°C)			Temperature (°C)		
Background	12.8 (001)	21.7 (001)	10.5 (002)	14.1 (003)	22.1 (003)	10.8 (003)
Near Dike	12.4 (003)	21.6 (002)	7.4 (002)	13.1 (001-002)	21.9 (003)	10.7 (003)
River	13.2 (001)	21.5 (002)	11.3 (001)	13.5 (002-003)	21.6 (001 & 003)	11.4 (002-003)
CDF	17.4 (002–003)	24.8 (003)	7.1 (003)	18.6 (001)	25.2 (001)	8.1 (001)
Landing wells	13.3 (CH-18)	13.8 (CH-19)	11.6 (CH-19)	13.8 (CH-19 & CH-20)	18.5 (CH-18)	16.3 (CH-18)

See the field logs in the appendices for additional detail.
The number in parenthesis is the station number or numbers from the location group.

ranged from about 1.4 to 2.9 mg/L, whereas lower concentrations (1.3 mg/L or less) were detected in the near dike, river and background samples.

Figure 3E shows that the highest ammonia nitrogen concentration (6.4 mg/L) was measured in landing well sample CH-19-81 from the November 04 event, and the next highest ammonia nitrogen concentration (5.1 mg/L) was measured in a sample from the same landing well (CH-19-81) from the May 04 event. The CDF pond samples from the three events all had lower ammonia nitrogen concentrations (0.37 to 0.15 mg/L) and so did the river, near-dike and background samples, which had concentrations of 0.066 mg/L or less. The background sample with the highest ammonia nitrogen concentration (0.060 mg/L) was measured in a sample from the November 04 event.

As observed in Figure 3F, the highest total phosphorus concentration (0.19 mg/L) was measured in a CDF pond sample from the May 04 event. The CDF pond samples had concentrations that ranged from 0.19 to 0.058 mg/L. All the river and near-dike samples had phosphorous concentrations that were 0.018 mg/L or less. The highest total phosphorous concentration detected in a background sample was 0.017 mg/L. This sample was collected during the May 04 event.

4.1.4 *Solids*

The monitoring results for Total Dissolved Solids (TDS) and Total Suspended Solids (TSS) are shown in Figures 3G and 3H, respectively. As seen in these figures, the dissolved and suspended solids were generally higher in the landing well and CDF pond samples. Figure 3G shows that the concentration of TDS in the landing well and CDF pond samples ranged from 970 to 480 mg/L, and the highest TDS concentration in a background sample was 210 mg/L (May 04 event).

Figure 3H shows that the highest TSS concentration of 85 mg/L was measured from a CDF pond sample collected during the May event, and the next highest TSS sample concentration of 62 mg/L was measured from a CDF pond sample also collected during the May 04 event. For comparison purposes, the concentrations of TSS in the river and near dike samples were 21 mg/L or less. The TSS concentrations of 5 of the near dike samples were less than the reporting limit. The highest TSS concentration in a background sample was 17 mg/L, and this was measured in two samples collected during the November event.

4.2 Quality Assurance/Quality Control (QA/QC)

The purpose of the data collection and analyses is to determine if the CDF is operating effectively by preventing pollutants from entering the Calumet River or Harbor. Data quality objectives include reviewing enough data for bias and precision to determine if it is accurate. This is done by reviewing the laboratory quality control reports for conformance with the scope of work requirements. Data quality assessments were written for the three monitoring events and are included along with the final laboratory and QA/QC reports in Appendices D-F. Holding time preservation requirements were met for all samples. Temperature preservation requirements were acceptable although not always within 4 ±2°C for all sampling events. These temperature preservation measurements were acceptable because chemical preservatives were also used. All reporting limits were met or were otherwise acceptable. Some August total phosphorus results were not reported because they were estimated. The data quality assessments, results, quality control data, and raw data are provided in the appendices. Discussion of laboratory control samples and matrix spike/matrix spike duplicates is also included in the appendices. The data from the three events was determined to be acceptable and suitable for its intended purpose and objectives.

4.3 Statistical Analysis

One of the goals of the monitoring plan is to generate a statistically analyzable data set for each monitoring event. To meet this goal, three samples are collected from different

locations within each of the five distinct sampling environments, (1) the background water of Calumet Harbor (BACK), (2) near-dike harbor composites (ND-Comp), (3) Calumet River (RIV), (4) CDF pond (CDF), and (5) landing wells (CH) (see Figure 2). A statistical analysis is then performed on the water quality parameter results provided by the analytical laboratory. Appendices D, E and F contain the statistical analysis printouts for the May, August and November 2004 sampling events, respectively. For each sampling event, these program tables summarize the concentration data and statistical analysis for each of the eight water quality parameters, chromium, manganese, zinc, TKN, ammonia nitrogen, total phosphorus, TDS and TSS.

The statistical analysis summarizes the completeness, count, degrees of freedom (df), mean, sample standard deviation and sample variance for each of the eight water quality parameters in each of the five sampling environments. If one or more of the water quality parameter concentration results is less than the reporting limit or if no data is obtained for a given parameter in a given sampling environment, the estimated and/or absent concentrations are not used in the statistical comparison. These estimated or absent data values are labeled as not applicable (N/A) in the statistical analysis spreadsheet. Completeness indicates whether three data values were present for a particular sampling environment. If less than three data values are present, the completeness is described as being “incomplete”, whereas “OK” indicates that three values are present for the analysis. The count displays the number of data values that are present for the analysis. The degree of freedom is simply one less than the count. The mean is computed when either two or three data values are present, and the sample variance and sample standard deviation are not calculated and the statistical comparison is not performed unless all three sample values are present and the data set is complete.

