Aquatic Enhancement
& Survey, Inc.

Aquatic Vegetation Management Plan Update 2008

Hamilton Lake, Steuben County

Prepared for the Hamilton Lake Association
By
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Scott Banfield, Aquatic Enhancement & Survey, Inc.

Table of Contents **Page**

Acknowledgements 2
1.0 Executive Summary 5
2.0 Problem Statement 6
3.0 Management History and Goals 6
4.0 Watershed and Water Body Characteristics 24
4.1 Hamilton Lake Hydraulic Residence Time Calculation 24
4.1.1 Hydraulic Residence Time Calculation by Estimating Annual Runoff 24
4.1.2 Hydraulic Residence Time Calculation Utilizing Flow Data 25
5.0 Present Water Body Uses 26
6.0 Aquatic Plant Community Characterization 26
6.1 Tier II Survey Methods 26
7.0 Threatened and Endangered Species Surveys 28
8.0 Description of Beneficial and Problem Plant Areas 38
9.0 Aquatic Plant Management Alternatives 42
10.0 Public Involvement 51
11.0 Implementation of Action Plan 53
12.0 Education 59
13.0 Monitoring and Evaluation of Plan 60
14.0 Literature Cited 61
Appendix A IDNR Aquatic Vegetation Permit Application 62
Appendix B Tier II Plant Survey Data Sheets 76
Appendix C Raw Data Sheets, 7/10/08, 11/22/08 Flow Rates 88
Appendix D Hamilton Lake Tier II Sampling Point Coordinates 96

List of Tables **Page**

Table 1 Fluridone (Sonar®) dosages for Crystal Bay and Crystal Cove in 2008 7
Table 2 Fluridone assay results for Crystal Bay and Crystal Cove in 2008 7
Table 3 Treatments on Hamilton Lake in 2008 11
Table 4 Hamilton Lake Curlyleaf pondweed and Eurasian watermilfoil treatment history 2002 to present 11
Table 5 Hyrdaulic Residence Time Estimate Data for Hamilton Lake 24
Table 6 Residence time estimate data for flow rate measured 7/10/08 25
Table 7 Summary of Tier II results 30
Table 8 Proposed sampling and application regime for fluridone treatment in 2009 44
Table 9 Summary of survey questions 2004, 2007, 2008 53
Table 10 2009 Option one cost estimates 55
Table 11 2009 Option two cost estimates 56
Table 12 2009 Option three cost estimates 57
Table 13 2009 through 2011 cost comparisons 58

List of Figures

Figure 1 Fluridone assay results for Crystal Bay and Crystal Cove in 2008 8
Figure 2 5/26/08 Exotic Plant Map for Hamilton Lake 12
Figure 3 Crystal Bay and Crystal Cove fluridone treatment area 2008 13
Figure 4 5/20/08 Herbicide treatments 14
Figure 5 5/28/08 Herbicide treatments 15
Figure 6 6/4/08 Herbicide treatments 16
Figure 7 6/18/08 Herbicide treatments 17
Figure 8 6/23/08 Herbicide treatments 18
Figure 9 7/15/08 Herbicide treatments 19
Figure 10 8/6/08 Herbicide treatments 20
Figure 11 8/8/08 Herbicide treatments 21
Figure 12 8/22/08 Herbicide treatments 22
Figure 13 2008 Season Algae treatments 23
Figure 14 Tier II collection waypoints 27
Figure 15 Hamilton Lake Secchi history 28
Figure 16 Summary past and current Tier II plant survey data for Hamilton Lake 29
Figure 17 Number of native species noted in 2004-2008 Tier II surveys 31
Figure 18 Percent occurrence (% of sites) of aquatic vegetation in Tier II surveys 2004-2008 31
Figure 19 Percent occurrence (% of sites) for Eurasian watermilfoil in Tier II surveys 2004-2008 31
Figure 20 Curlyleaf pondweed occurrence (% of sites) in Tier II surveys 2004-2008 32
Figure 21 General locations of noted Richardson's pondweed growth in the 2008 season 33
Figure 22 Tier II Eurasian watermilfoil 34
Figure 23 Tier II Curlyleaf pondweed 35
Figure 24 Tier II Coontail 36
Figure 25 Tier II Water stargrass 37
Figure 26 Hamilton Lake area of typical milfoil colonization if left in an unmanaged state 40
Figure 27 Curlyleaf pondweed problem areas in 2008 41
Figure 28 Areas for Sonar P.R. application near tributary inflows 45
Figure 29 Proposed fluridone assay collection points for 2009 46
Figure 30 Estimated area of Eurasian watermilfoil growth in 2009 48
Figure 31 Estimated area of curlyleaf pondweed growth in 2009 49
Figure 32 Hamilton Lake High Use Areas 51

1. Executive Summary

Executive Summary

Hamilton Lake is an 802 acre Kettle Lake in Steuben County Indiana. It has a maximum depth of 70 feet and an average depth of approximately 21 feet. Hamilton is relatively rich in nutrients (eutrophic) with low to moderate summertime water clarity. The public gains access to Hamilton Lake through an Indiana Department of Natural Resources (IDNR) access ramp at Circle Park on the west shore of the lakes southeast basin. The majority of the lake's shoreline has been developed with cottages, single family homes, and small businesses. Fishing, swimming, boating, and skiing are top uses of the lake. Hamilton contains a diverse aquatic flora including one state listed rare plant species, but has a history of extensive colonization by the non-native plants Curlyleaf pondweed *Potamogeton crispus* and Eurasian watermilfoil *Myriophyllum spicatum*. For several years these plants have impaired the aesthetic and ecological quality of the lake and provided a significant hindrance to the lake's floral ecology and the recreational activities of the lake's users. A program of aquatic pesticide applications has been ongoing for several years. Utilizing Hamilton Lake Association (HLA) and IDNR Lake and River Enhancement Program (LARE) funding a plant management plan was developed for the lake in 2007 (Aquatic Enhancement, Inc. 2007). The 2007 plan served to help guide plant management at the lake toward the following set of goals: 1. Maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality. 2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species. 3. Provide reasonable public recreational access while minimizing the negative impacts on plant, fish, and wildlife resources. Additionally the original 2007 plan established management success benchmarks of a 5% or less occurrence of Curlyleaf and Eurasian milfoil in a late season (post-treatment) Tier II Survey. This update document complements and updates that plan, detailing plant management activities in 2008 and serving to help IDNR and HLA direct further management efforts toward the original goals. Hamilton Lake underwent a "whole lake" treatment with Sonar® (fluridone) herbicide in 2003 to provide long-term control of Eurasian watermilfoil and also seasonal control of Curlyleaf pondweed. Whole lake fluridone treatments typically provide control of Eurasian milfoil for multiple seasons, and control of Curlyleaf pondweed only in the season of application. Significant milfoil growth began to return to the lake in 2005 (45 acres) so another fluridone treatment took place in 2006. Problems with milfoil in the 2007 season were minimal. Significant problems with Curlyleaf pondweed growth were however noted in 2007 with 144.5 acres treated using a combination of LARE and HLA funding. In the 2008 season Hamilton Lake had been recolonized to some extent by Eurasian watermilfoil with 2,4-D utilized to treat 56.5 acres of growth in the main lake basins using a combination of HLA and LARE funds. Curlyleaf pondweed presented a substantial problem as well with 172.5 acres treated by HLA by the season's end. A six part per billion "whole lake" type fluridone treatment also took place on a 41 acre channel system missed by treatment in 2006. A Tier II aquatic plant survey conducted on August 12th and 13th showed water clarity to be unusually good with a Secchi depth of 15.8 feet recorded. Fifteen plant species were identified. The highest occurrence was Coontail *Ceratophyllum demersum* (68 percent) followed by Water stargrass *Zosterella dubia* (56 percent). Curlyleaf pondweed occurrence was three percent meeting the benchmark established in the plan. Eurasian watermilfoil occurred at 19 percent of sites and did not meet the plan benchmark. Overall the plant community showed exceptional diversity and was dominated by native species, but low density milfoil growth was widespread throughout the season. Based on Hamilton Lake's treatment history it's estimated that successful and efficient management will employ another lake-wide 6 ppb fluridone treatment in the 2009 season. To maximize control longevity it's advised that all channels be included in the treatment areas and fluridone granular also be used at the mouths of inflowing tributaries to help prevent milfoil recolonization from these areas. It's estimated that total exotic plant treatment costs will

be $130,000.00 and the total cost of monitoring, surveys and other management tasks will be $6950.00.

2. Problem Statement

Exotic plants provide impairment to Hamilton Lake directly and indirectly by out-competing more beneficial native species for resources, contributing to a loss of diversity, impairing recreational use, and providing a complex habitat that can alter fish community functioning. Additionally the eutrophic conditions of Hamilton Lake can potentially be exacerbated if dense invasive vegetation is managed by allowing the lake to be colonized extensively and abruptly providing control during the growing season. This can produce a nutrient rich situation where the plant community biomass is dominated by Blue-green or Filamentous algae.

3. Management History and Goals

The Hamilton Lake Association has worked with the LARE program since 2005 for plan development and treatment of exotic plants. A plan developed in 2005 never gained IDNR approval and was replaced by a new plan developed in 2007. The 2007 plan was based on three aquatic vegetation management goals developed by IDNR that apply to Hamilton Lake and other Indiana Lakes. The goals are as follows:

1. Maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality.

2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.

3. Provide reasonable public recreational access while minimizing the negative impacts on plant, fish, and wildlife resources.

Recommended management activities at Hamilton Lake in 2008 were geared toward attainment of these goals with the following objectives maintained as measurable benchmarks for success:

1. Maintain the occurrence (number of sites) of Eurasian watermilfoil in the late season Tier II survey at or below five percent.

2. Maintain the occurrence (number of sites) of Curlyleaf pondweed in the late season Tier II survey at or below five percent.

Treatments for Eurasian watermilfoil and other plants have been ongoing at Hamilton Lake for many years. Hamilton Lake tends to gravitate toward colonization of approximately 264 acres by Eurasian watermilfoil if left unmanaged. Prior to 2003 the Hamilton Lake Association would raise enough funds to treat approximately 100 acres of milfoil targeting key “high use” areas of shoreline. Milfoil outside these areas was allowed to grow and reproduce. Since 2003 whole lake treatments have been initiated, followed up in the subsequent 2 seasons by a “seek and destroy” herbicidal management policy on all known milfoil plants to delay the return of the plants as a problem. Granular fluridone herbicide has been used in 2003 and 2006 (6ppb rate) to gain complete control over Eurasian watermilfoil. Curlyleaf pondweed growth at Hamilton Lake has been highly variable and difficult to predict. During some seasons treatment has been unnecessary. In 1996 and 1999, 40 acres were treated for Curlyleaf. In 2000 the treated area increased to 60 acres and treatment was again needed in 2004 on 65 acres. The growth soared to 170 acres in 2007 with 144.5 acres prioritized and treated. In 2007 approximately nine acres were treated for Eurasian watermilfoil with 2,4-D granular herbicide. Since the whole lake fluridone treatment in 2006 Eurasian watermilfoil is recolonizing the lake and the 2007

treatments were performed to kill all returning milfoil growth as it was noted. Much of the 2007 treatment for milfoil took place in the Crystal Bay and Crystal Cove channel system in the northwest part of the lake. This area was a primary location for Eurasian watermilfoil growth as a result of being excluded from the fluridone treatment in 2006.

The Hamilton Lake Association entered the 2008 season working toward plan goals with a continued seek and destroy policy for Eurasian watermilfoil and Curlyleaf pondweed in Hamilton Lake proper. This entails checking the lake for the growth of these plants and applying herbicides as needed to eliminate them wherever they occur. This was performed repeatedly on an ongoing basis throughout the season. A six bump six fluridone treatment was planned to control Eurasian milfoil at Crystal Bay and Crystal Cove in 2008 and carried out. LARE cost-share funding was granted for the treatment of 50 acres of Eurasian watermilfoil with 2, 4-D granular aquatic herbicide (brand name Navigate®). No cost-share funding was available for Curlyleaf pondweed control.

On May 26, 2008 time was spent on Hamilton Lake developing a map of exotic plant growth (See Figure 1 below). Five acres of significant Eurasian watermilfoil growth was noted and 78 acres of significant Curlyleaf pondweed growth. Areas containing both plants totaled 74 acres. Most of the areas of milfoil growth were low density scattered plants mixed with native plants. A season-long regime of treatments at Hamilton Lake began with a fluridone treatment at the concentration of six parts-per-billion (ppb) to control Eurasian milfoil in the Crystal Cove and Crystal Bay channel system (See Figure 3 below). This treatment was advised in the original Hamilton Lake Plant Management Plan (Aquatic Enhancement, Inc. 2007). The channel system was dosed with fluridone on April 30, May 20th and June 4th. Information about dosages and Lab assay results are contained in tables one and two respectively. A graph of assay results verses days after treatment (DAT) is presented in figure one.

Date treated	Amount of Sonar A.S. applied
4/30/08	126 ounces
5/20/08	25 ounces
6/4/08	64 ounces

Table 1 Fluridone (Sonar®) dosages for Crystal Bay and Crystal Cove in 2008

Date collected	5/2/08	5/14/08	5/31/08
Days after treatment	2	14	31
collection site 1	3.8	4.3	5.3
collection site 2	3.2	4	4.8
collection site 3	4.2	5.2	5.8
3 site avg.	4	4	5

Table 2 Fluridone assay results for Crystal Bay and Crystal Cove in 2008

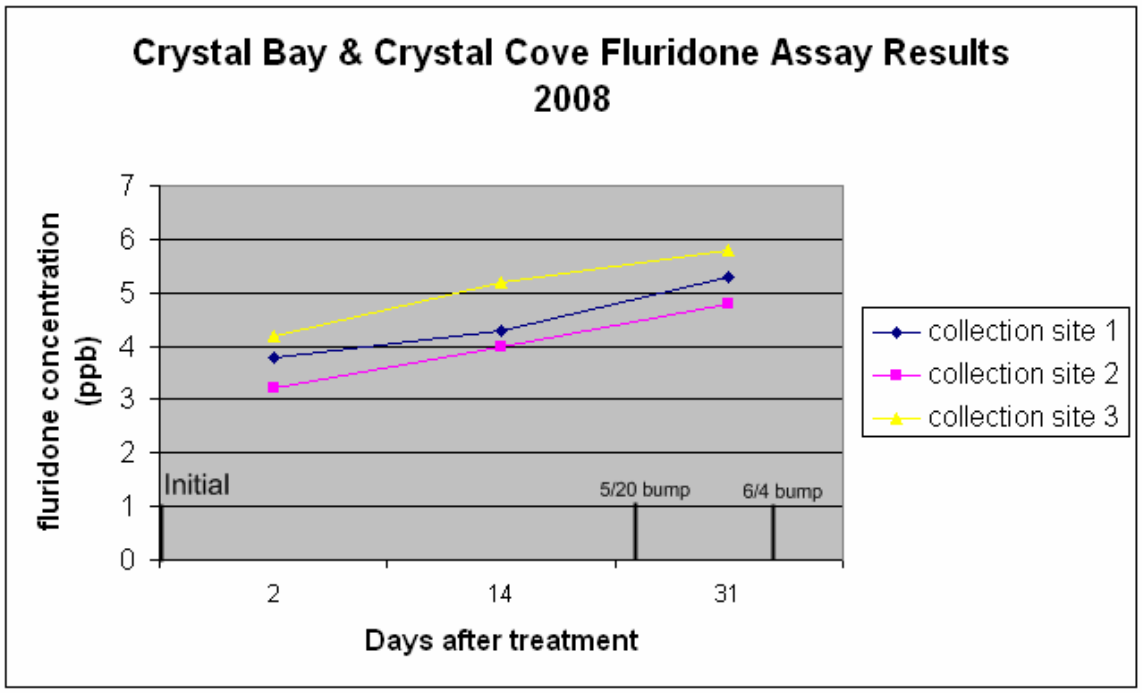

Figure 1 Fluridone assay results for Crystal Bay and Crystal Cove in 2008

The Crystal Bay and Crystal Cove treatment utilized Sonar® A.S. aquatic herbicide and was initiated on April 30, 2008. Three assays collected 2 DAT showed fluridone concentrations between 3.2 and 4.2 ppb with an average concentration of four ppb for all three sites. A "bump" application was performed on May 20. Another round of assays collected 14 DAT (May 14) at the three sites showed fluridone concentrations between 4ppb and 5.2ppb with an average of 4ppb for all three. A last bump treatment took place on June 4. Three more assays were then collected 31 DAT (May 31) showing concentrations between 4.8 and 5.8ppb with an average of 5ppb. At the time of the Tier II survey on August 12 there was Eurasian watermilfoil present in Crystal Bay and Crystal Cove. This milfoil growth was included in the exotic plant mapping done May 26 (Figure 2). Most plants were short and had not reached the surface but the milfoil observed did not show any obvious signs of damage. It is unknown why the Eurasian watermilfoil in Crystal Bay and Crystal Cove did not show more damage during the survey. The concentrations demonstrated by the assays appear to be sufficient to have begun to act on the plants by mid-July. Eurasian milfoil present in Hamilton Lake proper has not shown an unusual resistance to fluridone treatments in the 2003 and 2006 applications. Successful lakewide control has been achieved in both cases, with substantial regrowth delayed until the second season after treatment. The applicator and the HLA feel that the high number boats frequenting the channels transported a significant number of untreated milfoil fragments into Crystal Bay and Crystal Cove contributing to the growth. Although assays were stopped after 31 DAT it appears from the trajectory of the graph in figure one that a significant concentration of fluridone was probably present in this system for much of July which would have presented a hostile environment for colonization through most of the 2008 summer. Nevertheless it is difficult to ascertain the cause of the persistent milfoil without a longer assay record and continual observation until the season's end. It is possible the milfoil dropped from the water column later in the 2008 season as fluridone treatments can sometimes take an extended period of time to have their full effect. Sepro Corporation, the manufacturer of the product used, generally advises that a concentration of over 3ppb for a period of 90 to 120 days may be needed to insure good results (Bob Johnson pers. comm.).

In future fluridone treatments at Hamilton Lake it may be advisable to strive to achieve at least 6ppb with all doses in the first 60 days and continue with assays at 48 hours after treatment 14 DAT, 28 DAT, 60 DAT, 90 DAT, and 120 DAT. Maintenance doses should be applied as needed to bring concentrations to 4ppb within a week of each assay collection. The goal will be to holding concentrations to 3ppb or more for at least 90 days. An elevated initial dose rate of 8ppb should be used during the initial treatment at Crystal Bay and Crystal Cove in 2009 to help insure good results. Native plants of value such as the Variable watermilfoil *Myriophyllum heterophyllum*, and Richardson's pondweed *Potamogeton richardsonii* present in this area are not likely to be eliminated by this treatment. No alternative milfoil treatments were carried out at Crystal Bay or Crystal Cove as the plants were not providing a severe nuisance and the prevalence of scattered Eurasian milfoil plants throughout much of Hamilton Lake proper indicated to the HLA that a whole-lake treatment would again be necessary in 2009 provide sufficient control. Lacking a program including fluridone, Hamilton Lake's milfoil colonization seems to increase to a stabilization point of approximately 264 acres of problem-level growth in the main area of the lake with another 41 acres at Crystal Cove and Crystal Bay. The HLA feel that in that situation treatment of this acreage is needed every season in addition to follow-up later-season milfoil treatments and Curlyleaf pondweed treatments. Because of the greater expense, increased water-use restrictions and less beneficial results associated with the treatment of over 300 acres of milfoil colonization annually the HLA advises that they do not consider the fluridone treatment results at Crystal Bay and Crystal Cove in 2008 to be a sufficient rationale for abandoning fluridone as the most efficient management tool available for Hamilton Lake at this time.

Treatments in the main lake for Curlyleaf pondweed and Eurasian watermilfoil began on May 20th (Figure 4 below). It has been noted that Curlyleaf pondweed historically emerges at different times in different areas of Hamilton Lake. Its seasonal appearance or absence in various areas has also been difficult to predict. Because of this the HLA and their application contractor have not felt it practical to attempt to treat the entire area of possible emergence when water temperatures are between 50 and 55 degrees Fahrenheit (F) on the basis of preventing turion production. With limited private funding available for Curlyleaf pondweed control in 2008 the HLA has felt it would be a better course of action to treat later in the season when they are more certain of the results. The fear is that extensive emergence may actually occur after the treatment if application takes place to early. If a careful protocol for spotting and mapping emerging Curlyleaf early can be employed it may be able to work toward alleviating this situation. The HLA may wish to consider employing the residents and officers who currently assist with plant management as volunteers who can check the lake on a weekly or daily basis in April, check temperatures, and map Curlyleaf growth.

As problem plants emerged treatments continued through the 2008 season with both contact herbicides and translocated herbicides for Eurasian watermilfoil and Curlyleaf pondweed as well as Elodea *Elodea Canadensis*, Coontail *Ceratophyllum demersum*, Water stargrass *Zosterella dubia*, Flatstem pondweed *Potamogeton zosteriformis*, Vallisneria *Vallisneria americana*, and Common naiad *Najas flexilis*. Three lake-wide algae treatments were also performed on June 4th, June 23rd, and August 8th. These treatments took place around the perimeter of the lake in all developed areas. By the season's end 172.5 acres had been treated for Curlyleaf pondweed with contact herbicides, approximately 56.5 acres had been treated to control Eurasian watermilfoil, and treatment of native plants had taken place on approximately 25 acres of Hamilton Lake. Treatment maps for each day of application are located in figures 4 through 13. Unusually good water clarity in 2008 had led to increased Filamentous algae and native plant growth in Hamilton Lake. Treatment results for both exotic and native plants were satisfactory in each application but a significant amount of scattered Eurasian watermilfoil of relatively low density managed to grow

among the luxuriant Native flora present. Table four outlines the lakes treatment history for Eurasian watermilfoil and Curlyleaf pondweed from 2002 to present.

