ALTERNATIVE APPROACHES FOR MANAGING DREDGED SEDIMENT

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ABSTRACT

Every year, over 200 million cubic meters (m^3) or 300 million cubic yards (CY) of sediment are dredged to deepen harbors and clear shipping lanes in the United States. Approximately 2.3 to 9 million m^3 (3 - 12 million CY) of these sediments are contaminated to the extent that they require special, and often costly, handling. If dredging to improve navigation cannot be conducted because sediments are contaminated, the volume of shipping on these waterways will decline. In addition, about 300 sites (approximately 20 percent) currently on the Superfund National Priority List (NPL) appear to have contaminated sediment to some degree. The United States Environmental Protection Agency (USEPA) has made decisions at almost 50 percent of these sites to address that contamination. Most of the sites are small, but several sites are quite large and dredging would require significant disposal capacity.

Traditionally, uncontaminated sediment was disposed in open water while contaminated sediment was more often landfilled. Low to moderately contaminated sediments were, and are, often disposed in confined disposal facilities (CDFs). The economic element of sustainability has increased emphasis on green and sustainable environmental solutions that has reduced the desirability and cost of trucking materials over large distances to be landfilled. Also, the capacity of most existing CDFs has been used up, thereby presenting additional challenges for disposal of dredged sediment. Many sediment sites currently engaged in the Superfund process will place a heavy demand for sediment disposal capacity within the next decade and beyond. As strategies are being developed for the larger sites, there are many lessons to be learned from the use of alternate disposal approaches at smaller sites.

Keywords: Dredging, beneficial uses, on-site consolidation, dredged material disposal, contaminated sediment.

INTRODUCTION

Waterways are dredged for a variety of reasons that include navigational channel maintenance, flood control and environmental restoration. Both private and government agencies (e.g. United States Army Corps of Engineers [USACE]) routinely dredge the nation's lakes and rivers so vessels can access inland ports. Dredge spoils from maintenance or flood control dredging may be disposed in open water in the ocean or lakes or in confined disposal facilities (CDFs) as summarized by USACE (2015). Additionally, unimpacted dredged sediment may also be beneficially reused for beach nourishment or in various other restoration applications such as mine reclamation, aggregate manufacture (Tang et al., 2011), top soil blending and wetland creation (Clark and Knight, 2013). The presence of contaminants in dredged sediment severely limits the disposal options available for the sediment. This presence of contaminants also results in increased costs for handling and managing the sediment, especially when transporting it over long distances for landfill disposal.

Of the several available options for disposition of dredged sediment, ranging from reuse to disposal in landfills, the most appropriate for a given sediment is dependent on the sediment characteristics (Rakshith and Singh, 2017). The presence of chemical contaminants limits the disposal options of the dredged sediment since there is the need to be protective of human health and the environment. Consequently, several low-cost disposal options could be unacceptable. For example, in-water disposal is typically the least costly option for dredged sediment. However, this option is less viable because of the potential to contaminate other portions of the water body and pose other

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negative impacts to the ecosystem. Similarly, sediment that is potentially impacted with chemicals may be difficult to reuse as topsoil without several use restrictions or prior treatment. One of the lower cost and potentially viable options is reuse of the dredged sediment in reclamation of abandoned mines. These types of approaches such as minimizing the quantity of material to be dredged, beneficial reuse and on-site consolidation, are discussed below.

MINIMIZATION OF DREDGED QUANTITIES

One approach to minimizing the quantity of dredged sediment to be managed is to reassess whether dredging is all together necessary. If a navigation channel can be decommissioned or the required navigation depth reauthorized to a shallower depth, the extent of dredging can be reduced. A proposed innovation for reducing the quantity of sediment to be dredged is to reduce the amount of sediment entering the system in the first place (RDT - DE, 2013). For sediment sites with low levels of contaminants, a remedial strategy that avoids removal means that sediment will not be dredged and need to be managed. Avoiding removal by utilizing lower cost alternatives that provide the same level of benefit as dredging, is discussed below.

