Lake Seminole Sediment Removal Feasibility Study

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Pinellas County

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Executive Summary

The adopted *Lake Seminole Watershed Management Plan* (PBS&J, 2001) identifies the removal of flocculent organic sediments as a major water quality and habitat improvement project critical to meeting the lake restoration goals. In support of the Plan development, PBS&J completed a task deliverable document entitled *Lake Seminole Sediment Removal Feasibility Study* in 1999. This task report addressed the feasibility of removing accumulated sediments from Lake Seminole with these objectives in mind. However, since the completion of that document, and the adoption of the Plan by the Pinellas County Board of County Commissioners in 2004, some of the assumptions and conditions leading to the recommendations contained in Plan have changed (e.g., availability of publicly-owned parcels for spoil dewatering). In addition, in 2004 the City of St. Petersburg initiated a sediment removal project as part of the overall restoration plan for Lake Maggiore, and much relevant information is now available from that project.

The sediment removal project remains the most costly and complex project in the Plan. Therefore, the objectives of this project are: 1) update the sediment removal feasibility study based on current conditions and new information; and 2) conduct additional technical analyses and due diligence. The findings of this project will be used to develop specific recommendations for Pinellas County on the most cost-effective, permittable, and publicly acceptable approach to completing the sediment removal project. This document constitutes the final deliverable for the scope of work summarized above. It is anticipated that the information contained herein will be used by the County to secure funding, and to procure and implement the Lake Seminole Sediment Removal Project.

A review of similar sediment removal projects completed in Florida indicated that organic sediment removal as a lake management tool represents many challenges, and project logistics and results are not always predictable. Nonetheless, the removal of nutrient laden organic sediments has been demonstrated to be a potentially powerful strategy in reducing lake eutrophication and related water quality problems, as well as improving lake aesthetics and recreational opportunities.

Sediment samples were collected from five sites in Lake Seminole on May 9, 2005, using a PVC suction core sampler. The sampling procedure used for the second sampling event was in accordance with FDEP SOPs (FDEP, 2001). The five sampling sites were all located along the central north-south axis of the lake. Samples were analyzed for conductivity, percent organics, nutrients, and trace metals.

The results indicate a fair amount of variability between stations with respect to nutrient and organic content. Station 2, located in the Narrows portion of the lake, has by far the most nutrient and organic enriched sediments, followed by the north end of the South Lobe. Sediments in the North Lobe, and in the south end of the South Lobe, have the lowest concentrations of nutrients and organics. These analyses also indicate that Lake Seminole sediments are not enriched with respect to trace metals, and do not indicate significant anthropogenic contamination.

It should, however, be noted that the elutriate fraction results indicate that in-lake suspension of lake sediments will result in significant violations of water quality standards for trace metals, and will likely contribute to severe nuisance algae blooms and related trophic problems (e.g., low dissolved oxygen, low Secchi disk depth, etc.). These findings support a strong recommendation for sediment removal via hydraulic dredging. As opposed to mechanical dredging techniques, hydraulic dredging results in virtually the complete removal of suspended sediments from the lake water column via suction pumping.

As part of this study, the following nine engineering alternatives (six primary and three secondary alternatives) were comparatively evaluated:

- Alternative 1 - Lake drawdown with excavation
- Alternative 2A – In-lake lagoons with natural evaporation
- Alternative 2B – In-lake lagoons with polymer settling
- Alternative 3A – Upland lagoons with natural evaporation
- Alternative 3B – Upland lagoons with polymer settling
- Alternative 4 - Mechanical degritting, clarification, solids discharge to the County wastewater system
- Alternative 5 – Mechanical degritting, clarification, low gravity dewatering
- Alternative 6A - Mechanical degritting, clarification, high gravity dewatering
- Alternative 6B - Mechanical degritting, clarification, high gravity dewatering and drying

These alternatives were developed based on professional knowledge of methods used on other lake sediment removal projects conducted nationally. Each alternative was evaluated based on the following criteria:

- Project duration;
- Permittability;
- Public acceptance;
- Biddability and constructability; and
- Estimated project costs.

For each alternative a mass balance analysis was conducted; and where applicable, a conceptual process flow diagram was developed. The alternatives evaluated represent a wide range of construction techniques, some of which are obviously infeasible for Lake Seminole given the particular logistical constraints. Nonetheless, an attempt was made to objectively evaluate each alternative, and to disqualify those that are inconsistent with the critical project design criteria.

Several of the alternatives have significant process engineering deficiencies and logistical problems associated with their ability to complete the project within a reasonable schedule. Those alternatives that rely primarily on natural evaporation or percolation (Alternatives 1, 2A, 2B, 3A and 3B) are severely limited by local climatic conditions. It was shown that, given the average rainfall and estimated evaporation rates in Pinellas County, continuously efficient dewatering of dredged organic sediments would not be possible with these alternatives. Alternatives 3A and 3B would also require approximately 200-300 acres of land immediately

adjacent to the lake to be used as evaporative lagoons. However, the Lake Seminole watershed is essentially built out, and no appropriately sized vacant parcels of land exist.

In addition, Alternatives 1, 2A, 2B, 3A and 3B all pose very significant permitting and public acceptance problems. Lake Seminole is a designated Outstanding Florida Water, and much of the lake bottom area is sovereign lands owned and managed by the State of Florida. Furthermore, Lake Seminole is bordered by a major County park as well as intense residential development. Lake Seminole County Park is the third most heavily used park in the Pinellas County park system, and the lake supports extensive recreational activities including canoeing, boating, water skiing, personal watercraft use, fishing, and ultra-light aircraft use.

Any alternative that takes significant portions of the lake out of recreational use, even on a temporary basis, will not be supported by the public. Furthermore, any alternative that has the potential to degrade water quality and lake ecosystem functions, or disrupt habitat and associated fish and wildlife populations, even on a temporary basis, will not be permitted by the applicable environmental regulatory agencies. Therefore, Alternatives 1, 2A, 2B, 3A and 3B can all be rejected as infeasible, and should not receive any additional consideration due to the obvious and very significant impediments to their implementation.

Alternatives 4, 5, 6A, and 6B all involve hydraulic dredging with the dredge slurry being pumped to a small landward site adjacent to the lake for dewatering via process engineering, and disposal. None of these alternatives would pose the significant permitting or public acceptance problems identified for Alternatives 1, 2A, 2B, 3A and 3B. Alternative 4 proposes to provide for mechanical degritting and clarification of the dredge sediments from Lake Seminole. The alternative does not rely on natural evaporation or percolation for the dewatering of the sediment, but proposes to use proven technologies to meet the requirements of the project criteria. Alternative 4 requires a very small upland area for the processing plant and does not require trucked disposal of the dewatered sediment. The disposal of the partially dewatered sediment (8% solid) is via the Pinellas County wastewater collection and transmission system and the South Cross Bayou Water Reclamation Facility.

Initially, the apparent engineering simplicity, relatively low cost, and minimal environmental impacts associated with Alternative 4 made it an attractive option. However, after further analysis, it was determined that this alternative has several significant problems. First, this alternative would not provide for the return of adequate volumes of clean water back to the lake, an important design criterion established in the basis of design. The lack of adequate return water could potentially result in a protracted lake level drawdown, which could both delay the project and adversely impact recreational uses. In addition, this alternative is constrained by the existing wastewater collection, transmission, and treatment infrastructure, which would require substantial upgrades and maintenance to accommodate the project. Therefore, Alternative 4 can be rejected as infeasible.

Alternatives 5, 6A, and 6B all utilize a sophisticated process engineering approach that requires a small temporary “treatment plant” site adjacent to the lake, and results in the efficient dewatering of organic sediments with the return of clean process water back to the lake. Accordingly, these alternatives do not pose significant environmental permitting or public acceptance problems.

Based on an objective and balanced consideration of these factors, Alternative 6A – high gravity centrifuge dewatering with a dredge pumping rate of 800 gpm - is the only alternative investigated that satisfies all of the identified project criteria and standards completely. It is, therefore, concluded unequivocally that it is the preferred alternative for the Lake Seminole sediment removal project. The analysis indicates that using Alternative 6A the project could be completed within two years for an estimated cost of $13.9 million.

To ensure a high level of design engineering quality control, as well as a coordinated approach to project construction and operation, a modified Design/Build/Operate (D/B/O) procurement method is recommended. The modification of the D/B/O process involves the design portion of the project. It is recommended that the County retain a qualified Florida Professional Engineer to prepare the technical design documents (plans and specifications) for the dewatering facility. Based on these technical design documents, the County would then advertise the project for Build/Operate contractors to bid. The successful Build/Operate contractor would be selected on the basis of cost. The County would also retain the design professional to provide construction and operation management services throughout the duration of the project.

The design professional would be responsible for maintaining project schedules and approving invoices and change orders submitted by the Build/Operate contractor, and would be working for, and in the best interest of, the County. While conflicts could still arise between the design professional and the Build/Operate contractor, it would be solely the responsibility of the design professional to resolve such conflicts, pursuant to their contractual arrangement with the County. Under this modified D/B/O, the specialized design services called for in this project would not be under the control of the builder/operator but rather with the Professional Engineer. This modification would allow the County and the design professional to have control over the design, while also giving the County a single point of contact for construction management and operation.

Given the potential economic value of the dewatered dredged material, it is also recommended that the County explore a traditional D/B/O approach whereby a substantial portion of project construction costs would be borne by the contractor in exchange for the ability to sell the material for profit on the open market. Under this approach, the County would advertise and select a D/B/O engineer/contractor team on the basis of: 1) professional qualifications for the design component; and 2) cost for the build/operate components. The most obvious advantage of this approach is that total project costs to the County could be substantially reduced. In addition, most of the same advantages of the modified D/B/O process regarding the engineering responsibilities, and a single point of contact, could be realized. On the other hand, the most significant disadvantage of this approach would be a reduced level of County control over all components of the project. It is likely, however, that the County could implement sufficient project management controls through more stringent contractual coordination and reporting requirements on the part of the D/B/O contractor.

1.0 Introduction

1.1 Background and Objectives

Lake Seminole is a 684-acre freshwater lake located in west central Pinellas County, Florida. It was created by the impoundment of an arm of Long Bayou, an estuarine waterbody, in the 1940s. The Lake Seminole watershed encompasses approximately 3,500 acres, of which almost 90 percent is developed as urban land uses. Drainage from much of the historical watershed of the lake has been diverted to the Seminole Bypass Canal, which intercepts surface runoff and conveys it east of the lake to Long Bayou. The lake currently supports intense recreational use including boating, skiing, and fishing. In recent years, however, the sport fishery (primarily largemouth bass and bluegill) and water quality have declined. The available data indicate a trend of increasing eutrophication and harmful algal blooms in Lake Seminole.

Organic silt sediments have been accumulating in Lake Seminole since its impoundment and creation in the 1940s. The accumulation of organic silts in lakes is often associated with declining water quality and undesirable changes in aquatic invertebrate and fish communities. Organic silts are primarily formed by the accumulation of dead algal cells from blooms occurring in the water column. In addition to algal blooms, excessive accumulation of decaying emergent vegetation along lake shorelines degrades sport fisheries as well as recreational uses and aesthetics.

Due to cost and logistical factors, the removal of organic silt sediments as a means of restoring lake water quality and habitat has been attempted in Florida on a limited basis. Although these projects have generally resulted in mixed success, the removal of nutrient laden organic sediments has the potential to be a highly effective lake remediation method.

The adopted *Lake Seminole Watershed Management Plan* (PBS&J, 2001) identifies the removal of flocculent organic sediments as a major water quality and habitat improvement project critical to meeting the lake restoration goals. In support of the Plan development, PBS&J completed a task deliverable document entitled *Lake Seminole Sediment Removal Feasibility Study* in 1999. This task report addressed the feasibility of removing accumulated sediments from Lake Seminole with these objectives in mind. However, since the completion of that document, and the adoption of the Plan by the Pinellas County Board of County Commissioners in 2004, some of the assumptions and conditions leading to the recommendations contained in Plan have changed (e.g., availability of publicly owned parcels for spoil dewatering). Additionally in 2004, the City of St. Petersburg initiated a sediment removal project as part of the overall restoration plan for Lake Maggiore, and much relevant information is now available from that project.

The sediment removal project remains the most costly and complex project in the Plan. Therefore, the objectives of this project are: 1) update the sediment removal feasibility study based on current conditions and new information; and 2) conduct additional technical analyses and due diligence. The findings of this project will be used to develop specific recommendations for Pinellas County on the most cost-effective, permittable, and publicly acceptable approach to completing the sediment removal project.

1.2 Scope of Work

The scope of work completed for this project is summarized below.

- **Task 1 – Review of Other Previously Completed and Ongoing Lake Sediment Removal Projects in West Central Florida.** Obtain, review and summarize information regarding previously completed and ongoing lake sediment removal projects in west central Florida. Projects to be reviewed will include: Banana Lake; Lake Hollingsworth; Lake Panasoffkee; and Lake Maggiore. The information to be reviewed will include, but not be limited to:
    - Permitting history;
    - Sediment removal methods considered, permitted, and implemented;
    - Projected and actual project costs;
    - Projected and actual project duration;
    - Environmental monitoring data;
    - Problems encountered and corrective measures implemented.

- **Task 2 - Comparative Evaluation of Applicable Sediment Removal Methods and Approaches.** Conduct a comparative evaluation of various methods and approaches to sediment removal, applicable to Lake Seminole. Approaches to be evaluated will include:
    - Draw-down with mechanical removal;
    - Hydraulic dredging with municipal treatment of organics;
    - Hydraulic dredging with dewatering via evaporation in in-lake lagoons;
    - Hydraulic dredging with dewatering via polymer additions in in-lake lagoons;
    - Hydraulic dredging with dewatering via evaporation in upland lagoons;
    - Hydraulic dredging with dewatering via polymer additions in upland lagoons; and
    - Hydraulic dredging with dewatering via chemical process engineering.

  Prepare a comparative matrix of the various sediment removal alternatives evaluated. The criteria to be considered in this matrix evaluation will include the following:
    - Estimated project cost;
    - Estimated project duration;
    - Land area needed;
    - Permittability;
    - Public acceptability;
    - Biddability; and
    - Constructability.

  As part of this analysis, develop a conceptual process flow diagram and mass balance analysis of each alternative considered, providing sufficient detail to quantify the amount of land needed for sediment dewatering, approximate rates and project duration, and approximate project cost.

- **Task 3 - Conduct Chemical and Physical Analyses of Lake Seminole Sediments**. The purpose of these analyses will be to generally characterize the physical and chemical characteristics of Lake Seminole sediments sufficient to allow for conceptual design and

regulatory planning. Collect and analyze five (5) sediment samples. The location and collection of the core samples shall be coordinated with County staff. Sediment sample collection methods shall be consistent with those employed by the Pinellas County Environmental Management Department. Analysis of chemical parameters shall be conducted by a NELAC certified laboratory. Parameters to be analyzed will include the following**:**

- Percent fines and organic matter;
- Nutrients (bulk and elutriate TN and TP);
- Metals (RCRA metals);
- Polymer flocculation testing.

- **Task 4 - Conduct Regulatory Agency Pre-Application Meetings.** Conduct regulatory agency pre-application meetings with applicable federal and state regulatory agencies. The purpose of the pre-application meetings will be to determine: 1) what agencies will have jurisdiction over project activities: 2) what permits or exemptions will be applicable; and 3) initial concerns and comments regarding the various sediment removal approaches being considered. Meetings will be coordinated and conducted with the following agencies:
  - U.S. Army Corps of Engineers;
  - Southwest Florida Water Management District; and
  - Florida Department of Environmental Protection.

  Coordinate meeting dates and times with County staff as appropriate, and prepare written meeting summaries following each meeting.

- **Task 5 – Prepare Final Report.** Prepare a final report summarizing the findings of Tasks 1 through 4. The final report shall contain a clear and unambiguous recommendation regarding the most cost-effective, permittable, and publicly acceptable approach to completing the sediment removal project. In addition, the final report will also provide a comparison of the advantages and disadvantages of various contractual approaches to implementing the project (e.g., design-bid-build, design-build-operate, etc.). Submit five (5) hard copies and an electronic copy of the Final Report.

- **Task 6 – BOCC Presentation**. Make a presentation to the Pinellas County Board of County Commissioners. The presentation date, time and content shall be coordinated with County staff, as appropriate. The presentation will briefly summarize the work conducted and findings derived from the study effort, as well as a clear and unambiguous recommendation regarding the most cost-effective, permittable, and publicly acceptable approach to completing the sediment removal project.

This document constitutes the final deliverable for the scope of work summarized above. It is anticipated that the information contained herein will be used by the County to secure funding, and to procure and implement the Lake Seminole Sediment Removal Project.

2.0 Summary of Lake Sediment Removal Projects

This section presents a brief summary of four lake sediment removal projects conducted in the west central Florida area during the past 15 years. The purpose of this summary is to develop an understanding of the real-world problems that have been encountered, and the lessons that have been learned, on projects similar to sediment removal project proposed for Lake Seminole. The four projects summarized below include:

- Banana Lake – Polk County
- Lake Hollingsworth – Polk County
- Lake Panasoffkee – Sumter County
- Lake Maggiore – Pinellas County.

For each project summary the following subjects are addressed: 1) project history and permitting issues; 2) sediment removal methods considered and selected; 3) budgeted and actual project costs; 4) environmental monitoring data – including sediment quality data, discharge water quality, and pre- and post-dredge water quality data – where available; and 4) problems encountered – including engineering, environmental, and/or construction related issues - and corrective measures implemented. Various sources of information were used in developing these summaries including personal communication with project managers and both published and unpublished data.

2.1 Banana Lake

Banana Lake is a 342 acre lake located in Polk County. The lake exhibited very poor water quality for many years as reflected in high chlorophyll-a and low dissolved oxygen values. The hyper-eutrophic conditions were attributed to stormwater runoff from agricultural areas and the direct discharge of wastewater from a City of Lakeland municipal wastewater treatment plant. The wastewater treatment plant stopped discharging in 1986; however, water quality problems persisted. In the mid to late 1980s, Banana Lake was clearly a phytoplankton dominated lake characterized by year-round blooms of green algae and cyanobacteria. As a result, aquatic macrophyte communities were essentially eliminated and the lake sport fishery (e.g., largemouth bass) was replaced by a fish community dominated by planktivorous species (e.g., gizzard shad).

Because lake water quality did not improve significantly following the elimination of the wastewater treatment plant discharge, it was hypothesized by lake managers that the organic sediments that had accumulated on the lake bottom constituted a substantial nutrient reservoir sufficient to maintain high phytoplankton concentrations. The design and permitting of a sediment removal project for Banana Lake was conducted between 1987 and 1989 under direction of the Southwest Florida Water Management District Surface Water Improvement and Management (SWIM) program. Dredging was initiated 1989 and completed in 1990. A hydraulic dredge was used, and dredged spoil material was discharged in upland pits constructed on adjacent agricultural land. Permits were obtained from the U.S. Army Corps of Engineers (s. 404 Permit) and the Florida Department of Environmental Protection (Wetland Resource Permit). The upland drying pits were designed to contain the entire volume of dredged spoil material, and no return water was permitted back to the lake. The total in-lake volume of

sediments removed, and the total area of drying pits, was approximately 1 million cubic yards and 400 acres, respectively. The total construction cost of the project was approximately $1.5 million.

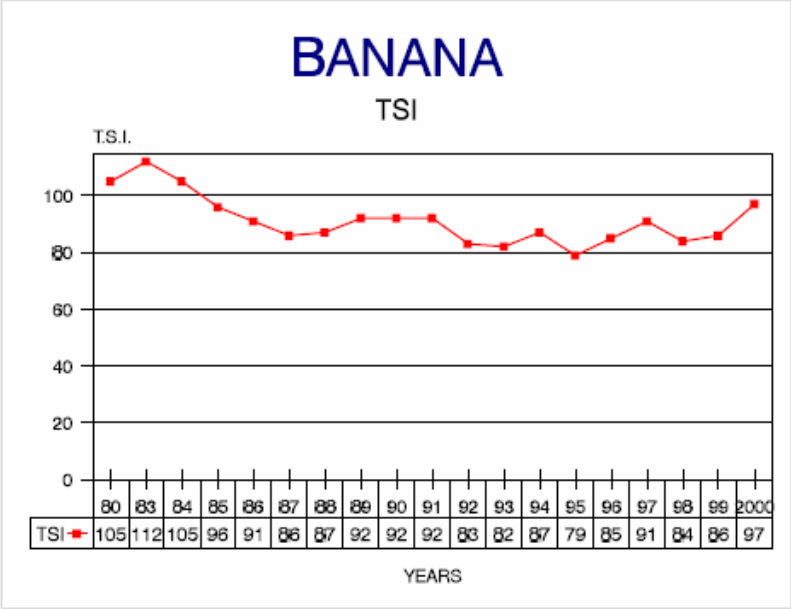
It was subsequently estimated that approximately 90% of the nutrient loads to Banana Lake were eliminated by the diversion of the wastewater treatment plant discharge and the dredging of organic lake sediments. Although trophic state and water quality in Banana Lake improved following the dredging project (see Figure 2-1), the observed improvements have generally been less than anticipated. In addition to water quality improvements, the fish community balance also shifted to a more sport fish (e.g., carnivorous vs. planktivorous) dominated population. Beginning in 1998, Banana Lake began inadvertently receiving a portion of the nutrient laden decant water from the Lake Hollingsworth project (see Section 2.2), a problem that was later corrected. It is likely that the high ambient phosphorus concentrations in the soils of the Banana Lake watershed are sufficient to maintain high algal productivity.

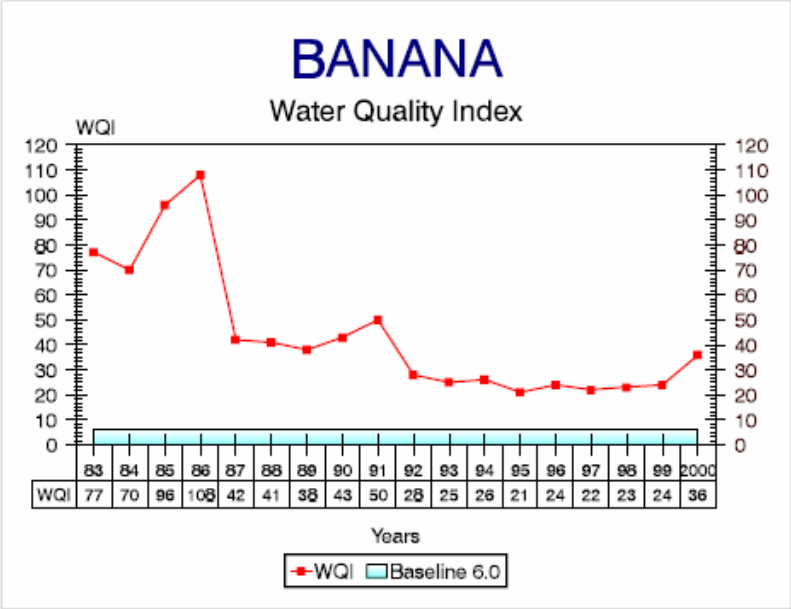
2.2 Lake Hollingsworth

Lake Hollingsworth is a 356 acre lake located within the City of Lakeland, Polk County. Lake water quality had been generally poor for many decades, with persistent algae blooms and low dissolved oxygen levels being the primary concern. Following implementation of several stormwater treatment projects water quality did not improve significantly, so the City of Lakeland contracted with BCI Engineers & Scientists to conduct a sediment removal feasibility study under the assumption that accumulated organic sediments in the lake were serving as a reservoir of nutrients and contributing to water quality problems. The BCI study was completed in 1995 and recommended hydraulic dredging of low density organic sediments combined with process treatment of the dredged slurry to separate the suspended solids. In 1996 project permitting was initiated, and a lake-side pilot test of the process treatment system was conducted. By mid 1996 all necessary permits had been obtained including a section 404 permit from the U.S. Army Corps of Engineers and an Environmental Resource Permit from Florida Department of Environmental Protection. The estimated project cost and duration were $7.5 million and 2 years, respectively.

In February of 1997 dredging was initiated with the dredge spoil being pumped to an adjacent site on which a temporary process treatment plant was constructed. The original design of the process treatment plant was modified several times as it failed to dewater the dredged material to an adequate percent solids to meet contractual requirements for trucking and disposal. Engineering problems with the process treatment plant included inefficient polymer dosing and mixing, and inadequate physical treatment of flocculated organics. In 2000, the plant was retrofitted with an earthen pit to be used as a clarifier for polymer dosing and mixing, combined with a system of evaporation/percolation lagoons comprising approximately 70-acres. This approach also failed primarily because the lagoons flooded prematurely due to inadequate percolation. In 2002, the treatment plant approach was scrapped, and the dredged spoil material was then pumped to the Holloway mine pits located on vacant lands approximately four miles from the plant site.

Figure 2-1
Water Quality Time-Series Data for Banana Lake





In March of 2001 the project was terminated due to low water levels in Lake Hollingsworth. Low water levels were attributed to both previous drought conditions and the limited amount of return water diverted back into the lake. The City of Lakeland estimated that at the time of termination the project was approximately 80 percent complete, with 2.96 million cubic yards of muck removed and 842,000 cubic yards remaining, and that a total of $12 million had been spent. This expenditure equates to a unit cost of $4.14/c.y. It should, however, be noted that the engineering approach to this sediment removal project evolved from a sophisticated mechanical spoil dewatering system to a lagoon disposal alternative. Therefore, it is difficult to evaluate the overall cost-effectiveness of the project.

In 2003 the City of Lakeland conducted a whole lake alum treatment of Lake Hollingsworth with the objective of chemically sequestering remaining phosphorus reserves in lake sediments. In addition, the City implemented several stormwater treatment projects to reduce nutrient inflows. Upon refilling of the lake by average or greater annual rainfall depths, water quality improvements (e.g., Secchi disk depth and chlorophyll-a) have been observed, however, the lake trophic state index remains in the eutrophic to hyper-eutrophic range. Additional data collected by the City indicate that water quality and ecological conditions have improved significantly in response to lake dredging and alum treatment. Appendix 1 contains summary pre- and post-dredging data collected by the City of Lakeland in Lake Hollingsworth. In addition to water quality, the City has reported a 10 percent increase in desirable aquatic vegetation as well as increases in both the abundance and diversity of benthic invertebrates (e.g., Shannon-Weaver Diversity Index increased from 1.04 to 1.60).

In summary, it is difficult to directly quantify the benefits associated with sediment removal in Lake Hollingsworth due to the multiple confounding effects of the dredging, stormwater treatment, and alum application projects, as well as recent climate change (e.g., increasing rainfall). Nonetheless, the net effect of these factors has clearly resulted in improved conditions in Lake Hollingsworth.

2.3 Lake Panasoffkee

Lake Panasoffkee is a very large (4,820-acres) lake located in rural Sumter County. Unlike many threatened Florida lakes, water quality in Lake Panasoffkee is generally very good, which is attributable to the substantial groundwater inflows into the lake from the Floridan aquifer. The threat to Lake Panasoffkee is the loss of desirable aquatic habitats for lake sport fish species. Since the 1940s, almost 800 acres, or 22 percent of the lake's area, has been lost due to sedimentation. Ironically, the groundwater inflow which keeps the lake's water quality high is also the major contributor to the sediment which is filling the lake. The groundwater carries large amounts of dissolved calcium carbonate. When the groundwater mixes with the lake water, the calcium carbonate solidifies, producing sediments which settle on the lake bottom covering fish-spawning areas. The apparent rate of sediment accumulation in Lake Panasoffkee has increased during the past two decades, possibly due to the impoundment of the hydrologic connection with the Withlacoochee River. These factors have combined to negatively impact the lake's fishery, promoting expanding shoreline vegetation and tussock formations, which in turn adversely impacts recreation and navigation. Unlike the other lakes discussed in this section, the

calcium carbonate sediments in Lake Panasoffkee are very low in organic matter, with about 85 percent of the mass of unconsolidated sediments being inorganic material.

Due to concerns regarding sport fishery habitat loss, and recreational and navigational impacts, the Southwest Florida Water Management District (SWFWMD) initiated the design and permitting of a sediment removal project in 2000. The volume of sediment material to be removed from the lake was substantial – over 8 million cubic yards – however, upland disposal without any chemical treatment was always contemplated given the availability of large areas of vacant land adjacent to the lake and the low percent of organics and clay in the lake sediments.

Because SWFWMD was the applicant, the Florida Department of Environmental Protection (FDEP) was responsible for State permitting of the project. In pre-application meetings, SWFWMD argued to the FDEP that the project was a habitat restoration project in the best interest of the public and the environment, and therefore should be permitted as a Notice General Permit (NGP). Even though the project was anticipated to involve the dredging of approximately 27 acres of submerged aquatic vegetation, the FDEP subsequently agreed with this assertion but required the SWFWMD to provide reasonable assurances that the project would not violate water quality standards, as Lake Panasoffkee is an Outstanding Florida Water. Such reasonable assurance would be required under a full Environmental Resource Permit, however, the time to process a NGP was significantly reduced over that likely required for an ERP. Since no flocculating chemicals were needed, return water back to the lake was permitted with a mixing zone. In addition, the U.S. Army Corps of Engineers also agreed with the classification of the project as habitat restoration, and issued their permit approval via a Nationwide 27 Permit. Had a full 404 Permit been required, consultation with other federal agencies and the public notice process would likely have extended the permitting timeframe significantly. All project permits were obtained within approximately one year.

The project design included hydraulic dredging of unconsolidated sediments, with spoil discharge directly to 450 acres of diked upland disposal areas composed of two primary drying cells and several smaller polishing cells. The project permits allow for treated return water back to the lake. The construction contract was awarded at an approximate cost of $2.76 per cubic yard of *in-situ* sediment removed, including the cost of all upland disposal area creation and maintenance. Approximately 8.2 million cubic yards of sediment are targeted for removal, and the total project budget is approximately $22.6 million. Construction of the upland disposal sites was initiated in 2002, and dredging was initiated in late 2003. As of the date of this writing, the project was progressing as planned without any significant problems.

2.4 Lake Maggiore

Lake Maggiore is a 380 acre lake located in the City of St. Petersburg, Pinellas County. The lake has exhibited poor water quality and hyper-eutrophic conditions for at least the past two decades. Diagnostic feasibility studies conducted in the early 1990s identified accumulated organic sediments as a significant source of nutrients impacting water quality. In addition, the lake had accumulated so much silt that historic recreational uses had been effectively curtailed due to shallow water depths. As part of a multi-faceted restoration program, the City of St. Petersburg, in cooperation with SWFWMD, initiated the design and permitting of a sediment removal

project in 1995. BCI Engineers & Scientists were hired to conduct a sediment removal feasibility study and to develop a conceptual design. BCI determined that approximately 2.3 million cubic yards of low density organic sediments should be removed from the lake.

Many project alternatives were considered, however, the recommended approach involved the filling of 34 acres of lake bottom and riparian wetlands with sand tailings generated from dredging, followed by the construction of upland drying pits on the 34 acres of created uplands. Hydraulic dredge spoil would then be pumped through a cyclone unit to remove sands, mixed with flocculating polymers, and then pumped into the pits where dewatering would occur via settling, evaporation and percolation. Upon settling, decant water would be pumped off and the settled solids would be physically removed from the pits, loaded into trucks and then disposed in the Toytown landfill and on the Sod Farm site. Upon completion of the project, the 34-acre drying pit area would then be restored to create an upland public park and recreational area for the City.

Regulatory permitting of the recommended alternative proved to be a challenge. The primary issue raised by both the U.S. Army Corps of Engineers and the FDEP was the proposed filling of 34 acres of lake bottom, which were determined by FDEP to be sovereign lands, and the eventual conversion of this area to an upland City park. In response to agency review comments the City and their consultants developed several modifications to the project as proposed in the original permit applications. The primary issue of concern was the restoration of the 34 acre drying pit area as functional riparian wetlands rather than an upland City park. In 1999 and 2000, respectively, the federal 404 Permit and the State Environmental Resource Permit were approved, requiring the drying pits to be restored back to wetlands.

The engineer's cost estimate for the project was $7-$8 million, however, when the project was let out to bid in 1999, the low bid for both dredging/treatment and disposal was $12.5 million. The City did not award the bid due to the cost discrepancy, and pursued additional funding from SWFWMD. In addition, based on discussions with bidders it was determined that project costs could be reduced if a process treatment system was incorporated into the bid package, and if disposal was pulled out as a separate bid item. Furthermore, it was recommended that the total volume of sediment to be removed be reduced to lower costs.

The project was re-bid in August of 2001 with dredging and disposal as separate bid items. The low bid for dredging and treatment was $7.7 million, while the low bid for disposal via trucking was $4.8 million. The City awarded the bid for dredging to the low bidder with the requirement that they be responsible for obtaining any necessary permit modifications. In addition, the City determined that it would be more cost effective if disposal was performed using City trucks and personnel. The contractual requirement for the volume of sediments to be removed was reduced from 2.3 to 1.54 million cubic yards, and the permits were modified by the contractor to address minor wetland impacts and decant water discharges associated with the proposed process treatment plant.

The on-site process treatment plant was completed in June of 2004 and dredging began in September of 2004. The plant is essentially composed of three primary components: 1) a screening and cyclone unit to separate large debris, sand and other high density material; 2) a

clarifier unit where polymer is mixed with the dredge spoil to flocculate low density organics; and 3) a series belt filter presses to compress and dewater the flocculated organics. Decant water from the belt filter presses is discharged into a polishing pond, which overflows into an existing 3-acre hardwood swamp along the lake shoreline. To date the plant has been operating fairly successfully at an average rate of about 2,000 cubic yards of dewatered muck per day. The dewatered muck, referred to as sludge or "cake", has been averaging approximately 25 percent solids. However, current data indicate that the cake contains a much higher fraction of sand than was anticipated, estimated at about 40 percent by weight. As of December 2005 the project was estimated to be approximately 50 percent complete, and the expected completion date is December of 2006. It should be noted that this project is the first lake sediment removal project in West Central Florida to demonstrate that a mechanical dewatering system can be successfully permitted and deployed.

In summary, the project summaries provided above indicate that organic sediment removal as a lake management tool represents many challenges, and project logistics and results are not always predictable. Nonetheless, the removal of nutrient laden organic sediments has been demonstrated to be a potentially powerful strategy in reducing lake eutrophication and related water quality problems, as well as improving lake aesthetics and recreational opportunities.

3.0 Lake Seminole Sediment Quality

This section presents updated sediment quality data developed as part of this study. Sediment quality was previously assessed as part of the Lake Seminole Watershed Management Plan project in task report entitled Lake Seminole Sediment Characterization Study (BCI, 1997). As part of the present study, sediment samples were collected and analyzed to provide updated information on organic content, as well as new contaminant information relevant to project planning and regulatory permitting of a sediment removal project.

3.1 Sample Collection

Sediment samples were collected from five sites in Lake Seminole on May 9, 2005, using a PVC suction core sampler. The sampling procedure use for the second sampling event was in accordance with FDEP SOPs (FDEP, 2001). The five sampling sites were all located along the central north-south axis of the lake. The general location of each of the stations is as follows:

- Station 1 – central North Lobe
- Station 2 – the Narrows
- Station 3 – north end of the South Lobe
- Station 4 – central South Lobe
- Station 5 – south end of the South Lobe

At each location, the boat was anchored, GPS coordinates were obtained, and two sediment core samples were collected. The coring device was manually pushed into the bottom sediments until strong resistance was felt. Core samples were photographed within the clear PVC sleeve, and then extruded into sample containers. One core sample from each of the five sites was composited into a single sample and shipped to the SNF Company for polymer analysis. The other core sample from each of the five sites was placed in a separate container and delivered to Benchmark EnviroAnalytical, Inc. for chemical analysis. The chemical parameters analyzed for are listed in Table 3-1 below.

Table 3-1
Sediment Chemistry Analyses

Specific conductance	Arsenic
Total solids	Copper
Total organic carbon	Silver
Kjeldahl nitrogen	Zinc
Nitrate/nitrite	Barium
Total nitrogen	Selenium
Total phosphorus	Chromium
Aluminum	Cadmium
Lead	Mercury

The above constituents were analyzed for both bulk sediments, and for an elutriate fraction of each sample using the U.S. Army Corps of Engineers methodology for assessing potential water quality impacts associated with dredging.

3.2 Results

The results of the sediment analyses are tabulated in Appendix 2. The results indicate a fair amount of variability between stations with respect to nutrient and organic content. Station 2, located in the Narrows portion of the lake, has by far the most nutrient and organic enriched sediments, followed by the north end of the South Lobe. Sediments in the North Lobe, and in the south end of the South Lobe, have the lowest concentrations of nutrients and organics.

While there are no specific state standards for sediment trace metals, guidance concentrations for Florida coastal areas have been developed by DEP (MacDonald 1994a,b). These guidance concentrations are based on two levels:

- The "Threshold Effect Level" (TEL), which represents the upper limit of the range of sediment contamination thought to have no measurable effect on associated organisms.

- The "Probable Effects Level" (PEL), which is the estimated lower level on the range of contaminant concentration that almost always is associated with adverse biological effects.

Table 3-2 shows the methods and detection limits for the sediment trace metal results, while Table 3-3 summarizes Lake Seminole sediment trace metal concentrations in relation to both the Threshold Effect Level (TEL) and Probable Effects Level (PEL) concentrations.

An alternative suggested method of investigating the relative concentrations of trace metals in Florida marine sediments has been to use ratios with naturally occurring aluminum sediment concentrations in order to provide relative estimates of anthropogenic enrichment (Schropp and Windom 1988, and Schropp et al. 1990). The graphical results of such analyses are presented in Appendix 2 for the six trace metals for which such methodologies have been developed - arsenic, cadmium, chromium, copper, lead, and zinc, respectively. These summary analyses indicate that Lake Seminole sediments are not enriched with respect to trace metals, and do not indicate significant anthropogenic contamination.

It should, however, be noted that the elutriate fraction results indicate that in-lake suspension of lake sediments will result in significant violations of water quality standards for trace metals, and will likely contribute to severe nuisance algae blooms and related trophic problems (e.g., low dissolved oxygen, low Secchi disk depth, etc.). These findings support a strong recommendation for sediment removal via hydraulic dredging. As opposed to mechanical dredging techniques, hydraulic dredging results in virtually the complete removal of suspended sediments from the lake water column via suction pumping.

Table 3-2
Methods and Detection Limits

Trace Metal	Method	Detection Limit (mg/kg)	TEL	PEL
Aluminum	EPA 365.3	47	-----	-----
Arsenic	EPA 6010	1.27	7.24	41.6
Barium	EPA 6010	0.150	----	----
Cadmium	EPA 6010	0.154	0.676	4.21
Chromium	EPA 6010	0.197	52.3	160
Copper	EPA 6010	0.5	18.7	108
Lead	EPA 6010	0.666	30.2	112
Mercury	EPA 7471	0.112	----	----
Selenium	EPA 6010	1.27	----	----
Silver	EPA 6010	1.28	0.733	1.77
Zinc	EPA 6010	0.338	124	271

TEL – Threshold Effects Level. This represents the upper limit of the range of sediment contaminant concentrations though to have no effect. Below this level, concentrations of sediment-associated contaminants are not thought to represent significant hazards to aquatic organisms.

PEL – Probable Effects Level. This is the lower limit of the range of contaminant concentrations that are usually, or always, associated with adverse biological effects.

Table 3-3
Sediment Trace Metal Concentrations (mg/kg)

Trace Metal	Sediment Sampling Locations					Guidelines	
	Station 1	Station 2	Station 3	Station 4	Station 5	TEL*	PEL**
Aluminum	3938	34479	15540	8229	3387	NA	NA
Arsenic	3.42	2.91	1.27	1.76	1.27	7.24	41.6
Barium	4.67	54.2	16.1	6.75	5.71	----	---
Cadmium	0.299	1.44	0.758	0.623	0.277	0.676	4.21
Chromium	4.60	34.4	17.1	9.31	4.60	52.3	160
Copper	0.729	16.5	6.12	0.500	0.707	18.7	108
Lead	1.62	28.3	4.69	2.19	1.83	30.2	112
Mercury	0.004	0.089	0.029	0.003	0.009	----	----
Selenium	1.27	1.27	1.27	1.27	1.27	----	----
Silver	1.28	1.28	1.28	1.28	1.28	0.733	1.77
Zinc	2.20	67.3	3.56	1.84	2.71	124	271

Guidelines based on "Approach to the Assessment of Sediment Quality in Florida Coastal Waters", MacDonald (1994)

* TEL – Threshold Effects Level. This represents the upper limit of the range of sediment contaminant concentrations though to have no effect. Below this level, concentrations of sediment-associated contaminants are not thought to represent significant hazards to aquatic organisms.