Treatment Date	Acres	Product Used	Application rate	Formulation type	Active ingredient	Target(s)
4/30/08	41	Sonar® A.S. 126 oz. (Crystals)		liquid	fluridone	Eurasian watermilfoil
5/20/08	41	Sonar® A.S. 25 oz. (Crystals)		liquid	fluridone	Eurasian watermilfoil
6/4/08	41	Sonar® A.S. 64 oz. (Crystals)		liquid	fluridone	Eurasian watermilfoil
5/20/08	47	Aquathol® K	1 gallon/acre	liquid	endotholl	curlyleaf pondweed
5/20/08	3	Navigate®	100 lb/acre	granular	2,4-D	Eurasian watermilfoil
5/28/08	120	Aquathol® K	1 gallon/acre	liquid	endotholl	curlyleaf pondweed
5/28/08	2.5	Reward®	1 gallon/acre	liquid	diquat dibromide	coontail, Elodea, Eurasian watermilfoil
6/4/08	2.5	Aquathol® K	1 gallon/acre	liquid	endotholl	curlyleaf pondweed
6/4/08	1	Reward®	1 gallon/acre	liquid	diquat dibromide	coontail, Eurasian watermilfoil
6/4/08	110	Copper sulfate®	2.6 lbs./ac-ft	fine granular	copper	filamentous algae
6/18/08	7	Reward®	1 gallon/acre	liquid	diquat dibromide	Eurasian watermilfoil
6/18/08	8	Copper sulfate®	2.6 lbs./ac-ft	fine granular	copper	filamentous algae
6/23/08	43	Navigate®	100 lb/acre	granular	2,4-D	Eurasian watermilfoil
6/23/08	110	Copper sulfate®	2.6 lbs./ac-ft	fine granular	copper	filamentous algae
7/15/08	3	Navigate®	100 lb/acre	granular	2,4-D	Eurasian watermilfoil
7/15/08	20	Reward®/Hydrothol® 191	1 gallon/ac both products	liquid	diquat dibromide/ endotholl	water stargrass, flatstem pondweed
8/6/08	16	Reward®	1 gallon/acre	liquid	diquat dibromide	common naiad
8/8/08	.5	Navigate®	100 lb/acre	granular	2,4-D	Eurasian watermilfoil
8/8/08	110	Copper sulfate	2.6 lbs./ac-ft	fine granular	copper	filamentous algae
8/22/08	1.5	Hydrothol® 191	81 lbs./ac-ft	granular	endotholl	common naiad

Table 3 Treatments on Hamilton Lake in 2008

Year	Activity	Approx. Acreage mapped/treated	Treatment Result	Funding
2002	Priority area partial shoreline treatment of Eurasian watermilfoil with contact herbicides	100 treated, total acreage approx. 264	Good results in treatment area, over 100 ac. milfoil left untreated	HLA
2003	Whole Lake Treatment for Eurasian watermilfoil (fluridone granular)	264 (ac. milfoil)	Good overall results by season's end	HLA
2004	Seek and Destroy Treatment of all significant noted Eurasian watermilfoil with granular 2.4-D	1.5	Good results in treated areas	HLA
2005	Seek and Destroy Treatment of all significant noted Eurasian watermilfoil with granular 2.4-D	45	Good results in treated areas	HLA/LARE
2006	Whole Lake Treatment for Eurasian watermilfoil (fluridone granular	n/d	Good results by season's end	HLA/LARE
2007	Treatment of Curlyleaf pondweed with Aquathol® K liquid	170 mapped/ 144.5 treated	Good results in treated areas	HLA/LARE
2007	Treatment of Eurasian watermilfoil with 2,4-D granular	6	Good results in treated areas	HLA/LARE
2008	Treatment of Curlyleaf pondweed with Aquathol K liquid	172.5	Good results in treated areas	HLA
2008	Treatment of Eurasian watermilfoil with 2,4-D granular	56.5	Good results in treated areas	HLA/LARE

Table 4 Hamilton Lake Curlyleaf pondweed and Eurasian watermilfoil treatment history 2002 to present

