BENEFICIAL USES OF DEAD END CANAL DREDGING IN COMBINATION WITH SPECIAL USE MATERIALS FOR EROSION CONTROL

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ABSTRACT

This paper looks at the obstacles that have to be overcome to improve or maintain the flushing of the canals and creeks. It will also give a practical example of an improvement project that helped with the channel flushing as well beneficial use of dredge material to help shoreline stabilization. The location of the project is off Assawoman Bay in Worcester County Maryland. In this case dredge spoils composed of organic silt from two dead end canals were used to develop a core for a shoreline stabilization project. The dredging was done in two natural canals (non-bulkheaded) with a total length of 1,000 meters and approximately 6,000 cubic meters. The project used a 0.4 meter dredge and took 4 months to complete.

The primary reason for the project was to redevelop a navigable channel. Beside the practical use of the canal for docks and boating access, the project had two beneficial environmental effects. The organic sediment in the canals had accumulated over 40 years. The sediment was at least 0.7 meters thick and killed all sub-aquatic vegetation. This contributed to a high sediment oxygen demand that in turn developed dangerously low dissolved oxygen. Therefore, the first beneficial effect of the dredging was that it cleared out much of the organic silt and allowed for more efficient tidal flushing. This will eventually increase the bio-diversity of the water and sediment column in the canal.

The second benefit was to use the sediment to naturally stabilize a highly erosive shoreline with a natural profile. Geobags were placed along the eroding shoreline and the sediment was pumped into the geobags. The geobags allowed for efficient dewatering and consolidation of the sediment. The geobags were covered with a permanent erosion reinforcement, articulated concrete block and a high performance three dimensional geotextile in a unique configuration.

Key words: Dredging, geobag, dead end canals, turf mat, permitting

INTRODUCTION

Common now in populated coastal areas is the degradation of canals, tidal creeks and waterways. A predicament comes in the fact that the presence of development contributes to the degradation but the presence of developments will not allow the problem to be solved by nature alone.

Erosion of the embankment of coastal waterways adds to the loss of wetlands and adds further to the degradation of the waterway. Waterway and wetland loss can also be linked to the improper maintenance of our flushing channels. For the purpose of this paper flushing channels are defined as any tidal waterway that brings water from an estuary or bay into manmade canals or natural creeks. (The creeks are also flushed from upland freshwater sources.) These terms (canals, creeks and waterways) will be used interchangeably in the paper. The size of these canals and creeks can be 15 meters to 50 meters wide and have a depth of 0 Mean Low Water (MLW) to –2 MLW.

This paper looks at the obstacles that have to be overcome to improve or maintain the flushing of the canals and creeks. It will also give a practical example of an improvement project that helped with the channel flushing as well as shoreline stabilization.

OBSTACLES TO IMPROVEMENT

There is a popular movement among many environmentalists and the general misinformed public to insist that the waterways, flushing channels and tidal creeks be left alone. The thought is leave nature be and it will take care of itself. This conjecture does not take into account that in many instances mankind has already affected many of these

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smaller waterways by building developments and just by living in the coastal communities. The natural process will continue, but natural results will probably not result in a desirable outcome.

Examples of this are plentiful throughout coastal communities. Figure 1 shows a typical flushing channel off the St. Martin River (which empties into Assawoman Bay in Worcester County, Maryland). Note organic silty sediment building up. Phragmites is taking over much of the natural vegetation. This channel was much healthier when there was less sediment. It is extremely likely that the sediment will continue to accumulate and the tidal marsh will change its characteristics. In a recent Worcester County public meeting to review the possibilities of dredging this channel as well as a few others, I pointed out the likelihood of the continued degradation and the growth of the phragmites unless something was done. Some in the audience yelled out “Let it grow”. Such ignorance is hard to overcome. The project failed to gain approval.

