# DELAWARE RIVER MAIN CHANNEL DEEPENING PROJECT

# WATER QUALITY SCOPES OF WORK

U.S. Army Corps of Engineers, Philadelphia District

# Delaware River
# Main Channel Deepening Project
# Confined Disposal Facility Water Quality Monitoring
# Reedy Point North and/or South

## I. Scope of Work

The work under this contract includes an evaluation of the chemical quality of dredged material and water flowing into and out of the Reedy Point North and/or South confined disposal facility during initial construction of the Delaware River Main Channel Deepening Project. Samples will be collected concurrent with dredging operations. Dredging will last approximately four to six weeks. Sampling will include material flowing into the disposal facility (influent), water and associated suspended sediment discharging from the facility (effluent), water samples collected in the Delaware River in the vicinity of the discharge point (representing the discharge plume), and water samples collected in the Delaware River at a location that can provide background water quality data. Samples will be collected and appropriately preserved in the field, and delivered to a laboratory for various chemical and geotechnical analyses. Instrumentation will be installed at the discharge pipe to collect daily readings of the volume of water being discharged from the disposal site and the concentration of suspended sediment associated with the discharge. In addition to the water quality monitoring, chronic toxicity of effluent discharged from the confined disposal facility will be estimated via seven-day, static renewal, water column bioassays.

## II. Sample Collection

Influent: Four influent samples shall be collected over the course of the dredging operation, which is estimated to last four to six weeks. Sample collection shall be evenly spaced over the period of dredging. Storage and preservation procedures for these sediment samples are provided as Appendix A. These procedures are from: *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (New Jersey Department of Environmental Protection, 1997). All analyses shall be conducted within the specified holding times. Samples to be analyzed for metals should not come in contact with metal sampling equipment, and samples to be analyzed for organic compounds should not come into contact with plastics. All sample containers should be appropriately cleaned: acid-rinsed (10% nitric acid) for metal analysis, and solvent-rinsed (acetone is preferred; however, other approved solvents such as methanol and hexane can be used as well) for organic analysis. When equipment will be used to take samples for both metal and organic compound analysis, the acid rinse must be conducted first, and the solvent rinse second. Samples should completely fill the storage container, leaving no head space, except for expansion volume required for potential freezing. Samples should be refrigerated or frozen with dry ice immediately after sample collection.

Effluent: A total of eight effluent samples will be collected over the discharge period. Composite effluent samples will be collected using an automatic sampler. The sampler will be programmed to collect water at six-hour intervals, over the course of four days. These composite samples will be used for analysis of metals, chlorinated pesticides and PCBs. Effluent samples for analysis of semi-volatile organic compounds will be collected in a single day. For these samples, water will be collected hourly, and composited over a six-hour period. Effluent samples will be collected from water that has overflowed the weir into the sluice box. Storage and preservation procedures for these water samples are provided as Appendix A. These procedures are from: *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (New Jersey Department of Environmental Protection, 1997). All analyses shall be conducted within the specified holding times. Water samples should be collected with either a non-contaminating pump (peristaltic or magnetically coupled impeller design pump) or a discrete water sampler. The pump system should be flushed with 10 times the volume of the collection tubing using site water. The discrete water sampler should be of stainless steel or acrylic plastic and be of the closed/opened/closed type. Seals should be teflon-coated. All water sampling devices should be acid-rinsed (10% nitric acid) for metal analysis, and solvent-rinsed (acetone is preferred; however, other approved solvents such as methanol and hexane can be used as well) for organic analysis. When equipment will be used to take samples for both metal and organic compound analysis, the acid rinse must be conducted first, and the solvent rinse second.

Delaware River (discharge plume): A total of eight water samples will be collected from the Delaware River in the vicinity of the discharge point, at a location considered representative of the discharge plume. These samples will be collected at slack tide, either high or low, depending on the tide cycle. Sample location will be based on Delaware River Basin Commission guidelines for mixing zones to the Delaware estuary: (1) five times the local water depth at the point of discharge; or (2) 50 times the discharge length scale of the discharge outlet. All samples shall be collected at a depth equal to 0.6 of the water depth at the collection site. Storage and preservation procedures for these water samples are the same as those described for the effluent samples.

Delaware River (background): A total of four water samples will be collected from the Delaware River at a location that can provide background water quality data. Sample collection shall be evenly spaced over the discharge period, which is estimated to be six to eight weeks. Samples will be collected at slack tide, either high or low, depending on the tide cycle. Samples will be collected from a location determined to be similar to the discharge site in physical regime, and free from direct influence of any known source of contaminants. All samples shall be collected at a depth equal to 0.6 of the water depth at the collection site. Storage and preservation procedures for these water samples are the same as those described for the effluent samples.

Weir Discharge: The volume of water discharged from the confined disposal facility and the concentration of total suspended solids associated with the discharge shall be measured on a daily basis for a total of 42 days following commencement of discharge from the site. The total daily volume of water discharged from the site must be recorded. An automatic sampler will be used to collect daily composite samples for determining total suspended solids concentrations. The sampler will be programmed to collect water at six-hour intervals, over a 24-hour period.

## III. Sample Analysis

Appendix B provides analytical procedures and associated quality assurance/quality control measures for sample analysis. These requirements are from: *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (New Jersey Department of Environmental Protection, 1997). All samples collected in association with operation of the confined disposal facility will be analyzed for the analytes listed in Attachment 1 of Appendix B. Note that volatile organic contaminants will not be analyzed in either the sediment or water samples. Attachment 1 also provides the required detection limits for sediment and water samples. In addition, for the water samples (effluent, discharge plume and background), because water quality criteria for seven metals are expressed as dissolved metal, dissolved inorganic analytes will be analyzed in addition to total inorganic analytes using test methods that can achieve detection limits of at least 2 ug/L. All samples (influent, effluent, discharge plume and background) will be analyzed for a conventional list of water quality parameters that include total suspended sediment, hardness, temperature, pH, conductivity, BOD, COD, TOC and ammonia.

In addition to the analytes listed in Attachment 1, the influent and effluent samples collected to evaluate the operation of the confined disposal facility will be analyzed using high resolution gas chromatograpy (HRGC) / high resolution mass spectrometry (HRMS) for 77 mono-ortho and di-ortho PCB congeners and four non-ortho coplanar PCB congeners using draft USEPA method 1668. The Delaware River discharge plume and background water samples will not be analyzed for PCB congeners. A list of the PCB congeners is provided as Appendix C. The HRGC/HRMS method shall provide detection limits of 1.25 ng/L for the mono- and di-ortho congeners and 25 pg/L for the non-ortho congeners in aqueous samples, and detection limits of 0.125 ng/g for mono- and di-ortho congeners and 12.5 pg/g for non-ortho congeners in sediment samples. Samples will not be analyzed for polychlorinated dibenzo-p-dioxin or dibenzofurans.

Dredged material is estimated to be composed of approximately 25 percent sediment and 75 percent water. In order to obtain chemical data for the influent samples, it will be necessary to partition the samples into the liquid and solid fractions. This will allow for the analysis of contaminants in the water fraction of the sample separately from the sediment-bound contaminants. After laboratory analysis, the concentrations of liquid- and solid-phase contaminants will be summed based on the volume of the original sample that was in liquid or solid form, and a total concentration for the influent sample will be obtained.

The grain size analyses will follow the methods described by Folk (1980), and the total organic carbon analyses will follow the procedure provided as

Attachment 4 to Appendix B. Total suspended solids will be analyzed using USEPA method 160.2.

## IV. Data Analysis

The data objectives of this study are: (1) to evaluate contaminant concentrations in the CDF weir discharge relative to State of Delaware regulatory criteria; (2) to estimate the percentage of contaminants in the dredged slurry retained by the CDF; (3) to estimate the total loadings of contaminants released back into the Delaware River through the CDF weir; and (4) to calculate changes in contaminant concentrations in the Delaware River as a result of the CDF discharge.

The confined disposal facility data will be analyzed to evaluate the efficiency of the site to contain contaminants associated with the dredged material placed in the site. Influent samples will provide an estimate of contaminant concentrations associated with the dredged material. Effluent samples collected at the point of discharge will provide an estimation of the approximate removal efficiency of the site. Data collected in the Delaware River in the vicinity of the discharge site will be compared with Delaware surface water quality standards to determine if the disposal operation meets applicable criteria after some initial mixing. Background receiving water samples will provide an evaluation of ambient conditions. The effects of the confined disposal facility discharge on ambient contaminant concentrations in the Delaware River will be analyzed using a Total Maximum Daily Load (TMDL) approach.

In addition to comparing contaminant concentrations to water quality standards for protection of aquatic life, the analysis will also include comparisons to water quality standards for protection of human health. This is most important with regard to PCBs, which are more a human health issue in the Delaware estuary (related to biomagnification within the food chain), rather than an aquatic life issue. It is understood that aquatic life concerns are a near-field issue, while human health concerns are a far-field issue. State of Delaware surface water quality standards (as amended, 11 August 1999) for protection of aquatic life and protection of human health can be found in Appendix D. These criteria will be evaluated using mass balance calculations and a Total Maximum Daily Load (TMDL) approach.

## V. Chronic Toxicity Testing

The chronic toxicity of effluent discharged from the confined disposal facility will be estimated via seven-day, static renewal, water column bioassays. Test procedures will follow: *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms* (EPA/600/4-91/003) July 1994. The inland silverside (*Menidia beryllina*) (Method 1006.0) and the mysid (*Mysidopsis bahia*) (Method 1007.0) will be used as indicator species. The test design will include the required number of serial dilutions and controls, and replicates of each as indicated by the methods. Effluent concentrations shall include 100%, 50%, 25%, 12.5% and 6.25%.

Test solutions will be renewed on a daily basis, with collection of new effluent samples on days one, three and five.

VI. Report Format and Content

Draft and final copies of the report of investigation will reflect and report the analysis outlined in this scope of work. Draft and final reports must contain the following features:

a. If the report has been written by someone other than the contract principal investigator, the cover and title page of the publishable report must bear the inscription Prepared Under the Supervision of (name), Principal Investigator. The principal investigator is required to sign the original copy of the report. In addition, the principal investigator must at least prepare a forward describing the overall research context of the report, the significance of the work, and any other related background circumstances relating to the manner in which the work was undertaken.

b. The TITLE PAGE will include the date (month and year) the report was submitted, the project name, the author, Prepared for the U.S. Army Corps of Engineers, Philadelphia District, and the contract number.

c. An EXECUTIVE SUMMARY that provides a brief description of the study's purpose, findings, conclusions and recommendations.

d. A TABLE OF CONTENTS that includes a list of all tables, figures and appendices presented in the report.

e. An INTRODUCTION section stating the purpose of the study with background information on the Delaware River Main Channel Deepening Project.

f. A METHODOLOGY section that describes the sampling and analysis equipment and methodologies.

g. A RESULTS section that presents collected data in tabular and graphic form, and details of applicable statistical analyses used to evaluate the data.

h. A DISCUSSION section that collates statistical data with published literature and draws inferences regarding operation of the confined disposal facility relative to Delaware River water quality issues.

i. A CONCLUSIONS section that emphasizes the main points articulated in the body of the report, and provides pertinent recommendations.

j. A LIST OF REFERENCES that includes literature cited and agencies/individuals consulted.

k. Appropriate APPENDICES for data sheets, records, and other pertinent information.

I. PAGE SIZE AND FORMAT. Each report will be produced on 8 ½ " x 11" paper, single spaced, with double spacing between paragraphs. Figures should not exceed 11" in height nor 12 " in length in most circumstances. Larger figures may be produced, but an 8 ½" x 11" version must be included in the report. All text pages (including appendices) must be consecutively numbered. Text print quality must be at least letter quality.

## VII. Period of Performance

Three copies of a draft report will be submitted to the Corps by (**Insert Date**). The draft report must be a polished product and an accurate representation of the content of the final report. The draft must be clean-typed, complete with all figures, tables and sections of the report. All graphics will appear in the same format, and general location in the report as they will be in the final report.

Subsequent to a two-month review period the Corps will provide the Contractor with comments on the draft report. The Contractor will then have an additional month to revise and submit the final report. The Contractor shall submit one unbound, reproducible original and five bound copies of the final report. The final report will be due on (**Insert Date**). When the Corps accepts the final report the contract will be complete.

## VIII. Inspection

The work will be conducted under the general discretion of the Contracting Officer and shall be subject to inspection by his appointed inspectors to insure strict compliance with the terms of the contract. The presence of the inspector shall not relieve the contractor of responsibility for the proper execution of the work in accordance with the above specifications.

# APPENDIX A
# SUMMARY OF RECOMMENDED PROCEDURES FOR SAMPLE COLLECTION, PRESERVATION AND STORAGE

Attachment 1

# SUMMARY OF RECOMMENDED PROCEDURES FOR SAMPLE COLLECTION, PRESERVATION, AND STORAGE

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| **Sediment** | | | | | | |
| **Chemical/Physical Analyses** | | | | | | |
| Metals | Grab/corer | 100 g | Precleaned polyethylene jar[e] | Dry ice[e] or freezer storage for extended storages; otherwise refrigerate | ≤ 4°C | Hg - 28 days<br>Others - 6 months[f] |
| Organic compounds (e.g., PCBs, pesticides, polycyclic aromatic hydrocarbons) | Grab/corer | 250 g | Solvent-rinsed glass jar with Teflon® lid[e] | Dry ice[e] or freezer storage for extended storage; otherwise refrigerate | ≤ 4°C[e]/dark[f] | 14 days[g] |
| Particle size | Grab/corer | 100 g | Whirl-pac bag[e] | Refrigerate | < 4°C | Undetermined |
| Total organic carbon | Grab/corer | 50 g | Heat treated glass vial with Teflon®-lined lid[e] | Dry ice[e] or freezer storage for extended storages; otherwise refrigerate | ≤ 4°C[e] | 14 days |
| Total solids/specific gravity | Grab/corer | 50 g | Whirl-pac bag | Refrigerate | < 4°C | Undetermined |
| Miscellaneous | Grab/corer | ≥ 50 g | Whirl-pac bag | Refrigerate | < 4°C | Undetermined |
| Sediment from which elutriate is prepared | Grab/corer | Depends on tests being performed | Glass with Teflon®-lined lid | Completely fill and refrigerate | 4°C/dark/airtight | 14 days |
| **Biological Tests** | | | | | | |
| Dredged material | Grab/corer | 12–15 L per sample | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |
| Reference sediment | Grab/corer | 45–50 L per test | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |
| Control sediment | Grab/corer | 21–25 L per test | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| **Water and Elutriate** | | | | | | |
| **Chemical/Physical Analyses** | | | | | | |
| Particulate analysis | Discrete sampler or pump | 500–2,000 mL | Plastic or glass | Lugols solution and refrigerate | 4°C | Undetermined |
| Metals | Discrete sampler or pump | 1 L | Acid-rinsed polyethylene or glass jar[j] | pH < 2 with $HNO_3$; refrigerate[j] | 4°C 2°C[j] | Hg - 14 days<br>Others - 6 months[k] |
| Total Kjeldahl nitrogen | Discrete sampler or pump | 100–200 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 24 h[k] |
| Chemical oxygen demand | Discrete sampler or pump | 200 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 7 days[k] |
| Total organic carbon | Discrete sampler or pump | 100 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | <48 hours[k] |
| Total inorganic carbon | Discrete sampler or pump | 100 mL | Plastic or glass[k] | Airtight seal; refrigerate[k] | 4°C[k] | 6 months[k] |
| Phenolic compounds | Discrete sampler or pump | 1 L | Glass[k] | 0.1–1.0 g $CuSO_4$; $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 24 hours[k] |
| Soluble reactive phosphates | Discrete sampler or pump | -- | Plastic or glass[k] | Filter; refrigerate[k] | 4°C[k] | 24 hours[k] |
| Extractable organic compounds (e.g., semi-volatile compounds) | Discrete sampler or pump | 4 L | Amber glass bottle[j] | pH < 2, 6N HCl; airtight seal; refrigerate | 4°C[j] | 7 days for extraction; 40 days for sample extract analyses[j] |
| Volatile organic compounds | Discrete sampler or pump | 80 mL | Glass vial[j] | pH < 2 with 1:1 HCL; refrigerate in airtight, completely filled container[j] | 4°C[j] | 14 days for sample analysis, if preserved[j] |
| Total phosphorus | Discrete sampler or pump | -- | Plastic or glass[h] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 7 days[k] |

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| Total solids | Discrete sampler or pump | 200 mL | Plastic or glass[k] | Refrigerate | 4°C[k] | 7 days[k] |
| Volatile solids | Discrete sampler or pump | 200 mL | Plastic or glass[k] | Refrigerate | 4°C[k] | 7 days[k] |
| Sulfides | Discrete sampler or pump | -- | Plastic or glass[k] | pH > 9 NaOH (ZnAc); refrigerate[k] | 4°C[k] | 24 hours[k] |
| **Biological Tests** | | | | | | |
| Site water | Grab | Depends on tests being performed | Plastic carboy | Refrigerate | < 4°C | 14 days |
| Dilution water | Grab or makeup | Depends on tests being performed | Plastic carboy | Refrigerate | < 4°C | 14 days |
| **Tissue** | | | | | | |
| Metals | Trawl/Teflon®-coated grab | 5–10 g | Double Ziploc®[e] | Handle with non-metallic forceps; plastic gloves; dry ice[e] | ≤ –20°C[e] or freezer storage | Hg - 28 days<br>Others - 6 months[m] |
| PCBs and chlorinated pesticides | Trawl/Teflon®-coated grab | 10–25 g | Hexane-rinsed double aluminum foil and double Ziploc®[e] | Handle with hexane-rinsed stainless steel forceps; dry ice[e] | ≤ –20°C[e] or freezer storage | 14 days[g] |
| Volatile organic compounds | Trawl/Teflon®-coated grab | 10–25 g | Heat-cleaned aluminum foil and watertight plastic bag[f] | Covered ice chest[f] | ≤ –20°C[m] or freezer storage | 14 days[m] |
| Semivolatile organic compounds | Trawl/Teflon®-coated grab | 10–25 g | Hexane-rinsed double aluminum foil and double Ziploc®[e] | Handle with hexane-rinsed stainless steel forceps; dry ice[e] | ≤ –20°C[e] or freezer storage | 14 days[g] |
| Lipids | Trawl/Teflon®-coated grab | Part of organic analyses | Hexane-rinsed aluminum foil | Handle with hexane-rinsed stainless steel forceps; quick freeze | ≤ –20°C or freezer storage | 14 days[g] |

**Note:** This table contains only a summary of collection, preservation, and storage procedures for samples. The cited references should be consulted for a more detailed description of these procedures.

PCB - polychlorinated biphenyl

[a] Collection method should include appropriate liners.

[b] Amount of sample required by the laboratory to perform the analysis (wet weight or volume provided, as appropriate). Miscellaneous sample size for sediment should be increased if auxiliary analytes that cannot be included as part of the organic or metal analyses are added to the list. The amounts shown are not intended as firm values; more or less tissue may be required depending on the analytes, matrices, detection limits, and particular analytical laboratory.

[c] All containers should be certified as clean according to U.S. EPA (1990c).

[d] These holding times are for sediment, water, and tissue based on guidance that is sometimes administrative rather than technical in nature. There are no promulgated, scientifically based holding time criteria for sediments, tissues, or elutriates. References should be consulted if holding times for sample extracts are desired. Holding times are from the time of sample collection.

[e] NOAA (1989).

[f] Tetra Tech (1986a).

[g] Sample may be held for up to 1 year if ≤ −20°C.

[h] Polypropylene should be used if phthalate bioaccumulation is of concern.

[i] Two weeks is recommended; sediments must not be held for longer than 8 weeks prior to biological testing.

[j] U.S. EPA (1987a); 40 CFR Part 136, Table III.

[k] Plumb (1981).

[l] If samples are not preserved to pH < 2, then aromatic compounds must be analyzed within 7 days.

[m] Tetra Tech (1986b).

Excerpted from pp. 54-57 of the USEPA "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations", Office of Water (EPA 823-B-95-0001, April 1995).

# APPENDIX B
# ANALYTICAL PROCEDURES AND ASSOCIATED QUALITY ASSURANCE/QUALITY CONTROL MEASURES

# APPENDIX B - ANALYTICAL PROCEDURES AND ASSOCIATED QUALITY ASSURANCE/QUALITY CONTROL MEASURES

## I. Required Target Analyte Lists and Methodologies:

### (a) Target analytes:

Required bulk sediment chemistry, modified elutriate, and leaching tests must include analysis for all target analytes listed in Attachment 1, excepting the volatile organic compounds list, which will be required on a case by case basis. Typically, volatile organic compound testing will be instituted where known or suspected discharges of such compounds have occurred. Dioxin/furan analysis is required for all projects in Region 1.

The list of target analytes in Attachment 1 represents the constituents common to both the USEPA Contract Laboratory Program (CLP) analytes and the much larger list of compounds evaluated under the USEPA SW-846 testing program (SW-846). This latter program specifically employs the Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Publication SW-846. While the SW-846 methods are distinct from the CLP methods, they are considered to be equivalent. Attachment 1 also details the required quantitation limit for each target analyte. The estimated quantitation limit (EQL) specified is the higher of the quantitation limits associated with the CLP and SW-846 programs. There is no requirement to use either the CLP or SW-846 analytical methodologies; however, the method employed must achieve the required EQL and must be from a standard method from a recognized agency. Alternatively, a method with prior approval by the Department may be employed. The analysis must be done by a Department certified laboratory.

### (b) Polychlorinated Biphenyls:

Polychlorinated biphenyls (PCBs) are required by the USEPA to be reported on an individual congener basis as well as a total PCB value. However, the Department anticipates that upland disposal of dredged material will be the primary type of proposal evaluated. This will increase the potential need to assess human health impacts due to PCBs.

The Department evaluates potential human health impacts of upland management and disposal activities using a Total Aroclor criterion. Therefore, it is acceptable to provide data to the Department using Aroclor based analysis methods (SW-846 Method 8081 or its equivalent) where aquatic species impacts are not anticipated. Where aquatic species impacts are a concern, the Department will require congener specific based analysis for PCBs using the Sloan method, NOAA Technical Memorandum NOS ORCA-71 or its equivalent. This is the same methodology that the USEPA employs. In order to be further consistent with the USEPA and to avoid duplicative analytical costs, the Department will also accept congener specific results if required by the USEPA or if already available. These congener specific results will be converted to a total PCB value by multiplying the sum of the 22 individual congeners by a factor of 2 as per the T. O'Connor, National Ocean Service, National Oceanic and Atmospheric Administration, July 20, 1994 memorandum to S. Ausubel, USEPA Region II (O'Connor 1994) and as per Contaminant Levels in Muscle and Hepatic Tissue of Lobster from the New York Bight Apex (National Marine Fisheries Service 1996). That computed result will then be compared against the

Total Aroclor based human health criteria. The recommended MDLs for all individual PCB congeners are 1 ug/kg dry weight (sediment) and 0.0005 ug/l (water).

### (c) Polychlorinated Dibenzo-p-Dioxin and Dibenzofurans

When required, analysis will be conducted for all seventeen (17) 2,3,7,8 substituted polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofurans using EPA Method 1613 Revision B. While not preferred, SW-846 Method 8290 is also acceptable. The required congeners and related isotopes used for analysis are shown in Attachment 2. The analytical sensitivity should be within 5 times that which is cited in the method for each matrix type. Testing for these analytes will be required by the Department on a case by case basis in Region 1 waters.

All polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran congener results, in both sediment and water matrices, must be reported in both individual congener concentrations and summarized as 2,3,7,8-tetrachlorodibenzo(p)dioxin toxic equivalents using the Toxic Equivalent Factors, International 1988 Method in Attachment 3. For those values reported as Estimated Maximum Possible Concentrations (EMPCs), the full EMPC value should be used.

### (d) Grain size analysis:

The grain size analysis must be conducted according to the methods described by Folk 1980.

Results must be reported as percentages within the general size classes:

Sand: equal to or greater than 0.0625 mm diameter

Silt: less than 0.0625 mm diameter and equal to or greater than 0.0039 mm diameter

Clay: less than 0.0039 mm diameter

### (e) Total Organic Carbon

Total organic carbon analysis must be conducted according to the USEPA 1986 method, excerpted from the December 1992 regional manual for USEPA Region II and the New York District Corps of Engineers, entitled, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal" (Attachment 4).

### (f) Multiple Extraction Procedure

Testing of sediments which have been modified prior to final placement may be required to undergo testing to evaluate their potential for contaminant leaching. One procedure used to accomplish this task is the Multiple Leaching Procedure (EPA Method 1320).

## II. Quality Assurance/Quality Control Guidance and Reporting Requirements

The guidance described below has been drawn from the December 1992 regional manual for USEPA Region II and the New York District Corps of Engineers, entitled, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal"; the EPA and the USACE "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations," (EPA 823-B-95-001, April 1995); and the "Field Sampling Procedures Manual," New Jersey Department of Environmental Protection and Energy, May 1992.

The following quality control samples or procedures will be required for chemical analysis of both sediment and water matrices:

1. Field blanks: One with every batch of 1-20 samples
2. Method blanks: One with every batch of 1-20 samples or every 12 hours, whichever is less
3. Matrix spike and matrix spike duplicate: One set with every batch of 1-20 samples
4. Surrogate spike recovery: Each sample, organic compounds only
5. Minimum detection limit verification within last 2 years for marine sediments and salt water matrices to be submitted to the Department upon request (procedure or citation at 40 CFR 136 [1994] Appendix B, Revision 1.11).
6. Duplicate analyses to be conducted as per method requirements

All bulk sediment chemistry results must be reported on a dry weight basis. All raw data should be presented along with the appropriate criterion. Exceedances of the criterion must be highlighted in an acceptable fashion.

The need to supply either full or reduced data deliverables will be determined by the Department on a case by case basis. The need for the applicant to obtain the services of a data validation contractor will concurrently be determined by the Department at the pre-application stage.

The data reports submitted to the Department for testing and analysis of material proposed for dredging must include a description of all methods and procedures used in the field and in the laboratory, referencing established protocols or guidance, for the following:

1. Sample collection
2. Sample preparation (including homogenizing and compositing)
3. Sample preservation methods and holding times (before and after extraction)
4. Chain of custody tracking documents
5. Sample transport, storage, and disposal
6. Sample analysis
7. Data entry and data reduction
8. Deviations from standard methods or prescribed procedures
9. QA/QC summary and data
10. Narrative of analytical problems, corrective action taken, effects on data interpretation

## III. References for APPENDICES A AND B

Folk, R. 1980. Petrology of Sedimentary Rocks. Hemphill Publishing Co., Texas. 181 p.

National Marine Fisheries Service. 1996. Contaminant Levels in Muscle and Hepatic Tissue of Lobster from the New York Bight Apex.

N.J. Department of Environmental Protection and Energy. 1992. Field Sampling Procedures Manual. 363 p.

O'Connor, T. 1994. Personal communication on July 20, 1994 to S. Ausubel, U.S. Environmental Protection Agency, Region II.

Sloan, N.; G. Adams; R. Pearce; D. Brown; and S-L Chan. 1993. Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects 1984 - 1992, Volume IV Comprehensive Descriptions of Trace Organic Analytical Methods. NOAA Technical Memorandum NOS ORCA 71. 97 p.

U.S. Army Corps of Engineers, New York District and the U.S. Environmental Protection Agency, Region II. 1992. Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal (Draft).

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1991. Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual. EPA-503/8-91/001.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1995. QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations. EPA 823-B-95-001.

Attachment 1

| TARGET ANALYTE LIST | | |
|---|---|---|
| Analyte | Limits of Detection | |
| **Volatiles** | Water (ug/L) | Soil (ug/Kg) |
| Chloromethane | 10 | 10 |
| Bromomethane | 10 | 10 |
| Vinyl Chloride | 10 | 10 |
| Chloroethane | 10 | 10 |
| Methylene Chloride | 10 | 10 |
| Acetone | 10 | 10 |
| Carbon Disulfide | 10 | 10 |
| 1,1-Dichloroethene | 10 | 10 |
| 1,1-Dichloroethane | 10 | 10 |
| 1,2-Dichloroethene (total) | 10 | 10 |
| Chloroform | 10 | 10 |
| 1,2-Dichloroethane | 10 | 10 |
| 2-Butanone(MEK) | 10 | 10 |
| 1,1,1-Trichloroethane | 10 | 10 |
| Carbon Tetrachloride | 10 | 10 |
| Bromodichloromethane | 10 | 10 |
| 1,2-Dichloropropane | 10 | 10 |
| cis-1,3-Dichloropropene | 10 | 10 |
| trichloroethene | 10 | 10 |
| Dibromochloromethane | 10 | 10 |
| 1,1,2-Trichloroethane | 10 | 10 |
| Benzene | 10 | 10 |
| trans-1,3-Dichloropropene | 10 | 10 |
| Bromoform | 10 | 10 |
| 4-Methyl-2-pentanone(MIBK) | 10 | 10 |
| 2-Hexanone | 10 | 10 |
| Tetrachloroethene | 10 | 10 |
| 1,1,2,2-Tetrachloroethane | 10 | 10 |
| Toluene | 10 | 10 |
| Chlorobenzene | 10 | 10 |
| Ethylbenzene | 10 | 10 |
| Styrene | 10 | 10 |
| Xylenes(total) | 10 | 10 |
| | | |
| | | |
| | | |
| | | |
| **Semivolatiles** | | |
| Phenol | 10 | 660 |
| bis-(2-Chloroethyl)ether | 10 | 660 |
| 2-Chlorophenol | 10 | 660 |
| 1,3-Dichlorobenzene | 10 | 660 |
| 1,4-Dichlorobenzene | 10 | 660 |
| 1,2-Dichlorobenzene | 10 | 660 |
| 2-Methylphenol | 10 | 660 |
| 2,2'-oxybis(1-Chloropropane) | 10 | 660 |
| 4-Methylphenol | 10 | 660 |
| N-Nitroso-di-n-propylamine | 10 | 660 |

|  | Limits of Detection |  |
|---|---|---|
| **Semivoilatiles (continued)** | Water (ug/L) | Soil (ug/Kg) |
| Hexachloroethane | 10 | 660 |
| Nitrobenzene | 10 | 660 |
| Isophorone | 10 | 660 |
| 2-Nitrophenol | 10 | 660 |
| 2,4-Dimethylphenol | 10 | 660 |
| bis(2-Chloroethoxy)methane | 10 | 660 |
| 2,4-Dichlorophenol | 10 | 660 |
| 1,2,4-Trichlorobenzene | 10 | 660 |
| Naphthalene | 10 | 660 |
| 4-Chloroaniline | 20 | 1300 |
| Hexachlorobutadiene | 10 | 660 |
| 4-Chloro-3-methylphenol | 20 | 1300 |
| 2-Methylnaphthalene | 10 | 660 |
| Hexachlorocylcopentadiene | 10 | 660 |
| 2,4,6-Trichlorophenol | 10 | 660 |
| 2,4,5-Trichlorophenol | 10 | 660 |
| 2-Chloronaphthalene | 10 | 660 |
| 2-Nitroaniline | 50 | 3300 |
| Dimethylphthalate | 10 | 660 |
| Acenaphthylene | 10 | 660 |
| 2,6-Dinitrotoluene | 10 | 660 |
| 3-Nitroaniline | 50 | 3300 |
| Acenaphthene | 10 | 660 |
| 2,4-Dinitrophenol | 50 | 3300 |
| 4-Nitrophenol | 50 | 3300 |
| Dibenzofuran | 10 | 660 |
| 2,4-Dinitrotoluene | 10 | 660 |
| Diethylphthalate | 10 | 660 |
| 4-Chlorophenyl-phenyl ether | 10 | 660 |
| Fluorene | 10 | 660 |
| 4-Nitroaniline | 20 | 830 |
| 4,6-Dinitro-2-methylphenol | 50 | 3300 |
| N-Nitroso-diphenylamine | 10 | 660 |
| 4-Bromophenyl-phenylether | 10 | 660 |
| Hexachlorobenzene | 10 | 660 |
| Pentachlorophenol | 50 | 3300 |
| Phenanthrene | 10 | 660 |
| Anthracene | 10 | 660 |
| Carbazole | 10 | 330 |
| Di-n-butylphthalate | 10 | 330 |
| Fluoranthene | 10 | 660 |
| Pyrene | 10 | 660 |
| Butylbenzylphthalate | 10 | 660 |
| 3,3'-Dichlorobenzidine | 20 | 1300 |
| Benzo(a)anthracene | 10 | 660 |
| Chrysene | 10 | 660 |
| bis(2-Ethylhexyl)phthalate | 10 | 660 |
| Di-n-octlyphthalate | 10 | 660 |
| Benzo(b)fluoranthene | 10 | 660 |

|  | Limits of Detection |  |
|---|---|---|
| **Semivolatiles (continued)** | Water (ug/L) | Soil (ug/Kg) |
| Benzo(k)fluoranthene | 10 | 660 |
| Benzo(a)pyrene | 10 | 660 |
| Indeno(1,2,3-cd)pyrene | 10 | 660 |
| Dibenzo(a,h)anthracene | 10 | 660 |
| Benzo(g,h,i)perylene | 10 | 660 |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
| **Pesticides/Aroclors** |  |  |
| alpha-BHC | 0.05 | 1.9 |
| beta-BHC | 0.05 | 3.3 |
| delta-BHC | 0.05 | 1.7 |
| gamma-BHC (Lindane) | 0.05 | 2 |
| Heptachlor | 0.05 | 2.1 |
| Aldrin | 0.05 | 2 |
| Heptachlor epoxide | 0.05 | 2.1 |
| Endosulfan I | 0.05 | 2.1 |
| Dieldrin | 0.10 | 3.3 |
| 4,4'-DDE | 0.10 | 4.2 |
| Endrin | 0.10 | 3.6 |
| Endosulfan II | 0.10 | 3.3 |
| 4,4'-DDD | 0.10 | 4.2 |
| Endosulfan sulfate | 0.10 | 3.6 |
| 4,4'-DDT | 0.10 | 3.6 |
| Methoxychlor | 0.50 | 17 |
| Endrin ketone | 0.10 | 3.3 |
| Endrin aldehyde | 0.10 | 3.3 |
| alpha-Chlordane | 0.05 | 1.7 |
| gamma-Chlordane | 0.05 | 1.7 |
| Toxaphene | 5.0 | 170 |
| Aroclor-1016 | 1.0 | 33 |
| Aroclor-1221 | 2.0 | 67 |
| Aroclor-1232 | 1.0 | 33 |
| Aroclor-1242 | 1.0 | 33 |
| Aroclor-1248 | 1.0 | 33 |
| Aroclor-1254 | 1.0 | 33 |
| Aroclor-1260 | 1.0 | 33 |
|  |  |  |
|  |  |  |
| **Inorganics** | ug/L | mg/Kg |
| Aluminum | 200 | 40 |
| Antimony | 60 | 12 |
| Arsenic | 10 | 2 |
| Barium | 200 | 40 |
| Beryllium | 5 | 1 |
| Cadmium | 5 | 1 |
| Calcium | 5000 | 1000 |
| Chromium | 10 | 2 |

|  | Limits of Detection |  |
|---|---|---|
| **Inorganics (continued)** | Water (ug/L) | Soil (mg/Kg) |
| Cobalt | 50 | 10 |
| Copper | 25 | 5 |
| Iron | 100 | 20 |
| Lead | 3 | 0.6 |
| Magnesium | 5000 | 1000 |
| Manganese | 15 | 3 |
| Mercury | 0.2 | 0.1 |
| Nickel | 40 | 8 |
| Potassium | 5000 | 1000 |
| Selenium | 5 | 1 |
| Silver | 10 | 2 |
| Sodium | 5000 | 1000 |
| Thallium | 10 | 2 |
| Vanadium | 50 | 10 |
| Zinc | 20 | 4 |
| Cyanide | 10 | 0.5 |

## Attachment 2

Retention Time References, Quantitation References, Relative Retention Times, and Minimum Levels for CDDs and CDFs

| Compound | Retention Time and Quantitation Reference | Relative Retention Time | Minimum Level[1] | | |
|---|---|---|---|---|---|
| | | | Water (pg/L; ppq) | Solid (ng/kg; ppt) | Extract (pg/µL; ppb) |
| *Compounds using $^{13}C_{12}$-1,2,3,4-TCDD as the injection internal standard* | | | | | |
| 2,3,7,8-TCDF | $^{13}C_{12}$-2,3,7,8-TCDF | 0.999–1.003 | 10 | 1 | 0.5 |
| 2,3,7,8-TCDD | $^{13}C_{12}$-2,3,7,8-TCDD | 0.999–1.002 | 10 | 1 | 0.5 |
| 1,2,3,7,8-PeCDF | $^{13}C_{12}$-1,2,3,7,8-PeCDF | 0.999–1.002 | 50 | 5 | 2.5 |
| 2,3,4,7,8-PeCDF | $^{13}C_{12}$-2,3,4,7,8-PeCDF | 0.999–1.002 | 50 | 5 | 2.5 |
| 1,2,3,7,8-PeCDD | $^{13}C_{12}$-1,2,3,7,8-PeCDD | 0.999–1.002 | 50 | 5 | 2.5 |
| *Compounds using $^{13}C_{12}$-1,2,3,7,8,9-HxCDD as the injection internal standard* | | | | | |
| 1,2,3,4,7,8-HxCDF | $^{13}C_{12}$-1,2,3,4,7,8-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,6,7,8-HxCDF | $^{13}C_{12}$-1,2,3,6,7,8-HxCDF | 0.997–1.005 | 50 | 5 | 2.5 |
| 1,2,3,7,8,9-HxCDF | $^{13}C_{12}$-1,2,3,7,8,9-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 2,3,4,6,7,8-HxCDF | $^{13}C_{12}$-2,3,4,6,7,8,-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,7,8-HxCDD | $^{13}C_{12}$-1,2,3,4,7,8-HxCDD | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,6,7,8-HxCDD | $^{13}C_{12}$-1,2,3,6,7,8,-HxCDD | 0.998–1.004 | 50 | 5 | 2.5 |
| 1,2,3,7,8,9-HxCDD | —[2] | 1.000–1.019 | 50 | 5 | 2.5 |
| 1,2,3,4,6,7,8-HpCDF | $^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,7,8,9-HpCDF | $^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,6,7,8-HpCDD | $^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD | 0.999–1.001 | 50 | 5 | 2.5 |
| OCDF | $^{13}C_{12}$-OCDD | 0.999–1.008 | 100 | 10 | 5.0 |
| OCDD | $^{13}C_{12}$-OCDD | 0.999–1.001 | 100 | 10 | 5.0 |

1. The Minimum Level (ML) for each analyte is defined as the level at which the entire analytical system must give a recognizable signal and acceptable calibration point. It is equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.
2. The retention time reference for 1,2 3,7,8,9-HxCDD is $^{13}C_{12}$-1,2,3,6,7,8-HxCDD, and 1,2,3,7,8,9-HxCDD is quantified using the averaged responses for $^{13}C_{12}$-1,2,3,4,7,8-HxCDD and $^{13}C_{12}$-1,2,3,6,7,8-HxCDD.

Attachment 3: This is the toxicity equivalent factor guidance. Note that CDD and CDF are acronyms for chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans. T, Pe, Hx, Hp, and O stand for tetra, penta, hexa, hepta, and octa, respectively.

| Compound | Toxicity Equivalency Factor (TEF) |
|---|---|
| 2,3,7,8-TCDD | 1.000 |
| 1,2,3,7,8-PeCDD | 0.500 |
| 1,2,3,4,7,8-HxCDD | 0.100 |
| 1,2,3,6,7,8-HxCDD | 0.100 |
| 1,2,3,7,8,9-HxCDD | 0.100 |
| 1,2,3,4,6,7,8-HpCDD | 0.010 |
| 1,2,3,4,6,7,8,9-OCDD | 0.001 |
| | |
| 2,3,7,8-TCDF | 0.100 |
| 1,2,3,7,8-PeCDF | 0.050 |
| 2,3,4,7,8-PeCDF | 0.500 |
| 1,2,3,6,7,8-HxCDF | 0.100 |
| 1,2,3,7,8,9-HxCDF | 0.100 |
| 1,2,3,4,7,8-HxCDF | 0.100 |
| 2,3,4,6,7,8-HxCDF | 0.100 |
| 1,2,3,4,6,7,8-HpCDF | 0.010 |
| 1,2,3,4,7,8,9-HpCDF | 0.010 |
| 1,2,3,4,6,7,8,9-OCDF | 0.001 |

ıll other CDD and CDF have a TEF of zero.