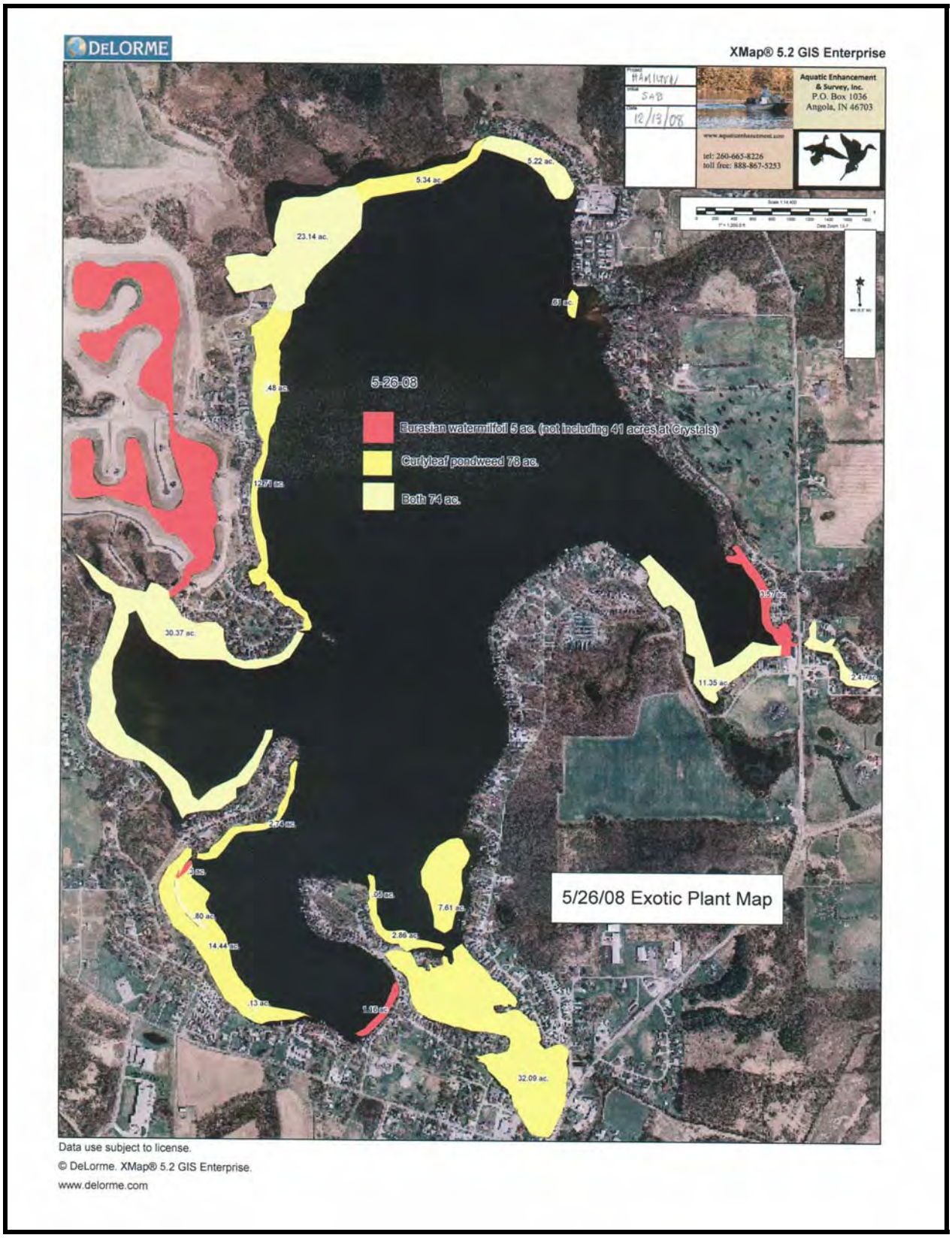

Figure 2 5/26/08 Exotic Plant Map for Hamilton Lake

Figure 3 Crystal Bay and Crystal Cove fluridone treatment area 2008

Figure 4 5/20/08 Herbicide treatments

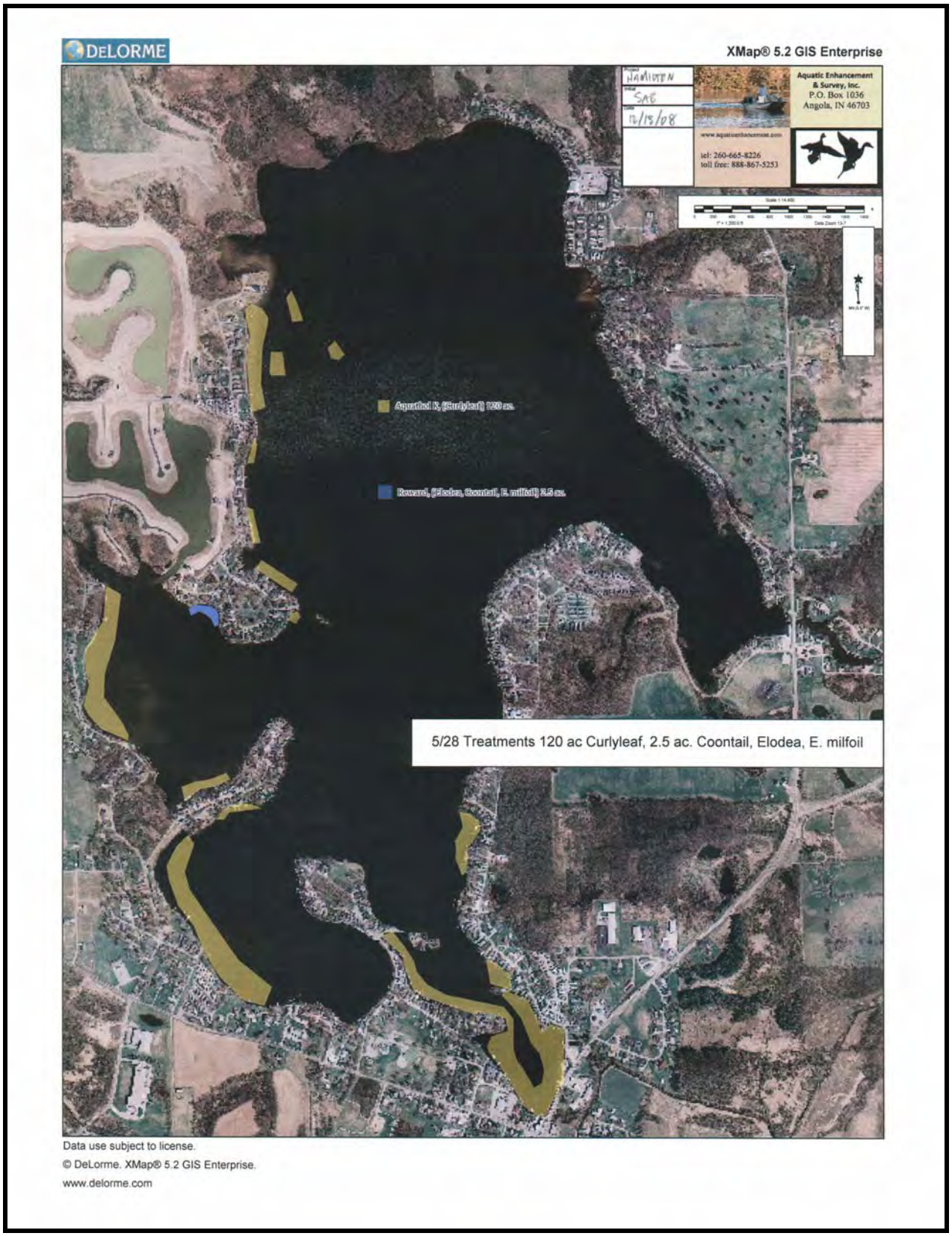

Figure 5 5/28/08 Herbicide treatments

Figure 6 6/4/08 Herbicide treatments

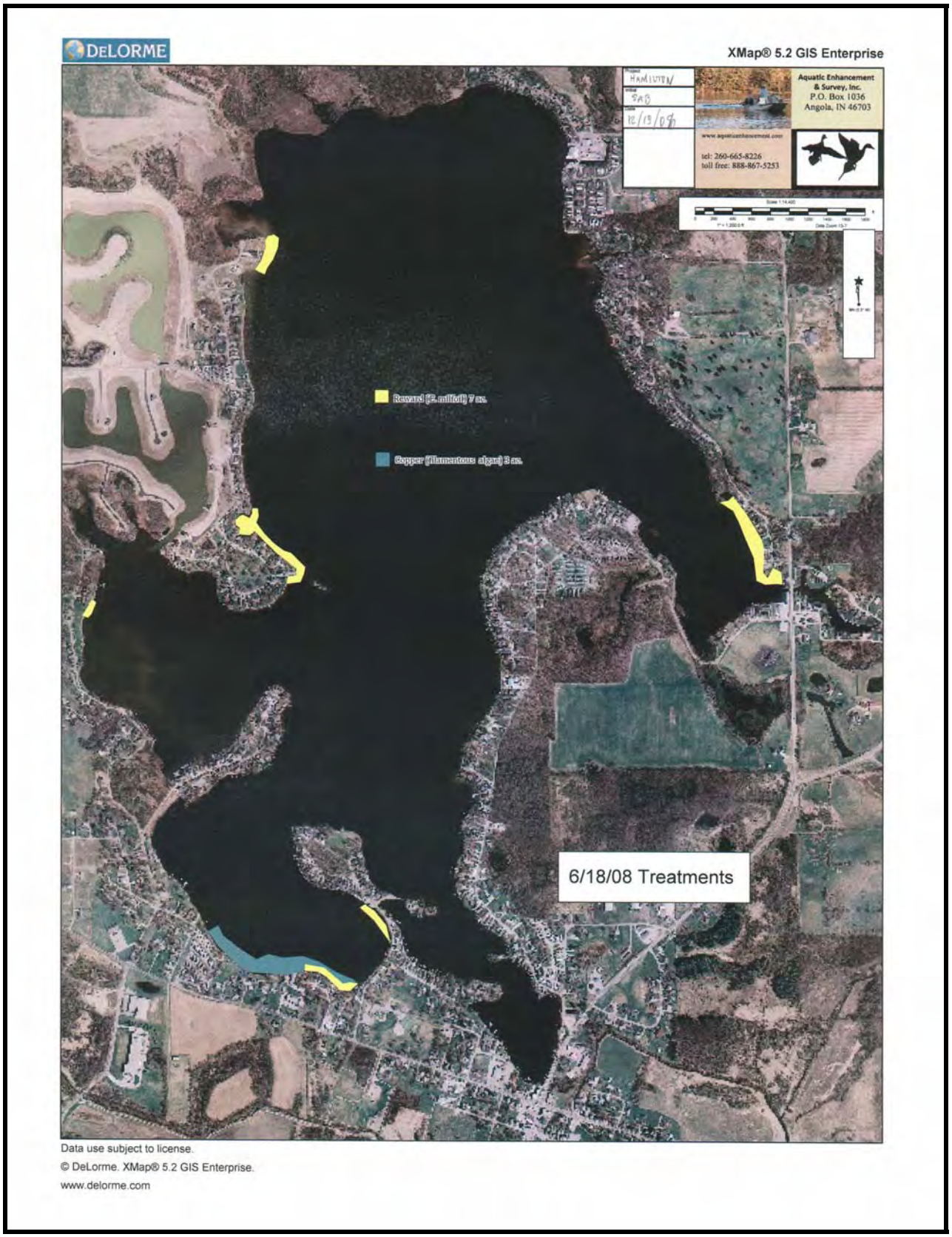

Figure 7 6/18/08 Herbicide treatments

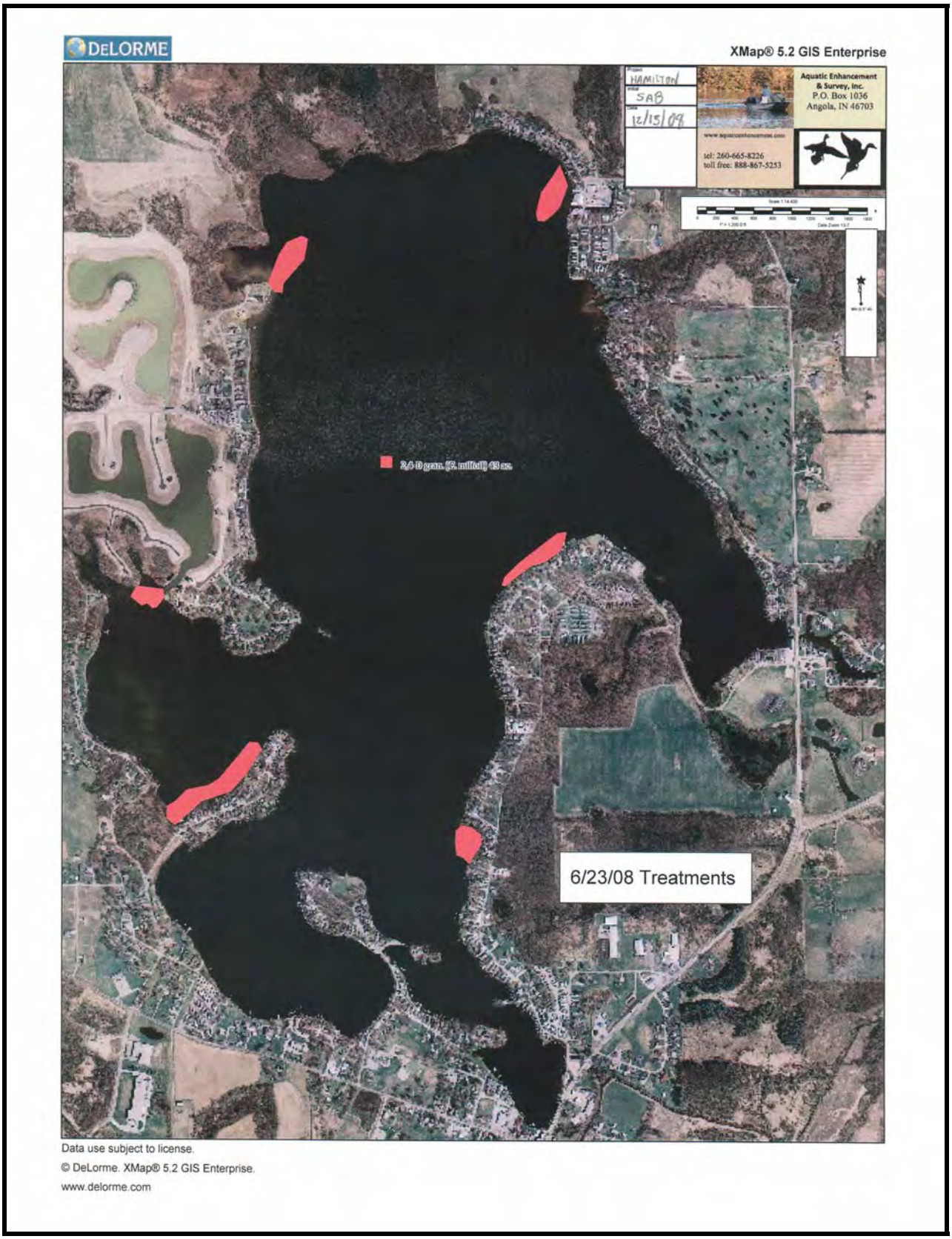

Figure 8 6/23/08 Herbicide treatments

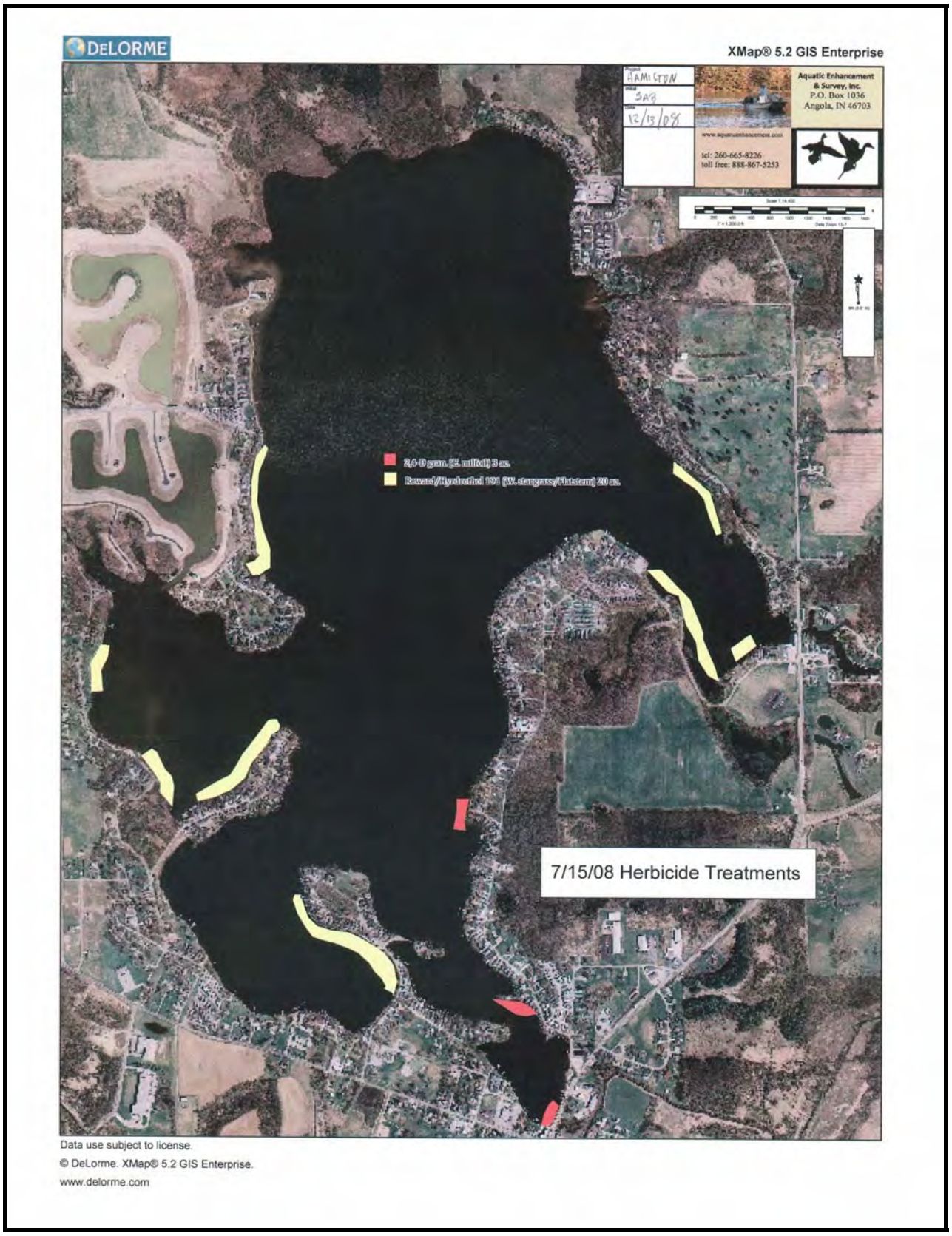

Figure 9 7/15/08 Herbicide treatments

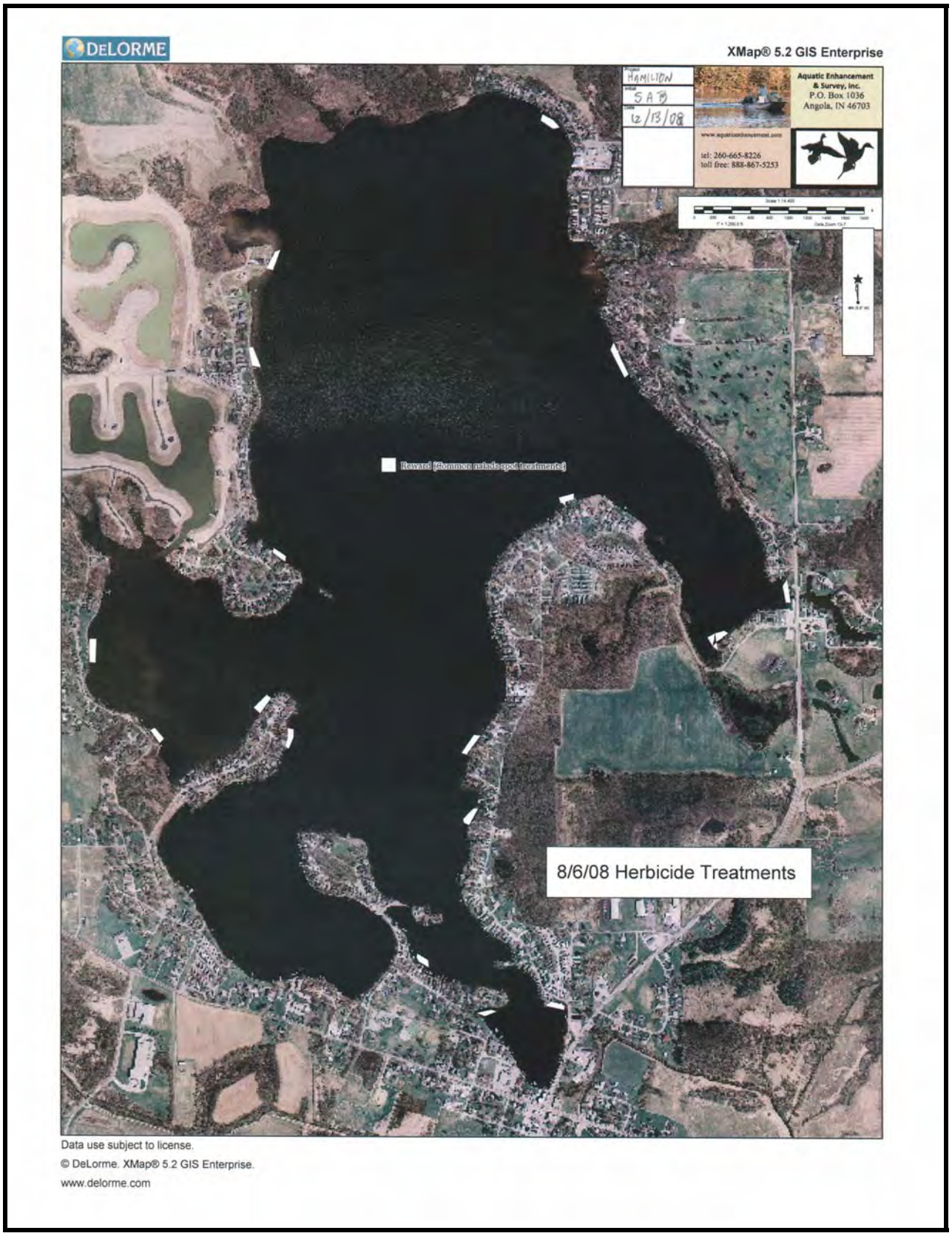

Figure 10 8/6/08 Herbicide treatments

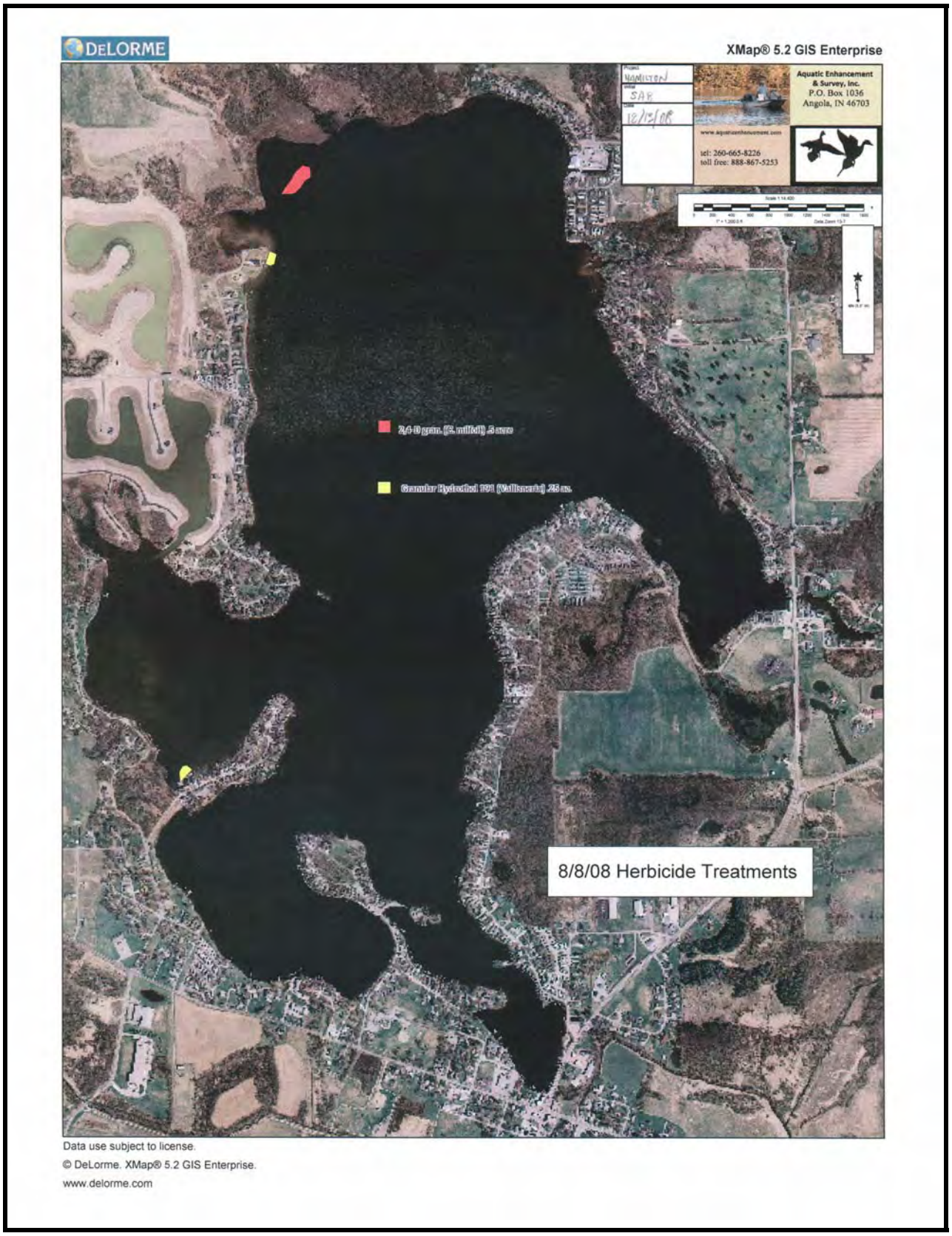

Figure 11 8/8/08 Herbicide treatments

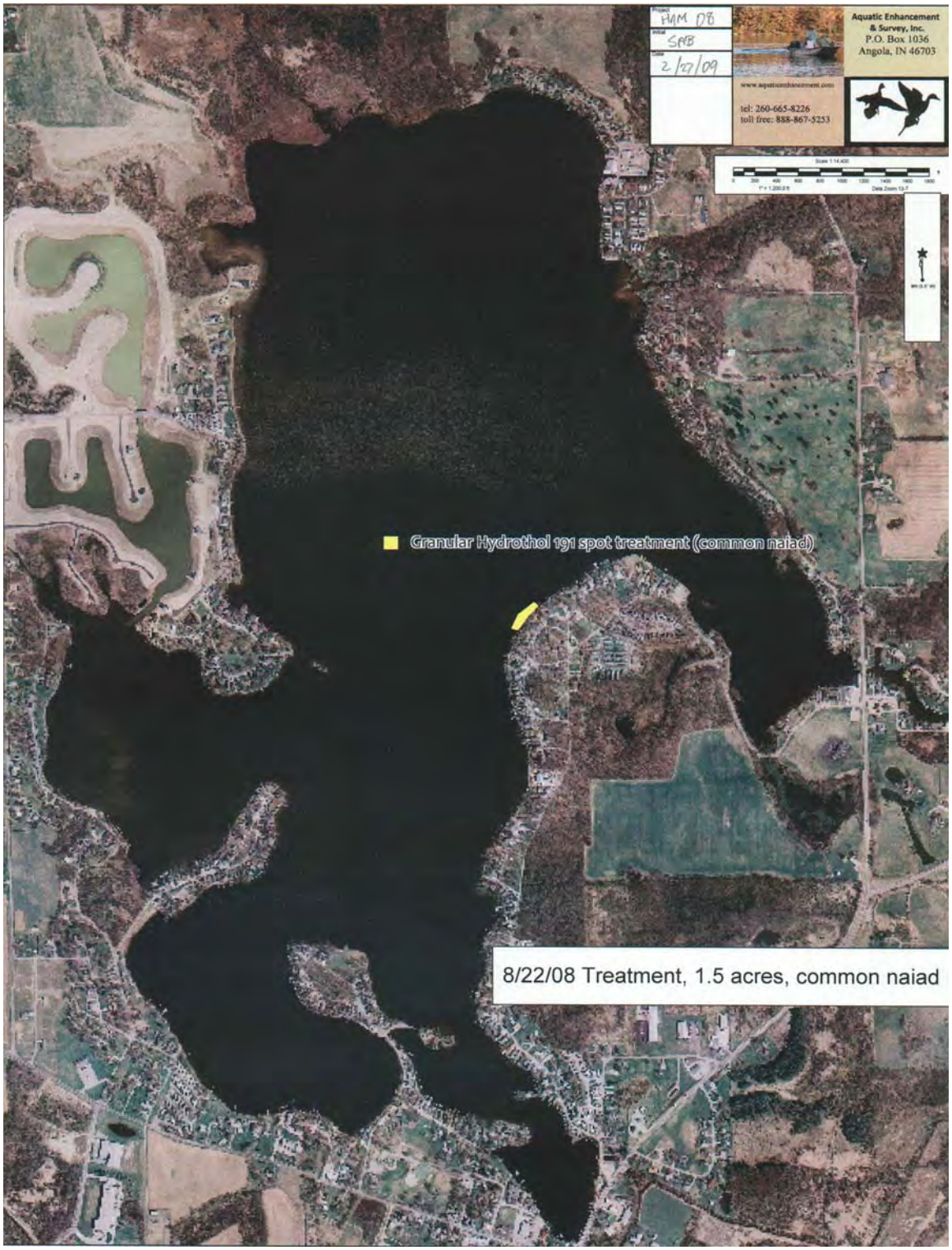

Figure 12 8/22/08 Herbicide treatments

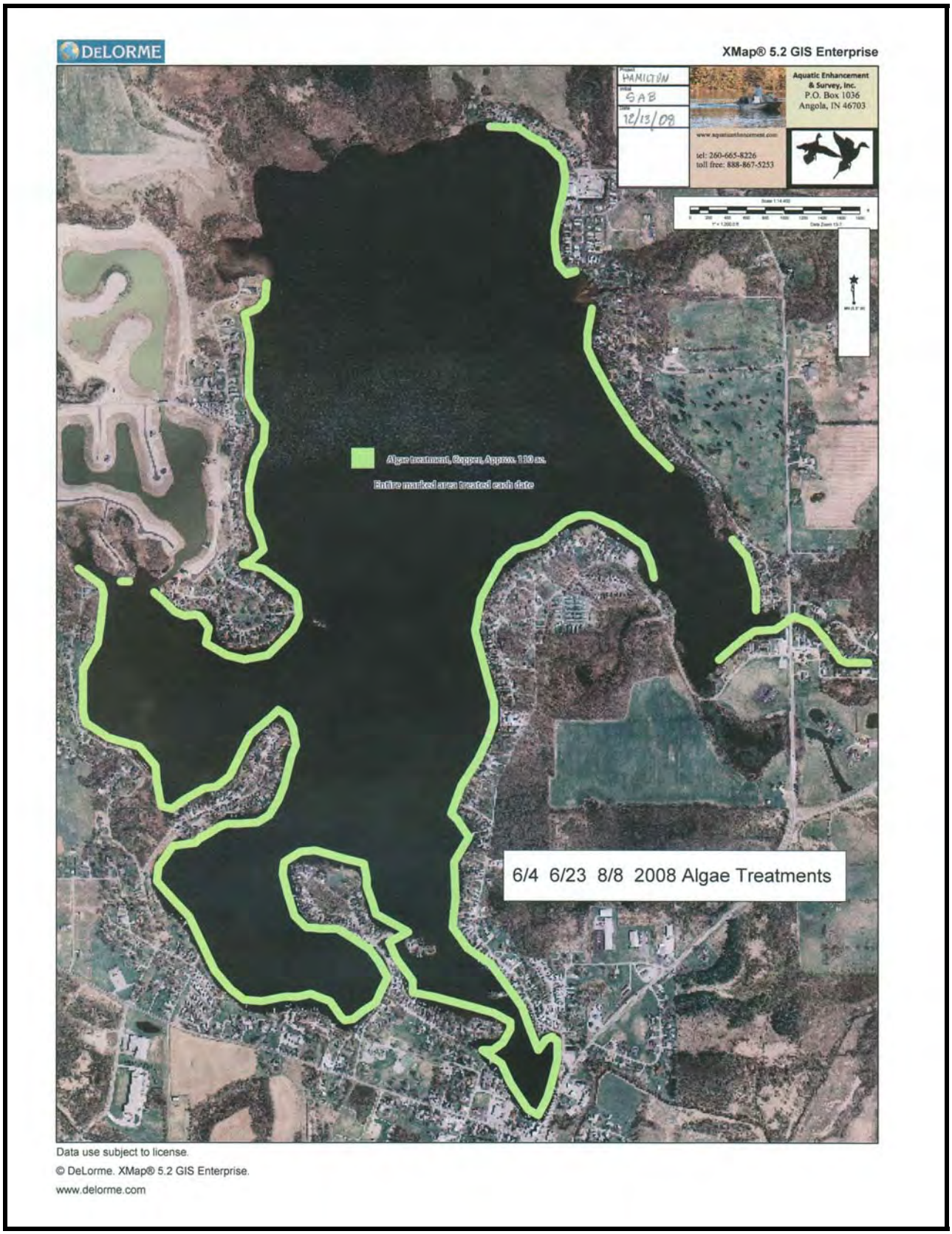

Figure 13 2008 Season Algae treatments

4. Watershed and Water Body Characteristics

4.1 Hamilton Lake Hydraulic Residence Time Calculation

An estimate for the hydraulic residence time of Hamilton Lake was calculated for the original 2007 Hamilton Lake Plant Management Plan. It is reiterated here followed by a recalculation based on actual flow data measured below the Hamilton Lake Dam in 2008. This was done because whole lake fluridone treatments like the one proposed for Hamilton Lake in 2009 are dependant upon retention of the applied herbicide in the lake for an extended period of time. The hydraulic residence time is the average time that a given drop of water finding its way to Hamilton Lake would spend in the lake before flowing out over the dam.

4.1.1 Hydraulic Residence Time Calculation by Estimating Annual Runoff

Because there is no U.S. Geological Survey operated on a stream-flow gauging station on the Hamilton Lake outlet to tell us how much water flows through the lake in response to precipitation, outlet outflow data from another nearby watershed of similar soil types and precipitation was used. This figure will be used to calculate contributions to the lake's water from surface rain and snow melt runoff. Data from the estimate calculation is listed in table 5. The U.S.G.S. operated a stream-flow gauging station on the outlet from Lime Lake and Lake Gage in Steuben County between 1969 and 1986 provided the outflow data specific to the same county, and sharing many of the same soil types as the Hamilton Lake watershed. A mean annual outflow figure for the period of record provided a starting point for runoff calculations. Runoff for the entire 17.5 square mile watershed was recorded at 6.25 inches annually. Dividing the runoff figure by mean annual precipitation (38.89 inches) for the same period of record produced a runoff coefficient of .16. This coefficient was then utilized in providing a rough estimate of the drainage from the 10873 acres in Hamilton Lake's watershed at 5653 acre feet of water. Dividing the total volume of Hamilton Lake (16,842 acre-ft) by the volume of water annually entering from the watershed provides an estimated residence time of three years. Because the lake is typically stratified for much of the year, mixing between the upper and lower layers of water is limited.

Watershed	Watershed Acreage
Watershed Acres	10873
Est. Runoff Coefficient	0.16
Annual Precip. (in)	38.89
Annual Precip. (ft)	3.24
Annual Runoff (ft) (Ann. Precip.)*(runoff coeff)	.52
Ann. Runoff Vol. (ac-ft) (Ft. runoff)*(ac. watershed)	5653
Lake Volume (802 ac @ 21 foot avg. depth)	16842
Residence time (yrs) (Lk vol/ann. Runoff)	3
Upper 10 ft Lake Volume (802 ac @ 10 foot depth)	8020
Residence time of upper ten feet (yrs) assuming no mixing of rainfall/runoff below 10 feet	1.41

Table 5 Hydraulic Residence Time Estimate Data for Hamilton Lake

This could provide the effect of having incoming waters simply flow through the upper part of the water column for much of the year, not mixing with the lakes lower strata. This is especially true during the summer when fluridone concentrations, often present only in the upper layer, must be held at a particular target concentration. To plan for a worst case scenario of having incoming waters flushing only the upper strata where the herbicide resides, the estimate is then refined to use only the upper ten feet of the lake in calculating the lake volume figure. This reduces the lake volume figure to 8020 acre-feet and produces a hydraulic residence estimate of 1.41 years. This is a relatively long residence time figure and if accurate, provides good prospects for successful retention of fluridone.

4.1.2 Hydraulic Residence Time Calculation Utilizing Flow Data Collected in 2008

Hydraulic residence time calculations which utilize a runoff coefficient from another watershed can be subject to considerable error. Groundwater contributions to the Hamilton Lake tributaries, and the lake itself could be very different from those in the watershed used to provide the coefficient. Other sources of error such as varying rates of evapotranspiration, infiltration through soils, or differences in impervious area and land cover can also be problematic. Because of this flow data was collected below Hamilton Lake and used to produce another estimate of hydraulic retention time. This was done utilizing a flow rate measured on July 10, 2008 and again on November 22, 2008. Raw data sheets are available in Appendix C. The flow rate on July 10 was calculated to be 974 cubic feet per minute (CFM). The flow rate on November 11 was calculated to be 290 CFM. Because the November flow rate was the result of extremely dry weather it was not considered to represent normal conditions. The July data was used in the residence time estimate to calculate a hydraulic residence time of 249 days. Data from the estimate calculation is listed in table 6.

Measured flow rate (CFM)	974
flow volume per day (cubic feet)	1,403,136
flow volume per day (acre-ft)	32.21
total annual flow volume at 974 CFM	11,757
Upper 10 ft Lake Volume (802 ac @ 10 foot depth)	8020
Residence time of upper ten feet (yrs) assuming no mixing of rainfall/runoff below 10 feet	.68
Residence time of upper ten feet (days) assuming no mixing of rainfall/runoff below 10 feet	249

Table 6 Residence time estimate data for flow rate measured 7/10/08

To further evaluate the applicability of this estimate Steuben County precipitation records were obtained for March through June of 2008. The total precipitation for this period in 2008 was 10.18 inches. The average rainfall for nearby Angola, Indiana for this same period is 13.9 inches (worldclimate.com). The 249 day residence time is probably high based on that fact that rainfall in the months prior to the measurement was below average. It should also be considered that spring time flow rates near the time when a fluridone initial dosage would be applied generally are higher than those observed in the warmer month of July. However the 249 day calculated residence time appears to provide a sufficient safely margin as a sustained flow of twice that measured in July of 2008 would bring a 125 day residence time, still providing a long enough retention if maintenance dosing (bumps) are utilized. Granular applications of fluridone have been used in the past at Hamilton Lake to provide a time-release effect, but it appears that a sufficient residence time is present to allow for effective dosing with a liquid fluridone product as

long as sufficient "bump" doses are employed. This could provide a substantial savings as granular fluridone formulations are generally associated with higher product costs than liquid formulations. Dosing with liquid fluridone at Hamilton Lake will never be free of risk, as the watershed at Hamilton is large enough to flush fluridone from the lake relatively quickly in the event of a highly abnormal season of high rainfalls, but it appears that in a normal season using a liquid product to obtain results is feasible.

In considering the watershed at Hamilton it should be noted that an Engineering Feasibility Study for Black Creek, a tributary to Hamilton Lake was completed in 2006 by Dynamic Environmental Services, Inc. This was a cost-share LARE project (Dynamic 2006). This study and follow-up work to be performed on Black Creek in the near future will prove valuable with regard to minimizing soil and nutrient pollutants carried into Hamilton Lake from the Black Creek watershed. For additional lake and watershed information see the original Hamilton Lake Plant Management Plan (Aquatic Enhancement, Inc. 2007).

5. Present Water Body Uses

There are no significant changes or additional fisheries management data for the 2008 season. For additional background see original Hamilton Lake Plant Management Plan (Aquatic Enhancement, Inc. 2007).

6. Aquatic Plant Community Characterization

6.1 Tier II Survey Methods

Methods used in 2008 were consistent with those detailed in the original Hamilton Lake Plant Management Plan (Aquatic Enhancement, Inc. 2007). Sampling deviated from the 2007 season in that only one Tier II Survey was performed in late summer. During plan development in 2007 both early and late season surveys were performed. Sampling sites used in 2008 were the same as those used in the August 12, 2007 survey. The survey sampling points are displayed in figure 14.

