Appendix 9.11 Natural Resource Management Plan

NATURAL RESOURCE MANAGEMENT PLAN

Silo Ridge Resort Community –
Traditional Neighborhood Alternative
Amenia, New York

AUDUBON INTERNATIONAL

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June, 2007

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES
(Continued)

1.0 INTRODUCTION

Plans are being made for redevelopment of the Silo Ridge Resort Community in Amenia, NY. The proposed Silo Ridge Resort Community – Traditional Neighborhood Alternative ("the project") will transform a 670±-acre parcel of property in Amenia, NY from an existing golf course to a mixture of housing, golf, recreation, and nature preserve. In keeping with its desire to develop this site in an ecologically sustainable manner, Silo Ridge Resort Community has formed a partnership with Audubon International (AI) by enrolling the development in AI's Silver Signature Program.

This management plan has been developed to detail how Silo Ridge Resort Community management activities will protect natural resources. Development strategies that encompass sustainability – using natural resources without depleting them, in ways that will support human activity – have been identified and evaluated, and will be implemented. By implementing the programs contained in this plan an environmentally sensitive approach to golf course and community management will be ensured.

The proposed Silo Ridge Resort Community – Traditional Neighborhood Alternative (or the project) will rely on a combination of management programs. Turfgrass cultural practices include mowing, fertilization, irrigation, cultivation, and the use of Integrated Pest Management. Many turfgrass cultural practices could have an impact on the environment. Erroneously, many people assume that when fertilizers or pesticides are used they move off-site in response to irrigation or rainfall and create environmental problems, particularly to surface water or shallow groundwater. While there is a potential for movement occurring, this possibility can be greatly reduced and any negative environmental impact virtually eliminated on a well designed and engineered golf course by developing low risk irrigation, fertilization and pesticide programs and ensuring these programs are administered on a day-to-day basis by a qualified golf course superintendent. Likewise, community landscapes will be managed in a manner similar to the golf course, with the result being minimization of negative environmental impacts.

1.1 MANAGEMENT APPROACHES AT SILO RIDGE RESORT COMMUNITY

Development and management of the project focuses on sustainable resource management and application of scientifically based environmental decisions in design, engineering, construction, and management. This proactive approach to development of the project integrates environmental and agronomic practices and promotes managing the golf course and associated development as an integrated component of the ecosystem. By managing the golf course and associated development as ecosystem components, the golf course takes advantage of, or mimics, naturally functioning ecosystems. On a practical level, this Natural Resource Management Plan for the project integrates design and engineering with cultural practices through Best Management Practices, Integrated Pest Management, and environmental monitoring. The result is a thoughtfully designed and carefully operated course in which there is integration between cultural practices and the environment, and protection of resources.

The focus of the Environmental Management Plan for the project is on the following:

1. *Prevention:* Prevent environmental problems by incorporating Best Management Practices into the design of the community, golf course and maintenance facility, and the use of Integrated Pest Management to control pests.

2. *Control:* Control potential problems at the source through appropriate turfgrass cultural practices including the judicious use of fertilizers and pesticides selected specifically for the project based on an ecological risk assessment; developing an effective irrigation management program; and identification of specialized management zones within the golf course where management practices will be more stringently monitored.

3. *Monitoring:* Conduct an environmental monitoring program that evaluates the effectiveness of the management program.

1.1.1 Prevention

The first step in preventing environmental problems was to design the project with an understanding of the ecological systems at the site, and incorporate Best Management Practices (BMPs) throughout the golf course and development. BMPs have been integrated into the golf course and community design and will be implemented during construction and maintenance operations. Examples of BMPs that incorporate this approach are given below.

An Integrated Pest Management (IPM) program will be used at the project. The IPM program is the cornerstone of the day-to-day management of the course because management of turfgrass pests rarely relies on a single control practice. IPM uses information about turfgrass pest problems including environmental conditions which may precipitate these problems, and integrates these with turfgrass cultural practices and pest control measures not to eradicate pests, but to prevent or control unacceptable levels of pest damage.

1.1.2 Control

Control means providing appropriate management of materials and systems at the project so that environmental problems do not occur. The main issues involving golf courses focus on the use of fertilizers and pesticides in the management program and operations at the maintenance facility. In order to protect sensitive environmental areas at the project, this management program will ensure that materials used to maintain the turf, the location of fertilizer and pesticide storage and mixing, equipment washing, and any drainage from these areas is are not detrimental to natural resources.

