

Lake Wellington Erosion Study

Prepared for

Acme Improvement District

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By

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3.0 Assessment

3.1 Geotechnical Findings

The soil composition of the area was determined by the auger borings. The lake banks generally consist of sandy fills over natural clean sands, clay-like sands and shell rock. The fill soils were assumed to be manmade deposits used for site grading in the area. The clay-like sands, which appeared to be very low in permeability, were found at or near the water surface elevation. Shell rock was also found underneath these clay-like soils in some cases.

The groundwater was also measured in the borings at depths that were very similar to the lake water surface levels. The soil conditions along the lake banks appeared to be contributing to the erosion that is occurring. After a rain event, the storm water is assumed to percolate vertically through the upper (cleaner) sands until it reaches the clay-like soils, which are very low in permeability. Accumulation of water occurs above the ambient levels of the clay-like soils and then moves horizontally toward the lake slopes. Exit seepage pressures at the slope face are assumed high enough to cause the upper sands to move from the slope to the inner parts of the lake. (See figure 6)

As these upper sands move inward, the hard clay-like soils remain as the surface soils. These soils do not erode; however, the finer soils have been displaced and leave a very steep slope at the water surface elevation. The upper sands that remain in place have a very weak matrix, and the strength and stability of this fine sand layer is lost. This result in a very poor lake bank slope, which has very poor stability and functionality. This process is also aided by wind and wave action across the entire lake.

3.2 Design Options

To bring the slopes back to a suitable configuration, several design alternatives were researched and evaluated. These alternatives were developed based on

recommendations from the Engineer and the Sub consultant team. The design options include:

- Concrete Mat – Strengthen the slopes with Armor flex or Fabriform, which consists of a concrete filled mat
- RipRap – Strengthen the slopes with stone, sand-cement bag rip-rap, gabions (rock-filled wire baskets), in combination with filter fabric
- Bulkhead – Install a timber bulkhead along the damaged lake banks
- Filter Fabric – Reinforce the slopes with a geo-synthetic material (filter fabric) and cover with sod
- Filter Tubes – Reinforce the slopes with earth filled geo-synthetic tubes and cover with sod
- Basic Restoration – Restore the slopes by re-grading and sodding

All the above options would require the same general preparation of re-grading the lake bank to a reasonable slope by dredging or bringing in new fill, compacting the regarded areas, and preparing the area for the type of restoration that is chosen. The options, estimated life spans, aesthetic qualities, and probable costs are shown below in Table 1.

**TABLE 1
Design Options**

<u>Option</u>	<u>Description</u>	<u>Life Span (years)</u>	<u>Cost per Linear foot</u>	<u>Aesthetic Quality</u>
1	Concrete Mat	35	\$85.00	Very Poor
2	Rip Rap	30	\$140.00	Poor
3	Bulkhead	20	\$150.00	Fair
4	Filter Fabric	15	\$35.00	Good
5	Filter Tubes	20	\$30.00	Excellent
6	Basic Restoration	10	\$22.00	Excellent

Although **Option 1** (Concrete mat) would appear to be a viable solution in terms of cost and life span, it has very poor aesthetic quality. It is very unlikely that residents would allow these mats to be installed.

Option 2 (Riprap) would be very effective in reducing the erosion, but it is expensive and also provides poor aesthetic quality.

Option 3 (Bulkhead) would require the construction of a timber bulkhead with piling spaced approximately 8 feet to 10 feet apart on center, with three cross members placed horizontally to retain the soil. This would be very effective, but it is the most expensive in terms of cost per linear foot.

Option 4 (filter fabric) would significantly reduce the erosion once the grass roots grow through the membrane. However, documented success of this approach in this region of Florida could not be located. Further, contractors who have used this approach (in other regions of Florida) applied hydro seed to increase the chances of successful root penetration. Hydro seed, which uses a "spray-on" technique would require more maintenance/protection to get started and would produce a different type of grass from the existing St. Augustine variety. For this reason, the aesthetic quality was designated as "good" as opposed to "excellent."

Option 5 (filter tubes) appears to have a relatively good life span and low cost per linear foot. This technique involves dredging the original material and placing it into what is referred to as a Geo-Filter Tube, which consists of a spun bond polyester filter fabric. The tubes are placed where the erosion has occurred and are then covered with top soil and sod. This option has the benefit of having been tested locally. Northern Palm Beach County Improvement District has used this technique for several years to battle lake erosion.

Option 6 (basic restoration) is the least expensive option, but also has the shortest life expectancy. The process of re-grading and sodding amounts to a maintenance

effort. Considering that these areas have eroded in the past, it can be expected that they will erode again without some form of protection.

3.3 Cost Estimate

Each repair option requires the costs of ground surface preparation, re-grading, compacting and sodding. The estimated probable construction costs for repairing the 6100 linear feet of damaged area and the entire lake perimeter are shown below in Table 2 for each of the design options.

Table 2
Probable Construction Cost Estimate

Option	Description	Unit Cost	Damaged Area	Entire Perimeter
1	Concrete Mat	\$85	\$518,500	\$2,564,025
2	Riprap	\$140	\$854,000	\$4,223,100
3	Bulkhead	\$150	\$915,000	\$4,524,750
4	Filter Fabric	\$35	\$213,500	\$1,055,775
5	Filter Tubes	\$30	\$183,000	\$904,950
6	Basic Restoration	\$22	\$134,200	\$663,630

3.4 Option Selection

There are several factors to consider in the selection of an appropriate solution, including cost, reliability, safety, constructability and aesthetics. These can be reduced to annual costs and aesthetics. Reliability and safety are considered in the estimate of life expectancy (table 1). Constructability is considered in the cost per

linear foot estimates which, when combined with the expected life, yields an estimated annual cost.

Table 3 (below) shows the estimated annual costs based on the total estimated cost of repairing the damaged areas (table 2) and the expected life estimates (table 1) at 3% inflation. These costs were then ranked and multiplied by a factor that is based on aesthetic ranking. The aesthetic rankings are from one to five, very poor to excellent (table 1), respectively. The formula for the overall ranking increases the cost ranking by between 10 and 50 percent depending on the aesthetic ranking.

Table 3
Rankings (Overall = Cost x (1 + Aesthetic/10))

Option	Description	Annual Cost	Cost Ranking	Aesthetic Ranking	Overall Ranking
1	Concrete Mat	\$24,131	2.5	1	2.8
2	Riprap	\$43,570	1.4	2	1.7
3	Bulkhead	\$61,502	1.0	3	1.3
4	Filter Fabric	\$17,884	3.4	4	4.8
5	Filter Tubes	\$8,200	7.5	5	11.3
6	Basic Restoration	\$10,727	5.7	5	8.6

3.5 Legal Review

Acme’s attorney, Caldwell & Pacetti, has researched the legal obligations and limitations of Acme in regard to implementing erosion control at Lake Wellington. If an expenditure is proposed from the general revenue in a chapter 298 District such as Acme, a “primary public purpose” must be involved that would have an overall benefit to all the taxpayers. The erosion problems at Lake Wellington do not constitute a “primary public purpose” because the expenditure would only benefit the property owners who abut the lake and a small number of others who use the lake for recreation.