** PEL – Probable Effects Level. This is the lower limit of the range of contaminant concentrations that are usually, or always, associated with adverse biological effects.

--- Not identified.

4.0 Project Design Criteria

To properly conduct a comparative evaluation of engineering alternatives it is first necessary to define all project assumptions and design criteria which then serve as the basis of design. This section provides a discussing of the assumptions and design criteria developed for the alternative evaluation that follows. In addition, all applicable parameters, rates, quantities, and calculations are summarized.

4.1 Sediment Volume and Organic Content

According to a sediment characterization study conducted as part of the watershed planning process (BCI, 1998), there were approximately 850,000 cubic yards of unconsolidated organically rich sediments in Lake Seminole. Since the mid-1990s the volume of organic sediments has likely increased due to the persistent hyper-eutrophic conditions in the lake. Sediment volume, solids content, and organic content are critically important design parameters for the sediment removal project, therefore, a thorough up-to-date survey will be necessary for detailed project engineering. For the purposes of this feasibility study, however, the following conservative design parameters were developed from available information:

- Estimated sediment volume = 1,000,000 cubic yards;
- *In situ* solids content = 15% (average);
- Organic content = 60% organics / 40% inorganics (average);
- Lake surface area = 684 acres;
- Lake depth = 5.5 feet (average).

Comparison with other successful national and international sediment removal projects prove that projects conducted on lakes of equivalent size with equivalent sediment volumes can generally be completed in two years of actual operation.

4.2 Project Duration and Continuous Operating Conditions

For the purposes of this feasibility study a project duration criterion of two years of actual operation, exclusive of mobilization and demobilization, was established. A project duration exceeding two years is considered to be undesirable given the high costs of construction, as well as potential neighborhood and recreational impacts related to increased truck traffic, noise, dust, impediments to navigation, etc. In addition, similar sediment removal projects conducted recently in west central Florida (e.g., Lake Hollingsworth and Lake Maggiore) were planned for completion in a 2-3 year timeframe for similar reasons. Therefore, project alternatives that have a feasible project duration of two years or less were given a high priority.

A secondary criterion for continuous operating conditions was also established for dredging and sediment dewatering activities. Dredging only on weekdays during daylight hours – a typical practice on many dredging projects - would extend the project duration for several years. Continuous operation of the dredging and sediment dewatering facilities (e.g., 24 hours per day, 7 days per week, exclusive of holidays) would significantly reduce the project duration and minimize costs and other project impacts. To account for downtime and maintenance activities

during the overall process, it is assumed that the 24/7 operating conditions would provide an average of 22 working days per month for the two year duration of the project. This is considered a conservative assumption and should provide reasonable estimates of project durations for the various project alternatives.

4.3 Selective Removal of Organic Sediments

For the purposes of this study, lake sediments are assumed to have three distinctly separate components - water, decomposing or decomposed organic material (e.g., dead plant and animal tissue), and sandy and silty inorganic mineral particles. Because the objective of the Lake Seminole sediment removal project is to improve water and habitat quality, rather than to deepen the lake, the targeted component for removal is the organic fraction, not the water or inorganic fraction.

Organically rich sediments are of lower density than the inorganics, and are, for the most part, in quasi-flotation in the upper part of the unconsolidated sediment column. The heavier inorganics tend to sink and concentrate toward the bottom of the sediment column. Therefore, there is always some "cut-line-depth" above which selective dredging can remove almost 95 percent of the organics and leave approximately 60 percent of the inorganics (see Figure 4-1). Dredging out an entire sediment layer would make the lake deeper, but the intent of the project is to clean Lake Seminole not to deepen it. Therefore, a design criterion for the selective removal of organic sediments was established, and project alternatives that provide for the selective removal of organics were given a higher priority.

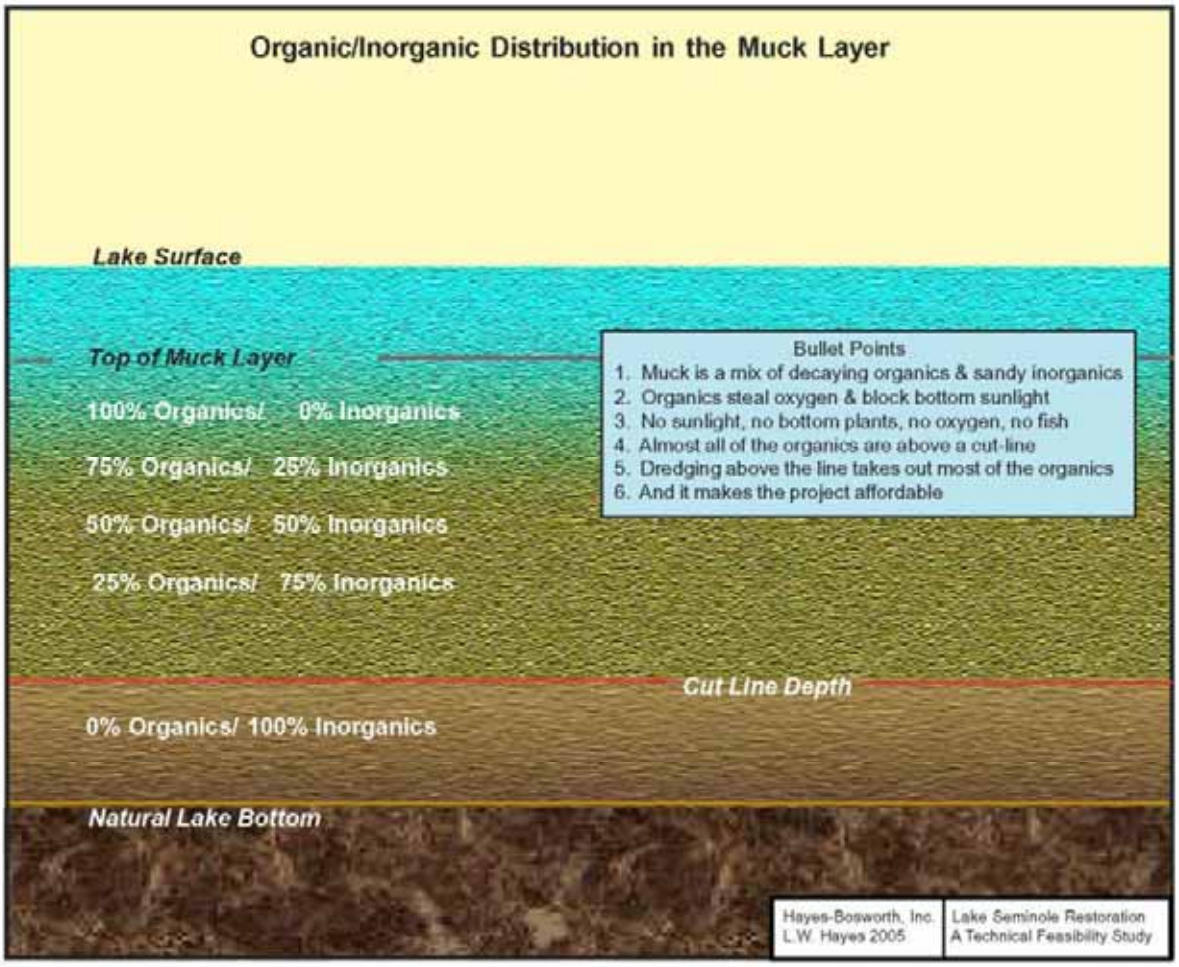
4.4 Lake Water Availability and Clean Return Water

The sediment removal project will require the removal of a significant percentage of the water in the lake, and frequently the volumes removed will equal or even exceed the total volume of the lake. Unless clean water is returned to the lake at a rate approximately equal to the rate of removal, the project could result in a long-term reduction in lake levels. Such lake level reductions could in turn result in severe recreational impacts, property damage (e.g., failed seawalls), project work stoppages (e.g., the dredge can no longer function), and unacceptable increases in the project duration. In addition, as part of the project permitting process, regulatory agencies will require that all water returned to the lake (e.g., Waters of the State), meet all applicable State Water Quality Standards. Therefore, a design criterion for the return of clean processed water back to the lake, at rates comparable to rates of removal, was established, and project alternatives that provide for this were given a higher priority.

4.5 Basis of Design Calculations

In addition to the design criteria discussed above, project alternatives were evaluated based upon several calculated rates, constants, and quantities. This section provides a summary of these calculations.

Figure 4-1
Distribution of Organic and Inorganic Fractions in the Sediment Column



4.5.1 Cut Line Depth

In 2002 quantitative and qualitative engineering analyses of Lake Seminole sediments were conducted by Hayes Bosworth, Inc. Additional samples were collected and analyzed as part of this study. Based on these analyses it was determined that relatively small amounts of material (0.16-1.47 percent dry weight) occurred in samples that were neither organic nor inorganic fine sediments (e.g., rock fragments). For the specific purposes of these calculations, however, organics and inorganic sediments were assumed to constitute 100% of the solids in each sample, and any other extraneous material was considered to be irrelevant. In addition, from the composite sediment layer analysis it was concluded that the *in situ* solids content of the entire unconsolidated sediment column is approximately 15 percent, and that selective Cut Line Depth (CLD) dredging would remove an average of:

- 95.8% of the submerged sediment organics; and
- 32.4% of the submerged sediment inorganics.

By applying these percentages to the solids dry basis (db) weight of the complete sediment layer, the total db solids (organics and inorganics) to be removed can be calculated.

4.5.2 Sediment Layer Density

Using engineering data from the analysis of Lake Seminole sediments the following densities were determined for the organic, inorganic and combined solids to be removed by selective CLD dredging:

- Organic specific gravity = 1.10
- Inorganic specific gravity = 2.40
- Combined solids specific gravity = 1.75
- Water specific gravity = 1.00
- Water density = 62.4 pounds/cubic foot (cf) = 8.34 pounds/gallon

As stated above, the overall sediment column was estimated to have an *in situ* solids content of 15 percent. Therefore, the sediment layer density was calculated as follows:

- Water density = (62.4 pounds/cf) x (27 cf/cy) x (1 ton/2000 lb) = 0.842 tons/cy
- Solids density = (1.75) x (62.4 lb/cf) x (27 cf/cy) x (1 ton/2000 lb) = 1.474 tons/cy
- Sediment layer density = 0.85 x (0.842) + 0.15 x (1.474) = 0.937 tons/cy

4.5.3 Sediment Layer Total Solids Weight

The total sediment layer db solids weight was calculated as follows:

- Total db solids weight = (1,000,000 cy) x (0.937 tons/cy) x 0.15 = 140,550 db tons

4.5.4 Sediment Layer Components Weight

The mass of the total and individual sediment components to be removed were calculated as follows:

- Sediment db solids = 60.0% db organics and 40.0% db inorganics
- Percent CLD organic removal = 95.8% of total organics
- Percent CLD inorganic removal = 32.4% of total inorganics

- Total organics *in situ* = 0.60(140,550) = 84,330 db tons
- Total inorganics *in situ* = 0.40(140,550) = 56,220 db tons
- Total solids *in situ* = 140,550 db tons

- Total organics removed = 0.958(84,330) = 80,800 db tons
- Total inorganics removed = 0.324(56,220) = 18,220 db tons
- Total db solids weight removed = 80,800 + 28,220 = 99,020 db tons

Based on this analysis, it is estimated that CLD dredging would remove approximately 70.4 percent of the total solids load as compared to dredging out the entire (100%) sediment layer. The use of CLD dredging will reduce the volume of material that is dredged, dewatered, and disposed, and will accordingly help to minimize project costs while still meeting project objectives.

4.5.5 Dredge Pumping Rate

When hydraulic dredges are used to deepen a channel or a lake, they are removing denser sands and inorganic material, and the solids content in dredge slurry frequently averages about 10 percent db solids. Comparatively, project records indicate that dredges removing lighter organically rich sediments average approximately 5 percent db solids, unless dredge heads are cutting into underlying denser sands.

The volume of dredge water required to remove one db ton of sediment solids from the lake assuming that the dredge operation is producing dredge water with 5 percent db solids by weight can be calculated as follows:

- Volume of dredge water needed to remove 1 db ton solids = (95 lb water/5 db lb solids) x (2000 db lb solids/db ton solids) x (1 gal water/8.34 lb) = 4,560 gal water /db ton solids

As stated in Section 4.2, continuous operation of the dredge is required to maximize the capacity of the equipment and minimize the project duration, the dredge operation is assumed to be on a 24/7 basis. The project duration will initially be assumed to be two years.

Two important contingency factors were applied to the calculations because: 1) actual dredging efficiency will be less than 100 percent; and 2) a small amount of solids will be returned to the lake in return water. Taking both factors into consideration, a 12% overall contingency was applied to the following calculation to determine the gallons per minute (gpm) for the dredge pumping rate. Therefore, the applicable rates and constants include the following:

- Sediment solids to be removed = 99,020 db tons
- Water/solids removal ratio = 4,560 gallons of water/ton of solids
- Continuous operation = 22 days/month, 24 hours/day
- Overall contingency factor = 1.12

Using these rates and constants, the dredge pumping rate necessary to remove all of the targeted sediments in one year was calculated as follows:

- Optimal dredge pumping rate = (99,020 tons/year) x 4,560 gal water/ton db solids) x (1 year/12 mons) x (1 mon/22 days) x (1 day/24 hrs) x (1 hr/60 min) x 1.12 = 1,330 gallons per minute (gpm)

The optimal dredge pumping rate of 1,330 gpm is used hereafter in all applicable calculations used in the evaluation of alternative. However, it must be emphasized that this rate constitutes a conservative process design rate only. Actual dredging is not a precise process, and solids content in the dredge slurry can be extremely variable. Even so, as a feed rate to the on-shore dewatering process, the dredge pumping rate must not exceed 1,350 gpm for reasons that will be explained later.

4.5.6 Lake Seminole Water Availability

The volume of water in Lake Seminole under average level conditions was calculated using the following applicable parameters:

- Lake Seminole surface area = 684 acres
- Lake Seminole average depth = 5.5 feet
- Total *in situ* organics = 84,330 db tons
- Total *in situ* inorganics = 56,220 db tons
- Organic specific gravity = 1.10
- Inorganic specific gravity = 2.40
- Water specific gravity = 1.00

The total volume of water in Lake Seminole, and hence the volume that must be balanced during the implementation of the sediment removal project, was estimated by first calculating the volume of sediment in the lake and subtracting this volume from the total lake volume. These calculations are shown below.

- Organic sediment volume = (84,330 tons) x (2000 lb/ ton) x (1 gal/8.34 lb) x (1.0/1.10) = 18,400,000 gal

- Inorganic sediment volume = (56,220 tons) x (2000 lb/ton) x (1 gal/8.34 lb) x (1.0/2.40) = 5,600,000 gal

- Total lake water volume = 1,226,000,000 – 24,000,000 = 1,202,000,000 gal

- Total sediment volume = 18,400,000 + 5,600,000 = 24,000,000 gal

- Total lake volume (water + sediment) = (684 acres) x (43,560 SF/AC) x (5.5 feet) x (7.48 gal/CF) = 1,226,000,000 gal

4.5.7 Lake Seminole Water Removal (1 year operation)

As discussed in Section 4.3, hydraulic dredge slurry generally contains about five percent db solids when dredging organically rich sediments. To calculate the actual water removal, the calculated dredge pumping rate must be reduced to reflect only water without solids. The following applicable parameters were used:

- Dredge water consistency = 95% water + 5% solids (organics + inorganics)
- Total organic removal = 80,800 db tons
- Total inorganic removal = 18,220 db tons
- Total solids removal = 99,020 db tons
- Organic specific gravity = 1.10
- Inorganic specific gravity = 2.40
- Water specific gravity = 1.00
- Standard water density = 8.34 pounds/gallon

The volume of water removed from Lake Seminole during one year of operation was calculated as follows:

- Dredge water consistency = 0.95 water + 0.05 (80,800/99,020) organics + 0.05 (18,220/99,020 inorganics) = 0.95 water + 0.0408 organics + 0.0092 inorganics

- Dredge water density = [0.95(1.0) + 0.0408(1.1) + 0.0092(2.4)](8.34) = 8.48 lb/gal

- Water mass in dredge slurry = 0.95 (8.48) = 8.06 lb/gal

- Lake water removal in 1 year = (1330 gpm) x (8.06/8.48) x (60 min/hr) x (24 hr/day) x (22 days/mon) x (12 mon) = 480,000,000 gal

This analysis indicates that almost 40% (480,000,000/1,202,000,000 = 39.9%) of all water available in Lake Seminole would be removed from the lake during one year of operations.

Therefore, return of clean water to the lake during the project is required regardless of which project alternative is selected. Water must be returned to the lake at approximately the same rate as it is pumped (dredged) out to avoid excessive lake draw down. In addition, the return water must be treated to a level such that State Water Quality Standards will not be violated in the lake.

4.5.8 Summary of Design Rates and Quantities

Table 4-1 summarizes the critical rates and quantities used in the comparative evaluation of project alternatives presented in Section 5.

Table 4-1
Summary of Basis of Design Calculations

Parameter	Value
Sediment Organic Component Specific Gravity	1.10
Sediment Inorganic Component Specific Gravity	2.40
Sediment Combined Specific Gravity	1.75
Overall Sediment Layer Density	0.937 ton/cy
Total Sediment Organics *In Situ*	84,300 db tons
Total Sediment Inorganics *In Situ*	56,220 db tons
Total Sediment Layer db Solids Weight	140,550 db tons
Sediment Total Organic Volume	18,400,000 gal
Sediment Total Inorganic Volume	5,600,000 gal
Total Lake Volume (water and sediment)	1,226,000,000 gal
Dredge Pumping Rate	1,330 gpm
Water Available in Lake Seminole	1,202,000,000 gal

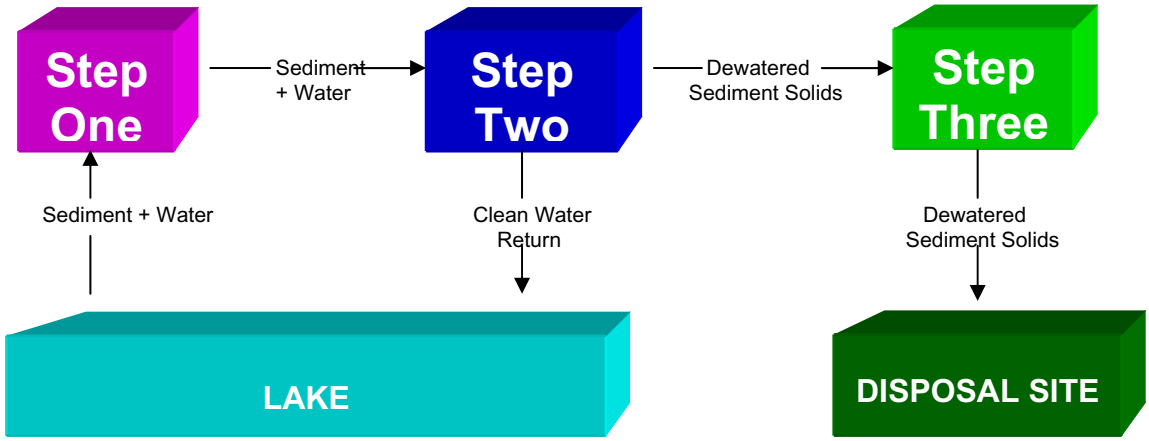
4.6 Process Design and Material Balance

Lake sediment removal via hydraulic dredging typically requires a three-step process sequence: 1) dredging; 2) dewatering; and 3) disposal (see Figure 4-2). Unfortunately, there is no standard three-step process that is suitable for every sediment removal project. Physical and chemical sediment variations, as well as project-specific environmental, economic and logistical considerations require significant differences in project design and permitting.

Each process step is represented by a simple block, however, multiple processes could be integrated into each step. During the process design, all of the material flows (by weight) in and out of the 3-step sequence are balanced first. All of the material flows in and out of each step in the sequence (considering all of the max-min variations in every material flow) are balanced next. Finally, after all of the functions have been defined, the equipment fitting each function can be selected and sized.

Step one involves the physical removal of sediment from the lake. There are really only two alternatives methods for sediment removal: 1) lake drawdown followed by mechanical excavation; or 2) dredging. Dredging can be accomplished using either a clam shell or hydraulic dredge.

Figure 4-2
Typical Three-Step Process of Lake Sediment Removal Projects



KEY POINTS

1. The total weight of everything put into the process must equal the total weight of everything taken out of the process.
2. Sediment + Water = Dewatered Sediment Solids + Clean Water Return.
3. Sediment cannot be dredged into the process sequence any faster than dewatered sediment solids can be disposed of.
4. The disposal rate of dewatered sediment solids establishes the dredge pumping rate.
5. Clean water in the lake is the objective.
6. The dewatering process must continually produce a clean return water as fast as it receives sediment + water from the dredge.

Dewatering, the second step, is almost always the most challenging step in the process design, depending on the nature of the dredged material and logistical constraints (e.g., land area for material processing). The dewatering of sludges and organically rich sediments is not new technology. The dewatering step must be approached in the same way as the overall project material balance – define and balance process functions first, then size and select process approaches and operating equipment elements. Mechanical dewatering has a long and successful history within the realm of wastewater and industrial engineering, although its application to lake restoration projects is relatively new. The proper application of planning and process design principles can deliver an acceptable project for Lake Seminole.

Step three is disposal which involves the physical transport of dewatered sediments to the final disposal site. This is typically accomplished by trucking or barging dewatered sediments to another location. If space for material processing is limited, the rate of disposal can become the defining rate for the entire process.

5.0 Evaluation of Project Alternatives

5.1 Introduction

This section provides a comparative evaluation of various engineering alternatives for removing organic sediments from Lake Seminole. Six primary alternatives were developed for evaluation, and three of the six included additional sub-alternatives (e.g., A and B). Therefore, a total of nine alternatives were evaluated, as listed in Table 5-1.

Table 5-1
Project Alternatives Evaluated

Alternative	Description
1	Lake Drawdown with Excavation
2A	In-Lake Lagoons with Natural Evaporation
2B	In-Lake Lagoons with Polymer Settling
3A	Upland Lagoons with Natural Evaporation
3B	Upland Lagoons with Polymer Settling
4	Mechanical Degritting, Clarification, Solids Discharge to County Wastewater System
5	Mechanical Degritting, Clarification, Low Gravity Dewatering
6A	Mechanical Degritting, Clarification, High Gravity Dewatering
6B	Mechanical Degritting, Clarification, High Gravity Dewatering and Drying

These alternatives were developed based on professional knowledge of methods used on other lake sediment removal projects conducted nationally. Each alternative was evaluated based on the following criteria:

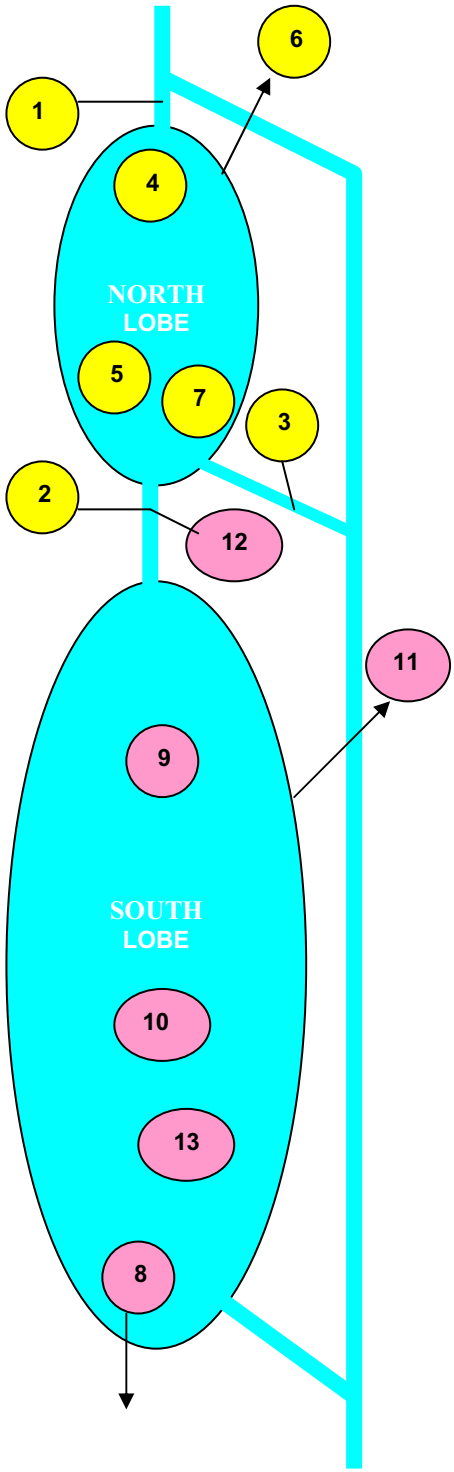
- Project duration;
- Permittability;
- Public acceptance;
- Biddability and constructability; and
- Estimated project costs.

For each alternative a mass balance analysis was conducted; and where applicable, a conceptual process flow diagram was developed. The alternatives evaluated represent a wide range of construction techniques, some of which are obviously infeasible for Lake Seminole given the particular logistical constraints. Nonetheless, an attempt has been made to objectively evaluate each alternative, and to disqualify those that are inconsistent with the project design criteria.

5.2 Alternative 1 - Lake Drawdown with Excavation

Alternative 1 would involve draining the entire water volume of the lake, air drying and compaction of the exposed sediments on the lake bottom, mechanical excavation of the dewatered sediments, and transport of the excavated material to a disposal site. Following completion of all earthwork, the lake would be allowed to refill from rainfall and runoff. Given the particular linear, segmented configuration of Lake Seminole, it would be advantageous for logistical reasons to isolate, drain, excavate, and refill the north and south lobes of Lake Seminole as separate operations. Figure 5.1 illustrates this phased approach to Alternative 1.

Figure 5-1
Phased Approach to Lake Drawdown and Excavation



PHASE ONE / NORTH LOBE

Concept

1. Interdict and block north inflow.
2. Interdict and block south outflow.
3. Drain North Lobe completely.
4. Air-dry settled, compacted sediment.
5. Bulldoze and load air-dried sediment.
6. Haul away air-dried sediment.
7. Refill North Lobe.

Removal Specification

Material – sediment, bottom-scrape and vegetation
Weight – 221,500 tons (total north lobe project)
Volume – 215,500 CY (total north lobe project)

North Lobe Project Duration
5.5 Years

PHASE TWO / SOUTH LOBE

Concept

8. Drain South Lobe completely.
9. Air-dry settled, compacted sediment.
10. Bulldoze and load air-dried sediment.
11. Haul away air-dried sediment.
12. Open narrows interdiction.
13. Refill South Lobe.

Removal Specification

Material – sediment, bottom-scrape, vegetation
Weight – 3,737,200 tons (total south lobe project)
Volume – 363,000 CY (total south lobe project)

South Lobe Project Duration
8.1 Years

5.2.1 Material Balance

As stated above, it would be advantageous for logistical reasons to isolate, drain, excavate, and refill the north and south lobes of Lake Seminole as separate operations. This approach is afforded by the particular linear, segmented configuration of Lake Seminole, and would allow for the compartmentalization of recreational and neighborhood impacts resulting from construction activities.

According to the Lake Seminole Watershed Management Plan, the north and south lobes of the lake make up about 37.2 and 62.8 percent of the total 684 acres lake area, respectively. Therefore, using the lake area estimates and the calculated *in situ* volume of organic and inorganic sediments (see Section 4.5.4), the mass of sediments to be removed from each lobe was calculated as follows:

- North Lobe component removal
  - Organics *in situ* = 0.372 (1.15) (84,330) = 36,100 db tons
  - Inorganics *in situ* = 0.372 (1.15) (56,330) = 24,100 db tons
  - Total North Lobe sediment removal = 60,200 db tons

- South Lobe component removal
  - Organics *in situ* = 0.628 (1.15) (84,330) = 60,900 db tons
  - Inorganics *in situ* = 0.628 (1.15) (56,330) = 40,700 db tons
  - Total South Lobe sediment removal = 101,600 db tons

Under this alternative sediments would be dewatered *in situ* via air drying and compaction prior to removal by excavation. This process would make portions of the now heavily vegetated shoreline accessible for excavation - areas that would otherwise be inaccessible to hydraulic dredges. In addition, selective removal of organic sediments (see Section 4.3) would be more difficult because gravity compaction of the sediment column would disrupt the density stratification of the organic and inorganic sediment fractions established in their aqueous state. The compacted sediment material would be bulldozed for loading onto trucks for disposal. The depth of the average bulldozer blade "scrape" was assumed to be 3 inches. If the compacted sediment did not air-dry as well as is assumed, the average scrape depth would necessarily be greater to achieve the targeted removal of organics. Because of irregularities in air drying in compaction, the heterogeneous horizontal distribution of organics on the compacted lake bottom, and the imprecise nature of mechanical excavation, it is likely that a greater volume of inorganics would be removed per unit surface area than would be removed via hydraulic dredging.

In consideration of these factors, a conservative contingency factor of 15 percent was assumed to account for the potential additional surface area excavated during the sediment removal process. Therefore, the respective surface area to be excavated in each lobe was calculated as follows:

- North Lobe = 37.2% of Total Lake Surface = 0.372 (1.15) (684) = 293 acres
- South Lobe = 62.8% of Total Lake Surface = 0.628 (1.15) (684) = 494 acres

The density of the compacted sediments was assumed to be 65 lb/cf (*Perry's Chemical Engineering Handbook, Densities of Misc. Material, Wet Excavations*). Therefore, the respective surface area to be excavated in each lobe was calculated as follows:

- North Lobe excavation db weight = (293 as/43,560 sf) x (3 in) x (1ft/12in) x (65 lb/cf) x (ton/2000 lb) = 103,700 db tons

- South Lobe excavation sediment db weight = (494 ac/43,560 sf) x (3 in) x (1ft/12in) x (65 lb/cf) x (ton/2000 lb) = 175,000 db tons

Assuming that the material in each lobe is 74 percent db solids, 25 percent water and 1 percent vegetation and miscellaneous debris, the estimated actual sediment removal weights for each lobe are:

- North Lobe excavation actual weight = (60,200 + 103,700)/0.74 = 221,500 tons
- North Lobe excavation actual weight = (101,200 + 175,000)/0.74 = 373,200 tons

Assuming a wet material density of 1.028 tons/cy (*Perry's Chemical Engineering Handbook, Densities of Misc. Material, Wet Excavations*), the estimated volume to be excavated from each lobe was estimated as follows:

- North Lobe excavation volume = (221,500)/1.028 = 215,500 cy
- South Lobe excavation volume = (373,100)/1.028 = 363,000 cy

5.2.2 Project Duration

Unlike the other alternatives evaluated, the project continuous operation design does not apply to Alternative 1. Mechanical excavation may be halted due to high rainfall volumes expected during summer months. Therefore, the effective year of operation for this alternative was assumed to be 44 weeks to allow for normal work stoppages due to wet conditions. Based upon the volumes estimated above, and the parameters identified below, the project duration for Alternative 1 was estimated as follows:

- Applicable parameters
  - Effective year = 44 weeks
  - Project operation = 10 hours/day; 6 days/week
  - Truck loading and turnaround time = 1 hour
  - Truck capacity = 18 cy/truck

- North Lobe project duration
  - Mobilization = 6 mo dam construction + 6 mo drying/compaction = 1.0 year
  - Operation = (215,500 cy) x (1 truck/18 cy) x (1 hr/truck) x (1 day/10 hr) x (1 wk/6 day) x (1 yr/44 wks) = 4.5 years
  - Total North Lobe project duration = 5.5 Years

- South Lobe project duration
  - Mobilization = 6 mo drying/compaction = 0.5 year
  - Operation = (363,000 cy) x (1 truck/18 cy) x (1 hr/truck) x (1 day/10 hr) x (1 wk/6 day) x (1 yr/44 wks) = 7.6 years
  - Total North Lobe project duration = 8.1 Years

5.2.3 Permittability

It would be extremely difficult to obtain environmental permits for Alternative 1 due to the severe and long-term disturbance to the Lake Seminole ecosystem. Lake Seminole is a designated Outstanding Florida Water, and as such is afforded extra regulatory protection with regard to water pollution. In addition, large portions of Lake Seminole are publicly-owned sovereign lands. The loss of wetland habitat and lake ecosystem functions over a period of time exceeding a decade, and the associated disruptions to fish and wildlife populations, would not be permitted regardless of the overall project objective of water quality and ecosystem restoration.

5.2.4 Public Acceptance

The project duration of 13 years estimated for Alternative 1 would clearly not be acceptable to the public due to the complete loss of recreational opportunities afforded by the lake, as well as the degraded waterfront aesthetics during project construction. Additional long-term neighborhood impacts such as truck traffic, noise, and dust would clearly not be tolerated by the local public.

5.2.5 Biddability and Constructability

Alternative 1 is a very simple approach to the removal of the sediments from Lake Seminole. Although substantial in scale, the earthwork and trucking operations should not present issues for most experienced general contractors. The draining operation and air drying/compaction of the lake bottom sediments may be problematic as the lake bottom elevation is below sea level, and drying conditions would need to be constantly maintained by well-points and pumping. Heavy rainfall, especially during the summer months, would also pose a continual challenge to maintaining drying conditions. Finally, there is a high potential for extensive seawall damage (e.g., cracking and washouts) during low water conditions. Nonetheless, Alternative 1 could most likely be bid and constructed without major issues for interested general contractors.

5.2.6 Estimated Cost

As discussed above, Alternative 1 poses very serious permitting, public acceptance, and constructability problems. Assuming those problems could be overcome, the total estimated cost for this alternative is approximately $50 million. A detailed cost breakdown for this alternative is provided in Appendix 3. Given the long project duration (14 years estimated), construction costs could vary significantly throughout the project tenure. In addition, given the high potential for changed conditions due to unpredictable meteorological events, claims of property damage, etc., the potential for contractor change orders and disputes is very high.

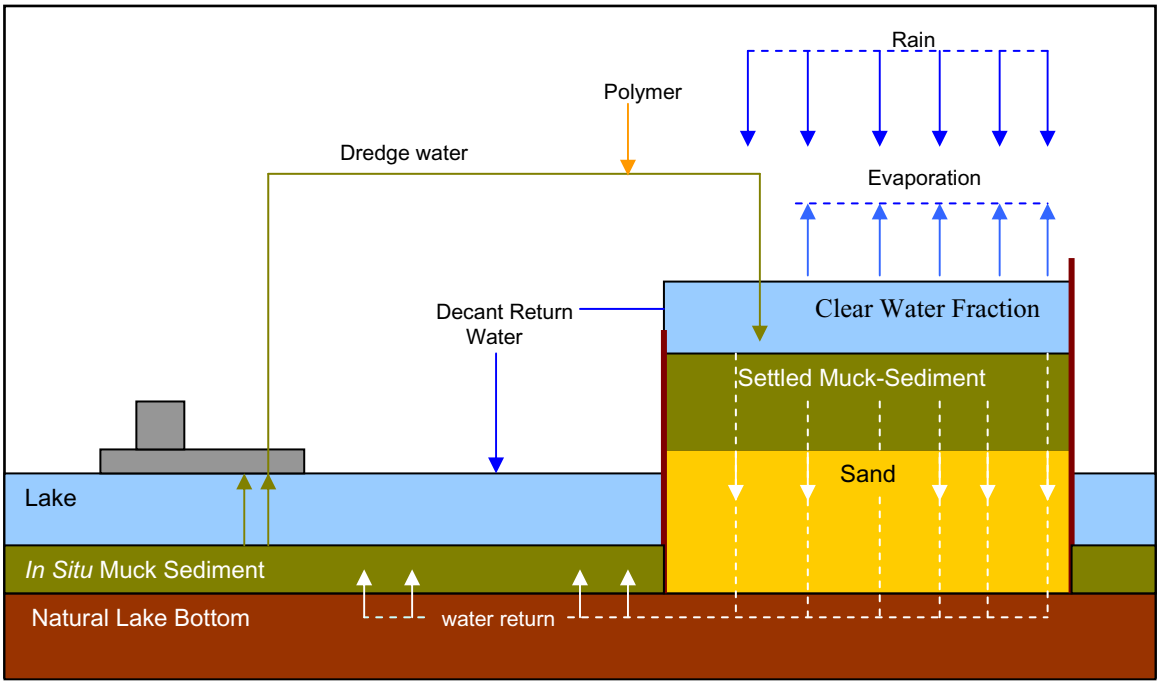
5.3 Alternatives 2A and 2B - In-Lake Lagoons with Natural Evaporation or Polymer Settling

Alternatives 2A and 2B would both involve the construction of in-lake evaporative lagoons, followed by the hydraulic dredging of organic sediment into the lagoons for dewatering. Alternative 2B differs from 2A only in that it would involve the addition of a polymer to the dredge slurry to facilitate flocculation of organics, separation from the water fraction and more rapid settling. To facilitate drying via both evaporation and percolation, in-lake lagoons must be constructed such that the bottom elevation of the lagoon is above the average lake water surface level. In-lake lagoons can be constructed using earthen berms, concrete or steel sheet pile, or a combination of the two. Figure 5-2 illustrates a typical in-lake lagoon.

Flocculent polymers cause smaller suspended organic particles to bind together thus creating larger, heavier particles that more readily settle out of suspension. The chemical and physical bonds imparted by polymer additions are, however, relatively weak and can be easily broken down by physical agitation or changes in water chemistry (e.g., acidic pH).

It must be stated that as the subject applies to these alternatives - a comparison of natural evaporation versus polymer settling – the comparison is technically inappropriate, as one has very little to do with the other. Water evaporates from the surface of a water column, regardless of what happens below, and it is only when all water overlying the sediment interface evaporates away that surface evaporation and drying of the sediment column can begin. If, however, the sediments are compacted by flocculent polymer additions, migration of the internal water to the surface of the sediment column can be impeded, and the overall drying time can actually be slowed.

Figure 5-2
Conceptual Diagram of an In-Lake Lagoon



5.3.1 Material Balance

As described in Section 4.5, 480,000,000 gallons of dredge water containing 100,000 tons of sediment will be pumped to the dewatering lagoons from project start to finish. It is estimated that the in-lake lagoon would need to be approximately 200 acres in size to be able to handle the process flows. A critical factor in determining the success of evaporative lagoons for dewatering dredged material is the local climate. In areas with high humidity, and where the annual rainfall depth exceeds the annual evapotranspiration depth, effective dewatering and drying cannot be consistently achieved unless augmented by percolation and/or pumping. Meteorologic data for Pinellas County were obtained from National Climatic Data Center (NOAA) in St. Petersburg, Florida. Standard psychometric charts were then used to determine relative humidity and moisture/dry air ratios for use in the calculation of evaporation rates. The following formula was used to calculate the evaporation rates from open air waterbodies (ASCE, 2005):

$$\mathbf{E = K_{HI}DR}$$

E = Evaporation (inches of water evaporated)
$\mathbf{K_{HI}}$ = 7.323 (a constant)
D = Duration (days in the evaporation period)
R = Ratio (lb moisture/lb dry air)

Table 5-2 provides a summary of the data used to calculate an annual estimate of open water evaporation applicable to Pinellas County.

Table 5-2
Meteorological Data Used to Calculate Evaporation Rate for Pinellas County

	NOAA DATA		EVAPORATION CALCULATION			
Month	**Dry Bulb**	**Wet Bulb**	**K_{HI}**	**D**	**R**	**E**
January	58.0	54.8	7.323	31	0.0080	1.82”
February	64.0	58.7	7.323	29	0.0092	1.95”
March	68.4	61.3	7.323	31	0.0103	2.34”
April	69.9	62.8	7.323	30	0.0114	2.50”
May	78.3	70.2	7.323	31	0.0141	3.20”
June	83.3	75.4	7.323	30	0.0151	3.32”
July	82.7	76.4	7.323	31	0.0171	3.88”
August	82.5	76.8	7.323	31	0.0183	4.15”
September	81.7	75.6	7.323	30	0.0172	3.78”
October	77.1	70.8	7.323	31	0.0148	3.36”
November	71.0	64.6	7.323	30	0.0118	2.59”
December	61.2	53.5	7.323	31	0.0082	1.86”
						34.75”

It should be noted that the calculated annual evaporation depth represents only evaporation from open waterbodies and does not include transpiration loss from vegetation, which can be considerable in more natural watersheds. In 2004, Pinellas County received 64.19 inches of rainfall, compared to the long-term annual average of 37.47 inches. Therefore, 2004 can be considered a "wet year" for comparison with the evaporation depths calculated. Average rainfall, calculated using NOAA departure from normal averages, can be considered to represent a "normal year" for comparison with the same evaporation depths.