The statistical comparison is performed using a parametric statistical test method known as an independent two-sample t-test. This test method employs a student’s t-distribution to assess whether there is a statistically significant difference between the means of two independent sample groups. The null hypothesis (H_0) is that a statistically significant difference does not exist between the means of the two sample groups. Hence, if the comparison indicates that the difference between the means of the two sample groups is not statistically significant, then it is concluded that the null hypothesis is true and the comparison is labeled *"OK"*. If the two compared sample population means are the same and both sample populations have a variance of zero, a division by zero error wll occur and is indicated. If the comparison indicates that the difference between the means of the two sample groups is indeed statistically significant, then it is concluded that the null hypothesis is false and the comparison is labeled *"Reject H_0"*. When the statistical comparison concludes that null hypothesis is true, it only indicates that there was not enough evidence to reject the null hypothesis. It is important to note that if the null hypothesis is concluded to be true, it does not imply any statistically significant similarity between the two sample groups. To the contrary, significant statistical differences may or may not exist when the null hypothesis is concluded to be true, and additional evidence, robust test methods, and analyses are required to reach a statistically based conclusion. Essentially, the statistical comparison used in this report is only informative for cases when the null hypothesis is rejected. This is because a rejection of the null

hypothesis indicates that there is convincing evidence that a statistically significant difference exists between the means of the two sample groups. Consequently, inferences concerning the results of the statistical comparison were only conducted for cases in which the null hypothesis was rejected.

4.4 Results of Statistical Analysis

One of the primary goals of the statistical analysis program is to provide an indication of whether the Chicago CDF is affecting the water quality in the Calumet River or Harbor. Such an impact may be indicated, for example, if there was a statistically significant difference between the means of the contaminant concentrations in the near-dike samples (ND-Comp-XXX) and background water samples (BACK-XXX). Moreover, if the mean of the near-dike samples was greater than the mean of the background samples, this might suggest that the water outside the CDF dike wall might be affected by the seepage of contaminants from the CDF pond, causing higher concentrations in the near-dike environment relative to the background environment.

For the current monitoring period, which includes the sampling events of May, August, and November of 2004, the statistical comparisons for the five sampling environments and eight parameters are summarized in Table 5. This table only provides information regarding the statistical comparisons that were complete and had all three data values present for each of the compared sampling environments. In addition, the table only provides information for cases in which the null hypothesis was rejected, indicating that a significant difference existed between the means of the two sample groups. For cases where the null hypothesis was rejected, the mean values were then compared to determine which of the sampling environments had the higher mean value.

4.5 Discussion of Results

4.5.1 *Metals*

Due to a high number of sample results that were less than the reporting limit for all three sampling events, May, August and November 2004, a statistical comparison was not conducted for any of the sampling environments for the chromium water quality parameter (Tables 3A, 3B, and 3C).

The statistical comparison for manganese indicated that the Calumet River sample mean concentration during the May event was higher than the Near dike composite sample mean. The river sample mean was also higher than background during the November event. The comparison for manganese indicated that the samples collected during the May and November events from the CDF pond environment had concentration means that were significantly different and higher than the corresponding means of the samples from the Near dike and Calumet River (Table 5). The May CDF pond manganese mean was comparatively higher than the landing well mean. The CDF pond manganese mean in August was also higher than the River and the landing well sample means. The landing well manganese sample means are higher in May and November than the near dike and river means and also higher than the August river mean.

Table 5: Chicago Area CDF Year 2004 Routine Water Quality Parameter Statistical Comparison Summary

Water Quality Parameter	May 2004		August 2004		November 2004	
	Sampling Environment With Higher Mean Value	Sampling Environment With Lower Mean Value	Sampling Environment With Higher Mean Value	Sampling Environment With Lower Mean Value	Sampling Environment With Higher Mean Value	Sampling Environment With Lower Mean Value
Chromium						
Manganese	RIV	NDC	CDF	RIV	RIV	BACK
	CDF	NDC			CDF	BACK
	CDF	RIV	CDF	CH	CDF	NDC
	CDF	CH			CDF	RIV
	CH	NDC	CH	RIV	CH	NDC
	CH	RIV			CH	RIV
Zinc	CDF	NDC				
	CDF	RIV				
TKN			NDC	BACK		
			CDF	BACK		
			CDF	NDC		
NH_3	RIV	BACK				
	RIV	NDC				
	CDF	BACK				
	CDF	NDC				
	CDF	RIV				
Phosphorus	CDF	CH				
Total Dissolved Solids	RIV	NDC	CDF	BACK	RIV	BACK
	CDF	BACK	CDF	NDC	RIV	NDC
	CDF	NDC	CDF	RIV	CDF	BACK
	CDF	RIV	CH	BACK	CDF	NDC
	CH	BACK	CH	NDC	CDF	RIV
	CH	NDC	CH	RIV	CH	BACK
	CH	RIV			CH	NDC
					CH	RIV
Total Suspended Solids					CDF	BACK
					CDF	NDC
					CDF	RIV

Comments:
BACK = Background Samples
NDC = Near CDF Dike Composite Samples
RIV = Calumet River Samples
CDF = CDF Pond Samples
CH = Landing Well Samples
This table summarizes the two-sample t-test statistical method comparisons, which were only performed on complete data sets. This table only provides information on comparisons for which the null hypothesis was rejected, indicating a statistically significant difference between the means of the two sampling environments.

As seen in Table 5, the statistical comparison for zinc shows that the samples collected during the May event from the CDF pond had a mean that was higher than the mean of the samples from the Calumet River and near dike environments.

4.5.2 *Nutrients*

Table 5 shows that the May Calumet River ammonia nitrogen concentration mean was comparatively higher than the background and near dike concentration. Also exhibited in Table 5, the statistical comparison for the nutrients, TKN, ammonia nitrogen, and total phosphorus, revealed that the mean of the samples collected from the CDF pond environment was higher than adjacent environments in several instances. For the May event, the mean ammonia nitrogen concentration of the CDF pond samples was higher than the mean ammonia nitrogen concentration of the Calumet River, near dike and background samples. For the May event, the mean total phosphorus concentration of the CDF pond samples was higher than the mean total phosphorus concentration of the landing well samples. For the August event the TKN near dike concentration was statistically significantly higher than the background concentration, and the TKN concentration in the CDF was higher than the near dike and background concentrations.