Attachment 4

# DETERMINATION OF TOTAL ORGANIC CARBON

## 1.0 APPLICATION AND SCOPE

This method, developed by the U.S. Environmental Protection Agency, Region II, Environmental Services Division laboratory in Edison, New Jersey, describes protocols for the determination of organic carbon in ocean sediments. Although the detection limit may vary with procedure or instrument, a minimum reporting value of 100 mg/kg will be required for the ocean dumping/dredging program. Several types of determinations, which are considered equivalent, are presented in this procedure. However, wet combustion methods are not considered to be equivalent to the pyrolytic methods described.

In this method, inorganic carbon from carbonates and bicarbonates is removed by acid treatment. The organic compounds are decomposed by pyrolysis in the presence of oxygen or air. The carbon dioxide that is formed is determined by direct nondispersive infrared detection, flame ionization gas chromatography after catalytic conversion of the carbon dioxide to methane; thermal conductivity gas chromatography, differential thermal conductivity detection by sequential removal of water and carbon dioxide; or thermal conductivity detection following removal of water with magnesium perchlorate.

Water content is determined on a separate portion of sediment and data are reported in mg/kg on a dry weight basis.

## 2.0 DEFINITIONS

The following terms and acronyms are associated with this procedure:

| | |
|---|---|
| LRB | Laboratory record book |
| TOC | Total organic carbon |

## 3.0 PROCEDURE

### 3.1 Sample collection

Collect sediments in glass jars with lids lined with Teflon or aluminum foil. Cool samples and maintain at 4°C. Analyze samples within 14 days. If unrepresentative material is to be removed from the sample, it should be removed in the field under the supervision of the chief scientist and noted in the LRB on the field log sheet.

### 3.2 Apparatus and Reagents

- Drying oven maintained at 103° to 105°C.
- Analytical instrument. No specific TOC analyzer is recommended as superior. The following listing is for information on instrument options only, and is not intended to restrict the use of other unlisted instruments capable of analyzing TOC. The instrument to be used must meet the following specifications:
  - A combustion boat that is heated in a stream of oxygen or air in a resistance or induction-type furnace to completely convert organic substances to $CO_2$ and water.
  - A means to physically or by measurement technique to separate water and other interferants from $CO_2$.
  - A means to quantitatively determine $CO_2$ with adequate sensitivity (100 mg/kg), and precision (25% at the 95% confidence level as demonstrated by repetitive measurements of a well-mixed ocean sediment sample).
  - A strip chart or other permanent recording device to document the analysis.

(1.) Perkin Elmer Model 240C Elemental Analyzer or equivalent. In this instrument, the sample from Section 3.5 is pyrolyzed under pure oxygen, water is removed by magnesium perchlorate and the carbon dioxide is removed by ascarite. The decrease in signal obtained by differential thermal conductivity detectors placed between the combustion gas stream before and after the ascarite tube is a measure of the organic carbon content.

(2.) Carlo Erba Model 1106 CHN Analyzer, or equivalent. In this apparatus, the sample is pyrolyzed in an induction-type furnace, and the resultant carbon dioxide is chromatographically separated and analyzed by a differential thermal conductivity

detector.

(3.) LECO Models WR12, WR112, or CR-12 carbon determinators, or Models 600 or 800 CHN analyzers. In the LECO WR-12, the sample is burned in high frequency induction furnace, and the carbon dioxide is selectively absorbed at room temperature in a molecular sieve. It is subsequently released by heating and is measured by a thermal conductivity detector. The WR-112 is an upgraded WR-12 employing microprocessor electronics and a printer to replace the electronic digital voltmeter.

In the LECO CR-12 carbon determinator, the sample is combusted in oxygen, moisture and dust are removed by appropriate traps, and the carbon dioxide is measured by a selective, solid state, infrared detector. The signal from the detector is then processed by a microprocessor and the carbon content is displayed on a digital readout and recorded on an integral printer.

In the LECO CHN-600 and CHN-800 elemental analyzers, the sample is burned under oxygen in a resistance furnace and the carbon dioxide is measured by a selective infrared detector.

(4.) Dohrman Model DC85 Digital High Temperature TOC Analyzer. In this instrument, the sample is burned in resistance furnace under oxygen, the interfering gases are removed by a sparger/scrubber system, and the carbon dioxide is measured by a non-dispersive infrared detector and shown on a digital display in concentration units.

- Reagents

(1.) Distilled water used in preparation of standards and for dilution of samples should be ultrapure to reduce the carbon concentration of the blank.

(2.) Potassium hydrogen phthalate, stock solution, 1000 mg carbon/L: Dissolve 0.2128 g of potassium hydrogen phthalate (Primary Standard Grade) in distilled water and dilute to 100.0 mL.

NOTE: Sodium oxalate and acetic acid are not recommended as stock solutions.

(3.) Potassium hydrogen phthalate, standard solutions: Prepare standard solutions from the stock solution by dilution with distilled water.

(4.) Phosphoric acid solution, 1:1 by volume.

### 3.3 Interferences

3.3.1 Volatile organics in the sediments may be lost in the decarbonation step resulting in a low bias.

3.3.2 Bacterial decomposition and volatilization of the organic compounds are minimized by maintaining the sample at 4 °C, analyzing within the specified holding time, and analyzing the wet sample.

### 3.4 Sample Preparation

3.4.1 Allow frozen samples to warm to room temperature. Homogenize each sample mechanically, incorporating any overlying water.

3.4.2 Weigh the well-mixed sample (up to 500 mg) into the combustion boat or cup. Add 1:1 phosphoric acid dropwise until effervescence stops. Heat to 75°C.

NOTE: This procedure will convert inorganic carbonates and bicarbonates to carbon dioxide and eliminate it from the sample.

### 3.5 Sample Analysis

Analyze the residue according to the instrument manufacturer's instructions.

### 3.6 Percent Residue Determination

Determine percent residue on a separate sample aliquot as follows:

3.6.1 Heat a clean 25-mL beaker at 103° to 105°C for 1 h. Cool in a desiccator, weigh to

the nearest mg, and store in desiccator until use.

3.6.2 Add 1 g, weighed to the nearest mg, of an aliquot of the well-mixed sample .

3.6.3 Dry and heat in the 103° to 105°C oven for 1 h. Cool in a desiccator. Weigh to the nearest mg.

### 3.7 Calibration

– Follow instrument manufacturer's instructions for calibration. Prepare a calibration curve by plotting mg carbon vs. instrument response using four standards and a blank, covering the analytical range of interest.

### 3.8 Data Recording

Record all data and sample information in LRBs or on project-specific data forms.

All transfers of data to forms and data reductions (e.g., concentration calculations, means, standard deviations) should be checked by the analyst and approved by a lab manager, project manager, or principal investigator. Hard copies of sample data and spreadsheet reports should be kept in the testing laboratory's central files.

### 3.9 QA/QC Procedures

3.9.1 Precision and Accuracy The precision and accuracy will differ with the various instruments and matrices, and must be determined by the laboratories reporting data. A representative sample of well-mixed, meshed, sediment should be analyzed in quadruplicate for 4 days to determine the analytical precision.

3.9.2 It is critical that each sample be thoroughly homogenized in the laboratory before a subsample is taken for analysis. Laboratory homogenization should be conducted even if samples were homogenized in the field.

3.9.3 Dried samples should be cooled in a desiccator and held there until they are weighed. If a desiccator is not used, the sediment will accumulate ambient moisture and the sample weight will be overestimated. A color-indicating desiccant is recommended so that spent desiccant can be detected easily. Also, the seal on the desiccator should be checked periodically and, if necessary, the ground glass rims should be greased or the "O" rings replaced.

## 4.0 DATA REDUCTION, DOCUMENTATION, AND REPORTING

### 4.1 Data Reduction

Data analysis and calculations will be performed whenever possible on computers using commercial spreadsheet software such as Lotus 1-2-3, Quattro Pro, or Microsoft Excel.

### 4.2 Documentation

Keep all laboratory records, test results, measurements, other and supporting documentation for each sediment test in a LRB or project file dedicated to that purpose.

### 4.3 Reporting

A report should be prepared including, but not limited to, the following information:

- Sources of samples
- Description of methods
- Summary of sample analysis results
- Summary of any deviations from the project test plan
- Copies raw data, observations, or data forms

Total organic carbon should be reported as a percentage of the dry weight of the unacidified sample to the nearest 0.1 unit. The laboratory should report the results of all samples (including QC replicates, method blanks, and standard reference measurements) and should note any problems that may have influenced sample quality. The laboratory should also provide a summary of the calibration procedure and results (e.g., range covered, regression equation, coefficient of determination).

Source: U.S. Army Corps of Engineers - New York District and Environmental Protection Agency -Region II, 1992, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal," Draft-18 Dec 1992.

# APPENDIX C
# PCB CONGENER LIST

## TABLE 2

## NON-ORTHO COPLANAR PCB CONGENERS SUBSTITUTED IN BOTH PARA AND TWO OR MORE META POSITIONS

| IUPAC NUMBER | STRUCTURE | HOMOLOG GROUP |
|---|---|---|
| 77 | 3,3',4,4' | Tetra-CB |
| 81 | 3,4,4',5 | Tetra-CB |
| 126 | 3,3',4,4',5 | Penta-CB |
| 169 | 3,3',4,4',5,5' | Hexa-CB |

## TABLE 3

## TARGETED PCB CONGENERS OTHER THAN NON-ORTHO PCBs

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 8 | 2,4' | Di-CB |
| 18 | 2,2',5 | Tri-CB |
| 28 | 2,4,4' | Tri-CB |
| 37 | 3,4,4' | Tri-CB |
| 42 | 2,2',3,4' | Tetra-CB |
| 44 | 2,2',3,5' | Tetra-CB |
| 47 | 2,2',4,4' | Tetra-CB |
| 49 | 2,2',4,5' | Tetra-CB |
| 52 | 2,2',5,5' | Tetra-CB |
| 60 | 2,3,4,4' | Tetra-CB |
| 64 | 2,3,4',6 | Tetra-CB |
| 66 | 2,3',4,4' | Tetra-CB |
| 70 | 2,3',4',5 | Tetra-CB |
| 74 | 2,4,4',5 | Tetra-CB |
| 80 | 3,3',5,5' | Tetra-CB |
| 82 | 2,2',3,3',4 | Penta-CB |
| 84 | 2,2',3,3',6 | Penta-CB |
| 86 | 2,2',3,4,5 | Penta-CB |
| 87 | 2,2',3,4,5' | Penta-CB |
| 91 | 2,2',3,4',6 | Penta-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 92 | 2,2',3,5,5' | Penta-CB |
| 95 | 2,2',3,5',6 | Penta-CB |
| 97 | 2,2',3',4,5 | Penta-CB |
| 99 | 2,2',4,4',5 | Penta-CB |
| 101 | 2,2',4,5,5' | Penta-CB |
| 105 | 2,3,3',4,4' | Penta-CB |
| 110 | 2,3,3',4',6 | Penta-CB |
| 114 | 2,3,4,4',5 | Penta-CB |
| 118 | 2,3',4,4',5 | Penta-CB |
| 119 | 2,3',4,4',6 | Penta-CB |
| 120 | 2,3',4,5,5' | Penta-CB |
| 123 | 2',3,4,4',5 | Penta-CB |
| 127 | 3,3',4,5,5' | Penta-CB |
| 128 | 2,2',3,3',4,4' | Hexa-CB |
| 137 | 2,2',3,4,4',5 | Hexa-CB |
| 138 | 2,2',3,4,4',5' | Hexa-CB |
| 141 | 2,2',3,4,5,5' | Hexa-CB |
| 146 | 2,2',3,4',5,5' | Hexa-CB |
| 149 | 2,2',3,4',5',6 | Hexa-CB |
| 151 | 2,2',3,5,5',6 | Hexa-CB |
| 153 | 2,2',4,4',5,5' | Hexa-CB |
| 156 | 2,3,3',4,4',5 | Hexa-CB |
| 157 | 2,3,3',4,4',5' | Hexa-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 158 | 2,3,3',4,4',6 | Hexa-CB |
| 166 | 2,3,4,4',5,6 | Hexa-CB |
| 167 | 2,3',4,4',5,5' | Hexa-CB |
| 168 | 2,3',4,4',5',6 | Hexa-CB |
| 170 | 2,2',3,3',4,4',5 | Hepta-CB |
| 171 | 2,2',3,3',4,4',6 | Hepta-CB |
| 174 | 2,2',3,3',4,5,6' | Hepta-CB |
| 177 | 2,2',3,3',4',5,6 | Hepta-CB |
| 179 | 2,2',3,3',5,6,6' | Hepta-CB |
| 180 | 2,2',3,4,4',5,5' | Hepta-CB |
| 183 | 2,2',3,4,4',5',6 | Hepta-CB |
| 185 | 2,2',3,4,5,5',6 | Hepta-CB |
| 187 | 2,2',3,4',5,5',6 | Hepta-CB |
| 189 | 2,3,3',4,4',5,5' | Hepta-CB |
| 190 | 2,3,3',4,4',5,6 | Hepta-CB |
| 191 | 2,3,3',4,4',5',6 | Hepta-CB |
| 194 | 2,2',3,3',4,4',5,5' | Octa-CB |
| 195 | 2,2',3,3',4,4',5,6 | Octa-CB |
| 196 | 2,2',3,3',4,4',5',6 | Octa-CB |
| 198 | 2,2',3,3',4,5,5',6 | Octa-CB |
| 200 | 2,2',3,3',4,5',6,6' | Octa-CB |
| 201 | 2,2',3,3',4',5,5',6 | Octa-CB |
| 203 | 2,2',3,4,4',5,5',6 | Octa-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 205 | 2,3,3',4,4',5,5',6 | Octa-CB |
| 206 | 2,2',3,3',4,4',5,5',6 | Nona-CB |
| 207 | 2,2',3,3',4,4',5,6,6' | Nona-CB |
| 208 | 2,2',3,3',4,5,5',6,6' | Nona-CB |
| 209 | 2,2',3,3',4,4',5,5',6,6' | Deca-CB |

# APPENDIX D
# STATE OF DELAWARE
# SURFACE WATER QUALITY STANDARDS
As Amended, August 11, 1999

## Section 9: Toxic Substances

9.1. Applicability: Criteria set forth in this section apply to all surface waters of the State, except as provided in Section 6, Regulatory Mixing Zones, Section 8, Critical Flows, and Section 12, Criteria for Low Flow Waters.

9.2. General Provisions:

(a) Waters of the State shall not exhibit acute toxicity to fish, aquatic life, and wildlife, except in special cases applying to regulatory mixing zones as provided in Section 6.

(b) Waters of the State shall not exhibit chronic toxicity to fish, aquatic life, and wildlife, except in regulatory mixing zones as provided in Section 6, at flows less than critical flows as provided in Section 8, or in low flow waters as provided in Section 12.

(c) Waters of the State shall be maintained to prevent adverse toxic effects on human health resulting from ingestion of chemically contaminated aquatic organisms and drinking water.

(d) The Department may consider synergistic, antagonistic, and additive impacts of combinations of toxicants to fish, aquatic life, and wildlife, and human health in assessing aggregate environmental impacts and mandating point and nonpoint source controls.

9.3. Specific Numerical Criteria:

(a) Aquatic Life Criteria:

(i) Numerical criteria for the protection of aquatic life are established in Table 1 for all toxic substances for which adequate aquatic life toxicity information is available. All criteria for metals in Table 1 are in the total recoverable form, except as specifically footnoted for cyanide. For toxic substances where the relationship of toxicity is defined as a function of pH or hardness, numerical criteria are presented as an equation based on this relationship. Appropriate pH or hardness values for such criteria shall be determined on a case-by-case basis by the Department.

(ii) For toxic substances for which specific numerical criteria are not listed in Table 1, concentrations shall not exceed those which are chronically toxic (as determined from appropriate chronic toxicity data or calculated as 0.1 of $LC_{50}$ values) to representative, sensitive aquatic organisms,

except as provided in Section 6, Regulatory Mixing Zones, Section 8, Critical Flows, or Section 12, Criteria for Low Flow Waters. Concentrations so determined shall be applied as four-day average concentrations not to be exceeded more than once in any three-year period.

(b) Human Health Criteria

(i) Numerical criteria for the protection of human health are established in Table 2 for all toxic substances for which adequate toxicity information is available. Water quality criteria appearing in Table 2 for pollutants identified as carcinogens have been established at an upper bound worst case risk management level of one excess cancer in a population of one million (1 x $10^{-6}$) over a 70 year lifetime. Criteria listed under the column header "Fish and Water Ingestion" apply only to surface waters of the State designated as Public Water Supply Sources in Section 10 of these Standards. Criteria listed under the column header "Fish/Shellfish Ingestion" apply only to marine surface waters of the State. Criteria listed under the column header "Fish Ingestion Only" apply to all fresh surface waters of the State not designated as Public Water Supply sources in Section 10 of these Standards.

(ii) For compounds in Table 2 which are considered as both systemic toxicants and human carcinogens, criteria based on both human health concerns are presented. In determining pollution control requirements, the more stringent criterion, after consideration of critical (design) flows in Section 8, shall be utilized.

# TABLE 1

## WATER QUALITY CRITERIA FOR PROTECTION OF AQUATIC LIFE
(All Values Are Listed or Calculated in Micrograms Per Liter)

| Parameter | Fresh Acute Criterion | Fresh Chronic Criterion | Marine Acute Criterion | Marine Chronic Criterion |
|---|---|---|---|---|
| Aldrin | 3.0 | -- | 1.3 | -- |
| Aluminum | 750. | 87. | -- | -- |
| Arsenic (III) | 360. | 190. | 69. | 36. |
| Cadmium | $e^{(1.128[\ln(Hd)]-3.828)}$ | $e^{(0.7852[\ln(Hd)]-3.490)}$ | 43. | 9.3 |
| Chlordane | 2.4 | 0.0043 | 0.09 | 0.004 |
| Chlorine | 19 | 11. | 13 | 7.5 |
| Chlorpyrifos | 0.083 | 0.041 | 0.011 | 0.0056 |
| Chromium (III) | $e^{(0.8190[\ln(Hd)]+3.688)}$ | $e^{(0.8190[\ln(Hd)]+1.561)}$ | — | -- |
| Chromium (VI) | 16. | 11. | 1,100. | 50. |
| Copper | $e^{(0.9422[\ln(Hd)]-1.464)}$ | $e^{(0.8545[\ln(Hd)]-1.465)}$ | 2.9 | -- |
| Cyanide[1] | 22. | 5.2 | 1.0 | -- |

| **Parameter** | **Fresh Acute Criterion** | **Fresh Chronic Criterion** | **Marine Acute Criterion** | **Marine Chronic Criterion** |
|---|---|---|---|---|
| DDT and Metabolites | 1.1 | 0.0010 | 0.13 | 0.0010 |
| Demeton | -- | 0.10 | -- | 0.10 |
| Dieldrin | 2.5 | 0.0019 | 0.71 | 0.0019 |
| Endosulfan | 0.22 | 0.056 | 0.034 | 0.0087 |
| Endrin | 0.18 | 0.0023 | 0.037 | 0.0023 |
| Guthion | -- | 0.01 | -- | 0.01 |
| Heptachlor | 0.52 | 0.0038 | 0.053 | 0.0036 |
| Hexachlorocylclohex | 2.0 | 0.08 | 0.16 | -- |
| Iron | -- | 1000. | -- | -- |
| Lead | $e^{(1.273[\ln(Hd)]-1.460)}$ | $e^{(1.273[\ln(Hd)]-4.705)}$ | 140. | 5.6 |
| Malathion | -- | 0.1 | -- | 0.1 |
| Mercury (II) | 2.4 | 0.012 | 2.1 | 0.025 |
| Methoxychlor | -- | 0.03 | -- | 0.03 |
| Mirex | -- | 0.001 | — | 0.001 |

| Parameter | Fresh Acute Criterion | Fresh Chronic Criterion | Marine Acute Criterion | Marine Chronic Criterion |
|---|---|---|---|---|
| Nickel | $e^{(0.8460[\ln(Hd)]+3.3612)}$ | $e^{(0.8460[\ln(Hd)]+1.1645)}$ | 75. | 8.3 |
| Total PCBs | 2.0 | 0.014 | 10 | 0.03 |
| Parathion | 0.065 | 0.013 | -- | -- |
| Pentachlorophenol | $e^{[1.005(pH)-4.830]}$ | $e^{[1.005(pH)-5.290]}$ | 13. | 7.9 |
| Selenium | 20 | 5.0 | 300. | 71. |
| Silver | $e^{(1.72[\ln(Hd)]-6.52)}$ | 0.12 | 2.3 | -- |
| Toxaphene | 0.78 | 0.0002 | 0.21 | 0.0002 |
| Zinc | $e^{(0.8473[\ln(Hd)]+0.8604)}$ | $e^{(0.8473[\ln(Hd)]+0.7614)}$ | 95. | 86. |

Notes:

[1] Cyanide measured as free cyanide at the lowest pH occurring in the receiving water, or cyanide amenable to chlorination.

Specific numerical acute criteria as presented in this table are applied as one-hour average concentrations not to be exceeded more than once in any three-year period. Specific numerical chronic criteria as presented in this table are applied as four-day average concentrations not to be exceeded more than once in any three-year period.

ln = natural log base e
e=2.71828
Hd= hardness is expressed as mg/L as $CaCO_3$
pH is expressed as Standard Units
Example calculation: Fresh acute criterion for silver at hardness of 50 mg/L. Criterion in ug/L = e raised to the [1.72 ln(50) - 6.52] power. This is equal to e to the 0.21 power, or 1.23 ug/L.

# TABLE 2
# WATER QUALITY CRITERIA FOR PROTECTION OF HUMAN HEALTH
## (All Values Are Listed in Micrograms Per Liter Unless Noted Otherwise)

| | Freshwater | | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
| | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish | |
| Acrolein | 1.0 mg/L | 360. | 140. | ST |
| Acrylonitrile | 0.83 | 0.06 | 0.12 | CA |
| Aldrin | 0.17 ng/L | 0.16 ng/L | 0.02 ng/L | CA |
| Aldrin | 0.086 | 0.080 | 0.012 | ST |
| Antimony | 5.4 mg/L | 14. | 760. | ST |
| Arsenic** | | 50. (MCL) | | CA |
| Barium** | | 1.0 mg/L | | ST |
| Benzene | 89. | 1.2 | 12.5 | CA |
| Benzidine | 0.67 ng/L | 0.12 ng/L | 0.09 ng/L | CA |
| Benzidine | 460. | 85. | 64. | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Benzo (A) Pyrene (3,4 Benzopyrene) | 0.037 | 0.0027 | 0.0053 | CA |
| Beryllium | 0.08 | 0.0038 | 0.011 | CA |
| Beryllium | 3.5 mg/L | 170. | 500. | ST |
| Bromoform (Tribromomethane) | 266 | 5.6 | 37.4 | CA |
| Bromoform | 34. mg/L | 690. | 4.7 mg/L | ST |
| Cadmium** |  | 10.(MCL) |  | ST |
| Carbon Tetrachloride (Tetrachloromethane) | 5.5 | 0.26 | 0.78 | CA |
| Carbon Tetrachloride | 500. | 23. | 70. | ST |
| Chlordane | 0.73 ng/L | 0.72 ng/L | 0.13 ng/L | CA |
| Chlordane | 0.057 | 0.056 | 0.008 | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Chlorobenzene | 26.1 mg/L | 680. | 3.7 mg/L | ST |
| Chloroethyl Ether (Bis-2 Chloroalkyl Ether) | 1.77 | 0.031 | 0.25 | CA |
| Chloroform (Trichloromethane) | 368. | 5.7 | 52. | CA |
| Chloroform (Trichloromethane) | 22. mg/L | 340. | 3.2 mg/L | ST |
| Chromium** |  | 50. (MCL) |  | ST |
| Chromium (Hexavalent) | 4.2 mg/L | 170. | 590. | ST |
| Chromium (Trivalent) | 840. mg/L | 34. mg/L | 120. mg/L | ST |
| Cyanide | 270. mg/L | 700. | 38. mg/L | ST |
| DDT and Metabolites | 0.74 ng/L | 0.73 ng/L | 0.10 ng/L | CA |
| DDT and Metabolites | 0.13 | 0.12 | 0.018 | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Dibenzo (A,H) Anthracene | 0.037 | 0.0027 | 0.0053 | CA |
| 1,2 Dichlorobenzene | 21.8 mg/L | 2.8 mg/L | 3.1 mg/L | ST |
| 1,3 Dichlorobenzene | 4.3 mg/L | 410. | 600. | ST |
| 1,4 Dichlorobenzene** | 24. mg/L | 75. (MCL) | 3.4 mg/L | ST |
| 3,3 Dichlorobenzidine | 0.025 | 0.011 | 0.0036 | CA |
| 1,2 Dichloroethane | 123. | 0.38 | 17. | CA |
| 1,1 Dichloroethylene | 4. | 0.058 | 0.56 | CA |
| 1,1 Dichloroethylene | 20. mg/L | 310. | 2.8 mg/L | ST |
| 1,2 Trans-dichloroethylene | 130. mg/L | 700. | 19. mg/L | ST |
| Dichloromethane | 2.0 | 4.7 | 277. | CA |
| Dichloromethane | 810. mg/L | 2.1 mg/L | 110 mg/L | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| 2,4 Dichlorophenoxyacetic acid (2,4-D)** |  | 100. (MCL) |  | ST |
| 1,3 Dichloropropene | 392. | 0.19 | 5.5 | CA |
| 1,3 Dichloropropene | 2.0 mg/L | 10.0 | 280. | ST |
| Dieldrin | 0.18 ng/L | 0.17 ng/L | 0.025 ng/L | CA |
| Dieldrin | 0.14 | 0.13 | 0.02 | ST |
| Diethylphthalate | 148. mg/L* | 24.0 mg/L | 21.0 mg/L | ST |
| Dimethylphthalate | 3,700. mg/L | 320. mg/L | 530. mg/L | ST |
| 2, 4 Dinitrotoluene | 96. | 0.94 | 13. | CA |
| 2, 4 Dinitrophenol | 13.0 mg/L | 70. | 1.9 mg/L | ST |
| Dioxin (2,3,7,8-TCDD) | 0 .000017 ng/L | 0.000016 ng/L | 0.0000024 ng/L | CA |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| 1, 2 Diphenylhydrazine | 0.68 | 0.041 | 0.095 | CA |
| Endosulfan | 2.5 | 1.0 | 0.35 | ST |
| Endrin** | 1.0 | 0.2 (MCL) | 0.14 | ST |
| Ethylbenzene | 35. mg/L | 3.2 mg/L | 5.0 mg/L | ST |
| Fluoranthene | 67. | 50. | 9.4 | ST |
| Fluoride** |  | 1.8 mg/L |  | ST |
| Heptachlor | 0.27 ng/L | 0.26 ng/L | 0 .037 ng/L | CA |
| Heptachlor | 0.60 | 0.58 | 0.084 | ST |
| Hexachloroethane | 11. | 2. | 1.6 | CA |
| Hexachloroethane | 150. | 29. | 22. | ST |
| Hexachlorobenzene | 0.88 ng/L | 0.85 ng/L | 0.12 ng/L | CA |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Hexachlorobenzene | 1.2 | 1.2 | 0.17 | ST |
| Hexachlorobutadiene | 62.1 | 0.44 | 8.7 | CA |
| Hexachlorobutadiene | 2.0 mg/L* | 69. | 1.3 mg/L | ST |
| Hexachlorocyclohexane | 0.08 | 0.02 | 0.011 | CA |
| Hexachlorocyclohexane (Gamma-Lindane) ** | 31. | 4.0 (MCL) | 4.4 | ST |
| Hexachlorocyclohexane (Alpha) | 0.016 | 0.0041 | 0.0023 | CA |
| Hexachlorocyclohexane (Beta) | 0.058 | 0.014 | 0.0081 | CA |
| Hexachlorocyclopentadiene | 1.8 mg/L* | 240. | 1.8 mg/L* | ST |
| Isophorone | 500. mg/L | 5.2 mg/L | 71. mg/L | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Lead** |  | 50.(MCL) |  | CA |
| Mercury** (Inorganic) | 7.1 | 2.0 (MCL) | 1.5 | ST |
| Methoxychlor** |  | 100.(MCL) |  | CA |
| Nickel | 5.7 mg/L | 620. | 810. | ST |
| Nitrate-Nitrogen** |  | 10. mg/L |  | ST |
| Nitrobenzene | 2.2 mg/L | 17.0 | 320. | ST |
| Nitrosodimethylamine-N | 10. | 0.68 ng/L | 1.4 | CA |
| Nitrosodiphenylamine-N | 20. | 5.3 | 2.8 | CA |
| Nitrosodipropylamine-N | 35. | 0.005 | 4.9 | CA |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| PCBs (1242,1254,1221, 1232, 1248, 1260, 1016) | 0.056 ng/L | 0.055 ng/L | 0.0079 ng/L | CA |
| (Bis-2) Ethyl Hexyl Phthalate | 7.4 | 1.9 | 1. | CA |
| (Bis-2) Ethyl Hexyl Phthalate | 400.* | 400.* | 290. | ST |
| Di-N-Butyl Phthalate | 13. mg/L* | 2.8 mg/L | 2.1 mg/L | ST |
| Selenium** | 1.1 mg/L | 10. (MCL) | 160. | ST |
| Silver** | 0. mg/L | 50. (MCL) | 5.7 mg/L | ST |
| 1,1,2,2 Tetrachloroethane | 13.5 | 0.17 | 1.9 | CA |
| Tetrachloroethylene | 4.3 mg/L | 320. | 610. | ST |
| Thallium | 60. | 14. | 8.4 | ST |
| Toluene | 370. mg/L | 10. mg/L | 52. mg/L | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Total Trihalomethanes** |  | 100.(MCL) |  | CA |
| Toxaphene | 0.93 ng/L | 0.91 ng/L | 0.13 ng/L | CA |
| 1,2,4 Trichlorobenzene | 19. mg/L | 680. | 2.7 mg/L | ST |
| 1,1,1 Trichloroethane** | 200. mg/L | 200. (MCL) | 28. mg/L | ST |
| 1,1,2 Trichloroethane | 52.5 | 0 .61 | 7.4 | CA |
| 1,1,2 Trichloroethane | 11. mg/L | 140. | 1.5 mg/L | ST |
| Trichloroethylene | 115. | 3.1 | 16. | CA |
| 2,4,6 Trichlorophenol | 4.5 | 1.3 | 0.63 | CA |
| 2,4,5 Trichlorophenoxypropionic acid (2,4,5-TP-Silvex)** |  | 10. (MCL) |  | ST |
| Vinyl Chloride | 677. | 2.1 | 95. | CA |

NOTES: mg/L = milligrams per liter ng/L = nanograms per liter CA = carcinogen ST = systemic toxicant

The columns labeled "Fish and Water Ingestion" shall apply only to waters of the State designated Public Water Supply sources in these standards.
The column labeled "Fish Ingestion Only" shall apply to all fresh waters of the State not designated Public Water Supply sources in this document.
The column labeled "Fish/Shellfish Ingestion" shall apply only to marine waters of the State.

*Calculated solubility of compound in water is less than criterion; therefore, solubility limit calculated at 25$^0$ C and 1 atm is substituted.
**Values shown under header "Fish and Water Ingestion" are Primary Maximum Contaminant Levels (MCLs) as given in the State of Delaware
Regulations Governing Public Drinking Water Systems as amended May 19, 1989.

# Delaware River
# Main Channel Deepening Project
# Reedy Point North and/or South Confined Disposal Facility
# Chemical Analysis of Dredged Material

## I. Scope of Work

The work under this contract includes collecting surface sediment samples from ten locations within the Reedy Point North and/or South confined disposal facility and conducting chemical analyses to evaluate potential impacts to terrestrial and avian species that may utilize the site. Samples will be collected and appropriately preserved in the field, and delivered to a laboratory for bulk sediment chemical and geotechnical analyses. Sediment samples will be analyzed for concentrations of heavy metals, chlorinated pesticides, PCB congeners and semi-volatile organic contaminants. Volatile organic contaminants will not be required. The data will be evaluated using U.S. Environmental Protection Agency ecological risk assessment methodology. The contractor will prepare a formal report that provides complete documentation of the entire investigation.

## II. Sample Collection

Ten composite surface sediment samples will be collected from the ten sample locations identified in Figure 1. The sample locations are approximate; actual locations will be determined in the field through coordination with the Government. The intent of the sampling plan is to collect sediment samples over the entire surface of the confined disposal facility. At each sample location, five surface sediment samples will be randomly collected and the material will be placed in an appropriately washed stainless steel container. Each surface sediment sample will uniformly represent the top six inches of material at that location. After the five individual samples have been collected, the material in the container will be thoroughly homogenized and subsampled to provide sufficient material for later chemical and geotechnical analysis. Samples for analysis of semi-volatile organic contaminants will be collected directly from each of the five individual samples, not the homogenized composite mixture.

Storage and preservation procedures for these sediment samples are provided as Appendix A. These procedures are from: *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (New Jersey Department of Environmental Protection, 1997). All analyses shall be conducted within the specified holding times. Samples to be analyzed for metals should not come in contact with metal sampling equipment, and samples to be analyzed for organic compounds should not come into contact with plastics. All sample containers should be appropriately cleaned: acid-rinsed (10% nitric acid) for metal analysis, and solvent-rinsed (acetone is preferred; however, other approved solvents such as methanol and hexane can be used as well) for organic analysis. When equipment will be used to take samples for both metal and organic compound analysis, the acid rinse must be conducted first, and the solvent rinse second. Samples should completely fill the storage container, leaving no head space, except for expansion volume required for potential freezing. Samples should be refrigerated or frozen with dry ice immediately after sample collection.

## III. Sample Analysis

Appendix B provides analytical procedures and associated quality assurance/quality control measures for sample analysis. These requirements are from: *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (New Jersey Department of Environmental Protection, 1997). All ten composite samples collected from the confined disposal facility will be analyzed for the analytes listed in Attachment 1 of Appendix B. Note that volatile organic contaminants will not be analyzed. Attachment 1 also provides the required detection limits for sediment samples.

In addition to the analytes listed in Attachment 1, the ten composite samples will be analyzed using high resolution gas chromatograpy (HRGC) / high resolution mass spectrometry (HRMS) for 77 mono-ortho and di-ortho PCB congeners and four non-ortho coplanar PCB congeners using draft USEPA method 1668. A list of the PCB congeners is provided as Appendix C. The HRGC/HRMS method shall provide detection limits of 0.125 ng/g for mono- and di-ortho congeners and 12.5 pg/g for non-ortho congeners. Samples will not be analyzed for polychlorinated dibenzo-p-dioxin or dibenzofurans.

The ten composited sediment samples will also be analyzed for grain size and total organic carbon. As discussed in Appendix B, the grain size analyses will follow the methods described by Folk (1980), and the total organic carbon analyses will follow the procedure provided as Attachment 4 to Appendix B.

## IV. Data Analysis

The primary data objective to be addressed is the ecological fate (wildlife effects) of sediment within the confined disposal facility. The data will be evaluated using U.S. Environmental Protection Agency ecological risk assessment methodology. Ecological risk assessment is a two-step analysis. The first step is problem formulation, which summarizes available site information relative to ecological resources, contaminants of potential concern associated with the site, and the pathways by which ecological receptors can be exposed to these contaminants. The second step, risk characterization, compares concentrations of contaminants to which receptors may be exposed to relevant toxicity values to assess the potential adverse effects to ecological resources. Appendix D provides Delaware uniform risk-based remediation standards for protection of the environment. These standards are from: *Remediation Standards Guidance Under The Delaware Hazardous Substance Cleanup Act* (Delaware Department of Natural Resources and Environmental Control, revised December 1999). This guidance can be obtained from the DNREC internet web site: **http://sirb.awm.dnrec.state.de.us**

## V. Report Format and Content

Draft and final copies of the report of investigation will reflect and report the analysis outlined in this scope of work. Draft and final reports must contain the following features:

a. If the report has been written by someone other than the contract principal investigator, the cover and title page of the publishable report must bear the inscription Prepared Under the Supervision of (name), Principal Investigator. The principal investigator is required to sign the original copy of the report. In addition, the principal investigator must at least prepare a forward describing the overall research context of the report, the significance of the work, and any other related background circumstances relating to the manner in which the work was undertaken.

b. The TITLE PAGE will include the date (month and year) the report was submitted, the project name, the author, Prepared for the U.S. Army Corps of Engineers, Philadelphia District, and the contract number.

c. An EXECUTIVE SUMMARY that provides a brief description of the study's purpose, findings, conclusions and recommendations.

d. A TABLE OF CONTENTS that includes a list of all tables, figures and appendices presented in the report.

e. An INTRODUCTION section stating the purpose of the study with background information on the Delaware River Main Channel Deepening Project.

f. A METHODOLOGY section that describes the sampling and analysis equipment and methodologies.

g. A RESULTS section that presents collected data in tabular and graphic form, and details of applicable statistical analyses used to evaluate the data.

h. A DISCUSSION section that collates statistical data with published literature and draws inferences regarding operation of the confined disposal facility relative to Delaware River water quality issues.

i. A CONCLUSIONS section that emphasizes the main points articulated in the body of the report, and provides pertinent recommendations.

j. A LIST OF REFERENCES that includes literature cited and agencies/individuals consulted.

k. Appropriate APPENDICES for data sheets, records, and other pertinent information.

I. PAGE SIZE AND FORMAT. Each report will be produced on 8 ½ " x 11" paper, single spaced, with double spacing between paragraphs. Figures should not exceed 11" in height nor 12 " in length in most circumstances. Larger figures may be produced, but an 8 ½" x 11" version must be included in the report. All text pages (including appendices) must be consecutively numbered. Text print quality must be at least letter quality.

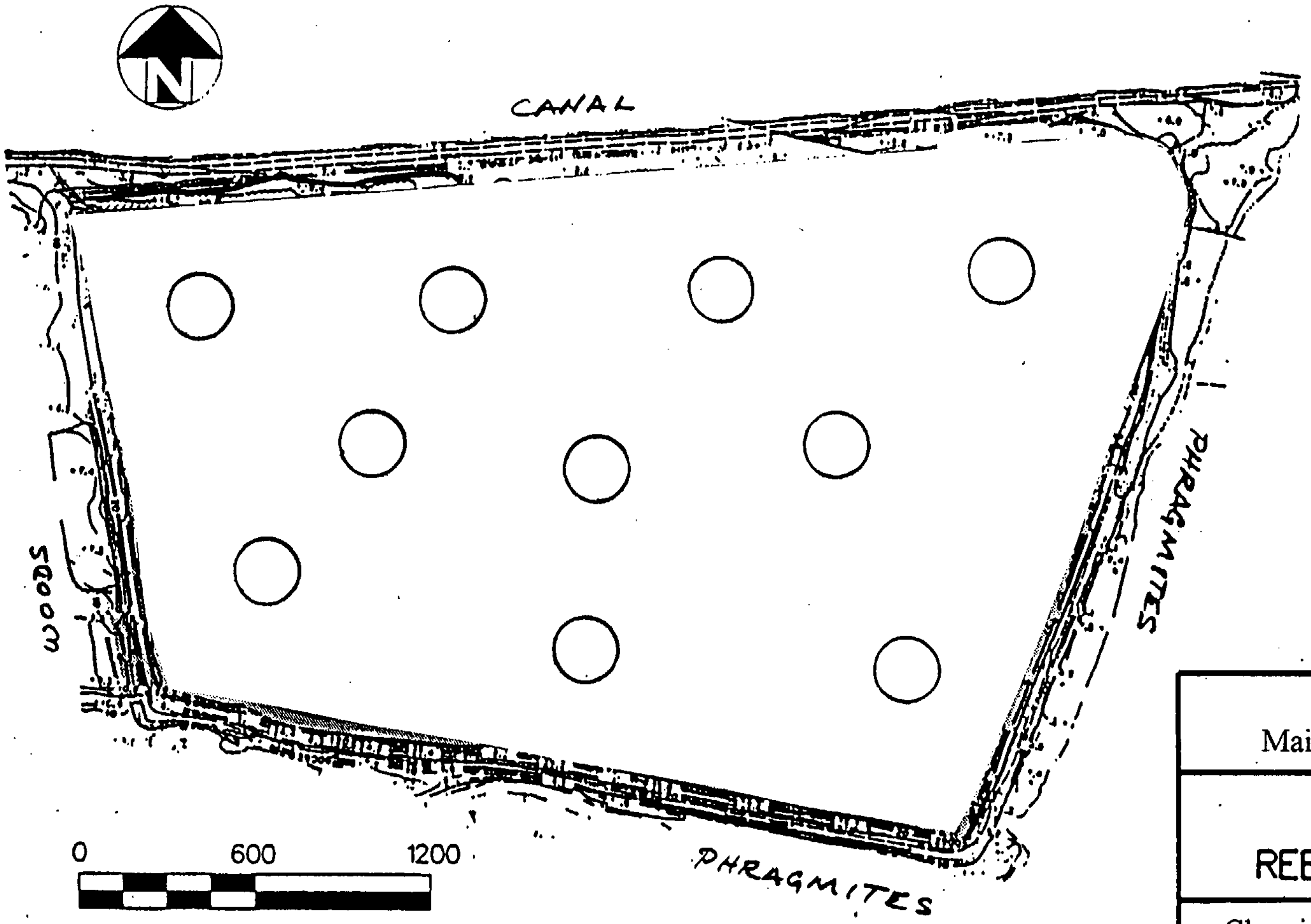
VI. Period of Performance

Three copies of a draft report will be submitted to the Corps by **(Insert Date)**. The draft report must be a polished product and an accurate representation of the content of the final report. The draft must be clean-typed, complete with all figures, tables and sections of the report. All graphics will appear in the same format, and general location in the report as they will be in the final report.

