# PLANNING, DESIGN AND CONTRACTING STRATEGY FOR A SMALL URBAN LAKE – WILDE LAKE, COLUMBIA, MARYLAND

Travis Merritts[1], Walter Dinicola[2], Ram Mohan[3], Dennis Mattey[4] and Diana Kelley[5]

**ABSTRACT**

Wilde Lake is a small urban lake owned and managed by Columbia Association (CA), on behalf of the residents of Columbia, Maryland. The lake has undergone considerable sedimentation over the last several decades which has resulted in a loss of storage capacity. Anchor QEA was commissioned by CA to undertake an investigation and propose recommendations on how the CA Board of Directors should proceed with respect to managing the sedimentation problem in the short and long term. Key considerations included minimal impacts to the residents near the lake, aesthetics, environmental protection, and cost effectiveness. As part of Anchor QEA's work, we investigated through modeling, dredging minimization techniques so that CA can cost effectively manage the site in the future. Options investigated include sediment traps, forebay creation, and sediment deflection structures. This paper presents a brief history of the project, discusses the planning considerations for the project, outlines the alternatives that were developed, and presents an innovative contracting strategy that is now being implemented by CA.

**Keywords:** planning, dredging, sedimentation, lakes, restoration, construction.

## PROJECT BACKGROUND

Anchor QEA was retained by the Columbia Association (CA) to perform geotechnical investigations, hydrographic surveys, dam investigations, hydrodynamic modeling, engineering design, and contract documents for dredging and forebay creation of Wilde Lake, a community lake in Howard County, Maryland. The Wilde Lake project involves sediment dredging and creation of a forebay in the 8.9-hectare (22-acre) constructed lake located amidst residential and open space in the Village of Wilde Lake, Columbia, Maryland. The primary objective of the project is to try and create a focused catchment basin near the inlet of the lake with a view to effectively dredge out the settled sediments so that the storage capacity of the lake is optimally maintained. Challenges to the dredging and fore bay creation project involve the need to effectively dewater the dredged material and find an appropriate and cost-effective disposal site for final placement of the dredged material.

Pertinent parameters of the lake include:

- Water Depth: 0.305-4.57 meters (1-15 feet)
- Length of the lake: Approximately 610 meters (2,000 feet)
- Average width of the lake: Approximately 106.7 meters (350 feet)
- Amount of materials to be dredged: Approximately 15,292 cubic meters (20,000 cubic yards)
- Depth of materials to be dredged: 0.305-0.91 m (1-3 ft) (center portion of the lake)

Columbia Association's goal, as the responsible environmental steward for the community, is to preserve this natural resource so that its citizens can continue to enjoy the Lake and its environs for recreational purposes. Two of the primary objectives of this project are to dredge sediments from Wilde Lake that have accumulated during the past 40 years and to construct a catchment basin near the inlet of the Lake to limit the spatial distribution of future upstream sediment loadings so that the storage capacity of the Lake can be efficiently maintained in the future. Challenges to the dredging and forebay creation project involve the need to effectively dewater the dredged material and find an appropriate and cost effective disposal site for final placement of the dredged material. There is open

[1,2,3] Civil Engineer, Project Manager/Associate, and Partner, Anchor QEA, LLC., 9194 Red Branch Road, Suite B, Columbia, Maryland, USA, T: 410-715-0824, Fax: 410-715-5681, Email: tmerritts@anchorqea.com; wdinicola@anchorqea.com; rmohan@anchorqea.com
[4,5] Director of Construction and Contract Administrator, Columbia Association, 10221 Wincopin Circle, Columbia, Maryland, USA, T: 410-381-2947, Fax: 410-381-0824, Email: dennis.mattey@columbiaassociation.com; diana.kelley@columbiaassociation.com

space near Wilde Lake via the Hyla Brook road, which is a roadway running along the perimeter of the lake. However, since this area has relatively high residential density, we envisioned it being used only as a temporary handling area.