Table 5-3 shows a comparison of monthly rainfall minus evaporation for wet versus normal rainfall years. Net values represent rainfall minus evaporation. Positive net values, where rainfall exceeds evaporation, are shown in blue, whereas negative net values, where evaporation exceeds rainfall, are shown in red. Based upon these data, evaporation alone will not provide for adequate dewatering of the dredged sediments in lagoons, even during normal years. The project dewatering process must continually, reliably, and efficiently convert in-flow quantities into clean return water to the lake, as well as a minimized volume of "truckable" dewatered sediment within a reasonable period of time. Based on this analysis, in-lake lagoons do not appear to meet the requirements of the project dewatering process.

Table 5-3
Pinellas County Evaporation - Extreme vs. Average Rainfall Years

	Wet Year			Normal Year		
Month	Evaporation (inches)	Rainfall (inches)	Net (inches)	Evaporation (inches)	Rainfall (inches)	Net (inches)
January	1.82	4.63	2.81	1.82	1.50	0.32
February	1.95	5.08	3.13	1.95	1.67	0.28
March	2.34	0.78	1.56	2.34	2.83	0.49
April	2.50	2.80	0.30	2.50	3.49	0.99
May	3.20	1.83	1.37	3.20	3.89	0.69
June	3.32	8.26	4.94	3.32	3.84	0.52
July	3.88	22.81	18.93	3.88	4.39	0.51
August	4.15	2.27	1.88	4.15	3.82	0.33
September	3.78	11.22	7.44	3.78	3.88	0.10
October	3.36	1.54	1.82	3.36	2.77	0.59
November	2.59	1.39	1.20	2.59	2.99	0.40
December	1.86	1.58	0.28	1.86	2.44	0.58
Totals	34.75	64.19	29.44	34.75	37.51	2.76

5.3.2 Project Duration

Given the expected rainfall in Pinellas County compared to the available evaporation, it is anticipated that Alternatives 2A and 2B would not reach completion without a supplemental sediment dewatering process. The most efficient design of an in-lake lagoon is shown in Figure 5-2, where the elevation of the sand bottom is higher than the lake surface water level. This configuration could provide for a hydraulic gradient and some percolation assuming that the sand bottom interface does not become clogged by fine organic particles. Nonetheless, in the absence of a supplemental sediment dewatering process, Alternatives 2A and 2B would not reach successful completion within any anticipated project duration due to the factors identified herein.

5.3.3 Permittability

It would be difficult to obtain environmental permits for Alternatives 2A and 2B, again due to the severe and long-term disturbance to the Lake Seminole ecosystem. Unlike Alternative 1, these alternatives would affect only a portion of the lake bottom, rather than the entire lake. However, a large portion of the lake bottom (approximately 30-40%) would be dedicated to the in-lake lagoons. As stated above, Lake Seminole is a designated Outstanding Florida Water, and as such is afforded extra regulatory protection with regard to water pollution. The potential for leakage from or catastrophic failure of the containment structures would likely be high. In addition, large portions of the lake bottom are publicly-owned sovereign lands, and the aquatic habitat and lake ecosystem functions lost in those areas affected by the in-lake lagoons would be very significant.

5.3.4 Public Acceptance

The uncertain project duration estimated for Alternatives 2A and 2B would not be acceptable to the public. The large area required for the in-lake lagoons for Alternatives 2A and 2B would impact the residents near Lake Seminole as well as recreational users of the lake. Additionally the unattractive nature of the lagoons and the long term heavy equipment operations associated with the removal of the sediments would also be unacceptable.

5.3.5 Biddability and Constructability

Although the construction aspects of Alternatives 2A and 2B are biddable and constructible, the operation of the project would be highly uncertain due to the impact of rainfall and inefficient dewatering. It is doubtful that any general contractor would accept the uncertainty associated with the weather influenced operations associated with these alternatives. Contractors would be uncertain about meeting the contract schedule and being liable for any stipulated liquidated damages.

5.3.6 Estimated Cost

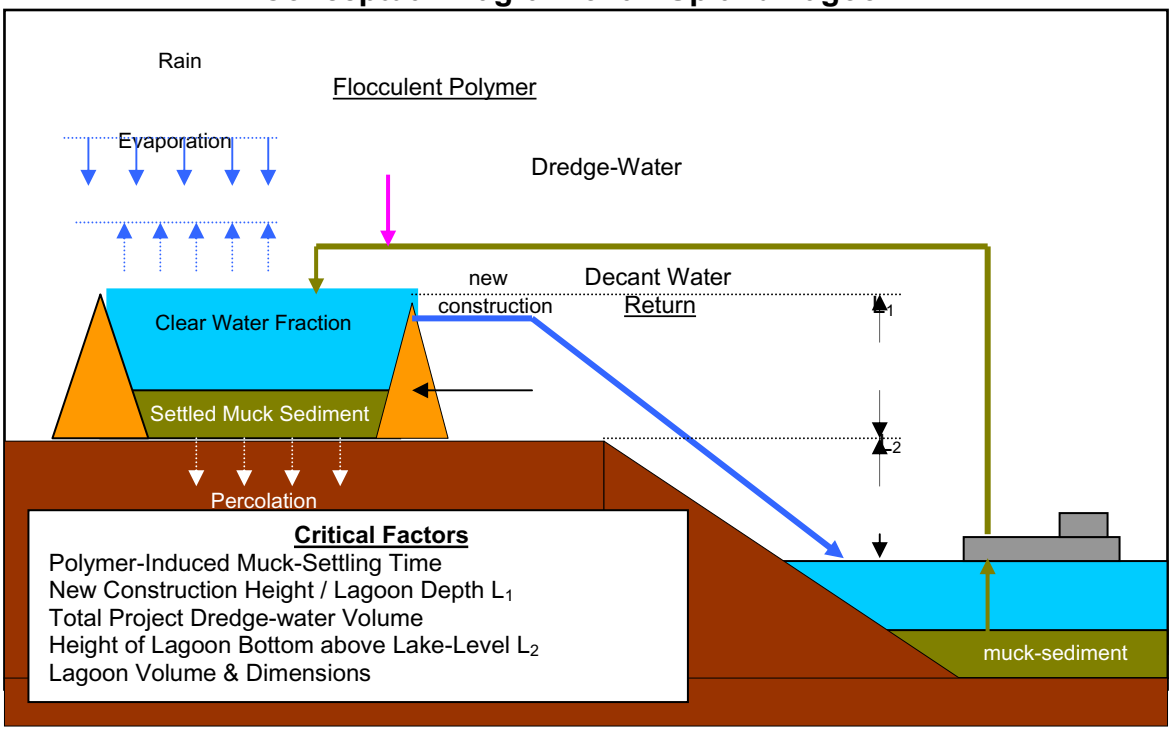
As discussed above, Alternatives 2A and 2B pose very serious permitting, public acceptance, and constructability problems. Assuming those problems could be overcome, the total estimated cost for Alternatives 2A and 2B are approximately $35.4 and $38.7 million, respectively. Detailed

cost breakdowns for these alternatives are provided in Appendix 3. Given the long project duration (4 years estimated), construction costs could vary significantly throughout the project tenure. In addition, given the high potential for changed conditions due to unpredictable meteorological events, claims of property damage, etc., the potential for contractor change orders and disputes is high.

5.4 Alternatives 3A and 3B - Upland Lagoons with Natural Evaporation or Polymer Settling

Alternatives 3A and 3B would both involve the construction of upland evaporative lagoons on lands adjacent to Lake Seminole, followed by the hydraulic dredging of organic sediment into the lagoons for dewatering. Alternative 3B differs from 3A only in that it would involve the addition of a polymer to the dredge slurry to facilitate flocculation of organics, separation from the water fraction and more rapid settling. Figure 5-3 illustrates a typical upland lagoon.

Figure 5-3
Conceptual Diagram of an Upland Lagoon



The term "upland lagoon" can be misleading. The upland lagoon must be engineered at a sufficient elevation to produce a hydraulic gradient out of the lagoon. The land around Lake Seminole is only slightly higher than the lake and any excavation that results in the lagoon being below the surficial groundwater table would not provide for the necessary hydraulic gradient. An upland lagoon must be completely above ground, above the lake-level and above the water-table, not excavated down.

As discussed in Section 5.3, in-lake lagoons relying on natural evaporation as the primary dewatering mechanism (Alternative 2A) were shown to be infeasible because Florida rainfall depths generally exceed open-air, waterbody evaporation rates. The same problem is applicable to Alternative 3A.

In-lake lagoons that are dependent on a combination of both natural evaporation and polymer-induced sediment settling (Alternative 2B) were also considered to be infeasible because polymer additions do not significantly improve the efficiency of evaporative drying. However, if upland lagoons can be constructed completely above ground, and above the lake-level, and if the primary dewatering mechanism is decantation, rather than evaporation, Alternative 3B's combination of hydraulic gradients and polymer-induced settling are important factors that must be considered, assuming that the total area required for the upland decantation lagoons does not exceed the limitations on publicly-owned land available for the Lake Seminole sediment removal project.

In general, the following assertions can be made regarding upland lagoons. Upland dewatering lagoons are technically acceptable and are used:

- If the natural and/or flocculent-induced settling characteristics of the solids to be settled are such that a clean water fraction above and a definite settled-solids fraction below can be generated within a reasonable period of time.

- In more arid states (i.e., California) with minimum yearly rainfall, low humidity and high natural evaporative rates.

- In wet states (i.e. Florida and Louisiana) only if the settled solids are sufficiently granular and porous to permit percolation down through the solids and into the soil beneath, which must also be sufficiently granular and porous.

Upland dewatering lagoons are not technically acceptable and are not used:

- If the natural and/or flocculent-induced settling characteristics of the solids to be settled are such that a definite clean water fraction and a definite settled solids fraction *cannot* be generated within a reasonable period of time.

- In wet states (i.e. Florida and Louisiana) with rainfall equal to, or in excess of, natural evaporation rates.

- In any state, wet or dry, if the solids to be settled are too fine and/or too compacted when they do settle to permit percolation down through the solids and into the soil beneath.

- In any application with a surrounding water table elevation equal to or above the water level in the lagoon.

5.4.1 Material Balance

As discussed in Section 4, for all alternatives involving hydraulic dredging the dredge will pump 480,000,000 gallons of water out of the lake, from project start to finish, to remove the targeted organic sediment mass. Applying the normally accepted contingency of 15 percent, the figure used for determining the number and sizes of the dewatering lagoons was 552,000,000 gallons.

The flooded average depth of the lagoon(s) was assumed for these calculations to be 12 feet. The external and internal side slopes of each lagoon would, however, have to be steeper than the typical 1 vertical to 3 horizontal in the interest of reducing the overall lagoon 'footprint' as much possible. With appropriate and adequate stabilization, the inner and outer sides could feasibly have a 50 degree slope (1v:2h).

Dredge water and decantation rate, and the height of lagoon bottom above the lake-level are all important hydraulic factors in the final engineering lagoon design, but they are not necessary for the lagoon sizing calculations that follow. There is little vacant land available around Lake Seminole. Pinellas County representatives have indicated that the total space available for on-shore processing might be 100 acres, maximum. Therefore, with at least 25% of the area allocated to access roads, pumping stations, on-site trailers and the like, the maximum footprint of the decantation lagoon(s) must be less than 75 acres. Therefore, the area of the lagoon(s) footprint was given first priority in the analysis of this alternative.

Several different flocculating polymers can flocculate Lake Seminole sediment. Based on bench test data it is estimated that settling will occur within 6 hours in a mechanical clarifier equipped with rakes, weirs and baffles. In open-air lagoons, it is estimated that settling will require 3 to 4 weeks assuming no climactic disturbance. Even so, the polymer experts consulted indicated that, with the unpredictability of Florida weather, two months should be the absolute lagoon design minimum.

Decantation requires a clear water fraction to decant. While dredge water is being pumped into a large lagoon, regardless of polymer efficiency, there will not be two well-defined zones in the lagoon - a clear water fraction above with settled sediment below. Rather, there will likely be three zones – clear water on top, a middle zone of cloudy suspended solids, and settled sediment on the bottom. The middle zone will be the largest zone. Because of this, a large open-air lagoon needs time to settle, which means that there cannot be continuous dredge water inflow and continuous decantation. Consequently, batch processing would need to be employed for this alternative. Batch processing involves filling a lagoon and allowing a certain period of settling time for the establishment of two well-defined zones - clear water above and sediment below. Batch processing also requires allowing a certain period of time for decantation.

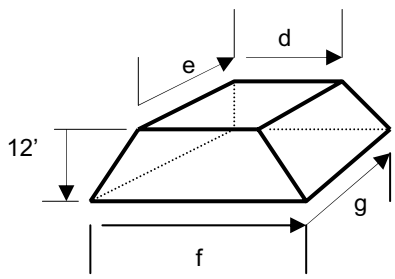
Evaporation versus rainfall has been discussed previously under Alternatives 2A and 2B and will not be revisited here, although it would be a critical factor in the final engineering design if either Alternative 3A or 3B proved to be feasible.

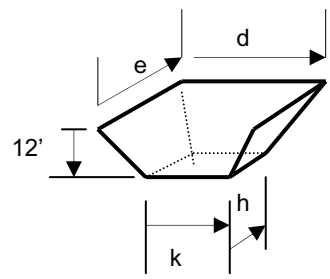
Finally, as discussed in Section 2, the Lake Hollingsworth project exemplifies the fact that settled organic sediments can seal the bottom of a lagoon as effectively as a clay liner, thus negating any significant dewatering via percolation. Because the settled sediment will "blind" the sand at the bottom of a lagoon relatively quickly, it would be necessary to periodically scarify the lagoon bottom to restore the percolation potential of the sand bottom.

One 552,000,000 gallon lagoon twelve feet deep with four sides would require less land area than multiple smaller lagoons. At least two lagoons would be required to operate the system in a batch process. Ideally, however, a minimum of 4 lagoons would be used to provide for optimal flexibility and operational efficiency. Therefore, the volume necessary for a system of four lagoons can be calculated as follows:

- Total lagoon volume required = (552,000,000 gal) / (4 lagoons x 2 uses) x (1CF/7.48 gal) = 9,225,000 CF

The dimensions of a lagoon may be calculated for estimating purposes by recognizing that externally it is the frustrum of a pyramid and internally it is an inverted frustrum.





External Lagoon Dimensions and Volume
Top Surface Area $A_1 = e \times d$
Bottom Surface Area $A_2 = f \times g$
Volume $V_{EX} = \frac{12}{2}(A_1 + A_2)$

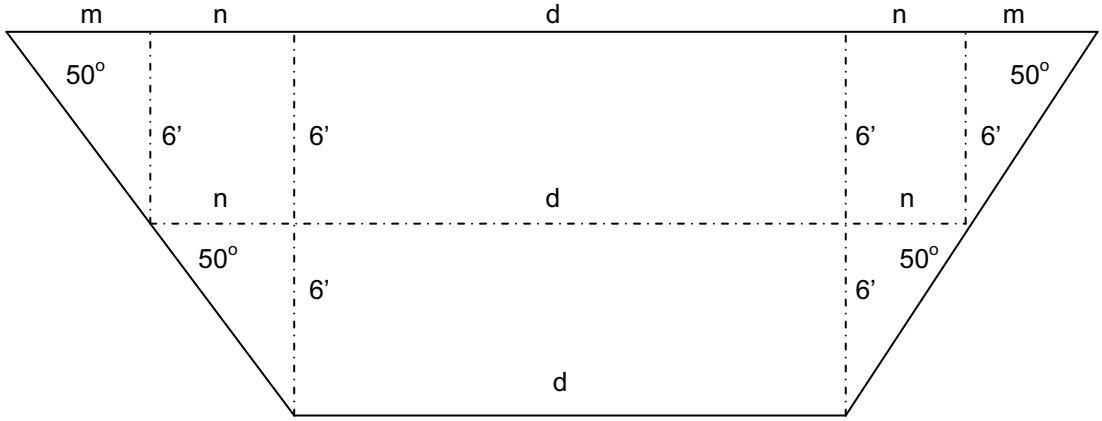
Internal Lagoon Dimensions and Volume
Top Surface Area $A_1 = e \times d$
Bottom Surface Area $A_3 = k \times h$
Volume $V_{IN} = \frac{12}{2}(A_1 + A_3)$

Note that the top surface of the external lagoon and the internal lagoon are here taken to be the same, which was one of the reasons for applying a 15 percent contingency factor previously to 480,000,000 gallons

Also note that since surface areas (A_1, A_2 and A_3) are the objective, it is mathematically irrelevant whether e>d, or f>g, or k>g. So for these purposes, e = d, f = g and k = g, which reduces the area equations above to:

$$A_1 = d^2 : A_2 = f^2 : A_3 = k^2$$

It is now possible to calculate A1 and A3 using a cross section of the internal lagoon.



$$m = n = \frac{6}{\tan 50^{o}} = 5.035'$$

$$V_{IN} = 9{,}225{,}000 \text{ CF}$$

$$\frac{12\,(d + 2n)^2}{2} = \frac{6(d + 10.07)^2}{2} = 9{,}225{,}000$$

$$d^2 + 20.14d + 101.4 = 1{,}537{,}500$$

$$d^2 + 20.14 - 1{,}537{,}398.6 = 0$$

Therefore, applying the standard quadratic equation solution:

$$d = \frac{-b + (b^2 - 4ac)^{1/2}}{2a} = \frac{-20.14 + [20.14^2 - 4(1)(-1{,}537{,}398.6)]^{1/2}}{2(1)} = 1{,}230'$$

$$A_1 = [1{,}230 + 4(5.03)]^2 = 1{,}562{,}000 \text{ SF} = 35.88 \text{ acres}$$

$$A_3 = 1{,}230^2 = 1{,}512{,}900 \text{ SF} = 34.73 \text{ acres}$$

$$A^2 = \frac{35.88}{34.73}(35.88) = 37.07 \text{ acres}$$

Based on the calculations shown above, the total lagoon footprint area for the 4 process lagoons, allowing for 25 percent of the area to be used for piping, pumps, etc., can be calculated as follows:

- Total lagoon footprint area = 1.25 [4 (37.07)] = 185.05 acres

It should be noted that this figure only includes the actual footprint area for four on-shore decantation lagoons with an allowance for necessary mechanical and piping equipment. It does not include the area required for piping to and from the lake, the set-back area necessary to buffer the lagoons from adjacent properties, or the areas required for electrical substations, parking, etc. If all of these additional facilities are added to the figure above, the total actual area required could exceed 300 acres.

This estimate far exceeds the total surface area of all vacant publicly-owned parcels in the immediate perimeter of Lake Seminole. As stated previously, County staff has indicated that the total available land area of applicable publicly-owned parcels is approximately 100 acres. Therefore, the land area requirement of upland lagoons exceeds the available land area by a factor of at least three. For the upland lagoon alternatives to be feasible with regard to land area, either additional privately-owned lands would need to be purchased, or portions of Lake Seminole County Park would need to be converted and temporarily utilized for construction.

5.4.2 Project Duration

Given that the expected rainfall in Pinellas County will exceed the local evaporation rate in most years, evaporative drying alone cannot be relied upon. As discussed above, upland lagoons would provide for a hydraulic gradient and some percolation assuming that the sand bottom interface does not become clogged by fine organic particles. However, based on the performance of lagoons on other projects (e.g., Lake Hollingsworth), this is not a viable assumption. The accumulation of settled organic sediments on the lagoon floor would likely seal the sand bottom and significantly reduce or eliminate percolation. Therefore, in the absence of a supplemental sediment dewatering process, it is concluded that Alternatives 3A and 3B would not reach successful completion within a reasonable timeframe.

5.4.3 Permittability

Upland lagoons have been permitted on several projects (e.g., Lake Hollingsworth, Lake Panasoffkee), and would likely be permittable for the Lake Seminole sediment removal project. Assuming that impacts to wetlands and listed species could be minimized, the most critical issues to the permitting of upland lagoons would likely be controlling pollutant discharges to surface water and groundwater.

5.4.4 Public Acceptance

The uncertain project duration estimated for Alternatives 3A and 3B would not be acceptable to the public. Furthermore, the large area of adjacent land required for these alternatives would significantly impact the aesthetics of residents near Lake Seminole, as well as recreational users of the lake. Finally, the long-term heavy equipment operations would generate noise, dust, odor, and truck traffic concerns. Even if adequate land area was available, the use of upland lagoons in an intensely developed urban environment would likely be very strongly opposed by the public.

5.4.5 Biddability and Constructability

Technically, Alternatives 3A and 3B are biddable and constructible, but the operation of the project would be highly uncertain due to the potential impacts of rainfall and poor percolation on dewatering rates. Therefore, it is doubtful that general contractors would accept the uncertainty associated with meeting the contract schedule and being liable for any stipulated liquidated damages. For these reasons, it is doubtful that experienced and responsible general contractors would be interested in bidding Alternatives 3A and 3B.

5.4.6 Estimated Cost

As discussed above, Alternatives 3A and 3B pose very serious land availability and public acceptance. Assuming those problems could be overcome, the total estimated cost for Alternatives 3A and 3B are approximately $37.6 and $40.8 million, respectively. Detailed cost breakdowns for these alternatives are provided in Appendix 3. Given the long project duration (4 years estimated), construction costs could vary significantly throughout the project tenure. In addition, given the high potential for changed conditions due to unpredictable meteorological events, claims of property damage, etc., the potential for contractor change orders and disputes is high.

5.5 Alternative 4 - Mechanical Degritting, Clarification and Solids Discharge to County Wastewater System

This alternative would involve hydraulic dredging of the lake, with the discharge of the dredge slurry to an on-shore primary treatment facility to screen out large debris (slag) and to remove sand and grist. Following this primary treatment, the organically rich dredge slurry would be pumped into the Pinellas County municipal wastewater collection and transmission system for subsequent advanced treatment at the South Cross Bayou Water Reclamation Facility. Based on preliminary analysis, this alternative was considered to be very attractive for several reasons:

- Small land area requirement (<10 acres) for primary treatment facility;
- Process not subject to shut-downs due to any climactic variations;
- Minimal disposal trucking required;
- Minimal permitting and public acceptance issues.

However, following a more detailed analysis several problems with this alternative were revealed, as discussed below.

5.5.1 Material Balance

If all of the dredge water pumped out of Lake Seminole during the course of the sediment removal project was pumped directly to the municipal sewer system, almost 45 percent of all of the water available in Lake Seminole would be removed from the lake. Although some refilling would naturally occur from rainfall and runoff, lake level recovery would be unpredictable, and a protracted lake drawdown is undesirable for several reasons (e.g., compromised recreational uses). Therefore, Alternative 4 and all of the succeeding on-shore, mechanical-chemical dewatering alternatives, incorporate clarification-thickening to avoid the undesirable consequences of an uncontrolled long-term lake drawdown.

5.5.1.1 Dredge Water Feed

Florida dredging contractors typically can produce dredge water with 10 percent solids, or higher when dredging more dense inorganic material (e.g., mineral sand and silt). However, when low-density organic sediments are dredged, project records consistently show dredge water solids range from 3-8 percent solids. Therefore, an overall project average of 5 percent solids can be

reasonably assumed. Dredge water feed calculations for this alternative are summarized as follows.

APPLICABLE PARAMETERS

Dredge-Water Feed
1,330 gpm with 5% solids (avg)

Dredging Removal
99,020 db tons total solids = 80,800 db tons organics + 18,220 db tons inorganics

Specific Gravities (SG)
Organics = 1.05 to 1.15 = 1.10 avg.
Inorganics = 2.30 to 2.50 = 2.40 avg.
Water = 1.00 (standard)

Standard Water Density
8.34 pounds/gallon

Dredge Water Consistency

0.95 water + 0.05 solids =

0.95 water + 0.05((80,800 organics) + (18,220 inorganics)) = 99,020

0.95 water + 0.0408 organics + 0.0092 inorganics

Dredge Water Density

[0.95 x (1.00) + 0.0408 x (1.10) + 0.0092 x (2.40)] x (8.34) = 8.48 lb/gal

Total Dredge Water Feed to the Dewatering Process

(1330 gpm) x (8.48 lb/gal) x (ton/2000 lb) x (60 min/hr) = 338.35 tons

Dredge Water Component Feed to the Dewatering Process

Water = 0.9500 x (338.35) = 321.43 tons/hr (TPH)
Organics = 0.0408 x (338.35) = 13.81 db tons/hr (db TPH)
Inorganics = 0.0092 x (338.35) = 3.11 db tons/hr (db TPH)

5.5.1.2 Municipal Sewer Disposal

Material balance calculations for the wastewater treatment plant inflow and handling of the primary treated dredge water are summarized below.

APPLICABLE PARAMETERS

Process Operation
24 hours/day
7 days/week
22 operating days/month (accepted overall industry project average)

Dredge-Water Feed
1,330 gpm with 5% solids (avg)
Organics = 13.81 db TPH
Inorganics = 3.11 db TPH
Water = 321.43 TPH

Specific Gravities
Organics = 1.10
Inorganics = 2.40
Water = 1.00

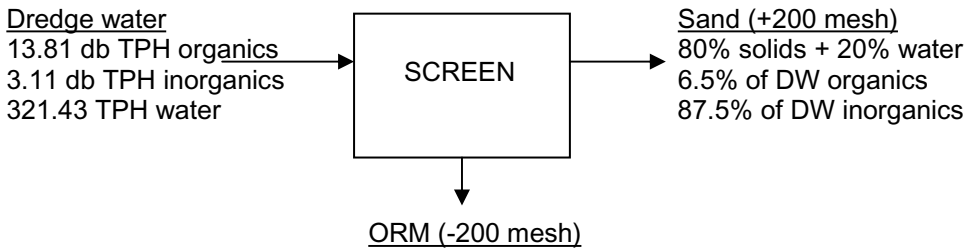
Dredging Material Removal
99,020 db tons total solids = 80,800 db tons organics + 18,220 db tons inorganics

Screen Design Criteria
Sand (+200 mesh) Takeoff – 80% solids + 20% water
Sand Organic Recovery = 5-8% = 6.5% avg.
Sand Inorganic Recovery = 85-90% = 87.5% avg.

Sand (+200 mesh) Dewatering Design Criteria
Material = 85% solids + 15% water
70%-80% organic recovery = 75.0%
90%-95% inorganic recovery = 92.5%
Density = 1.221 tons/CY

Clarifier Design Criteria
Underflow Consistency = 8% solids
Underflow Recovery Organics = 95% of combined inflow organics
Underflow Recovery Inorganics = 97% of combined inflow inorganics

Screen Material Balance

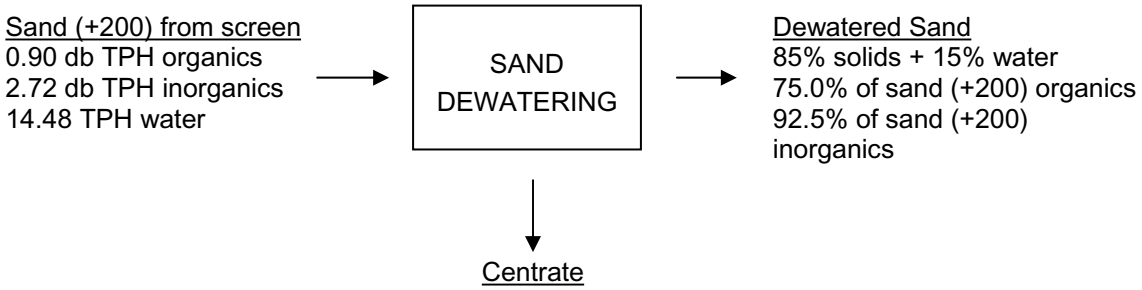


Sand (+200) Composition
Organics = 0.65 x (13.81) = 0.90 db TPH
Inorganics = 0.875 x (3.11) = 2.72 db TPH
Total = 3.62 db TPH

Water – (3.62/0.20) – 3.62 = 14.48 TPH

ORM (-200) Composition
Organics = 13.81 – 0.90 = 12.91 db TPH
Inorganics = 3.11 – 2.72 = 0.39 db TPH
Water = 321.43 – 14.48 = 306.95 TPH

Sand Dewatering Material Balance



Dewatered Sand Composition
Organics = 0.750 (0.90) = 0.68 db TPH
Inorganics = 0.925 (2.72) = 2.52 db TPH
Total = 3.20 db TPH

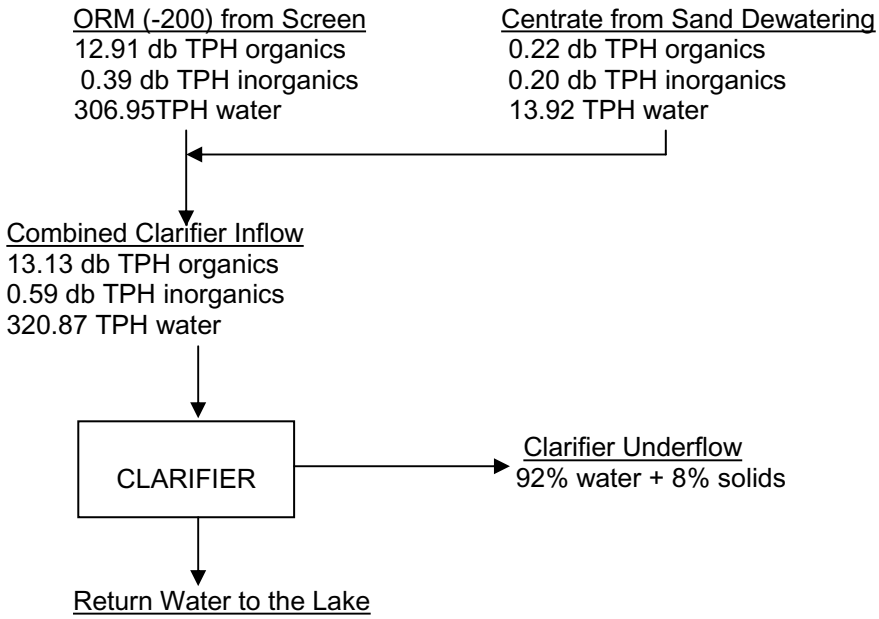
Water = (3.20/0.85) – 3.20 = 0.56 TPH

Centrate Composition
Organics = 0.90 – 0.68 = 0.22 db TPH
Inorganics = 2.72 – 2.52 = 0.20 db TPH
Water = 14.48 – 0.56 = 13.92 TPH

Dewatered Sand Hourly Volumetric Rate
((O.68 + 2.52 + 0.56) tons/hr) x CY/1.221 tons = 3.08 CY/hr

Dewatered Sand Daily Production Rate
(3.08 CY/hr) x (24 hr/day = 73.92 CY or 3.89 trucks @ 18CY/truck

Clarifier Material Balance



Clarifier Underflow Consistency

Organics = 0.95 (13.13) = 12.46 db TPH
Inorganics = 0.97 (0.59) = 0.57 db TPH
Total = 13.03 db TPH

Water = (13.03/0.08) – 13.03 = 149.85 TPH

Clarifier Underflow Density

$$\frac{[149.85(1.00) + 12.46(1.10) + 0.57(2.40)]}{149.85 + 13.03}(8.34) = 8.44 \text{ lb/gal}$$

Clarifier Underflow Flow Rate to Sewer

(162.88 tons/hr) x (2000 lb/ton) x (hr/60 min) x (gal/8.44 lb) = 640 gallons

Clarifier Overflow Consistency

Organics = 13.13 – 12.47 = 0.66 db TPH
Inorganics = 0.59 – 0.57 = 0.02 db TPH
Water = 320.87 – 149.85 = 171.02 TPH
Total = 171.70 TPH

Clarifier Overflow Density

[171.02(1.00) + 0.66(1.10) + 0.02(2.40)] (8.34)/171.70 = 8.34 lb/gal

Clarifier Overflow Return Water Rate to the Lake

(171.02 + 0.66 + 0.02) tons/hr) x (2000 lb/ton) x (hr/60 min) x (gal/8.34 lb) = 690 gpm

Clarifier Overflow Return Water Consistency

(0.66 + 0.02)/171.70 = 0.396% solids

Daily Clarifier Underflow Loading to the Sewer

640 gpm x (60 min/hr) x (24 hr/day) = 921,600 gallons

Project Duration

Net db Solids Removal = (0.68 + 2.52 + 12.46 + 0.57) = 16.23 db TH
Total db Solids for Removal = 99,020 db tons

(99,020 db tons) x (hr/16.23 db tons) x (day/24 hr) x (mon/22 day) = 11.6 months

5.5.1.3 Process Flow Diagram

Process flow diagrams for Alternative 4, for both the calculated maximum 1,330 gpm dredge water feed rate, and an alternative 800 gpm dredge water feed rate, are shown below in Figures 5-4 and 5-5, respectively. The following conclusion can be derived from the material balance calculations and the flow diagrams for Alternative 4.

- 55 percent of the water pumped (dredged) out of Lake Seminole to the clarifier(s) would be returned to the lake.
- The remaining water, containing over 90 percent of all the organic sediment solids pumped (dredged) out of Lake Seminole would be pumped from the clarifier(s) to the municipal sewers.
- Only 20 percent of the water available in Lake Seminole would be removed from the lake during the course of the project.
- The estimated project duration would be 11.6 months.

Figure 5-4
Process Flow Diagram for Alternative 4 (1,330 gpm)

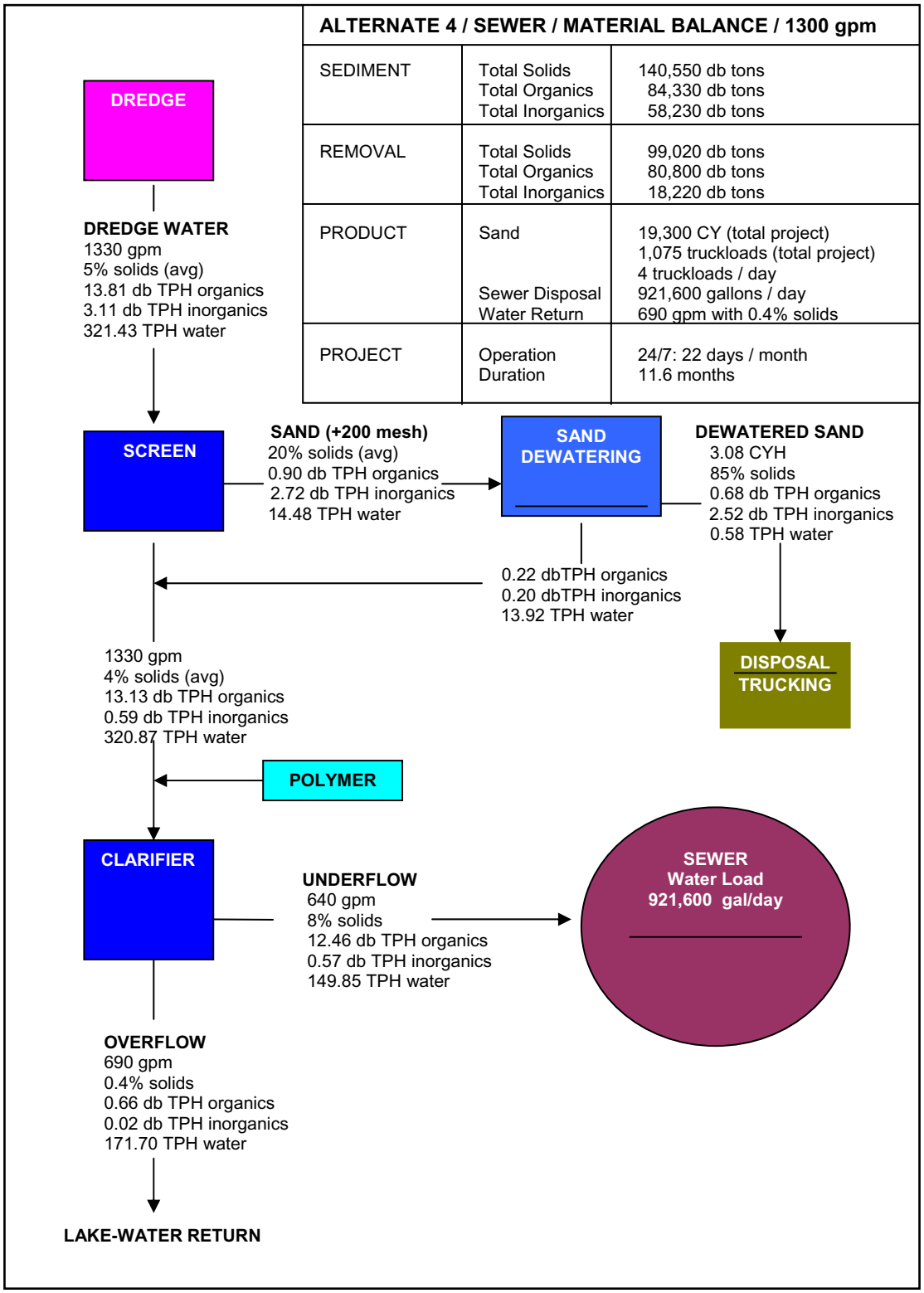
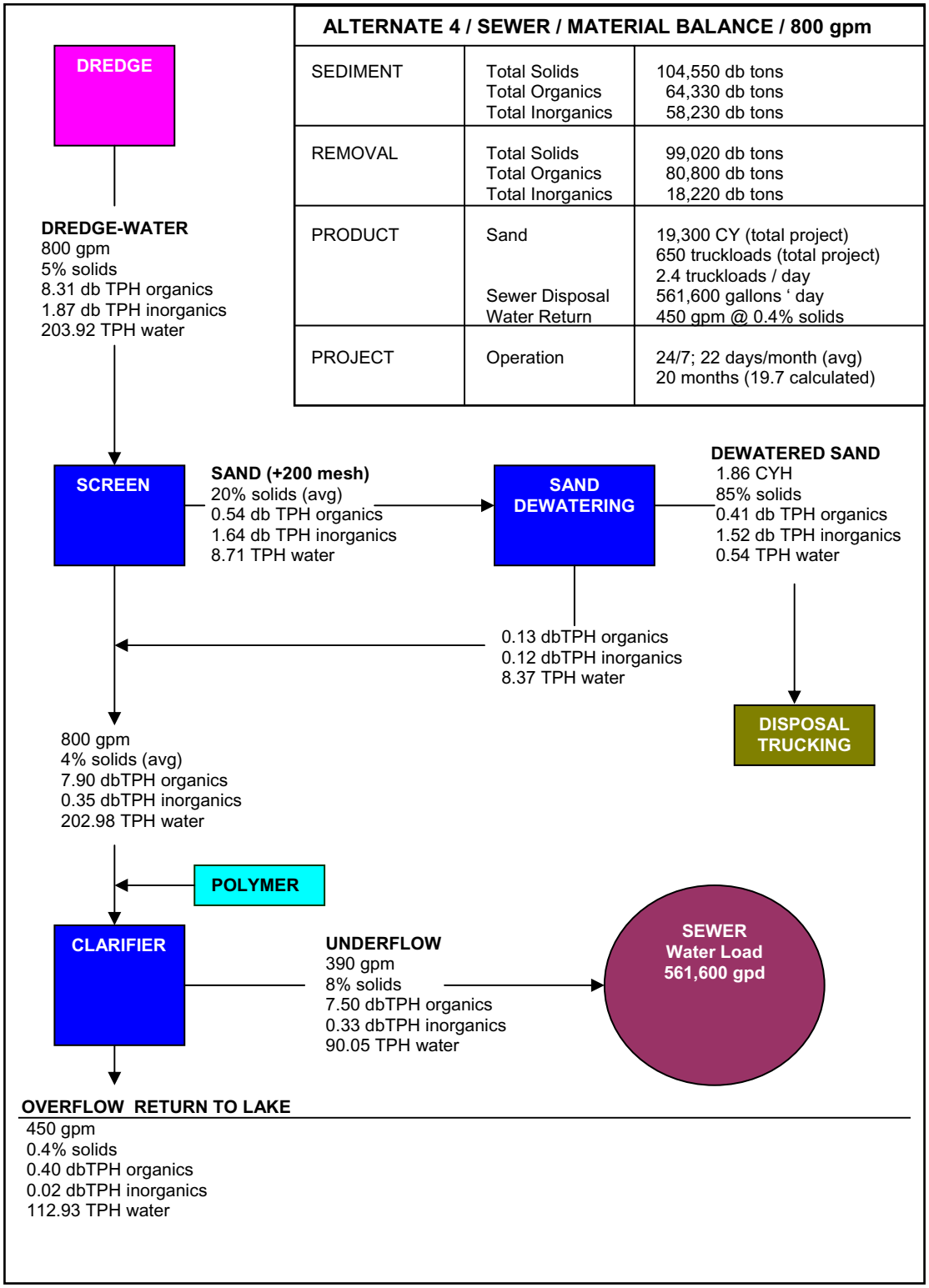


Figure 5-5
Process Flow Diagram for Alternative 4 (800 gpm)



ALTERNATE 4 / SEWER / MATERIAL BALANCE / 800 gpm		
SEDIMENT	Total Solids Total Organics Total Inorganics	104,550 db tons 64,330 db tons 58,230 db tons
REMOVAL	Total Solids Total Organics Total Inorganics	99,020 db tons 80,800 db tons 18,220 db tons
PRODUCT	Sand Sewer Disposal Water Return	19,300 CY (total project) 650 truckloads (total project) 2.4 truckloads / day 561,600 gallons ' day 450 gpm @ 0.4% solids
PROJECT	Operation	24/7; 22 days/month (avg) 20 months (19.7 calculated)

5.5.2 Project Duration

The material balance calculations summarized above indicate that with a dredge water feed rate of 1,330 gpm the project could feasibly be completed within one year (11.6 months). This project duration estimate assumes continuous operation of the dredge and primary treatment facility, and the efficient transfer of the organic solids from the primary treatment facility to the wastewater treatment plant via the Pinellas County wastewater collection and transmission system.

