DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
WANAMAKER BUILDING, 100 PENN SQUARE EAST
PHILADELPHIA, PENNSYLVANIA 19107-3390

REPLY TO ATTENTION OF

Executive Office

August 18, 2010

Mr. Collin P. O'Mara, Secretary
State of Delaware
Department of Natural Resources and Environmental Control
89 Kings Highway
Dover, Delaware 19901

Dear Secretary O'Mara:

Please find enclosed the Corps' responses to the comments provided in your letter dated June, 15, 2010. As stated in Lieutenant Colonel Tickner's June 24, 2010 interim response, we intended to submit these responses prior to the public hearings held on July 13 and July 14, 2010. However, it took longer than expected to consolidate the responses and to finalize some of the additional documentation provided with the responses. We regret the delay.

We are also in receipt of the July 27, 2010, letter from the Hearing Officer, Timothy Bureau, which transmitted a list of questions generated from his initial review of the Record. The Corps' responses to those questions will be sent under separate cover.

The Corps submits this documentation in accordance with the representations made by each party to the United States District Court in Delaware Department of Natural Resources and Environmental Control v. United States Army Corps of Engineers, et al. The Corps does not waive any right, claim or defense with respect to matters that come before the Court in that lawsuit.

Sincerely,

Philip M. Secrist III
Lieutenant Colonel, Corps of Engineers
District Commander

Enclosures

August 18, 2010

USACE Responses to
DNREC Comments Provided June 15, 2010

On March 12, 2010, the U.S. Army Corps of Engineers, Philadelphia District (Corps) submitted to the Delaware Department of Natural Resources and Environmental Control (DNREC) materials that would be required in conjunction with the submission of an application for a State of Delaware Subaqueous Lands and Wetlands Permit for applicable portions of the Delaware River Main Channel Deepening Project. DNREC provided initial review comments on April 22, 2010 and the Corps submitted responses on May 21, 2010. On June 15, 2010, DNREC provided additional comments. The Corps provided an interim response on June 24, 2010. Detailed responses to DNREC's additional comments are provided below. Additional information provided as attachments are denoted by superscripts and listed at the end of the document.

COMMENTS AND RESPONSES

1. Water Quality

(Section 4.7.1.1 of the Regulations Governing the Use of Subaqueous Lands and Section 401 of the Clean Water Act)

The Corps should provide its preliminary analysis of the monitoring data being collected during the Reach C dredging, including data collected for the Killcohook CDF, data collected behind the cutterhead, plus background water and sediment quality data.

We also understand that the Corps is completing an analysis of potential toxics impacts associated with deepening the Sunoco Marcus Hook and Conoco Phillips berthing areas in response to the Department's concerns over secondary impacts from the main channel deepening. That analysis should be submitted prior to the public hearing.

Response: *The Corps has prepared an interim report summarizing the environmental monitoring data collected for the Reach C dredging through May 17, 2010*[1]*. A complete report presenting all data collected will be prepared subsequent to completion of the work in Reach C.*

The analysis of previously collected data from the Sunoco and Conoco Philips berthing areas was completed and provided to DNREC via e-mail on June 15, 2010 (this analysis is available on DNREC's website). The Corps recently collected additional sediment samples in these berthing areas (as well as samples in the lower portion of Reach B of the Federal channel) and will re-run the analysis once the results of the sampling are available. The scope of work for this effort was coordinated with Rick Greene at DNREC and is attached[2]*.*

2. Secondary and Cumulative Impacts
(Sections 4.7.3 and 4.7.5.4 of the Regulations Governing the Use of Subaqueous Lands)

Updated Salinity Model
(Sections 4.7.1.3 and 4.7.1.4 of the Regulations Governing the Use of Subaqueous Lands)

Significant questions still remain regarding the validity of the input data used for the salinity model. DNREC and Corps technical staff have discussed remaining issues at their June 14, 2010 meeting based upon detailed DNREC comments already transmitted to the Corps via e:mail on June 7, 2010. Those comments are attached.

Response: *In the Corps' May 21, 2010 responses, specifically on pages 18 through 24, the Corps addressed multiple DNREC comments and questions regarding the capabilities of the salinity model itself, as well as other details of the application of the model to salinity questions in Delaware River and Bay. Responses to DNREC's additional comments included as Attachment IV to the June 15, 2010, letter are provided below in the section labeled "Attachment IV".*

We do not concur with the DNREC statement above that "Significant questions still remain regarding the validity of the input data used for the salinity model". This is a broad and unsubstantiated generalization that does not characterize the merits of the salinity/hydrodynamic modeling performed for the project.

The specific hydrodynamic computer model employed is called CH3D-WES (Computational Hydrodynamics in Three Dimensions – Waterways Experiment Station). The basic model was developed by Y. Peter. Sheng in 1986 for WES ("A three-dimensional mathematical model of coastal, estuarine and lake currents using boundary-fitted grid," Report No. 585, A.R.A.P. Group of Titan Research and Technology, Princeton, NJ), but was subsequently extensively modified by WES. As its name implies, CH3D-WES makes hydrodynamic computations on a curvilinear or boundary-fitted planform grid. Physical processes impacting baywide circulation and vertical mixing that are modeled include tides, wind, density effects (salinity and temperature), freshwater inflows, turbulence, and the effect of the earth's rotation. CH3D has been successfully applied to model numerous tidal and non-tidal waterways in the US over the past two decades. The principal investigator for the Delaware deepening hydraulic analyses, Dr. Billy Johnson, was involved in the development and applications of CH3D for three decades while at WES, and has continued in that role since his retirement. Scoping of the modeling effort began in 1992, and a program of inter-agency coordination was conducted during the entire conduct of the salinity-hydrodynamic modeling effort for the Delaware Deepening study. DNREC was a participant along with other Federal and state regulatory agencies and academic institutions during the conduct of the modeling and attended the multiple "progress" and "results" coordination workshops held between 1992 and the release of the SEIS in 1997. Work with the CH3D model for the Delaware estuary has continued up to the present (2010). DNREC has been an invited participant to all coordination meetings on this effort.

Sediment Budget Impacts
(Section 4.7.1.6 of the Regulations Governing the Use of Subaqueous Lands)

See the attached detailed concerns already transmitted to the Corps via e:mail on June 7, 2010. These issues have been further discussed at the June 14, 2010 meeting of technical staff.

Response: *Responses to questions and comments regarding sediment budget impacts are provided below in responses to Attachment IV.*

3. Operational Concerns

Air Quality Conformity
(Section 4.7.1.5 of the Regulations Governing the Use of Subaqueous Lands)

There is one remaining issue with regard to Air Quality Conformity. The Corps must still provide certification/documentation that the NJ credits are surplus to the states ozone and fine particulate matter SIPs, and eligible for use as general conformity offsets. This is necessary, as Delaware is part of multi-state ozone and fine particulate matter nonattainment areas.

The Corps' May 21 response that "*All of the credits purchased for the Delaware River Main Channel Deepening Project NOx ERCs were identified on their respective state's registry systems or confirmed by the Philadelphia Regional Port Authority's (PRPA) broker as being valid and available for sale or trade, and thus not bound by state SIPs"* is inconsistent with 7 DE Admin Code 1135, and the corresponding federal conformity regulations. The treatment of the ERCs in the state SIPs is paramount to the demonstration that the ERCs may be used as general conformity offsets.

Specifically, 7 DE Admin Code 1135 defines emission offsets as, *"emissions reductions which are quantifiable, consistent with the applicable implementation plan attainment and reasonable further progress demonstrations, surplus to reductions required by, and credited to, other applicable implementation plan provisions, enforceable under both State of Delaware and Federal law, and permanent within the time frame specified by the program. Emissions reductions intended to be achieved as emissions offsets under this regulation must be monitored and enforced in a manner equivalent to that under EPA's New Source Review (NSR) rules."*

Response: *The only pollutant for which the Delaware or Federal general conformity regulations require a conformity determination based on anticipated emission levels for the project in a relevant nonattainment area would be NOx as a precursor for ozone. See 7 DE Admin. Code 1135.3.2: 40 C.F.R § 93.153(b). The New Jersey "credits" qualify under Delaware and federal general conformity regulations, as applicable, to offset estimated NOx emissions from the project. In New Jersey, a facility that reduces emissions of a pollutant such*

as NOx may qualify that decrease as a "creditable emission reduction," which is defined as a decrease in actual emissions that is (N.J.A.C. § 7:27-18.1):

1. *Quantifiable;*

2. *Federally enforceable;*

3. *Not required pursuant to any federal or state law, rule, permit, order or other legal document;*

4. *Not relied on by the New Jersey Department of Environmental Protection (NJDEP) in the SIP or any revision thereto to demonstrate attainment or maintenance of a NAAQS or to demonstrate reasonable further progress toward attainment of a NAAQS; and*

5. *Verifiable, to the satisfaction of NJDEP, to have in fact occurred.*

Pursuant to N.J.A.C. § 7:27-18.8, NJDEP may approve emission reductions for banking for future application as emission offsets if NJDEP determines that a creditable emission reduction has been achieved. The credits purchased by the PRPA from New Jersey were recorded in New Jersey's banking registry system, as NJDEP confirmed in correspondence to the entities generating credits through NOx reductions at their respective facilities. As such, they would have been banked pursuant to N.J.A.C. § 7:27-18.8 and approved by NJDEP as creditable emission reductions, thereby representing emission reductions meeting the criteria specified in N.J.A.C. § 7:27-18.1. These criteria match the criteria specified in Delaware's definition of emission offsets in its general conformity regulations and qualify as offsetting the project's anticipated emissions as specified in 7 DE Admin. Code 1135.8.1.2 and 40 C.F.R § 93.158(a)(2).

In a letter to PRPA dated June 16, 2010, NJDEP confirmed that 266.0 tons of NOx Creditable Emission Reductions (CERs) were transferred from AGC Flat Glass North America, Inc. to PRPA.[3] *In a letter to PRPA dated June 30, 2010, NJDEP confirmed that 266.1 tons of NOx CERs were transferred from Gerresheimer Glass, Inc. to PRPA.*[4] *Confirmation of transfer of 223.62 tons of NOx CERs from El Paso Merchant Energy North America to PRPA is forthcoming and will be forwarded to DNREC once received.*

4. Updated Dredge Material Disposal Plan
(Section 4.6.7 of the Regulations Governing the Use of Subaqueous Lands and Section 12.0 of the Wetlands Regulations)

The Department still has significant remaining concerns regarding the Kelly Island and Broadkill projects which were discussed at the June 14, 2010 meeting of technical staff. DNREC's detailed comments were transmitted to the Corps via e:mail on June 7, 2010 and are attached here. Some additional information to address those concerns was presented to DNREC at the meeting and it is our understanding that further information will be forthcoming later this week.

Response: *DNREC's concerns regarding the Kelly Island and Broadkill Beach projects were discussed in detail during the June 14, 2010 meeting. At the meeting the Corps provided a table summarizing all of the available geotechnical data obtained to date in the lower Delaware Bay (the table is included on the DNREC website as "Delaware Deepening Reach E Boring Summary"). On June 15, 2010, the Corps provided various reports that contain the geotechnical data summarized in the table (it does not appear that these reports are available on DNREC's website). With the provision of this additional geotechnical data, the Corps believes that DNREC's concerns with respect to the median grain size (d-50) of the material should be resolved.*

The Corps maintains that both the Kelly Island and Broadkill Beach projects are technically feasible and environmentally sound. DNREC has been thoroughly involved in the development of the Kelly Island project since the project's inception and the current design is the result of coordination between DNREC and the Corps. Correspondence documenting this coordination is contained in the 1997 SEIS.

5. Cost Benefit Ratio
(Section 4.6.8 of the Regulations Governing the Use of Subaqueous Lands)

The Corps has agreed to perform an updated quantitative assessment of the impact of relevant market and industry trends on the previously projects project benefits to augment the qualitative port assessment. The Department requests the following during the interim:

1. A copy of the qualitative port assessment for reference;
2. A timeline regarding the updated quantitative assessment; and
3. An outline of what will be covered in the quantitative assessment (i.e. for which benefit categories are relevant market and industry trends being considered?)

Response: *As requested, the "Delaware River and Bay Channel Deepening Project: Current and Future Port Assessment," dated February 2010, is attached for reference.*[5] *A summary of what will be covered in the Updated Assessment of Relevant Market and Industry Trends is also attached.*[6] *It is anticipated that the updated quantitative assessment will be completed by March 2011.*

6. Coastal Zone Management Act Federal Consistency
(P.L.92-583) Section 307(c); 15 CFR Part 930)

The application did not include a Consistency Determination in accordance with the Federal Coastal Zone Management Act. In order to process this application in the most expeditious and proper manner, please submit a Consistency Determination to the Delaware Coastal Management Program so the 20 day public notice period and 60 day review timeframe may be met.

Response: *Please refer to the Corps' interim response letter, dated June 24, 2010.*

Attachment I: Comments Re: Kelly Island

We have reviewed the COE's 5/21/2010 response letter to DNREC Comments Provided April 22, 2010 and have some critical comments.

In short, we do not concur with the Corps' statement that concerns raised over the Use of Kelly Island as a beneficial use site have been addressed since the publication of 1997 SEIS.

The main purposes of Kelly island [sic] project as described in the SEIS are to restore intertidal wetland using dredged sediment from the deepening of the Delaware River navigation channel, stem erosion of Kelly island shoreline, provide extensive sandy beach for spawning horseshoe crabs, and provide continued protection to the entrance of the Mahon River. Insufficient data has been submitted to document that these purposes can be met, and at least one has been completely abandoned by the USACE.

It is our finding that the Corps has made some substantial changes and proposed a new design; but has not adequately addressed the concerns, has created some additional concerns with the proposed changes that need to be evaluated and addressed, and does not have adequate sediment geophysical data to support that the proposed project and changes are feasible.

Response: *The Corps has NOT made substantial changes or proposed a new design. The current design is essentially the same design presented in the 1997 SEIS, which was developed after considerable coordination with DNREC and modified to address DRNEC's concerns. The principal difference between the present plan for Kelly Island and the one presented in the 1997 SEIS is that the entire project will have to be shifted landward due to the continued and unmitigated shoreline erosion that has occurred in the interim (the shoreline erosion is depicted in Figure 1 below). The ultimate alignment of the project and any minor modifications to the design necessary to reflect actual conditions will be determined during preparation of the plans and specifications for construction, which is currently scheduled to begin in April 2014. Since the 1997 SEIS, additional sediment cores were collected in the section of the channel proposed as the source of material to construct the Kelly Island project. During the June 14, 2010 meeting, the Corps provided a table summarizing all of the available geotechnical data obtained to date in the lower Delaware Bay. As shown on the table, the median grain size (d-50) for the sand proposed for construction of the project is 0.7 mm, which will provide both a stable beach and suitable horseshoe crab habitat. (It should be noted that in the Corps' May 21, 2010 responses to DNREC's comments dated April 22, 2010, on Page 11 of 29, it is incorrectly stated that the median grain size (d-50) is "between 0.2 and 0.4 mm.")*

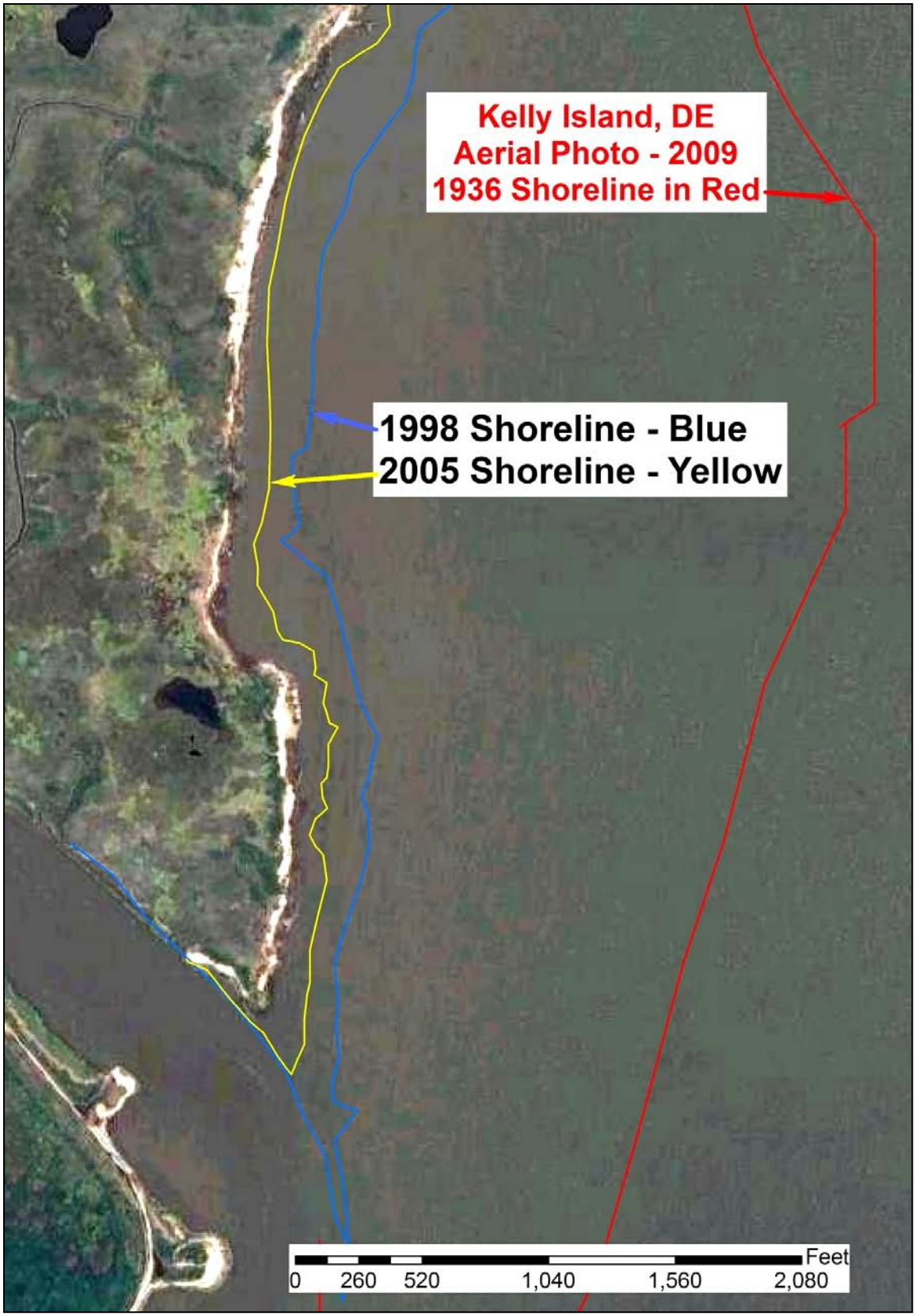

Kelly Island, DE
Aerial Photo - 2009
1936 Shoreline in Red
1998 Shoreline - Blue
2005 Shoreline - Yellow
Feet
0
260
520
1,040
1,560
2,080

Figure 1

These are thematically grouped as 1) No Final Plan to enable a review, 2) berm/beach design problems, 3) wetland design concerns, 4) long term maintenance responsibility and cost, 5) incomplete and inadequate sediment data, 6) sea level rise concerns, and 7) reduction in benefits due to abandonment of protection for Port Mahon boat ramp.

Lack of Final Design Plan

The Kelly Island Project does not have a final design plan that allows for an adequate review and evaluation of the project. The conceptual plans may provide some reasonable ideas for consideration of a construction project; however, they do not provide necessary information for a competent review of the project. It is not the policy of the State of Delaware to review and make a decision on hypothetical concepts.

Response: *The Kelly Island project is not a "hypothetical concept." The 1997 SEIS documents the extensive environmental and engineering studies that were conducted during the development of the design (refer to Sections 3.3 and 9.0). Furthermore, the project was designed in coordination with Federal and State regulatory agencies including DNREC. Due to the dynamic nature of the project site with its severe erosion rate, and in order to reflect the most current pre-construction conditions, final construction plans and specifications will not be prepared until just prior to actual construction, which is currently scheduled to begin in April 2014. Note that this is typical for any multi-year construction project. The Corps will coordinate the construction plans and specifications with DNREC, the Bombay Hook NWR, and other appropriate regulatory agencies prior to actual construction.*

Beach/Berm Design Problems

On Page 10, the Corps describes very significant design changes to the 1997 original design for the Kelly Island project. These changes included abandoning a 20 foot-width footprint stacked geotube design, to a 200 foot-width beach structure with a buried geotube. The revised footprint averages 600 feet wide at its base. It also adds 12 – 600 ft. timber groins. The extensive footprint will significantly impact subaqueous bottom and living resources and we have not been provided with any quantitative data that indicates that the benefits will outweigh the environmental cost.

Response: *All of the listed changes to the original design were made to address DNREC's concerns, and, with the exception of the replacement of geotextile tube groins for timber groins, the listed changes to the original design were made prior to the publication of the 1997 SEIS. Thus, the current design for Kelly Island is essentially the same design described and depicted in the 1997 SEIS, which was coordinated with and reviewed and concurred by DNREC.*

The Kelly Island project will reestablish high marsh habitat that has been lost over the past 100-plus years due to erosion of the wetland fringe of Delaware Bay. It is true that the newly created high marsh will impact the existing shallow sub tidal habitat; however, the shallow sub tidal habitat offshore of Kelly Island is simply what has been created by the century-plus loss of

fringing intertidal marsh. If the project is not constructed, the continued loss of wetlands is assured and new shallow sub tidal habitat will be left in its place. It is generally accepted that wetlands provide a higher habitat value than do shallow tidal areas. This generalization was recognized in the December 2003 Hearing Officer's Report in which the Hearing Officer made the following statements regarding the proposed Kelly Island project:

> *"I find there is a demonstrable need for the [Kelly Island] project, as evidenced primarily by the State request for and advocacy of the project. In addition, the beneficial use of unpolluted dredged materials should be a basic goal of any dredge project." (Page 30)*
>
> *"However, since most involved agencies acknowledge this portion [Kelly Island] of the MCD project will have positive net biological benefit, the quantification of benefit does not appear necessary under the statutory regulations. Also, the SEIS (Exhibit 4) characterizes the area as having some of the poorest benthic habitat with considerably less diversity than background communities, contrary to the summary phrase contained within the "Essential Fish Habitat Evaluation (Exhibit 120, 11/01). Based on the SEIS and interaction between agencies, the conclusion of net benefit appears tangible and logical." (Page 32)*

It has been well documented in recent decades in Delaware Bay that horseshoe crab site selection, density of eggs in the sand, and rates of egg development are dependent upon sediment characteristics, foreshore slope and width, and wave activity. The proposed design does not meet the requirements that must be met to create the type of habitat needed. The proposed beach will be of poor quality for horseshoe crabs and shorebirds due to the fine to medium grain sediment to be used and the low foreshore slope. These conditions should be expected to limit habitat use.

Smith et al, 2002 recommend that to create horseshoe crab spawning habitat, sand for replenishment projects should be selected to have a mean sediment size of 0.35 to 0.50 mm for the sand fraction. The sediment should also contain a gravel sub fraction. On page 11 of the Corps responses, it is stated that "The typical sediment size (D50) for the sand to be used in the construction of Kelly Island is between 0.3 and 0.4 mm". This sediment size will not "provide both a stable beach and suitable horseshoe crab habitat" (page 11) as opined by the Corps in their response to DNREC. Minimal if any habitat benefits for horseshoe crabs, and key species of shorebirds, can be expected to be realized from the project.

Additionally, 4-5 degrees is the slope that is characteristic of mid-Delaware Bay beaches that receive the heaviest spawning levels (Smith et al, 2002a). The proposed project and fine to medium grain size sand will create a low angle beach or berm for the proposed confined disposal facility. We have observed on Delaware Bay beaches that the chances of stranding that lead to individual horseshoe crab death are increased on a wide beach with a slope of 0-2 degrees. Horseshoe crabs use slope to guide their return to water after a spawning event; low foreshore slope may result in horseshoe crabs becoming disoriented and permanently stranded (Dr. Richard

Weber personal observation). The inclusion of timber groins in a low slope beach area may further impede the crabs' ability to return to the Bay.

Horseshoe crabs prefer to spawn on narrow beaches. Density of spawning females is indirectly related to foreshore width (Smith, 2002b). Consequently, density of live horseshoe crab eggs in surface sediment is inversely associated to foreshore width. Smith et al, 2002b found that density of live eggs was $2.36*10^5$ m-2 where foreshore width was less than 16.5 m, and was $2.28*10^4$ m-2 in beaches wider than 16.5 m.

Finally, for this berm/beach to be stable we must have a better idea of the geophysical characteristic of the differentiated volumes being placed. Due to the high current, wind, and wave energy, we believe that we must have a courser [sic] grain size. While timber groins have been proposed to stop littoral drift, we are concerned that the likely scenario is for a large volume to be exported off the beach along the groins affecting even greater amounts of subaqueous habitat. The norm for a beach fill project is to have a 1/4 to 1/3 to be eroded off the beach before it stabilizes. We are concerned that with the high concentration of fine to medium grained sand and this being an area that experiences extensive wave driven erosion, much more sand will be lost.

Response: *As shown on the table summarizing all of the available geotechnical data obtained to date in the lower Delaware Bay (provided to DNREC on 14 June 2010), the median grain size (d-50) for the sand proposed for construction of the project is 0.7 mm. (It should be noted that in the Corps' May 21, 2010 responses, on Page 11 of 29, it is incorrectly stated that the median grain size (d-50) is "between 0.2 and 0.4 mm."). The draft Delaware Bay habitat suitability index (HSI) model prepared by Brady and Schrading (1996) for the Corps suggests that optimal sediment size (HSI=1) is 0.6 to 0.8 mm, with a median of 0.7mm. This indicates that the sand to be used for the Kelly Island project is optimal for the creation of horseshoe crab spawning habitat. DNREC cites Smith et al (2002) above and in later comments, and additional discussion of the relationship between beach sediment grain size, beach slope, and horseshoe crab spawning habitat is presented there (see Pages 21 and 22 below in Attachment III).*

The USACE is not clear on the wave data used in the sediment transport model, only stating "boundary conditions were developed from a larger-scale finite difference grid covering the Egg Island Point area, the Kelly Island area, and the stockpile site area". The "wave" parameter would be a highly sensitive input in any sediment transport model. Without a better description of how the wave data was developed, calibrated, and verified; the integrity of the results of the sediment transport model is in questions [sic]. The Delaware Coastal program from 1998 to present has had two wave buoys deployed in the middle and lower reaches of the Delaware Bay on an intermittent basis. The equivalent of more than two year's data and several coastal storm events has been captured by each buoy. This data is available to the USACE.

Response: *The potential sediment transport impacts of the Kelly Island beneficial use site are presented in the Corps' May 1996 "Delaware River Main Channel Deepening Project, Design Memorandum". Specifically, Appendix B of the Design Memorandum ("Modeling Efforts/Hydraulic Analysis") included the section titled "Appendix B-5A, Fine Scale Modeling of*

Potential of Four Proposed Dredged Material Disposal Sites". Pages 1 through 5 of Appendix B5-A describe in detail the wave modeling performed by OCTI, Inc., to support the design and impact analysis of the Kelly Island plan. The wave modeling involved the application of STWAVE, a directional spectral steady state wave model. STWAVE results were integrated with a two-dimensional flow model of Delaware Bay to determine quantitative predictions of sediment transport under both normal and storm conditions. Additionally, prototype current measurements using ADCP (acoustic Doppler current profiler) technology were obtained at Kelly Island and other potential sites in Delaware Bay in order to provide verification data for the modeled currents. Figures 6 through 9 of Appendix B5-A demonstrate the ability of the 2D hydrodynamic model to accurately reproduce current speeds and directions measured by the ADCP. Pages 20 through 26 of Appendix B5-A present the detailed results of sediment transport modeling, in terms of both quantity and direction of transport, under storm and normal conditions. It should be noted that the wave hindcast period used in this analysis included 1986 through 1993, during which time the October 1991 and December 1992 nor'easters occurred, both of which were major extratropical cyclones that impacted the region.

Wetland Design Concerns

In order to create the wetland area, fine silts and sands will be disposed of in a confined disposal site, for which future management is unclear. It may be an open tidal area or it may be proposed as an impounded area. There are serious logistical constraints to access this site that will present serious operational challenges for management. In addition, the requirement for a large permanent beach with hard structures will limit any bay front tidal exchange. It is also undetermined if and when sediments would consolidate to a point of a stable wetland area, and any efforts to manage the wetland as an open tidal area prior to this condition would come with a high risk of excessive erosion and sediment loss in close proximity to Delaware's prime oyster seed bed areas. This is a crucial concern as these ecological resources are highly susceptible to damage from increased sedimentation.

Response: *As presented in the 1997 SEIS, Kelly Island will be converted from an "impoundment" to a tidal wetland with managed water levels over a period of several years, during which it is anticipated that sediments will consolidate and equilibrate, and after which wetland vegetation will be propagated. The Kelly Island "plan" as presented in the SEIS was the product of a significant amount of planning, design, and coordination that included experienced subject matter experts from the Corps' Environmental Laboratory (EL) and Coastal Hydraulics Laboratory (CHL) at the Engineer Design and Research Center (ERDC) in Vicksburg, Mississippi. Other participants in the Kelly Island design process included staff from DNREC, USFWS, and other state and Federal regulatory agencies. As part of the preparation of plans and specifications for Kelly Island, the Corps will work closely with the Bombay Hook NWR and DNREC to ensure that the construction and subsequent management of the site leads to success of the tidal wetland.*

Note that the proposed plan for the Kelly Island site since the 1997 SEIS has included tidewater control structures to be located at the north end of the site, protected from open water of Delaware Bay. There is no "bay front tidal exchange" planned or envisioned for the Kelly

Island site. Additionally, water levels will be managed to optimally encourage the growth of robust wetland vegetation, which will reduce, rather than exacerbate, the likelihood of release of fine-grained sediment to the Bay above the levels that presently occur due to the continued erosion of the Kelly Island fringing marsh shoreline. The reduced likelihood of fine-grained sediment release to the Bay with a stable Kelly Island shoreline also reduces the risk of dispersal of sediment to potentially affect adjacent oyster beds.

Even if the significantly changed project reduces the likelihood of a catastrophic beach breach for a period of time, it will require continuous maintenance to ensure this protection for the long term. Simply conducting a onetime beach construction project in this well documented area of high erosion would likely only delay a catastrophic breach in this ecologically sensitive area. If the US Army Corps of Engineers constructs this project, it must accept the responsibility to manage and maintain it in perpetuity. Maintenance of this disposal area will require substantial fiscal and operational resources in the long term, which should not be relegated as a responsibility and unfunded mandate to the State. A detailed assessment of the long term operational responsibilities and costs must be conducted; and a detailed description of how the USACE will maintain this site long term at no fiscal cost to the State of Delaware must be provided.

Response: *The Corps disagrees with the characterization of the Kelly Island project in 2010 as a "significantly changed project" relative to the plan presented in the 1997 SEIS. Nevertheless, the Corps recognizes that maintenance of the Kelly Island site is a Federal responsibility that would be funded as a part of the District's Operation and Maintenance program. The responsibility for this activity would not become an "unfunded mandate" for the State of Delaware.*

In a related concern, highly disturbed sediments have a tendency to be colonized and dominated by invasive species such as phragmites, leading to an extremely low quality and low benefit wetland system. In addition, providing this type of habitat directly adjacent to the high quality habitat found on the Bombay Hook National Wildlife Refuge could provide additional seed stock that may spread and cause ecological degradation of the adjacent marsh area. Avoidance and control of this invasive species requires significant management of water levels, and may require routine spraying with herbicides over the long term. Addressing these issues in perpetuity should also be included in a long term maintenance agreement for the site.

Response: *The Kelly Island plan presented in the 1997 SEIS (see page 3-50) anticipated the need to control phragmites in order to encourage the growth of more beneficial wetland vegetation. A combination of water level management and herbicide spraying will be used to maximize the success of healthy, stable wetland vegetation.*

Long Term Maintenance Responsibility and Cost

Due to the concerns associated with the long term problems this site may create, a signed maintenance agreement clarifying the long term responsibilities of the USACE and the estimated costs per decade must be provided. If it is the intent of the USACE to relegate this responsibility to the State of Delaware or any other agency for long term maintenance, please provide a copy of that agreement.

Response: *The 1997 SEIS establishes that the Corps will monitor and maintain the Kelly Island project as a component of the Delaware River Main Channel Deepening Project. Concerns over invasive species, erosion, and wetland vegetation are key elements to continued maintenance of the site that will be closely monitored and managed by the Corps and coordinated with DNREC and Bombay Hook NWR.*

Incomplete and Inadequate Sediment Data

The Corps has stated that "twenty-nine channel vibracores were collected in the Delaware River and gaps in channel sedimentation quality were covered by a geoacoustic survey of the channel". No core info (locations and detailed grain sizes analysis data) was provided, for Reach E, to DNREC for review. It is impossible for us to assess whether these cores adequately characterize the sediment in this reach without the data being provided for our review. It is unclear if the core locations were based upon the seismic data collected during the geoaccustic [sic] study completed by McGee. DNREC is also concerned that the geoacoustic data is not of high enough vertical resolution nullifying its ability for use to pick out areas of transition or shallow reflectors identification and characterization. We need to understand whether the overall distribution of the cores is in clusters or randomly distributed, and whether or not it was conducted in a way that provides adequate resolution for statistically defensive mapping and characterizations of the sediment in this reach.

DNREC recently conducted our own independent geoacoustic study, and have indications that significantly finer grained areas (mixed silt/sand deposits) that are rich in organic material dominate large stretches of Reach E. We question whether these areas were adequately sampled. We have inadequate data to access whether the additional cores collected by the USACE are a true representation of the reach. We must have the full core data, locations, core logs, and the criteria used to collect them, and the quality assurance/quality control used.

Understanding this is critical, as our independent geoacoustic data indicates that there are several rapid transitions in the sub-bottom that could result in huge disparities in the estimated volumes of certain grain sizes. We question whether the existing sediment conditions will be conducive to the proposed sediment allocations for the conceptual plans of the USACE.

Response: *During the June 14, 2010 meeting, the Corps provided a table summarizing all of the available geotechnical data obtained to date in the lower Delaware Bay. On June 15, 2010, the Corps provided various reports that contain the geotechnical data summarized in the table (it does not appear that these reports are available on DNREC's website). As shown on the table,*

the median grain size (d-50) for the sand proposed for construction of the project is 0.7 mm, which will provide both a stable beach and suitable horseshoe crab habitat. With the provision of this additional geotechnical data, the Corps believes that DNREC's concerns with respect to the median grain size (d-50) of the material should be resolved. In addition, this data will enable DNREC to better calibrate the geoacoustic data so that it is more reliable in predicting the nature of sub bottom sediments throughout the estuary.

Future Sea Level Rise

The Corps has stated that "the impact of continued sea level rise on the proposed sand dike containment structure at Kelly Island is not deemed sufficient to compromise the intended function and durability of this feature of the project", yet this finding appears to be an unsubstantiated opinion. More importantly, it may be in direct conflict with the latest Army Corps of Engineers guidance that stipulates that sea level rise must be considered in all phases of Civil Works programs (Department of Army Circular No. 1165-2-211; July 1, 2009). What is the basis for this opinion? What scenario did the Philadelphia District of the USACE use as a future sea level rise and why was it chosen? The Corps must provide a detailed vulnerability assessment for the long term impact on this disposal site, and incorporate these findings into the long term maintenance plan for the site.

Response: *Sea Level Rise (SLR) in the Delaware estuary, and along the entire US East coast, has been a "noisy, linear" process for at least the past 100 years, and likely longer than that. There is no evidence that any acceleration of SLR has occurred during the mid- to late 20th century, or in the first decade of the 21st century, notwithstanding the potential for this to occur in the future. The measured rate of relative SLR within and adjacent to the Delaware estuary has been approximately one foot per century over the past hundred years, as documented by a number of long-term tide gages operated by NOAA/NOS. Further, there is no scientific consensus that identifies historic sea level rise as the predominant factor leading to loss of fringing and other wetlands in Delaware Bay.*

EC 1165-2-211 is relatively new guidance (1 July 2009) that directs the Corps to consider low, intermediate, and high levels of future sea level rise for project design and functioning. Paragraph 6c of the EC states that planners and designers should "determine how sensitive alternative plans and designs are to these rates of future local mean sea-level change, how this sensitivity affects calculated risk, and what design or operations and maintenance measures should be implemented to minimize adverse consequences while maximizing beneficial effects. Consider sensitivity relative to human health and safety, economic costs and benefits, environmental impacts, and other social effects." In this regard, the Corps views the Kelly Island dike, which is essentially comprised of 100% sand, as being inherently flexible and adaptable to potential future changes in sea level. At such point in the future, if in fact any regional acceleration of SLR is measured to have occurred, and more importantly, to have affected the performance of the Kelly Island sand dike, the design elevation or width of the Kelly Island dike can be adjusted accordingly with the addition of relatively small quantities of additional sand. EC 1165-2-211 does not require the Corps to design or construct projects in

2010 for possible alternate rates of SLR that are higher than those experienced for the past century or more.

Reduction in benefits due to abandonment of protection for Mahon Boat Ramp

We are concerned that one of the major "benefits", that of protecting the entrance to the Mahon River and the Boat Ramp, has been disregarded. While the Corps contends "that the loss of the spit and its impact on protection of the Mahon River boat ramp is not relevant to the intended ecosystem restoration purpose of the Kelly Island site", this benefit was a major factor in the assessment of project benefits during the early planning of the project. The complete abandonment of this is a significant change in the scope and benefit of the project. It also highlights the shifting public policy in Delaware to begin to consider the strategic retreat from the area rather than development of hard structure and other facilities in this area. Like the boat ramp and Mahon Road, the Kelly Island area will likely be cost prohibitive to maintain in the long term. The prudent public policy decision in this area, after considering the erosion rate, potential sea level rise scenarios, and logistical challenges to site maintenance and management, is to abandon the consideration of this site and pursue wiser public policy and a common sense approach to management of the coast.

Response: *The elimination of the protection of the Mahon River boat ramp does not constitute "a significant change in the scope and benefit of the project." The protection of boat ramp was an incidental benefit of the Kelly Island wetland restoration, was never identified or quantified as part of the total project benefits, and is no longer feasible due to the continued erosion of the spit at the entrance of the Mahon River. The continued erosion of the spit and its possible effect on the final design of the project was contemplated in the 1997 SEIS (Page 3-50):*

> *"It is possible that by the time construction begins the eroded point at the southern end of Kelly Island may be gone due to continued erosion. In such a case, the southern end of the project may need redesign prior to construction."*

The creation of over 60 acres of high quality tidal wetland and establishment of over one mile of horseshoe crab habitat in an area where there is virtually none will be a great benefit to the ecosystem. In addition, the project will protect hundreds of additional acres of wetlands that would likely be lost in the coming decades if no action comparable to the Kelly Island plan is undertaken. Although there are great concerns over erosion and loss of habitat throughout the Estuary, Kelly Island is the only major project that will be constructed in the foreseeable future. As part of the Delaware River Main Channel Deepening Project, the Corps has expended considerable time and resources to ensure that the Kelly Island project is successful and will continue to work closely with DNREC and the Bombay Hook NWR to ensure that all aspects of the project are functional and meet the intended need.

Attachment II: Additional Comments Re: Kelly Island

The Corps reports that Kelly Island has been eroding at an estimated rate of 20 feet per year. I did not see an analysis of the eroding forces that result in this unusually high rate. The proposed wetland restoration project includes the placement of 1.7 million cubic yards of sand to form a containment dike for the wetland. Groins are proposed to reduce longshore sediment losses. If the material placed; sand, silt and clay, at this very erodible site is released through future erosion into the water column, it will result in subaqueous deposition that may not be compatible with current underwater habitat and navigation values. Therefore, I ask the following questions.

1. Are the forces that result in the historic erosion of Kelly Island been identified and quantified? If the answer to #1 is yes, can we see that analysis?

   If the answer to #1 is no, what is the annual erosion rate of the beneficial use project expected to be?

Response: *The forces causing erosion of Kelly Island have not been identified and quantified. There are numerous theories regarding the cause of this fringing wetland loss that include factors from SLR to ship wakes to nutrient supply to the marshes. But there is no generally accepted single cause (or even multiple causes) that the scientific community has embraced. Kelly Island sediment transport modeling was documented in Appendix B5-A of the Corps' 1996 Design Memorandum. Pages 20 through 30 of Appendix B5-A, and specifically Table 1, summarize the predicted normal and storm condition transport rates and directions for the Kelly Island project, and discriminate between normal tidal current transport, normal wave-driven transport, and storm wave-driven transport. The calculated transport rates range from 5,000 to 50,000 cubic yards per year, depending on the factor considered. The largest of those rates, 50,000 cubic yards per year, corresponds to a maximum annual shoreline retreat rate estimated at 18 feet per year.*

2. Where has the substantial amount of sediment that has eroded from Kelly Island over the past several decades ended up?

Response: *No one has measured or made direct observation of the rate and direction of Kelly Island sediment dispersal as the wetlands fringing the Bay shore have continued to erode. It is likely that the fine-grained and organic sediments of the eroded marsh have been dispersed by waves and tidal currents to become part of the background load of suspended sediment in the Delaware Bay. The small quantity of naturally occurring sand in the vicinity of Kelly Island has persisted in forming a small "beach" along the bayward edge of the site.*

3. What is the projected longshore transport rate at the new beach? This is pertinent in considering the expected performance of the groins.

Response: *See response to Comment 1 above.*

4. Where will eroded sediment be deposited?

Response: *The sand eroded from the Kelly Island sand dike will be transported both north and south. The CERC and OCTI wave and sand transport modeling concluded that the dominant net transport direction will be to the north. (See the responses to Attachment I: Comments Re: Kelly Island above for information regarding the CERC and OCTI wave and sand transport modeling.)*

5. Do the design elevations of the dike and wetlands account for post construction settlement? Typically, newly placed sediment has a higher void than native, in situ, material. There will likely be settlement that will lower the actual elevation of the features to be built. Is this accounted for in an 'overage' allowance? This is important for both level of protection provided by the dike as well as the ability of the unplanted wetland surface to succeed as intertidal wetland.

Response: *Settlement of the dike and wetlands was accounted for in the establishment of the top elevation of the dike.*

6. What is the maintenance plan for this new beach system? Typically, beach creation projects go through a period of equilibration, followed by annual erosion that continues to move sediment from within the project area. We need to know the full geomorphic cycle that is expected for this new land accompanied by a plan to sustain it through future placement of material.

Response: *The 1997 SEIS establishes that the Corps will monitor and maintain the Kelly Island project as a component of the Delaware River Main Channel Deepening Project. See pages 9-20 through 9-24 of the 1997 SEIS for a more thorough discussion of the Kelly Island maintenance plan.*

7. What is the funding source for beach maintenance?

Response: *Any post-construction costs associated with maintenance of the Kelly Island site will be funded as part of the operations and maintenance program of the Delaware River, Philadelphia to the Sea Project.*

8. Is there an annual monitoring plan to measure the performance of this site? If so, is the funding for this stable?

Response: *The 1997 SEIS establishes that the Corps will monitor and maintain the Kelly Island project as a component of the Delaware River Main Channel Deepening Project. As such, the maintenance of Kelly Island will be incorporated into the annual operations and maintenance budget for the Delaware River, Philadelphia to the Sea Project. The level of funding for federal projects is determined by the President and Congress on an annual basis.*

Attachment III: Comments Re: Kelly Island Horseshoe Crab Issues

Most of the remaining concerns, outside of time-of-year restrictions, involve uncertainty about sediment characterization.

Should the Kelly Island restoration component of the project ultimately be deemed appropriate, we would like to revisit the landside construction schedule to minimize adverse impacts to spawning horseshoe crabs and their eggs/larvae. It may be reasonable to adjust the work schedule to more closely reflect the construction schedule proposed for the Broadkill replenishment at the May 13, 2010 project coordination meeting. It is recognized that this may be difficult given the competing closures and anticipated six month construction requirement. However, given that the justification for disposing of the sediment is focused on providing spawning habitat for horseshoe crabs, it seems reasonable to avoid detrimental impacts to the target restoration species, particularly during the peak spawning season in May and June. The Atlantic States Marine Fisheries Commission's (ASFMC) recommended seasonal restriction for construction activities is from April 15 to August 30. Can the Corps accommodate this seasonal restriction?

Response: *As noted, it is estimated that the Kelly Island project will take approximately six months to construct. This estimated construction period assumes the use and availability of two large hopper dredges. Project construction is scheduled to commence in April to coincide with the applicable hopper dredging window. Waiting to start the project until September, in addition to violating the applicable hopper dredging window, increases the risk of not completing the project in a single construction season. A shutdown midway during the winter season poses a risk that completed portions of the project could be severely damaged and would also substantially increase mobilization and demobilization costs. However, as with the proposed schedule for construction of the Broadkill Beach project, the Corps is willing to discuss revisions or modifications of the construction schedule for Kelly Island with regard to environmental windows.*

The characterization of the grain-size of the material proposed for placement at both the Kelly Island and Broadkill sites remains in question. Based on the comments of others and a limited examination of Roxann and CHIRP data, my concern is that there has been insufficient core sampling to adequately characterize the proposed placement material. I think additional sediment cores (located based on recently conducted CHIRP sampling) and subsequent modeling, could significantly reduce the uncertainty to a reasonable level. Without an adequate characterization of the sediments to be placed, however, it seems difficult if not impossible to have effectively modeled the dynamics of the sediment proposed for placement. For this reason, I am not confident that the Kelly Island material will remain in place and that it will not impact the oyster grounds immediately offshore. There is little question that a catastrophic failure of the proposed structure will have devastating consequences on the nearby oyster resources.

The ASMFC recommends that the grain-size of renourishment material be similar in size to the grain size that currently exists. Smith et al. (2002) reported that data from unnourished beaches located in the Delaware Bay indicated that sediments finer than 0.063 mm were uncommon on

the foreshore. The USACE states that, " The typical sediment size (D50) for the sand to be used in the construction of Kelly Island is between 0.2 and 0.4 mm (medium to medium-fine sand), which will provide both a stable beach and suitable horseshoe crab habitat." It is my understanding that the "D50" indicates that 50% of the material would, in fact, be expected to be less than the reported range. That would result in a significant portion of fine to very fine sand and possibly large quantities of silt or clay. If a significant proportion of fined-grained material exists in the placed material, it may settle in layers creating a substrate more resistant to waves and burrowing organisms because a sediment bed with low porosity and high density will behave as a solid (Smith et al 2002). Further, I am concerned that the fine sand may inhibit horseshoe crab egg development due to low interstitial oxygen. Once again, if my interpretation of "D50" is correct, it seems implausible that the placement of this material would have a negligible impact on the nearby oyster resources, but I must defer to others on this.

