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REPORT ON CLARKSTON LAKE & CRYSTAL POND HYDROLOGIC & ENVIRONMENTAL EVALUATION CLARKSTON, GEORGIA

Submitted to:

DeKalb County
Public Works Department
Roads & Drainage Division
727 Camp Road
Decatur, Georgia 30032

Prepared by:

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June 2007 063-3587

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June 29, 2007 Our Ref: 063-3587

DeKalb County
Public Works Department
Roads & Drainage Division
727 Camp Road
Decatur, Georgia 30032

Attn: Mr. Alex Mohajer, MSCE, P.E.

RE: REPORT ON CLARKSTON LAKE & CRYSTAL POND HYDROLOGIC & ENVIRONMENTAL EVALUATION CLARKSTON, GEORGIA

Dear Mr. Mohajer:

The following report presents the results of the work carried out by Golder Associates Inc. (Golder) at the Clarkston and Crystal Pond Lakes. The structures are located within the City of Clarkston, but part of the watershed is in unincorporated DeKalb County (DeKalb). On three occasions (March 6, 2007; April 16, 2007; & June 13, 2007) Golder and Dewberry and Davis, LLC met with DeKalb officials to discuss the project. The draft report was issued electronically on May 30, 2007.

Based on the work conducted throughout the project, Golder has recommended several projects that can be implemented within the watershed to improve the watershed quality. These projects range from small grass-roots type projects to large structural designs. We recommend that the smaller least costly projects be implemented first and the cost/benefit relationship of the more costly projects be weighed against the recommendations of the Corps of Engineers Comprehensive Snapfinger Creek Watershed Plan prior to implementation. If grants and funding become available and the larger projects have a positive cost/benefit relationship, these more costly projects can be implemented.

Golder Associates appreciates the opportunity to provide engineering and environmental services to DeKalb County. Please do not hesitate to contact one of the undersigned if you have any further questions, require additional information, or would like to discuss the results presented in this report.

Very truly yours,

GOLDER ASSOCIATES INC.

Y. Jim Su, Ph.D.
Water Resources Engineer

Gregg W. Hudock, P.E.
Senior Engineer

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1.0 EXECUTIVE SUMMARY

Golder Associates Inc. (Golder) in cooperation with Dewberry and Davis, LLC (Dewberry) performed an environment assessment of the watershed, streams, and lakes in the Clarkston Lake basin. The work consisted of the following:

- Discussion with representatives of the Clarkston Shores Lake Association concerning their issues with Crystal Pond and Clarkston Lake;
- Field assessment of the watershed, streams, and lakes in the Clarkston Lake Watershed;
- Dam Safety Inspection of the two earthfill dams that impound Crystal Pond and Clarkston Lake; and,
- Analytical analyses of water quality samples from both Crystal Pond and Clarkston Lake.

During the project, Golder determined the following:

- Based on information provided by the Clarkston Shores Lake Association, four (4) separate sewer spills have discharged sewage into Crystal Pond and Clarkston Lake. On three of these occasions, residents indicate that the sewage spills resulted in a fish kill in Crystal Pond.
- Golder's field inspections identified that sedimentation in Crystal Pond has occurred. However, Crystal Pond behaves as a sediment forebay for Clarkston Lake. The performance of Crystal Pond in protecting Clarkston Lake has been excellent.
- Above Reilly lane, the stream quality is excellent. Below Reilly Lane, to Crystal Pond, the stream is widening and transporting sediment, trash, and debris.
- With the exception of nitrogen and likely phosphorus, the water quality analyses indicate that the quality of the water in both Crystal Pond and Clarkston Lake meets the standards established by the Georgia Department of Natural Resources and Environmental Protection Agency for phosphorus, pH, total dissolved solids, total suspended solids, turbidity, dissolved oxygen, biochemical oxygen demand, and fecal coliform. The common source of nitrogen and phosphorus in surface waters is from fertilizers used in lawn care products. Excess nitrogen and phosphorus could cause eutrophication and algal blooms.
- Both embankment dams are in fair condition, but major repairs are needed to the spillways at each structure and the structures should be cleared of trees and brush. A more thorough inspection should be completed upon clearing. A slough was observed at the left toe of the Clarkston Lake Dam, where the sanitary sewer line exits the earthfill.

Numerous options are presented to improve watershed quality; however, based upon our understanding of the needs of all stakeholders (i.e. Clarkston Shores Lake Association, the City of Clarkston, and DeKalb County) Golder selected a series of project options for consideration. One or more of these options can be implemented with benefits to all stakeholders, however; prior to selection the overall cost/benefit relationship of each option should be considered in detail relative to other DeKalb County projects, as grants or other funding sources become available. Each alternative has distinct advantages and disadvantages but address many of the concerns poised by the stakeholders. Each option is also progressively more expensive:

- Option 1 – Public Education and Outreach; additional water quality sampling of water and sediments, and dam maintenance;

- Option 2 – Implementation of structural BMP’s (best management practices) in the watershed. Proposed BMP’s include energy dissipators and sediment traps at the entrance to Crystal Pond;
- Future Options
  - Construction of a stormwater management facility upstream of Crystal Pond
  - Stream and floodplain restoration downstream of the proposed facility; and,
  - Rehabilitation of the Clarkston Lake and Crystal Pond dam structures.

Please note that the U.S. Corps of Engineers (COE) is currently engaged in a Comprehensive Watershed Plan for the Snapfinger Creek basin, with the end result being a feasibility study for watershed improvement work. The cost/benefit relationship of the Clarkston Lake Watershed improvement work relative to the entire Snapfinger Creek Watershed improvement work should be thoroughly evaluated prior to implementation of any project suggested herein

A suggested cost share between all parties and funding sources for the work are included based on relative costs and benefits to each stakeholder.

2.0 INTRODUCTION

2.1 Site Location & Description

The Clarkston Lake and Crystal Pond structures are located east of Atlanta on the eastern boundary of the City of Clarkston in DeKalb County, Georgia. The structures are located in the 18th district, land-lot 96, lot 16 with an approximate area of 5.1 acres. The site location is identified in Figure 1. The two structures flow both in series and in parallel and are connected by an inlet structure and drainage channel, respectively. Crystal Pond is the upper lake and Clarkston Lake is the lower lake. Crystal Pond has an approximate area of 0.8 acres and performs as a sediment forebay for Clarkston Lake. Clarkston Lake has an approximately area of 4.3 acres. Norman Road crosses the Clarkston Lake embankment. Milan Park is located across Norman Road, south of the two structures and contains baseball fields, picnic area, and a swimming pool.

The structures have been an integral part of the Clarkston Community for more than 80 years and have provided fishing, swimming, ice skating, and boating recreation benefits.

2.2 Structure History

Based on information provided by residents who live around the two structures the following historical timeline was created:

- The structure was constructed in 1926 as a lake for a dairy farm. The lake was originally known as Prather Lake, since it was constructed by Mr. Prather;
- At a later date, the area was sold to Mr. Clark and was renamed to Clark's Lake;
- Once in the 1930's and again in the 1940's the lake was drained and sediment was moved from the lower lake to the upper lake. The upper lake (Crystal Pond) was created as part of this work;
- The lake property was purchased in 1954 as part of the Clark Estates development;
- Land immediately around the lake was deeded in 1970 to Clarkston Shores Corporation, creating the Clarkston Shores Lake Association;
- In 1971, the lakes were dredged and the spillways repaired;
- In the mid 1990's a stone wall and dam was constructed in Sara's Creek, upstream of Crystal Pond, to stop erosion of the stream and stream banks; Crystal Pond was also partially dredged;
- In 1998, the upper lake was dredged;
- On four occasions (April 1996, June 1999, January 2004, and September 2004) the residents report that sewage was discharged into Crystal Pond. During the 1996 and both 2004 events, it was reported that the sewage spills resulted in a fish kill in Crystal Pond.

2.3 Watershed Description

According to Dekalb County topographic information, the watershed is approximately 300.6 acres. The watershed is approximately bounded by the CSX Railroad and East Ponce de Leon in the north, Norman Road in the south, and Otello Avenue in the southeast. Topographic relief bounds the remaining western and eastern boundaries. Approximately 20 percent (%) of the watershed area is within the City of Clarkston city limits; the remaining 80% is located within unincorporated DeKalb County. The watershed has a maximum elevation of approximately 1200 feet-mean sea level (ft-msl) and drains to an approximate reservoir pool elevation of 940 ft-msl. Land-use throughout the watershed is mostly single family residential developed in the late 1950's through the 1990's. The watershed is the headwaters of Snapfinger Creek, which is a 303(d) impaired water for Fecal Coliform.

2.4 Stream Description

The tributary to the two lake structures is known as Sara's Creek. Sara's Creek flows into Indian Creek and then Snapfinger Creek. Snapfinger Creek flows into the South River and the South River flows into Lake Jackson, which is the confluence of the South River, Yellow River, and Alcovy Rivers at the Newton, Jasper, and Butts County boundaries. The Ocmulgee River is formed below the Lloyd Shoals Dam on Lake Jackson. The Ocmulgee River Watershed joins the Oconee River Watershed and forms the Atlamaha River, which flows into the Atlantic Ocean.