6.2 Tier II Survey Results

The 2008 Tier II survey for Hamilton Lake was conducted on August 12th and 13th in good weather conditions. A summary of results is contained in the table below. Water clarity was considered to be unusually good with a Secchi depth of 15.8 feet recorded. Hamilton Lake's overall water clarity history lacks Secchi data for many seasons, but a general trend toward better water clarity since whole lake treatments began in 2003 is apparent. (fig 15 page 28) Without a more complete data set it will be more difficult to determine with any certainty which factors at Hamilton Lake are affecting water clarity. The HLA may want to consider enrolling in voluntary water quality monitoring through the Indiana Clean Lakes Program to establish a more complete record. For more information contact Bill Jones at the Indiana University School of Public and Environmental Affairs (812-855-4556, email: joneswi@indiana.edu).

During the Tier II survey plants were found to a depth of 14.5 feet. The 15 foot sampling depth for Hamilton Lake appears to be adequate. Fifteen species were identified in the survey. This is well above the average number of 8 species for a set of 21 other northern Indiana lakes compiled by IDNR (Pearson 2004). The highest occurrence was Coontail (68 percent) followed by Water stargrass (56 percent) and Slender naiad (46 percent). Curlyleaf pondweed occurrence was three percent and Eurasian watermilfoil occurred at 19 percent of sites. Overall the Hamilton Lake plant community showed exceptional diversity and was dominated by native species. Plant maps for Eurasian watermilfoil, Curlyleaf pondweed, Coontail, and Water stargrass are in figures 22 through 25 below. Coordinates for the Hamilton Lake Tier II collection sites are listed in appendix D.

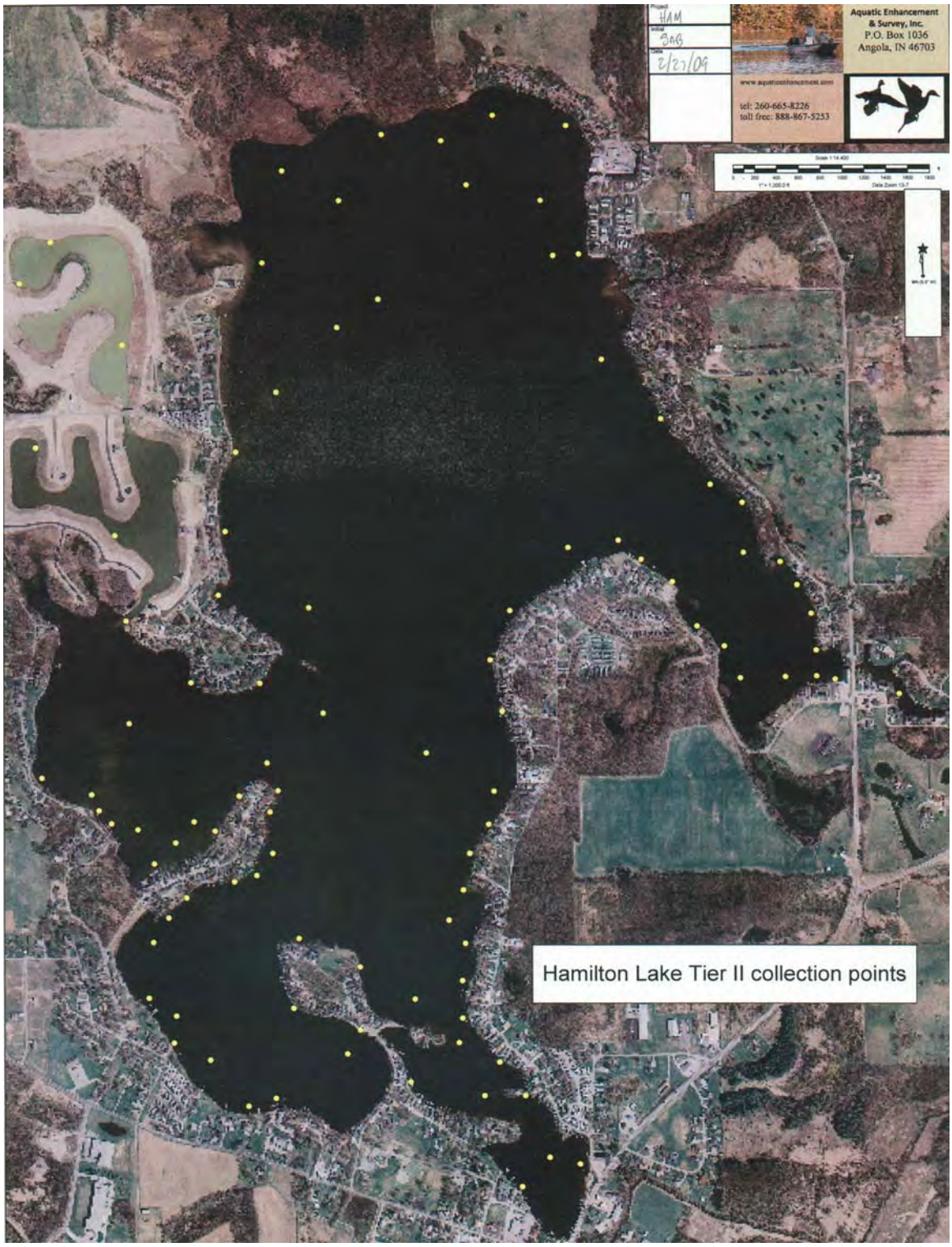

Figure 14 Tier II collection waypoints

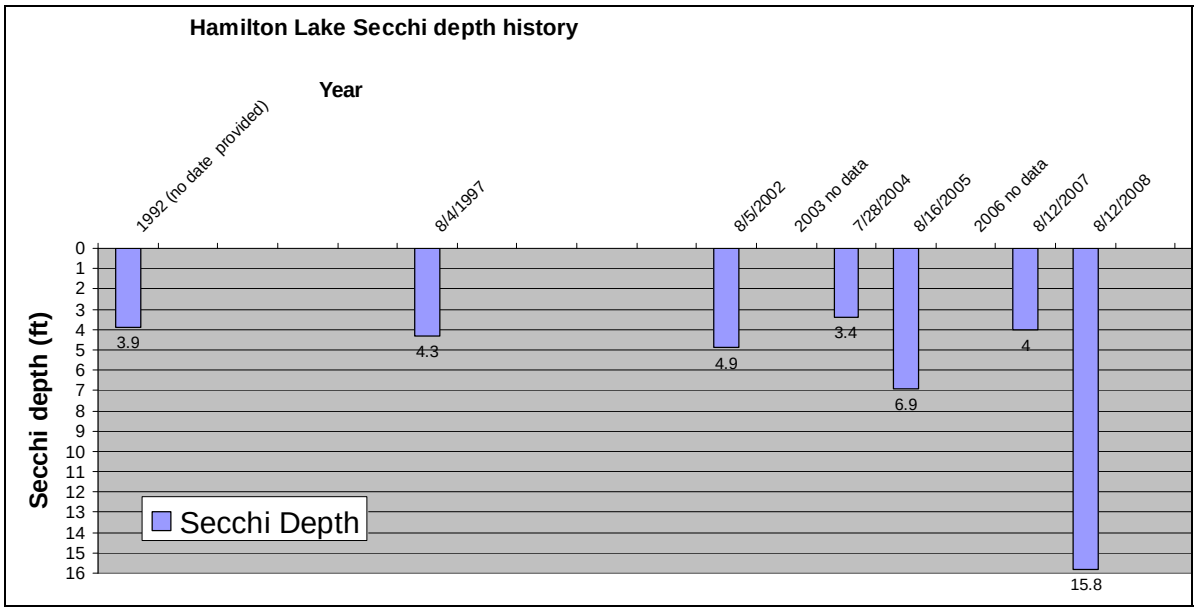

Figure 14 Hamilton Lake Secchi history, 1992, 1997, 2002 IDEM/SPEA, 2004 and 2005 Weed Patrol, Inc., 2007, 2008 Aquatic Enhancement, Inc.

7. Threatened and Endangered Species Surveys

Richardson's pondweed a state listed RTE species was found in Hamilton Lake in 2007 and again in 2008. This species is common in the Crystal Bay and Crystal Cove areas and is also present in the main lake. No further RTE species were noted in 2008. No voucher plant specimens were collected. General locations where Richardson's pondweed was found growing are noted on the lake map in figure 21 page 33. In review comments for this work IDNR noted that Water stargrass *Heteranthera dubia* is an unusual species in Indiana about which the state is concerned due to potential nuisance invasive characteristics. We were unaware of this concern and have observed Water stargrass growing at normal levels in native plant communities on various lakes. No voucher specimens of this plant were collected. Water stargrass growth was indeed dramatic at Hamilton Lake in 2008 having jumped from an occurrence at 23 percent of sampling sites in the late season 2007 survey to a 56 percent occurrence in 2008. This was the tallest and most robust growth of this plant we have noted in an Indiana Lake. Because this plant did present a nuisance, approximately 20 acres of Hamilton Lake were treated to control Water stargrass and Flatstem pondweed *Potamogeton zosteriformis* on July 15, 2008. A combination of Diquat (Reward®) and endotholl (Hydrothol® 191) herbicides was used. Both products were applied at the rate of one gallon per surface acre. The applicator noted that this treatment was successful. The growth, extent of interference with recreational activity, and treatment effectiveness, for this plant should continue be tracked each season to see if an extensive problem is emerging that may require additional management.

Summary of Season's Treatment										Crystalr Fluridone (41ac)
Eurasian milfoil	2-4,D (45 ac.)	fluridone 6ppb 264 acres	2-4,D (6 ac.)		2-4,D (1.5 ac.)	2-4,D (1.5 ac.)	2-4,D (45 ac.)		2-4,D (6 ac.)	2-4,D (56.5 ac.)
Curlyleaf		fluridone 6ppb acres unkn	Aq-k 144.5 ac.		Aq-k 65 ac.	Aq-k 65 ac.			Aq-k 144.5 ac.	Aq-k 172.5 ac.
Hamilton Lake	**WPI**	**IDNR**	**AES**		**IDNR**	**WPI**	**WPI**		**AES**	**AES**
Date	5/8/05	5/23/06	6/5,6/07		7/28/04	7/28/04	8/16/05	2006 no data	8/12/07	8/12,13/08
IDNR protocol 1 or 2	1	2	2		1	1	1		2	2
Depth range (ft)	0-10	0-14	0-15		0-15*	0-20*	0-15		0-15	0-15
Sample sites (n)	120	97	100		118	164	120		100	100
Secchi (ft)	7.4	12.5	6.0		4.0	3.4	6.9		4.0	15.8
Littoral depth (ft)	9.0	14.0	13.0		13.0	14.0	12.0		11.0	14.5
Occurence (%)	89.2	31.0	87.0		94.0	87.2	63.3		82.0	96.0
Species (N)	12	8	12		13	12	12		13	14
No. of Native species	10	6	10		11	10	10		11	12
Species/site (max)	5	4	4		6	6	5		6	6
Mean species/site	1.49	0.86	1.68		2.31	1.96	0.82		1.87	2.76
Mean Native species/site	0.50	0.36	0.96		1.86	1.49	0.43		1.65	2.44
Species diversity	n/d	0.75	0.75		0.83	n/d			0.86	0.85
Native diversity	n/d	0.60	0.76		0.76	n/d			0.83	0.82
Species occurrence										
Coontail	24.2	20.6	36.0		70.9	54.5	19.2		43.0	68.0
Flatstem pondweed	14.2	5.2	20.0		48.7	50.3	11.7		18.0	2.0
Eurasian watermilfoil	74.2	28.9	3.0		28.2	42.0	38.3		3.0	19.0
Chara	15		18.0		16.2	18.9			13.0	16.0
Curlyleaf pondweed	26.7	20.6			16.2	5.6	0.8		11.0	3.0
Sago pondweed			12.0		14.5	19.6	1.7		28.0	1.0
Slender naiad	2.5		1.0		12.0	12.6	5.8		30.0	46.0
Small pondweed			2.0		12.0				4.0	13.0
Nitella		1.0			4.3					
Great Bladderwort					1.7	2.1			1.0	4.0
Elodea	4.2	6.2			1.7	0.7	1.7			18.0
Vallisneria					1.7	4.9	5.0			12.0
Largeleaf pondweed	0.8	1.0	2.0			0.7	5.8		2.0	4.0
Water stargrass			1.0						23.0	56.0
Brittle naiad									8.0	10.0
Richardson's pondwee	4.7		3.0			6.3	7.0		2.0	
Horned pondweed									1.0	
Southern naiad										4.0
Water buttercup			1.0							
Algae occurrence (%)			50.0			5.0			32.0	16.0
Species dominance*										
Coontail		6.2	10.8		45.6				28.2	45.6
Flatstem pondweed		1.2	4.4		24.3				5.6	0.4
Eurasian watermilfoil		15.7	1.4		9.1				1.8	4.2
Chara		0.2	5.2		6.3				2.6	6.0
Curlyleaf pondweed		9.9	35.4		3.9				4.6	0.6
Sago pondweed			3.6		5.5				14.8	0.2
Slender naiad			0.2		6.0				8.0	29.2
Small pondweed			0.4		4.4				0.8	3.8
Nitella		0.2			2.4					
Great Bladderwort					0.3				0.2	1.6
Elodea		1.2			0.3					5.6
Vallisneria					0.7					4.4
Largeleaf pondweed		0.6	0.8						0.4	1.6
Water stargrass			0.2						10.6	28.0
Brittle naiad									1.6	2.0
Richardson's pondweed			0.6						0.4	
Horned pondweed									0.2	
Southern naiad										0.8
Water buttercup			0.2							
* Dominance is not provided for WPI data										

Figure 15 Summary past and current Tier II plant survey data for Hamilton Lake

Occurrence and abundance of submersed aquatic plants in Hamilton Lake.						
County:	Stueben	Sites with plants:	96	Mean species/site:		2.76
Date:	8/12,13/08	Sites with native plants:	96	Standard error (ms/s):		0.14
Secchi (ft):	15.8	Number of species:	14	Mean native species/site:		2.44
Maximum depth (ft):	14.5	Number of native species:	11	Standard error (mns/s):		0.13
Trophic status:	Eutrophic	Maximum species/site:	6	Species diversity:		0.85
Total sites:	100			Native species diversity:		0.82

All depths (0 to 20 ft)	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
Coontail	68.0	32.0	24.0	8.0	36.0	45.6
Water stargrass	56.0	44.0	29.0	12.0	15.0	28.0
Slender naiad	46.0	54.0	17.0	8.0	21.0	29.2
Eurasian milfoil	19.0	81.0	18.0	1.0	0.0	4.2
Elodea	18.0	82.0	15.0	1.0	2.0	5.6
Chara	16.0	84.0	12.0	1.0	3.0	6.0
Small pondweed	13.0	87.0	10.0	3.0	0.0	3.8
Vallisneria	12.0	88.0	9.0	1.0	2.0	4.4
Brittle naiad	10.0	90.0	10.0	0.0	0.0	2.0
Largeleaf pondweed	4.0	96.0	3.0	0.0	1.0	1.6
Great bladderwort	4.0	96.0	3.0	0.0	1.0	1.6
Southern naiad	4.0	96.0	4.0	0.0	0.0	0.8
Curlyleaf pondweed	3.0	97.0	3.0	0.0	0.0	0.6
Flatstem pondweed	2.0	98.0	2.0	0.0	0.0	0.4
Sago pondweed	1.0	99.0	1.0	0.0	0.0	0.2

All depths (0 to 5 ft)	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
Water stargrass	70.2	29.8	38.6	17.5	14.0	32.3
Slender naiad	66.7	33.3	22.8	10.5	33.3	44.2
Coontail	64.9	35.1	26.3	3.5	35.1	42.5
Elodea	21.1	87.9	15.8	1.8	3.5	7.7
Chara	19.3	80.7	14.0	1.8	3.5	7.4
Vallisneria	19.3	80.7	15.8	1.8	1.8	6.0
Eurasian milfoil	15.8	84.2	14.0	1.8	0.0	3.9
Brittle naiad	12.3	87.7	12.3	0.0	0.0	2.5
Small pondweed	8.8	91.2	7.0	1.8	0.0	2.5
Largeleaf pondweed	5.3	94.7	3.5	0.0	1.8	2.5
Great bladderwort	5.3	94.7	3.5	0.0	1.8	2.5
Southern naiad	5.3	94.7	5.3	0.0	0.0	1.1
Curlyleaf pondweed	3.5	96.5	3.5	0.0	0.0	0.7
Flatstem pondweed	1.8	98.2	1.8	0.0	0.0	0.4

All depths (5 to 10 ft)	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
Coontail	75.8	24.2	21.2	12.1	42.4	53.9
Water stargrass	45.5	54.5	18.2	18.2	21.2	28.5
Slender naiad	24.2	75.8	12.1	12.1	6.1	12.1
Eurasian milfoil	24.2	75.8	24.2	24.2	0.0	4.8
Small pondweed	18.2	81.8	12.1	12.1	0.0	6.1
Elodea	15.2	84.8	15.2	15.2	0.0	3.0
Chara	12.1	87.9	9.1	9.1	3.0	4.8
Brittle naiad	6.1	93.9	6.1	6.1	0.0	1.2
Vallisneria	3.0	97.0	0.0	0.0	3.0	3.0
Southern naiad	3.0	97.0	3.0	3.0	0.0	0.6
Largeleaf pondweed	3.0	97.0	3.0	3.0	0.0	0.6
Flatstem pondweed	3.0	97.0	3.0	3.0	0.0	0.6
Sago pondweed	3.0	97.0	3.0	3.0	0.0	0.6

All depths (10 to 15 ft)	Frequency of Occurrence	Rake score frequency per species				Plant Dominance
Species		0	1	3	5	
Coontail	60.0	40.0	20.0	20.0	20.0	36.0
Eurasian milfoil	20.0	80.0	20.0	0.0	0.0	4.0
Small pondweed	20.0	80.0	20.0	0.0	0.0	4.0
Chara	10.0	90.0	10.0	0.0	0.0	2.0
Elodea	10.0	90.0	10.0	0.0	0.0	2.0
Brittle naiad	10.0	90.0	10.0	0.0	0.0	2.0
Curlyleaf pondweed	10.0	90.0	10.0	0.0	0.0	2.0
Great bladderwort	10.0	90.0	10.0	0.0	0.0	2.0
Water stargrass	10.0	90.0	10.0	0.0	0.0	2.0

Table 7 Summary of Tier II results

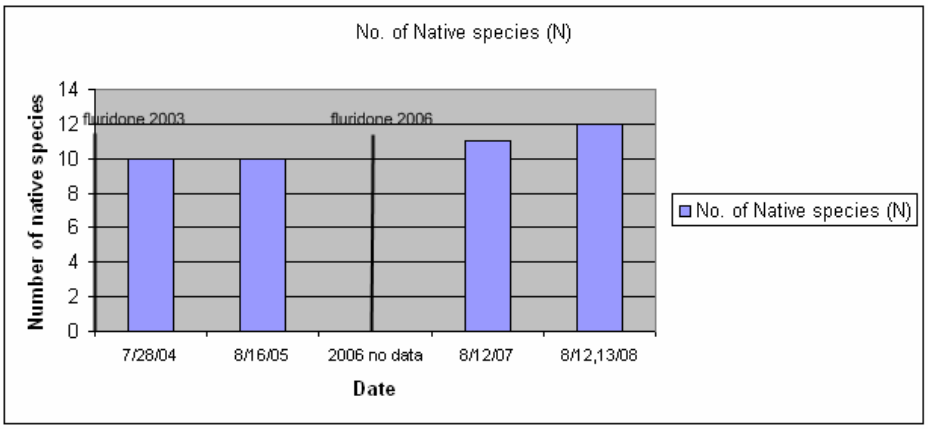

Figure 17 Number of native species noted in 2004-2008 Tier II surveys

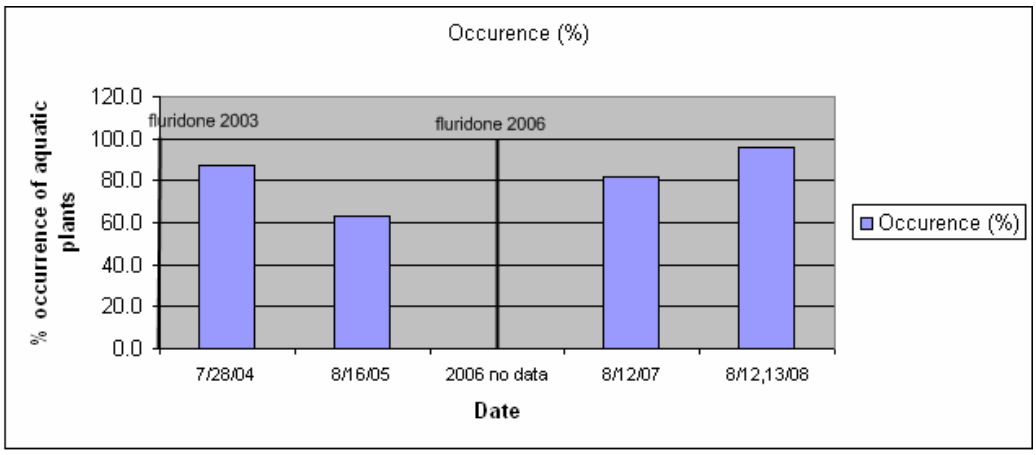

Figure 16 Percent occurrence (% of sites) of aquatic vegetation in Tier II surveys 2004-2008

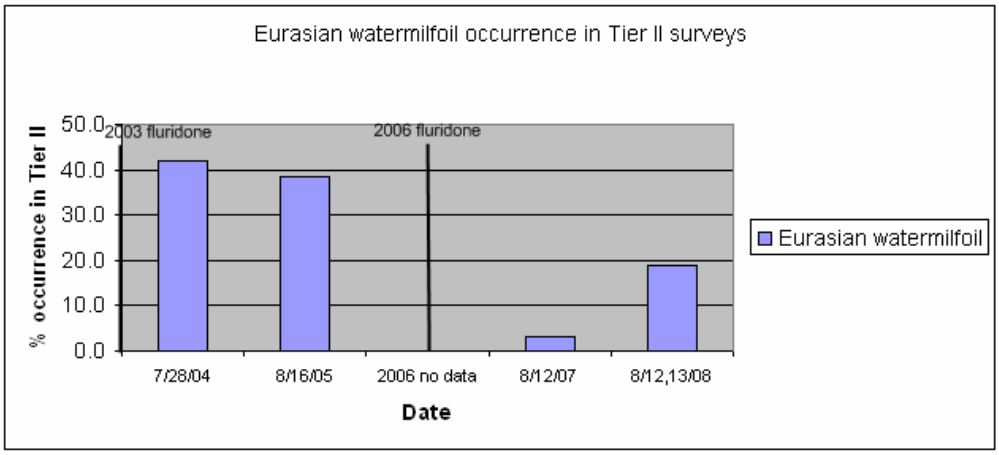

Figure 17 Percent occurrence (% of sites) for Eurasian watermilfoil in Tier II surveys 2004-2008

