Review of "Kilcohook Upland CDF Effluent Monitoring"

Reviewed by: Rick Greene, Delaware DNREC, Watershed Assessment
Date of Review: February 12, 2010

I have reviewed the above referenced document. The undated document was provided to the Delaware Department of Justice (DOJ) on February 8, 2010 via email from Ms. Rachel Horowitz under the subject title "NJDEP analyses of discharges from Kilcohook." Ms. Horowitz appears to be an attorney representing the State of New Jersey in the Delaware River Main Channel Deepening litigation. The Delaware DOJ forwarded the email and NJDEP analyses to DNREC. The Deputy Secretary of DNREC in turn forwarded the email and NJDEP analyses to me for review. My comments follow.

1. **Geographic Setting and Problem Context:** The Kilcohook confined disposal facility (CDF) is located on the New Jersey side of the Delaware Estuary approximately 5 miles southwest of the Delaware Memorial Bridge and approximately 2 miles north-northeast of Pea Patch Island. The USACE pumps dredged material (a slurry of ~ 25% solids and 75% water) through a pipeline into this CDF during maintenance dredging of the Delaware River Main Navigation Channel. This CDF, like all CDFs, is designed to retain the solids and return the water back to the surface water. CDFs are essentially large settling basins surrounded by earthened, diked walls. Partially clarified water within the CDF is channeled towards a weir structure where the water, dissolved constituents in the water, and any remaining particles suspended in the water are discharged back to the surface water. In this case, the receiving water for the discharge is the Delaware Estuary or a small tributary leading to the Delaware Estuary. The Delaware Estuary is Waters of the State of Delaware in the vicinity of the Kilcohook CDF. During an average incoming (flood) tide, water discharged from Kilcohook will travel an average of 12 miles to the north, which is still within Delaware waters. On an average outgoing (ebb) tide, water discharged from Kilcohook will also travel roughly 12 miles south, which places it primarily in Delaware waters but also potentially in New Jersey waters near Artificial Island, NJ, which lies about 9 miles south of Kilcohook.

2. **Kilcohook CDF Monitoring:** The USACE monitored the quality of the Kilcohook CDF discharge, the resulting near-field discharge plume, and "background" locations in the Delaware Estuary during 3 separate periods: (i) late 1999; (ii) late 2003/early 2004; (iii) and late 2004. In each case, the discharge appears to have lasted between 1 to 3 months. Monitoring data collected by the USACE during those discharge periods are the subject of the NJDEP analysis submitted to the Delaware DOJ on February 8, 2010. The actual field data were collected by the consulting firm Versar under contract with the USACE. NJDEP appears to have required the USACE to collect the data as a condition of 401 water quality certification. NJDEP issued a new water quality certification for maintenance dredging of the existing 40' channel in September of

2007. It is unclear whether the new certification requires discharge monitoring of the Kilcohook CDF and whether any monitoring has occurred there since issuance of the new certification.

3. **Summary of Approach and Overall Impression of NJDEP Analysis:** The NJDEP analysis compares the concentrations of various metals and organic contaminants in the Kilcohook CDF discharge, discharge plume, and ambient "background" samples from the Delaware Estuary to the Delaware River Basin Commission's (DRBC) stream quality objectives. Tables are presented that indicate which contaminants exceed the DRBC stream quality objectives along with the associated exceedance frequencies. The NJDEP analysis concludes that, "The observed (and potential) exceedances of the applicable DRBC 'Stream Quality Objectives' … indicate that dewatering effluent discharges from the Kilcohook Upland CDF associated with the maintenance dredging of the New Castle Range may be adversely impacting the water quality of the Delaware River." It is my professional opinion that this conclusion is not substantiated by sound scientific analysis. In short, I believe the NJDEP conclusion seriously overstates ecological and human health risk. Specific concerns and deficiencies in the analysis are detailed below.

4. **Actual CDF Discharge, Plume, and Background Concentrations Not Included:** The actual concentration data are not presented in the analysis. Without the data, individuals trained in the assessment and interpretation of such data cannot independently reproduce the NJDEP analysis. Furthermore, without the discharge concentration data and associated flow rates, it is not possible to perform more sophisticated analyses of fate and transport in the receiving water. At a minimum, the data should be tabulated and included as an appendix. Simple scatterplots would also be useful. Further, the results of QA/QC samples should also be included so that the overall analytical quality of the data can be evaluated.