2.5 Scope of Work

Dewberry received a scope of work from DeKalb County in July 2006. The scope of work identified was the following:

- Evaluate the hydrologic and environmental issues affecting the Clarkston Lake Community;
- Evaluate the upstream and downstream hydrology and environmental impacts, focusing on solutions to flooding and erosion, which leads to siltation;
- Evaluate the need for dredging of the upper lake as opposed to by-pass of the lake during high level flows;
- Evaluate the lake structures, to include but not be limited to the dam, spillway, over-flow structures, etc.;
- Determine the flow rates and capacity for the different stages and functions of stream flow and the ability of the in-place structure to function;
- Evaluate the placement and survivability of adjacent utilities and roadways;
- Summarize present and recommended lake management, maintenance, repair, capacity issues and other related areas that affect lake hydraulics and environmental issues;
- Note any possible modes of dam failure given the present installed facilities.

The deliverable item requested by DeKalb County was a report which addresses the following issues:

1. Observation of water quality issues based on visual inspection with recommended possible solutions;
2. List of lake management, and lake maintenance, issues based on field observation only and any recommendations to address these issues;
3. Calculation of capacity of the lake and its structures;
4. Assessment of the adequacy of the dam and possible recommended improvements;
5. Determination of ownership of the lake and responsibility for maintenance requirements of the State of Georgia;
6. Recommendations for a cost share plan between City, County and Lake Association for corrective measures.

In Golder's proposal to Dewberry dated November 8, 2006, the following items were identified as Golder's scope of work for the project:

1. Observation of water quality issues based on visual inspection with recommended possible solutions based on the following items:
   a. Site visit conducted on July 28, 2006.
   b. Walk of the stream and major tributaries feeding the lakes to document possible environmental concerns within the watershed.
   c. No more than two water quality samples taken at discrete locations within the lakes to evaluate water concerns. Tests and methods would be conducted to not exceed $500.00 each.
2. List of lake management and lake maintenance issues based on field observations only;
3. Assessment of the adequacy of the dam and possible recommended improvements based on visual site inspection;
4. Determination of ownership of the lake and responsibility for maintenance requirements of the State of Georgia based on use of Dekalb County tax maps for the site and discussions with the Georgia Safe Dams Program about the methodology used by the State of Georgia to determine ownership of the structure;

2.6 Work Performed

Golder performed the following tasks in conducting the items identified in the scope of work:

1. Site visit to visually inspect the dam and reservoir on July 28, 2006;
2. Meeting with Ms. Cathy Burroughs and Mr. Bob Bradford of the Clarkston Shores Association to discuss the Association's concerns with the lake. Mr. Bradford provided a tour of the lakes;
3. Field inspection of both lakes, the Sara's Creek, and the watershed on January 14, 2007;
4. Surface water collection of one water quality sample from Crystal Pond and Clarkston Lake, each; and,
5. Using Dewberry's hydrologic models, options for attenuating stormwater runoff discharges for the watershed.

The results of items 1, 2, and 3 are discussed in Section 3 of this report. A discussion of the water quality results for both the upper and lower lakes is located in Section 4. The hydrologic evaluation of the watershed is found in Section 5. Conceptual options for watershed improvements and water quality improvements in both lakes are found in Section 6.

3.0 WATERSHED FIELD INSPECTION

3.1 Dam and Lake Inspection

On July 28, 2006, Mr. Gregg Hudock, P.E. and Mr. Duncan Hastie, P.E. of Golder and Dewberry, respectively, visited Clarkston Lake and Crystal Pond to perform a preliminary reconnaissance of the structures. During the site visit, Golder assessed the current condition of the structure by visual inspection of the earthen embankment, spillways, and reservoir. Golder noted the following:

General

- Vegetation on both embankments is overgrown in some areas, including the upstream slope of the lower dam and near the low level spillway on the upper dam. In these areas Golder could not perform a thorough inspection of the embankment;

Lower Dam (Clarkston Lake)

- The downstream slope of the lower dam is very steep and is not easily traversed for inspection;
- On the upstream side of the left abutment is a spillway structure that collects and routes water from the lower lake beneath Norman Road. The structure is overgrown with trees and brush, access is controlled by a fence, and is located on private property, therefore an inspection could not be complete. Based on visual observations from Norman Road, the structure appears to be in disrepair.
- A metal culvert spillway crosses beneath Norman Road on the left abutment of the dam. The downstream headwall is constructed of brick and stone. A crack is located on the headwall at the crown of the pipe. The brick mortar joint is displaced.
- A metal culvert spillway crosses beneath Norman Road on the right abutment of the dam. The spillway carries water from the upper dam that is routed around the lower dam during rain events. A culvert pipe in the lower lake also transports water into this spillway channel when the lake level increases.
- A channel located at the toe of the embankment carries water from spillways on both abutments and routes the flows into a culvert beneath the ball fields at Milan Park. The channel is lined with riprap in numerous locations.
- A sewer line is exposed on the downstream slope. A slough has formed where the sewer line is exposed.
- An emergency spillway is located at the crest of the dam. When the water level rises in the lake, water flows over Norman Road and down a concrete lined flume on the downstream side of the dam.
- Riprap was placed at two locations on the downstream side of the dam in a stepped like configuration. Presumably, the riprap was placed to repair sloughs on the downstream slope or to armor the downstream slope when the embankment overtops.
- A corrugated metal riser structure was observed in the lower lake. A corrugated metal pipe was found on the downstream side of the embankment, but no water was observed flowing from the pipe.
- Seepage from the embankment was observed in several locations at the downstream toe.

Lower Lake (Clarkston Lake)

- Water in the lake appears to be stagnant without much flow.
- Close to the dam, the lake water appeared to have a thin organic sheen.

Upper Dam (Crystal Pond)

- A corrugated low level metal spillway structure is located on the left side of the dam. The structure is tilted westward and appears to be in disrepair. Golder could not locate the outlet pipe on the downstream of the dam.
- An open channel auxiliary spillway is located on the right abutment. The channel routes flow around the lower lake and into the channel on the downstream side of the lower dam.

Upper Lake (Crystal Pond)

- The water in the upper lake was fairly turbid.
- Sediment islands were observed.
- The lake is fairly shallow, with sediment deposited throughout the lake. Little to no aquatic vegetation was observed within the upper lake.

3.2 Meeting with Clarkston Shores Lake Association Representatives

Mr. Hudock and Mr. Hastie met with Ms. Cathy Burroughs and Mr. Bob Bradford, representatives of the Clarkston Shores Lake Association, on November 13, 2006 to discuss the resident's concerns about the lake structures. Mr. Bradford guided a tour of the structures and provided historical information discussed herein. After the meeting, Ms. Burroughs provided the following list[1] of objectives for the Clarkston Shores Association:

1. Dredge the lake;
2. Construct a siltation trap;
3. Cooperatively build retention ponds at the neighboring apartments, and two subdivisions;
4. DeKalb County taking responsibility for the impact of storm water on the water quality and ecological well-being of the lake;
5. Fortification of the dam and protection of Norman Road and Milam Park;
6. Finding partners who can share the on-gong challenges of maintaining the health and well being of our beautiful lake;
7. Exploring ways to interface with the City of Clarkston and the people of DeKalb County (nature education programs, Annual Regatta; fishing and boating days; conservation activities with Friendly Forest, Fernbank, etc.); and,
8. Animal Safe Habitat and Preservation

3.3 Stream and the Watershed

On January 4, 2007, Golder personnel performed a watershed walk to identify hydrological and environmental issues within the watershed. The work was documented with field notes and photographs. Appendix 2 presents the field photos and notes from Golder's Site visit.

[1] Email from Ms. Cathy Burroughs dated November 15, 2006 to Messrs. Duncan Hastie and Gregg Hudock.

The watershed of the two structures is highly urbanized with individual houses, apartment complexes, roads and streets in the watershed. For the purposes of the stream walk, Sara's Creek was divided geometrically into three segments.

- The upper stream segment is from the headwaters to the culvert under Country Address;
- The mid-stream segment is between Country Address and Reilly Lane; and
- The lower stream segment is between Reilly Lane and the lake.

The upper stream segment exhibited no noticeable erosion and sedimentation issues during the site visit. The watercourse is protected either by well covered vegetation or armored by stones and is in stable condition. No noticeable sedimentation or erosion issues in the stream were observed. The 48-inch diameter corrugated metal pipe (CMP) culvert under the Country Address was functional and appeared in good condition.

Moderate erosion and sedimentation were observed at some sections in the mid-stream segment between Country Address and Reilly Lane. Some moderate bank erosions were observed along with sedimentation issues (such as joint of tributary in the middle section of the middle segment, see photos 91, 92 and 93 in Appendix 2). The dual CMP culverts under Reilly Lane appeared to be in good condition.