**Figure 1. Wilde Lake, Maryland**

The third primary objective of the project is dam inspection and repairs. Challenges associated with this phase of the project involve access to the dam, staging area for contractor operations and conducting repairs in wet conditions and weir overflow. However, this phase of the project is beyond the scope of this paper and thus not further discussed.

## PLANNING CONSIDERATIONS

We observed ongoing dredging and forebay construction/restoration projects owned by CA such as Lake Kittamaqundi and Lake Elkhorn in Columbia, Maryland, with a view to understand and possibly import valuable lessons learned to this project – that way, we did not have to reinvent the process all over again. The following key similarities between these projects made such comparisons more logical:

- All three lakes are man-made and are of similar size, ranging from 8.9 to 15 hectares (22 to 37 acres), with maximum depths that range from approximately 2.1 to 4.57 meters (7 to 15 feet),
- All three lakes are surrounded by residential and commercial development and also by open space, and
- The overall quality of all three lakes has been diminished over time due to increased sedimentation from upstream sources.

Given the similarities among the three lakes, we anticipated that the project design and implementation issues associated with the Wilde Lake project will be similar to those encountered to date on the ongoing Lake Kittamaqundi and Lake Elkhorn dredging and forebay creation/restoration projects. Specifically, there are three primary issues that needed to be addressed during the course of the project design and implementation phases for the Wilde Lake project that are similar to the two aforementioned ongoing projects. These three issues are:

- **Selection of a suitable site for use as a project staging area -** Given the nature of the land use surrounding Wilde Lake, selection of a suitable staging area will have to balance the often competing forces of accessibility, current land use, aesthetics, and economics. Overall project efficiency is a key component to resolving these issues in an acceptable manner.

- **Selection of a suitable dredging/disposal technology –** Two types of dredging technologies have been evaluated to date for the two ongoing dredging projects – these technologies are also suitable for Wilde Lake and thus, needed to be evaluated as part of the proposed project as well. Typically, the important variables which must be considered in a comparative analysis of these two dredging technologies include the volume of sediments to be dredged, the location of these sediments relative to the staging area, the costs of sediment disposal (de-watered vs. wet), and whether there are any opportunities for on-site beneficial re-use of dredged materials.

- **Design of a suitable forebay structure –** The proposed project includes the design and construction of a suitable and effective forebay structure to constrain the distribution of future sediment loads to Lake Wilde to a small manageable area. Similar to the two aforementioned ongoing projects, design considerations include an understanding of long-term sediment loadings to the system and an understanding of sediment transport patterns within the lake. Thus, long-term best management practices that reduce sediment loadings to the lake and alternative forebay designs should be analyzed in an integrated fashion to minimize the long-term net present value of current and future lake maintenance costs.

## DESIGN CONSIDERATIONS

Design for the project started with a review of existing studies and documents, developing alternate options for dredging, disposal, staging and forebay creation (and presenting to CA Board with pros and cons); preparing construction documents for dredging and forebay creation; obtaining the necessary permits; and providing bidding and construction phase services. Key design elements are discussed below (Anchor, 2008).

### Field Investigations

Field investigations focused primarily on obtaining additional geotechnical characterization of the lake bed sediments to be dredged, including characterization of depth and extent of sediments to be dredged, sediment types, visual nature, strength of sediments, moisture content, Atterberg limits, gradation analysis (sieve and hydrometer), and specific gravity. In addition, sediment samples were also tested for presence of the following contaminants and nutrients using the toxic characteristic leaching procedure (TCLP), and other standard procedures:

- Phosphorous
- Nitrogen
- pH
- Potassium
- Total petroleum hydrocarbons (TPH)
- Herbicides
- Pesticides
- Heavy Metals, and
- Volatile organic compounds (VOCs) and Semi-VOCs

In addition, to obtain a good understanding of the topographic features surrounding Wilde Lake, hydrographic surveys were conducted along the entire lake as well as topography transects located every 30.5 meters (100 feet). along the lake boundary. Topographic surveys measured the elevations at the top of the embankment along the lake edge and extended 7.62 meters (25 feet) landward from the top of the embankment at each transect location. This provided the elevation and distance to the top of the water level of the lake. In addition, two potential staging areas (at the northwestern end of the lake adjacent to Hyla Brook Road) were also surveyed to obtain general topography along those areas for staging area design considerations.