Subsequent to a two-month review period the Corps will provide the Contractor with comments on the draft report. The Contractor will then have an additional month to revise and submit the final report. The Contractor shall submit one unbound, reproducible original and five bound copies of the final report. The final report will be due on **(Insert Date)**. When the Corps accepts the final report the contract will be complete.

VII. Inspection

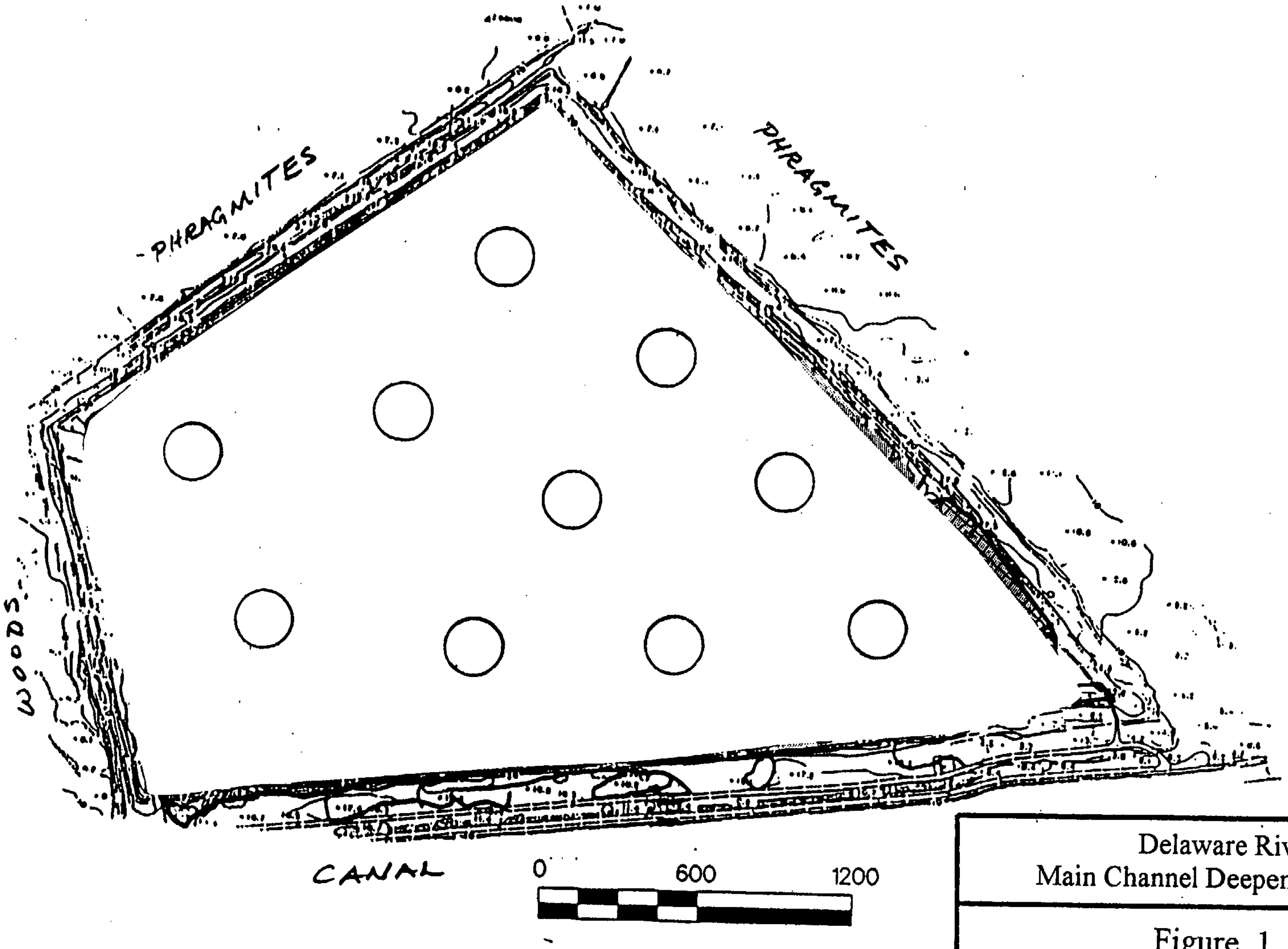
The work will be conducted under the general discretion of the Contracting Officer and shall be subject to inspection by his appointed inspectors to insure strict compliance with the terms of the contract. The presence of the inspector shall not relieve the contractor of responsibility for the proper execution of the work in accordance with the above specifications.



Delaware River
Main Channel Deepening Project

Figure 1
REEDY POINT SOUTH D.A.

Chemical Analysis of Dredged Material



Delaware River
Main Channel Deepening Project

Figure 1
REEDY POINT NORTH D.A.

Chemical Analysis of Dredged Material

# APPENDIX A

# SUMMARY OF RECOMMENDED PROCEDURES FOR SAMPLE COLLECTION, PRESERVATION AND STORAGE

Attachment 1

## SUMMARY OF RECOMMENDED PROCEDURES FOR SAMPLE COLLECTION, PRESERVATION, AND STORAGE

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| **Sediment** | | | | | | |
| **Chemical/Physical Analyses** | | | | | | |
| Metals | Grab/corer | 100 g | Precleaned polyethylene jar[e] | Dry ice[e] or freezer storage for extended storages; otherwise refrigerate | ≤ 4°C | Hg - 28 days<br>Others - 6 months[f] |
| Organic compounds (e.g., PCBs, pesticides, polycyclic aromatic hydrocarbons) | Grab/corer | 250 g | Solvent-rinsed glass jar with Teflon® lid[e] | Dry ice[e] or freezer storage for extended storage; otherwise refrigerate | ≤ 4°C[e]/dark[f] | 14 days[g] |
| Particle size | Grab/corer | 100 g | Whirl-pac bag[e] | Refrigerate | < 4°C | Undetermined |
| Total organic carbon | Grab/corer | 50 g | Heat treated glass vial with Teflon®-lined lid[e] | Dry ice[e] or freezer storage for extended storages; otherwise refrigerate | ≤ 4°C[e] | 14 days |
| Total solids/specific gravity | Grab/corer | 50 g | Whirl-pac bag | Refrigerate | < 4°C | Undetermined |
| Miscellaneous | Grab/corer | ≥ 50 g | Whirl-pac bag | Refrigerate | < 4°C | Undetermined |
| Sediment from which elutriate is prepared | Grab/corer | Depends on tests being performed | Glass with Teflon®-lined lid | Completely fill and refrigerate | 4°C/dark/airtight | 14 days |
| **Biological Tests** | | | | | | |
| Dredged material | Grab/corer | 12–15 L per sample | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |
| Reference sediment | Grab/corer | 45–50 L per test | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |
| Control sediment | Grab/corer | 21–25 L per test | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| **Water and Elutriate** | | | | | | |
| **Chemical/Physical Analyses** | | | | | | |
| Particulate analysis | Discrete sampler or pump | 500–2,000 mL | Plastic or glass | Lugols solution and refrigerate | 4°C | Undetermined |
| Metals | Discrete sampler or pump | 1 L | Acid-rinsed polyethylene or glass jar[j] | pH < 2 with $HNO_3$; refrigerate[j] | 4°C 2°C[l] | Hg - 14 days<br>Others - 6 months[k] |
| Total Kjeldahl nitrogen | Discrete sampler or pump | 100–200 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 24 h[k] |
| Chemical oxygen demand | Discrete sampler or pump | 200 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 7 days[k] |
| Total organic carbon | Discrete sampler or pump | 100 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | <48 hours[k] |
| Total inorganic carbon | Discrete sampler or pump | 100 mL | Plastic or glass[k] | Airtight seal; refrigerate[k] | 4°C[k] | 6 months[k] |
| Phenolic compounds | Discrete sampler or pump | 1 L | Glass[k] | 0.1–1.0 g $CuSO_4$; $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 24 hours[k] |
| Soluble reactive phosphates | Discrete sampler or pump | -- | Plastic or glass[k] | Filter; refrigerate[k] | 4°C[k] | 24 hours[k] |
| Extractable organic compounds (e.g., semivolatile compounds) | Discrete sampler or pump | 4 L | Amber glass bottle[j] | pH < 2, 6N HCl; airtight seal; refrigerate | 4°C[j] | 7 days for extraction; 40 days for sample extract analyses[j] |
| Volatile organic compounds | Discrete sampler or pump | 80 mL | Glass vial[j] | pH < 2 with 1:1 HCL; refrigerate in airtight, completely filled container[j] | 4°C[j] | 14 days for sample analysis, if preserved[j] |
| Total phosphorus | Discrete sampler or pump | -- | Plastic or glass[h] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 7 days[k] |

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| Total solids | Discrete sampler or pump | 200 mL | Plastic or glass[k] | Refrigerate | 4°C[k] | 7 days[k] |
| Volatile solids | Discrete sampler or pump | 200 mL | Plastic or glass[k] | Refrigerate | 4°C[k] | 7 days[k] |
| Sulfides | Discrete sampler or pump | -- | Plastic or glass[k] | pH > 9 NaOH (ZnAc); refrigerate[k] | 4°C[k] | 24 hours[k] |
| **Biological Tests** | | | | | | |
| Site water | Grab | Depends on tests being performed | Plastic carboy | Refrigerate | < 4°C | 14 days |
| Dilution water | Grab or makeup | Depends on tests being performed | Plastic carboy | Refrigerate | < 4°C | 14 days |
| **Tissue** | | | | | | |
| Metals | Trawl/Teflon®-coated grab | 5–10 g | Double Ziploc®[e] | Handle with non-metallic forceps; plastic gloves; dry ice[e] | ≤ –20°C[e] or freezer storage | Hg - 28 days<br>Others - 6 months[m] |
| PCBs and chlorinated pesticides | Trawl/Teflon®-coated grab | 10–25 g | Hexane-rinsed double aluminum foil and double Ziploc®[e] | Handle with hexane-rinsed stainless steel forceps; dry ice[e] | ≤ –20°C[e] or freezer storage | 14 days[g] |
| Volatile organic compounds | Trawl/Teflon®-coated grab | 10–25 g | Heat-cleaned aluminum foil and water-tight plastic bag[l] | Covered ice chest[f] | ≤ –20°C[m] or freezer storage | 14 days[m] |
| Semivolatile organic compounds | Trawl/Teflon®-coated grab | 10–25 g | Hexane-rinsed double aluminum foil and double Ziploc®[e] | Handle with hexane-rinsed stainless steel forceps; dry ice[e] | ≤ –20°C[e] or freezer storage | 14 days[g] |
| Lipids | Trawl/Teflon®-coated grab | Part of organic analyses | Hexane-rinsed aluminum foil | Handle with hexane-rinsed stainless steel forceps; quick freeze | ≤ –20°C or freezer storage | 14 days[g] |

**Note:** This table contains only a summary of collection, preservation, and storage procedures for samples. The cited references should be consulted for a more detailed description of these procedures.

PCB - polychlorinated biphenyl

[a] Collection method should include appropriate liners.

[b] Amount of sample required by the laboratory to perform the analysis (wet weight or volume provided, as appropriate). Miscellaneous sample size for sediment should be increased if auxiliary analytes that cannot be included as part of the organic or metal analyses are added to the list. The amounts shown are not intended as firm values; more or less tissue may be required depending on the analytes, matrices, detection limits, and particular analytical laboratory.

[c] All containers should be certified as clean according to U.S. EPA (1990c).

[d] These holding times are for sediment, water, and tissue based on guidance that is sometimes administrative rather than technical in nature. There are no promulgated, scientifically based holding time criteria for sediments, tissues, or elutriates. References should be consulted if holding times for sample extracts are desired. Holding times are from the time of sample collection.

[e] NOAA (1989).

[f] Tetra Tech (1986a).

[g] Sample may be held for up to 1 year if ≤ -20°C.

[h] Polypropylene should be used if phthalate bioaccumulation is of concern.

[i] Two weeks is recommended; sediments must not be held for longer than 8 weeks prior to biological testing.

[j] U.S. EPA (1987a); 40 CFR Part 136, Table III.

[k] Plumb (1981).

[l] If samples are not preserved to pH < 2, then aromatic compounds must be analyzed within 7 days.

[m] Tetra Tech (1986b).

Excerpted from pp. 54-57 of the USEPA "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations", Office of Water (EPA 823-B-95-0001, April 1995).

# APPENDIX B
# ANALYTICAL PROCEDURES AND ASSOCIATED QUALITY ASSURANCE/QUALITY CONTROL MEASURES

# APPENDIX B - ANALYTICAL PROCEDURES AND ASSOCIATED QUALITY ASSURANCE/QUALITY CONTROL MEASURES

## I. Required Target Analyte Lists and Methodologies:

(a) Target analytes:

Required bulk sediment chemistry, modified elutriate, and leaching tests must include analysis for all target analytes listed in Attachment 1, excepting the volatile organic compounds list, which will be required on a case by case basis. Typically, volatile organic compound testing will be instituted where known or suspected discharges of such compounds have occurred. Dioxin/furan analysis is required for all projects in Region 1.

The list of target analytes in Attachment 1 represents the constituents common to both the USEPA Contract Laboratory Program (CLP) analytes and the much larger list of compounds evaluated under the USEPA SW-846 testing program (SW-846). This latter program specifically employs the Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Publication SW-846. While the SW-846 methods are distinct from the CLP methods, they are considered to be equivalent. Attachment 1 also details the required quantitation limit for each target analyte. The estimated quantitation limit (EQL) specified is the higher of the quantitation limits associated with the CLP and SW-846 programs. There is no requirement to use either the CLP or SW-846 analytical methodologies; however, the method employed must achieve the required EQL and must be from a standard method from a recognized agency. Alternatively, a method with prior approval by the Department may be employed. The analysis must be done by a Department certified laboratory.

(b) Polychlorinated Biphenyls:

Polychlorinated biphenyls (PCBs) are required by the USEPA to be reported on an individual congener basis as well as a total PCB value. However, the Department anticipates that upland disposal of dredged material will be the primary type of proposal evaluated. This will increase the potential need to assess human health impacts due to PCBs.

The Department evaluates potential human health impacts of upland management and disposal activities using a Total Aroclor criterion. Therefore, it is acceptable to provide data to the Department using Aroclor based analysis methods (SW-846 Method 8081 or its equivalent) where aquatic species impacts are not anticipated. Where aquatic species impacts are a concern, the Department will require congener specific based analysis for PCBs using the Sloan method, NOAA Technical Memorandum NOS ORCA-71 or its equivalent. This is the same methodology that the USEPA employs. In order to be further consistent with the USEPA and to avoid duplicative analytical costs, the Department will also accept congener specific results if required by the USEPA or if already available. These congener specific results will be converted to a total PCB value by multiplying the sum of the 22 individual congeners by a factor of 2 as per the T. O'Connor, National Ocean Service, National Oceanic and Atmospheric Administration, July 20, 1994 memorandum to S. Ausubel, USEPA Region II (O'Connor 1994) and as per Contaminant Levels in Muscle and Hepatic Tissue of Lobster from the New York Bight Apex (National Marine Fisheries Service 1996). That computed result will then be compared against the

Total Aroclor based human health criteria. The recommended MDLs for all individual PCB congeners are 1 ug/kg dry weight (sediment) and 0.0005 ug/l (water).

(c) Polychlorinated Dibenzo-p-Dioxin and Dibenzofurans

When required, analysis will be conducted for all seventeen (17) 2,3,7,8 substituted polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofurans using EPA Method 1613 Revision B. While not preferred, SW-846 Method 8290 is also acceptable. The required congeners and related isotopes used for analysis are shown in Attachment 2. The analytical sensitivity should be within 5 times that which is cited in the method for each matrix type. Testing for these analytes will be required by the Department on a case by case basis in Region 1 waters.

All polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran congener results, in both sediment and water matrices, must be reported in both individual congener concentrations and summarized as 2,3,7,8-tetrachlorodibenzo(p)dioxin toxic equivalents using the Toxic Equivalent Factors, International 1988 Method in Attachment 3. For those values reported as Estimated Maximum Possible Concentrations (EMPCs), the full EMPC value should be used.

(d) Grain size analysis:

The grain size analysis must be conducted according to the methods described by Folk 1980.

Results must be reported as percentages within the general size classes:

Sand: equal to or greater than 0.0625 mm diameter

Silt: less than 0.0625 mm diameter and equal to or greater than 0.0039 mm diameter

Clay: less than 0.0039 mm diameter

(e) Total Organic Carbon

Total organic carbon analysis must be conducted according to the USEPA 1986 method, excerpted from the December 1992 regional manual for USEPA Region II and the New York District Corps of Engineers, entitled, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal" (Attachment 4).

(f) Multiple Extraction Procedure

Testing of sediments which have been modified prior to final placement may be required to undergo testing to evaluate their potential for contaminant leaching. One procedure used to accomplish this task is the Multiple Leaching Procedure (EPA Method 1320).

## II. Quality Assurance/Quality Control Guidance and Reporting Requirements

The guidance described below has been drawn from the December 1992 regional manual for USEPA Region II and the New York District Corps of Engineers, entitled, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal"; the EPA and the USACE "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations," (EPA 823-B-95-001, April 1995); and the "Field Sampling Procedures Manual," New Jersey Department of Environmental Protection and Energy, May 1992.

The following quality control samples or procedures will be required for chemical analysis of both sediment and water matrices:

1. Field blanks: One with every batch of 1-20 samples

2. Method blanks: One with every batch of 1-20 samples or every 12 hours, whichever is less

3. Matrix spike and matrix spike duplicate: One set with every batch of 1-20 samples

4. Surrogate spike recovery: Each sample, organic compounds only

5. Minimum detection limit verification within last 2 years for marine sediments and salt water matrices to be submitted to the Department upon request (procedure or citation at 40 CFR 136 [1994] Appendix B, Revision 1.11).

6. Duplicate analyses to be conducted as per method requirements

All bulk sediment chemistry results must be reported on a dry weight basis. All raw data should be presented along with the appropriate criterion. Exceedances of the criterion must be highlighted in an acceptable fashion.

The need to supply either full or reduced data deliverables will be determined by the Department on a case by case basis. The need for the applicant to obtain the services of a data validation contractor will concurrently be determined by the Department at the pre-application stage.

The data reports submitted to the Department for testing and analysis of material proposed for dredging must include a description of all methods and procedures used in the field and in the laboratory, referencing established protocols or guidance, for the following:

1. Sample collection
2. Sample preparation (including homogenizing and compositing)
3. Sample preservation methods and holding times (before and after extraction)
4. Chain of custody tracking documents
5. Sample transport, storage, and disposal
6. Sample analysis
7. Data entry and data reduction
8. Deviations from standard methods or prescribed procedures
9. QA/QC summary and data
10. Narrative of analytical problems, corrective action taken, effects on data interpretation

## III. References for APPENDICES A AND B

Folk, R. 1980. Petrology of Sedimentary Rocks. Hemphill Publishing Co., Texas. 181 p.

National Marine Fisheries Service. 1996. Contaminant Levels in Muscle and Hepatic Tissue of Lobster from the New York Bight Apex.

N.J. Department of Environmental Protection and Energy. 1992. Field Sampling Procedures Manual. 363 p.

O'Connor, T. 1994. Personal communication on July 20, 1994 to S. Ausubel, U.S. Environmental Protection Agency, Region II.

Sloan, N.; G. Adams; R. Pearce; D. Brown; and S-L Chan. 1993. Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects 1984 - 1992, Volume IV Comprehensive Descriptions of Trace Organic Analytical Methods. NOAA Technical Memorandum NOS ORCA 71. 97 p.

U.S. Army Corps of Engineers, New York District and the U.S. Environmental Protection Agency, Region II. 1992. Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal (Draft).

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1991. Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual. EPA-503/8-91/001.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1995. QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations. EPA 823-B-95-001.

Attachment 1

| TARGET ANALYTE LIST | | |
|---|---|---|
| Analyte | Limits of Detection | |
| Volatiles | Water (ug/L) | Soil (ug/Kg) |
| Chloromethane | 10 | 10 |
| Bromomethane | 10 | 10 |
| Vinyl Chloride | 10 | 10 |
| Chloroethane | 10 | 10 |
| Methylene Chloride | 10 | 10 |
| Acetone | 10 | 10 |
| Carbon Disulfide | 10 | 10 |
| 1,1-Dichloroethene | 10 | 10 |
| 1,1-Dichloroethane | 10 | 10 |
| 1,2-Dichloroethene (total) | 10 | 10 |
| Chloroform | 10 | 10 |
| 1,2-Dichloroethane | 10 | 10 |
| 2-Butanone(MEK) | 10 | 10 |
| 1,1,1-Trichloroethane | 10 | 10 |
| Carbon Tetrachloride | 10 | 10 |
| Bromodichloromethane | 10 | 10 |
| 1,2-Dichloropropane | 10 | 10 |
| cis-1,3-Dichloropropene | 10 | 10 |
| trichloroethene | 10 | 10 |
| Dibromochloromethane | 10 | 10 |
| 1,1,2-Trichloroethane | 10 | 10 |
| Benzene | 10 | 10 |
| trans-1,3-Dichloropropene | 10 | 10 |
| Bromoform | 10 | 10 |
| 4-Methyl-2-pentanone(MIBK) | 10 | 10 |
| 2-Hexanone | 10 | 10 |
| Tetrachloroethene | 10 | 10 |
| 1,1,2,2-Tetrachloroethane | 10 | 10 |
| Toluene | 10 | 10 |
| Chlorobenzene | 10 | 10 |
| Ethylbenzene | 10 | 10 |
| Styrene | 10 | 10 |
| Xylenes(total) | 10 | 10 |
| | | |
| | | |
| | | |
| | | |
| Semivolatiles | | |
| Phenol | 10 | 660 |
| bis-(2-Chloroethyl)ether | 10 | 660 |
| 2-Chlorophenol | 10 | 660 |
| 1,3-Dichlorobenzene | 10 | 660 |
| 1,4-Dichlorobenzene | 10 | 660 |
| 1,2-Dichlorobenzene | 10 | 660 |
| 2-Methylphenol | 10 | 660 |
| 2,2'-oxybis(1-Chloropropane) | 10 | 660 |
| 4-Methylphenol | 10 | 660 |
| N-Nitroso-di-n-propylamine | 10 | 660 |

|  | Limits of Detection |  |
|---|---|---|
| **Semivoilatiles (continued)** | Water (ug/L) | Soil (ug/Kg) |
| Hexachloroethane | 10 | 660 |
| Nitrobenzene | 10 | 660 |
| Isophorone | 10 | 660 |
| 2-Nitrophenol | 10 | 660 |
| 2,4-Dimethylphenol | 10 | 660 |
| bis(2-Chloroethoxy)methane | 10 | 660 |
| 2,4-Dichlorophenol | 10 | 660 |
| 1,2,4-Trichlorobenzene | 10 | 660 |
| Naphthalene | 10 | 660 |
| 4-Chloroaniline | 20 | 1300 |
| Hexachlorobutadiene | 10 | 660 |
| 4-Chloro-3-methylphenol | 20 | 1300 |
| 2-Methylnaphthalene | 10 | 660 |
| Hexachlorocylcopentadiene | 10 | 660 |
| 2,4,6-Trichlorophenol | 10 | 660 |
| 2,4,5-Trichlorophenol | 10 | 660 |
| 2-Chloronaphthalene | 10 | 660 |
| 2-Nitroaniline | 50 | 3300 |
| Dimethylphthalate | 10 | 660 |
| Acenaphthylene | 10 | 660 |
| 2,6-Dinitrotoluene | 10 | 660 |
| 3-Nitroaniline | 50 | 3300 |
| Acenaphthene | 10 | 660 |
| 2,4-Dinitrophenol | 50 | 3300 |
| 4-Nitrophenol | 50 | 3300 |
| Dibenzofuran | 10 | 660 |
| 2,4-Dinitrotoluene | 10 | 660 |
| Diethylphthalate | 10 | 660 |
| 4-Chlorophenyl-phenyl ether | 10 | 660 |
| Fluorene | 10 | 660 |
| 4-Nitroaniline | 20 | 830 |
| 4,6-Dinitro-2-methylphenol | 50 | 3300 |
| N-Nitroso-diphenylamine | 10 | 660 |
| 4-Bromophenyl-phenylether | 10 | 660 |
| Hexachlorobenzene | 10 | 660 |
| Pentachlorophenol | 50 | 3300 |
| Phenanthrene | 10 | 660 |
| Anthracene | 10 | 660 |
| Carbazole | 10 | 330 |
| Di-n-butylphthalate | 10 | 330 |
| Fluoranthene | 10 | 660 |
| Pyrene | 10 | 660 |
| Butylbenzylphthalate | 10 | 660 |
| 3,3'-Dichlorobenzidine | 20 | 1300 |
| Benzo(a)anthracene | 10 | 660 |
| Chrysene | 10 | 660 |
| bis(2-Ethylhexyl)phthalate | 10 | 660 |
| Di-n-octlyphthalate | 10 | 660 |
| Benzo(b)fluoranthene | 10 | 660 |

| | Limits of Detection | |
|---|---|---|
| **Semivolatiles (continued)** | Water (ug/L) | Soil (ug/Kg) |
| Benzo(k)fluoranthene | 10 | 660 |
| Benzo(a)pyrene | 10 | 660 |
| Indeno(1,2,3-cd)pyrene | 10 | 660 |
| Dibenzo(a,h)anthracene | 10 | 660 |
| Benzo(g,h,i)perylene | 10 | 660 |
| | | |
| | | |
| | | |
| | | |
| **Pesticides/Aroclors** | | |
| alpha-BHC | 0.05 | 1.9 |
| beta-BHC | 0.05 | 3.3 |
| delta-BHC | 0.05 | 1.7 |
| gamma-BHC (Lindane) | 0.05 | 2 |
| Heptachlor | 0.05 | 2.1 |
| Aldrin | 0.05 | 2 |
| Heptachlor epoxide | 0.05 | 2.1 |
| Endosulfan I | 0.05 | 2.1 |
| Dieldrin | 0.10 | 3.3 |
| 4,4'-DDE | 0.10 | 4.2 |
| Endrin | 0.10 | 3.6 |
| Endosulfan II | 0.10 | 3.3 |
| 4,4'-DDD | 0.10 | 4.2 |
| Endosulfan sulfate | 0.10 | 3.6 |
| 4,4'-DDT | 0.10 | 3.6 |
| Methoxychlor | 0.50 | 17 |
| Endrin ketone | 0.10 | 3.3 |
| Endrin aldehyde | 0.10 | 3.3 |
| alpha-Chlordane | 0.05 | 1.7 |
| gamma-Chlordane | 0.05 | 1.7 |
| Toxaphene | 5.0 | 170 |
| Aroclor-1016 | 1.0 | 33 |
| Aroclor-1221 | 2.0 | 67 |
| Aroclor-1232 | 1.0 | 33 |
| Aroclor-1242 | 1.0 | 33 |
| Aroclor-1248 | 1.0 | 33 |
| Aroclor-1254 | 1.0 | 33 |
| Aroclor-1260 | 1.0 | 33 |
| | | |
| | | |
| **Inorganics** | ug/L | mg/Kg |
| Aluminum | 200 | 40 |
| Antimony | 60 | 12 |
| Arsenic | 10 | 2 |
| Barium | 200 | 40 |
| Beryllium | 5 | 1 |
| Cadmium | 5 | 1 |
| Calcium | 5000 | 1000 |
| Chromium | 10 | 2 |

|  | Limits of Detection |  |
|---|---|---|
| **Inorganics (continued)** | Water (ug/L) | Soil (mg/Kg) |
| Cobalt | 50 | 10 |
| Copper | 25 | 5 |
| Iron | 100 | 20 |
| Lead | 3 | 0.6 |
| Magnesium | 5000 | 1000 |
| Manganese | 15 | 3 |
| Mercury | 0.2 | 0.1 |
| Nickel | 40 | 8 |
| Potassium | 5000 | 1000 |
| Selenium | 5 | 1 |
| Silver | 10 | 2 |
| Sodium | 5000 | 1000 |
| Thallium | 10 | 2 |
| Vanadium | 50 | 10 |
| Zinc | 20 | 4 |
| Cyanide | 10 | 0.5 |

## Attachment 2

Retention Time References, Quantitation References, Relative Retention Times, and Minimum Levels for CDDs and CDFs

| Compound | Retention Time and Quantitation Reference | Relative Retention Time | Minimum Level[1] | | |
|---|---|---|---|---|---|
| | | | Water (pg/L; ppq) | Solid (ng/kg; ppt) | Extract (pg/µL; ppb) |
| *Compounds using $^{13}C_{12}$-1,2,3,4-TCDD as the injection internal standard* | | | | | |
| 2,3,7,8-TCDF | $^{13}C_{12}$-2,3,7,8-TCDF | 0.999–1.003 | 10 | 1 | 0.5 |
| 2,3,7,8-TCDD | $^{13}C_{12}$-2,3,7,8-TCDD | 0.999–1.002 | 10 | 1 | 0.5 |
| 1,2,3,7,8-PeCDF | $^{13}C_{12}$-1,2,3,7,8-PeCDF | 0.999–1.002 | 50 | 5 | 2.5 |
| 2,3,4,7,8-PeCDF | $^{13}C_{12}$-2,3,4,7,8-PeCDF | 0.999–1.002 | 50 | 5 | 2.5 |
| 1,2,3,7,8-PeCDD | $^{13}C_{12}$-1,2,3,7,8-PeCDD | 0.999–1.002 | 50 | 5 | 2.5 |
| *Compounds using $^{13}C_{12}$-1,2,3,7,8,9-HxCDD as the injection internal standard* | | | | | |
| 1,2,3,4,7,8-HxCDF | $^{13}C_{12}$-1,2,3,4,7,8-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,6,7,8-HxCDF | $^{13}C_{12}$-1,2,3,6,7,8-HxCDF | 0.997–1.005 | 50 | 5 | 2.5 |
| 1,2,3,7,8,9-HxCDF | $^{13}C_{12}$-1,2,3,7,8,9-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 2,3,4,6,7,8-HxCDF | $^{13}C_{12}$-2,3,4,6,7,8,-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,7,8-HxCDD | $^{13}C_{12}$-1,2,3,4,7,8-HxCDD | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,6,7,8-HxCDD | $^{13}C_{12}$-1,2,3,6,7,8,-HxCDD | 0.998–1.004 | 50 | 5 | 2.5 |
| 1,2,3,7,8,9-HxCDD | –[2] | 1.000–1.019 | 50 | 5 | 2.5 |
| 1,2,3,4,6,7,8-HpCDF | $^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,7,8,9-HpCDF | $^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,6,7,8-HpCDD | $^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD | 0.999–1.001 | 50 | 5 | 2.5 |
| OCDF | $^{13}C_{12}$-OCDD | 0.999–1.008 | 100 | 10 | 5.0 |
| OCDD | $^{13}C_{12}$-OCDD | 0.999–1.001 | 100 | 10 | 5.0 |

1. The Minimum Level (ML) for each analyte is defined as the level at which the entire analytical system must give a recognizable signal and acceptable calibration point. It is equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.
2. The retention time reference for 1,2,3,7,8,9-HxCDD is $^{13}C_{12}$-1,2,3,6,7,8-HxCDD, and 1,2,3,7,8,9-HxCDD is quantified using the averaged responses for $^{13}C_{12}$-1,2,3,4,7,8-HxCDD and $^{13}C_{12}$-1,2,3,6,7,8-HxCDD.

Attachment 3: This is the toxicity equivalent factor guidance. Note that CDD and CDF are acronyms for chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans. T, Pe, Hx, Hp, and O stand for tetra, penta, hexa, hepta, and octa, respectively.

| Compound | Toxicity Equivalency Factor (TEF) |
|---|---|
| 2,3,7,8-TCDD | 1.000 |
| 1,2,3,7,8-PeCDD | 0.500 |
| 1,2,3,4,7,8-HxCDD | 0.100 |
| 1,2,3,6,7,8-HxCDD | 0.100 |
| 1,2,3,7,8,9-HxCDD | 0.100 |
| 1,2,3,4,6,7,8-HpCDD | 0.010 |
| 1,2,3,4,6,7,8,9-OCDD | 0.001 |
| | |
| 2,3,7,8-TCDF | 0.100 |
| 1,2,3,7,8-PeCDF | 0.050 |
| 2,3,4,7,8-PeCDF | 0.500 |
| 1,2,3,6,7,8-HxCDF | 0.100 |
| 1,2,3,7,8,9-HxCDF | 0.100 |
| 1,2,3,4,7,8-HxCDF | 0.100 |
| 2,3,4,6,7,8-HxCDF | 0.100 |
| 1,2,3,4,6,7,8-HpCDF | 0.010 |
| 1,2,3,4,7,8,9-HpCDF | 0.010 |
| 1,2,3,4,6,7,8,9-OCDF | 0.001 |

All other CDD and CDF have a TEF of zero.

# Attachment 4

## DETERMINATION OF TOTAL ORGANIC CARBON

### 1.0 APPLICATION AND SCOPE

This method, developed by the U.S. Environmental Protection Agency, Region II, Environmental Services Division laboratory in Edison, New Jersey, describes protocols for the determination of organic carbon in ocean sediments. Although the detection limit may vary with procedure or instrument, a minimum reporting value of 100 mg/kg will be required for the ocean dumping/dredging program. Several types of determinations, which are considered equivalent, are presented in this procedure. However, wet combustion methods are not considered to be equivalent to the pyrolytic methods described.

In this method, inorganic carbon from carbonates and bicarbonates is removed by acid treatment. The organic compounds are decomposed by pyrolysis in the presence of oxygen or air. The carbon dioxide that is formed is determined by direct nondispersive infrared detection, flame ionization gas chromatography after catalytic conversion of the carbon dioxide to methane; thermal conductivity gas chromatography, differential thermal conductivity detection by sequential removal of water and carbon dioxide; or thermal conductivity detection following removal of water with magnesium perchlorate.

Water content is determined on a separate portion of sediment and data are reported in mg/kg on a dry weight basis.

### 2.0 DEFINITIONS

The following terms and acronyms are associated with this procedure:

| | |
|---|---|
| LRB | Laboratory record book |
| TOC | Total organic carbon |

### 3.0 PROCEDURE

#### 3.1 Sample collection

Collect sediments in glass jars with lids lined with Teflon or aluminum foil. Cool samples and maintain at 4°C. Analyze samples within 14 days. If unrepresentative material is to be removed from the sample, it should be removed in the field under the supervision of the chief scientist and noted in the LRB on the field log sheet.

#### 3.2 Apparatus and Reagents

- Drying oven maintained at 103° to 105°C.
- Analytical instrument. No specific TOC analyzer is recommended as superior. The following listing is for information on instrument options only, and is not intended to restrict the use of other unlisted instruments capable of analyzing TOC. The instrument to be used must meet the following specifications:
    - A combustion boat that is heated in a stream of oxygen or air in a resistance or induction-type furnace to completely convert organic substances to $CO_2$ and water.
    - A means to physically or by measurement technique to separate water and other interferants from $CO_2$.
    - A means to quantitatively determine $CO_2$ with adequate sensitivity (100 mg/kg), and precision (25% at the 95% confidence level as demonstrated by repetitive measurements of a well-mixed ocean sediment sample).
    - A strip chart or other permanent recording device to document the analysis.

(1.) <u>Perkin Elmer Model 240C Elemental Analyzer or equivalent.</u> In this instrument, the sample from Section 3.5 is pyrolyzed under pure oxygen, water is removed by magnesium perchlorate and the carbon dioxide is removed by ascarite. The decrease in signal obtained by differential thermal conductivity detectors placed between the combustion gas stream before and after the ascarite tube is a measure of the organic carbon content.

(2.) <u>Carlo Erba Model 1106 CHN Analyzer, or equivalent.</u> In this apparatus, the sample is pyrolyzed in an induction-type furnace, and the resultant carbon dioxide is chromatographically separated and analyzed by a differential thermal conductivity

detector.

(3.) LECO Models WR12, WR112, or CR-12 carbon determinators, or Models 600 or 800 CHN analyzers. In the LECO WR-12, the sample is burned in high frequency induction furnace, and the carbon dioxide is selectively absorbed at room temperature in a molecular sieve. It is subsequently released by heating and is measured by a thermal conductivity detector. The WR-112 is an upgraded WR-12 employing microprocessor electronics and a printer to replace the electronic digital voltmeter.

In the LECO CR-12 carbon determinator, the sample is combusted in oxygen, moisture and dust are removed by appropriate traps, and the carbon dioxide is measured by a selective, solid state, infrared detector. The signal from the detector is then processed by a microprocessor and the carbon content is displayed on a digital readout and recorded on an integral printer.

In the LECO CHN-600 and CHN-800 elemental analyzers, the sample is burned under oxygen in a resistance furnace and the carbon dioxide is measured by a selective infrared detector.

(4.) Dohrman Model DC85 Digital High Temperature TOC Analyzer. In this instrument, the sample is burned in resistance furnace under oxygen, the interfering gases are removed by a sparger/scrubber system, and the carbon dioxide is measured by a non-dispersive infrared detector and shown on a digital display in concentration units.

- Reagents

(1.) Distilled water used in preparation of standards and for dilution of samples should be ultrapure to reduce the carbon concentration of the blank.

(2.) Potassium hydrogen phthalate, stock solution, 1000 mg carbon/L: Dissolve 0.2128 g of potassium hydrogen phthalate (Primary Standard Grade) in distilled water and dilute to 100.0 mL.

NOTE: Sodium oxalate and acetic acid are not recommended as stock solutions.

(3.) Potassium hydrogen phthalate, standard solutions: Prepare standard solutions from the stock solution by dilution with distilled water.

(4.) Phosphoric acid solution, 1:1 by volume.

## 3.3 Interferences

3.3.1 Volatile organics in the sediments may be lost in the decarbonation step resulting in a low bias.

3.3.2 Bacterial decomposition and volatilization of the organic compounds are minimized by maintaining the sample at 4 °C, analyzing within the specified holding time, and analyzing the wet sample.

## 3.4 Sample Preparation

3.4.1 Allow frozen samples to warm to room temperature. Homogenize each sample mechanically, incorporating any overlying water.

3.4.2 Weigh the well-mixed sample (up to 500 mg) into the combustion boat or cup. Add 1:1 phosphoric acid dropwise until effervescence stops. Heat to 75°C.

NOTE: This procedure will convert inorganic carbonates and bicarbonates to carbon dioxide and eliminate it from the sample.

## 3.5 Sample Analysis

Analyze the residue according to the instrument manufacturer's instructions.

## 3.6 Percent Residue Determination

Determine percent residue on a seperate sample aliquot as follows:

3.6.1 Heat a clean 25-mL beaker at 103° to 105°C for 1 h. Cool in a desiccator, weigh to

the nearest mg, and store in desiccator until use.

3.6.2 Add 1 g, weighed to the nearest mg, of an aliquot of the well-mixed sample .

3.6.3 Dry and heat in the 103° to 105°C oven for 1 h. Cool in a desiccator. Weigh to the nearest mg.

## 3.7 Calibration

– Follow instrument manufacturer's instructions for calibration. Prepare a calibration curve by plotting mg carbon vs. instrument response using four standards and a blank, covering the analytical range of interest.

## 3.8 Data Recording

Record all data and sample information in LRBs or on project-specific data forms.

All transfers of data to forms and data reductions (e.g., concentration calculations, means, standard deviations) should be checked by the analyst and approved by a lab manager, project manager, or principal investigator. Hard copies of sample data and spreadsheet reports should be kept in the testing laboratory's central files.