At the project, the IPM program is coupled with an ecological risk assessment which determined the chemicals that can safely be used at the golf course and community. Management zones have been established, so that the course will be managed differently at different locations. For example, areas next to wetlands, ponds, and streams are managed differently than other areas.

1.1.3 Monitoring

Monitoring provides a means to measure the success of the design, construction and operations of the project through an environmental monitoring program that strives to detect environmental problems. The monitoring program also will evaluate the effectiveness of the management program. This will encompass sampling groundwater and surface water to determine if any detrimental effects on the environment are noted. The goals of the monitoring program are as follows: 1) to provide baseline data as to the site characteristics regarding environmental conditions; 2) to provide data that assesses environmental conditions, thus providing a basis for measuring compliance with environmental regulations; and 3) to ensure that IPM and the BMPs are functioning properly.

1.2 Concept of Best Management Practices and Integrated Pest Management

A key component to environmentally sensitive management of the project is the implementation of BMPs and IPM. Numerous scientific studies have documented that BMPs and IPM coupled with efficiency in rate and timing of fertilizer and pesticide applications and efficient irrigation management will substantially reduce or completely eliminate potential water quality problems (Peacock and Smart, 1995; Peacock et al., 1996). Scientific studies on golf courses and water quality are summarized in **Appendix IV**. The conclusions of the studies indicate that Best Management Practices are highly effective in controlling environmental impact from applied materials. These studies were conducted on golf courses under their prevailing approaches to course management.

1.2.1 Best Management Practices

Best Management Practices are those engineering or cultural approaches to golf course and landscape management which act to prevent the movement of sediments, nutrients or pesticides into environmentally sensitive areas. Through the use of Best Management Practices (BMPs) golf course and landscape management can have a positive impact within a natural setting. The use of BMPs to protect water quality can be affordable, easily implemented and effective pollution control practices. BMPs can effectively eliminate the risk of unwanted materials reaching environmentally sensitive areas. BMPs are identical or similar to those suggested by the US Department of Agriculture, Natural Resource Conservation Service (Bottcher and Baldwin, 1986).

Examples of BMPs include cultural control of pests, biological control of pests, risk assessment based pesticide selection, correct application of pesticides, correct pesticide container disposal, proper timing and placement of fertilizers, planting resistant crop varieties, use of soil testing and plant analysis to establish fertilizer application rates, use of slow release or natural organic fertilizers, good irrigation water management, use of aquatic filter ponds, good subsurface drainage routing, use of land absorption areas, grassed waterways or outlets, and critical area plantings for filtering drainage. Design and engineering and turfgrass management cultural practices and IPM strategies at the project have employed those BMPs described.

1.2.2 Integrated Pest Management

Integrated Pest Management (IPM) is a program that uses information about turfgrass pest problems and environmental conditions which may precipitate these problems, and integrates these with turfgrass cultural practices and pest control measures to prevent or control unacceptable levels of pest damage (Ferrentino, 1990). This approach integrates a number of efforts including:

1. Development of a healthy turf that can withstand pest pressure;
2. Judicious and efficient use of chemicals;
3. Enhancement of populations of natural, beneficial organisms; and
4. Effective timing of handling pest problems at the most vulnerable stage, often resulting in reduced pesticide usage.

It is an ecologically based system that uses both biological and chemical approaches to control. As with BMPs, IPM strategies have been incorporated into every aspect of this plan for the project, and have taken into consideration the entire scheme of golf course operations as they relate to environmental impact.

The IPM method incorporates the following approaches:

1. **Monitoring** of potential pest populations and their environment;
2. **Determining** pest injury levels and establishing treatment thresholds;
3. **Decision making**, developing and integrating all biological, cultural, and chemical control strategies;
4. **Educating** personnel on all biological and chemical control strategies;
5. **Timing and spot treatment** utilizing either the chemical, biological or cultural methods; and
6. **Evaluating** the results of treatment.

1.2.3 Audubon International's Signature Program

Audubon International is a not-for-profit environmental organization that focuses on sustainable natural resource management. Audubon International was created to administer and unify programs with a national and international focus including the Audubon Cooperative Sanctuary

System, the Audubon Signature Program, Audubon Canada, and the Audubon Society of New York State.

The Audubon Signature Program provides comprehensive environmental planning assistance to landowners with projects in the design and development stages. Audubon International staff work with owners, architects, consultants, and managers from the design stages through construction. By offering guidance and technical assistance, the staff helps to establish a management program that focuses on sustainable natural resource management. The Signature Program focuses on wildlife conservation and habitat enhancement, water quality management and conservation, waste reduction and management, energy efficiency, and Integrated Pest Management. Projects that receive Audubon Signature Status are considered internationally significant environmental demonstration sites for sustainable resource management. See **Appendix VIII** for additional information on the Signature Program and Audubon International.

