Alternative Particulate Control Option for Sediment Removal

Abstract

An "Alternative Particulate Control Option" that will minimise generation of suspended solids when dredging in waterways where flow caused by natural current, tide or storm events does not permit the use of stationary silt curtains has been proposed by Cable Arm, Inc. This article explains this alternative method for controlling turbidity that eliminates the need for the deployment of a silt curtain.

Introduction

Silt curtains employed in water flow exceeding 2 feet/second generate excessive turbidity because of bottom scouring (see "Impact of 1996 Cole Drain Area, Contaminated Sediment Cleanup on St. Clair River Water Quality", P.B. Kauss and P.C. Nettleton of the Ontario Ministry of the Environment [April, 1999]).

The "Environmental Dredging" portion of bid documents typically specify the use of a floating barrier curtain assembly with filtration media extending the full depth of the water column. Important considerations related to the use of a silt curtain at a project site include installation (most likely requiring pile driving), cost of the filter media, clogging, storm-generated or wind-generated wave action, and silt curtain stability during tidal ebb and flow. An important, but frequently overlooked, problem with bottom-anchored silt curtains is that under tidal fluctuations or storm or heavy wind conditions, scouring of the sediment bottom occurs which results in the release of suspended sediment in the form of turbidity. Environmental dredging at White Lake, Michigan (off Lake Michigan) in 2003 indicated that environmental dredging using a mobile dredge cell and environmental clamshell bucket could generate less turbidity than an anchored silt curtain scouring the sediment bottom known as the Venturi effect.

Alternative Particulate Control Option

The Alternative Particulate Control Option proposed here provides equal or better environmental protection from re-suspended sediment through the use of specially developed Cable Arm equipment and operating procedures during the dredging operation. In addition, turbidity will be continuously monitored at the mobile Data Control center during dredging at select locations and depths in the project area to verify that turbidity does not exceed a specified NTU above background turbidity at a specified distance from the dredge cell.

The Alternative Dredging Particulate Control Option utilises an environmental dredging system, which consists of: a crane barge; a material holding barge; a material transfer barge; a mobile dredge cell; an operator trained in Cable Arm standard operating procedures; a Cable Arm environmental clamshell bucket with associated rigging including open/close alarms and depth sensors; real-time ClamVision bucket positioning software; a bucket wash tank; inclined particulate surface collection screens; secondary subsurface spill transfer containment installed in the dredge cell to allow the transfer of bucket contents between the water and the material holding barge; and deck spill containment from the holding barge to the transfer barge (Figure 1).

The primary means of particulate control in the water column is this environmental clamshell bucket. Sediment re-suspension is controlled by a trained and experienced operator using a Cable Arm environmental clamshell bucket in conjunction with real-time precision ClamVision bucket positioning software within a dredge cell.

Secondary turbidity controls used to provide further controls on sediment re-suspension include:

- a secondary subsurface spill containment pan attached to the dredge cell to capture spillage of dredged material as the bucket is lifted upward from the water to the holding barge;
- a wash/rinse tank to submerge the clamshell bucket prior to its downward cycle to minimise any re-suspension of sediment from the bucket itself;
- inclined particulate surface collection screens attached to the dredge cell to capture fugitive re-suspended sediment;
- a deck containment corridor for transferring material from the holding barge to the transfer barge.

Figure 1. The environmental bucket releasing sediment into the holding barge during July 2004 dredging operations in Jacksonville, Florida.

Secondary spill containment
A secondary subsurface spill containment, resembling a metal sediment catch basin, provides secondary containment for preventing material spillage from the bucket resulting from equilibrium changes in the bucket from water to the air, or from possible incomplete closure.

Wash/rinse tank
A wash/rinse tank is used to remove all sediments adhering to the bucket surface (interior/exterior) following sediment discharge to the receiving barge and prior to the start of the each bucket cycle. This simple approach is effective in removing sediment clinging to the bucket that would typically be resuspended during the bucket's next descent into the water column.

Inclined particulate surface collection screens
Two inclined particulate surface collection screens are attached to the dredge cell as an innovative turbidity control device. The barge is positioned in the direction of the flow of the current so that the inclined particulate surface collection screens capture fugitive re-suspended sediment. In addition, the inclined screens also capture re-suspended sediment from tidal fluctuations.

Deck containment corridor system
In order to address the problem of shallow draft barge access to the shore for off-loading of dredged material, the dredged material is transferred from a holding barge to a transfer barge. This allows continual dredging without downtime if only one barge is used to both hold the material and offload the material. However, during the transfer of material from the holding barge to the transfer barge, an innovative deck containment corridor with sides is used to contain any spillage from the bucket. This is another measure to ensure that sediment is controlled during the dredging operation at the project site.

Turbidity monitoring during dredging
To verify the control of re-suspended sediment, turbidity will be continuously monitored inside and outside of the dredge cell. The dredge operator has access to real-time turbidity data from all monitoring stations and can adjust the operational procedure (cycle time, cleaning and so on) to insure that the turbidity readings in NTUs do not exceed the specified background level.

CASE STUDY

In July 2004, the Alternative Particulate Control Option to minimise suspended sediment was used for dredging approximately 6,000 cubic yards of contaminated sediment from the Longbranch Cut of the St. John's River in Jacksonville, Florida, USA. Precursors of this method were successful at the Dow Canada site near Sarnia, Ontario, at 25 ft below the surface of the water in a 5 ft/sec current in the St. Clair River and later at a site in White Lake, Michigan, USA at 60 ft below the surface of the water, where up to 3 cubic yards (1%) of sediment were removed from the wash tank at the end of a 10 hour dredging day (using a 4.5 cubic yard bucket).

The success of the dredging project at Jacksonville, Florida was measured by real-time turbidity monitoring of the water column within the Data Control center, the removal of contaminated sediment from a predetermined project boundary, and confirmatory sediment sampling verifying that the sediment clean-up criteria had been met.

Using an environmental clamshell bucket operated by a trained operator and real-time precision bucket positioning software were the major factors in the successful removal of the contaminated sediment from the project site. However, implementing secondary turbidity controls as outlined above, all contributed to minimisation of re-suspended contaminated sediment.

Conclusions

The Cable Arm environmental clamshell bucket is the primary means of controlling sediment re-suspension. Secondary means of controlling sediment re-suspension include: (1) a secondary subsurface spill containment system; (2) a wash or rinse tank; and (3) a deck containment corridor used during transference of material. Quality assurance/quality control procedures are used that meet all applicable requirements.

The Alternative Particulate Control Option eliminates the need for the use, handling, and maintenance of an expensive silt curtain that may itself contribute to turbidity as a result of scouring of the sediment bottom (Venturi effect). Using this design, contaminated sediments can be dredged without a silt curtain in waterways where flow velocity exceeds 2 ft/sec.

Environmental dredging using the Alternative Particulate Control Option benefits the marine environment by removing contaminated sediment and assisting in the recovery of fish and wildlife impairments. It also benefits site owners of contaminated sediment by providing a cost-effective alternative to the use of traditional, but expensive, silt curtains.