## 3.9 QA/QC Procedures

3.9.1 Precision and Accuracy The precision and accuracy will differ with the various instruments and matrices, and must be determined by the laboratories reporting data. A representative sample of well-mixed, meshed, sediment should be analyzed in quadruplicate for 4 days to determine the analytical precision.

3.9.2 It is critical that each sample be thoroughly homogenized in the laboratory before a subsample is taken for analysis. Laboratory homogenization should be conducted even if samples were homogenized in the field.

3.9.3 Dried samples should be cooled in a desiccator and held there until they are weighed. If a desiccator is not used, the sediment will accumulate ambient moisture and the sample weight will be overestimated. A color-indicating desiccant is recommended so that spent desiccant can be detected easily. Also, the seal on the desiccator should be checked periodically and, if necessary, the ground glass rims should be greased or the "O" rings replaced.

# 4.0 DATA REDUCTION, DOCUMENTATION, AND REPORTING

## 4.1 Data Reduction

Data analysis and calculations will be performed whenever possible on computers using commercial spreadsheet software such as Lotus 1-2-3, Quattro Pro, or Microsoft Excel.

## 4.2 Documentation

Keep all laboratory records, test results, measurements, other and supporting documentation for each sediment test in a LRB or project file dedicated to that purpose.

## 4.3 Reporting

A report should be prepared including, but not limited to, the following information:

- Sources of samples
- Description of methods
- Summary of sample analysis results
- Summary of any deviations from the project test plan
- Copies raw data, observations, or data forms

Total organic carbon should be reported as a percentage of the dry weight of the unacidified sample to the nearest 0.1 unit. The laboratory should report the results of all samples (including QC replicates, method blanks, and standard reference measurements) and should note any problems that may have influenced sample quality. The laboratory should also provide a summary of the calibration procedure and results (e.g., range covered, regression equation, coefficient of determination).

Source: U.S. Army Corps of Engineers - New York District and Environmental Protection Agency -Region II, 1992, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal," Draft-18 Dec 1992.

# APPENDIX C
# PCB CONGENER LIST

# TABLE 2

## NON-ORTHO COPLANAR PCB CONGENERS SUBSTITUTED IN BOTH PARA AND TWO OR MORE META POSITIONS

| IUPAC NUMBER | STRUCTURE | HOMOLOG GROUP |
|---|---|---|
| 77 | 3,3',4,4' | Tetra-CB |
| 81 | 3,4,4',5 | Tetra-CB |
| 126 | 3,3',4,4',5 | Penta-CB |
| 169 | 3,3',4,4',5,5' | Hexa-CB |

# TABLE 3

## TARGETED PCB CONGENERS OTHER THAN NON-ORTHO PCBs

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 8 | 2,4' | Di-CB |
| 18 | 2,2',5 | Tri-CB |
| 28 | 2,4,4' | Tri-CB |
| 37 | 3,4,4' | Tri-CB |
| 42 | 2,2',3,4' | Tetra-CB |
| 44 | 2,2',3,5' | Tetra-CB |
| 47 | 2,2',4,4' | Tetra-CB |
| 49 | 2,2',4,5' | Tetra-CB |
| 52 | 2,2',5,5' | Tetra-CB |
| 60 | 2,3,4,4' | Tetra-CB |
| 64 | 2,3,4',6 | Tetra-CB |
| 66 | 2,3',4,4' | Tetra-CB |
| 70 | 2,3',4',5 | Tetra-CB |
| 74 | 2,4,4',5 | Tetra-CB |
| 80 | 3,3',5,5' | Tetra-CB |
| 82 | 2,2',3,3',4 | Penta-CB |
| 84 | 2,2',3,3',6 | Penta-CB |
| 86 | 2,2',3,4,5 | Penta-CB |
| 87 | 2,2',3,4,5' | Penta-CB |
| 91 | 2,2',3,4',6 | Penta-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 92 | 2,2',3,5,5' | Penta-CB |
| 95 | 2,2',3,5',6 | Penta-CB |
| 97 | 2,2',3',4,5 | Penta-CB |
| 99 | 2,2',4,4',5 | Penta-CB |
| 101 | 2,2',4,5,5' | Penta-CB |
| 105 | 2,3,3',4,4' | Penta-CB |
| 110 | 2,3,3',4',6 | Penta-CB |
| 114 | 2,3,4,4',5 | Penta-CB |
| 118 | 2,3',4,4',5 | Penta-CB |
| 119 | 2,3',4,4',6 | Penta-CB |
| 120 | 2,3',4,5,5' | Penta-CB |
| 123 | 2',3,4,4',5 | Penta-CB |
| 127 | 3,3',4,5,5' | Penta-CB |
| 128 | 2,2',3,3',4,4' | Hexa-CB |
| 137 | 2,2',3,4,4',5 | Hexa-CB |
| 138 | 2,2',3,4,4',5' | Hexa-CB |
| 141 | 2,2',3,4,5,5' | Hexa-CB |
| 146 | 2,2',3,4',5,5' | Hexa-CB |
| 149 | 2,2',3,4',5',6 | Hexa-CB |
| 151 | 2,2',3,5,5',6 | Hexa-CB |
| 153 | 2,2',4,4',5,5' | Hexa-CB |
| 156 | 2,3,3',4,4',5 | Hexa-CB |
| 157 | 2,3,3',4,4',5' | Hexa-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 158 | 2,3,3',4,4',6 | Hexa-CB |
| 166 | 2,3,4,4',5,6 | Hexa-CB |
| 167 | 2,3',4,4',5,5' | Hexa-CB |
| 168 | 2,3',4,4',5',6 | Hexa-CB |
| 170 | 2,2',3,3',4,4',5 | Hepta-CB |
| 171 | 2,2',3,3',4,4',6 | Hepta-CB |
| 174 | 2,2',3,3',4,5,6' | Hepta-CB |
| 177 | 2,2',3,3',4',5,6 | Hepta-CB |
| 179 | 2,2',3,3',5,6,6' | Hepta-CB |
| 180 | 2,2',3,4,4',5,5' | Hepta-CB |
| 183 | 2,2',3,4,4',5',6 | Hepta-CB |
| 185 | 2,2',3,4,5,5',6 | Hepta-CB |
| 187 | 2,2',3,4',5,5',6 | Hepta-CB |
| 189 | 2,3,3',4,4',5,5' | Hepta-CB |
| 190 | 2,3,3',4,4',5,6 | Hepta-CB |
| 191 | 2,3,3',4,4',5',6 | Hepta-CB |
| 194 | 2,2',3,3',4,4',5,5' | Octa-CB |
| 195 | 2,2',3,3',4,4',5,6 | Octa-CB |
| 196 | 2,2',3,3',4,4',5',6 | Octa-CB |
| 198 | 2,2',3,3',4,5,5',6 | Octa-CB |
| 200 | 2,2',3,3',4,5',6,6' | Octa-CB |
| 201 | 2,2',3,3',4',5,5',6 | Octa-CB |
| 203 | 2,2',3,4,4',5,5',6 | Octa-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 205 | 2,3,3',4,4',5,5',6 | Octa-CB |
| 206 | 2,2',3,3',4,4',5,5',6 | Nona-CB |
| 207 | 2,2',3,3',4,4',5,6,6' | Nona-CB |
| 208 | 2,2',3,3',4,5,5',6,6' | Nona-CB |
| 209 | 2,2',3,3',4,4',5,5',6,6' | Deca-CB |

# APPENDIX D

# Delaware Uniform Risk-Based Remediation Standards For Protection of the Environment

(Revised December 1999)

# REMEDIATION STANDARDS GUIDANCE
# UNDER THE
# DELAWARE HAZARDOUS SUBSTANCE
# CLEANUP ACT

DELAWARE DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL

Revised
DECEMBER 1999

LEGEND
C = Carcinogenic/ N= Non-Carcinogenic
DWQ - Delaware Surface Water Criteria
ECTX - EPA EcoTox Threshold Benchmark Value, January 1996
EPAR - EPA National Recommended Water Quality Criteria, December 1998
MAX - Maximum value - actual DWQ, ECTX, or ORNL value higher
NDA - No data available
ORNL - Oak Ridge National Laboratory May 1998 Screening Benchmark Levels for Eco Risk Assessment

**All surface soil and sediment values are dry weight basis/surface water values are dissolved concentration**

| | | | | URS for Protection of the Environment | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | V<br>O | Surface Water | | Sediment | | Surface Soil | |
| Contaminant | | CAS | C | µg/L | | mg/kg | | mg/kg | |
| Acetaldehyde | N | 75070 | | | NDA | | NDA | | NDA |
| Acetochlor | N | 34256821 | | | NDA | | NDA | | NDA |
| Acetone | N | 67641 | | 1500 | ORNL | 0.01 | ORNL | | NDA |
| Acetonitrile | N | 75078 | | | NDA | | NDA | | NDA |
| Acetophenone | N | 98862 | ☒ | | NDA | | NDA | | NDA |
| Acrolein | N | 107028 | | 320 | EPAR | | NDA | | NDA |
| Acrylamide | C | 79061 | | | NDA | | NDA | | NDA |
| Acrylonitrile | C | 107131 | ☒ | 0.06 | EPAR | | NDA | 1000 | ORNL |
| Alachlor | C | 15972608 | | | NDA | | NDA | | NDA |
| Alar | N | 1596845 | | | NDA | | NDA | | NDA |
| Aldicarb | N | 116063 | | | NDA | | NDA | | NDA |
| Aldicarb sulfone | N | 1646884 | | | NDA | | NDA | | NDA |
| Aldrin | C | 309002 | | 3 | DWQ | 0.08 | ORNL | | NDA |
| Aluminum | N | 7429905 | | 87 | ORNL | | NDA | | NDA |
| Aminodinitotoluenes | N | | | | NDA | | NDA | | NDA |
| 4-Aminopyridine | N | 504245 | | | NDA | | NDA | | NDA |
| Aniline | N | 62533 | | | NDA | | NDA | | NDA |
| Antimony and compounds | N | 7440360 | | 30 | ORNL | 2 | ORNL | 5 | ORNL |
| Antimony pentoxide | N | 1314609 | | | NDA | | NDA | | NDA |
| Antimony tetroxide | N | 1332316 | | | NDA | | NDA | | NDA |
| Antimony trioxide | N | 1309644 | | | NDA | | NDA | | NDA |
| Arsenic | N | 7440382 | | 3 | ORNL | 8 | ECTX | 10 | ORNL |
| Assure | N | 76578148 | | | NDA | | NDA | | NDA |
| Atrazine | C | 1912249 | | | NDA | | NDA | | NDA |
| Azobenzene | C | 103333 | | | NDA | | NDA | | NDA |
| Barium and compounds | N | 7440393 | | 4 | ORNL | 20 | ORNL | 283 | ORNL |
| Baygon | N | 114261 | | | NDA | | NDA | | NDA |
| Baythroid | N | 68359375 | | | NDA | | NDA | | NDA |
| Bentazon | N | 25057890 | | | NDA | | NDA | | NDA |
| Benzaldehyde | N | 100527 | ☒ | | NDA | | NDA | | NDA |
| Benzene | C | 71432 | ☒ | 1 | EPAR | 0.06 | ECTX | | NDA |
| Benzenethiol | N | 108985 | | | NDA | | NDA | | NDA |
| Benzidine | C | 92875 | | 1.E-04 | EPAR | 0.002 | ORNL | | NDA |
| Benzoic acid | N | 65850 | | 42 | ORNL | 0.7 | ORNL | | NDA |
| Benzyl alcohol | N | 100516 | | 9 | ORNL | 0.001 | ORNL | | NDA |
| Benzyl chloride | C | 100447 | ☒ | | NDA | | NDA | | NDA |
| Beryllium and compounds | C | 7440417 | | 0.7 | ORNL | | NDA | 10 | ORNL |
| 1,1-Biphenyl | N | 92524 | | 14 | ECTX | 1 | ECTX | 60 | ORNL |
| Bis(2-chloroethyl)ether | C | 111444 | ☒ | 0.03 | EPAR | | NDA | | NDA |
| Bis(2-chloroisopropyl)ether | C | 39638329 | ☒ | 1400 | EPAR | | NDA | | NDA |
| Bis(chloromethyl)ether | C | 542881 | ☒ | | NDA | | NDA | | NDA |
| Bis(2-ethylhexyl)phthalate (DEHP) | C | 117817 | | 0.1 | ORNL | 3 | ORNL | | NDA |
| Boron (and borates) | N | 7440428 | | 2 | ORNL | | NDA | 0.5 | ORNL |
| Bromodichloromethane | C | 75274 | ☒ | | NDA | | NDA | | NDA |
| Bromoform (tribromomethane) | C | 75252 | ☒ | 4 | EPAR | | NDA | | NDA |
| Bromomethane | C | 74839 | ☒ | 48 | EPAR | | NDA | | NDA |
| Bromophos | N | 2104963 | | | NDA | | NDA | | NDA |
| 1-Butanol | N | 71363 | | | NDA | | NDA | | NDA |
| N-Butylbenzene | N | 104518 | ☒ | | NDA | | NDA | | NDA |
| Butyl benzyl phthalate | N | 85687 | | 19 | ECTX | 11 | ECTX | | NDA |
| Butylate | N | 2008415 | | | NDA | | NDA | | NDA |
| sec-Butylbenzene | N | 135988 | ☒ | | NDA | | NDA | | NDA |
| tert-Butylbenzene | N | 104518 | ☒ | | NDA | | NDA | | NDA |
| Cadmium and compounds | N | 7440439 | | 1.0 | ORNL | 1 | ECTX | 3 | ORNL |

**LEGEND**
C = Carcinogenic/ N= Non-Carcinogenic
DWQ - Delaware Surface Water Criteria
ECTX - EPA EcoTox Threshold Benchmark Value, January 1996
EPAR - EPA National Recommended Water Quality Criteria, December 1998
MAX - Maximum value - actual DWQ, ECTX, or ORNL value higher
NDA - No data available
ORNL - Oak Ridge National Laboratory May 1998 Screening Benchmark Levels for Eco Risk Assessment

**All surface soil and sediment values are dry weight basis/surface water values are dissolved concentration**

| Contaminant | | CAS | VOC | URS for Protection of the Environment | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Surface Water µg/L | | Sediment mg/kg | | Surface Soil mg/kg | |
| Caprolactam | N | 105602 | | | NDA | | NDA | | NDA |
| Carbaryl | N | 63252 | | | NDA | | NDA | | NDA |
| Carbon disulfide | N | 75150 | ☒ | 0.9 | ORNL | 9.E-04 | ORNL | | NDA |
| Carbon tetrachloride | C | 56235 | ☒ | 0.3 | EPAR | 1 | ORNL | 1000 | ORNL |
| Carbosulfan | N | 55285148 | | | NDA | | NDA | | NDA |
| Chloral | N | 75876 | | | NDA | | NDA | | NDA |
| Chloranil | C | 118752 | | | NDA | | NDA | | NDA |
| Chlordane | C | 57749 | | 0.004 | EPAR | 0.005 | ORNL | | NDA |
| Chlorine | N | 7782505 | | | NDA | | NDA | | NDA |
| Chloroacetic acid | N | 79118 | | | NDA | | NDA | | NDA |
| 4-Chloroaniline | N | 106478 | | | NDA | | NDA | 30 | ORNL |
| Chlorobenzene | N | 108907 | ☒ | 64 | ORNL | 0.4 | ORNL | 40 | ORNL |
| Chlorobenzilate | C | 510156 | | | NDA | | NDA | | NDA |
| p-Chlorobenzoic acid | N | 74113 | | | NDA | | NDA | | NDA |
| 2-Chloro-1,3-butadiene | N | 126998 | ☒ | | NDA | | NDA | | NDA |
| 1-Chlorobutane | N | 109693 | ☒ | | NDA | | NDA | | NDA |
| Chloroethane | C | 75003 | ☒ | | NDA | | NDA | | NDA |
| Chloroform | C | 67663 | ☒ | 6 | EPAR | 0.18 | ORNL | | NDA |
| Chloromethane | C | 74873 | ☒ | | NDA | | NDA | | NDA |
| 4-Chloro-2-methylaniline | C | 95692 | | | NDA | | NDA | | NDA |
| beta-Chloronaphthalene | N | 91587 | | 1700 | EPAR | | NDA | | NDA |
| o-Chloronitrobenzene | C | 88733 | ☒ | | NDA | | NDA | | NDA |
| p-Chloronitrobenzene | C | 100005 | ☒ | | NDA | | NDA | | NDA |
| 2-Chlorophenol | N | 95578 | | 120 | EPAR | | NDA | 10 | ORNL |
| o-Chlorotoluene | N | 95498 | ☒ | | NDA | | NDA | | NDA |
| Chlorpyrifos | N | 2921882 | | | NDA | | NDA | | NDA |
| Chlorpyrifos-methyl | N | 5598130 | | | NDA | | NDA | | NDA |
| Chromium III and compounds | N | 16065831 | | 210 | ORNL | 81 | ECTX | 0.4 | ORNL |
| Chromium VI and compounds | N | 18540299 | | 11 | ORNL | | NDA | | NDA |
| Cobalt | N | 7440484 | | 23 | ORNL | | NDA | 20 | ORNL |
| Copper and compounds | N | 7440508 | | 12 | ORNL | 34 | ECTX | 50 | ORNL |
| Crotonaldehyde | C | 123739 | | | NDA | | NDA | | NDA |
| Cumene | N | 98828 | | | NDA | | NDA | | NDA |
| Cyanides: | | | | 5 | ORNL | | | | |
| Calcium cyanide | N | 592018 | | | NDA | | NDA | | NDA |
| Copper cyanide | N | 544923 | | | NDA | | NDA | | NDA |
| Cyanazine | C | 21725462 | | | NDA | | NDA | | NDA |
| Cyanogen | N | 460195 | | | NDA | | NDA | | NDA |
| Cyanogen bromide | N | 506683 | | | NDA | | NDA | | NDA |
| Cyanogen chloride | N | 506774 | | | NDA | | NDA | | NDA |
| Free cyanide | N | 57125 | | 22 | DWQ | 0.1 | ORNL | | NDA |
| Hydrogen cyanide | N | 74908 | | | NDA | | NDA | | NDA |
| Potassium cyanide | N | 151508 | | | NDA | | NDA | | NDA |
| Potassium silver cyanide | N | 506616 | | | NDA | | NDA | | NDA |
| Silver cyanide | N | 506649 | | | NDA | | NDA | | NDA |
| Sodium cyanide | N | 143339 | | | NDA | | NDA | | NDA |
| Thiocyanate | N | 0 | | | NDA | | NDA | | NDA |
| Zinc cyanide | N | 557211 | | | NDA | | NDA | | NDA |
| Cyclohexanone | N | 108941 | ☒ | | NDA | | NDA | | NDA |
| Cyhalothrin/Karate | N | 68085858 | | | NDA | | NDA | | NDA |
| Cypermethrin | N | 52315078 | | | NDA | | NDA | | NDA |
| Dacthal | N | 1861321 | | | NDA | | NDA | | NDA |
| Dalapon | N | 75990 | | | NDA | | NDA | | NDA |
| DDD | C | 72548 | | 4.E-05 | ORNL | 0.008 | ORNL | | NDA |
| DDE | C | 72559 | | | NDA | 0.03 | ORNL | | NDA |

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| Contaminant | | CAS | VOC | URS for Protection of the Environment | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Surface Water | | Sediment | | Surface Soil | |
| | | | | µg/L | | mg/kg | | mg/kg | |
| DDT | C | 50293 | | 4.E-05 | ORNL | 0.002 | ECTX | | NDA |
| Diazinon | N | 333415 | | 0.04 | ORNL | 0.002 | ECTX | | NDA |
| Dibenzofuran | N | 132649 | | 4 | ORNL | 0.4 | ORNL | | NDA |
| 1,4-Dibromobenzene | N | 106376 | ☒ | | NDA | | NDA | | NDA |
| Dibromochloromethane | C | 124481 | ☒ | | NDA | | NDA | | NDA |
| 1,2-Dibromo-3-chloropropane | C | 96128 | ☒ | | NDA | | NDA | | NDA |
| 1,2-Dibromoethane | C | 106934 | ☒ | | NDA | | NDA | | NDA |
| Dibutyl phthalate | N | 84742 | | 33 | ECTX | 11 | ECTX | 200 | ORNL |
| Dicamba | N | 1918009 | | | NDA | | NDA | | NDA |
| 1,2-Dichlorobenzene | N | 95501 | ☒ | 14 | ECTX | 0.3 | ECTX | | NDA |
| 1,3-Dichlorobenzene | N | 541731 | ☒ | 71 | ECTX | 1.7 | ECTX | | NDA |
| 1,4-Dichlorobenzene | C | 106467 | ☒ | 15 | ECTX | 0.4 | ECTX | 20 | ORNL |
| 3,3'-Dichlorobenzidine | C | 91941 | | 0.04 | EPAR | | NDA | | NDA |
| Dichlorodifluoromethane (Freon 12) | N | 75718 | ☒ | | NDA | | NDA | | NDA |
| 1,1-Dichloroethane | N | 75343 | ☒ | 47 | ECTX | 0.03 | ORNL | | NDA |
| 1,2-Dichloroethane (EDC) | C | 107062 | ☒ | 910 | ORNL | 0.3 | ORNL | | NDA |
| 1,1-Dichloroethylene | C | 75354 | ☒ | 25 | ORNL | 0.06 | ORNL | | NDA |
| 1,2-Dichloroethylene (cis) | N | 156592 | ☒ | 31 | ORNL | 0.02 | ORNL | | NDA |
| 1,2-Dichloroethylene (trans) | N | 156605 | ☒ | 31 | ORNL | 0.02 | ORNL | | NDA |
| 1,2-Dichloroethylene (mixture) | N | 540590 | ☒ | 590 | ORNL | | NDA | | NDA |
| 2,4-Dichlorophenol | N | 120832 | | 93 | EPAR | | NDA | | NDA |
| 2,4-Dichlorophenoxyacetic Acid (2,4-D) | N | 94757 | ☒ | | NDA | | NDA | | NDA |
| 4-(2,4-Dichlorophenoxy)butyric Acid | N | 94826 | | | NDA | | NDA | | NDA |
| 1,2-Dichloropropane | C | 78875 | ☒ | | NDA | | NDA | 700 | ORNL |
| 2,3-Dichloropropanol | N | 616239 | | | NDA | | NDA | | NDA |
| 1,3-Dichloropropene | C | 542756 | ☒ | 10 | EPAR | | NDA | | NDA |
| Dichlorvos | C | 62737 | | | NDA | | NDA | | NDA |
| Dicofol | C | 115322 | | | NDA | | NDA | | NDA |
| Dicyclopentadiene | N | 77736 | ☒ | | NDA | | NDA | | NDA |
| Dieldrin | C | 60571 | | 3 | DWQ | 0.004 | ORNL | | NDA |
| Diethyl phthalate | N | 84662 | | 210 | ORNL | 0.6 | ECTX | 100 | ORNL |
| Diethylene glycol, monoethyl ether | N | 111900 | | | NDA | | NDA | | NDA |
| Di(2-ethylhexyl)adipate | C | 103231 | | | NDA | | NDA | | NDA |
| Diethylstilbestrol | C | 56531 | | | NDA | | NDA | | NDA |
| Difenzoquat (Avenge) | N | 43222486 | | | NDA | | NDA | | NDA |
| Diisopropyl methylphosphonate (DIMP) | N | 1445756 | | | NDA | | NDA | | NDA |
| 3,3'-Dimethoxybenzidine | C | 119904 | | | NDA | | NDA | | NDA |
| 2,4-Dimethylaniline hydrochloride | C | 21436964 | | | NDA | | NDA | | NDA |
| 2,4-Dimethylaniline | C | 95681 | | | NDA | | NDA | | NDA |
| N-N-Dimethylaniline | N | 121697 | | | NDA | | NDA | | NDA |
| 3,3'-Dimethylbenzidine | C | 119937 | | | NDA | | NDA | | NDA |
| 1,1-Dimethylhydrazine | C | 57147 | | | NDA | | NDA | | NDA |
| 1,2-Dimethylhydrazine | C | 540738 | | | NDA | | NDA | | NDA |
| 2,4-Dimethylphenol | N | 105679 | | 540 | EPAR | 0.3 | ORNL | | NDA |
| 2,6-Dimethylphenol | N | 576261 | | | NDA | | NDA | | NDA |
| 3,4-Dimethylphenol | N | 95658 | | | NDA | | NDA | | NDA |
| Dimethyl phthalate | N | 131113 | | 313000 | EPAR | | NDA | 200 | ORNL |
| 1,2-Dinitrobenzene | N | 528290 | | | NDA | | NDA | | NDA |
| 1,3-Dinitrobenzene | N | 99650 | | | NDA | | NDA | | NDA |
| 1,4-Dinitrobenzene | N | 100254 | | | NDA | | NDA | | NDA |
| 4,6-Dinitro-o-cyclohexyl phenol | N | 131895 | | | NDA | | NDA | | NDA |
| 2,4-Dinitrophenol | N | 51285 | | 70 | EPAR | | NDA | 20 | ORNL |
| Dinitrotoluene mix | C | | | | NDA | | NDA | | NDA |
| 2,4-Dinitrotoluene | N | 121142 | | 0.1 | EPAR | | NDA | | NDA |

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|---|---|---|---|---|---|---|---|---|---|
| | | | V O C | Surface Water | | Sediment | | Surface Soil | |
| Contaminant | | CAS | | µg/L | | mg/kg | | mg/kg | |
| 2,6-Dinitrotoluene | N | 606202 | | | NDA | | NDA | | NDA |
| Dinoseb | N | 88857 | | | NDA | | NDA | | NDA |
| di-n-Octyl phthalate | N | 117840 | | 708 | ORNL | 1000 | MAX | | NDA |
| 1,4-Dioxane | C | 123911 | | | NDA | | NDA | | NDA |
| Diphenylamine | N | 122394 | | | NDA | | NDA | | NDA |
| 1,2-Diphenylhydrazine | C | 122667 | | 0.04 | EPAR | | NDA | | NDA |
| Diquat | N | 85007 | | | NDA | | NDA | | NDA |
| Disulfoton | N | 298044 | | | NDA | | NDA | | NDA |
| 1,4-Dithiane | N | 505293 | | | NDA | | NDA | | NDA |
| Diuron | N | 330541 | | | NDA | | NDA | | NDA |
| Endosulfan | N | 115297 | | 0.05 | ORNL | 0.005 | ECTX | | NDA |
| Endothall | N | 145733 | | | NDA | | NDA | | NDA |
| Endrin | N | 72208 | | 0.06 | ORNL | 0.02 | ECTX | | NDA |
| Epichlorohydrin | C | 106898 | | | NDA | | NDA | | NDA |
| Ethion | N | 563122 | | | NDA | | NDA | | NDA |
| 2-Ethoxyethanol | N | 110805 | | | NDA | | NDA | | NDA |
| Ethyl acetate | N | 141786 | | | NDA | | NDA | | NDA |
| Ethylbenzene | N | 100414 | ☒ | 7 | ORNL | 4 | ECTX | | NDA |
| Ethylene diamine | N | 107153 | | | NDA | | NDA | | NDA |
| Ethylene glycol | N | 107211 | | | NDA | | NDA | | NDA |
| Ethylene oxide | C | 75218 | | | NDA | | NDA | | NDA |
| Ethylene thiourea (ETU) | C | 96457 | | | NDA | | NDA | | NDA |
| Ethyl ether | N | 60297 | ☒ | | NDA | | NDA | | NDA |
| Ethyl methacrylate | N | 97632 | | | NDA | | NDA | | NDA |
| Fenamiphos | N | 22224926 | | | NDA | | NDA | | NDA |
| Fluometuron | N | 2164172 | | | NDA | | NDA | | NDA |
| Flourine | N | 7782414 | | | | | | 200 | ORNL |
| Fomesafen | C | 72178020 | | | NDA | | NDA | | NDA |
| Fonofos | N | 944229 | | | NDA | | NDA | | NDA |
| Formaldehyde | N | 50000 | | | NDA | | NDA | | NDA |
| Formic Acid | N | 64186 | | | NDA | | NDA | | NDA |
| Furan | N | 110009 | | | NDA | | NDA | 600 | ORNL |
| Furazolidone | C | 67458 | | | NDA | | NDA | | NDA |
| Furfural | N | 98011 | | | NDA | | NDA | | NDA |
| Glycidaldehyde | N | 765344 | | | NDA | | NDA | | NDA |
| Glyphosate | N | 1071836 | | | NDA | | NDA | | NDA |
| HCH (alpha) | C | 319846 | | 0.004 | EPAR | | NDA | | NDA |
| HCH (beta) | C | 319857 | | 0.01 | EPAR | | NDA | | NDA |
| HCH (gamma) Lindane | C | 58899 | | 2 | DWQ | 0.001 | ORNL | | NDA |
| HCH-technical | C | 608731 | | | NDA | | NDA | | NDA |
| Heptachlor | C | 76448 | ☒ | 0.007 | ORNL | 0.005 | ORNL | | NDA |
| Heptachlor epoxide | C | 1024573 | ☒ | 0.004 | EPAR | | NDA | | NDA |
| Hexabromobenzene | N | 87821 | ☒ | | NDA | | NDA | | NDA |
| Hexachlorobenzene | C | 118741 | ☒ | 8.E-04 | EPAR | | NDA | 1000 | ORNL |
| Hexachlorobutadiene | C | 87683 | ☒ | 0.4 | EPAR | | NDA | | NDA |
| Hexachlorocyclopentadiene | N | 77474 | ☒ | 240 | EPAR | | NDA | 10 | ORNL |
| Hexachlorodibenzo-p-dioxin mixture | C | 19408743 | | | NDA | | NDA | | NDA |
| Hexachloroethane | C | 67721 | ☒ | 2 | EPAR | 1 | ECTX | | NDA |
| Hexachlorophene | N | 70304 | | | NDA | | NDA | | NDA |
| n-Hexane | N | 110543 | ☒ | 0.6 | ORNL | 0.04 | ORNL | | NDA |
| 2-Hexanone | N | 591786 | | 0.1 | ORNL | 0.02 | ORNL | | NDA |
| Hexazinone | N | 51235042 | | | NDA | | NDA | | NDA |
| HMX | N | 2691410 | | | NDA | | NDA | | NDA |
| Hydrazine | C | 302012 | | | NDA | | NDA | | NDA |

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|---|---|---|---|---|---|---|---|---|---|
| | | | O | Surface Water | | Sediment | | Surface Soil | |
| Contaminant | | CAS | C | µg/L | | mg/kg | | mg/kg | |
| Hydrogen sulfide | N | 7783064 | | | NDA | | NDA | | NDA |
| Hydroquinone | N | 123319 | | | NDA | | NDA | | NDA |
| Iron | N | 7439896 | | 1000 | ECTX | | NDA | | NDA |
| Isobutanol | N | 78831 | ☒ | | NDA | | NDA | | NDA |
| Isophorone | C | 78591 | | 36 | EPAR | | NDA | | NDA |
| Isopropalin | N | 33820530 | | | NDA | | NDA | | NDA |
| Isopropyl methyl phosphonic acic | N | 1832548 | | | NDA | | NDA | | NDA |
| Lead | N | 7439921 | | 3 | ORNL | 47 | ORNL | 41 | ORNL |
| Lithium | N | 7439932 | | 14 | ORNL | | NDA | 2 | ORNL |
| Malathion | N | 121755 | | 0.10 | ECTX | 7.E-04 | ECTX | | NDA |
| Maleic anhydride | N | 108316 | | | NDA | | NDA | | NDA |
| Manganese and compounds | N | 7439965 | | 80 | ECTX | | NDA | | NDA |
| Mephosfolan | N | 950107 | | | NDA | | NDA | | NDA |
| Mepiquat chloride | N | 24307264 | | | NDA | | NDA | | NDA |
| Mercuric chloride | N | 7487947 | | | NDA | | NDA | | NDA |
| Mercury (inorganic) | N | 7439976 | | 1 | ORNL | 0.2 | ECTX | 5.E-04 | ORNL |
| Mercury (methyl) | N | 22967926 | | 0.003 | ORNL | | NDA | | NDA |
| Methacrylonitrile | N | 126987 | | | NDA | | NDA | | NDA |
| Methanol | N | 67561 | | | NDA | | NDA | | NDA |
| Methidathion | N | 950378 | | | NDA | | NDA | | NDA |
| Methoxychlor | N | 72435 | | 0.02 | ECTX | 0.02 | ECTX | | NDA |
| Methyl acetate | N | 79209 | | | NDA | | NDA | | NDA |
| Methyl acrylate | N | 96333 | | | NDA | | NDA | | NDA |
| 2-Methylaniline | C | 95534 | | | NDA | | NDA | | NDA |
| 4-(2-Methyl-4-chlorophenoxy) butyric acid | N | 94815 | | | NDA | | NDA | | NDA |
| 2-Methyl-4-chlorophenoxyacetic acic | N | 94746 | | | NDA | | NDA | | NDA |
| 2-(2-Methyl-14-chlorophenoxy)propionic a | N | 93652 | | | NDA | | NDA | | NDA |
| Methylene bromide | N | 74953 | ☒ | | NDA | | NDA | | NDA |
| Methylene chloride | C | 75092 | ☒ | 5 | EPAR | 0.4 | ORNL | | NDA |
| 4,4'-Methylene bis(2-chloroaniline | C | 101144 | | | NDA | | NDA | | NDA |
| 4,4'-Methylene bis(N,N'-dimethyl)anilin | C | 101611 | | | NDA | | NDA | | NDA |
| Methyl ethyl ketone | N | 78933 | ☒ | | NDA | | NDA | | NDA |
| Methyl hydrazine | C | 60344 | | | NDA | | NDA | | NDA |
| Methyl isobutyl ketone | N | 108101 | | | NDA | | NDA | | NDA |
| Methyl methacrylate | N | 80626 | | | NDA | | NDA | | NDA |
| 2-Methyl-5-nitroaniline | C | 99558 | | | NDA | | NDA | | NDA |
| Methyl parathion | N | 298000 | | | NDA | | NDA | | NDA |
| 2-Methylphenol (o-cresol) | N | 95487 | | 13 | ORNL | 0.01 | ORNL | | NDA |
| 3-Methylphenol (m-cresol) | N | 103394 | | | NDA | | NDA | | NDA |
| 4-Methylphenol (p-cresol) | N | 106445 | | | NDA | | NDA | | NDA |
| Methyl styrene (mixture) | N | 25013154 | ☒ | | NDA | | NDA | | NDA |
| Methyl styrene (alpha) | N | 98839 | ☒ | | NDA | | NDA | | NDA |
| Methyl tertbutyl ether (MTBE) | N | 1634044 | ☒ | | NDA | | NDA | | NDA |
| Metolaclor (Dual) | N | 51218452 | | | NDA | | NDA | | NDA |
| Mirex | C | 2385855 | | | NDA | 1 | ORNL | | NDA |
| Molybdenum | N | 7439987 | | 370 | ORNL | | NDA | 2 | ORNL |
| Monochloramine | N | 10599903 | | | NDA | | NDA | | NDA |
| Naled | N | 300765 | | | NDA | | NDA | | NDA |
| Nickel and compounds | N | 7440020 | | 160 | ORNL | 21 | ECTX | 30 | ORNL |
| Nitrate | N | 14797558 | | | NDA | | NDA | | NDA |
| Nitric oxide | N | 10102439 | | | NDA | | NDA | | NDA |
| Nitrite | N | 14797650 | | | NDA | | NDA | | NDA |
| 2-Nitroaniline | N | 88744 | | | NDA | | NDA | | NDA |
| Nitrobenzene | N | 98953 | ☒ | 17 | EPAR | | NDA | 40 | ORNL |

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|---|---|---|---|---|---|---|---|---|---|
| | | | V | Surface Water | | Sediment | | Surface Soil | |
| Contaminant | | CAS | O<br>C | µg/L | | mg/kg | | mg/kg | |
| Nitrofurantoin | N | 67209 | | | NDA | | NDA | | NDA |
| Nitrofurazone | C | 59870 | | | NDA | | NDA | | NDA |
| Nitrogen dioxide | N | 10102440 | | | NDA | | NDA | | NDA |
| Nitroglycerin | C | 55630 | | | NDA | | NDA | | NDA |
| 4-Nitrophenol | N | 100027 | | 300 | ORNL | | NDA | 7 | ORNL |
| N-Nitrosodi-n-butylamine | C | 924163 | | | NDA | | NDA | | NDA |
| N-Nitrosodiethanolamine | C | 1116547 | | | NDA | | NDA | | NDA |
| N-Nitrosodiethylamine | C | 55185 | | | NDA | | NDA | | NDA |
| N-Nitrosodimethylamine | C | 62759 | | 7.E-04 | EPAR | | NDA | | NDA |
| N-Nitrosodiphenylamine | C | 86306 | | 5 | EPAR | | NDA | 20 | ORNL |
| N-Nitroso di-n-propylamine | C | 621647 | | 0.005 | EPAR | | NDA | | NDA |
| N-Nitroso-N-methylethylamine | C | 10595956 | | | NDA | | NDA | | NDA |
| N-Nitrosopyrrolidine | C | 930552 | | | NDA | | NDA | | NDA |
| m-Nitrotoluene | N | 99081 | ☒ | | NDA | | NDA | | NDA |
| o-Nitrotoluene | N | 88722 | ☒ | | NDA | | NDA | | NDA |
| p-Nitrotoluene | N | 99990 | ☒ | | NDA | | NDA | | NDA |
| NuStar | N | 85509199 | | | NDA | | NDA | | NDA |
| Oryzalin | N | 19044883 | | | NDA | | NDA | | NDA |
| Oxadiazon | N | 19666309 | | | NDA | | NDA | | NDA |
| Oxamyl | N | 23135220 | | | NDA | | NDA | | NDA |
| Oxyfluorfen | N | 42874033 | | | NDA | | NDA | | NDA |
| Paraquat | N | 1910425 | | | NDA | | NDA | | NDA |
| Parathion | N | 56382 | | | NDA | | NDA | | NDA |
| Pentachlorobenzene | N | 608935 | ☒ | 0.5 | ECTX | 0.7 | ECTX | 20 | ORNL |
| Pentachloronitrobenzene | C | 82688 | ☒ | | NDA | | NDA | | NDA |
| Pentachlorophenol | C | 87865 | | 20 | DWQ | 0.4 | ORNL | 3 | ORNL |
| Permethrin | N | 52645531 | | | NDA | | NDA | | NDA |
| **Petroleum Hydrocarbons** | | | | | | | | | |
| C5 through C8 Aliphatic Hydrocarbons | | n/a | | | NDA | | NDA | | NDA |
| C9 through C12 Aliphatic Hydrocarbons | | n/a | | | NDA | | NDA | | NDA |
| C9 through C18 Aliphatic Hydrocarbons | | n/a | | | NDA | | NDA | | NDA |
| C19 through C36 Aliphatic Hydrocarbons | | n/a | | | NDA | | NDA | | NDA |
| C9 through C10 Aromatic Hydrocarbons | | n/a | | | NDA | | NDA | | NDA |
| C11 through C22 Aromatic Hydrocarbons | | n/a | | | NDA | | NDA | | NDA |
| Phenol | N | 108952 | | 110 | ORNL | 0.03 | ORNL | 30 | ORNL |
| m-Phenylenediamine | N | 108452 | | | NDA | | NDA | | NDA |
| o-Phenylenediamine | C | 95545 | | | NDA | | NDA | | NDA |
| p-Phenylenediamine | N | 106503 | | | NDA | | NDA | | NDA |
| 2-Phenylphenol | C | 90437 | | | NDA | | NDA | | NDA |
| Phosphine | N | 7803512 | | | NDA | | NDA | | NDA |
| Phosphorus (white) | N | 7723140 | | | NDA | | NDA | | NDA |
| p-Phthalic acid | N | 100210 | | | NDA | | NDA | | NDA |
| Phthalic anhydride | N | 85449 | | | NDA | | NDA | | NDA |
| Picloram | N | 1918021 | | | NDA | | NDA | | NDA |
| Polybrominated biphenyls | C | 0 | | | NDA | | NDA | | NDA |
| **Polychlorinated biphenyls (PCBs)** | C | 1336363 | | 0.002 | ORNL | 0.002 | ECTX | 40 | ORNL |
| Aroclor 1016 | N | 12674112 | | 0.2 | ORNL | 0.5 | ORNL | | NDA |
| Aroclor 1221 | C | 11104282 | | 0.3 | ORNL | 0.1 | ORNL | | NDA |
| Aroclor 1232 | C | 11141165 | | 0.6 | ORNL | 0.6 | ORNL | | NDA |
| Aroclor 1242 | C | 53469219 | | 0.05 | ORNL | 29 | ORNL | | NDA |
| Aroclor 1248 | C | 12672296 | | 0.002 | ORNL | 1 | ORNL | | NDA |
| Aroclor 1254 | N | 11097691 | | 0.002 | ORNL | 72 | ORNL | | NDA |
| Aroclor 1260 | C | 11096825 | | 94 | ORNL | 63 | ORNL | | NDA |
| Polychlorinated terphenyls (PCTs) | C | 0 | | | NDA | | NDA | | NDA |
| **Polynuclear aromatic hydrocarbons** | | | | | | | | | |