The limited published data available suggests that the size of the proposed placement material is toward the lower (smaller grain-size) end or even outside of the bounds of suitability for horseshoe crab spawning. Smith et al. (2002) reported from their work conducted in the Delaware Bay that, "The source of sediment for nourishment should be chosen to reflect a coarse estuarine beach. The nourished sediment should have a gravel sand subfraction and have a mean sediment size of 0.35 to 0.50 mm in the sand fraction." Brady and Schrading (1996) prepared a draft Delaware Bay habitat suitability index (HIS) model for the Corps. This draft model suggests that optimal sediment size (HSI=1.0) is 0.6 to 0.8 mm; whereas, the material proposed for placement would score about 0.33 to 0.68 (HSI). The grain-size of DE Bay (NJ) beaches with the highest concentrations of horseshoe crabs ranged from 0.5 to 2.0 mm, with a medium [median] grain of 0.7 mm. It is further my understanding that finer grained sediments will result in a flatter beach once "settled". Horseshoe crabs adults and juveniles require an appropriate slope to orient themselves. A beach slope of 7% is believed to be optimal according to Brady and Schrading (1996) and some assurance that this slope would be likely is desirable. Once again, it would seem that such an assurance should be predicated on adequate sediment characterization and subsequent modeling.

Response: *As shown on the table summarizing all of the available geotechnical data obtained to date in the lower Delaware Bay (provided to DNREC during the June 14, 2010 meeting), the median grain size (d-50) of the sand proposed for construction of the project is 0.7 mm, which will provide both a stable beach and suitable horseshoe crab habitat. Smith et al. 2002 ("Beach Nourishment on Delaware Bay Beaches to Restore Habitat for Horseshoe Crab Spawning and Shorebird Foraging") evaluated several parameters that affect the success of horseshoe crab spawning on Delaware Bay beaches, of which grain size of the beach sediment was one factor. On page 45 of their report, they state:*

> *"Study results showed a stable or increasing amount of spawning activity at beaches that were recently nourished (North Bowers and Pickering) while spawning activity at previously nourished (i.e., control) beaches (Ted Harvey and Kitts Hummock) declined from 2001 to 2002. . . . These results are consistent with the hypotheses that 1) horseshoe crabs can sense and are attracted to recently nourished beaches and 2) egg development and viability are affected by beach-*

> *specific moisture characteristics. Horseshoe crabs are thought to be generalists."*

Further, the authors present a number of conclusions, including the following on page 49:

> *"3. Grain size may affect egg development through its impact on egg development especially in the upper, dryer foreshore. Finer sizes may be more important for egg viability because of moisture retention.*
>
> *4. The source of sediment for nourishment should be chosen to reflect a coarse estuarine beach. The nourished sediment should have a gravel subfraction and have a mean sediment size of 0.35 to 0.50 mm in the sand fraction.*
>
> *5. Beach nourishment can have a positive effect on site selection and egg viability, but more research is required to assess optimum size of fill materials and timing of the operations."*

Regardless of the grain size of any sandy material placed at Kelly Island, the ultimate slope of the foreshore at Kelly Island is not predictable as a single, unique constant value based on grain size alone. Other parameters continuously act upon and modify the foreshore slope - waves, currents, season, antecedent storm activity, etc. The best one can predict is a range of probable foreshore slopes. The Brady-Schrading paper discusses a range of slopes, presented in both % grade as well as degrees of slope. The effective range of slopes, presented in the form of "rise-over-run" or "delta y to delta x" is in the range from 1:8 (steeper) to 1:19 (flatter). The 0.7 median grain size of the Kelly Island sand fill will very likely form stable foreshore slopes in this range. The ultimate range of naturally-evolving foreshore slopes at Kelly Island should be entirely satisfactory as horseshoe crab spawning habitat. Further, there is at best only a thin veneer of sand at the eroding Kelly Island marsh shoreline for horseshoe crabs to spawn on at present. The Kelly Island beachfill (sand dike) will immediately change that situation, very plausibly for the better.

The "0.063" sediment grain size that Smith et al. (2002) quote as "uncommon on the foreshore" is the boundary between find sand and silt size particles. The reason such sediments are not found on the foreshore of typical Delaware Bay beaches is that even the relatively lower wave climate of the Bay shore, compared to that of the ocean, is adequate to transport silt sized particles away as suspended load, for dispersal over larger areas and likely deposition in areas of lower wave/current energy. As the marsh fringe erodes, only the small fraction of sand in this environment is stable, even if it is in very short supply. The proposed Kelly Island sand fill will significantly correct this deficit to the benefit of horseshoe crab spawning. Also, sand transport northward from Kelly Island to the adjacent eroding shoreline in Bombay Hook NWR would provide new horseshoe crab spawning habitat where there is little or none at present.

In view of the evidence presented to DNREC in the comprehensive sediment grain size data relevant to Kelly Island construction, and in view of the above-cited findings in Smith et al. (2002) and in Brady and Schrading (1996), it would appear that the construction of the Kelly island beneficial use site would be highly advantageous to providing and enhancing horseshoe

crab spawning habitat in Delaware Bay. The project will also provide the dual benefits of restoring tidal wetlands that have been lost at Kelly Island over the past century, in addition to preventing further loss of remaining wetlands.

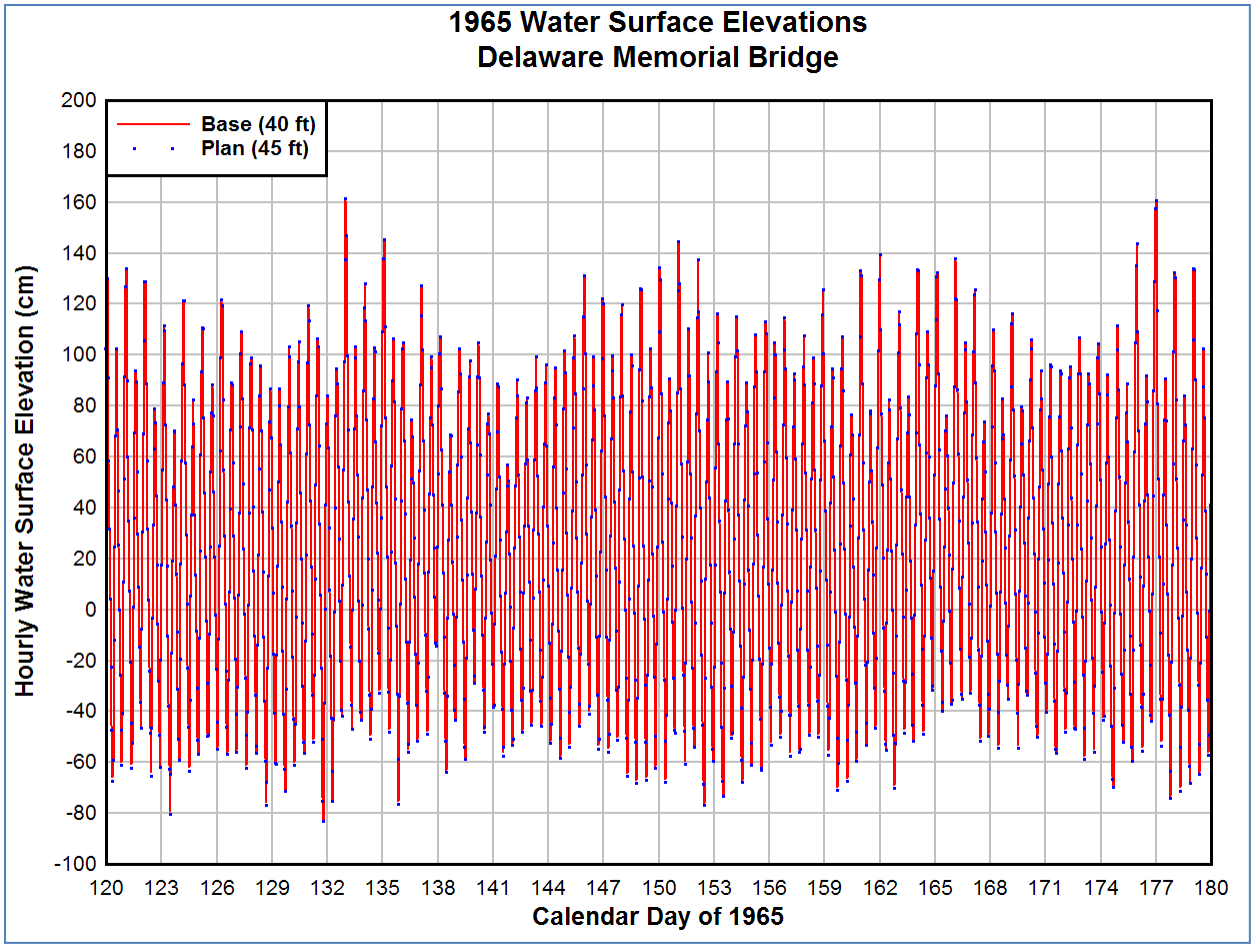
Attachment IV: Comments Re: the Sediment Budget and Salinity Model

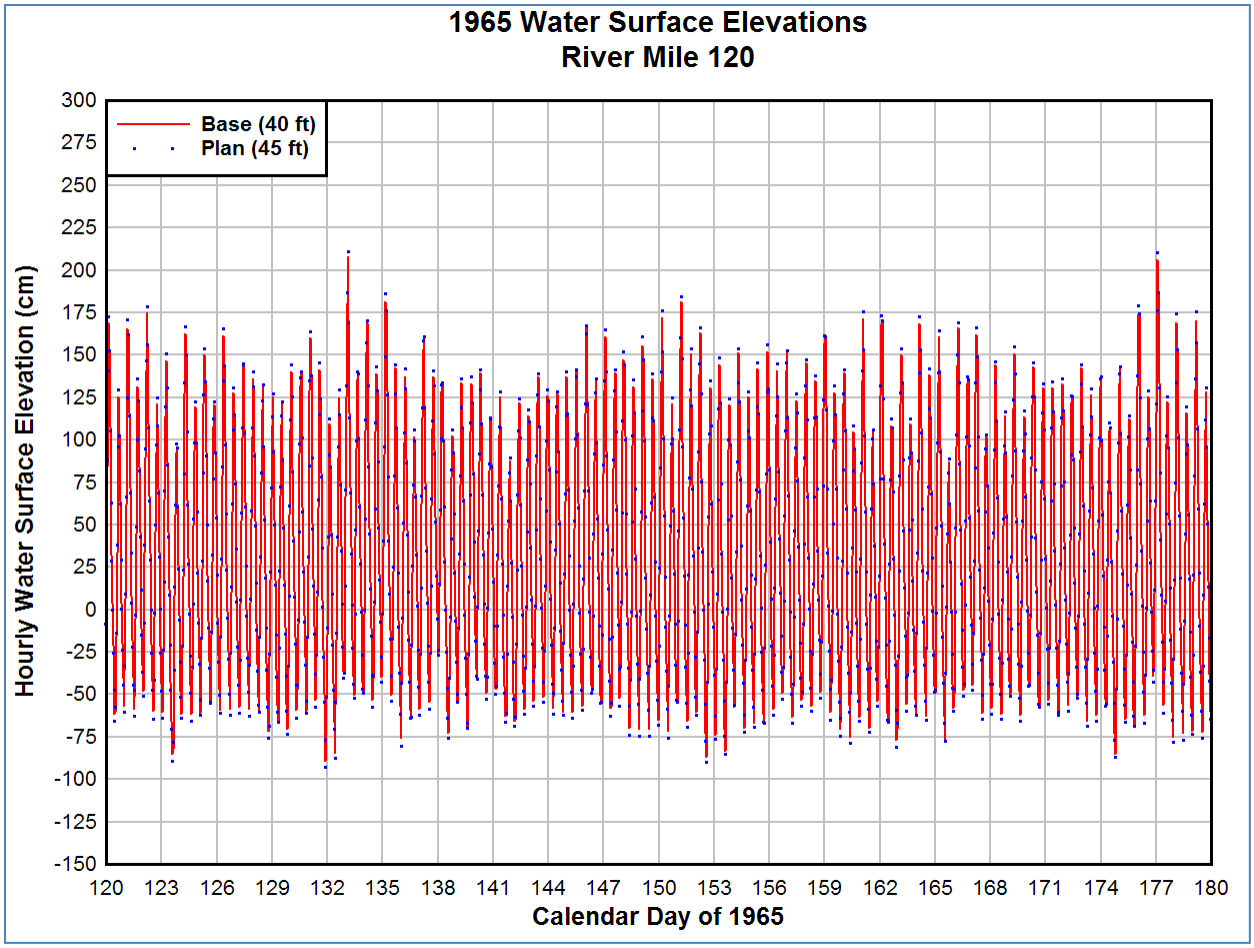
Sediment Budget Questions:

There is much remaining uncertainty surrounding the effect of channel deepening on the sediment budget.

In their response, the Corps states: " Based on our numerical hydrodynamic modeling the deepened 45 ft channel will not contribute to increased tidal amplitudes." This is a point that has been a non-argued point until now. Everyone seemed to agree on this effect of deepening (since it is clearly documented from the past deepening), but now that it is placed in the context of wetland loss, the Corp seems to doubt that it would occur. The Corps application should clearly show this asserted non effect by showing a time-series of tide level with sea-level removed. This would show the increase in tide-level that resulted from the deepening in the 1940's and 60's.

Response: *A copy of DiLorenzo, 1993 ("Dredging Impacts on Delaware Estuary Tides") was provided to DNREC in May 2010. This investigation evaluated changes to the tidal regime of the Delaware Estuary, especially in terms of the observed tide range at, and upstream of Philadelphia that occurred in the period between 1910 and 1980. The investigation also applied an analytical tidal model of the estuary to evaluate potential tidal regime changes that would accompany deepening the navigation channel to 45 feet. The paper concluded that ". . . an additional 5-foot (1.5-meter) dredging of the navigational channel (below Philadelphia) will have a comparatively small or negligible impact on the tidal regime" of the Delaware Estuary. Additionally, we have assembled water surface elevation ("tide height") data from the Corps' 3D numerical hydrodynamic model to further substantiate this point. Hourly water surface elevation (WSE) data were saved at the Delaware Memorial Bridge (RM 69) and at River Mile 120 from simulations of calendar year 1965 inflow and tidal conditions, for the existing 40 foot and proposed 45 foot navigation channels. These locations respectively represent conditions for the portion of the estuary between Philadelphia and the mouth of the Bay, and for the portion between Philadelphia and the head of tide at Trenton. At the Delaware Memorial Bridge location, the effect of deepening the channel to 45 feet is to increase the tidal range by an average of approximately 1 cm, which is less than a 1% increase. At River Mile 120, the effect of deepening the channel to 45 feet is to increase the tidal range by an average of 5 cm, which is approximately a 2% increase. Although the model indicates a finite, non-zero change to tidal range at these locations as a consequence of deepening the channel to 45 feet, we concluded that this change "will have a comparatively small or negligible impact on the tidal regime" of the estuary, as was independently concluded in DiLorenzo (1993). Two plots are presented below to illustrate these findings, first for the RM 69 location of the Delaware Memorial Bridge, and then for the RM 120 location between Philadelphia (RM 100) and Trenton (RM 130). Each plot shows an arbitrarily selected 60-day portion of the 1965 simulation, with hourly values of WSE plotted for the 40 foot channel (red line) and the 45 foot channel (blue points). The plots illustrate our conclusion that deepening the navigation channel to 45 feet leads to finite increases in tidal amplitude, but that such changes are small enough to be considered "negligible" from any practical standpoint.*


1965 Water Surface Elevations
Delaware Memorial Bridge
Base (40 ft)
Plan (45 ft)
Hourly Water Surface Elevation (cm)
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
120 123 126 129 132 135 138 141 144 147 150 153 156 159 162 165 168 171 174 177 180
Calendar Day of 1965



In conversations I have had directly with Dr. Chris Sommerfield, University of Delaware, there is no question that further deepening will result in further changes in the sediment budget. More sediment will be deposited in the deeper channel and less will be re-distributed into the shallow flanks and shoals of the river and bay. <u>How will the Corps monitor, assess and address these changes to the estuary should the project be approved</u>?

Response: *The Corps anticipates that the deepened channel will be accompanied by marginally higher sedimentation rates than are experienced with the existing channel. Documentation of historic maintenance dredging rates of the 40 foot channel, as well as estimates of required maintenance dredging for the 45 foot channel, are presented in Appendix B-3 of the Corps' 1996 Design Memorandum, and are updated in the Corps' 2002 Comprehensive Reanalysis report. The Corps monitors the sedimentation status of the existing 40 foot channel through a program of regular hydrographic surveying. These surveys are the basis for ensuring that safe and efficient navigable conditions exist in the 40 foot channel, and are the basis from which maintenance dredging decisions are made. Before- and after-dredging surveys are used to determine payments to dredging contractors.*

The subject of the estuary sediment budget has received significant scrutiny in the past decade as improvements have been made in understanding both qualitative and quantitative aspects of the sediment transport/deposition regime. However, the current state of the science in terms of the estuary sediment budget is insufficiently precise to allow a realistic, quantitative assessment of impacts associated with the relatively small increase in maintenance dredging quantities associated with the channel deepening. There is no reliable, scientific basis from which to conclude that maintenance dredging associated with the deepened channel (from 40 to 45 feet) will lead to unacceptable adverse impacts to the estuary sediment budget.

Data requests:

The core locations, core logs, and grain size analysis data for all the cores located in Reach E. There are 27 cores that are in the reach that would have sediments used in the construction of Kelly Island and another 8 in the lower reach for the area that will be used to construct Broadkill Beach. We have not had access to any of that data, and that data is vital in our review of the feasibility of the Kelly Island and Broadkill projects.

Response: *During the June 14, 2010 meeting, the Corps provided a table summarizing all of the available geotechnical data obtained to date in the lower Delaware Bay. On June 15, 2010, the Corps provided various reports that contain the geotechnical data summarized in the table (it does not appear that these reports are available on DNREC's website).*

<u>Salinity Model</u>:

Our understanding is that the Corp does not intend to do any adjustments or re-runs of the salinity model. We still contend that the most up to date and reliable data has not been utilized in the model, and that calls the modeling results into question. Jeff Gebert has stated that any new data collection would be unrealistic due to monetary and time constraints. However, at the very least, we request that the Corps change the bathymetry grid to incorporate realistic depths that would represent actual post-construction conditions (for example, in Reach C many of the areas will have a depth of 47 ft not 45 ft). If this cannot be accomplished, the Department cannot be confident that the other input data, or the model output, is the best available representation of the Delaware Estuary conditions and predicted changes.

Response: *The Corps addressed DNREC's comments pertaining to the Salinity Model in its May 21, 2010 responses (please refer to Pages 18 to 24 of the responses). The model uses the depth of 45 ft MLLW as the "with-project" depth for the deepened channel simulations because areas of the channel that will be dredged deeper than 45 ft MLLW during construction of the project are anticipated to shoal to the depth of 45 ft MLLW before the next annual maintenance cycle. Also, it is the Corps technical opinion that if alternate depths other than 45 ft MLLW were applied in selected reaches of the channel, the model would show no significant salinity differences compared to results with a uniform channel depth of 45 ft MLLW.*

List of Attachments

[1] Interim Report, Killcohook (Cells 2 and 3) Confined Disposal Facility Monitoring and Reach C Water Quality Monitoring at the Point of Dredging, June 2010

[2] Scope of Work, Delaware River Channel Deepening Project, 2010 Sediment Core Analysis, Reach B Contract (Station 137+000 to Station 176+000)

[3] Letter from NJDEP to PRPA, dated June 16, 2010, confirming transfer of 266.0 tons of NOx CERs from AGC Flat Glass North America, Inc. to PRPA.

[4] Letter from NJDEP to PRPA, dated June 30, 2010, confirming transfer of 266.1 tons of NOx CERs from Gerresheimer Glass, Inc. to PRPA.

[5] Delaware River and Bay Channel Deepening Project: Current and Future Port Assessment, February 2010

[6] Scope of Work Summary for Updated Assessment of Relevant Market and Industry Trends

DELAWARE RIVER
MAIN CHANNEL DEEPENING PROJECT

- INTERIM REPORT –

KILLCOHOOK (CELLS 2 AND 3) CONFINED DISPOSAL FACILITY MONITORING AND REACH C WATER QUALITY MONITORING AT THE POINT OF DREDGING

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Contract No. W912BU-06-D-0003
Task Order Numbers 54 and 55

June 2010

EXECUTIVE SUMMARY

Dredging for the Delaware River Main Stem Channel Deepening Project began on March 1, 2010. The first construction contract is for Reach C of the channel, which extends from the Delaware Memorial Bridge to just below the Chesapeake and Delaware Canal. In conjunction with the dredging, environmental monitoring for potential water quality impacts is on-going at the Federally owned Killcohook dredged material containment facility and at the point of active dredging following a program coordinated with the Delaware Department of Natural Resources and Environmental Control (DNREC). This interim report presents environmental monitoring data for the deepening project collected up to May 17, 2010. Environmental monitoring efforts are continuing. A summary report presenting all data will be prepared subsequent to completion of the on-going work.

The Killcohook dredged material containment facility is comprised of three separate placement cells. Cells 2 and 3 are receiving dredged material from the deepening. Cell 2 is receiving material dredged by the Pullen. Cell 3 is receiving material dredged by the Charleston. The Pullen and the Charleston are both 24-inch hydraulic cutterhead suction dredges owned and operated by the Norfolk Dredging Company. The environmental monitoring program for cells 2 and 3 includes material flowing into the containment cells (influent), water and associated suspended solids discharging from the cells back to the Delaware River (effluent), water samples collected in the Delaware River in the vicinity of the discharge point (representing some initial mixing), and water samples collected in the Delaware River at a location that can provide background water quality data. Effluent samples were collected with an automatic sampler set to collect aliquots of water at six-hour intervals. Composited samples were retrieved from the automatic sampler every three to four days. Water samples representing background and some initial mixing and samples of the dredged material slurry entering the cells were collected as grab samples. Samples were analyzed in the laboratory for metals, pesticides, polychlorinated biphenyls (PCBs) and semi-volatile organics.

Sample results were compared to Delaware River Basin Commission (DRBC) and Delaware DNREC freshwater water quality criteria for protection of aquatic life. Acute criteria were considered to assess short duration, higher concentration exposures in the Delaware River near the discharge points ("near-field" assessment). Chronic criteria were considered to assess longer term, lower concentration exposures after complete mixing over a broader area of the Delaware River ("far-field" assessment).

Total aluminum concentrations exceeded the DRBC and DNREC chronic criterion, and in most samples acute criterion, in all background, weir discharge and Delaware River mix samples. Because aluminum criteria were exceeded in all background samples, results for the weir discharge and mix samples are not attributed to the dredged material disposal operation. Excluding aluminum, only two metals exceeded acute criteria during the monitoring period in isolated incidences. Dissolved zinc exceeded the acute criterion in a cell 2 weir discharge sample collected on March 18, 2010. Dissolved chromium exceeded the acute criterion for chromium VI in a cell 2 mix sample collected on March 22, 2010. The remaining 39 samples

collected at the weirs and at locations representing some initial mixing for cells 2 and 3 were all below acute criteria for zinc and chromium VI. The chromium VI exceedance is a worst case evaluation because the laboratory analyzed for total chromium and it is not known if chromium VI was actually present in the sample. The acute criterion for the less toxic chromium III is much higher than the concentration of chromium detected in the March 22, 2010 sample. No pesticides or PCBs were detected at concentrations above acute criteria. Overall acute water quality criteria were not exceeded and it is concluded that operation of cells 2 and 3 of the Killcohook dredged material containment facility is not impacting water quality in the immediate vicinity of the discharge.

There were infrequent detections of a few metals and pesticides at concentrations slightly above chronic criteria. Mercury did frequently exceed the lowest DRBC chronic criterion of 12 parts per trillion (ppt). However, mercury only exceeded the DNREC chronic criterion of 77 ppt in one sample, and did not exceed the U.S. Environmental Protection Agency recommended chronic criterion of 770 ppt. Mercury also exceeded the lowest chronic criterion in background. Considering that exceedances of chronic criteria were infrequent and at concentrations slightly above criteria along with the amount of mixing that takes place in this portion of the Delaware River, it is concluded that "far-field" water quality objectives established by the lower chronic criteria are being met in the Delaware River during this period of discharge from the Killcohook facility.

A mass balance evaluation of the contaminant load entering and leaving cell 2 of the Killcohook facility indicates that for most contaminants detected in the material entering the site, greater than 99 percent of the contaminant load was retained in cell 2 and not released back to the Delaware River. The lowest retention efficiency was 94.7 percent for the pesticide dieldrin. Previous mass balance analyses for containment facilities in the vicinity of Marcus Hook, PA have demonstrated similar results. This may be perceived by some to be a benefit to the aquatic environment. Delaware River dredged material has been used for a variety of beneficial uses. Past testing of dried dredged material has shown that concentrations of contaminants retained in the sites are not high enough to require any special consideration for how the material is used.

Water quality has also been monitored at the point of active dredging. Sampling occurs at a distance of 200 feet directly down-current of the working cutterhead so as to capture any plume generated by the cutterhead. Monitoring includes the collection of detailed data on total suspended sediments (TSS) and turbidity in the dredge plume. A TSS performance standard of 250 mg/L at a distance of 200 feet down-current of the cutterhead has been established through modeling calculations as a TSS level at which water quality criteria would be met. Water samples have also been collected within the dredge plume and at background locations in the Delaware River for contaminant testing.

Correlation of turbidity data collected with a monitoring probe in the field with water samples collected at the same time in the field and later analyzed for TSS in the laboratory established that a probe reading of 168 NTUs equates to a TSS concentration of 250 mg/L. Over 16,000 turbidity measurements have been collected at 0.5, 6 and 11 meter depth increments during active dredging. The data indicate similar results for background and at the point of

dredging. Eighteen percent of the background turbidity measurements were higher than 168 NTUs (primarily recorded from lower depths), while 12 percent of the 11-m and 4 percent of the 6-m turbidity values were over this benchmark. Essentially no values over 168 NTUs were observed at the surface.

Two sets of water samples have also been collected at 6 meter and 11 meter depths at the point of active dredging and at a Delaware River background location and analyzed in the laboratory for metals, pesticides, PCBs and semi-volatile organics. As was the case with Killcohook samples, all background and point of dredging samples exceeded the DRBC and DNREC acute criterion for total aluminum. No other acute criteria were exceeded. Chronic criteria were slightly exceeded for both 11 meter samples for the pesticide 4,4-DDE and one 11 meter sample for the pesticide 4,4-DDD. No other chronic criteria were exceeded at the 6 and 11 meter depths at the point of dredging. Two 11 meter and one 6 meter background samples slightly exceeded the chronic criterion for 4,4-DDE, at concentrations similar to those detected at the dredge. The lack of exceedances of both acute and chronic water quality criteria at the point of dredging, and data demonstrating that TSS levels down-current of the cutterhead are similar to background indicate that water quality is not being impacted at the dredge.

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1.0 INTRODUCTION

This is an interim report of the on-going environmental monitoring associated with the first construction contract for the Delaware River Main Stem Channel Deepening Project. The project calls for deepening the existing Delaware River Federal Navigation Channel from 40 to 45 feet from Philadelphia Harbor, Pa., and Beckett Street Terminal, Camden, N.J., to the mouth of the Delaware Bay, appropriate bend widening, and partial deepening of the Marcus Hook anchorage and relocation of and addition of aids to navigation. Dredged material is to be placed by hydraulic and hopper dredges in confined upland containment areas in the Delaware River portion of the project and for beneficial uses in Delaware Bay.

On March 1, 2010 the dredge Pullen, which is owned and operated by Norfolk Dredging Company, began dredging for the deepening project in Reach C of the Delaware River Federal navigation channel (Figure 1-1). Dredging for deepening in Reach C extends from channel station 182+000 (vicinity of the Delaware Memorial Bridge) to channel station 242+514.5 (vicinity of Elsinboro Point, NJ). The Pullen is a 24-inch hydraulic cutterhead suction dredge. The Pullen began dredging in the navigation channel at station 231+000 (vicinity of Salem River, NJ). Dredged material is being pumped via pipeline from the Pullen to cell 2 of the Federally owned Killcohook confined upland dredged material containment facility (Figure 1-1).

On April 18, 2010 a second Norfolk Dredging Company dredge, the Charleston, also began dredging in Reach C of the navigation channel for the deepening project. The Charleston is also a 24-inch hydraulic cutterhead suction dredge. The Charleston began dredging in the navigation channel at station 216+000 (vicinity of the Killcohook dredged material containment facility). Dredged material is being pumped via pipeline from the Charleston to cell 3 of the Federally owned Killcohook confined upland dredged material containment facility (Figure 1-1).

Two types of environmental monitoring are being conducted during Reach C construction for the deepening project. Water quality is being monitored at cells 2 and 3 of the Killcohook dredged material confined disposal facility (CDF). Sampling includes material flowing into the containment cells (influent), water and associated suspended solids discharging from the cells back to the Delaware River (effluent), water samples collected in the Delaware River in the vicinity of the discharge point (representing some initial mixing), and water samples collected in the Delaware River at a location that can provide background water quality data.

In addition to monitoring at the Killcohook facility, periodic water quality monitoring is also taking place at the working dredge at a distance of 200 feet directly down-current so as to capture any plume generated by the dredge. Monitoring includes the collection of detailed data on total suspended sediments (TSS) and turbidity in the dredge plume. A TSS performance standard of 250 mg/L at a distance of 200 feet down-current of the cutterhead has been established through modeling calculations as a TSS level at which water quality criteria would be met. Water samples have also been collected within the dredge plume and at background locations in the Delaware River for contaminant testing.

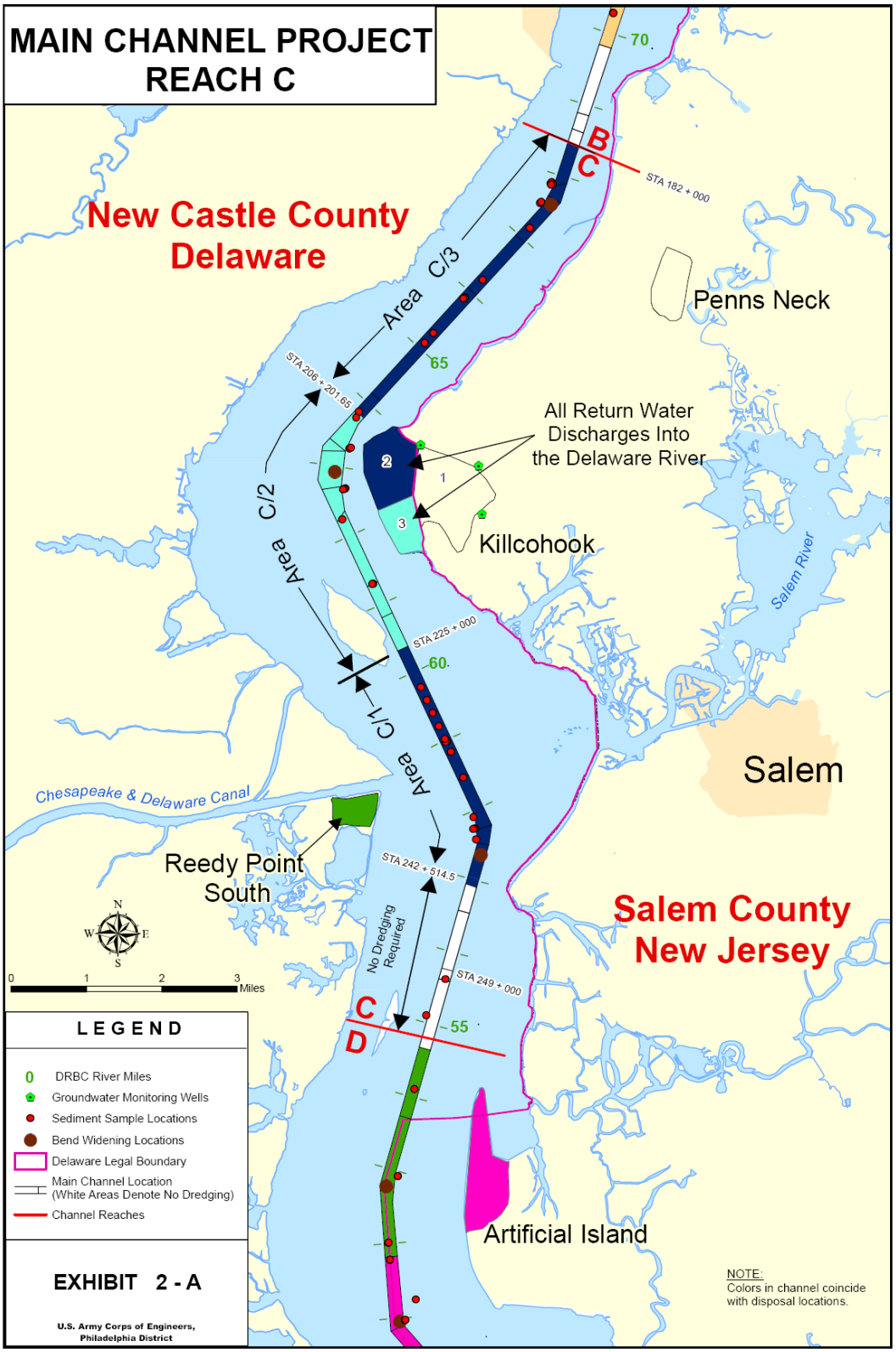

Figure 1-1. Main channel Reach C dredging area and the location of Killcohook Cells 2 and 3

2.0 CONFINED DISPOSAL FACILITY MONITORING

2.1 CDF MONITORING FIELD METHODS

The weir discharges were sampled using ISCO® automatic samplers to obtain composite samples throughout the discharge period as well as daily TSS samples. The sampler consists of a peristaltic pump, controlled by a computer, which allows for collecting fixed amounts of water into sample containers over a period of time. The samples were collected through Teflon tubing that was suspended into the weir at the mouth of the outfall pipe. The sample routine for this project was designed to collect water at 6-hour intervals. Sample jars for inorganics, pesticides, PCBs, and TSS were filled over the course of 3-4 days. Daily samples of TSS were analyzed and the remaining parameters were composited for the 3-4 day time series. Semi-volatile organic samples and low resolution mercury samples at the weir were not collected in this manner, since the samples must be sealed immediately following collection. A grab sample was collected when the field crew arrived at the site, by manually starting the sampler pump.

Mix samples were collected at the point of discharge where the weir water initially mixes with river water. A grab sample was taken using a swing-arm sampler with individual sample containers fixed onto one end.

Background samples were collected following the methods established for collection of the discharge plume area sample. The background sample location, north of Killcohook at Pennsville, New Jersey was determined to be similar to the discharge plume site in physical regime and free from direct chemical influence from any known source of pollutants.

Given the high-pressure flow out of the influent pipe, a grab sample was taken using a swing-arm sampler with individual sample containers fixed onto one end. The sample container was lowered into the influent flow, at the point where the dredged material was falling into the accumulated dredged material in the CDF. This is an area of rapid mixing, which allowed for sampling the influent as close to the hydraulic pipeline discharge point as possible.

2.2 CONTAMINANT RESULTS

Contaminant data have been evaluated from water samples collected at the weirs of cells 2 and 3 (the points where water is discharged from the dredged material containment cells back to the Delaware River), at locations in the Delaware River near the discharge points that represent some initial mixing of the discharge water with Delaware River water, and at a background location in Pennsville, New Jersey outside the influence of the dredging or dredged material disposal operations or other known sources of contamination. These data are presented in Tables 2-1 through 2-21. Where applicable, the data are compared to Delaware River Basin

Commission (DRBC, 2008 section 3.30.2 C.14.b Table 5[1]) and State of Delaware (DNREC, 2004 section 4.6.3.3.1.2 Table 2-1[2]) freshwater acute and chronic criteria for the protection of aquatic life. Freshwater criteria are used because at the time of discharge the salinity of Delaware River water in the vicinity of the Killcohook facility was less than five parts per thousand. If the salinity was greater than five parts per thousand, marine criteria would apply. Salinity measurements collected with a YSI water quality monitoring probe from March 15 through March 17, 2010 showed salinity in the vicinity of Killcohook to be less than 1.5 parts per thousand. Salinity measurements collected on May 20, 2010 showed salinity in the vicinity of Killcohook to be less than 4 parts per thousand, with many readings between 1 and 2 parts per thousand. The tables highlight exceedances of the lower DRBC or DNREC acute criteria in yellow and exceedances of the lower DRBC or DNREC chronic criteria in green. The lowest concentrations used in the comparison are highlighted in the criteria column. According to Greene (2010[3]), acute criteria are used to assess short duration, higher concentration exposures near sources ("near-field" assessment) while chronic criteria are used to assess longer term, lower concentration exposures after complete mixing over broader areas ("far-field" assessment).

2.2.1 Metals

Metals data for Killcohook cells 2 and 3 weir, mix and background samples are presented in Tables 2-1 through 2-10 for both the dissolved and total forms. Delaware River Basin Commission Water Quality Regulations (DRBC, 2008[1]) section 3.10.3 C.2 indicate that stream water quality objectives for cadmium, chromium, copper, lead, nickel, silver and zinc are expressed as the dissolved form of the metal. Stream water quality objectives for aluminum, arsenic, mercury, selenium and cyanide are compared to the total form of the metal. In addition, both DRBC and DNREC criteria for cadmium, chromium III, copper, nickel, silver and zinc are calculated based on water hardness. DNREC also calculates criteria for lead based on water hardness. To calculate these criteria, a conservative water hardness of 75 mg/L was assumed. Weir discharges were consistently measured for low resolution mercury but due to changes in the work scope as the project progressed mix and background collections were not consitently sampled for low level mercury, particularly in earlier sample dates.

Tables 2-1 and 2-2 present background dissolved metal data and background total metal data measured approximately 4.5 miles up-river of Killcohook at Riverview Beach Park in Pennsville, New Jersey. The lowest of the DRBC and DNREC acute and chronic criteria were

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[1] **Delaware River Basin Commission. 2008**. Administrative Manual - Part III Water Quality Regulations with Amendments Through July 16, 2008. 18 CFR Part 410.

[2] **Delaware Department of Natural Resources and Environmental Control. 2004**. State of Delaware Surface Water Quality Standards as Amended, July 11, 2004.

[3] **Greene, R. 2010**. An Evaluation of Toxic Contaminants in the Sediments of the Tidal Delaware River and Potential Impacts Resulting from Deepening the Main Navigation Channel in Reach C. Delaware Department of Natural Resources and Environmental Control, Division of Water Resources Watershed Assessment Branch, Dover, DE. Final of June 7, 2010.

met for all metals except aluminum and mercury (Table 2-2). Total aluminum concentrations exceeded the DRBC and DNREC freshwater chronic criterion of 87 µg/L (parts per billion) in all seven samples. Total aluminum concentrations exceeded the DRBC and DNREC freshwater acute criterion of 750 µg/L in five of the seven samples. One of the seven background water samples collected on May 4, 2010 had a total mercury concentration of 16.8 ng/L (parts per trillion). This exceeded the DRBC chronic criterion of 12 ng/L but not the DNREC chronic criterion of 77 ng/L.

Tables 2-3 through 2-6 present dissolved and total metal data for the weir discharge points of cells 2 and 3. Similar to background, total aluminum concentrations exceeded the DRBC and DNREC freshwater chronic criterion of 87 µg/L in all 15 cell 2 samples (Table 2-4) and all six cell 3 samples (Table 2-6). Also, total aluminum concentrations exceeded the DRBC and DNREC freshwater acute criterion of 750 µg/L in 14 of 15 cell 2 samples (Table 2-4) and five of six cell 3 samples (Table 2-6). Other than aluminum, the only exceedance of an acute criterion in water samples collected at the discharge points of cells 2 and 3 was one sample collected at cell 2 on March 18, 2010. This sample had a zinc concentration of 155 ug/L, which is above both DRBC and DNREC acute criteria for zinc. All other water samples collected at the discharge points of cells 2 and 3 had zinc concentrations well below acute and chronic criteria.

Weir data for cell 3 indicate that there were no exceedances of DRBC or DNREC freshwater chronic criteria for any metal except aluminum (Tables 2-5 and 2-6). For cell 2, there were no exceedances of chronic criteria for arsenic, copper, nickel, selenium, silver and cyanide (Tables 2-3 and 2-4). There were chronic exceedences at cell 2 for mercury, cadmium, chromium and lead. Total mercury concentrations exceeded the DRBC chronic criterion of 12 ng/L in 10 of the 15 samples (Table 2-4). None of the total mercury concentrations exceeded the DNREC chronic criterion of 77 ng/L. Dissolved cadmium concentrations in three samples (1.5, 0.25 and 0.23 µg/L) exceeded the DNREC freshwater chronic criterion of 0.20 µg/L and one sample exceeded the DRBC chronic criterion of 0.90 µg/L (Table 2-3). Two of the 15 samples (14.1 and 13.5 µg/L) exceeded the DRBC and DNREC dissolved chromium chronic criterion of 11 µg/L (Table 2-3). Finally, one of the 15 samples (1.9 µg/L) slightly exceeded the DNREC dissolved lead chronic criterion of 1.84 µg/L but not the DRBC criterion of 16 µg /L (Table 2-3).

Tables 2-7 through 2-10 present dissolved and total metal data for the mix samples collected for cells 2 and 3. The mix samples were collected at locations in the Delaware River near the discharge points that represent some initial mixing of the discharge water with Delaware River water. Again similar to background, total aluminum concentrations exceeded DRBC and DNREC freshwater chronic and acute criteria in all 13 cell 2 samples (Table 2-8) and all six cell 3 samples (Table 2-10). Other than aluminum, the only exceedance of an acute criterion in water samples collected at the mix locations for cells 2 and 3 was one sample collected at cell 2 on March 22, 2010. This sample had a chromium concentration of 21.4 ug/L, which is above both DRBC and DNREC acute criteria for chromium.

Mix data for cell 3 is presented in Tables 2-9 and 2-10. Other than aluminum, there were no exceedances of DRBC or DNREC freshwater chronic criteria for any metal except mercury and cyanide. Total mercury concentrations exceeded the DRBC chronic criterion of 12 ng/L in

three of the four samples (Table 2-10). None of the total mercury concentrations exceeded the DNREC chronic criterion of 77 ng/L. One of seven samples (11.4 µg/L) exceeded the DNREC and DRBC chronic criterion for cyanide, which is 5.2 µg/L (Table 2-10). For cell 2 mix samples, there were no exceedances of chronic criteria for arsenic, cadmium, nickel, selenium, silver, zinc and cyanide (Tables 2-7 and 2-8). Total mercury concentrations exceeded the DRBC chronic criterion of 12 ng/L in five of the 13 samples (Table 2-8). Only one of the total mercury concentrations exceeded the DNREC chronic criterion of 77 ng/L, which was 216 ng/L on May 6, 2010. Four of the 13 samples (21.4, 11.4, 15.2 and 12.8 µg/L) exceeded the DRBC and DNREC dissolved chromium chronic criterion of 11 µg/L (Table 2-7). Two of the 13 samples (2.8 and 4.6 µg/L) exceeded the DNREC dissolved lead chronic criterion of 1.84 µg/L but not the DRBC criterion of 16 µg/L (Table 2-7). One sample (9.9 µg/L) exceeded the DNREC and DRBC chronic criteria for copper, which are 7.0 and 9.25, respectively.

Total aluminum exceeded the DNREC and DRBC chronic criterion of 87 µg/L in all background, weir discharge and Delaware River mix samples. Total aluminum exceeded the DNREC and DRBC acute criterion of 750 µg/L in 44 of the 47 samples. Because aluminum criteria were exceeded in all background samples, aluminum exceedances in weir discharge and Delaware River mix samples are not considered to be the result of the dredged material disposal operation.

With regard to water quality impacts in close proximity to discharges of water from cells 2 and 3 of the Killcohook dredged material containment facility ("near-field" impacts), only one weir discharge sample had a zinc concentration above acute criteria and one mix sample had a chromium concentration above the acute criterion. The lack of exceedances of acute criteria indicate that the dredged material disposal operations are not impacting water quality close to the discharges.

With regard to "far-field" water quality impacts (exceedances of chronic criteria over a broader area after complete mixing), arsenic, nickel, selenium and silver did not exceed DRBC or DNREC freshwater chronic criteria for the protection of aquatic life in any water samples. Zinc, copper and cyanide exceeded criteria in one sample each. Zinc had a concentration of 155 µg/L in the cell 2 weir discharge sample collected on March 18, 2010. This concentration was above both DRBC and DNREC chronic criteria. No other sample has exceeded zinc chronic criteria. One Delaware River mix sample (cell 2 mix collected on March 22, 2010) had a dissolved copper concentration of 9.9 µg/L. That concentration is slightly above DRBC and DNREC chronic criteria, which are 9.25 and 7.00, respectively. No other sample has exceeded copper acute or chronic criteria. The copper criteria were calculated with a conservative hardness value of 75 mg/L but if a hardness of 115 or greater had been used, both criteria would be above 9.9 µg/L. One Delaware River mix sample (cell 3 mix collected on April 27, 2010) had a dissolved cyanide concentration of 11.4 µg/L. That concentration is above the DRBC and DNREC chronic criterion for cyanide, which is 5.2 µg/L. No other sample has exceeded the chronic criterion for cyanide. These one-time sample exceedances of zinc, copper and cyanide are not considered significant relative to these elements impacting Delaware River water quality. Lead exceeded the DNREC chronic criterion of 1.84 µg/L but not the DRBC chronic criterion of 16 µg/L in three samples. The April 2, 2010 cell 2 weir discharge sample had a lead

concentration of 1.9 µg/L. The April 6, 2010 and April 8, 2010 cell 2 Delaware River mix samples had lead concentrations of 2.8 and 4.6 µg/L, respectively. As it is with copper, the DNREC chronic criteria were calculated with a hardness value of 75 mg/L. Back calculating these hardness based criteria indicated that if a hardness of 115 had been used, the lead concentrations of 1.9 and 2.8 µg/L would be below the DNREC chronic criterion. Cell 2 weir discharge samples for March 22 and 24, 2010 had cadmium concentrations above the DNREC chronic criterion of 0.20 µg/L but not above the DRBC chronic criterion of 0.90 µg/L. These water samples had cadmium concentrations of 0.25 and 0.23 µg/L, respectively. The cell 2 weir discharge sample for March 18, 2010 had a cadmium concentration of 1.5 µg/L, which is above both the DNREC and DRBC chronic criterion. Again, the cadmium criteria were calculated with a hardness of 75 mg/L. If a hardness of 115 had been used, the March 22 and 24 concentrations of cadmium would fall below the DNREC chronic criterion. In any event, the copper exceedance, two of the lead exceedances and two of the cadmium exceedances were very close to the chronic criteria assuming a conservative hardness of 75 mg/L. These few and minor exceedances of chronic criteria would not have an impact on Delaware River water quality from a "far-field" perspective considering the amount of mixing that occurs at this location.