2.0 ENVIRONMENTAL PLANNING

Increasing attention has been focused recently on the interrelationships between development golf courses and the environment, in particular on protecting habitat and water resources from contamination by nutrients and pesticides (Balogh and Anderson 1992; Walker and Branham 1992). By taking a pro-active environmental approach to construction and management of the Silo Ridge Resort Community, the potential for adverse impacts can be mitigated (Peacock and Smart 1995; Peacock et al, 1996). In the process of environmental planning, existing site conditions and resources were identified and measures to protect those resources, and reduce probabilities of negative occurrences during development and operations were specified. At the project, several steps were followed and they are identified below.

The first step in the project's proactive approach was to examine the project site in terms of natural resources (Section 2.1). The second step was to identify environmentally and ecologically sensitive areas. Identification allows protection of the sensitive areas (Section 4.0), and this was done at the watershed level, because drainage basins are the units of management at the ecosystem level, and this level of inspection allows determinations of broad-scale processes, including, for example, wildlife core areas, drainage patterns, and other land uses in the watershed. The third step was to identify those management practices that would be appropriate to ensure protection of these sensitive areas, and these are discussed in Sections 3.0 through 9.0.

2.1 SITE DESCRIPTION AND EVALUATION

The project site has been examined relative to environmental characteristics, including location of wetlands and proximity of environmentally sensitive areas to the golf course and community. The project site was visited in May, 2007 to reconcile topographic maps, development plans and golf course routing plans, and to provide a more detailed analysis of the vegetation, types of wetlands, soil conditions and relationship of the ecological community to the community design and maintenance facility. A site plan is shown in **Figure 2-1.**