Moderate to severe erosion and sedimentation were observed in the lower stream segment of Sara's Creek. Stream scouring and sedimentation commonly occurred in many segments of the stream. One of the most serious erosion problems was identified at the lower stream section at the English Oaks apartment complex. This area showed evidence of serious erosion and scour between the apartment complex and the eastern stream bank. Debris and falling trees were found downstream of the junction of the apartment complex's watershed and the existing stream. It was also noted trash and other debris (shopping carts, large branches, falling trees, etc.) were found in the stream and stream buffers, especially in the lower stream segment.

At 1141 Cleavemark Drive, the natural stream channel was filled and a concrete channel was built. Little to no sediment was observed within the concrete channel. Therefore, we presume that the concrete channel has stabilized the channel and prevented erosion of the stream similar to what was observed at the English Oaks apartment complex junction. However, after 1141 Cleavemark Drive, the concrete channel ends and the natural stream resumes. At this location, a storm sewer pipe which carries surface runoff from properties on Cleavemark Drive and Clydedale Drive enters the stream.

Significant erosion was observed at this junction. Since the pipe enters the stream perpendicular to the stream, significant erosion has occurred on the eastern stream bank. Residents have stacked riprap on the eastern stream bank to protect the slope (work identified in the timeline in Section 2.2 which occurred in the mid 1990's). The pipe outlet has also eroded and the pipe is in need of repair.

3.4 Upper and Lower Lakes

Severe sedimentation was observed in Crystal Pond (the sediment forebay of Clarkston Lake). From the start of the lake to about mid-distance to the dam sediment and debris deposition in Crystal Pond has built up to an elevation higher than the normal water level. Sedimentation within the upper lake has decreased the pool capacity and debris was causing the water to back up onto resident's property. Sediment islands had established vegetation. Water in the pond was turbid.

Based on the field inspection, the sediment impact to the lower lake appears to be minimal. The first twenty feet of the lower dam appears to have been impacted by sedimentation, but the retention time provided by Crystal Pond and the overflow diversion on the right abutment appears to protect much of Clarkston Lake from sediment deposition. The preceding statement is based upon a visual observation of the lake. We recommend that a sediment survey be completed to confirm the actual impacts to Clarkston Lake.

4.0 WATER QUALITY SAMPLES

4.1 Sampling Procedures

Golder conducted surface water sampling during a dry weather day on February 22, 2007. One (1) grab water specimen was sampled from each of the upper and lower lakes. The sampling information is summarized in Table 1 and Appendix 3.

TABLE 1
SAMPLING LOCATIONS

Sample I.D.	Remarks	Notes
Sample # 1	Upper lake water sample, at the inflow point of the upper lake	See Appendix 3 for sampling locations and photos
Sample # 2	Lower lake water sample, approximately 30’ from the western bank of the lower lake	

Samples were obtained and preserved in the sample containers following the sampling procedures provided by STL laboratory. Samples were shipped overnight to STL laboratory in Savannah, Georgia for water quality analysis.

4.2 Sample Analysis Methods

STL laboratory conducted the analysis of both samples. Constituents tested include Total Phosphorus, Total Nitrogen, pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Turbidity, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), and Fecal Coliform. All tests performed by STL laboratory meet the National Environmental Laboratory Accreditation Conference (NELAC) requirements and the standard methods used for the analysis are presented in Table 2.

TABLE 2
STANDARD METHODS USED IN THE SAMPLE ANALYSIS

Parameters	Method Description
Phosphorus, total	EPA 365.4 (365.2/365.3/365) Total Phosphorus
pH	MCAWW 150.1 pH, Electrometric
Total Dissolved Solids	MCAWW 160.1 Residue, Filterable, Gravimetric, Dried at 180°C (TDS)
Total Suspended Solids	MCAWW 160.2 Residue, Non-Filterable (Gravimetric, Dried at 103-105C)
Turbidity	MCAWW 180.1 Turbidity, Nephelometric
Dissolved Oxygen	MCAWW 360.2 Oxygen (Dissolved, Membrane Electrode)
Total Nitrogen	EPA Total Nitrogen Standard
Biochemical Oxygen Demand	MCAWW 405.1 Biochemical Oxygen Demand, BOD (5 day, 20 °C)
Fecal Coliform	SM18 9222D Membrane Filter Technique - Fecal Coliform Procedure

4.3 Results

Table 3 summarizes the analysis results of the water samples. See Appendix 4 for the detailed laboratory report from STL laboratory.

TABLE 3
SURFACE WATER SAMPLE CONSTITUENT CONCENTRATIONS

	General Remarks of Water Quality Parameters	Upper Lake Inflow Sample (Sample #2)	Lower Lake Sample (Sample #1)
Phosphorus, total	Nutrient pollutant; may cause lake eutrophication problems	<0.1 mg/L	<0.1 mg/L
pH	Indictor of acidity or alkalinity of a solution	6.40	6.53
Total Dissolved Solids	Aggregate indicator of presence of a broad array of chemical contaminants; Indication of aesthetic characteristics;	11 mg/L	44 mg/L
Total Suspended Solids	Particles trapped by a filter; Indication of aesthetic characteristics;	<5.0 mg/L	7.0 mg/L
Turbidity	Light attenuation measure; Indication of aesthetic characteristics and presents of suspended solids;	3.7 NTU	14 NTU
Dissolved Oxygen	Amount of oxygen dissolved in the water, necessary to keep favorable habitat for fauna and flora.	8.5 mg/L	11 mg/L
Nitrogen, Total	Nutrient pollutant; may cause lake eutrophication problems;	1.2 mg/L	0.84 mg/L
Biochemical Oxygen Demand	Measure of relative oxygen-depletion effect. Indicator of pollution by biodegradable organic matter;	<2.0 mg/L	<2.0 mg/L
Fecal Coliform	Indicator of the presence of health risk bacteria;	80 CFU/100mL	88 CFU/100mL

4.4 Interpretation of Water Quality Data

Table 4 summarizes the water quality of samples obtained at Crystal Pond and Clarkston Lake and relevant water quality criteria or benchmarks.

TABLE 4
WATER QUALITY INTERPRETATION AND COMPARISION

	Upper Lake Sample (Sample #2)	Lower Lake Sample (Sample #1)	Water Quality Criteria and Benchmarks	References	Remarks
Phosphorus, total	<0.1 mg/L	<0.1 mg/L	< 20 ug/L	USEPA (2000a), Ambient Water Quality Criteria Recommendations (1)	N/A Lab detection limit exceeds benchmark value
pH	6.40	6.53	6.0 ~ 8.5	GAEPD (2005), Rules and	In general accordance with

				Regulations for Water Quality Control, Chapter 391-3-6 (2)	the criteria
Total Dissolved Solids	11 mg/L	44 mg/L	< 250 mg/L (Human Health for Consumption of)	USEPA (1986), Quality Criteria for Water (3)	In general accordance with the criteria
Total Suspended Solids	<5.0 mg/L	7.0 mg/L	Freshwater fish and other aquatic life: Settleable and suspended soils should not reduce the depth of the compensation point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life.	USEPA (1986), Quality Criteria for Water (3)	NA
Turbidity	3.7 NTU	14 NTU	All waters shall be free from turbidity which results in a substantial visual contrast in a water body due to a man-made activity.	GAEPD (2005), Rules and Regulations for Water Quality Control, Chapter 391-3-6 (2)	No numerical criteria to be compared with. No substantial visual contrast was observed during the sampling at the Lake.
Dissolved Oxygen	8.5 mg/L	11 mg/L	A daily average of 6.0 mg/l and no less than 5.0 mg/l at all times for waters designated as trout streams. A daily average of 5.0 mg/l and no less than 4.0 mg/l at all times for waters supporting warm water species of fish.	GAEPD (2005), Rules and Regulations for Water Quality Control, Chapter 391-3-6 (2)	In general accordance with the criteria
Nitrogen, Total	1.2 mg/L	0.84 mg/L	< 0.36 mg/L	USEPA (2000a), Ambient Water Quality Criteria Recommendations (1)	Exceeded the recommended ambient water quality criteria recommendations
Biochemical Oxygen Demand	<2.0 mg/L	<2.0 mg/L	N/A	N/A	See narratives below

Fecal Coliform	80 CFU/100mL	88 CFU/100mL	<100 CFU/100mL Fecal Coliform not to exceed the following geometric means based on at least four samples collected from a given sampling site over a 30-day period at intervals not less than 24 hours. (1) Coastal waters 100 per 100 ml (2) All other recreational waters 200 per 100 ml	GAEPD (2005), Rules and Regulations for Water Quality Control, Chapter 391-3-6 [(2)]	In general accordance with the criteria

(1) Reference source: USEPA Recommended Values in Ambient Water Quality Criteria Recommendations – Information Supporting the Development of State and Tribal Nutrient Criteria - Lakes and Reservoirs in Nutrient Ecoregion IX, EPA 822-B-00-011. (USEPA, 2000a).

(2) Reference source: Georgia Department of Natural Resources, Environmental Protection Division, Rules and Regulations for Water Quality Control, Chapter 391-3-6 (GAEPD, 2005).