The statistical comparison for the August event revealed that the mean TKN concentration of the near dike samples was statistically significantly higher than the background samples. This statistical comparison is a resourceful scientific tool for analyzing and making inferences based on the available data, but further investigation is still required to determine the importance of the results. The actual data for the August event shows that the mean TKN concentrations of the near dike and background samples were 0.70 and 0.59 mg/L, respectively, and the difference between these mean values is only 0.11 mg/L. The means are significantly different due to the very low standard deviations (0.021 for background and 0.026 for near dike). It should be noted that TKN is a measure of the nitrogen components of biological origin, so the TKN concentration is expected to be higher for regions where the biological activity is more intense. Consequently, it is plausible that some pronounced biological activity along the lakeside dike face during August might have slightly elevated the TKN concentration in comparison to the open water background. Overall, in this particular instance, the statistical comparison between the mean TKN concentrations in the near dike and background environments appears to be of limited value and does not indicate any adverse impact.

4.5.3 *Solids*

Table 5 shows that the May and November mean TDS concentration for the samples from the Calumet River environment was statistically different and higher than the TDS concentration mean for the samples collected during the May and November events from the near-dike environment. The TDS concentration in the Calumet River for the November event was also higher than the background concentration in Calumet Harbor. In addition, for the three sampling events, May, August and November 2004, the mean TDS concentration from the landing well and CDF pond environment samples was higher than the corresponding TDS concentration mean of the Calumet River, near-dike and background environment samples (Table 5). These differences can also be observed in the graphical analysis in Figure 3G.

The May and August events did not have complete TSS sample sets or the null hypothesis was accepted. Therefore, no TSS comparisons were made for May and August events. TSS mean comparisons made for November 2004, showed that the CDF concentrations were higher than the Calumet River, near dike, and background concentrations.

5 Water Level Data

The water level in Calumet Harbor and in the Chicago CDF is continuously measured at two nearby gage stations. The water level monitoring station at Calumet Harbor (Station #7044) is maintained by the National Oceanographic and Atmospheric Administration (NOAA), and the water level monitoring station within the CDF pond is maintained by the U.S. Geological Survey (USGS). As observed in Figure 4, the data from these stations was used to compare the daily mean elevations in Calumet Harbor with the daily mean elevations in the CDF pond using Low Water Datum 1955 in feet. This figure shows that the water level daily mean elevations were close together in Calumet Harbor and the CDF pond for the Water Year 2004. The annual average daily mean difference (CDF Pond – Calumet Harbor) was 0.16 feet. The daily mean pond surface water levels in the CDF ranged from 1.7 ft above low water datum to minus 0.68 ft below low water datum 1955. The daily mean Calumet Harbor water elevation ranged from 1.86 ft above low water datum to minus 1.01 ft below low water datum 1955. Piezometric data collected from landing wells CH-18-81 (CH 1), CH-19-81 (CH 2), and CH-20-81 (CH 3) was recorded for the three monitoring events in May, August, and November 04, and this data is presented in Table 6 along with the daily mean water levels for those dates for Calumet Harbor and the CDF pond.

The NOAA Calumet Harbor gage data and the Chicago Area CDF pond data in Figure 4 and Table 6 is referenced to 1955 Low Water Datum 576.8 feet above mean water level at Father Point Quebec International Great Lakes Datum, IGLD, (1955) for the purpose of this report.

Table 6: Chicago Area CDF Well, Pond, and Harbor Water Level Comparison 2004

	Elevation Expressed from Low Water Datum 1955 (feet)			Remarks
Location/Date	18 May 04	23 Aug 04	8 Nov 04	For this report
CH-18-81	2.36	2.46	2.46	(CH 1)*
CH-19-81	2.3	2.5	2.0	(CH 2)*
CH-20-81	4.37	3.87	3.87	(CH 3)*
CDF Pond	0.69	1.16	0.75	Daily Mean USGS**
Calumet Harbor	0.70	1.17	0.51	Daily Mean NOAA***

* Designation in Statistical Summary Tables in Appendices D-F
** Data taken from gage in CDF pond by USGS Urbana
*** Data taken from NOAA web site

6 Conclusion

This report presents the results of the water quality data that was collected on May 18, August 23, and November 8 of 2004 at the Chicago Area CDF. The purpose of this

report is to analyze and summarize the water quality data to determine if the Chicago CDF had an adverse impact on the water quality of the Calumet River or Harbor during the Water Year 2004. In accordance with the IEPA permit, samples were acquired from five different sampling environments that included background samples for a baseline comparison and near-dike, river, CDF pond and landing well samples. The samples were analyzed for metals (chromium, manganese, and zinc), nutrients (Total Kjeldahl Nitrogen, ammonia nitrogen, and total phosphorus), and Total Dissolved and Total Suspended Solids. Based on an analysis of the water quality data, it appears that the Calumet River and Harbor was not adversely impacted by the Chicago CDF during 2004.

7 References

(1) Chicago Area Confined Disposal Facility: Monitoring Well Data Report, January - August 1997, prepared by USACE, Chicago District, October 1997.

(2) Final Environmental Impact Statement, Chicago Area Confined Disposal Facility and Maintenance Dredging in Cook County, Illinois, prepared by USACE, Chicago District, May 1982.

(3) Final Supplemental Environmental Impact Statement, Chicago Area Confined Disposal Facility, at Calumet Harbor, Chicago, Cook County, Illinois, prepared by USACE, Chicago District, 26 August 1998.

(4) Illinois Environmental Protection Agency, Water Pollution Control Permit Number 1997-EA-3213, Chicago Area Confined Disposal Facility, issued to USACE, Chicago District, April 30, 1997.

(5) Illinois Environmental Protection Agency, Water Pollution Control Permit Number 2001-EA-4691, Chicago District, Corps of Engineers, Chicago Area Confined Disposal Facility, December 7, 2001.