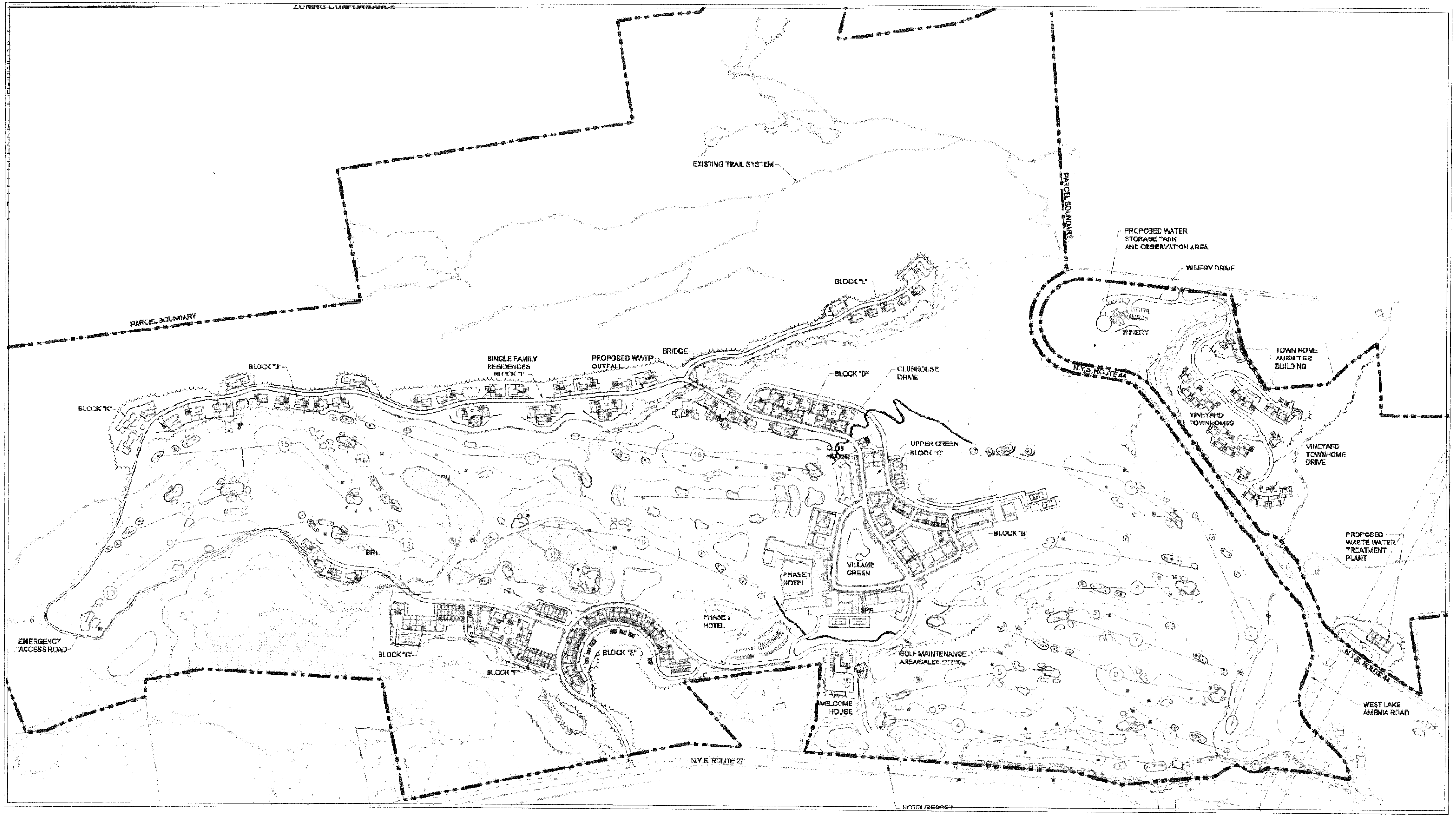


Figure 2-1. Silo Ridge Resort Community - Traditional Neighborhood Alternative Site Plan

Information in this section is a compilation of site conditions. We used data from various reports prepared by the development team for the project and site plans; however, the majority of the information came from the Draft Environmental Impact Statement that was prepared under the direction of the Chazen Companies. We present an overview of a particular natural resource and reference the DEIS should one wish to review the detailed analyses of the project site.

2.1.1 Physical Setting

The project is to be developed on a 670±-acre site located west of New York State (NYS) Route 22 in the Town of Amenia, Dutchess County, New York. The project site is currently developed with an 18-hole golf course and clubhouse on approximately 170 acres. The proposed development will consist of homes, with a mix of townhouses and single-family units, in addition to a resort hotel, banquet space, restaurants, conference space, and a spa and fitness center (DEIS, The Chazen Companies).

Approximately 170 acres of the project site is developed with the Silo Ridge Country Club, an 18-hole golf course and clubhouse with associated amenities. The project site also includes approximately 47± acres of ponds, streams, and wetlands and 6± acres of roads, buildings, and other paved surfaces. The remaining 450± acres consist primarily of undeveloped land not in agricultural use. This includes approximately 230 acres of wooded land on the hillsides and ridge to the west of the golf course (DEIS, The Chazen Companies).

Land uses in the vicinity of the project site are a mix of residential, agricultural, and commercial uses, public and community service uses, and undeveloped land. Land uses north of the site consist primarily of single-family residences and vacant land. The hamlet of Amenia lies approximately one-half mile northeast of the project site. This small, relatively densely developed area is comprised of uses typical of a town or village center, encompassing a mix of residential, community and public service, and recreational lands (DEIS, The Chazen Companies).

2.1.2 Topography

The project site has varying topography, with slopes ranging from almost 100% to nearly flat. Site elevations range from approximately 480 feet above mean sea level (msl) to over 1,100 feet above msl. The northern end of the site (north of NYS Route 44) generally slopes southeasterly toward Route 44. The western portion of the site is higher in elevation than the rest of the site and slopes toward the central and eastern areas of the site. Approximately 58% of the project area has slopes greater than or equal to 15% (DEIS, The Chazen Companies).

2.1.3 Soils

Golf course construction usually includes extensive disturbance of native soils. Soils at the project site are not expected to be imported because the site has been engineered for a balanced cut and fill. Soils mapping was from NRCS documents. While the properties reflected in the table are for native soil conditions, they may be highly modified during the construction process. Further, extensive soil testing must be performed after grading and prior to turf establishment to determine exact nutrient levels and the need for any type of soils modification.

2.1.3.1. *Soil Type Descriptions*. Selected soil physical and chemical characteristics for the predominant soil series on the site are listed in **Table 2-1**. The project site consists of a series of rolling hills with an elevated marsh area and several series of wetland areas. A description of the predominant soil series on the project site follows:

Copake - The Copake series consists of well drained soils formed in loamy mantled stratified drift and glacial outwash. The soils are moderately deep to stratified sand and gravel and are very deep to bedrock. They are nearly level to very steep soils on outwash plains, terraces, kames, eskers, and moraines. Permeability is moderate or moderately rapid in the surface layer and subsoil, and very rapid in the substratum. Mean annual temperature is 47°F, and mean annual precipitation is 46 inches. Taxonomically they are Coarse-loamy over sandy or sandy-skeletal, mixed, mesic Dystric Eutrochrepts. A typical pedon is as follows:

> Copake gravelly loam, on a 3% slope in a grass-legume hayfield. (Colors are for moist soil unless otherwise noted.)