(3) Reference source: USEPA Quality Criteria for Water (USEPA, 1986).

pH, DO, Fecal Coliform and Turbidity in the surface water samples obtained at the lakes were compared with the most recent Water Use Classifications and Water Quality Standards in Chapter 391-3-6 of Georgia Water Quality Control (Georgia Department of Natural Resources, Environmental Protection Division- GAEPD, 2005). The definition of recreational water activities include such activities as water skiing, boating, and swimming, or for any other use requiring water of a lower quality, such as recreational fishing. As shown in Table 4, pH, DO and Fecal Coliform of the samples are in general accordance with the Georgia criteria for recreation water. There is no numerical requirement for turbidity in the Georgia criteria. However, no substantial visual contrast was noticeable at the sampling sites at Clarks Twin Lakes during the sampling.

TDS and TSS criteria are not addressed in the Georgia Water Quality Control Standard. These parameters were compared with the current National Recommended Water Quality Criteria (USEPA, 1986). TDS concentrations were lower than the criteria presented by USEPA for water consumption, indicating the total dissolved solids of lake samples are less than maximum the acceptable concentration. Only narrative statements were addressed for the TSS in the National Recommended Water Quality Criteria (USEPA, 1986), which is not applicable to the TSS concentration measures.

There are no total nitrogen and total phosphorus criteria in Georgia Water Quality Control Standard (GAEPD, 2005). These parameters were compared with the EPA's Ambient Water Quality Criteria

Recommendations (USEPA, 2000a). It should be noted that the EPA's Ambient Water Quality Criteria Recommendations are based on the 25th percentile of studied ambient water bodies in specified ecoregions, which are not water quality criteria. The lab detection limit of total phosphorus in this study exceeded the recommended value. A common practice in these cases is to assume that the most likely concentration is half of the detection limit, which is 50 mg/l. Therefore it is assumed that the total phosphorus concentration exceeds the recommended standard. The total nitrogen at the Clarks Twin Lakes exceeded the Ambient Water Quality Criteria Recommendations. The watershed of Clarks Twin Lakes is developed residential area with home laws, gardens, and excessive leaves etc. along the feeding creek. Excessive nutrients may come from the runoff of fertilizers and garden wastes from within the watershed. High nutrients such as total nitrogen and phosphorus will accelerate lake eutrophication and result in excessive algae and plant growth.

No numerical BOD concentration is regulated in any of the above references. In general, BOD concentration of less than 2.0 mg/L in the samples indicates that the biodegradable organic matter is acceptable (for example, the effluence criterion for secondary treatment is 30 mg/L [40 CFR 133]).

The purpose of the water quality study is for general watershed evaluation purposes. The information of water quality analysis is limited to the set of the samples taken at the stated locations during a dry weather day. Due to the water quality variations, this study does not necessarily reflect the water quality during runoff events or other seasonal conditions. In addition, no sediments were sampled as part of this work. Contaminants that may degrade water quality, if the sediment was to be disturbed, were not tested.

5.0 WATERSHED ANALYSIS

5.1 Hydrologic Analysis

Dewberry created a hydrologic model of the watershed to assess stormwater runoff discharge. All hydrological modeling was completed in HEC-HMS. Flood Discharge values for the 1-, 2-, 5-, 10-, 25-, 50-, and 100-year floods were calculated for existing (2007) land use conditions for the watershed. The SCS Unit Hydrograph method was used in HEC-HMS. Sub-basins were delineated using a triangular irregular network (TIN) generated from masspoints, breaklines and other GIS data in the County's GIS files. Sub-basins were selected at each road crossing and at confluences of tributaries and lakes and are identified in Figure 2. Hydrologic Soils Group (HSG) came from NRCS GIS data. Only groups B and C exist within the watershed. Existing land use maps were provided in the County's GIS files. Average curve numbers were calculated for each sub-basin for land uses based on the area overlay of the sub-basin, soils, and land use polygons. Sub-basin areas were calculated from the standard ArcGIS tools. Curve numbers and time concentration values were calculated using the NRCS TR-55 Methodologies.

For time of concentration, overland sheet flow Manning's "n" values were determined from aerial photos overlaid with the GIS and digital photos for sample locations. Overland Flow sheet flow lengths were determined from aerial maps. Sheet flow lengths are the maximum 100' for existing conditions. Slope values were taken from the TIN. Shallow concentrated flow lengths and slopes were taken from the TIN, and travel times calculated using either the paved, or non-paved formulas in the NRCS TR-55 manual Lengths and slopes for open channel flow were taken from the TIN. Manning's "n" values were made from field visits and the TIN. Hydraulic radii values were made from field visits/measurements and the TIN.

Sub-basin areas, curve numbers, and times of concentration were input into the HEC-HMS model. The Muskingum-Cunge eight point (MC8P) method was used to route hydrographs through the watershed. MC8P sections were average sections best representing the given reach. Reservoir routing was performed behind Norman Road. Surface area – elevation relationships were obtained from the TIN. Discharge-Elevation rating curves were developed from the riser structures/spillway pipes and top of road from field visits and the TIN. Weir/Orifice equations were used for the rating curves at low levels where the riser weirs/orifices control the flow, and HEC-RAS was used for the higher levels of the rating curve where flow is controlled by the top of the road. Diversion flows in

HMS were determined using weir/orifice equations. Diversion from the side channel into the lower pond was considered negligible.

5.2 Hydraulic Analysis

All hydraulic modeling was completed in HEC-RAS. Flow inputs were calculated in HEC-HMS, as described above. Cross sections were at a minimum 600 feet apart. Cross sections are cut using existing Dekalb GIS data. Topographic information is approximate since no survey ground-truthing was performed. Channel Manning's "n" value for all cross sections was assumed to be 0.05. Overbank Manning's "n" value for all cross sections was assumed to 0.12. Downstream slope boundary condition is 1%. Adjustments were made at certain cross sections based on rough field measurements and engineering judgment.

5.3 Results

The HEC-HMS and RAS modeling results illustrates the following:

- Crystal Pond and Clarkston Lake overtop during the 1-year and greater storm events.
- The Clarkston Lake spillway structure does not have the capacity to retain and route the 1-year or greater flood event without overtopping the dam.
- The 48" culvert passing beneath the fields at Milan Park overtops during the 1-year and greater storm events.
- The 48" CMP culvert on Country Address overtops during the 50- and 100-year flood events.
- The unknown culvert approximately 1700 feet upstream of the upper pond overtops during 1-year and greater storm events.

Using Dewberry's results and an approximate channel geometry, Golder determined that during storms less than the 1-year event (channel protection storm) flow at the junction of Sara's Creek with the English Oaks apartment complex (south of Reily Lane) overtops the existing stream channel and is out of bank.

6.0 CONCEPTUAL WATERSHED IMPROVEMENT OPTIONS

Based on the information presented in this report, Golder developed watershed improvement options to address the concerns of Clarkston Shores Lake Association and DeKalb County. The items discussed are categorized as watershed, lake, or dam improvements and can be classified as either nonstructural or structural measures. Advantages and disadvantages associated with each item are discussed. The location of watershed BMPs are identified in Figure 3. The cost/benefit relationship for each option should be considered as part of the selection process. Since the COE is currently engaged in a Comprehensive Watershed Plan for the Snapfinger Creek basin, we recommend that the cost/benefit relationship for each project option be considered and weighted against the recommendations of the COE.

Please note that one option which was not considered as part of this work is the adoption of Crystal Pond and/or Clarkston Lake by either the City of Clarkston or DeKalb County. Golder understands that the Clarkston Shores Lake Association is not interested in relinquishing ownership of the structures. We also understand that neither the City of Clarkston nor DeKalb County wishes to attain ownership of the structures.

6.1 Watershed Improvement - Nonstructural BMPs

Public educations and involvement:

Public education and involvement can raise public awareness about the current stormwater related issues at both lakes. The improvement of the structures' hydrological and environmental conditions requires the participation of the community in the entire watershed. Distributing educational materials and conducting other educational practices provide non-structural solutions to reduce the amount of pollutants exposed to storm water runoff and to minimize the potential of illicit discharge. In addition, stream cleanups are highly recommended to remove the trash and obstructions from the stream and buffer zone, which can directly improve the drainage features and the scenery of the site.

Good house-keeping and street sweeping

Good housekeeping requires the maintenance of the watershed that may contribute pollutants to storm water discharges in a clean, orderly manner. Golder recommends proper inspections and controls within the watershed. Some general practices include inspecting and properly covering open dumpsters or trash facilities; cleaning and disposing animal wastes from the drainage surfaces;

minimizing erosion by use of vegetation or other erosion and sediment control measures; properly collecting and disposing of leaves and garden wastes; and using appropriate amounts of fertilizer.

The nonstructural BMPs suggested are fairly simple with minimal costs and have the potential to dramatically improve the quality of the watershed. However, since the watershed has already been impacted and much of the impacts are associated with increased stormwater runoff, we recommend that this option be implemented with other options.

