The Use of Geotextile Tube Dewatering Technology in the Remediation of Contaminated Sediments-Selected Case Studies

William J. Cretens, President, Infrastructure Alternatives, Grand Rapids, Michigan, USA

ABSTRACT

Geotextile tube dewatering technology is an effective, low-cost process that can be used successfully in the remediation of contaminated sediments in waterways. Often utilized in conjunction with hydraulic dredging, geotextile tube units provide contaminant containment while simultaneously dewatering the sediments. The separated water can then be collected, treated and discharged into the water way, leaving the dewatered sediments to be disposed of at lower costs due to reduction in volume and weight. The effectiveness of this process has been demonstrated in a variety of projects, including the following case studies:

The Conner Creek Combined Sewer Overflow Project hydraulically dredged and dewatered more than 180,000 cubic yards of contaminated river sediments. The geotextile tube units were staged in three separate lay down areas and stacked in three layers to facilitate ongoing construction activities and project schedule. The dredge slurry was chemically conditioned with polymers prior to entering the tubes to facilitate dewatering.

The Black River Contaminated Sediment Remediation project removed 25,000 cubic yards of PCB and mercury contaminated sediments. Geotextile tube units were stacked two layers to minimize the foot –print of the lay down area.

1. INTRODUCTION

Geotextiles have been utilized for many years in a wide variety of applications. Geotextiles sown in tubular form, often called Geotubes®, have emerged as a cost effective and efficient technology to dewater and store large volumes of materials including contaminated sediments. Getextile tube units are commonly used in conjunction with hydraulic dredges. Project experience has demonstrated that chemical conditioning of the dredge slurry prior to entering the geotextile tubes significantly enhances sediment dewatering and filtrate water leaving the geotextile tube often requires minimal treatment prior to discharge back to the waterway being dredged. In most instances, geotextile tube units are then utilized to store the dewatered sediments on-site prior to ultimate disposal or reuse of the dewatered sediments.

The descriptions of two selected projects demonstrate the accrued benefits of the process. The Conner Creek Combined Sewer Overflow Project utilized a geotextile tube system in conjunction with hydraulic dredging to remove and dewater over 180,000 cubic yards of contaminated sediments from a one-mile stretch of Conner Creek. The project was part of the construction of a one billion gallon per day combined sewer overflow treatment facility for the City of Detroit, Michigan, USA. The contaminated sediments entered the waterway through municipal storm sewers and combined sewer overflows.

The Black River Contaminated Sediment Remediation project utilized hydraulic dredging and geotubes to remove 25000 cubic yards of sediments contaminated with PBB's, mercury, chromium and other heavy metals. The sediments had accumulated in a mill pond segment of the Black River located near Kalamazoo, Michigan, USA. Filtrate water from the tubes required minimal downstream treatment prior to discharge back to the Black River.

2. CONNER CREEK COMBINED SEWER OVERFLOW PROJECT

2.1 Design

As part of the construction of a 1 billion gallon per day combined sewer overflow treatment facility, the City of Detroit, Michigan, USA was required to remove 180,000 cubic yards of contaminated in-situ sediments from a one mile stretch of Conner Creek. Conner Creek provides a conduit to carry treated effluent from the CSO to Lake Erie. Project schedules required that the dredging operation be performed during the construction of the CSO facility. This provided a unique set of challenges. The geotextile tube containers were staged in three separate laydown areas to minimize impact on ongoing construction activities. Each laydown area was stacked three layers and turned over three times during dredging operations to complete the project.