5. **Specific DRBC Stream Quality Objectives Not Presented:** In a similar manner, the specific DRBC criteria used for the comparisons should be listed in the analysis. Without the specific criteria and measured concentrations, the magnitude of 'exceedance' cannot be determined. Knowing how far or close the measured discharge concentrations are to the applicable criteria provides important information concerning the probability of impact. The other issue that needs to be considered at the site is whether the ambient water during the time of sampling was fresh (< 5 ppt salinity) or marine (> 5 ppt salinity). The distinction is important because there are different DRBC aquatic life criteria for fresh and marine waters. The salinity of the Delaware Estuary where the Kilcohook CDF is located sometimes meets the definition of fresh and sometimes meets the definition of marine, depending largely on seasonal variations in freshwater inflow from the upstream drainage area. Although both fresh and marine criteria should be considered for continuous, year-round discharges to receiving waters that can be either fresh or marine, the Kilcohook CDF discharge is not a continuous discharge. From a more fundamental perspective, evaluating whether

an ambient water sample (not an effluent sample) complies with water quality criteria is predicated on using the appropriate criteria. If the salinity of the ambient water at the time of sampling is less than 5 ppt, then freshwater criteria should be used. If the salinity of the ambient water at the time of sampling is greater than 5 ppt, then marine criteria should be used. As an example of why this distinction is important, consider the case of aluminum. The NJDEP analysis concludes that there were frequent exceedances of the DRBC acute and chronic aquatic life criteria for aluminum in discharge plume samples. The DRBC, like DE and NJ, only has freshwater aquatic life criteria for aluminum, not marine criteria for aluminum. So, if the salinity of the receiving water near Kilcohook had been greater than 5 ppt on the day the plume and background samples had been taken, then applying freshwater criteria would not be appropriate. The point here is that it's important to list and justify the specific water quality criteria used.

6. **Handling of Non-detected Results:** It appears that many, if not most, of the metals 'exceedances' identified in the NJDEP analysis for plume and background samples were actually non-detected values assumed to be present at one-half the detection level. These are not clear, unequivocal 'exceedances'. Only actual 'exceedances' should be called exceedances. Non-detected values are just that, non-detected values. If high detection levels hamper evaluation of the data (i.e., DL > wqc), then the proper response is to improve detection levels.

7. **Near-Field Mixing of Discharge and Ambient Water Not Considered:** The NJDEP analysis compares concentrations in undiluted CDF discharge to DRBC acute aquatic life criteria. This is, in general, an improper application of ambient water quality criteria. Ambient water quality criteria apply in receiving waters after proper consideration of mixing, fate processes, and other factors (e.g., salinity as discussed above). With regard to mixing, current regulations and standard practice in DE, NJ, and the DRBC allow for near-field mixing of discharges and receiving waters prior to acute criteria compliance. Specifically, section 4.20.5 A.1 of the DRBC's Water Quality Regulations (DRBC, 2008) allows for near-field mixing zones where acute aquatic life criteria can be exceeded. Based on experience, near-field dilution factors are typically on the order of 10 to 1. Using a value of 10 to 1 for illustration, and not considering any other factors, the concentration of the contaminant in the CDF discharge would need to be at least 10 times greater than the acute aquatic life criterion for there to be a chance that the discharge causes an exceedance of the acute criterion at the edge of the near-field mixing zone. I cannot assess this possibility since the NJDEP analysis does not include the actual discharge concentrations, nor flow rates. As an aside, there is a version of the near-field mixing zone model CORMIX that could be used to get a better handle on site-specific near-field dilution factors for the Kilcohook CDF discharge. A copy of the model that accounts for tidal flows is available on the DRBC's web site. Delaware helped to support the original CORMIX model and also provided the conceptual framework for its adaptation to the more complex problem of plume dynamics in tidal waters.