6.2 Watershed Improvement - Structural BMPs

Additional detention facilities within the watershed

The major problem within the watershed is that stormwater runoff is uncontrolled since most development in the watershed occurred prior to regulations limiting stormwater discharge. As the watershed developed, the percent impervious surface in the watershed increased. This change decreases the soil infiltration and increases the quantity of surface runoff. As the watershed developed, the addition of pipes and channels to convey stormwater decreases the watershed time of concentration. The decrease in the time of concentration and increase in the percent impervious has an overall effect of greatly increasing the discharge for a developed watershed. Studies have shown that peak discharge during the 10 year storm for an urbanized watershed is the equivalent to the 100 year storm for a rural watershed of the same size. Therefore, the addition of detention facilities within the watershed could significantly reduce the discharge and velocity of stormwater runoff from the watershed and provide future erosion.

Golder studied two locations within the watershed to add or improve stormwater detention. The first location is in the headwaters near Pounds Lane. An existing detention facility could be improved to control stormwater discharge. The improvements would likely consist of raising the pond and modifying the outlet structure. Immediately downstream of this structure is the lower portion of the English Oaks apartment complex. This is the confluence of Sara’s Creek with the stormwater discharge from the English Oaks apartment complex. The addition of a detention structure at this location would greatly reduce downstream discharge. Preliminary results of the potential reduction in stormwater discharge by this structure are illustrated in Table 5.

The English Oaks apartment complex is owned by ENGL Properties Group LLC (ENGL) which is a subsidiary of Diversified Assets Management. Diversified Assets Management is owned by State

Senator Robert Lamutt. The conceptual pond would require acquisition of approximately 3 acres of the 14.5 acres where the existing English Oaks complex resides. Golder met with Mr. Ed Spencer of ENGL on May 10, 2007 to discuss the potential project. Based on these discussions, the owners of the English Oaks property are interested in discussing the project with DeKalb County.

TABLE 5
CONCEPTUAL POND DISCHARGE FOR ENGLISH OAKS REGIONAL STORMWATER DETENTION POND

Design Storm	Probability of Occurance	Existing Conditions (cfs)	Proposed Conditions (cfs)	Percent Reduction
1-year	1	118.3	24.96	79%
2-year	0.5	167.13	30.35	82%
5-year	0.2	287.32	39.48	86%
10-year	0.1	377.82	129.42	66%
25-year	0.04	511.35	285.08	44%
50-year	0.02	607.82	427.5	30%
100-year	0.01	673.13	509.21	24%

Construction of stormwater detention ponds is the most expensive option to improve watershed quality, but is also the most effective, since most of the watershed impacts are caused by stormwater runoff. Golder estimates that the acquisition of the property required for the additional detention facility at the English Oaks apartment complex could cost approximately $750,000 to $1,000,000. Existing buildings would need to be demolished and the BMP constructed. We estimate that demolition would cost approximately $100,000; excavation and earthfill operations would cost approximately $150,000; miscellaneous concrete structures and piping would cost between $100,000 to $300,000 depending on the work completed at Reilly Lane to divert runoff into the detention facility. The total project cost ranges between approximately $1.1 million to $1.55 million.

The Georgia Stormwater Manual indicates that the increase of bankfull flows in streams because of urban development is the primary cause of streambank erosion, widening, and downcutting. Designing a stormwater detention facility to comply with the *channel protection storm* design criteria recommended in the Georgia Stormwater Manual would require approximately 15.8 acre-ft of storage. This is approximately ¾ of the total storage afforded by the stormwater detention facility suggested above. Therefore, the cost to construct a smaller pond is not significantly less than that of the proposed larger pond. Furthermore, smaller ponds do not provide flood attenuation for larger storm events.

An opportunity may exist with ENGL to redevelop the English Oaks property using the proposed stormwater detention pond as a focal point, similar to Clarkston Lake downstream. As a public/private partnership, land could be donated in exchange for the improvements to the ENGL property. Without the need to purchased the land, the cost for the detention facility would be reduced by $750,000 to $1,000,000.

Energy Dissipation Devices at Stormwater Outlet Pipes

The addition of energy dissipation devices at the two stormwater outlet pipes from Nielsen and Cleavemark Drives could prevent additional erosion and sediment deposition in Crystal Lake. A portion of the sediment deposited in Crystal Pond is the result of erosion occurring at these two outlets. The supplemental addition of underground detention at these locations would also enhance the results.

The costs for energy dissipation devices are significantly less than those for detention structures and could be implemented by existing DeKalb County crews at concrete and riprap material costs. Underground detention systems average approximately $200,000 per acre feet of storage. Based on the locations in the watershed where underground detention could be utilized, each system would average approximately $100,000 and provide approximately 0.5 acre-feet of storage.

Stream and Floodplain Restoration Downstream of the English Oaks Apartment Complex.

A stream and floodplain restoration project downstream of the English Oaks apartment complex to Crystal Pond would re-establish the riparian system in Sara's Creek. Properly designed, the work would provide a small amount of flood attenuation through the use of pools and steps. Restoration work would harden the stream to hinder further erosion and sediment transport into Crystal Pond, during smaller design storms.

Stream restoration projects can cost as much as $350,000 per river mile. Approximately 0.2 miles would need to be restored for this project, therefore the estimated cost is approximately $70,000.

6.3 Lake Improvements - Structural BMPs

Removal of sediment in Crystal Pond and a portion of Clarkston Lake

Next to controlling pollutants and erosion within the watershed, removing the sediment in both Lakes is a priority for the Clarkston Shores Association. Dredging Crystal Pond would restore its original storage capacity and provide additional protection for Clarkston Lake from future sedimentation problems. However, since Crystal Pond appears to have been constructed as a sediment forebay for Clarkston Lake, removing the sediment is a maintenance issue, not necessarily an improvement to the lake and watershed.

The Clarkston Shores Corporation contends that the four (4) sewer spills discussed in Section 2.2 are a significant reason to request that DeKalb County dredge Crystal Pond and the upper portion of Clarkston Lake. The sewer spills, while having environmental impacts to the lakes was not a significant source of the sediment in Crystal Pond. However, contamination of the sediment as a result of the sewer spills may be an issue for sediment disposal. If the sediment is disturbed, contaminants trapped by the sediment could result in poor water quality in the lakes.

Construct sediment forebay for Crystal Pond

If Crystal Pond is to be dredged to remove the sediment, we recommend that additional sediment forebays be constructed at the inlets to the pond to trap sediment. The sediment traps could be constructed to minimize space requirements and for ease of maintenance. However, since the sediment forebay would be relatively small, a routine maintenance program would be required for the structure to be effective. The sediment forebay could be implemented by existing DeKalb County crews.

Construct a Water Quality Pond in Crystal Pond

Crystal Pond could be converted to a water quality pond which is used to detain runoff from smaller storms and remove approximately 80% of the total suspended solids from the pond discharge. Crystal Pond would need to be dredged to achieve additional storage volume and the structure would need to be modified to meet the requirements of a water quality pond. Clarkston Shores Lake Association would be required to permit DeKalb County or the City of Clarkston to acquire a stormwater drainage easement on the Crystal Pond property. An additional easement would be required to access the site for routine maintenance.

Constructed wetland at the upper lake

Since removing and disposing of the sediment in Crystal Lake is costly and access to the site is difficult, construction of a natural wetland may be an alternative to dredging. Engineered or constructed wetlands utilize natural processes, including vegetation, soils, and associated microbial assemblages, to assist in reducing adverse effects of an effluent or other pollutant source (USEPA 2000b). A constructed wetland can restore the degraded water quality and enhance the wildlife habitat in Clarkston Lake. Wetland plant intakes can reduce the nutrient load (total nitrogen and total phosphate) to the receiving water bodies. Moreover, the community can also benefit from improved scenery in the upper lake.

Lake aeration

Aeration of the lower lake can improve the overall water quality, enhancing the environmental, aesthetic, and recreational value and provide algae control. Depending on the capacity of each aerator and lake volume and geometry, single or multiple lake aerators can be installed in the lower lake. Examples of aerator manufacturers include SimplyFountains (NetShops Inc., 2007) and solar powered Solarbee water circulator (Solarbee Inc., 2007). Please note that the water quality results indicate the dissolved oxygen in Clarkston Lake is approximately 11 mg/l; therefore, based on these results the lake does not require aeration. Nevertheless, dissolved oxygen can fluctuate throughout the year. During dry periods when stream flows are reduced and the lake water becomes stagnant (as observed in July 2006) the dissolved oxygen may be reduced thereby stressing the aquatic life within the lake. Additional water quality sampling should be conducted to determine if aeration is indeed needed.

Coagulation/flocculation treatment

Coagulation/flocculation together are used to remove suspended solids and even some large microbes, thus enhancing the aesthetic and environmental values of the lake. There are various coagulant/flocculant reagents on the market, such as alum or other aluminum salts and polymers. Usually the treatment process requires pH adjustment and dosage control, in order to reduce the residue of the chemical regents in the water body and to optimize the treatment efficiency. There are also passive treatment products, such as Gel-Floc™ Chitosan Polymer by natural site solutions Inc (Natural Site Solutions Inc. 2007), which requires little maintenance. Further laboratory studies on the treatbility of the water are needed and associated operation and maintenance costs shall be considered.