A PLAN OR A PROGRAM

Developing the plan from an engineering perspective is not difficult but to get the plan through the approval process is problematic. Too often, after many hours of study and design spent on a project, resource agencies and the public does not want to approve the project unless there is near a 100% chance of success. The process often does not recognize that without a risk, there is little chance for advancement. Innovative processes barely get a nod of approval because there is no guarantee of success and there is no previous record of success. The approval process as set up to develop and implement a program wastes time and precious financial resources. Time delays for continued reviews and revisions cost tens of thousands to millions of dollars that could be put to better use to expand the environmental improvement projects. Often when too many entities enter into a design solution for an environmental problem, good engineering solutions are compromised to meet all parties conflicting objectives. This often results in a solution that does not work quite as well as it could have or should have worked. An example of this will be shown in this paper.

THE DEAD END CANALS IN OCEAN PINES, MD

There are several dead end canals at the southeast end of the Ocean Pines Community in Worcester County, MD. Most are bullheaded and used for boating. There are some that are left in a more natural state. There is some evidence from aerial photos that these canals were dredged for drainage in the 1950’s and 60’s. However there has been no maintenance performed on these canals in the last 40 years. One example is shown in Figure 1.

Many attempts to dredge these canals have encountered significant obstacles and have been abandoned. One developer decided to take the long road and try to find a solution to the poor water quality in two of these canals. A solution would enhance the flushing capacity of the canals and increase the recreational use of the canals. It must be realized that investment by private industry to enhance the environment will not occur without an economic benefit. It must also be recognized this is not all bad. In this case, a plan was developed to dredge out the canal from an approximate depth of –0.2 meters MLW with shoals at the mouth to -0.9 meters. The length of the two canals to be dredged was approximately 1,000 meters. The average width mean low water to mean low water was 40 meters. The total dredge volume was 6,000 cubic meters.

The biggest obstacle to overcome was the deposit of the dredge spoils. There was an eroding shoreline on Assawoman Bay in front of two townhouse complexes. The shoreline eroded 30’ to 45’ in eight years and was threatening the foundations of one of the buildings (See Figure 2). It was proposed to place geobags on the eroding shoreline and fill them with the dredge sediment. The center of eroding shoreline was approximately 1,000 meters from the dredge sites. Other alternatives for the dredge spoils included building a wetland island in the St. Martin River 200 to 2,000 meters from the dredge areas. The third option considered hauling the dredge sediment off site to an upland fill area.

Obtaining a permit to create wetlands in the river would be riddled with problems. Stabilizing the site and proving that the system would work was the main obstacle. Trucking to an offsite upland was very expensive. Even when considering the cost of setting up a site for geobag placement and purchasing the geobags, the cost for the geobag shoreline stabilization was less expensive than trucking by about $5 a cubic meter. When filling and stabilizing the eroding shoreline was added to the cost savings, the geobag alternative was chosen as for the best dredge disposal. The site plan and location design of the geobags is shown in Figure 3.

Figure 1. Typical dead end canal tidal creek in Worcester County, Maryland.

SHORELINE STABILIZATION

The Assawoman Bay in the area of the stabilization has a six kilometer fetch to the northeast. This is the exposure of greatest concern with longest duration storms and greatest potential for damages. Storms from high winds that may come from the south and southeast would have depth limited waves and would not be larger than a strong nor'easter. An analysis was done on the rock size needed for riprap protection developing a beach revetment to the east of the placed geobags. Riprap was the first choice of the developer. This was mainly because riprap is most familiar. Articulated concrete block mat (ABM) was looked at as a second alternative. A cost comparison was completed for both armoring alternatives. The ABM came out at $900/meter of shoreline. The rock riprap alternative came to $1,350/meter. Using the ABM created a savings of $148,000 for 330 meters of shoreline protection. The developer chose the ABM alternative for permitting.

CROSS SECTIONAL DESIGNS

The next step was to design the placement of the ABM on the newly filled geobags. The project completion was under time restraints. It was not acceptable to keep the geobags exposed for a long period to allow dewatering and consolidation of the dredged sediment. The sediment had high organic content and over 50% silt and would take six to nine months to reach 90% consolidation.