Chromium exceeded the chronic criterion of 11 µg/L in the March 22, 2010 and April 19, 2010 cell 2 weir discharge samples. Chromium concentrations were 14.1 and 13.5 µg/L, respectively. Chromium also exceeded the chronic criterion in the March 22, 2010, March 29, 2010, April 18, 2010 and April 19, 2010 cell 2 Delaware River mix samples. Chromium concentrations were 21.4, 11.4, 15.2 and 12.8 µg/L, respectively. Different water quality criteria for the protection of aquatic life have been established for chromium III and the more toxic chromium VI. For this monitoring effort, only total chromium was measured. Therefore it is not possible to tell the percentages of chromium III and chromium VI in the samples. The lowest chronic criterion for chromium III is 58.56 µg/L, which is well above the measured concentrations of total chromium in all samples. The lower chronic criterion for chromium VI (11 µg/L) was used as a worst case analysis assuming that 100 percent of measured chromium was chromium VI. If it was assumed that only 70 percent of the chromium in the samples was chromium VI then five of the six samples above the chronic criterion would fall below the criterion. It is likely that if the percentages of chromium III and chromium VI were known then some of the exceedances noted in the tables would be removed.

A number of weir discharge and Delaware River mix samples did exceed the lower DRBC mercury chronic criterion of 12 parts per trillion, but only one sample exceeded the DNREC chronic criterion of 77 parts per trillion. For protection of aquatic life, the U.S. Environmental Protection Agency recommends 770 ng/L as the mercury freshwater chronic criterion (http://www.epa.gov /waterscience/criteria/wqctable/). The highest concentration of mercury detected was 216 ng/L. This is less than a third of the USEPA chronic criterion. Considering the amount of mixing that occurs between weir discharge water and Delaware River water at this location, even the lower DRBC chronic mercury objective will be achieved.

Overall, the metals data presented in this interim monitoring report suggest that operation of cells 2 and 3 of the Killcohook dredged material containment facility is not impacting Delaware River water quality. Arsenic, copper, nickel, selenium, silver, zinc and cyanide did not

exceed criteria or only exceeded in one sample. Cadmium and lead each had three exceedances of their respective chronic criteria, but some of the exceedances were very close to the chronic criteria and if the criteria had been calculated with a slightly higher hardness value some of the exceedances would not have occurred. The chromium analysis was worst case assuming 100 percent of the chromium in samples was the more toxic chromium VI rather than chromium III. If the percentages of chromium III and chromium VI were known, it is likely that some of the exceedances would not have occurred. While there were a number of exceedances of mercury above the lowest DRBC chronic criterion (12 parts per trillion) there was only one exceedance of mercury above the DNREC chronic criterion (77 parts per trillion). Considering that; 1) acute criteria were only exceeded in two samples (a cell 2 weir discharge sample for zinc and a cell 2 Delaware River mix sample for chromium, which is suspect as discussed above), 2) that infrequent chronic exceedances occurred (except for mercury) at concentrations slightly above the lowest chronic criterion, and 3) the volume of Delaware River water that completely mixes with the weir discharge water at this location, it is concluded that operation of cells 2 and 3 of the Killcohook dredged material containment facility is not impacting Delaware River water quality relative to metals from both “near-field and “far-field” perspectives.

Table 2-1. Killcohook Background Dissolved Metal Data.

Sample ID Lab Report ID		BG03188 C0C190563002	BG0324 C0C250605001	BG0402 C0D060501002	BG0406 C0D070526002	BG0504 C0E060542002	BG0511 C0E120504002	BG0517 C0E180492002	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		3/18/2010	3/24/2010	4/2/2010	4/6/2010	5/4/2010	5/11/2010	5/17/2010				
Analyte	**Unit**											
Aluminum-Diss	µg/L	10.3	29	7.2	158	4.4	5.2	9.8				
Antimony-Diss	µg/L	0.76	0.14	0.32	0.46	0.31	0.46	0.47				
Arsenic-Diss	µg/L	4.7	0.9	0.6	0.33	2.4	1.7	3.8				
Barium-Diss	µg/L	20.8	12.8	18	21.3	13.4	17.5	22.8				
Beryllium-Diss	µg/L	ND	ND	ND	ND	ND	ND	ND				
Cadmium-Diss	µg/L	ND	ND	ND	ND	ND	ND	ND	1.52	0.20	2.84	0.90
Calcium-Diss	µg/L	15500	12500	12200	13600	20900	20100	26600				
Chromium-Diss	µg/L	3.4	4.3	5.7	6.2	4.1	3.5	4.9	16	11	16	11
Cobalt-Diss	µg/L	0.033	0.081	0.05	0.15	0.081	0.085	0.081				
Copper-Diss	µg/L	2	2.4	1.3	2	1.1	1.3	1.5	10.25	7.00	13.52	9.25
Iron-Diss	µg/L	16.5	108	30.5	237	7.8	10.3	34.6				
Lead-Diss	µg/L	0.23	0.23	0.59	0.58	ND	ND	0.035	47.15	1.84	48	16
Magnesium-Diss	µg/L	5900	4070	3540	4350	10900	8370	33400				
Manganese-Diss	µg/L	11.1	7.8	13.7	14	0.41	0.6	3.1				
Nickel-Diss	µg/L	0.58	1.1	2.6	1.2	0.76	0.91	0.86	367.08	40.77	1111.87	123.61
Potassium-Diss	µg/L	2020	1800	1600	1940	3380	2700	10400				
Selenium-Diss	µg/L	0.7	0.43	1.5	ND	0.57	ND	1.1				
Silver-Diss	µg/L	ND	ND	ND	ND	ND	ND	ND	1.96	none	2.47	none
Sodium-Diss	µg/L	25800	18500	14200	16900	56800	35400	255000				
Thallium-Diss	µg/L	0.036	0.091	0.023	0.059	0.021	0.22	0.28				
Vanadium-Diss	µg/L	4.5	ND	0.88	ND	0.15	0.98	2.5				
Zinc-Diss	µg/L	7.2	7.6	9.7	14.6	5.2	4.3	8.6	91.83	92.58	91.71	83.06

Table 2-2. Killcohook Background Total Metal Data.

Sample ID **Lab Report ID**		**BG0318** **C0C190563002**	**BG0324** **C0C250605001**	**BG0402** **C0D060501002**	**BG0406** **C0D070526002**	**BG0504** **C0E060542002**	**BG0511** **C0E120504002**	**BG0517** **C0E180492002**	**DNREC Acute**	**DNREC Chronic**	**DRBC Acute**	**DRBC Chronic**
Sample Date		3/18/2010	3/24/2010	4/2/2010	4/6/2010	5/4/2010	5/11/2010	5/17/2010				
Analyte:	**Unit**											
Aluminum	µg/L	**967**	**7610**	**520**	**921**	**2780**	**1140**	**672**	750	87	750	87
Antimony	µg/L	0.28	0.36	0.39	0.27	0.54	0.6	0.51				
Arsenic	µg/L	8.9	4.6	1.1	ND	2.7	3.3	2.3	340	150	360	190
Barium	µg/L	26.7	70	21.5	27	32	29	26				
Beryllium	µg/L	0.096	0.36	0.071	0.064	0.17	0.06	0.037				
Cadmium	µg/L	ND	0.15	ND	ND	ND	ND	ND				
Calcium	µg/L	15100	14000	12000	13600	19700	21000	25400				
Chromium	µg/L	9.4	23.5	6.1	8.6	9.8	7.4	5.3				
Cobalt	µg/L	0.45	4.8	0.37	0.54	1.8	0.96	0.43				
Copper	µg/L	3	13.7	2.7	3.2	5.2	4	2.2				
Iron	µg/L	1240	11900	919	1330	4160	1760	903				
Lead	µg/L	2.2	19.9	1.6	2.3	6.2	3	1.4				
Magnesium	µg/L	5840	6040	3580	4480	10800	8780	31500				
Manganese	µg/L	60.5	509	47.1	50.5	183	123	39.2				
Mercury	**ng/L**	Not sampled	Not sampled	2.7	5.2	**16.8**	5.7	1.8	1400	77	2400	12
Nickel	µg/L	1.3	10.9	1.1	2.1	4.1	2.8	1.6				
Potassium	µg/L	2140	3480	1930	1970	4010	3360	9970				
Selenium	µg/L	0.71	ND	0.86	ND	ND	0.66	1.1	20	5.0	20	5.0
Silver	µg/L	ND	0.1	ND	ND	0.04	ND	ND				
Sodium	µg/L	24700	18800	13900	16200	52500	35300	241000				
Thallium	µg/L	0.29	0.21	ND	0.14	0.069	0.22	0.16				
Vanadium	µg/L	14.8	17.6	1.8	2.2	7.1	4	3.8				
Zinc	µg/L	12.1	84.4	18.1	15.8	34.3	46.4	20.3				
Cyanide	µg/L	ND	ND	ND	ND	ND	ND	ND	22	5.2	22	5.2

Table 2-3. Killcohook Cell 2 Weir Dissolved Metal Data.

Sample ID **Lab Report ID**		**WIER0318** **C0C190563007**	**WIER0322** **C0C230507002**	**WIER0324** **C0C250605003**	**WIER0329** **C0C300513003**	**WIER0402** **C0D060501004**	**DNREC** **Acute**	**DNREC** **Chronic**	**DRBC** **Acute**	**DRBC** **Chronic**
Sample Date		3/18/2010	3/22/2010	3/24/2010	3/29/2010	4/2/2010				
Analyte	**Unit**									
Aluminum-Diss	µg/L	3.3	52	1240	7	1360				
Antimony-Diss	µg/L	0.54	0.79	0.58	0.84	0.83				
Arsenic-Diss	µg/L	7.4	5.5	4.2	4	3.6				
Barium-Diss	µg/L	80.2	68.5	54.1	28.5	24.7				
Beryllium-Diss	µg/L	ND	ND	0.048	ND	0.076				
Cadmium-Diss	µg/L	**1.5**	**0.25**	**0.23**	ND	ND	1.52	0.20	2.84	0.90
Calcium-Diss	µg/L	78100	50800	39400	25000	18600				
Chromium-Diss	µg/L	6.2	**14.1**	7.7	9.6	8.7	16	11	16	11
Cobalt-Diss	µg/L	2.1	1.3	2	0.91	1.1				
Copper-Diss	µg/L	3.5	4.9	4.8	2.3	3.9	10.25	7.00	13.52	9.25
Iron-Diss	µg/L	63.9	97.8	1060	69.2	1330				
Lead-Diss	µg/L	0.14	0.11	1.4	0.076	**1.9**	47.15	1.84	48	16
Magnesium-Diss	µg/L	162000	101000	68400	41300	31600				
Manganese-Diss	µg/L	3030	1600	2110	1320	797				
Nickel-Diss	µg/L	11.4	5.3	6.6	4.1	3.9	367.08	40.77	1111.87	123.61
Potassium-Diss	µg/L	37600	28200	20800	15300	12800				
Selenium-Diss	µg/L	2.7	1.6	2.9	2.1	2.3				
Silver-Diss	µg/L	ND	ND	ND	ND	ND	1.96	none	2.47	none
Sodium-Diss	µg/L	1060000	693000	457000	258000	220000				
Thallium-Diss	µg/L	0.054	0.11	0.069	0.034	ND				
Vanadium-Diss	µg/L	3.8	<5.0	1.6	5.1	1.7				
Zinc-Diss	µg/L	**155**	23.7	42.7	7.6	15.7	91.83	92.58	91.71	83.06

Table 2-3. (Continued).

Sample ID Lab Report ID		WIER0406 C0D070526004	WIER0408 C0D090487003	WIER0414 C0D150544003	WIER0419 C0D200485002	WIER0422 C0D230554002	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		4/6/2010	4/8/2010	4/14/2010	4/19/2010	4/22/2010				
Analyte	**Unit**									
Aluminum-Diss	µg/L	129	1900	36.2	766	1640				
Antimony-Diss	µg/L	0.87	0.77	1.3	0.66	1.2				
Arsenic-Diss	µg/L	2.3	2.9	2.7	3.3	2.8				
Barium-Diss	µg/L	15.8	22.5	12.6	23.9	63.3				
Beryllium-Diss	µg/L	ND	0.12	ND	0.057	0.067				
Cadmium-Diss	µg/L	ND	ND	ND	ND	ND	1.52	0.20	2.84	0.90
Calcium-Diss	µg/L	17900	16600	16200	20200	36300				
Chromium-Diss	µg/L	8.8	10	3.2	**13.5**	5.8	16	11	16	11
Cobalt-Diss	µg/L	0.63	1.1	0.52	1.1	2				
Copper-Diss	µg/L	3.7	4.8	5	4	3.2	10.25	7.00	13.52	9.25
Iron-Diss	µg/L	132	1640	36.4	816	1530				
Lead-Diss	µg/L	0.26	1.8	0.14	1	1.7	47.15	1.84	48	16
Magnesium-Diss	µg/L	31700	28600	24300	39100	72200				
Manganese-Diss	µg/L	711	599	578	1290	2340				
Nickel-Diss	µg/L	2.7	4	2.6	3.3	3.7	367.08	40.77	1111.87	123.61
Potassium-Diss	µg/L	14100	13100	11000	12700	22000				
Selenium-Diss	µg/L	1.2	0.93	0.86	3.1	2.5				
Silver-Diss	µg/L	ND	ND	ND	ND	ND	1.96	none	2.47	none
Sodium-Diss	µg/L	227000	201000	162000	211000	463000				
Thallium-Diss	µg/L	0.017	0.036	0.07	0.085	0.048				
Vanadium-Diss	µg/L	ND	2.4	2.7	2.5	2.4				
Zinc-Diss	µg/L	12.5	19.1	12.4	8.9	18.8	91.83	92.58	91.71	83.06

Table 2-3. (Continued).

Sample ID Lab Report ID		WIER0427 C0D280512003	WIER0504 C0E060542004	WEIR0506 C0E070494003	WIER0511 C0E120504003	WIER0517 C0E180492004	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		4/27/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**									
Aluminum-Diss	µg/L	9.5	74.2	58	5.4	ND				
Antimony-Diss	µg/L	0.76	1.7	0.77	0.93	1.1				
Arsenic-Diss	µg/L	3.1	4	5.3	5.1	4.4				
Barium-Diss	µg/L	60.6	45.6	54.2	62	113				
Beryllium-Diss	µg/L	ND	ND	ND	ND	ND				
Cadmium-Diss	µg/L	ND	ND	ND	ND	ND	1.52	0.20	2.84	0.90
Calcium-Diss	µg/L	36000	33800	33000	35000	54500				
Chromium-Diss	µg/L	4.4	2.9	3.9	4	4.2	16	11	16	11
Cobalt-Diss	µg/L	1.5	1.2	1.3	1.4	5.3				
Copper-Diss	µg/L	2.8	2.4	2	2.1	1.6	10.25	7.00	13.52	9.25
Iron-Diss	µg/L	22.5	140	99.8	14.2	33.6				
Lead-Diss	µg/L	0.046	0.14	0.14	ND	ND	47.15	1.84	48	16
Magnesium-Diss	µg/L	71600	59700	55800	54200	109000				
Manganese-Diss	µg/L	2030	2210	2180	2340	6510				
Nickel-Diss	µg/L	2.9	2.7	2.6	2.8	3.8	367.08	40.77	1111.87	123.61
Potassium-Diss	µg/L	20500	18700	18400	19400	31900				
Selenium-Diss	µg/L	3.1	2.7	2.9	2.3	3.8				
Silver-Diss	µg/L	ND	0.059	ND	ND	ND	1.96	none	2.47	none
Sodium-Diss	µg/L	471000	414000	388000	388000	918000				
Thallium-Diss	µg/L	0.11	ND	0.099	0.13	0.16				
Vanadium-Diss	µg/L	ND	0.33	0.41	1.1	1.5				
Zinc-Diss	µg/L	8.1	4.2	5	4	11.4	91.83	92.58	91.71	83.06

Table 2-4. Killcohook Cell 2 Weir Total Metal Data.

Sample ID **Lab Report ID**		**WIER0318** **C0C190563007**	**WIER0322** **C0C230507002**	**WIER0324** **C0C250605003**	**WIER0329** **C0C300513003**	**WIER0402** **C0D060501004**	**DNREC** **Acute**	**DNREC** **Chronic**	**DRBC** **Acute**	**DRBC** **Chronic**
Sample Date		3/18/2010	3/22/2010	3/24/2010	3/29/2010	4/2/2010				
Analyte	**Unit**									
Aluminum	µg/L	**1440**	**6120**	**6490**	**13000**	**15800**	750	87	750	87
Antimony	µg/L	0.3	0.71	0.43	1.1	0.93				
Arsenic	µg/L	12.8	7	7.9	10.2	7.9	340	150	360	190
Barium	µg/L	87.4	94.5	83.3	88.8	87.8				
Beryllium	µg/L	0.09	0.3	0.28	0.59	0.72				
Cadmium	µg/L	1.8	0.54	0.46	0.24	0.15				
Calcium	µg/L	77600	50000	40200	25900	20000				
Chromium	µg/L	11.4	22.5	16.1	36.5	38.9				
Cobalt	µg/L	2.7	3.4	3.9	6.4	7				
Copper	µg/L	5.5	8.9	8.1	15.2	15.2				
Iron	µg/L	2520	5110	6560	14100	16400				
Lead	µg/L	2.3	5.8	7.6	19.2	17.6				
Magnesium	µg/L	160000	97600	70100	46300	34800				
Manganese	µg/L	3070	1770	2200	1650	1390				
Mercury	**ng/L**	**12.1**	**13.9**	**17.8**	**48.1**	**39.7**	1400	77	2400	12
Nickel	µg/L	13	10	10.9	15.8	15.3				
Potassium	µg/L	37400	28300	22300	17900	15200				
Selenium	µg/L	1.8	1.5	3.2	2.4	1.9	20	5.0	20	5.0
Silver	µg/L	0.062	0.092	0.075	0.12	0.11				
Sodium	µg/L	1040000	654000	456000	276000	222000				
Thallium	µg/L	0.13	0.14	0.14	0.34	0.064				
Vanadium	µg/L	13.1	ND	10.6	34.1	28.9				
Zinc	µg/L	196	87.3	88.9	99.8	108				
Cyanide	µg/L	ND	ND	ND	ND	ND	22	5.2	22	5.2

Table 2-4. (Continued).

Sample ID Lab Report ID		WIER0406 C0D070526004	WIER0408 C0D090487003	WIER0414 C0D150544003	WIER0419 C0D200485002	WIER0422 C0D230554002	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		4/6/2010	4/8/2010	4/14/2010	4/19/2010	4/22/2010				
Analyte	**Unit**									
Aluminum	µg/L	**17400**	**15100**	**9590**	**6450**	**7190**	750	87	750	87
Antimony	µg/L	0.93	0.84	0.85	0.68	0.79				
Arsenic	µg/L	7.1	7.3	6	5.7	8.4	340	150	360	190
Barium	µg/L	91.7	78.4	57.5	53.5	95.4				
Beryllium	µg/L	0.76	0.74	0.45	0.26	0.29				
Cadmium	µg/L	0.2	<1.0	0.18	<1.0	<1.0				
Calcium	µg/L	18600	17600	17200	25200	37700				
Chromium	µg/L	42.2	39	24	14.9	15.7				
Cobalt	µg/L	7.3	5.6	3.6	2.7	4.1				
Copper	µg/L	16.2	15.5	12.2	9	7.1				
Iron	µg/L	16800	14300	8940	5570	7630				
Lead	µg/L	18.5	15.4	9.9	5.8	8.5				
Magnesium	µg/L	33400	31300	25900	44500	74700				
Manganese	µg/L	1260	960	879	1570	2590				
Mercury	**ng/L**	**33.4**	**27.3**	**19.3**	7.6	**24.9**	1400	77	2400	12
Nickel	µg/L	16.9	14.5	9.7	6.9	7.8				
Potassium	µg/L	16800	15700	13200	15900	23400				
Selenium	µg/L	1.2	<5.0	1	1.9	3	20	5.0	20	5.0
Silver	µg/L	0.1	0.07	0.04	0.099	<1.0				
Sodium	µg/L	213000	201000	163000	263000	471000				
Thallium	µg/L	0.21	0.15	0.25	0.077	0.22				
Vanadium	µg/L	28.5	24.9	19.7	13.4	12				
Zinc	µg/L	115	89.5	51.6	34.6	45				
Cyanide	µg/L	<10.0	<10.0	<10.0	<10.0	<10.0	22	5.2	22	5.2

Table 2-4. (Continued).

Sample ID **Lab Report ID**		**WIER0427** **C0D280512003**	**WIER0504** **C0E060542004**	**WEIR0506** **C0E070494003**	**WIER0511** **C0E120504003**	**WIER0517** **C0E180492004**	**DNREC** **Acute**	**DNREC** **Chronic**	**DRBC** **Acute**	**DRBC** **Chronic**
Sample Date		4/27/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**									
Aluminum	µg/L	**2930**	**1770**	**2020**	**2480**	**376**	750	87	750	87
Antimony	µg/L	0.68	1.6	0.72	1	1				
Arsenic	µg/L	6.3	5.1	6.9	7.7	5.6	340	150	360	190
Barium	µg/L	79.5	56.8	68.8	83.5	121				
Beryllium	µg/L	0.085	0.082	0.12	0.095	ND				
Cadmium	µg/L	ND	ND	ND	ND	ND				
Calcium	µg/L	37000	33900	34000	34800	54200				
Chromium	µg/L	8.3	6.7	7.4	10.2	5				
Cobalt	µg/L	2.4	2	2.2	2.6	6.1				
Copper	µg/L	4.6	4.2	3.8	4.6	2.5				
Iron	µg/L	3140	2430	2570	3060	1870				
Lead	µg/L	3.1	2.3	2.9	4	1.3				
Magnesium	µg/L	72900	58300	57300	54300	106000				
Manganese	µg/L	2280	2290	2320	2300	6850				
Mercury	**ng/L**	3	4.9	**23.6**	2.6	5.8	1400	77	2400	12
Nickel	µg/L	4.7	4.5	4.4	5.2	4.2				
Potassium	µg/L	21400	19200	18900	20200	31600				
Selenium	µg/L	3	2.6	2.8	2.8	3.8	20	5.0	20	5.0
Silver	µg/L	0.046	ND	ND	ND	ND				
Sodium	µg/L	475000	401000	392000	389000	908000				
Thallium	µg/L	0.035	0.025	0.097	0.13	0.096				
Vanadium	µg/L	3.5	3.5	3.7	5	ND				
Zinc	µg/L	23	23.8	15.7	48.2	34.2				
Cyanide	µg/L	ND	ND	ND	2.9	3.4	22	5.2	22	5.2

Table 2-5. Killcohook Cell 3 Weir Dissolved Metal Data.

Sample ID Lab Report ID		WIER0427 C0D280518003	WIER0429 C0D300570003	WIER0504 C0E060543003	WIER0506 C0E070562003	WIER0511 C0E120515002	WIER0517 C0E180515003	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		4/27/2010	4/29/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**										
Aluminum-Diss	µg/L	3.2	ND	3.4	3	3.4	ND				
Antimony-Diss	µg/L	0.54	0.47	0.64	0.61	0.85	0.55				
Arsenic-Diss	µg/L	1.7	2	4.9	3.1	1.9	3.2				
Barium-Diss	µg/L	75.2	39.6	29.8	18.6	20.9	74.3				
Beryllium-Diss	µg/L	ND	ND	ND	ND	ND	ND				
Cadmium-Diss	µg/L	ND	ND	ND	ND	ND	ND	1.52	0.20	2.84	0.90
Calcium-Diss	µg/L	23400	30000	28200	22200	25200	43800				
Chromium-Diss	µg/L	4.1	4.2	5.4	4.2	5	4.9	16	11	16	11
Cobalt-Diss	µg/L	0.8	1.1	0.7	0.78	0.36	0.88				
Copper-Diss	µg/L	1.2	1.3	1.6	1.2	1.7	1.3	10.25	7.00	13.52	9.25
Iron-Diss	µg/L	13.1	10.7	11	8.5	19.4	25.2				
Lead-Diss	µg/L	0.02	ND	ND	ND	0.044	ND	47.15	1.84	48	16
Magnesium-Diss	µg/L	41100	52800	38500	24400	27100	84300				
Manganese-Diss	µg/L	653	717	597	574	265	690				
Nickel-Diss	µg/L	2.8	5.4	3	2.7	2.7	2.9	367.08	40.77	1111.87	123.61
Potassium-Diss	µg/L	13400	16400	12400	8540	9590	26000				
Selenium-Diss	µg/L	1.6	1.8	1.4	1.1	1.6	3				
Silver-Diss	µg/L	ND	0.085	ND	ND	ND	ND	1.96	none	2.47	none
Sodium-Diss	µg/L	305000	411000	291000	178000	191000	716000				
Thallium-Diss	µg/L	0.031	0.15	ND	0.038	0.026	0.063				
Vanadium-Diss	µg/L	2.8	0.95	2.6	ND	0.5	1.8				
Zinc-Diss	µg/L	16.9	18.9	7.5	5.1	5.8	12.5	91.83	92.58	91.71	83.06

Table 2-6. Killcohook Cell 3 Weir Total Metal Data.

Sample ID Lab Report ID		WIER0427 C0D280518003	WIER0429 C0D300570003	WIER0504 C0E060543003	WIER0506 C0E070562003	WIER0511 C0E120515002	WIER0517 C0E180515003	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		4/27/2010	4/29/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**										
Aluminum	µg/L	**2600**	**1210**	**927**	**1280**	**1100**	**546**	750	87	750	87
Antimony	µg/L	0.79	0.91	0.65	0.71	0.97	0.49				
Arsenic	µg/L	2	3.1	3.2	3	3	4.5	340	150	360	190
Barium	µg/L	83.3	47.2	32.8	25	25.7	76.6				
Beryllium	µg/L	0.099	0.091	0.049	0.078	0.064	ND				
Cadmium	µg/L	ND	0.14	ND	ND	ND	ND				
Calcium	µg/L	23700	31800	26200	22700	22900	43400				
Chromium	µg/L	7.6	6.7	6	7	7	5.7				
Cobalt	µg/L	1.8	1.8	1.4	1.7	1.3	1.4				
Copper	µg/L	3.6	3.4	3.3	4	3.7	1.6				
Iron	µg/L	1850	1540	1280	1810	1440	1290				
Lead	µg/L	1.8	2	1.4	1.8	2.3	0.88				
Magnesium	µg/L	41700	55700	36100	25000	25500	82200				
Manganese	µg/L	712	781	604	656	502	823				
Mercury	**ng/L**	2.5	3.3	2.6	2.4	1.7	0.52	1400	77	2400	12
Nickel	µg/L	5	7.1	4	4.8	4	3.8				
Potassium	µg/L	14000	17400	11900	9010	9700	26000				
Selenium	µg/L	1.7	1.8	1.5	0.9	1.4	2.3	20	5.0	20	5.0
Silver	µg/L	ND	0.042	ND	ND	ND	ND				
Sodium	µg/L	307000	424000	272000	179000	184000	706000				
Thallium	µg/L	0.03	0.17	0.025	0.045	0.044	0.036				
Vanadium	µg/L	8.2	5.4	2.4	3.2	4.2	5.3				
Zinc	µg/L	33.9	46.8	20.2	20.1	40.5	23.5				
Cyanide	µg/L	ND	N	ND	ND	ND	ND	22	5.2	22	5.2

Table 2-7. Killcohook Cell 2 Mix Dissolved Metal Data.

Sample ID Lab Report ID		MIX0318 C0C190563001	MIX0322 C0C230507001	MIX0324 C0C250605002	MIX0329 C0C300513001	MIX0402 C0D060501001	MIX0406 C0D070526001	MIX0408 C0D090487001	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		3/18/2010	3/22/2010	3/24/2010	3/29/2010	4/2/2010	4/6/2010	4/8/2010				
Analyte	**Unit**											
Aluminum-Diss	µg/L	30.4	7.6	175	248	8.2	2020	3680				
Antimony-Diss	µg/L	0.25	0.98	1.2	0.29	0.32	0.96	0.72				
Arsenic-Diss	µg/L	5	7.5	2.5	2.4	0.86	0.94	2.6				
Barium-Diss	µg/L	32	47.9	51.1	19.4	16	30.4	38.6				
Beryllium-Diss	µg/L	ND	ND	ND	ND	ND	0.12	0.2				
Cadmium-Diss	µg/L	ND	ND	0.27	ND	ND	ND	ND	1.52	0.20	2.84	0.90
Calcium-Diss	µg/L	23100	33200	41400	15200	12400	14400	13600				
Chromium-Diss	µg/L	4.9	**21.4**	5.3	**11.4**	4.1	9.6	**15.2**	16	11	16	11
Cobalt-Diss	µg/L	0.3	1.2	1.7	0.28	0.073	0.95	1.7				
Copper-Diss	µg/L	2.2	**9.9**	3.8	2	1.4	4	5.4	10.25	7.00	13.52	9.25
Iron-Diss	µg/L	71.4	50.8	199	408	29.8	2040	3940				
Lead-Diss	µg/L	0.25	0.097	0.35	0.8	0.79	**2.8**	**4.6**	47.15	1.84	48	16
Magnesium-Diss	µg/L	26300	75400	70900	8090	5020	14200	9210				
Manganese-Diss	µg/L	322	1460	2040	114	32.3	241	224				
Nickel-Diss	µg/L	1.3	5.4	6.1	1.6	2.8	3.3	8.2	367.08	40.77	1111.87	123.61
Potassium-Diss	µg/L	6910	23500	21200	2920	2110	6910	4750				
Selenium-Diss	µg/L	0.85	1.1	3.1	ND	1.4	0.47	ND				
Silver-Diss	µg/L	ND	ND	ND	ND	ND	ND	ND	1.96	none	2.47	none
Sodium-Diss	µg/L	158000	518000	470000	40000	24400	89500	41200				
Thallium-Diss	µg/L	0.3	0.25	0.099	0.27	ND	0.17	0.071				
Vanadium-Diss	µg/L	6.9	ND	ND	8.1	ND	1.6	5.9				
Zinc-Diss	µg/L	11.5	18.2	35.3	14.2	9.8	31.1	49.4	91.83	92.58	91.71	83.06

Table 2-7. (Continued).

Sample ID Lab Report ID		MIX0419 C0D200485001	MIX0427 C0D280512001	MIX0504 C0E060542001	MIX0506 C0E070494001	MIX0511 C0E120504001	MIX0517 C0E180492001	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		4/19/2010	4/27/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**										
Aluminum-Diss	µg/L	24.6	21	3.4	280	4.2	221				
Antimony-Diss	µg/L	0.51	0.44	0.61	0.96	0.54	0.76				
Arsenic-Diss	µg/L	ND	1.1	2.9	2.2	1.6	2.6				
Barium-Diss	µg/L	19.2	22.6	20.6	19.8	17.3	31				
Beryllium-Diss	µg/L	ND	ND	ND	ND	ND	ND				
Cadmium-Diss	µg/L	ND	ND	ND	ND	ND	ND	1.52	0.20	2.84	0.90
Calcium-Diss	µg/L	16700	23200	24800	22300	22500	30200				
Chromium-Diss	µg/L	**12.8**	3.3	3.8	3.7	3.3	4.2	16	11	16	11
Cobalt-Diss	µg/L	0.29	0.33	0.21	0.3	0.22	0.34				
Copper-Diss	µg/L	1.8	1.7	2	1.9	1.4	1.8	10.25	7.00	13.52	9.25
Iron-Diss	µg/L	33	37.4	11.6	502	16.9	323				
Lead-Diss	µg/L	0.09	0.083	ND	0.77	ND	0.55	47.15	1.84	48	16
Magnesium-Diss	µg/L	16400	32500	26800	20000	13000	47400				
Manganese-Diss	µg/L	233	111	143	22.4	151	265				
Nickel-Diss	µg/L	1.7	1.3	1.5	1.6	1.2	1.4	367.08	40.77	1111.87	123.61
Potassium-Diss	µg/L	5030	9230	8530	6370	4230	14600				
Selenium-Diss	µg/L	1.3	1.4	0.96	0.76	0.76	1.4				
Silver-Diss	µg/L	ND	ND	ND	ND	ND	ND	1.96	none	2.47	none
Sodium-Diss	µg/L	84500	224000	177000	129000	71100	368000				
Thallium-Diss	µg/L	0.11	0.13	0.059	0.018	0.16	0.18				
Vanadium-Diss	µg/L	2.7	1.6	ND	0.38	ND	0.95				
Zinc-Diss	µg/L	6.9	7	4.6	6.7	4.7	8.5	91.83	92.58	91.71	83.06

Table 2-8. Killcohook Cell 2 Mix Total Metal Data.

Sample ID **Lab Report ID**		**MIX0318** **C0C190563001**	**MIX0322** **C0C230507001**	**MIX0324** **C0C250605002**	**MIX0329** **C0C300513001**	**MIX0402** **C0D060501001**	**MIX0406** **C0D070526001**	**MIX0408** **C0D090487001**	**DNREC Acute**	**DNREC Chronic**	**DRBC Acute**	**DRBC Chronic**
Sample Date		3/18/2010	3/22/2010	3/24/2010	3/29/2010	4/2/2010	4/6/2010	4/8/2010				
Analyte	**Unit**											
Aluminum	µg/L	**3590**	**12700**	**6760**	**3010**	**3380**	**14000**	**17800**	750	87	750	87
Antimony	µg/L	0.38	1.4	0.54	0.52	0.5	1.1	0.66				
Arsenic	µg/L	11.3	10.2	8.4	2.9	1.9	6.6	7	340	150	360	190
Barium	µg/L	53.1	108	87.6	40.7	41.5	100	120				
Beryllium	µg/L	0.2	0.6	0.35	0.12	0.19	0.66	0.84				
Cadmium	µg/L	0.24	0.46	0.66	ND	ND	0.31	0.2				
Calcium	µg/L	23600	39500	42400	15400	13200	16300	15400				
Chromium	µg/L	14.3	31.9	19.2	12.8	13.2	37.3	44.3				
Cobalt	µg/L	2	6.5	5.2	1.7	2.1	7.3	8.5				
Copper	µg/L	6.2	16	11	6.2	6.6	19.2	19.4				
Iron	µg/L	4410	12800	9240	4410	5000	17000	20800				
Lead	µg/L	7.8	16.3	12.8	7	7.4	24.9	27.3				
Magnesium	µg/L	27800	76800	73300	8360	5590	18600	12900				
Manganese	µg/L	522	2060	2360	237	238	1000	696				
Mercury	**ng/L**	Not sampled	Not sampled	Not sampled	Not sampled	**20.1**	**68.9**	Not sampled	1400	77	2400	12
Nickel	µg/L	4.8	14.3	13.4	4.8	4.6	15.9	19				
Potassium	µg/L	7730	25000	22900	3650	2880	9660	7400				
Selenium	µg/L	0.7	1.5	3.4	ND	0.6	ND	ND	20	5.0	20	5.0
Silver	µg/L	0.039	0.16	0.11	ND	0.051	0.14	0.14				
Sodium	µg/L	162000	498000	471000	37200	22800	102000	41300				
Thallium	µg/L	0.26	0.11	0.22	0.24	ND	0.23	0.22				
Vanadium	µg/L	20	ND	10.3	ND	7.3	25.8	28.8				
Zinc	µg/L	54.9	110	122	45.1	45	124	160				
Cyanide	µg/L	ND	ND	ND	ND	ND	ND	ND	22	5.2	22	5.2

Table 2-8. (Continued).

Sample ID Lab Report ID		MIX0419 C0D200485001	MIX0427 C0D280512001	MIX0504 C0E060542001	MIX0506 C0E070494001	MIX0511 C0E120504001	MIX0517 C0E180492001	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		4/19/2010	4/27/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**										
Aluminum	µg/L	**15100**	**10500**	**23800**	**22200**	**2160**	**7780**	750	87	750	87
Antimony	µg/L	0.86	0.7	1.1	1.9	0.64	0.65				
Arsenic	µg/L	8	3.5	16.4	16.6	3.3	6.9	340	150	360	190
Barium	µg/L	113	73	154	158	34.2	72.5				
Beryllium	µg/L	0.8	0.42	1.2	1.2	0.098	0.39				
Cadmium	µg/L	0.32	0.14	0.72	0.65	ND	ND				
Calcium	µg/L	23900	25100	25400	27400	22400	30400				
Chromium	µg/L	33.3	24	68.9	67.8	9.6	22.4				
Cobalt	µg/L	8.3	5	17.3	17.3	1.6	5.2				
Copper	µg/L	19.1	11.5	37	37.6	4.9	11				
Iron	µg/L	18000	12100	40500	39800	3170	11500				
Lead	µg/L	28	16.8	59.9	61.2	5.3	19.5				
Magnesium	µg/L	26700	36400	24500	29300	14300	48100				
Manganese	µg/L	1300	566	2300	2470	310	1070				
Mercury	**ng/L**	Not sampled	Not sampled	**58.4**	**216**	9.4	**32.1**	1400	77	2400	12
Nickel	µg/L	16.4	10.9	33.8	33.1	3.9	10.4				
Potassium	µg/L	9790	11500	9780	11000	5180	15800				
Selenium	µg/L	1.3	1.4	2.1	2.2	1.4	1.6	20	5.0	20	5.0
Silver	µg/L	0.23	0.13	0.38	0.41	ND	0.096				
Sodium	µg/L	132000	230000	106000	144000	75800	359000				
Thallium	µg/L	0.21	0.12	0.34	0.27	0.16	0.23				
Vanadium	µg/L	30.1	21.3	60.9	60.3	6.7	20.1				
Zinc	µg/L	124	78.1	251	240	51.9	84.1				
Cyanide	µg/L	ND	ND	ND	ND	ND	1.8	22	5.2	22	5.2

Table 2-9. Killcohook Cell 3 Mix Dissolved Metal Data.

Sample ID **Lab Report ID**		**MIX0427** **C0D280518001**	**MIX0429** **C0D300570001**	**MIX0504** **C0E060543001**	**MIX0506** **C0E070562001**	**MIX0511** **C0E120515001**	**MIX0517** **C0E180515001**	**DNREC** **Acute**	**DNREC** **Chronic**	**DRBC** **Acute**	**DRBC** **Chronic**
Sample Date		4/27/2010	4/29/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**										
Aluminum-Diss	µg/L	206	161	132	4.5	ND	ND				
Antimony-Diss	µg/L	0.16	0.46	0.45	0.4	1.2	0.39				
Arsenic-Diss	µg/L	0.65	1.7	2.5	2.5	2.3	2.6				
Barium-Diss	µg/L	25.6	16.2	17.1	16.1	23.5	26.5				
Beryllium-Diss	µg/L	ND	ND	ND	ND	ND	ND				
Cadmium-Diss	µg/L	ND	ND	ND	ND	ND	ND	1.52	0.20	2.84	0.90
Calcium-Diss	µg/L	26600	19900	23700	21900	36700	28700				
Chromium-Diss	µg/L	4.6	3.3	5	3.5	4.2	4.7	16	11	16	11
Cobalt-Diss	µg/L	0.27	0.17	0.19	0.12	0.15	0.1				
Copper-Diss	µg/L	1.9	1.5	1.7	1.3	1.2	1.5	10.25	7.00	13.52	9.25
Iron-Diss	µg/L	245	217	208	10.1	22.9	23.5				
Lead-Diss	µg/L	0.38	0.35	0.3	ND	ND	ND	47.15	1.84	48	16
Magnesium-Diss	µg/L	47600	18700	21600	19400	59200	42900				
Manganese-Diss	µg/L	35.5	14.4	13.6	24.6	2	11.7				
Nickel-Diss	µg/L	1.2	1.2	1.2	0.87	0.99	1	367.08	40.77	1111.87	123.61
Potassium-Diss	µg/L	13400	6000	6750	6200	19100	13400				
Selenium-Diss	µg/L	1.9	0.72	0.8	0.87	2.1	1.8				
Silver-Diss	µg/L	ND	0.53	ND	ND	ND	ND	1.96	none	2.47	none
Sodium-Diss	µg/L	350000	128000	146000	131000	475000	338000				
Thallium-Diss	µg/L	0.048	0.12	0.017	0.057	0.04	0.091				
Vanadium-Diss	µg/L	3.3	0.11	0.65	0.36	0.47	2.6				
Zinc-Diss	µg/L	9.4	4.8	6.5	4.1	4.3	6.6	91.83	92.58	91.71	83.06

Table 2-10. Killcohook Cell 3 Mix Total Metal Data.

Sample ID **Lab Report ID**		**MIX0427** **C0D280518001**	**MIX0429** **C0D300570001**	**MIX0504** **C0E060543001**	**MIX0506** **C0E070562001**	**MIX0511** **C0E120515001**	**MIX0517** **C0E180515001**	**DNREC** **Acute**	**DNREC** **Chronic**	**DRBC** **Acute**	**DRBC** **Chronic**
Sample Date		4/27/2010	4/29/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**										
Aluminum	µg/L	**3120**	**7460**	**5980**	**5530**	**10700**	**1710**	750	87	750	87
Antimony	µg/L	0.2	0.36	0.59	0.64	1.7	0.32				
Arsenic	µg/L	1	5.1	4.7	4.9	8.7	3.5	340	150	360	190
Barium	µg/L	38.4	56.7	51.3	53.5	84.7	34.8				
Beryllium	µg/L	0.13	0.44	0.32	0.29	0.51	0.058				
Cadmium	µg/L	ND	ND	ND	ND	0.18	ND				
Calcium	µg/L	26700	20800	22900	24500	37100	28500				
Chromium	µg/L	10.3	19.7	18.8	18.2	33.5	8.1				
Cobalt	µg/L	1.5	4.2	3.9	4	7.7	1				
Copper	µg/L	4.7	10.3	9.1	9.6	17.2	2.9				
Iron	µg/L	3580	10000	9380	9240	17300	2520				
Lead	µg/L	5.1	15.9	13.7	14.2	27.2	3.5				
Magnesium	µg/L	47900	20600	22000	22200	61200	42400				
Manganese	µg/L	164	494	473	528	855	107				
Mercury	**ng/L**	Not sampled	Not sampled	**42.6**	**28.8**	**59.8**	10	1400	77	2400	12
Nickel	µg/L	3.9	8.8	8.3	8.3	15.5	2.7				
Potassium	µg/L	13800	7440	7670	7860	20600	13600				
Selenium	µg/L	1.4	0.67	0.74	0.98	3	1.2	20	5.0	20	5.0
Silver	µg/L	0.037	0.11	0.079	0.077	0.14	ND				
Sodium	µg/L	343000	126000	137000	137000	460000	336000				
Thallium	µg/L	0.04	0.15	0.091	0.12	0.16	0.068				
Vanadium	µg/L	10.1	17	15.8	15	29.4	7				
Zinc	µg/L	29.2	67.1	57.9	59.8	132	34.4				
Cyanide	µg/L	**11.4**	ND	ND	ND	1.9	ND	22	5.2	22	5.2

2.2.2 Pesticides and PCB Aroclors

Table 2-11 presents background pesticide and PCB Aroclor data. Two of the five background samples had chronic exceedances of pesticides. A background sample collected on April 6, 2010 had a dieldrin concentration of 0.0035 µg/L, which is 3.5 parts per trillion. That concentration is above the DRBC freshwater chronic criterion of 0.0019 µg/L but below the DNREC chronic criterion of 0.056 µg/L. That same background water sample had a heptachlor concentration of 0.0085 µg/L. That concentration is above the DRBC and DNREC freshwater chronic criterion of 0.0038 µg/L. A background water sample collected on May 11, 2010 had a 4,4-DDD concentration of 0.0012 µg/L. That concentration is above the DRBC and DNREC freshwater chronic criterion of 0.001 µg/L. PCB Aroclors were not detected in any of the five samples.

Tables 2-12 and 2-13 present pesticide and PCB Aroclor data for the weir discharge points of cells 2 and 3. There were no detections of pesticides or PCB Aroclors above the lowest of the DNREC or DRBC acute criteria. The pesticides 4,4-DDD, 4,4-DDE, 4,4-DDT, dieldrin and endrin were detected above the lowest of the DNREC or DRBC chronic criteria at the weir discharge point of cell 2 (Table 2-12). The pesticide 4,4-DDD was detected in one of 15 samples at a concentration of 0.0053 µg/L, which is above the DNREC and DRBC chronic criterion of 0.001 µg/L. The pesticide 4,4-DDE was detected in three of 15 samples at concentrations of 0.0012, 0.0018 and 0.0059 µg/L, which are above the DNREC and DRBC chronic criterion of 0.001 µg/L. The pesticide 4,4-DDT was detected in three of 15 samples at a concentration of 0.0018, 0.018 and 0.0019 µg/L, which are above the DNREC and DRBC chronic criterion of 0.001 µg/L. The pesticide dieldrin was detected in one of 15 samples at a concentration of 0.013 µg/L, which is above the DRBC chronic criterion of 0.0019 µg/L but below the DNREC chronic criterion of 0.056 µg/L. The pesticide endrin was detected in one of 15 samples at a concentration of 0.013 µg/L, which is above the DRBC chronic criterion of 0.0023 µg/L but below the DNREC chronic criterion of 0.036 µg/L. For cell 3, only the pesticide heptachlor was detected above the DNREC and DRBC chronic criterion (Table 2-13). Heptachlor was detected in two of six samples at concentrations of 0.0044 and 0.0068 µg/L, which are above the DNREC and DRBC chronic criterion of 0.0038 µg/L. PCB Aroclor 1242 was detected in one of 15 samples for cell 2 at a concentration of 0.044 µg/L (Table 2-12). This concentration is above the DNREC and DRBC chronic criterion for total PCBs, which is 0.014 µg/L. No other PCB Aroclors were detected in Cells 2 and 3.