### Forebay Evaluations

Initial plans for the project called for forebay construction near the inlet of Wilde Lake (See Figure 2). While forebays have been constructed in some lakes, their efficiency and effectiveness compared to other means of controlling sedimentation remains debated. The overall idea of the forebay is to construct an underwater berm or dike to capture future upstream sediment loadings and debris that is washed into the system. However, these underwater structures alter the existing bathymetry and hydraulics of the water body in which they are constructed and can potentially alter flooding patterns during extreme storm events.

A 2D hydrodynamic model, RMA-2 was set up to evaluate the effectiveness of various configurations of Forebay concepts. The model ran a base case under existing conditions, and used that condition to simulate the effectiveness of three future conditions (See Table 1):

- A full weir across the inlet of the lake
- A submerged structure along the inlet of the lake, and
- A deep sediment trap in the inlet of the lake.

**Table 1 - Sediment management options for Wilde Lake Forebay.**

| Pros | Cons |
|---|---|
| **Option 1 - Above-Water Forebay** | |
| - Increased retention time and volume results in longer time between maintenance dredging events<br>- Less fine sediment deposition to the main body of the lake as compared to the submerged alternative | - Results in an change to the lake flood stage<br>- Less pleasing aesthetically, since it will be visible above water surface<br>- More expensive than underwater forebay alternative<br>- Most difficult alternative to implement from a construction standpoint<br>- May require access controls to prevent pedestrians from traversing the berm<br>- Will require periodic berm maintenance |
| **Option 2 - Submerged Forebay** | |
| - Aesthetically pleasing as construction will not result in a visual change to the current lake configuration<br>- Allows for easier small vessel access to all areas of the lake (but will restrict navigation to some extent due to the weir)<br>- Least expensive of the proposed construction alternatives<br>- Does not alter the current lake flood stage | - Will require periodic berm maintenance (underwater maintenance will be more labor intensive)<br>- Will capture a lower volume of fine sediment as compared to the above-ground forebay alternative<br>- Decreased retention time as compared to the above-water alternative will result in more frequent maintenance dredging events |
| **Option 3 - Forebay Creation by Dredging** | |
| -Does not require construction of an in-water structure<br>- Aesthetically pleasing as construction will not result in a visual change to the current lake configuration<br>- Minimal to no maintenance required in between maintenance dredging events<br>- Most easily implemented forebay construction alternative<br>- Shortest projected construction completion period<br>- Does not alter the current lake flood stage | - Will require deepening of the forebay portion of the lake by dredging (could vary dredging depths resulting in varying storage capacities)<br>- More expensive option than the forebay structure concept, but also provides additional storage capacity, without increasing flood levels |


**Figure 2. Proposed Forebay location.**

Thus, for Wilde Lake, in addition to moving forward with the design and construction of a forebay structure, we also investigated alternate sediment control schemes such as sediment traps, which could be viewed as an "optimized forebay concept" and could be easily constructed as part of the dredging operation. For this option, we altered the bathymetry near the inlet in one of the model runs to simulate a sediment trap in order to evaluate the net effect on sedimentation patterns and rates.

If sediment traps are implemented, they could easily be constructed as part of the dredging process by digging deeper along a set design footprint. The weir forebay could be constructed using a barge mounted excavator which would place the gravel/run-of-bank material over the soft lake bottom sediments until the design elevation is achieved. The forebay could be constructed along the northwest tip of the lake (see Figure 2), about 228.7 meters (750 feet) offset from the western shoreline. The forebay structure was estimated to have a 3.05 meter (10 foot) crest width (and 2:1 side slopes) and varying top-of-berm heights depending upon the design configuration.