6.4 Dam Restoration

Both lakes are impounded by dams. As such, the dams are an important component for the overall health of the lakes. The dams, in particular the lower dam, are in need of repair. Since the lower dam ultimately controls discharge from the upper dam, the lower dam should be addressed with the highest priority. We recommend at a minimum that the following immediate maintenance items be addressed:

- Clear trees and brush from both embankments. Re-vegetate the embankments with grass.
- The spillway structures are in disrepair and consist of corrugated metal pipe which is subject to corrosion. The structures should be replaced with reinforced concrete structures.
- Repair the slough on the downstream side of the lower dam.

In addition to the immediate maintenance items, we recommend that the following items also be addressed

- Investigate the existing embankment materials and foundation conditions to confirm that the existing embankments are stable.
- Construct new emergency spillway structure to prevent discharge from overtopping Norman Road. The new spillway should be designed such that Norman Road does not flood during storms with a high probability of occurance.
- Determine the location of underground conduits and utilities.

6.5 Operation and Maintenance Issues

Any BMP implemented needs to be properly operated and maintained. BMPs should be selected based on DeKalb County's, the City of Clarkston's, and the Clarkston Shores Corporation ability to maintain the structures.

7.0 RECOMMENDATIONS

Based on the items discussed herein, Golder recommends that DeKalb County, the City of Clarkston, and Clarkston Shores Corporation develop a program to improve watershed quality using funding supplied by all three stakeholders. Several options are recommended below to improve watershed quality. One or more of these options can be implemented with benefits to all stakeholders, however; prior to selection, the overall cost/benefit relationship of each option should be considered relative to other DeKalb County projects. Once the Comprehensive Snapfinger Creek Watershed Plan is completed by the COE additional options are recommended for watershed improvement, but the cost/benefit relationship of these projects needs to be compared against those basin-wide projects recommended by the COE. All parties should periodically evaluate the success of the watershed improvement efforts before preceding with additional options Proposed cost sharing for the various options is presented in Section 7.4.

7.1 Option One

Golder recommends that this option consist of the following three items:

1. Non-structural watershed improvement option of public education;
2. Additional water quality and sediment sampling; and,
3. Routine maintenance on the dam embankments.

Public education and awareness can be achieved using signage posted along road crossings, at storm drain inlets, and sanitary sewer manholes. The signage should be specific to each structure. For example, many communities have implemented signage at stormwater drainage inlets that states “no dumping, leads to streams” to prevent dumping of chemicals into waterbodies via the stormwater collection system. Since Milan Park is located immediately downstream of Clarkston Lake, a kiosk type education marker could be installed to educate residents about the watershed and their role in protecting the water bodies. An educational program at the Jolly School could also be implemented to teach younger children the very same ideas.

Since the water quality samples obtained by Golder represent water quality in the lake at a specific period in time, we recommend that additional sampling be performed to assess water quality for a longer period of time. During this process we recommend that sediments in Crystal Pond also be sampled to determine if the sediments are hazardous or represent a long-term water quality liability.

Since the embankment dams which form Crystal Pond and Clarkston Lake represent a liability to all parties, we also recommend the dams and spillways be cleared of all brush, trees, and debris. Upon clearing, the embankments should be re-vegetated with a permanent grass and sloughs and erosion on the embankments should be repaired Clearing the dams and spillways of these items will facilitate inspection of the structures to identify any additional potential deficiencies.

7.2 Option Two

Golder recommends that this option consist of the following four items[2]:

1. Construction of energy dissipators and repair of the two stormwater drainage structures draining into Crystal Pond;
2. Construction of a small sediment forebay at the inlet to Crystal Pond;
3. Clearing of brush, trees, and debris in Crystal Pond; and,
4. Dam breach analysis for a sunny day breach of Clarkston Lake.

Maintenance of the energy dissipators and sediment forebay is required to ensure proper operation of these structures. Maintenance agreements should be agreed to by the City of Clarkston and Dekalb County prior to implementing these solutions.

A dam breach analysis should be conducted for Clarkston Lake to identify properties inundated by a breach of the structure. Based on the potential for loss of life and other economic impacts as a result of a breach of Clarkston Lake, rehabilitation of the Clarkston Lake Dam and Norman Road should be considered.

7.3 Future Options Based on the Corps of Engineers Comprehensive Watershed Plan for Snapfinger Creek

Once the Comprehensive Watershed Plan for Snapfinger Creek is completed by the COE, Golder recommends the consideration of additional options consisting of the following:

1. Design and construction of the proposed stormwater management facility upstream of Crystal Pond.
2. Design and construction of stream and floodplain restoration downstream of the proposed stormwater management facility.
3. Rehabilitation of the dam embankment, spillway system, and Norman Road.

Since these projects are some of the most costly watershed improvement options identified herein, the projects have been identified for later implementation to facilitate procurement of grants and other

[2] Work recommendations could change if the results of the water and sediment sampling indicates unfavorable conditions in Crystal Pond and Clarkston Lake

funding mechanisms for the work. Delaying these projects until a later date provides necessary time to develop a public/private partnership in the upper parts of the watershed for re-development and construction of the proposed stormwater management facility.

As part of the stream and floodplain restoration project, restoration of Milan Park downstream of Clarkston Lake should also be considered, since much of the stream within the park has been diverted into underground stormwater drainage pipes. Restoration of Milan Park would provide additional flood attenuation and natural habitat.

Unless previous work identifies major deficiencies with the Clarkston Lake Dam we recommend that rehabilitation of the dam embankment, spillway system, and Norman Road be completed at a later date. The design should consider repair of the existing principal spillway system (including the installation of a low level outlet to drain the lake), repair of the road embankment and utilities, and providing additional spillway capacity to prevent the overtopping of Norman Road during storms with a high probability of occurance. Construction of the stormwater management facility proposed above would aid in minimizing the work required to rehabilitate the dam.

7.4 Proposed Cost Share

Based on the projects proposed, Golder has attempted to determine a fair cost share between DeKalb County, the City of Clarkston, and Clarkston Shores Association. In evaluating the proposed projects and the cost share, specific items such as the following were carefully considered:

- Location of improvement relative to the City of Clarkston's and unincorporated DeKalb County boundaries and the Clarkston Shores Association Property;
- Direct recipient of the benefits for the proposed improvements;
- Past, present, and future operations and maintenance obligations relative to the structure and proposed improvements; and,
- Magnitude of funds availability.

Table 6 provides the proposed cost share and Table 7 provides the estimated costs for DeKalb County, the City of Clarkston, and the Clarkston Shores Association (CSA). The costs are preliminary as they are based on conceptual designs where quantity estimates are approximate and they may not be fully inclusive of all construction costs. The estimates do not include the costs associated with investigations, design, construction quality assurance and construction management. Other issues influencing final project cost that cannot be predicted or controlled include: cost pricing of labor and materials; unknown geotechnical conditions of existing structures; the competitive bidding climate and market conditions; time or quality of performance by third parties; quality, type, management, or direction of operating personnel; inflation; and other economic and operational factors that may affect the ultimate project cost. Costs represent the estimated present value for the project. We recommend periodically reviewing and adjusting the cost for future value, based on historical market trends and inflation rates.

TABLE 6
RECOMMENDED COST SHARE

OPTION	PROJECT DESCRIPTION	OPINION OF PROBABLE COST	COST SHARE		
			DEKALB	CLARKSTON	CSA
1	Public Education	$10,000	50%	50%	
	Water Quality and Sediment Sampling	$20,000	100%		
	Clearing of brush and trees on dam embankments	$10,000			100%
2	Energy Dissipators	$10,000	50%	50%	
	Sediment Forebay	$15,000	100%		
	Clearing of brush, trees, and debris in Crystal Pond	$2,500			100%
	Dam Breach Analysis	$5,000	100%		
FUTURE Based on COE Comprehensive Watershed Plan for Snapfinger Creek Basin	Regional Flood Detention Facility	$1,500,000	100%		
	Stream & Floodplain Restoration	$70,000	50%	50%	
	Dam Rehabilitation				
	Existing Spillways	$25,000			100%
	Existing Earthfill Crystal Pond Dam	N/A			100%
	Existing Earthfill Clarkston Lake Dam	$500,000	100%		
	New Auxiliary Spillway/Culvert	$100,000	100%		

TABLE 7
ESTIMATE OF PROJECT COSTS

OPTION	PROJECT DESCRIPTION	OPINION OF PROBABLE COST	COST SHARE		
			DEKALB	CLARKSTON	CSA
1	Public Education	$10,000	$5,000	$5,000	
	Water Quality and Sediment Sampling	$20,000	$20,000		
	Clearing of brush and trees on dam embankments	$10,000			$10,000
2	Energy Dissipators	$10,000	$5,000	$5,000	
	Sediment Forebay	$15,000	$15,000		
	Clearing of brush, trees, and debris in Crystal Pond	$2,500			$2,500
	Dam Breach Analysis	$5,000	$5,000		
FUTURE Based on COE Comprehensive Watershed Plan for Snapfinger Creek Basin	Regional Flood Detention Facility	$1,500,000	$1,500,000		
	Stream & Floodplain Restoration	$70,000	$35,000	$35,000	
	Dam Rehabilitation				
	Existing Spillways	$25,000			$25,000
	Existing Earthfill Crystal Pond Dam	N/A			
	Existing Earthfill Clarkston Lake Dam	$500,000	$500,000		
	New Auxiliary Spillway/Culvert	$100,000	$100,000		
ESTIMATED TOTAL PROJECT COSTS		**$2,267,500**	**$2,185,000**	**$45,000**	**$37,500**

8.0 POTENTIAL FUNDING SOURCES

A variety of grant funding sources are available for watershed restoration efforts. Golder has outlined four grants that may be suitable for moving forward with the Clarkston Lake restoration efforts. Potential grants may be funded by state, local, and federal governments or private entities. The requirements for these grants will vary considerably. Eligible participants and projects also differ with each funding program. In applying for these grants the results of the COE's Comprehensive Snapfinger Creek Watershed Plan will be beneficial in determining cost/benefit relationships and procurement of the required matching funds.