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**All surface soil and sediment values are dry weight basis/surface water values are dissolved concentration**

| | | | | URS for Protection of the Environment | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | V | | | | | | |
| | | | O | Surface Water | | Sediment | | Surface Soil | |
| Contaminant | | CAS | C | µg/L | | mg/kg | | mg/kg | |
| Acenaphthene | N | 83329 | | 23 | ORNL | 0.09 | ORNL | 20 | ORNL |
| Anthracene | N | 120127 | | 0.7 | ORNL | 0.3 | ORNL | | NDA |
| Benzo[a]anthracene | C | 56553 | | 0.004 | EPAR | 0.1 | ORNL | | NDA |
| Benzo[b]fluoranthene | C | 205992 | | 0.004 | EPAR | 4 | ORNL | | NDA |
| Benzo[k]fluoranthene | C | 207089 | | 0.004 | EPAR | 4 | ORNL | | NDA |
| Benzo[a]pyrene | C | 50328 | | 0.004 | EPAR | 0.1 | ORNL | | NDA |
| Carbazole | C | 86748 | | | NDA | | NDA | | NDA |
| Chrysene | C | 218019 | | 0.004 | EPAR | 0.9 | ORNL | | NDA |
| Dibenz[ah]anthracene | C | 53703 | | 0.004 | EPAR | | NDA | | NDA |
| Fluoranthene | N | 206440 | | 6 | ECTX | 0.8 | ORNL | | NDA |
| Fluorene | N | 86737 | | 4 | ECTX | 0.1 | ORNL | 30 | ORNL |
| Indeno[1,2,3-cd]pyrene | C | 193395 | | 0.004 | EPAR | 0.8 | ORNL | | NDA |
| 2-Methylnapthalene | N | 91576 | | | NDA | | NDA | | NDA |
| Naphthalene | N | 91203 | | 12 | ORNL | 0.4 | ORNL | | NDA |
| Phenanthrene | N | 85018 | | 6 | ECTX | 0.5 | ORNL | | NDA |
| Pyrene | N | 129000 | | 960 | EPAR | | NDA | | NDA |
| N-Propylbenzene | N | | | | NDA | | NDA | | NDA |
| Prometon | N | 1610180 | | | NDA | | NDA | | NDA |
| Prometryn | N | 7287196 | | | NDA | | NDA | | NDA |
| Propachlor | N | 1918167 | | | NDA | | NDA | | NDA |
| Propanil | N | 709988 | | | NDA | | NDA | | NDA |
| Propargite | N | 2312358 | | | NDA | | NDA | | NDA |
| Propylene glycol | N | 57556 | | | NDA | | NDA | | NDA |
| Propylene glycol, monoethyl ether | N | 52125538 | | | NDA | | NDA | | NDA |
| Propylene glycol, monomethyl ether | N | 107982 | | | NDA | | NDA | | NDA |
| Pursuit | N | 81335775 | | | NDA | | NDA | | NDA |
| Pyridine | N | 110861 | | | NDA | | NDA | | NDA |
| Quinoline | C | 91225 | | | NDA | | NDA | | NDA |
| RDX | C | 121824 | | | NDA | | NDA | | NDA |
| Resmethrin | N | 10463868 | | | NDA | | NDA | | NDA |
| Ronnel | N | 299843 | | | NDA | | NDA | | NDA |
| Rotenone | N | 83794 | | | NDA | | NDA | | NDA |
| Selenious Acid | N | 7783008 | | | NDA | | NDA | | NDA |
| Selenium | N | 7782492 | | 0.4 | ORNL | | NDA | 0.2 | ORNL |
| Silver and compounds | N | 7440224 | | 0.4 | ORNL | 1 | ORNL | 2 | ORNL |
| Simazine | C | 122349 | | | NDA | | NDA | | NDA |
| Sodium azide | N | 26628228 | | | NDA | | NDA | | NDA |
| Sodium diethyldithiocarbamate | C | 148185 | | | NDA | | NDA | | NDA |
| Strontium, stable | N | 7440246 | | 1500 | ORNL | | NDA | | NDA |
| Strychnine | N | 57249 | | | NDA | | NDA | | NDA |
| Styrene | N | 100425 | ☒ | | NDA | | NDA | 300 | ORNL |
| 2,3,7,8-TCDD (dioxin) | C | 1746016 | | | NDA | | NDA | 3.E-06 | ORNL |
| 1,2,4,5-Tetrachlorobenzene | N | 95943 | ☒ | | NDA | | NDA | | NDA |
| 1,1,1,2-Tetrachloroethane | C | 630206 | ☒ | | NDA | | NDA | | NDA |
| 1,1,2,2-Tetrachloroethane | C | 79345 | ☒ | 0.2 | EPAR | 0.9 | ECTX | | NDA |
| Tetrachloroethylene (PCE) | C | 127184 | ☒ | 0.8 | EPAR | 0.5 | ECTX | | NDA |
| 2,3,4,6-Tetrachlorophenol | N | 58902 | | | NDA | | NDA | | NDA |
| p,a,a,a-Tetrachlorotoluene | C | 5216251 | ☒ | | NDA | | NDA | | NDA |
| Tetraethyl lead | N | 78002 | | | NDA | | NDA | | NDA |
| Tetrahydrofuran | C | 109999 | | | NDA | | NDA | | NDA |
| Tetryl | N | 479458 | | | NDA | | NDA | | NDA |
| Thallic oxide | N | 1314325 | | | NDA | | NDA | | NDA |
| Thallium | N | 7440280 | | 9 | ORNL | | NDA | 1 | ORNL |
| Thallium acetate | N | 563688 | | | NDA | | NDA | | NDA |

LEGEND
C = Carcinogenic/ N= Non-Carcinogenic
DWQ - Delaware Surface Water Criteria
ECTX - EPA EcoTox Threshold Benchmark Value, January 1996
EPAR - EPA National Recommended Water Quality Criteria, December 1998
MAX - Maximum value - actual DWQ, ECTX, or ORNL value higher
NDA - No data available
ORNL - Oak Ridge National Laboratory May 1998 Screening Benchmark Levels for Eco Risk Assessment

**All surface soil and sediment values are dry weight basis/surface water values are dissolved concentration**

| | | | | URS for Protection of the Environment | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | V O C | Surface Water | | Sediment | | Surface Soil | |
| Contaminant | | CAS | | µg/L | | mg/kg | | mg/kg | |
| Thallium carbonate | N | 6533739 | | | NDA | | NDA | | NDA |
| Thallium chloride | N | 7791120 | | | NDA | | NDA | | NDA |
| Thallium nitrate | N | 10102451 | | | NDA | | NDA | | NDA |
| Thallium sulfate | N | 7446186 | | | NDA | | NDA | | NDA |
| Thiobencarb | N | 28249776 | | | NDA | | NDA | | NDA |
| Tin and compounds | N | 7440315 | | 73 | ORNL | | NDA | 50 | ORNL |
| Titanium | N | 7440326 | | | NDA | | NDA | | NDA |
| Titanium Dioxide | N | 13463677 | | | NDA | | NDA | | NDA |
| Toluene | N | 108883 | ☒ | 10 | ORNL | 0.05 | ORNL | 200 | ORNL |
| Toluene-2,4-diamine | C | 95807 | | | NDA | | NDA | | NDA |
| Toluene-2,5-diamine | N | 95705 | | | NDA | | NDA | | NDA |
| Toluene-2,6-diamine | N | 823405 | | | NDA | | NDA | | NDA |
| p-Toluidine | C | 106490 | | | NDA | | NDA | | NDA |
| Toxaphene | C | 8001352 | | 0.8 | DWQ | 0.03 | ECTX | | NDA |
| 1,2,4-Tribromobenzene | N | 615543 | ☒ | | NDA | | NDA | | NDA |
| Tributyltin oxide (TBTO) | N | 56359 | | | NDA | | NDA | | NDA |
| 2,4,6-Trichloroaniline | C | 634935 | | | NDA | | NDA | | NDA |
| 1,2,4-Trichlorobenzene | N | 120821 | ☒ | 110 | ECTX | 9 | ECTX | 20 | ORNL |
| 1,1,1-Trichloroethane | N | 71556 | ☒ | 11 | ORNL | 0.2 | ECTX | | NDA |
| 1,1,2-Trichloroethane | C | 79005 | ☒ | 0.6 | EPAR | 1 | ORNL | | NDA |
| Trichloroethylene (TCE) | C | 79016 | ☒ | 3 | EPAR | 1 | ORNL | | NDA |
| Trichlorofluoromethane | N | 75694 | ☒ | | NDA | | NDA | | NDA |
| 2,4,5-Trichlorophenol | N | 95954 | | | NDA | | NDA | 9 | ORNL |
| 2,4,6-Trichlorophenol | C | 88062 | | 2 | EPAR | | NDA | 10 | ORNL |
| 2,4,5-Trichlorophenoxyacetic acid | N | 93765 | | | NDA | | NDA | | NDA |
| 2-(2,4,5-Trichlorophenoxy)propionic acid | N | 93721 | | | NDA | | NDA | | NDA |
| 1,1,2-Trichloropropane | N | 598776 | ☒ | | NDA | | NDA | | NDA |
| 1,2,3-Trichloropropane | C | 96184 | ☒ | | NDA | | NDA | | NDA |
| 1,2,3-Trichloropropene | N | 96195 | ☒ | | NDA | | NDA | | NDA |
| 1,1,2-Trichloro-1,2,2- trifluoroethane | N | 76131 | ☒ | | NDA | | NDA | | NDA |
| 1,2,4-Trimethylbenzene | N | 95636 | ☒ | | NDA | | NDA | | NDA |
| 1,3,5-Trimethylbenzene | N | 108678 | ☒ | | NDA | | NDA | | NDA |
| Trimethyl phosphate | C | 512561 | | | NDA | | NDA | | NDA |
| 1,3,5-Trinitrobenzene | N | 99354 | | | NDA | | NDA | | NDA |
| 2,4,6-Trinitrotoluene | C | 118967 | | | NDA | | NDA | | NDA |
| Uranium (soluble salts) | N | 7440611 | | 3 | ORNL | | NDA | 5 | ORNL |
| Vanadium | N | 7440622 | | 19 | ECTX | | NDA | 2 | ORNL |
| Vanadium pentoxide | N | 1314621 | | | NDA | | NDA | | NDA |
| Vanadium sulfate | N | 36907423 | | | NDA | | NDA | | NDA |
| Vinclozolin | N | 50471448 | | | NDA | | NDA | | NDA |
| Vinyl acetate | N | 108054 | | 16 | ORNL | 8.E-04 | ORNL | | NDA |
| Vinyl chloride | C | 75014 | ☒ | 2 | EPAR | 0.02 | ORNL | | NDA |
| Warfarin | N | 81812 | | | NDA | | NDA | | NDA |
| m-Xylene | N | 108323 | ☒ | | NDA | | NDA | | NDA |
| o-Xylene | N | 95476 | ☒ | | NDA | | NDA | | NDA |
| p-Xylene | N | 106423 | ☒ | | NDA | | NDA | | NDA |
| Xylene (mixed) | N | 1330207 | ☒ | 2 | ORNL | 0.03 | ECTX | | NDA |
| Zinc and compounds | N | 7440666 | | 110 | ORNL | 150 | ECTX | 8.5 | ORNL |
| Zinc phosphide | N | 1314847 | | | NDA | | NDA | | NDA |
| Zineb | N | 12122677 | | | NDA | | NDA | | NDA |

# Delaware River
# Main Channel Deepening Project
# Water Quality Monitoring at the Point of Dredging
# Three Channel Locations Within State of Delaware Waters

## I. Scope of Work

The work under this contract includes an evaluation of the chemical quality of Delaware River water immediately downstream of a working, hydraulic cutterhead dredge during initial construction of the Delaware River Main Channel Deepening Project. Specifically, the same parcel of water will be sampled before and after it passes the point of dredging to identify changes in total suspended sediment and contaminant concentrations. Discrete water samples will be collected at the surface, mid-point and bottom of the water column. Downstream samples (ie., after the parcel of water has passed the point of dredging) will be collected at a distance of 200 feet from the point of dredging. In addition, composite samples of bottom sediment in the area of dredging will be collected and analyzed to characterize the total contaminant loading of the dredged material. Samples will be collected and appropriately preserved in the field, and delivered to a laboratory for various chemical and geotechnical analyses. Contaminant data will be compared to Delaware water quality standards for protection of aquatic life and human health. Total suspended sediment concentrations will be compared to a criterion established by DNREC for protection of water quality, 250 mg/L. Composited sediment sample data will be used to estimate the release of contaminants to the water column using equilibrium partitioning theory. These data will be compared to actual concentrations measured in the water column downstream of the cutterhead dredge.

It is understood that contaminant and total suspended sediment data are not available immediately following sample collection. As such, the monitoring can not be used to direct the day to day operation of the dredge. Samples will be evaluated upon collection to determine if total suspended sediment concentrations are in the range of 250 mg/L. Any field signs that suggest the potential for violating Delaware water quality standards will be reported to the Delaware Department of Natural Resources and Environmental Control, and addressed immediately. Modifications to dredging operations will be made as necessary to address violations observed through the field and laboratory evaluations. Modifications to dredging operations will follow:

> Raymond, G.L. 1984. *Techniques to Reduce the Sediment Resuspension Caused by Dredging*, Miscellaneous Paper HL-84-3, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

## II. Sample Collection

Sample collection will take place in three channel dredging locations within State of Delaware waters. These locations are: (1) the Marcus Hook and Bellevue Ranges; (2) the Deepwater Point and New Castle Ranges; and (3) the Reedy Island and Baker Ranges

(Figure 1). The contractor will need to coordinate with the dredge operator to ensure that the testing is done during active dredging. Testing will be conducted two times a day on two separate days for each dredging reach. Testing will not be conducted on consecutive days, but will be distributed over time to capture changes in field conditions.

For each sampling day, the contractor will collect two sets of water samples downstream and upstream of the cutterhead dredge. The two sets of water samples will be collected at least two hours apart, to reflect any possible changes in dredging conditions. Downstream samples will be collected at approximately 200 feet from the working dredge (or as close as safety considerations will allow). Upstream samples will represent background concentrations and will be collected first. Downstream samples will be collected immediately after the upstream samples and will be timed to approximate sampling the same upstream water mass based on tidal velocity. Surface, mid-water, and bottom samples will be collected at each station. Water samples should be collected with either a non-contaminating pump (peristaltic or magnetically coupled impeller design pump) or a discrete water sampler. The pump system should be flushed with 10 times the volume of the collection tubing using site water. The discrete water sampler should be of stainless steel or acrylic plastic and be of the closed/opened/closed type. Seals should be teflon-coated. All water sampling devices should be acid-rinsed (10% nitric acid) for metal analysis, and solvent-rinsed (acetone is preferred; however, other approved solvents such as methanol and hexane can be used as well) for organic analysis. When equipment will be used to take samples for both metal and organic compound analysis, the acid rinse must be conducted first, and the solvent rinse second. Temperature, dissolved oxygen, pH, and salinity will be measured at each sample collection point for each sampling event.

Water samples collected for the monitoring effort will be analyzed for total suspended sediment and concentrations of heavy metals, chlorinated pesticides, PCB congeners and semi-volatile organic contaminants. Volatile organic contaminants will not be required. Storage and preservation procedures for these water samples are provided as Appendix A. These procedures are from: *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (New Jersey Department of Environmental Protection, 1997). The specified holding times by analyte group for water samples must be adhered to.

To characterize contaminant concentrations in the sediment being dredged at the time water column tests are conducted, three grab samples will be collected each sampling day with a decontaminated Young grab and composited into one sample. Sediment will be collected as close to the cutterhead dredge as safety considerations will allow. Storage and preservation procedures for these sediment samples are provided as Appendix A. These procedures are from: *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (New Jersey Department of Environmental Protection, 1997). The specified holding times must be adhered to. Samples to be analyzed for metals should not come in contact with metal sampling equipment, and samples to be analyzed for organic compounds should not come into contact with plastics. All sample containers should be appropriately cleaned: acid-rinsed

(10% nitric acid) for metal analysis, and solvent-rinsed (acetone is preferred; however, other approved solvents such as methanol and hexane can be used as well) for organic analysis. When equipment will be used to take samples for both metal and organic compound analysis, the acid rinse must be conducted first, and the solvent rinse second. Samples should completely fill the storage container, leaving no head space, except for expansion volume needed for potential freezing. Samples should be refrigerated or frozen with dry ice immediately after sample collection.

## III. Sample Analysis

Appendix B provides analytical procedures and associated quality assurance/quality control measures for sample analysis. These requirements are from: *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (New Jersey Department of Environmental Protection, 1997). All samples will be analyzed for the analytes listed in Attachment 1 of Appendix B. Note that volatile organic contaminants will not be analyzed in either the sediment or water samples. Attachment 1 also provides the required detection limits for sediment and water samples. In addition, for the water samples, because water quality criteria for seven metals are expressed as dissolved metal, dissolved inorganic analytes will be analyzed in addition to total inorganic analytes using test methods that can achieve detection limits of at least 2 ug/L.

In addition to the analytes listed in Attachment 1, the water and sediment samples will be analyzed using high resolution gas chromatograpy (HRGC) / high resolution mass spectrometry (HRMS) for 77 mono-ortho and di-ortho PCB congeners and four non-ortho coplanar PCB congeners using draft USEPA method 1668. A list of the PCB congeners is provided as Appendix C. The HRGC/HRMS method shall provide detection limits of 1.25 ng/L for the mono- and di-ortho congeners and 25 pg/L for the non-ortho congeners in aqueous samples, and detection limits of 0.125 ng/g for mono- and di-ortho congeners and 12.5 pg/g for non-ortho congeners in sediment samples. Samples will not be analyzed for polychlorinated dibenzo-p-dioxin or dibenzofurans.

The composited sediment samples will be analyzed for grain size and total organic carbon. As discussed in Appendix B, the grain size analyses will follow the methods described by Folk (1980), and the total organic carbon analyses will follow the procedure provided as Attachment 4 to Appendix B. The water samples will be analyzed for total suspended solids using USEPA method 160.2.

## IV. Data Analysis

The data objectives of this study are: (1) to evaluate contaminant concentrations in the Delaware River water column approximately 200 feet downstream of a working cutterhead dredge relative to State of Delaware regulatory criteria; (2) to monitor increased total suspended sediment concentrations in the Delaware River water column resulting from dredging operations; and (3) to compare actual contaminant concentrations measured in the water column downstream of the cutterhead dredge to estimated concentrations derived from the bulk sediment data using equilibrium partitioning theory.

In addition to comparing contaminant concentrations to water quality standards for protection of aquatic life, the analysis will also include comparisons to water quality standards for protection of human health. This is most important with regard to PCBs, which are more a human health issue in the Delaware estuary (related to biomagnification within the food chain), rather than an aquatic life issue. It is understood that aquatic life concerns are a near-field issue, while human health concerns are a far-field issue. State of Delaware surface water quality standards (as amended, 11 August 1999) for protection of aquatic life and protection of human health can be found in Appendix D.

## V. Report Format and Content

Draft and final copies of the report of investigation will reflect and report the analysis outlined in this scope of work. Draft and final reports must contain the following features:

a. If the report has been written by someone other than the contract principal investigator, the cover and title page of the publishable report must bear the inscription Prepared Under the Supervision of (name), Principal Investigator. The principal investigator is required to sign the original copy of the report. In addition, the principal investigator must at least prepare a forward describing the overall research context of the report, the significance of the work, and any other related background circumstances relating to the manner in which the work was undertaken.

b. The TITLE PAGE will include the date (month and year) the report was submitted, the project name, the author, Prepared for the U.S. Army Corps of Engineers, Philadelphia District, and the contract number.

c. An EXECUTIVE SUMMARY that provides a brief description of the study's purpose, findings, conclusions and recommendations.

d. A TABLE OF CONTENTS that includes a list of all tables, figures and appendices presented in the report.

e. An INTRODUCTION section stating the purpose of the study with background information on the Delaware River Main Channel Deepening Project.

f. A METHODOLOGY section that describes the sampling and analysis equipment and methodologies.

g. A RESULTS section that presents collected data in tabular and graphic form, and details of applicable statistical analyses used to evaluate the data.

h. A DISCUSSION section that collates statistical data with published literature and draws inferences regarding operation of the confined disposal facility relative to Delaware River water quality issues.

i. A CONCLUSIONS section that emphasizes the main points articulated in the body of the report, and provides pertinent recommendations.

j. A LIST OF REFERENCES that includes literature cited and agencies/individuals consulted.

k. Appropriate APPENDICES for data sheets, records, and other pertinent information.

l. PAGE SIZE AND FORMAT. Each report will be produced on 8 ½ " x 11" paper, single spaced, with double spacing between paragraphs. Figures should not exceed 11" in height nor 12 " in length in most circumstances. Larger figures may be produced, but an 8 ½" x 11" version must be included in the report. All text pages (including appendices) must be consecutively numbered. Text print quality must be at least letter quality.

## VI. Period of Performance

Three copies of a draft report will be submitted to the Corps by **(Insert Date)**. The draft report must be a polished product and an accurate representation of the content of the final report. The draft must be clean-typed, complete with all figures, tables and sections of the report. All graphics will appear in the same format, and general location in the report as they will be in the final report.

Subsequent to a two-month review period the Corps will provide the Contractor with comments on the draft report. The Contractor will then have an additional month to revise and submit the final report. The Contractor shall submit one unbound, reproducible original and five bound copies of the final report. The final report will be due on **(Insert Date)**. When the Corps accepts the final report the contract will be complete.

## VII. Inspection

The work will be conducted under the general discretion of the Contracting Officer and shall be subject to inspection by his appointed inspectors to insure strict compliance with the terms of the contract. The presence of the inspector shall not relieve the contractor of responsibility for the proper execution of the work in accordance with the above specifications.

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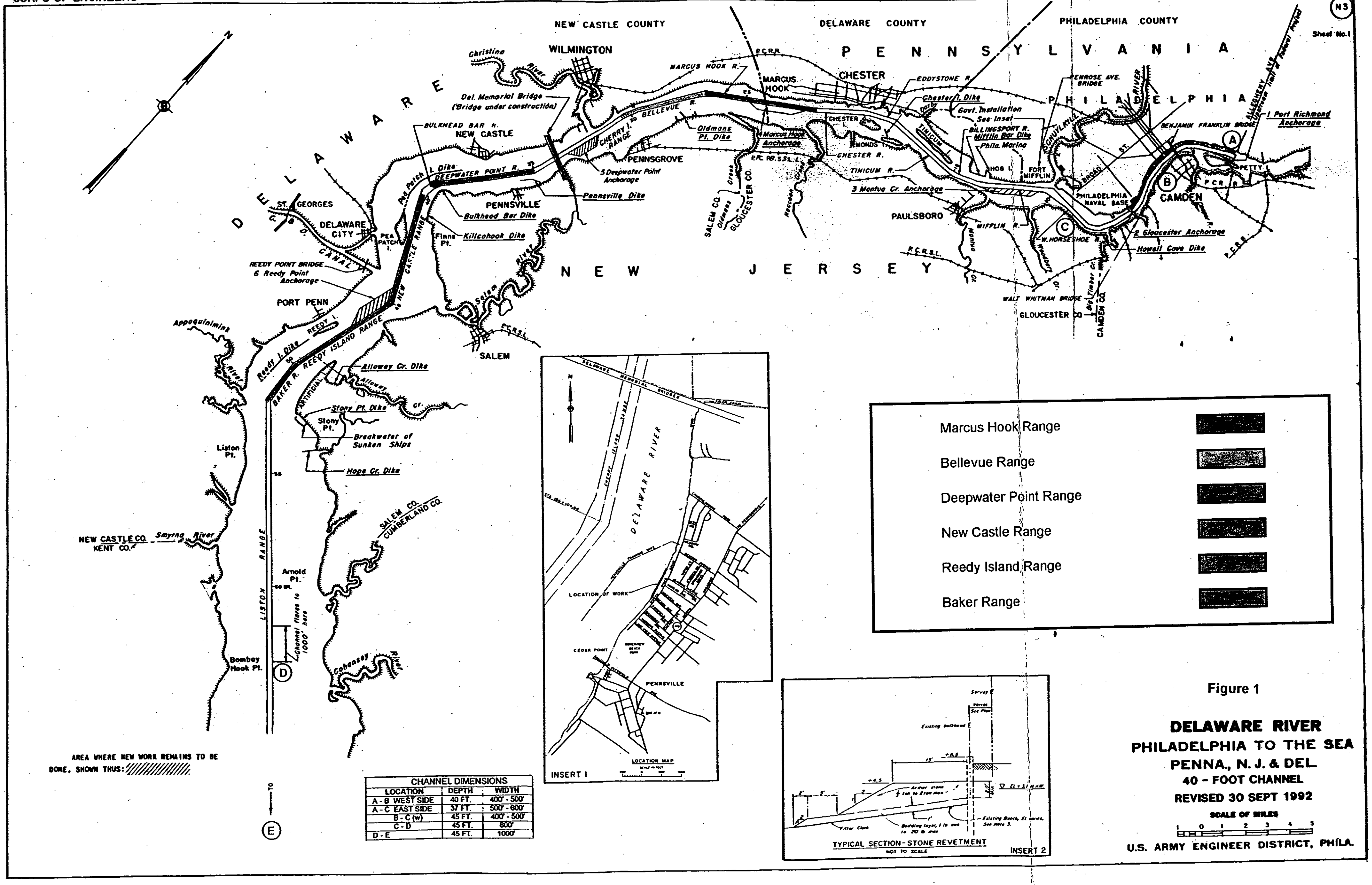

| CHANNEL DIMENSIONS | | |
|---|---|---|
| LOCATION | DEPTH | WIDTH |
| A - B WEST SIDE | 40 FT. | 400' - 500' |
| A - C EAST SIDE | 37 FT. | 500' - 600' |
| B - C (w) | 45 FT. | 400' - 500' |
| C - D | 45 FT. | 800' |
| D - E | 45 FT. | 1000' |

Figure 1

**DELAWARE RIVER**
**PHILADELPHIA TO THE SEA**
**PENNA., N. J. & DEL.**
**40 - FOOT CHANNEL**
**REVISED 30 SEPT 1992**

U.S. ARMY ENGINEER DISTRICT, PHILA.

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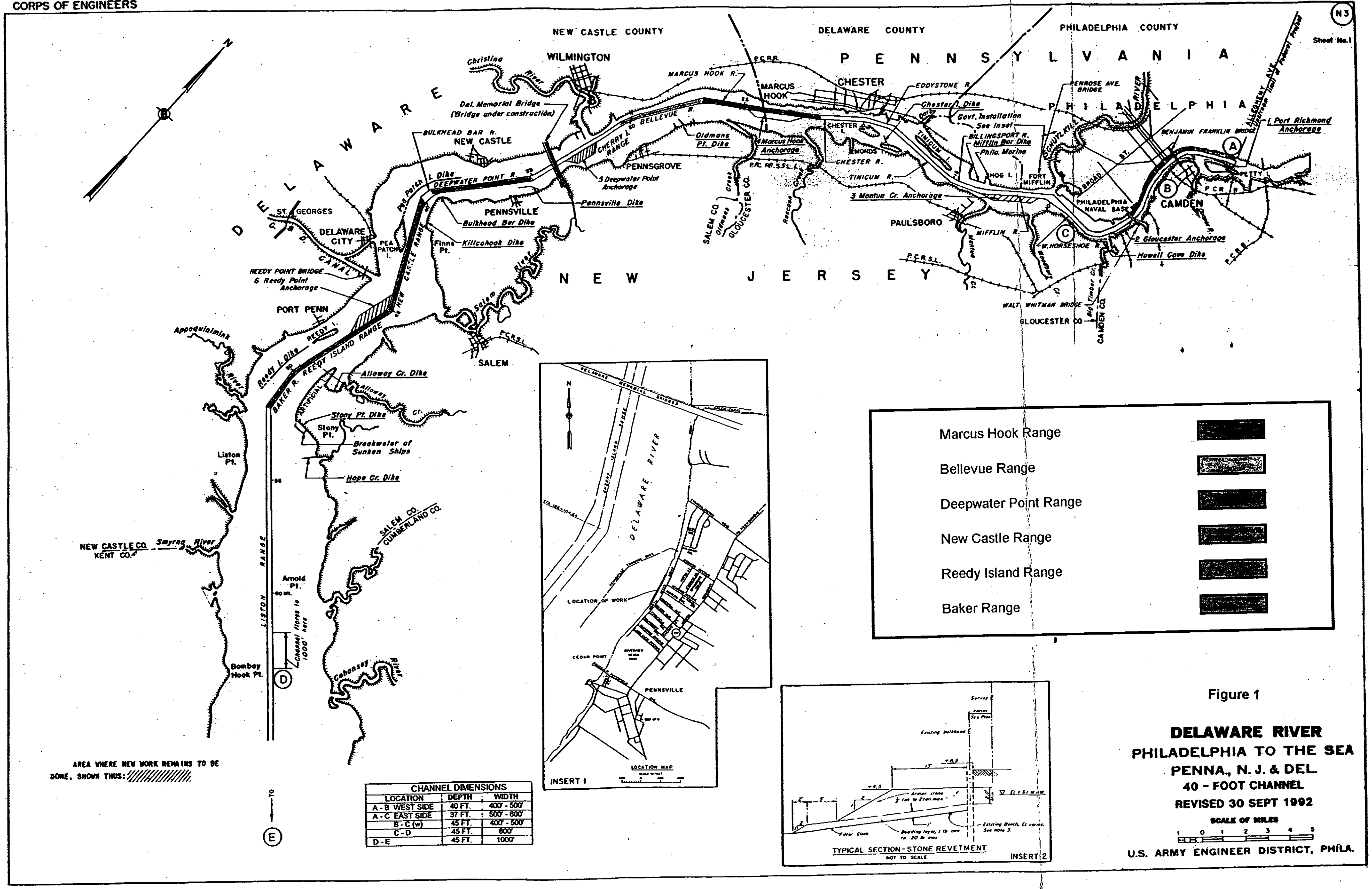

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Figure 1

**DELAWARE RIVER**
**PHILADELPHIA TO THE SEA**
**PENNA., N. J. & DEL.**
**40 - FOOT CHANNEL**
**REVISED 30 SEPT 1992**

U.S. ARMY ENGINEER DISTRICT, PHILA.

# APPENDIX A
# SUMMARY OF RECOMMENDED PROCEDURES FOR SAMPLE COLLECTION, PRESERVATION AND STORAGE

Attachment 1

## SUMMARY OF RECOMMENDED PROCEDURES FOR SAMPLE COLLECTION, PRESERVATION, AND STORAGE

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| **Sediment** | | | | | | |
| **Chemical/Physical Analyses** | | | | | | |
| Metals | Grab/corer | 100 g | Precleaned polyethylene jar[e] | Dry ice[e] or freezer storage for extended storages; otherwise refrigerate | ≤ 4°C | Hg - 28 days<br>Others - 6 months[f] |
| Organic compounds (e.g., PCBs, pesticides, polycyclic aromatic hydrocarbons) | Grab/corer | 250 g | Solvent-rinsed glass jar with Teflon® lid[e] | Dry ice[e] or freezer storage for extended storage; otherwise refrigerate | ≤ 4°C[e]/dark[f] | 14 days[g] |
| Particle size | Grab/corer | 100 g | Whirl-pac bag[e] | Refrigerate | < 4°C | Undetermined |
| Total organic carbon | Grab/corer | 50 g | Heat treated glass vial with Teflon®-lined lid[e] | Dry ice[e] or freezer storage for extended storages; otherwise refrigerate | ≤ 4°C[e] | 14 days |
| Total solids/specific gravity | Grab/corer | 50 g | Whirl-pac bag | Refrigerate | < 4°C | Undetermined |
| Miscellaneous | Grab/corer | ≥ 50 g | Whirl-pac bag | Refrigerate | < 4°C | Undetermined |
| Sediment from which elutriate is prepared | Grab/corer | Depends on tests being performed | Glass with Teflon®-lined lid | Completely fill and refrigerate | 4°C/dark/airtight | 14 days |
| **Biological Tests** | | | | | | |
| Dredged material | Grab/corer | 12–15 L per sample | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |
| Reference sediment | Grab/corer | 45–50 L per test | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |
| Control sediment | Grab/corer | 21–25 L per test | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| **Water and Elutriate** | | | | | | |
| **Chemical/Physical Analyses** | | | | | | |
| Particulate analysis | Discrete sampler or pump | 500–2,000 mL | Plastic or glass | Lugols solution and refrigerate | 4°C | Undetermined |
| Metals | Discrete sampler or pump | 1 L | Acid-rinsed polyethylene or glass jar[j] | pH < 2 with $HNO_3$; refrigerate[j] | 4°C 2°C[j] | Hg - 14 days<br>Others - 6 months[k] |
| Total Kjeldahl nitrogen | Discrete sampler or pump | 100–200 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 24 h[k] |
| Chemical oxygen demand | Discrete sampler or pump | 200 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 7 days[k] |
| Total organic carbon | Discrete sampler or pump | 100 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | <48 hours[k] |
| Total inorganic carbon | Discrete sampler or pump | 100 mL | Plastic or glass[k] | Airtight seal; refrigerate[k] | 4°C[k] | 6 months[k] |
| Phenolic compounds | Discrete sampler or pump | 1 L | Glass[k] | 0.1–1.0 g $CuSO_4$; $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 24 hours[k] |
| Soluble reactive phosphates | Discrete sampler or pump | -- | Plastic or glass[k] | Filter; refrigerate[k] | 4°C[k] | 24 hours[k] |
| Extractable organic compounds (e.g., semivolatile compounds) | Discrete sampler or pump | 4 L | Amber glass bottle[j] | pH < 2, 6N HCl; airtight seal; refrigerate | 4°C[j] | 7 days for extraction; 40 days for sample extract analyses[j] |
| Volatile organic compounds | Discrete sampler or pump | 80 mL | Glass vial[j] | pH < 2 with 1:1 HCL; refrigerate in airtight, completely filled container[j] | 4°C[j] | 14 days for sample analysis, if preserved[j] |
| Total phosphorus | Discrete sampler or pump | -- | Plastic or glass[h] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 7 days[k] |

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| Total solids | Discrete sampler or pump | 200 mL | Plastic or glass[k] | Refrigerate | 4°C[k] | 7 days[k] |
| Volatile solids | Discrete sampler or pump | 200 mL | Plastic or glass[k] | Refrigerate | 4°C[k] | 7 days[k] |
| Sulfides | Discrete sampler or pump | -- | Plastic or glass[k] | pH > 9 NaOH (ZnAc); refrigerate[k] | 4°C[k] | 24 hours[k] |
| **Biological Tests** | | | | | | |
| Site water | Grab | Depends on tests being performed | Plastic carboy | Refrigerate | < 4°C | 14 days |
| Dilution water | Grab or makeup | Depends on tests being performed | Plastic carboy | Refrigerate | < 4°C | 14 days |
| **Tissue** | | | | | | |
| Metals | Trawl/Teflon®-coated grab | 5–10 g | Double Ziploc®[e] | Handle with non-metallic forceps; plastic gloves; dry ice[e] | ≤ –20°C[e] or freezer storage | Hg - 28 days<br>Others - 6 months[m] |
| PCBs and chlorinated pesticides | Trawl/Teflon®-coated grab | 10–25 g | Hexane-rinsed double aluminum foil and double Ziploc®[e] | Handle with hexane-rinsed stainless steel forceps; dry ice[e] | ≤ –20°C[e] or freezer storage | 14 days[g] |
| Volatile organic compounds | Trawl/Teflon®-coated grab | 10–25 g | Heat-cleaned aluminum foil and water-tight plastic bag[l] | Covered ice chest[l] | ≤ –20°C[m] or freezer storage | 14 days[m] |
| Semivolatile organic compounds | Trawl/Teflon®-coated grab | 10–25 g | Hexane-rinsed double aluminum foil and double Ziploc®[e] | Handle with hexane-rinsed stainless steel forceps; dry ice[e] | ≤ –20°C[e] or freezer storage | 14 days[g] |
| Lipids | Trawl/Teflon®-coated grab | Part of organic analyses | Hexane-rinsed aluminum foil | Handle with hexane-rinsed stainless steel forceps; quick freeze | ≤ –20°C or freezer storage | 14 days[g] |

**Note:** This table contains only a summary of collection, preservation, and storage procedures for samples. The cited references should be consulted for a more detailed description of these procedures.

PCB - polychlorinated biphenyl

[a] Collection method should include appropriate liners.

[b] Amount of sample required by the laboratory to perform the analysis (wet weight or volume provided, as appropriate). Miscellaneous sample size for sediment should be increased if auxiliary analytes that cannot be included as part of the organic or metal analyses are added to the list. The amounts shown are not intended as firm values; more or less tissue may be required depending on the analytes, matrices, detection limits, and particular analytical laboratory.

[c] All containers should be certified as clean according to U.S. EPA (1990c).

[d] These holding times are for sediment, water, and tissue based on guidance that is sometimes administrative rather than technical in nature. There are no promulgated, scientifically based holding time criteria for sediments, tissues, or elutriates. References should be consulted if holding times for sample extracts are desired. Holding times are from the time of sample collection.

[e] NOAA (1989).

[f] Tetra Tech (1986a).

[g] Sample may be held for up to 1 year if ≤ -20°C.

[h] Polypropylene should be used if phthalate bioaccumulation is of concern.

[i] Two weeks is recommended; sediments must not be held for longer than 8 weeks prior to biological testing.

[j] U.S. EPA (1987a); 40 CFR Part 136, Table III.

[k] Plumb (1981).

[l] If samples are not preserved to pH < 2, then aromatic compounds must be analyzed within 7 days.

[m] Tetra Tech (1986b).

Excerpted from pp. 54-57 of the USEPA "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations", Office of Water (EPA 823-B-95-0001, April 1995).

# APPENDIX B
# ANALYTICAL PROCEDURES AND ASSOCIATED QUALITY ASSURANCE/QUALITY CONTROL MEASURES

# APPENDIX B - ANALYTICAL PROCEDURES AND ASSOCIATED QUALITY ASSURANCE/QUALITY CONTROL MEASURES

## I. Required Target Analyte Lists and Methodologies:

### (a) Target analytes:

Required bulk sediment chemistry, modified elutriate, and leaching tests must include analysis for all target analytes listed in Attachment 1, excepting the volatile organic compounds list, which will be required on a case by case basis. Typically, volatile organic compound testing will be instituted where known or suspected discharges of such compounds have occurred. Dioxin/furan analysis is required for all projects in Region 1.

The list of target analytes in Attachment 1 represents the constituents common to both the USEPA Contract Laboratory Program (CLP) analytes and the much larger list of compounds evaluated under the USEPA SW-846 testing program (SW-846). This latter program specifically employs the Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Publication SW-846. While the SW-846 methods are distinct from the CLP methods, they are considered to be equivalent. Attachment 1 also details the required quantitation limit for each target analyte. The estimated quantitation limit (EQL) specified is the higher of the quantitation limits associated with the CLP and SW-846 programs. There is no requirement to use either the CLP or SW-846 analytical methodologies; however, the method employed must achieve the required EQL and must be from a standard method from a recognized agency. Alternatively, a method with prior approval by the Department may be employed. The analysis must be done by a Department certified laboratory.

### (b) Polychlorinated Biphenyls:

Polychlorinated biphenyls (PCBs) are required by the USEPA to be reported on an individual congener basis as well as a total PCB value. However, the Department anticipates that upland disposal of dredged material will be the primary type of proposal evaluated. This will increase the potential need to assess human health impacts due to PCBs.