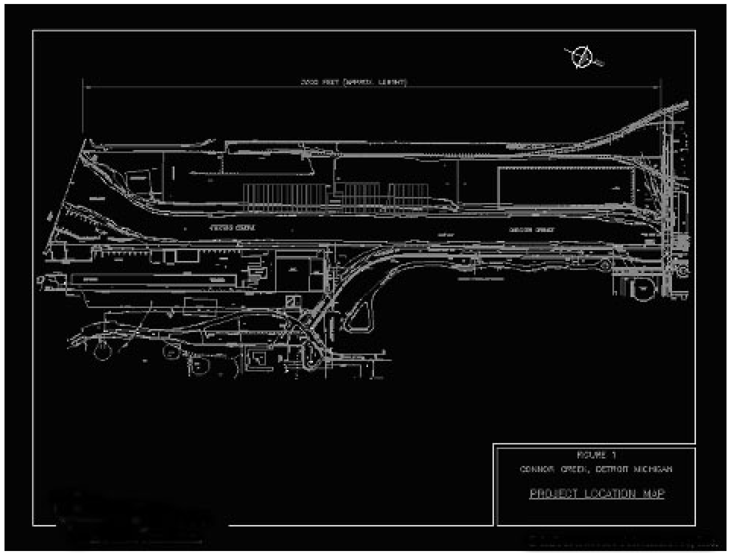


Figure 1

The dredged slurry was conditioned with a cationic polymer to aid the dewatering process and produce a high quality filtrate prior to discharge back into Conner Creek. In order to treat a wide range of slurry concentrations the polymer solution was feed by a flow and density based dose control system.

Field testing determined that 60 foot circumference tubes utilizing the GT 500 fabric was the most effective dewatering fabric. They were fabricated with circumferential seaming techniques to maximize the strength and capacity of each tube. Each one had an approximate length of 150 feet. Specifications of the GT 500 fabric are shown in Figure 2.

Mechanical Properties	**Test Method**	**Unit**	**Minimum Average Roll Value**	
			Machine Direction	**Cross Direction**
Wide Width Tensile Strength (at ultimate)	ASTM D 4595	kN/m (lbs/in)	70 (400)	96.3 (550)
Wide Width Tensile Elongation	ASTM D 4595	%	20 (max.)	20 (max.)
Factory Seam Strength	ASTM D 4884	kN/m (lbs/in)	70.1 (400)	
Apparent Opening Size (AOS)	ASTM D 4751	mm (U.S. Sieve #)	0.425 (40)	
Water Flow Rate	ASTM D 4491	l/m^2 (gpm/ft^2)	813 (20)	
Mass/Unit Area	ASTM D 5261	g/m^2 (oz/yd^2)	585 (17.3) (Typical Value)	
UV Resistance (% strength retained after 500 hrs)	ASTM D 4355	%	80	

Figure 2

The in-situ material solids concentration varied from approximately 15% total solids (by weight) to over 70% total solids with an average of approximately 40% solids.

2.2 Implementation

Each tube was filled approximately 6 times until maximum final fill volume of approximately 5.5 dewatered yards per lineal foot of geotextile tube was realized. The polymer dose averaged approximately 3.5 pounds per dry ton of sediment treated.

Figure 3

Figure 4

Figure 5

Figure 6

As tubes reached there maximum capacity, measured by a final fill height of approximately 6 feet, they were taken off line and continued to consolidate the dredged material contained within. After approximately 21 days the material consolidated to an average concentration of 50% total solids, measure by weight.

2.3 Considerations

The geotextile tube system in conjunction with hydraulic dredging proved to be an effective means to complete this project. When considering the application of this technology, one must consider the configuration and the foot print on the staging area for the tubes. In addition, it is critically important to evaluate the utilization of conditioning chemicals (polymers) to enhance the dewatering process. It is also important it consider the site drainage conditions to adequately handle the large volumes of filtrate water generated during the active filling cycles of the geotubes.

In situations were the geotextile tube units are stacked, one must consider the possibility of tubes rolling and incorporate measures to prevent this from happening.

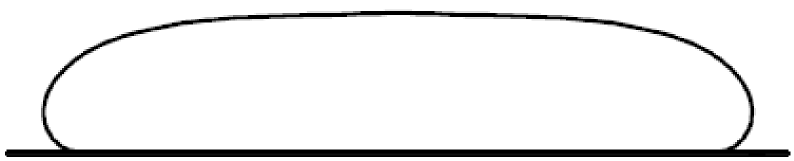
3. BLACK RIVER CONTAMINATED SEDIMENT REMEDIATION

3.1 Design

The project scope included the dredging and dewatering of 25000 cubic yards of contaminated river sediments. To accommodate this volume of in-situ material, 4600 lineal feet of 60-foot circumference geotextile tube units were required. After careful sediment testing, the GT 500 fabric was utilized for the project possessing the following characteristics:

Restricted site conditions limited the options of available laydown area. Therefore all the tubes were 60 feet in length. They were deployed in an earthen bermed, lay down area lined with 40 ml HDPE fabric to collect and store filtrate prior to treatment before discharge back into the Black River.