A profile was developed which allowed the geobags to dewater and consolidate without significant aesthetic consequences to the final look of the completed revetment. The profile consisted of a highly porous thick non-woven drainage geotextile placed over the geobags. Usually the drainage geotextile is on the bottom of the geobag

Figure 2. Pre-conditions of shoreline at project site.

but in this case the drainage geotextile was used as a surface conduit for drainage. It would also protect the geobags from heavy equipment that had to run on the filled geobags. The important function of the non-woven geotextile was to act as a sponge and release for water to bleed from the geobags as the fill consolidated. A cross section of the design drawing showing the relative position of the revetment components is shown in Figure 4.

OTHER INNOVATIONS

Engineering innovations also solved two other problems: how to anchor the ABM and the width of the ABM revetment. The first was solved by designing a dead man anchor on the back-side of the seaward geobag. This is illustrated in Figure 4. It was simple and easy to construct. The main issue in anchoring the ABM was that all the soils placed would be unconsolidated. They could not be compacted because it would have caused failure in the geobags. The anchor was placed on the downward slope of the filled geobags. It consisted of encasing the timber piles in concrete. The timber piles were used in a mechanical and “snugging up” of the system. The weight of the concrete in the anchor was calculated to equal the weight of the ABM. The safety factor was the static friction of the mat on the prepared slope.

The second issue was the width of the ABM revetment. Of course the wider the ABM treatment on the revetment the more protected the slope is from erosion. The downside is the wider, the greater the cost. The material cost for the ABM is $45 a square meter. A permanent high performance turf mat (PHPTM) cost $10 a square meter. The transition point was designed at +0.9 meters MLW, or + 0.3 meters above MHW. This elevation was chosen so the ABM took all the day-to-day wave activity, the PHPTM took the storm waves.