Avoiding Removal Altogether

Sediment in a pond in Central New York State was sampled and analyzed for volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), various metals and total organic carbon (TOC). Like most states, New York does not have standards for sediment that have to be met. Instead, there is technical guidance that provides screening levels for use in determining whether further evaluation is necessary and another guidance that separates dredged sediment into three categories which dictate potential future disposition. These guidance documents were deemed inappropriate in this case and it was requested that the sediment data be compared to New York State Protection of Groundwater Soil Cleanup Objectives (SCOs). Several analytes in sediment were found to exceed the New York State default Protection of Groundwater SCOs and so sediment removal was presumed to be necessary.

A protective scenario, acceptable to the New York State Department of Environmental Conservation (NYSDEC), was developed that allowed for the sediment to remain in place. The approach involved data evaluation using site-specific information, scientific principles and the underpinnings of the regulations to support a protective remedy that involved leaving the sediment in place. Using the TOC data that had been collected, site-specific SCOs were calculated and compared to observed chemical concentrations in the sediment. The magnitude of exceedances was used as an indicator that the extent of the purported impact was limited. Uncertainty associated with some of the data generated by the analytical laboratory were also relevant to the assessment.

Other relevant factors included temporal effects on contaminant fate. Since the facility had been in operation for several decades, various attenuation processes would have already taken place. Other factors noted included the conservative methodology utilized in deriving the SCOs, the potential impact of a portion of highly sorbent black carbon, an overlying water column that promoted dilution, the low affinity for PAHs (especially aged in the sediment) to solubilize and the colder area temperatures, in a preponderance of evidence approach, to support the conclusion that dredging was unnecessary. This conclusion and concurrence by the Agency, precluded the need for potentially costly dredging and associated dredged sediment management.

Use of Alternative Technologies to Removal

The apparent presumptive remedy for contaminated sediment sites has largely been dredging. However, in situ remedies such as capping and activated carbon treatment have been gaining acceptance. Recently, other in situ techniques have been included as major components of the remedy in Records of Decision (RODs) for Superfund sites. Increased use of these and other in situ sediment remediation technologies offer the advantage of significantly limiting the amount of sediment to be dredged and disposed at landfills.

The ROD for the Lower Duwamish Waterway in Seattle, Washington (USEPA, 2014) includes the use of multiple technologies. It includes extensive monitored natural recovery (MNR) for over 95 hectares (235 acres) and enhanced natural recovery (ENR) for over 19 hectares (48 acres). In addition to dredging of approximately 734,000 m^3 (960,000 CY) of sediment over 42 hectares (105 acres), an engineered cap will be placed over 10 hectares (24 acres). This combination remedy reduces the amount of the total impacted sediment that would ordinarily be dredged and landfilled. Instead, in situ technologies are being used extensively.

The ROD for the Gowanus Canal in Queens, New York (USEPA, 2013), also includes the use of multiple technologies. In addition to dredging of approximately 459,000 m^3 (600,000 CY) of sediment, the use of significant amounts of in situ solidification is also included. There will also be a multi-layered reactive cap placed above the stabilized sediment that contains non-aqueous phase liquids (NAPL). These components are intended to preclude removal and disposal of the native underlying material contaminated with NAPL.

REUSE OF DREDGED SEDIMENT

Significant effort is being made to maximize the reuse of dredged sediment when feasible. Sediments that are uncontaminated may be reused as topsoil following blending with other soil components, or in land reclamation of open water areas. Uncontaminated and moderately contaminated dredged sediment may also be used as fill and/or in reclamation of abandoned mines. As in many other communities, the dredging community in the Great Lakes also has been working to find productive uses for dredged material. Every year, over 2.2 million m^3 (3 million CY) of sediment is removed from the five Great Lakes (GLDT, 2016). As described above, dredgers have traditionally placed excavated sediment at authorized locations in the lakes or delivered it to CDFs. Changes in the dredging industry is expected to provide greater emphasis on the use of dredged sediment in a wider range of commercial, environmental, and agricultural projects. Some of these approaches are discussed below.