- Ap--0 to 9 inches; dark brown (10YR 3/3) gravelly loam, pale brown 10YR 6/3) dry; moderate medium granular structure; very friable; many very fine, common fine, and few medium roots; 12% gravel and 5% cobbles; slightly acid; clear smooth boundary. (6 to 10 inches thick)
- Bw1--9 to 18 inches; dark yellowish brown (10YR 4/6) gravelly loam; weak medium subangular blocky structure; friable; common very fine and fine, and few medium roots; 15% gravel and 5% cobbles; moderately acid; gradual wavy boundary.

- Bw2--18 to 26 inches; dark yellowish brown (10YR 4/4) gravelly loam; weak medium subangular blocky structure; friable; common very fine and fine roots; 15% gravel and 5% cobbles; slightly acid; clear wavy boundary.
- Bw3--26 to 33 inches; light olive brown (2.5Y 5/4) gravelly loam; weak medium subangular blocky structure; friable; few very fine and fine roots; 20% gravel and 10% cobbles; slightly acid; abrupt smooth boundary. (Combined thickness of the Bw horizon is 14 to 34 inches.)
- 2C1--33 to 48 inches; brown (10YR 4/3) very gravelly loamy sand; single grain; loose; few very fine roots in upper part; 40% gravel and 15% cobbles; slightly acid; abrupt smooth boundary. (0 to 20 inches thick)
- 2C2--48 to 62 inches; brown (10YR 4/3) and yellowish brown (10YR 5/4) sand; single grain; loose; 5% fine gravel; neutral; abrupt smooth boundary. (0 to 20 inches thick)
- 2C3--62 to 78 inches; dark yellowish brown (10YR 4/4) loamy sand; single grain; loose; 5% gravel; slight effervescence; mildly alkaline; abrupt smooth boundary. (0 to 20 inches thick)
- 2C4--78 to 99 inches; olive brown (2.5Y 4/4) very gravelly sand; single grain; loose; 45% gravel and 10% cobbles; secondary lime deposits on pebbles; slight effervescence; mildly alkaline.

Thickness of the solum ranges from 20 to 40 inches and typically corresponds to the depth to sand and gravel. Rock fragments range from 5 to 35% by volume in the solum and from 5 to 70% in the substratum. The weighted average in the substratum is more than 20%. Typically, 75% or more of the rock fragments is rounded gravel. Reaction ranges from very strongly acid through neutral in the A horizon, strongly acid through neutral in the B horizon, and slightly acid through moderately alkaline in the 2C horizon. At least one subhorizon of the B ranges from moderately acid through neutral. Depth to carbonates is greater than 40 inches.

The Ap horizon has hue of 7.5YR through 2.5Y, value of 3 through 5, and chroma of 2 through 4. Dry value is 6 or more. Undisturbed pedons have a thin A horizon with value of 2 or 3 and chroma of 1 through 3. The Ap or A horizon is silt loam, loam, or fine sandy loam in the fine-earth fraction. It has weak or moderate granular structure and is friable or very friable.

The Bw horizon has hue of 7.5YR through 5Y, value of 4 through 6, and chroma of 3 through 8. It is silt loam, loam, or fine sandy loam in the fine-earth fraction and has less than 50% fine or coarser sand. The Bw horizon has weak granular or weak subangular blocky structure, or it is massive. Consistence is friable or very friable.

The 2C horizon has hue of 7.5YR through 5Y, value of 3 through 6, and chroma of 2 through 6. Texture ranges from loamy fine sand through coarse sand in the fine-earth fraction.

Copake soils are nearly level to very steep and are on outwash plains, terraces, kames, eskers, and moraines. Slopes range from 0 to 60%. The soils formed in a loamy mantle over sandy and gravelly glaciofluvial materials derived mainly from schist, limestone, gneiss, and dolomite. Mean annual temperature ranges from 45 to 50°F, mean annual precipitation ranges from 36 to 50 inches, and the growing season ranges from 120 to 180 days.

Copake soils are well drained and surface runoff is slow to rapid. Permeability is moderate or moderately rapid in the solum and very rapid in the substratum. Most areas are used for cultivated crops, hay, and pasture. Common crops are silage corn and grass-legume hay. Some areas are wooded or in community development. Common trees are red, white, and black oak, white pine, beech, black birch, sugar maple, and white ash. Gravel commonly is excavated from areas of these soils.