While researching potential funding sources, Golder considered both watershed restoration and wildlife/plant habitat restoration as potential future projects. Local governments are eligible participants in the four grant programs that Golder has outlined. Partnerships are either requirements or favorably viewed by the grant funding programs provided. The four grants that Golder has outlined require some effort of match funding that can be provided as a cash option or through in-kind services. The grants outlined are not available to implement requirements of local permits. Potential funding sources are identified in Table 8.

TABLE 8
POTENTIAL FUNDING SOURCES

Funding Program Name	Application Deadline	Funding Range	Match Requirements
Non-Point Source Implementation Grants (319 Program)	May 31, 2007	Varies	40% Match required Funds or In-Kind Services
Five Star Restoration Program	No-Deadline	\$300 - \$25,000	Typically 50% Match Funds or In-Kind Services
National Fish and Wildlife Foundation General Matching Grants	Pre-proposal No-Deadline Full proposals reviewed June 1 and November 1	\$25,000-\$250,000	Minimum of 50% Match Required, higher match ratios are more competitive.
Partners for Fish and Wildlife Program	No-Deadline	\$300 - \$25,000	Typically 50% Match Funds or In-Kind Services

9.0 CONCLUSIONS

Based on the work conducted we conclude the following about the Environmental and Hydrologic conditions of Crystal Pond and Clarkston Lake:

- The watershed of the lakes is urbanized, with large impervious areas, and few detention/retention structures in the watershed. Those features contribute to the emerging water quality and quantity issues, such as increased peak flow rates, increased runoff volume, and increased constituent concentrations in the runoff.

- The lower segment of Sara's Creek from the Reilly Lane culvert to the upper lake has the most significant erosion and sedimentation problems, especially downstream of the apartment complex area and immediately upstream of Crystal Pond.

- Crystal Pond has lost a significant amount of storage volume due to sedimentation.

- Analysis of water samples taken at the upper and lower lake indicate that the dry weather water quality is generally in accordance with the recreation water quality criteria for pH, Fecal Coliform and DO. The total nitrogen and likely phosphorus are higher than the recommended Ambient Water Quality Criteria Recommendations, indicating a potential for lake eutrophication.

- Nonstructural BMPs should be considered to minimize pollutants washed off from drainage surfaces to the stream and the lake, thus improve the overall environmental conditions.

- Other structural BMPs within the watershed including coagulation and flocculation, wetland construction, and/or detention, etc. should be considered.

- Both dams are in need of immediate maintenance.

- Options are recommended to continually improve the watershed quality as grants and funding become available

- Several funding sources are available for watershed restoration efforts.

- The results of the Corps of Engineers Comprehensive Snapfinger Creek Watershed Plan should be utilized in determining the cost/benefit relationship of the options suggested herein relative to other improvements recommended for the Snapfinger Creek watershed.

10.0 REFERENCES

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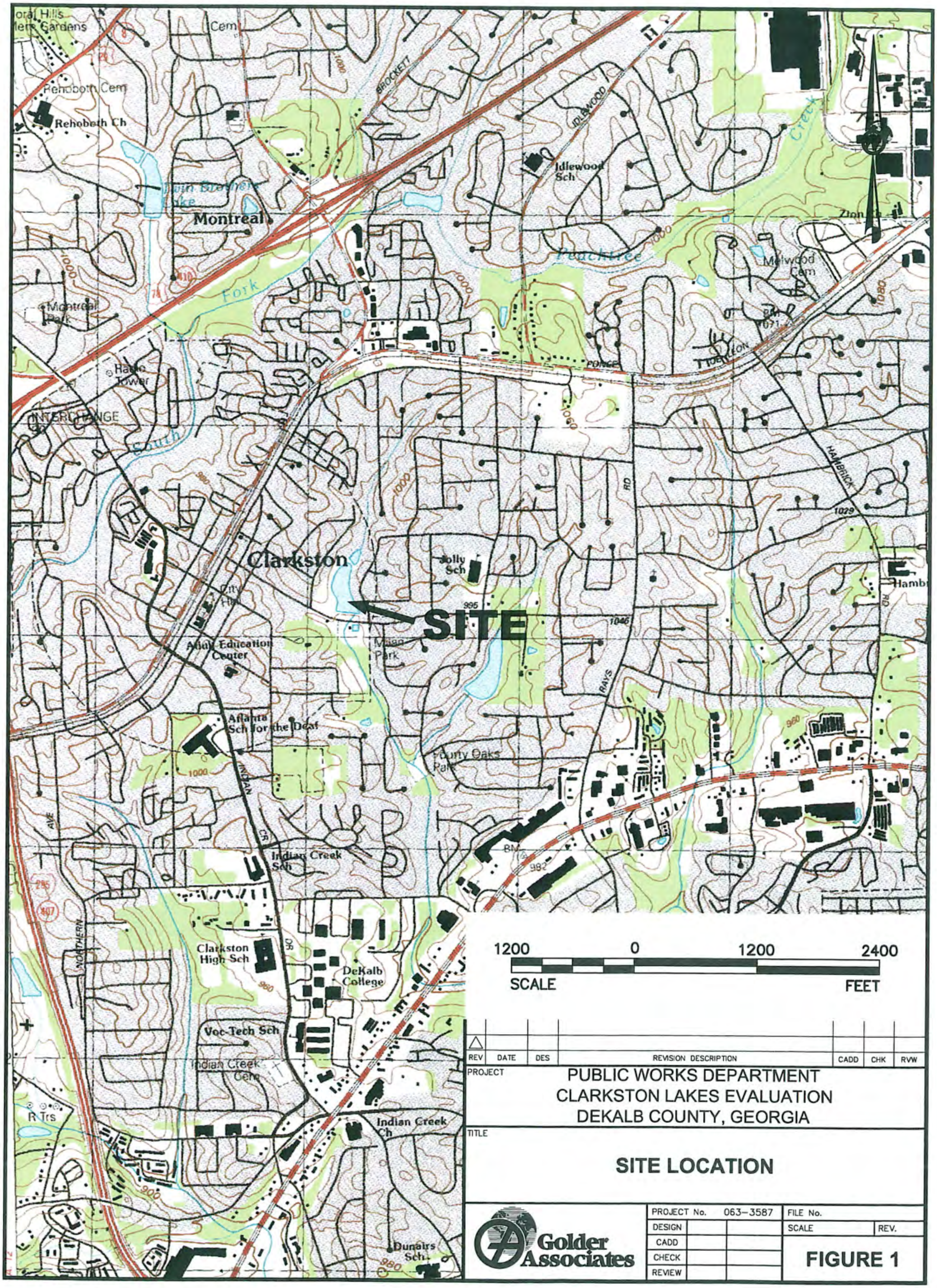