Tables 2-14 and 2-15 present pesticide and PCB Aroclor data for the mix samples collected for cells 2 and 3. No pesticides were detected above acute criteria. The pesticides 4,4-DDE and 4,4-DDT were detected above the DNREC and DRBC chronic criteria at the mix sample location for cell 2 (Table 2-14). The pesticide 4,4-DDE was detected in one of six samples at a concentration of 0.0024 µg/L, which is above the DNREC and DRBC chronic criterion of 0.001 µg/L. The pesticide 4,4-DDT was detected in two of six samples at concentrations of 0.0028 and 0.0027 µg/L, which are above the DNREC and DRBC chronic criterion of 0.001 µg/L. For cell 3, only the pesticide 4,4-DDT was detected above the DNREC and DRBC chronic criterion (Table 2-15). The pesticide 4,4-DDT was detected in one of four samples at a concentration of

Table 2-11. Killcohook Background Pesticide and PCB Aroclor Data

Sample ID Lab Report ID		BG0402 C0D060501002	BG0406 C0D070526002	BG0504 C0E060542002	BG0511 C0E120504002	BG0517 C0E180492002	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		4/2/2010	4/6/2010	5/4/2010	5/11/2010	5/17/2010				
Analyte	**Unit**									
4,4-DDD	µg/L	ND	ND	ND	**0.0012**	ND	1.1	0.001	0.55	0.001
4,4-DDE	µg/L	ND	ND	ND	ND	ND	1.1	0.001	0.55	0.001
4,4-DDT	µg/L	ND	ND	ND	ND	ND	1.1	0.001	0.55	0.001
Aldrin	µg/L	ND	ND	ND	ND	ND	3.0	none	1.5	none
alpha-BHC	µg/L	ND	0.0016	ND	ND	ND				
alpha-Chlordane	µg/L	ND	ND	ND	ND	ND				
Aroclor 1016	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1221	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1232	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1242	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1248	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1254	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1260	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
beta-BHC	µg/L	ND	0.007	ND	0.003	0.0015				
Chlordane (technical)	µg/L	ND	ND	ND	ND	ND	2.4	0.0043	1.2	0.0043
Chlorpyrifos	µg/L	ND	ND	ND	ND	ND	0.083	0.041	0.083	0.041
delta-BHC	µg/L	ND	0.0039	ND	ND	0.00058				
Dieldrin	µg/L	0.0011	**0.0035**	ND	0.00085	ND	0.24	0.056	1.25	0.0019
Endosulfan I	µg/L	ND	ND	ND	ND	ND	0.22	0.056	0.11	0.056
Endosulfan II	µg/L	0.0013	0.0026	ND	0.0019	0.0015	0.22	0.056	0.11	0.056
Endosulfan sulfate	µg/L	ND	0.0026	ND	ND	ND				
Endrin	µg/L	ND	ND	ND	ND	ND	0.086	0.036	0.09	0.0023
Endrin aldehyde	µg/L	ND	0.0018	ND	ND	ND				
Endrin ketone	µg/L	ND	0.0021	ND	ND	ND				
gamma-BHC (Lindane)	µg/L	0.00077	0.0047	ND	0.0013	0.002	none	none	1.0	0.08
gamma-Chlordane	µg/L	ND	0.0019	ND	ND	ND				
Heptachlor	µg/L	0.0013	**0.0085**	ND	ND	0.0014	0.52	0.0038	0.26	0.0038
Heptachlor epoxide	µg/L	ND	ND	ND	ND	ND				
Methoxychlor	µg/L	ND	ND	ND	ND	ND	none	0.03	none	none
Parathion	µg/L	ND	ND	ND	ND	ND	0.065	0.013	0.065	0.013
Toxaphene	µg/L	ND	ND	ND	ND	ND	0.73	0.0002	0.73	0.0002

Table 2-12. Killcohook Cell 2 Weir Pesticide and PCB Aroclor Data

Sample ID **Lab Report ID**		**WIER0318** **C0C190563007**	**WIER0322** **C0C230507002**	**WIER0324** **C0C250605003**	**WIER0329** **C0C300513003**	**WIER0402** **C0D060501004**	**DNREC Acute**	**DNREC Chronic**	**DRBC Acute**	**DRBC Chronic**
Sample Date		3/18/2010	3/22/2010	3/24/2010	3/29/2010	4/2/2010				
Analyte	**Unit**									
4,4-DDD	µg/L	0.00073	ND	ND	ND	0.00087	1.1	0.001	0.55	0.001
4,4-DDE	µg/L	**0.0012**	ND	ND	ND	**0.0018**	1.1	0.001	0.55	0.001
4,4-DDT	µg/L	**0.0018**	ND	ND	ND	ND	1.1	0.001	0.55	0.001
Aldrin	µg/L	ND	ND	ND	ND	ND	3.0	none	1.5	none
alpha-BHC	µg/L	0.0027	ND	ND	0.001	ND				
alpha-Chlordane	µg/L	ND	ND	ND	ND	ND				
Aroclor 1016	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1221	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1232	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1242	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1248	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1254	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1260	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
beta-BHC	µg/L	0.0068	0.0097	ND	0.0031	ND				
Chlordane (technical)	µg/L	ND	ND	ND	ND	ND	2.4	0.0043	1.2	0.0043
Chlorpyrifos	µg/L	ND	ND	ND	ND	ND	0.083	0.041	0.083	0.041
delta-BHC	µg/L	0.00097	ND	ND	0.0014	0.00073				
Dieldrin	µg/L	0.0012	ND	ND	ND	ND	0.24	0.056	1.25	0.0019
Endosulfan I	µg/L	0.0012	ND	ND	ND	ND	0.22	0.056	0.11	0.056
Endosulfan II	µg/L	ND	ND	ND	ND	0.0011	0.22	0.056	0.11	0.056
Endosulfan sulfate	µg/L	ND	ND	ND	ND	ND				
Endrin	µg/L	ND	ND	ND	ND	ND	0.086	0.036	0.09	0.0023
Endrin aldehyde	µg/L	ND	ND	ND	ND	ND				
Endrin ketone	µg/L	ND	ND	ND	ND	ND				
gamma-BHC (Lindane)	µg/L	ND	ND	ND	ND	ND	none	none	1.0	0.08
gamma-Chlordane	µg/L	0.0015	ND	ND	0.0047	ND				
Heptachlor	µg/L	ND	ND	ND	ND	ND	0.52	0.0038	0.26	0.0038
Heptachlor epoxide	µg/L	ND	ND	ND	ND	ND				
Methoxychlor	µg/L	0.00093	ND	ND	ND	ND	none	0.03	none	none
Parathion	µg/L	ND	ND	ND	ND	ND	0.065	0.013	0.065	0.013
Toxaphene	µg/L	ND	ND	ND	ND	ND	0.73	0.0002	0.73	0.0002

Table 2-12. (Continued)

Sample ID Lab Report ID		WIER0406 C0D070526004	WIER0408 C0D090487003	WIER0414 C0D150544003	WIER0419 C0D200485002	WIER0422 C0D230554002	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		4/6/2010	4/8/2010	4/14/2010	4/19/2010	4/22/2010				
Analyte	**Unit**									
4,4-DDD	µg/L	ND	ND	ND	ND	**0.0053**	1.1	0.001	0.55	0.001
4,4-DDE	µg/L	ND	ND	ND	ND	**0.0059**	1.1	0.001	0.55	0.001
4,4-DDT	µg/L	ND	ND	ND	ND	**0.018**	1.1	0.001	0.55	0.001
Aldrin	µg/L	ND	ND	0.0014	ND	ND	3.0	none	1.5	none
alpha-BHC	µg/L	0.0013	0.001	0.00081	ND	0.0048				
alpha-Chlordane	µg/L	ND	ND	ND	ND	ND				
Aroclor 1016	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1221	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1232	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1242	µg/L	ND	ND	ND	ND	**0.044**	none	0.014	1.0	0.014
Aroclor 1248	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1254	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1260	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
beta-BHC	µg/L	0.0031	ND	ND	ND	ND				
Chlordane (technical)	µg/L	ND	ND	ND	ND	ND	2.4	0.0043	1.2	0.0043
Chlorpyrifos	µg/L	ND	ND	ND	ND	ND	0.083	0.041	0.083	0.041
delta-BHC	µg/L	ND	0.00057	0.00053	ND	0.0074				
Dieldrin	µg/L	ND	ND	ND	ND	**0.013**	0.24	0.056	1.25	0.0019
Endosulfan I	µg/L	ND	ND	ND	ND	ND	0.22	0.056	0.11	0.056
Endosulfan II	µg/L	ND	ND	ND	ND	ND	0.22	0.056	0.11	0.056
Endosulfan sulfate	µg/L	0.0027	ND	ND	ND	ND				
Endrin	µg/L	ND	ND	ND	ND	**0.013**	0.086	0.036	0.09	0.0023
Endrin aldehyde	µg/L	ND	ND	ND	ND	ND				
Endrin ketone	µg/L	ND	ND	ND	ND	ND				
gamma-BHC (Lindane)	µg/L	0.0023	ND	ND	ND	ND	none	none	1.0	0.08
gamma-Chlordane	µg/L	ND	ND	ND	ND	ND				
Heptachlor	µg/L	0.0031	0.0023	ND	ND	0.0082	0.52	0.0038	0.26	0.0038
Heptachlor epoxide	µg/L	0.0065	ND	ND	ND	ND				
Methoxychlor	µg/L	ND	ND	ND	ND	0.012	none	0.03	none	none
Parathion	µg/L	ND	ND	ND	ND	ND	0.065	0.013	0.065	0.013
Toxaphene	µg/L	ND	ND	ND	ND	ND	0.73	0.0002	0.73	0.0002

Table 2-12. (Contiinued)

Sample ID Lab Report ID		WIER0427 C0D280512003	WIER0504 C0E060542004	WEIR0506 C0E070494003	WIER0511 C0E120504003	WIER0517 C0E180492004	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		4/27/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**									
4,4-DDD	µg/L	ND	ND	ND	ND	ND	1.1	0.001	0.55	0.001
4,4-DDE	µg/L	0.00087	ND	0.00081	ND	ND	1.1	0.001	0.55	0.001
4,4-DDT	µg/L	ND	ND	**0.0019**	ND	ND	1.1	0.001	0.55	0.001
Aldrin	µg/L	ND	ND	ND	ND	ND	3.0	none	1.5	none
alpha-BHC	µg/L	ND	ND	ND	ND	0.00088				
alpha-Chlordane	µg/L	ND	ND	ND	ND	ND				
Aroclor 1016	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1221	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1232	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1242	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1248	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1254	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1260	µg/L	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
beta-BHC	µg/L	ND	ND	0.0025	0.0021	ND				
Chlordane (technical)	µg/L	ND	ND	ND	ND	ND	2.4	0.0043	1.2	0.0043
Chlorpyrifos	µg/L	ND	ND	ND	ND	ND	0.083	0.041	0.083	0.041
delta-BHC	µg/L	0.0018	ND	0.0024	0.0011	0.00063				
Dieldrin	µg/L	ND	ND	ND	ND	ND	0.24	0.056	1.25	0.0019
Endosulfan I	µg/L	ND	ND	ND	ND	ND	0.22	0.056	0.11	0.056
Endosulfan II	µg/L	ND	ND	ND	0.0014	ND	0.22	0.056	0.11	0.056
Endosulfan sulfate	µg/L	ND	ND	ND	ND	ND				
Endrin	µg/L	ND	ND	ND	ND	ND	0.086	0.036	0.09	0.0023
Endrin aldehyde	µg/L	ND	ND	ND	ND	ND				
Endrin ketone	µg/L	ND	ND	ND	ND	ND				
gamma-BHC (Lindane)	µg/L	0.0013	ND	0.0025	0.0034	0.0047	none	none	1.0	0.08
gamma-Chlordane	µg/L	ND	ND	0.0011	0.0012	ND				
Heptachlor	µg/L	0.0033	ND	0.0081	0.0083	0.0033	0.52	0.0038	0.26	0.0038
Heptachlor epoxide	µg/L	ND	ND	0.001	ND	ND				
Methoxychlor	µg/L	ND	ND	ND	ND	ND	none	0.03	none	none
Parathion	µg/L	ND	ND	ND	ND	ND	0.065	0.013	0.065	0.013
Toxaphene	µg/L	ND	ND	ND	ND	ND	0.73	0.0002	0.73	0.0002

Table 2-13. Killcohook Cell 3 Weir Pesticide and PCB Aroclor Data

Sample ID Lab Report ID		WIER0427 C0D280518003	WIER0429 C0D300570003	WIER0504 C0E060543003	WIER0506 C0E070562003	WIER0511 C0E120515002	WIER0517 C0E180515003	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Sample Date		4/27/2010	4/29/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**										
GCSEMI											
4,4-DDD	µg/L	ND	ND	ND	ND	ND	ND	1.1	0.001	0.55	0.001
4,4-DDE	µg/L	ND	ND	ND	ND	ND	ND	1.1	0.001	0.55	0.001
4,4-DDT	µg/L	ND	ND	ND	ND	ND	ND	1.1	0.001	0.55	0.001
Aldrin	µg/L	ND	ND	ND	ND	ND	ND	3.0	none	1.5	none
alpha-BHC	µg/L	0.00083	ND	ND	ND	ND	ND				
alpha-Chlordane	µg/L	ND	ND	ND	ND	ND	ND				
Aroclor 1016	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1221	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1232	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1242	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1248	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1254	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1260	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
beta-BHC	µg/L	ND	ND	ND	ND	ND	ND				
Chlordane (technical)	µg/L	ND	ND	ND	ND	ND	ND	2.4	0.0043	1.2	0.0043
Chlorpyrifos	µg/L	ND	ND	ND	ND	ND	ND	0.083	0.041	0.083	0.041
delta-BHC	µg/L	ND	0.00053	ND	ND	ND	0.00062				
Dieldrin	µg/L	ND	0.0011	ND	ND	ND	ND	0.24	0.056	1.25	0.0019
Endosulfan I	µg/L	ND	ND	ND	ND	ND	ND	0.22	0.056	0.11	0.056
Endosulfan II	µg/L	ND	0.0014	ND	ND	0.0016	ND	0.22	0.056	0.11	0.056
Endosulfan sulfate	µg/L	ND	ND	ND	ND	ND	ND				
Endrin	µg/L	ND	ND	ND	ND	ND	ND	0.086	0.036	0.09	0.0023
Endrin aldehyde	µg/L	ND	ND	ND	ND	ND	ND				
Endrin ketone	µg/L	ND	ND	ND	ND	ND	ND				
gamma-BHC (Lindane)	µg/L	0.0016	ND	ND	ND	ND	0.0038	none	none	1.0	0.08
gamma-Chlordane	µg/L	ND	ND	ND	0.018	ND	ND				
Heptachlor	µg/L	0.0014	**0.0044**	0.0019	**0.0068**	0.0024	0.0037	0.52	0.0038	0.26	0.0038
Heptachlor epoxide	µg/L	ND	ND	ND	ND	ND	ND				
Methoxychlor	µg/L	ND	ND	ND	0.0048	ND	ND	none	0.03	none	none
Parathion	µg/L	ND	ND	ND	ND	ND	ND	0.065	0.013	0.065	0.013
Toxaphene	µg/L	ND	ND	ND	ND	ND	ND	0.73	0.0002	0.73	0.0002

Table 2-14. Killcohook Cell 2 Mix Pesticide and PCB Aroclor Data

Sample ID **Lab Report ID**		**MIX0402** **C0D060501001**	**MIX0406** **C0D070526001**	**MIX0504** **C0E060542001**	**MIX0506** **C0E070494001**	**MIX0511** **C0E120504001**	**MIX0517** **C0E180492001**	**DNREC** **Acute**	**DNREC** **Chronic**	**DRBC** **Acute**	**DRBC** **Chronic**
Sample Date		4/2/2010	4/6/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**										
4,4-DDD	µg/L	ND	ND	ND	ND	ND	ND	1.1	0.001	0.55	0.001
4,4-DDE	µg/L	0.00078	**0.0024**	0.00089	0.00087	0.00078	ND	1.1	0.001	0.55	0.001
4,4-DDT	µg/L	ND	**0.0028**	ND	**0.0027**	ND	ND	1.1	0.001	0.55	0.001
Aldrin	µg/L	ND	ND	ND	ND	ND	ND	3.0	none	1.5	none
alpha-BHC	µg/L	ND	0.0014	ND	ND	ND	ND				
alpha-Chlordane	µg/L	ND	ND	ND	ND	ND	ND				
Aroclor 1016	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1221	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1232	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1242	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1248	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1254	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1260	µg/L	ND	ND	ND	ND	ND	ND	none	0.014	1.0	0.014
beta-BHC	µg/L	ND	0.0042	0.001	0.0018	0.003	0.0017				
Chlordane (technical)	µg/L	ND	ND	ND	ND	ND	ND	2.4	0.0043	1.2	0.0043
Chlorpyrifos	µg/L	ND	ND	ND	ND	ND	ND	0.083	0.041	0.083	0.041
delta-BHC	µg/L	ND	0.0012	0.00059	ND	0.0011	0.0013				
Dieldrin	µg/L	0.0013	ND	ND	0.001	0.001	ND	0.24	0.056	1.25	0.0019
Endosulfan I	µg/L	ND	ND	ND	ND	ND	ND	0.22	0.056	0.11	0.056
Endosulfan II	µg/L	0.00095	ND	ND	0.0013	0.0022	ND	0.22	0.056	0.11	0.056
Endosulfan sulfate	µg/L	ND	0.0015	ND	ND	ND	ND				
Endrin	µg/L	ND	0.0019	ND	ND	ND	ND	0.086	0.036	0.09	0.0023
Endrin aldehyde	µg/L	ND	0.002	ND	ND	ND	ND				
Endrin ketone	µg/L	ND	ND	ND	ND	ND	ND				
gamma-BHC (Lindane)	µg/L	0.001	0.0021	0.00094	ND	0.0017	0.0023	none	none	1.0	0.08
gamma-Chlordane	µg/L	ND	0.0048	ND	0.0063	ND	ND				
Heptachlor	µg/L	0.0017	0.0036	ND	ND	0.0018	ND	0.52	0.0038	0.26	0.0038
Heptachlor epoxide	µg/L	ND	ND	ND	ND	ND	ND				
Methoxychlor	µg/L	ND	0.014	ND	0.0055	ND	ND	none	0.03	none	none
Parathion	µg/L	ND	ND	ND	ND	ND	ND	0.065	0.013	0.065	0.013
Toxaphene	µg/L	ND	ND	ND	ND	ND	ND	0.73	0.0002	0.73	0.0002

Table 2-15. Killcohook Cell 3 Mix Pesticide and PCB Aroclor Data

Sample ID **Lab Report ID**		**MIX0504** **C0E060543001**	**MIX0506** **C0E070562001**	**MIX0511** **C0E120515001**	**MIX0517** **C0E180515001**	**DNREC** **Acute**	**DNREC** **Chronic**	**DRBC** **Acute**	**DRBC** **Chronic**
Sample Date		5/4/2010	5/6/2010	5/11/2010	5/17/2010				
Analyte	**Unit**								
4,4-DDD	µg/L	ND	ND	0.00086	ND	1.1	0.001	0.55	0.001
4,4-DDE	µg/L	ND	ND	0.001	ND	1.1	0.001	0.55	0.001
4,4-DDT	µg/L	ND	**0.0023**	ND	ND	1.1	0.001	0.55	0.001
Aldrin	µg/L	ND	ND	ND	ND	3.0	none	1.5	none
alpha-BHC	µg/L	ND	ND	ND	ND				
alpha-Chlordane	µg/L	ND	ND	ND	ND				
Aroclor 1016	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1221	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1232	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1242	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1248	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1254	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1260	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
beta-BHC	µg/L	ND	0.0021	0.0031	0.0016				
Chlordane (technical)	µg/L	ND	ND	ND	ND	2.4	0.0043	1.2	0.0043
Chlorpyrifos	µg/L	ND	ND	ND	ND	0.083	0.041	0.083	0.041
delta-BHC	µg/L	ND	ND	ND	0.0005				
Dieldrin	µg/L	ND	ND	ND	ND	0.24	0.056	1.25	0.0019
Endosulfan I	µg/L	ND	ND	ND	ND	0.22	0.056	0.11	0.056
Endosulfan II	µg/L	ND	0.0014	0.0014	0.0012	0.22	0.056	0.11	0.056
Endosulfan sulfate	µg/L	ND	ND	ND	ND				
Endrin	µg/L	ND	ND	ND	ND	0.086	0.036	0.09	0.0023
Endrin aldehyde	µg/L	ND	ND	ND	ND				
Endrin ketone	µg/L	ND	ND	ND	ND				
gamma-BHC (Lindane)	µg/L	ND	0.00094	0.0012	0.0019	none	none	1.0	0.08
gamma-Chlordane	µg/L	ND	0.00096	ND	ND				
Heptachlor	µg/L	ND	ND	ND	0.0025	0.52	0.0038	0.26	0.0038
Heptachlor epoxide	µg/L	ND	ND	ND	ND				
Methoxychlor	µg/L	ND	0.0042	ND	ND	none	0.03	none	none
Parathion	µg/L	ND	ND	ND	ND	0.065	0.013	0.065	0.013
Toxaphene	µg/L	ND	ND	ND	ND	0.73	0.0002	0.73	0.0002

0.0023 µg/L, which is above the DNREC and DRBC chronic criterion of 0.001 µg/L. PCB Aroclors were not detected in any of the mix samples.

There were no pesticide detections above DRBC or DNREC freshwater acute criteria for the protection of aquatic life. This indicates that the dredged material disposal operations are not impacting water quality close to the discharges relative to pesticides and PCBs. There were infrequent detections of six pesticides above DRBC chronic criteria. Dieldrin, endrin and DDD were each detected once and heptachlor was detected twice. Heptachlor was detected twice in cell 3 weir discharge samples at concentrations above the DNREC and DRBC chronic criterion of 0.0038 µg/L. The cell 3 weir concentrations were 0.0044 and 0.0068 µg/L. A background water sample collected on April 6, 2010 had a higher heptachlor concentration (0.0085 µg/L). Dieldrin and endrin were each detected in one sample collected at the cell 2 weir discharge on April 22, 2010. Dieldrin was detected at a concentration of 0.013 µg/L, which is above the DRBC chronic criterion of 0.0019 µg/L but below the DNREC and USEPA chronic criterion of 0.056 µg/L. Endrin was also detected at a concentration of 0.013 µg/L, which is above the DRBC chronic criterion of 0.0023 µg/L but below the DNREC and USEPA chronic criterion of 0.036 µg/L. 4,4-DDD was only detected once at a concentration above the DRBC and DNREC chronic criteria of 0.001 µg/L. 4,4-DDD was detected at a concentration of 0.0053 µg/L in the April 22, 2010 cell 2 weir discharge sample. 4,4-DDD was also detected above the chronic criterion in a May 11, 2010 background water sample (0.0012 µg/L). 4,4-DDE and 4,4-DDT were the most frequently detected pesticides above the DRBC and DNREC chronic criterion of 0.001 µg/L. 4,4-DDE and 4,4-DDT were detected four and six times, respectively. 4,4-DDE was detected three times above the chronic criterion at the cell 2 weir discharge at concentrations of 0.0012, 0.0018 and 0.0059 µg/L. 4,4-DDE was only detected once above the chronic criterion in Delaware River mix samples at a concentration of 0.0024 µg/L. 4,4-DDT was also detected three times above the chronic criterion at the cell 2 weir discharge at concentrations of 0.0018, 0.0019 and 0.018 µg/L. 4,4-DDT was detected above the chronic criterion three times in Delaware River mix samples at concentrations of 0.0028, 0.0027 and 0.0023 µg/L. Concentrations of 4,4-DDE and 4,4-DDT in Delaware River mix samples were less than three times the chronic criterion. Considering that 1) no pesticide acute criteria were exceeded and that infrequent chronic exceedances occurred at the weir discharges (one to three depending on the pesticide), that 2) only 4,4-DDE and 4,4-DDT were detected above the chronic criteria in Delaware River mix samples at concentrations less than three times the chronic criterion, and 3) the volume of Delaware River water that completely mixes with the weir discharge water at this location, it is concluded that operation of cells 2 and 3 of the Killcohook dredged material containment facility is not impacting Delaware River water quality relative to pesticides from both “near-field” and “far-field” perspectives.

Only one sample had a PCB Aroclor detection. The April 22, 2010 cell 2 weir discharge sample had a detection of PCB Aroclor 1242 at a concentration of 0.044 µg/L. This concentration was above the DRBC and DNREC chronic criterion of 0.014 µg/L for total PCBs. High resolution PCB and Dioxin analyses were conducted on the March 29 and April 14 cell 2 weir discharge samples. While there are no water quality criteria for Dioxins, the sum of PCB

congeners were orders of magnitude below DNREC and DRBC acute and chronic criterion (Table 2-16).

Table 2-16. Killcohook Cell 2 Weir PCB Congener and Dioxin Data

Sample ID:		**WIER0329**	**WIER0414**				
Laboratory ID:		**C0C300513003**	**C0D150544003**				
Sample Date:		3/29/2010	4/14/2010				
				DNREC	**DNREC**	**DRBC**	**DRBC**
				Acute	**Chronic**	**Acute**	**Chronic**
Monochlorobiphenyl (total)	ng/L	0.05	0.019				
Dichlorobiphenyl (total)	ng/L	0.51	0.19				
Trichlorobiphenyl (total)	ng/L	1.4	0.32				
Tetrachlorobiphenyl (total)	ng/L	3.8	0.85				
Pentachlorobiphenyl (total)	ng/L	5.2	1.3				
Hexachlorobiphenyl (total)	ng/L	3.5	1.1				
Heptachlorobiphenyl (total)	ng/L	1.7	0.57				
Octachlorobiphenyl (total)	ng/L	0.97	0.37				
Nonachlorobiphenyl (total)	ng/L	2.2	0.91				
Decachlorobiphenyl (total)	ng/L	3.1	1.1				
Sum of PCB Congeners	ng/L	22.43	6.729	none	14,000	1,000,000	14,000
Total HpCDD	ng/L	0.4	0.24				
Total HpCDF	ng/L	0.042	0.024				
Total HxCDD	ng/L	0.067	0.062				
Total HxCDF	ng/L	0.018	0.012				
Total PeCDD	ng/L	<0.048	<0.048				
Total PeCDF	ng/L	0.0067	0.0081				
Total TCDD	ng/L	0.0044	<0.0095				
Total TCDF	ng/L	0.01	0.0074				
OCDD	ng/L	2.8	1.8				
OCDF	ng/L	0.051	0.031				
Sum of Dioxin Homologs	ng/L	3.3991	2.1845				

2.2.3 Semi-Volatile Organic Compounds

Semi-volatile organic data are presented for background samples (Table 2-17), cell 2 weir discharge samples (Table 2-18), cell 3 weir discharge samples (Table 2-19), cell 2 mix samples (Table 2-20) and cell 3 mix samples (Table 2-21). The only semi-volatile organic compound with established water quality criteria is pentachlorophenol. DRBC and DNREC criteria for pentachlorophenol are calculated using formulas that include the pH of the water. To make these calculations, a pH of 7.0 was assumed. Using a pH of 7.0, the lowest freshwater criterion for pentachlorophenol is the DRBC chronic criterion of 5.73 µg/L. Pentachlorophenol was detected at a concentration of 3 µg/L in one cell 2 weir discharge sample (Table 2-18) and at a concentration of 0.08 µg/L in one cell 2 mix sample (Table 2-20). These concentrations are below the DRBC chronic criterion of 5.73 µg/L.

The most frequently detected semi-volatile organic compounds were polynuclear aromatic hydrocarbons (PAHs) including benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene. PAHs are one of the most widespread organic pollutants. In addition to their presence in fossil fuels, they are also formed by incomplete combustion of carbon containing fuels such as coal, oil and gas, diesel, wood, garbage, or other organic substances like tobacco or charbroiled meat. PAHs do not dissolve easily in water and are most likely attached to suspended sediment in the Delaware River. All the PAHs listed above, except fluorene, were detected in background water samples within the same general range of concentrations (i.e. hundredths to tenths of a part per billion). Although one cell 2 mix water sample collected on May 17, 2010 did have some higher concentrations (i.e. on the order of 1 to 2 parts per billion). Fluorene was detected in three cell 2 weir discharge samples, three cell 2 mix samples and one cell 3 mix sample at a concentration range of 0.02 to 0.11 parts per billion. The presence of PAHs in the weir discharge water and in the mix water is not considered to be a result of dredging or dredged material disposal operations.

A second group of frequently detected semi-volatile organic compounds were phthalates including bis(2-ethylhexyl) phthalate, butyl benzyl phthalate, di-n-butyl phthalate and diethyl phthalate. Phthalates are used in the manufacturing of adhesives and glues, building materials, personal care products, medical devices, detergents and surfactants, packaging, children's toys, modeling clay, waxes, paints, printing inks and coatings, pharmaceuticals, food products, and textiles. Phthalates are easily released into the environment. As plastics age and break down the release of phthalates accelerates. All the phthalates listed above were detected in background water samples within the same general range of concentrations (i.e. tenths to a few parts per billion). One cell 2 weir discharge sample collected on May 17, 2010 did have a concentration of bis(2-ethylhexyl) phthalate of 11 parts per billion. Like PAHs, because phthalates were detected at similar concentrations in background water samples their presence in weir discharge water and in the mix water is not considered to be a result of dredging or dredged material disposal operations.

Other frequently detected semi-volatile organic compounds include 2-methylnaphthalene, acetophenone, benzaldehyde and caprolactam. 2-Methylnaphthalene is a component of crude oil and a product of combustion, which is produced and released to the environment during natural fires. Emissions from petroleum refining, coal tar distillation, and gasoline and diesel fueled engines are major contributors of 2-methylnaphthalene to the environment. Acetophenone is used in perfume manufacture, as a flavorant in tobacco and in the synthesis of pharmaceuticals. Benzaldehyde is used in the manufacture of perfumes, dyes and flavors. Caprolactam is used in the manufacture of nylon and plastics. These organic compounds were also found in background samples at similar concentration ranges. Several other semi-volatile organic compounds were detected infrequently (i.e. one to four detections out of a total of 36 samples). Overall it is concluded that operation of cells 2 and 3 of the Killcohook dredged material containment facility is not impacting Delaware River water quality relative to semi-volatile organic compounds.

Table 2-17. Killcohook background Semi-volatile Organic Data.

Sample ID **Lab Report ID**		**BG0402** **C0D060501002**	**BG0406** **C0D070526002**	**BG0504** **C0E060542002**	**BG0511** **C0E120504002**	**BG0517** **C0E180492002**
Sample Date		4/2/2010	4/6/2010	5/4/2010	5/11/2010	5/17/2010
Analyte	**Unit**					
1,1-Biphenyl	µg/L	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	µg/L	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	µg/L	ND	ND	ND	0.074	ND
1,2-Diphenylhydrazine	µg/L	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dimethylphenol	µg/L	ND	ND	ND	ND	ND
2,4-Dinitrophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND
2-Chloronaphthalene	µg/L	ND	ND	ND	ND	ND
2-Chlorophenol	µg/L	ND	ND	ND	ND	ND
2-Methylnaphthalene	µg/L	ND	0.017	ND	ND	ND
2-Methylphenol	µg/L	ND	ND	ND	ND	ND
2-Nitroaniline	µg/L	ND	ND	ND	ND	ND
2-Nitrophenol	µg/L	ND	ND	ND	ND	ND
3,3-Dichlorobenzidine	µg/L	ND	ND	ND	ND	ND
3-Nitroaniline	µg/L	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	µg/L	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	µg/L	ND	ND	ND	ND	ND
4-Chloroaniline	µg/L	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND
4-Methylphenol	µg/L	ND	ND	ND	ND	ND
4-Nitroaniline	µg/L	ND	ND	ND	ND	ND
4-Nitrophenol	µg/L	ND	ND	ND	ND	ND
Acetophenone	µg/L	ND	0.35	ND	ND	0.37
Benzaldehyde	µg/L	0.79	0.57	0.56	0.81	0.63
Benzidine	µg/L	ND	ND	ND	ND	ND
Benzo(a)anthracene	µg/L	0.073	ND	ND	ND	0.53
Benzo(a)pyrene	µg/L	0.077	ND	ND	ND	0.36
Benzo(b)fluoranthene	µg/L	0.14	ND	ND	ND	0.4
Benzo(ghi)perylene	µg/L	0.25	ND	ND	ND	0.53
Benzo(k)fluoranthene	µg/L	0.21	ND	ND	ND	0.59
bis(2-Chloroethoxy)methane	µg/L	ND	ND	ND	ND	ND

Table 2-17. (Continued)

Sample ID Lab Report ID		BG0402 C0D060501002	BG0406 C0D070526002	BG0504 C0E060542002	BG0511 C0E120504002	BG0517 C0E180492002
Sample Date		4/2/2010	4/6/2010	5/4/2010	5/11/2010	5/17/2010
Analyte	**Unit**					
bis(2-Chloroethyl) ether	µg/L	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	µg/L	ND	ND	ND	ND	ND
bis(2-Ethylhexyl) phthalate	µg/L	ND	1.1	ND	ND	4.6
Butyl benzyl phthalate	µg/L	0.13	0.71	0.15	0.34	0.29
Caprolactam	µg/L	ND	ND	ND	2.1	2.5
Carbazole	µg/L	ND	ND	ND	ND	ND
Chrysene	µg/L	0.11	ND	ND	ND	0.59
Di-n-butyl phthalate	µg/L	ND	0.41	ND	0.12	0.12
Di-n-octyl phthalate	µg/L	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	µg/L	0.23	ND	ND	ND	0.57
Dibenzofuran	µg/L	ND	ND	ND	ND	ND
Diethyl phthalate	µg/L	ND	ND	ND	0.19	0.19
Dimethyl phthalate	µg/L	ND	ND	ND	ND	ND
Fluoranthene	µg/L	0.022	0.026	0.039	0.029	0.13
Fluorene	µg/L	ND	ND	ND	ND	ND
Hexachlorobenzene	µg/L	ND	ND	ND	ND	ND
Hexachlorobutadiene	µg/L	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	µg/L	ND	ND	ND	ND	ND
Hexachloroethane	µg/L	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	µg/L	0.23	ND	ND	ND	0.56
Isophorone	µg/L	ND	ND	ND	ND	ND
N-Nitrosodi-n-propylamine	µg/L	ND	ND	ND	ND	ND
N-Nitrosodimethylamine	µg/L	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	µg/L	ND	ND	ND	ND	ND
Naphthalene	µg/L	ND	ND	ND	0.02	ND
Nitrobenzene	µg/L	ND	ND	ND	ND	ND
Pentachlorophenol	µg/L	ND	ND	ND	ND	ND
Phenanthrene	µg/L	0.063	0.076	0.12	0.059	0.11
Phenol	µg/L	ND	ND	ND	ND	ND
Pyrene	µg/L	ND	0.022	0.029	0.018	0.097

Table 2-18. Killcohook Cell 2 Weir Semi-volatile Organic Data

Sample ID Lab Report ID		WIER0318 C0C190563007	WIER0322 C0C230507002	WIER0324 C0C250605003	WIER0329 C0C300513003	WIER0402 C0D060501004
Sample Date		3/18/2010	3/22/2010	3/24/2010	3/29/2010	4/2/2010
Analyte	**Unit**					
1,1-Biphenyl	µg/L	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	µg/L	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	µg/L	0.079	ND	ND	ND	ND
1,2-Diphenylhydrazine	µg/L	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dimethylphenol	µg/L	ND	ND	ND	ND	ND
2,4-Dinitrophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND
2-Chloronaphthalene	µg/L	ND	ND	ND	ND	ND
2-Chlorophenol	µg/L	ND	ND	ND	ND	ND
2-Methylnaphthalene	µg/L	0.019	0.014	0.013	0.015	ND
2-Methylphenol	µg/L	0.014	ND	ND	ND	ND
2-Nitroaniline	µg/L	ND	ND	ND	ND	ND
2-Nitrophenol	µg/L	ND	ND	ND	ND	ND
3,3-Dichlorobenzidine	µg/L	ND	ND	ND	ND	ND
3-Nitroaniline	µg/L	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	µg/L	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	µg/L	ND	ND	ND	ND	ND
4-Chloroaniline	µg/L	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND
4-Methylphenol	µg/L	0.029	ND	ND	ND	ND
4-Nitroaniline	µg/L	ND	ND	ND	ND	ND
4-Nitrophenol	µg/L	ND	ND	ND	ND	ND
Acetophenone	µg/L	0.033	ND	ND	ND	ND
Benzaldehyde	µg/L	0.6	ND	0.97	ND	0.8
Benzidine	µg/L	ND	ND	ND	ND	ND
Benzo(a)anthracene	µg/L	ND	0.066	ND	ND	ND
Benzo(a)pyrene	µg/L	ND	0.044	ND	ND	ND
Benzo(b)fluoranthene	µg/L	0.02	0.072	ND	ND	ND

Table 2-18. (Continued)

Sample ID Lab Report ID		WIER0318 C0C190563007	WIER0322 C0C230507002	WIER0324 C0C250605003	WIER0329 C0C300513003	WIER0402 C0D060501004
Sample Date		3/18/2010	3/22/2010	3/24/2010	3/29/2010	4/2/2010
Analyte	**Unit**					
Benzo(ghi)perylene	µg/L	ND	0.035	ND	ND	ND
Benzo(k)fluoranthene	µg/L	ND	0.056	ND	ND	ND
bis(2-Chloroethoxy)methane	µg/L	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	µg/L	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	µg/L	ND	ND	ND	ND	ND
bis(2-Ethylhexyl) phthalate	µg/L	0.17	ND	ND	ND	1.6
Butyl benzyl phthalate	µg/L	ND	0.71	ND	ND	ND
Caprolactam	µg/L	ND	ND	ND	ND	ND
Carbazole	µg/L	ND	ND	ND	ND	ND
Chrysene	µg/L	ND	0.054	ND	ND	ND
Di-n-butyl phthalate	µg/L	0.097	ND	0.19	ND	ND
Di-n-octyl phthalate	µg/L	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	µg/L	ND	0.037	ND	0.099	ND
Dibenzofuran	µg/L	0.029	ND	ND	ND	ND
Diethyl phthalate	µg/L	0.089	ND	ND	ND	ND
Dimethyl phthalate	µg/L	ND	ND	ND	ND	ND
Fluoranthene	µg/L	0.033	0.029	0.023	0.022	ND
Fluorene	µg/L	0.035	0.11	ND	ND	ND
Hexachlorobenzene	µg/L	ND	ND	ND	ND	ND
Hexachlorobutadiene	µg/L	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	µg/L	ND	ND	ND	ND	ND
Hexachloroethane	µg/L	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	µg/L	ND	0.045	ND	ND	ND
Isophorone	µg/L	ND	ND	ND	ND	ND
N-Nitrosodi-n-propylamine	µg/L	ND	ND	ND	ND	ND
N-Nitrosodimethylamine	µg/L	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	µg/L	ND	ND	ND	ND	ND
Naphthalene	µg/L	ND	ND	0.058	ND	0.033
Nitrobenzene	µg/L	ND	ND	ND	ND	ND
Pentachlorophenol	µg/L	ND	ND	ND	ND	ND
Phenanthrene	µg/L	0.076	0.12	0.098	0.085	0.078
Phenol	µg/L	ND	ND	ND	ND	ND
Pyrene	µg/L	0.03	0.02	0.022	ND	ND

Table 2-18. (Continued)

Sample ID Lab Report ID		WIER0406 C0D070526004	WIER0408 C0D090487003	WIER0414 C0D150544003	WIER0419 C0D200485002	WIER0422 C0D230554002
Sample Date		4/6/2010	4/8/2010	4/14/2010	4/19/2010	4/22/2010
Analyte	**Unit**					
1,1-Biphenyl	µg/L	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	µg/L	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND
1,2-Diphenylhydrazine	µg/L	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dimethylphenol	µg/L	ND	ND	ND	ND	ND
2,4-Dinitrophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND
2-Chloronaphthalene	µg/L	ND	ND	ND	ND	ND
2-Chlorophenol	µg/L	ND	ND	ND	ND	ND
2-Methylnaphthalene	µg/L	0.018	0.015	ND	ND	ND
2-Methylphenol	µg/L	ND	ND	ND	ND	ND
2-Nitroaniline	µg/L	ND	ND	ND	ND	ND
2-Nitrophenol	µg/L	ND	ND	ND	ND	ND
3,3-Dichlorobenzidine	µg/L	ND	ND	ND	ND	ND
3-Nitroaniline	µg/L	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	µg/L	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	µg/L	ND	ND	ND	ND	ND
4-Chloroaniline	µg/L	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND
4-Methylphenol	µg/L	ND	ND	ND	ND	ND
4-Nitroaniline	µg/L	ND	ND	ND	ND	ND
4-Nitrophenol	µg/L	ND	ND	ND	ND	ND
Acetophenone	µg/L	0.36	ND	ND	0.37	0.36
Benzaldehyde	µg/L	0.61	0.82	0.6	0.67	0.6
Benzidine	µg/L	ND	ND	ND	ND	ND
Benzo(a)anthracene	µg/L	ND	ND	ND	ND	ND
Benzo(a)pyrene	µg/L	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	µg/L	ND	ND	ND	ND	ND
Benzo(ghi)perylene	µg/L	ND	ND	ND	ND	ND

Table 2-18. (Continued)

Sample ID Lab Report ID		WIER0406 C0D070526004	WIER0408 C0D090487003	WIER0414 C0D150544003	WIER0419 C0D200485002	WIER0422 C0D230554002
Sample Date		4/6/2010	4/8/2010	4/14/2010	4/19/2010	4/22/2010
Analyte	**Unit**					
Benzo(k)fluoranthene	µg/L	ND	ND	ND	ND	ND
bis(2-Chloroethoxy)methane	µg/L	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	µg/L	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	µg/L	ND	ND	ND	ND	ND
bis(2-Ethylhexyl) phthalate	µg/L	ND	2.1	ND	ND	ND
Butyl benzyl phthalate	µg/L	0.21	3.9	ND	ND	ND
Caprolactam	µg/L	ND	ND	ND	ND	ND
Carbazole	µg/L	ND	ND	ND	ND	ND
Chrysene	µg/L	ND	ND	ND	ND	ND
Di-n-butyl phthalate	µg/L	0.25	0.23	ND	ND	ND
Di-n-octyl phthalate	µg/L	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	µg/L	ND	ND	ND	ND	ND
Dibenzofuran	µg/L	ND	ND	ND	ND	ND
Diethyl phthalate	µg/L	ND	ND	ND	ND	ND
Dimethyl phthalate	µg/L	ND	ND	ND	ND	ND
Fluoranthene	µg/L	0.022	0.028	ND	ND	0.019
Fluorene	µg/L	ND	ND	ND	ND	ND
Hexachlorobenzene	µg/L	ND	ND	ND	ND	ND
Hexachlorobutadiene	µg/L	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	µg/L	ND	ND	ND	ND	ND
Hexachloroethane	µg/L	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	µg/L	ND	ND	ND	ND	ND
Isophorone	µg/L	ND	ND	ND	ND	ND
N-Nitrosodi-n-propylamine	µg/L	ND	ND	ND	ND	ND
N-Nitrosodimethylamine	µg/L	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	µg/L	ND	ND	ND	ND	ND
Naphthalene	µg/L	ND	ND	0.032	ND	ND
Nitrobenzene	µg/L	ND	ND	ND	ND	ND
Pentachlorophenol	µg/L	ND	ND	3	ND	ND
Phenanthrene	µg/L	0.072	0.13	0.052	0.042	0.058
Phenol	µg/L	ND	ND	ND	ND	ND
Pyrene	µg/L	ND	0.015	ND	ND	0.019

Table 2-18. (Continued)

Sample ID Lab Report ID		WIER0427 C0D280512003	WIER0504 C0E060542004	WEIR0506 C0E070494003	WIER0511 C0E120504003	WIER0517 C0E180492004
Sample Date		4/27/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010
Analyte	**Unit**					
1,1-Biphenyl	µg/L	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	µg/L	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND
1,2-Diphenylhydrazine	µg/L	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dichlorophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dimethylphenol	µg/L	ND	ND	ND	ND	ND
2,4-Dinitrophenol	µg/L	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND
2-Chloronaphthalene	µg/L	ND	ND	ND	ND	ND
2-Chlorophenol	µg/L	ND	ND	ND	ND	ND
2-Methylnaphthalene	µg/L	ND	ND	0.025	ND	ND
2-Methylphenol	µg/L	ND	ND	ND	ND	ND
2-Nitroaniline	µg/L	ND	ND	ND	ND	ND
2-Nitrophenol	µg/L	ND	ND	ND	ND	ND
3,3-Dichlorobenzidine	µg/L	ND	ND	ND	ND	ND
3-Nitroaniline	µg/L	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	µg/L	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	µg/L	ND	ND	ND	ND	ND
4-Chloroaniline	µg/L	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND
4-Methylphenol	µg/L	ND	ND	ND	ND	ND
4-Nitroaniline	µg/L	ND	ND	ND	ND	ND
4-Nitrophenol	µg/L	ND	ND	ND	ND	ND
Acetophenone	µg/L	ND	0.38	0.35	ND	0.39
Benzaldehyde	µg/L	0.6	ND	ND	0.82	0.61
Benzidine	µg/L	ND	ND	ND	ND	ND
Benzo(a)anthracene	µg/L	ND	ND	ND	0.028	ND
Benzo(a)pyrene	µg/L	ND	ND	ND	0.034	ND
Benzo(b)fluoranthene	µg/L	ND	ND	ND	ND	ND
Benzo(ghi)perylene	µg/L	ND	ND	ND	0.069	ND

Table 2-18. (Continued)

Sample ID Lab Report ID		WIER0427 C0D280512003	WIER0504 C0E060542004	WEIR0506 C0E070494003	WIER0511 C0E120504003	WIER0517 C0E180492004
Sample Date		4/27/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010
Analyte	**Unit**					
Benzo(k)fluoranthene	µg/L	ND	ND	ND	ND	ND
bis(2-Chloroethoxy)methane	µg/L	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	µg/L	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	µg/L	ND	ND	ND	ND	ND
bis(2-Ethylhexyl) phthalate	µg/L	ND	ND	ND	ND	11
Butyl benzyl phthalate	µg/L	ND	ND	ND	0.36	0.69
Caprolactam	µg/L	ND	ND	ND	ND	3.7
Carbazole	µg/L	ND	ND	ND	ND	ND
Chrysene	µg/L	ND	ND	ND	0.034	ND
Di-n-butyl phthalate	µg/L	ND	ND	ND	0.13	0.19
Di-n-octyl phthalate	µg/L	ND	ND	ND	ND	ND
Dibenz(a,h)anthracene	µg/L	ND	ND	ND	0.088	ND
Dibenzofuran	µg/L	ND	ND	ND	ND	ND
Diethyl phthalate	µg/L	ND	ND	ND	0.15	0.31
Dimethyl phthalate	µg/L	ND	ND	ND	ND	ND
Fluoranthene	µg/L	ND	0.022	0.03	0.019	0.019
Fluorene	µg/L	ND	ND	0.02	ND	ND
Hexachlorobenzene	µg/L	ND	ND	ND	ND	ND
Hexachlorobutadiene	µg/L	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	µg/L	ND	ND	ND	ND	ND
Hexachloroethane	µg/L	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	µg/L	ND	ND	ND	0.067	ND
Isophorone	µg/L	ND	ND	ND	ND	ND
N-Nitrosodi-n-propylamine	µg/L	ND	ND	ND	ND	ND
N-Nitrosodimethylamine	µg/L	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	µg/L	ND	ND	ND	ND	ND
Naphthalene	µg/L	ND	ND	ND	ND	ND
Nitrobenzene	µg/L	ND	ND	ND	ND	ND
Pentachlorophenol	µg/L	ND	ND	ND	ND	ND
Phenanthrene	µg/L	0.082	0.13	0.073	0.067	0.11
Phenol	µg/L	ND	ND	ND	ND	ND
Pyrene	µg/L	ND	ND	ND	0.018	0.016