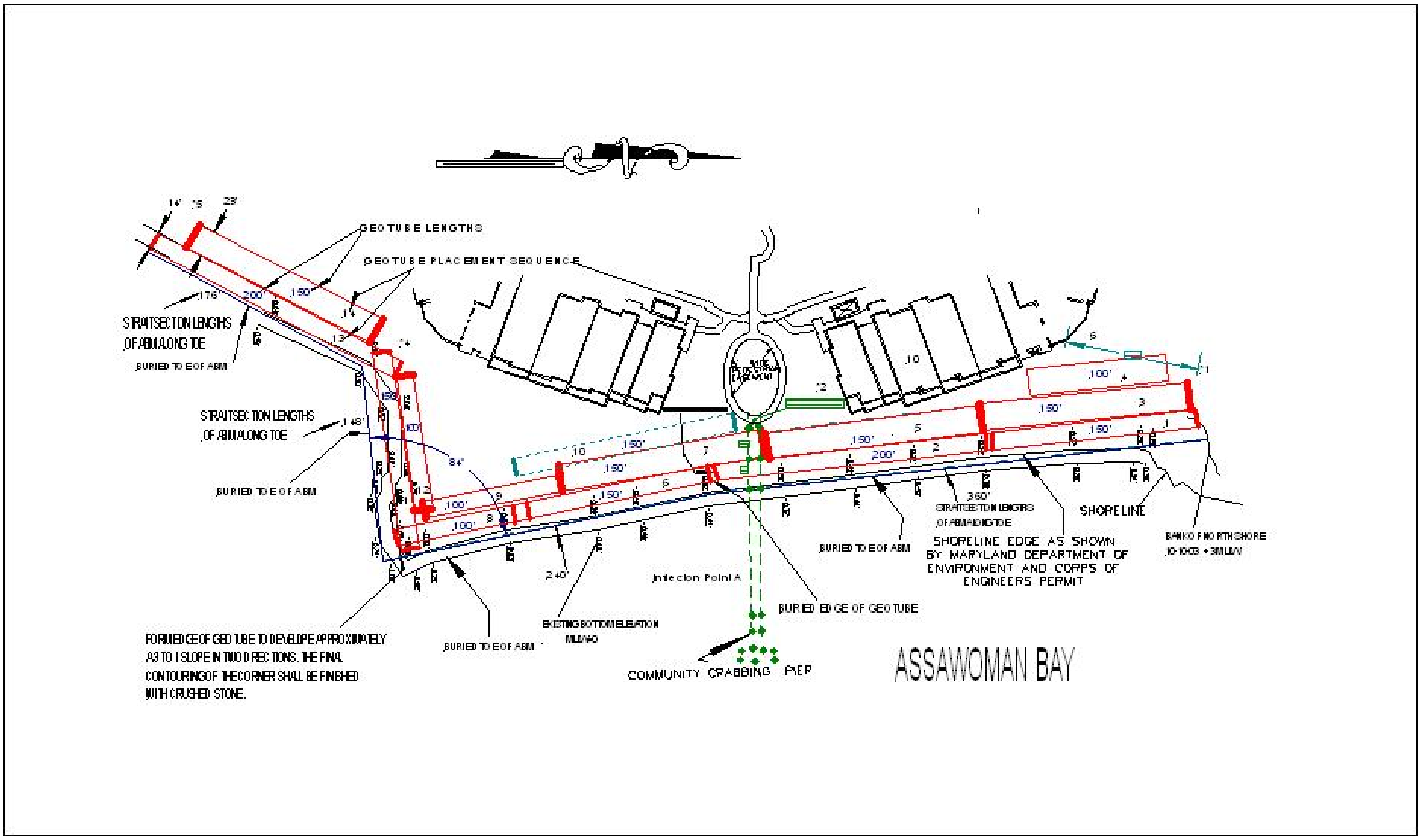

Figure 3. Plan view of project.