5.5.3 Permittability

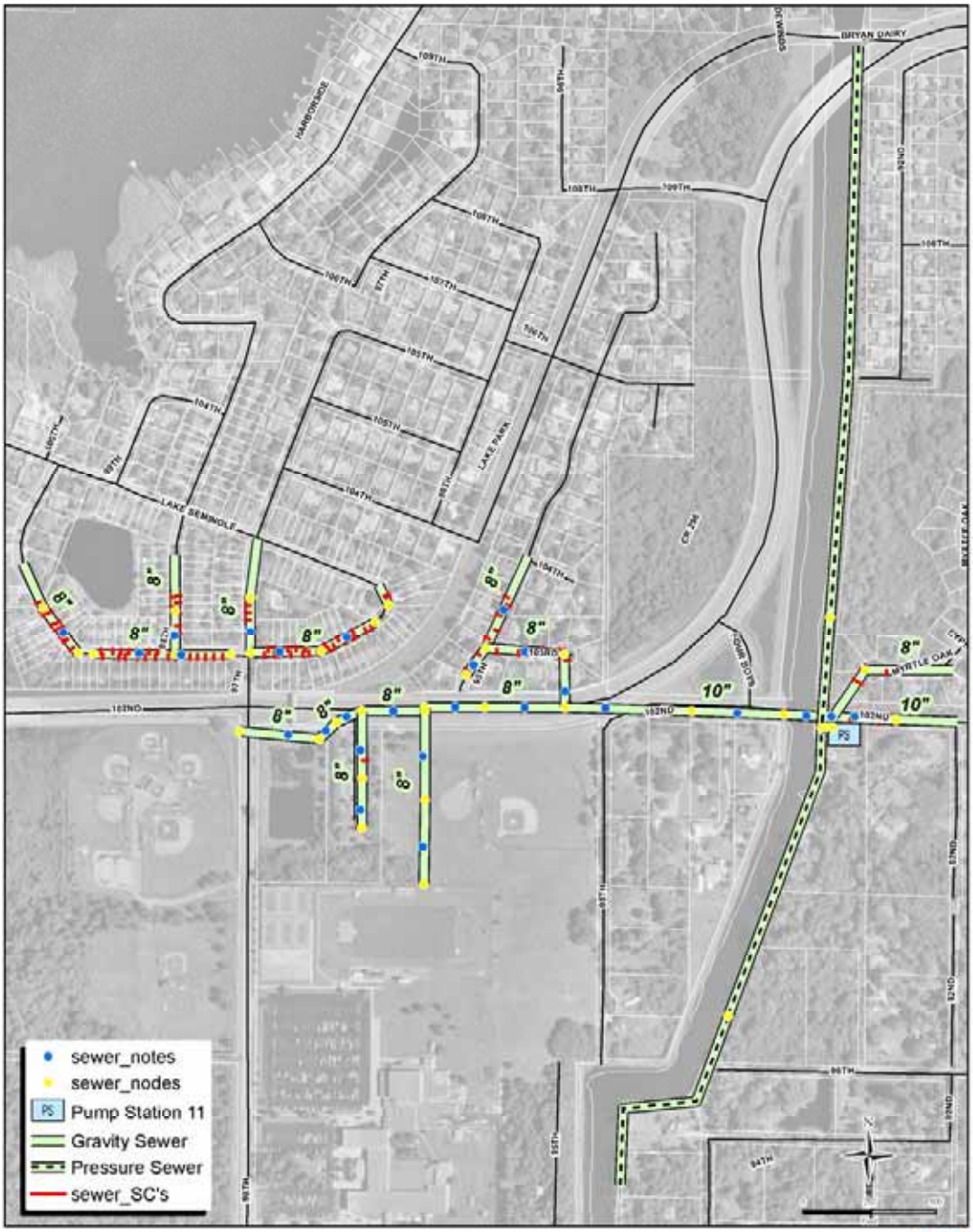
As stated previously, Alternative 4 is attractive because the environmental and neighborhood impacts would be minimal. There would be no significant return water pollution problems, and the onshore primary treatment facility would require minimal land area and disposal truck traffic.

In addition to permits issued by environmental permitting agencies the permittability of a project alternative is also dependent on approvals from the affected local government public works and utilities departments. Alternative 4 would likely be permittable if the Pinellas County Utilities Department would allow the discharge of the clarifier underflow (sludge) to their wastewater collection and transmission system. In reviewing the wastewater collection and transmission system facilities in the areas of the project site, however, it is doubtful that the existing infrastructure could accommodate the additional flows from the project. In addition, the Utilities Department has expressed concerns about the potential impacts of project flows and solids on their South Cross Bayou Water Reclamation Facility. Specifically, Utilities has expressed concern that the anticipated sand, grit, and salts associated with the treated clarifier overflow could adversely affect the wastewater treatment plant processes.

Figure 5-6 shows the existing wastewater collection and transmission facilities in the vicinity of the proposed project site. Based upon GIS utilities data available from Pinellas County, the nearest County manhole is at the intersection of 102nd Avenue North and 98th Street North. This manhole discharges to an 8-inch diameter gravity sewer running east under 102nd Avenue North. The gravity sewer increases to a 10-inch diameter just east of 95th Street North along 102nd Avenue North. The 10-inch gravity sewer discharges to the County's Pump Station No. 11 on 102nd Avenue North. Pump Station No. 11 contains two 47-horsepower submersible pumps each with 375 gpm discharge capacity. Pump Station No. 11 discharges to a 16-inch force main that ultimately discharges to the County's South Cross Bayou Water Reclamation Facility.

Typically, gravity sewers are designed to operate and flow at about one-half of their pipe full capacity. Assuming this, an 8-inch gravity sewer flowing full at minimum slope (0.4%) can discharge approximately 350 gpm. Given that Alternative 4 anticipates a discharge from the project to be between 640 and 390 gpm at 8 percent solids, the Lake Seminole project would effectively use up the capacity of the gravity sewer discharging to Pump Station No. 11. Additionally the Lake Seminole project would at least use up one-half of the pumping capacity of Pump Station No. 11.

Figure 5-6
Wastewater Collection and Transmission Facilities in the Project Vicinity



Also the discharge of 8 percent solids process water to the County's wastewater collection and transmission system would most likely result in the deposition of a substantial volume of solids in the gravity sewers and pump station wetwell causing system blockages and requiring significant additional maintenance efforts by County operations personnel.

The South Cross Bayou Water Reclamation Facility probably could accept this temporary discharge from the Lake Seminole project if it could be conveyed to the facility, but additional organic solids would result in increased sludge and solids handling efforts at the facility. Furthermore, because the bottom of Lake Seminole is below sea level, and the lake used to be a tidal estuary, sediment pore water is slightly saline, as confirmed in sediment samples collected and analyzed as part of this study. The addition of significant concentrations of chlorides and other salts into the South Cross Bayou Water Reclamation Facility may result in changes to the biological processes used in the facility and would be strongly opposed by the Pinellas County Utilities Department.

5.5.4 Public Acceptance

Alternative 4 generally would be very acceptable to the public assuming that there would be no disruption of collection, transmission, and treatment of municipal sewage, or reduction in the current level of service. As stated previously, this alternative requires relatively little land area (<10 acres), and would generate minimal noise, dust, odor, or truck traffic. Therefore, neighborhood impacts would be minimal. If, however, the municipal sewer level of service was to be significantly impacted, there would likely be substantial public opposition.

One other potential problem with public acceptance of this alternative relates to the removal of water from the lake without return water, and the potential for a protracted lake level drawdown. Process flow analysis described above indicates that only 20 percent of the water available in Lake Seminole would be removed from the lake during the course of the project conducted under this alternative. With normal inflows and rainfall, however, this is not deemed sufficient to produce unacceptable and undesirable lake-drawdown effects, and the resulting compromised recreational opportunities.

5.5.5 Biddability and Constructability

Alternative 4 is both biddable and constructible, however, the operation of the project is uncertain due to the impact of the project's discharge to the Pinellas County wastewater collection and transmission system. This analysis indicates that the local wastewater collection and transmission facilities could not accept either a 640 gpm or a 390 gpm dredge water inflow on a 24-hour 7-day a week basis while still maintaining the appropriate level of service to its wastewater customers. The discharge of 8 percent solid process water to the collection system would most likely produce blockages and maintenance issues for the County operations personnel. It is likely that general contractors would avoid bidding on a project with such potential liabilities without substantial indemnification from the County regarding damages caused to the existing infrastructure.

5.5.6 Estimated Cost

As discussed above, Alternatives 4 is attractive because of the minimal land area required, as well as the relatively minor public acceptance problems. The lack of return water to the lake, however, does pose a significant permitting issue. The total estimated cost for Alternative 4 is approximately $10.1 million. A detailed cost breakdown for this alternative is provided in Appendix 3. This cost estimate does not include the costs associated with improving and maintaining the County wastewater collection and transmission infrastructure, or any improvement, maintenance or repair of the County wastewater treatment plant.

5.6 Alternative 5 - Mechanical Degritting, Clarification, Low Gravity Sediment Dewatering

The remaining alternatives evaluated in this section are variations of process treatment systems designed to dewater hydraulic dredge slurry on small (<10 acres) sites located adjacent to the lake, with truck disposal of all separated solids to off-site locations. This particular alternative investigates organic solids dewatering using low-gravity (LoG) belt filters. Therefore, the elements of this process treatment system approach include the following:

- Dredge muck-sediment to on-shore dewatering process;
- Screen-separate slag, inorganics (sand) and organics;
- Dewater inorganics to 85% dryness;
- Dewater organics to 20% with low gravity belt filters; and
- Return clarified, clean water to Lake Seminole.

In this alternative, belt filter presses are used to “squeeze” and filter additional water out of the organics that have been flocculated via polymer additions and settled in the clarifier. In process engineering, a filter should ideally possess the following characteristics:

- It must retain the solids to be filtered, giving a reasonably clear filtrate;
- It must not plug or blind;
- It must be resistant chemically and strong enough physically to withstand the process conditions;
- It must permit the cake formed to discharge cleanly and completely; and
- It must not be prohibitively expensive.

Belt filter presses are especially useful in the treatment of industrial wastewater since industrial waste streams (e.g., paper pulp) frequently contain a wide range of particle sizes. The organics contained in dredge water are primarily composed of exceptionally fine particles which quickly clog the pore spaces or septum of any filter media. For the reasons cited above belt filter presses are not generally considered to be the best technical approach for dewatering very fine organic particulates. However, since belt filter presses are being used on a number of current Florida sediment removal projects (e.g., Lake Maggiore), this alternative has been included for evaluation.

5.6.1 Material Balance

Material balance calculations for this alternative are summarized below.

APPLICABLE PARAMETERS

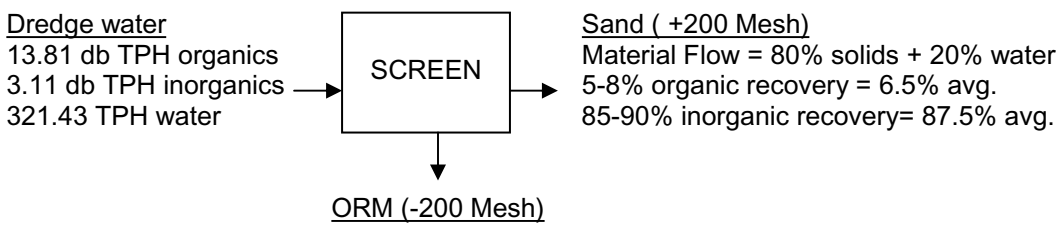
Process Operation
24 hours/day
7 days/week
22 operating days/month (accepted industry overall project average)

Dredge-Water Feed
1,330 gpm @ 5% solids (avg)
Organics = 13.81 db TPH
Inorganics = 3.11 db TPH
Water = 321.43 TPH

Specific Gravities
Organics = 1.10
Inorganics = 2.40
Water = 1.00

Dredging Removal
99,020 db tons total solids = 80,800 db tons organics + 18,220 db tons inorganics

Screen Material Balance

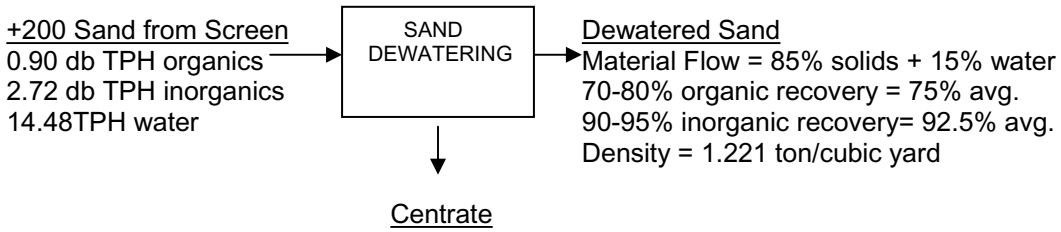


Sand (+200) Composition
Organics = 0.065 x (13.81) = 0.90 db TPH
Inorganics = 0.875 x (3.11) = 2.72 db TPH
Total = 3.62 db TPH

Water = (3.62/0.20) – 3.62 = 14.48 TPH

ORM (-200) Composition
Organics = 13.81 – 0.90 = 12.91 db TPH
Inorganics = 3.11 - 2.72 = 0.39 db TPH
Water = 321.43 – 14.48 = 306.95 TPH

Sand Dewatering Material Balance



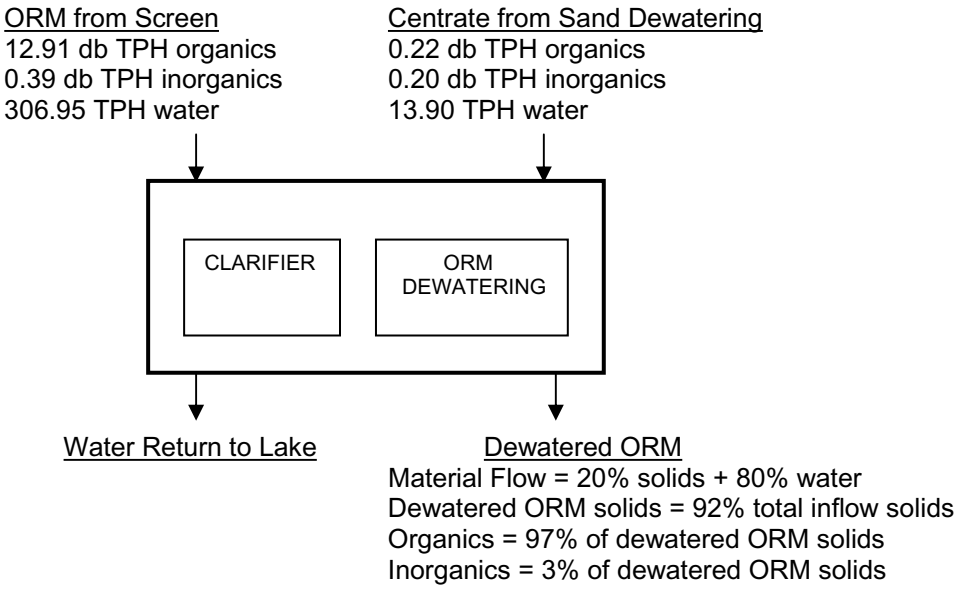
Dewatered Sand Composition
Organics = 0.750 x (0.90) = 0.68 db TPH
Inorganics = 0.925 x (2.72) = 2.52 db TPH
Total = 3.20 TPH

Water = (3.20/0.85) - 3.20 = 0.56 TPH

Centrate Composition
Organics = 0.90 – 0.68 = 0.22 db TPH
Inorganics = 2.72 – 2.52 = 0.20 db TPH
Water = 14.48 – 0.56 = 13.92TPH

Dewatered Sand Volumetric Rate
(0.68 + 2.52 + 0.56) ton/hr x (CY/1.221 ton) x 24hr = 3.08 CY/hr

Clarifier/ORM Dewatering Material Balance



Dewatered ORM Solids
0.92 (12.91 + 0.39 + 0.22 + 0.20) = 12.62 db TPH total solids

Dewatered ORM Composition
Organics = 0.97 (12.62) = 12.24 db TPH
Inorganics = 0.03 (12.62) = 0.38 db TPH

Water = (12.62/0.20) - 12.62 = 50.48 TPH

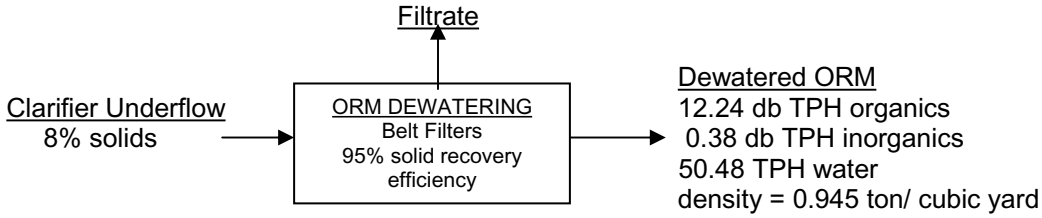
Water Return to Lake Composition
Dredge water – Dewatered Sand – Dewatered ORM = Composition

Organics = 13.81 - 0.68 – 12.24 = 0.89 db TPH
Inorganics = 3.11 - 2.52 – 0.38 = 0.21 db TPH
Water = 321.43 - 0.56 – 50.48 = 270.39 TPH
Total = 271.49 TPH

Water Return to Lake Consistency
(0.89 + 0.21)/271.49 = 0.405% total solids

Water Return to Lake Volumetric Rate
(271.49 ton/hr) x (2000 lb/ton) x (gal/8.34 lb) x (hr/60 min) = 1,085 gpm

ORM Dewatering Material Balance

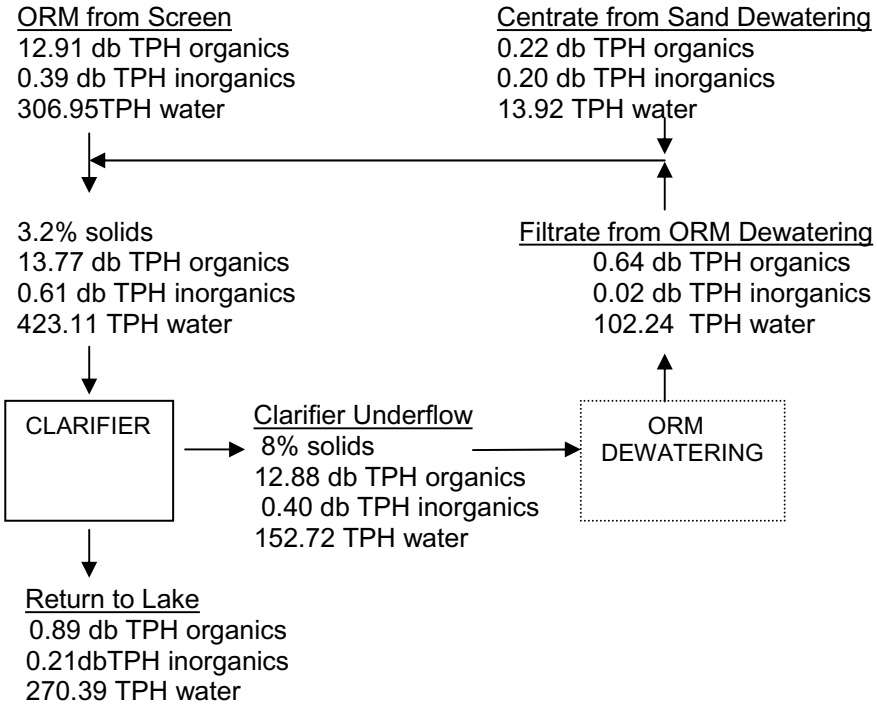


Clarifier Underflow Composition
Organics = 12.24/0.95 = 12.88 db TPH
Inorganics = 0.38/0.95 = 0.40 db TPH
Water = ((12.88 + 0.40)/0.08) - (12.88 + 0.40) = 152.72 TPH

ORM Filtrate Composition
Organics = 12.88 – 12.24 = 0.64 db TPH
Inorganics = 0.40 – 0.38 = 0.02 db TPH
Water = 152.72 – 50.48 = 102.24 TPH

Dewatered ORM Volumetric Rate
(12.24 +0.38+ 50.48) ton/hr x (CY/0.945 ton) = 66.77 CY/hr

Clarifier Material Balance



Project Duration

Total Solids for Removal = 99,020 db tons

Hourly Sand Removal = (0.68 + 2.52) db TPH = 3.20 db TPH
Hourly ORM Removal = (12.24 + 0.38) db TPH = 12.62 db TPH
Total = 15.82 db TPH

Project Operation = 24/7; 22 days/month

Project Duration - 99,020 tons x (hr/15.82 ton) x (day/24 hr) x (mon/22 day) = 11.85 months

Total Project Sand and ORM Volumes

	Volumetric Rate	Dryness	Density
Sand	3.08 CY/hr	85% solids	1.221 tons/CY
ORM	66.77CY/hr	20% solids	0.945 tons/CY

Total Project Sand Volume

3.08 CY/hr x (24 hr/day) x (22 day/mon) x 11.85 mon = 19,300 CY

Total Project ORM Volume

66.77 CY/hr x (24 hr/day) x (22 day/mon) x 11.85 mon = 420,000 CY

Total Project Sand Trucks

19,300 CY/11.85 mon x (truck/18 CY) x (mon/22 days) = 4 trucks/day

Total Project ORM Trucks

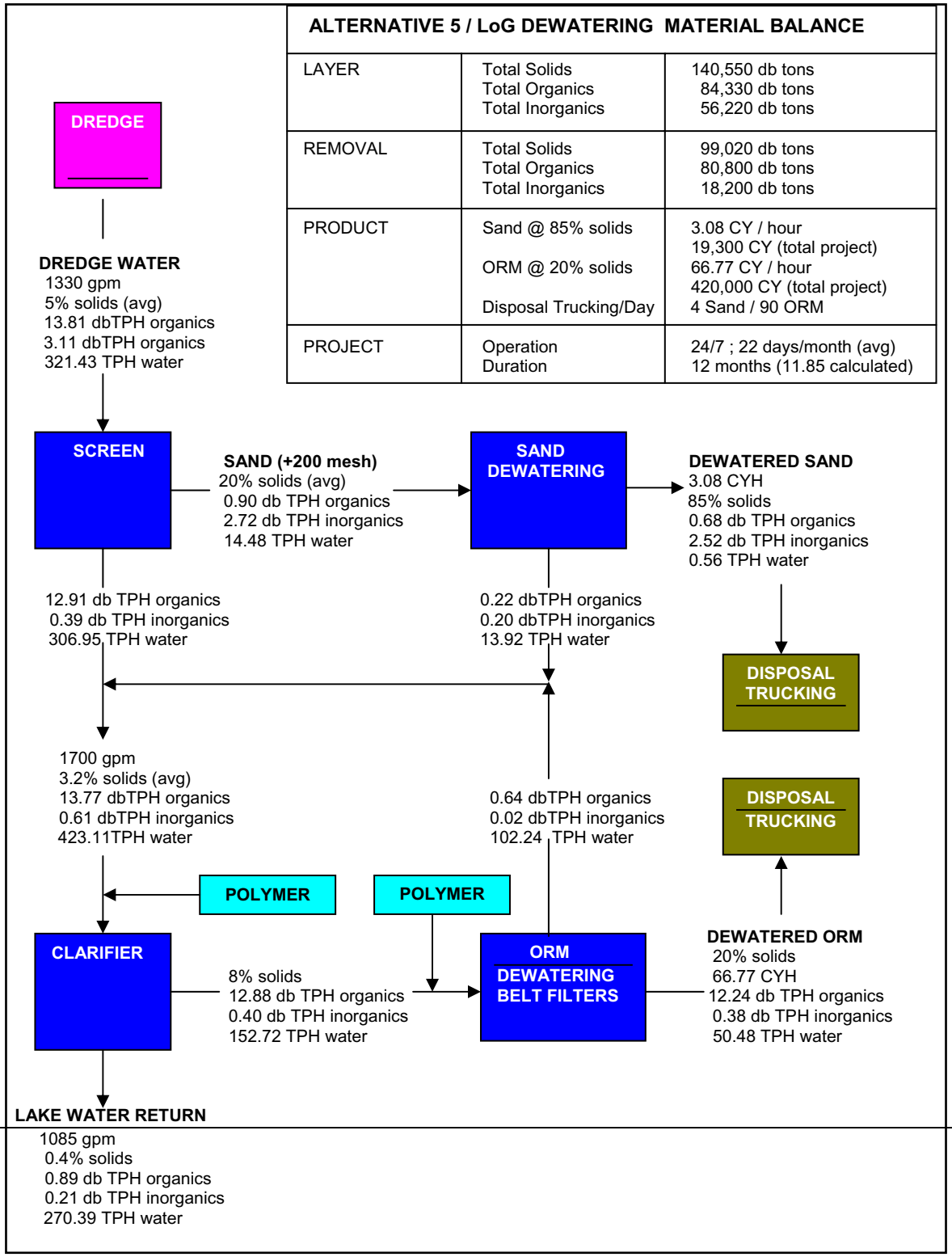
420,000 CY/11.85 mon x (truck/18 CY) x (mon/22 day) = 90 trucks/day

5.6.1.1 Process Flow Diagram

The process flow diagram for Alternative 5 is shown in Figure 5.7. The following conclusions can be derived from the material balance calculations and the process flow diagram for Alternative 5.

- The process would generate 19,300 cubic yards of sand and 420,000 cubic yards of organic cake.
- Disposal of the separated solids would require 4 truck trips per day for the sand and 90 truck trips per day for the organic cake.
- The project could be completed in one year assuming truck traffic could be managed.

Figure 5-7
Process Flow Diagram for Alternative 5



ALTERNATIVE 5 / LoG DEWATERING MATERIAL BALANCE		
LAYER	Total Solids Total Organics Total Inorganics	140,550 db tons 84,330 db tons 56,220 db tons
REMOVAL	Total Solids Total Organics Total Inorganics	99,020 db tons 80,800 db tons 18,200 db tons
PRODUCT	Sand @ 85% solids ORM @ 20% solids Disposal Trucking/Day	3.08 CY / hour 19,300 CY (total project) 66.77 CY / hour 420,000 CY (total project) 4 Sand / 90 ORM
PROJECT	Operation Duration	24/7 ; 22 days/month (avg) 12 months (11.85 calculated)

5.6.2 Project Duration

The estimated volume of dewatered organic sediments that would need to be trucked away from the project site - 420,000 cubic yards - is considerable due to only obtaining 20 percent solids from the belt filter presses. Although dewatered organic sediment at 20 percent solids is generally considered to be a "truckable" product, it would have a wet, clumpy consistency that could present a transport problem, requiring trucks to be sealed to prevent dirty water leakage onto the highway. In addition, the volume of material to be transported would require 90 truckloads each day, which, in a 10 hour work-day, equates to 9 truckloads each hour. That means each truck would need to pull up to a loading position, be loaded, and then drive away in less than 7 minutes. Assuming truck traffic at this rate could actually be managed throughout the project duration, the analysis summarized above shows that the project could be completed in approximately one year. Given the nature of the material this is likely not a feasible rate of trucking disposal.

The rate of disposal truck traffic could potentially be reduced by extending the project duration. This would be accomplished by reducing the dredge feed rate. For example, reducing the dredge feed rate from 1,330 to 800 gpm would extend the project duration to over 4 years. A project duration of 4 years is, however, considered unacceptably long and outside the basis of design criteria. Extending the project duration to a more acceptable two years would allow double the truck turn-around time from 7 to 14 minutes, which is logistically feasible. Unfortunately, this would also increase the costs of all other time-influenced operations associated with the project (e.g., daily cost of maintaining the dredge on site) by a factor of two or more, and prolong potential neighborhood impacts. In the absence of any other possible alternatives, this may be a reasonable alternative. However, there are other possible alternatives that result in greater time-efficiency, with less truck traffic (see Section 5.7); therefore, extending the project duration to resolve this problem is not considered to be a viable option.

5.6.3 Permittability

Alternative 5 would be permittable with federal and state environmental regulatory agencies. The concept proposed by Alternative 5 is very similar to the process currently being used by the City of St. Petersburg on the Lake Maggiore sediment removal project, and permits were issued for it. The primary issues with the environmental regulatory agencies are likely to include:

- Hydraulic dredge water quality impacts to lake surface waters;
- Hydraulic dredge pipeline impacts to shoreline wetlands;
- On-site process treatment facility construction impacts on wetland and listed species;
- Return water quality impacts on lake receiving waters; and
- Impacts to wetlands, listed species, and water quality at the final dewatered sediment disposal site.

5.6.4 Public Acceptance

While the volume of truck traffic generated for the project duration, and other "neighborhood" impacts such as noise, dust and odor, are typically not a concern of federal and state

environmental regulatory agencies, such issues are of major importance to affected local governments responsible for managing traffic level of service and for enforcing ordinances and code violations. As with the other process treatment alternatives, Alternative 5 would garner public support provided that the project duration was short enough and the number of trucks entering and leaving the site each day is tolerable. Lake-dependent recreation would not be affected, and the area of land dedicated to the process treatment facility would be small, and the associated noise, dust, and odor could be effectively buffered from surrounding neighborhoods. However, it is doubtful that the public would tolerate 90 or even 45 trucks entering and leaving the project site on a daily basis for up to two years. Although truck traffic would not traverse through residential neighborhoods (assuming 98th Street to 102nd Avenue route), conflicts with local school traffic could be significant. Therefore, Alternative 5 as proposed would likely not be supported by the public.

5.6.5 Biddability and Constructability

Alternative 5 is biddable and constructible, however, the operation of the disposal portion of Alternative 5 would be problematic for contractors. The volume and frequency of the truck traffic needed for disposal could lead to safety and public relations issues. Nonetheless, this project alternative would likely receive numerous qualified bids, which could be successfully implemented.

5.6.6 Estimated Cost

The total estimated cost for Alternative 5 is approximately $27.1 million. A detailed cost breakdown for this alternative is provided in Appendix 3. This cost estimate does not include the any costs associated with land acquisition for alternative process treatment sites, or site reclamation once the project is complete.

5.7 Alternatives 6A and 6B - Mechanical Degritting, Clarification, High Gravity Sediment Dewatering

The final two alternatives evaluated in this section are variations of the process treatment system described under Alternative 5. Alternative 6A is differentiated from Alternative 5 by the use of high gravity centrifuges in lieu of belt filter presses, resulting in an organic cake product that is approximately 50 percent solids as opposed to the 20 percent solids product generated from the belt filter presses. Alternative 6B takes the process treatment one step further by adding heating dryers to increase the solid content of the organic cake to 75-80 percent solids, resulting in a fertilizer grade product suitable for bagging and distribution for sale. The process treatment elements for Alternatives 6A and 6B can be summarized as follows:

<u>Alternative 6A</u>

- Dredge muck-sediment to on-shore dewatering process;
- Screen-separate slag, inorganics (sand) and organics;
- Dewater inorganics to 85% dryness;
- Dewater organics to 50% with high gravity centrifuges; and
- Return clarified, clean water to Lake Seminole.

Alternative 6B

- Dredge muck-sediment to on-shore dewatering process;
- Screen-separate slag, inorganics (sand) and organics;
- Dewater inorganics to 85% dryness;
- Dewater organics to 50% with high gravity centrifuges;
- Return clarified, clean water to Lake Seminole; and
- Heat dry dewatered organics to 75% solids to produce a fertilizer grade product.

Very small, light-weight particles in solution, such as sediment organics in dredge slurry, do not readily settle out as quickly as larger, heavier particles (i.e. sand) under natural gravitation. However, if those very small, light-weight particles are placed in mechanical units that can significantly multiply the natural gravitational forces (g forces) by using centrifugal forces, the settling time of such particles can be greatly accelerated. In process engineering, centrifugal separators have to a considerable extent replaced gravity separators in production operations because of their greater effectiveness and their smaller size for a given capacity.

Belt filter presses operate under natural gravity, but provide for some additional dewatering via mechanical pressure which has the effect of "squeezing" water out of large chain organic molecules that have been flocculated by polymer additions. Comparatively, dewatering centrifuges capable of producing g forces exceeding 1,000 are far more efficient than belt filter presses in the dewatering of low density organics in solution. Based on industry data, belt filter presses can dewater sediment organics to approximately 20 percent solids, while centrifuges can produce an organic cake product with approximately 50 percent solids. Heat drying units can further dry dewatered organics to approximately 75-80% solids.

Centrifuges and heat dryers add costs to the process treatment system. In addition to capital costs, the energy costs associated with operating this equipment is substantially greater than those for operating belt filter presses. However, the most important balancing factor in optimizing the process treatment system for the Lake Seminole sediment removal project is the volume of dewatered sediments that must be disposed of. Disposal trucking costs typically account for a substantial proportion of the total project cost (30-60%) for dredging and sediment dewatering projects, depending on the volume of material to be disposed and the trucking distances involved.

While the capital and operating costs are greater for centrifuges and dryers, the additional costs can be partially or totally offset by the reduced volume of dewatered sediments that need to be disposed. For example, the volume of sediment dewatered to 20 percent solids by belt filter presses is approximately three times greater than the volume of sediment dewatered to 50 solids by centrifuges. Therefore, the additional capital and operating costs associated with using centrifuges must be balanced against the reduced costs of trucking approximately one-third the volume of dewatered sediments to the disposal site.

Lake Seminole sediments are organically rich, and dewatered organics contain substantial concentrations of soil nutrients such as nitrogen and phosphorus that promote healthy plant growth. Consequently, dewatered organics could be used as a fertilizer grade topsoil additive for landscaping purposes. At 20 percent solids, the dewatered organics have a wet, clumpy

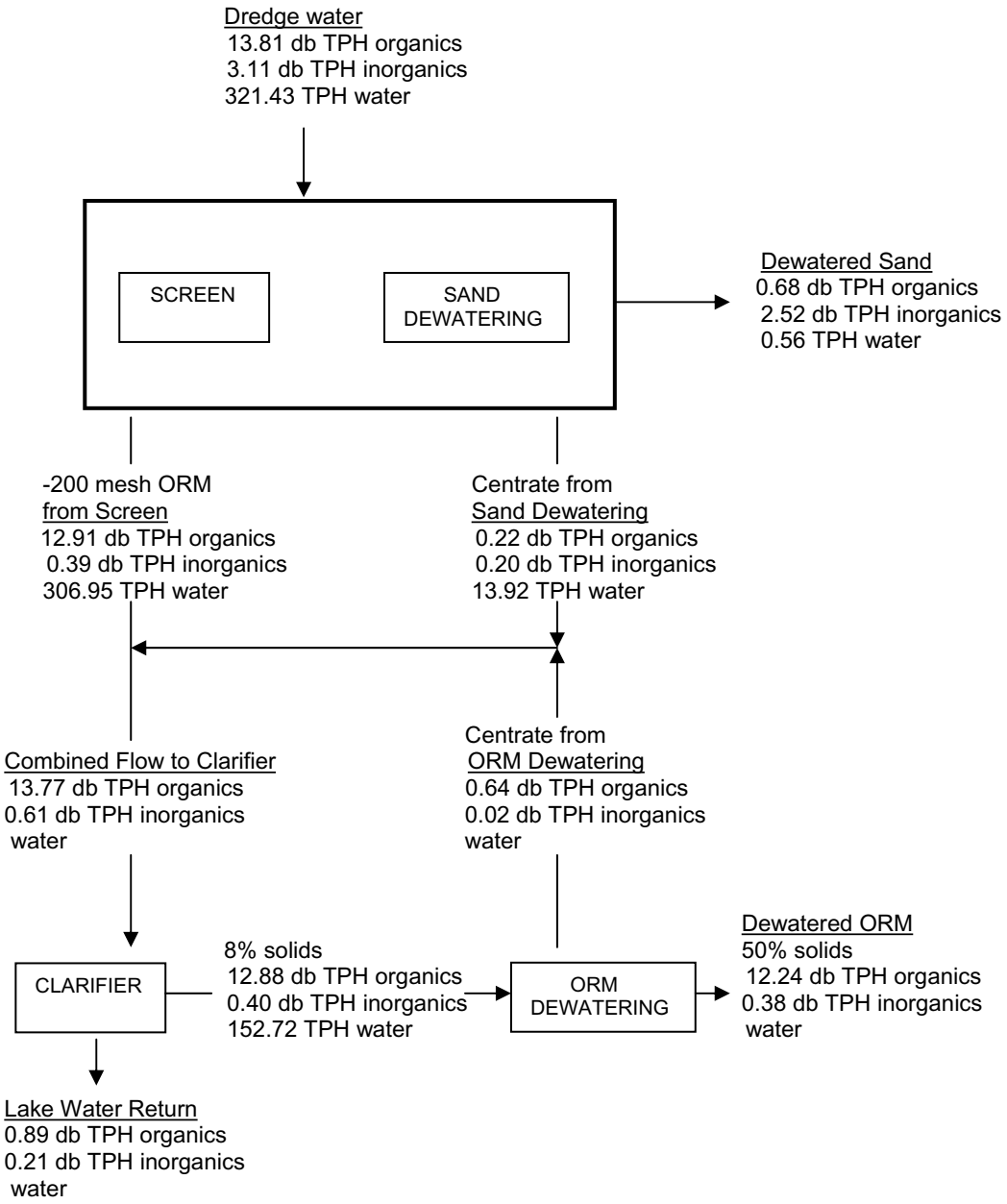
consistency that is barely suitable for trucking with minimal leakage. At 50 percent solids, the material is still moist and clumpy, but can be trucked without leakage, and can be spread and tilled into topsoil. However, at 75 percent solids, dewatered organics have a dry, rich topsoil consistency that is suitable for "pelletizing," bagging and distribution for wholesale or retail sales.

Project costs could potentially be offset through the production and sale of a fertilizer grade product. However, the local demand for such a product has not been demonstrated, and it is beyond the scope of this study to investigate the production and marketing of a fertilizer grade product. At first glance, the volume of organically rich sediments to be removed from Lake Seminole does not appear to be great enough to economically justify the additional capital, operating, marketing, and management costs associated with producing a marketable fertilizer product. Nonetheless, the addition of dryers to the process treatment system was evaluated in terms of material balance.

5.7.1 Material Balance

The material balance for Alternatives 6A and 6B maintains exactly the same solids (organic and inorganic) flows as the Alternative 5 material balance. Therefore, only water balancing of the clarifier-ORM dewatering system is required. Material balance calculations for the clarifier-ORM dewatering system are provided on the following pages.