## Dredging

Two possible options exist, in the broadest sense, for dredging Wilde Lake – mechanical and hydraulic. Depending on the specific modes of the dredge operation, transport mode and dewatering techniques, either of these options are potentially applicable. The dredging options are illustrated in Figure 3 and discussed below.

### *Mechanical Dredging*

Approximately 15,292 cubic meters (20,000 cubic yards) of sediment can be mechanically dredged from Wilde Lake with an excavator mounted and chained to a flat deck flotation barge or flexi-float system equipped with spuds. Dredge thickness would vary from approximately 0.152 meters (6 inches) to greater than 0.91 meters (3 feet) below the mudline. Water depths above the mudline vary over the area from less than 0.305 meter up to 4.57 meters (1 foot up to 15 feet). The dredging could be performed using a 0.76 to 1.53 cubic meter (1 to 2 cubic yard) capacity closed environmental clamshell bucket capable of performing a relatively flat, or level, cut. The dredge bucket will be designed to completely enclose the dredged sediment and water captured and slowly release water through the water column as the bucket is being drawn upward. The clamshell will deposit the dredged material onto a second or third flat barge setup each equipped with two 22.9- cubic meters (30-cy) open top containers. Once full, the barge will be navigated to the shoreline where the sediment will be stabilized. Stabilized dredged material will then be off-loaded with a long-stick excavator equipped with a smooth bucket and placed into haul trucks and transported to final disposal destination.  An alternative approach for mechanical dredging is to draw down the water level in Wilde Lake or isolate and dewater smaller dredge areas through the use of temporary sheeting or coffer dams so that mechanical dredging can occur by driving excavators on mats. Dredged material can be placed directly into haul trucks (using long stick excavators) and stabilized prior to transport for final disposal destination.  It is anticipated that the dredge production rate will be approximately 191.2 cubic meters per day (250 cy per day). Mechanical dredging operations would be conducted utilizing a global positioning system (GPS).