Stockbridge - The Stockbridge series consists of very deep, well drained soils formed in loamy calcareous glacial till on uplands. They are nearly level to very steep soils on till plains, smooth hills, low ridges and drumlodial landforms. Permeability of the Stockbridge soils is moderate in the surface layer and subsoil and moderately slow or slow in the substratum. Mean annual temperature is 48°F, and mean annual precipitation is 45 inches. Taxonomically they are Coarse-loamy, mixed, mesic Dystric Eutrochrepts. A typical pedon is as follows:

Stockbridge loam - cultivated field, 5% slope with a north aspect. (Colors are for moist soil unless otherwise noted.)

- Ap--0 to 10 inches; dark brown (10YR 3/3) loam, light brownish gray (2.5Y 6/2) dry; weak coarse granular structure; friable; many fine and very fine roots; 10% gravel; moderately acid; clear smooth boundary. (6 to 10 inches thick)

- Bw1--10 to 20 inches; olive brown (2.5Y 4/4) loam; weak coarse subangular blocky structure; friable; common fine roots; 10% gravel; neutral; clear wavy boundary.
- Bw2--20 to 28 inches; light olive brown (2.5Y 5/4) loam; weak coarse subangular blocky structure; firm; few fine roots; few weathered limestone fragments in lower part; 10% gravel; neutral; gradual wavy boundary. (Combined thickness of the Bw horizon is 12 to 30 inches)
- C1--28 to 42 inches; olive (5Y 4/3) gravelly loam; weak thick platy structure; firm; few fine roots; many brown (10YR 4/3) weathered limestone fragments and few grayish brown (2.5Y 5/2) streaks; 15% gravel and 2% cobbles; neutral; gradual wavy boundary. (5 to 45 inches thick)
- C2--42 to 48 inches; olive (5Y 4/3) gravelly loam; weak thick platy structure; firm; few brown (10YR 4/3) and light gray (10YR 7/1) streaks from weathered and partially weathered limestone and quartzite fragments; 15% gravel and 2% cobbles; slight effervescence; mildly alkaline; gradual wavy boundary. (0 to 30 inches thick)
- C3--48 to 65 inches; olive (5Y 4/3) gravelly loam; weak thick platy structure; firm; few brown (10YR 4/3) and light gray (10YR 7/1) streaks from weathered and partially weathered limestone and quartzite fragments; 15% gravel and 2% cobbles; slight effervescence; moderately alkaline.

Thickness of the solum ranges from 20 to 40 inches. Depth to bedrock is commonly more than 6 feet. Rock fragments range from 5 to 35% to a depth of 40 inches and up to 50% below 40 inches. Except where the surface layer is stony, the fragments are mostly subrounded pebbles and typically make up 60% or more of the total rock fragments. The soil is strongly acid to neutral in the surface layer, moderately acid to neutral to a depth of 40 inches and moderately acid to moderately alkaline below 40 inches. Depth to carbonates is greater than 40 inches.

The Ap horizon has hue of 10YR or 2.5Y, value of 2 through 4 and chroma of 1- 3. Dry value is 6 or more. Undisturbed pedons have a thin A horizon with value of 2 or 3 and chroma of 1 through 3. The Ap or A horizon is loam, silt loam or very fine sandy loam in the fine earth. It has weak or moderate granular structure and is friable or very friable.

The Bw horizon has hue of 7.5YR through 2.5Y in the upper part and hue of 10YR through 5Y in the lower part. Value is 4 through 6 and chroma is 3 through 6. Texture of the Bw horizon is loam or silt loam in the fine earth. Structure is weak or moderate subangular blocky. Some pedons have subhorizons that are massive. Consistence is friable or firm.

The C horizon has hue of 10YR through 5Y, value of 3 through 6 and chroma of 2 through 4. Some pedons have faint mottles below a depth of 30 inches. Texture is dominantly loam on silt loam in the fine earth, but ranges to fine sandy loam below a depth of 40 inches. The C horizon is platy or massive and firm or very firm.

Stockbridge soils are nearly level to very steep soils on glaciated uplands associated with limestone valleys. They are commonly on drumlins or smooth low hills within valleys or on smooth footslopes that grade into acid glacial till uplands. Slopes range from 0 to 60%, but are dominantly 3 to 25%. Stockbridge soils formed in loamy glacial till derived mainly from limestone, schist and quartzite. Mean annual temperature is 45 to 50°F, mean annual precipitation is 36 to 48 inches and the growing season is 120 to 175 days.