Table 2-19. Killcohook Cell 3 Weir Semi-volatile Organic Data

Sample ID Lab Report ID		WIER0427 C0D280518003	WIER0429 C0D300570003	WIER0504 C0E060543003	WIER0506 C0E070562003	WIER0511 C0E120515002	WIER0517 C0E180515003
Sample Date		4/27/2010	4/29/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010
Analyte	**Unit**						
1,1-Biphenyl	µg/L	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	µg/L	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND	ND
1,2-Diphenylhydrazine	µg/L	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	µg/L	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	µg/L	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	µg/L	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	µg/L	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	µg/L	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	µg/L	ND	ND	ND	ND	ND	ND
2-Chlorophenol	µg/L	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	µg/L	ND	ND	ND	ND	ND	ND
2-Methylphenol	µg/L	ND	ND	ND	ND	ND	ND
2-Nitroaniline	µg/L	ND	ND	ND	ND	ND	ND
2-Nitrophenol	µg/L	ND	ND	ND	ND	ND	ND
3,3-Dichlorobenzidine	µg/L	ND	ND	ND	ND	ND	ND
3-Nitroaniline	µg/L	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	µg/L	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	µg/L	ND	ND	ND	ND	ND	ND
4-Chloroaniline	µg/L	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND	ND
4-Methylphenol	µg/L	ND	ND	ND	ND	ND	ND
4-Nitroaniline	µg/L	ND	ND	ND	ND	ND	ND
4-Nitrophenol	µg/L	ND	ND	ND	ND	ND	ND
Acetophenone	µg/L	ND	ND	0.38	ND	ND	0.35
Benzaldehyde	µg/L	0.51	ND	0.72	0.57	ND	ND
Benzidine	µg/L	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	µg/L	ND	0.067	0.58	0.13	ND	ND
Benzo(a)pyrene	µg/L	ND	0.16	0.32	0.12	ND	ND
Benzo(b)fluoranthene	µg/L	ND	0.13	0.56	0.28	ND	ND
Benzo(ghi)perylene	µg/L	ND	0.44	0.59	0.4	ND	ND

Table 2-19. (Continued)

Sample ID Lab Report ID		WIER0427 C0D280518003	WIER0429 C0D300570003	WIER0504 C0E060543003	WIER0506 C0E070562003	WIER0511 C0E120515002	WIER0517 C0E180515003
Sample Date		4/27/2010	4/29/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010
Analyte	**Unit**						
Benzo(k)fluoranthene	µg/L	ND	0.29	0.63	0.31	ND	ND
bis(2-Chloroethoxy)methane	µg/L	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	µg/L	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	µg/L	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl) phthalate	µg/L	ND	3.1	1.5	ND	ND	1.1
Butyl benzyl phthalate	µg/L	ND	0.28	0.28	ND	0.28	0.45
Caprolactam	µg/L	ND	ND	ND	ND	1.8	2.1
Carbazole	µg/L	ND	ND	0.026	ND	ND	ND
Chrysene	µg/L	ND	0.092	0.62	0.2	ND	ND
Di-n-butyl phthalate	µg/L	ND	ND	0.18	ND	0.18	ND
Di-n-octyl phthalate	µg/L	ND	ND	0.53	ND	ND	ND
Dibenz(a,h)anthracene	µg/L	ND	0.4	0.67	0.44	ND	ND
Dibenzofuran	µg/L	ND	ND	ND	ND	ND	ND
Diethyl phthalate	µg/L	ND	ND	0.76	ND	0.22	0.2
Dimethyl phthalate	µg/L	ND	ND	ND	ND	ND	ND
Fluoranthene	µg/L	ND	ND	0.15	ND	0.015	ND
Fluorene	µg/L	ND	ND	ND	ND	ND	ND
Hexachlorobenzene	µg/L	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	µg/L	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	µg/L	ND	ND	ND	ND	ND	ND
Hexachloroethane	µg/L	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	µg/L	ND	0.35	0.62	0.37	ND	ND
Isophorone	µg/L	ND	ND	ND	ND	ND	ND
N-Nitrosodi-n-propylamine	µg/L	ND	ND	ND	ND	ND	ND
N-Nitrosodimethylamine	µg/L	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	µg/L	ND	ND	ND	ND	ND	ND
Naphthalene	µg/L	ND	ND	ND	ND	0.021	ND
Nitrobenzene	µg/L	ND	ND	ND	ND	ND	ND
Pentachlorophenol	µg/L	ND	ND	ND	ND	ND	ND
Phenanthrene	µg/L	0.071	ND	0.46	0.058	0.059	0.077
Phenol	µg/L	ND	ND	ND	ND	ND	0.17
Pyrene	µg/L	ND	ND	0.15	ND	ND	ND

Table 2-20. Killcohook Cell 2 Mix Semi-volatile Organic Data

Sample ID Lab Report ID		MIX0402 C0D060501001	MIX0406 C0D070526001	MIX0504 C0E060542001	MIX0506 C0E070494001	MIX0511 C0E120504001	MIX0517 C0E180492001
Sample Date		4/2/2010	4/6/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010
Analyte	**Unit**						
1,1-Biphenyl	µg/L	ND	ND	ND	ND	ND	ND
1,2,4-Trichlorobenzene	µg/L	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND	ND
1,2-Diphenylhydrazine	µg/L	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	ND	ND	ND	ND	ND	ND
2,4,5-Trichlorophenol	µg/L	ND	ND	ND	ND	ND	ND
2,4,6-Trichlorophenol	µg/L	ND	ND	ND	ND	ND	ND
2,4-Dichlorophenol	µg/L	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	µg/L	ND	ND	ND	ND	ND	ND
2,4-Dinitrophenol	µg/L	ND	ND	ND	ND	ND	ND
2,4-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND	ND
2,6-Dinitrotoluene	µg/L	ND	ND	ND	ND	ND	ND
2-Chloronaphthalene	µg/L	ND	ND	ND	ND	ND	ND
2-Chlorophenol	µg/L	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	µg/L	0.012	0.026	0.049	0.024	ND	0.023
2-Methylphenol	µg/L	ND	ND	ND	ND	ND	ND
2-Nitroaniline	µg/L	ND	ND	ND	ND	ND	ND
2-Nitrophenol	µg/L	ND	ND	ND	ND	ND	ND
3,3-Dichlorobenzidine	µg/L	ND	ND	ND	ND	ND	ND
3-Nitroaniline	µg/L	ND	ND	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	µg/L	ND	ND	ND	ND	ND	ND
4-Bromophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND	ND
4-Chloro-3-methylphenol	µg/L	ND	ND	ND	ND	ND	ND
4-Chloroaniline	µg/L	ND	ND	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	µg/L	ND	ND	ND	ND	ND	ND
4-Methylphenol	µg/L	ND	ND	ND	ND	ND	ND
4-Nitroaniline	µg/L	ND	ND	ND	ND	ND	ND
4-Nitrophenol	µg/L	ND	ND	ND	ND	ND	ND
Acenaphthene	µg/L	ND	0.023	ND	ND	ND	ND
Acenaphthylene	µg/L	ND	ND	ND	ND	ND	ND
Acetophenone	µg/L	ND	0.42	ND	ND	ND	0.41
Anthracene	µg/L	0.033	0.024	ND	ND	0.014	0.18
Atrazine	µg/L	ND	ND	ND	ND	ND	ND
Benzaldehyde	µg/L	0.8	0.69	0.62	0.62	0.81	0.65
Benzidine	µg/L	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	µg/L	0.099	ND	0.041	ND	ND	1.4
Benzo(a)pyrene	µg/L	0.091	ND	ND	ND	ND	0.86

Table 2-20. (Continued)

Sample ID Lab Report ID		MIX0402 C0D060501001	MIX0406 C0D070526001	MIX0504 C0E060542001	MIX0506 C0E070494001	MIX0511 C0E120504001	MIX0517 C0E180492001
Sample Date		4/2/2010	4/6/2010	5/4/2010	5/6/2010	5/11/2010	5/17/2010
Analyte	**Unit**						
Benzo(b)fluoranthene	µg/L	0.11	ND	ND	ND	ND	1.2
Benzo(ghi)perylene	µg/L	0.17	ND	ND	ND	ND	1.4
Benzo(k)fluoranthene	µg/L	0.18	ND	ND	ND	ND	1.5
bis(2-Chloroethoxy)methane	µg/L	ND	ND	ND	ND	ND	ND
bis(2-Chloroethyl) ether	µg/L	ND	ND	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	µg/L	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl) phthalate	µg/L	ND	1	ND	ND	ND	1.1
Butyl benzyl phthalate	µg/L	0.19	ND	0.13	ND	0.23	0.5
Caprolactam	µg/L	ND	ND	ND	ND	1.7	3.3
Carbazole	µg/L	0.062	ND	ND	ND	0.024	0.037
Chrysene	µg/L	0.13	ND	0.028	ND	ND	1.5
Di-n-butyl phthalate	µg/L	ND	0.31	ND	ND	0.12	0.22
Di-n-octyl phthalate	µg/L	ND	ND	ND	ND	ND	0.37
Dibenz(a,h)anthracene	µg/L	0.16	ND	ND	ND	ND	1.6
Dibenzofuran	µg/L	ND	ND	ND	ND	ND	0.062
Diethyl phthalate	µg/L	ND	ND	ND	ND	0.17	0.38
Dimethyl phthalate	µg/L	ND	ND	ND	ND	ND	ND
Fluoranthene	µg/L	0.075	0.058	0.085	ND	0.037	0.36
Fluorene	µg/L	ND	0.03	0.032	ND	ND	0.048
Hexachlorobenzene	µg/L	ND	ND	ND	ND	ND	ND
Hexachlorobutadiene	µg/L	ND	ND	ND	ND	ND	ND
Hexachlorocyclopentadiene	µg/L	ND	ND	ND	ND	ND	ND
Hexachloroethane	µg/L	ND	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	µg/L	0.16	ND	ND	ND	ND	1.4
Isophorone	µg/L	ND	ND	ND	ND	ND	ND
N-Nitrosodi-n-propylamine	µg/L	ND	ND	ND	ND	ND	ND
N-Nitrosodimethylamine	µg/L	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine	µg/L	ND	ND	ND	ND	ND	ND
Naphthalene	µg/L	ND	0.044	0.1	ND	ND	0.048
Nitrobenzene	µg/L	ND	ND	ND	ND	ND	ND
Pentachlorophenol	µg/L	ND	ND	ND	ND	ND	0.08
Phenanthrene	µg/L	0.094	0.12	0.13	0.071	0.08	0.22
Phenol	µg/L	ND	ND	ND	ND	ND	0.39
Pyrene	µg/L	0.073	0.052	0.062	0.023	0.028	0.29

Table 2-21. Killcohook Cell 3 Mix Semi-volatile Organic Data

Sample ID **Lab Report ID**		**MIX0504** **C0E060543001**	**MIX0506** **C0E070562001**	**MIX0511** **C0E120515001**	**MIX0517** **C0E180515001**
Sample Date		5/4/2010	5/6/2010	5/11/2010	5/17/2010
Analyte	**Unit**				
1,1-Biphenyl	µg/L	ND	ND	ND	ND
1,2,4-Trichlorobenzene	µg/L	ND	ND	ND	ND
1,2-Dichlorobenzene	µg/L	ND	ND	ND	ND
1,2-Diphenylhydrazine	µg/L	ND	ND	ND	ND
1,3-Dichlorobenzene	µg/L	ND	ND	ND	ND
1,4-Dichlorobenzene	µg/L	ND	ND	ND	ND
2,4,5-Trichlorophenol	µg/L	ND	ND	ND	ND
2,4,6-Trichlorophenol	µg/L	ND	ND	ND	ND
2,4-Dichlorophenol	µg/L	ND	ND	ND	ND
2,4-Dimethylphenol	µg/L	ND	ND	ND	ND
2,4-Dinitrophenol	µg/L	ND	ND	ND	ND
2,4-Dinitrotoluene	µg/L	ND	ND	ND	ND
2,6-Dinitrotoluene	µg/L	ND	ND	ND	ND
2-Chloronaphthalene	µg/L	ND	ND	ND	ND
2-Chlorophenol	µg/L	ND	ND	ND	ND
2-Methylnaphthalene	µg/L	ND	0.017	0.019	ND
2-Methylphenol	µg/L	ND	ND	ND	ND
2-Nitroaniline	µg/L	ND	ND	ND	ND
2-Nitrophenol	µg/L	ND	ND	ND	ND
3,3-Dichlorobenzidine	µg/L	ND	ND	ND	ND
3-Nitroaniline	µg/L	ND	ND	ND	ND
4,6-Dinitro-2-methylphenol	µg/L	ND	ND	ND	ND
4-Bromophenyl phenyl ether	µg/L	ND	ND	ND	ND
4-Chloro-3-methylphenol	µg/L	ND	ND	ND	ND
4-Chloroaniline	µg/L	ND	ND	ND	ND
4-Chlorophenyl phenyl ether	µg/L	ND	ND	ND	ND
4-Methylphenol	µg/L	ND	ND	ND	ND
4-Nitroaniline	µg/L	ND	ND	ND	ND
4-Nitrophenol	µg/L	ND	ND	ND	ND
Acenaphthene	µg/L	ND	ND	ND	ND
Acenaphthylene	µg/L	ND	ND	ND	ND
Acetophenone	µg/L	ND	ND	ND	0.38
Anthracene	µg/L	ND	ND	ND	ND
Atrazine	µg/L	ND	ND	ND	ND
Benzaldehyde	µg/L	0.59	ND	0.8	0.59
Benzidine	µg/L	ND	ND	ND	ND
Benzo(a)anthracene	µg/L	ND	ND	0.067	ND
Benzo(a)pyrene	µg/L	ND	ND	0.11	ND
Benzo(b)fluoranthene	µg/L	ND	ND	ND	ND
Benzo(ghi)perylene	µg/L	ND	ND	0.26	ND

Table 2-21. (Continued)

Sample ID Lab Report ID		MIX0504 C0E060543001	MIX0506 C0E070562001	MIX0511 C0E120515001	MIX0517 C0E180515001
Sample Date		5/4/2010	5/6/2010	5/11/2010	5/17/2010
Analyte	**Unit**				
Benzo(k)fluoranthene	µg/L	ND	ND	0.26	ND
bis(2-Chloroethoxy)methane	µg/L	ND	ND	ND	ND
bis(2-Chloroethyl) ether	µg/L	ND	ND	ND	ND
bis(2-Chloroisopropyl) ether	µg/L	ND	ND	ND	ND
bis(2-Ethylhexyl) phthalate	µg/L	ND	ND	ND	ND
Butyl benzyl phthalate	µg/L	ND	ND	0.27	0.13
Caprolactam	µg/L	ND	ND	ND	3.5
Carbazole	µg/L	ND	ND	ND	ND
Chrysene	µg/L	ND	ND	0.11	ND
Di-n-butyl phthalate	µg/L	ND	ND	0.12	ND
Di-n-octyl phthalate	µg/L	ND	ND	ND	ND
Dibenz(a,h)anthracene	µg/L	ND	ND	0.29	ND
Dibenzofuran	µg/L	ND	ND	ND	ND
Diethyl phthalate	µg/L	ND	ND	0.15	ND
Dimethyl phthalate	µg/L	ND	ND	ND	ND
Fluoranthene	µg/L	0.046	0.042	0.04	0.026
Fluorene	µg/L	ND	ND	ND	0.021
Hexachlorobenzene	µg/L	ND	ND	ND	ND
Hexachlorobutadiene	µg/L	ND	ND	ND	ND
Hexachlorocyclopentadiene	µg/L	ND	ND	ND	ND
Hexachloroethane	µg/L	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	µg/L	ND	ND	0.2	ND
Isophorone	µg/L	ND	ND	ND	ND
N-Nitrosodi-n-propylamine	µg/L	ND	ND	ND	ND
N-Nitrosodimethylamine	µg/L	ND	ND	ND	ND
N-Nitrosodiphenylamine	µg/L	ND	ND	ND	ND
Naphthalene	µg/L	ND	ND	0.041	0.03
Nitrobenzene	µg/L	ND	ND	ND	ND
Pentachlorophenol	µg/L	ND	ND	ND	ND
Phenanthrene	µg/L	0.095	0.082	0.09	0.11
Phenol	µg/L	ND	ND	ND	ND
Pyrene	µg/L	0.034	0.027	0.039	0.029

2.3 TOTAL SUSPENDED SEDIMENT

Tables 2-22 through 2-26 present total suspended sediment (TSS) data for the weir discharge of cells 2 and 3, the Delaware River mix samples for cells 2 and 3 and background. As can be seen from Table 2-23 (cell 2 weir discharge) and Table 2-24 (cell 3 weir discharge), the dredged material containment cells are very efficient at retaining sediment. The highest concentration of TSS detected at either weir was at cell 2 on March 30, 2010. On that day the TSS concentration was 210 mg/L, or less than a quarter of a gram of sediment per liter of water which was lower than the maximum background concentration. This level of TSS indicates that both cells and discharge weirs are working in optimum fashion (Figures 2-1 and 2-2). Mix zone samples taken along the Delaware River shore line where the CDFs discharged into the river had much higher TSS levels than weir or back ground samples. This was largely due to the shallow nature of the shoreline at Killcohook where wind and vessel induced wave action increased the TSS levels along the entire shoreline (Figure 2-2).

Table 2-22. Killcohook Background Total Suspended Solids Data

Sample ID	Lab Report ID	Date Collected	TSS (mg/L)
BG0318	C0C190563002	3/18/2010	15.2
BG0324	C0C250605001	3/24/2010	291
BG0402	C0D060501002	4/2/2010	14.4
BG0406	C0D070526002	4/6/2010	34
BG0504	C0E060542002	5/4/2010	91
BG0511	C0E120504002	5/11/2010	37.6
BG0517	C0E180492002	5/17/2010	16

Table 2-23. Killcohook Cell 2 Weir Total Suspended Solids Data

Sample ID	Lab Report ID	Date Collected	TSS (mg/L)	Sample ID	Lab Report ID	Date Collected	TSS (mg/L)
WIER0311	C0C190563003	3/11/2010	33.2	WIER0418	C0D200485003	4/18/2010	67.2
WIER0312	C0C190563004	3/12/2010	42.8	WIER0419	C0D200485008	4/19/2010	48
WIER0313	C0C190563005	3/13/2010	66.4	WIER0420	C0D230554004	4/20/2010	88
WIER0314	C0C190563006	3/14/2010	25.2	WIER0421	C0D230554003	4/21/2010	174
WIER0318	C0C230507004	3/18/2010	46.4	WIER0422	C0D280512008	4/22/2010	122
WIER0319	C0C230507003	3/19/2010	66	WIER0423	C0D280512007	4/23/2010	49.3
WIER0322	C0C250605004	3/22/2010	120	WIER0424	C0D280512006	4/24/2010	39.2
WIER0324	C0C300513007	3/24/2010	75	WIER0425	C0D280512005	4/25/2010	36.4
WIER0326	C0C300513006	3/26/2010	101	WIER0426	C0D280512004	4/26/2010	50.7
WIER0327	C0C300513005	3/27/2010	72	WIER0429	C0E060542009	4/29/2010	3
WIER0328	C0C300513004	3/28/2010	188	WIER0430	C0E060542008	4/30/2010	43
WIER0329	C0D060501008	3/29/2010	169	WIER0501	C0E060542007	5/1/2010	9
WIER0330	C0D060501007	3/30/2010	210	WIER0502	C0E060542006	5/2/2010	<4.0
WIER0331	C0D060501006	3/31/2010	143	WIER0503	C0E060542005	5/3/2010	4
WIER0401	C0D060501005	4/1/2010	152	WEIR0504	C0E070494005	5/4/2010	36
WIER0402	C0D070526008	4/2/2010	204	WEIR0505	C0E070494004	5/5/2010	51.2
WIER0403	C0D070526007	4/3/2010	186	WIER0506	C0E120504009	5/6/2010	45.6
WIER0404	C0D070526006	4/4/2010	94	WIER0507	C0E120504008	5/7/2010	52.4
WIER0405	C0D070526005	4/5/2010	143	WIER0508	C0E120504007	5/8/2010	24
WIER0406	C0D090487005	4/6/2010	91	WIER0509	C0E120504006	5/9/2010	8.4
WIER0407	C0D090487004	4/7/2010	78	WIER0510	C0E120504005	5/10/2010	14
WIER0414	C0D200485007	4/14/2010	50.4	WIER0513	C0E180492008	5/13/2010	26
WIER0415	C0D200485006	4/15/2010	63.6	WIER0514	C0E180492007	5/14/2010	13
WIER0416	C0D200485005	4/16/2010	83.2	WIER0515	C0E180492006	5/15/2010	10
WIER0417	C0D200485004	4/17/2010	44.8	WIER0516	C0E180492005	5/16/2010	35

Table 2-24. Killcohook Cell 3 Weir Total Suspended Solids Data

Sample ID	Lab Report ID	Date Collected	TSS (mg/L)
WIER0422	C0D280518008	4/22/2010	26
WIER0423	C0D280518007	4/23/2010	45.2
WIER0424	C0D280518006	4/24/2010	12.8
WIER0425	C0D280518005	4/25/2010	16.4
WIER0426	C0D280518004	4/26/2010	24
WIER0427	C0D300570005	4/27/2010	10
WIER0428	C0D300570004	4/28/2010	19
WIER0429	C0E060543008	4/29/2010	10
WIER0430	C0E060543007	4/30/2010	18
WIER0501	C0E060543006	5/1/2010	19
WIER0502	C0E060543005	5/2/2010	20
WIER0503	C0E060543004	5/3/2010	28
WIER0504	C0E070562005	5/4/2010	24.4
WIER0505	C0E070562004	5/5/2010	39.6
WIER0506	C0E120515008	5/6/2010	28.8
WIER0507	C0E120515007	5/7/2010	25.6
WIER0508	C0E120515006	5/8/2010	27.6
WIER0509	C0E120515005	5/9/2010	30.8
WIER0510	C0E120515004	5/10/2010	20.8
WIER0514	C0E180515006	5/14/2010	6
WIER0515	C0E180515005	5/15/2010	9
WIER0516	C0E180515004	5/16/2010	59

Table 2-25. Killcohook Cell 2 Mix Total Suspended Solids Data.

Sample ID	Lab Report ID	Date Collected	TSS (mg/L)
MIX0318	C0C190563001	3/18/2010	94
MIX0322	C0C230507001	3/22/2010	347
MIX0324	C0C250605002	3/24/2010	319
MIX0329	C0C300513001	3/29/2010	79.6
MIX0402	C0D060501001	4/2/2010	106
MIX0406	C0D070526001	4/6/2010	334
MIX0408	C0D090487001	4/8/2010	388
MIX0419	C0D200485001	4/19/2010	432
MIX0427	C0D280512001	4/27/2010	499
MIX0504	C0E060542001	5/4/2010	1060
MIX0506	C0E070494001	5/6/2010	988
MIX0511	C0E120504001	5/11/2010	63.2
MIX0517	C0E180492001	5/17/2010	284

Table 2-26. Killcohook Cell 3 Mix Total Suspended Solids Data.

Sample ID	Lab Report ID	Date Collected	TSS (mg/L)
MIX0427	C0D280518001	4/27/2010	76.4
MIX0429	C0D300570001	4/29/2010	258
MIX0504	C0E060543001	5/4/2010	220
MIX0506	C0E070562001	5/6/2010	207
MIX0511	C0E120515001	5/11/2010	357
MIX0517	C0E180515001	5/17/2010	51

Figure 2-1. Dredge slurry being pumped into the Killcohook CDF during Reach C Deepening in the spring of 2010

Figure 2-2. Killcohook Cell 2 weir discharge during Reach C Deepening in the spring of 2010

3.0 POINT OF DREDGE MONITORING

Water quality monitoring was conducted during dredging operations in Reach C to evaluate contaminant releases at the cutterhead and to correlate turbidity measured in Nephelometer Units (NTUs) to Total Suspended Solids (TSS). Previous turbidity plume studies by USACE and subsequent reviews by DNREC established that if TSS levels are kept below 250 mg/L 200 feet from the point of dredging then Delaware River water quality will be maintained. However, real time measurements for turbidity can only be accomplished with a turbidity meter that records NTUs. Turbidity is an optical measurement of light attenuation caused by particles in the water column. To convert NTUs into TSS site specific water sampling and simultaneous NTU measurements are needed to develop a regression equation to accurately convert on-site turbidity into TSS. Once a regression equation is created with sufficient replication at various levels of TSS, real time monitoring of turbidity can be employed during dredging operations to assure that TSS levels stay within water quality goals.

3.1 FIELD METHODS

For this interim report TSS and water samples for contaminant testing were conducted off the dredge Pullen (Figure 3-1) in four specific events. All four sampling events included simultaneous TSS and turbidity measurements while events 2 and 4 also included water sampling for contaminants (Table 3-1). Event 4 sampling for contaminants was conducted on 5/20/2010 but the laboratory analyses were not available for this interim report.

Table 3-1. Point of Dredge sampling dates and parameters sampled in 4 of the 7 scheduled monitoring events for Reach C deepening

Date	Event Number	TSS	NTU	Water Column Contaminants
3/16-17/2010	1	X	X	
4/1/2010	2	X	X	X
4/30/2010	3	X	X	
5/20/2010	4	X	X	X*

* Samples collected but laboratory data were not available

For each sampling event two rounds of sampling was conducted during flood tide from Versar's sampling vessel moored onto the starboard side of the Pullen dredge approximately 200 feet downstream of where the cutterhead contacted the river bottom (Figure 3-2). All dredging operations on the Pullen are being conducted with the cutterhead pointing downriver. Therefore only flood tide water sampling was conducted to insure that data were taken down current of the working hydraulic cutterhead. For logistical reasons (e.g., the dredge's side to side swinging) and safety concerns (e.g., presence of pipelines, anchor chain, high currents, and mobile workboats) sampling could only be conducted while moored to the dredge boat.

Turbidity and TSS samples were taken at 0.5, 6, and 11-meter depths while water samples for contaminant testing were only taken at the 6 and 11-meter increments. Using a data logging YSI 6600 water quality meter turbidity, temperature, salinity, dissolved oxygen, and pH were recorded every 2 seconds at each of three depths for at total of 15 minutes during active dredging. Because the dredge barge swings in a 400 foot arch while dredging, the swing position was recorded on field sheets every minute during the data logging. Slightly starboard of the center position sampling was more likely to be in the turbidity plume created at the cutterhead while the extreme starboard and port positions would be out of the plume 200 feet from the cutter head. Dredge boat swing position and swing rate varied according to bottom hardness, depth of cut, and ambient depth and other conditions deemed necessary by the captain who operated independently of the environmental sampling team.

Figure 3-1. Pullen dredge boat working in Reach C of the Delaware River in spring 2010

Figure 3-2. Versar sampling vessel, RV Integrity, moored along the starboard side of the Pullen dredge approximately 200 feet from where the cutterhead contacted the river bottom

The YSI meter was attached horizontally to a Wildco® opening and closing sample bottle (Figure 3-3). After 15 minutes of data logging at depth three water samples for TSS measurements were taken by sending a weighted tripping mechanism down the cable to close the bottle. The field NTU on the YSI hand held display was recorded when the bottle tripped shut. TSS samples were taken at port, center, and starboard swing positions whenever possible. Water samples for contaminant testing were taken during Event 2 (two rounds of collections) using a peristaltic pump and a Teflon® hose attached to the closing sample bottle. Upriver and downriver background samples were taken approximately 1/2 mile away from the dredge boat for each sampling event. A data logging water quality cast from surface to 11-meters was taken along with TSS and contaminant sampling at 0.5, 6 and 11-meter depths similar to the collection taken while moored to the Pullen. Only one round of background samples was taken per event. To characterize the grain size of the dredged material sediment samples were taken in front to the cutterhead with a ponar grab. During Event 2 water sampling for contaminants, the ponar grab was decontaminated with an alconox wash, an acetone rinse, and a final deionized water rinse before obtaining sediment samples for bulk sediment testing.

Figure 3-3. YSI water quality meter attached to open sample bottle for the Point of Dredge TSS and turbidity testing in Reach C of the Delaware River Deepening project

All water and sediment samples were labeled and shipped on ice to Test America laboratories in Pittsburgh, PA for analysis. TSS samples were processed the next day in Versar's sediment laboratory in Columbia, MD. Contaminant testing included Pesticides, PCBs (as Aroclors and congener-specific), dioxins and furans, semi-volatile organics, metals and inorganics, and dissolved and particulate organic carbon. Only the 11-meter depth water samples and the bulk sediment sample taken in Event 2 were tested for high resolution congener specific PCBs and dioxins and furans.

The field measurements of turbidity (NTUs) fluctuated in real time due to the flow by of particles making the exact turbidity at the time the Wildco® bottle closed subject to some uncertainty. Therefore turbidity was re-measured in the laboratory using the same YSI meter just before filtering the water through the filter pad for the TSS analysis. Regression analysis was run on both field and laboratory NTUs against the sample specific gravimetric measurement of TSS.

3.2 RESULTS

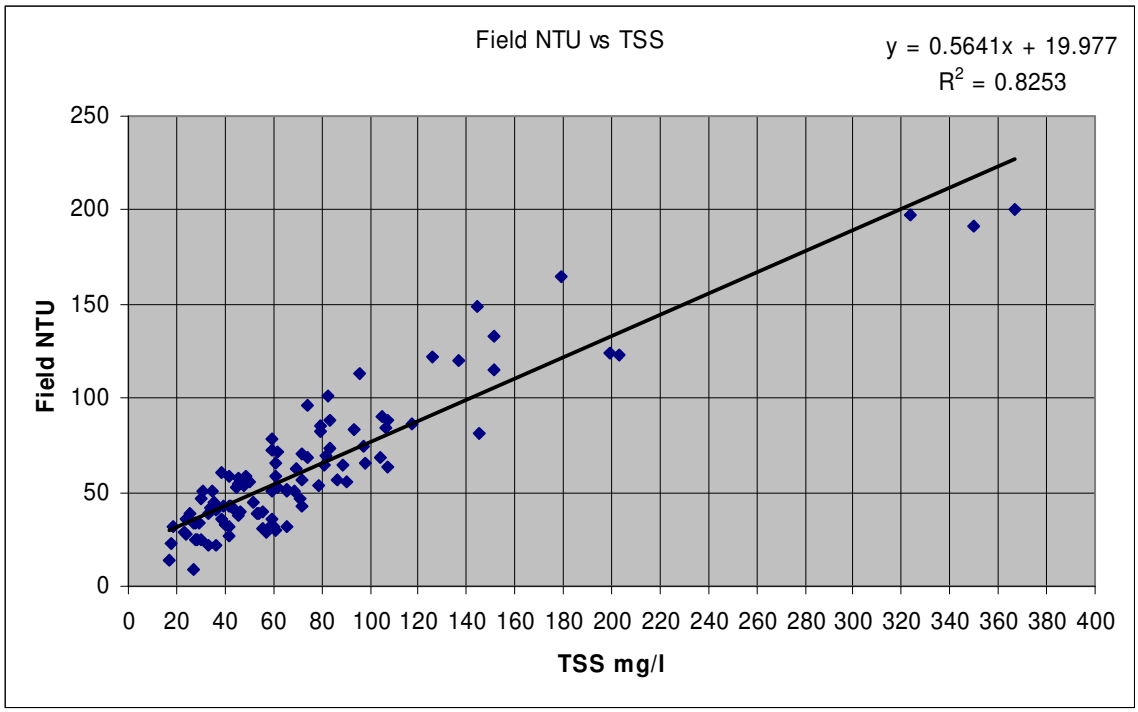
3.2.1 Turbidity

Among the four sampling events for TSS and turbidity a total of 104 paired samples were collected. The highest TSS concentration measured was 367 mg/L with a corresponding lab NTU of 228 while the lowest values in the data series was a TSS of 17 mg/L and a lab NTU of 27. Figure 3-4 presents the regression analysis of the field and lab turbidity, respectively. In the controlled laboratory environment the lab NTU regression had a slightly better R^2 of 0.88 relative to the field turbidity regression with an R^2 of 0.83. Table 3-2 presents the expected turbidity value that corresponds to various TSS concentrations using the laboratory based regression. Based on the regression, turbidity readings of 168 or less meets the 250 mg/l TSS water quality goal 200 feet from the hydraulic cutterhead.

Table 3-2. Expected NTUs at various mg/l TSS using lab based regression equation; ($y = 0.5715x + 24.878$)

y (NTU)	x (TSS)
167.8	250
139.2	200
110.6	150
82.0	100
53.5	50

Among the four point of dredge sampling events over 16,000 measurements of turbidity were logged at 0.5, 6 and 11 meter depth increments during active dredging. These data were binned into 5 NTU categories from 0 to 300 NTUs (for a total of 60 bins) and the frequency of occurrence in each category calculated for each depth increment (Figure 3-5). At the point of dredging essentially no values over 168 NTUs were observed at the surface during active dredging and only a small percentage of the 6 and 11 meter observations were over 168 NTUs. Background measurements logged during a slowly descending surface to 11 meter cast had a similar turbidity pattern to that observed at the 11-m depth increment 200 feet behind the working cutterhead. Eighteen percent of the background turbidity measurements were higher than 168 NTUs (primarily recorded from the lower depths), while 12% of the 11-m and 4% of the 6-m turbidity values were over this benchmark.



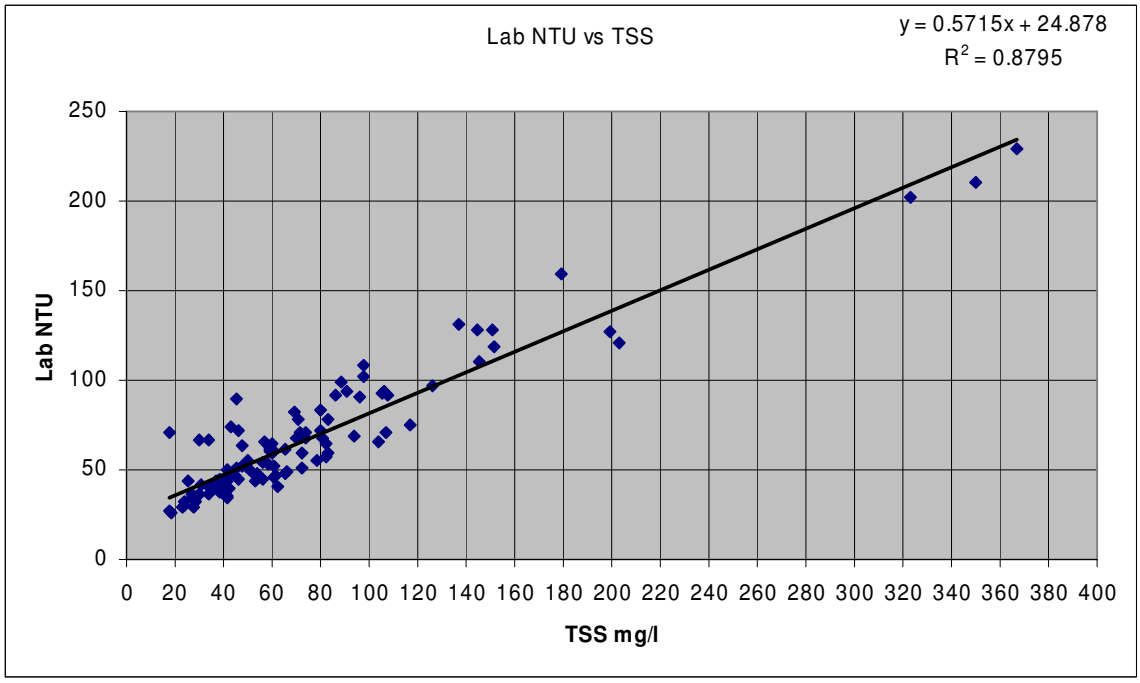


Figure 3-4. Results of regression analysis of field and laboratory turbidity measurements relative to TSS concentrations for samples collected on and around the Pullen dredge boat in the spring of 2010

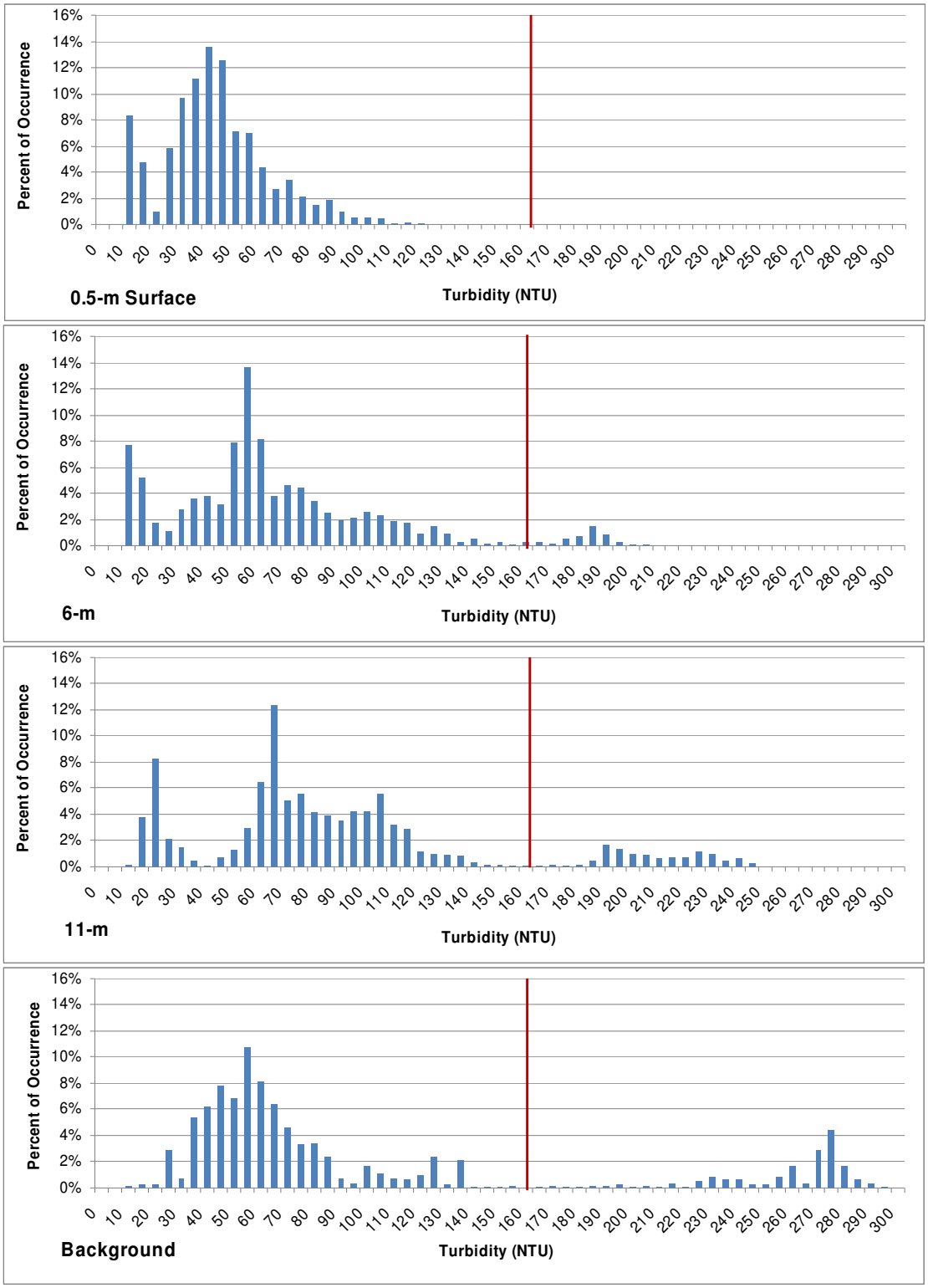


Figure 3-5. Frequency distribution of turbidity measurements in 5 NTU increments observed at 0.5, 6, and 11 meter depths 200 feet down current of the working cutterhead and at upriver and downriver background stations monitored in Reach C during spring 2010.

3.2.2 Contaminants

Contaminant samples collected during Event 2 (both Round 1 and 2) at the 6 and 11 meter depth increments suggest that water quality behind the working dredge was maintained. Tables 3-3 through 3-16 present the Pesticides/PCBs, semi-volatile organics, total metals, dissolved metals for the 11-m, 6-m and background samples. With the exception of total Aluminum, none of the inorganic parameters were measured in concentrations above their respective acute and chronic criteria for both DNREC and DRBC published water quality criteria. Although total aluminum concentrations at the 11 meter sample depth was over the acute criteria (Table 3-5), the observed concentrations were within the range reported for the upriver and downriver background samples (Table 3-13). The DDT pesticide breakdown byproducts DDE and DDD were slightly over the chronic criteria of 0.001 µg/L in the point of dredge 11 meter sample for Round 2 (Table 3-3), but similar concentrations for DDE over the chronic criteria were observed in the background 11 meter samples (Table 3-11). All other pesticides and semi-volatile organics were either not detected or below existing water quality criteria. Contaminant sampling at the 6 meter depth increment also resulted in total aluminum concentrations over acute criteria (Table 3-9) but again concentrations near the point of dredging was in the same range as the background samples (Table 3-13). Pesticides and semi-volatile organics at the 6 meter depth increment were either not detected or below existing water quality criteria (Tables 3-7 and 3-8).

Congener-specific high resolution PCB analyses were conducted on the 11- meter point of dredge Round 1 and 2 samples and the 11 meter upriver and downriver background samples. The sum of congeners was orders of magnitude below DNREC and DRBC acute and chronic water quality for total PCBs (Table 3-15). While there are no water quality criteria established for dioxin and furans for the Delaware River, the sum of homologs suggests point of dredge concentrations were in a similar range to those observed in the background samples (Table 3-16).