(6) Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility (September 1997-July 1998) prepared by USACE, Chicago District, June 1999.

(7) Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 99 (October 1998 – September 1999) prepared by USACE, Chicago District, June 2000.

(8) Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2000 (October 1999 – September 2000) prepared by USACE, Chicago District, September 2001.

(9) Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2001 (October 2000 – September 2001) prepared by USACE, Chicago District, June 6, 2002.

(10) Report on Maintenance Dredging of Calumet Harbor (9/17/2001 through 12/13/2001) prepared by USACE, Chicago District, September 2002.

(11) Design Analysis – Calumet Harbor Illinois Chicago Area Confined Disposal Facility Vols. I and II prepared by USACE, Chicago District, January 1982.

(12) Water Quality Monitoring Report for Routine Monitoring Events at Chicago Area Confined Disposal Facility Water Year 2002 (October 01 – October 02) prepared by USACE, Chicago District, April 2003

(13) Water Quality Report Routine Monitoring Events Chicago Area Confined Disposal Facility Year 2003 prepared by USACE, Chicago District, December 2003

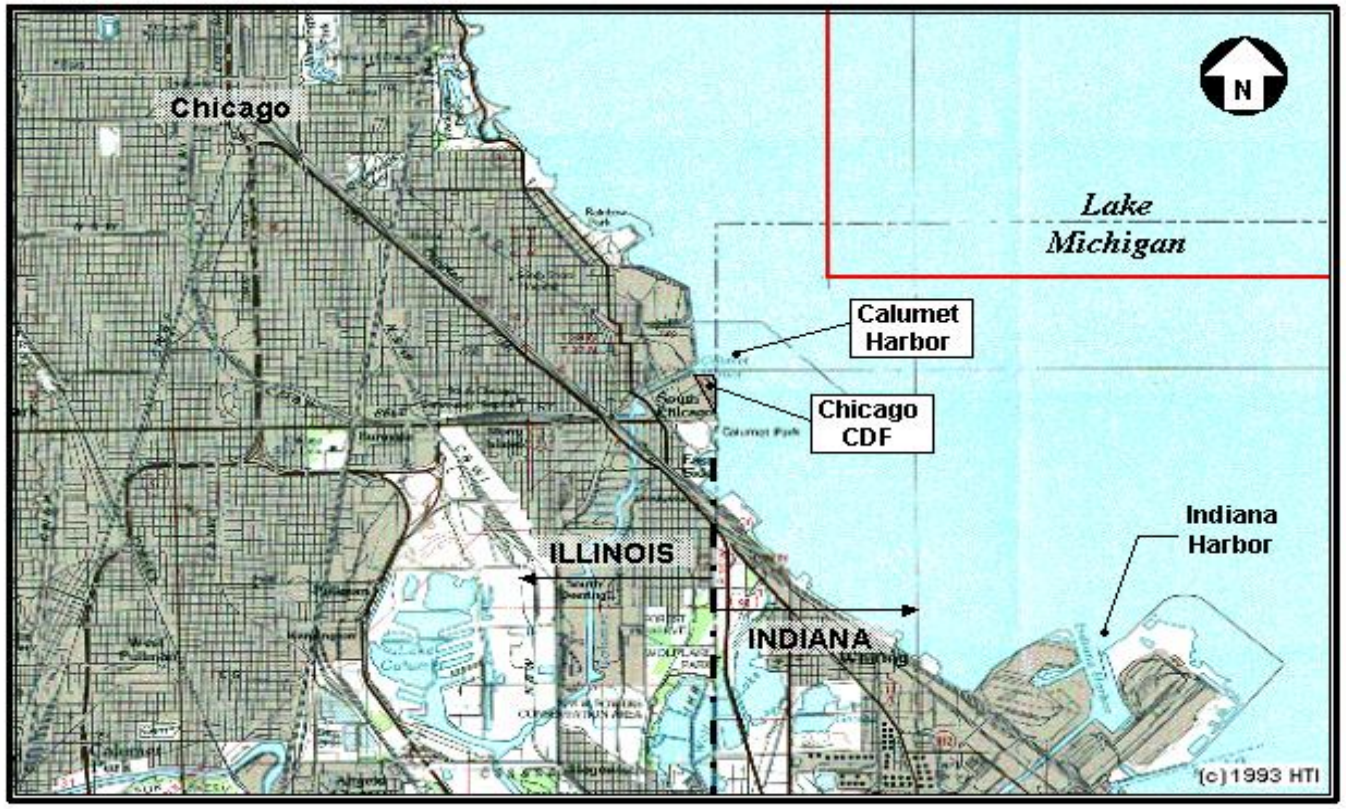

Figure 1: Location of Chicago Area CDF and Calumet Harbor

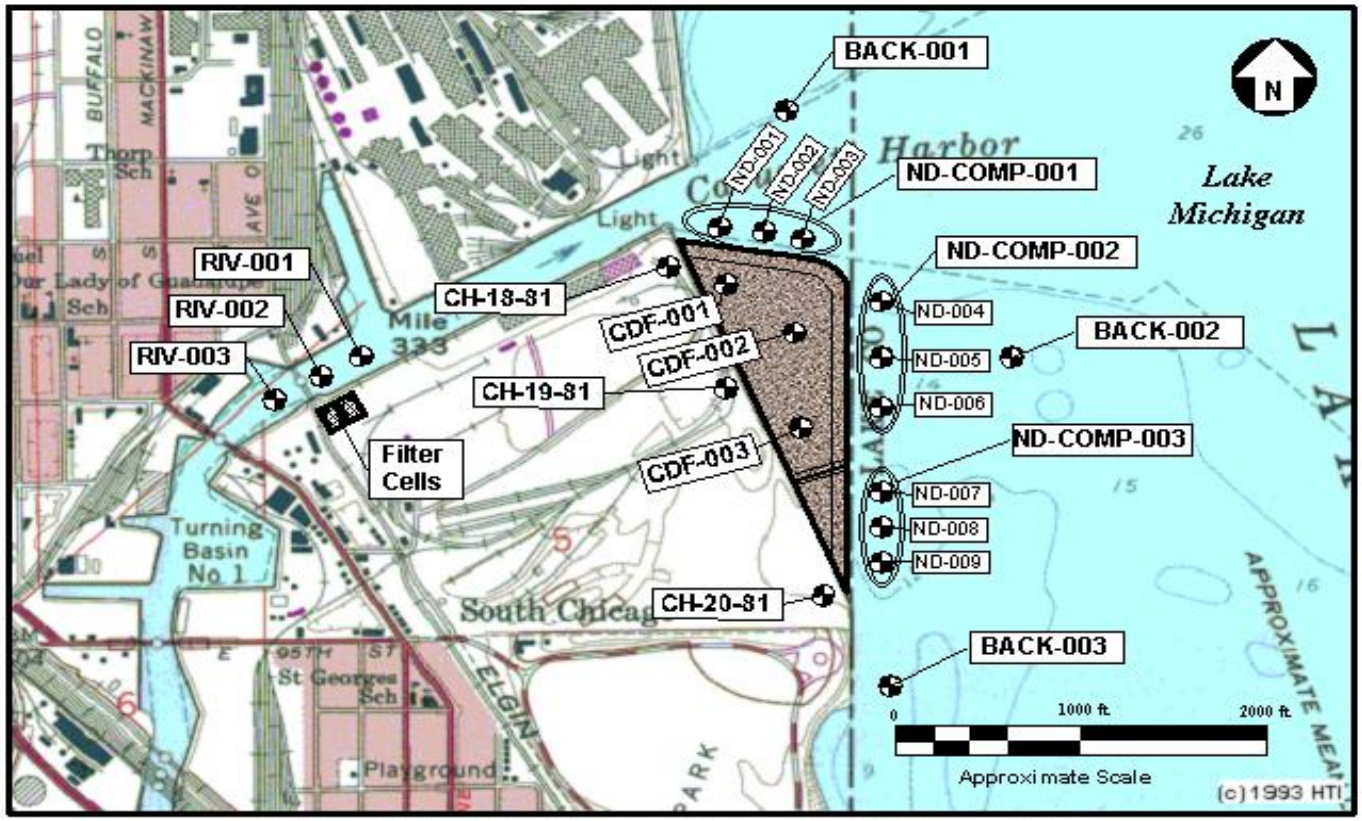

Figure 2: Sampling Locations for Routine Monitoring Events