The Department evaluates potential human health impacts of upland management and disposal activities using a Total Aroclor criterion. Therefore, it is acceptable to provide data to the Department using Aroclor based analysis methods (SW-846 Method 8081 or its equivalent) where aquatic species impacts are not anticipated. Where aquatic species impacts are a concern, the Department will require congener specific based analysis for PCBs using the Sloan method, NOAA Technical Memorandum NOS ORCA-71 or its equivalent. This is the same methodology that the USEPA employs. In order to be further consistent with the USEPA and to avoid duplicative analytical costs, the Department will also accept congener specific results if required by the USEPA or if already available. These congener specific results will be converted to a total PCB value by multiplying the sum of the 22 individual congeners by a factor of 2 as per the T. O'Connor, National Ocean Service, National Oceanic and Atmospheric Administration, July 20, 1994 memorandum to S. Ausubel, USEPA Region II (O'Connor 1994) and as per Contaminant Levels in Muscle and Hepatic Tissue of Lobster from the New York Bight Apex (National Marine Fisheries Service 1996). That computed result will then be compared against the

Total Aroclor based human health criteria. The recommended MDLs for all individual PCB congeners are 1 ug/kg dry weight (sediment) and 0.0005 ug/l (water).

(c) Polychlorinated Dibenzo-p-Dioxin and Dibenzofurans

When required, analysis will be conducted for all seventeen (17) 2,3,7,8 substituted polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofurans using EPA Method 1613 Revision B. While not preferred, SW-846 Method 8290 is also acceptable. The required congeners and related isotopes used for analysis are shown in Attachment 2. The analytical sensitivity should be within 5 times that which is cited in the method for each matrix type. Testing for these analytes will be required by the Department on a case by case basis in Region 1 waters.

All polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran congener results, in both sediment and water matrices, must be reported in both individual congener concentrations and summarized as 2,3,7,8-tetrachlorodibenzo(p)dioxin toxic equivalents using the Toxic Equivalent Factors, International 1988 Method in Attachment 3. For those values reported as Estimated Maximum Possible Concentrations (EMPCs), the full EMPC value should be used.

(d) Grain size analysis:

The grain size analysis must be conducted according to the methods described by Folk 1980.

Results must be reported as percentages within the general size classes:

Sand: equal to or greater than 0.0625 mm diameter

Silt: less than 0.0625 mm diameter and equal to or greater than 0.0039 mm diameter

Clay: less than 0.0039 mm diameter

(e) Total Organic Carbon

Total organic carbon analysis must be conducted according to the USEPA 1986 method, excerpted from the December 1992 regional manual for USEPA Region II and the New York District Corps of Engineers, entitled, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal" (Attachment 4).

(f) Multiple Extraction Procedure

Testing of sediments which have been modified prior to final placement may be required to undergo testing to evaluate their potential for contaminant leaching. One procedure used to accomplish this task is the Multiple Leaching Procedure (EPA Method 1320).

## II. Quality Assurance/Quality Control Guidance and Reporting Requirements

The guidance described below has been drawn from the December 1992 regional manual for USEPA Region II and the New York District Corps of Engineers, entitled, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal"; the EPA and the USACE "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations," (EPA 823-B-95-001, April 1995); and the "Field Sampling Procedures Manual," New Jersey Department of Environmental Protection and Energy, May 1992.

The following quality control samples or procedures will be required for chemical analysis of both sediment and water matrices:

1. Field blanks: One with every batch of 1-20 samples

2. Method blanks: One with every batch of 1-20 samples or every 12 hours, whichever is less

3. Matrix spike and matrix spike duplicate: One set with every batch of 1-20 samples

4. Surrogate spike recovery: Each sample, organic compounds only

5. Minimum detection limit verification within last 2 years for marine sediments and salt water matrices to be submitted to the Department upon request (procedure or citation at 40 CFR 136 [1994] Appendix B, Revision 1.11).

6. Duplicate analyses to be conducted as per method requirements

All bulk sediment chemistry results must be reported on a dry weight basis. All raw data should be presented along with the appropriate criterion. Exceedances of the criterion must be highlighted in an acceptable fashion.

The need to supply either full or reduced data deliverables will be determined by the Department on a case by case basis. The need for the applicant to obtain the services of a data validation contractor will concurrently be determined by the Department at the pre-application stage.

The data reports submitted to the Department for testing and analysis of material proposed for dredging must include a description of all methods and procedures used in the field and in the laboratory, referencing established protocols or guidance, for the following:

1. Sample collection
2. Sample preparation (including homogenizing and compositing)
3. Sample preservation methods and holding times (before and after extraction)
4. Chain of custody tracking documents
5. Sample transport, storage, and disposal
6. Sample analysis
7. Data entry and data reduction
8. Deviations from standard methods or prescribed procedures
9. QA/QC summary and data
10. Narrative of analytical problems, corrective action taken, effects on data interpretation

## III. References for APPENDICES A AND B

Folk, R. 1980. Petrology of Sedimentary Rocks. Hemphill Publishing Co., Texas. 181 p.

National Marine Fisheries Service. 1996. Contaminant Levels in Muscle and Hepatic Tissue of Lobster from the New York Bight Apex.

N.J. Department of Environmental Protection and Energy. 1992. Field Sampling Procedures Manual. 363 p.

O'Connor, T. 1994. Personal communication on July 20, 1994 to S. Ausubel, U.S. Environmental Protection Agency, Region II.

Sloan, N.; G. Adams; R. Pearce; D. Brown; and S-L Chan. 1993. Sampling and Analytical Methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects 1984 - 1992, Volume IV Comprehensive Descriptions of Trace Organic Analytical Methods. NOAA Technical Memorandum NOS ORCA 71. 97 p.

U.S. Army Corps of Engineers, New York District and the U.S. Environmental Protection Agency, Region II. 1992. Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal (Draft).

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1991. Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual. EPA-503/8-91/001.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1995. QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations. EPA 823-B-95-001.

# Attachment 1

| TARGET ANALYTE LIST | | |
|---|---|---|
| Analyte | Limits of Detection | |
| **Volatiles** | Water (ug/L) | Soil (ug/Kg) |
| Chloromethane | 10 | 10 |
| Bromomethane | 10 | 10 |
| Vinyl Chloride | 10 | 10 |
| Chloroethane | 10 | 10 |
| Methylene Chloride | 10 | 10 |
| Acetone | 10 | 10 |
| Carbon Disulfide | 10 | 10 |
| 1,1-Dichloroethene | 10 | 10 |
| 1,1-Dichloroethane | 10 | 10 |
| 1,2-Dichloroethene (total) | 10 | 10 |
| Chloroform | 10 | 10 |
| 1,2-Dichloroethane | 10 | 10 |
| 2-Butanone(MEK) | 10 | 10 |
| 1,1,1-Trichloroethane | 10 | 10 |
| Carbon Tetrachloride | 10 | 10 |
| Bromodichloromethane | 10 | 10 |
| 1,2-Dichloropropane | 10 | 10 |
| cis-1,3-Dichloropropene | 10 | 10 |
| trichloroethene | 10 | 10 |
| Dibromochloromethane | 10 | 10 |
| 1,1,2-Trichloroethane | 10 | 10 |
| Benzene | 10 | 10 |
| trans-1,3-Dichloropropene | 10 | 10 |
| Bromoform | 10 | 10 |
| 4-Methyl-2-pentanone(MIBK) | 10 | 10 |
| 2-Hexanone | 10 | 10 |
| Tetrachloroethene | 10 | 10 |
| 1,1,2,2-Tetrachloroethane | 10 | 10 |
| Toluene | 10 | 10 |
| Chlorobenzene | 10 | 10 |
| Ethylbenzene | 10 | 10 |
| Styrene | 10 | 10 |
| Xylenes(total) | 10 | 10 |
| | | |
| | | |
| | | |
| | | |
| **Semivolatiles** | | |
| Phenol | 10 | 660 |
| bis-(2-Chloroethyl)ether | 10 | 660 |
| 2-Chlorophenol | 10 | 660 |
| 1,3-Dichlorobenzene | 10 | 660 |
| 1,4-Dichlorobenzene | 10 | 660 |
| 1,2-Dichlorobenzene | 10 | 660 |
| 2-Methylphenol | 10 | 660 |
| 2,2'-oxybis(1-Chloropropane) | 10 | 660 |
| 4-Methylphenol | 10 | 660 |
| N-Nitroso-di-n-propylamine | 10 | 660 |

| | Limits of Detection | |
|---|---|---|
| **Semivoilatiles (continued)** | Water (ug/L) | Soil (ug/Kg) |
| Hexachloroethane | 10 | 660 |
| Nitrobenzene | 10 | 660 |
| Isophorone | 10 | 660 |
| 2-Nitrophenol | 10 | 660 |
| 2,4-Dimethylphenol | 10 | 660 |
| bis(2-Chloroethoxy)methane | 10 | 660 |
| 2,4-Dichlorophenol | 10 | 660 |
| 1,2,4-Trichlorobenzene | 10 | 660 |
| Naphthalene | 10 | 660 |
| 4-Chloroaniline | 20 | 1300 |
| Hexachlorobutadiene | 10 | 660 |
| 4-Chloro-3-methylphenol | 20 | 1300 |
| 2-Methylnaphthalene | 10 | 660 |
| Hexachlorocylcopentadiene | 10 | 660 |
| 2,4,6-Trichlorophenol | 10 | 660 |
| 2,4,5-Trichlorophenol | 10 | 660 |
| 2-Chloronaphthalene | 10 | 660 |
| 2-Nitroaniline | 50 | 3300 |
| Dimethylphthalate | 10 | 660 |
| Acenaphthylene | 10 | 660 |
| 2,6-Dinitrotoluene | 10 | 660 |
| 3-Nitroaniline | 50 | 3300 |
| Acenaphthene | 10 | 660 |
| 2,4-Dinitrophenol | 50 | 3300 |
| 4-Nitrophenol | 50 | 3300 |
| Dibenzofuran | 10 | 660 |
| 2,4-Dinitrotoluene | 10 | 660 |
| Diethylphthalate | 10 | 660 |
| 4-Chlorophenyl-phenyl ether | 10 | 660 |
| Fluorene | 10 | 660 |
| 4-Nitroaniline | 20 | 830 |
| 4,6-Dinitro-2-methylphenol | 50 | 3300 |
| N-Nitroso-diphenylamine | 10 | 660 |
| 4-Bromophenyl-phenylether | 10 | 660 |
| Hexachlorobenzene | 10 | 660 |
| Pentachlorophenol | 50 | 3300 |
| Phenanthrene | 10 | 660 |
| Anthracene | 10 | 660 |
| Carbazole | 10 | 330 |
| Di-n-butylphthalate | 10 | 330 |
| Fluoranthene | 10 | 660 |
| Pyrene | 10 | 660 |
| Butylbenzylphthalate | 10 | 660 |
| 3,3'-Dichlorobenzidine | 20 | 1300 |
| Benzo(a)anthracene | 10 | 660 |
| Chrysene | 10 | 660 |
| bis(2-Ethylhexyl)phthalate | 10 | 660 |
| Di-n-octlyphthalate | 10 | 660 |
| Benzo(b)fluoranthene | 10 | 660 |

|  | Limits of Detection |  |
|---|---|---|
| **Semivolatiles (continued)** | Water (ug/L) | Soil (ug/Kg) |
| Benzo(k)fluoranthene | 10 | 660 |
| Benzo(a)pyrene | 10 | 660 |
| Indeno(1,2,3-cd)pyrene | 10 | 660 |
| Dibenzo(a,h)anthracene | 10 | 660 |
| Benzo(g,h,i)perylene | 10 | 660 |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
| **Pesticides/Aroclors** |  |  |
| alpha-BHC | 0.05 | 1.9 |
| beta-BHC | 0.05 | 3.3 |
| delta-BHC | 0.05 | 1.7 |
| gamma-BHC (Lindane) | 0.05 | 2 |
| Heptachlor | 0.05 | 2.1 |
| Aldrin | 0.05 | 2 |
| Heptachlor epoxide | 0.05 | 2.1 |
| Endosulfan I | 0.05 | 2.1 |
| Dieldrin | 0.10 | 3.3 |
| 4,4'-DDE | 0.10 | 4.2 |
| Endrin | 0.10 | 3.6 |
| Endosulfan II | 0.10 | 3.3 |
| 4,4'-DDD | 0.10 | 4.2 |
| Endosulfan sulfate | 0.10 | 3.6 |
| 4,4'-DDT | 0.10 | 3.6 |
| Methoxychlor | 0.50 | 17 |
| Endrin ketone | 0.10 | 3.3 |
| Endrin aldehyde | 0.10 | 3.3 |
| alpha-Chlordane | 0.05 | 1.7 |
| gamma-Chlordane | 0.05 | 1.7 |
| Toxaphene | 5.0 | 170 |
| Aroclor-1016 | 1.0 | 33 |
| Aroclor-1221 | 2.0 | 67 |
| Aroclor-1232 | 1.0 | 33 |
| Aroclor-1242 | 1.0 | 33 |
| Aroclor-1248 | 1.0 | 33 |
| Aroclor-1254 | 1.0 | 33 |
| Aroclor-1260 | 1.0 | 33 |
|  |  |  |
|  |  |  |
| **Inorganics** | ug/L | mg/Kg |
| Aluminum | 200 | 40 |
| Antimony | 60 | 12 |
| Arsenic | 10 | 2 |
| Barium | 200 | 40 |
| Beryllium | 5 | 1 |
| Cadmium | 5 | 1 |
| Calcium | 5000 | 1000 |
| Chromium | 10 | 2 |

| | Limits of Detection | |
|---|---|---|
| **Inorganics (continued)** | Water (ug/L) | Soil (mg/Kg) |
| Cobalt | 50 | 10 |
| Copper | 25 | 5 |
| Iron | 100 | 20 |
| Lead | 3 | 0.6 |
| Magnesium | 5000 | 1000 |
| Manganese | 15 | 3 |
| Mercury | 0.2 | 0.1 |
| Nickel | 40 | 8 |
| Potassium | 5000 | 1000 |
| Selenium | 5 | 1 |
| Silver | 10 | 2 |
| Sodium | 5000 | 1000 |
| Thallium | 10 | 2 |
| Vanadium | 50 | 10 |
| Zinc | 20 | 4 |
| Cyanide | 10 | 0.5 |

# Attachment 2

Retention Time References, Quantitation References, Relative Retention Times, and Minimum Levels for CDDs and CDFs

| Compound | Retention Time and Quantitation Reference | Relative Retention Time | Minimum Level[1] | | |
|---|---|---|---|---|---|
| | | | Water (pg/L; ppq) | Solid (ng/kg; ppt) | Extract (pg/µL; ppb) |
| *Compounds using $^{13}C_{12}$-1,2,3,4-TCDD as the injection internal standard* | | | | | |
| 2,3,7,8-TCDF | $^{13}C_{12}$-2,3,7,8-TCDF | 0.999–1.003 | 10 | 1 | 0.5 |
| 2,3,7,8-TCDD | $^{13}C_{12}$-2,3,7,8-TCDD | 0.999–1.002 | 10 | 1 | 0.5 |
| 1,2,3,7,8-PeCDF | $^{13}C_{12}$-1,2,3,7,8-PeCDF | 0.999–1.002 | 50 | 5 | 2.5 |
| 2,3,4,7,8-PeCDF | $^{13}C_{12}$-2,3,4,7,8-PeCDF | 0.999–1.002 | 50 | 5 | 2.5 |
| 1,2,3,7,8-PeCDD | $^{13}C_{12}$-1,2,3,7,8-PeCDD | 0.999–1.002 | 50 | 5 | 2.5 |
| *Compounds using $^{13}C_{12}$-1,2,3,7,8,9-HxCDD as the injection internal standard* | | | | | |
| 1,2,3,4,7,8-HxCDF | $^{13}C_{12}$-1,2,3,4,7,8-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,6,7,8-HxCDF | $^{13}C_{12}$-1,2,3,6,7,8-HxCDF | 0.997–1.005 | 50 | 5 | 2.5 |
| 1,2,3,7,8,9-HxCDF | $^{13}C_{12}$-1,2,3,7,8,9-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 2,3,4,6,7,8-HxCDF | $^{13}C_{12}$-2,3,4,6,7,8,-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,7,8-HxCDD | $^{13}C_{12}$-1,2,3,4,7,8-HxCDD | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,6,7,8-HxCDD | $^{13}C_{12}$-1,2,3,6,7,8,-HxCDD | 0.998–1.004 | 50 | 5 | 2.5 |
| 1,2,3,7,8,9-HxCDD | —[2] | 1.000–1.019 | 50 | 5 | 2.5 |
| 1,2,3,4,6,7,8-HpCDF | $^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,7,8,9-HpCDF | $^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,6,7,8-HpCDD | $^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD | 0.999–1.001 | 50 | 5 | 2.5 |
| OCDF | $^{13}C_{12}$-OCDD | 0.999–1.008 | 100 | 10 | 5.0 |
| OCDD | $^{13}C_{12}$-OCDD | 0.999–1.001 | 100 | 10 | 5.0 |

1. The Minimum Level (ML) for each analyte is defined as the level at which the entire analytical system must give a recognizable signal and acceptable calibration point. It is equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.
2. The retention time reference for 1,2,3,7,8,9-HxCDD is $^{13}C_{12}$-1,2,3,6,7,8-HxCDD, and 1,2,3,7,8,9-HxCDD is quantified using the averaged responses for $^{13}C_{12}$-1,2,3,4,7,8-HxCDD and $^{13}C_{12}$-1,2,3,6,7,8-HxCDD.

Attachment 3: This is the toxicity equivalent factor guidance. Note that CDD and CDF are acronyms for chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans. T, Pe, Hx, Hp, and O stand for tetra, penta, hexa, hepta, and octa, respectively.

| Compound | Toxicity Equivalency Factor (TEF) |
|---|---|
| 2,3,7,8-TCDD | 1.000 |
| 1,2,3,7,8-PeCDD | 0.500 |
| 1,2,3,4,7,8-HxCDD | 0.100 |
| 1,2,3,6,7,8-HxCDD | 0.100 |
| 1,2,3,7,8,9-HxCDD | 0.100 |
| 1,2,3,4,6,7,8-HpCDD | 0.010 |
| 1,2,3,4,6,7,8,9-OCDD | 0.001 |
| | |
| 2,3,7,8-TCDF | 0.100 |
| 1,2,3,7,8-PeCDF | 0.050 |
| 2,3,4,7,8-PeCDF | 0.500 |
| 1,2,3,6,7,8-HxCDF | 0.100 |
| 1,2,3,7,8,9-HxCDF | 0.100 |
| 1,2,3,4,7,8-HxCDF | 0.100 |
| 2,3,4,6,7,8-HxCDF | 0.100 |
| 1,2,3,4,6,7,8-HpCDF | 0.010 |
| 1,2,3,4,7,8,9-HpCDF | 0.010 |
| 1,2,3,4,6,7,8,9-OCDF | 0.001 |

.ll other CDD and CDF have a TEF of zero.

Attachment 4

## DETERMINATION OF TOTAL ORGANIC CARBON

## 1.0 APPLICATION AND SCOPE

This method, developed by the U.S. Environmental Protection Agency, Region II, Environmental Services Division laboratory in Edison, New Jersey, describes protocols for the determination of organic carbon in ocean sediments. Although the detection limit may vary with procedure or instrument, a minimum reporting value of 100 mg/kg will be required for the ocean dumping/dredging program. Several types of determinations, which are considered equivalent, are presented in this procedure. However, wet combustion methods are not considered to be equivalent to the pyrolytic methods described.

In this method, inorganic carbon from carbonates and bicarbonates is removed by acid treatment. The organic compounds are decomposed by pyrolysis in the presence of oxygen or air. The carbon dioxide that is formed is determined by direct nondispersive infrared detection, flame ionization gas chromatography after catalytic conversion of the carbon dioxide to methane; thermal conductivity gas chromatography, differential thermal conductivity detection by sequential removal of water and carbon dioxide; or thermal conductivity detection following removal of water with magnesium perchlorate.

Water content is determined on a separate portion of sediment and data are reported in mg/kg on a dry weight basis.

## 2.0 DEFINITIONS

The following terms and acronyms are associated with this procedure:

| | |
|---|---|
| LRB | Laboratory record book |
| TOC | Total organic carbon |

## 3.0 PROCEDURE

### 3.1 Sample collection

Collect sediments in glass jars with lids lined with Teflon or aluminum foil. Cool samples and maintain at 4°C. Analyze samples within 14 days. If unrepresentative material is to be removed from the sample, it should be removed in the field under the supervision of the chief scientist and noted in the LRB on the field log sheet.

### 3.2 Apparatus and Reagents

- Drying oven maintained at 103° to 105°C.
- Analytical instrument. No specific TOC analyzer is recommended as superior. The following listing is for information on instrument options only, and is not intended to restrict the use of other unlisted instruments capable of analyzing TOC. The instrument to be used must meet the following specifications:
  - A combustion boat that is heated in a stream of oxygen or air in a resistance or induction-type furnace to completely convert organic substances to $CO_2$ and water.
  - A means to physically or by measurement technique to separate water and other interferants from $CO_2$.
  - A means to quantitatively determine $CO_2$ with adequate sensitivity (100 mg/kg), and precision (25% at the 95% confidence level as demonstrated by repetitive measurements of a well-mixed ocean sediment sample).
  - A strip chart or other permanent recording device to document the analysis.

(1.) Perkin Elmer Model 240C Elemental Analyzer or equivalent. In this instrument, the sample from Section 3.5 is pyrolyzed under pure oxygen, water is removed by magnesium perchlorate and the carbon dioxide is removed by ascarite. The decrease in signal obtained by differential thermal conductivity detectors placed between the combustion gas stream before and after the ascarite tube is a measure of the organic carbon content.

(2.) Carlo Erba Model 1106 CHN Analyzer, or equivalent. In this apparatus, the sample is pyrolyzed in an induction-type furnace, and the resultant carbon dioxide is chromatographically separated and analyzed by a differential thermal conductivity

detector.

(3.) LECO Models WR12, WR112, or CR-12 carbon determinators, or Models 600 or 800 CHN analyzers. In the LECO WR-12, the sample is burned in high frequency induction furnace, and the carbon dioxide is selectively absorbed at room temperature in a molecular sieve. It is subsequently released by heating and is measured by a thermal conductivity detector. The WR-112 is an upgraded WR-12 employing microprocessor electronics and a printer to replace the electronic digital voltmeter.

In the LECO CR-12 carbon determinator, the sample is combusted in oxygen, moisture and dust are removed by appropriate traps, and the carbon dioxide is measured by a selective, solid state, infrared detector. The signal from the detector is then processed by a microprocessor and the carbon content is displayed on a digital readout and recorded on an integral printer.

In the LECO CHN-600 and CHN-800 elemental analyzers, the sample is burned under oxygen in a resistance furnace and the carbon dioxide is measured by a selective infrared detector.

(4.) Dohrman Model DC85 Digital High Temperature TOC Analyzer. In this instrument, the sample is burned in resistance furnace under oxygen, the interfering gases are removed by a sparger/scrubber system, and the carbon dioxide is measured by a non-dispersive infrared detector and shown on a digital display in concentration units.

- Reagents

(1.) Distilled water used in preparation of standards and for dilution of samples should be ultrapure to reduce the carbon concentration of the blank.

(2.) Potassium hydrogen phthalate, stock solution, 1000 mg carbon/L: Dissolve 0.2128 g of potassium hydrogen phthalate (Primary Standard Grade) in distilled water and dilute to 100.0 mL.

NOTE: Sodium oxalate and acetic acid are not recommended as stock solutions.

(3.) Potassium hydrogen phthalate, standard solutions: Prepare standard solutions from the stock solution by dilution with distilled water.

(4.) Phosphoric acid solution, 1:1 by volume.

### 3.3 Interferences

3.3.1 Volatile organics in the sediments may be lost in the decarbonation step resulting in a low bias.

3.3.2 Bacterial decomposition and volatilization of the organic compounds are minimized by maintaining the sample at 4 °C, analyzing within the specified holding time, and analyzing the wet sample.

### 3.4 Sample Preparation

3.4.1 Allow frozen samples to warm to room temperature. Homogenize each sample mechanically, incorporating any overlying water.

3.4.2 Weigh the well-mixed sample (up to 500 mg) into the combustion boat or cup. Add 1:1 phosphoric acid dropwise until effervescence stops. Heat to 75°C.

NOTE: This procedure will convert inorganic carbonates and bicarbonates to carbon dioxide and eliminate it from the sample.

### 3.5 Sample Analysis

Analyze the residue according to the instrument manufacturer's instructions.

### 3.6 Percent Residue Determination

Determine percent residue on a separate sample aliquot as follows:

3.6.1 Heat a clean 25-mL beaker at 103° to 105°C for 1 h. Cool in a desiccator, weigh to

the nearest mg, and store in desiccator until use.

3.6.2 Add 1 g, weighed to the nearest mg, of an aliquot of the well-mixed sample .

3.6.3 Dry and heat in the 103° to 105°C oven for 1 h. Cool in a desiccator. Weigh to the nearest mg.

### 3.7 Calibration

– Follow instrument manufacturer's instructions for calibration. Prepare a calibration curve by plotting mg carbon vs. instrument response using four standards and a blank, covering the analytical range of interest.

### 3.8 Data Recording

Record all data and sample information in LRBs or on project-specific data forms.

All transfers of data to forms and data reductions (e.g., concentration calculations, means, standard deviations) should be checked by the analyst and approved by a lab manager, project manager, or principal investigator. Hard copies of sample data and spreadsheet reports should be kept in the testing laboratory's central files.

### 3.9 QA/QC Procedures

3.9.1 Precision and Accuracy The precision and accuracy will differ with the various instruments and matrices, and must be determined by the laboratories reporting data. A representative sample of well-mixed, meshed, sediment should be analyzed in quadruplicate for 4 days to determine the analytical precision.

3.9.2 It is critical that each sample be thoroughly homogenized in the laboratory before a subsample is taken for analysis. Laboratory homogenization should be conducted even if samples were homogenized in the field.

3.9.3 Dried samples should be cooled in a desiccator and held there until they are weighed. If a desiccator is not used, the sediment will accumulate ambient moisture and the sample weight will be overestimated. A color-indicating desiccant is recommended so that spent desiccant can be detected easily. Also, the seal on the desiccator should be checked periodically and, if necessary, the ground glass rims should be greased or the "O" rings replaced.

## 4.0 DATA REDUCTION, DOCUMENTATION, AND REPORTING

### 4.1 Data Reduction

Data analysis and calculations will be performed whenever possible on computers using commercial spreadsheet software such as Lotus 1-2-3, Quattro Pro, or Microsoft Excel.

### 4.2 Documentation

Keep all laboratory records, test results, measurements, other and supporting documentation for each sediment test in a LRB or project file dedicated to that purpose.

### 4.3 Reporting

A report should be prepared including, but not limited to, the following information:

- Sources of samples
- Description of methods
- Summary of sample analysis results
- Summary of any deviations from the project test plan
- Copies raw data, observations, or data forms

Total organic carbon should be reported as a percentage of the dry weight of the unacidified sample to the nearest 0.1 unit. The laboratory should report the results of all samples (including QC replicates, method blanks, and standard reference measurements) and should note any problems that may have influenced sample quality. The laboratory should also provide a summary of the calibration procedure and results (e.g., range covered, regression equation, coefficient of determination).

Source: U.S. Army Corps of Engineers - New York District and Environmental Protection Agency -Region II, 1992, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal," Draft-18 Dec 1992.

# APPENDIX C
# PCB CONGENER LIST

# TABLE 2

## NON-ORTHO COPLANAR PCB CONGENERS SUBSTITUTED IN BOTH PARA AND TWO OR MORE META POSITIONS

| IUPAC NUMBER | STRUCTURE | HOMOLOG GROUP |
|---|---|---|
| 77 | 3,3',4,4' | Tetra-CB |
| 81 | 3,4,4',5 | Tetra-CB |
| 126 | 3,3',4,4',5 | Penta-CB |
| 169 | 3,3',4,4',5,5' | Hexa-CB |

## TABLE 3

## TARGETED PCB CONGENERS OTHER THAN NON-ORTHO PCBs

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 8 | 2,4' | Di-CB |
| 18 | 2,2',5 | Tri-CB |
| 28 | 2,4,4' | Tri-CB |
| 37 | 3,4,4' | Tri-CB |
| 42 | 2,2',3,4' | Tetra-CB |
| 44 | 2,2',3,5' | Tetra-CB |
| 47 | 2,2',4,4' | Tetra-CB |
| 49 | 2,2',4,5' | Tetra-CB |
| 52 | 2,2',5,5' | Tetra-CB |
| 60 | 2,3,4,4' | Tetra-CB |
| 64 | 2,3,4',6 | Tetra-CB |
| 66 | 2,3',4,4' | Tetra-CB |
| 70 | 2,3',4',5 | Tetra-CB |
| 74 | 2,4,4',5 | Tetra-CB |
| 80 | 3,3',5,5' | Tetra-CB |
| 82 | 2,2',3,3',4 | Penta-CB |
| 84 | 2,2',3,3',6 | Penta-CB |
| 86 | 2,2',3,4,5 | Penta-CB |
| 87 | 2,2',3,4,5' | Penta-CB |
| 91 | 2,2',3,4',6 | Penta-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 92 | 2,2',3,5,5' | Penta-CB |
| 95 | 2,2',3,5',6 | Penta-CB |
| 97 | 2,2',3',4,5 | Penta-CB |
| 99 | 2,2',4,4',5 | Penta-CB |
| 101 | 2,2',4,5,5' | Penta-CB |
| 105 | 2,3,3',4,4' | Penta-CB |
| 110 | 2,3,3',4',6 | Penta-CB |
| 114 | 2,3,4,4',5 | Penta-CB |
| 118 | 2,3',4,4',5 | Penta-CB |
| 119 | 2,3',4,4',6 | Penta-CB |
| 120 | 2,3',4,5,5' | Penta-CB |
| 123 | 2',3,4,4',5 | Penta-CB |
| 127 | 3,3',4,5,5' | Penta-CB |
| 128 | 2,2',3,3',4,4' | Hexa-CB |
| 137 | 2,2',3,4,4',5 | Hexa-CB |
| 138 | 2,2',3,4,4',5' | Hexa-CB |
| 141 | 2,2',3,4,5,5' | Hexa-CB |
| 146 | 2,2',3,4',5,5' | Hexa-CB |
| 149 | 2,2',3,4',5',6 | Hexa-CB |
| 151 | 2,2',3,5,5',6 | Hexa-CB |
| 153 | 2,2',4,4',5,5' | Hexa-CB |
| 156 | 2,3,3',4,4',5 | Hexa-CB |
| 157 | 2,3,3',4,4',5' | Hexa-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 158 | 2,3,3',4,4',6 | Hexa-CB |
| 166 | 2,3,4,4',5,6 | Hexa-CB |
| 167 | 2,3',4,4',5,5' | Hexa-CB |
| 168 | 2,3',4,4',5',6 | Hexa-CB |
| 170 | 2,2',3,3',4,4',5 | Hepta-CB |
| 171 | 2,2',3,3',4,4',6 | Hepta-CB |
| 174 | 2,2',3,3',4,5,6' | Hepta-CB |
| 177 | 2,2',3,3',4',5,6 | Hepta-CB |
| 179 | 2,2',3,3',5,6,6' | Hepta-CB |
| 180 | 2,2',3,4,4',5,5' | Hepta-CB |
| 183 | 2,2',3,4,4',5',6 | Hepta-CB |
| 185 | 2,2',3,4,5,5',6 | Hepta-CB |
| 187 | 2,2',3,4',5,5',6 | Hepta-CB |
| 189 | 2,3,3',4,4',5,5' | Hepta-CB |
| 190 | 2,3,3',4,4',5,6 | Hepta-CB |
| 191 | 2,3,3',4,4',5',6 | Hepta-CB |
| 194 | 2,2',3,3',4,4',5,5' | Octa-CB |
| 195 | 2,2',3,3',4,4',5,6 | Octa-CB |
| 196 | 2,2',3,3',4,4',5',6 | Octa-CB |
| 198 | 2,2',3,3',4,5,5',6 | Octa-CB |
| 200 | 2,2',3,3',4,5',6,6' | Octa-CB |
| 201 | 2,2',3,3',4',5,5',6 | Octa-CB |
| 203 | 2,2',3,4,4',5,5',6 | Octa-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 205 | 2,3,3',4,4',5,5',6 | Octa-CB |
| 206 | 2,2',3,3',4,4',5,5',6 | Nona-CB |
| 207 | 2,2',3,3',4,4',5,6,6' | Nona-CB |
| 208 | 2,2',3,3',4,5,5',6,6' | Nona-CB |
| 209 | 2,2',3,3',4,4',5,5',6,6' | Deca-CB |

# APPENDIX D
# STATE OF DELAWARE
# SURFACE WATER QUALITY STANDARDS
As Amended, August 11, 1999

## Section 9: Toxic Substances

9.1. Applicability: Criteria set forth in this section apply to all surface waters of the State, except as provided in Section 6, Regulatory Mixing Zones, Section 8, Critical Flows, and Section 12, Criteria for Low Flow Waters.

9.2. General Provisions:

(a) Waters of the State shall not exhibit acute toxicity to fish, aquatic life, and wildlife, except in special cases applying to regulatory mixing zones as provided in Section 6.

(b) Waters of the State shall not exhibit chronic toxicity to fish, aquatic life, and wildlife, except in regulatory mixing zones as provided in Section 6, at flows less than critical flows as provided in Section 8, or in low flow waters as provided in Section 12.

(c) Waters of the State shall be maintained to prevent adverse toxic effects on human health resulting from ingestion of chemically contaminated aquatic organisms and drinking water.

(d) The Department may consider synergistic, antagonistic, and additive impacts of combinations of toxicants to fish, aquatic life, and wildlife, and human health in assessing aggregate environmental impacts and mandating point and nonpoint source controls.

9.3. Specific Numerical Criteria:

(a) Aquatic Life Criteria:

(i) Numerical criteria for the protection of aquatic life are established in Table 1 for all toxic substances for which adequate aquatic life toxicity information is available. All criteria for metals in Table 1 are in the total recoverable form, except as specifically footnoted for cyanide. For toxic substances where the relationship of toxicity is defined as a function of pH or hardness, numerical criteria are presented as an equation based on this relationship. Appropriate pH or hardness values for such criteria shall be determined on a case-by-case basis by the Department.

(ii) For toxic substances for which specific numerical criteria are not listed in Table 1, concentrations shall not exceed those which are chronically toxic (as determined from appropriate chronic toxicity data or calculated as 0.1 of $LC_{50}$ values) to representative, sensitive aquatic organisms,

except as provided in Section 6, Regulatory Mixing Zones, Section 8, Critical Flows, or Section 12, Criteria for Low Flow Waters. Concentrations so determined shall be applied as four-day average concentrations not to be exceeded more than once in any three-year period.

(b) Human Health Criteria

(i) Numerical criteria for the protection of human health are established in Table 2 for all toxic substances for which adequate toxicity information is available. Water quality criteria appearing in Table 2 for pollutants identified as carcinogens have been established at an upper bound worst case risk management level of one excess cancer in a population of one million (1 x $10^{-6}$) over a 70 year lifetime. Criteria listed under the column header "Fish and Water Ingestion" apply only to surface waters of the State designated as Public Water Supply Sources in Section 10 of these Standards. Criteria listed under the column header "Fish/Shellfish Ingestion" apply only to marine surface waters of the State. Criteria listed under the column header "Fish Ingestion Only" apply to all fresh surface waters of the State not designated as Public Water Supply sources in Section 10 of these Standards.

(ii) For compounds in Table 2 which are considered as both systemic toxicants and human carcinogens, criteria based on both human health concerns are presented. In determining pollution control requirements, the more stringent criterion, after consideration of critical (design) flows in Section 8, shall be utilized.

# TABLE 1

## WATER QUALITY CRITERIA FOR PROTECTION OF AQUATIC LIFE
(All Values Are Listed or Calculated in Micrograms Per Liter)

| Parameter | Fresh Acute Criterion | Fresh Chronic Criterion | Marine Acute Criterion | Marine Chronic Criterion |
|---|---|---|---|---|
| Aldrin | 3.0 | -- | 1.3 | -- |
| Aluminum | 750. | 87. | -- | -- |
| Arsenic (III) | 360. | 190. | 69. | 36. |
| Cadmium | $e^{(1.128[\ln(Hd)]-3.828)}$ | $e^{(0.7852[\ln(Hd)]-3.490)}$ | 43. | 9.3 |
| Chlordane | 2.4 | 0.0043 | 0.09 | 0.004 |
| Chlorine | 19 | 11. | 13 | 7.5 |
| Chlorpyrifos | 0.083 | 0.041 | 0.011 | 0.0056 |
| Chromium (III) | $e^{(0.8190[\ln(Hd)]+3.688)}$ | $e^{(0.8190[\ln(Hd)]+1.561)}$ | — | -- |
| Chromium (VI) | 16. | 11. | 1,100. | 50. |
| Copper | $e^{(0.9422[\ln(Hd)]-1.464)}$ | $e^{(0.8545[\ln(Hd)]-1.465)}$ | 2.9 | -- |
| Cyanide[1] | 22. | 5.2 | 1.0 | -- |

| Parameter | Fresh Acute Criterion | Fresh Chronic Criterion | Marine Acute Criterion | Marine Chronic Criterion |
|---|---|---|---|---|
| DDT and Metabolites | 1.1 | 0.0010 | 0.13 | 0.0010 |
| Demeton | -- | 0.10 | -- | 0.10 |
| Dieldrin | 2.5 | 0.0019 | 0.71 | 0.0019 |
| Endosulfan | 0.22 | 0.056 | 0.034 | 0.0087 |
| Endrin | 0.18 | 0.0023 | 0.037 | 0.0023 |
| Guthion | -- | 0.01 | -- | 0.01 |
| Heptachlor | 0.52 | 0.0038 | 0.053 | 0.0036 |
| Hexachlorocylclohex | 2.0 | 0.08 | 0.16 | -- |
| Iron | -- | 1000. | -- | -- |
| Lead | $e^{(1.273[\ln(Hd)]-1.460)}$ | $e^{(1.273[\ln(Hd)]-4.705)}$ | 140. | 5.6 |
| Malathion | -- | 0.1 | -- | 0.1 |
| Mercury (II) | 2.4 | 0.012 | 2.1 | 0.025 |
| Methoxychlor | -- | 0.03 | -- | 0.03 |
| Mirex | -- | 0.001 | — | 0.001 |

| Parameter | Fresh Acute Criterion | Fresh Chronic Criterion | Marine Acute Criterion | Marine Chronic Criterion |
|---|---|---|---|---|
| Nickel | $e^{(0.8460[\ln(Hd)]+3.3612)}$ | $e^{(0.8460[\ln(Hd)]+1.1645)}$ | 75. | 8.3 |
| Total PCBs | 2.0 | 0.014 | 10 | 0.03 |
| Parathion | 0.065 | 0.013 | -- | -- |
| Pentachlorophenol | $e^{[1.005(pH)-4.830]}$ | $e^{[1.005(pH)-5.290]}$ | 13. | 7.9 |
| Selenium | 20 | 5.0 | 300. | 71. |
| Silver | $e^{(1.72[\ln(Hd)]-6.52)}$ | 0.12 | 2.3 | -- |
| Toxaphene | 0.78 | 0.0002 | 0.21 | 0.0002 |
| Zinc | $e^{(0.8473[\ln(Hd)]+0.8604)}$ | $e^{(0.8473[\ln(Hd)]+0.7614)}$ | 95. | 86. |

Notes:

[1] Cyanide measured as free cyanide at the lowest pH occurring in the receiving water, or cyanide amenable to chlorination.

Specific numerical acute criteria as presented in this table are applied as one-hour average concentrations not to be exceeded more than once in any three-year period. Specific numerical chronic criteria as presented in this table are applied as four-day average concentrations not to be exceeded more than once in any three-year period.

ln = natural log base e

e=2.71828

Hd= hardness is expressed as mg/L as $CaCO_3$

pH is expressed as Standard Units

Example calculation: Fresh acute criterion for silver at hardness of 50 mg/L. Criterion in ug/L = e raised to the [1.72 ln(50) - 6.52] power. This is equal to e to the 0.21 power, or 1.23 ug/L.