These soils are well drained and surface runoff is medium to rapid. Permeability is moderate in the solum and moderately slow or slow in the substratum. Most areas are cleared and used for silage corn, hay and pasture. A few areas are in orchards or in community development. Common trees in wooded areas are sugar maple, red and white oak, yellow, gray and black birch, beech, white ash, white pine and hemlock.

Table 2-1. Selected Soil Physical and Chemical Characteristics for the Predominant Soil Series Found On-Site at Silo Ridge Resort Community.

Soil Series	Descriptors	Clay %	Bulk density g/cc	Perme-ability in/hr	Available water in/in	pH	Organic matter %
Copake							
0-9"	cn-l, cn-sil,cn-fsl	4-18	1.10-1.40	0.6-6.0	0.10-0.18	4.5-7.3	2.0-5.0
9-33"	cn-l, cn-sil, fsl	4-18	1.25-1.55	0.6-6.0	0.10-0.20	5.1-7.3	-
33-99"	sr, cn-lfs, cn-cos	1-10	1.45-1.70	20	0.01-0.06	6.1-8.4	-
Stockbridge							
0-10"	gr-l, gr-sil, gr-vfsl	5-18	1.00-1.25	0.6-2.0	0.11-0.20	5.1-7.3	2.0-6.0
10-28"	l, sil, gr-l	5-18	1.40-1.65	0.6-2.0	0.12-0.22	5.6-7.3	-
28-42"	gr-l, l, sil	5-18	1.60-1.85	0.06-0.6	0.08-0.18	5.6-7.3	-
42-65"	gr-l, sil, gr-vfsl	5-18	1.60-1.85	0.06-0.6	0.07-0.17	5.6-8.4	-

gr = gravelly fsl = fine sandy loam l=loam cos = consolidated material
sl = sandy loam sil = silt sr = sandy rocky vfsl = very fine sandy loam

2.1.4 Surface Water

The project site is located within the drainage basin of Ten Mile River, which flows southeast into the Housatonic River in Connecticut. Within the project site, there are two perennial streams (Amenia/Cascade Brook and an unnamed stream); seven intermittent streams; eight ponds; and eleven wetlands. A perennial stream is a stream that contains water at all times except during extreme drought, while an intermittent stream ceases to flow occasionally or seasonally. For the location of onsite waterbodies, see Figure 2-1 (DEIS, The Chazen Companies).

Of the two perennial streams onsite, Amenia/Cascade Brook is identified as a NYSDEC Class "C(Ts)" stream. In addition to supporting fisheries and being suitable for non-contact activities, the "Ts" classification indicates that the quality of the water can also support trout populations and trout spawning. Amenia/Cascade Brook enters the project site south of NYS Route 44, traverses along the eastern property boundary and exits the site near the existing site entrance at NYS Route 22. The other perennial stream is an unnamed Class "C" stream that flows through Wetland L/LL located in the east-central portion of the site and eventually flows into Amenia/Cascade Brook at a location off of the project site. All of the intermittent streams onsite are also Class "C" waterbodies (DEIS, The Chazen Companies).

The eight ponds or open water areas total approximately 10.5 acres and are scattered throughout the site. Two of the ponds are located on either side of the entrance driveway off of NYS Route 22 and two are located in the northern portion of the project site. The two largest ponds are located within the golf course and are used as water features and for irrigation storage (DEIS, The Chazen Companies).

There are 11 wetlands located throughout the project site. The largest wetland is approximately 26 acres and is under the jurisdiction of the New York State Department of Environmental Conservation (NYSDEC). The status of each wetland is discussed fully in the DEIS.

2.1.5 Vegetation and Habitat, Wildlife and Special Species of Concern

Based on the results of investigations by The Chazen Companies, it was determined that ten vegetative communities exist on the project site. According to Ecological Communities of New York State, the onsite vegetative communities can be categorized as:

- Successional southern hardwood forest/oak hickory forest;
- Beech-maple mesic forest;
- Chestnut oak forest;
- Shallow emergent marsh;
- Red maple swamp;
- Shrub swamp;.
- Highbush blueberry bog thicket;
- Common reed/purple loosestrife marsh;
- Successional old field; and
- Mowed lawn.

A complete description of each of these vegetative communities can be found in the DEIS.