Screen and Sand Dewatering Material Balance



Clarifier-ORM System Water Balance

Water in Dewatered ORM

(12.24 + 0.38)/0.50 - (12.24 + 0.38) = 12.62 TPH

Water in Centrate from ORM Dewatering

152.72 – 12.62 = 140.10 TPH

Water in Lake Water Return

Dredge water – Dewatered Sand Water – Dewatered ORM Water
321.43 – 0.56 – 12.62 = 308.25 TPH

Water in Combined Flow to Clarifier

306.95 + 13.92 + 140.10 = 460.97 TPH

Dewatered ORM Volumetric Rate

ORM Density @ 50% solids = 1.058 tons/CY
(12.24 + 0.38 + 12.62) ton/hr x (CY/1.058 ton) = 23.86 CY/hr

Total Project Dewatered ORM Volume

23.86 CY/hr x (24 hr/day) x (22 day/mon) x 11.85 mon = 150,000 CY

5.7.2 Process Flow Diagrams

Three high gravity centrifuge dewatering alternatives were evaluated in this analysis:

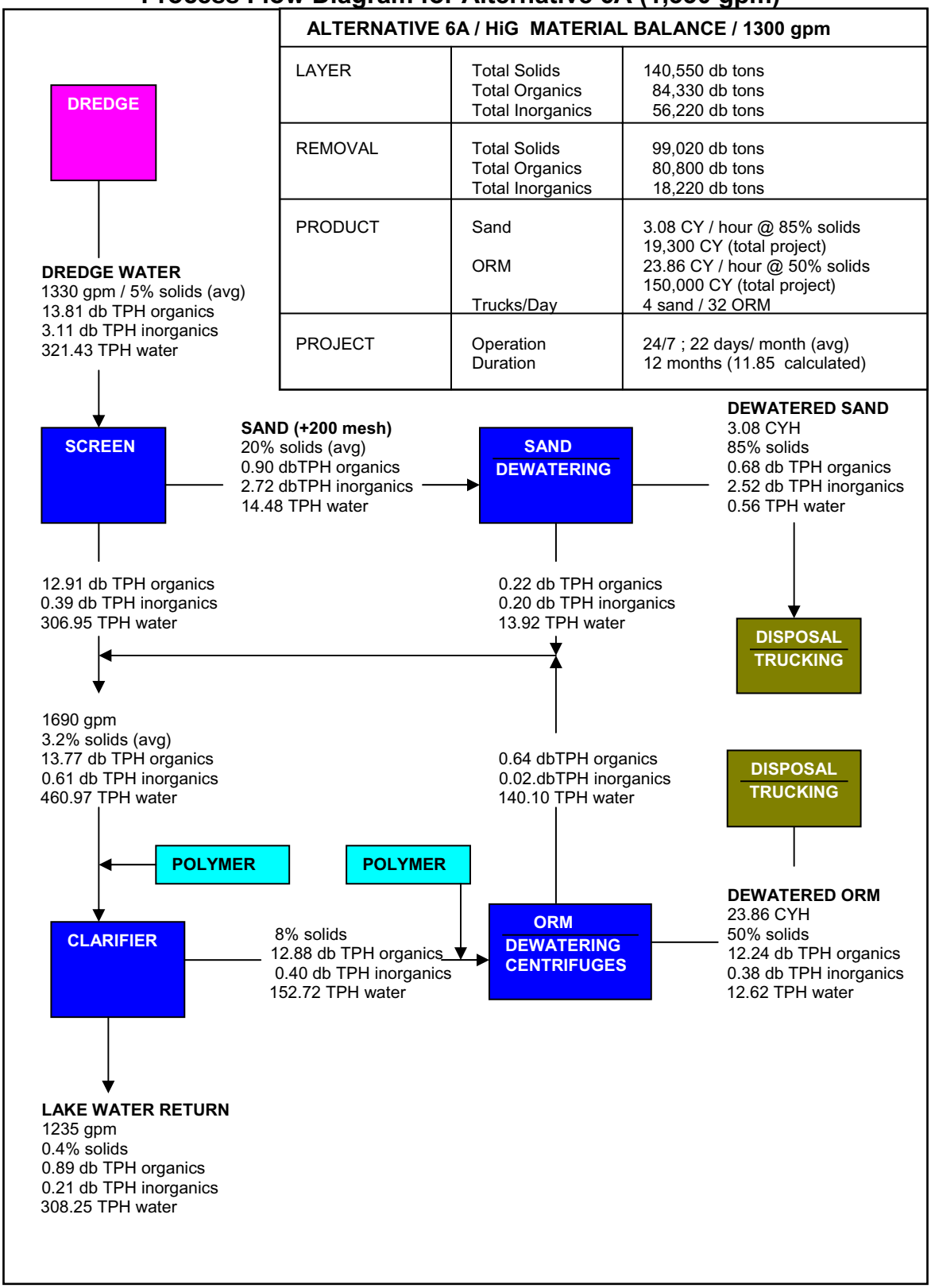
- Centrifuge dewatering with a 1,330 gpm dredge feed rate;
- Centrifuge dewatering with an 800 gpm dredge feed rate;
- Centrifuge dewatering and drying with a 1,330 gpm dredge feed rate.

The first alternative (centrifuge with 1,330 gpm dredge feed rate) would result in a reduction of the dewatered sediment volume produced by belt filter presses by approximately 65 percent - from 450,000 to 150,000 cubic yards. This volume produced under the 1,330 dredge feed rate would result in a project duration of approximately one year. Under this alternative the disposal of the dewatered organic sediment would require approximately 32 truck trips per day. This volume of truck traffic is still considered unacceptable with regard to neighborhood impacts.

The second alternative (centrifuge with 800 gpm dredge feed rate) would also result in a dewatered sediment volume of 150,000 cubic yards, but would extend the project duration from one year to 20 months. At the 800 gpm dredge feed rate, however, the number of truck trips required per day to dispose the dewatered organics would be reduced from 32 to 19. This reduced truck traffic volume is considered to be acceptable with regard to both cost and neighborhood impacts.

Process flow diagrams for Alternative 6A, for both the calculated maximum 1,330 gpm dredge water feed rate, and the alternative minimum 800 gpm dredge water feed rate, are shown below in Figures 5-8 and 5-9, respectively. The process flow diagram for Alternative 6B is shown in Figure 5-10.

Figure 5-8
Process Flow Diagram for Alternative 6A (1,330 gpm)



ALTERNATIVE 6A / HiG MATERIAL BALANCE / 1300 gpm		
LAYER	Total Solids Total Organics Total Inorganics	140,550 db tons 84,330 db tons 56,220 db tons
REMOVAL	Total Solids Total Organics Total Inorganics	99,020 db tons 80,800 db tons 18,220 db tons
PRODUCT	Sand ORM Trucks/Day	3.08 CY / hour @ 85% solids 19,300 CY (total project) 23.86 CY / hour @ 50% solids 150,000 CY (total project) 4 sand / 32 ORM
PROJECT	Operation Duration	24/7 ; 22 days/ month (avg) 12 months (11.85 calculated)

Figure 5-9
Process Flow Diagram for Alternative 6A (800gpm)

ALTERNATIVE 6A / HiG MATERIAL BALANCE / 800 gpm		
LAYER	Total Solids Total Organics Total Inorganics	140,550 db tons 84,330 db tons 56,220 db tons
LAYER	Total Solids Total Organics Total Inorganics	99,020 db tons 80,800 db tons 18,220 db tons
PRODUCT	Sand ORM Trucks/day	1.86 CYH @ 85% solids 19,300 CY (total project) 2.4 trucks/day (avg) 14.35 CYH @ 50% solids 150,000 CY (total project) 19 trucks/day (avg)
PROJECT	Operation Duration	24/7 ; 22 days/month (avg) 20 months (19.7 calculated)

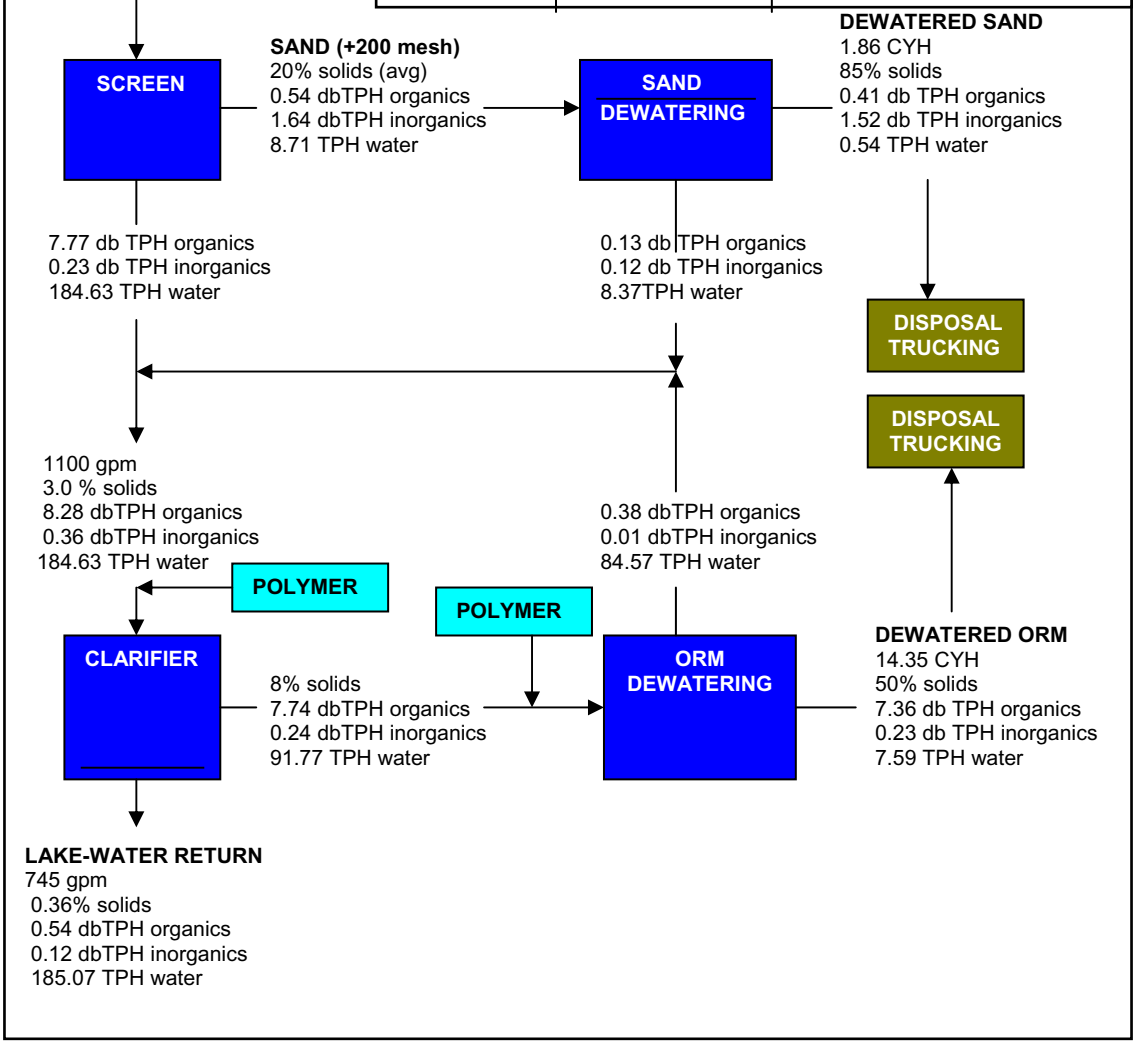
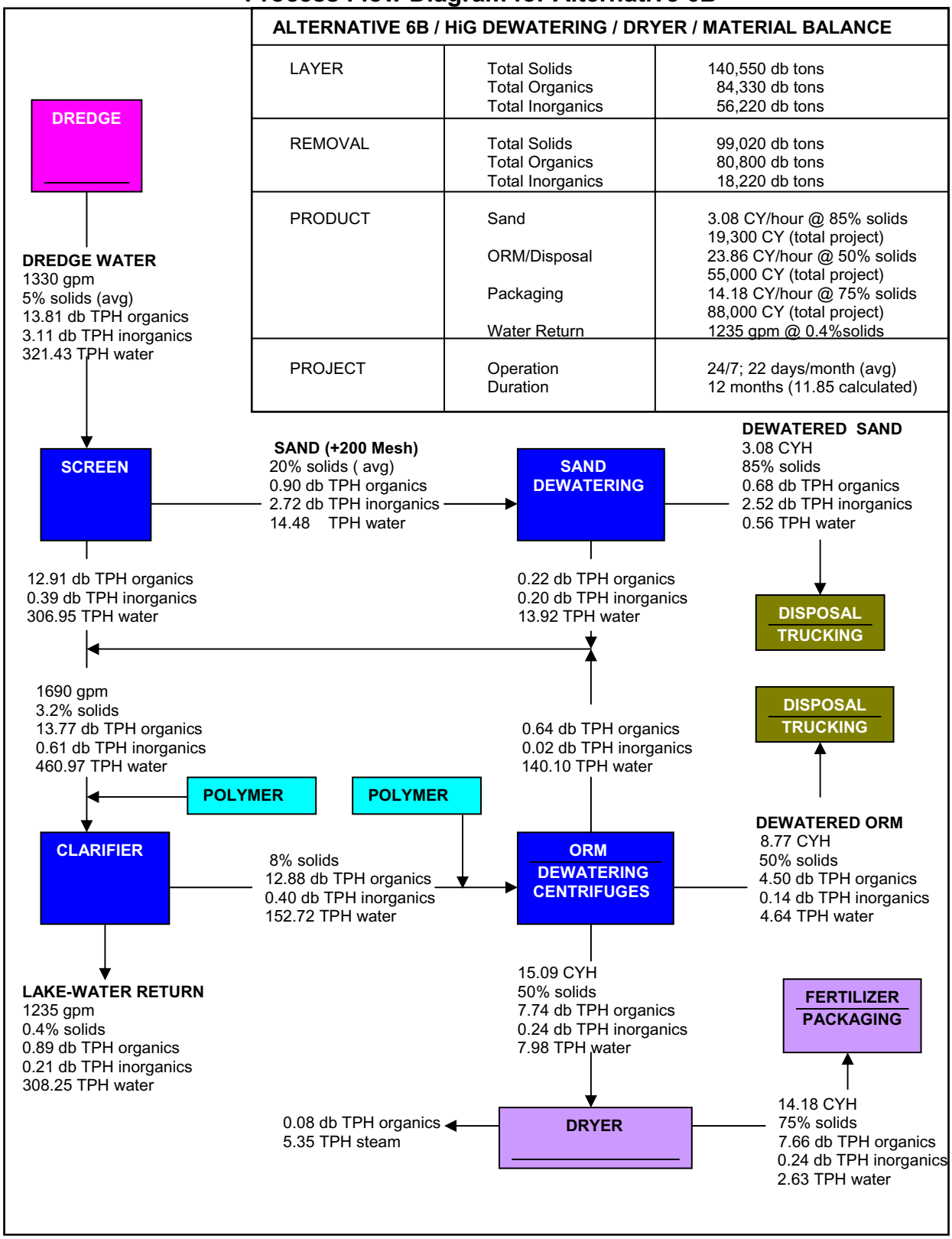


Figure 5-10
Process Flow Diagram for Alternative 6B



ALTERNATIVE 6B / HiG DEWATERING / DRYER / MATERIAL BALANCE		
LAYER	Total Solids Total Organics Total Inorganics	140,550 db tons 84,330 db tons 56,220 db tons
REMOVAL	Total Solids Total Organics Total Inorganics	99,020 db tons 80,800 db tons 18,220 db tons
PRODUCT	Sand ORM/Disposal Packaging Water Return	3.08 CY/hour @ 85% solids 19,300 CY (total project) 23.86 CY/hour @ 50% solids 55,000 CY (total project) 14.18 CY/hour @ 75% solids 88,000 CY (total project) 1235 gpm @ 0.4%solids
PROJECT	Operation Duration	24/7; 22 days/month (avg) 12 months (11.85 calculated)

5.7.3 Project Duration

Under Alternative 6A, with both the 1,330 and 800 gpm dredge feed rates, the estimated volume of dewatered organic sediments that would need to be trucked away from the project site is 150,000 cubic yards. This volume is approximately 65 percent less than that produced by belt filter presses due to greater dewatering efficiency of the centrifuges (50% vs. 20% solids). Dewatered organic sediment at 50 percent solids is considered to be a very "truckable" product, presenting no leakage problems during transport.

The 1,330 gpm dredge feed rate would require approximately 36 truck trips per day to remove both the sand and dewatered organic sediments from the process treatment site over a one-year project duration. Comparatively, the 800 gpm dredge feed rate would require approximately 23 truck trips per day to remove both the sand and dewatered organic sediments from the process treatment site over a 20 month project duration.

The project duration of Alternative 6B cannot be estimated at this time without further analysis of the demand and market for a fertilizer grade product.

5.7.4 Permittability

Alternatives 6A and 6B would be permittable with federal and state environmental regulatory agencies. The concept proposed by Alternative 6A is very similar to the process that was permitted, and is currently being used, by the City of St. Petersburg on Lake Maggiore sediment removal project, with the exception of centrifuges in lieu of belt filter presses. The primary issues with the environmental regulatory agencies are likely to include:

- Hydraulic dredge water quality impacts to lake surface waters;
- Hydraulic dredge pipeline impacts to shoreline wetlands;
- On-site process treatment facility construction impacts on wetland and listed species;
- Return water quality impacts on lake receiving waters; and
- Impacts to wetlands, listed species, and water quality at the final dewatered sediment disposal site.

Centrifuges will produce a drier organic cake and cleaner return water than the belt filter presses being used on the Lake Maggiore project, therefore, the management of stormwater runoff from the process treatment site – problems experienced on aforementioned project - would be more effective and less of a concern to the regulatory agencies.

5.7.5 Public Acceptance

While the volume of truck traffic generated for the project duration, and other "neighborhood" impacts such as noise, dust and odor, are typically not a concern of federal and state environmental regulatory agencies, such issues are of major importance to affected local governments responsible for managing traffic level of service and for enforcing ordinances and code violations.

As with the other process treatment alternatives, Alternative 6A would garner public support provided that the project duration was short enough and the number of truck entering leaving the site each day is tolerable. Lake-dependent recreation would not be affected, and the area of land dedicated to the process treatment facility would be small, and the associated noise, dust, and odor could be effectively buffered from surrounding neighborhoods.

As stated above, the 1,330 gpm dredge feed rate would require approximately 36 truck trips per day to remove both the sand and dewatered organic sediments from the process treatment site over a one-year project duration. Comparatively, the 800 gpm dredge feed rate would require approximately 23 truck trips per day to remove both the sand and dewatered organic sediments from the process treatment site over a 20 month project duration. The 36 percent reduction in truck traffic volume associated with the reducing the dredge feed rate to 800 gpm is considered to be significant with respect to neighborhood impacts and public acceptance. Therefore, it is concluded that if presented with both alternatives the longer duration project would garner greater public support.

5.7.6 Biddability and Constructability

Alternative 6A would be both biddable and constructible. The operation of the disposal portion of Alternative 6A at the rate of 23-36 truck trips per day would not be problematic for contractors, and would not likely lead to safety and public relations issues. This project alternative would likely receive numerous qualified bids, which could be successfully implemented.

5.7.7 Estimated Cost

The total estimated cost for Alternatives 6A and 6B are approximately $13.9 and $19.1 million, respectively. Detailed cost breakdowns for these alternatives are provided in Appendix 3. These cost estimates do not include the costs associated with land acquisition for any alternative process treatment sites, or site reclamation once the project is complete. In addition, it should be noted that trucking costs to dispose of the ORM has been included in the Alternative 6B cost estimate since it cannot be assumed that the production of a fertilizer grade product will eliminate the need for trucking this material to another location. Furthermore, revenues generated from the sale of this product have not been included. If trucking costs could be eliminated (e.g., product removed from the site by buyers), and if revenues could be added to offset project costs, the estimated cost of Alternative 6B would likely be lower than that of 6A.

5.8 Comparison of Alternatives

Table 5-4 shows a side by side comparison of all nine alternatives evaluated in this section with respect to the following evaluation criteria:

- Project duration;
- Permittability;
- Public acceptance;

- Biddability and constructability; and
- Estimated project costs.

Table 5-4
Summary Comparison of Project Alternatives

Alternative	Project Duration	Permit-ability	Public Acceptance	Construct-ability	Estimated Cost	Conclusions
1	14 years	Very Low	Very Low	Very Low	$50.7 million	Not feasible due to logistical problems
2A	4 years	Very Low	Very Low	Very Low	$35.4 million	Not feasible due to permitting constraints
2B	4 years	Very Low	Very Low	Very Low	$38.7 million	Not feasible due to permitting constraints
3A	4 years	Moderate	Low	Low	$37.6 million	Not feasible due to lack of available land
3B	4 years	Moderate	Low	Low	$40.8 million	Not feasible due to lack of available land
4	2 years	High	High	Moderate	$10.1 million	Not feasible due to infrastructure limitations
5	2 years	Moderate	Moderate	Moderate	$27.6 million	Feasible but not cost-effective
6A	2 years	High	High	High	$13.9 million	Feasible – the preferred alternative
6B	2 years	High	High	High	$19.1 million	Feasible but cost savings not proven

5.9 The Preferred Alternative

In conducting this evaluation of alternatives the following critical project planning design criteria for the Lake Seminole sediment removal project were identified:

- Project duration of two years or less;
- Selective removal of organics;
- Lake water availability for hydraulic dredging;
- Clean water return back to the lake;
- Dewatering process relatively unaffected by climatic variability;
- Minimal on-shore land area requirements for dewatering;
- Minimal volume of dewatered solids for disposal;
- Minimal truck traffic for solids disposal
- Minimal disturbance to water quality, wetlands, and listed species;
- Minimal disturbance to recreation and aesthetics; and
- Proven, cost-effective technology.

For sediment removal projects such as the Lake Seminole project, where on-shore processing space is severely limited, and for which sediment disposal trucking must be minimized, the only

logical and reasonable alternatives involve an on-shore dewatering system that can produce the minimum feasible dewatered sediment volumes on the smallest space possible, and return clean water back to lake Seminole at a rate equal to the dredge flow rate.

Based on an objective and balanced consideration of these factors, Alternative 6A – high gravity centrifuge dewatering with a dredge pumping rate of 800 gpm - is the only alternative investigated that satisfies all of the identified project criteria and standards completely. It is, therefore, concluded unequivocally that it must be the recommended alternative for Lake Seminole sediment removal project.

Figure 5-11 shows a conceptual diagram of the process dewatering facility addressed in the preferred alternative. The actual on-shore dewatering process equipment area - excluding boundary set-backs from adjacent properties, piping to and from the lake, roads, administration support buildings and the like – would be 140' by 100'. Compared to all of the other alternatives investigated, this alternative best satisfies the extremely limited space-available criterion while meeting the other criteria.

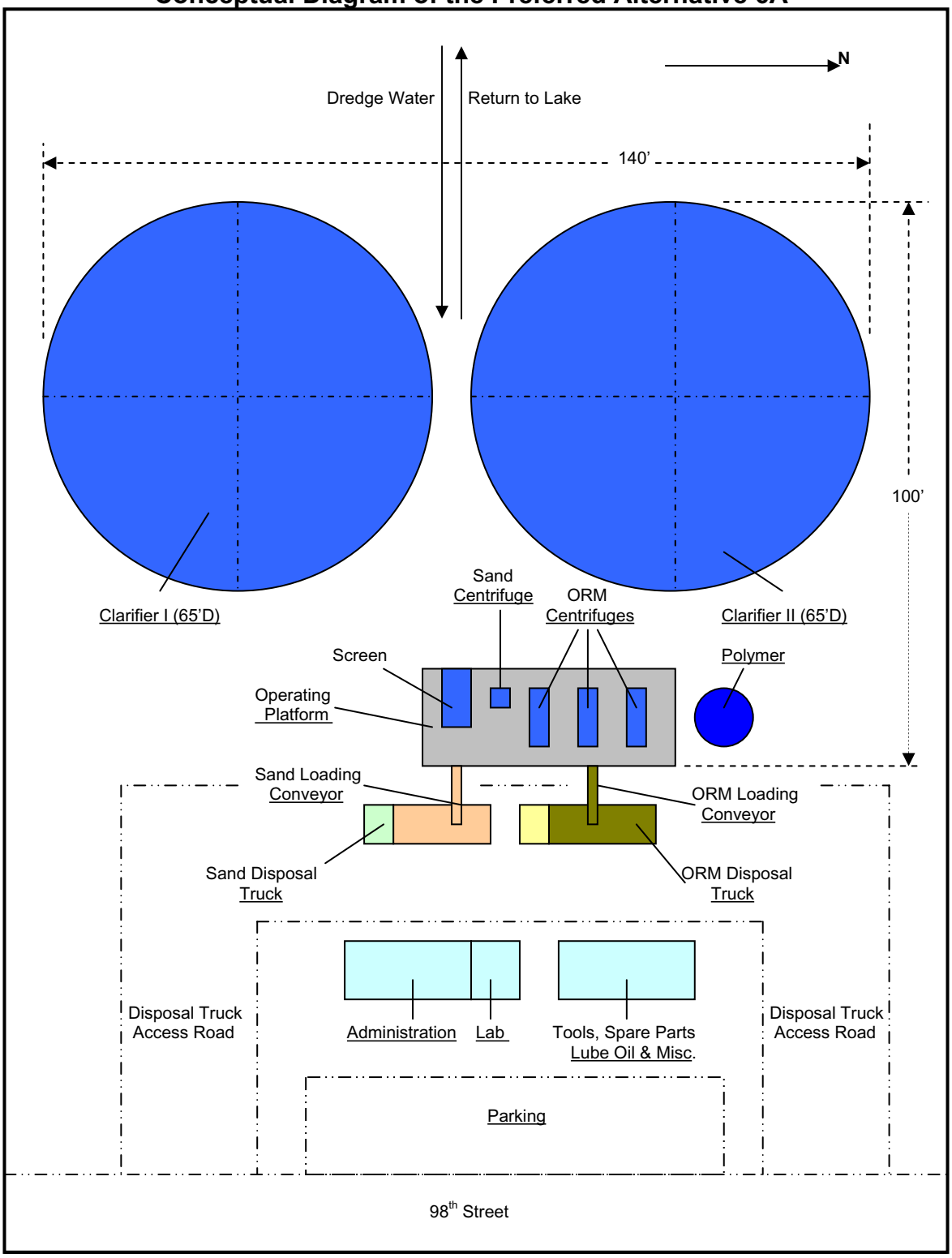
All of the process operating equipment elements and the process configuration itself are well-known and have been proven nationally and internationally for decades in the same, and even more complex, applications. Furthermore, the principal dewatering equipment elements would be "closed" and would not be susceptible to the sort of inclement weather conditions that might shut down "open" dewatering equipment elements such as lagoons.

The preferred alternative would return 93 percent of the water pumped out of the lake back to the lake. Therefore, there would be no undesirable lake drawdown effects. The water returned to the lake would contain about 0.36% solids. These solids would be the miniscule organic/inorganic residual remaining from the on-shore dewatering process, which does not pass through any other material (i.e. polymer) used in the process whatsoever. Therefore, by any accepted standard of water cleanliness, except those applicable to drinking water, the water returned to Lake Seminole would be clean and would meet Class III water quality standards.

Finally, the preferred alternative would result in minimal impacts to wetlands and listed species, lake recreation and aesthetics, and neighborhood integrity. For these reasons, as well as the overall lake restoration objective of the project, it is anticipated that the preferred alternative would garner strong public acceptance and support.

These conclusions are based on the project criteria and standards presented and discussed previously in this study. It must be expressly understood that any and all conclusions presented here, or in any other part of this study, are based solely on the data, information, diagrams and calculations developed for, and provided in, this study; and that any deviation from the data information, diagrams and calculations provided herein may result in different findings and conclusions.

Figure 5-11
Conceptual Diagram of the Preferred Alternative 6A



6.0 Regulatory Considerations

This section presents a summary of informational meetings conducted with regulatory agency personnel regarding the permittability of the preferred alternative. Meetings were conducted with the:

- U.S. Army Corps of Engineers;
- Florida Department of Environmental Protection; and
- Southwest Florida Water Management District.

At each meeting, an overview of the preferred alternative was presented, and comments regarding regulatory authority, permit application informational requirements, and the overall permittability of the project were requested from the regulatory staff present. A summary of each meeting is provided below.

6.1 U.S. Army Corps of Engineers

A meeting was held at the U.S. Army Corps of Engineers (USACE) Tampa Field Office on August 12, 2005. Those in attendance included Mark Peterson of the USACE, David Talhouk and Kelli Levy from Pinellas County, and Doug Robison from PBS&J. The following comments and conclusions were derived from this meeting.

- The preferred alternative would only require a Section 10 permit from the USACE, rather than a permit addressing both Section10 and Section 404 of the Clean Water Act. As such, no Water Quality Certification would be required from the State of Florida.

- Other federal agencies would provide comments to the USACE in the processing of the Section 10 permit. These agencies include the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and the U.S. Environmental Protection Agency (EPA).

- The USFWS would be primarily interested in potential project impacts on the nesting bald eagles in the project vicinity. The NMFS would be primarily interested in the direct and indirect impacts to water quality in the adjacent tidal waters of Boca Ciega Bay, as well as associated impacts to essential fish habitat.

- The USACE has no regulatory authority over the return water quality unless it is so heavily laden with silt to constitute fill material. However, the EPA may comment on impacts to surface water quality, both in the lake and in the ultimate receiving waters of Boca Ciega Bay.

- Mr. Peterson speculated that the preferred project alternative would be permittable with the federal agencies, and concerns regarding listed species and essential fish habitat could be easily overcome. He added that because only a Section 10 permit would be required, a Section 7 (Endangered Species Act) review by USFWS may not be required.

- The USACE has the ability to issue a Nationwide Permit (Letter of Permission) for projects involving less than 50,000 cubic yards of dredging. This may be applicable for a pilot project, but not for the preferred alternative.

- The Nationwide Permit No. 27 may be applicable to the entire project due to the fact that the work is being done to restore lake habitats and water quality. If so, only limited coordination with the USFWS and NMFS would be required.

- The worst-case scenario is that an Individual Permit addressing Section 10 Clean Water Act provisions would be required including a Public Notice and Section 7 Coordination with the USFWS.

- The USACE would have to review and approve the jurisdictional wetland delineation on the treatment plant site to ensure that pipelines and other infrastructure do not adversely impact wetlands.

6.2 Florida Department of Environmental Protection

A meeting was held at the Florida Department of Environmental Protection (FDEP) Tampa District Office on August 29, 2005. Those in attendance included Cece McKiernan, Charles Kovach, Ted Murray, Harry Michaels, and Kathy Litscher of FDEP, David Talhouk and Kelli Levy from Pinellas County, and Doug Robison from PBS&J. The following comments and conclusions were derived from this meeting.

- The FDEP clearly has State permitting authority over the project with respect to water quality, wetlands, and potentially affected aquatic species. The preferred project alternative would require both a State Environmental Resource Permit (ERP) and a National Pollutant Discharge Elimination System (NPDES) permit. The FDEP has delegated authority from the EPA to issue NPDES permits in Florida. Water quality criteria set forth in 62-302, Florida Administrative Code, would apply.

- Potential adverse impacts to lake surface waters associated with the discharge of process return water are the most serious concern with the preferred alternative. In addition to water quality impacts, the Florida Fish and Wildlife Conservation Commission (FWS) would be consulted with regard to potential bald eagle impacts.

- The ongoing Lake Maggiore sediment removal project, using a similar process treatment approach, has had problems controlling conductivity and nutrients – primarily unionized ammonia – in return water. Demonstration of adequate polishing treatment of return water will absolutely be required for permit approval.

- The permit application must include baseline water quality data for both lake surface waters, as well as sediment interstitial pore water, near the point of discharge. Parameters should include: specific conductivity; TSS, nutrients, pH, and chlorides. Benthic invertebrate populations will also need to be sampled and documented.

- Instantaneous end of pipe measurements of water quality must meet State Water Quality Standards. A water quality mixing zone, variance, or waiver for the process return water may be granted but would require thorough baseline documentation of ambient conditions.

- The permit application should demonstrate a nutrient balance. That is, the project will not result in an increase in dissolved nutrient concentrations in lake surface waters. There are no numeric criteria for nutrients in the State water quality standards. Rather a complex rule based on ecological impairment (e.g., eutrophication) is used to determine compliance. On the Lake Maggiore project, project-specific end of pipe standards for nutrients were developed at plus/minus one standard deviation of in-lake N and P concentrations.

- Acute toxicity testing will be required for process return water. The organism(s) used for toxicity testing would be determined by the conductivity of the process return water. Toxicity testing at points of inflow and outflow would be helpful to determine water quality changes along the treatment train.

- An MSDS will be required for any polymers used in the process treatment system. The discharge of residual polymer material leaving the treatment system in the return water discharge is a potential concern.

- Severance fees for dredged sovereign lands would apply if structural fill material generated from the project is used for profit (e.g., as a soil additive), or deposited on privately-owned lands. The ultimate disposal site(s) and use of the material must be clearly spelled out in the permit application.

- Revenues from the sale of byproducts from the sediment dewatering process (e.g., organic soil additive or sand) could potentially be used to offset project costs if the revenues go back to the County rather than a for-profit entity.

- The permit previously issued to Pinellas County for the Lake Seminole sediment removal pilot test project requires process water to be discharged to the sanitary sewer system, with no return water to the lake. From a water quality standpoint, this would be the preferred approach. Potential adverse impacts associated with a protracted lake drawdown resulting from this approach were, however, acknowledged.

- Pinellas County is authorized to undertake the sediment removal pilot test project, as permitted. A pre-construction meeting with FDEP would be required prior to project initiation.

- FDEP staff warned that third party objections could significantly affect the ultimate permitting decisions, and that potential third party objectors should be consulted early on in the process to avoid conflicts.

- FDEP speculated that the preferred project alternative would be permittable with the State of Florida, and noted that the Lake Maggiore sediment removal project was permitted by the same local staff. However, staff also indicated that due to poor planning it has been necessary to issue four permit modifications for the Lake Maggiore project, and that compliance with project-specific water quality standards has been inconsistent. They strongly recommended a review of the Lake Maggiore permit file to determine positive and negative aspect of that project and to avoid potential mistakes in project planning and permitting.

6.3 Southwest Florida Water Management District

A meeting was held at the Southwest Florida Water Management District (SWFWMD), Tampa District Office, on August 24, 2005. Those in attendance included Richard Alt and Alberto Martinez of SWFWMD, Kelli Levy from Pinellas County, and Doug Robison from PBS&J.

After presenting the elements of the preferred project alternative to SWFWMD regulatory staff, they concluded that all State permitting of the project should be handled by the Florida Department of Environmental Protection. Although the SWFWMD had delegated authority from the FDEP for ERP permitting, they do not have delegated authority for the required NPDES permit.

7.0 Conclusions and Recommendations

7.1 Recommended Alternative

As part of this study, the following nine engineering alternatives (six primary and three secondary alternatives) were comparatively evaluated:

- Alternative 1 - Lake drawdown with excavation
- Alternative 2A – In-lake lagoons with natural evaporation
- Alternative 2B – In-lake lagoons with polymer settling
- Alternative 3A – Upland lagoons with natural evaporation
- Alternative 3B – Upland lagoons with polymer settling
- Alternative 4 - Mechanical degritting, clarification, solids discharge to the County wastewater system
- Alternative 5 – Mechanical degritting, clarification, low gravity dewatering
- Alternative 6A - Mechanical degritting, clarification, high gravity dewatering
- Alternative 6B - Mechanical degritting, clarification, high gravity dewatering and drying

Several of the alternatives have significant process engineering deficiencies and logistical problems associated with their ability to complete the project within a reasonable schedule. Those alternatives that rely primarily on natural evaporation or percolation (Alternatives 1, 2A, 2B, 3A and 3B) are severely limited by local climatic conditions. It was shown that, given the average rainfall and estimated evaporation rates in Pinellas County, continuously, efficient dewatering of dredged organic sediments would not be possible with these alternatives. In addition, Alternatives 3A and 3B would require approximately 200-300 acres of land immediately adjacent to the lake to be used as evaporative lagoons. However, the Lake Seminole watershed is essentially built out, and no appropriately sized vacant parcels of land exist.

In addition, Alternatives 1, 2A, 2B, 3A and 3B all pose very significant permitting and public acceptance problems. Lake Seminole is a designated Outstanding Florida Water, and much of the lake bottom area is sovereign lands owned and managed by the State of Florida. Furthermore, Lake Seminole is bordered by a major County park as well as intense residential development. Lake Seminole County Park is the third most heavily used park in the Pinellas County park system, and the lake supports extensive recreational activities including canoeing, boating, water skiing, personal watercraft use, fishing, and ultra-light aircraft use.

Any alternative that takes any significant portion of the lake out of recreational use, even on a temporary basis, will not be supported by the public. Furthermore, any alternative that has the potential to degrade water quality and lake ecosystem functions, or disrupt habitat and associated fish and wildlife populations, even on a temporary basis, will not be permitted by the applicable environmental regulatory agencies.

Therefore, Alternatives 1, 2A, 2B, 3A and 3B can all be rejected as infeasible, and should not receive any additional consideration due to the obvious and very significant impediments to their implementation.

Alternatives 4, 5, 6A, and 6B all involve hydraulic dredging with the dredge slurry being pumped to a small landward site adjacent to the lake for dewatering via process engineering, and disposal. None of these alternatives would pose the significant permitting or public acceptance problems identified for Alternatives 1, 2A, 2B, 3A and 3B.

Alternative 4 proposes to provide for mechanical degritting and clarification of the dredge sediments from Lake Seminole. The alternative does not rely on natural evaporation or percolation for the dewatering of the sediment, but proposes to use proven technologies to meet the requirements of the project criteria. Alternative 4 requires a very small upland area for the processing plant and does not require trucked disposal of the dewatered sediment. The disposal of the partially dewatered sediment (8% solid) is via the Pinellas County wastewater collection and transmission system and the South Cross Bayou Water Reclamation Facility.

Initially, the apparent engineering simplicity, relatively low cost, and minimal environmental impacts associated with Alternative 4 made it an attractive option. However, after further analysis, it was determined that this alternative has several significant problems. First, this alternative would not provide for the return of adequate volumes of clean water back to the lake, an important design criterion established in the basis of design. The lack of return water could potentially result in a protracted lake level drawdown if there is inadequate rainfall to refill the lake, which could both delay the project and adversely impact recreational uses. In addition, this alternative is constrained by the existing wastewater collection, transmission, and treatment infrastructure.

In order to convey the sediments to the wastewater system, additional piping will be required. Additionally the 8-inch gravity sewer hydraulic capacity will be exceeded with the introduction of a minimum flow of 450 gpm to a maximum of approximate 700 gpm of 8 percent solids. Sewer blockages and normal wastewater customer service interruptions are expected with Alternative 4. Existing wastewater Pump Station No. 11 is a duplex submersible pump facility with a firm capacity of 375 gpm, and cannot accept the sediment discharge flow from Alternative 4. Even if the recognized capacity and operational issues with the wastewater collection and transmission system were resolved through infrastructure upgrades, significant impacts to the South Cross Bayou Water Reclamation Facility is possible due to the additional organic load from the Lake Seminole sediment. For these reasons, the Pinellas County Utilities Department indicated that they would not support this alternative.

Therefore, Alternative 4 can be rejected as infeasible. The lack of adequate return water to the lake is a significant violation of the basis of design for this project. In addition, although the engineering constraints could possibly be overcome through upgrades to the wastewater collection, transmission, and treatment infrastructure, the cost of such upgrades would likely not prove justifiable for a temporary project.

Alternatives 5, 6A, and 6B all utilize a sophisticated process engineering approach that requires a small temporary “treatment plant” site adjacent to the lake, and results in the efficient dewatering of organic sediments with the return of clean process water back to the lake. Accordingly, these alternatives do not pose significant environmental permitting or public acceptance problems.