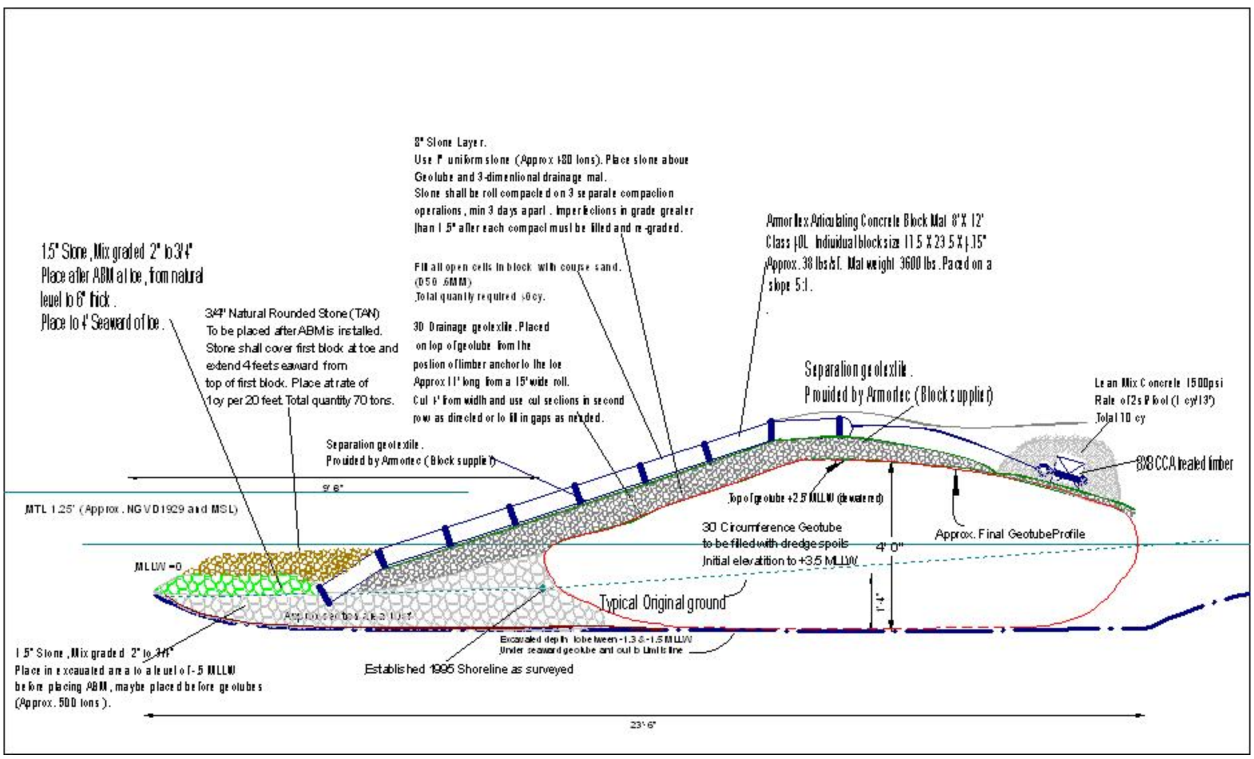

Figure 4. Cross-section design of seaward geobag and ABM.

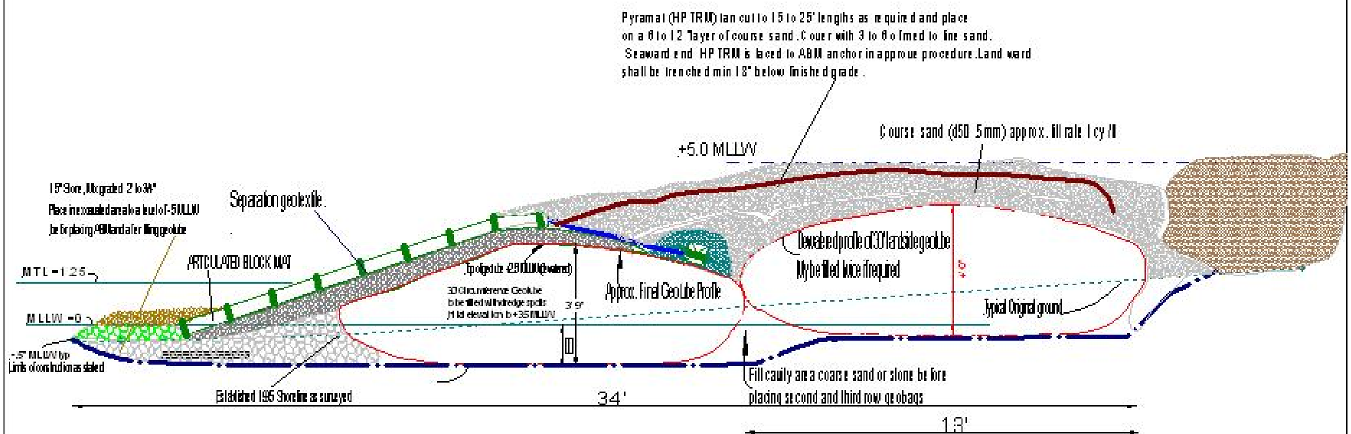

Figure 5. Cross-section design of seaward geobag and second row.

With this design the transition point was the weakest section. There was little chance of failure in the ABM section of the revetment. The problem was in the fact that a deep anchor trench could not be dug to protect the seaward edge of the PHPTM from the scour and erosion. The geobag was in the way. The solution was to lay the last row (landward) of ABM in a one-foot trench, pull the last section downward and landward tight to the anchor, then tie the PHPTM to the anchor cabling with copper wire. Fourteen-gauge plastic coated solid copper wire in 150 meter spools was chosen. It was felt the copper would hold up very well in the marine environment. There was no galvanic series set up because the anchor cabling was polyester and the wire could be tired and twisted to itself to develop a strong attachment. Figure 5 shows the position of the PHPTM in revetment profile. The PHPTM section was seven (7) meters long and was trenched 0.5 meters deep on the landward side.