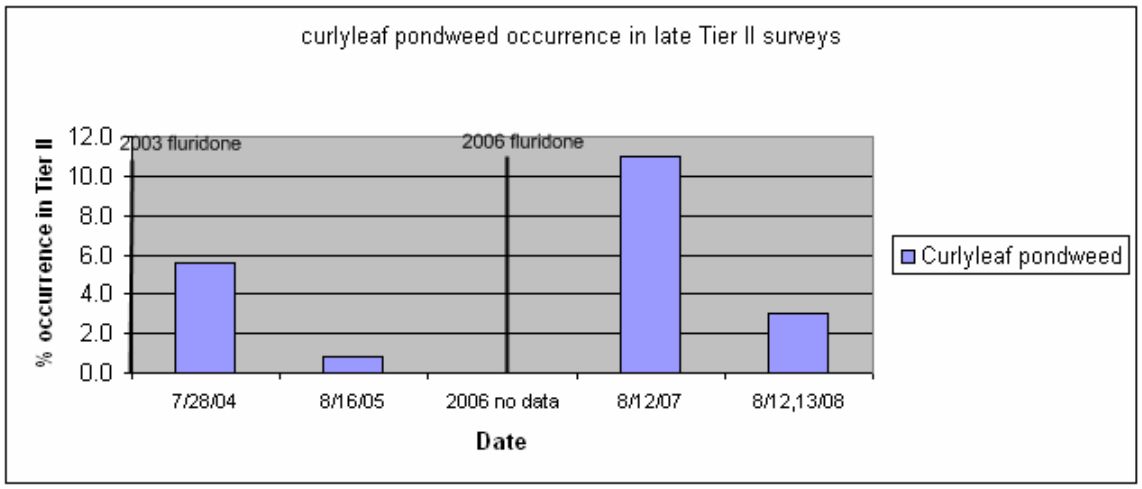

Figure 20 Curlyleaf pondweed occurrence (% of sites) in Tier II surveys 2004-2008

Figure 18 General locations of noted Richardson's pondweed growth in the 2008 season

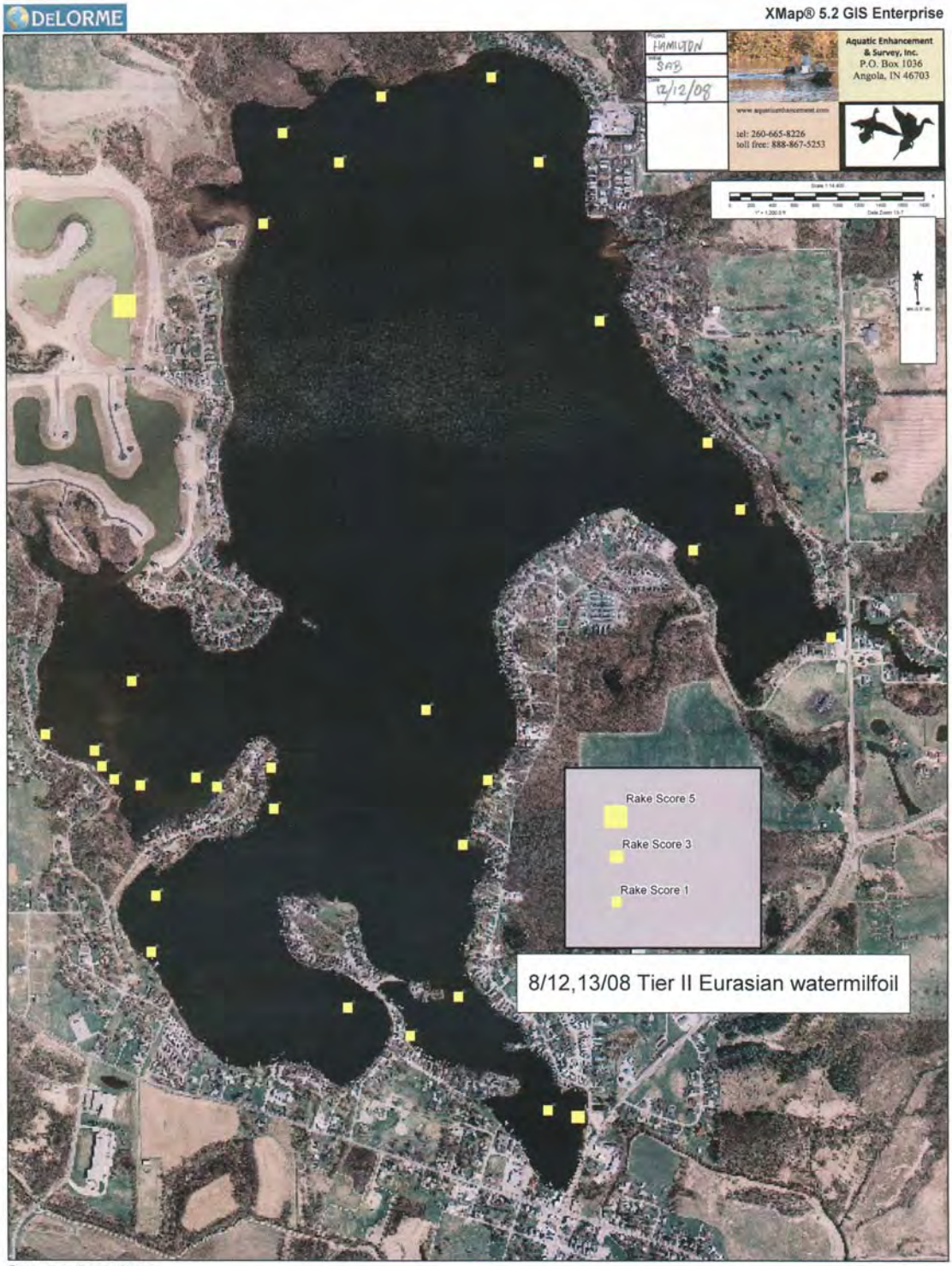

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Figure 19 Tier II Eurasian watermilfoil

Figure 20 Tier II Curlyleaf pondweed

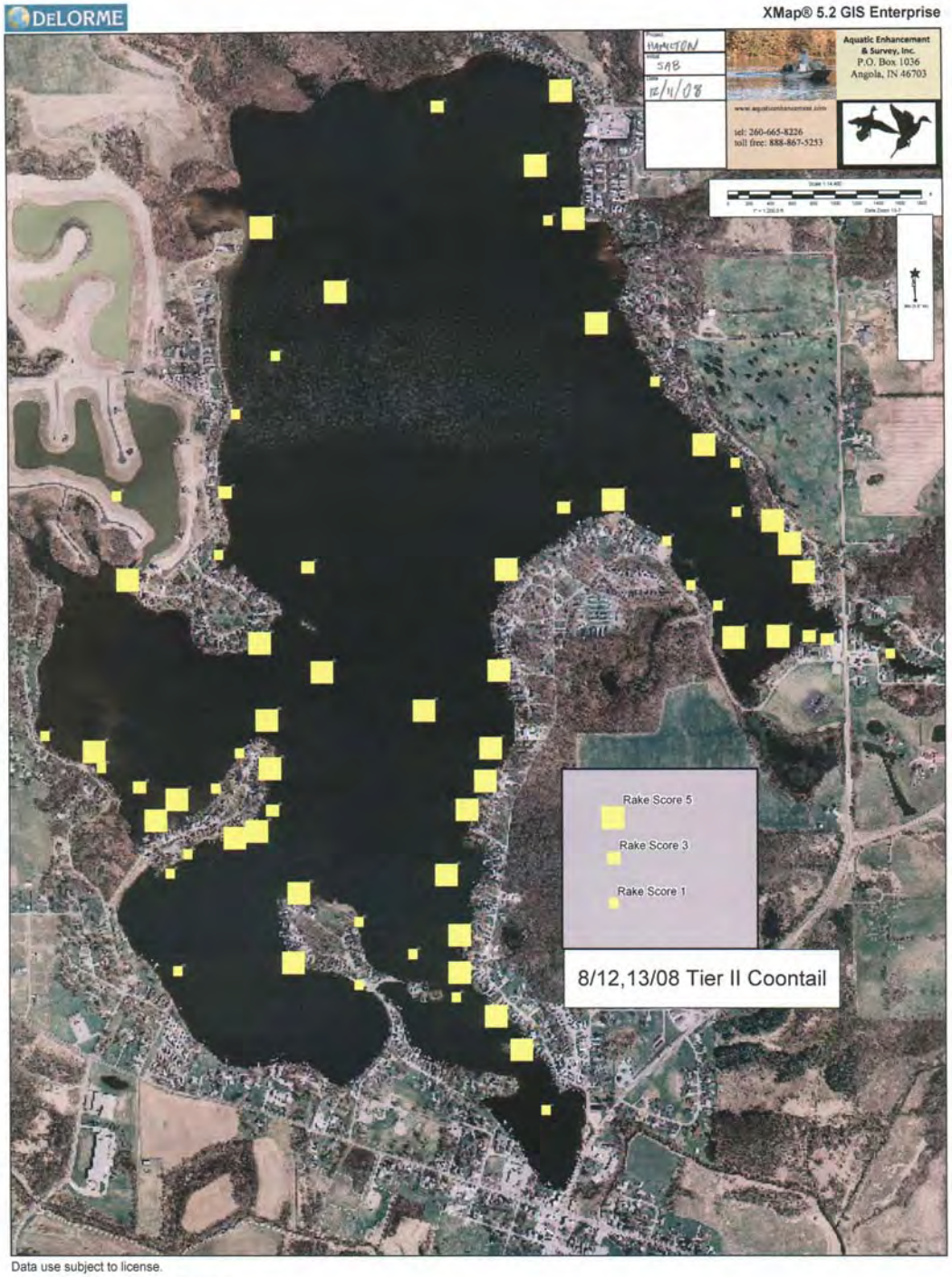

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Figure 21 Tier II Coontail

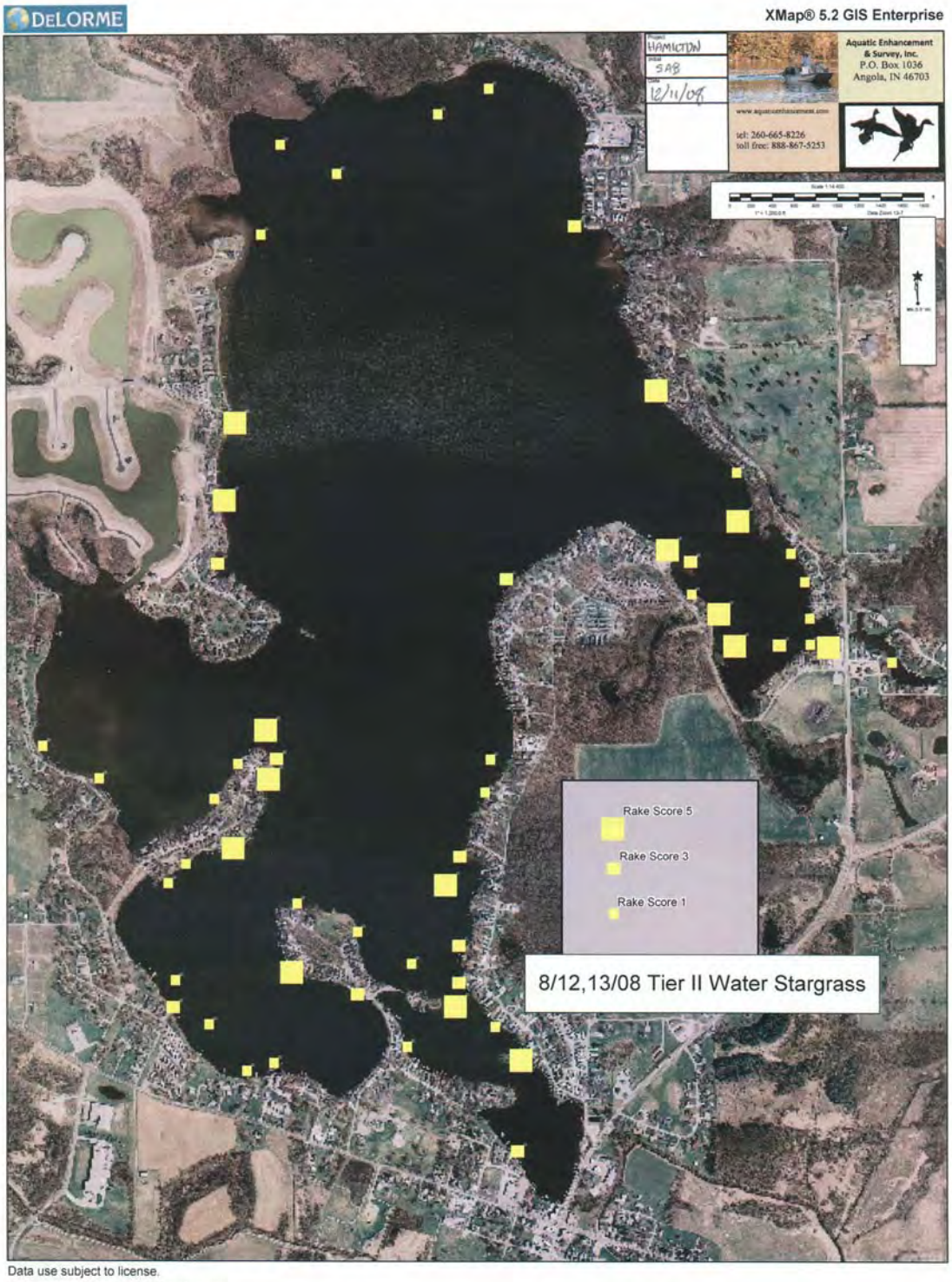

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Figure 22 Tier II Water stargrass

8. Description of Beneficial and Problem Plant Areas

Eurasian Watermilfoil Problem Areas

According to the HLA and the current application contractor Eurasian watermilfoil has repeatedly heavily colonized nearly all of the Hamilton Lake littoral area between approximately the five and eight foot depth contours arriving at a 264 acre area of dense colonization. With the recent addition of 41 acres of new water to the lake through the construction of the Crystal Bay and Crystal Cove channel system this area has been boosted to approximately 305 acres (Figure 26). This type of stratified littoral growth pattern is a typical for Eurasian watermilfoil colonization and dense plant growth in glacial lakes in general. Submersed aquatic vegetation growth, especially Eurasian watermilfoil, favors fine-textured inorganic sediments with an intermediate sediment density while plants grow more poorly both on sands with a high sediment density and on highly organic sediments with a low sediment density (Barko and Smart 1985). Many of the shallowest areas of Hamilton Lake have the mechanical influence of wave action continually influencing their substrate, sweeping finer soil particles and organic materials into deeper or quieter areas of the lake. Sandy substrates dominate the sediment's surface in the shallowest areas. It follows that the preferred intermediate substrate densities are present in deeper areas along contour breaks, in coves and quiet protected backwaters, and the dredged channels connected to the lake. Beyond the eight foot contour a lack of light begins to restrict plant colonization. With a lack of available light limiting growth on the deep side and less favorable substrates limiting growth on the shallow side the plant growth is naturally confined to this five to eight foot "weedline" zone. This can be considered Hamilton Lake's "problem area" with regard to Eurasian watermilfoil.

In 2003 and again in 2006 when whole lake fluridone treatments were performed all Eurasian watermilfoil growth in contact with the treated water dropped had dropped in response to the treatment by the summer's end. Six ppb whole lake fluridone treatments like those completed at Hamilton do not typically produce an eradication of Eurasian watermilfoil from the treated waterbody. The Michigan Department of Environmental Quality MDEQ is the primary regulatory agency with respect to aquatic pesticide applications, processing permits and establishing administrative rules for aquatic nuisance control. In that state, where six ppb fluridone treatments have been used to control natural lake milfoil problems for many years, MDEQ personnel report that they have not observed a single case of true eradication of Eurasian watermilfoil (Pers. comm. Eric Bacon). Results of whole lake treatments can vary widely, from initial treatment failure, to several seasons of effective control after the initial treatment.

In the typical case a six ppb treatments will provide complete control by the end of the season of dosage, often maintaining this control through the first season after the dosage. By the second or third season after the fluridone treatment the formerly colonized areas often begin to develop some level of Eurasian watermilfoil growth again. In Hamilton Lake control remained complete through 2007 after the 2006 fluridone treatment. In both the early and late season tier II surveys only one rake toss produced a Eurasian watermilfoil plant in Hamilton Lake proper in 2007. Milfoil was found mainly in the Crystal Bay and Crystal Cove subdivisions which were not included in the whole lake treatment. The exact mechanism of recolonization after whole lake treatments is not well understood. Recolonization can certainly occur as new untreated fragments enter from water bodies upstream of the managed lake or are carried into the lake on boat trailers. Additionally milfoil plants in areas of the lake at tributary deltas that receive a continual inflow of fresh, untreated water may retain a number of live plants buffered from treatment. Root crowns of plants present may also survive the treatment in some cases even as all the other tissues of the same plant become necrotic and die-back in response to the treatment (Bob Johnson pers. comm.).

Hamilton Lake, like most natural lakes its size has multiple tributaries and multiple ponds and marshes that drain to it, each a potential source of milfoil fragments. With complete eradication presently excluded as a realistic goal the HLA is left to select the most efficient method of management. To treat 100 percent of the typical growth pattern with traditional systemic herbicides like 2, 4-D each spring will provide relieve to lake users and minimize the need for follow-up maintenance treatments later in the season, but using a treatment cost of $450.00 per acre this will result in an annual cost of $137,250.00 and is unlikely to provide much control beyond the season of application. To continue this regime for two seasons will cost $274,500.00. Based on the results of the past two treatments a whole lake fluridone treatment at Hamilton Lake using a liquid fluridone formulation is very likely to provide two seasons of control for a cost of approximately $130,000.00. The cost of control with the whole lake treatment is less than half that of conventional spot treatment with systemic herbicides. In addition to being vastly more cost-effective in terms of providing control, the whole lake option also offers additional advantages including: the more complete control offered by the whole lake treatment, the complete control of Curlyleaf pondweed provided in the season of application, and minimal risk of water quality problems resulting from a more rapid die-off of plants associated will more conventional herbicides like 2, 4-D. For this reason the HLA is advised to consider the fluridone option again in the 2009 season, but to also utilize a granular component of the application in areas of tributary inflow. If the term of control can be extended into a third season after treatment by providing a more complete die-off of milfoil plants in areas that receive fresh water input the already superior efficacy provide by a whole lake scenario can be increased dramatically. A whole lake treatment should again be followed up by a regime of spot treatments as needed with systemic herbicides as milfoil growth appears in seasons after the whole lake treatment.

Curlyleaf Pondweed

The HLA experienced significant problems with Curlyleaf pondweed on approximately 170 acres of the lake in 2008 (Figure 27). Early in the season this entire area can be considered a problem area as it presents a considerable hindrance to recreational lake uses. If the HLA initiates a whole lake treatment in 2009 curlyleaf can be expected to present a considerable problem again in the early part of the 2010 season. The HLA may want to consider attempting to observe and map growth earlier in the season so applications can prevent turion formation and potentially result in longer term control. If curlyleaf emerges at different times in different sections of the lake, the number of trips necessary to map growth and perform treatments may be beyond the scope of assistance offered in typical LARE cost-share funded management programs, but volunteer observers already working with the applicator during the summer may be able to collect information on a regular basis to help treatments be timed early in the season.

Figure 23 Hamilton Lake area of typical milfoil colonization if left in an unmanaged state

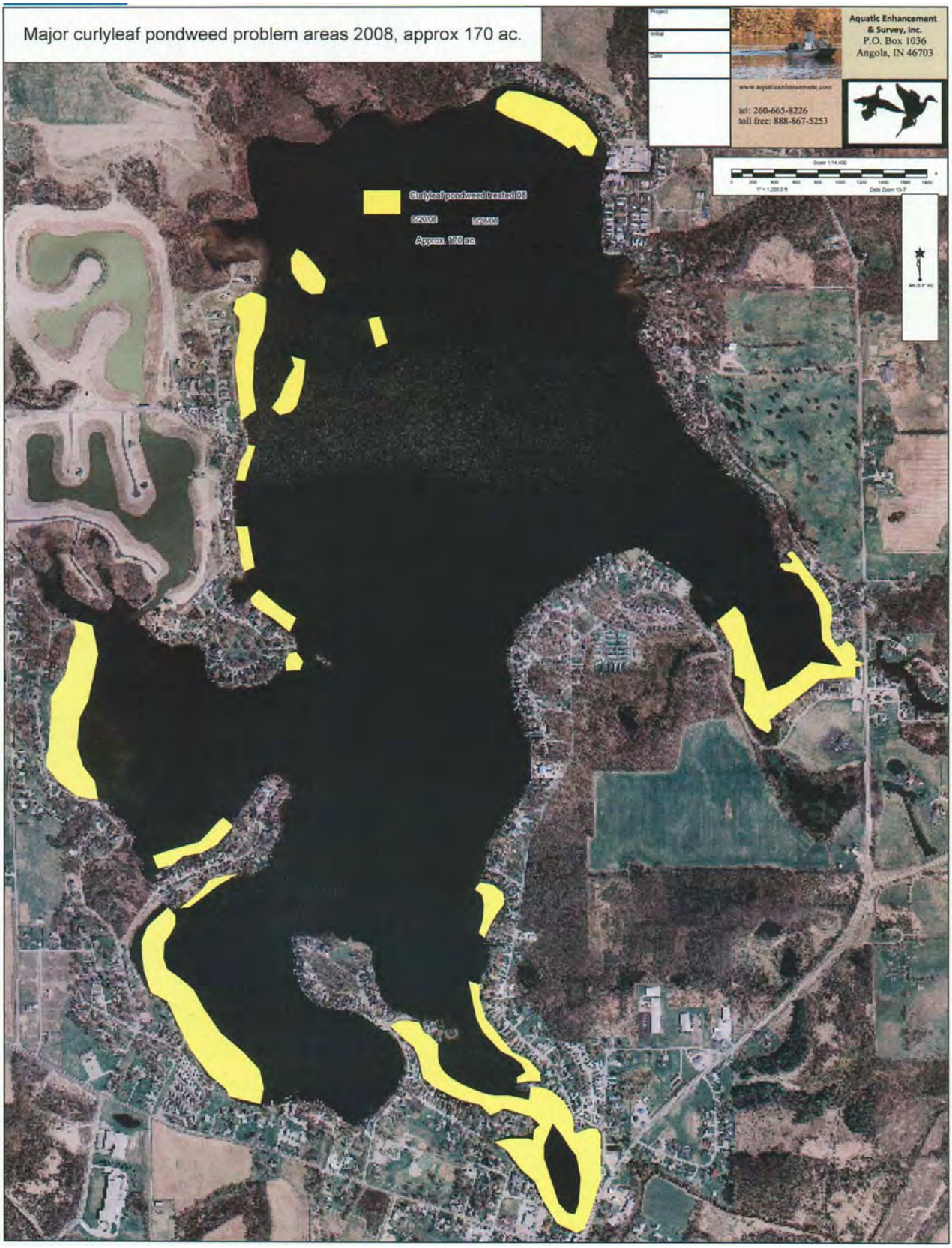

Figure 24 Curlyleaf pondweed problem areas in 2008

9. Aquatic Plant Management Alternatives

General alternatives for plant management remain similar to the 2007 season. For more information on general options see the 2007 Hamilton Lake Aquatic Plant Management Plan (Aquatic Enhancement 2007). Options for herbicidal plant management, the option recommended in the Hamilton Lake Plant Management Plan are provided below.