Sediment Use for Surface Soil Enhancement

Legislation passed by the State of Ohio to reduce in-lake placement - the historical practice of placing dredged sediment into designated areas of a lake, typically adjacent to the harbor being dredged - has bolstered emphasis on beneficial use alternatives in the State. The Toledo-Lucas County Port Authority (TLCPA) is currently leading an effort to plan for the full-scale implementation of beneficial use of dredged materials for agricultural and blended soil product purposes (Izard-Carroll, 2017). The TLCPA designed and constructed a facility specifically for this purpose, called the Great Lakes Dredged Material Center for Innovation. This facility is now operational, and received approximately 30,582 m^3 (40,000 cy) of dredged sediment in the summer of 2016. TLCPA is currently assessing best management practices for use of these soils on farm fields.

Another notable example of a useful application of dredged sediment in Ohio, is the Cuyahoga Valley Industrial Center (CVIC) project, completed in 2010. This unique Recovery Act demonstration project involved the reuse of approximately 229,366 m^3 (300,000 CY) of dredged sediment, taken from a USACE-confined disposal facility near Burke Lakefront Airport in Cleveland, Ohio. The material was used at a 23-ha (58-acre) Brownfield site. The objective of the project was to overlay the existing site soils with cleaner dredged sediments to create a viable location for redevelopment. The work resulted in an elevated, buildable site that garnered widespread support from local and state stakeholders.

Land Reclamation

Land creation and improvement includes the building of dikes and berms for shore protection; filling, raising and protection of submerged and low-lying areas; and applying material to areas where the quality of existing land is poor, such as mine land or brownfields reclamation. Land creation and improvement with dredged material is often associated with other benefits, such as capping or habitat creation. Material has been harvested from a Cleveland Harbor CDF for use in brownfield restoration and from a Duluth-Superior CDF for mine land reclamation. In Pennsylvania, the State considers dredged material “residual waste,” and its use and disposal are governed by permits that relate to the processing and beneficial use of dredged material for specific applications (e.g., WMGR085—Use of dredged Material in Mines). This facilitates reuse of the dredged material, including for land reclamation.

Sediment Use as Fill

An approximately 93 kilometers (58 miles) long canal provides a water source to various purveyors and users in a northeastern state. Sediment and debris accumulation has diminished the flow of water within the canal. Water flow had been further impeded by submerged aquatic vegetation growth during the summer months, when water demand peaks. Dredging of the larger canal section was deemed necessary to maintain overall flow volume with an initial target of an approximately 17 km (10.5-mile) long segment. The primary objective of the dredging project is to restore the flow of water by providing a nominal water depth of 2 m (7 feet) along the main channel of the canal for varying widths along the proposed project area.

Dredging technologies were evaluated based on suitability to dredge the sediment present, accessibility, precision of cut, resuspension of sediments, bench-scale dewatering test results, associated dewatering needs, required area for staging, volume generated for disposal, minimizing impacts to park users, stakeholder considerations, habitat, and overall project implementation costs. Approximately 206,000 m^3 (270,000 CY) of sediments were identified for removal from the canal. Following an in-depth review, the material was found to be suitable for re-use as fill at non-residential sites, and a portion could also be considered for residential sites. An Acceptable Use Determination was obtained as part of the dredging design and permitting to beneficially re-use the dredged material as fill. Hydraulic dredging with geotextile bag dewatering was chosen as the recommended technologies recognizing the intended use of the dewatered sediment as fill.

ON-SITE CONSOLIDATION OF DREDGED SEDIMENT

The presumptive approach for addressing contaminated sediment has traditionally been dredging and landfilling at off-site facilities. This can be very costly for large sediment quantities, underscoring the need to identify both more economical remedial and disposal alternatives. However, on-site consolidation has been used to varying degrees at numerous smaller sites as an alternative to off-site landfills. This section discusses an example of on-site consolidation for uncontaminated sediment and three examples with contaminated sediment for relatively smaller sites.