Table 3-3. Point of Dredge 11-m Pesticide and PCB Aroclor Data

Sample ID		**C-11m (EVENT 2 ROUND 1)**	**C-11m (EVENT 2 ROUND 2)**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501013**	**C0D060501015**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010				
GCSEMI							
4,4-DDD	µg/L	ND	**0.0013**	1.1	0.001	0.55	0.001
4,4-DDE	µg/L	0.0014	**0.0016**	1.1	0.001	0.55	0.001
4,4-DDT	µg/L	ND	ND	1.1	0.001	0.55	0.001
Aldrin	µg/L	ND	ND	3.0	none	1.5	none
alpha-BHC	µg/L	ND	ND				
alpha-Chlordane	µg/L	ND	ND				
Aroclor 1016	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1221	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1232	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1242	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1248	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1254	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1260	µg/L	ND	ND	none	0.014	1.0	0.014
beta-BHC	µg/L	ND	ND				
Chlordane (technical)	µg/L	ND	ND	2.4	0.0043	1.2	0.0043
Chlorpyrifos	µg/L	ND	ND	0.083	0.041	0.083	0.041
delta-BHC	µg/L	ND	ND				
Dieldrin	µg/L	0.0012	0.0015	0.24	0.056	1.25	0.0019
Endosulfan I	µg/L	ND	ND	0.22	0.056	0.11	0.056
Endosulfan II	µg/L	ND	ND	0.22	0.056	0.11	0.056
Endosulfan sulfate	µg/L	ND	ND				
Endrin	µg/L	ND	ND	0.086	0.036	0.09	0.0023
Endrin aldehyde	µg/L	ND	ND				
Endrin ketone	µg/L	ND	ND				
gamma-BHC (Lindane)	µg/L	ND	0.0035	none	none	1.0	0.08
gamma-Chlordane	µg/L	ND	ND				
Heptachlor	µg/L	0.0022	0.0022	0.52	0.0038	0.26	0.0038
Heptachlor epoxide	µg/L	ND	ND				
Methoxychlor	µg/L	ND	ND	none	0.03	none	none
Parathion	µg/L	ND	ND	0.065	0.013	0.065	0.013
Toxaphene	µg/L	ND	ND	0.73	0.0002	0.73	0.0002

Table 3-4. Point of Dredge 11-m Semi-volatile Data

Sample ID		C-11m (EVENT 2 ROUND 1)	C-11m (EVENT 2 ROUND 2)	DNREC	DNREC	DRBC	DRBC
Lab Report ID		**C0D060501013**	**C0D060501015**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010				
MSSEMI							
1,1-Biphenyl	µg/L	ND	ND				
1,2,4-Trichlorobenzene	µg/L	ND	ND				
1,2-Dichlorobenzene	µg/L	ND	ND				
1,2-Diphenylhydrazine	µg/L	ND	ND				
1,3-Dichlorobenzene	µg/L	ND	ND				
1,4-Dichlorobenzene	µg/L	ND	ND				
2,4,5-Trichlorophenol	µg/L	ND	ND				
2,4,6-Trichlorophenol	µg/L	ND	ND				
2,4-Dichlorophenol	µg/L	ND	ND				
2,4-Dimethylphenol	µg/L	ND	ND				
2,4-Dinitrophenol	µg/L	ND	ND				
2,4-Dinitrotoluene	µg/L	ND	ND				
2,6-Dinitrotoluene	µg/L	ND	ND				
2-Chloronaphthalene	µg/L	ND	ND				
2-Chlorophenol	µg/L	ND	ND				
2-Methylnaphthalene	µg/L	ND	0.013				
2-Methylphenol	µg/L	ND	ND				
2-Nitroaniline	µg/L	ND	ND				
2-Nitrophenol	µg/L	ND	ND				
3,3-Dichlorobenzidine	µg/L	ND	ND				
3-Nitroaniline	µg/L	ND	ND				
4,6-Dinitro-2-methylphenol	µg/L	ND	ND				
4-Bromophenyl phenyl ether	µg/L	ND	ND				
4-Chloro-3-methylphenol	µg/L	ND	ND				
4-Chloroaniline	µg/L	ND	ND				
4-Chlorophenyl phenyl ether	µg/L	ND	ND				
4-Methylphenol	µg/L	ND	ND				
4-Nitroaniline	µg/L	ND	ND				
4-Nitrophenol	µg/L	ND	ND				
Acenaphthene	µg/L	ND	ND				
Acenaphthylene	µg/L	ND	ND				
Acetophenone	µg/L	ND	ND				
Anthracene	µg/L	ND	ND				
Atrazine	µg/L	ND	ND				
Benzaldehyde	µg/L	ND	0.89				
Benzidine	µg/L	ND	ND				
Benzo(a)anthracene	µg/L	ND	ND				

Table 3-4. (Continued)

Sample ID		C-11m (EVENT 2 ROUND 1)	C-11m (EVENT 2 ROUND 2)	DNREC	DNREC	DRBC	DRBC
Lab Report ID		**C0D060501013**	**C0D060501015**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010				
Benzo(a)pyrene	µg/L	ND	ND				
Benzo(b)fluoranthene	µg/L	ND	ND				
Benzo(ghi)perylene	µg/L	ND	ND				
Benzo(k)fluoranthene	µg/L	ND	ND				
bis(2-Chloroethoxy)methane	µg/L	ND	ND				
bis(2-Chloroethyl) ether	µg/L	ND	ND				
bis(2-Chloroisopropyl) ether	µg/L	ND	ND				
bis(2-Ethylhexyl) phthalate	µg/L	ND	ND				
Butyl benzyl phthalate	µg/L	0.7	0.63				
Caprolactam	µg/L	ND	ND				
Carbazole	µg/L	ND	ND				
Chrysene	µg/L	ND	ND				
Di-n-butyl phthalate	µg/L	ND	0.12				
Di-n-octyl phthalate	µg/L	ND	ND				
Dibenz(a,h)anthracene	µg/L	ND	ND				
Dibenzofuran	µg/L	ND	ND				
Diethyl phthalate	µg/L	ND	ND				
Dimethyl phthalate	µg/L	ND	ND				
Fluoranthene	µg/L	0.041	0.031				
Fluorene	µg/L	ND	ND				
Hexachlorobenzene	µg/L	ND	ND				
Hexachlorobutadiene	µg/L	ND	ND				
Hexachlorocyclopentadiene	µg/L	ND	ND				
Hexachloroethane	µg/L	ND	ND				
Indeno(1,2,3-cd)pyrene	µg/L	ND	ND				
Isophorone	µg/L	ND	ND				
N-Nitrosodi-n-propylamine	µg/L	ND	ND				
N-Nitrosodimethylamine	µg/L	ND	ND				
N-Nitrosodiphenylamine	µg/L	ND	ND				
Naphthalene	µg/L	ND	ND				
Nitrobenzene	µg/L	ND	ND				
Pentachlorophenol	µg/L	ND	ND	8.72	6.69	9.07	5.73
Phenanthrene	µg/L	0.082	0.099				
Phenol	µg/L	ND	ND				
Pyrene	µg/L	0.035	ND				

Table 3-5. Point of Dredge 11-m Total Metals Data

Sample ID		**C-11m (EVENT 2 ROUND 1)**	**C-11m (EVENT 2 ROUND 2)**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501013**	**C0D060501015**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010				
MET							
Aluminum	µg/L	**2280**	**3660**	750	87	750	87
Antimony	µg/L	0.38	0.42				
Arsenic	µg/L	1.6	2.5	340	150	360	190
Barium	µg/L	36	44.5				
Beryllium	µg/L	0.14	0.24				
Cadmium	µg/L	ND	ND				
Calcium	µg/L	11700	12500				
Chromium	µg/L	10.1	14				
Cobalt	µg/L	1.6	2.5				
Copper	µg/L	5.7	7.8				
Cyanide, Total	µg/L	ND	ND	22	5.2	22	5.2
Iron	µg/L	3530	5600				
Lead	µg/L	5.5	8.1				
Magnesium	µg/L	3970	4890				
Manganese	µg/L	188	272				
Mercury	µg/L	2.1	6.6	1400	77	2400	12
Nickel	µg/L	3.3	4.8				
Potassium	µg/L	2100	2550				
Selenium	µg/L	0.81	0.83	20	5.0	20	5.0
Silver	µg/L	ND	0.053				
Sodium	µg/L	13500	17500				
Thallium	µg/L	ND	ND				
Vanadium	µg/L	5.1	8.8				
Zinc	µg/L	35.7	47.7				

Table 3-6. Point of Dredge 11-m Dissolved Metals Data

Sample ID		**C-11m (EVENT 2 ROUND 1)**	**C-11m (EVENT 2 ROUND 2)**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501013**	**C0D060501015**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010				
MET							
Aluminum-Diss	µg/L	15.8	8				
Antimony-Diss	µg/L	0.34	0.8				
Arsenic-Diss	µg/L	0.84	0.46				
Barium-Diss	µg/L	18.1	17.1				
Beryllium-Diss	µg/L	ND	ND				
Cadmium-Diss	µg/L	ND	ND	1.52	0.20	2.84	0.90
Calcium-Diss	µg/L	11400	12500				
Chromium-Diss	µg/L	5.2	4.8	16	11	16	11
Cobalt-Diss	µg/L	0.057	0.035				
Copper-Diss	µg/L	1.6	1.4	10.25	7.00	13.52	9.25
Iron-Diss	µg/L	46.6	30.4				
Lead-Diss	µg/L	0.37	0.42	47.15	1.84	48	16
Magnesium-Diss	µg/L	3510	4160				
Manganese-Diss	µg/L	14.5	8.9				
Nickel-Diss	µg/L	1.8	1.3	367.08	40.77	1111.87	123.61
Potassium-Diss	µg/L	1490	1710				
Selenium-Diss	µg/L	1.3	1.1				
Silver-Diss	µg/L	ND	ND	1.96	none	2.47	none
Sodium-Diss	µg/L	14000	18300				
Thallium-Diss	µg/L	ND	ND				
Vanadium-Diss	µg/L	ND	0.4				
Zinc-Diss	µg/L	12.1	9.8	91.83	92.58	91.71	83.06

Table 3-7. Point of Dredge 6-m Pesticides and PCB Aroclor Data

Sample ID		**C-6m (EVENT 2 ROUND 1)**	**C-6m (EVENT 2 ROUND 2)**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501014**	**C0D060501016**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010				
GCSEMI							
4,4-DDD	µg/L	ND	0.00094	1.1	0.001	0.55	0.001
4,4-DDE	µg/L	ND	0.001	1.1	0.001	0.55	0.001
4,4-DDT	µg/L	ND	ND	1.1	0.001	0.55	0.001
Aldrin	µg/L	ND	ND	3.0	none	1.5	none
alpha-BHC	µg/L	ND	ND				
alpha-Chlordane	µg/L	ND	ND				
Aroclor 1016	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1221	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1232	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1242	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1248	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1254	µg/L	ND	ND	none	0.014	1.0	0.014
Aroclor 1260	µg/L	ND	ND	none	0.014	1.0	0.014
beta-BHC	µg/L	ND	ND				
Chlordane (technical)	µg/L	ND	ND	2.4	0.0043	1.2	0.0043
Chlorpyrifos	µg/L	ND	ND	0.083	0.041	0.083	0.041
delta-BHC	µg/L	ND	ND				
Dieldrin	µg/L	ND	0.0016	0.24	0.056	1.25	0.0019
Endosulfan I	µg/L	ND	ND	0.22	0.056	0.11	0.056
Endosulfan II	µg/L	0.0011	0.0013	0.22	0.056	0.11	0.056
Endosulfan sulfate	µg/L	ND	ND				
Endrin	µg/L	ND	ND	0.086	0.036	0.09	0.0023
Endrin aldehyde	µg/L	ND	ND				
Endrin ketone	µg/L	ND	ND				
gamma-BHC (Lindane)	µg/L	0.0013	0.002	none	none	1.0	0.08
gamma-Chlordane	µg/L	ND	ND				
Heptachlor	µg/L	0.0032	0.0021	0.52	0.0038	0.26	0.0038
Heptachlor epoxide	µg/L	ND	ND				
Methoxychlor	µg/L	ND	ND	none	0.03	none	none
Parathion	µg/L	ND	ND	0.065	0.013	0.065	0.013
Toxaphene	µg/L	ND	ND	0.73	0.0002	0.73	0.0002

Table 3-8. Point of Dredge 6-m Semi-volatile Data

Sample ID		**C-6m (EVENT 2 ROUND 1)**	**C-6m (EVENT 2 ROUND 2)**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501014**	**C0D060501016**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010				
MSSEMI							
1,1-Biphenyl	µg/L	ND	ND				
1,2,4-Trichlorobenzene	µg/L	ND	ND				
1,2-Dichlorobenzene	µg/L	ND	ND				
1,2-Diphenylhydrazine	µg/L	ND	ND				
1,3-Dichlorobenzene	µg/L	ND	ND				
1,4-Dichlorobenzene	µg/L	ND	ND				
2,4,5-Trichlorophenol	µg/L	ND	ND				
2,4,6-Trichlorophenol	µg/L	ND	ND				
2,4-Dichlorophenol	µg/L	ND	ND				
2,4-Dimethylphenol	µg/L	ND	ND				
2,4-Dinitrophenol	µg/L	ND	ND				
2,4-Dinitrotoluene	µg/L	ND	ND				
2,6-Dinitrotoluene	µg/L	ND	ND				
2-Chloronaphthalene	µg/L	ND	ND				
2-Chlorophenol	µg/L	ND	ND				
2-Methylnaphthalene	µg/L	ND	ND				
2-Methylphenol	µg/L	ND	ND				
2-Nitroaniline	µg/L	ND	ND				
2-Nitrophenol	µg/L	ND	ND				
3,3-Dichlorobenzidine	µg/L	ND	ND				
3-Nitroaniline	µg/L	ND	ND				
4,6-Dinitro-2-methylphenol	µg/L	ND	ND				
4-Bromophenyl phenyl ether	µg/L	ND	ND				
4-Chloro-3-methylphenol	µg/L	ND	ND				
4-Chloroaniline	µg/L	ND	ND				
4-Chlorophenyl phenyl ether	µg/L	ND	ND				
4-Methylphenol	µg/L	ND	ND				
4-Nitroaniline	µg/L	ND	ND				
4-Nitrophenol	µg/L	ND	ND				
Acenaphthene	µg/L	ND	ND				
Acenaphthylene	µg/L	ND	ND				
Acetophenone	µg/L	ND	ND				
Anthracene	µg/L	ND	ND				
Atrazine	µg/L	ND	ND				
Benzaldehyde	µg/L	ND	ND				
Benzidine	µg/L	ND	ND				
Benzo(a)anthracene	µg/L	ND	ND				

Table 3-8. (Continued)

Sample ID		C-6m (EVENT 2 ROUND 1)	C-6m (EVENT 2 ROUND 2)	DNREC	DNREC	DRBC	DRBC
Lab Report ID		**C0D060501014**	**C0D060501016**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010				
Benzo(a)pyrene	µg/L	ND	ND				
Benzo(b)fluoranthene	µg/L	ND	ND				
Benzo(ghi)perylene	µg/L	ND	ND				
Benzo(k)fluoranthene	µg/L	ND	ND				
bis(2-Chloroethoxy)methane	µg/L	ND	ND				
bis(2-Chloroethyl) ether	µg/L	ND	ND				
bis(2-Chloroisopropyl) ether	µg/L	ND	ND				
bis(2-Ethylhexyl) phthalate	µg/L	ND	ND				
Butyl benzyl phthalate	µg/L	0.91	0.51				
Caprolactam	µg/L	ND	ND				
Carbazole	µg/L	ND	ND				
Chrysene	µg/L	ND	ND				
Di-n-butyl phthalate	µg/L	ND	0.12				
Di-n-octyl phthalate	µg/L	ND	ND				
Dibenz(a,h)anthracene	µg/L	ND	ND				
Dibenzofuran	µg/L	ND	ND				
Diethyl phthalate	µg/L	ND	ND				
Dimethyl phthalate	µg/L	ND	ND				
Fluoranthene	µg/L	ND	0.059				
Fluorene	µg/L	ND	ND				
Hexachlorobenzene	µg/L	ND	ND				
Hexachlorobutadiene	µg/L	ND	ND				
Hexachlorocyclopentadiene	µg/L	ND	ND				
Hexachloroethane	µg/L	ND	ND				
Indeno(1,2,3-cd)pyrene	µg/L	ND	ND				
Isophorone	µg/L	ND	ND				
N-Nitrosodi-n-propylamine	µg/L	ND	ND				
N-Nitrosodimethylamine	µg/L	ND	ND				
N-Nitrosodiphenylamine	µg/L	ND	ND				
Naphthalene	µg/L	ND	ND				
Nitrobenzene	µg/L	ND	ND				
Pentachlorophenol	µg/L	ND	ND	8.72	6.69	9.07	5.73
Phenanthrene	µg/L	0.055	0.1				
Phenol	µg/L	ND	ND				
Pyrene	µg/L	ND	0.041				

Table 3-9. Point of Dredge 6-m Total Metals Data

Sample ID		**C-6m (EVENT 2 ROUND 1)**	**C-6m (EVENT 2 ROUND 2)**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501014**	**C0D060501016**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010				
MET							
Aluminum	µg/L	**970**	**2720**	750	87	750	87
Antimony	µg/L	0.34	0.36				
Arsenic	µg/L	1.3	2.2	340	150	360	190
Barium	µg/L	26.4	36.3				
Beryllium	µg/L	0.067	0.11				
Cadmium	µg/L	ND	ND				
Calcium	µg/L	11700	13200				
Chromium	µg/L	6.9	11.7				
Cobalt	µg/L	0.7	1.7				
Copper	µg/L	3.4	6				
Cyanide, Total	µg/L	ND	ND	22	5.2	22	5.2
Iron	µg/L	1550	4040				
Lead	µg/L	2.4	5.7				
Magnesium	µg/L	3750	5270				
Manganese	µg/L	94.7	186				
Mercury	ng/L	5.6	6.1	1400	77	2400	12
Nickel	µg/L	1.5	3.7				
Potassium	µg/L	1860	2600				
Selenium	µg/L	0.74	0.78	20	5.0	20	5.0
Silver	µg/L	ND	ND				
Sodium	µg/L	13800	22400				
Thallium	µg/L	ND	ND				
Vanadium	µg/L	3.9	6				
Zinc	µg/L	20.8	38.4				

Table 3-10. Point of Dredge 6-m Dissolved Metals Data							
Sample ID		**C-6m (EVENT 2 ROUND 1)**	**C-6m (EVENT 2 ROUND 2)**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501014**	**C0D060501016**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010				
MET							
Aluminum-Diss	µg/L	6.2	43.5				
Antimony-Diss	µg/L	0.3	0.34				
Arsenic-Diss	µg/L	0.65	0.73				
Barium-Diss	µg/L	17.7	17.7				
Beryllium-Diss	µg/L	ND	ND				
Cadmium-Diss	µg/L	ND	ND	1.52	0.20	2.84	0.90
Calcium-Diss	µg/L	11100	12500				
Chromium-Diss	µg/L	5.6	5	16	11	16	11
Cobalt-Diss	µg/L	0.064	0.072				
Copper-Diss	µg/L	1.4	1.5	10.25	7.00	13.52	9.25
Iron-Diss	µg/L	32.8	76.7				
Lead-Diss	µg/L	0.29	0.39	47.15	1.84	48	16
Magnesium-Diss	µg/L	3400	4610				
Manganese-Diss	µg/L	25.4	11.9				
Nickel-Diss	µg/L	1.4	1.3	367.08	40.77	1111.87	123.61
Potassium-Diss	µg/L	1420	1860				
Selenium-Diss	µg/L	0.92	1.1				
Silver-Diss	µg/L	ND	ND	1.96	none	2.47	none
Sodium-Diss	µg/L	13700	22500				
Thallium-Diss	µg/L	ND	ND				
Vanadium-Diss	µg/L	ND	0.2				
Zinc-Diss	µg/L	11.3	9.7	91.83	92.58	91.71	83.06

Table 3-11. Point of Dredge Background Pesticide and PCB Aroclor Data

Sample ID		**BGU-11m**	**BGU-6m**	**BGD-11m**	**BGD-6m**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501009**	**C0D060501010**	**C0D060501011**	**C0D060501012**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010	4/1/2010	4/1/2010				
GCSEMI									
4,4-DDD	µg/L	0.00074	0.00078	0.00077	0.00092	1.1	0.001	0.55	0.001
4,4-DDE	µg/L	**0.0013**	**0.0014**	**0.0017**	0.00088	1.1	0.001	0.55	0.001
4,4-DDT	µg/L	ND	ND	ND	ND	1.1	0.001	0.55	0.001
Aldrin	µg/L	ND	ND	ND	ND	3.0	none	1.5	none
alpha-BHC	µg/L	ND	ND	ND	ND				
alpha-Chlordane	µg/L	ND	ND	ND	ND				
Aroclor 1016	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1221	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1232	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1242	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1248	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1254	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
Aroclor 1260	µg/L	ND	ND	ND	ND	none	0.014	1.0	0.014
beta-BHC	µg/L	ND	ND	ND	ND				
Chlordane (technical)	µg/L	ND	ND	ND	ND	2.4	0.0043	1.2	0.0043
Chlorpyrifos	µg/L	ND	ND	ND	ND	0.083	0.041	0.083	0.041
delta-BHC	µg/L	ND	ND	ND	ND				
Dieldrin	µg/L	0.0011	0.0012	0.0014	0.0012	0.24	0.056	1.25	0.0019
Endosulfan I	µg/L	ND	ND	ND	ND	0.22	0.056	0.11	0.056
Endosulfan II	µg/L	0.001	0.0011	0.001	0.0012	0.22	0.056	0.11	0.056
Endosulfan sulfate	µg/L	ND	ND	ND	ND				
Endrin	µg/L	ND	ND	ND	ND	0.086	0.036	0.09	0.0023
Endrin aldehyde	µg/L	ND	ND	ND	ND				
Endrin ketone	µg/L	ND	ND	ND	ND				
gamma-BHC (Lindane)	µg/L	0.0014	0.0014	0.0015	0.0018	none	none	1.0	0.08
gamma-Chlordane	µg/L	ND	ND	ND	ND				
Heptachlor	µg/L	0.0013	0.0012	0.0011	ND	0.52	0.0038	0.26	0.0038
Heptachlor epoxide	µg/L	ND	ND	ND	ND				

Table 3-11. (Continued)

Sample ID		**BGU-11m**	**BGU-6m**	**BGD-11m**	**BGD-6m**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501009**	**C0D060501010**	**C0D060501011**	**C0D060501012**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010	4/1/2010	4/1/2010				
Methoxychlor	µg/L	ND	ND	ND	ND	none	0.03	none	none
Parathion	µg/L	ND	ND	ND	ND	0.065	0.013	0.065	0.013
Toxaphene	µg/L	ND	ND	ND	ND	0.73	0.0002	0.73	0.0002

Table 3-12. Point of Dredge Background Semi-volatile Data

Sample ID		**BGU-11m**	**BGU-6m**	**BGD-11m**	**BGD-6m**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501009**	**C0D060501010**	**C0D060501011**	**C0D060501012**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010	4/1/2010	4/1/2010				
MSSEMI									
1,1-Biphenyl	µg/L	ND	ND	ND	ND				
1,2,4-Trichlorobenzene	µg/L	ND	ND	ND	ND				
1,2-Dichlorobenzene	µg/L	ND	ND	ND	ND				
1,2-Diphenylhydrazine	µg/L	ND	ND	ND	ND				
1,3-Dichlorobenzene	µg/L	ND	ND	ND	ND				
1,4-Dichlorobenzene	µg/L	ND	ND	ND	ND				
2,4,5-Trichlorophenol	µg/L	ND	ND	ND	ND				
2,4,6-Trichlorophenol	µg/L	ND	ND	ND	ND				
2,4-Dichlorophenol	µg/L	ND	ND	ND	ND				
2,4-Dimethylphenol	µg/L	ND	ND	ND	ND				
2,4-Dinitrophenol	µg/L	ND	ND	ND	ND				
2,4-Dinitrotoluene	µg/L	ND	ND	ND	ND				
2,6-Dinitrotoluene	µg/L	ND	ND	ND	ND				
2-Chloronaphthalene	µg/L	ND	ND	ND	ND				
2-Chlorophenol	µg/L	ND	ND	ND	ND				
2-Methylnaphthalene	µg/L	ND	ND	0.014	ND				
2-Methylphenol	µg/L	ND	ND	ND	ND				
2-Nitroaniline	µg/L	ND	ND	ND	ND				
2-Nitrophenol	µg/L	ND	ND	ND	ND				
3,3-Dichlorobenzidine	µg/L	ND	ND	ND	ND				
3-Nitroaniline	µg/L	ND	ND	ND	ND				
4,6-Dinitro-2-methylphenol	µg/L	ND	ND	ND	ND				
4-Bromophenyl phenyl ether	µg/L	ND	ND	ND	ND				
4-Chloro-3-methylphenol	µg/L	ND	ND	ND	ND				
4-Chloroaniline	µg/L	ND	ND	ND	ND				
4-Chlorophenyl phenyl ether	µg/L	ND	ND	ND	ND				
4-Methylphenol	µg/L	ND	ND	ND	ND				

Table 3-12. (Continued)

Sample ID		BGU-11m	BGU-6m	BGD-11m	BGD-6m	DNREC	DNREC	DRBC	DRBC
Lab Report ID		**C0D060501009**	**C0D060501010**	**C0D060501011**	**C0D060501012**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010	4/1/2010	4/1/2010				
4-Nitroaniline	µg/L	ND	ND	ND	ND				
4-Nitrophenol	µg/L	ND	ND	ND	ND				
Acenaphthene	µg/L	ND	0.016	ND	ND				
Acenaphthylene	µg/L	ND	ND	ND	ND				
Acetophenone	µg/L	ND	ND	ND	ND				
Anthracene	µg/L	ND	ND	ND	ND				
Atrazine	µg/L	ND	ND	ND	ND				
Benzaldehyde	µg/L	0.79	0.8	0.8	0.88				
Benzidine	µg/L	ND	ND	ND	ND				
Benzo(a)anthracene	µg/L	ND	0.23	ND	ND				
Benzo(a)pyrene	µg/L	ND	0.25	ND	ND				
Benzo(b)fluoranthene	µg/L	ND	0.43	ND	ND				
Benzo(ghi)perylene	µg/L	ND	0.43	ND	ND				
Benzo(k)fluoranthene	µg/L	ND	0.37	ND	ND				
bis(2-Chloroethoxy)methane	µg/L	ND	ND	ND	ND				
bis(2-Chloroethyl) ether	µg/L	ND	ND	ND	ND				
bis(2-Chloroisopropyl) ether	µg/L	ND	ND	ND	ND				
bis(2-Ethylhexyl) phthalate	µg/L	ND	ND	ND	ND				
Butyl benzyl phthalate	µg/L	0.23	ND	ND	1				
Caprolactam	µg/L	ND	ND	ND	ND				
Carbazole	µg/L	ND	ND	ND	ND				
Chrysene	µg/L	ND	0.27	ND	ND				
Di-n-butyl phthalate	µg/L	ND	ND	ND	0.14				
Di-n-octyl phthalate	µg/L	ND	0.34	ND	ND				
Dibenz(a,h)anthracene	µg/L	ND	0.4	ND	ND				
Dibenzofuran	µg/L	ND	ND	ND	ND				
Diethyl phthalate	µg/L	ND	ND	ND	ND				
Dimethyl phthalate	µg/L	ND	ND	ND	ND				

Table 3-12. (Continued)

Sample ID		**BGU-11m**	**BGU-6m**	**BGD-11m**	**BGD-6m**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501009**	**C0D060501010**	**C0D060501011**	**C0D060501012**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010	4/1/2010	4/1/2010				
Fluoranthene	µg/L	0.02	0.042	0.026	0.031				
Fluorene	µg/L	ND	ND	ND	ND				
Hexachlorobenzene	µg/L	ND	ND	ND	ND				
Hexachlorobutadiene	µg/L	ND	ND	ND	ND				
Hexachlorocyclopentadiene	µg/L	ND	ND	ND	ND				
Hexachloroethane	µg/L	ND	ND	ND	ND				
Indeno(1,2,3-cd)pyrene	µg/L	ND	0.45	ND	ND				
Isophorone	µg/L	ND	ND	ND	ND				
N-Nitrosodi-n-propylamine	µg/L	ND	ND	ND	ND				
N-Nitrosodimethylamine	µg/L	ND	ND	ND	ND				
N-Nitrosodiphenylamine	µg/L	ND	ND	ND	ND				
Naphthalene	µg/L	ND	0.027	0.035	0.015				
Nitrobenzene	µg/L	ND	ND	ND	ND				
Pentachlorophenol	µg/L	ND	ND	ND	ND	8.72	6.69	9.07	5.73
Phenanthrene	µg/L	0.054	0.06	0.08	0.084				
Phenol	µg/L	ND	ND	ND	ND				
Pyrene	µg/L	0.021	0.043	0.031	0.023				

Table 3-13. Point of Dredge background Total Metals Data

Sample ID		**BGU-11m**	**BGU-6m**	**BGD-11m**	**BGD-6m**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501009**	**C0D060501010**	**C0D060501011**	**C0D060501012**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010	4/1/2010	4/1/2010				
MET									
Aluminum	µg/L	**1460**	**2460**	**5200**	**2700**	750	87	750	87
Antimony	µg/L	0.83	0.5	0.54	0.39				
Arsenic	µg/L	0.78	1.4	2.2	1.5	340	150	360	190
Barium	µg/L	29.4	37.8	55.3	36.4				
Beryllium	µg/L	0.1	0.16	0.3	0.089				
Cadmium	µg/L	ND	ND	ND	ND				
Calcium	µg/L	12000	12200	13600	13000				
Chromium	µg/L	7.3	9.8	17.9	11.6				
Cobalt	µg/L	0.95	1.7	3.5	1.9				
Copper	µg/L	3.9	5.7	10.1	6.1				
Cyanide, Total	µg/L	ND	ND	ND	ND	22	5.2	22	5.2
Iron	µg/L	2150	3760	7890	4230				
Lead	µg/L	3.5	5.7	11.6	6.2				
Magnesium	µg/L	3930	4160	5750	5110				
Manganese	µg/L	108	193	378	198				
Mercury	ng/L	10.4	4.7	**37.6**	5.6	1400	77	2400	12
Nickel	µg/L	2.1	3.3	6.9	3.9				
Potassium	µg/L	2020	2170	3030	2520				
Selenium	µg/L	1.2	0.52	0.7	0.58	20	5.0	20	5.0
Silver	µg/L	ND	ND	0.069	ND				
Sodium	µg/L	14400	14200	20500	20600				
Thallium	µg/L	ND	ND	ND	ND				
Vanadium	µg/L	4.4	5.3	9.4	5.3				
Zinc	µg/L	26.6	36.6	66.4	35.8				

Table 3-14. Point of Dredge Background Dissolved Metals Data

Sample ID		**BGU-11m**	**BGU-6m**	**BGD-11m**	**BGD-6m**	**DNREC**	**DNREC**	**DRBC**	**DRBC**
Lab Report ID		**C0D060501009**	**C0D060501010**	**C0D060501011**	**C0D060501012**	**Acute**	**Chronic**	**Acute**	**Chronic**
Sample Date		4/1/2010	4/1/2010	4/1/2010	4/1/2010				
MET									
Aluminum-Diss	µg/L	7	9.9	8.3	126				
Antimony-Diss	µg/L	0.33	0.91	0.33	0.27				
Arsenic-Diss	µg/L	0.63	1.2	0.42	0.89				
Barium-Diss	µg/L	17.8	18.4	15.8	16.8				
Beryllium-Diss	µg/L	ND	ND	ND	ND				
Cadmium-Diss	µg/L	ND	ND	ND	ND	1.52	0.20	2.84	0.90
Calcium-Diss	µg/L	12000	12000	12400	12400				
Chromium-Diss	µg/L	5.2	6	5.7	5.8	16	11	16	11
Cobalt-Diss	µg/L	0.058	0.063	0.035	0.11				
Copper-Diss	µg/L	1.1	1.4	1.4	1.7	10.25	7.00	13.52	9.25
Iron-Diss	µg/L	30.6	30.3	29.6	218				
Lead-Diss	µg/L	0.42	0.4	0.45	0.66	47.15	1.84	48	16
Magnesium-Diss	µg/L	3620	3640	4280	4440				
Manganese-Diss	µg/L	11.2	14.1	3.7	12.1				
Nickel-Diss	µg/L	3.4	1.5	1.6	2.2	367.08	40.77	1111.87	123.61
Potassium-Diss	µg/L	1570	1500	1730	1790				
Selenium-Diss	µg/L	1.2	1.2	1.1	1				
Silver-Diss	µg/L	ND	ND	ND	ND	1.96	none	2.47	none
Sodium-Diss	µg/L	14600	14600	19800	20600				
Thallium-Diss	µg/L	ND	ND	ND	ND				
Vanadium-Diss	µg/L	ND	0.2	0.78	1.7				
Zinc-Diss	µg/L	15.1	10.2	10.6	11.9	91.83	92.58	91.71	83.06

Table 3-15. PCB homolog concentrations observed at the 11 meter depths 200 feet down current of the working cutterhead and at upriver and downriver background stations sampled in Reach C during spring 2010

		BGU-11m	BGD-11m	11-m (ROUND 1)	11-m (ROUND 2)	DNREC Acute	DNREC Chronic	DRBC Acute	DRBC Chronic
Monochlorobiphenyl	ng/L	0.033	0.014	0.018	0.014				
Dichlorobiphenyl	ng/L	0.17	0.15	0.13	0.1				
Trichlorobiphenyl	ng/L	0.45	0.46	0.4	0.32				
Tetrachlorobiphenyl	ng/L	0.89	1.2	0.89	0.82				
Pentachlorobipheny	ng/L	1.7	2.5	1.7	1.5				
Hexachlorobiphenyl	ng/L	1.5	2	1.3	1.3				
Heptachlorobiphenyl	ng/L	0.85	1	0.68	0.61				
Octachlorobiphenyl	ng/L	0.34	0.47	0.26	0.26				
Nonachlorobiphenyl	ng/L	0.49	1.2	0.48	0.53				
Decachlorobiphenyl	ng/L	0.48	1.6	0.65	0.58				
Sum of PCB Congeners	ng/L	6.903	10.594	6.508	6.034	none	14,000	1,000,000	14,000

Table 3-16. Dioxin and Furan homolog concentrations observed at the 11 meter depths 200 feet down current of the working cutterhead and at upriver and downriver background stations sampled in Reach C during spring 2010

		BGU-11m	**BGD-11m**	**11-m (ROUND 1)**	**11-m (ROUND 2)**
Total HpCDD	pg/L	12	15	17	26
Total HpCDF	pg/L	ND	ND	3.3	2.6
Total HxCDD	pg/L	3.5	ND	ND	9
Total HxCDF	pg/L	1.1	ND	ND	ND
Total PeCDD	pg/L	ND	ND	ND	ND
Total PeCDF	pg/L	1.6	ND	ND	ND
Total TCDD	pg/L	ND	ND	ND	ND
Total TCDF	pg/L	ND	ND	ND	8.5
OCDD	pg/L	110	140	130	270
OCDF	pg/L	<95	6.7	9.6	7
Sum of Dioxin Homologs	pg/L	128.2	161.7	159.9	323.1

3.3 CONTAMINANT LEVELS RELATIVE TO BACKGROUND

To evaluate whether the dredging activities elevated contaminant concentrations the minimum, maximum, and average concentrations were calculated for all the 6 and 11 meter samples taken at the point of dredge and compared to the concentrations reported for the background samples. Only parameters that were detected in both cutterhead plume and background samples were included in this comparison. With the exception of 4,4-DDD, gamma-BHC, and Heptachlor the ratio of mean Point of Dredge concentration to mean background concentration was near or below 1.0. The results of this analysis suggest that concentrations behind the cutterhead (e.g., the 6 and 11 meter samples) were not dramatically altered relative to parameters measured in the background collections (Table 3-17).

Table 3-17. Comparison of the minimum, maximum, and average contaminant concentrations observed at the Point of Dredge samples relative to those recorded in the background samples taken near the dredge boat Pullen while working in Reach C during spring of 2010. Values above 1.0 in the ratio column indicate Point of Dredge concentration was higher than background. Values less than 1.0 indicate background concentration was higher than Point of Dredge concentration.

		Point of Drege Min	Point of Dredge Max	Ave Point of Dredge	Back-ground Min	Back-ground Max	Ave Back-ground	Ratio Dredge/ Back-ground
GCSEMI								
4,4-DDD	µg/L	0.00094	0.0013	0.0013	0.00074	0.00092	0.0008025	1.62
4,4-DDE	µg/L	0.001	0.0016	0.0015	0.00088	0.0017	0.00132	1.14
Dieldrin	µg/L	0.0012	0.0016	0.00135	0.0011	0.0014	0.001225	1.10
Endosulfan II	µg/L	0.0011	0.0013	0.0011	0.001	0.0012	0.001075	1.02
gamma-BHC (Lindane)	µg/L	0.0013	0.0035	0.0035	0.0014	0.0018	0.001525	2.30
Heptachlor	µg/L	0.0021	0.0032	0.0022	0.0011	0.0013	0.0012	1.83
MET								
Aluminum	µg/L	970	3660	2970	1460	5200	2955	1.01
Aluminum-Diss	µg/L	6.2	43.5	11.9	7	126	37.8	0.31
Antimony	µg/L	0.34	0.42	0.4	0.39	0.83	0.565	0.71
Antimony-Diss	µg/L	0.3	0.8	0.57	0.27	0.91	0.46	1.24
Arsenic	µg/L	1.3	2.5	2.05	0.78	2.2	1.47	1.39
Arsenic-Diss	µg/L	0.46	0.84	0.65	0.42	1.2	0.785	0.83
Barium	µg/L	26.4	44.5	40.25	29.4	55.3	39.725	1.01
Barium-Diss	µg/L	17.1	18.1	17.6	15.8	18.4	17.2	1.02
Beryllium	µg/L	0.067	0.24	0.19	0.089	0.3	0.162	1.17
Calcium	µg/L	11700	13200	12100	12000	13600	12700	0.95
Calcium-Diss	µg/L	11100	12500	11950	12000	12400	12200	0.98
Chromium	µg/L	6.9	14	12.05	7.3	17.9	11.65	1.03
Chromium-Diss	µg/L	4.8	5.6	5	5.2	6	5.675	0.88
Cobalt	µg/L	0.7	2.5	2.05	0.95	3.5	2.0125	1.02
Cobalt-Diss	µg/L	0.035	0.072	0.046	0.035	0.11	0.067	0.69
Copper	µg/L	3.4	7.8	6.75	3.9	10.1	6.45	1.05
Copper-Diss	µg/L	1.4	1.6	1.5	1.1	1.7	1.4	1.07
Iron	µg/L	1550	5600	4565	2150	7890	4507.5	1.01
Iron-Diss	µg/L	30.4	76.7	38.5	29.6	218	77.125	0.50
Lead	µg/L	2.4	8.1	6.8	3.5	11.6	6.75	1.01
Lead-Diss	µg/L	0.29	0.42	0.395	0.4	0.66	0.483	0.82
Magnesium	µg/L	3750	5270	4430	3930	5750	4737.5	0.94
Magnesium-Diss	µg/L	3400	4610	3835	3620	4440	3995	0.96
Manganese	µg/L	94.7	272	230	108	378	219.25	1.05
Manganese-Diss	µg/L	8.9	25.4	11.7	3.7	14.1	10.275	1.14
Mercury	µg/L	2.1	6.6	4.35	4.7	37.6	14.575	0.30
Nickel	µg/L	1.5	4.8	4.05	2.1	6.9	4.05	1.00
Nickel-Diss	µg/L	1.3	1.8	1.55	1.5	3.4	2.175	0.71

Table 3-17. (Continued)

		Point of Dredge Min	Point of Dredge Max	Ave Point of Dredge	Back-ground Min	Back-ground Max	Ave Back-ground	Ratio Dredge/ Back.
Potassium	µg/L	1860	2600	2325	2020	3030	2435	0.95
Potassium-Diss	µg/L	1420	1860	1600	1500	1790	1647.5	0.97
Selenium	µg/L	0.74	0.83	0.82	0.52	1.2	0.75	1.09
Selenium-Diss	µg/L	0.92	1.3	1.2	1	1.2	1.125	1.07
Silver	µg/L	0.053	0.053	0.053	0.069	0.069	0.069	0.77
Sodium	µg/L	13500	22400	15500	14200	20600	17425	0.89
Sodium-Diss	µg/L	13700	22500	16150	14600	20600	17400	0.93
Vanadium	µg/L	3.9	8.8	6.95	4.4	9.4	6.1	1.14
Vanadium-Diss	µg/L	0.2	0.4	0.4	0.2	1.7	0.89	0.45
Zinc	µg/L	20.8	47.7	41.7	26.6	66.4	41.35	1.01
Zinc-Diss	µg/L	9.7	12.1	10.95	10.2	15.1	11.95	0.92
DOC	mg/L	2.9	3	2.9	2.8	3	2.95	0.98
POC	mg/L	1.7	6	5.25	4.1	7.8	5.225	1.00
TSS	mg/L	34.4	135	115.1	104	182	124.25	0.93
MSSEMI								
2-Methylnaphthalene	µg/L	0.013	0.013	0.013	0.014	0.014	0.014	0.93
Benzaldehyde	µg/L	0.89	0.89	0.89	0.79	0.88	0.818	1.09
Butyl benzyl phthalate	µg/L	0.51	0.91	0.665	0.23	1	0.615	1.08
Di-n-butyl phthalate	µg/L	0.12	0.12	0.12	0.14	0.14	0.14	0.86
Fluoranthene	µg/L	0.031	0.059	0.036	0.02	0.042	0.030	1.21
Naphthalene	µg/L	0.026	0.026	0.026	0.015	0.035	0.026	1.01
Phenanthrene	µg/L	0.055	0.1	0.0905	0.054	0.084	0.070	1.30
Pyrene	µg/L	0.035	0.041	0.035	0.021	0.043	0.030	1.19

4.0 MASS BALANCE RESULTS

The act of hydraulic dredging removes Delaware River sediments and associated contaminants and places them in a CDF where the pumped slurry is dewatered. Most of the contaminants in the sediment settles out and remains in the upland disposal site while a percentage stays in suspension and is ultimately discharged back into the river through the weir. Previous studies funded by the Philadelphia District evaluating maintenance dredging operations in the Marcus Hook area indicated that over 95% of the contaminants are sequestered in the CDF[4], a net benefit from an aquatic toxicology perspective. CDF retention efficiencies can be calculated by multiplying the mean contaminant concentration in the inlet samples by an estimate of the total kilograms of material pumped into the CDF and comparing that to similar estimates of total kilograms of contaminants discharged at the weir over a prescribed period of time. To evaluate the CDF efficiencies for the Reach C deepening work dredging logs from the Pullen were obtained and the accumulative cubic yards as of June 7, 2010 for "new work" was inputted into a mass balance spread sheet (1,011,561 cubic yards placed into cell 2 of the Killcohook CDF). Total cubic yards of dredged material were converted to total kg of dry sediment by multiplying cubic yards times 830.7 as per Greene (2010[5]). Inlet sample data from the 3/18, 3/24, 4/19, and 5/17 collections (Appendix A) were used to calculate average inlet contaminant concentrations. Using the weir discharge flow data recorded by the ISCO area velocity meters installed in the discharge pipes between 3/15 and 6/7/2010 the total liters discharged for the time period was calculated. Multiplying the total discharge (3.1 billion liters) by the mean weir concentrations measured among 15 weir samples collected between 3/18 and 5/4 at cell 2 provides an estimate of the total kilograms of contaminants that were released back into the Delaware River as of June 7. Only parameters detected in both the inlet and weir samples were included in the analysis and non-detections were assumed to be zero. Total metals data, which includes dissolved metals, was used for this analysis.

The estimated contaminant sequestering efficiencies for Killcolhook cell 2 CDF were high, all above 90% (Table 4-1). The pesticide Dieldrin had the lowest retention efficiency of 94.7% largely due to one weir sample with high concentration 0.013 ug/L on April 22. Aldrin had retention efficiency of 97%, while 98% of the Aroclor 1242 PCBs, alpha-BHC, and Endosulfan sulfate were captured by the CDF. All other metal and organic parameters had retention efficiencies of 99% or better. Delaware River dredged material has been used for a variety of beneficial uses. Past testing of dried dredged material has shown that concentrations of contaminants retained in the sites are not high enough to require any special consideration for how the material is used.

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[4] **Burton and Farrar 2003.** Contaminant Sequestering And Water Quality Discharges At Confined Disposal Facilities. In: M. Pellei and A. Porta (Eds.), Remediation of Contaminated Sediments—2003. Proceedings of the Second International Conference on Remediation of Contaminated Sediments (Venice, Italy; 30 Sep–3 Oct 2003). ISBN 1-57477- 143-4, published by Battelle Press, Columbus, OH, www.battelle.org/bookstore.

[5] **Greene, R. 2010**. An Evaluation of Toxic Contaminants in the Sediments of the Tidal Delaware River and Potential Impacts Resulting from Deepening the Main Navigation Channel in Reach C. Delaware Department of Natural Resources and Environmental Control, Division of Water Resources Watershed Assessment Branch, Dover, DE. Final of June 7, 2010.

Table 4-1. Mass balance estimate and estimated Cell 2 sequestering efficiencies (%) at Killcohook among the various contaminants detected in both the inlet and weir samples.

Total Liters Discharged from Cell 2	3,103,198,154
Total Kg pumped into Cell 2	840,303,722.70

Weir/Inlet Parameters Detected	Unit	Ave Weir Con.	Total kg Discharged from Weir	Ave Inlet Con.	Unit	Total kg into CDF	Percent (%) Sequestered in CDF
GCSEMI							
4,4-DDD	µg/L	0.002	0.007	401.150	ug/kg	337.088	99.9979
4,4-DDE	µg/L	0.002	0.007	36.925	ug/kg	31.028	99.9788
4,4-DDT	µg/L	0.007	0.022	210.770	ug/kg	177.111	99.9873
Aldrin	µg/L	0.001	0.004	0.185	ug/kg	0.155	97.2053
alpha-BHC	µg/L	0.002	0.006	0.295	ug/kg	0.248	97.7663
Aroclor 1242	µg/L	0.044	0.137	10.000	ug/kg	8.403	98.3751
beta-BHC	µg/L	0.005	0.014	2.000	ug/kg	1.681	99.1599
Dieldrin	µg/L	0.007	0.022	0.497	ug/kg	0.417	94.7208
Endosulfan sulfate	µg/L	0.003	0.008	0.480	ug/kg	0.403	97.9227
Endrin	µg/L	0.013	0.040	1.100	ug/kg	0.924	95.6356
gamma-BHC (Lindane)	µg/L	0.003	0.009	0.940	ug/kg	0.790	98.8843
gamma-Chlordane	µg/L	0.002	0.007	53.760	ug/kg	45.175	99.9854
Heptachlor epoxide	µg/L	0.004	0.012	7.055	ug/kg	5.928	99.8037
MET							
Aluminum	µg/L	7210.400	22375.300	14175.000	mg/kg	11911305.269	99.8122
Antimony	µg/L	0.837	2.598	0.413	mg/kg	346.625	99.2504
Arsenic	µg/L	7.460	23.150	11.025	mg/kg	9264.349	99.7501
Barium	µg/L	81.860	254.028	53.700	mg/kg	45124.310	99.4370
Beryllium	µg/L	0.347	1.078	0.820	mg/kg	689.049	99.8436
Cadmium	µg/L	0.510	1.583	0.515	mg/kg	432.756	99.6343
Chromium	µg/L	19.920	61.816	41.600	mg/kg	34956.635	99.8232

Table 4-1. (Continued)

Weir/Inlet Parameters Detected	Unit	Ave Weir Con.	Total kg Discharged from Weir	Ave Inlet Con.	Unit	Total kg into CDF	Percent (%) Sequestered in CDF
MET							
Cobalt	µg/L	4.133	12.827	10.625	mg/kg	8928.227	99.8563
Copper	µg/L	8.840	27.432	22.025	mg/kg	18507.689	99.8518
Iron	µg/L	7400.000	22963.666	25725.000	mg/kg	21616813.266	99.8938
Lead	µg/L	8.280	25.694	38.575	mg/kg	32414.716	99.9207
Mercury	**ng/L**	18.933	0.059	151.150	ug/kg	127.012	99.9537
Nickel	µg/L	9.587	29.749	21.050	mg/kg	17688.393	99.8318
Selenium	µg/L	2.350	7.293	0.813	mg/kg	682.747	98.9319
Silver	µg/L	0.081	0.253	0.280	mg/kg	235.285	99.8926
Thallium	µg/L	0.140	0.435	0.205	mg/kg	172.262	99.7473
Vanadium	µg/L	15.454	47.956	40.200	mg/kg	33780.210	99.8580
Zinc	µg/L	70.707	219.417	148.250	mg/kg	124575.027	99.8239
MSSEMI							
2-Methylnaphthalene	µg/L	0.017	0.054	15.667	ug/kg	13164.758	99.9996
2-Methylphenol	µg/L	0.014	0.043	20.000	ug/kg	16806.074	99.9997
4-Methylphenol	µg/L	0.029	0.090	18.500	ug/kg	15545.619	99.9994
Benzaldehyde	µg/L	0.690	2.141	167.000	ug/kg	140330.722	99.9985
Benzo(a)anthracene	µg/L	0.047	0.146	41.500	ug/kg	34872.604	99.9996
Benzo(a)pyrene	µg/L	0.039	0.121	41.750	ug/kg	35082.680	99.9997
Benzo(b)fluoranthene	µg/L	0.046	0.143	46.750	ug/kg	39284.199	99.9996
Benzo(ghi)perylene	µg/L	0.052	0.161	34.333	ug/kg	28850.428	99.9994
bis(2-Ethylhexyl) phthalate	µg/L	4.423	13.726	95.750	ug/kg	80459.081	99.9829
Butyl benzyl phthalate	µg/L	1.174	3.643	96.000	ug/kg	80669.157	99.9955

Table 4-1. (Continued)

Weir/Inlet Parameters Detected	Unit	Ave Weir Con.	Total kg Discharged from Weir	Ave Inlet Con.	Unit	Total kg into CDF	Percent (%) Sequestered in CDF
MSSEMI							
Chrysene	µg/L	0.044	0.137	48.250	ug/kg	40544.655	99.9997
Di-n-butyl phthalate	µg/L	0.181	0.562	140.000	ug/kg	117642.521	99.9995
Dibenz(a,h)anthracene	µg/L	0.063	0.194	7.450	ug/kg	6260.263	99.9969
Fluoranthene	µg/L	0.024	0.076	70.750	ug/kg	59451.488	99.9999
Indeno(1,2,3-cd)pyrene	µg/L	0.056	0.174	28.333	ug/kg	23808.605	99.9993
Pentachlorophenol	µg/L	3.000	9.310	20.500	ug/kg	17226.226	99.9460
Phenanthrene	µg/L	0.085	0.265	45.750	ug/kg	38443.895	99.9993
Pyrene	µg/L	0.020	0.062	61.250	ug/kg	51468.603	99.9999

5.0 CONCLUSION

Dredging for the Delaware River Main Stem Channel Deepening Project began on March 1, 2010. The first construction contract is for Reach C of the channel, which extends from the Delaware Memorial Bridge to Elsinboro Point, NJ. Environmental monitoring for potential water quality impacts is on-going at the Federally owned Killcohook dredged material containment facility and at the point of active dredging. The following conclusions are made based on monitoring data collected up to May 17, 2010:

(1) because of the limited number of exceedances of acute water quality criteria in weir discharge and Delaware River samples collected close to the discharge it is concluded that operation of cells 2 and 3 of the Killcohook dredged material containment facility is not impacting water quality in the immediate vicinity of the discharge;

(2) considering that exceedances of chronic criteria were mostly infrequent, and at concentrations slightly above criteria, along with the amount of mixing that takes place in this portion of the Delaware River, it is concluded that water quality objectives established by the lower chronic criteria are being met in the Delaware River during this period of discharge from the Killcohook facility;

(3) a mass balance evaluation of the contaminant load entering and leaving cell 2 of the Killcohook facility indicates that for most contaminants detected in the material entering the site, greater than 99 percent of the contaminant load was retained in cell 2 and not released back to the Delaware River; and

(4) the lack of exceedances of both acute and chronic water quality criteria at the point of dredging, and data demonstrating that TSS levels down-current of the cutterhead are similar to background indicate that water quality is not being impacted at the dredge.