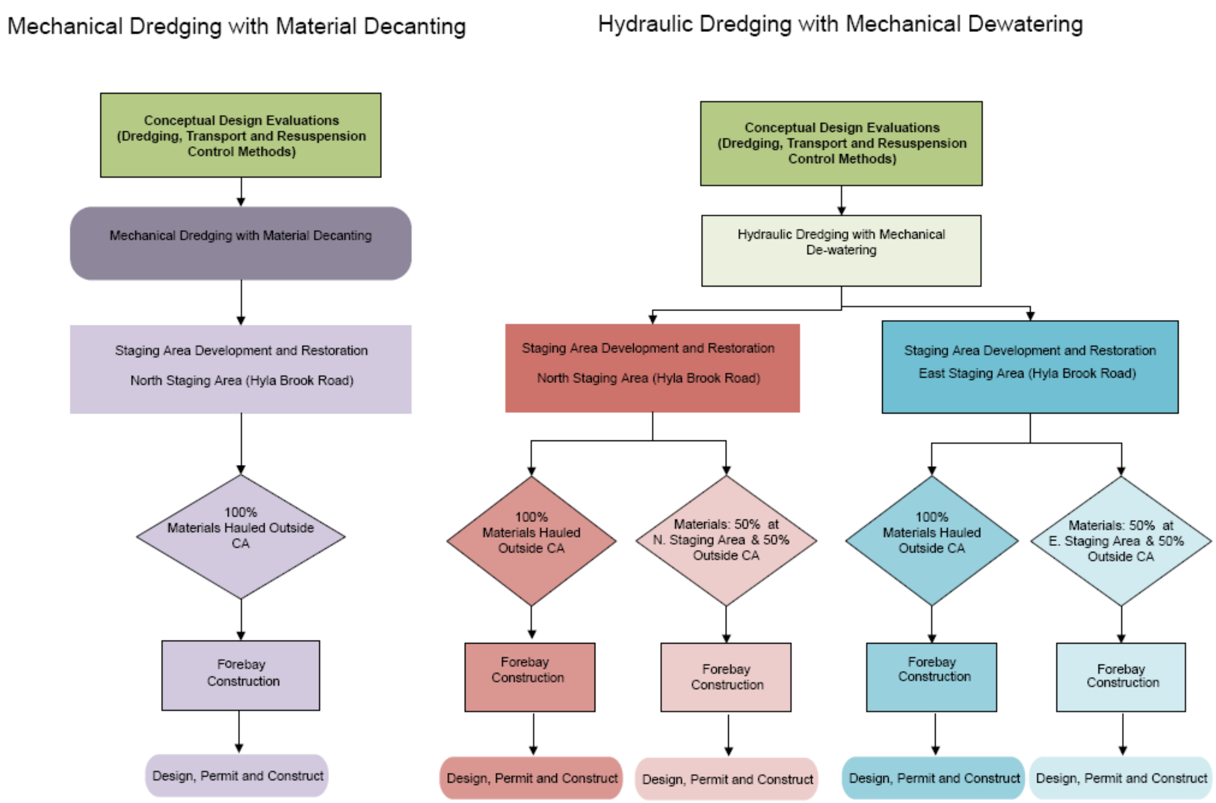


**Figure 3.  Dredging evaluation flowchart.**

***Hydraulic Dredging***

Approximately 15,292 cubic meters (20,000 cy) of sediment can be dredged from Wilde Lake with a 203 to 254-millimeter (8 to 10-inch) cutterhead dredge. This operation will be conducted in parallel with the some mechanical excavation activities at the shore (and in areas with limited access due to shallow water depths) and is anticipated to have a production rate of 4,164 lpm (1,100 gpm) (approximately 382.3 cubic meters per day (500 CY per day)). In order to ensure that the dredging operations do not exceed design templates, specialized software will be utilized. This software will enable the dredger to control the x, y and z coordinates of the cutterhead. The dredged material will be transferred to the sediment processing/staging area as 6 to15 percent solids (by weight) slurry within a floating HDPE pipeline.

Depending upon any odor and noise considerations that may be deemed necessary, dredged material may be pumped directly into geotextile tubes (geotubes). On-site staging area is limited, so given the rough dimensions and number of geotubes needed to dispose of 15,292 cubic meters (20,000 cy), stacking geotubes will present the best opportunity for onsite dewatering. Once the water has been drained out of the geotubes, the dredged material will be removed and placed into haul trucks and transported to final disposal destination. Dredged material removed form the geotubes will have significantly reduced water content than dredged material removed mechanically. This would greatly reduce final disposal volumes thus resulting in considerable savings in off-site disposal costs.

**Staging Area**

Access to the lake and the creation of an adequate staging area are necessary components of a successful dredging project. Two staging areas were identified (see Figure 4).


**Figure 4. Proposed staging areas.**

***North Staging Area (Hyla Brook Road)***

The North Staging Area is located along the north shoreline of the western half of Wilde Lake. The location of this staging area is attractive because it is closer to the majority of the dredge areas and represents minimal impacts to local residents. In addition, because this open space is currently used only for passive recreation; the vegetation type within this area is typically grass, brush and trees; and CA currently owns the land and has complete access to this property. The largest inconvenience to residents would be the relocation of the foot path around the Wilde Lake. Construction vehicle traffic would utilize Hyla Brook Road as the sole access to the project site.

***East Staging Area (Hyla Brook Road)***

The East Staging Area is located east of Wilde Lake located below the dam. The location of this staging area represents another alternative to the North Staging Area, but is located within the 100 year floodplain. The site also would minimize the impact on local residents because the open space is currently used only for passive recreation; the vegetation type within this area is typically grass, brush and trees and some regulated wetlands; and CA currently owns the land and has complete access to property. The largest inconvenience to residents would be the relocation of the foot path around the Wilde Lake. Construction vehicle traffic would utilize Hyla Brook Road as the sole access to the project site, but would not impact the residents as much as the North Staging Area since the density and proximity of residences are less of a cause for concern than that area.