Figure 3A Total Chromium Routine Monitoring Chicago Area CDF 2004

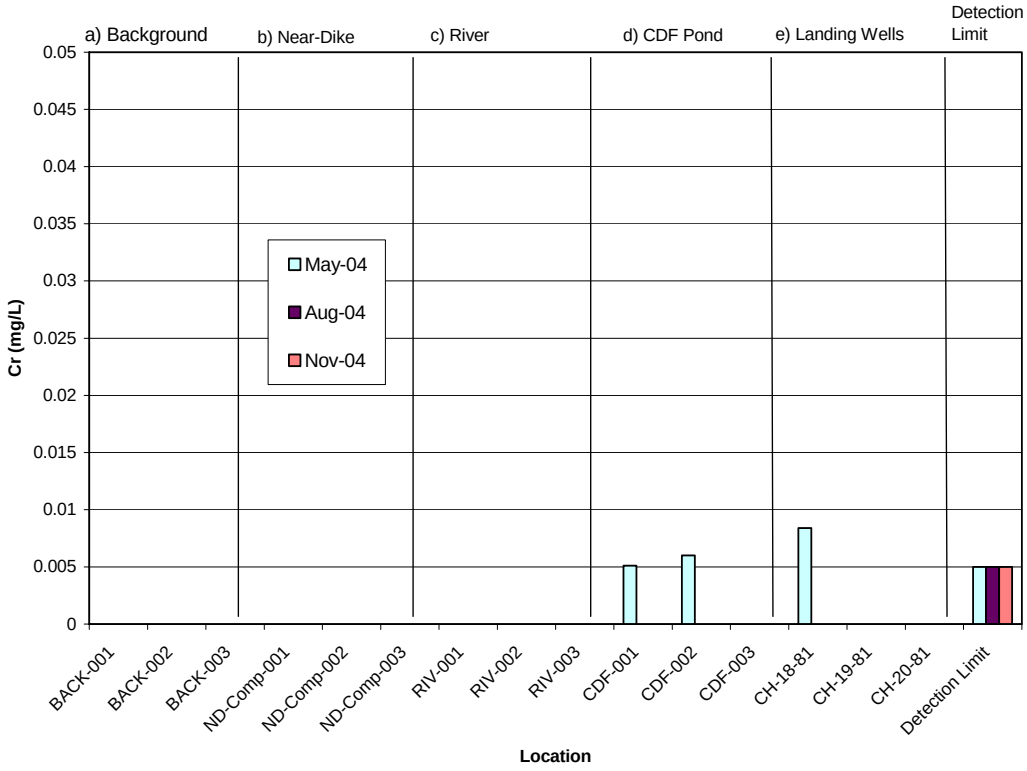

Figure 3B Total Manganese Routine Monitoring Chicago Area CDF 2004

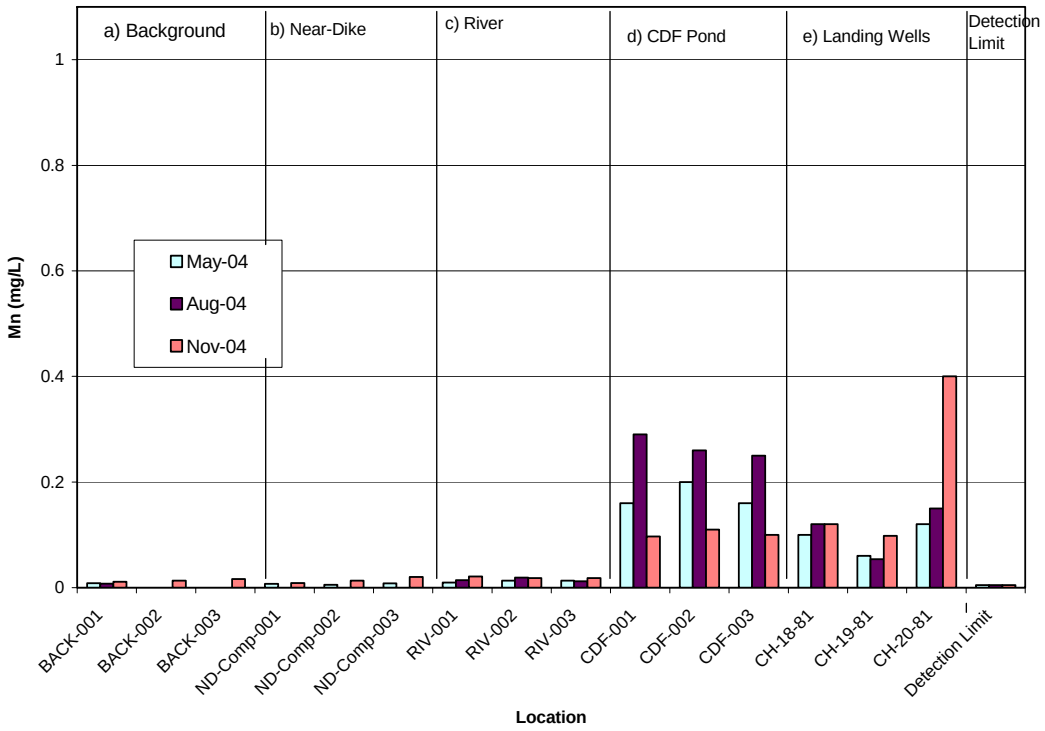

Figure 3C Total Zinc Routine Monitoring Chicago Area CDF 2004

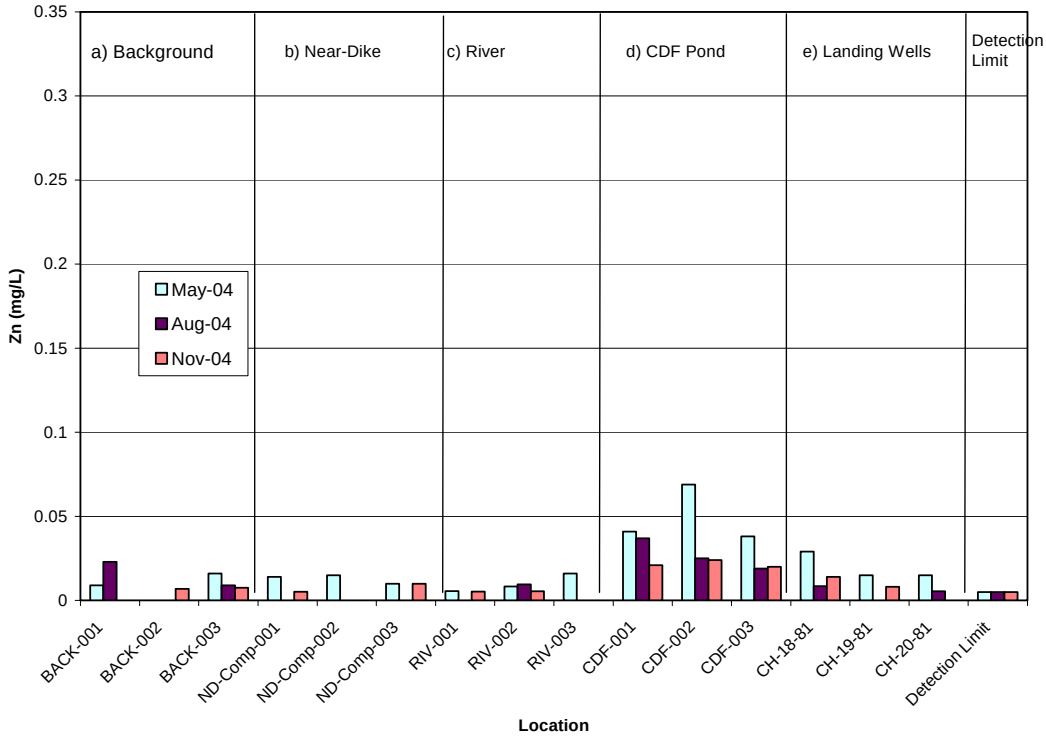

Figure 3D Total Kjedahl Nitrogen Routine Monitoring Chicago Area CDF 2004

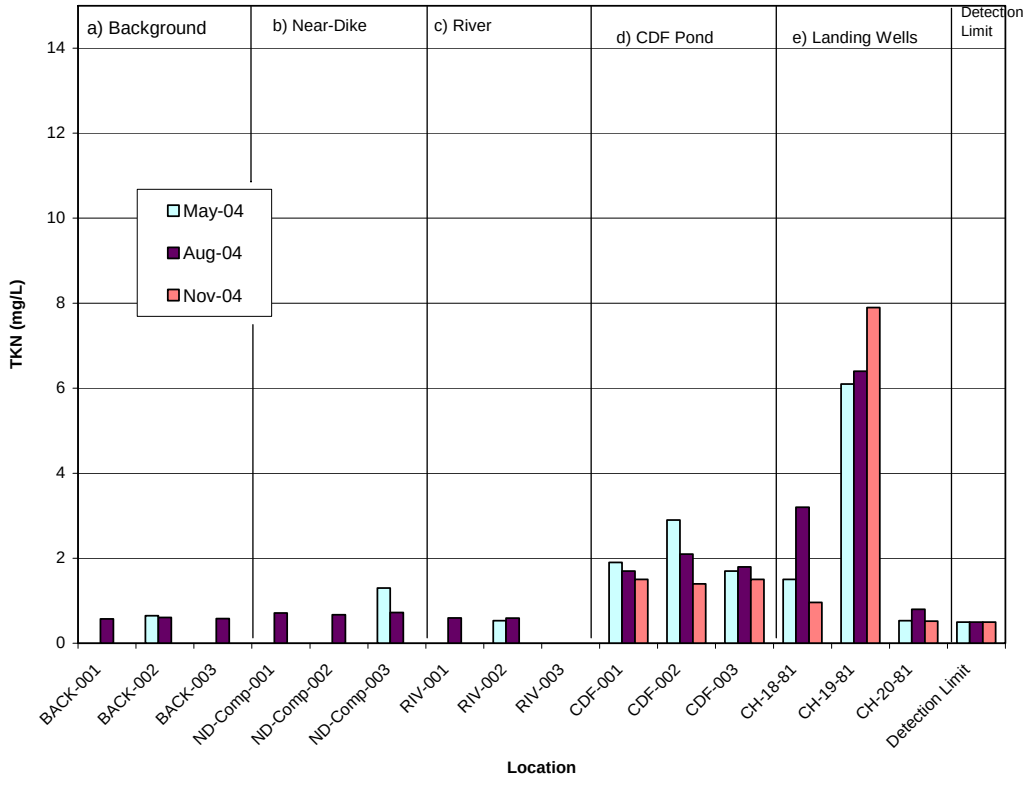

Figure 3E Total Ammonia Chicago Area CDF Routine Monitoring 2004