APPENDIX A

INLET SEDIMENT CONCENTRATIONS

Table A-1. Pesticide and PCB Aroclor concentrations in inlet samples from Cells 2 and 3 reported for Reach C Deepening in the spring of 2010

		Cell 2	Cell 2	Cell 2	Cell 2	Cell 3	Cell 3
Sample ID:		**INLET0318**	**INLET0324**	**INLET0419**	**INLET0517**	**INLET0422**	**INLET0504**
Laboratory ID:		**C0C190561001**	**C0C250608001**	**C0D200483001**	**C0E180468001**	**C0D230556001**	**C0E060550001**
Sample Date:		3/18/2010	3/24/2010	4/19/2010	5/17/2010	4/22/2010	5/4/2010
GCSEMI							
4,4-DDD	µg/kg	1	1.7	1600	1.9	<0.18	0.52
4,4-DDE	µg/kg	2.1	2.3	140	3.3	0.093	0.82
4,4-DDT	µg/kg	0.58	1	840	1.5	<0.18	0.57
Aldrin	µg/kg	0.16	0.21	<27	<2.3	0.073	0.074
alpha-BHC	µg/kg	0.34	0.25	<27	<2.3	<0.18	<0.20
alpha-Chlordane	µg/kg	2.1	<0.28	54	<2.3	<0.18	<0.20
Aroclor 1016	µg/kg	<4.6	<2.8	<2.7	<2.4	8	<1.0
Aroclor 1221	µg/kg	<4.6	<2.8	<2.7	<2.4	<1.7	<1.0
Aroclor 1232	µg/kg	<4.6	<2.8	<2.7	<2.4	<1.7	<1.0
Aroclor 1242	µg/kg	<4.6	<2.8	<2.7	<2.4	<1.7	<1.0
Aroclor 1248	µg/kg	<4.6	<2.8	10	<2.4	<1.7	<1.0
Aroclor 1254	µg/kg	<4.6	<2.8	<2.7	<2.4	<1.7	1.9
Aroclor 1260	µg/kg	<4.6	3.1	13	<2.4	<1.7	2.3
beta-BHC	µg/kg	1.9	<0.28	<27	2.1	<0.18	1.1
Chlordane (technical)	µg/kg	<4.6	<2.8	<270	<23	<1.8	<2.0
Chlorpyrifos	µg/kg	<91	<54	<54	<47	<35	<80
delta-BHC	µg/kg	<0.46	<0.28	<27	<2.3	0.15	0.083
Dieldrin	µg/kg	0.32	0.35	<27	0.82	0.054	0.24
Endosulfan I	µg/kg	<0.46	<0.28	<27	<2.3	<0.18	<0.20
Endosulfan II	µg/kg	<0.46	<0.28	<27	<2.3	<0.18	0.072
Endosulfan sulfate	µg/kg	<0.46	0.48	<27	<2.3	<0.18	0.16
Endrin	µg/kg	1.1	1.1	<27	<2.3	0.18	<0.20
Endrin aldehyde	µg/kg	<0.46	<0.28	<27	<2.3	<0.18	0.81
Endrin ketone	µg/kg	0.56	0.53	<27	<2.3	<0.18	0.25
gamma-BHC (Lindane)	µg/kg	1.1	0.9	<27	0.82	0.15	0.31
gamma-Chlordane	µg/kg	0.45	0.83	160	<2.3	0.28	0.53
Heptachlor	µg/kg	<0.46	<0.28	<27	<2.3	0.31	0.086
Heptachlor epoxide	µg/kg	0.11	<0.28	14	<2.3	<0.18	<0.20
Methoxychlor	µg/kg	<0.92	<0.55	<55	<4.7	<0.35	0.094
Parathion	µg/kg	<91	<54	<54	<47	<35	<80
Toxaphene	µg/kg	<18	<11	<1100	<93	<7.0	<8.1

Table A-2. Metal concentrations in inlet samples from Cells 2 and 3 reported for Reach C Deepening in the spring of 2010

		Cell 2	Cell 2	Cell 2	Cell 2	Cell 3	Cell 3
Sample ID:		**INLET0318**	**INLET0324**	**INLET0419**	**INLET0517**	**INLET0422**	**INLET0504**
Laboratory ID:		**C0C190561001**	**C0C250608001**	**C0D200483001**	**C0E180468001**	**C0D230556001**	**C0E060550001**
Sample Date:		3/18/2010	3/24/2010	4/19/2010	5/17/2010	4/22/2010	5/4/2010
MET							
Aluminum	mg/kg	14400	12700	17000	12600	18300	1750
Antimony	mg/kg	0.57	0.28	0.38	0.42	0.27	0.53
Arsenic	mg/kg	13.6	10.1	10.2	10.2	3.7	6.9
Barium	mg/kg	53.9	48.5	62.8	49.6	62.7	233
Beryllium	mg/kg	0.86	0.72	1	0.7	1	0.085
Cadmium	mg/kg	0.45	0.53	0.65	0.43	0.25	0.34
Calcium	mg/kg	3530	2370	2800	1930	863	184000
Chromium	mg/kg	43.3	42.1	42.8	38.2	31.2	12.8
Cobalt	mg/kg	10.4	10.9	11.9	9.3	15	4.6
Copper	mg/kg	22.4	22.6	25.5	17.6	18.2	53.4
Cyanide, Total	mg/kg	<2.8	<1.7	<1.7	0.98	<1.1	<1.2
Iron	mg/kg	25400	26700	27600	23200	31700	14000
Lead	mg/kg	35.9	37.8	41.1	39.5	15.7	14.6
Magnesium	mg/kg	6260	5320	6940	4340	5000	2680
Manganese	mg/kg	1120	1150	1260	867	312	3210
Mercury	ug/kg	168	139	205	92.6	21.1	27.6
Nickel	mg/kg	21.1	21.6	23.4	18.1	21.5	11.3
Potassium	mg/kg	2570	2120	2530	2050	1820	515
Selenium	mg/kg	0.52	0.92	1	0.81	0.37	0.76
Silver	mg/kg	0.32	0.24	0.33	0.23	0.035	0.78
Sodium	mg/kg	1040	1530	1290	1380	708	248
Thallium	mg/kg	0.28	0.18	0.2	0.16	0.2	0.081
Vanadium	mg/kg	43.6	37.9	41.4	37.9	31.7	10.3
Zinc	mg/kg	145	146	167	135	67.5	131

Table A-3. Semi-volatile concentrations in inlet samples from Cells 2 and 3 reported for Reach C Deepening in the spring of 2010

		Cell 2	Cell 2	Cell 2	Cell 2	Cell 3	Cell 3
Sample ID:		**INLET0318**	**INLET0324**	**INLET0419**	**INLET0517**	**INLET0422**	**INLET0504**
Laboratory ID:		**C0C190561001**	**C0C250608001**	**C0D200483001**	**C0E180468001**	**C0D230556001**	**C0E060550001**
Sample Date:		3/18/2010	3/24/2010	4/19/2010	5/17/2010	4/22/2010	5/4/2010
MSSEMI							
1,1-Biphenyl	µg/kg	<460	<110	<270	<190	<70	<80
1,2,4-Trichlorobenzene	µg/kg	<92	<22	<55	<38	<14	<16
1,2-Dichlorobenzene	µg/kg	<92	<22	<55	<38	<14	<16
1,2-Diphenylhydrazine	µg/kg	<92	<22	<55	<38	<14	<16
1,3-Dichlorobenzene	µg/kg	<92	<22	<55	<38	<14	<16
1,4-Dichlorobenzene	µg/kg	<92	<22	<55	<38	<14	<16
2,4,5-Trichlorophenol	µg/kg	<460	<110	<270	<190	<70	<80
2,4,6-Trichlorophenol	µg/kg	<460	<110	<270	<190	<70	<80
2,4-Dichlorophenol	µg/kg	<92	<22	<55	<38	<14	<16
2,4-Dimethylphenol	µg/kg	<460	<110	<270	<190	<70	<80
2,4-Dinitrophenol	µg/kg	<2300	<570	<1400	<960	<360	<410
2,4-Dinitrotoluene	µg/kg	<460	<110	<270	<190	<70	<80
2,6-Dinitrotoluene	µg/kg	<460	<110	<270	<190	<70	<80
2-Chloronaphthalene	µg/kg	<92	<22	<55	<38	<14	<16
2-Chlorophenol	µg/kg	<460	<110	<270	<190	<70	<80
2-Methylnaphthalene	µg/kg	<92	14	11	22	<14	3.8
2-Methylphenol	µg/kg	20	<110	<270	<190	<70	<80
2-Nitroaniline	µg/kg	<2300	<570	<1400	<960	<360	<410
2-Nitrophenol	µg/kg	<460	<110	<270	<190	<70	<80
3,3-Dichlorobenzidine	µg/kg	<460	<110	<270	<190	<70	<80
3-Nitroaniline	µg/kg	<2300	<570	<1400	<960	<360	<410
4,6-Dinitro-2-methylphenol	µg/kg	<2300	<570	<1400	<960	<360	<410
4-Bromophenyl phenyl ether	µg/kg	<460	<110	<270	<190	<70	<80
4-Chloro-3-methylphenol	µg/kg	<460	<110	<270	<190	<70	<80
4-Chloroaniline	µg/kg	<460	<110	<270	<190	<70	<80
4-Chlorophenyl phenyl ether	µg/kg	<460	<110	<270	<190	<70	<80
4-Methylphenol	µg/kg	21	16	<270	<190	<70	<80

Table A-3. (Continued)

		Cell 2	Cell 2	Cell 2	Cell 2	Cell 3	Cell 3
Sample ID:		**INLET0318**	**INLET0324**	**INLET0419**	**INLET0517**	**INLET0422**	**INLET0504**
Laboratory ID:		**C0C190561001**	**C0C250608001**	**C0D200483001**	**C0E180468001**	**C0D230556001**	**C0E060550001**
Sample Date:		3/18/2010	3/24/2010	4/19/2010	5/17/2010	4/22/2010	5/4/2010
4-Nitroaniline	µg/kg	<2300	<570	<1400	<960	<360	<410
4-Nitrophenol	µg/kg	<2300	<570	<1400	<960	<360	<410
Acenaphthene	µg/kg	<92	6	<55	6.4	<14	1.6
Acenaphthylene	µg/kg	<92	9	<55	11	<14	<16
Acetophenone	µg/kg	<460	<110	<270	<190	<70	<80
Anthracene	µg/kg	<92	17	13	25	<14	5
Atrazine	µg/kg	<460	<110	<270	<190	<70	<80
Benzaldehyde	µg/kg	230	98	220	120	<70	78
Benzidine	µg/kg	<9200	<2200	<5500	<3800	<1400	<1600
Benzo(a)anthracene	µg/kg	40	39	41	46	<14	16
Benzo(a)pyrene	µg/kg	36	43	41	47	22	14
Benzo(b)fluoranthene	µg/kg	35	71	21	60	<14	32
Benzo(ghi)perylene	µg/kg	<92	30	35	38	<14	12
Benzo(k)fluoranthene	µg/kg	<92	<22	<55	24	<14	<16
bis(2-Chloroethoxy)methane	µg/kg	<460	<110	<270	<190	<70	<80
bis(2-Chloroethyl) ether	µg/kg	<92	<22	<55	<38	<14	<16
bis(2-Chloroisopropyl) ether	µg/kg	<92	<22	<55	<38	<14	<16
bis(2-Ethylhexyl) phthalate	µg/kg	110	66	77	130	11	68
Butyl benzyl phthalate	µg/kg	140	<110	52	<190	<70	15
Caprolactam	µg/kg	<2300	<570	<1400	<960	<360	<410
Carbazole	µg/kg	<92	4.3	<55	<38	<14	<16
Chrysene	µg/kg	41	44	52	56	<14	16
Di-n-butyl phthalate	µg/kg	<460	<110	<270	<190	<70	<80
Di-n-octyl phthalate	µg/kg	<460	<110	140	<190	<70	<80
Dibenz(a,h)anthracene	µg/kg	<92	8.1	<55	6.8	<14	<16
Dibenzofuran	µg/kg	<460	<110	<270	<190	<70	<80
Diethyl phthalate	µg/kg	<460	<110	<270	<190	<70	<80
Dimethyl phthalate	µg/kg	<460	<110	<270	<190	<70	<80
Fluoranthene	µg/kg	59	71	63	90	3	29

Table A-3. (Continued)

		Cell 2	Cell 2	Cell 2	Cell 2	Cell 3	Cell 3
Sample ID:		**INLET0318**	**INLET0324**	**INLET0419**	**INLET0517**	**INLET0422**	**INLET0504**
Laboratory ID:		**C0C190561001**	**C0C250608001**	**C0D200483001**	**C0E180468001**	**C0D230556001**	**C0E060550001**
Sample Date:		3/18/2010	3/24/2010	4/19/2010	5/17/2010	4/22/2010	5/4/2010
Fluorene	µg/kg	<92	<22	<55	16	<14	<16
Hexachlorobenzene	µg/kg	<92	<22	<55	<38	<14	<16
Hexachlorobutadiene	µg/kg	<92	<22	<55	<38	<14	<16
Hexachlorocyclopentadiene	µg/kg	<460	<110	<270	<190	<70	<80
Hexachloroethane	µg/kg	<460	<110	<270	<190	<70	<80
Indeno(1,2,3-cd)pyrene	µg/kg	<92	26	29	30	<14	8.1
Isophorone	µg/kg	<460	<110	<270	<190	<70	<80
N-Nitrosodi-n-propylamine	µg/kg	<92	<22	<55	<38	<14	<16
N-Nitrosodimethylamine	µg/kg	<92	<22	<55	<38	<14	11
N-Nitrosodiphenylamine	µg/kg	<92	<22	<55	<38	<14	<16
Naphthalene	µg/kg	<92	23	18	33	<14	6.3
Nitrobenzene	µg/kg	<92	<22	<55	<38	<14	<16
Pentachlorophenol	µg/kg	<460	<110	<270	<190	<70	<80
Phenanthrene	µg/kg	43	42	37	61	3.1	16
Phenol	µg/kg	20	<22	<55	<38	<14	10
Pyrene	µg/kg	64	61	55	65	3.1	23

APPENDIX B

PULLEN AND CHARLESTON DREDGING LOGS

Table B-1. Dredging logs for the dredge boat Pullen recorded during Reach C deepening in spring of 2010

Date	Dredge Location	Dredging Time		Dredged	Sediment Type
		Hours	Minutes	Quantity (cy)	
3/1-3/2/2010	N/A	N/A	N/A	10222	N/A
3/3/2010	STA 233+775 to STA 234+000	22	5	10889	100% silt, trace sand
3/9/2010	STA 231+000 to STA 231+140	7	5	2074	100% silt, trace sand
3/10/2010	STA 231+140 to STA 231+665	20	0	14778	100% silt, trace sand
3/11/2010	STA 231+665 to STA 232+225	21	5	33185	100% silt, trace sand
3/12/2010	STA 232+225 to STA 232+910	20	35	40593	100% silt, trace sand
3/13/2010	STA 232+910 to STA 233+310	14	40	23704	100% silt, trace sand
3/14/2010	STA 233+310 to STA 233+775	21	10	20667	100% silt, trace sand
3/15/2010	STA 233+775 to STA 234+000	16	5	10000	100% silt, trace sand
3/16/2010	STA 231+960 to STA 232+500	20	40	3185	100% silt, trace sand
3/17/2010	STA 233+215 to STA 233+500	16	50	12444	100% silt, trace sand
3/18/2010	STA 228+185 to STA 228+620	20	10	19333	100% silt, trace sand
3/19/2010	STA 228+620 to STA 229+115	20	10	22000	100% silt, trace sand
3/20/2010	STA 229+115 to STA 229+600	21	30	21556	100% silt, trace sand
3/21/2010	STA 229+600 to STA230+045	19	15	19778	100% silt, trace sand
3/22/2010	STA 230+045 to STA 230+140	5	55	4222	100% silt, trace sand
3/23/2010	STA 230+140 to STA 230+300	7	25	7111	100% silt, trace sand
3/24/2010	STA 230+300 to STA 230760	21	20	20444	100% silt, trace sand
3/25/2010	STA 230+760 to STA 231+000	17	30	16178	100% silt, trace sand
3/26/2010	STA 226+060 to STA 226+225	13	0	9778	80% silt, 15% sand, 15% gravel
3/27/2010	STA 226+225 to STA 226+535	21	55	11941	60% silt, 35% sand, 5% gravel
3/28/2010	STA 226+535 to STA 226+710	12	50	8296	60% silt, 40% sand, trace gravel
3/29/2010	STA 226+710 to STA 226+990	N/A	N/A	N/A	N/A
3/30/2010	STA 226+990 to STA 227+375	20	10	17111	70% silt, 30% sand, trace gravel
3/31/2010	STA 227+375 to STA 227+765	20	50	19067	95% silt, 5% sand
4/1/2010	STA 227+765 to STA 228+000	17	55	13034	95% silt, 5% sand
4/2/2010	STA 226+170 to STA 226+425	16	15	5237	95% silt, 5% sand
4/3/2010	STA 227+315 to STA 227+480	11	5	4711	100% silt, trace sand
4/4/2010	STA 226+090 to STA 226+290	20	50	6519	100% silt, trace sand
4/5/2010	STA 226+290 to STA 226+455	16	45	6844	silt, sand, gravel
4/13/2010	STA 230+920 to STA 231+000	16	55	15037	100% silt, trace sand and gravel
4/14/2010	STA 228+290 to STA 228+520	6	55	11926	100% silt, trace sand and gravel

Table B-1. (Continued)

Date	Dredge Location	Dredging Time		Dredged	Sediment Type
		Hours	Minutes	Quantity (cy)	
4/15/2010	STA 228+520 to STA	N/A	N/A	N/A	100% silt, trace sand
4/16/2010	STA 228+500 to STA 228+525	0	50	1407	100% silt, trace sand
4/17/2010	STA 228+525 to STA 229+100	19	55	29815	100% silt, trace sand
4/18/2010	STA 229+100 to STA 229+575	16	50	24630	100% silt, trace sand
4/19/2010	STA 229+575 to STA 230+165	21	30	32341	60% silt, 40% sand, trace gravel
4/20/2010	STA 230+165 to STA 230+670	17	0	26185	90% silt, 10% sand, trace gravel
4/21/2010	STA 230+670 to STA 231+000	18	55	18305	90% silt, 10% sand, trace gravel
4/22/2010	STA 230+040 to STA 230+350	21	20	5259	90% silt, 10% sand, trace gravel
4/23/2010	STA 231+210 to STA 231+600	22	0	8163	100% silt, trace sand
4/24/2010	STA 231+145 to STA 231+575	20	15	23570	100% silt, trace sand
4/25/2010	STA 231+575 to STA 231+600	21	40	1370	100% silt, trace sand
4/30/2010	STA 233+760 to STA 234+000	18	25	8296	100% silt, trace sand
5/1/2010	STA 231+740 to STA 232+215	21	55	26741	100% silt, trace sand
5/2/2010	STA 232+215 to STA 232+785	21	40	32089	100% silt, trace sand
5/3/2010	STA 232+785 to STA 233+470	22	15	30444	100% silt, trace sand
5/4/2010	STA 233+470 to STA 234+000	20	55	27481	100% silt, trace sand
5/5/2010	STA 234+000 to STA 234+045	18	0	12022	100% silt, trace sand
5/6/2010	STA 234+155 to STA 234+575	20	45	21778	80% silt, 20% fine sand, trace soft clay
5/7/2010	STA 234+575 to STA 235+025	20	55	18000	70% silt, 30% sand, trace soft clay
5/8/2010	STA 235+023 to STA 235+475	19	30	8705	60% silt, sand, trace soft clay
5/9/2010	STA 235+475 to STA 235+800	20	5	4770	70% silt, 30% sand, trace soft clay
5/10/2010	STA 235+975 to STA 236+200	7	35	5625	70% silt, trace sand
5/11/2010	STA 238+570 to STA 238+780	5	15	657	90% silt, 10% fine sand
5/12/2010	STA 238+780 to STA 239+345	18	30	10550	90% silt, 10% sand
5/13/2010	STA 239+345 to STA 239+500	7	25	314	90% silt, 10% sand
5/14/2010	N/A	N/A	N/A	N/A	100% silt, trace sand
5/15/2010	STA 234+000 to STA 234+195	11	20	8089	100% silt, trace sand
5/16/2010	STA 234+195 to STA 234+545	18	5	15556	80% silt, 20% sand
5/17/2010	STA 234+545 to STA 234+890	17	20	16867	100% silt, trace sand
5/18/2010	STA 234+890 to STA 235+200	21	5	14696	100% silt, trace sand
5/19/2010	STA 235+200 to STA 235+510	18	20	12400	100% silt, trace sand
5/20/2010	STA 235+510 to STA 235+785	17	25	9778	100% silt, trace sand

Table B-1. (Continued)

Date	Dredge Location	Dredging Time		Dredged	Sediment Type
		Hours	Minutes	Quantity (cy)	
5/21/2010	STA 235+785 to STA 235+845	7	30	5265	100% silt, trace sand
5/22/2010	STA 235+090 to STA 235+680	16	25	10773	80% fine sand and 20% silt
5/23/2010	STA 235+680 to STA 235+850	17	55	12624	80% fine sand and 20% silt
5/24/2010	STA 236+095 to STA 236+385	19	0	6119	20% silt, 80% fine sand
5/25/2010	STA 235+840 to STA 236+295	18	35	18840	90% fine sand, 10% silt, trace gravel
5/26/2010	STA 236+295 toSTA 236+400	15	40	4761	80% fine sand and 20% silt, trace gravel
5/27/2010	STA 236+400 to STA 236+755	17	20	13806	90% fine sand, 10% silt, trace gravel
5/28/2010	STA 236+755 to STA 237+045	15	15	6606	90% fine sand, 10% silt, trace gravel
5/29/2010	STA 237+045 to STA 237+360	16	55	7062	90% fine sand, 10% silt, trace gravel, trace soft clay
5/30/2010	STA 237+360 to STA 237+800	20	55	6844	90% fine sand, 10% silt, trace gravel, trace soft clay
5/31/2010	STA 237+800 to STA 238+300	17	35	3504	90% fine sand, 10% silt, trace gravel
6/1/2010	STA 236+085 to STA 236+220	20	15	2233	90% fine sand, 10% silt, trace gravel
6/2/2010	STA 236+700 to STA 237+000	14	35	2573	90% fine sand, 10% silt, trace gravel
6/3/2010	STA 234+335 to STA 234+530	5	40	188	90% fine sand, 10% silt, trace gravel
6/4/2010	STA 238+400 to STA 239+000	11	0	N/A	90% fine sand, 10% silt, trace gravel
6/5/2010	STA 239+000 to STA 239+655	10	45	N/A	90% fine sand, 10% silt, trace gravel
6/6/2010	N/A	N/A	N/A	N/A	90% fine sand, 10% silt, trace gravel
6/7/2010	N/A	N/A	N/A	N/A	90% fine sand, 10% silt, trace gravel
6/8/2010	N/A	N/A	N/A	N/A	90% fine sand, 10% silt, trace gravel
6/9/2010	N/A	N/A	N/A	N/A	90% fine sand, 10% silt, trace gravel
6/10/2010	STA 206+200 to STA 205+965	5	40	6223	50% fine sand, 50% silt, trave gravel
6/11/2010	STA 205+965 to STA 205+495	20	45	15144	100% silt, trace fine sand
6/12/2010	STA 205+495 to STA 205+050	21	45	19036	100% silt, trace fine sand
6/13/2010	STA 205+050 to STA 204+770	16	45	15307	90% fine sand, 10% silt, trace gravel
6/14/2010	STA 204+770 to STA 204+610	15	50	14314	100% silt, trace gravel
6/15/2010	STA 204+555 to STA 204+140	22	5	25838	100% silt, gravel and soft clay

Table B-2. Dredging logs for the dredge boat Charleston recorded during Reach C deepening in spring of 2010

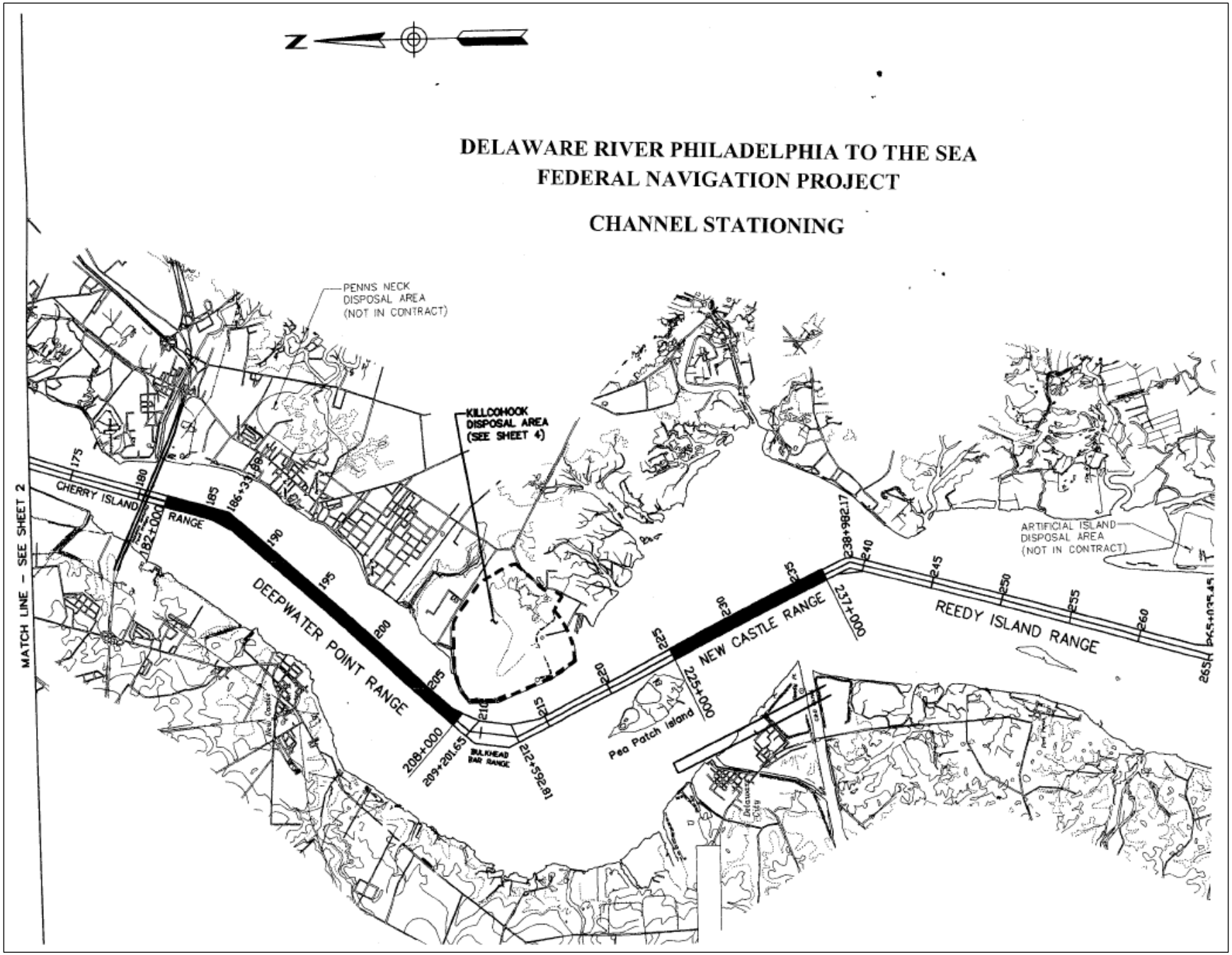
Date	Dredge Location	Dredging Time		Dredged	Sediment Type
		Hours	Minutes	Quantity (cy)	
4/18/2010	STA 216+180 to STA 216+270	N/A	N/A	609	10% mud, 45% gravel, 45% rock
4/19/2010	STA 216+235 to STA 216+255	N/A	N/A	3872	10% mud, 45% gravel, 45% rock
4/20/2010	STA 216+615 to STA 216+830	N/A	N/A	4459	10% mud, 45% gravel, 45% rock
4/21/2010	STA 216+830 to STA 217+040	N/A	N/A	3733	10% mud, 45% gravel, 45% rock
4/22/2010	STA 217+040 to STA 217+325	15	55	5489	N/A
4/23/2010	STA 217+325 to STA 217+735	20	25	7289	N/A
4/24/2010	STA 217+735 to STA 217+840	12	15	1867	N/A
4/25/2010	STA 217+840 to STA 218+045	13	40	3341	N/A
4/26/2010	STA 218+045 to STA 218+290	19	30	3267	N/A
4/27/2010	STA 218+290 to STA 218+395	7	0	2333	N/A
4/28/2010	STA 218+395 to STA 218+785	20	55	15022	N/A
4/29/2010	STA 218+785 to STA 219+000	15	40	6022	N/A
4/30/2010	STA 219+060 to STA 219+590	20	35	11307	N/A
5/1/2010	STA 219+590 to STA 220+040	N/A	N/A	N/A	N/A
5/2/2010	STA 220+040 to STA 220+440	17	35	12444	N/A
5/3/2010	STA 220+440 to STA 220+705	16	20	8244	N/A
5/4/2010	STA 220+705 to STA 221+050	20	25	10733	N/A
5/5/2010	STA 221+050 to STA 221+320	N/A	N/A	N/A	N/A
5/6/2010	STA 221+320 to STA 221+770	21	35	6900	N/A
5/7/2010	STA 221+770 to STA 222+000	18	0	5179	N/A
5/8/2010	STA 224+065 to STA 224+450	14	10	5669	N/A
5/9/2010	STA 224+450 to STA 224+530	2	35	1041	N/A
5/10/2010	STA 224+535 to STA 224+660	13	0	3772	N/A
5/11/2010	STA 225+715 to STA 226+000	15	5	2356	N/A
5/12/2010	STA 217+110 to STA 217+325	15	15	231	N/A
5/13/2010	STA 217+570 to STA 217+680	13	55	408	N/A
5/14/2010	STA 218+875 to STA 218+875	9	30	N/A	N/A
5/15/2010	STA 218+875 to STA 219+000	5	0	N/A	N/A
5/16/2010	STA 214+360 to STA 214+870	18	25	2763	N/A
5/17/2010	STA 214+870 to STA 214+980	6	45	1161	N/A
5/19/2010	STA 214+490 to STA 215+780	19	30	5098	N/A
5/20/2010	STA 215+510 to STA 215+850	18	25	4015	N/A

Table B-2. (Continued)

Date	Dredge Location	Dredging Time Hours	Dredging Time Minutes	Dredged Quantity (cy)	Sediment Type
5/21/2010	STA 213+840 to STA 213+840	18	20	5303	N/A
5/22/2010	STA 213+470 to STA 213+025	21	5	4399	N/A
5/23/2010	STA 212+805 to STA 212+295	20	20	5163	N/A
5/24/2010	STA 214+010 to STA 213+360	20	15	10546	N/A
5/25/2010	STA 213+360 to STA 212+960	15	25	9289	N/A
5/26/2010	STA 212+960 to STA 212+170	19	40	8519	N/A
5/27/2010	STA 212+170 to STA 212+100	19	10	5071	N/A
5/28/2010	STA 212+100 to STA 211+930	21	30	5981	N/A
5/29/2010	STA 212+930 to STA 211+690	21	50	10200	N/A
5/30/2010	STA 211+690 to STA 211+460	20	40	9992	N/A
5/31/2010	STA 211+460 to STA 211+275	20	25	10175	N/A
6/1/2010	STA 211+275 to STA 211+225	17	5	8379	N/A
6/2/2010	STA 211+000 to STA 210+855	16	5	9711	N/A
6/3/2010	STA 211+060 to STA 210+750	21	50	9254	N/A
6/4/2010	STA 210+750 to STA 210+565	19	35	8784	N/A
6/5/2010	STA 210+740 to STA 210+645	N/A	N/A	4085	10% mud, 60% fine sand, 25% gravel, 5% rock
6/6/2010	STA 210+645 to STA 210+400	N/A	N/A	11760	10% mud, 60% fine sand, 25% gravel, 5% rock
6/7/2010	STA 210+400 to STA 210+275	21	10	8470	N/A
6/8/2010	STA 210+310 to STA 210+175	21	45	11134	N/A
6/9/2010	STA 210+075 to STA 209+895	22	15	9507	N/A
6/10/2010	STA 209+895 to STA 209+690	22	15	13782	N/A
6/11/2010	STA 209+620 to STA 209+167	21	40	12716	N/A
6/12/2010	STA 208+910 to STA 208+595	21	30	16641	N/A
6/13/2010	STA 208+595 to STA 208+215	22	15	15664	N/A
6/14/2010	STA 208+215 to STA 207+785	21	50	16712	N/A
6/15/2010	STA 207+785 to STA 207+455	17	25	10325	N/A
6/16/2010	STA 207+455 to STA 206+680	22	20	11393	N/A

DELAWARE RIVER PHILADELPHIA TO THE SEA
FEDERAL NAVIGATION PROJECT

CHANNEL STATIONING



Delaware River Channel Deepening Project
2010 Sediment Core Analysis
Reach B Contract (Station 137+000 to Station 176+000)

I. Scope of Work

The work under this contract includes collecting sediment cores from 21 locations within Reach B of the Delaware River Philadelphia to the Sea navigation channel and conducting bulk sediment analyses of 21 sediment samples collected from the cores and modified elutriate analyses of two sediment samples collected from the cores to evaluate the extent of any sediment contamination. Sediment samples will be collected between the Marcus Hook Range and the Cherry Island Range. Seventeen cores will be collected in the navigation channel, two cores will be collected in a Sun Marcus Hook berthing area and two sediment cores will be collected in a ConocoPhillips berthing area. Sample location coordinates are provided in Table 1. In addition to sediment cores, a sufficient quantity of water will be collected from the sampling site to prepare filtered and unfiltered modified elutriate samples for two sediment samples. The modified elutriate analysis will be conducted on sediment samples collected from cores DRV-93 and DRV-101. Sediments will be collected and appropriately preserved in the field and delivered to a laboratory for analyses. Bulk sediment samples will be analyzed for grain size (Folk, 1980), TAL inorganics, total mercury, TCL pesticides, organo phosphorus pesticides, PCB congeners/dioxin and furans, TCL volatile organic compounds, TCL semi-volatile organic compounds, cyanide, particulate organic carbon, dissolved organic carbon and total organic carbon. The filtered and unfiltered modified elutriate samples and the Delaware River water used to prepare the elutriates will be analyzed for TAL inorganics, total mercury, TCL pesticides, organo phosphorus pesticides, PCB congeners/dioxin and furans, TCL semi-volatile organic compounds, cyanide, particulate organic carbon, dissolved organic carbon, and total suspended sediment. Table 2 provides a list of the number and type of samples to be analyzed for each contaminant group. Sediment sampling and analysis will commence immediately after a Delivery Order is issued for this work. The contractor will prepare a brief report that documents the sampling procedures, sample preparation techniques, laboratory methods, QA/QC, test results and data analysis.

II. Corps Point of Contact

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III. Sediment Sample Collection

The work consists of furnishing all plant, labor, materials, supplies, and accessories required to accomplish the investigation, together with all other operations incidental to the work, in strict accordance with these specifications. Core sample locations and the approximate water depth are provided in Table 1. Changes necessitated by field conditions shall be approved by the Government over the telephone immediately prior to vibrational coring.

The U.S. Coast Guard, River Pilots Association and the Maritime Exchange for the Delaware River and Bay will have to be contacted for notification of working in and near the channel and for channel closing or ship traffic diversion that may be required as the vibracoring work proceeds. The vibracoring shall be performed during daylight hours and the floating plant shall be removed from the immediate channel area to a safe location for overnight mooring. The Sun Marcus Hook and ConocoPhillips facilities will also be contacted to schedule the work in their berthing areas.

All equipment and supplies, as specified herein, are subject to approval by the Contracting Officer prior to issuing notice to proceed. The vibracore subcontractor shall have a copy of these specifications on the drill rig and shall be familiar with the applicable provisions of the specifications governing the contract work at all times.

The work under this contract includes collecting sediment samples from twenty one (21) vibrational core borings. The work shall be performed in the Delaware River channel off the coast of Pennsylvania and Delaware. The areas to be sampled range in depth from approximately forty (40) to fifty (50) feet below MLLW. All vibrational cores are to be fifteen (15) feet long, with continuous samples obtained to the termination depth of the vibracores for geotechnical analysis and contaminant testing.

The order in which the vibrational cores are drilled will be at the Contractor's discretion, unless otherwise stated by the Government.

Positioning – The vibrational cores will be collected from locations furnished by the Government. These locations are or shall be designated by New Jersey state plane coordinates (NAD 83). The positioning of the vessel relative to the sample site locations shall meet standards outlined in the Corps of Engineers Hydrographic Surveying Manual, EM 1110-2-1003, dated 1 April 2004 for Class 1 surveys. Differential GPS positioning shall be determined immediately prior to the start of the vibrational core boring at each location. Positioning systems used for sediment sampling activities must have an accuracy of ± 1 meter. Before each core is taken, the exact position and the water depth at that point shall be recorded. Depths shall be corrected for tide and converted to North American Vertical Datum (NAVD 88) elevations and presented in depth below MLLW depth on the vibracores logs.

Vibrational core borings – Vibrational cores comprising the surface of the bottom and sub-bottom sediments shall be obtained by pneumatic- or hydraulically-activated borings

having a minimum diameter of three (3) inches. The continuous samples recovered shall be representative of the relative position of the bottom and sub-bottom strata. A transparent plastic rigid tube of appropriate size that permits visual inspection of the cored material will be placed inside the coring tool prior to operation. The same tube shall be removed from the coring tool when the operation at a site has been completed. If a core is to be transported to another location for processing, the plastic tube with the sample shall be cut into five (5) foot length segments for ease of handling and appropriately marked as to the sequence of segments and sample location. If necessary, packing will be inserted at both ends of the tube to prevent disturbance of the core during handling and shipping. Both ends of the segments will be sealed with plastic caps and plastic pressure sensitive tape. The plastic segments will be identified as to top and bottom of each core segment. The depth of the top and bottom shall be printed on the top and bottom of each five (5) foot core segment. The core identification number and the sample designation shall also be recorded on each core segment. This information shall be clearly and coherently marked on each five (5) foot core segment with a water-proof marking pen.

When located over a boring site, the Contractor shall make every reasonable effort to reach the required depth or to reach penetration refusal. Penetration refusal shall be completed when less than one tenth of one foot of advance is accomplished after one (1) minute of vibration with vibrating-type coring tool. Sample penetration of less than ten (10) feet will not be accepted as a complete sample. The depth of penetration shall be determined by measuring the depth to the vibrating core head and comparing it to the depth to the sediment surface. An estimate of the penetration resistance will be determined by timing the rate of penetration of the vibracore sampler during sampler penetration into the sediment. Depth of penetration beneath the surface of the bottom must be known to within plus or minus 0.5 feet of actual penetration. The desired depth of penetration is fifteen (15) feet. It is recognized, however, that maximum penetration may not be achieved at all sample locations. When refusal is met at less than ten (10) feet, the Contractor will remove the sampled portion from the pipe, and a new liner will be inserted into the core pipe. One retry will be accomplished in an attempt to reach at least ten (10) feet of penetration. The coring device shall recover a minimum of eighty (80) percent of the unconsolidated strata through which it has penetrated. The percent recovery will be measured by placing a tape measure, with a weighted end, down the top of the retrieved core to measure the distance to the top of the sediment in the core. This value will be compared to the measured depth of penetration to calculate percent recovery.

Upon completion of the sample collection activities, the Contractor shall provide a table that lists the individual sediment core sample identification numbers, the actual latitude/longitude and New Jersey State Plane coordinates where the individual sediment core samples were collected, and the actual water and sampling depths (i.e. core lengths) for each individual sediment core sample. This table shall also list any strata identified within each core sample. The Contractor shall also provide figures that identify the actual locations where the individual core samples were collected.

Upon retrieval, each sediment core will be inspected and a core log will be prepared. This work will be done by a geologist provided by the Government. When the core log is completed a sediment sample for contaminant testing will be collected. The sample will represent the portion of the core from the surface of the bottom to a depth of -46 feet below Mean Low Water (MLW). The geologist will determine the location of any distinct sediment strata greater than two feet in length within the core. If distinct sediment strata greater than two feet exist within the portion of the core representing the surface of the bottom to -46 feet MLW, the Corps Point of Contact will be contacted by telephone before any sample is collected. For cost estimating purposes, it is assumed that only one sediment sample will be analyzed in the laboratory per core. Material will be removed from the core(s) with stainless steel knives and spoons, thoroughly homogenized in a stainless steel container and stored in appropriate containers. All utensils and containers shall be appropriately washed to minimize any sample contamination. Enough sediment will be collected to provide sufficient material for later chemical and geotechnical analysis. **Samples for analysis of volatile and semi-volatile organic contaminants will be collected with as little disturbance to the sediments as possible (ie. prior to homogenization).**

When collecting individual sediment core samples, the Contractor must ensure that a sufficient volume of sediment is collected to conduct all of the tests specified in Table 2. This may entail the collection of additional individual core samples co-located with those specified in Table 1. If this occurs, the Contractor shall document how and where these additional core samples were collected.

Individual sediment core samples shall be homogenized consistent with the requirements specified in Chapter III-Section D(2)d & e of NJDEP *The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters* (1997) and USEPA *Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual* EPA-823-B-01-002 (2001). Provided they are of uniform consistency (i.e. apparent grain size distribution and visual characteristics), individual sediment core samples six (6) feet or less in length may be homogenized. Individual sediment core samples greater than six (6) feet in length may be homogenized unless there are distinct visual strata in grain size and composition which are at least two (2) feet in depth. For those individual sediment core samples that show grain size stratification, each strata with a depth of two (2) feet or greater must be tested and analyzed separately (i.e. the entire core must not be homogenized for testing purposes if distinct strata are present). For cost estimating purposes, it is assumed that only one sediment sample will be analyzed in the laboratory per core. If distinct sediment strata greater than 2 feet occur in a core the Contractor will contact the Corps Point of Contact prior to compositing a sample.

For DRV-102, DRV-103, DRV-104 and DRV-105 the bottom six (6) inches of the sediment core sample shall be visually inspected to determine if the sediments are predominantly sand, gravel, silt or clay. If the bottom six (6) inch sample of a core is similar in grain size and visual characteristics to the overlying material in that core, these

sediments may then be homogenized with the rest of the sediment core (or appropriate core strata) sample for analysis. Otherwise, unless the bottom six (6) inch sample is greater than 90% sand (as determined by grain size analysis), Bulk Sediment Chemistry (only) analysis of the bottom six (6) inch sample shall be required. For cost estimating purposes, it is assumed that the bottom 6 inch samples from these cores will be similar in grain size to the overlying material.

The sample preservation requirements and holding times for each analysis, as specified in the analytical methods, must be adhered to. The sample handling, preservation, and storage procedures (including achieved holding times) shall be summarized in a report. Chain of custody documentation for each individual sediment core sample shall be maintained and provided to the Corps. Storage and preservation procedures for 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* (NJDEP, 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.

One equipment blank will be created in the field by pouring laboratory grade water over all sampling equipment that comes in contact with the sediments (e.g., stainless steel spoons, knives and bowls). The equipment blank will be created in the middle of the sampling, immediately after the equipment has been cleaned. The water will be collected into an appropriate sample container after it has been poured over the equipment, and analyzed for TAL inorganics, total mercury, TCL pesticides, organo phosphours pesticides, PCB congeners/dioxin and furans, TCL semi-volatiles, TCL volatiles and cyanide.

IV. Sediment and Water Sample Analysis

The Contractor shall prepare a table for the Methods Section of the report that provides the following:

- Target Analyte List (TAL)
- Analytical Method (for each target analyte)
- Analyte Method Detection Limits (MDL; for each target analyte)
- Required sample volume/mass
- Identify the certified laboratory that will perform the test

Sediment and water samples will be analyzed using the following procedures: TAL inorganics (SW846-6020), total mercury (USEPA Method 1631E), total cyanide (SW846-9012A), TCL pesticides (Low Level SW846-8081A), organo phosphorus pesticides (SW846-8141A), TCL volatiles (SW846-8260B) and TCL semi-volatile organic compounds including PAHs (Low Level SW846-8270C). Samples will also be analyzed for particulate organic carbon (POC) using USEPA Method 440.0, dissolved organic carbon (DOC) using USEPA Method 415.2 and total organic carbon analyses will follow the procedure provided as Attachment 2 to Appendix B. Total organic carbon will not be analyzed on the four elutriate water samples and one Delaware River water sample. These parameters are essential for partitioning calculations. In addition, sediment and water samples will be analyzed for PCB congeners using USEPA Method 1668A and a dioxin/furan analysis (USEPA Method 1613). Table 2 provides a complete summary of the analyses to be conducted for each of the tests. Attachment 1 of Appendix B provides a complete list of contaminant parameters and the required detection limits for sediment samples. The 21 bulk sediment samples will also be analyzed for grain size following the methods described by Folk (1980).

The modified elutriate test procedure can be found on the web at: www.wes.army.mil/el/dots/eedptn.html#section4 Environmental Effects of Dredging Technical Note EEDP-04-2. A slurry concentration of 150 grams of sediment per liter of river water (dry weight basis) will be used. After aeration the samples will be allowed to settle for 24 hours. Both filtered and unfiltered water samples will be obtained and analyzed from the modified elutriate test. In addition, the Delaware River water sample collected for preparation of the elutriates will be analyzed to represent background river conditions. All five samples will be analyzed for total suspended sediment.

All analytical laboratory procedures must be conducted by a laboratory certified by the New Jersey Department of Environmental Protection to conduct that procedure pursuant to the Regulations Governing the Certification of Laboratories and Environmental Measurements (NJ.A.C. 7:18) or the National Environmental Laboratory Accreditation Program (NELAP). Analytical detection limits for all target analytes must be below the applicable regulatory criteria or the analytical detection limit must not exceed the PQL.