Alternative 5 proposes to build on Alternative 4 in that it provides for dewatering of the sediment in the clarifier underflow via belt filter presses. Belt filter presses are proven technology in the wastewater industry for dewatering biological sludges to 15 to 20 percent solids. Based upon information provided by belt filter press manufacturers and assuming that the inorganic fraction of the sediment is removed in the upstream screening and pretreatment components of the processing plant, it is anticipated that the belt filter presses would produce a dewatered sediment or "cake" to about 20 percent solids.

The analysis of Alternative 5 revealed that the project could be completed in approximately one year, however, to do so would require over ninety 18-cubic yard truck trips per day. This equates to a 7 minute turn around for each truck over a 10 hour day. This extremely short turn around time is not practical, and ninety trucks each day for one year would produce significant traffic congestion in and around the project site. In order to minimize the daily truck traffic volume, a doubling of the truck turn around time was considered. This would result in extending project duration to two years, as well as the truck turn around time to 14 minutes. Despite these adjustments, truck traffic congestion would not be reduced significantly enough to minimize neighborhood impacts. For this reason, it was concluded that Alternative 5 implemented over a two year duration would not garner the strong public acceptance necessary for project implementation.

Alternatives 6A and 6B propose to increase the dewatering of the sediment from the 20 percent solids anticipated in Alternative 5 to 50 percent solids using high gravity centrifuges. Centrifuges are a proven technology and are well suited to high gravity dewatering of organic sediments. The increase in the percent solids of the cake produced under Alternatives 6A and 6B significantly reduces the required number of trucks for disposal of the cake. Alternative 6A would require approximately 22 trucks per day over a one-year project duration to dispose of the dewatered inorganics and organic cake. Over a two-year project duration, this truck traffic volume would be relatively minimal and would not result in significant traffic congestion in local neighborhoods. For this reason, it was concluded that Alternative 6A would likely receive adequate public acceptance for implementation.

Alternative 6B proposes drying the dewatered cake to about 85 percent solids, and would generate an organic cake suitable for marketing as a topsoil additive. Assuming that consumers removed the product from the plant site, even less truck traffic would be required for disposal. Furthermore, if a local market for this product existed, product sales could be used to partially offset project costs. However, the local demand for such a product has not been established. Given the uncertainty and potential complexities associated with marketing the organic cake product, the additional costs associated with Alternative 6B cannot be justified at this time.

Therefore, in consideration of the factors summarized above, Alternative 6A is recommended as the preferred project engineering alternative for implementation on the Lake Seminole sediment removal project.

7.2 Project Procurement

Implementation of the recommended preferred alternative for the Lake Seminole sediment removal project will present some unique procurement and project management challenges. First, the preferred alternative involves three distinct, yet interdependent components: 1) the hydraulic dredge for sediment removal; 2) the process treatment plant for sediment dewatering; and 3) the disposal operation. To maintain the project schedule and to control costs, it is critical that all three of these components work efficiently and continuously at compatible rates from project initiation to completion. Second, the project essentially entails the construction of a temporary treatment facility that must be constructed, operated for a period of a few years, and then dismantled. There are likely very few if any analogous projects in the history of project procurement in Pinellas County. The complex yet temporary nature of the design, construction, operation, and dismantling of the facilities necessary for a successful project will require a creative approach to procurement and project management.

Given the relatively sparse record of similar lake sediment removal projects completed in Florida, there are few precedents for contractors to base their bids on. With this uncertainty comes a potentially increased risk for conflicts between the project engineer and the contractor. For this reason, Pinellas County prefers to have a single entity responsible for all three components of the project, as well as for any necessary dispute resolution between designers, builders, and operators.

There are several options available to Pinellas County for the procurement of preferred Alternative 6A. These procurement options include:

- Traditional Design/Bid/Build
- Design/Build; and
- Design/Build/Operate

In addition to these traditional alternatives, each can be modified to meet specific needs of the project. Each of the options is discussed further below.

7.2.1 Traditional Design/Bid/Build

The traditional method for governments (the owner) to procure engineering design and construction services is the Design/Bid/Build process. The first step in this process is to retain a Professional Engineer to prepare project construction plans, technical specifications, and contract documents for the owner to advertise for competitive bids from qualified contractors. In the case of the Lake Seminole sediment removal project, Pinellas County would retain a Professional Engineer registered in the State of Florida to prepare the construction plans, technical specifications, and contract documents.

Once the design and contract documents are complete, the project would be advertised to solicit bids from qualified general contractors. The successful low bidding general contractor would enter into contract with Pinellas County for the construction of the project. In many cases, the County would also enter into an agreement with the Professional Engineer to observe and inspect

the general contractor's work for conformance to the intent of the construction plan, technical specifications, and contract documents. The project would then be built by the general contractor in accordance with the design and contract documents. Because there is typically no contractual relationship between the Professional Engineer and the general contractor, potential exists for conflict to arise between these two entities with regard to clarity of the design documents and their intent. In such cases, disputes are typically directed through the County for settlement.

In the case of the Lake Seminole sediment removal project, the project does not end with construction. There are the additional steps of operating the dredge system, the dewatering process plant, and the trucking disposal of the sediment, and then demobilizing all facilities. Typically, under the Design/Bid/Build the general contractor responsible for construction would initiate operations per the technical specifications, train the owner's operation personnel and turn the project over to the owner with the caveat of a one year warranty period. This approach is used most commonly for facilities such as wastewater treatment plants. In the case of the Lake Seminole sediment removal project, Pinellas County would either operate the three project components using County operations staff, or hire an operations contractor/firm to actually operate the system. With the latter option, issues could arise with an outside operations contractor being critical of the design or construction of the project, and using such problems as reasons for poor operational performance.

Given the temporary nature, and project-specific equipment and facilities involved in this project, it is unlikely that Pinellas County would choose to operate the project components. In addition, hiring an operations contractor/firm independent of the designer is inconsistent with the single entity approach preferred by the County. Therefore, the traditional Design/Bid/Build procurement method is clearly inappropriate for this project

7.2.2 Design/Build

The Design/Build (D/B) procurement method provides for one point of contractual contact for the owner. Instead of separate contracts with the designer (Professional Engineer) and the general contractor, the D/B procurement method contractually groups the designer and builder together as one entity. The owner develops a set of procurement documents under the D/B method that provides contractual requirements and project information to qualified D/B contractors upon which to base their bids, and the successful D/B is selected on the basis of cost.

This relationship can lead to more of a "partnership" between the Professional Engineer and the general contractor. It provides for the designer and builder to work together to resolve issues and deliver a quality designed and constructed end product to the owner. In many cases the overall project schedule can be compressed as the design can proceed slightly ahead of construction, and the design documents (construction plans and technical specifications) can contain less detail since the designer and constructor are working in concert as a single contractual entity.

In the case of the Lake Seminole sediment removal project, the D/B procurement method could provide an excellent constructed project in a shortened delivery time. However, the Design/Build method of procurement would not adequately address the operational requirements

of the project. As with Design/Bid/Build approach, either the County would be responsible for operations, or a separate operations contractor/firm would need to be hired, neither of which are acceptable options Therefore, the Design/Build procurement method is also inappropriate for this project.

7.2.3 Design/Build/Operate

The Design/Build/Operate (D/B/O) project delivery method provides for one contractual entity for the design, construction, and operation of a project. Similar to the D/B delivery method, the owner develops a set of procurement documents that provide project information and requirements for qualified D/B/O contractors to base their bids on, and qualified contractors are selected on the basis of cost. Also similar to the D/B method, the designer and constructor are contractually connected for the delivery of the constructed project.

Furthermore, operation of the constructed project is also included in the overall contract for some defined time of operation. The operation of the project is usually based upon performance requirements. In the case of the Lake Seminole sediment removal project, performance requirements could include a minimum percent solids concentration in the dewatered sediment, a minimum number of disposal truck trips per day, etc. Finally, since the Lake Seminole sediment removal project involves the construction and operation of temporary facilities, dismantling and demobilization would be included in the overall contract.

While the D/B/O method would provide for a single contractual entity for the County to coordinate with on all aspects of the project, it does not provide a perfect procurement solution for the Lake Seminole sediment removal project. D/B/O procurement generally results in the selection of qualified general contractors, rather than design professionals, primarily on the basis of cost, and is best suited to projects involving traditional engineering design. Given the unique requirements of the process engineering design called for in the preferred alternative, the potential exists for inferior engineering design. The sediment dewatering facility is the most critical component of the project, and will require specialized engineering design experience.

7.2.4 Procurement Recommendation

To ensure a high level of design engineering quality control, as well as a coordinated approach to project construction and operation, a modified Design/Build/Operate (D/B/O) procurement method is recommended. The modification of the D/B/O process involves the design portion of the project. It is recommended that the County retain a qualified Florida Professional Engineer to prepare the technical design documents (plans and specifications) for the dewatering facility. Based on these technical design documents, the County would then advertise the project for Build/Operate contractors to bid. The successful Build/Operate contractor would be selected on the basis of cost. The County would also retain the design professional to provide construction and operation management services throughout the duration of the project.

The design professional would be responsible for maintaining project schedules and approving invoices and change orders submitted by the Build/Operate contractor, and would be working for, and in the best interest of, the County. While conflicts could still arise between the design

professional and the Build/Operate contractor, it would be solely the responsibility of the design professional to resolve such conflicts, pursuant to their contractual arrangement with the County. Under this modified D/B/O, the specialized design services called for in this project would not be under the control of the builder/operator but rather with the Professional Engineer. This modification would allow the County and the design professional to have control over the design, while also giving the County a single point of contact for construction management and operation.

Given the potential economic value of the dewatered dredged material, it is also recommended that the County explore a traditional D/B/O approach whereby a substantial portion of project construction costs would be borne by the contractor in exchange for the ability to sell the material for profit on the open market. Under this approach, the County would advertise and select a D/B/O engineer/contractor team on the basis of: 1) professional qualifications for the design component; and 2) cost for the build/operate components. The most obvious advantage of this approach is that total project costs to the County could be substantially reduced. In addition, most of the same advantages of the modified D/B/O process regarding the engineering responsibilities, and a single point of contact, could be realized. On the other hand, the most significant disadvantage of this approach would be a reduced level of County control over all components of the project. It is likely, however, that the County could implement sufficient project management controls through more stringent contractual coordination and reporting requirements on the part of the D/B/O contractor.

Pinellas County has received a permit from the Florida Department of Environmental Protection to conduct a "pilot project" of the process treatment system. Limitations of this permit include: 1) dredged organic sediment volume must not exceed-3,000 cubic yards; and 2) all process return water must be discharged into the County sanitary sewer collection system, with no discharge to the lake. The permit expires in 2008.

Regardless of the procurement method utilized, it is recommended that a system evaluation phase be required as a component of the construction project. The system evaluation would allow the design professional to determine if the selected Build/Operate contractor has the necessary understanding and capabilities to construct the process treatment system to the design plans and specifications, and would allow the Build/Operate contractor to gain a familiarity with the unique aspects of the operation. The system evaluation would also be used to identify potential design, construction and operational problems, as well as potential conflicts between the design professional and the contractor. This problem identification and resolution process should ensure that the full scale project is completed with minimal conflicts.

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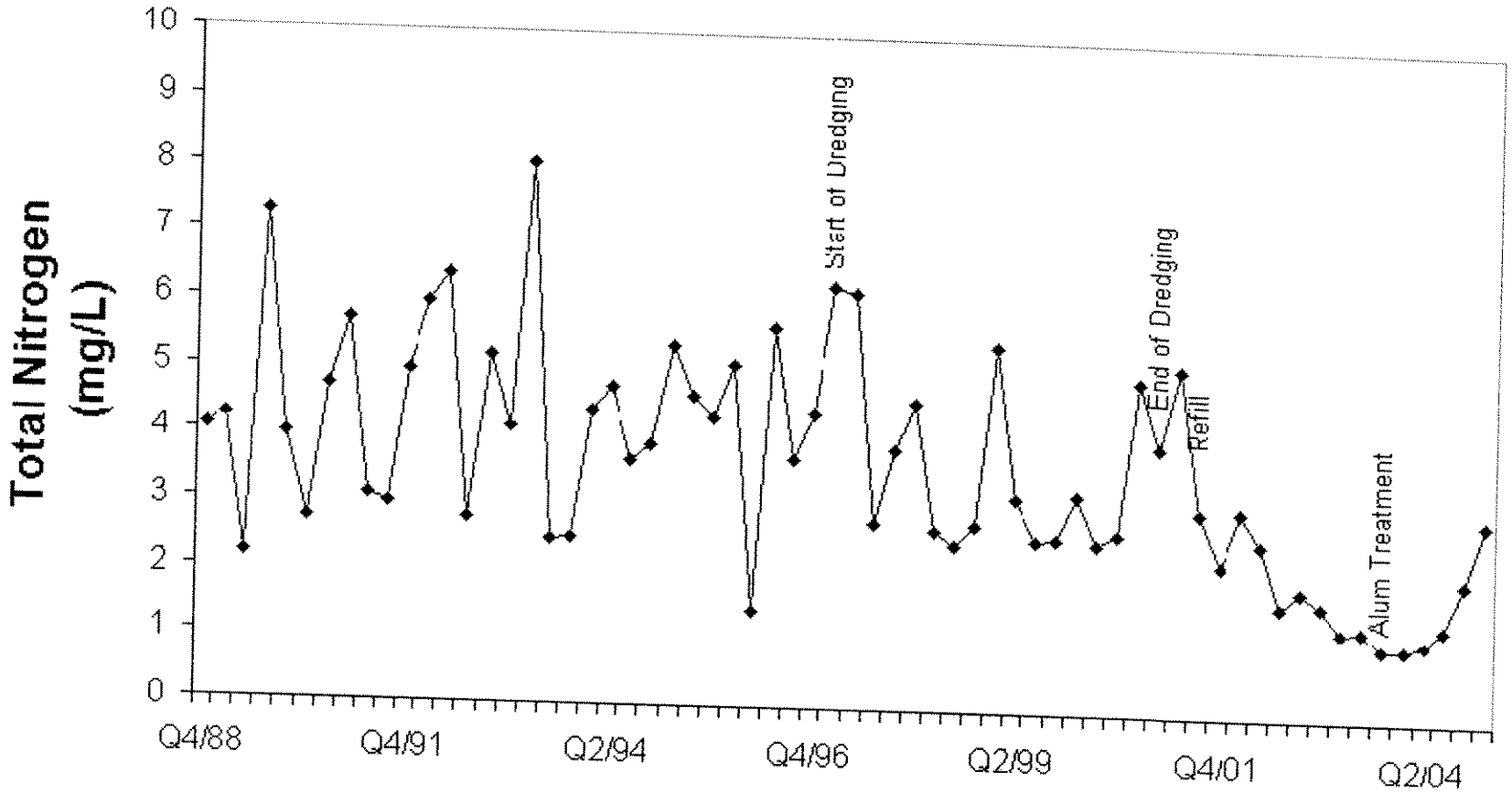
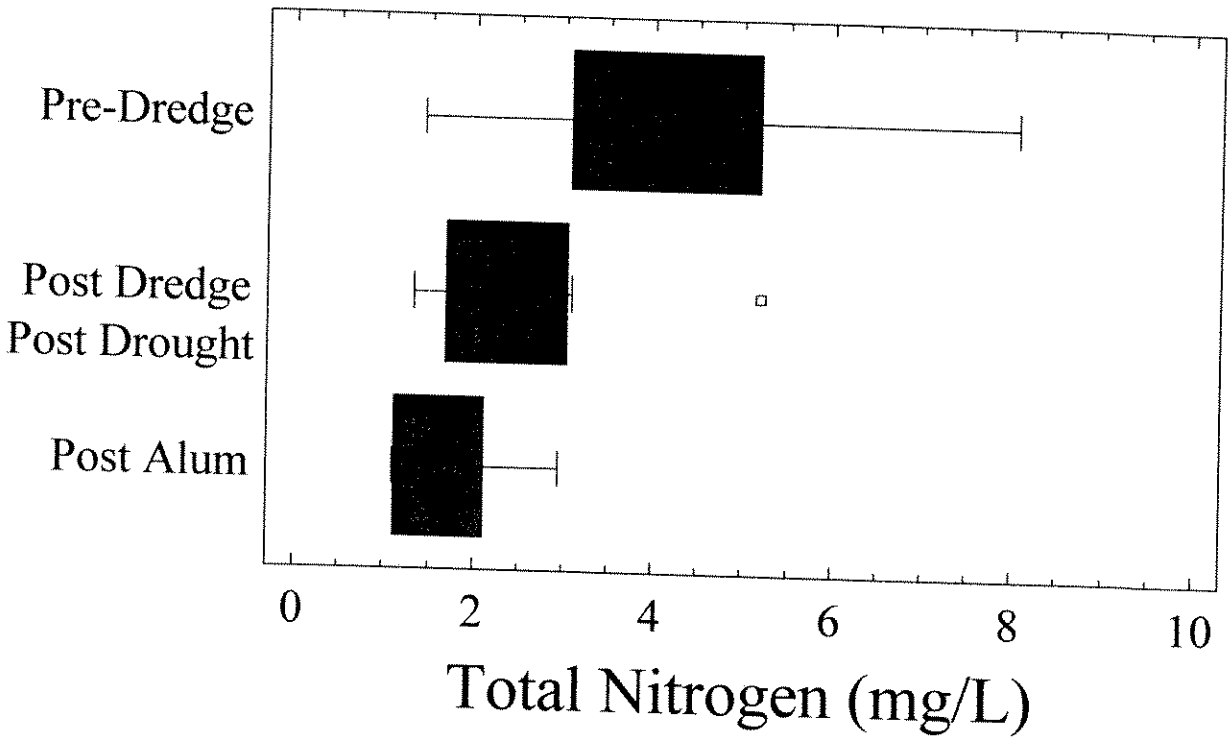
Appendix 1 – Lake Hollingsworth Water Quality Data

This appendix contains summary data for Lake Hollingsworth, as provided by the City of Lakeland (Gene Medley, personal communication). These data indicate water quality changes and improvements associated with sediment removal and whole lake alum treatment.