# TABLE 2
## WATER QUALITY CRITERIA FOR PROTECTION OF HUMAN HEALTH
(All Values Are Listed in Micrograms Per Liter Unless Noted Otherwise)

| | Freshwater | | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
| | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish | |
| Acrolein | 1.0 mg/L | 360. | 140. | ST |
| Acrylonitrile | 0.83 | 0.06 | 0.12 | CA |
| Aldrin | 0.17 ng/L | 0.16 ng/L | 0.02 ng/L | CA |
| Aldrin | 0.086 | 0.080 | 0.012 | ST |
| Antimony | 5.4 mg/L | 14. | 760. | ST |
| Arsenic** | | 50. (MCL) | | CA |
| Barium** | | 1.0 mg/L | | ST |
| Benzene | 89. | 1.2 | 12.5 | CA |
| Benzidine | 0.67 ng/L | 0.12 ng/L | 0.09 ng/L | CA |
| Benzidine | 460. | 85. | 64. | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Benzo (A) Pyrene (3,4 Benzopyrene) | 0.037 | 0.0027 | 0.0053 | CA |
| Beryllium | 0.08 | 0.0038 | 0.011 | CA |
| Beryllium | 3.5 mg/L | 170. | 500. | ST |
| Bromoform (Tribromomethane) | 266 | 5.6 | 37.4 | CA |
| Bromoform | 34. mg/L | 690. | 4.7 mg/L | ST |
| Cadmium** |  | 10.(MCL) |  | ST |
| Carbon Tetrachloride (Tetrachloromethane) | 5.5 | 0.26 | 0.78 | CA |
| Carbon Tetrachloride | 500. | 23. | 70. | ST |
| Chlordane | 0.73 ng/L | 0.72 ng/L | 0.13 ng/L | CA |
| Chlordane | 0.057 | 0.056 | 0.008 | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Chlorobenzene | 26.1 mg/L | 680. | 3.7 mg/L | ST |
| Chloroethyl Ether (Bis-2 Chloroalkyl Ether) | 1.77 | 0.031 | 0.25 | CA |
| Chloroform (Trichloromethane) | 368. | 5.7 | 52. | CA |
| Chloroform (Trichloromethane) | 22. mg/L | 340. | 3.2 mg/L | ST |
| Chromium** |  | 50. (MCL) |  | ST |
| Chromium (Hexavalent) | 4.2 mg/L | 170. | 590. | ST |
| Chromium (Trivalent) | 840. mg/L | 34. mg/L | 120. mg/L | ST |
| Cyanide | 270. mg/L | 700. | 38. mg/L | ST |
| DDT and Metabolites | 0.74 ng/L | 0.73 ng/L | 0.10 ng/L | CA |
| DDT and Metabolites | 0.13 | 0.12 | 0.018 | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Dibenzo (A,H) Anthracene | 0.037 | 0.0027 | 0.0053 | CA |
| 1,2 Dichlorobenzene | 21.8 mg/L | 2.8 mg/L | 3.1 mg/L | ST |
| 1,3 Dichlorobenzene | 4.3 mg/L | 410. | 600. | ST |
| 1,4 Dichlorobenzene** | 24. mg/L | 75. (MCL) | 3.4 mg/L | ST |
| 3,3 Dichlorobenzidine | 0.025 | 0.011 | 0.0036 | CA |
| 1,2 Dichloroethane | 123. | 0.38 | 17. | CA |
| 1,1 Dichloroethylene | 4. | 0.058 | 0.56 | CA |
| 1,1 Dichloroethylene | 20. mg/L | 310. | 2.8 mg/L | ST |
| 1,2 Trans-dichloroethylene | 130. mg/L | 700. | 19. mg/L | ST |
| Dichloromethane | 2.0 | 4.7 | 277. | CA |
| Dichloromethane | 810. mg/L | 2.1 mg/L | 110 mg/L | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| 2,4 Dichlorophenoxyacetic acid (2,4-D)** |  | 100. (MCL) |  | ST |
| 1,3 Dichloropropene | 392. | 0.19 | 5.5 | CA |
| 1,3 Dichloropropene | 2.0 mg/L | 10.0 | 280. | ST |
| Dieldrin | 0.18 ng/L | 0.17 ng/L | 0.025 ng/L | CA |
| Dieldrin | 0.14 | 0.13 | 0.02 | ST |
| Diethylphthalate | 148. mg/L* | 24.0 mg/L | 21.0 mg/L | ST |
| Dimethylphthalate | 3,700. mg/L | 320. mg/L | 530. mg/L | ST |
| 2, 4 Dinitrotoluene | 96. | 0.94 | 13. | CA |
| 2, 4 Dinitrophenol | 13.0 mg/L | 70. | 1.9 mg/L | ST |
| Dioxin (2,3,7,8-TCDD) | 0 .000017 ng/L | 0.000016 ng/L | 0.0000024 ng/L | CA |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| 1, 2 Diphenylhydrazine | 0.68 | 0.041 | 0.095 | CA |
| Endosulfan | 2.5 | 1.0 | 0.35 | ST |
| Endrin** | 1.0 | 0.2 (MCL) | 0.14 | ST |
| Ethylbenzene | 35. mg/L | 3.2 mg/L | 5.0 mg/L | ST |
| Fluoranthene | 67. | 50. | 9.4 | ST |
| Fluoride** |  | 1.8 mg/L |  | ST |
| Heptachlor | 0.27 ng/L | 0.26 ng/L | 0 .037 ng/L | CA |
| Heptachlor | 0.60 | 0.58 | 0.084 | ST |
| Hexachloroethane | 11. | 2. | 1.6 | CA |
| Hexachloroethane | 150. | 29. | 22. | ST |
| Hexachlorobenzene | 0.88 ng/L | 0.85 ng/L | 0.12 ng/L | CA |

| | Freshwater | | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
| | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish | |
| Hexachlorobenzene | 1.2 | 1.2 | 0.17 | ST |
| Hexachlorobutadiene | 62.1 | 0.44 | 8.7 | CA |
| Hexachlorobutadiene | 2.0 mg/L* | 69. | 1.3 mg/L | ST |
| Hexachlorocyclohexane | 0.08 | 0.02 | 0.011 | CA |
| Hexachlorocyclohexane (Gamma-Lindane) ** | 31. | 4.0 (MCL) | 4.4 | ST |
| Hexachlorocyclohexane (Alpha) | 0.016 | 0.0041 | 0.0023 | CA |
| Hexachlorocyclohexane (Beta) | 0.058 | 0.014 | 0.0081 | CA |
| Hexachlorocyclopentadiene | 1.8 mg/L* | 240. | 1.8 mg/L* | ST |
| Isophorone | 500. mg/L | 5.2 mg/L | 71. mg/L | ST |

|  | Freshwater<br>Fish Ingestion Only | <br>Fish and Water Ingestion | Marine/Estuarine<br>Fish/Shellfish | Human Health Concern |
|---|---|---|---|---|
| Lead** |  | 50.(MCL) |  | CA |
| Mercury**<br>(Inorganic) | 7.1 | 2.0 (MCL) | 1.5 | ST |
| Methoxychlor** |  | 100.(MCL) |  | CA |
| Nickel | 5.7 mg/L | 620. | 810. | ST |
| Nitrate-Nitrogen** |  | 10. mg/L |  | ST |
| Nitrobenzene | 2.2 mg/L | 17.0 | 320. | ST |
| Nitrosodimethylamine-N | 10. | 0.68 ng/L | 1.4 | CA |
| Nitrosodiphenylamine-N | 20. | 5.3 | 2.8 | CA |
| Nitrosodipropylamine-N | 35. | 0.005 | 4.9 | CA |

| | Freshwater | | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
| | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish | |
| PCBs (1242,1254,1221, 1232, 1248, 1260, 1016) | 0.056 ng/L | 0.055 ng/L | 0.0079 ng/L | CA |
| (Bis-2) Ethyl Hexyl Phthalate | 7.4 | 1.9 | 1. | CA |
| (Bis-2) Ethyl Hexyl Phthalate | 400.* | 400.* | 290. | ST |
| Di-N-Butyl Phthalate | 13. mg/L* | 2.8 mg/L | 2.1 mg/L | ST |
| Selenium** | 1.1 mg/L | 10. (MCL) | 160. | ST |
| Silver** | 0. mg/L | 50. (MCL) | 5.7 mg/L | ST |
| 1,1,2,2 Tetrachloroethane | 13.5 | 0.17 | 1.9 | CA |
| Tetrachloroethylene | 4.3 mg/L | 320. | 610. | ST |
| Thallium | 60. | 14. | 8.4 | ST |
| Toluene | 370. mg/L | 10. mg/L | 52. mg/L | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Total Trihalomethanes** |  | 100.(MCL) |  | CA |
| Toxaphene | 0.93 ng/L | 0.91 ng/L | 0.13 ng/L | CA |
| 1,2,4 Trichlorobenzene | 19. mg/L | 680. | 2.7 mg/L | ST |
| 1,1,1 Trichloroethane** | 200. mg/L | 200. (MCL) | 28. mg/L | ST |
| 1,1,2 Trichloroethane | 52.5 | 0 .61 | 7.4 | CA |
| 1,1,2 Trichloroethane | 11. mg/L | 140. | 1.5 mg/L | ST |
| Trichloroethylene | 115. | 3.1 | 16. | CA |
| 2,4,6 Trichlorophenol | 4.5 | 1.3 | 0.63 | CA |
| 2,4,5 Trichlorophenoxypropionic acid (2,4,5-TP-Silvex)** |  | 10. (MCL) |  | ST |
| Vinyl Chloride | 677. | 2.1 | 95. | CA |

NOTES: mg/L = milligrams per liter ng/L = nanograms per liter CA = carcinogen ST = systemic toxicant

The columns labeled "Fish and Water Ingestion" shall apply only to waters of the State designated Public Water Supply sources in these standards.
The column labeled "Fish Ingestion Only" shall apply to all fresh waters of the State not designated Public Water Supply sources in this document.
The column labeled "Fish/Shellfish Ingestion" shall apply only to marine waters of the State.

*Calculated solubility of compound in water is less than criterion; therefore, solubility limit calculated at 25° C and 1 atm is substituted.
**Values shown under header "Fish and Water Ingestion" are Primary Maximum Contaminant Levels (MCLs) as given in the State of Delaware Regulations Governing Public Drinking Water Systems as amended May 19, 1989.

# Delaware River
# Main Channel Deepening Project
# Water Quality Monitoring
# Economic Loading of Hopper Dredges

## I. Scope of Work

Hopper dredges are self-propelled ships equipped with propulsion machinery, hoppers for dredged material storage, and dredge pumps. Dredged material is hydraulically raised through trailing dragarms in contact with the channel bottom and is discharged into the hoppers. The material is then held in the hoppers until it is transported to the placement site. Hopper dredges are often loaded past the point of overflow for economic reasons. As the hopper is filled, dredged material is stored in the hopper until overflow begins. The density of the hopper contents is increased by allowing the low-density supernatant to overflow back into the waterway. As the low-density supernatant overflows, the average density of the hopper contents increases. Thus, more material can be transported per trip to the placement location, resulting in an economical loading.

The work under this contract includes monitoring any increases in suspended sediment and associated contaminant concentrations in dredging site water immediately following hopper dredging activity to achieve an economic load. The hopper dredging will take place in Delaware Bay, during initial construction of the Delaware River Main Channel Deepening Project. A boat will be anchored behind the hopper dredge, in its path, immediately after it passes, and water samples will be collected to measure the decay of any plume as it settles through the water column. Discrete water samples will be collected over time at the surface, mid-water, and bottom of the water column. Lateral plume dispersion will not be measured. In addition, composite samples of bottom sediment in the area of dredging will be collected and analyzed to characterize the total contaminant loading of the dredged material. Samples will be collected and appropriately preserved in the field, and delivered to a laboratory for various chemical and geotechnical analyses. Contaminant data will be compared to Delaware water quality standards for protection of aquatic life and human health. Composited sediment sample data will be used to estimate the release of contaminants to the water column using equilibrium partitioning theory. These data will be compared to actual concentrations measured in the water column subsequent to hopper dredging activity.

## II. Sample Collection

Sample collection will take place in four channel dredging locations within Delaware Bay waters. These locations will be coordinated and approved by the Delaware Department of Natural Resources and Environmental Control prior to monitoring. The contractor will be required to coordinate with the dredge operator to ensure that testing is done during active dredging with overflow. One set of water quality samples will be collected in each dredging location. Testing will not be conducted on consecutive days, but will be distributed over time to capture changes in field conditions.

For each sampling day, the contractor will collect a set of water samples that represent decay of the suspended sediment plume resulting from passage of a hopper dredge pumping past overflow. Immediately following passage of the hopper dredge pumping past overflow, a boat will be anchored behind the dredge, in its path. Surface, mid-water, and bottom samples will be collected at ten-minute intervals for a period of one hour. Specifically, water samples will be collected from the surface, mid-water, and bottom at 0 minutes, 10 minutes, 20 minutes, 30 minutes, 40 minutes, 50 minutes and 60 minutes from the start of sampling.

Prior to hopper dredging activity, a series of water samples will be collected from the surface, mid-water and bottom to represent background conditions in the vicinity of the dredging location. Specifically, water samples will be collected from the surface, mid-water, and bottom at 0 minutes, 10 minutes, 20 minutes and 30 minutes from the start of sampling.

Water samples should be collected with either a non-contaminating pump (peristaltic or magnetically coupled impeller design pump) or a discrete water sampler. The pump system should be flushed with 10 times the volume of the collection tubing using site water. The discrete water sampler should be of stainless steel or acrylic plastic and be of the closed/opened/closed type. Seals should be teflon-coated. All water sampling devices should be acid-rinsed (10% nitric acid) for metal analysis, and solvent-rinsed (acetone is preferred; however, other approved solvents such as methanol and hexane can be used as well) for organic analysis. When equipment will be used to take samples for both metal and organic compound analysis, the acid rinse must be conducted first, and the solvent rinse second. Temperature, dissolved oxygen, pH, and salinity will be measured at each sample collection depth for each sample collection interval.

All water samples collected for the monitoring effort will be analyzed for total suspended sediment. A subset of the samples will be analyzed for concentrations of heavy metals, chlorinated pesticides, PCB congeners and semi-volatile organic contaminants. Volatile organic contaminants will not be required. Samples to be analyzed for contaminants include the surface, mid-water and bottom samples collected at the 0 minute, 20 minute, and 50 minute intervals for the plume decay monitoring, and a composite background sample representing each of the three sampling depths. The composite background sample for each sample depth will be prepared by mixing equal volumes of water for each time interval (ie. 0 minutes, 10 minutes, 20 minutes and 30 minutes from the start of sampling). Storage and preservation procedures for these water samples are provided as Appendix A. These procedures are from: *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (New Jersey Department of Environmental Protection, 1997). The specified holding times by analyte group for water samples must be adhered to.

To characterize contaminant concentrations in the sediment being dredged at the time water column monitoring is conducted, three grab samples will be collected at each dredging location with a decontaminated Young grab and composited into one representative sample for each dredging location. Sediment will be collected in the navigation channel prior to hopper dredging. Storage and preservation procedures for these sediment samples are provided as Appendix A. These procedures are from: *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (New Jersey Department of Environmental Protection, 1997). The specified holding times must be adhered to. Samples to be analyzed for metals should not come in contact with metal sampling equipment, and samples to be analyzed for organic compounds should not come into contact with plastics. All sample containers should be appropriately cleaned: acid-rinsed (10% nitric acid) for metal analysis, and solvent-rinsed (acetone is preferred; however, other approved solvents such as methanol and hexane can be used as well) for organic analysis. When equipment will be used to take samples for both metal and organic compound analysis, the acid rinse must be conducted first, and the solvent rinse second. Samples should completely fill the storage container, leaving no head space, except for expansion volume needed for potential freezing. Samples should be refrigerated or frozen with dry ice immediately after sample collection.

## III. Sample Analysis

Appendix B provides analytical procedures and associated quality assurance/quality control measures for sample analysis. These requirements are from: *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (New Jersey Department of Environmental Protection, 1997). The water samples identified for contaminant analysis in Section II of this scope of work, and the composited sediment samples will be analyzed for the analytes listed in Attachment 1 of Appendix B. Note that volatile organic contaminants will not be analyzed in either the sediment or water samples. Attachment 1 also provides the required detection limits for sediment and water samples. In addition, for the water samples, because water quality criteria for seven metals are expressed as dissolved metal, dissolved inorganic analytes will be analyzed in addition to total inorganic analytes using test methods that can achieve detection limits of at least 2 ug/L.

In addition to the analytes listed in Attachment 1, the water and sediment samples will be analyzed using high resolution gas chromatograpy (HRGC) / high resolution mass spectrometry (HRMS) for 77 mono-ortho and di-ortho PCB congeners and four non-ortho coplanar PCB congeners using draft USEPA method 1668. A list of the PCB congeners is provided as Appendix C. The HRGC/HRMS method shall provide detection limits of 1.25 ng/L for the mono- and di-ortho congeners and 25 pg/L for the non-ortho congeners in aqueous samples, and detection limits of 0.125 ng/g for mono- and di-ortho congeners and 12.5 pg/g for non-ortho congeners in sediment samples. Samples will not be analyzed for polychlorinated dibenzo-p-dioxin or dibenzofurans.

The composited sediment samples will be analyzed for grain size and total organic carbon. As discussed in Appendix B, the grain size analyses will follow the methods described by Folk (1980), and the total organic carbon analyses will follow the procedure provided as Attachment 4 to Appendix B. All water samples will be analyzed for total suspended solids using USEPA method 160.2.

## IV. Data Analysis

The data objectives of this study are: (1) to evaluate contaminant concentrations in the Delaware Bay water column in the vicinity of hopper dredging activity with pumping past overflow relative to State of Delaware regulatory criteria; (2) to monitor increased total suspended sediment concentrations in the Delaware Bay water column resulting from economic loading operations and to measure the rate of decay of any suspended sediment plume over time; and (3) to compare actual contaminant concentrations measured in the water column as a result of the economic loading practice to estimated concentrations derived from the bulk sediment data using equilibrium partitioning theory.

In addition to comparing contaminant concentrations to water quality standards for protection of aquatic life, the analysis will also include comparisons to water quality standards for protection of human health. This is most important with regard to PCBs, which are more a human health issue in the Delaware estuary (related to biomagnification within the food chain), rather than an aquatic life issue. It is understood that aquatic life concerns are a near-field issue, while human health concerns are a far-field issue. State of Delaware surface water quality standards (as amended, 11 August 1999) for protection of aquatic life and protection of human health can be found in Appendix D.

## V. Report Format and Content

Draft and final copies of the report of investigation will reflect and report the analysis outlined in this scope of work. Draft and final reports must contain the following features:

a. If the report has been written by someone other than the contract principal investigator, the cover and title page of the publishable report must bear the inscription Prepared Under the Supervision of (name), Principal Investigator. The principal investigator is required to sign the original copy of the report. In addition, the principal investigator must at least prepare a forward describing the overall research context of the report, the significance of the work, and any other related background circumstances relating to the manner in which the work was undertaken.

b. The TITLE PAGE will include the date (month and year) the report was submitted, the project name, the author, Prepared for the U.S. Army Corps of Engineers, Philadelphia District, and the contract number.

c. An EXECUTIVE SUMMARY that provides a brief description of the study's purpose, findings, conclusions and recommendations.

d. A TABLE OF CONTENTS that includes a list of all tables, figures and appendices presented in the report.

e. An INTRODUCTION section stating the purpose of the study with background information on the Delaware River Main Channel Deepening Project.

f. A METHODOLOGY section that describes the sampling and analysis equipment and methodologies.

g. A RESULTS section that presents collected data in tabular and graphic form, and details of applicable statistical analyses used to evaluate the data.

h. A DISCUSSION section that collates statistical data with published literature and draws inferences regarding operation of the confined disposal facility relative to Delaware River water quality issues.

i. A CONCLUSIONS section that emphasizes the main points articulated in the body of the report, and provides pertinent recommendations.

j. A LIST OF REFERENCES that includes literature cited and agencies/individuals consulted.

k. Appropriate APPENDICES for data sheets, records, and other pertinent information.

l. PAGE SIZE AND FORMAT. Each report will be produced on 8 ½ " x 11" paper, single spaced, with double spacing between paragraphs. Figures should not exceed 11" in height nor 12 " in length in most circumstances. Larger figures may be produced, but an 8 ½" x 11" version must be included in the report. All text pages (including appendices) must be consecutively numbered. Text print quality must be at least letter quality.

VI. Period of Performance

Three copies of a draft report will be submitted to the Corps by (**Insert Date**). The draft report must be a polished product and an accurate representation of the content of the final report. The draft must be clean-typed, complete with all figures, tables and sections of the report. All graphics will appear in the same format, and general location in the report as they will be in the final report.

Subsequent to a two-month review period the Corps will provide the Contractor with comments on the draft report. The Contractor will then have an additional month to revise and submit the final report. The Contractor shall submit one unbound, reproducible original and five bound copies of the final report. The final report will be due on (**Insert Date**). When the Corps accepts the final report the contract will be complete.

## VII. Inspection

The work will be conducted under the general discretion of the Contracting Officer and shall be subject to inspection by his appointed inspectors to insure strict compliance with the terms of the contract. The presence of the inspector shall not relieve the contractor of responsibility for the proper execution of the work in accordance with the above specifications.

# APPENDIX A

# SUMMARY OF RECOMMENDED PROCEDURES FOR SAMPLE COLLECTION, PRESERVATION AND STORAGE

Attachment 1

## SUMMARY OF RECOMMENDED PROCEDURES FOR SAMPLE COLLECTION, PRESERVATION, AND STORAGE

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| **Sediment** | | | | | | |
| **Chemical/Physical Analyses** | | | | | | |
| Metals | Grab/corer | 100 g | Precleaned polyethylene jar[e] | Dry ice[e] or freezer storage for extended storages; otherwise refrigerate | ≤ 4°C | Hg - 28 days<br>Others - 6 months[f] |
| Organic compounds (e.g., PCBs, pesticides, polycyclic aromatic hydrocarbons) | Grab/corer | 250 g | Solvent-rinsed glass jar with Teflon® lid[e] | Dry ice[e] or freezer storage for extended storage; otherwise refrigerate | ≤ 4°C[e]/dark[f] | 14 days[g] |
| Particle size | Grab/corer | 100 g | Whirl-pac bag[e] | Refrigerate | < 4°C | Undetermined |
| Total organic carbon | Grab/corer | 50 g | Heat treated glass vial with Teflon®-lined lid[e] | Dry ice[e] or freezer storage for extended storages; otherwise refrigerate | ≤ 4°C[e] | 14 days |
| Total solids/specific gravity | Grab/corer | 50 g | Whirl-pac bag | Refrigerate | < 4°C | Undetermined |
| Miscellaneous | Grab/corer | ≥ 50 g | Whirl-pac bag | Refrigerate | < 4°C | Undetermined |
| Sediment from which elutriate is prepared | Grab/corer | Depends on tests being performed | Glass with Teflon®-lined lid | Completely fill and refrigerate | 4°C/dark/airtight | 14 days |
| **Biological Tests** | | | | | | |
| Dredged material | Grab/corer | 12–15 L per sample | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |
| Reference sediment | Grab/corer | 45–50 L per test | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |
| Control sediment | Grab/corer | 21–25 L per test | Plastic bag or container[h] | Completely fill and refrigerate; sieve | 4°C/dark/airtight | 14 days[i] |

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| **Water and Elutriate** | | | | | | |
| **Chemical/Physical Analyses** | | | | | | |
| Particulate analysis | Discrete sampler or pump | 500–2,000 mL | Plastic or glass | Lugols solution and refrigerate | 4°C | Undetermined |
| Metals | Discrete sampler or pump | 1 L | Acid-rinsed polyethylene or glass jar[j] | pH < 2 with $HNO_3$; refrigerate[j] | 4°C 2°C[l] | Hg - 14 days<br>Others - 6 months[k] |
| Total Kjeldahl nitrogen | Discrete sampler or pump | 100–200 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 24 h[k] |
| Chemical oxygen demand | Discrete sampler or pump | 200 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 7 days[k] |
| Total organic carbon | Discrete sampler or pump | 100 mL | Plastic or glass[k] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | <48 hours[k] |
| Total inorganic carbon | Discrete sampler or pump | 100 mL | Plastic or glass[k] | Airtight seal; refrigerate[k] | 4°C[k] | 6 months[k] |
| Phenolic compounds | Discrete sampler or pump | 1 L | Glass[k] | 0.1–1.0 g $CuSO_4$; $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 24 hours[k] |
| Soluble reactive phosphates | Discrete sampler or pump | -- | Plastic or glass[k] | Filter; refrigerate[k] | 4°C[k] | 24 hours[k] |
| Extractable organic compounds (e.g., semi-volatile compounds) | Discrete sampler or pump | 4 L | Amber glass bottle[j] | pH < 2, 6N HCl; airtight seal; refrigerate | 4°C[l] | 7 days for extraction; 40 days for sample extract analyses[l] |
| Volatile organic compounds | Discrete sampler or pump | 80 mL | Glass vial[j] | pH < 2 with 1:1 HCL; refrigerate in airtight, completely filled container[j] | 4°C[l] | 14 days for sample analysis, if preserved[l] |
| Total phosphorus | Discrete sampler or pump | -- | Plastic or glass[h] | $H_2SO_4$ to pH < 2; refrigerate | 4°C[k] | 7 days[k] |

| Analyses | Collection Method[a] | Sample Volume[b] | Container[c] | Preservation Technique | Storage Conditions | Holding Times[d] |
|---|---|---|---|---|---|---|
| Total solids | Discrete sampler or pump | 200 mL | Plastic or glass[k] | Refrigerate | 4°C[k] | 7 days[k] |
| Volatile solids | Discrete sampler or pump | 200 mL | Plastic or glass[k] | Refrigerate | 4°C[k] | 7 days[k] |
| Sulfides | Discrete sampler or pump | -- | Plastic or glass[k] | pH > 9 NaOH (ZnAc); refrigerate[k] | 4°C[k] | 24 hours[k] |
| **Biological Tests** | | | | | | |
| Site water | Grab | Depends on tests being performed | Plastic carboy | Refrigerate | < 4°C | 14 days |
| Dilution water | Grab or makeup | Depends on tests being performed | Plastic carboy | Refrigerate | < 4°C | 14 days |
| **Tissue** | | | | | | |
| Metals | Trawl/Teflon®-coated grab | 5–10 g | Double Ziploc®[e] | Handle with non-metallic forceps; plastic gloves; dry ice[e] | ≤ -20°C[e] or freezer storage | Hg - 28 days<br>Others - 6 months[m] |
| PCBs and chlorinated pesticides | Trawl/Teflon®-coated grab | 10–25 g | Hexane-rinsed double aluminum foil and double Ziploc®[e] | Handle with hexane-rinsed stainless steel forceps; dry ice[e] | ≤ -20°C[e] or freezer storage | 14 days[g] |
| Volatile organic compounds | Trawl/Teflon®-coated grab | 10–25 g | Heat-cleaned aluminum foil and water-tight plastic bag[l] | Covered ice chest[l] | ≤ -20°C[m] or freezer storage | 14 days[m] |
| Semivolatile organic compounds | Trawl/Teflon®-coated grab | 10–25 g | Hexane-rinsed double aluminum foil and double Ziploc®[e] | Handle with hexane-rinsed stainless steel forceps; dry ice[e] | ≤ -20°C[e] or freezer storage | 14 days[g] |
| Lipids | Trawl/Teflon®-coated grab | Part of organic analyses | Hexane-rinsed aluminum foil | Handle with hexane-rinsed stainless steel forceps; quick freeze | ≤ -20°C or freezer storage | 14 days[g] |

**Note:** This table contains only a summary of collection, preservation, and storage procedures for samples. The cited references should be consulted for a more detailed description of these procedures.

PCB - polychlorinated biphenyl

[a] Collection method should include appropriate liners.

[b] Amount of sample required by the laboratory to perform the analysis (wet weight or volume provided, as appropriate). Miscellaneous sample size for sediment should be increased if auxiliary analytes that cannot be included as part of the organic or metal analyses are added to the list. The amounts shown are not intended as firm values; more or less tissue may be required depending on the analytes, matrices, detection limits, and particular analytical laboratory.

[c] All containers should be certified as clean according to U.S. EPA (1990c).

[d] These holding times are for sediment, water, and tissue based on guidance that is sometimes administrative rather than technical in nature. There are no promulgated, scientifically based holding time criteria for sediments, tissues, or elutriates. References should be consulted if holding times for sample extracts are desired. Holding times are from the time of sample collection.

[e] NOAA (1989).

[f] Tetra Tech (1986a).

[g] Sample may be held for up to 1 year if ≤ -20°C.

[h] Polypropylene should be used if phthalate bioaccumulation is of concern.

[i] Two weeks is recommended; sediments must not be held for longer than 8 weeks prior to biological testing.

[j] U.S. EPA (1987a); 40 CFR Part 136, Table III.

[k] Plumb (1981).

[l] If samples are not preserved to pH < 2, then aromatic compounds must be analyzed within 7 days.

[m] Tetra Tech (1986b).

Excerpted from pp. 54-57 of the USEPA "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations", Office of Water (EPA 823-B-95-0001, April 1995).

# APPENDIX B
# ANALYTICAL PROCEDURES AND ASSOCIATED QUALITY ASSURANCE/QUALITY CONTROL MEASURES

# APPENDIX B - ANALYTICAL PROCEDURES AND ASSOCIATED QUALITY ASSURANCE/QUALITY CONTROL MEASURES

## I. Required Target Analyte Lists and Methodologies:

### (a) Target analytes:

Required bulk sediment chemistry, modified elutriate, and leaching tests must include analysis for all target analytes listed in Attachment 1, excepting the volatile organic compounds list, which will be required on a case by case basis. Typically, volatile organic compound testing will be instituted where known or suspected discharges of such compounds have occurred. Dioxin/furan analysis is required for all projects in Region 1.

The list of target analytes in Attachment 1 represents the constituents common to both the USEPA Contract Laboratory Program (CLP) analytes and the much larger list of compounds evaluated under the USEPA SW-846 testing program (SW-846). This latter program specifically employs the Test Methods for Evaluating Solid Waste Physical/Chemical Methods, Publication SW-846. While the SW-846 methods are distinct from the CLP methods, they are considered to be equivalent. Attachment 1 also details the required quantitation limit for each target analyte. The estimated quantitation limit (EQL) specified is the higher of the quantitation limits associated with the CLP and SW-846 programs. There is no requirement to use either the CLP or SW-846 analytical methodologies; however, the method employed must achieve the required EQL and must be from a standard method from a recognized agency. Alternatively, a method with prior approval by the Department may be employed. The analysis must be done by a Department certified laboratory.

### (b) Polychlorinated Biphenyls:

Polychlorinated biphenyls (PCBs) are required by the USEPA to be reported on an individual congener basis as well as a total PCB value. However, the Department anticipates that upland disposal of dredged material will be the primary type of proposal evaluated. This will increase the potential need to assess human health impacts due to PCBs.

The Department evaluates potential human health impacts of upland management and disposal activities using a Total Aroclor criterion. Therefore, it is acceptable to provide data to the Department using Aroclor based analysis methods (SW-846 Method 8081 or its equivalent) where aquatic species impacts are not anticipated. Where aquatic species impacts are a concern, the Department will require congener specific based analysis for PCBs using the Sloan method, NOAA Technical Memorandum NOS ORCA-71 or its equivalent. This is the same methodology that the USEPA employs. In order to be further consistent with the USEPA and to avoid duplicative analytical costs, the Department will also accept congener specific results if required by the USEPA or if already available. These congener specific results will be converted to a total PCB value by multiplying the sum of the 22 individual congeners by a factor of 2 as per the T. O'Connor, National Ocean Service, National Oceanic and Atmospheric Administration, July 20, 1994 memorandum to S. Ausubel, USEPA Region II (O'Connor 1994) and as per Contaminant Levels in Muscle and Hepatic Tissue of Lobster from the New York Bight Apex (National Marine Fisheries Service 1996). That computed result will then be compared against the

Total Aroclor based human health criteria. The recommended MDLs for all individual PCB congeners are 1 ug/kg dry weight (sediment) and 0.0005 ug/l (water).

(c) Polychlorinated Dibenzo-p-Dioxin and Dibenzofurans

When required, analysis will be conducted for all seventeen (17) 2,3,7,8 substituted polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofurans using EPA Method 1613 Revision B. While not preferred, SW-846 Method 8290 is also acceptable. The required congeners and related isotopes used for analysis are shown in Attachment 2. The analytical sensitivity should be within 5 times that which is cited in the method for each matrix type. Testing for these analytes will be required by the Department on a case by case basis in Region 1 waters.

All polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran congener results, in both sediment and water matrices, must be reported in both individual congener concentrations and summarized as 2,3,7,8-tetrachlorodibenzo(p)dioxin toxic equivalents using the Toxic Equivalent Factors, International 1988 Method in Attachment 3. For those values reported as Estimated Maximum Possible Concentrations (EMPCs), the full EMPC value should be used.

(d) Grain size analysis:

The grain size analysis must be conducted according to the methods described by Folk 1980.

Results must be reported as percentages within the general size classes:

Sand: equal to or greater than 0.0625 mm diameter

Silt: less than 0.0625 mm diameter and equal to or greater than 0.0039 mm diameter

Clay: less than 0.0039 mm diameter

(e) Total Organic Carbon

Total organic carbon analysis must be conducted according to the USEPA 1986 method, excerpted from the December 1992 regional manual for USEPA Region II and the New York District Corps of Engineers, entitled, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal" (Attachment 4).

(f) Multiple Extraction Procedure

Testing of sediments which have been modified prior to final placement may be required to undergo testing to evaluate their potential for contaminant leaching. One procedure used to accomplish this task is the Multiple Leaching Procedure (EPA Method 1320).

## II. Quality Assurance/Quality Control Guidance and Reporting Requirements

The guidance described below has been drawn from the December 1992 regional manual for USEPA Region II and the New York District Corps of Engineers, entitled, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal"; the EPA and the USACE "QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations," (EPA 823-B-95-001, April 1995); and the "Field Sampling Procedures Manual," New Jersey Department of Environmental Protection and Energy, May 1992.

The following quality control samples or procedures will be required for chemical analysis of both sediment and water matrices:

1. Field blanks: One with every batch of 1-20 samples

2. Method blanks: One with every batch of 1-20 samples or every 12 hours, whichever is less

3. Matrix spike and matrix spike duplicate: One set with every batch of 1-20 samples

4. Surrogate spike recovery: Each sample, organic compounds only

5. Minimum detection limit verification within last 2 years for marine sediments and salt water matrices to be submitted to the Department upon request (procedure or citation at 40 CFR 136 [1994] Appendix B, Revision 1.11).

6. Duplicate analyses to be conducted as per method requirements

All bulk sediment chemistry results must be reported on a dry weight basis. All raw data should be presented along with the appropriate criterion. Exceedances of the criterion must be highlighted in an acceptable fashion.

The need to supply either full or reduced data deliverables will be determined by the Department on a case by case basis. The need for the applicant to obtain the services of a data validation contractor will concurrently be determined by the Department at the pre-application stage.

The data reports submitted to the Department for testing and analysis of material proposed for dredging must include a description of all methods and procedures used in the field and in the laboratory, referencing established protocols or guidance, for the following:

1. Sample collection
2. Sample preparation (including homogenizing and compositing)
3. Sample preservation methods and holding times (before and after extraction)
4. Chain of custody tracking documents
5. Sample transport, storage, and disposal
6. Sample analysis
7. Data entry and data reduction
8. Deviations from standard methods or prescribed procedures
9. QA/QC summary and data
10. Narrative of analytical problems, corrective action taken, effects on data interpretation

## III. References for APPENDICES A AND B

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N.J. Department of Environmental Protection and Energy. 1992. Field Sampling Procedures Manual. 363 p.

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U.S. Army Corps of Engineers, New York District and the U.S. Environmental Protection Agency, Region II. 1992. Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal (Draft).

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1991. Evaluation of Dredged Material Proposed for Ocean Disposal - Testing Manual. EPA-503/8-91/001.

U.S. Environmental Protection Agency and U.S. Army Corps of Engineers. 1995. QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations. EPA 823-B-95-001.