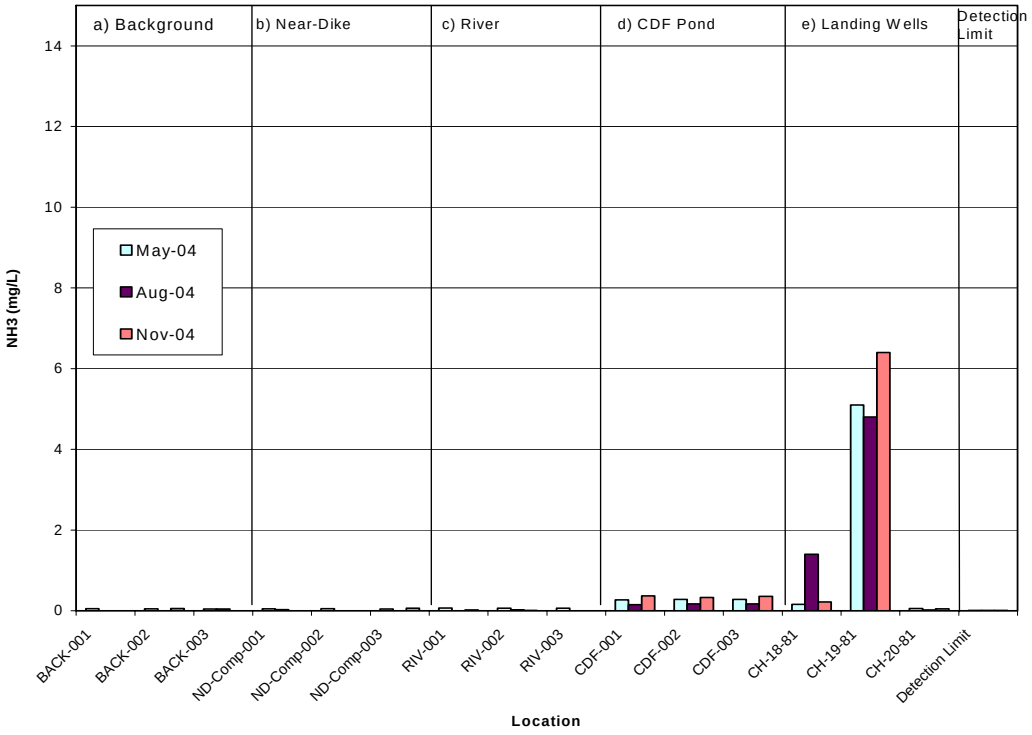

Figure 3F Total Phosphorus Routine Monitoring Chicago Area CDF 2004

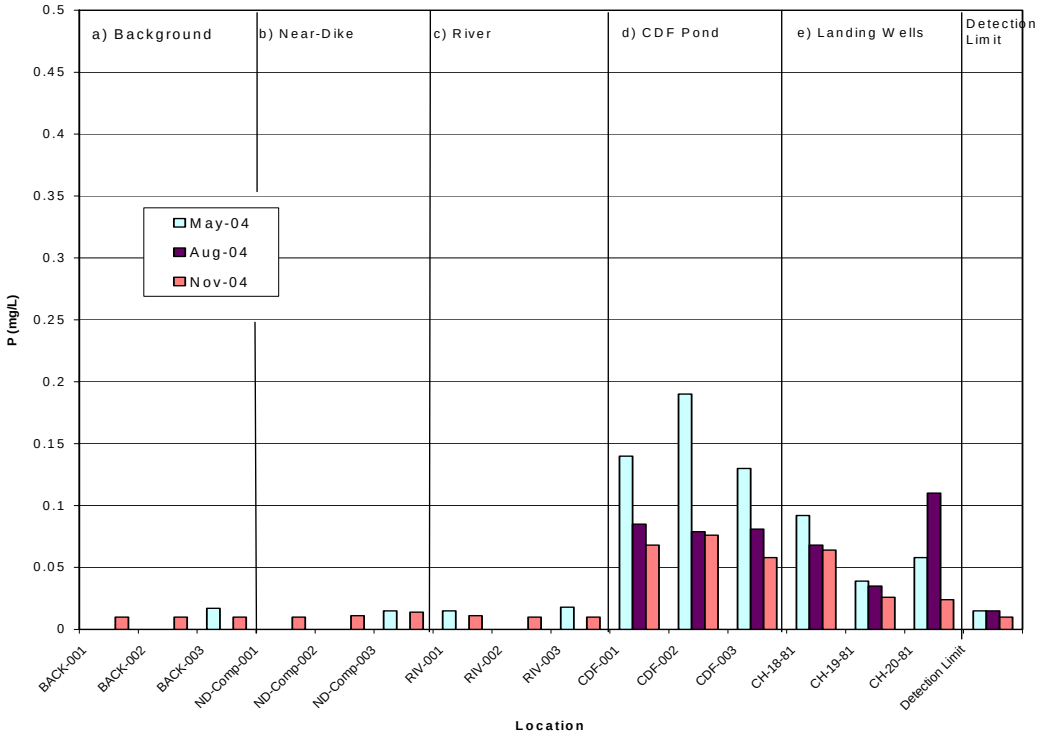

Figure 3G Total Dissolved Solids Routine Monitoring Chicago Area CDF 2004

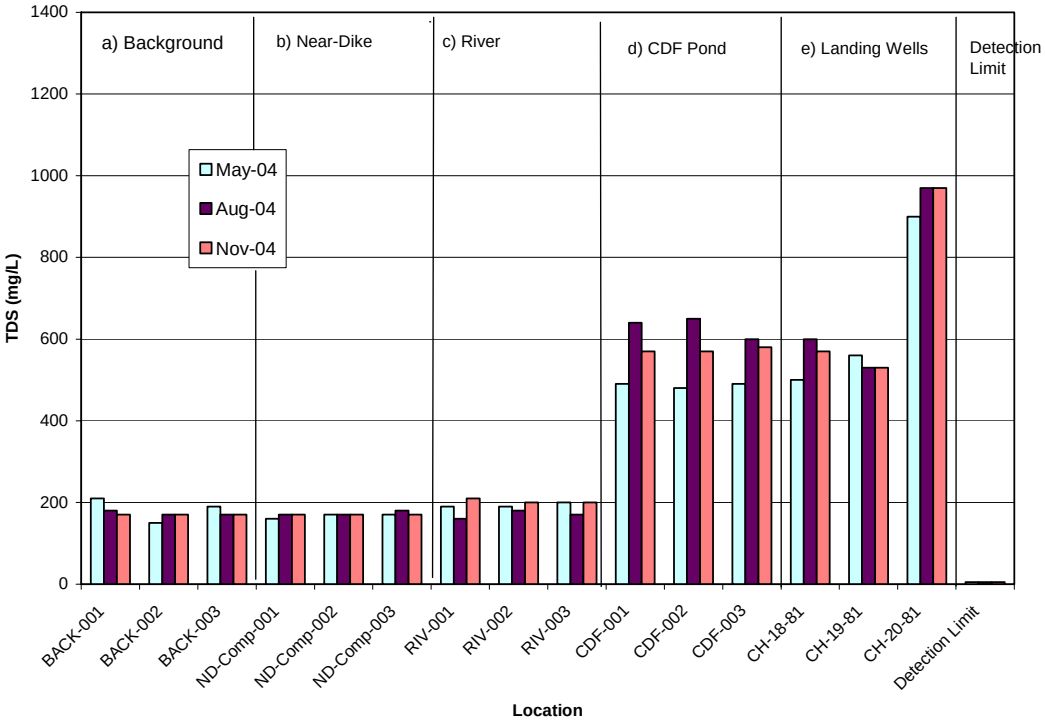

Figure 3H Total Suspended Solids Routine Monitoring Chicago Area CDF 2004

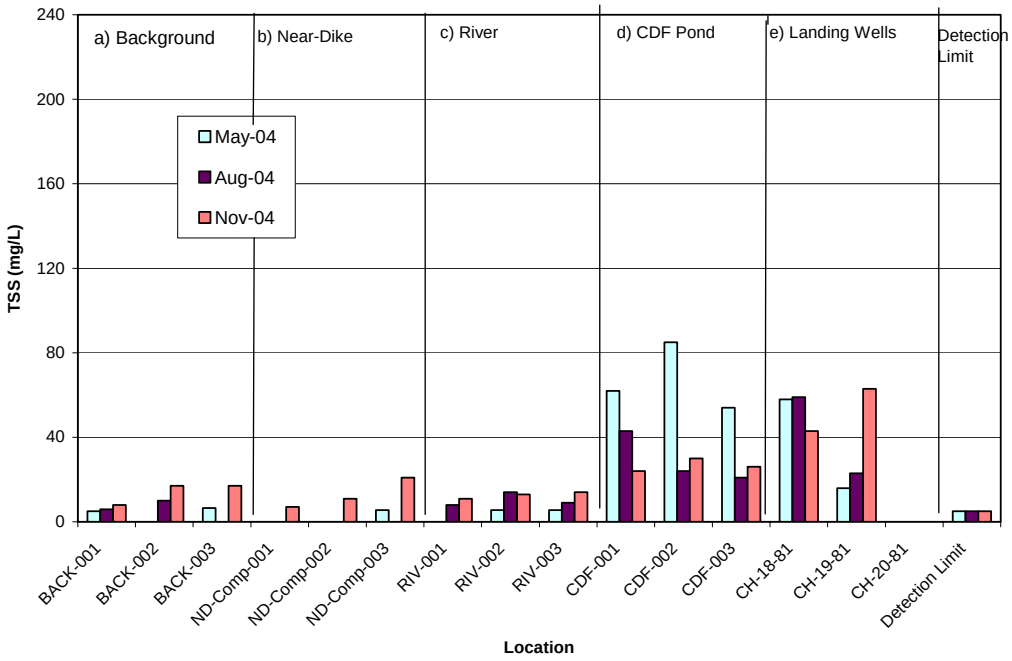

Figure 4 Comparison of Daily Mean Water Levels in Calumet Harbor and Chicago Area CDF