8. **Far-Field Mixing of Discharge and Ambient Water Not Considered:** The NJDEP analysis compares concentrations in the undiluted CDF discharge directly to chronic aquatic life criteria and human health criteria. This is a gross misapplication of these criteria. The DRBC's chronic aquatic life criteria and human health water quality criteria apply under complete mix conditions as specified in section 4.20.5.A.5 of the DRBC Water Quality Regulations. In applying the complete mix assumption, different Estuary net advective 'design flows' are used for chronic aquatic life criteria and human health criteria. For chronic aquatic life criteria, a combination of 7Q10 for all tributaries plus 2500 cfs at the Delaware River at Trenton is used (section 4.30.7.B.2). This translates to an aquatic life design flow of approximately 4,160 cfs in the part of the Estuary near the Kilcohook CDF (Greene, 2004). Similarly, the harmonic mean flow is used for human health criteria for carcinogens and a 30Q5 flow is used for human health criteria for systemic toxicants (section 4.30.7.B.2). The net advective harmonic mean flow in the part of the Estuary where the Kilcohook CDF is located is approximately 284 cubic meters per sec (Fikslin and Greene, 1998), or 10,000 cfs. The design flows for chronic aquatic life protection and human health protection are both enormous and provide orders of magnitude mixing and dilution. The NJDEP conclusion concerning exceedances of the chronic aquatic life criteria and human health criteria as a result of the Kilcohook CDF discharge are highly suspect and almost certainly incorrect. I have made a very rough estimate of the average discharge flowrate from the Kilcohook CDF of 8.6 cfs [75% of 994,000 cubic yards/27 days]. For the chronic criterion, this translates to a dilution factor of 484 (i.e., = 4160 cfs/8.6 cfs). For human health criteria with a cancer endpoint, the dilution factor is 1160 (i.e., 10000 cfs/8.6 cfs). The NJDEP analysis in contrast, assumes no dilution.

9. **NJDEP Analysis Fails to Consider Bioavailability:** Metals and organic contaminants partition in the environment between the sorbed (particulate) phase and dissolved phase. Years of research have demonstrated that toxicity and bioaccumulation are more strongly related to and dependent on the dissolved phase than the particulate phase. There is no discussion in the NJDEP analysis regarding the chemical forms of the contaminants in the CDF discharge, nor is there discussion of partitioning behavior once the discharge mixes with the ambient waters of the Delaware Estuary. It appears that the NJDEP analysis assumes that all contaminants in the CDF discharge are dissolved and fully bioavailable and that they stay that way after mixing with the receiving water. This is unrealistically conservative.

10. **NJDEP Analysis Fails to Consider Overall Mass Balance of Dredging and Dewatering Operation:** Dredged material pumped into the Kilcohook CDF is derived from the Delaware Estuary. During dredging, most of the excavated material is drawn into a pipeline and pumped to the CDF. However, there is a certain percentage of solids and associated contaminants that are released to the water column near the cutterhead. Research and modeling exercises suggests that percentage to be between 2 to 4 % depending on several operating characteristics

of the dredge (assuming a hydraulic dredge). Much of the heavier material released to the water column settles back out near the dredge, while finer material can be transported further from the dredge. When released to the water column, some of the sorbed contaminant can desorb and become dissolved, representing an important consideration in dredging impacts. The USACE, at the insistence of and with the assistance of DNREC, considered this loss to the water column, partitioning behavior, and expected exposures as part of the main channel deepening environmental assessment (USACE, 2009). Of course the other key consideration in evaluating dredging impacts is the disposal and dewatering of the dredged material. In this situation, a proper analysis considers the mass loading of material and contaminants that enter the CDF and the mass loading of material and contaminants that are discharged from the CDF during dewatering. The NJDEP analysis focused solely on the concentrations of contaminants leaving the CDF without consideration of mass loadings into the CDF and mass loading out of the CDF. Had this broader mass loading approach been taken, I am confident that it would show that dredging results in a net removal of contamination from the open aquatic environment of the Delaware Estuary.

11. **Inspection and Engineering Review of Kilcohook CDF:** The NJDEP analysis recommends that an engineering evaluation of the design and operation of the Kilcohook CDF be completed. I fully agree with that recommendation. Proper operation of these CDFs is in everyone's interest.

References

USACE. 2009. Delaware River Main Stem and Channel Deepening Project Environmental Assessment. U.S. Army Corps of Engineers, Philadelphia, PA.

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