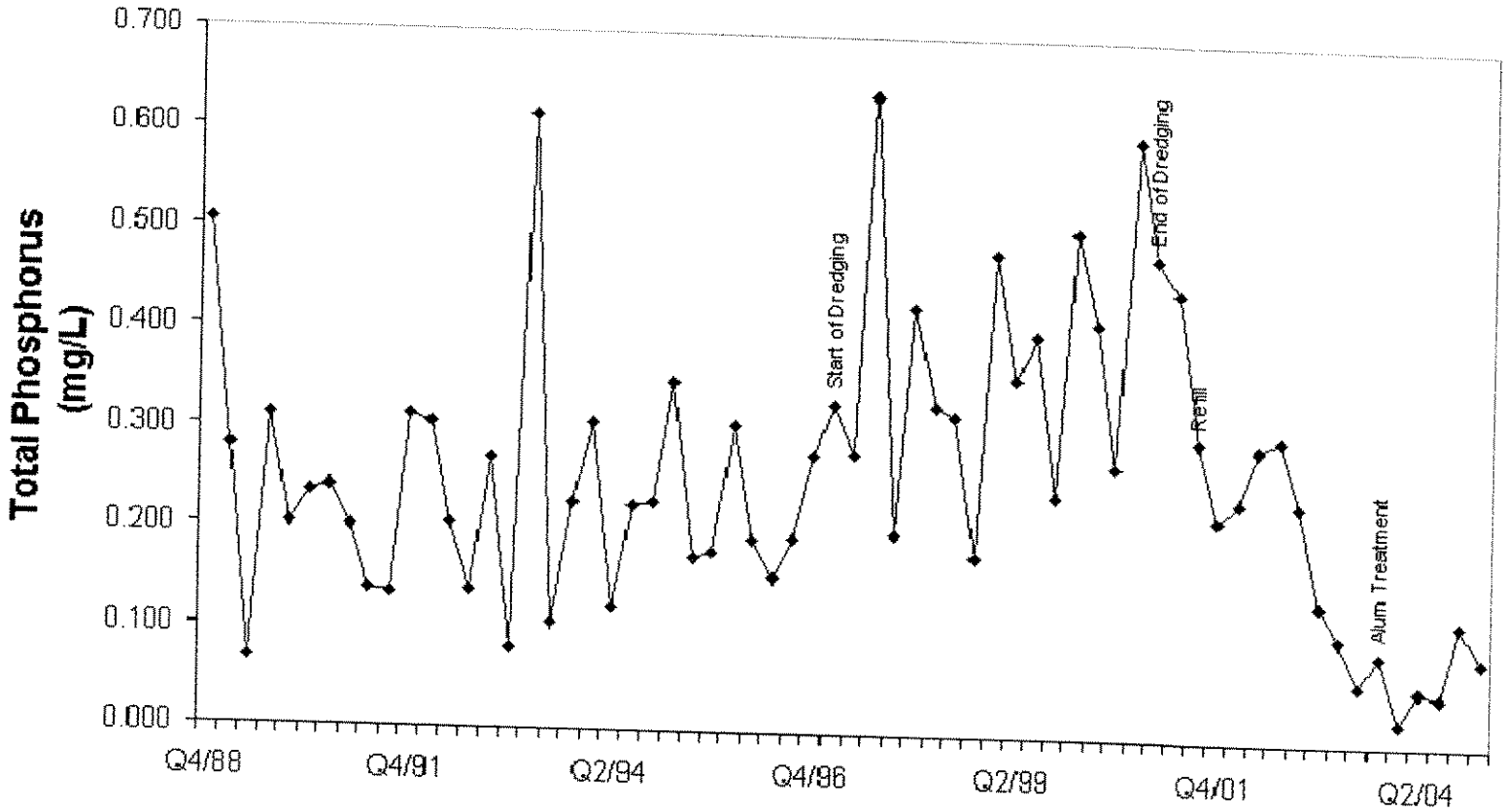
Lake Hollingsworth
Total Nitrogen



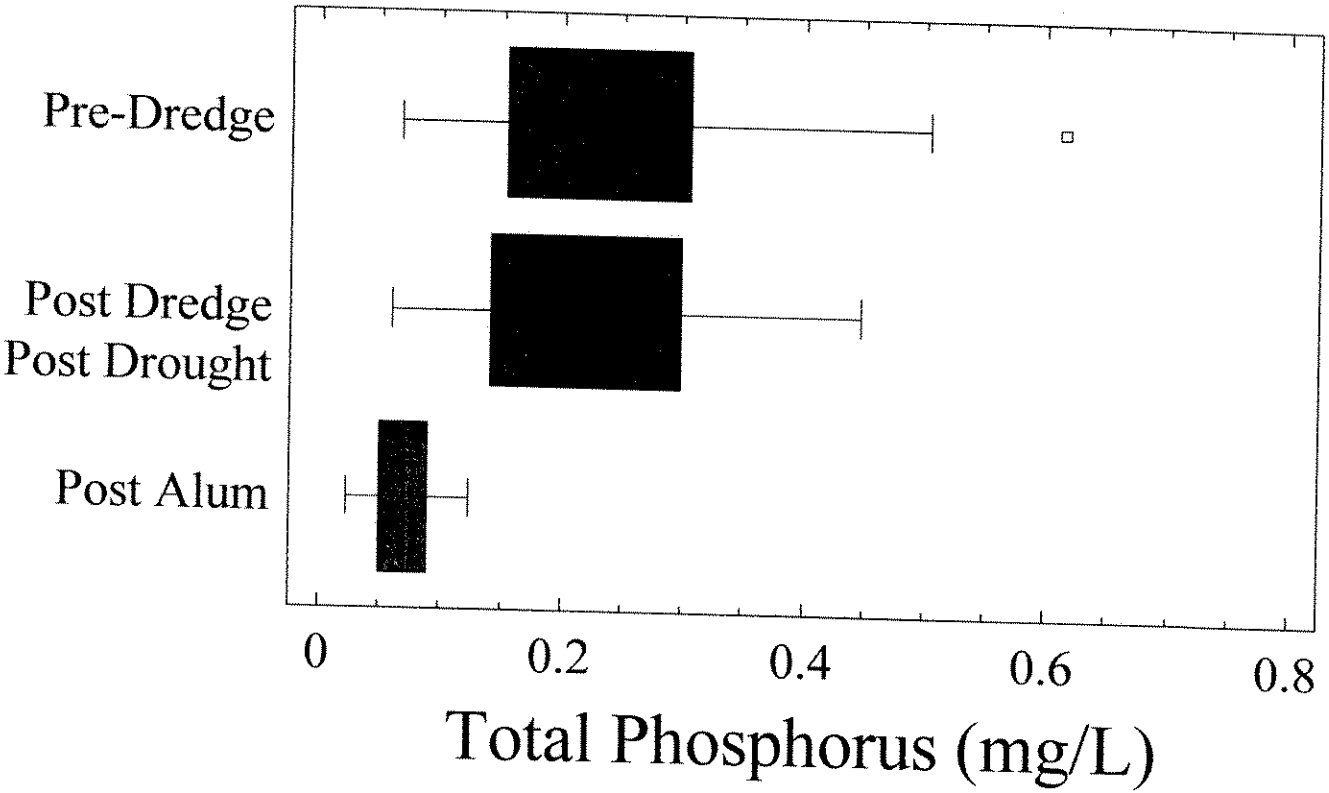
Lake Hollingsworth
Total Nitrogen



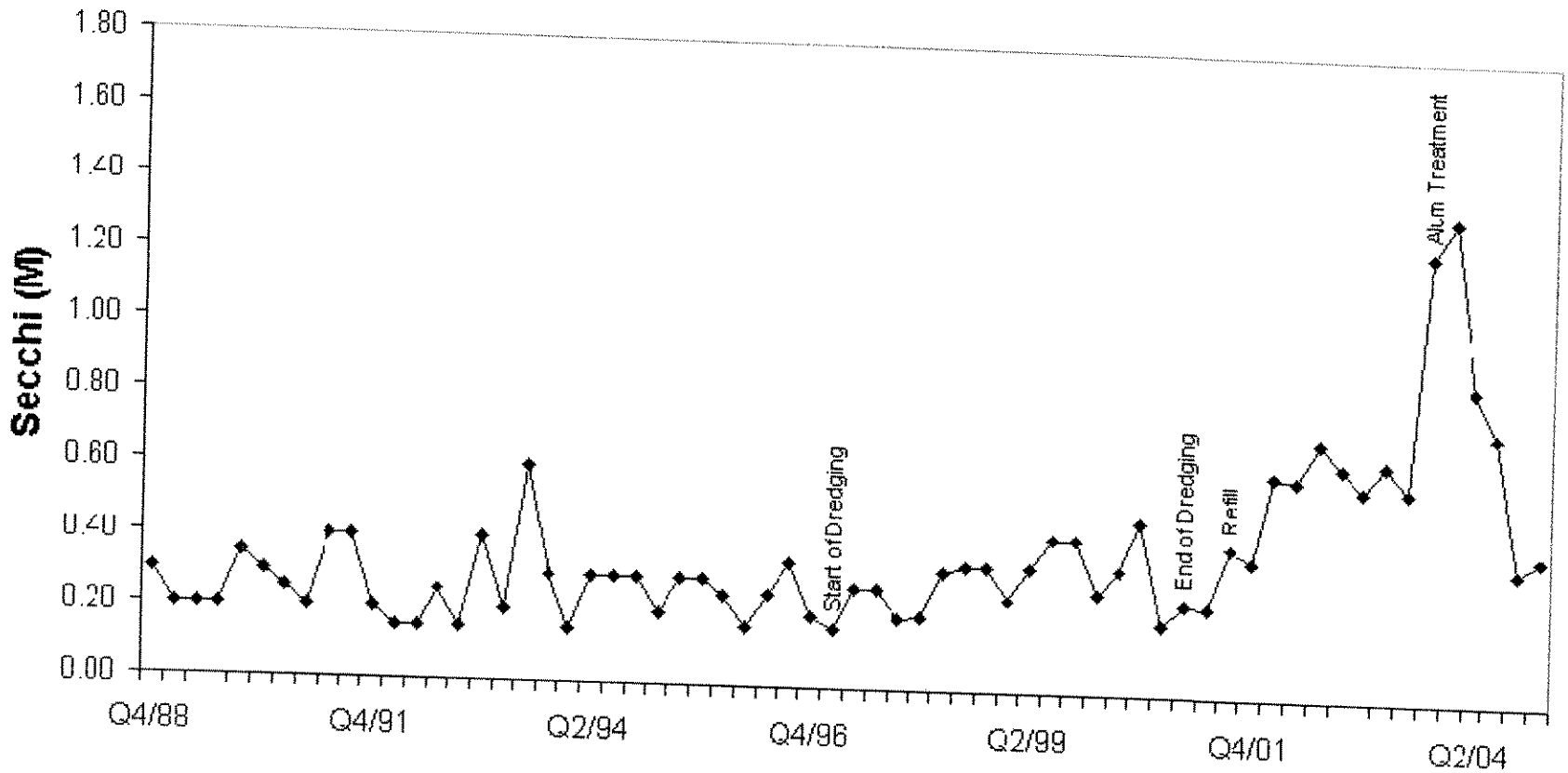
Lake Hollingsworth
Total Phosphorus



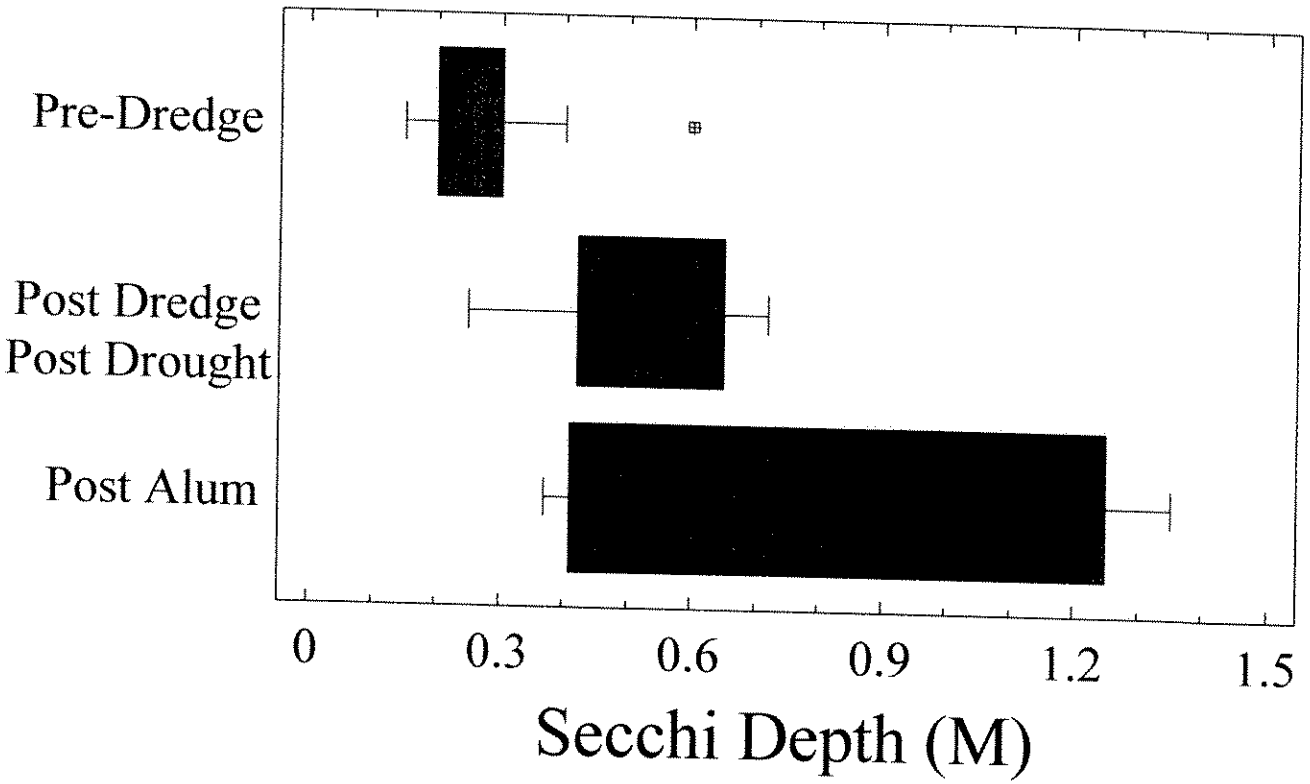
Lake Hollingsworth Total Phosphorus



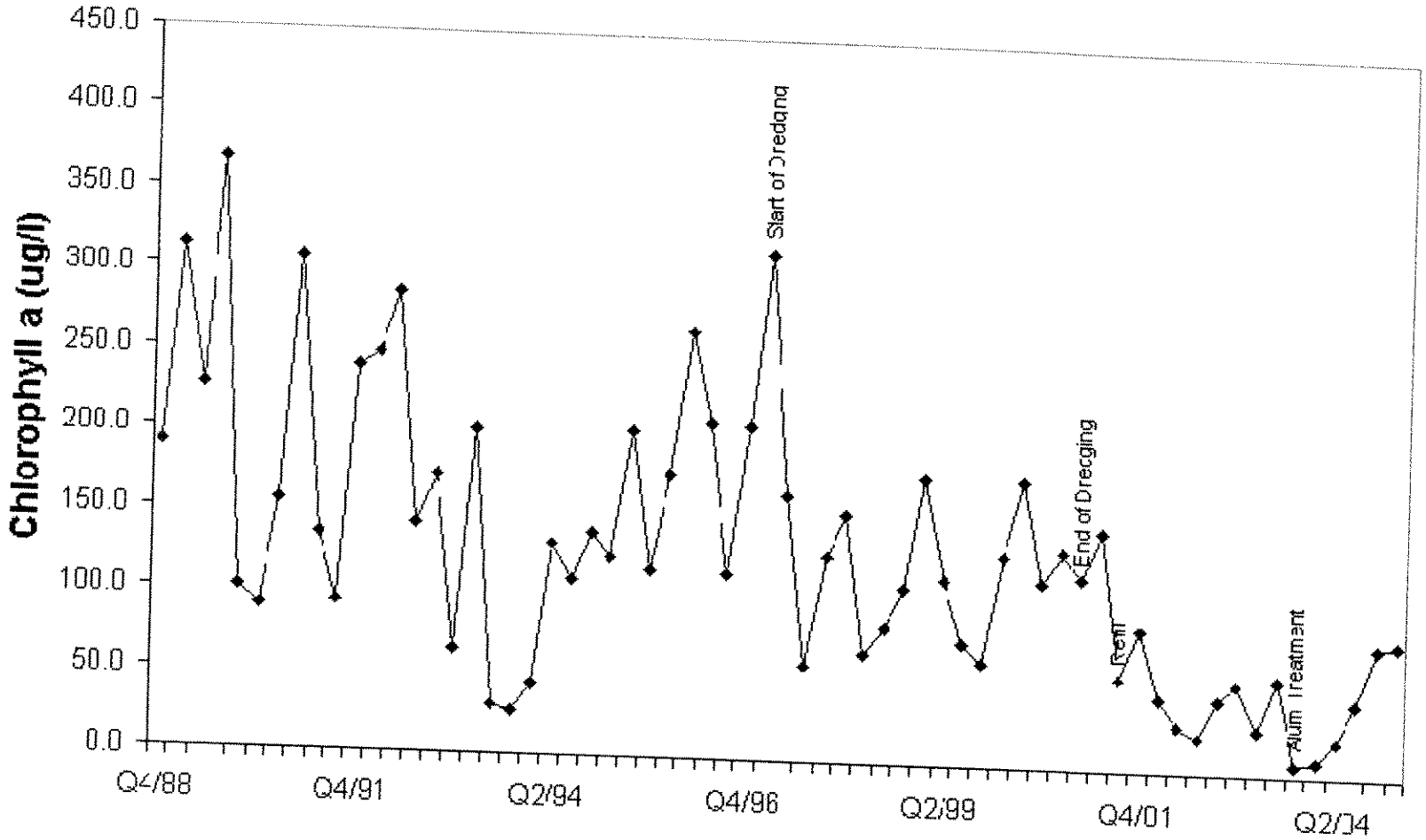
Lake Hollingsworth
Water Clarity



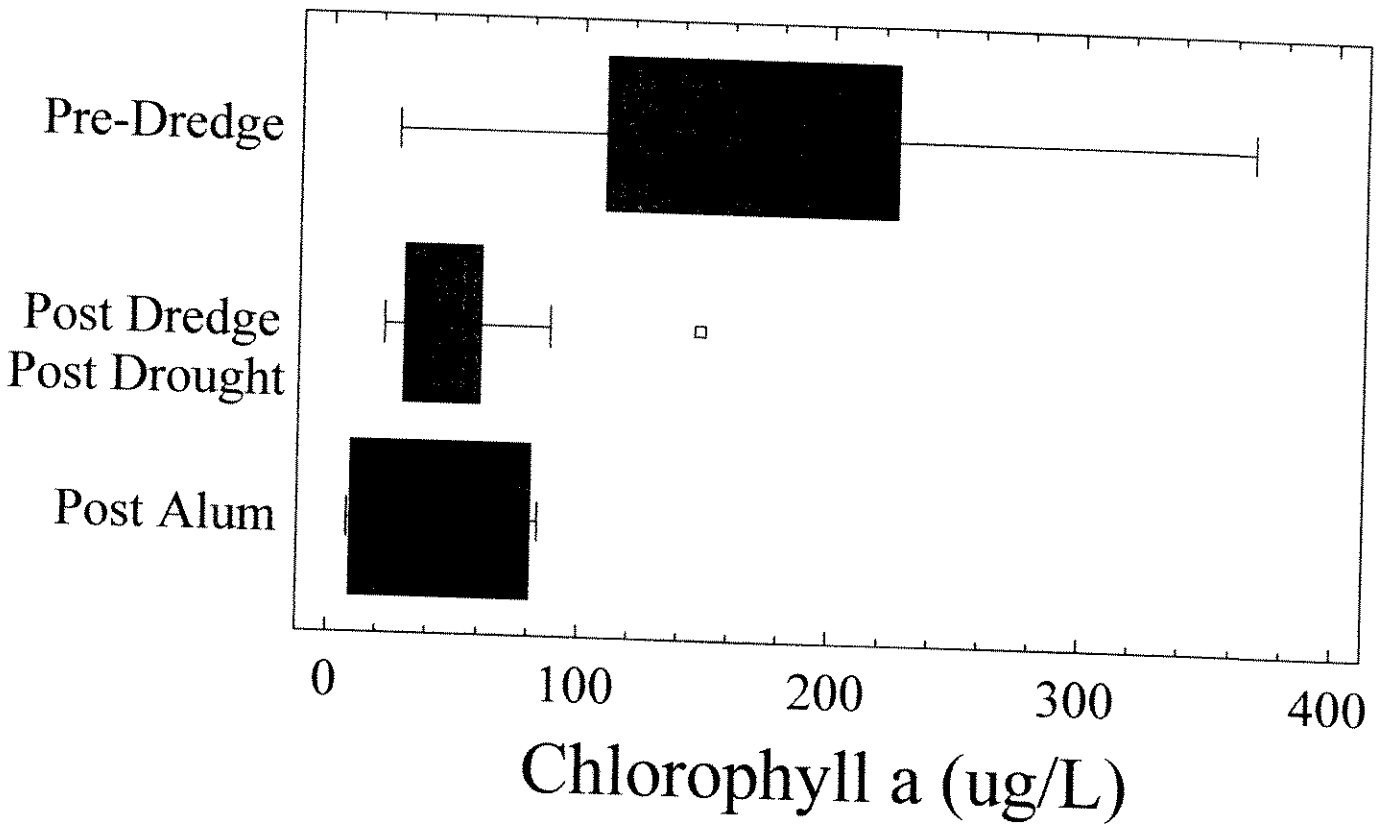
Lake Hollingsworth
Water Clarity



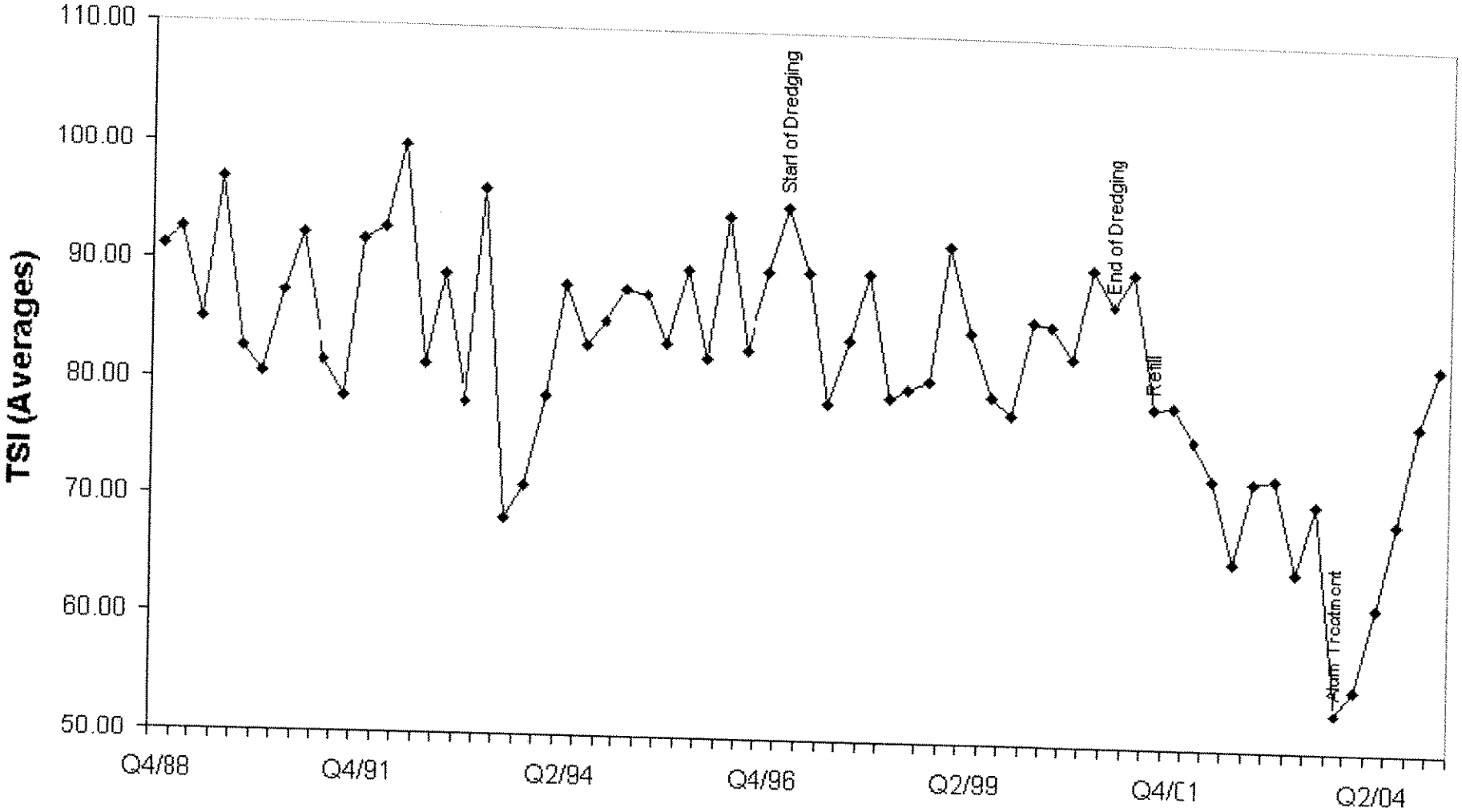
Lake Hollingsworth Chlorophyll a



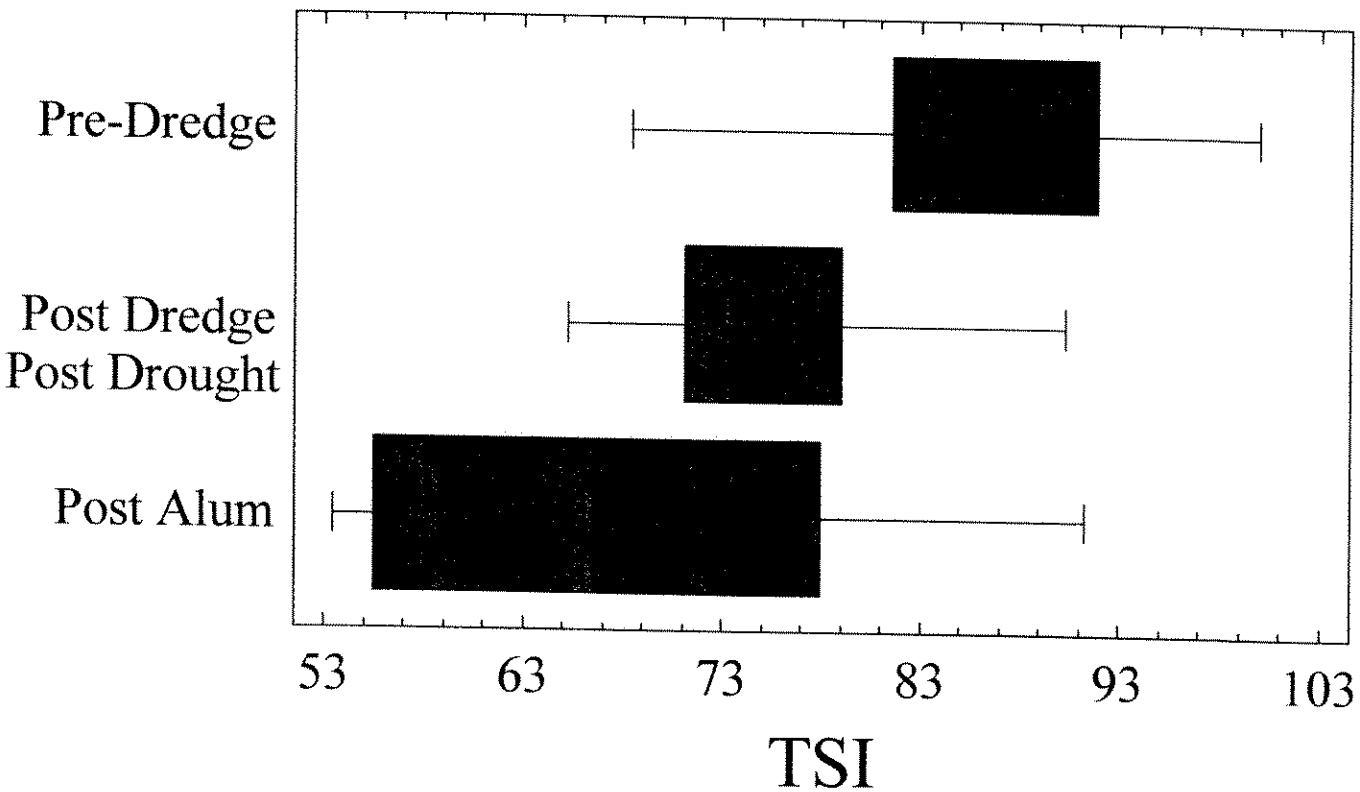
Lake Hollingsworth
Chlorophyll a



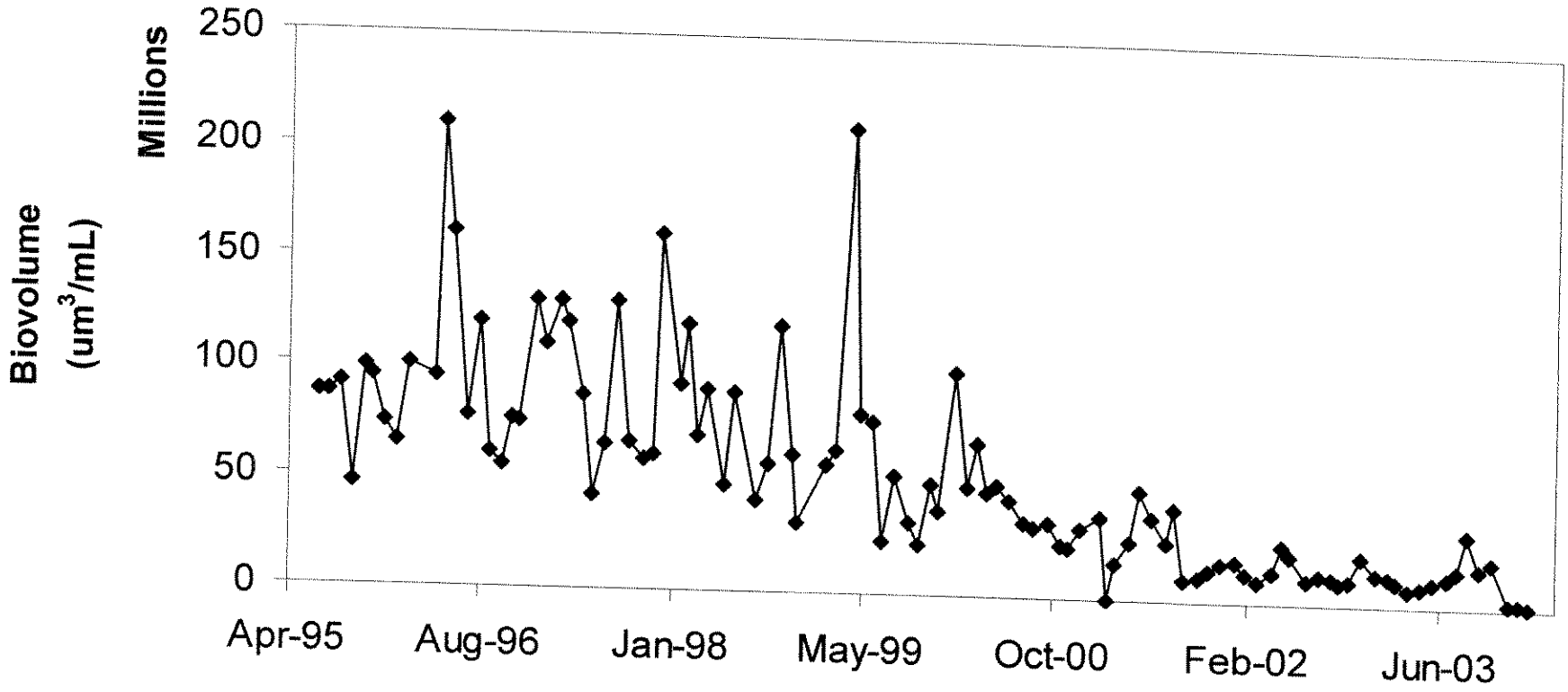
Lake Hollingsworth
Trophic State Index



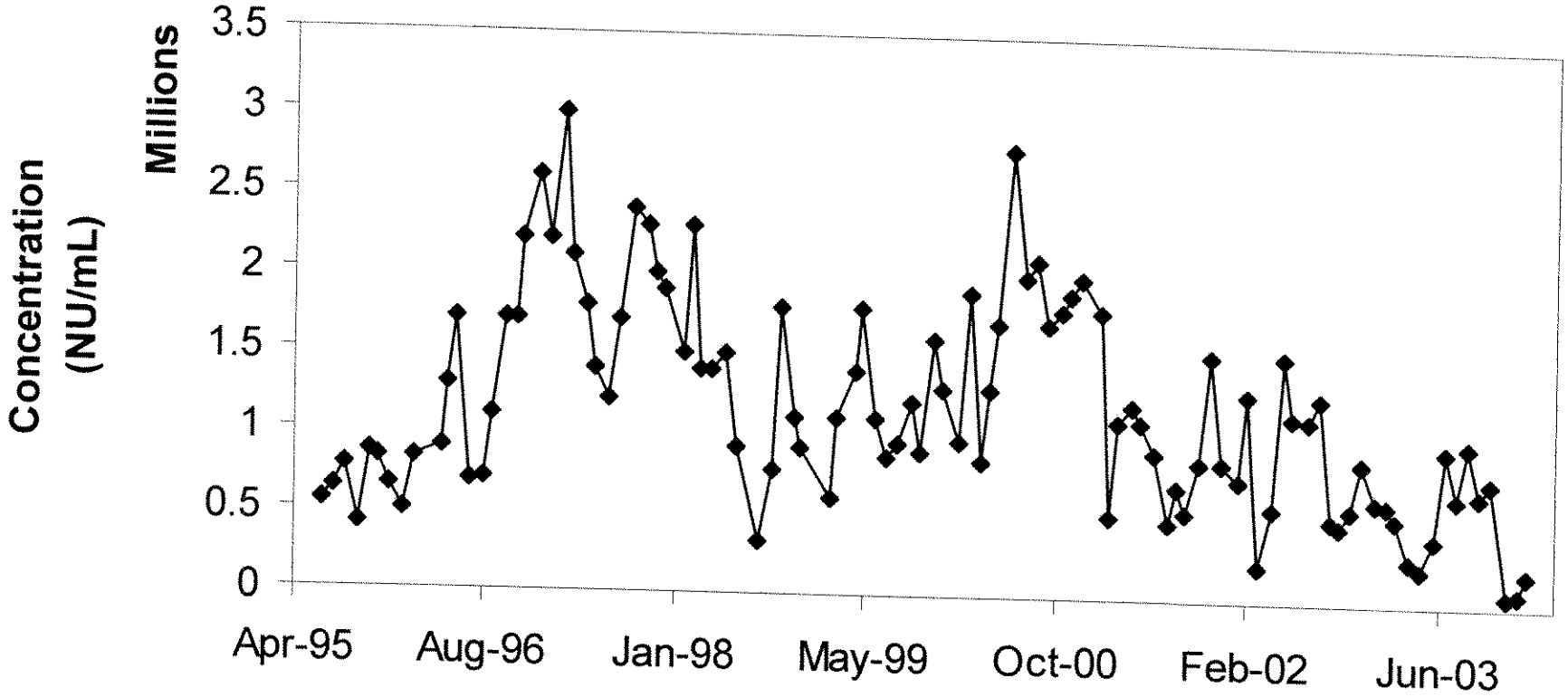
Lake Hollingsworth Trophic State Index



Lake Hollingsworth Phytoplankton



Lake Hollingsworth Phytoplankton



Appendix 2 – Lake Seminole Sediment Quality Data

This appendix contains sediment quality data for Lake Seminole, collected and analyzed as part of this study. Information includes raw laboratory data, and plots of sediment metal:aluminum ratio for selected metals from Lake Seminole samples.

BENCHMARK

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FDHRS Certification #E84167

CORRECTED REPORT

THESE RESULTS MEET NELAC STANDARDS

Submission	Sample #	Sample Description	Sample Date	Sample Time	Sample Method	Compound	Result	Units	MDL	Method	Analysis Date	Analysis Time	Analyst
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	TOTAL KJELDAHL NITROGEN	512	MG//KG	10	351.2	5/26/2005		TDT
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	TOTAL NITROGEN	515	MG/KG	10	353+351	6/1/2005		HAL/TDT
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	NITRATE+NITRITE	3.87	MG/KG	2	353.2	6/1/2005		HAL
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	TOTAL PHOSPHORUS	421	MG/KG	2	365.3	6/15/2005		YW
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	ALUMINUM	3938	MG/KG	23.5	6010	6/7/2005		TB
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	ARSENIC	3.42	MG/KG	1.27	6010	6/7/2005		TB
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	BARIUM	4.67	MG/KG	0.150	6010	6/7/2005		TB
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	CADMIUM	0.299 I	MG/KG	0.154	6010	6/7/2005		TB
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	CHROMIUM	4.60	MG/KG	0.197	6010	6/7/2005		TB
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	LEAD	1.62 I	MG/KG	0.666	6010	6/7/2005		TB
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	COPPER	0.729 I	MG/KG	0.500	6010	6/7/2005		TB
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	ZINC	2.20	MG/KG	0.338	6010	6/7/2005		TB
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	SELENIUM	1.27U	MG/KG	1.27	6010	6/7/2005		TB
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	SILVER	1.28U	MG/KG	1.28	6010	6/7/2005		TB
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	MERCURY	0.004 I	MG/KG	0.003	7471	6/6/2005		TB
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	TOTAL ORGANIC CARBON	2.40	% DRY WT	0.1	NOTES	6/3/2005		JP
5050289	1A	Station 1 Bulk	5/9/2005	1110	Grab	TOTAL SOLIDS	70.6	% DRY WT	0.1	SM2540G	5/23/2005		AK
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	TOTAL KJELDAHL NITROGEN	4522	MG//KG	10	351.2	5/26/2005		TDT
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	TOTAL NITROGEN	4551	MG/KG	10	353+351	6/1/2005		HAL/TDT
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	NITRATE+NITRITE	29.5	MG/KG	2	353.2	6/1/2005		HAL
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	TOTAL PHOSPHORUS	367	MG/KG	2	365.3	5/24/2005		YW
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	ALUMINUM	58146	MG/KG	9.42	6010	6/7/2005		TB
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	ZINC	38.8	MG//KG	0.338	6010	6/7/2005		TB
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	SILVER	1.28U	MG//KG	1.28	6010	6/7/2005		TB
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	LEAD	22.9	MG//KG	0.666	6010	6/7/2005		TB
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	ARSENIC	8.74	MG//KG	1.27	6010	6/7/2005		TB
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	CADMIUM	3.99	MG//KG	0.154	6010	6/7/2005		TB
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	BARIUM	66.1	MG//KG	0.150	6010	6/7/2005		TB
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	SELENIUM	5.81	MG//KG	1.27	6010	6/7/2005		TB
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	CHROMIUM	256	MG//KG	0.197	6010	6/7/2005		TB
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	COPPER	63.8	MG//KG	0.500	6010	6/7/2005		TB
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	MERCURY	0.409 I	MG/KG	0.112	7471	6/6/2005		TB
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	TOTAL ORGANIC CARBON	42.8	% DRY WT	0.1	NOTES	6/3/2005		JP
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	TOTAL SOLIDS	1.78	% DRY WT	0.1	SM2540G	5/23/2005		AK
5050289	1C	Station 1 Elut/Unfiltered	5/9/2005	1110	Grab	SPECIFIC CONDUCTANCE	44700Q	UMHOS/CM	1.24	SM5210B	7/13/2005		JSM
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	TOTAL KJELDAHL NITROGEN	3598	MG//KG	10	351.2	5/26/2005		TDT
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	TOTAL NITROGEN	3773	MG/KG	10	353+351	6/1/2005		HAL/TDT
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	NITRATE+NITRITE	175	MG/KG	2	353.2	6/1/2005		HAL
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	TOTAL PHOSPHORUS	763303	MG/KG	2	365.3	5/24/2005		YW
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	ALUMINUM	34479	MG/KG	47.1	365.3	6/7/2005		TB
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	LEAD	28.3	MG//KG	0.666	6010	6/7/2005		TB
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	ARSENIC	2.91 I	MG//KG	1.27	6010	6/7/2005		TB
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	COPPER	16.5	MG//KG	0.500	6010	6/7/2005		TB
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	SILVER	1.28U	MG//KG	1.28	6010	6/7/2005		TB
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	ZINC	67.3	MG//KG	0.338	6010	6/7/2005		TB
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	BARIUM	54.2	MG//KG	0.150	6010	6/7/2005		TB
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	SELENIUM	1.27U	MG//KG	1.27	6010	6/7/2005		TB
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	CHROMIUM	34.4	MG//KG	0.197	6010	6/7/2005		TB
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	CADMIUM	1.44	MG//KG	0.154	6010	6/7/2005		TB
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	MERCURY	0.089 I	MG/KG	0.024	7471	6/6/2005		TB
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	TOTAL ORGANIC CARBON	23.3	% DRY WT	0.1	NOTES	6/3/2005		JP
5050289	2A	Station 2 Bulk	5/9/2005	1135	Grab	TOTAL SOLIDS	17.6	% DRY WT	0.1	SM2540G	5/23/2005		AK
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	TOTAL KJELDAHL NITROGEN	7785	MG//KG	10	351.2	5/26/2005		TDT
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	TOTAL NITROGEN	7785	MG/KG	10	353+351	6/1/2005		HAL/TDT
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	NITRATE+NITRITE	2U	MG/KG	2	353.2	6/1/2005		HAL
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	TOTAL PHOSPHORUS	909	MG/KG	2	365.3	5/24/2005		YW
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	ALUMINUM	37459	MG/KG	9.42	6010	6/7/2005		TB
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	SILVER	1.28U	MG//KG	1.28	6010	6/7/2005		TB
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	COPPER	43.8	MG//KG	0.500	6010	6/7/2005		TB
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	SELENIUM	1.27U	MG//KG	1.27	6010	6/7/2005		TB
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	LEAD	46.2	MG//KG	0.666	6010	6/7/2005		TB
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	CHROMIUM	74.9	MG//KG	0.197	6010	6/7/2005		TB
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	CADMIUM	3.65	MG//KG	0.154	6010	6/7/2005		TB
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	BARIUM	82.1	MG//KG	0.150	6010	6/7/2005		TB
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	ARSENIC	5.54	MG//KG	1.27	6010	6/7/2005		TB
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	ZINC	5.00	MG//KG	0.338	6010	6/7/2005		TB
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	MERCURY	0.315	MG/KG	0.065	7471	6/6/2005		TB
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	TOTAL ORGANIC CARBON	34.3	% DRY WT	0.1	NOTES	6/3/2005		JP
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	TOTAL SOLIDS	3.07	% DRY WT	0.1	SM2540G	5/23/2005		AK
5050289	2C	Station 2 Elut/Unfiltered	5/9/2005	1135	Grab	SPECIFIC CONDUCTANCE	15470Q	UMHOS/CM	1.24	SM5210B	7/13/2005		JSM
5050289	3A	Station 3 Bulk	5/9/2005	1200	Grab	TOTAL KJELDAHL NITROGEN	625	MG//KG	10	351.2	5/26/2005		TDT
5050289	3A	Station 3 Bulk	5/9/2005	1200	Grab	TOTAL NITROGEN	648	MG/KG	10	353+351	6/1/2005		HAL/TDT

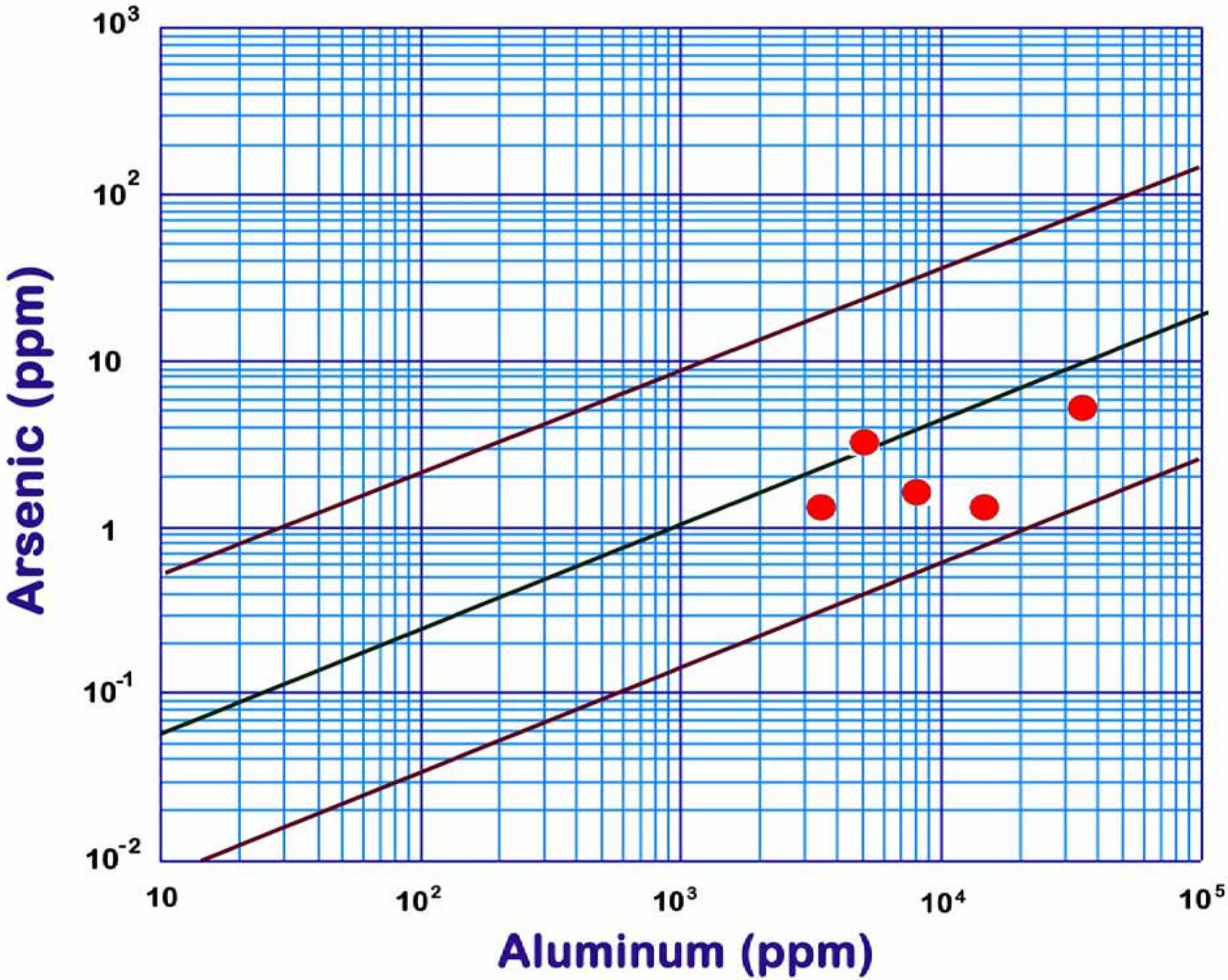
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	NITRATE+NITRITE	22.8	MG/KG	2	353.2	6/1/2005	HAL
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	TOTAL PHOSPHORUS	172344	MG/KG	2	365.3	5/24/2005	YW
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	ALUMINUM	15540	MG/KG	471	365.3	6/7/2005	TB
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	SELENIUM	1.27U	MG//KG	1.27	6010	6/7/2005	TB
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	CADMIUM	0.758	MG//KG	0.154	6010	6/7/2005	TB
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	COPPER	6.12	MG//KG	0.500	6010	6/7/2005	TB
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	BARIUM	16.1	MG//KG	0.150	6010	6/7/2005	TB
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	SILVER	1.28U	MG//KG	1.28	6010	6/7/2005	TB
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	ZINC	3.56	MG//KG	0.338	6010	6/7/2005	TB
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	CHROMIUM	17.1	MG//KG	0.197	6010	6/7/2005	TB
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	ARSENIC	1.27U	MG//KG	1.27	6010	6/7/2005	TB
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	LEAD	4.69	MG//KG	0.666	6010	6/7/2005	TB
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	MERCURY	0.029	MG/KG	0.004	7471	6/6/2005	TB
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	TOTAL ORGANIC CARBON	4.78	% DRY WT	0.1	NOTES	6/3/2005	JP
5050289 3A	Station 3	Bulk	5/9/2005	1200	Grab	TOTAL SOLIDS	56.2	% DRY WT	0.1	SM2540G	5/23/2005	AK
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	TOTAL KJELDAHL NITROGEN	2090	MG//KG	10	351.2	5/26/2005	TDT
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	TOTAL NITROGEN	2093	MG/KG	10	353+351	6/1/2005	HAL/TDT
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	NITRATE+NITRITE	2.58	MG/KG	2	353.2	6/1/2005	HAL
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	TOTAL PHOSPHORUS	597	MG/KG	2	365.3	5/24/2005	YW
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	ALUMINUM	58438	MG/KG	47.1	6010	6/7/2005	TB
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	ARSENIC	3.06 I	MG//KG	1.27	6010	6/7/2005	TB
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	LEAD	17.4	MG//KG	0.666	6010	6/7/2005	TB
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	SELENIUM	1.27U	MG//KG	1.27	6010	6/7/2005	TB
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	SILVER	1.28U	MG//KG	1.28	6010	6/7/2005	TB
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	COPPER	25.9	MG//KG	0.500	6010	6/7/2005	TB
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	ZINC	15.6	MG//KG	0.338	6010	6/7/2005	TB
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	BARIUM	58.7	MG//KG	0.150	6010	6/7/2005	TB
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	CHROMIUM	245	MG//KG	0.197	6010	6/7/2005	TB
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	CADMIUM	3.23	MG//KG	0.154	6010	6/7/2005	TB
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	MERCURY	0.062 I	MG/KG	0.025	7471	6/6/2005	TB
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	TOTAL ORGANIC CARBON	11.8	% DRY WT	0.1	NOTES	6/3/2005	JP
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	TOTAL SOLIDS	7.94	% DRY WT	0.1	SM2540G	5/23/2005	AK
5050289 3C	Station 3	Elut/Unfiltered	5/9/2005	1200	Grab	SPECIFIC CONDUCTANCE	9200Q	UMHOS/CM	1.24	SM5210B	7/13/2005	JSM
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	TOTAL KJELDAHL NITROGEN	338	MG//KG	10	351.2	5/26/2005	TDT
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	TOTAL NITROGEN	7004	MG/KG	10	353+351	6/1/2005	HAL/TDT
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	NITRATE+NITRITE	6667	MG/KG	2	353.2	6/1/2005	HAL
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	TOTAL PHOSPHORUS	73356	MG/KG	2	365.3	5/24/2005	YW
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	ALUMINUM	8229	MG/KG	471	6010	6/7/2005	TB
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	ARSENIC	1.76 I	MG//KG	1.27	6010	6/7/2005	TB
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	BARIUM	6.75	MG//KG	0.150	6010	6/7/2005	TB
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	CADMIUM	0.623	MG//KG	0.154	6010	6/7/2005	TB
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	CHROMIUM	9.31	MG//KG	0.197	6010	6/7/2005	TB
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	LEAD	2.19 I	MG//KG	0.666	6010	6/7/2005	TB
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	SELENIUM	1.27U	MG//KG	1.27	6010	6/7/2005	TB
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	COPPER	0.500U	MG//KG	0.500	6010	6/7/2005	TB
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	ZINC	1.84	MG//KG	0.338	6010	6/7/2005	TB
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	SILVER	1.28U	MG//KG	1.28	6010	6/7/2005	TB
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	MERCURY	0.003U	MG/KG	0.003	7471	6/6/2005	TB
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	TOTAL ORGANIC CARBON	2.56	% DRY WT	0.1	NOTES	6/3/2005	JP
5050289 4A	Station 4	Bulk	5/9/2005	1210	Grab	TOTAL SOLIDS	68.8	% DRY WT	0.1	SM2540G	5/23/2005	AK
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	TOTAL KJELDAHL NITROGEN	3288	MG//KG	10	351.2	5/26/2005	TDT
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	TOTAL NITROGEN	3288	MG/KG	10	353+351	6/1/2005	HAL/TDT
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	NITRATE+NITRITE	2U	MG/KG	2	353.2	6/1/2005	HAL
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	TOTAL PHOSPHORUS	213	MG/KG	2	365.3	5/24/2005	YW
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	ALUMINUM	25170	MG/KG	9.42	6010	6/7/2005	TB
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	LEAD	9.02	MG//KG	0.666	6010	6/7/2005	TB
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	ZINC	9.75	MG//KG	0.338	6010	6/7/2005	TB
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	BARIUM	25.3	MG//KG	0.150	6010	6/7/2005	TB
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	CHROMIUM	881	MG//KG	0.197	6010	6/7/2005	TB
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	CADMIUM	2.73	MG//KG	0.154	6010	6/7/2005	TB
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	SELENIUM	1.27U	MG//KG	1.27	6010	6/7/2005	TB
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	SILVER	1.28U	MG//KG	1.28	6010	6/7/2005	TB
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	COPPER	98.0	MG//KG	0.500	6010	6/7/2005	TB
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	ARSENIC	5.66	MG//KG	1.27	6010	6/7/2005	TB
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	MERCURY	0.083 I	MG/KG	0.027	7471	6/6/2005	TB
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	TOTAL ORGANIC CARBON	10.6	% DRY WT	0.1	NOTES	6/3/2005	JP
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	TOTAL SOLIDS	7.33	% DRY WT	0.1	SM2540G	5/23/2005	AK
5050289 4C	Station 4	Elut/Unfiltered	5/9/2005	1210	Grab	SPECIFIC CONDUCTANCE	12700Q	UMHOS/CM	1.24	SM5210B	7/13/2005	JSM
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	TOTAL KJELDAHL NITROGEN	260	MG//KG	10	351.2	5/26/2005	TDT
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	TOTAL NITROGEN	267	MG/KG	10	353+351	6/1/2005	HAL/TDT
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	NITRATE+NITRITE	6.39	MG/KG	2	353.2	6/1/2005	HAL
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	TOTAL PHOSPHORUS	111063	MG/KG	2	365.3	5/24/2005	YW
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	ALUMINUM	3387	MG/KG	23.5	6010	6/7/2005	TB
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	SELENIUM	1.27U	MG//KG	1.27	6010	6/7/2005	TB
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	LEAD	1.83 I	MG//KG	0.666	6010	6/7/2005	TB
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	ARSENIC	1.27U	MG//KG	1.27	6010	6/7/2005	TB
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	BARIUM	5.71	MG//KG	0.150	6010	6/7/2005	TB
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	CADMIUM	0.277 I	MG//KG	0.154	6010	6/7/2005	TB
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	CHROMIUM	4.60	MG//KG	0.197	6010	6/7/2005	TB
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	SILVER	1.28U	MG//KG	1.28	6010	6/7/2005	TB
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	COPPER	0.707 I	MG//KG	0.500	6010	6/7/2005	TB
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	ZINC	2.71	MG//KG	0.338	6010	6/7/2005	TB
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	MERCURY	0.009	MG/KG	0.002	7471	6/6/2005	TB
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	TOTAL ORGANIC CARBON	0.966	% DRY WT	0.1	NOTES	6/3/2005	JP
5050289 5A	Station 5	Bulk	5/9/2005	1225	Grab	TOTAL SOLIDS	78.3	% DRY WT	0.1	SM2540G	5/23/2005	AK
5050289 5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	TOTAL KJELDAHL NITROGEN	6388	MG//KG	10	351.2	5/26/2005	TDT
5050289 5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	TOTAL NITROGEN	6393	MG/KG	10	353+351	6/1/2005	HAL/TDT

5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	NITRATE+NITRITE	5.14	MG/KG	2	353.2	6/1/2005	HAL
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	TOTAL PHOSPHORUS	388	MG/KG	2	365.3	5/24/2005	YW
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	ALUMINUM	39354	MG/KG	9.42	6010	6/7/2005	TB
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	ARSENIC	9.41	MG//KG	1.27	6010	6/7/2005	TB
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	ZINC	36.8	MG//KG	0.338	6010	6/7/2005	TB
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	COPPER	90.6	MG//KG	0.500	6010	6/7/2005	TB
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	SILVER	1.28U	MG//KG	1.28	6010	6/7/2005	TB
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	SELENIUM	6.90	MG//KG	1.27	6010	6/7/2005	TB
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	LEAD	23.4	MG//KG	0.666	6010	6/7/2005	TB
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	CHROMIUM	1243	MG//KG	0.197	6010	6/7/2005	TB
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	BARIUM	66.9	MG//KG	0.150	6010	6/7/2005	TB
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	CADMIUM	38.0	MG//KG	0.154	6010	6/7/2005	TB
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	MERCURY	0.06	MG/KG	0.003	7471	6/7/2005	TB
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	TOTAL ORGANIC CARBON	17.1	% DRY WT	0.1	NOTES	6/3/2005	JP
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	TOTAL SOLIDS	2.63	% DRY WT	0.1	SM2540G	5/23/2005	AK
5050289	5C	Station 5	Elut/Unfiltered	5/9/2005	1225	Grab	SPECIFIC CONDUCTANCE	9200Q	UMHOS/CM	1.24	SM5210B	7/13/2005	JSM

Qualifiers:
I = Reported value is between laboratory MDL and the PQL (PQL = 4xMDL)
U = Analyte not detected at the value indicated.