Herbicidal Option 1- Whole Lake Fluridone Treatment (recommended)

The HLA is advised to complete a six ppb (initial dose) fluridone application in 2009 for lakewide control of Eurasian watermilfoil and Curlyleaf pondweed. Based on the 2006 whole lake treatment at least two seasons of control can be expected. Some changes in treatment and sampling design over the 2006 season are recommended to help extend the length of control provided. The major goal in this treatment is to retain a concentration of 3ppb or more for approximately 90 days. This option offers the advantage of being less costly than a typical spot-treatment approach if the full extent of exotic plant growth is to be treated over the course of the next two seasons. An additional advantage includes the completeness of control. All target plants in contact with the treated lake waters for a sufficient period of time will be affected. Disadvantages include possible damage to non-target plants, especially those with a high sensitivity to fluridone such as elodea *Elodea canadensis.* The proposed treatment regime is more aggressive than those prescribed by Sepro Corporation in 2003 and 2006. The potential for water use restrictions are not generally applied when in-lake fluridone levels are below 10ppb but the recommended treatment regime may produce higher concentrations in localized areas where fluridone granular herbicide is applied. This may impose temporary irrigation restrictions on homes adjacent to these areas and offers another disadvantage.

IDNR has directed that this fluridone treatment be developed and prescribed by Sepro Corporation, a provider of fluridone herbicide products. Sepro Corporation has also provided the prescription for both the 2003 and 2006 fluridone treatments at Hamilton Lake designating specific dose rates, application areas, and assay timing and locations. The proposed 2009 season treatment regime has been discussed with a representative of Sepro Corporation with information and maps forwarded to collect input. At the time of this update the information was still being examined, but no written prescription for treatment had yet been obtained. Information conveyed in personal communications with Sepro representatives was utilized to formulate the application procedure below. Specific information regarding the treatment timing, dose rates, application rates, and assay collection may be subject to change pending the IDNR required Sepro Corporation prescription.

The initial fluridone treatment will involve three separate elements with the main application goal being to achieve a fluridone concentration of 3ppb or more for a period of approximately 90 days. Treatment of the main body of the lake and its bays is to be completed using liquid fluridone herbicide at the rate of six ppb. A separate application of Sonar® PR granular herbicide is to be made to a one acre area at the entrance point for nine areas of tributary flow or runoff at the rate of 20 ppb. Crystal Bay and Crystal Cove are to be treated with liquid fluridone herbicide at the rate of eight ppb.

It should be noted that final dose rates should be adjusted in accordance with the depth of the thermocline on Hamilton Lake prior to each application. The treatment and sampling regime elements are as follows: In April when Eurasian watermilfoil plants have begun actively growing an initial application of liquid fluridone herbicide (active ingredient 41.7 percent, four pounds active ingredient per gallon) should be applied to Hamilton Lake at the rate of six ppb. Eight quarts (two gallons) should be applied to the water around the outer perimeter of the lake providing even coverage of the area between the zero and five foot depth contours with the exception of the millpond area (southernmost bay). No fluridone should be applied to the

millpond. This area contains the Hamilton Lake outlet and has a relatively small residence time. Fluridone from the application performed outside this area will soon circulate and diffuse into the millpond after as an even distribution occurs. Herbicide applied directly to this area could leave the lake prematurely before mixing is complete. The remaining areas of the lake (beyond the five foot depth contour) should receive an even application of 130 quarts (32.5 gallons). An area of one acre around the mouth of each of nine designated tributary/runoff areas is to be dosed with Sonar® PR granular aquatic herbicide at the rate of 3.24 pounds per surface acre. The total applied for all nine areas will be 29.16 pounds (See Figure 28 page 45). The Crystal Bay and Crystal Cove subdivisions are to be dosed initially at the rate of eight ppb. A total of 7.5 quarts (1.9 gallons) of fluridone herbicide should be applied evenly across the 41 acres of water within the Crystal Bay and Crystal Cove channels. All initial fluridone applications should be completed within the same 48 hour period.

Forty eight hours after the completion of the application seven assay samples should be collected from designated areas and sent for laboratory analysis (Figure 29 page 46). In the main lake, if the average fluridone level of the assays is less than 6ppb a bump dosage should be applied at 7 days after treatment (DAT). This dosage should be calculated to "bump" the lake concentration to six ppb. In Crystal Bay and Crystal Cove an average concentration of less than eight ppb will call for an application at 7 DAT calculated to bump the concentration to eight ppb. On 28 DAT a second set of assays is to be collected from the same sampling locations. If an average concentration of 6ppb is not achieved in the main body of the lake a bump treatment should be applied at 35 DAT to achieve a target of six ppb. On 35 DAT the granular fluridone application at the mouths of tributaries is to be repeated with Sonar® PR applied again at the rate of 3.24 pounds per surface acre. On Crystal Bay and Crystal Cove if a concentration of eight ppb or more is not detected a bump application should be applied at 35 DAT to bring the concentration back to eight ppb. At 60 DAT a third set of assays is to be collected and sent in for analysis. If a target concentration of 4 ppb is not achieved (average) a bump treatment calculated to bring the main lake concentration back to a target 4 ppb should be performed at 67 DAT. On Crystal Bay and Crystal Cove if a target concentration of 4 ppb is not achieved a bump treatment should be applied at 67 DAT to bring the channels back to at least 6 ppb. At 90 and 120 DAT complete sets of assays should again be collected to document concentrations at that time. The aforementioned information is summarized in table 8 below.

It should be noted that concentrations of fluridone in Hamilton Lake will be subject to changes in response to temperature, plant uptake, and rainfall. The treatment program and dosages may need to retain flexibility and be adjusted in response to assay results during the 2009 season. Smaller bumps can be used if degradation of fluridone is occurring very slowly. Visible effects on native plants should also be taken into account. Under this treatment regime limited treatments for problem native plants may still be needed in high use areas. The HLA may also find that Filamentous algae treatments are needed as in 2008. The fluridone treatment will not affect algae species. The HLA is in agreement with this option for the 2009 season.

Timing	Action	Hamilton Lake proper 0-5 foot contour	Hamilton Lake proper beyond 5 foot contour	Crystal Bay/Cove	tributary inlets
April, milfoil plants actively growing	applications	apply 8 quarts liquid fluridone herbicide	apply 130 quarts liquid fluridone herbicide	apply 7.5 quarts liquid fluridone herbicide	apply 3.24 lbs./ac at 9 designated sites (29.16 lb total)
48 hours after treatment	collect assays from 7 designated sites				
7 DAT	applications as needed	bump as needed to 6ppb	bump as needed to 6ppb	bump as needed to 8ppb	
28 DAT	collect assays from 5 designated sites				
35 DAT	applications as needed	bump as needed to 6ppb	bump as needed to 6ppb	bump as needed to 8ppb	apply 3.24 lbs./ac at 9 designated sites (29.16 lb total)
60 DAT	collect assays from 7 designated sites				
67 DAT	applications as needed	bump as needed to 4ppb	bump as needed to 4ppb	bump as needed to 6ppb	
90 DAT	collect assays from 7 designated sites				
120 DAT	collect assays from 7 designated sites				

Table 8 Proposed sampling and application regime for fluridone treatment in 2009

Figure 25 Areas for Sonar® P.R. application near tributary inflows

Figure 26 Proposed fluridone assay collection points for 2009

Herbicidal Option 2- Treatment of the full extent of Eurasian watermilfoil growth and Curlyleaf pondweed growth utilizing 2,4-D granular and Aquathol® K liquid.
One available option is to utilize 2, 4-D (Navigate®) granular herbicide at the rate of 100 pounds per acre to address the full extent of Eurasian watermilfoil and endotholl Aquathol® K liquid to treat all areas where dense Curlyleaf pondweed is noted. It is estimated that milfoil treatment with this method will be necessary on approximately 264 acres of Hamilton Lake proper in 2009 with another 41 acres needing treatment at Crystal Cove and Crystal Bay. The main advantage of this approach is a relatively small risk of non-target damage to most of the native plants present. The vast majority of native plants present in Hamilton Lake are not classified as "broadleaf" plants. Because 2, 4-D is a broadleaf specific herbicide it selectively affects those plants, leaving most natives unaffected. The main disadvantage over a whole lake fluridone treatment is the increased cost of control over the next two to three years. Hamilton Lake may continue to require annual treatments of 305 acres if this method is employed (Figure 30). Another disadvantage is the lack of complete control that can be expected. Hamilton is a large and very diverse water body with numerous tributaries, islands, and bays. Good results can be expected in treatment areas, but there will always be some areas of milfoil growth that go undetected that may be continually spreading throughout the lake establishing regrowth in treated areas. With a fluridone treatment the completeness of control is much better as the herbicide is more or less spread evenly throughout the lake, contacting plants regardless of whether the herbicide was actually applied in close proximity to them. Another possible disadvantage of this method of control is possible ramifications for water quality. In general plant death and decomposition occurs more rapidly with this type of treatment than with fluridone use. Decaying treated plants could be a large enough nutrient source to induce planktonic algae blooms, resulting in aesthetic and ecological problems for the lake.

Curlyleaf pondweed can be effectively addressed utilizing endotholl (Aquathol® K liquid) applied at the rate of one ppm. If these treatments can be performed early enough on Hamilton Lake the production of turions can be effectively prevented leading to an eventual reduction in the area of Curlyleaf colonization over several years. These treatments should be performed when water temperatures reach approx. 50-55 degrees F. One disadvantage of this approach is the amount of hours necessary to determine the optimal time to treat various areas of Hamilton Lake. It appears that Curlyleaf emergence occurs at different times in various parts of the lake. The HLA and current applicator have thus far been concerned that early treatment of areas these plants are expected to emerge in could result in an emergence occurring after treatment, resulting in a wasted application. One possible way to overcome this would be for volunteers to be utilized to make multiple checks of the lake and map growth through April so herbicide applications can be timed properly. Another possible disadvantage of this method of control is possible ramifications for water quality. In general plant death and decomposition occurs more rapidly with this type of treatment than with fluridone use. Decaying treated plants could be a large enough nutrient source to induce planktonic algae blooms, resulting in increased aesthetic and ecological problems for the lake.

It is estimated that approximately 150 acres will need to be treated in 2009 to control all significant growth (Figure 30). Under this treatment regime limited treatments for problem native plants may still be needed in high use areas utilizing the endotholls (Aquathol® K or Hydrothol® 191) or diquat (Reward®). The HLA may also find that Filamentous algae treatments are needed as in 2008. In the past this has been treated using copper sulfate. The HLA is not in favor of this option at this time due to the cost involved. An additional drawback with this regime is the likely repeated imposition of water use restrictions in high use areas. In past seasons problem Eurasian watermilfoil and Curlyleaf pondweed growth have repeatedly shown up in different areas of the lake at different times, requiring repeated herbicide applications to be performed on various parts of the lake.

Figure 30 Estimated area of Eurasian watermilfoil growth in 2009

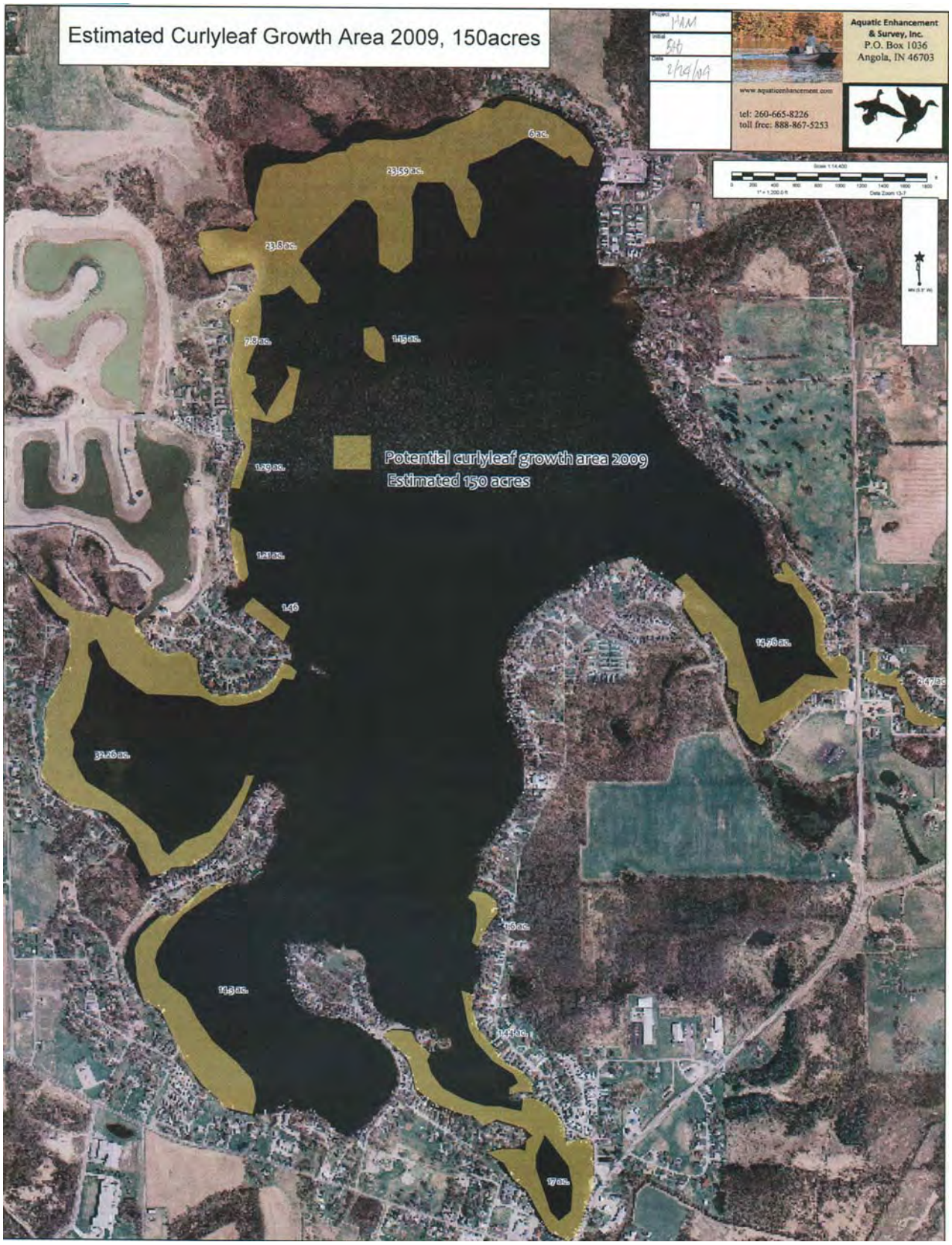

Figure 27 Estimated area of curlyleaf pondweed growth in 2009

Herbicidal Option 3- Partial Control of Non-native plants

Before a comprehensive plant management plan was in place to address non-native plant growth on a lakewide basis the HLA treated approximately 100 acres of Eurasian watermilfoil annually. One available option would be to target non-native growth in the lake's "high use" areas. This would include the areas depicted in figure 32 below. It is estimated that treatment of approximately 100 acres of Eurasian watermilfoil and 100 acres of Curlyleaf pondweed would be needed under this option. Because the extent of the growth pattern for both Curlyleaf pondweed and Eurasian watermilfoil emerging in the 2009 season is yet unknown, final treatment areas will need to be established after a spring mapping of exotic plant growth. Treatment for Eurasian watermilfoil under this regime would consist of the application of 100 pounds per acre granular 2, 4-D (Navigate®) to be performed in the spring or early summer when plants are actively growing. Treatment for Curlyleaf pondweed should be performed as soon as plant emergence is detected. If available funding potentially allows for the treatment of all emerging Curlyleaf problem areas an early season treatment should be performed when water temperatures are at 50-55 degrees and plants are present. If this regime can be repeated for multiple seasons it is possible to produce a significant reduction in Curlyleaf turion numbers and limit growth in future seasons. Under this treatment regime limited treatments for problem native plants may still be needed in high use areas utilizing the endotholls (Aquathol® K or Hydrothol® 191) or diquat (Reward®). The HLA may also find that Filamentous algae treatments are needed as in 2008. In the past this has been done using copper sulfate. The HLA is currently not in favor of this course of action due to the limited control offered and the aesthetic and ecological problems presented by leaving large areas of the lake choked with invasive non-native vegetation. An additional drawback with this regime is the likely repeated imposition of water use restrictions in high use areas. With a reservoir of non-native plants providing a source of fragments and new growth treatments may need to be repeated in the high use areas.

Regardless of the treatment regime employed the HLA is advised to continue with follow-up on work recently completed toward restoration of the Black Creek watershed and to review prior studies. Recommendations of past studies may be available to offer additional ways to reduce nutrient and sediment input to the lake, and ultimately work to benefit of the Hamilton Lake plant management program.

Figure 32 Hamilton Lake High Use Areas

10. Public Involvement

A public meeting for Hamilton Lake was incorporated into a regular association meeting on 6/21/08. Approximately 68 were in attendance. This was considered slightly below normal attendance for an HLA meeting. Nearly all present were Hamilton Lake property owners. A discussion of the aquatic plant management program in general was held with both Aquatic Enhancement & Survey, Inc. and Weed Patrol, Inc. present to answer questions. Those present generally expressed support for ongoing efforts to manage plants at the lake. A short survey was filled out by attendees and collected. Questions and responses are below. All 38 respondents were Hamilton Lake residents and all 38 also marked that they were HLA members. In preparing comments for this update IDNR noted that 19 (54%) of respondents indicated they felt "Hamilton Lake has aquatic plants in nuisance quantities at this time (2008)" while 16 (46%) indicated it did not. This was cited in IDNR comments as a possible rationale for discontinuing fluridone use at Hamilton Lake. In 2008 Eurasian watermilfoil was still dramatically limited in growth by the fluridone treatment conducted in 2006 and follow up spot treatments of nuisance non-native growth in 2007 and 2008. Active plant management by the HLA in cooperation with the LARE program has produced this result by reducing the 305 acres of potential dense milfoil growth to approximately 50 acres of problem growth in 2008. It should be noted that 37 of 37 respondents (100%) indicated they were in favor of continuing plant management at Hamilton Lake.

Lake User Survey Hamilton Lake 6/21/08

1. Are you a lake property owner? Yes____38____ No_____

2. Are you currently a member of your lake association? Yes _38__ No___

3. How many years have you been at the lake? (circle one) 0-5 years 6
6-10 years 11
11-20 years 9
more than 20 years 12

4. Has the growth of aquatic plants on Hamilton Lake ever negatively affected your enjoyment of the lake?
Yes__32___ No___5____

5. How do you use the lake? (mark all that apply)
_35_Swimming 5_Irrigation (including lawn) _38__Enjoy View and Atmosphere
_38__Boating _22_Fishing __21__View Wildlife ___28_Skiing/boarding/Tubing

Other _____

6. Do you feel that Hamilton Lake has Aquatic plants in nuisance quantities at this time(2008)? Yes _19__ No _16__

7. Do you own or occupy property on a __1___channel ___32___Lakeshore__5___Neither

8. Do you feel the level of vegetation in the lake affects your property values? Yes _33_ No _21_

9. Are you in favor of continuing efforts to control vegetation on the lake? Yes _37__
No ___
10. Mark any of these you think are problems on your lake:
_2__ Too much fishing
_14__ Canada Geese
__4_ Excessive boat traffic
_24__ Dredging needed
_24__ Too many aquatic plants
___ Not enough aquatic plants
_3__ Poor water clarity
_5__ Additional Speed enforcement needed

Other___Algae problems (3)_____

For comparison over time a past survey was located for the 2004 season and 2007 season. No survey was found among materials for 2005 or 2006. It should be noted that the 2004 survey was only collected from nine respondents so comparisons with the 2006 and 2007 data may be of limited use. In 2007- 63 responded and in 2008- 38 surveys were collected. Selected questions in common among the three surveys and their respective answers are listed in table 10. Answers were generally consistent between 2007 and 2008, but a shift occurred in the percentage of respondents reporting whether aquatic vegetation affects their property values. In 2007 respondents overwhelmingly believed that it did (97%). In 2008 these answers were more evenly distributed with 61% reporting that it did and 39% reporting that it did not. In all three years 100% of respondents were in favor of continuing with efforts to manage aquatic vegetation.

Year	2004		2007		2008	
	yes	no	yes	no	yes	no
Are you a lake property owner?	78%	22%	98%	2%	100%	0%
Are you a lake association member?	100%	0%	100%	0%	100%	0%
Do you have nuisance plants along your shoreline/in the lake ?	66%	33%	47%	53%	54%	46%
Does aquatic vegetation interfere with your enjoyment of the lake?	56%	44%	97%	3%	86%	14%
Does the level of vegetation in the lake affect your property values?	66%	33%	97%	3%	61%	39%
Are you in favor of continuing efforts to control vegetation on the lake?	100%	0%	100%	0%	100%	0%

Table 9 Summary of survey questions 2004, 2007, 2008

The HLA is advised to continue to inform the public about plant management efforts at Hamilton Lake through their website, newsletter, and meetings. "Hands on" experience provided in 2007 and 2008 at HLA meetings by bringing live examples of non-native plants should be continued to help residents and lake users understand that there are a variety of plants present in the lake, some of which are beneficial and worthy of protection. Any efforts directed at increasing attendance at HLA meetings will be beneficial in raising awareness of efforts thus far to manage aquatic plant problems and keeping residents interested in providing assistance. It will be most critical to reach newer residents to the lake who have not yet experienced the full extent of problems which have developed in the past when non-native aquatic plant management was more limited.