Water Storage Reservoir

The City of Philadelphia Water Department utilizes several large pumped-storage reservoirs for storage of raw surface water from the Schuylkill and Delaware Rivers. In addition to volume storage, a secondary purpose of the reservoirs is for settling of suspended solids prior to intake of the raw water into the treatment plant. The 7-hectare (18-acre) reservoir has been in operation for over 100 years. The facility cannot be dewatered for one-time removal of accumulated sediments due to continuous system demand. Hence, periodic maintenance dredging is performed to manage the estimated 5,400 m^3 (7,000 CY) of annual sediment accumulation. The Water Department has historically utilized an on-plant residuals lagoon to dewater and store dredged sediments and treatment residuals. However, revised state residual waste regulations forced closure of the lagoon over 25 years ago.

The City is now faced with the costly task of off-site disposal of an estimated 229,000 m^3 (300,000 CY) of sediment accumulation within the reservoir. The problem is compounded by the lack of plant property available for a sediment dewatering and loading facility in a densely populated urban area. An evaluation of alternatives for disposal of the sediment quickly recognized that the dewatering component of the sediment removal process was most critical. Therefore, an evaluation of the feasibility and permitting hurdles associated with dewatering and permanent disposal of the sediment in the abandoned on-plant lagoon was performed. Bench-scale testing was performed to evaluate performance of polymer flocculants on the sediment, including filtration tests using geotextile tubes. The most viable approach appeared to be on-site consolidation of the sediment in a sufficiently creative manner that maximized use of the limited available footprint. This approach is being developed further for this site.

Former Manufactured Gas Plant Site

A former MGP site in Utica, New York, is located on a peninsula formed by the intersection of the New York State Barge Canal, Utica Harbor, and the Mohawk River. A 30-hectare (73-acre) portion of the site included a former Water Gas Plant (WGP), a former Coal Gas Plant (CGP), and two former steam electricity generating stations. The NYSDEC issued a Record of Decision (ROD) for the site which required remediation of several areas. At the former Mohawk Valley Oil (MVO) portion of the site, the ROD required that soil containing 1,000 ppm PAHs or visual tar or NAPL contaminated soil be removed to a depth of 2.7 m (9 feet) below grade from portions of the MVO site and treated. A Proof of Concept Report proposed changes to the excavation plans for the MVO site. The proposed change contemplated that rather than excavating to 2.7 m (9 ft) as called for in the ROD, the MVO site be excavated to a depth of 3.5 m (11.5 ft) below ground surface (bgs) and lined to later accommodate the 61,000 m^3 (80,000 CY) volume of sediment to be dredged from Utica Harbor during a separate Remedial Action task. This approach was taken and led to cost savings by minimizing the quantity of sediment for off-site disposal and in backfill costs for the MVO site.

Shipping Terminal Site

A bulk liquid petroleum storage facility is located adjacent to a shipping canal in New Jersey. This tidally influenced canal supported historical navigational access to several area petrochemical facilities. The canal measured approximately 23 m (75 ft) in width and, historically, was approximately 0.5 km (1,400 ft) in length, stretching from the interior of the Site to its confluence with an adjacent River. The canal was constructed using engineered shoreline stabilization structures (timber bulkheads and cribbing). Remedial work at the Site has focused on two segments of this canal – the North and South Cells.

Investigations were performed to support design activities and evaluate current site conditions for approximately 23,000 m^3 (30,000 CY) of affected sediments at the North Cell. A feasibility evaluation was performed which supported the selection of *in situ* solidification as the preferred remedy. This evaluation included two phases of bench-scale treatability studies to first assess the viability of achieving the regulatory toxicity characteristic leaching procedure (TCLP) criteria. The second phase evaluated the viability of achieving the perimeter containment criteria of 1×10^{-7} cm/sec permeability for the solidified sediments in lieu of perimeter sheeting. However, a sheet pile cutoff wall was used to isolate the North Cell from the South Cell prior to performing the sediment solidification.

The South Cell is the portion of the former shipping canal that remained open water. The South Cell runs approximately 137 m (450 ft) from the former North Cell to its confluence with the River. An investigation was performed to characterize the horizontal and vertical extent of affected sediment in the South Cell. Results of the investigation indicated that the surficial and underlying sediments of the South Cell were affected with total petroleum hydrocarbons, PAHs, metals, petroleum-based volatiles and other constituents. The impacted sediment was subsequently dredged mechanically and consolidated in the North Cell. Local consolidation of the dredged sediment thereby precluded the need for transportation and off-site landfilling.