Further design considerations include the monitoring and control of PCB, Chromium, and Mercury in the tube filtrate. The use of cationic polymers in pre-project bench testing demonstrated that these contaminates remained below established effluent limits when the total suspended solids (TSS) concentrations in the filtrate remained below 30 milligrams per liter. This TSS limit was incorporated as a key process control indicator during full scale dredging operations. Bag filters and granulated activated carbon units were utilized to further polish the filtrate water prior to discharge.



12/11/07	Project:		Black River		
Units:	English		Maximum Tensile Force (T) =	76.08	lb/in.
Water Level:	Emerged		Geotube® Base Contact Width (B) =	24.07	ft
Geotube® Height (H) =	6	ft	Geotube® Filled Width (W) =	27.16	ft
Geotube® Circumference (C) =	60	ft	Geotube® Cross Section Area (A) =	145.01	sq ft
Specific Gravity of Fill Material (SGint) =	1.6	sg	Geotube® Volume Per Unit of Length (V) =	5.37	cu yd/ft
Geotube® Fabric Type:	GT500		Factor of Safety =	5.3	FS

Figure 7

3.2 Implementation

Each tube was filled approximately 6 times until maximum tube capacity, measured by a final fill height of 6 feet, was realized. Dredging was accomplished by an 8-inch horizontal auger dredge. Dredge slurry average 800 gallons per minute at an average slurry concentration 0f 8 % solids (by weight).

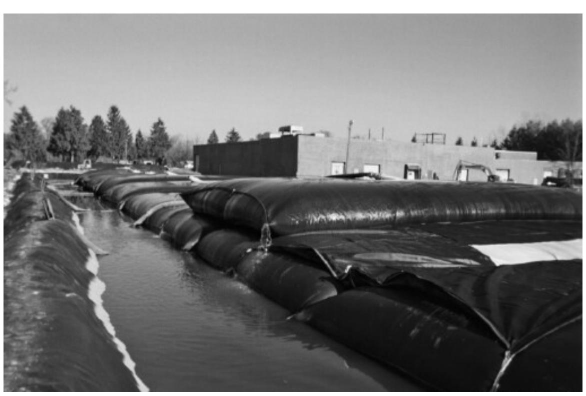


Figure 8

Figure 9

The geotextile tube containers were stacked in two layers to accommodate the limited space available for construction of the lay down area. Sediments were dewatered and consolidated to a solids concentration of 50

% by weight within 30 days. The material was then removed from the tubes and transported to a licensed landfill for ultimate disposal.

Figure 10

3.3 Considerations

Geotextile tube units in conjunction with hydraulic dredging proved to be a particularly effective method to dewater the dredged sediments. In addition to providing an excellent means of dewatering, the chemical conditioning of the dredged slurry prior to entering the tubes proved to reduce the levels of contaminates in the filtrate below permitted discharge limits. This significantly reduced the degree of additional water treatment processes and associated costs required for the project. The ability to draw correlations between TSS levels and contaminate levels provided an effective and easy way to monitor process control parameters that were utilized during full scale production.

Figure 11

4. CONCLUSIONS

Through the projects described above and several other recent projects of similar scope and contaminate levels, the use of geotextile tube technology in conjunction with hydraulic dredging has proven to be an effective means of remediation. The design and overall size of tubes accommodates large volumes of sediments and relatively high dredge production rates. Dredge slurries of 3000 gpm to 5000 gpm at concentrations up to 20% total solids are not uncommon. Because there are essentially no mechanical parts to geotextile tube operations the process is less susceptible to the impact of debris when compared to other mechanical means of dewatering such as filter presses.

In addition, these projects demonstrate the ability of geotextile tube technology to produce filtrate water with exceptionally low levels of TSS.   TSS levels are directly correlated to the type of conditioning chemical selected and the ability to accurately control chemical dose rates. This feature reduces the requirement for downstream water treatment systems.