Attachment 1

| TARGET ANALYTE LIST | | |
|---|---|---|
| Analyte | Limits of Detection | |
| **Volatiles** | Water (ug/L) | Soil (ug/Kg) |
| Chloromethane | 10 | 10 |
| Bromomethane | 10 | 10 |
| Vinyl Chloride | 10 | 10 |
| Chloroethane | 10 | 10 |
| Methylene Chloride | 10 | 10 |
| Acetone | 10 | 10 |
| Carbon Disulfide | 10 | 10 |
| 1,1-Dichloroethene | 10 | 10 |
| 1,1-Dichloroethane | 10 | 10 |
| 1,2-Dichloroethene (total) | 10 | 10 |
| Chloroform | 10 | 10 |
| 1,2-Dichloroethane | 10 | 10 |
| 2-Butanone(MEK) | 10 | 10 |
| 1,1,1-Trichloroethane | 10 | 10 |
| Carbon Tetrachloride | 10 | 10 |
| Bromodichloromethane | 10 | 10 |
| 1,2-Dichloropropane | 10 | 10 |
| cis-1,3-Dichloropropene | 10 | 10 |
| trichloroethene | 10 | 10 |
| Dibromochloromethane | 10 | 10 |
| 1,1,2-Trichloroethane | 10 | 10 |
| Benzene | 10 | 10 |
| trans-1,3-Dichloropropene | 10 | 10 |
| Bromoform | 10 | 10 |
| 4-Methyl-2-pentanone(MIBK) | 10 | 10 |
| 2-Hexanone | 10 | 10 |
| Tetrachloroethene | 10 | 10 |
| 1,1,2,2-Tetrachloroethane | 10 | 10 |
| Toluene | 10 | 10 |
| Chlorobenzene | 10 | 10 |
| Ethylbenzene | 10 | 10 |
| Styrene | 10 | 10 |
| Xylenes(total) | 10 | 10 |
| | | |
| | | |
| | | |
| | | |
| **Semivolatiles** | | |
| Phenol | 10 | 660 |
| bis-(2-Chloroethyl)ether | 10 | 660 |
| 2-Chlorophenol | 10 | 660 |
| 1,3-Dichlorobenzene | 10 | 660 |
| 1,4-Dichlorobenzene | 10 | 660 |
| 1,2-Dichlorobenzene | 10 | 660 |
| 2-Methylphenol | 10 | 660 |
| 2,2'-oxybis(1-Chloropropane) | 10 | 660 |
| 4-Methylphenol | 10 | 660 |
| N-Nitroso-di-n-propylamine | 10 | 660 |

|  | Limits of Detection |  |
|---|---|---|
| **Semivoilatiles (continued)** | Water (ug/L) | Soil (ug/Kg) |
| Hexachloroethane | 10 | 660 |
| Nitrobenzene | 10 | 660 |
| Isophorone | 10 | 660 |
| 2-Nitrophenol | 10 | 660 |
| 2,4-Dimethylphenol | 10 | 660 |
| bis(2-Chloroethoxy)methane | 10 | 660 |
| 2,4-Dichlorophenol | 10 | 660 |
| 1,2,4-Trichlorobenzene | 10 | 660 |
| Naphthalene | 10 | 660 |
| 4-Chloroaniline | 20 | 1300 |
| Hexachlorobutadiene | 10 | 660 |
| 4-Chloro-3-methylphenol | 20 | 1300 |
| 2-Methylnaphthalene | 10 | 660 |
| Hexachlorocylcopentadiene | 10 | 660 |
| 2,4,6-Trichlorophenol | 10 | 660 |
| 2,4,5-Trichlorophenol | 10 | 660 |
| 2-Chloronaphthalene | 10 | 660 |
| 2-Nitroaniline | 50 | 3300 |
| Dimethylphthalate | 10 | 660 |
| Acenaphthylene | 10 | 660 |
| 2,6-Dinitrotoluene | 10 | 660 |
| 3-Nitroaniline | 50 | 3300 |
| Acenaphthene | 10 | 660 |
| 2,4-Dinitrophenol | 50 | 3300 |
| 4-Nitrophenol | 50 | 3300 |
| Dibenzofuran | 10 | 660 |
| 2,4-Dinitrotoluene | 10 | 660 |
| Diethylphthalate | 10 | 660 |
| 4-Chlorophenyl-phenyl ether | 10 | 660 |
| Fluorene | 10 | 660 |
| 4-Nitroaniline | 20 | 830 |
| 4,6-Dinitro-2-methylphenol | 50 | 3300 |
| N-Nitroso-diphenylamine | 10 | 660 |
| 4-Bromophenyl-phenylether | 10 | 660 |
| Hexachlorobenzene | 10 | 660 |
| Pentachlorophenol | 50 | 3300 |
| Phenanthrene | 10 | 660 |
| Anthracene | 10 | 660 |
| Carbazole | 10 | 330 |
| Di-n-butylphthalate | 10 | 330 |
| Fluoranthene | 10 | 660 |
| Pyrene | 10 | 660 |
| Butylbenzylphthalate | 10 | 660 |
| 3,3'-Dichlorobenzidine | 20 | 1300 |
| Benzo(a)anthracene | 10 | 660 |
| Chrysene | 10 | 660 |
| bis(2-Ethylhexyl)phthalate | 10 | 660 |
| Di-n-octlyphthalate | 10 | 660 |
| Benzo(b)fluoranthene | 10 | 660 |

|  | Limits of Detection |  |
|---|---|---|
| **Semivolatiles (continued)** | Water (ug/L) | Soil (ug/Kg) |
| Benzo(k)fluoranthene | 10 | 660 |
| Benzo(a)pyrene | 10 | 660 |
| Indeno(1,2,3-cd)pyrene | 10 | 660 |
| Dibenzo(a,h)anthracene | 10 | 660 |
| Benzo(g,h,i)perylene | 10 | 660 |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
| **Pesticides/Aroclors** |  |  |
| alpha-BHC | 0.05 | 1.9 |
| beta-BHC | 0.05 | 3.3 |
| delta-BHC | 0.05 | 1.7 |
| gamma-BHC (Lindane) | 0.05 | 2 |
| Heptachlor | 0.05 | 2.1 |
| Aldrin | 0.05 | 2 |
| Heptachlor epoxide | 0.05 | 2.1 |
| Endosulfan I | 0.05 | 2.1 |
| Dieldrin | 0.10 | 3.3 |
| 4,4'-DDE | 0.10 | 4.2 |
| Endrin | 0.10 | 3.6 |
| Endosulfan II | 0.10 | 3.3 |
| 4,4'-DDD | 0.10 | 4.2 |
| Endosulfan sulfate | 0.10 | 3.6 |
| 4,4'-DDT | 0.10 | 3.6 |
| Methoxychlor | 0.50 | 17 |
| Endrin ketone | 0.10 | 3.3 |
| Endrin aldehyde | 0.10 | 3.3 |
| alpha-Chlordane | 0.05 | 1.7 |
| gamma-Chlordane | 0.05 | 1.7 |
| Toxaphene | 5.0 | 170 |
| Aroclor-1016 | 1.0 | 33 |
| Aroclor-1221 | 2.0 | 67 |
| Aroclor-1232 | 1.0 | 33 |
| Aroclor-1242 | 1.0 | 33 |
| Aroclor-1248 | 1.0 | 33 |
| Aroclor-1254 | 1.0 | 33 |
| Aroclor-1260 | 1.0 | 33 |
|  |  |  |
|  |  |  |
| **Inorganics** | ug/L | mg/Kg |
| Aluminum | 200 | 40 |
| Antimony | 60 | 12 |
| Arsenic | 10 | 2 |
| Barium | 200 | 40 |
| Beryllium | 5 | 1 |
| Cadmium | 5 | 1 |
| Calcium | 5000 | 1000 |
| Chromium | 10 | 2 |

|  | Limits of Detection |  |
|---|---|---|
| **Inorganics (continued)** | Water (ug/L) | Soil (mg/Kg) |
| Cobalt | 50 | 10 |
| Copper | 25 | 5 |
| Iron | 100 | 20 |
| Lead | 3 | 0.6 |
| Magnesium | 5000 | 1000 |
| Manganese | 15 | 3 |
| Mercury | 0.2 | 0.1 |
| Nickel | 40 | 8 |
| Potassium | 5000 | 1000 |
| Selenium | 5 | 1 |
| Silver | 10 | 2 |
| Sodium | 5000 | 1000 |
| Thallium | 10 | 2 |
| Vanadium | 50 | 10 |
| Zinc | 20 | 4 |
| Cyanide | 10 | 0.5 |

Attachment 2

### Retention Time References, Quantitation References, Relative Retention Times, and Minimum Levels for CDDs and CDFs

| | | | Minimum Level[1] | | |
|---|---|---|---|---|---|
| Compound | Retention Time and Quantitation Reference | Relative Retention Time | Water (pg/L; ppq) | Solid (ng/kg; ppt) | Extract (pg/µL; ppb) |
| *Compounds using $^{13}C_{12}$-1,2,3,4-TCDD as the injection internal standard* | | | | | |
| 2,3,7,8-TCDF | $^{13}C_{12}$-2,3,7,8-TCDF | 0.999–1.003 | 10 | 1 | 0.5 |
| 2,3,7,8-TCDD | $^{13}C_{12}$-2,3,7,8-TCDD | 0.999–1.002 | 10 | 1 | 0.5 |
| 1,2,3,7,8-PeCDF | $^{13}C_{12}$-1,2,3,7,8-PeCDF | 0.999–1.002 | 50 | 5 | 2.5 |
| 2,3,4,7,8-PeCDF | $^{13}C_{12}$-2,3,4,7,8-PeCDF | 0.999–1.002 | 50 | 5 | 2.5 |
| 1,2,3,7,8-PeCDD | $^{13}C_{12}$-1,2,3,7,8-PeCDD | 0.999–1.002 | 50 | 5 | 2.5 |
| *Compounds using $^{13}C_{12}$-1,2,3,7,8,9-HxCDD as the injection internal standard* | | | | | |
| 1,2,3,4,7,8-HxCDF | $^{13}C_{12}$-1,2,3,4,7,8-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,6,7,8-HxCDF | $^{13}C_{12}$-1,2,3,6,7,8-HxCDF | 0.997–1.005 | 50 | 5 | 2.5 |
| 1,2,3,7,8,9-HxCDF | $^{13}C_{12}$-1,2,3,7,8,9-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 2,3,4,6,7,8-HxCDF | $^{13}C_{12}$-2,3,4,6,7,8,-HxCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,7,8-HxCDD | $^{13}C_{12}$-1,2,3,4,7,8-HxCDD | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,6,7,8-HxCDD | $^{13}C_{12}$-1,2,3,6,7,8,-HxCDD | 0.998–1.004 | 50 | 5 | 2.5 |
| 1,2,3,7,8,9-HxCDD | –[2] | 1.000–1.019 | 50 | 5 | 2.5 |
| 1,2,3,4,6,7,8-HpCDF | $^{13}C_{12}$-1,2,3,4,6,7,8-HpCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,7,8,9-HpCDF | $^{13}C_{12}$-1,2,3,4,7,8,9-HpCDF | 0.999–1.001 | 50 | 5 | 2.5 |
| 1,2,3,4,6,7,8-HpCDD | $^{13}C_{12}$-1,2,3,4,6,7,8-HpCDD | 0.999–1.001 | 50 | 5 | 2.5 |
| OCDF | $^{13}C_{12}$-OCDD | 0.999–1.008 | 100 | 10 | 5.0 |
| OCDD | $^{13}C_{12}$-OCDD | 0.999–1.001 | 100 | 10 | 5.0 |

1. The Minimum Level (ML) for each analyte is defined as the level at which the entire analytical system must give a recognizable signal and acceptable calibration point. It is equivalent to the concentration of the lowest calibration standard, assuming that all method-specified sample weights, volumes, and cleanup procedures have been employed.
2. The retention time reference for 1,2 3,7,8,9-HxCDD is $^{13}C_{12}$-1,2,3,6,7,8-HxCDD, and 1,2,3,7,8,9-HxCDD is quantified using the averaged responses for $^{13}C_{12}$-1,2,3,4,7,8-HxCDD and $^{13}C_{12}$-1,2,3,6,7,8-HxCDD.

ttachment 3: This is the toxicity equivalent factor guidance. Note that CDD and CDF are acronyms for chlorinated dibenzo-p-dioxins and chlorinated dibenzofurans. T, Pe, Hx, Hp, and O stand for tetra, penta, hexa, hepta, and octa, respectively.

| Compound | Toxicity Equivalency Factor (TEF) |
|---|---|
| 2,3,7,8-TCDD | 1.000 |
| 1,2,3,7,8-PeCDD | 0.500 |
| 1,2,3,4,7,8-HxCDD | 0.100 |
| 1,2,3,6,7,8-HxCDD | 0.100 |
| 1,2,3,7,8,9-HxCDD | 0.100 |
| 1,2,3,4,6,7,8-HpCDD | 0.010 |
| 1,2,3,4,6,7,8,9-OCDD | 0.001 |
| | |
| 2,3,7,8-TCDF | 0.100 |
| 1,2,3,7,8-PeCDF | 0.050 |
| 2,3,4,7,8-PeCDF | 0.500 |
| 1,2,3,6,7,8-HxCDF | 0.100 |
| 1,2,3,7,8,9-HxCDF | 0.100 |
| 1,2,3,4,7,8-HxCDF | 0.100 |
| 2,3,4,6,7,8-HxCDF | 0.100 |
| 1,2,3,4,6,7,8-HpCDF | 0.010 |
| 1,2,3,4,7,8,9-HpCDF | 0.010 |
| 1,2,3,4,6,7,8,9-OCDF | 0.001 |

ll other CDD and CDF have a TEF of zero.

Attachment 4

# DETERMINATION OF TOTAL ORGANIC CARBON

## 1.0 APPLICATION AND SCOPE

This method, developed by the U.S. Environmental Protection Agency, Region II, Environmental Services Division laboratory in Edison, New Jersey, describes protocols for the determination of organic carbon in ocean sediments. Although the detection limit may vary with procedure or instrument, a minimum reporting value of 100 mg/kg will be required for the ocean dumping/dredging program. Several types of determinations, which are considered equivalent, are presented in this procedure. However, wet combustion methods are not considered to be equivalent to the pyrolytic methods described.

In this method, inorganic carbon from carbonates and bicarbonates is removed by acid treatment. The organic compounds are decomposed by pyrolysis in the presence of oxygen or air. The carbon dioxide that is formed is determined by direct nondispersive infrared detection, flame ionization gas chromatography after catalytic conversion of the carbon dioxide to methane; thermal conductivity gas chromatography, differential thermal conductivity detection by sequential removal of water and carbon dioxide; or thermal conductivity detection following removal of water with magnesium perchlorate.

Water content is determined on a separate portion of sediment and data are reported in mg/kg on a dry weight basis.

## 2.0 DEFINITIONS

The following terms and acronyms are associated with this procedure:

| | |
|---|---|
| LRB | Laboratory record book |
| TOC | Total organic carbon |

## 3.0 PROCEDURE

### 3.1 Sample collection

Collect sediments in glass jars with lids lined with Teflon or aluminum foil. Cool samples and maintain at 4°C. Analyze samples within 14 days. If unrepresentative material is to be removed from the sample, it should be removed in the field under the supervision of the chief scientist and noted in the LRB on the field log sheet.

### 3.2 Apparatus and Reagents

- Drying oven maintained at 103° to 105°C.
- Analytical instrument. No specific TOC analyzer is recommended as superior. The following listing is for information on instrument options only, and is not intended to restrict the use of other unlisted instruments capable of analyzing TOC. The instrument to be used must meet the following specifications:
  - A combustion boat that is heated in a stream of oxygen or air in a resistance or induction-type furnace to completely convert organic substances to $CO_2$ and water.
  - A means to physically or by measurement technique to separate water and other interferants from $CO_2$.
  - A means to quantitatively determine $CO_2$ with adequate sensitivity (100 mg/kg), and precision (25% at the 95% confidence level as demonstrated by repetitive measurements of a well-mixed ocean sediment sample).
  - A strip chart or other permanent recording device to document the analysis.

(1.) <u>Perkin Elmer Model 240C Elemental Analyzer or equivalent.</u> In this instrument, the sample from Section 3.5 is pyrolyzed under pure oxygen, water is removed by magnesium perchlorate and the carbon dioxide is removed by ascarite. The decrease in signal obtained by differential thermal conductivity detectors placed between the combustion gas stream before and after the ascarite tube is a measure of the organic carbon content.

(2.) <u>Carlo Erba Model 1106 CHN Analyzer, or equivalent.</u> In this apparatus, the sample is pyrolyzed in an induction-type furnace, and the resultant carbon dioxide is chromatographically separated and analyzed by a differential thermal conductivity

detector.

(3.) LECO Models WR12, WR112, or CR-12 carbon determinators, or Models 600 or 800 CHN analyzers. In the LECO WR-12, the sample is burned in high frequency induction furnace, and the carbon dioxide is selectively absorbed at room temperature in a molecular sieve. It is subsequently released by heating and is measured by a thermal conductivity detector. The WR-112 is an upgraded WR-12 employing microprocessor electronics and a printer to replace the electronic digital voltmeter.

In the LECO CR-12 carbon determinator, the sample is combusted in oxygen, moisture and dust are removed by appropriate traps, and the carbon dioxide is measured by a selective, solid state, infrared detector. The signal from the detector is then processed by a microprocessor and the carbon content is displayed on a digital readout and recorded on an integral printer.

In the LECO CHN-600 and CHN-800 elemental analyzers, the sample is burned under oxygen in a resistance furnace and the carbon dioxide is measured by a selective infrared detector.

(4.) Dohrman Model DC85 Digital High Temperature TOC Analyzer. In this instrument, the sample is burned in resistance furnace under oxygen, the interfering gases are removed by a sparger/scrubber system, and the carbon dioxide is measured by a non-dispersive infrared detector and shown on a digital display in concentration units.

- Reagents

(1.) Distilled water used in preparation of standards and for dilution of samples should be ultrapure to reduce the carbon concentration of the blank.

(2.) Potassium hydrogen phthalate, stock solution, 1000 mg carbon/L: Dissolve 0.2128 g of potassium hydrogen phthalate (Primary Standard Grade) in distilled water and dilute to 100.0 mL.

NOTE: Sodium oxalate and acetic acid are not recommended as stock solutions.

(3.) Potassium hydrogen phthalate, standard solutions: Prepare standard solutions from the stock solution by dilution with distilled water.

(4.) Phosphoric acid solution, 1:1 by volume.

## 3.3 Interferences

3.3.1 Volatile organics in the sediments may be lost in the decarbonation step resulting in a low bias.

3.3.2 Bacterial decomposition and volatilization of the organic compounds are minimized by maintaining the sample at 4 °C, analyzing within the specified holding time, and analyzing the wet sample.

## 3.4 Sample Preparation

3.4.1 Allow frozen samples to warm to room temperature. Homogenize each sample mechanically, incorporating any overlying water.

3.4.2 Weigh the well-mixed sample (up to 500 mg) into the combustion boat or cup. Add 1:1 phosphoric acid dropwise until effervescence stops. Heat to 75°C.

NOTE: This procedure will convert inorganic carbonates and bicarbonates to carbon dioxide and eliminate it from the sample.

## 3.5 Sample Analysis

Analyze the residue according to the instrument manufacturer's instructions.

## 3.6 Percent Residue Determination

Determine percent residue on a separate sample aliquot as follows:

3.6.1 Heat a clean 25-mL beaker at 103° to 105°C for 1 h. Cool in a desiccator, weigh to

the nearest mg, and store in desiccator until use.

3.6.2 Add 1 g, weighed to the nearest mg, of an aliquot of the well-mixed sample .

3.6.3 Dry and heat in the 103° to 105°C oven for 1 h. Cool in a desiccator. Weigh to the nearest mg.

### 3.7 Calibration

Follow instrument manufacturer's instructions for calibration. Prepare a calibration curve by plotting mg carbon vs. instrument response using four standards and a blank, covering the analytical range of interest.

### 3.8 Data Recording

Record all data and sample information in LRBs or on project-specific data forms.

All transfers of data to forms and data reductions (e.g., concentration calculations, means, standard deviations) should be checked by the analyst and approved by a lab manager, project manager, or principal investigator. Hard copies of sample data and spreadsheet reports should be kept in the testing laboratory's central files.

### 3.9 QA/QC Procedures

3.9.1 Precision and Accuracy The precision and accuracy will differ with the various instruments and matrices, and must be determined by the laboratories reporting data. A representative sample of well-mixed, meshed, sediment should be analyzed in quadruplicate for 4 days to determine the analytical precision.

3.9.2 It is critical that each sample be thoroughly homogenized in the laboratory before a subsample is taken for analysis. Laboratory homogenization should be conducted even if samples were homogenized in the field.

3.9.3 Dried samples should be cooled in a desiccator and held there until they are weighed. If a desiccator is not used, the sediment will accumulate ambient moisture and the sample weight will be overestimated. A color-indicating desiccant is recommended so that spent desiccant can be detected easily. Also, the seal on the desiccator should be checked periodically and, if necessary, the ground glass rims should be greased or the "O" rings replaced.

## 4.0 DATA REDUCTION, DOCUMENTATION, AND REPORTING

### 4.1 Data Reduction

Data analysis and calculations will be performed whenever possible on computers using commercial spreadsheet software such as Lotus 1-2-3, Quattro Pro, or Microsoft Excel.

### 4.2 Documentation

Keep all laboratory records, test results, measurements, other and supporting documentation for each sediment test in a LRB or project file dedicated to that purpose.

### 4.3 Reporting

A report should be prepared including, but not limited to, the following information:

- Sources of samples
- Description of methods
- Summary of sample analysis results
- Summary of any deviations from the project test plan
- Copies raw data, observations, or data forms

Total organic carbon should be reported as a percentage of the dry weight of the unacidified sample to the nearest 0.1 unit. The laboratory should report the results of all samples (including QC replicates, method blanks, and standard reference measurements) and should note any problems that may have influenced sample quality. The laboratory should also provide a summary of the calibration procedure and results (e.g., range covered, regression equation, coefficient of determination).

Source: U.S. Army Corps of Engineers - New York District and Environmental Protection Agency -Region II, 1992, "Guidance for Performing Tests on Dredged Material Proposed for Ocean Disposal," Draft-18 Dec 1992.

# APPENDIX C
# PCB CONGENER LIST

## TABLE 2

## NON-ORTHO COPLANAR PCB CONGENERS SUBSTITUTED IN BOTH PARA AND TWO OR MORE META POSITIONS

| IUPAC NUMBER | STRUCTURE | HOMOLOG GROUP |
|---|---|---|
| 77 | 3,3',4,4' | Tetra-CB |
| 81 | 3,4,4',5 | Tetra-CB |
| 126 | 3,3',4,4',5 | Penta-CB |
| 169 | 3,3',4,4',5,5' | Hexa-CB |

## TABLE 3

## TARGETED PCB CONGENERS OTHER THAN NON-ORTHO PCBs

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 8 | 2,4' | Di-CB |
| 18 | 2,2',5 | Tri-CB |
| 28 | 2,4,4' | Tri-CB |
| 37 | 3,4,4' | Tri-CB |
| 42 | 2,2',3,4' | Tetra-CB |
| 44 | 2,2',3,5' | Tetra-CB |
| 47 | 2,2',4,4' | Tetra-CB |
| 49 | 2,2',4,5' | Tetra-CB |
| 52 | 2,2',5,5' | Tetra-CB |
| 60 | 2,3,4,4' | Tetra-CB |
| 64 | 2,3,4',6 | Tetra-CB |
| 66 | 2,3',4,4' | Tetra-CB |
| 70 | 2,3',4',5 | Tetra-CB |
| 74 | 2,4,4',5 | Tetra-CB |
| 80 | 3,3',5,5' | Tetra-CB |
| 82 | 2,2',3,3',4 | Penta-CB |
| 84 | 2,2',3,3',6 | Penta-CB |
| 86 | 2,2',3,4,5 | Penta-CB |
| 87 | 2,2',3,4,5' | Penta-CB |
| 91 | 2,2',3,4',6 | Penta-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 92 | 2,2',3,5,5' | Penta-CB |
| 95 | 2,2',3,5',6 | Penta-CB |
| 97 | 2,2',3',4,5 | Penta-CB |
| 99 | 2,2',4,4',5 | Penta-CB |
| 101 | 2,2',4,5,5' | Penta-CB |
| 105 | 2,3,3',4,4' | Penta-CB |
| 110 | 2,3,3',4',6 | Penta-CB |
| 114 | 2,3,4,4',5 | Penta-CB |
| 118 | 2,3',4,4',5 | Penta-CB |
| 119 | 2,3',4,4',6 | Penta-CB |
| 120 | 2,3',4,5,5' | Penta-CB |
| 123 | 2',3,4,4',5 | Penta-CB |
| 127 | 3,3',4,5,5' | Penta-CB |
| 128 | 2,2',3,3',4,4' | Hexa-CB |
| 137 | 2,2',3,4,4',5 | Hexa-CB |
| 138 | 2,2',3,4,4',5' | Hexa-CB |
| 141 | 2,2',3,4,5,5' | Hexa-CB |
| 146 | 2,2',3,4',5,5' | Hexa-CB |
| 149 | 2,2',3,4',5',6 | Hexa-CB |
| 151 | 2,2',3,5,5',6 | Hexa-CB |
| 153 | 2,2',4,4',5,5' | Hexa-CB |
| 156 | 2,3,3',4,4',5 | Hexa-CB |
| 157 | 2,3,3',4,4',5' | Hexa-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 158 | 2,3,3',4,4',6 | Hexa-CB |
| 166 | 2,3,4,4',5,6 | Hexa-CB |
| 167 | 2,3',4,4',5,5' | Hexa-CB |
| 168 | 2,3',4,4',5',6 | Hexa-CB |
| 170 | 2,2',3,3',4,4',5 | Hepta-CB |
| 171 | 2,2',3,3',4,4',6 | Hepta-CB |
| 174 | 2,2',3,3',4,5,6' | Hepta-CB |
| 177 | 2,2',3,3',4',5,6 | Hepta-CB |
| 179 | 2,2',3,3',5,6,6' | Hepta-CB |
| 180 | 2,2',3,4,4',5,5' | Hepta-CB |
| 183 | 2,2',3,4,4',5',6 | Hepta-CB |
| 185 | 2,2',3,4,5,5',6 | Hepta-CB |
| 187 | 2,2',3,4',5,5',6 | Hepta-CB |
| 189 | 2,3,3',4,4',5,5' | Hepta-CB |
| 190 | 2,3,3',4,4',5,6 | Hepta-CB |
| 191 | 2,3,3',4,4',5',6 | Hepta-CB |
| 194 | 2,2',3,3',4,4',5,5' | Octa-CB |
| 195 | 2,2',3,3',4,4',5,6 | Octa-CB |
| 196 | 2,2',3,3',4,4',5',6 | Octa-CB |
| 198 | 2,2',3,3',4,5,5',6 | Octa-CB |
| 200 | 2,2',3,3',4,5',6,6' | Octa-CB |
| 201 | 2,2',3,3',4',5,5',6 | Octa-CB |
| 203 | 2,2',3,4,4',5,5',6 | Octa-CB |

| IUPAC NUMBER | CHLORINE POSITIONING | HOMOLOG GROUP |
|---|---|---|
| 205 | 2,3,3',4,4',5,5',6 | Octa-CB |
| 206 | 2,2',3,3',4,4',5,5',6 | Nona-CB |
| 207 | 2,2',3,3',4,4',5,6,6' | Nona-CB |
| 208 | 2,2',3,3',4,5,5',6,6' | Nona-CB |
| 209 | 2,2',3,3',4,4',5,5',6,6' | Deca-CB |

# APPENDIX D
# STATE OF DELAWARE
# SURFACE WATER QUALITY STANDARDS

As Amended, August 11, 1999

## Section 9: Toxic Substances

9.1. Applicability: Criteria set forth in this section apply to all surface waters of the State, except as provided in Section 6, Regulatory Mixing Zones, Section 8, Critical Flows, and Section 12, Criteria for Low Flow Waters.

9.2. General Provisions:

(a) Waters of the State shall not exhibit acute toxicity to fish, aquatic life, and wildlife, except in special cases applying to regulatory mixing zones as provided in Section 6.

(b) Waters of the State shall not exhibit chronic toxicity to fish, aquatic life, and wildlife, except in regulatory mixing zones as provided in Section 6, at flows less than critical flows as provided in Section 8, or in low flow waters as provided in Section 12.

(c) Waters of the State shall be maintained to prevent adverse toxic effects on human health resulting from ingestion of chemically contaminated aquatic organisms and drinking water.

(d) The Department may consider synergistic, antagonistic, and additive impacts of combinations of toxicants to fish, aquatic life, and wildlife, and human health in assessing aggregate environmental impacts and mandating point and nonpoint source controls.

9.3. Specific Numerical Criteria:

(a) Aquatic Life Criteria:

(i) Numerical criteria for the protection of aquatic life are established in Table 1 for all toxic substances for which adequate aquatic life toxicity information is available. All criteria for metals in Table 1 are in the total recoverable form, except as specifically footnoted for cyanide. For toxic substances where the relationship of toxicity is defined as a function of pH or hardness, numerical criteria are presented as an equation based on this relationship. Appropriate pH or hardness values for such criteria shall be determined on a case-by-case basis by the Department.

(ii) For toxic substances for which specific numerical criteria are not listed in Table 1, concentrations shall not exceed those which are chronically toxic (as determined from appropriate chronic toxicity data or calculated as 0.1 of $LC_{50}$ values) to representative, sensitive aquatic organisms,

except as provided in Section 6, Regulatory Mixing Zones, Section 8, Critical Flows, or Section 12, Criteria for Low Flow Waters. Concentrations so determined shall be applied as four-day average concentrations not to be exceeded more than once in any three-year period.

(b) Human Health Criteria

(i) Numerical criteria for the protection of human health are established in Table 2 for all toxic substances for which adequate toxicity information is available. Water quality criteria appearing in Table 2 for pollutants identified as carcinogens have been established at an upper bound worst case risk management level of one excess cancer in a population of one million ($1 \times 10^{-6}$) over a 70 year lifetime. Criteria listed under the column header "Fish and Water Ingestion" apply only to surface waters of the State designated as Public Water Supply Sources in Section 10 of these Standards. Criteria listed under the column header "Fish/Shellfish Ingestion" apply only to marine surface waters of the State. Criteria listed under the column header "Fish Ingestion Only" apply to all fresh surface waters of the State not designated as Public Water Supply sources in Section 10 of these Standards.

(ii) For compounds in Table 2 which are considered as both systemic toxicants and human carcinogens, criteria based on both human health concerns are presented. In determining pollution control requirements, the more stringent criterion, after consideration of critical (design) flows in Section 8, shall be utilized.

## TABLE 1

## WATER QUALITY CRITERIA FOR PROTECTION OF AQUATIC LIFE
(All Values Are Listed or Calculated in Micrograms Per Liter)

| Parameter | Fresh Acute Criterion | Fresh Chronic Criterion | Marine Acute Criterion | Marine Chronic Criterion |
|---|---|---|---|---|
| Aldrin | 3.0 | -- | 1.3 | -- |
| Aluminum | 750. | 87. | -- | -- |
| Arsenic (III) | 360. | 190. | 69. | 36. |
| Cadmium | $e^{(1.128[\ln(Hd)]-3.828)}$ | $e^{(0.7852[\ln(Hd)]-3.490)}$ | 43. | 9.3 |
| Chlordane | 2.4 | 0.0043 | 0.09 | 0.004 |
| Chlorine | 19 | 11. | 13 | 7.5 |
| Chlorpyrifos | 0.083 | 0.041 | 0.011 | 0.0056 |
| Chromium (III) | $e^{(0.8190[\ln(Hd)]+3.688)}$ | $e^{(0.8190[\ln(Hd)]+1.561)}$ | — | -- |
| Chromium (VI) | 16. | 11. | 1,100. | 50. |
| Copper | $e^{(0.9422[\ln(Hd)]-1.464)}$ | $e^{(0.8545[\ln(Hd)]-1.465)}$ | 2.9 | -- |
| Cyanide[1] | 22. | 5.2 | 1.0 | -- |

| Parameter | Fresh Acute Criterion | Fresh Chronic Criterion | Marine Acute Criterion | Marine Chronic Criterion |
|---|---|---|---|---|
| DDT and Metabolites | 1.1 | 0.0010 | 0.13 | 0.0010 |
| Demeton | -- | 0.10 | -- | 0.10 |
| Dieldrin | 2.5 | 0.0019 | 0.71 | 0.0019 |
| Endosulfan | 0.22 | 0.056 | 0.034 | 0.0087 |
| Endrin | 0.18 | 0.0023 | 0.037 | 0.0023 |
| Guthion | -- | 0,01 | -- | 0.01 |
| Heptachlor | 0.52 | 0.0038 | 0.053 | 0.0036 |
| Hexachlorocylclohex | 2.0 | 0.08 | 0.16 | -- |
| Iron | -- | 1000. | -- | -- |
| Lead | $e^{(1.273[\ln(Hd)]-1.460)}$ | $e^{(1.273[\ln(Hd)]-4.705)}$ | 140. | 5.6 |
| Malathion | -- | 0.1 | -- | 0.1 |
| Mercury (II) | 2.4 | 0.012 | 2.1 | 0.025 |
| Methoxychlor | -- | 0.03 | -- | 0.03 |
| Mirex | -- | 0.001 | — | 0.001 |

| Parameter | Fresh Acute Criterion | Fresh Chronic Criterion | Marine Acute Criterion | Marine Chronic Criterion |
|---|---|---|---|---|
| Nickel | $e^{(0.8460[\ln(Hd)]+3.3612)}$ | $e^{(0.8460[\ln(Hd)]+1.1645)}$ | 75. | 8.3 |
| Total PCBs | 2.0 | 0.014 | 10 | 0.03 |
| Parathion | 0.065 | 0.013 | -- | -- |
| Pentachlorophenol | $e^{[1.005(pH)-4.830]}$ | $e^{[1.005(pH)-5.290]}$ | 13. | 7.9 |
| Selenium | 20 | 5.0 | 300. | 71. |
| Silver | $e^{(1.72[\ln(Hd)]-6.52)}$ | 0.12 | 2.3 | -- |
| Toxaphene | 0.78 | 0.0002 | 0.21 | 0.0002 |
| Zinc | $e^{(0.8473[\ln(Hd)]+0.8604)}$ | $e^{(0.8473[\ln(Hd)]+0.7614)}$ | 95. | 86. |

<u>Notes:</u>

[1] Cyanide measured as free cyanide at the lowest pH occurring in the receiving water, or cyanide amenable to chlorination.

Specific numerical acute criteria as presented in this table are applied as one-hour average concentrations not to be exceeded more than once in any three-year period. Specific numerical chronic criteria as presented in this table are applied as four-day average concentrations not to be exceeded more than once in any three-year period.

ln = natural log base e
e=2.71828
Hd= hardness is expressed as mg/L as $CaCO_3$
pH is expressed as Standard Units
Example calculation: Fresh acute criterion for silver at hardness of 50 mg/L. Criterion in ug/L = e raised to the [1.72 ln(50) - 6.52] power. This is equal to e to the 0.21 power, or 1.23 ug/L.

# TABLE 2
# WATER QUALITY CRITERIA FOR PROTECTION OF HUMAN HEALTH
(All Values Are Listed in Micrograms Per Liter Unless Noted Otherwise)

| | Freshwater | | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
| | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish | |
| Acrolein | 1.0 mg/L | 360. | 140. | ST |
| Acrylonitrile | 0.83 | 0.06 | 0.12 | CA |
| Aldrin | 0.17 ng/L | 0.16 ng/L | 0.02 ng/L | CA |
| Aldrin | 0.086 | 0.080 | 0.012 | ST |
| Antimony | 5.4 mg/L | 14. | 760. | ST |
| Arsenic** | | 50. (MCL) | | CA |
| Barium** | | 1.0 mg/L | | ST |
| Benzene | 89. | 1.2 | 12.5 | CA |
| Benzidine | 0.67 ng/L | 0.12 ng/L | 0.09 ng/L | CA |
| Benzidine | 460. | 85. | 64. | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Benzo (A) Pyrene<br>(3,4 Benzopyrene) | 0.037 | 0.0027 | 0.0053 | CA |
| Beryllium | 0.08 | 0.0038 | 0.011 | CA |
| Beryllium | 3.5 mg/L | 170. | 500. | ST |
| Bromoform<br>(Tribromomethane) | 266 | 5.6 | 37.4 | CA |
| Bromoform | 34. mg/L | 690. | 4.7 mg/L | ST |
| Cadmium** |  | 10.(MCL) |  | ST |
| Carbon Tetrachloride<br>(Tetrachloromethane) | 5.5 | 0.26 | 0.78 | CA |
| Carbon Tetrachloride | 500. | 23. | 70. | ST |
| Chlordane | 0.73 ng/L | 0.72 ng/L | 0.13 ng/L | CA |
| Chlordane | 0.057 | 0.056 | 0.008 | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
| [illegible] | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Chlorobenzene | 26.1 mg/L | 680. | 3.7 mg/L | ST |
| Chloroethyl Ether (Bis-2 Chloroalkyl Ether) | 1.77 | 0.031 | 0.25 | CA |
| Chloroform (Trichloromethane) | 368. | 5.7 | 52. | CA |
| Chloroform (Trichloromethane) | 22. mg/L | 340. | 3.2 mg/L | ST |
| Chromium** |  | 50. (MCL) |  | ST |
| Chromium (Hexavalent) | 4.2 mg/L | 170. | 590. | ST |
| Chromium (Trivalent) | 840. mg/L | 34. mg/L | 120. mg/L | ST |
| Cyanide | 270. mg/L | 700. | 38. mg/L | ST |
| DDT and Metabolites | 0.74 ng/L | 0.73 ng/L | 0.10 ng/L | CA |
| DDT and Metabolites | 0.13 | 0.12 | 0.018 | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Dibenzo (A,H) Anthracene | 0.037 | 0.0027 | 0.0053 | CA |
| 1,2 Dichlorobenzene | 21.8 mg/L | 2.8 mg/L | 3.1 mg/L | ST |
| 1,3 Dichlorobenzene | 4.3 mg/L | 410. | 600. | ST |
| 1,4 Dichlorobenzene** | 24. mg/L | 75. (MCL) | 3.4 mg/L | ST |
| 3,3 Dichlorobenzidine | 0.025 | 0.011 | 0.0036 | CA |
| 1,2 Dichloroethane | 123. | 0.38 | 17. | CA |
| 1,1 Dichloroethylene | 4. | 0.058 | 0.56 | CA |
| 1,1 Dichloroethylene | 20. mg/L | 310. | 2.8 mg/L | ST |
| 1,2 Trans-dichloroethylene | 130. mg/L | 700. | 19. mg/L | ST |
| Dichloromethane | 2.0 | 4.7 | 277. | CA |
| Dichloromethane | 810. mg/L | 2.1 mg/L | 110 mg/L | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| 2,4 Dichlorophenoxyacetic acid (2,4-D)** |  | 100. (MCL) |  | ST |
| 1,3 Dichloropropene | 392. | 0.19 | 5.5 | CA |
| 1,3 Dichloropropene | 2.0 mg/L | 10.0 | 280. | ST |
| Dieldrin | 0.18 ng/L | 0.17 ng/L | 0.025 ng/L | CA |
| Dieldrin | 0.14 | 0.13 | 0.02 | ST |
| Diethylphthalate | 148. mg/L* | 24.0 mg/L | 21.0 mg/L | ST |
| Dimethylphthalate | 3,700. mg/L | 320. mg/L | 530. mg/L | ST |
| 2, 4 Dinitrotoluene | 96. | 0.94 | 13. | CA |
| 2, 4 Dinitrophenol | 13.0 mg/L | 70. | 1.9 mg/L | ST |
| Dioxin (2,3,7,8-TCDD) | 0 .000017 ng/L | 0.000016 ng/L | 0.0000024 ng/L | CA |

| | Freshwater | | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
| | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish | |
| 1, 2 Diphenylhydrazine | 0.68 | 0.041 | 0.095 | CA |
| Endosulfan | 2.5 | 1.0 | 0.35 | ST |
| Endrin** | 1.0 | 0.2 (MCL) | 0.14 | ST |
| Ethylbenzene | 35. mg/L | 3.2 mg/L | 5.0 mg/L | ST |
| Fluoranthene | 67. | 50. | 9.4 | ST |
| Fluoride** | | 1.8 mg/L | | ST |
| Heptachlor | 0.27 ng/L | 0.26 ng/L | 0 .037 ng/L | CA |
| Heptachlor | 0.60 | 0.58 | 0.084 | ST |
| Hexachloroethane | 11. | 2. | 1.6 | CA |
| Hexachloroethane | 150. | 29. | 22. | ST |
| Hexachlorobenzene | 0.88 ng/L | 0.85 ng/L | 0.12 ng/L | CA |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Hexachlorobenzene | 1.2 | 1.2 | 0.17 | ST |
| Hexachlorobutadiene | 62.1 | 0.44 | 8.7 | CA |
| Hexachlorobutadiene | 2.0 mg/L* | 69. | 1.3 mg/L | ST |
| Hexachlorocyclohexane | 0.08 | 0.02 | 0.011 | CA |
| Hexachlorocyclohexane (Gamma-Lindane) ** | 31. | 4.0 (MCL) | 4.4 | ST |
| Hexachlorocyclohexane (Alpha) | 0.016 | 0.0041 | 0.0023 | CA |
| Hexachlorocyclohexane (Beta) | 0.058 | 0.014 | 0.0081 | CA |
| Hexachlorocyclopentadiene | 1.8 mg/L* | 240. | 1.8 mg/L* | ST |
| Isophorone | 500. mg/L | 5.2 mg/L | 71. mg/L | ST |

|  | Freshwater |  | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
|  | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish |  |
| Lead** |  | 50.(MCL) |  | CA |
| Mercury** (Inorganic) | 7.1 | 2.0 (MCL) | 1.5 | ST |
| Methoxychlor** |  | 100.(MCL) |  | CA |
| Nickel | 5.7 mg/L | 620. | 810. | ST |
| Nitrate-Nitrogen** |  | 10. mg/L |  | ST |
| Nitrobenzene | 2.2 mg/L | 17.0 | 320. | ST |
| Nitrosodimethylamine-N | 10. | 0.68 ng/L | 1.4 | CA |
| Nitrosodiphenylamine-N | 20. | 5.3 | 2.8 | CA |
| Nitrosodipropylamine-N | 35. | 0.005 | 4.9 | CA |

|  | <u>Freshwater</u> |  | <u>Marine/Estuarine</u> |  |
|---|---|---|---|---|
|  | **Fish Ingestion Only** | **Fish and Water Ingestion** | **Fish/Shellfish** | **Human Health Concern** |
| PCBs (1242,1254,1221, 1232, 1248, 1260, 1016) | 0.056 ng/L | 0.055 ng/L | 0.0079 ng/L | CA |
| (Bis-2) Ethyl Hexyl Phthalate | 7.4 | 1.9 | 1. | CA |
| (Bis-2) Ethyl Hexyl Phthalate | 400.* | 400.* | 290. | ST |
| Di-N-Butyl Phthalate | 13. mg/L* | 2.8 mg/L | 2.1 mg/L | ST |
| Selenium** | 1.1 mg/L | 10. (MCL) | 160. | ST |
| Silver** | 0. mg/L | 50. (MCL) | 5.7 mg/L | ST |
| 1,1,2,2 Tetrachloroethane | 13.5 | 0.17 | 1.9 | CA |
| Tetrachloroethylene | 4.3 mg/L | 320. | 610. | ST |
| Thallium | 60. | 14. | 8.4 | ST |
| Toluene | 370. mg/L | 10. mg/L | 52. mg/L | ST |

| | Freshwater | | Marine/Estuarine | Human Health Concern |
|---|---|---|---|---|
| | Fish Ingestion Only | Fish and Water Ingestion | Fish/Shellfish | |
| Total Trihalomethanes** | | 100.(MCL) | | CA |
| Toxaphene | 0.93 ng/L | 0.91 ng/L | 0.13 ng/L | CA |
| 1,2,4 Trichlorobenzene | 19. mg/L | 680. | 2.7 mg/L | ST |
| 1,1,1 Trichloroethane** | 200. mg/L | 200. (MCL) | 28. mg/L | ST |
| 1,1,2 Trichloroethane | 52.5 | 0 .61 | 7.4 | CA |
| 1,1,2 Trichloroethane | 11. mg/L | 140. | 1.5 mg/L | ST |
| Trichloroethylene | 115. | 3.1 | 16. | CA |
| 2,4,6 Trichlorophenol | 4.5 | 1.3 | 0.63 | CA |
| 2,4,5 Trichlorophenoxypropionic acid (2,4,5-TP-Silvex)** | | 10. (MCL) | | ST |
| Vinyl Chloride | 677. | 2.1 | 95. | CA |

NOTES: mg/L = milligrams per liter ng/L = nanograms per liter CA = carcinogen ST = systemic toxicant

The columns labeled "Fish and Water Ingestion" shall apply only to waters of the State designated Public Water Supply sources in these standards.
The column labeled "Fish Ingestion Only" shall apply to all fresh waters of the State not designated Public Water Supply sources in this document.
The column labeled "Fish/Shellfish Ingestion" shall apply only to marine waters of the State.

*Calculated solubility of compound in water is less than criterion; therefore, solubility limit calculated at 25° C and 1 atm is substituted.
**Values shown under header "Fish and Water Ingestion" are Primary Maximum Contaminant Levels (MCLs) as given in the State of Delaware
Regulations Governing Public Drinking Water Systems as amended May 19, 1989.