1200 0 1200 2400

SCALE FEET

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT

PUBLIC WORKS DEPARTMENT
CLARKSTON LAKES EVALUATION
DEKALB COUNTY, GEORGIA

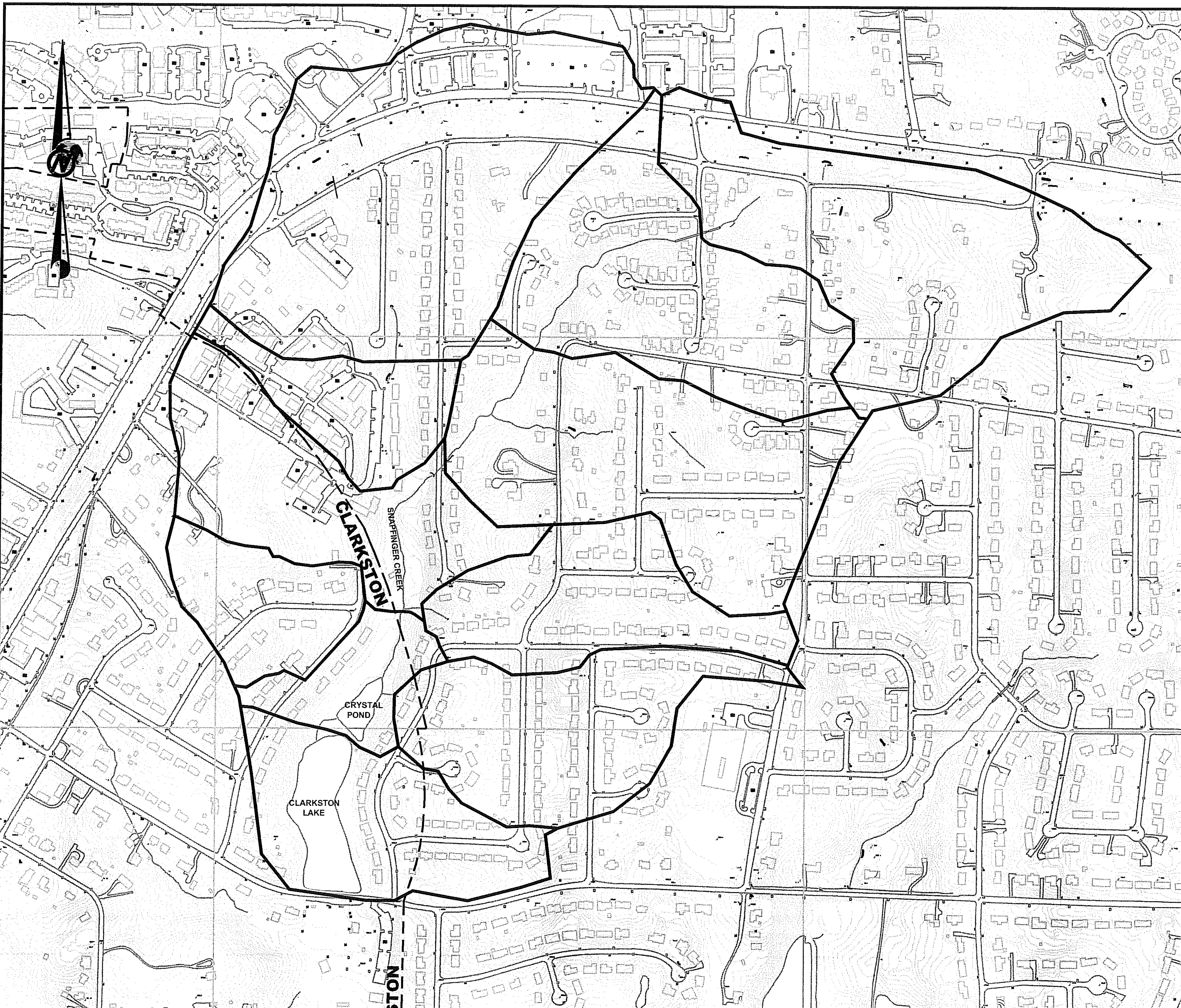
TITLE

SITE LOCATION

Golder Associates

PROJECT No.	063-3587	FILE No.	
DESIGN		SCALE	REV.
CADD			
CHECK		**FIGURE 1**	
REVIEW			

X:\Clients\Dewberry\063-3587 Clarks Twin Lakes\2007_Design Information\FIGURE1.dwg



LEGEND

WATERSHED BOUNDARY

CLARKSTON CITY LIMIT

EX. BUILDING

NOTES

1. THE DATA PRESENTED ON THIS DRAWING HAS BEEN DIGITIZED FROM EXISTING SOURCES OF INFORMATION. THE ACCURACY OF THE DATA IS NOT GUARANTEED.

REFERENCES

1. BASE DATA PROVIDED BY DEKALB COUNTY.
2. WATERSHED DATA PROVIDED BY DEWBERRY & DAVIS, LLC.

50 0 50
SCALE FEET

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
PUBLIC WORKS DEPARTMENT
CLARKSTON LAKES EVALUATION
DEKALB COUNTY, GEORGIA

TITLE
WATERSHED MAP

Golder Associates

PROJECT No.	063-3587	FILE No.	
DESIGN		SCALE	REV.
CADD			
CHECK		FIGURE 2	
REVIEW			

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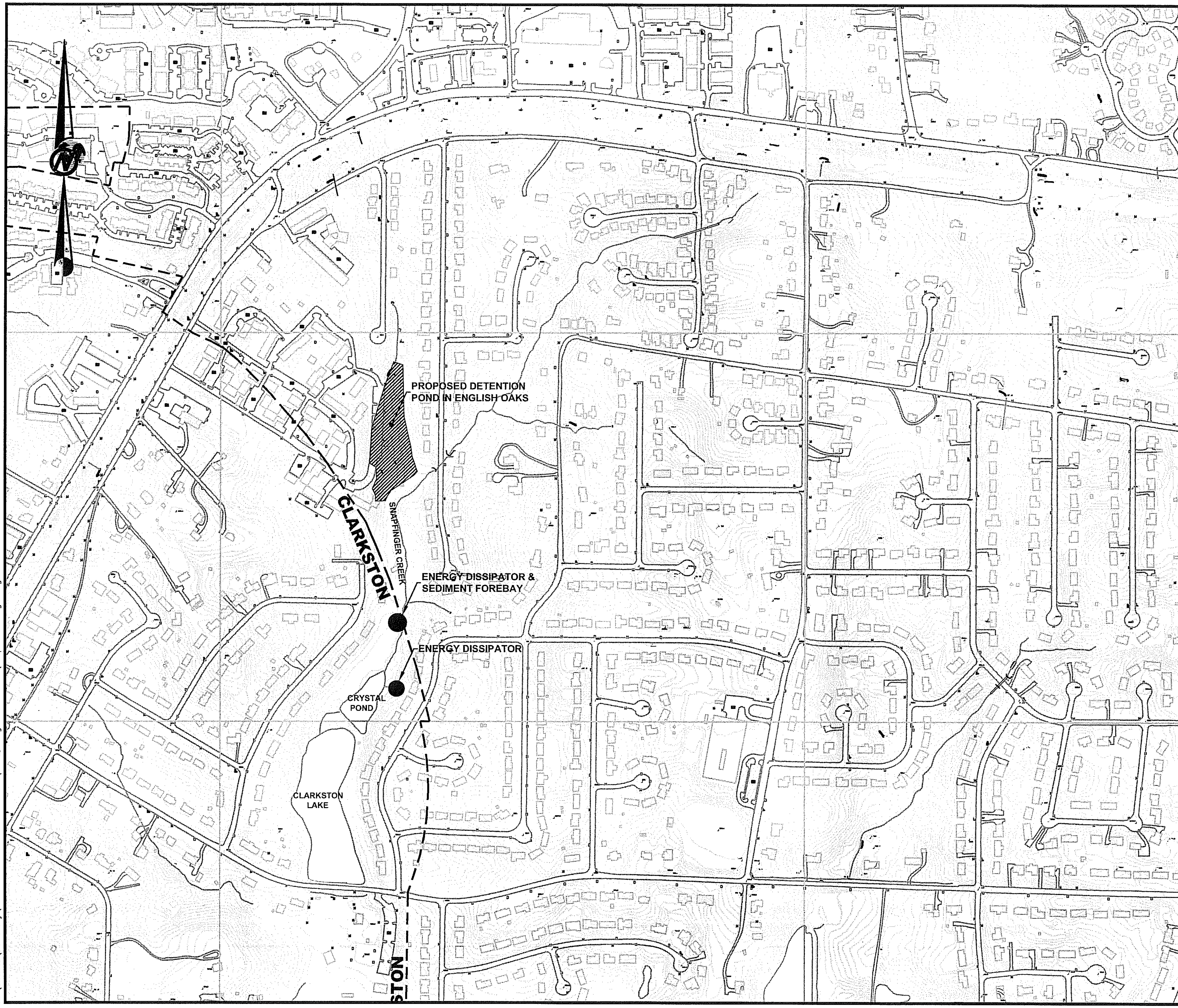

LEGEND

- — — — CLARKSTON CITY LIMIT
- EX. BUILDING

NOTES

1. THE DATA PRESENTED ON THIS DRAWING HAS BEEN DIGITIZED FROM EXISTING SOURCES OF INFORMATION. THE ACCURACY OF THE DATA IS NOT GUARANTEED.

REFERENCES

1. BASE DATA PROVIDED BY DEKALB COUNTY.
2. WATERSHED DATA PROVIDED BY DEWBERRY & DAVIS, LLC.

50 0 50
SCALE FEET

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW

PROJECT
PUBLIC WORKS DEPARTMENT
CLARKSTON LAKES EVALUATION
DEKALB COUNTY, GEORGIA

TITLE
PROPOSED BMP's

Golder Associates

PROJECT No.	063-3587	FILE No.	
DESIGN		SCALE	REV.
CADD			
CHECK		FIGURE 3	
REVIEW			

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