Notes:
PQL is 4 x MDL

CORRECTED REPORT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10^{-2}
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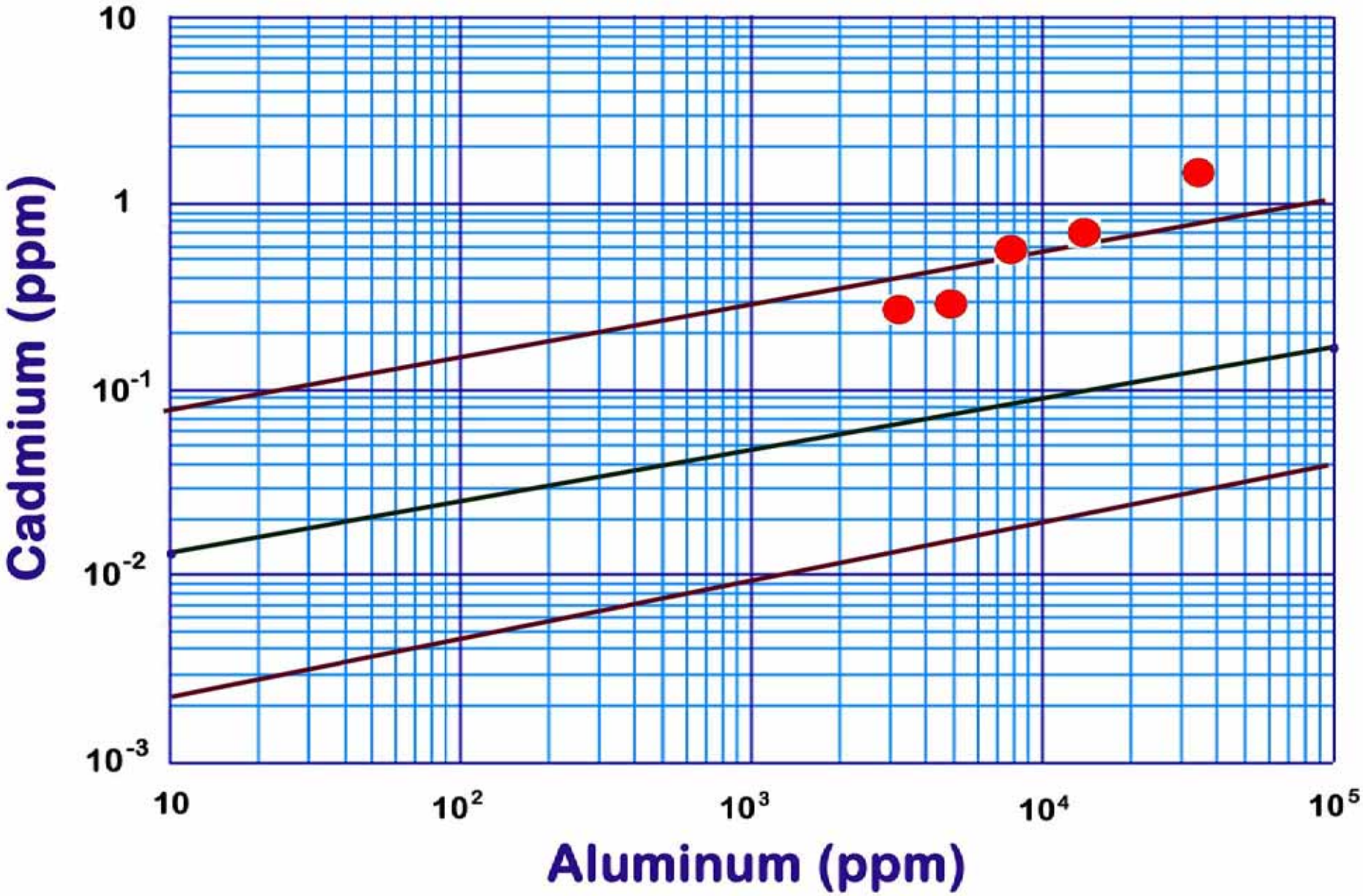
10^2
10^3
10^4
10^5
Aluminum (ppm)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10^{-3}
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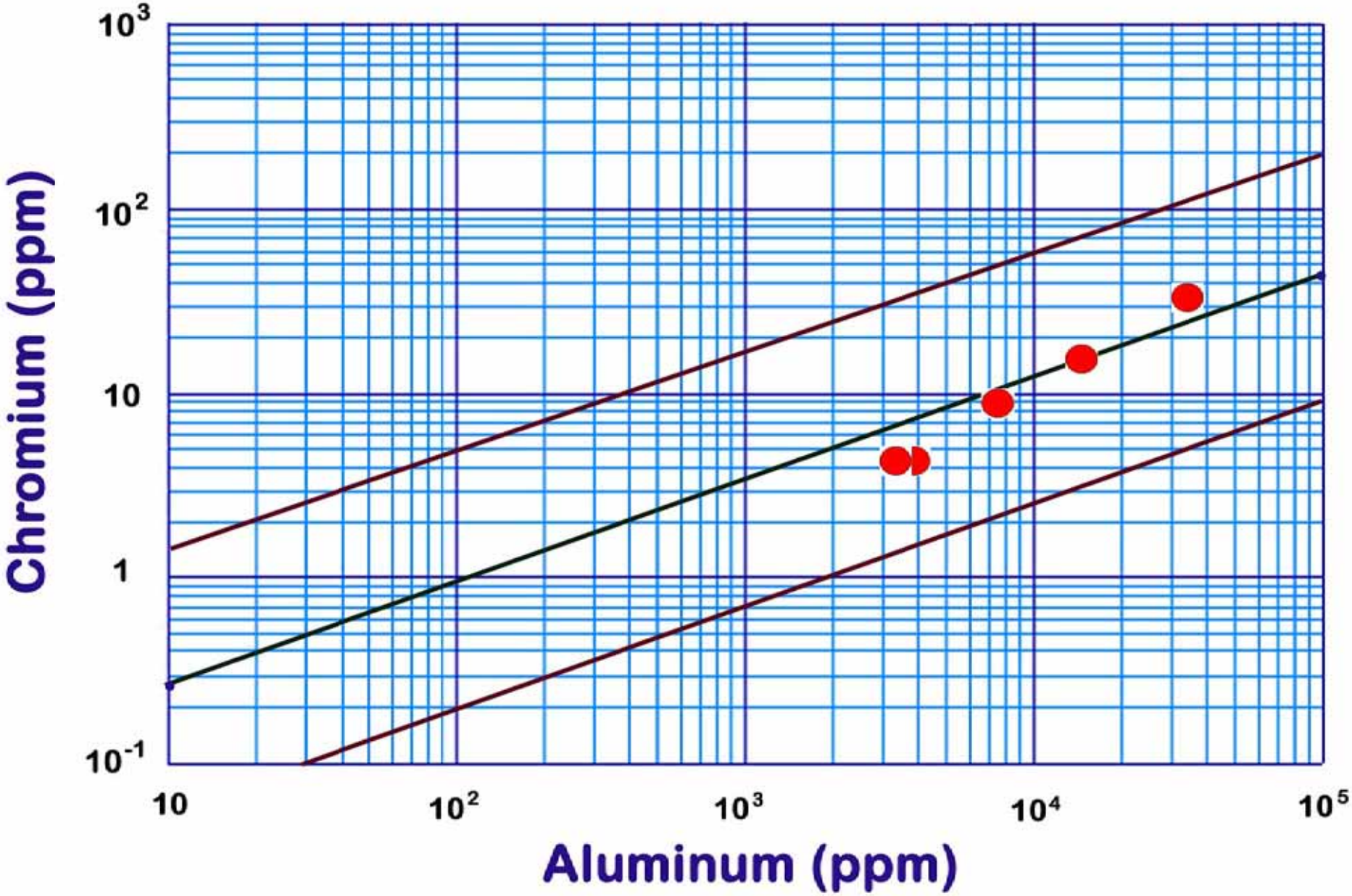
Aluminum (ppm)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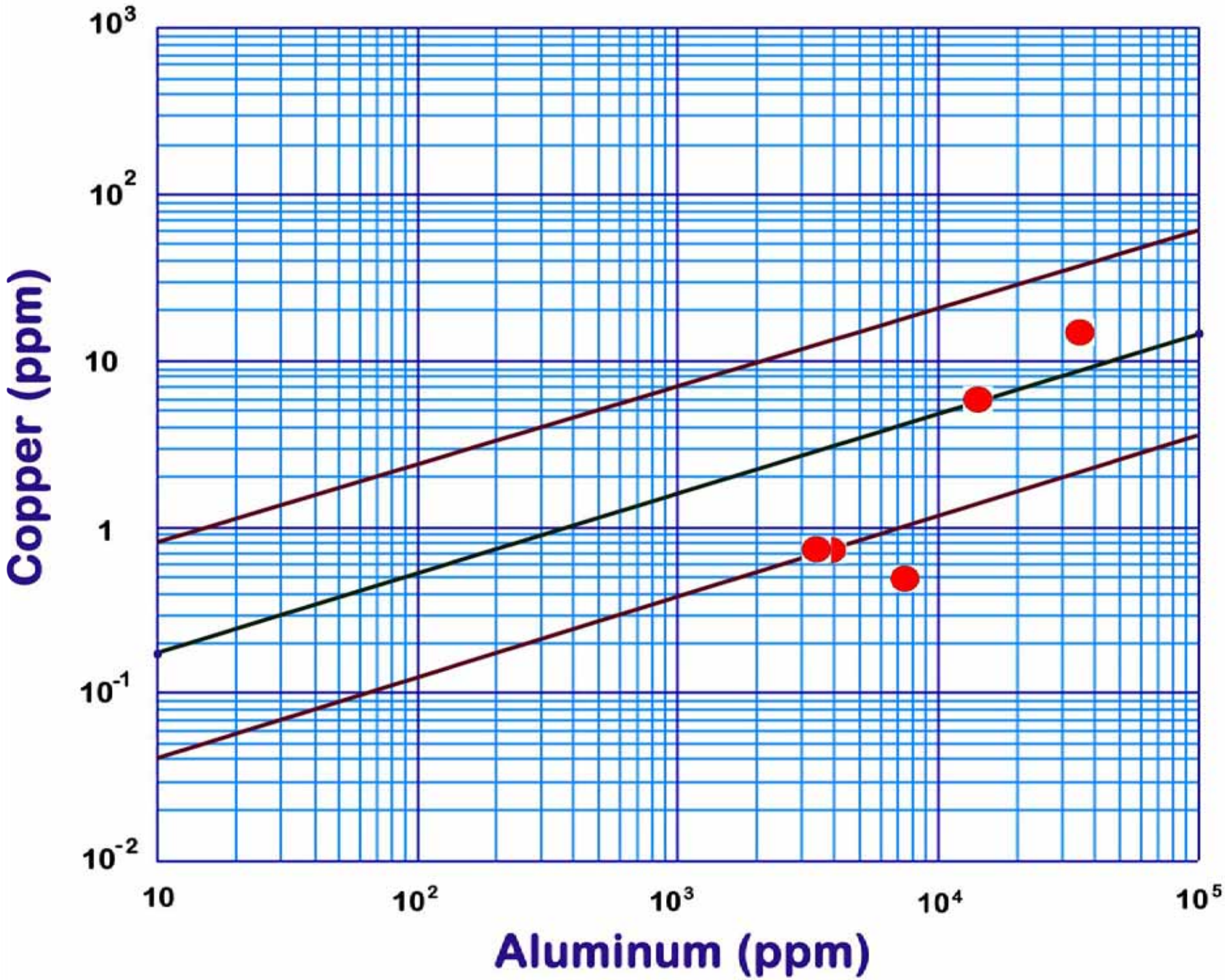
10^2
10^3
10^4
10^5
Aluminum (ppm)


Copper (ppm)
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10^3
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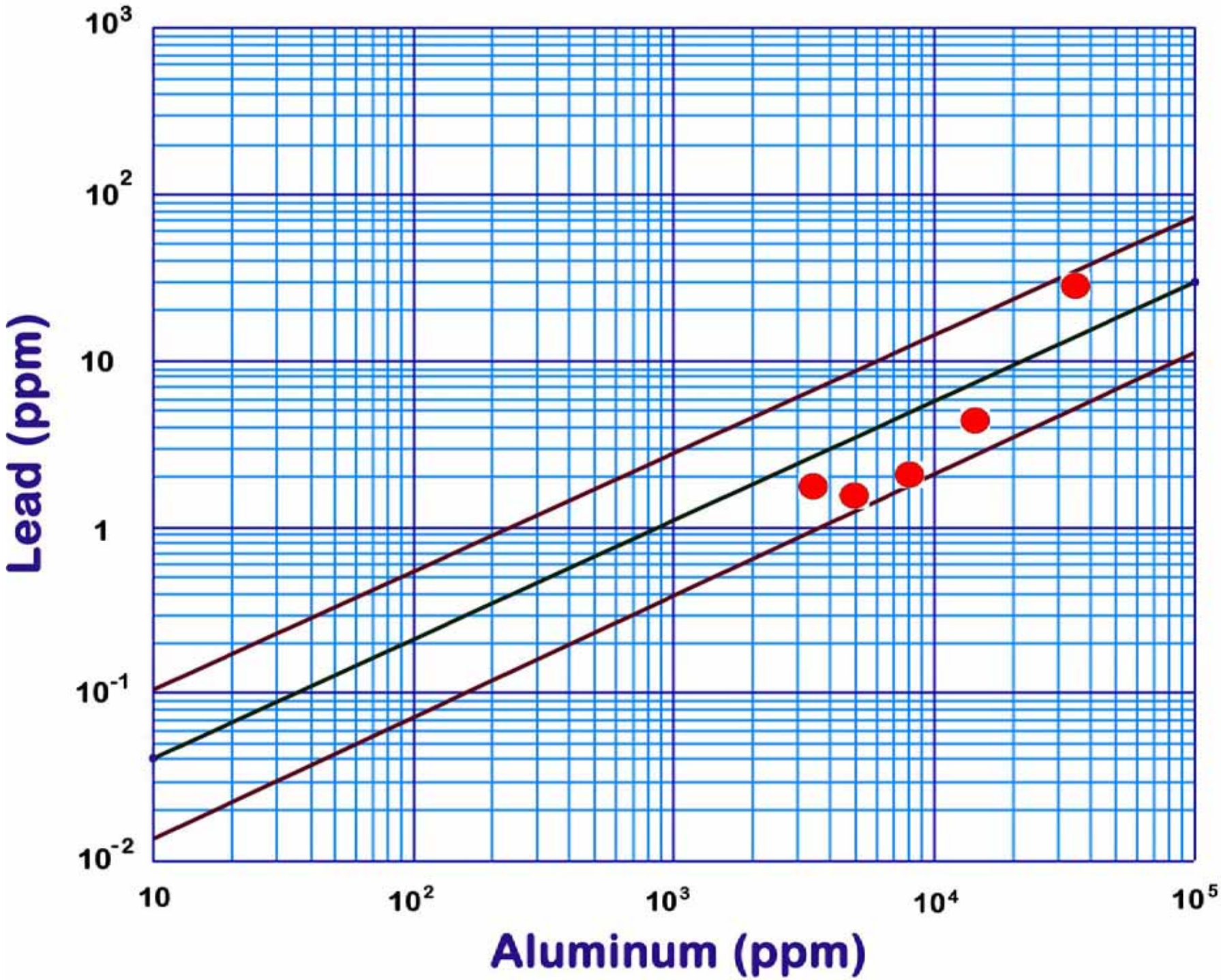
Aluminum (ppm)


Lead (ppm)
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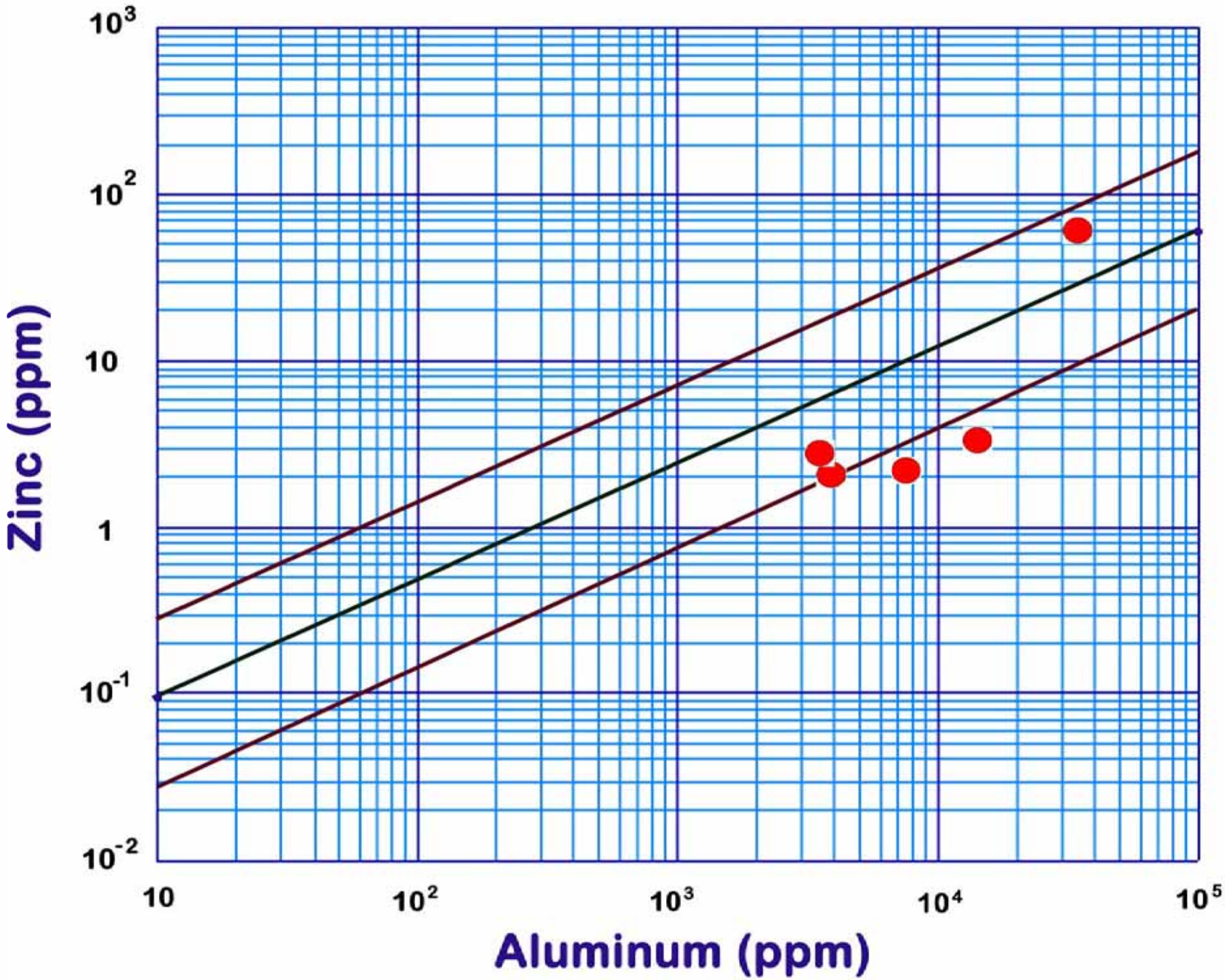
10^2
10^3
10^4
10^5
Aluminum (ppm)


Zinc (ppm)
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10^2
10
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10^{-1}
10^{-2}
10
10^2
10^3
10^4
10^5
Aluminum (ppm)

Appendix 3 – Project Alternative Cost Analysis

This Appendix contains detailed cost breakdowns for all project alternatives considered in Section 5 of this document. Where applicable, footnotes are used to provide additional detail.

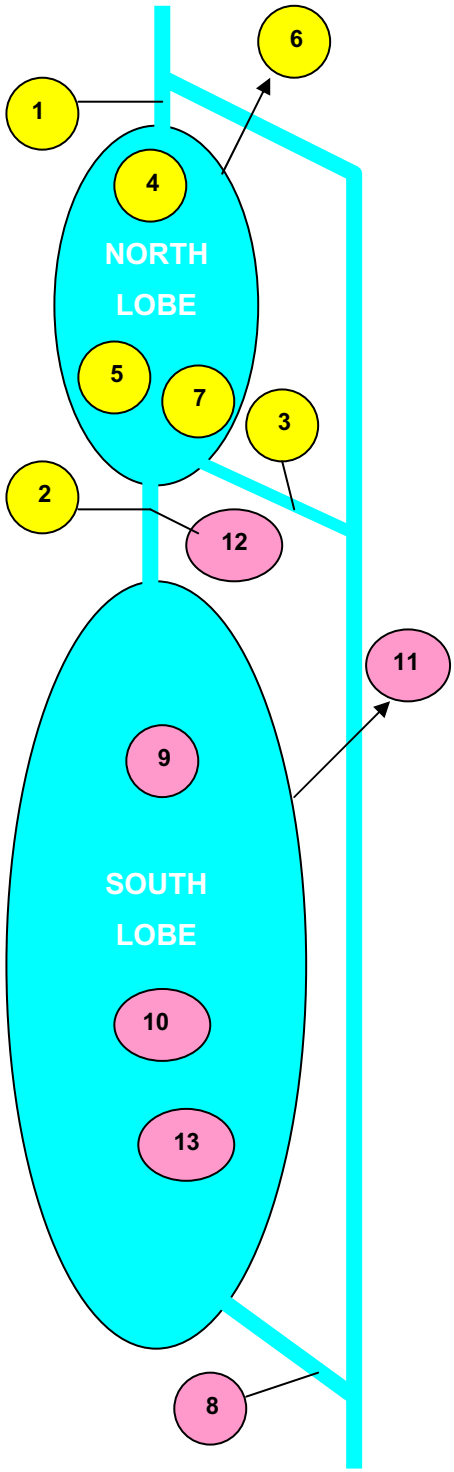
Alternative 1 – Lake Drawdown with Excavation

The cost breakdown for Alternative 1 is shown in Table A3-1. These cost estimates were developed based on the project phasing plan shown in Figure A3-1. Applicable footnotes are provided below.

Table A3-1
Cost Estimate for Alternative 1

WORK ITEM	COST
CONSTRUCTION COSTS	
Phase One/North Lobe	
Interdict and block surface water inflows (1) install level-control dam[A]	$750,000
Interdict and block south outflow (2) install dam[B] at narrows	$1,360,000
Drain north lobe[C] through diversion channel (3) w/ new level-control dam	$280,000[D]
Air-dry settled, compacted muck sediment[E]	-----
Bulldoze, load and dispose air-dried sediment / 350,000 cy[F] @ $25/	$8,750,000
Refill north lobe by lowering level-control at level-control dam (1)	$200,000
Total Phase 1 Construction Cost	$11,340,00
Phase Two/South Lobe	
Interdict and block south outflow (8) install level-control dam[A]	$750,000
Drain south lobe through diversion channel and new level-control dam at (8)	$280,000
Air-dry settled, compacted muck-sediment[E]	-----
Bulldoze, load and dispose air-dried sediment / 600,000[G] cy @ $25/cy	$15,000,000
Break-down, load and dispose narrows dam material / 185,000 cy[H] @ $25/cy	$4,625,000
Refill south lobe by raising level-control at level-control dam	$100,000
Total Phase 2 Construction Cost	**$20,755,000**
Total Construction Cost	**$32,095,000**
Contingency Factor (40%)[K]	**$12,838,000**
Total Construction Cost with Contingency	**$44,933,000**
ENGINEERING AND ADMINISTRATION COSTS	
Contractor Administrative Cost & Profit / included in contracted cost items	-----
Engineering and Permitting @ 6% of Total Contracted Cost	$2,960,000
On-Going Project-Engineering Management @ $200,000/year for 14 years	$2,800,000
Pinellas County Administrative Costs @ $250,000/year for 14 years	--NI--
Total Engineering and Administrative Cost/No Contingency	**$5,760,000**
TOTAL COST ESTIMATE FOR ALTERNATIVE 1	**$50,7000,000**

Figure A3-1
Phased Approach to Lake Drawdown and Excavation



PHASE ONE / NORTH LOBE

Concept

1. Interdict and block north inflow.
2. Interdict and block south outflow.
3. Drain North Lobe completely.
4. Air-dry settled, compacted sediment.
5. Bulldoze and load air-dried sediment.
6. Haul away air-dried sediment.
7. Refill North Lobe.

Removal Specification

Material – sediment, bottom-scrape and vegetation
Weight – 221,500 tons (total north lobe project)
Volume – 215,500 CY (total north lobe project)

North Lobe Project Duration

5.5 Years

PHASE TWO / SOUTH LOBE

Concept

8. Drain South Lobe completely.
9. Air-dry settled, compacted sediment.
10. Bulldoze and load air-dried sediment.
11. Haul away air-dried sediment.
12. Open narrows interdiction.
13. Refill South Lobe.

Removal Specification

Material – sediment, bottom-scrape, vegetation
Weight – 3737,200 tons (total south lobe project)
Volume – 363,000 CY (total south lobe project)

South Lobe Project Duration

8.1 Years

- Level-Control Dam[A] – The purpose of interdicting and blocking the points indicated on the phasing diagram is to promote air-drying by eliminating surface-water incursion, insofar as it may be possible. Therefore, a tight seal for several years is called for – something that cannot be achieved by an earthen levee which would likely be porous to seepage. This impoundment would require the construction of a mini-dam with deep piling, interlocking steel sheeting (and sand and gravel), anchored securely from the shoreline to a sufficient distance inland. It should be noted that no cost for removal has been included because it is assumed that it could be desirable to leave such a structure in place to allow for management of bypass canal inflows.

- Dam[B] – The narrows-dam would serve exactly the same purpose and, therefore, must be constructed in exactly the same way (albeit without level-control mechanisms), even though it would be totally removed upon project completion. It is, however, a comparatively larger undertaking, which is reflected in the much greater cost.

- Drain north lobe[C] and air-dry settled, compacted muck-sediment[E] – There is virtually no possibility that the north lobe (or the south lobe) will drain sufficiently to produce an air-dried, settled, compacted muck-sediment, except around the exposed shallow lake periphery. Rain and the hydraulic-gradient relative to surrounding areas and the Gulf are natural factors that would be very difficult to overcome.

- $280,000[D] – The figure represents work necessary on the diversion channels, not the level-control dams.

- 350,000 cy[F] – The phasing diagram indicates 205,000 cy, which would be the correct figure, if the material were actually air-dried, which is highly unlikely. The material would actually be wet muck with a much larger volume.

- 600,000 cy[G] – Again, the phasing diagram indicates 350,000 cy, which would be the correct figure if the material were actually air-dried, which is highly unlikely.

- 40%[K] – Realistically, considering the 14 year project duration, long-term escalations and all of the potential problems associated with dewatering the lake bottom, a higher contingency – 50% to 60% - could be justified.

Alternative 2 – In-Lake Lagoons

The cost breakdown for Alternatives 2A and 2B are shown in Table A3-2. Applicable footnotes are provided below.

Table A3-2
Cost Estimate for Alternatives 2A and 2B

WORK ITEM	COST ALTERNATIVE 2A	COST ALTERNATIVE 2B
CONSTRUCTION COSTS		
Drawdown lake (using Alternative I methods)[A]	$300,000	$300,000
Construct In-Lake Lagoon[B]		
- Bulldoze and Labor	$1,200,000	$1,200,000
- Sand and Gravel / 105,000cy @ $3.50/cy	$525,000	$525,000
- Poly-net / 2-ply / 16,500 sy @ $3.00/sy installed	$49,500	$49,500
- Distributor piping and pumps / installed	$250,000	$250,000
- Sand[C] / Internal Base / 1,450,000 cy @ $2.75/cy	$3,990,000	$3,990,000
Flocculent Polymer and Polymer Injection System[D]	-----	$2,500,000
Dredging / Equipment and Labor	$1,000,000	$1,000,000
Excavate and Remove Lagoons / 1,555,000 cy[E] @ $12/cy	$18,660,000	$18,660,000
Total Construction Cost w/o Contingency	$25,974,500	$28,474,500
Contingency Factor (25%)	$6,493,625	$7,118,625
Total Construction Cost with Contingency	$32,468,125	$35,593,125
ENGINEERING AND ADMINISTRATION COSTS		
Contractor Admin Cost & Profit / included in Task Items	-----	-----
Engineering and Permitting @ 6% of Total Contracted Cost	$2,109,000	$2,297,000
Project Engineering Management @ $200,000/yr/4 years	$800,000	$800,000
Pinellas County Administration @ $250,000/yr for 4 years	--NI--	--NI--
Total Engineering/Administrative Cost/No Contingency	$2,909,000	$3,097,000
TOTAL COST ESTIMATE FOR ALTERNATIVES 2A & 2B	**$35,400,000**	**$38,700,000**

- Drawdown lake (using Alternative 1 methods)[A] – The drawdown must only expose that portion of the lake necessary for construction. Therefore, it would involve only a partial drawdown.

- Construct In-Lake Lagoon[B] – All of the quantities have been calculated based on these assumptions: a 200 acre lagoon upper surface, periphery diking with a 1 in 6 internal and external slope, with external and internal 2-ply poly-net dike-surface reinforcement.

- Sand[C] /Internal Base – calculated based on a 6 foot depth.

- Flocculent Polymer and Polymer Injection System[D] – A quotation based on current pricing only.

- 1,555,000 cy[E] – The total of all lagoon sand and gravel, exclusive of poly-net to be hauled away and disposed.

Alternative 3 – Upland Lagoons

The cost breakdown for Alternatives 3A and 3B are shown in Table A3-3. Applicable footnotes are provided below.

Table A3-3
Cost Estimate for Alternatives 3A and 3B

WORK ITEM	COST ALTERNATIVE 3A	COST ALTERNATIVE 3B
CONSTRUCTION COSTS		
Land Acquisition / 300 acres[A]	--NI--	--NI--
Site Preparation[B] / 300 acres @ $50 acres	$1,500,000	$1,500,000
Install Appurtenant Facilities (ingress and egress)	$1,500,000	$1,500,000
Construct Four Upland Lagoons[C]	-----	-----
- Sand and Gravel / 270,000 cy @ $3.50/cy	$945,000	$945,000
- Poly-net / 2-ply / 21,900 sy @ $3.00/sy installed	$66,000	$66,000
- Distributor Piping and Pumps / installed	$1,800,000	$1,800,000
- Electrical Equipment & Material / installed	$1,640,000	$1,640,000
Flocculent Polymer and Polymer Injection System	-----	$2,500,000
Dredging Equipment, Pumps, Pipe and Labor	$1,460,000	$1,460,000
Excavate and Remove Lagoons / 1,520,000 cy[D] @ $12/cy	$18,240,000	$18,240,000
Restore Site 300 acres @ $1500/acre	$600,000	$600,000
Total Construction Cost w/o Contingency	**$27,751,000**	**$30,251,000**
Contingency Factor (25%)	**$6,937,750**	**$7,562,750**
Total Construction Cost with Contingency	**$34,688,750**	**$37,813,750**
ENGINEERING AND ADMINISTRATION COSTS		
Contractor Admin Cost & Profit / included in Task Items	-----	-----
Engineering and Permitting @ 6% of Total Contracted Cost	$2,066,000	$2,194,000
Project Engineering Management @ $200,000/yr/4 years	$800,000	$800,000
Pinellas County Administration @ $250,000/yr for 4 years	--NI--	--NI--
Total Engineering/Administrative Cost/No Contingency	**$2,866,000**	**$2,994,000**
TOTAL COST ESTIMATE FOR ALTERNATIVES 3A & 3B	**$37,600,000**	**$40,800,000**

- Land acquisition[A] – The cost of land acquisition is a tremendously important consideration, particularly insofar as these alternatives require 300 acres in an area where whatever land that may be available can only be purchased at premium prices.

- Site Preparation [B] – The unit cost for site preparation includes hauling away material.

- Construct Four Up-Land Lagoons[C] – All of the quantities have been calculated based on these assumptions: periphery diking with a 500 internal and exterior slope and external and internal 2-ply poly-net dike-surface reinforcement.

- 1,520,000 cy[D] – The figure includes both lagoon construction and settled material.

Alternative 4 – Mechanical Dewatering with Solids Discharge to the County Wastewater System

The cost breakdown for Alternative 4 is shown in Table A3-4.

Table A3-4
Cost Estimate for Alternative 4

WORK ITEM	COST
CAPITAL COSTS	
Land Acquisition / 10 acres	--NI--
Dredge / Ellicott Mud-Cat / 1500 gpm capacity	$247,000
Dredge Water Vibrating Screen / Synergy / w/ motors and spare screen	$54,300
Centrifuge, Sand / Bird-Wemco / coal-type w/ motor and lube system	$101,540
Clarifier-Thickeners / Two / Eimco / w/ drives, rakes and weirs	$202,000
Polymer, Flocculent / SNF / w/ dosing system and tank	$1,520,000
Conveyor, Sand Centrifuge Take-Off / screw-type w/ motor	$13,120
Conveyor, Sand Disposal-Truck Loading	$12,000
Pumps, Clarifier Underflow / Two / positive displacement w/ motor	$16,800
Pumps, Clarifier Overflow / Two / centrifugal w/ motor	$14,700
Pump, Dredge-Water Boost / 300 Hp w/ steel base plate	$42,800
Instrumentation and Control Panels / incl. two mag-flow meters w/ n-density	$312,000
Buildings, Site Temporary / Three / admin., lab, tool-storage / w/ furniture	$115,000
Loader, Front-End	$28,500
Fork-Lift	$18,300
Truck, Pick-Up / used	$22,000
Tools and Miscellaneous	$80,000
Capital Cost Item Sub-Total / w/o Contingency	**$2,800,060**
Contingency Factor (15%)	**$420,009**
Capital Cost Item Total / w/ Contingency	**$3,220,069**
OPERATIONAL COSTS	
Personnel, On-site	$2,640,000
Erection and Installation / incl. electrical, piping, roads, site-clearing, etc.	$940,000
Maintenance, Outside Contract / general – mechanical and electrical equipment	$400,000
Power, Electrical / 22 months	$270,000
Trucking, Disposal / 19,300 cy sand @ $2.50/cy	$48,000
Operational Cost Item Sub-Total / w/o Contingency	**$4,298,000**
Contingency Factor (15%)	**$644,700**
Operational Cost Item Total / w/ Contingency	**$4,942,700**
ENGINEERING AND ADMINISTRATION COSTS	
Contractor Administrative Cost and Profit	$1,000,000
Engineering and Permitting @ 6% of total capital and operational cost	$489,766
Project Engineering Management @ $200,000 for 2 years	$400,000
Pinellas County Administration @ $250,000 for 2 years	--NI--
Engineering and Administration Cost Item Total / w/o Contingency	**$1,889,766**
TOTAL COST ESTIMATE FOR ALTERNATIVE 4	**$10,052,535**

Alternative 5 – Mechanical Low Gravity Dewatering

The cost breakdown for Alternative 5 is shown in Table A3-5.

Table A3-5
Cost Estimate for Alternative 5

WORK ITEM	COST
CAPITAL COSTS	
Land Acquisition / 10 acres	--NI--
Dredge / Ellicott Mud-Cat / 1500 gpm capacity	$247,000
Dredge Water Vibrating Screen / Synergy / w/ motors and spare screen	$54,300
Centrifuge, Sand / Bird-Wemco / coal-type w/ motor and lube system	$101,540
Clarifier-Thickeners / Two / Eimco / w/ drives, rakes and weirs	$202,000
Polymer, Flocculent / SNF / w/ dosing system and tank	$1,920,000
Conveyor, ORM Belt Filter Take-Off / Belt-type w/motor	$14,200
Conveyor, Sand Centrifuge Take-Off / Screw-type w/motor	$13,120
Conveyor, ORM Disposal-Truck Loading weigh belt w/motor	$18,200
Conveyor, Sand Disposal-Truck Loading weigh belt w/motor	$18,200
Pumps, Clarifier Underflow / Two / positive displacement w/ motor	$16,800
Pumps, Clarifier Overflow / Two / centrifugal w/ motor	$14,700
Pumps, ORM Screen Underflow / centrifugal w/ motor	$19,600
Pump, Dredge-Water Boost / 300 Hp w/ steel base plate	$42,800
Instrumentation and Control Panels / incl. two mag-flow meters w/ n-density	$312,000
Platform, Steel Operating/ double-deck with ladder and stairs	$285,000
Buildings, Site Temporary / Three / admin., lab, tool-storage / w/ furniture	$115,000
Loader, Front-End	$28,500
Fork-Lift	$18,000
Truck, Pick-Up / used	$22,000
Tools and Miscellaneous	$80,000
Capital Cost Item Sub-Total / w/o Contingency	**$4,122,960**
Contingency Factor (15%)	**$618,440**
Capital Cost Item Total / w/ Contingency	**$4,741,400**
OPERATIONAL COSTS	
Personnel, On-site	$3,425,000
Erection and Installation / incl. electrical, piping, roads, site-clearing, etc.	$1,340,000
Maintenance, Outside Contract / general – mechanical and electrical equipment	$400,000
Power, Electrical / 22 months	$245,000
Trucking, Disposal / 19,300 cy sand + 420,000 cy ORM @ $2.50/cy	$10,982,000
Operational Cost Item Sub-Total / w/o Contingency	**$16,392,000**
Contingency Factor (15%)	**$2,458,800**
Operational Cost Item Total / w/ Contingency	**$18,850,800**
ENGINEERING AND ADMINISTRATION COSTS	
Contractor Administrative Cost and Profit	$2,200,000
Engineering and Permitting @ 6% of total capital and operational cost	$1,415,532
Project Engineering Management @ $200,000 for 2 years	$400,000
Pinellas County Administration @ $250,000 for 2 years	--NI--
Engineering and Administration Cost Item Total / w/o Contingency	**$4,015,532**
TOTAL COST ESTIMATE FOR ALTERNATIVE 5	**$27,607,732**

Alternative 6A – Mechanical High Gravity Dewatering

The cost breakdown for Alternative 6A is shown in Table A3-6.

Table A3-6
Cost Estimate for Alternative 6A

WORK ITEM	COST
CAPITAL COSTS	
Land Acquisition / 10 acres	--NI--
Dredge / Ellicott Mud-Cat / 1500 gpm capacity	$247,000
Dredge Water Vibrating Screen / Synergy / w/ motors and spare screen	$54,300
Centrifuge, Sand / Bird-Wemco / coal-type w/ motor and lube system	$101,540
Centrifuge, ORM / Three / Andrits-Bird w/ motor, back drives and lube system	$637,200
Clarifier-Thickeners / Two / Eimco / w/ drives, rakes and weirs	$202,000
Polymer, Flocculent / SNF / w/ dosing system and tank	$1,920,000
Conveyor, ORM Centrifuge Take-Off / Screw-type w/motor	$13,120
Conveyor, Sand Centrifuge Take-Off / Screw-type w/motor	$13,120
Conveyor, ORM Disposal-Truck Loading weigh belt w/motor	$18,200
Conveyor, Sand Disposal-Truck Loading weigh belt w/motor	$18,200
Pumps, Clarifier Underflow / Two / positive displacement w/ motor	$16,800
Pumps, Clarifier Overflow / Two / centrifugal w/ motor	$14,700
Pumps, ORM Screen Underflow / centrifugal w/ motor	$19,600
Pump, Dredge-Water Boost / 300 Hp w/ steel base plate	$42,800
Instrumentation and Control Panels / incl. two mag-flow meters w/ n-density	$312,000
Platform, Steel Operating/ double-deck with ladder and stairs	$146,000
Buildings, Site Temporary / Three / admin., lab, tool-storage / w/ furniture	$115,000
Loader, Front-End	$28,500
Fork-Lift	$18,300
Truck, Pick-Up / used	$22,000
Tools and Miscellaneous	$80,000
Capital Cost Item Sub-Total / w/o Contingency	**$4,040,380**
Contingency Factor (15%)	**$606,100**
Capital Cost Item Total / w/ Contingency	**$4,646,480**
OPERATIONAL COSTS	
Personnel, On-site	$3,425,000
Erection and Installation / incl. electrical, piping, roads, site-clearing, etc.	$1,200,000
Maintenance, Outside Contract / general – mechanical and electrical equipment	$400,000
Power, Electrical / 22 months	$320,000
Trucking, Disposal / 19,300 cy sand + 145,000 cy ORM @ $2.50/cy	$423,250
Operational Cost Item Sub-Total / w/o Contingency	**$5,768,250**
Contingency Factor (15%)	**$865,000**
Operational Cost Item Total / w/ Contingency	**$6,633,250**
ENGINEERING AND ADMINISTRATION COSTS	
Contractor Administrative Cost and Profit	$1,500,000
Engineering and Permitting @ 6% of total capital and operational cost	$676,784
Project Engineering Management @ $200,000 for 2 years	$400,000
Pinellas County Administration @ $250,000 for 2 years	--NI--
Engineering and Administration Cost Item Total / w/o Contingency	**$2,576,784**
TOTAL COST ESTIMATE FOR ALTERNATIVE 6A	**$13,856,514**

Alternative 6B – Mechanical High Gravity Dewatering with Drying

The cost breakdown for Alternative 6B is shown in Table A3-7.

Table A3-7
Cost Estimate for Alternative 6B

WORK ITEM	COST
CAPITAL COSTS	
Land Acquisition / 10 acres	--NI--
Dredge / Ellicott Mud-Cat / 1500 gpm capacity	$247,000
Dredge Water Vibrating Screen / Synergy / w/ motors and spare screen	$54,300
Centrifuge, Sand / Bird-Wemco / coal-type w/ motor and lube system	$101,540
Centrifuge, ORM / Three / Andrits-Bird w/ motor, back drives and lube system	$637,200
Dryer, ORM / One / Atlas-Stord / complete w/ boiler and accessories	$1,600,000
Clarifier-Thickeners / Two / Eimco / w/ drives, rakes and weirs	$202,000
Polymer, Flocculent / SNF / w/ dosing system and tank	$1,920,000
Conveyor, ORM Centrifuge Take-Off / Screw-type w/motor	$13,120
Conveyor, Sand Centrifuge Take-Off / Screw-type w/motor	$13,120
Conveyor, ORM Disposal-Truck Loading weigh belt w/motor	$18,200
Conveyor, Sand Disposal-Truck Loading weigh belt w/motor	$18,200
Pumps, Clarifier Underflow / Two / positive displacement w/ motor	$16,800
Pumps, Clarifier Overflow / Two / centrifugal w/ motor	$14,700
Pumps, ORM Screen Underflow / centrifugal w/ motor	$19,600
Pump, Dredge-Water Boost / 300 Hp w/ steel base plate	$42,800
Instrumentation and Control Panels / incl. two mag-flow meters w/ n-density	$465,000
Platform, Steel Operating/ double-deck with ladder and stairs	$310,000
Buildings, Site Temporary / Three / admin., lab, tool-storage / w/ furniture	$115,000
Loader, Front-End	$28,500
Fork-Lift	$18,000
Truck, Pick-Up / used	$22,000
Tools and Miscellaneous	$80,000
Capital Cost Item Sub-Total / w/o Contingency	**$5,957,380**
Contingency Factor (15%)	**$893,607**
Capital Cost Item Total / w/ Contingency	**$6,850,987**
OPERATIONAL COSTS	
Personnel, On-site	$3,960,000
Erection and Installation / incl. electrical, piping, roads, site-clearing, etc.	$2,000,500
Maintenance, Outside Contract / general – mechanical and electrical equipment	$780,000
Power, Electrical / 22 months	$520,000
Natural Gas / 22 months	$480,000
Trucking, Disposal / 19,300 cy sand + 145,000 cy ORM @ $2.50/cy	$411,500
Operational Cost Item Sub-Total / w/o Contingency	**$8,152,000**
Contingency Factor (15%)	**$1,222,800**
Operational Cost Item Total / w/ Contingency	**$9,374,800**
ENGINEERING AND ADMINISTRATION COSTS	
Contractor Administrative Cost and Profit	$1,500,000
Engineering and Permitting @ 6% of total capital and operational cost	$973,547
Project Engineering Management @ $200,000 for 2 years	$400,000
Pinellas County Administration @ $250,000 for 2 years	--NI--
Engineering and Administration Cost Item Total / w/o Contingency	**$2,873,547**
TOTAL COST ESTIMATE FOR ALTERNATIVE 6B	**$19,099,334**

Project Cost Escalation

Contingency cost percentages are based on a variety of factors – the most influential are generally potential unforeseen conditions and inflation over time. As the technical complexity of a project increases, the greater probability of unforeseen condition will *probably* justify a higher contingency. But, as the duration or delays in starting a project stretch out, the cost escalation due to increased time will *absolutely* justify one.

Alternative 6A – Mechanical High Gravity Dewatering – has been recommended because it is not only the best alternative, it is irrefutably the *only* alternative that satisfies *every* optimized environmental, technical, economic and logistical requirement. The approach is neither complex nor experimental, having been proven many times in many national and international projects. Thus, the unforeseen factors are substantially reduced and the project duration and tabulated costs are based on real numbers. Therefore, the 15% contingency factor applied is considered to be entirely realistic provided that the project is initiated in 2007 – two years from mid 2005, the time-base for every cost item listed in the project cost estimates shown herein. Based on recent construction data, it is estimated that project costs will escalated by approximately 7.2 percent per year, or 0.63 percent compounded monthly.