11. Implementation of Action Plan

The following goals were established in the 2007 Hamilton Lake Aquatic Plant Management Plan:

1. Maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality.

2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.

3. Provide reasonable public recreational access while minimizing the negative impacts on plant, fish, and wildlife resources.

With respect to goal one the Hamilton Lake plant community was probably not best described as "stable". While Eurasian watermilfoil and Curlyleaf pondweed as treated did not present major recreational or ecological hindrances, scattered Eurasian watermilfoil growth increased significantly over 2007 season levels. The Hamilton Lake plant community displayed excellent diversity in 2008 and water quality at Hamilton Lake was the best that has been seen in recent history. On balance goal one appears to have been accomplished. Goal two was considered to be accomplished by the management conducted in the 2008 season, however the same treatment regime if repeated at the same acreage in 2009 is not expected to maintain this goal in 2009. With major exotic growth controlled in 2008 goal three appears to have been accomplished for the duration of the season.

In the 2007 plan it was directed that exotic plant management at Hamilton Lake take an approach consisting of three tiers of action working toward the above primary goals:

Tier 1. Nutrient and Sediment control.
The Hamilton Lake Association should continue to be vigilant in spotting and addressing nutrient and sediment sources in the watershed, stopping pollutants at their source before water quality can be impacted. Progress made so far in addressing the Black Creek drainage should be continued.

Tier 2. Public Education.
Proper education should be implemented to inform lake users about invasive exotic plants. This can potentially prevent a very costly infestation of new exotic plants and animals at the lakes, saving resources that can be utilized to address current problems.

Tier 3. Non-native Plant Control.
Addressing the submersed aquatic non-native plants present at Hamilton Lake on a lakewide basis with professional applications of EPA approved aquatic pesticides and monitoring results closely can potentially limit their spread while providing relief to lake users. Reasonable success benchmarks for the 2008 applications will be to maintain a 10 percent or less coverage of dense Curlyleaf pondweed and Eurasian watermilfoil growth in Hamilton's littoral area and 5% or less occurrence of Eurasian milfoil and Curlyleaf pondweed in the July Tier II Survey.

With regard to Tier I the HLA is in the process of following up on work in Black Creek. More progress could be made in spotting and addressing current erosion problems by working with local and state officials to see that erosion is prevented in areas of new construction. Public education continued in 2008 mainly through the Association meetings. Improving meeting attendance could help enhance this as well as help the HLA motivate residents and lake users to

assist with the plant management program. Non-native plant control accomplished its main objective of providing relief to lake users. A treatment response benchmark of maintaining a 10 percent or less coverage of dense exotic growth of Eurasian watermilfoil or Curlyleaf pondweed was met after treatments were initiated. Low density growth of Eurasian watermilfoil, however became widespread hinting at possible difficulties that will emerge in maintaining this benchmark in 2009. The benchmark of establishing a five percent or lower occurrence of Eurasian milfoil and Curlyleaf pondweed in the late-season Tier II Survey was met for Curlyleaf pondweed (three percent) but not for Eurasian watermilfoil (19 percent). Scattered Eurasian milfoil growth was widespread. The HLA is advised to retain these objectives continuing to pursue each in 2009 and has expressed agreement with this strategy.

2009 Cost Estimates/Timeline Herbicidal Option 1 Whole Lake Fluridone Treatment (recommended)

2009 Season			
Month	**Activity**	**Acreage**	**Cost Estimate**
April	Map Curlyleaf pondweed And Eurasian watermilfoil growth		1300.00
May	April/May Begin Whole lake fluridone treatments, Crystal fluridone treatments, granular fluridone applications at tribs.	843	130,000.00
June	Algae/native plant treatment as needed/permitted	120	(Est. 10,800.00 HLA costs)
July or August	Tier II Survey		1900.00
July or August	Algae/native plant treatment as needed/permitted	120	(Est. 10,800.00 HLA costs)
As arranged	Public Meeting		350.00
October/November	Permit Meeting		300.00
December	Plan Update Document Due		3100.00
	Total native plant/algae cost (HLA)		**$21,600.00**
	Total planning/survey costs		**$6950.00**
	Total Non-native Treatment Costs		**$130,000.00**
	Total non-native management cost including planning		**$136,950.00**
	Total plant management costs		**$158,550.00**

Table 9 2009 Option one cost estimates

2009 Cost Estimates/Timeline Herbicidal Option 2 Treatment of the full extent of Eurasian watermilfoil growth and Curlyleaf pondweed growth utilizing 2,4-D granular and Aquathol® K liquid.

2009 Season			
Month	**Activity**	**Acreage**	**Cost Estimate**
April	Map Curlyleaf pondweed And Eurasian watermilfoil growth		1300.00
April	April Curlyleaf pondweed treatments	150	49,500.00
May	Eurasian milfoil treatments (2,4-D)	305	137,250.00
June	Algae/native plant treatment as needed/permitted	120	(Est. 10,800.00 HLA costs)
July or August	Tier II Survey		1900.00
July or August	Algae/native plant treatment as needed/permitted	120	(Est. 10,800.00 HLA costs)
As arranged	Public Meeting		350.00
October/November	Permit Meeting		300.00
December	Plan Update Document Due		3100.00
	Total native plant/algae cost (HLA)		**$21,600.00**
	Total planning/survey costs		**$6950.00**
	Total Non-native Treatment Costs		**$186,750.00**
	Total non-native management cost including planning		**$193,700.00**
	Total plant management costs		**$215,300.00**

Table 10 2009 Option two cost estimates

2009 Cost Estimates/Timeline Herbicidal Option 3
Partial Control of Non-native plants

2009 Season			
Month	**Activity**	**Acreage**	**Cost Estimate**
April	Map Curlyleaf pondweed And Eurasian watermilfoil growth		1300.00
April	April Curlyleaf pondweed treatments	100	33,000.00
May	Eurasian milfoil treatments (2,4-D)	100	45,000.00
June	Algae/native plant treatment as needed/permitted	120	(Est. 10,800.00 HLA costs)
July or August	Tier II Survey		1900.00
July or August	Algae/native plant treatment as needed/permitted	120	(Est. 10,800.00 HLA costs)
As arranged	Public Meeting		350.00
October/November	Permit Meeting		300.00
December	Plan Update Document Due		3100.00
	Total native plant/algae cost (HLA)		**$21,600.00**
	Total planning/survey costs		**$6950.00**
	Total Non-native Treatment Costs		**$78,000.00**
	Total non-native management cost including planning		**$84,950.00**
	Total plant management costs		**$106,550.00**

Table 11 2009 Option three cost estimates

Non-native plant management 3 year cost comparison

Year	2009	2010	2011	3 year total
Option 1, Whole Lake Fluridone Treatment (recommended)	130,000.00	58,700.00	60,950.00	**249,650.00**
Estimated acres milfoil (pre-treatment)	305	5	50	
Estimated acres curlyleaf (pre-treatment)	150	150	150	
Option 2 Treatment of the full extent of Eurasian watermilfoil growth and Curlyleaf pondweed growth utilizing 2,4-D granular and Aquathol® K liquid.	193,700.00	193,700.00	193,700.00	**581,100.00**
Estimated acres milfoil (pre-treatment)	305	305	305	
Estimated acres curlyleaf (pre-treatment)	150	150	150	
Option 3 Partial Control of Non-native plants	84,950.00	84,950.00	84,950.00	**254,850.00**
Estimated acres milfoil (pre-treatment)	305	305	305	
Estimated acres curlyleaf (pre-treatment)	150	150	150	

Table 12 2009 through 2011 cost comparisons

A comparison of non-native plant control options over three years shows that option three (partial control) is the least expensive option. A whole-lake fluridone treatment as prescribed ranks in the middle in terms of expense, while option two, conventional treatment of all Curlyleaf and Eurasian milfoil, is the most expensive. This is assuming that the more aggressive fluridone dosing coupled with elevated dosing of Crystal Bay and Crystal Cove in 2009 will delay extensive milfoil growth for two seasons after treatment. There is no way to be certain this will occur as the exact results of the treatment are difficult to predict. The HLA had hoped that an additional season of Eurasian watermilfoil control would be provided by the treatments prescribed by Sepro Corporation in 2003 and 2006, but a failure to include Crystal Bay and Crystal Cove in the treatments and possible residual milfoil growth in the area of the lake's tributaries may have acted to hasten recolonization. IDNR has required that Sepro Corporation prescribe the fluridone treatment again in 2009 and they have expressed interest in working with the HLA in that regard toward long term non-native plant management. It is hoped that changes in the treatment regime in 2009 will help lessen the chances of extensive regrowth in the second

season after treatment. The HLA is prepared to continue with treatment of non-native plants if denied LARE cost-share funding in 2009, but the treatment area may be limited due to a funding shortfall and resemble option three somewhat. At this time the HLA is in favor of option one for it's completeness of control coupled with its probable cost-effectiveness over the next three years and is prepared to invest the required cost-share.

12. Education

Proper education should be implemented to inform lake users about three main areas: the ongoing management program at Hamilton Lake, best management practices (BMP's) for the shoreline and watershed, and invasive exotic plants. If users lack an understanding and appreciation of the management program at Hamilton Lake and its successes thus far it will be difficult to draw the necessary support from the lake community. The use of websites, newsletters, and well attended meetings to inform and educate can all be helpful. It is also important to help lake property owners understand basic practices to be implemented along their shoreline to help keep nutrients and sediments out of the lake. Practices such as natural shoreline restoration or the use of non-phosphorus lawn fertilizers should be encouraged. With the appearance of Hydrilla Hydrilla *verticillata* and now Parrot feather *Myriophyllum aquaticum* in Indiana's natural lakes it is crucial that lake users be instructed about the early detection of these invaders to provide additional eyes on the water. In the past year example of non-native aquatic plants have been presented to the HLA membership to assist with identification. The HLA website contains information about invasive species to help keep residents informed about potential problem species. This can prevent a very costly infestation of new exotic plants and animals at lakes, saving resources that can be utilized to address current problems. The HLA website also provides updates on the bank stabilization project on Black Creek. This source of information should be updated and continued to help keep the lake community aware of ongoing management efforts.

Important program dates for the HLA in the 2009 season are below. These dates are based on a timeline needed if the HLA intends to have an early-season Curlyleaf treatment done or a whole lake fluridone treatment. There is considerably more flexibility in timing if only a localized milfoil treatment is being performed as milfoil treatments generally do not begin until May.

March 1	Send in treatment permit form to IDNR
March 15, 2009	IDNR funding decisions
March 20	Send a request for proposals to planning and application contractors due in one week
March 27	Receive bids from contractors
March 31	Select and notify contractor(s) and call IDNR to have application contractor noted on permit (260-244-6805)
April 10	Obtain signed contract
May 15	Schedule Lake Association Meeting with contractor (s)
November 1	Last day for contractors to provide maps for management plan or plan updates and schedule a meeting with DNR Fisheries and LARE biologists
December 15	First draft of management plan or plan updates due from contractors
January 15	Grant application due for current year funding
March 1	Final copy of revised plan or update due from contractors

13.0 Monitoring and Evaluation of Plan

The Hamilton Lake Aquatic Plant Management Program should be monitored and updated on an annual basis. Monitoring will consist of monitoring not only the lake's plant community, but the thoughts and opinions of the lake's users. To monitor the lake's plants, exotic growth will be remapped each spring and compared with the previous season's growth pattern. A Tier II survey in the late season after treatment has been initiated will serve to characterize the lake's overall plant community statistically and also gage if treatment response bench marks have been attained. Treatment response benchmarks for the 2009 season are as follows:

Herbicidal Option 1- Whole Lake Fluridone Treatment (recommended)
●2009 Season-Maintain a fluridone concentration of at least 3ppb for a period of 90 days in both Hamilton Lake proper and the Crystal Bay/Crystal Cove subdivision.
●2010-2011 Produce an occurrence of five percent of sites or less for Eurasian watermilfoil in a late-season Tier II plant survey.

Herbicidal Option 2- Treatment of the full extent of Eurasian watermilfoil growth and Curlyleaf pondweed growth utilizing 2, 4-D granular and Aquathol® K liquid.
●2009 Season- Produce an occurrence of 15 percent of sites or less for Eurasian watermilfoil and five percent of sites or less for Curlyleaf pondweed in a late-season Tier II survey

Herbicidal Option 3- Partial Control of Non-native plants
●Maintain navigability and an aesthetic quality in designated "high use" areas. Maintain at least 40% of written survey respondents at an HLA meeting responding in the affirmative that the aforementioned is being accomplished.

If treatment response bench marks are not attained changes in the treatment timing, chemical used, or integrated approach will all be options for setting a new course toward success. To monitor the thoughts and opinions of lake users at least one public meeting should be held annually and a survey distributed. An open forum at the meeting should exist to allow for discussion of water-use restrictions associated with treatments, new problems arising at the lake, or treatment effectiveness. Updates on program progress and developments should be issued in the Hamilton Lake Association Newsletter and on the Hamilton Lake Website.

14.0 Literature Cited

Aquatic Enhancement 2007. Aquatic Plant Management Plan 2007-2011 Hamilton Lake Steuben County, Indiana. Aquatic Enhancement & Survey, Inc. Angola. IN. 46703

Barko, John. W. and Smart R. Michael. Environmental Laboratory, Waterways Experiment Station, Vicksburg, Mississippi 39180, U.S.A. Sediment composition: Effects on growth of submersed aquatic vegetation. Proceedings 1st international symposium on watermilfoil (*Myriophyllum spicatum*) and related Haloragaceae species. July 23 and 24 – Vancouver, B.C. Aquatic Plant Management Society, Inc. Post Office Box 16 Vicksburg, Mississippi 39180. pp.72-78

Dynamic Environmental Solutions, Inc. Black Creek Engineering Feasibility Study Hamilton, Indiana. October 2006. Dynamic Environmental Solutions, Inc. 9226 B E. County Highway 3. Newton, IL 62448

MDEQ 2004, Esman Laura, Bacon Eric, 2004. Procedures for fluridone Use in Michigan. Calculating lake volumes and preparing product distribution maps for lakes being treated with fluridone. Inland Lakes and Remedial Action Unit, Michigan Department of Environmental Quality. Lansing Michigan.

Data Sources

Angola, IN rainfall data- Midwestern Regional Climatic Center, Illinois State Water Survey, 2204 Griffith Dr., Champaign, IL 61820-7495, Cooperative Station 120200, Angola, IN

Average rainfall data- Worldclimate.com. website URL: http://www.worldclimate.com/ Accessed November 22, 2008

Flow data, watershed data, Lime Lake Outlet- U.S Geological Survey Water Resources Division, 5957 Lakeside Boulevard, Indianapolis, IN 46278-1996

Hamilton Lake watershed data- Purdue online watershed support tool. website URL : http://cobweb.ecn.purdue.edu/~watergen/owls/htmls/reg5.htm

Appendix A
IDNR Aquatic Vegetation Permit Application

			Return to: Page 1 of 3
APPLICATION FOR AQUATIC VEGETATION CONTROL PERMIT	**FOR OFFICE USE ONLY**		DEPARTMENT OF NATURAL RESOURCES
State Form 26727 (R / 11-03)	License No.		Division of Fish and Wildlife
Approved State Board of Accounts 1987			Commercial License Clerk
X Whole Lake ☐ Multiple Treatment Areas	Date Issued		402 West Washington Street, Room W273
Check type of permit			Indianapolis, IN 46204
INSTRUCTIONS: Please print or type information	Lake County		FEE: $5.00

Applicant's Name: Bill Martins Hamilton Lake Assoc.	Lake Assoc. Name: Hamilton Lake Association	
Rural Route or Street: PO Box 515		Phone Number:
City and State: Hamilton, IN		ZIP Code: 46472
Certified Applicator (if applicable):	Company or Inc. Name:	Certification Number:
Rural Route or Street:		Phone Number:
City and State:		ZIP Code:
Lake (One application per lake): Hamilton Lake	Nearest Town: Hamilton	County: Steuben
Does water flow into a water supply		☐ Yes ☒ No

Please complete one section for *EACH* treatment area. Attach lake map showing treatment area and denote location of any water supply intake.

Treatment Area #	1	LAT/LONG or UTM's	whole lake 6 bump 6 Sonar A.S.
Total acres to be controlled	appr 305	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)
Maximum Depth of Treatment (ft)	n/a	Expected date(s) of treatment(s)	May-September

Treatment method: X Chemical ☐ Physical ☐ Biological Control ☐ Mechanical

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. whole lake sonar, 6 bump 6

Plant survey method: X Rake x Visual ☐ Other (specify) Formal Plant Survey

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Eurasian Watermilfoil	X	1.8
Sago Pondweed		7.1
Flatstem Pondweed		11.9
Largeleaf Pondweed		1.2
Chara Algae		9.6
Richardson's Pondweed		1.8
Small Pondweed/Horned Pondweed		1.7
Coontail		21.4
Slender Naiad/Brittle Naiad		18
Baldderwort		0.5
Water Stargrass		12
Curlyleaf Pondweed	X	41 (seasonal)
Filamentous Algae		Present

Treatment Area # 2	LAT/LONG or UTM's		
Total acres to be controlled 9	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)	
Maximum Depth of Treatment (ft) 7	Expected date(s) of treatment(s) April or May		
Treatment method: [X] Chemical [ ] Physical	[ ] Biological Control	[ ] Mechanical	

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. Sonar PR or Q two times at 20ppb for milfoil in inflow areas (see map)

Plant survey method: [X] Rake [ ] Visual [ ] Other (specify) Formal Plant Survey

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Eurasian Watermilfoil	X	1.8
Sago Pondweed		7.1
Flatstem Pondweed		11.9
Largeleaf Pondweed		1.2
Chara Algae		9.6
Richardson's Pondweed		1.8
Small Pondweed/Horned Pondweed		1.7
Coontail		21.4
Slender Naiad/Brittle Naiad		18
Curlyleaf pondweed	X	25.5

Treatment Area # 3	LAT/LONG or UTM's see map		
Total acres to be controlled 110	Proposed shoreline treatment length (ft) 47900	Perpendicular distance from shoreline (ft) 100	
Maximum Depth of Treatment (ft) 5	Expected date(s) of treatment(s) June, July, August		
Treatment method: [X] Chemical [ ] Physical	[ ] Biological Control	[ ] Mechanical	

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. Copper Sulfate or Chelated Copper Algaecide

Plant survey method: [X] Rake [X] Visual [ ] Other (specify) Formal Plant Survey

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Eurasian Watermilfoil		9
Sago Pondweed		12
Flatstem Pondweed		10
Largeleaf Pondweed		1.2
Chara Algae		15
Richardson's Pondweed		1.8
Small Pondweed/Horned Pondweed		3
Coontail		20
Filamentous algae	X	10
Slender Naiad/Brittle Naiad		18

Treatment Area # 4	LAT/LONG or UTM's N41 55.49150 W84 34.66560		
Total acres to be controlled 0.5	Proposed shoreline treatment length (ft) see map	Perpendicular distance from shoreline (ft) see map	
Maximum Depth of Treatment (ft) 5	Expected date(s) of treatment(s) May - September		

Treatment method: [X] Chemical [ ] Physical [ ] Biological Control [ ] Mechanical

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. 2,4-D granular applied to control Eurasian watermilfoil in Black Creek/Black Creek delta

Plant survey method: [X] Rake [ ] Visual [ ] Other (specify) Formal Plant Survey

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Eurasian Watermilfoil	X	2
Sago Pondweed		7
Flatstem Pondweed		5
Largeleaf Pondweed		1
Chara Algae		9
Richardson's Pondweed		2
Small Pondweed/Horned Pondweed		1
Coontail		10
Slender Naiad/Brittle Naiad		9
Baldderwort		1
Water Stargrass		12
Curlyleaf Pondweed		41
Filamentous Algae		Present

INSTRUCTIONS: Whoever treats the lake fills in "Applicant's Signature" unless they are a professional. If they are a professional company who specializes in lake treatment, they should sign on the "Certified Applicant" line.

Applicant Signature	Date
Certified Applicant's Signature	Date

FOR OFFICE ONLY

[ ] Approved [ ] Disapproved	Fisheries Staff Specialist
[ ] Approved [ ] Disapproved	Environmental Staff Specialist

Mail check or money order in the amount of $5.00 to:

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
COMMERCIAL LICENSE CLERK
402 WEST WASHINGTON STREET ROOM W273
INDIANAPOLIS, IN 46204

Aquatic Enhancement
& Survey, Inc.
P.O. Box 1036
Angola, IN 46703
www.aquaticenhancement.com
tel: 260-665-8226
toll free: 888-867-5253
Area 2, Delta Areas for two Sonar PR or Q gran. Applications 20ppb, 9 acres total
Area One is Whole Lake 6 bump 6 Sonar A.S.

Aquatic Enhancement
& Survey, Inc.
P.O. Box 1036
Angola, IN 46703
www.aquaticenhancement.com
tel: 260-665-8226
toll free: 888-867-5253
Area 3, Algae Treatment
Area One is Whole Lake 6 bump 6 Sonar A.S.
Algae treatment, Copper, Approx. 110 ac.

Project
Initial
Date
Aquatic Enhancement
& Survey, Inc.
P.O. Box 1036
Angola, IN 46703
www.aquaticenhancement.com
tel: 260-665-8226
toll free: 888-867-5253
Area 4, 2,4-D granular as needed at Black Creek .5 acres

Appendix B
Tier II Plant Survey Data Sheets

Aquatic Vegetation Random Sampling (Tier 2)

Waterbody Cover Sheet

Surveying Organization: Aquatic Enhancement

Contact Information: (260) 665-8226

Waterbody Name: Hamilton

Lake ID:

County(s): Steuben

Date: 8-12-08 ; 8-13-08

Habitat Stratum:

Avg. Lake Depth (ft):

Lake Level:

GPS Metadata

Datum: Zone: Accuracy:

Crew Leader: Scott Banfield

Recorder: Joseph Clossor

Method:

Secchi Depth (ft): 15 ft 10 in

Total # of Points Surveyed:

Total # of Species:

Littoral Zone Size (acres):

- ☐ Measured
- ☐ Estimated

Littoral Zone Max. Depth (ft):

- ☐ Measured
- ☐ Estimate (historical Secchi)
- ☐ Estimated (current Secchi)

Notable Conditions:

57
33
10
TOTAL

802 ACRES
EUTROPHIC
MAX SAMPLING 15'

Submersed Aquatic Vegetation Survey (Tier II) Datasheet

Page 1 of 4

WATERBODY NAME: HAMILTON LAKE	DATE: 8/12/08
COUNTY: Steuben	SECCHI DEPTH (FT): 15 ft 10 in
SITE ID:	MAX PLANT DEPTH (FT):
SURVEYING ORGANIZATION: Aquatic Enhancement	WEATHER: 80° Partly Cloudy Calm
CREW LEADER: Scott Banfield	COMMENTS (Include voucher codes - V1, V2...):
RECORDER: Joseph Classon	
CONTACT INFO: (260)665-8220	

Rake score (1, 3, 5). 9 = algae, emergent or species observed but not sampled.