To minimize, or otherwise address, analytical errors in the data to be collected, a Quality Assurance/Quality Control (QA/QC) Program shall be implemented in support of all sediment sample collection, testing, and analytical activities. The goal of this QA/QC program is to ensure the collection and analysis of sediment samples to provide accurate and high quality data. This will include the use of state-of-the art analytical methods for all sediment analyses. Analytical laboratories must follow all of the required QA/QC procedures specified in the analytical methods used. Any deviations from these procedures must be documented and justified. The sample preservation requirements and holding times for each analysis, as specified in the analytical method, must be adhered to.

The following Quality Control (QC) samples and procedures are required for the collection and chemical analysis of sediment and water samples:

- Field Blanks: one (1) with every batch of 1-20 samples.
  Method Blanks: one (1) with every batch of 1-20 samples or every twelve (12) hours, whichever is less.
- Matrix Spike/Duplicate: one (1) with every batch of 1-20 samples.
- Surrogate Spike Recovery: each sample (organic compounds only).
- Duplicate/Split Samples: analyses to be conducted as per method requirements.
- Minimum Detection Limit (MDL) Verification: within last two (2) years, to be submitted to the NJDEP upon request.

The accuracy of the analytical methods used must be within ± 20 per cent compared to a certified reference material, standard reference material, or another standard with a known concentration. The precision of analytical laboratory replicates must be within ± 20 per cent (20%), and the precision of field duplicate samples within ± 30 per cent (30%), calculated using relative per cent difference.

All routine procedures associated with the sampling, handling, transport, storage, preservation, and analysis of the sediments must be specified in Standard Operating Procedure (SOP) documents maintained by the parties actually collecting and/or analyzing the sediments. These SOPs must be followed when collecting, handling, transporting, storing, preserving, and analyzing the sediments. Any deviations from these SOPs must be documented and justified. These SOPs must be available for review, if so requested.

Sample handling, storage, preservation, and transport procedures must be implemented so as to maintain sample integrity and minimize potential contamination from external sources. Samples must be preserved immediately after collection, homogenization, and/or compositing.

Sample chain of custody must be documented, beginning with sample collection and continuing through all sample handling, transport, preservation, and storage activities, ending with laboratory analysis of the sample. The sample custody documentation must identify the condition of the sample (temperature/preservation status, etc.). The NJDEP Field Sampling Procedures Manual (NJDEP, 2005) presents and discusses the NJDEP's sample chain of custody requirements (http://www.state.nj.us/dep/srp/guidance/fspm/).

V. Report Format and Content

The Contractor shall provide electronic copies of the summary analytical data reports prepared by the analytical laboratories. These reports will include, at a minimum, the following information:

- Laboratory certification number for all performed analyses;
- A summary of all sample handling, storage, preparation, and analysis methods.
- A summary of sample preservation methods, sample conditions, and actual sample holding times (before and after extraction);
- Sample analytical results for all required parameters and target analytes, including method detection limits and practical quantitation levels (PQLs), and laboratory QA flags;
- QA/QC program summary;
- A discussion of any analytical problems, corrective actions taken, and potential effects on interpretation of the sample data.

Laboratory reports shall be provided as they become available from the laboratory rather than after completion of a report.

A brief report will be prepared that describes all methodologies and the data obtained. The intent of the report is to document the sampling procedures, sample preparation techniques, laboratory methods, QA/QC and test results. The report will include figures that show the core sample locations. The report will also include tables that display the concentrations of detected parameters. The bulk sediment tables will display New Jersey Department of Environmental Protection residential and non-residential soil remediation criteria. The bulk sediment tables will include the particulate organic carbon, dissolved organic carbon and total organic carbon data. The report shall include all laboratory data sheets. Grain size curves will also be provided for each of the 21 sediment samples.

Bulk sediment data collected from the berthing areas of Sun Oil Marcus Hook and ConocoPhillips and the navigation channel will be analyzed for the potential impact on Delaware River water quality during deepening of these berthing areas from 40 to 45 feet using the methodology provided in: *Greene, Rick 2010. An Evaluation of Toxic Contaminants in the Sediments of the Tidal Delaware River and Potential Impacts Resulting from Deepening the Main Navigation Channel in Reach C. Delaware DNREC Division of Water Resources, Watershed Assessment Branch. Dover, DE.* Both data analysis and report preparation will follow the approach presented in the referenced report. Analyses will include inorganics, pesticides, semi-volatile organics and PCBs. Three separate analyses will be prepared (Sun Oil Marcus Hook, ConocoPhillips, and the navigation channel).

VI. Period of Performance

One electronic copy of a draft report will be submitted to the Corps within three months of issuing a Delivery Order for this work. 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 draft report as they will in the final report.

The Corps will provide the Contractor with comments on the draft report. The Contractor will then have an additional week to revise and submit the final report. The Contractor shall submit five bound copies and a pdf file of the final report. When the Corps accepts the final report the Delivery Order will be complete.

This Delivery Order must be complete by 31 October 2010.

VII. Inspection

All 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 Channel Deepening Project
2010 Sediment Core Analysis
Reach B Contract (Station 137+000 to Station 176+000)

Table 1. Sediment Core Sample Location Coordinates.

Core	State	Northing	Easting	Approximate Water Depth (- feet MLW)
DRV-89	NJ	350184	225899	-41.9
DRV-90	NJ	349355	224811	-42.2
DRV-91	NJ	348713	223791	-42.2
DRV-92	NJ	347561	222208	-43.1
DRV-93	NJ	346425	222588	-43.0
DRV-94	NJ	346336	221248	-42.3
DRV-95	NJ	345904	220877	-42.9
DRV-96	NJ	345021	220246	-41.9
DRV-97	NJ	341553	217688	-44.1
DRV-98	NJ	337428	214662	-41.1
DRV-99	NJ	335212	213974	-44.4
DRV-100	NJ	332673	212125	-42.4
DRV-101	NJ	332416	211400	-41.7
DRV-102	NJ	325407	209195	-39.2
DRV-103	NJ	323987	208790	-39.7
DRV-104	NJ	322519	208920	-40.6
DRV-105	NJ	321951	208047	-41.2
SMH-1	DE	658031.15	655862.92	NA
SMH-2	DE	657048.40	654627.98	NA
CP-1	DE	660044.80	659001.20	NA
CP-2	DE	659705.09	658677.90	NA

Delaware River Channel Deepening Project
2010 Sediment Core Analysis
Reach B Contract (Station 137+000 to Station 176+000)

Table 2. Summary Matrix of Required Testing.

	Laboratory Method	Bulk Sediment	Modified Elutriate*	Equipment Blank	Total
TAL Inorganics	SW846-6020	21	5	1	27
Mercury	USEPA Method 1631E	21	5	1	27
TCL Pesticides	Low Level SW846-8081A	21	5	1	27
Organo-Phosphorus Pesticides	SW846-8141A	21	5	1	27
TCL Semi-Volatiles	Low Level SW846-8270C	21	5	1	27
TCL Volatiles	SW846-8260B	21	0	1	22
PCB Congeners	USEPA Method 1668A	21	5	1	27
Dioxin and Furans	USEPA Method 1613	21	5	1	27
Cyanide	SW846-9012A	21	5	1	27
Total Organic Carbon	Appendix B Attachment 2	21	0	0	21
Particulate Organic Carbon	USEPA Method 440.0	21	5	0	26
Dissolved Organic Carbon	USEPA Method 415.2	21	5	0	26
Grain Size	Folk 1980	21	0	0	21
Total Suspended Sediment	Filter Method	0	5	0	5

* Includes one sample of Delaware River water used to prepare the elutriates.

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 Others - 6 months[f]
Organic compounds (e.g., PCBs, pesticides, polycyclic aromatic hydrocarbons)	Grab/corer	250 g	Solvent-rinsed glass jar with Teflon[e] 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[e]-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[e]-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 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[g]
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®	Handle with non-metallic forceps; plastic gloves; dry ice[e]	≤ −20°C[e] or freezer storage	Hg - 28 days Others - 6 months[m]
PCBs and chlorinated pesticides	Trawl/Teflon®-coated grab	10–25 g	Hexane-rinsed double aluminum foil and double Ziploc®	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®	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]

ote: 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

' Collection method should include appropriate liners.

' 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 ncreased 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; nore or less tissue may be required depending on the analytes, matrices, detection limits, and particular analytical laboratory.

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

' 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 imes are from the time of sample collection.

NOAA (1989).

Tetra Tech (1986a).

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

Polypropylene should be used if phthalate bioaccumulation is of concern.

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

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

Plumb (1981).

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

' 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

TARGET ANALYTE LIST AND CONTRACT REQUIRED QUANTITATION LIMITS

1.0 Aqueous and Soil Medium Level CRQLs

Target Analyte Metals and Cyanide for Medium Level Aqueous Samples and Soil/Sediment/Solid Samples

Analyte	Medium Level Contract Required Quantitation Limits[1,2] Water (µg/L)	Soil[3] (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
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	2.5

(1) Method detection limits must be less than or equal to one-third of the Contract Required Quantitation Limits (CRQLs).

(2) Subject to the restrictions specified in Exhibits D and E, any analytical method specified in the REAP Inorganic SOW, Exhibit D, may be utilized as long as the documented method detection limits achieve the CRQL requirements (MDLs must be less than or equal to one-third of the CRQLs). Higher detection limits may only be used in the following circumstance:

If the sample concentration exceeds five times the method detection limit, the value may be reported even though the method detection limit may not meet the Contract Required Quantitation Limit requirement. This is illustrated in the example below:

Pesticides/Aroclors Target Compound List and Corresponding CRQLs

COMPOUND	CONTRACT REQUIRED QUANTITATION LIMITS		
	OLC03.2 Water (ug/L)	OLM04.2 Water (ug/L)	OLM04.2 Soil (ug/Kg)
alpha-BHC	0.01	0.05	1.7
beta-BHC	0.01	0.05	1.7
delta-BHC	0.01	0.05	1.7
gamma-BHC (Lindane)	0.01	0.05	1.7
Heptachlor	0.01	0.05	1.7
Aldrin	0.01	0.05	1.7
Heptachlor epoxide	0.01	0.05	1.7
Endosulfan I	0.01	0.05	1.7
Dieldrin	0.02	0.10	3.3
4,4'-DDE	0.02	0.10	3.3
Endrin	0.02	0.10	3.3
Endosulfan II	0.02	0.10	3.3
4,4'-DDD	0.02	0.10	3.3
Endosulfan sulfate	0.02	0.10	3.3
4,4'-DDT	0.02	0.10	3.3
Methoxychlor	0.10	0.50	17.0
Endrin ketone	0.02	0.10	3.3
Endrin aldehyde	0.02	0.10	3.3
alpha-Chlordane	0.01	0.05	1.7
gamma-Chlordane	0.01	0.05	1.7
Toxaphene	1.0	5.0	170.0
Aroclor-1016	0.20	1.0	33.0
Aroclor-1221	0.40	2.0	67.0

Aroclor-1232 EXIT EPA	0.20	1.0	33.0
Aroclor-1242 EXIT EPA	0.20	1.0	33.0
Aroclor-1248 EXIT EPA	0.20	1.0	33.0
Aroclor-1254 EXIT EPA	0.20	1.0	33.0
Aroclor-1260 EXIT EPA	0.20	1.0	33.0

EXIT EPA *DISCLAIMER: The following links are pointers to other hosts and locations on the Internet. This information is provided as a service; however, the U.S. Environmental Protection Agency (EPA) does not endorse, approve, or otherwise support the non-EPA sites.*

Volatile Target Compound List and Corresponding CRQLs

COMPOUND	CONTRACT REQUIRED QUANTITATION LIMITS			
	OLC03.2 Water (ug/L)	OLM04.2 Water (ug/L)	OLM04.2 Low Soil (ug/Kg)	OLM04.2 Medium Soil (ug/Kg)
Dichlorodifluoromethane	0.5	10	10	1,200
Chloromethane EXIT disclaimer	0.5	10	10	1,200
Bromomethane EXIT disclaimer	0.5	10	10	1,200
Vinyl Chloride EXIT disclaimer	0.5	10	10	1,200
Chloroethane EXIT disclaimer	0.5	10	10	1,200
Trichlorofluoromethane	0.5	10	10	1,200
1,1,2-Trichloro-1,2,2-trifluoroethane	0.5	10	10	1,200
Methylene Chloride EXIT disclaimer	0.5	10	10	1,200
Acetone EXIT disclaimer	5	10	10	1,200
Carbon Disulfide	0.5	10	10	1,200
Methyl Acetate	0.5	10	10	1,200
1,1-Dichloroethene EXIT disclaimer	0.5	10	10	1,200
1,1-Dichloroethane EXIT disclaimer	0.5	10	10	1,200
cis-1,2-Dichloroethene EXIT disclaimer	0.5	10	10	1,200
trans-1,2-Dichloroethene EXIT disclaimer	0.5	10	10	1,200
Methyl tert-Butyl Ether	0.5	10	10	1,200
Chloroform EXIT disclaimer	0.5	10	10	1,200
1,2-Dichloroethane EXIT disclaimer	0.5	10	10	1,200
2-Butanone EXIT disclaimer	5	10	10	1,200
Bromochloromethane	0.5	NA	NA	NA

1,1,1-Trichloroethane EXIT disclaimer	0.5	10	10	1,200
Cyclohexane	0.5	10	10	1,200
Carbon Tetrachloride EXIT disclaimer	0.5	10	10	1,200
Bromodichloromethane EXIT disclaimer	0.5	10	10	1,200
1,2-Dichloropropane EXIT disclaimer	0.5	10	10	1,200
cis-1,3-Dichloropropene EXIT disclaimer	0.5	10	10	1,200
Trichloroethene EXIT disclaimer	0.5	10	10	1,200
Methylcyclohexane	0.5	10	10	1,200
Dibromochloromethane	0.5	10	10	1,200
1,1,2-Trichloroethane	0.5	10	10	1,200
Benzene EXIT disclaimer	0.5	10	10	1,200
trans-1,3-Dichloropropene EXIT disclaimer	0.5	10	10	1,200
Bromoform EXIT disclaimer	0.5	10	10	1,200
Isopropylbenzene	0.5	10	10	1,200
4-Methyl-2-pentanone	5	10	10	1,200
2-Hexanone EXIT disclaimer	5	10	10	1,200
Tetrachloroethene EXIT disclaimer	0.5	10	10	1,200
1,2-Dibromoethane EXIT disclaimer	0.5	10	10	1,200
Toluene EXIT disclaimer	0.5	10	10	1,200
1,1,2,2-Tetrachloroethane EXIT disclaimer	0.5	10	10	1,200
Chlorobenzene EXIT disclaimer	0.5	10	10	1,200
Ethylbenzene EXIT disclaimer	0.5	10	10	1,200
Styrene EXIT disclaimer	0.5	10	10	1,200
Xylenes (Total) EXIT disclaimer	0.5	10	10	1,200
1,2-Dibromo-3-chloropropane EXIT disclaimer	0.5	10	10	1,200
1,3-Dichlorobenzene	0.5	10	10	1,200
1,4-Dichlorobenzene EXIT disclaimer	0.5	10	10	1,200
1,2-Dichlorobenzene	0.5	10	10	1,200
1,2,3-Trichlorobenzene	0.5	NA	NA	NA
1,2,4-Trichlorobenzene	0.5	10	10	1,200

Semivolatile Target Compound List and Corresponding CRQLs

COMPOUND	CONTRACT REQUIRED QUANTITATION LIMITS			
	OLC03.2 Water (ug/L)	OLM04.2 Water (ug/L)	OLM04.2 Low Soil (ug/Kg)	OLM04.2 Medium Soil (ug/Kg)
Benzaldehyde	5	10	330	10,000
Phenol	5	10	330	10,000
bis(2-Chloroethyl) ether	5	10	330	10,000
2-Chlorophenol	5	10	330	10,000
2-Methylphenol	5	10	330	10,000
2,2'-oxybis(1-Chloropropane)	5	10	330	10,000
Acetaphenone	5	10	330	10,000
4-Methylphenol	5	10	330	10,000
N-Nitroso-di-n-propylamine	5	10	330	10,000
Hexachloroethane	5	10	330	10,000
Nitrobenzene	5	10	330	10,000
Isophorone	5	10	330	10,000
2-Nitrophenol	5	10	330	10,000
2,4-Dimethylphenol	5	10	330	10,000
bis(2-Chloroethoxy) methane	5	10	330	10,000
2,4-Dichlorophenol	5	10	330	10,000
Naphthalene	5	10	330	10,000
4-Chloroaniline	5	10	330	10,000
Hexachlorobutadiene	5	10	330	10,000
Caprolactam	5	10	330	10,000
4-Chloro-3-methylphenol	5	10	330	10,000
2-Methylnaphthalene	5	10	330	10,000

Hexachlorocyclopentadiene	5	10	330	10,000
2,4,6-Trichlorophenol EXT EPA	5	10	330	10,000
2,4,5-Trichlorophenol EXT EPA	20	25	830	25,000
1,1'-Biphenyl	5	10	330	10,000
2-Chloronapthalene	5	10	330	10,000
2-Nitroaniline	20	25	830	25,000
Dimethylphthalate	5	10	330	10,000
Acenaphthylene EXT EPA	5	10	330	10,000
2,6-Dinitrotoluene	5	10	330	10,000
3-Nitroaniline	20	25	830	25,000
Acenaphthene EXT EPA	5	10	330	10,000
2,4-Dinitrophenol	20	25	830	25,000
4-Nitrophenol EXT EPA	20	25	830	25,000
Dibenzofuran	5	10	330	10,000
2,4-Dinitrotoluene	5	10	330	10,000
Diethylphthalate	5	10	330	10,000
4-Chlorophenyl-phenylether	5	10	330	10,000
Fluorene EXT EPA	5	10	330	10,000
4-Nitroaniline	20	25	830	25,000
4,6-Dinitro-2-methylphenol	20	25	830	25,000
N-Nitrosodiphenylamine EXT EPA	5	10	330	10,000
4-Bromophenyl-phenylether	5	10	330	10,000
Hexachlorobenzene	5	10	330	10,000
Atrazine	5	10	330	10,000
Pentachlorophenol EXT EPA	5	25	830	25,000
Phenanthrene EXT EPA	5	10	330	10,000
Anthracene EXT EPA	5	10	330	10,000
Carbazole	NA	10	330	10,000
Di-n-butylphthalate EXT EPA	5	10	330	10,000
Fluoranthene EXT EPA	5	10	330	10,000
Pyrene EXT EPA	5	10	330	10,000
Butylbenzylphthalate	5	10	330	10,000
3,3'-Dichlorobenzidine	5	10	330	10,000
Benzo(a)anthracene EXT EPA	5	10	330	10,000
Chrysene EXT EPA	5	10	330	10,000
bis-(2-Ethylhexyl)phthalate EXT EPA	5	10	330	10,000

Di-n-octylphthalate	5	10	330	10,000
Benzo(b)fluoranthene	5	10	330	10,000
Benzo(k)fluoranthene	5	10	330	10,000
Benzo(a)pyrene	5	10	330	10,000
Indeno(1,2,3-cd)pyrene	5	10	330	10,000
Dibenzo(a,h)anthracene	5	10	330	10,000
Benzo(g,h,i)perylene	5	10	330	10,000
1,2,4,5-Tetrachlorobenzene	5	NA	NA	NA

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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.

COPY

State of New Jersey

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

DEPARTMENT of ENVIRONMENTAL PROTECTION

BOB MARTIN
Commissioner

Division of Air Quality
Bureau of Air Permits
401 E. State Street, 2nd floor, P.O. Box 27
Trenton, NJ 08625-0027

June 16, 2010

Buyer's Information
Lisa Magee
Philadelphia Regional Port Authority
3460 N. Delaware Avenue, 2nd Floor
Philadelphia, PA 19134

Seller's Information
Christopher Correnti
AGC Flat Glass North America, Inc.
700 Union Landing Road
Cinnaminson, NJ 08077

RE: Your Combined Request for NOx CER Transfer dated March 19, 2010

Dear Ms. Magee and Mr. Correnti:

This is in response to the above referenced letter in which you requested the transfer of 266.0 tons of NOx Creditable Emission Reductions (CERs). These CERs which were represented by banking log number BK-M7-0003 in the name of AGC Flat Glass North America, Inc. (PI 45982) are transferred to Philadelphia Regional Port Authority.

The transfer of the 266.0 tons of NOx CERs is completed, and the CERs now reside in the name of Philadelphia Regional Port Authority under the Transfer Banking Log Number T-M10-0004. This transfer log number must be referenced when Philadelphia Regional Port Authority intends to use the CERs. Upon accepting ownership of these CERs, Philadelphia Regional Port Authority recognizes that:

1. Use of any CERs is subject to all provisions of N.J.A.C. 7:27-18 et seq.
2. The listing in the DEP database does not constitute DEP approval to use any CERs as offsets. At the time of any future transfer, these credits will be re-verified and adjusted as described in item 4 and 5 below.
3. Approval for the use of any CERs as offsets will only be determined during the review of a permit application for a particular project. Upon approval of a permit application emission reductions used as emission offsets, or used in calculating the proposed net emission increase (in accordance with N.J.A.C. 7:27-18.7(a) 1) <u>may not be used again as emission offsets</u>.
4. Any CERs will be adjusted if any rule decreases the amount of allowable emissions for an air contaminant pursuant to N.J.A.C 7:27-18.8(e) prior to their use, and
5. Any shutdown CERs will be subject to time discounts as per N.J.A.C 7:27-18.8 (f) & (g).

Although the department continues to stress that general conformity cannot be achieved here by relying solely on CERs, it will continue its review of the validity of your proposed CERs upon receipt of an amended application. This review will be without prejudice to the Department's position that the proposed use of CERs is inadequate to meet conformity requirements. Should you have any questions concerning this matter, please contact me at (609) 633-8220.

Sincerely,

Francis C Steitz

Francis Steitz, Chief
Bureau of Air Permits

C: R. Esposito, NJDEP (for Facility's Banking file)
K. Kalim, NJDEP
Lt. Col. Thomas J. Tickner: Philadelphia District, U.S. Army Corps of Engineers
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3390

RECEIVED
JUL 9 2010

State of New Jersey

DEPARTMENT of ENVIRONMENTAL PROTECTION

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

BOB MARTIN
Commissioner

Division of Air Quality
Bureau of Air Permits
401 E. State Street, 2nd floor, P.O. Box 27
Trenton, NJ 08625-0027

June 30, 2010

Buyer's Information
Lisa Magee
Philadelphia Regional Port Authority
3460 N. Delaware Avenue, 2nd Floor
Philadelphia, PA 19134

Seller's Information
Dave Watson
Gerresheimer Glass, Inc.
537 Crystal Avenue
Vineland, NJ 08360

RE: Your Combined Request for NOx CER Transfer dated June 21, 2010

Dear Ms. Magee and Mr. Watson:

This is in response to the above referenced letter in which you requested the transfer of 266.1 tons of NOx Creditable Emission Reductions (CERs). These CERs which were represented by banking log number BK-M9-0002 in the name of Gerresheimer Glass, Inc (PI 75503) are transferred to Philadelphia Regional Port Authority.

The transfer of the 266.1 tons of NOx CERs is completed, and the CERs now reside in the name of Philadelphia Regional Port Authority under the Transfer Banking Log Number T-M10-0002. This transfer log number must be referenced when Philadelphia Regional Port Authority intends to use the CERs. Upon accepting ownership of these CERs, Philadelphia Regional Port Authority recognizes that:

1. Use of any CERs is subject to all provisions of N.J.A.C. 7:27-18 et seq.
2. The listing in the DEP database does not constitute DEP approval to use any CERs as offsets. At the time of any future transfer, these credits will be re-verified and adjusted as described in item 4 and 5 below.
3. Approval for the use of any CERs as offsets will only be determined during the review of a permit application for a particular project. Upon approval of a permit application emission reductions used as emission offsets, or used in calculating the proposed net emission increase (in accordance with N.J.A.C. 7:27-18.7(a) 1) <u>may not be used again as emission offsets</u>.
4. Any CERs will be adjusted if any rule decreases the amount of allowable emissions for an air contaminant pursuant to N.J.A.C 7:27-18.8(e) prior to their use, and
5. Any shutdown CERs will be subject to time discounts as per N.J.A.C 7:27-18.8 (f) & (g).

Although the department continues to stress that general conformity cannot be achieved here by relying solely on CERs, it will continue its review of the validity of your proposed CERs upon receipt of an amended application. This review will be without prejudice to the Department's position that the proposed use of CERs is inadequate to meet conformity requirements. Should you have any questions concerning this matter, please contact me at (609) 633-8220.

Sincerely,

Francis Steitz, Chief
Bureau of Air Permits

C: R. Esposito, NJDEP (for Facility's Banking file)
K. Kalim, NJDEP
Lt. Col. Thomas J. Tickner: Philadelphia District, U.S. Army Corps of Engineers
Wanamaker Building, 100 Penn Square East
Philadelphia, PA 19107-3390

David Miller & Associates, Inc.

Memorandum For the Record

To: Robert Selsor, Philadelphia District USACE

From: Jerry Diamantides, DMA

Date: 15 February, 2010

Re: Delaware River and Bay Channel Deepening Project: Current and Future Port Assessment

This report presents a summary assessment of the potential impacts of changes in existing and without-project conditions on projected Delaware River Deepening Project benefits. Included in this report are changes concerning liquid bulk, dry bulk, and containerized commodities. Overall, apart from the substantial reduction in dry bulk commodity imports due to the recent recession, changes in liquid bulk, dry bulk, and containerized commodity imports suggest that project benefits are likely to be greater than estimated in 2004. The potential increase in benefits would be related to greater than projected steel imports, an increase in petroleum product imports, and an additional large containership service calling at the Packer Avenue Terminal.

There have been no major structural changes related to maritime trade on the Delaware River in the years since the 2002-2004 Economic Reanalysis. All of the commodities, modes of transport, and vessel operations identified in 2004 as "benefiting" from the proposed project are still in place in 2010. The severe recession experienced in the downside of this business cycle does not alter the long-term benefit stream generated by the project any more than the upside of the business cycle experienced in 2005 – 2007. Commodity forecasts and benefit calculations used in the 2004 Economic Reanalysis are based, conservatively, on long-term trends and not on peaks and troughs of recurring business cycles.

The long-term trends identified in the 2004 Economic Reanalysis, which are the underlying forces generating project benefits, continue to be substantiated by observation and analysis. For example:

- Philadelphia continues to be one of the major refrigerated cargo ports on the US East Coast
    - Fresh and frozen meat tonnage is 12% greater in 2007 than in 2003
    - The port is currently constructing a new cold-storage facility that is double the size of the existing facility, which will open in mid-2010

- The Energy Information Administration's Annual Energy Outlook for 2010 predicts stable and slightly increasing long-term demand for petroleum-based liquid fuels
    - Reductions in refining capacity at Delaware River facilities have induced increased petroleum product imports on deep draft vessels at Delaware River facilities
- The US Geological Survey's Mineral Commodity Summary for 2009 reports that imported steel mill products are a consistent component of domestic steel consumption (27.7% in 2004 and 27.5% in 2008)
    - Steel import tonnage on the Delaware River has exceeded the 2004 Economic Reanalysis projections in each year through 2008
    - The new Paulsboro Marine Terminal, specializing in break-bulk commodities, is under construction and scheduled to open in 2012.

The economic recession has adversely impacted commodity tonnages handled at most US ports. For example, the year-over-year measure of total US import and export tonnage has been negative for each month between November 2008 and November 2009. Although negative, the year-over-year change has been improving each month since August 2009. Another measure of the impact of the recent recession is that the total amount of US containerized foreign trade, measured in twenty-foot equivalent units from January through November 2009, is 14% lower than trade in the first 11 months of 2008. However, the total number of TEUs in November is an improvement over the total number in October, which itself was an improvement over September. The Journal of Commerce (08 Feb 2010) reports that the Institute of Supply Management's monthly US manufacturing index has registered a reading of over 50% for the fifth consecutive month in a row, which indicates an expanding manufacturing sector.

In general, the indication is that imports and exports are beginning to recover from the worst impacts of the recession. It is important to note that in the 2002-2004 Comprehensive Reanalysis project benefits were not based on strong projected growth, but were mostly based on stable levels of trade as observed in 2000 – 2003. By the time the project becomes operational (2014), the impact of the recent economic recession on project benefits would likely be minimal.

Liquid Bulk – Petroleum Commodities

Half of the benefits calculated in the 2004 Supplemental Economic Reanalysis were based on the movement of petroleum-related import commodities from foreign origins to refineries and storage facilities along the Delaware River. The petroleum-related commodities included imported crude oil and imported refined products. The imported crude oil gets processed at Delaware River refineries into transportation fuels, heating oil, and other mostly fuel-related refined products. The imported refined petroleum products serve the same purposes as domestically refined products. The 2004 Economic Reanalysis was based on a 0.2% average annual growth rate for petroleum based commodities. More current projections of future demand

for petroleum based fuels also indicate stable slow growth. The DOI Annual Energy Outlook 2010 projects a steady domestic demand for petroleum based fuel oils with an average annual growth rate of 0.34% from 2007 through 2035. The 2007 domestic demand for liquid fuels was the equivalent of 39.93 quadrillion BTUs. Projected domestic demand increases slightly by 2027 to 40.09 quadrillion BTUs and to 41.4 quadrillion BTUs by 2035(AEO2010 18Dec09).

Observed petroleum related commodity movements on the Delaware River since the 2004 Economic Reanalysis indicate a steady flow of imported petroleum-related commodities (WCSC 2003 – 2007 (last year currently available from WCSC)).The Waterborne Commerce Statistics Center reports that petroleum-related commodity imports at the Delaware River increased slightly from 65.0 million short tons in 2003 to 65.2 million short tons in 2007. The composition of imported petroleum related commodities shifted during that time from 97% crude oil (by weight) in 2003 to 93% crude oil in 2007. Crude oil imports decreased slightly from 63.3 million short tons in 2003 to 60.7 million short tons in 2007. This slight decrease in crude oil imports was more than offset by a greater than five-fold increase in gasoline imports and a greater than eight-fold increase in imported distillate fuels (diesel, home heating oil, etc.).

Delaware River Petroleum Imports 2003 – 2007
(short tons)

	2003	2004	2005	2006	2007
Total Petroleum Commodities	64,994,459	65,328,709	61,019,883	60,880,976	65,214,421
Crude Oil	63,262,812	63,048,236	58,792,467	57,069,966	60,677,465
Gasoline	199,908	332,689	472,780	938,543	1,079,314
Distillate Fuels	287,350	809,509	1,305,810	1,599,700	2,392,570
Other	1,244,389	1,138,275	448,826	1,272,767	1,065,072

Source: Waterborne Commerce Statistics Center

The replacement of some imported crude by imported refined product is also observed in vessel characteristics. Petroleum product vessels typically do not lighter their cargo as a standard operating practice and therefore tend to arrive at the Delaware River with shallower drafts than crude oil vessels, which often lighter their cargo. Data obtained from the Maritime Exchange for the Delaware River and Bay indicates that there were 187 more liquid bulk vessel arrivals in 2007 than there were in 2004, but there were 49 fewer liquid bulk vessel arrivals at drafts greater than 35 feet. The partial shift from crude to refined imports had increased the overall number of vessel calls and decreased the number of vessels arriving at deep drafts.

The potential impact on project benefits due to a small percentage replacement of imported crude oil by imported refined product is two-fold. One aspect of the potential impact is that fewer crude oil deliveries would result in fewer lightering trips, however the 4% reduction in crude oil imports observed between 2003 and 2007 would result in only a 1% reduction in lightered

tonnage (the 2004 Reanalysis estimated that approximately 25% of imported crude tonnage is lightered under without-project conditions). On the other hand, a deeper channel could result in a shift towards larger refined product vessels, which could take advantage of the deeper channel. Under existing and without-project conditions, refined product vessels are loading up to a maximum draft of 40 feet. Under with-project conditions petroleum product vessels with available design draft capability could load more deeply without being impacted by without-project condition under-keel clearance constraints. Lloyd's Register of Ships Online (SEA WEB) indicates that there are more than 700 oil product carrier vessels in the world fleet with dead weight tonnages ranging from 60,000 to 100,000 tons, which could take advantage of channel depths greater than 40 feet.

In 2009, Valero closed its Delaware City refinery, identified as the Motiva refinery in the 2004 Economic Reanalysis. The Motiva facility was estimated to have lightered 35% of its imported crude, but did not generate vessel-related benefits due to the three-mile long access channel, which was not projected to be deepened under with-project conditions. Also in 2009, Sunoco stopped production at the Eagle Point refinery. Sunoco announced that production will be shifted to its Fort Mifflin and Marcus Hook facilities. The Eagle Point facility was estimated in the 2004 Reanalysis to lighter 32% of its imports. The Eagle Point facility was idled in November 2009.

A comparison of import crude oil vessel calls in 2000 and 2009 indicates that there has been relatively little change in the overall number of crude oil vessel calls requiring lightering. Increases in the number of crude oil vessel calls requiring lightering to Valero (Paulsboro) and Ft. Mifflin were offset by decreases in crude oil vessel calls requiring lightering at Conoco/Phillips and Eagle Point. The sale of Maritrans Inc., the primary lightering firm in the Delaware River and Bay at the time of the 2004 Economic Reanalysis, to OSG America has substantially increased the fleet available for lightering in the Delaware River and Bay. OSG America was scheduled to receive two new 330,000 bbl articulated tug-barge vessels in early 2010 for service in the Delaware River and Bay. These vessels will be equipped with a closed vapor balancing system as required by the Delaware Department of Natural Resources and Environmental Control.

Overall, a partial shift from crude oil imports to refined product imports may increase project benefits if the transportation cost savings of avoided refined product trips are greater than the transportation cost savings of reduced lightering. The closing of the Motiva refinery (Valero Delaware City) does not decrease benefits because there were no project benefits associated with this facility. The closing of this refinery may in fact increase project benefits if the fuel oils formerly produced at this refinery must now be imported to Delaware River storage facilities, and if importing vessels can take advantage of a deeper channel. The closing of the Eagle Point refinery may not significantly impact project benefits if production is shifted to Sunoco facilities at Marcus Hook and Fort Mifflin as indicated by Sunoco. Again, if decreases in refinery

production are fully offset by increases in refined product imports, as they appear to have been in the recent past, then project benefits may increase.

Dry Bulk – Slag and Steel

Ferrous slags are a co-product of iron and steel making, which are used in the production of cement. Slag cement replaces a portion of Portland cement in concrete. The use of slag cement is a lower cost and environmentally beneficial alternative to using 100% Portland cement. The St. Lawrence Cement Company operates a slag processing facility in Camden, New Jersey on the Delaware River. In 2007, the facility was granted a NJDEP permit to increase production at the facility from 785,000 metric tons per year to 1,051,000 metric tons per year. The 2004 Economic analysis identified six import slag vessel calls in 2001for a total of 368,000 tons and projected 17 vessel calls and one million tons by 2009. By 2005 the number of import slag vessel calls had increased to 14. However, slag imports are directly related to concrete production and the construction industry. The impact of the recent recession has been to reduce import slag vessel calls from seven calls in 2008 to only two calls in 2009. Domestic slag production and consumption has also been severely impacted by the recession. Domestic consumption fell by more than 30% between 2005 (21.6 million tons) and 2008 (15.0 million tons).

Slag imports accounted for $1.8 million average annual benefits, 7.5% of total benefits, in the 2004 Economic Reanalysis. All but one of the import slag vessel arrivals from 2004 – 2009 were in the 38 to 40-foot draft range, with most vessels arriving at a draft of 40 feet. These vessel operating characteristics are consistent with the without-project condition projections used in the 2004 Economic Reanalysis. Domestic slag consumption is expected to increase as a result of increased construction activity associated with economic recovery from the recession. Domestic slag supply is constrained by the number of operating blast furnaces in the US. The USGS reports that the number of domestic blast furnaces capable of producing slag has decreased in recent years and there are no plans for construction of new domestic blast furnaces (Iron and Steel Slag, Mineral Commodities Summary Jan. 2009). The long term growth of slag supply is dependent on imported sources.

The 2004 Economic Reanalysis reported that there were 19 steel import calls delivering 831,000 tons to Delaware River port facilities. Steel imports were projected to increase to 23 calls and one million tons by 2009. The forecast beyond 2009 projected modest growth ranging from 2.4% annual growth in the first 20 years declining to less than 0.5% growth per year in the later years of the project life. Total steel tonnage was projected to eventually increase to 1.6 million tons in 2058 (36 vessel calls). Steel imports accounted for $3.6 million in average annual benefits, 14.9% of total benefits, in the 2004 Economic Reanalysis.

Actual steel import activity at all Delaware River port facilities from 2003 through 2008 has exceeded the forecasts used in the 2004 Economic Reanalysis. Steel imports increased from 1.5

million tons in 2003 to a peak of 2.7 million tons in 2006. The number of import steel vessel calls reached a high of 80 calls in 2006. Imports were largely from Russia, Brazil, Poland and China with vessel drafts typically ranging from 36 to 40 feet. Since 2006, the number of vessel calls has decreased to 47 in 2007, 30 in 2008, and only four calls in 2009. The recent recession has severely impacted steel demand, however steel imports are expected to revive with the economic recovery. For example, the South Jersey Port Corporation is currently developing a new bulk terminal in Paulsboro, New Jersey (Paulsboro Marine Terminal) in anticipation of renewed steel import activity.

Containerized Commodities

The containership-related benefits calculated in the 2004 Economic Reanalysis were based on two services: one from Australia-New Zealand and one from the east coast of South America. Both of these services are operating in the same manner as projected under without-project conditions. In addition, a weekly service from the west coast of South America and a weekly service from Northern Europe are calling at the Packer Avenue Terminal. Both of these services currently use Panamax size vessels. A second liner service from Australia and New Zealand, which operates on a bi-weekly basis, also now calls at the Packer Avenue Terminal, but with smaller vessels.

Meat, produce, and wine were identified in the 2004 Economic Reanalysis as important import commodities for containerized trade on the Delaware River. The Waterborne Commerce Statistics data shows consistent tonnage for meat imports and high, but somewhat fluctuating tonnages for fruits and nuts (excluding bananas and plantains).

Delaware River Imports
(short tons)

	2003	2004	2005	2006	2007
Fresh Frozen Meat	406,838	467,556	460,974	451,282	455,125
Fruit & Nuts (not bananas)	730,608	698,120	1,090,306	568,613	682,745

Source: WCSC

The United States Department of Agriculture provides annual statistics on total US import tonnage from specific countries. Important levels of Delaware River meat imports were identified as coming from Australia and New Zealand in the 2004 Economic Analysis. USDA data indicate that total US meat imports from this part of the world increase more than five-fold from 2003 to 2004, and nearly doubled from 2004 to 2008. South American produce imports to the US, another important containerized commodity identified in the 2004 Economic Reanalysis, have grown by 13% from 2004 to 2008. Wine imports to the US from Australia, New Zealand, and South America have grown by 33% from 2004 to 2008. The strong growth exhibited by

these containerized commodities is greater through 2008 than had been projected by the 2004 Economic Reanalysis, which had been based on constant trade volumes.

US Imports: Selected Commodities and Countries
(metric Tons)

	2004	2005	2006	2007	2008
ANZ Meat	4,105	23,486	28,229	34,803	44,650
S. American Produce[1]	1,079,308	1,170,187	1,203,229	1,306,550	1,218,005
ANZ & S. American Wine[2]	526,007	589,976	634,814	682,709	700,779

[1] Excludes Bananas and plantains; [2] Measured in kiloliters
Source: USDA

Although the number of containership calls to the Delaware River has fluctuated from 2004 to 2009, the total number of calls in each year since 2004 is greater than the number of calls in 2004. The total number of calls in 2009, even with the impact of the recession is sufficient for six weekly services and additional bi-weekly calls. The data also indicates that containerships regularly sail at drafts that approach the depth constraint.

Delaware River Containership Calls

	2004	2005	2006	2007	2008	2009
Total calls	340	418	516	459	435	354
Calls >35 ft	99	97	103	86	77	55

Source: Maritime Exchange of the Delaware River and Bay

Panama Canal Expansion

The Panama Canal Expansion project, which is projected to be operational in 2014, will accommodate vessels with drafts up to 50 feet. The expanded Panama Canal is a major change to projected future conditions, and was not included at the time of the 2004 Economic Reanalysis. The expansion project adds more than ten feet to the controlling depth of the Panama Canal as well as channel widening and is projected to have a substantial impact on the transportation of Asian imports to the US East Coast. The expansion will increase the competitiveness of Asian import bulk commodities to the US East Coast, such as steel, which had previously been constrained by a Panama Canal sailing draft of 39.5 feet. Similarly, containerized imports on the all water route from Asia to the US East Coast (via the Panama Canal) will gain an additional transportation cost advantage over the land bridge route, which predominantly transports Asian imports from U.S. West Coast ports to the central and eastern US by rail. There is a high likelihood that some containerized imports to the US will shift from

West Coast ports to East Coast ports, in response to the Panama Canal Expansion project. Similar shifts are expected for exports to Asia.

Overall Impact on Project Benefits

The changes that have occurred in navigation operations at the Delaware River since the 2004 Economic Analysis are mostly captured within projected without-project conditions, with the notable exception of the short-term impacts of the recent recession. Changes which might influence benefits include reduced imported crude oil tonnage, increased imported petroleum product tonnage, imported steel tonnage, and containership services.

The closing of one refinery and the merging of three refinery operations into two facilities will likely reduce crude oil imports. This reduction in imports will likely reduce benefits generated by crude oil tankers because there will be fewer of these vessels using the system, however it is important to note that one closed facility (identified as Motiva in the 2004 Economic Reanalysis) did not generate project benefits. The reduction in crude oil vessel calls may not reduce lightering benefits because the remaining facilities on the Delaware River are currently doing more lightering than observed in the 2004 Economic Reanalysis. Furthermore, any reductions in crude oil related benefits will most likely be offset by increases in benefits related to petroleum product vessels which have substantially increased activity on the Delaware River in response to the reduction in domestic refining capacity. The overall impact to benefits based on changes in all petroleum related trade is potentially an increase in project benefits.

The recent recession has reduced steel and slag imports to Delaware River facilities. Slag imports (used in concrete production) are directly related to domestic construction activities, which have been most severely impacted by the recession. Post-recession import slag tonnage is expected to return to levels achieved prior to the recession which are fully consistent with the expectation of the 2004 Economic Reanalysis without-project condition. Until 2009, steel imports to Delaware River facilities were greater than projected by the 2004 Economic Reanalysis. It is important to note that a substantial proportion of imported steel tonnage was delivered to facilities other than, and north of, the Packer Avenue facility. Under with-project conditions, these facilities, which are beyond the Delaware River-Philadelphia to the Sea limits of the proposed project, will be at a comparative disadvantage because they will have a maintained authorized depth of 40 ft compared to the proposed project depth of 45 ft. The economically rational expectation is that, under with-project conditions, Delaware River steel deliveries could shift between facilities within the project boundaries. This expectation is supported by the fact that the northern-most facility, which has recently received the largest share of steel imports, is owned by a firm (Kinder Morgan Terminals) which also has a southern bulk terminal operation within the project boundaries (at Camden, NJ). Additionally, a new bulk terminal has been constructed in Paulsboro, NJ. This new bulk terminal is owned by a firm currently operating another bulk facility within the project boundaries in New Jersey. Overall,

project benefits related to dry bulk commodity imports would potentially increase due to the evolution of expected steel import tonnage.

Changes in containership operations since the 2004 Economic Reanalysis include the addition of a new service from Northern Europe, and greater commodity tonnage than projected. The benefit generating services identified in the 2004 Economic Reanalysis continue to call at the Packer Avenue Terminal and operate in the same manner as identified in 2004. Currently and under without-project conditions, Philadelphia is typically shallower than the preceding port and the next port in the service rotation, which indicates that controlling depth at the Delaware River poses a constraint on containership services. Prior to the recession, the number of containership calls at depths approaching the without-project constraint has been consistent at approximately two calls per week. The Panama Canal Expansion may provide an additional positive effect on containership-related project benefits, if vessel sizes increase as generally expected.

Summary of Probable Impacts on Project Benefits

Commodity	Vessel Type	Type of Change Observed	Probable Impact on Benefits
Refrigerated	Containership	Increased tonnage	Increase
General	Containership	New liner service	Increase
Crude Oil	Tanker	Non-benefiting refinery closed; One refinery closed & operations consolidated with others	Decrease
Crude Oil	Lightering vessels	Increased lightering at some refineries	Ambivalent
Petroleum Products	Tanker	Increased tonnage to offset decreased refinery capacity	Increase
Steel	Break Bulk	Tonnage greater than projected	Increase
Slag	Dry Bulk	Recession sensitivity	None

A sensitivity analysis was conducted to identify the net impact on the December 2009 Economic Update summary table benefit-cost ratio (BCR) if benefits (under a pessimistic scenario) are decreased by 20% for each commodity category, or increased by 20% (under an optimistic scenario). The BCR of 1.35 in the 2009 Economic Update would be bracketed by BCRs of 1.14 (pessimistic) and 1.56 (optimistic). A BCR of unity (1.00) would necessitate a reduction of approximately 34% in benefits for the commodity categories.

In summation, other than the short-term impacts of the recession, changes in navigation operations at the Delaware River would potentially increase project benefits. Changes which would likely have a negative impact on project benefits, such as the reduction in crude oil imports, would be expected to be offset by the positive effects of increases in petroleum product, steel, and containerized import categories.

Updated Assessment of Relevant Market and Industry Trends to Address GAO March 2010 (GAO-10-420) Report Recommendation

Scope of Work Summary

The overall GAO March 2010 Report conclusion regarding the Delaware River Main Channel Deepening Project was that the 2002-2004 Corps' Comprehensive Reanalysis and Supplement Reports corrected errors identified by the prior GAO report and was responsive overall to GAO's 2002 recommendations. As a follow-up, GAO recommended that "the Corps should conduct and provide an Updated Assessment of relevant market and industry trends that identify the extent to which data and assumptions have changed, and quantify the effects of these changes on each benefit category and on net benefits". The Assistant Secretary of the Army (Civil Works) concurred with the GAO recommendation in a March 25, 2010 response to the GAO draft report.

The GAO March 2010 report was heavily focused on the uncertainties being caused by the current severe national and global economic downturn. Business cycle fluctuations generally do not result in significant changes to the long term underlying nature of the productive process. Clearly, short-term cargo trends for imports and exports are certainly impacted by the current conditions in the overall economy. However, these trends do not generally reflect long term secular trends in the economy including technological change and the impact of federal policy changes on future economic activity. The 50-year period of analysis to be applied in the Updated Assessment will incorporate the long-term secular trend of the economy on market and industry trends, while also taking into account short-term business cycle fluctuations.

The benefiting modeling/calculation techniques developed for the Comprehensive Reanalysis and Supplement will be applied and incorporate updated data. The Updated Assessment will be organized according to the categories of benefits (by commodity) that have been claimed for the project, including containers, steel slab, slag, crude oil, and petroleum products. Once market trends and industry trends are assessed, they will be related to benefits as previously calculated to determine the impact on overall project benefits.