PROJECT GOALS AND LESSONS

The final treatment of the revetment width included 4 meters of ABM and 7 meters of PHPTM. The increased quantity of HPTM had significantly decreased the cost while enhancing the natural appearance of the revetment. The system did not significantly sacrifice the erosion potential. One of the goals of the project was to develop as natural as possible stable shoreline. The PHPTM could be planted with dune grasses and salt tolerant shrubs while the matrix of the mat held the soil from erosion. The final look of the project before planting is shown in Figure 6. (Compare to Figure 7 to Figure 2 looking in the same direction.)

The PHPTM has performed very well over the last 22 months that the project has been completed. The toe and upper anchor trench is 95% in place, even after 3 or 4 nor’easter storms and two tropical storms with wave heights of 1.2 meters and water level elevations 1 meter over mean high tide. See Figure7. On inspection it was noted that the failure areas occurred where careful attention was not paid to properly tie the PHPTM to the anchor.

The seams between the PHPTM sections became the apparent major weak areas. During construction the contractor placed wire staples as recommended by the PHPTM manufacturer. These staples did not perform well. I do not think the staples should be depended on in a high-energy environment (even though the PHPTM stapling system is specifically designed for high energy environments). One hope may be that the vegetation would bind the mat to the ground. However, there was not enough time to develop a thick vegetation cover before the storms hit.

Figure 6. Finished revetment.

A better solution to develop a robust cover with the PHPTM is to stitch the seams with copper wire, the same as was done with the anchor. On a follow up project, I specified a procedure to lay the cut sections on top of each other and stitch the seam with wire. Then the sections were unfolded so that the stitched seam was facing downward into the soil. This adds extra time to the process but the mat then develops a continuous cover on the protected slope with no exposed edges. Maybe with some encouragement the manufacturer can improve the process by incorporating grommets on the edges of the PHPTM or a wider reinforced edge seam.

Early on in this project the main focus was to dredge the canal and fill the geobags with the sediment from the canal. The process did not go smoothly. The biggest issue was to develop a process to continue dredging while filling the geobags. The contractor gave the impression he was familiar with putting dredge spoils into a geobag. This was not apparent on the site. Only two geobags were set up in the early part of the project. A polymer injection system to help with settlement of the fines was installed but not monitored. The two bags filled with water and binded almost right away. It took five weeks of trial and error to get the right number of geobags and the correct polymer ratio injected to get a reliable smooth filling process in place. Figure 8 shows geobag filling in full operation. Future projects should integrate the responsibilities of the polymer manufacturer, geobag manufacturer and the contractor in the performance contract. Such contracts should require a complete submittal to show complete understanding and cooperation among the partners.

The ABM is performing extremely well and is conforming to the consolidation of the geobags below. The one issue I have is with the ABM is the slope angle. In a final note on issues, a discussion of the designed revetment slope should be included. The original design called for a seaward revetment with a 1:5 gradient. This would allow the open cells of the ABM to fill with sand and become a more natural shoreline. The design called for the ABM revetment slope to *intersect* the vertical plane of the horizontal position of the MHW of the 1992 shoreline. See Figure 9. During the permit review a COE biologist in the Baltimore District said the project limits are defined by the *horizontal* position of the new toe of the ABM at MLW on the vertical plan where the high water mark occurred in 1992. This intersection was incorrect but the owner of the project did not want to argue and slow down the approval process. This change altered the engineering properties of the project. Instead of a 5:1 slope, the slope was steepened to 2.5:1. This affected the cell fill on the open cell mats, the wave run up and the effectiveness of the slope protection to reduce erosion and altered the ability of vegetation to grow along the shoulder.

The uninformed public and/or misguided agency personnel with antidotal comments sabotage many projects with good engineering designs. Often the recommendations by such people are included into the project to speed up the permitting process. We have to solve this problem for efficient future projects.

Figure 7. ABM with PHPTM after twenty-two months.

Figure 8. Geobags being filled.