**Dredged Material Disposal**

Two potential alternatives for disposal of dredged material from Wilde Lake were investigated, as discussed below.

***On-site Disposal***

In evaluating the area around Wilde Lake, there does not appear to be sufficient area to construct and maintain an on-site disposal facility. Table 2 investigates various disposal scenarios for areas and resulting dredged material thicknesses required to accommodate on-site placement of the estimated volume of sediments to be dredged from Wilde Lake.

**Table 2. On-site disposal area options.**

| Option | Area (acre) | Dredged Material Thickness (ft)* | Volume (cy) |
|---|---|---|---|
| 1 | 3.9 | 3 | 20,000 |
| 2 | 2.3 | 5 | 20,000 |
| 3 | 1.7 | 7 | 20,000 |
| 4 | 1.3 | 9 | 20,000 |

* *Additional 2 ft of dike height is required to manage water and prevent overfilling of the site.*

The creation of an on-site disposal facility would require material to create the dikes, areas sufficient enough to handle the estimated dredged volume and a weir structure to be able to handle water on the site for dewatering purposes. As is evident from Table 2, creation of on-site disposal sites within the limited available areas would require high dikes, which will be aesthetically unpleasant and disruptive to the local community.

If an on-site disposal area is considered, final end use of the land must be considered. Due to the silty organic nature of the dredged material, consolidation will be a factor that would limit any type of structural end use. The dredged material can be amended with Portland cement, fly ash or another type of stabilization agent to improve the structural characteristics of the dredged material. This would enable the end use of this product to be used for more fill-related types of purposes such as for embankments, landscaping, or as a cap for land fills.

Another option would be to dig a pit along the East Hyla Brook Staging area and use the excavated sediments from pit construction for local beneficial projects (such as spreading as fill in local quarries or farms along Howard County). That way, the dredged slurry from the lake can be pumped into (with flocculants) or placed in the pits, and the decant water discharged back to the lake. This option involves altering the current landscape of the surrounding areas (resulting in likely community issues), construction in the 100 year floodplain (resulting in permit issues), and creation of wetland areas (jurisdictional issues). Thus, this option may not be too attractive unless other cost effective disposal options do not work out for the project.

***Off-site Disposal***

The options for off-site disposal are limited. Stabilized dredged material can be placed in landfills located in Anne Arundel County and Baltimore County. There are several rock quarries located in Maryland (such as in Jessup and Laurel) that are capable of handling stabilized dredged material. Material may also be placed along farms in Howard County, provided agreements can be negotiated with owners. Cox Creek Dredged Material Containment Facility is capable of handling the projected volume of dredged material from Wilde Lake – however, this would require negotiations with the Maryland Port Administration. If the dredged material is stabilized, it may be used as structural fill for internal dikes construction, raising existing dikes or used for internal use at existing dredged material sites such as Cox Creek. With off-site disposal, truck traffic will be a temporary inconvenience for the local community. Using the mechanical dredging production rate of 191.2 cubic meters/day (250 cy/day), this would equate to roughly

32 haul trucks per day for 4 months during the construction season.

## CONTRACTING STRATEGY

Due to the limited options available for disposal of dredged material, it was decided by CA and the project team to invite potential bidders to submit proposals as to how they might beneficially use the dredged material. Since the final design will be affected by the selected bid from the contractor and its specific plan for dredging, dewatering, transport and disposal, it was decided to accelerate the bid process by inviting bids shortly after completion of the 30% (preliminary) design stage. Three bids were received from contractors, with options varying from dry dredging of the lake (after dewatering), to a mixed approach – where portion of the lake would be dredged in the dry (after limited lake drawdown) and the rest hydraulically, to the last bid approach consisting of hydraulic dredging the lake. The dewatering approaches varied as well, with some suggesting dewatering on the lake bed, while others suggesting mechanical plants. Disposal options ranged as well, with most suggesting beneficial end uses.