Tarpon Springs Site

The approximately 130-acre Stauffer Chemical Co. Superfund site is located on Anclote Road in a residential, light industrial and commercial area of Tarpon Springs, Pinellas County, Florida. The Site abuts the Anclote River, which flows into the Gulf of Mexico approximately two miles downstream of the Site. Between 1947 and 1981, operators used a series of unlined settling ponds as part of the manufacturing operations. The remedy for the Site included addressing soil and sediment containing arsenic, antimony, beryllium, elemental phosphorus, thallium, radium-226, and/or total carcinogenic PAHs. It involved limited excavation of radiological and chemically-contaminated material/soil that exceeded the cleanup standards for those contaminants.

In total, excavation, handling and consolidation of 170,000 m^3 (222,103 CY) of roadway and former railroad bed slag, waste fill, and contaminated soil and sediment from the North Anomaly, Pond 39, Pond 42 (Meyers Cove) and other impacted areas on site, was performed. This included dredging of 48,000 m^3 (63,000 CY) of sediment from the Meyer's cove area. The contaminated material was consolidated in the main pond area, slag area and/or other areas on site. A cap meeting Florida Administrative Code Section 62- 701.600.5(g), was placed over the consolidation area and a groundwater cutoff wall installed to reduce the potential for contaminant migration from the former wastewater ponds. The site is now grass covered and under a deed restriction. The use of on-site consolidation for the excavated sediment and other materials eliminated the need for transport and off-site disposal.

SUMMARY AND CONCLUSIONS

Large quantities of sediment are dredged on an annual basis for a variety of reasons. These include uncontaminated sediment from navigation channels and flood control channel deepening projects as well as sediment dredged during remediation of contaminated sediment sites. Due to the large demand for disposal space, alternate dredged sediment disposition alternatives are increasing in usage. These include minimizing the scale of dredging projects, beneficial reuse of non-contaminated sediment and on-site consolidation of contaminated sediment. There has been a significant amount of reuse for uncontaminated sediment. For contaminated sediment, on-site consolidation is a very viable alternative that may be implemented in creative ways. Overall experience gained from using alternatives to landfill disposal for both uncontaminated and contaminated sediment is valuable for reducing the use of landfill capacity and large haul distances and associated costs.

REFERENCES

Izard-Carroll, M.D. (2017). “Dirt Cheap Design: The Emerging Market for a Dredging By-product.” *The Construction Specifier*. March 3, 2017.

Clark, G., Knight, D.L. (2013). “Beneficial Use of Dredged Material in the Great Lakes.” Great Lakes Dredging Team, Great Lakes Commission des Grands Lacs.

GLDT, Great Lakes Dredging Team (2016). “Guide to policies and Projects Related to Beneficial Use of Dredged Material in the Great Lakes.” Great Lakes Dredging Team.

Rakshith, S. and Singh, D.N. (2017). “Utilization of Dredged Sediments: Contemporary Issues.” *Journal of Waterway, Port, Coastal and Ocean Engineering*, 143 (3), ASCE.

RDT – DE (2013). “Dredging and Dredged Material Management.” Regional Dredging Team (RDT) for the Delaware Estuary (DE).

Tang, C-W., Chen, H-J., Wang, S-Y. and Spaulding, J. (2011). “Production of Synthetic Lightweight Aggregate Using Reservoir Sediments for Concrete and Masonry.” *Cement & Concrete Composites*, 33, 292-300.

USEPA (2013). Record of Decision – Gowanus Canal Superfund Site, Brooklyn, Kings County, New York. United States Environmental Protection Agency, Region II, New York, New York. September 2013.

USEPA (2014). Record of Decision – Lower Duwamish Waterway Superfund Site, King County, Seattle and Tukwila, Washington. United States Environmental Protection Agency, Region X, Seattle, Washington. November 2014.

USACE (2015). “Dredging and Dredged Material Management.” EM 110-2-5025, United States Army Corps of Engineers, Washington, DC 20314.

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