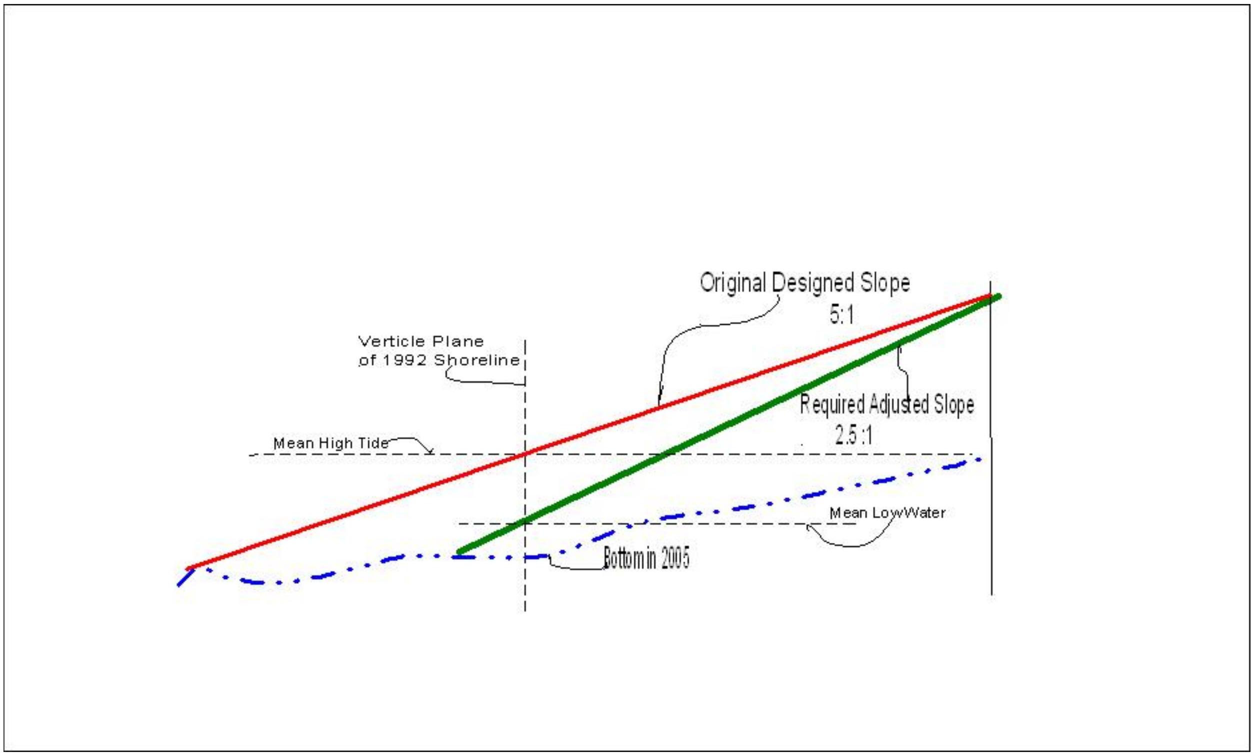

Figure 9. Revetment slope adjustment required by COE.

CONCLUSIONS

Innovative solutions are available for most any environmental problem. It is important to lay down the goals of the project and the concerns of the public and regulating agencies. Once the goals and concerns are identified (the plan), the next step is to develop a program to incorporate a solution. In the case of this project the goals were to develop better flushing, recreational use of two dead end canals and also to stabilize an eroding shoreline. The concern was how to environmentally and cost efficiently dispose of the dredge spoils and stabilize an eroding shoreline without bulk-heading and keep the shoreline as natural as possible. That is the situation in a nutshell. To make it any more complicated than that would add unnecessary issues resulting in increased time and cost to the project.

The final design was completed in three months. It answered the goals and concerns of the project. The permit process took two and a half years. In conclusion, the final project was permitted as designed except for the slope changes of the ABM revetment forced by the COE.

The project was an overall success. The innovative solution of combining ABM and PHPTM to develop a stabilized shoreline was cost effective and environmentally friendly. The use of the geobags to place dredged spoils was problematic but in the end resulted in an effective method to develop a fill area to replace an eroded shoreline with a coastal habitat.