Based on the bids received, CA and the Engineer evaluated the bids based on a number of criteria including technical approach, qualifications and environmental aspects. Overall, the best value proposal for CA was judged to be the winner. Accordingly, Genesis Fluid Solutions (Genesis) was selected for this project. Anchor QEA is currently working with Genesis and CA to develop the final design of the project.

## PROPOSED CONSTRUCTION APPROACH

Genesis will start construction operations by performing clearing and grubbing activities necessary to construct the project staging area (Genesis, 2008). Genesis will construct the staging area at the east location (see Figure 3). This location was selected due to this area being able to accommodate a larger dewatering system footprint, the reduced impact on surrounding property owners, and the relatively flat terrain which will reduce the amount of earthwork necessary to construct the staging area. The staging area will consist of creating a level surface necessary for operating the sediment dewatering equipment, construction of a temporary truck entrance and truck turnaround, and installation of any required site access controls. The components of the sediment dewatering system to be placed at the staging area include a coarse screening unit, de-sanding unit, polymer dosage system, Rapid Dewatering System (RDS), four Genesis dewatering cells and settling tank. The Genesis team proposes to utilize a 254 millimeter (10 inch) Barracuda dredge to perform the dredging operations within Wilde Lake. The dredge will be set up in either the swinging ladder or conventional configuration. The 254-millimeter x 254 millimeter (10-inch x 10-inch), 460 H.P. dredge pump will be capable of delivering approximately 9,463.5 to 11,356.2 lpm (2,500 to 3,000 gpm) of dredge slurry to the dewatering system. The dredge pipe will be 305-millimeter (12-inch) OD polyethylene pipe and will be fused in 61 to 91.5 meter (200 to 300 foot) sections. The dredging equipment anticipated to be present on-site consists of the dredge, support barge, work boat, dredge pipe, pipe fusion machine, booster pumps, and all dewatering system equipment.

The Genesis high-speed dewatering process to be implemented at the site will produce truckable dirt at more than 50 percent solids by weight. The return water from this process is anticipated to have a turbidity that is less than or equal to 29 NTU. The first step in the high-speed dewatering process is to remove the coarse debris utilizing a single centrifugal drive system. Coarse debris removed during this process will be stockpiled for disposal and the remaining dredge slurry will be passed through a de-sanding unit. The de-sanding unit operates similar to hydro-cyclones, and will produce a relatively dry recovered sand product. Following de-sanding, polymer is added to the slurry to achieve flocculation. The polymer dosage will be adjusted as necessary from an automated flocculent control system to achieve optimal dosage. Following introduction of the polymer, the Genesis RDS will dewater the flocculated, fine grained sediment. This system allows for dredge slurry to be dewatered at the same rate that it is being pumped from the dredge. Secondary dewatering of the dredged sediments will be provided by the Genesis dewatering cells which will be housed adjacent to the RDS. Water from the dewatering cells will combine with RDS effluent in the settling tank prior to discharge back into Wilde Lake. The dewatered sediment will then be trucked off-site for final disposal at a dredged material placement site. Following the completion of construction activities, Genesis will perform all necessary site restoration operations.

## CONCLUSIONS

CA, along with Anchor QEA and Genesis was able to develop an innovative approach to cost effectively dredge and beneficially use the dredged material from Wilde Lake. The proposed approach is expected to save the client considerable costs, while resulting in a project that is environmentally efficient and minimizes on site operating time. Final design is now ongoing, and construction is expected to occur in 2010.

## ACKNOWLEDGEMENTS

The authors wish to thank the Columbia Association for granting permission to publish this paper. And special thanks are also to Genesis Fluid Solutions for permission to summarize the proposed construction plan for this project in this paper.

## REFERENCES

Anchor Environmental, L.L.C. (Anchor). (2008). Preliminary (15%) Design Report and Presentation to Columbia Association, Columbia, MD.

Genesis Fluid Solutions. (Genesis). (2008). Proposal for Wilde Lake Dredging, Submitted to Columbia Association, Columbia, MD.