Species Codes:

Point #	R/T	Latitude	Longitude	Depth (ft)	CHARA	STUPEC	~~ZOSDUB~~	CERDEM	NASTHE	MYRSPI	POTAMP	VALAME	NASMIC	POTPUS	POTZOS	POTCRI	NAIGUA ~~Notes~~	ELOCAN	AIGA
86				5.5			5	1	1	9	9	9							
87				2					1										
88				8.5				5											
89				13				3					1	1					
90				8			3	5					1	1					
91				2					5										
92				3				5	1										
* 93				11				5		1						1			
94				9			1	5							1				
95			VOUCHER	3			1	5	1	1				1		1			
96			MYR SP.	4				5	5	1		1	1				1		
97				2	1		3		5	1									
98				7			5	5			1							1	
99				5.5	1				5				1	3					
100				4.5			3	5	5									1	
101				4			3	5	5										
102				7			5	1		1				1				1	
103				3			1	5	5			1							
104				7															9
105				4			5	5	1			1		1					
106				7				1		1									9
107				3.5						3								3	9
108				2.5	5		3		1									1	
109				4	1		1		1	1			1						9
110				14.5			1	1											
111				3	1		1	1	3				1				1		
112				4.5			1	5	3				1						
113				6			5	5	1	3									
114				4			3	1	5			1							
115				12						1									

Other plant species observed at lake:

Submersed Aquatic Vegetation Survey (Tier II) Datasheet

Page 2 of 4

WATERBODY NAME: Hamilton Lake	DATE: 8-12-08 / 8-13-08
COUNTY: Steuben	SECCHI DEPTH (FT): recorded 8-13 14' 6"
SITE ID:	MAX PLANT DEPTH (FT):
SURVEYING ORGANIZATION: Aquatic Enhancement	WEATHER: 8-13-08 Cloudy, 10 N, 70°
CREW LEADER: Scott Banfield	COMMENTS (Include voucher codes - V1, V2...):
RECORDER: Joseph Classon	
CONTACT INFO: (260) 665-8220	

Rake score (1, 3, 5). 9 = algae, emergent or species observed but not sampled.

Species Codes:

Point #	R/T	Latitude	Longitude	Depth (ft)	CHARA	STUPEC	ZOSDUB	CERDEM	NAJFLE	MYRSPI	POTAMP	VACAME	NAJMIN	POTPUS	POTCRI	POTZOS	NASGUA	ELO CAN	ALGA	UTRMAC
116				3	1		1		3											
117				2.5			1		1									5	9	
118				5.2			1												9	
119				2.5			3		5						1			1		
120				5.5			1	1						1				1	9	
121				4					3	1								5	9	
122				5.1	1					1									9	
123				4.5			1	1	5			1								
124				3.5	1		1	1	5		5	3								
125				4			5	5	5		1									
126				7.5				5												
127				11.5				3		1				1						
128				4			5	5	1	1										
129				4			3		5				1					1		
130				7			5	5												
131				3			1	1	1					1						
132				3			1	1	5	1										
133			14.5	~~8~~						1										
134			8	~~4.8~~				5												
135			4.8	~~6.5~~				5			1									
136			6.5	~~4.5~~				3		1									9	
137			4.5	~~7~~					1	1								1	9	
138			4	~~11~~			1	1	5	1								1	9	
139			11	~~14~~				5		1										
140			4	~~6.5~~			1	1	5	1										
141			6.5	~~7.7~~		1				1									9	
142			7	~~3.5~~				5	1											
143			3.5	~~4.5~~	1			1											1	1
144			4.9	~~11.4~~	5															
145			11	~~5.1~~	1					5								1	1	1
Other plant species observed at lake:																				
				7	1										1					1

146 3

* WPT for POTRIC was taken

* Pseudobasistrite in the crystals

Submersed Aquatic Vegetation Survey (Tier II) Datasheet

WATERBODY NAME:	DATE: 8-13-08
COUNTY:	SECCHI DEPTH (FT):
SITE ID:	MAX PLANT DEPTH (FT):
SURVEYING ORGANIZATION:	WEATHER:
CREW LEADER:	COMMENTS (Include voucher codes - V1, V2...):
RECORDER:	
CONTACT INFO:	*Rake score (1, 3, 5). 9 = algae, emergent or species observed but not sampled.*

Species Codes:

Point #	R/T	Latitude	Longitude	Depth (ft)	CHARA	ZOS DUB	CERDEM	NASFIE	MYRSPI	POTAMP	VALAME	NASMIN	POTPUS	POTCRI	POTZOS	NASGUA	ELOCAN ~~Notes~~	ALGA	STUPEC	UTRMAL
147				3	3															5
148				2.5	1			5										9		
149				4			5	1			1		3		1					
150				8			5										1			
151				7.5			3	3					3							
152				3.5		3	1	5			1									
153				5.5		5	3	3			5									
154				4.9		5	1													
155				9			1													
check depth 156				~~27~~			5													
157				14.5																
158				4.5		1	5		1							1	1			
159				3.5		1			1									9		
160				5.5	1	1			1				1	1						
161				6.5																
162				8			5		1											
163				12			1													
164				4.8				1	1								1	9		
165				5.5		1	3										1	9		
166				4.9		1		5	1			1								
167				4			5				5									
168				4.9		3	5													
169				8.5			5		1							1				
170				4		5	1							1						
171				7			5		1											
172				3		1	1	3												
173				7		5	1		1											
174				2			5				1							9		
175				4		1	5	1					1							
176				4.5		1	5													

Other plant species observed at lake: POTNOD - in crystal

* Myriophyllum just inside of crystal

Submersed Aquatic Vegetation Survey (Tier II) Datasheet

WATERBODY NAME:	DATE: 8-13
COUNTY:	SECCHI DEPTH (FT):
SITE ID:	MAX PLANT DEPTH (FT):
SURVEYING ORGANIZATION:	WEATHER:
CREW LEADER:	COMMENTS (Include voucher codes - V1, V2...):
RECORDER:	
CONTACT INFO:	

Rake score (1, 3, 5). 9 = algae, emergent or species observed but not sampled.

Species Codes:

Point #	R/T	Latitude	Longitude	Depth (ft)	CHARA	ZOSDOB	CERDEM	NASFLE	MYRSPI	POTAMP	VALAME	NASMIN	POTPUS	POTCRI	POTZOS	NAJGUA	FLOCAN	Notes
177				4		1		5			1							1
178				3		5	3		1									
179				6.5		1	1	1										
180				4		1	3	3										
181				4.9		3	5											
182				4.5		5	5											
183				4.5		5	1											9
184				3.5		1	1					1						9
185				5.1	5	3		5	1									

ALGA

Other plant species observed at lake:

Appendix C
Raw Data Sheets, 7/10/08, 11/22/08 Flow Rates

Sheet1

Tributary /site/waypoint name: HAMILTON OUTLET UPPER

Date: 7/10/08 9:00 am

Description: At culvert

Aquatic Enhancement & Survey, Inc. Angola, Indiana

Depth measurement interval (1" or 1'): 2 feet

Field measurement

Lab Result

Tributary Width ~~in inches~~	8 feet
Tributary Depth in Inches Point 1	10 in
Tributary Depth in Inches Point 2	8.5 in
Tributary Depth in Inches Point 3	7.5 in
Tributary Depth in Inches Point 4	9 in
Tributary Depth in Inches Point 5	5 in
Tributary Depth in Inches Point 6	
Tributary Depth in Inches Point 7	
Tributary Depth in Inches Point 8	
Tributary Depth in Inches Point 9	
Tributary Depth in Inches Point 10	
Tributary Depth in Inches Point 11	
Tributary Depth in Inches Point 12	
Tributary Depth in Inches Point 13	
Tributary Depth in Inches Point 14	
Tributary Depth in Inches Point 15	
Tributary Depth in Inches Point 16	
Tributary Depth in Inches Point 17	
Tributary Depth in Inches Point 18	
Tributary Depth in Inches Point 19	
Tributary Depth in Inches Point 20	
Tributary Depth in Inches Point 21	
Tributary Depth in Inches Point 22	
Tributary Depth in Inches Point 23	
Tributary Depth in Inches Point 24	
Tributary Depth in Inches Point 25	
Tributary Depth in Inches Point 26	
Tributary Depth in Inches Point 27	
Tributary Depth in Inches Point 28	
Tributary Depth in Inches Point 29	
Tributary Depth in Inches Point 30	
25 feet in how many seconds	
three feet in how many seconds	13.34 0.00
Total Phosphorus (ppm)	
Nitrates (ppm)	
TSS (mg/l)	

Measuring Vessel
Marked Rope
Stopwatch
Plastic Bottle
Tape Measure
pH meter
D.O. meter

3 ft in 13.34

Flow Rate: 1 - 0
2 - 0
3 - 0

Note - Half stream is flowing and other half is note. Flow too slow for meter to read.

Mean Tributary Depth	#DIV/0!	inches
CFM	#DIV/0!	
pH		
D.O.		ppm
Temp.		Deg C
Specific Conductance		
ORP (oxydation reduction pot.)		mV
B.O.D. (5day ppm)		
Nitrite (ppm)		0=<.02 BDL
E-coli (CFU/ml)		
Total Phosphorus Loading Kg/dy	#DIV/0!	
Total Nitrate Loading Kg/dy	#DIV/0!	
Tss Loading Kg/dy	#DIV/0!	

Page 1

Tributary /site/waypoint name: HAMILTON OUTLET ~~UPPER~~ LOWER

Date: 7/10/08 9:15 am

Description: At end of Raceway (within the raceway) (on top of concrete)

Aquatic Enhancement & Survey, Inc. Angola, Indiana

Depth measurement interval (1" or 1'): 1 foot

Field measurement

Lab Result

Tributary Width in inches	118 inches = 9.83 ft
Tributary Depth in Inches Point 1	.6 ft
Trilbutary Depth in Inches Point 2	.6 ft
Tributary Depth in Inches Point 3	.9 ft
Tributary Depth in Inches Point 4	.95 ft
Tributary Depth in Inches Point 5	1 ft
Tributary Depth in Inches Point 6	1.05 ft
Trilbutary Depth in Inches Point 7	1 ft
Tributary Depth in Inches Point 8	.9 ft
Tributary Depth in Inches Point 9	.9 ft
Tributary Depth in Inches Point 10	.8 ft
Tributary Depth in Inches Point 11	.6 ft
Trilbutary Depth in Inches Point 12	
Tributary Depth in Inches Point 13	
Tributary Depth in Inches Point 14	
Tributary Depth in Inches Point 15	
Tributary Depth in Inches Point 16	
Tributary Depth in Inches Point 17	
Tributary Depth in Inches Point 18	
Tributary Depth in Inches Point 19	
Tributary Depth in Inches Point 20	
Tributary Depth in Inches Point 21	
Trilbutary Depth in Inches Point 22	
Tributary Depth in Inches Point 23	
Tributary Depth in Inches Point 24	
Tributary Depth in Inches Point 25	
Tributary Depth in Inches Point 26	
Trilbutary Depth in Inches Point 27	
Tributary Depth in Inches Point 28	
Tributary Depth in Inches Point 29	
Tributary Depth in Inches Point 30	
25 feet in how many seconds	
three feet in how many seconds	0.00
Total Phosphorus (ppm)	
Nitrates (ppm)	
TSS (mg/l)	

Measuring Vessel
Marked Rope
Stopwatch
Plastic Bottle
Tape Measure
pH meter
D.O. meter

Flow rates: (done in reverse order of the flow rates)
1 - 2.5 ft/sec
2 - 4.0 ft/sec
3 - 3.5 ft/sec
4 - 3.0 ft/sec
5 - 2.0 ft/sec
6 - 2.0 ft/sec
7 - 1.5 ft/sec
8 - 1.0 ft/sec
9 - 1.0 ft/sec
10 - .5 ft/sec
11 - .5 ft/sec

Mean Tributary Depth	#DIV/0!	Inches
CFM	#DIV/0!	
pH		
D.O.		ppm
Temp.		Deg C
Specific Conductance		
ORP (oxydation reduction pot.)		mV
B.O.D. (5day ppm)		
Nitrite (ppm)		0=<.02 BDL
E-coli (CFU/ml)		
Total Phosphorus Loading Kg/dy	#DIV/0!	
Total Nitrate Loading Kg/dy	#DIV/0!	
Tss Loading Kg/dy	#DIV/0!	

MEAN DEPTH - .85 FT.
(.85 FT)(9.83) = 8.31 FT²

MEAN FLOW 1.95 FT/SEC
* (COULD ALSO USE 1.7 FPS)
(1.95)(8.31 FT²) = 16.24 CFS

974.5 CFM

32.23 ACRE-FT/DAY

8020 / 32.23 = 249 DAYS

Sheet1

Tributary /site/waypoint name: HAMILTON N. OUTLET

Date: 11/22/08

Description: MEASURE IN DOWNSTR. END OF CULVERT

LITTLE FLOW ON S. OUTLET - NOT MEASUREABLE

Depth measurement interval: 1 FT

Field measurement

Aquatic Enhancement & Survey, Inc.
Angola, Indiana

	distance fm s	depth inches	velocity	Lab Result
Tributary Width in inches 6'5"	0	0	0	
Tributary Depth in Inches Point 1	1	2.5	3.38 FPS	
Tributary Depth in Inches Point 2	2	3.0	4.32 FPS	
Tributary Depth in Inches Point 3	3	3.75	4.74 FPS	
Tributary Depth in Inches Point 4	4	3.25	4.59 FPS	
Tributary Depth in Inches Point 5	5	2.5	4.17 FPS	
Tributary Depth in Inches Point 6	6	.75"	1.00 FPS	
Tributary Depth in Inches Point 7				
Tributary Depth in Inches Point 8				
Tributary Depth in Inches Point 9				
Tributary Depth in Inches Point 10				
Tributary Depth in Inches Point 11				
Tributary Depth in Inches Point 12				
Tributary Depth in Inches Point 13				
Tributary Depth in Inches Point 14				
Tributary Depth in Inches Point 15				
Tributary Depth in Inches Point 16				
Tributary Depth in Inches Point 17				
Tributary Depth in Inches Point 18				
Tributary Depth in Inches Point 19			Mean Tributary Depth	#DIV/0! Inches
Tributary Depth in Inches Point 20			CFM	#DIV/0!
Tributary Depth in Inches Point 21				
Tributary Depth in Inches Point 22			pH	
Tributary Depth in Inches Point 23			D.O.	ppm
Tributary Depth in Inches Point 24			Temp.	Deg C
Tributary Depth in Inches Point 25			Specific Conductance	
Tributary Depth in Inches Point 26				
Tributary Depth in Inches Point 27				
Tributary Depth in Inches Point 28				
Tributary Depth in Inches Point 29				
Tributary Depth in Inches Point 30				
25 feet in how many seconds		15.00	E-coli (CFU/ml)	
three feet in how many seconds		1.81		
Total Phosphorus (ppm)		0.0299	Total Phosphorus Loading Kg/dy	#DIV/0!
Nitrates (ppm)		0.73	Total Nitrate Loading Kg/dy	#DIV/0!
TSS (mg/l)		0.80	Tss Loading Kg/dy	#DIV/0!

DEPTH 15.75"/7 = 2.25" MEAN

Measuring Vessel
Marked Rope
Stopwatch
Plastic Bottle
Tape Measure
pH meter
D.O. meter

VELOCITY ~~= 21.2 FPS/7 = 3.71 FPS~~

RECALC USING .85 4.03 FPS

2.25" MEAN DEPTH 3.71 FPS MEAN VELOCITY

(2.25")(77") = 173.25"²/144 = 1.2 FT²

(1.2 FT²)(3.71 FT/4.03) = ~~4.46 FT³/S~~ ~~4.54 FT³/S~~

~~4.46 CFS~~

~~267.82 CFM~~

290.4 CFM

Page 1

Appendix D
Hamilton Lake Tier II Sampling Point Coordinates

BEGIN WAYPOINT
41.550566,-84.909383,WPT086,GREEN DOT
41.551132,-84.910433,WPT087,GREEN DOT
41.551617,-84.911200,WPT088,GREEN DOT
41.551433,-84.912883,WPT089,GREEN DOT
41.549849,-84.914850,WPT090,GREEN DOT
41.548582,-84.915517,WPT091,GREEN DOT
41.547283,-84.915117,WPT092,GREEN DOT
41.546249,-84.917666,WPT093,GREEN DOT
41.545283,-84.915399,WPT094,GREEN DOT
41.544450,-84.915582,WPT095,GREEN DOT
41.543716,-84.916216,WPT096,GREEN DOT
41.542799,-84.916433,WPT097,GREEN DOT
41.542050,-84.916916,WPT098,GREEN DOT
41.541467,-84.916366,WPT099,GREEN DOT
41.540516,-84.916466,WPT100,GREEN DOT
41.539566,-84.916466,WPT101,GREEN DOT
41.538950,-84.916582,WPT102,GREEN DOT
41.538450,-84.915232,WPT103,GREEN DOT
41.537599,-84.915733,WPT104,GREEN DOT
41.537599,-84.914366,WPT105,GREEN DOT
41.536050,-84.913549,WPT106,GREEN DOT
41.535883,-84.912533,WPT107,GREEN DOT
41.535317,-84.914483,WPT108,GREEN DOT
41.537950,-84.918216,WPT109,GREEN DOT
41.540050,-84.918066,WPT110,GREEN DOT
41.540866,-84.919900,WPT111,GREEN DOT
41.541583,-84.921950,WPT112,GREEN DOT
41.539817,-84.922133,WPT113,GREEN DOT
41.539267,-84.919900,WPT114,GREEN DOT
41.538666,-84.920332,WPT115,GREEN DOT
41.537533,-84.922732,WPT116,GREEN DOT
41.537332,-84.923649,WPT117,GREEN DOT
41.538500,-84.924933,WPT118,GREEN DOT
41.538933,-84.926149,WPT119,GREEN DOT
41.539616,-84.926066,WPT120,GREEN DOT
41.540066,-84.926983,WPT121,GREEN DOT
41.541482,-84.926832,WPT122,GREEN DOT
41.542100,-84.926316,WPT123,GREEN DOT
41.542600,-84.925716,WPT124,GREEN DOT
41.543000,-84.924116,WPT125,GREEN DOT
41.543166,-84.923367,WPT126,GREEN DOT
41.543716,-84.922833,WPT127,GREEN DOT
41.544766,-84.922916,WPT128,GREEN DOT

41.545299,-84.922649,WPT129,GREEN DOT
41.545999,-84.923016,WPT130,GREEN DOT
41.545166,-84.923950,WPT131,GREEN DOT
41.544283,-84.924766,WPT132,GREEN DOT
41.544517,-84.925466,WPT133,GREEN DOT
41.543983,-84.926083,WPT134,GREEN DOT
41.543450,-84.926799,WPT135,GREEN DOT
41.544317,-84.927349,WPT136,GREEN DOT
41.544466,-84.928233,WPT137,GREEN DOT
41.544799,-84.928650,WPT138,GREEN DOT
41.545199,-84.928900,WPT139,GREEN DOT
41.545615,-84.930566,WPT140,GREEN DOT
41.546983,-84.927633,WPT141,GREEN DOT
41.549600,-84.927733,WPT142,GREEN DOT
41.551750,-84.928100,WPT143,GREEN DOT
41.553949,-84.930749,WPT144,GREEN DOT
41.556533,-84.927832,WPT145,GREEN DOT
41.559133,-84.930216,WPT146,GREEN DOT
41.558099,-84.931266,WPT147,GREEN DOT
41.548016,-84.925566,WPT148,GREEN DOT
41.548000,-84.923249,WPT149,GREEN DOT
41.547249,-84.921133,WPT150,GREEN DOT
41.549933,-84.921599,WPT151,GREEN DOT
41.550250,-84.924633,WPT152,GREEN DOT
41.551850,-84.924400,WPT153,GREEN DOT
41.553833,-84.924033,WPT154,GREEN DOT
41.555333,-84.922667,WPT155,GREEN DOT
41.556966,-84.920617,WPT156,GREEN DOT
41.557683,-84.919232,WPT157,GREEN DOT
41.558617,-84.923116,WPT158,GREEN DOT
41.560916,-84.922433,WPT159,GREEN DOT
41.560166,-84.920533,WPT160,GREEN DOT
41.560549,-84.916250,WPT161,GREEN DOT
41.560149,-84.913766,WPT162,GREEN DOT
41.558767,-84.913349,WPT163,GREEN DOT
41.561832,-84.919083,WPT164,GREEN DOT
41.561666,-84.917082,WPT165,GREEN DOT
41.562299,-84.915350,WPT166,GREEN DOT
41.562033,-84.912883,WPT167,GREEN DOT
41.558800,-84.912483,WPT168,GREEN DOT
41.556133,-84.911733,WPT169,GREEN DOT
41.554633,-84.909750,WPT170,GREEN DOT
41.552999,-84.908100,WPT171,GREEN DOT
41.552549,-84.907032,WPT172,GREEN DOT
41.551300,-84.907000,WPT173,GREEN DOT

41.551067,-84.905766,WPT174,GREEN DOT
41.550483,-84.905200,WPT175,GREEN DOT
41.549766,-84.904733,WPT176,GREEN DOT
41.548833,-84.904566,WPT177,GREEN DOT
41.548083,-84.903932,WPT178,GREEN DOT
41.547716,-84.901783,WPT179,GREEN DOT
41.548166,-84.904550,WPT180,GREEN DOT
41.548150,-84.905600,WPT181,GREEN DOT
41.548116,-84.907116,WPT182,GREEN DOT
41.548932,-84.907650,WPT183,GREEN DOT
41.549449,-84.908567,WPT184,GREEN DOT
END