2.1.5.1. Endangered, Threatened or Rare Species. Correspondence from the U.S. Fish and Wildlife Service (USFWS) dated May 17, 2005, indicated that there are no federally listed or proposed endangered or threatened plant species known to exist in the vicinity of the project site. Correspondence with the NYSDEC dated May 9, 2005 indicated that Hill's pondweed (*Potamogeton hillii*), a State listed threatened species, is documented within NYSDEC Wetland AM-15, a portion of which is located within the project site (DEIS, The Chazen Companies).

No endangered, threatened or rare (ETR) wildlife species were observed within the project site during field visits (DEIS, The Chazen Companies).

A detailed discussion of each of the wildlife at the property is given in the DEIS.

2.1.6 Climate

The following tables (**Tables 2-2 and 2-3**) summarize conditions related to growth of cool-season grasses. These are exceptionally good conditions for maintaining cool-season grasses in the northeastern United States. Cool-season grasses such as creeping bentgrass, perennial ryegrass, Kentucky bluegrass and fine fescues have optimum growth in the temperature range of 60 to 75°F. While adequate rainfall would seem to occur to maintain turfgrass growth, distribution demands that irrigation supplement rainfall in the summer months. This will be highly variable from year-to-year. Irrigation requirements in relation to climatic data is discussed in the section entitled "Water Conservation Management" (Section 7.0).

Table 2-2. Average Precipitation and Snowfall Data over a 55 Year Period from 1948 to 2003 at Millbrook, NY.													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Avg**
Rain	2.80	2.33	3.02	3.34	3.74	3.80	3.67	3.95	3.55	3.18	3.32	3.29	40.91
Snow	13.0	10.7	8.9	1.9	0.2	0	0	0	0	0.1	2.4	9.7	46.9

Table 2-3. Maximum and Minimum Average Temperatures over a 55 Year Period from 1948 to 2003 at Millbrook, NY.													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Avg**
Max	33.8	37.0	45.2	58.1	69.7	77.4	82.2	80.1	72.7	62.5	49.9	38.0	59.0
Min	13.4	15.5	24.3	34.4	44.1	53.0	57.8	56.3	48.5	37.7	29.4	19.1	36.2

2.2 ENVIRONMENTAL CONSIDERATIONS AND REQUIREMENTS

After identifying site conditions, the next steps in the environmental planning and management process were to determine the development parcels' position in the landscape, determine areas that require protection, and design management practices and strategies that would be appropriate to protect sensitive areas.

Management practices and strategies that are addressed in the following sections include: Section 3.0, Construction Management; Section 4.0, Best Management Practices; Section 5.0, Landscaping and Cultural Practices; Section 6.0, Integrated Pest Management with selection of pesticides and fertilizer and restrictions on the use of certain materials in sensitive areas; Section 7.0, Water Conservation Management; Section 8.0, Environmental Monitoring Program, and Section 9.0, Maintenance Facility Management.

2.2.1 Environmental Protection Areas

Environmental areas that require protection are those natural resources that are susceptible to change which can alter ecosystem structure or function, and include areas that exhibit any of the following characteristics: 1) it supports a rare, threatened, or endangered species; 2) it is valuable because of its maturity, density, or diversity of plant or animal species; 3) it is a highly productive habitat; 4) it has a high commercial, economic, or recreational value. Environmental protection is necessary for these areas, as well as those protected by regulations. Environmental protection will be provided to the following areas at the project site:

- Cascade Brook and all other perennial and intermittent streams;
- Wetlands and created ponds;
- Open Space wildlife habitat corridors; and
- The steep forest ridge.

One of the objectives of this plan is to provide the necessary protection for these environmentally sensitive areas by correct design and operation of the golf course and maintenance facility. This is accomplished through Best Management Practices, careful selection of pesticides and fertilizers (in the Integrated Pest Management section), restrictions on the use of certain materials in sensitive areas (i.e., no spray zones, IPM), and proper construction to minimize point and non-point source pollutant input to sensitive areas within the management zones at the course. The diversity of habitat that is found on the site should be maintained, and the placement of the golf holes should occur with a minimum amount of site disturbance.

3.0 CONSTRUCTION MANAGEMENT

Managing site disturbance during clearing and construction is an important step in minimizing ecological damage to the project site. Site disturbance should be minimized, as should earth movement. One of the goals of the project is to allow the golf course and community to reflect natural site conditions, thus extensive reshaping should not need to be conducted.

Minimization of disturbance is important because disturbance upsets ecological systems at the project site which negatively affect biodiversity, stability and overall ecological health of the project site. Even though the project site can be revegetated so that it looks attractive or perhaps as it once did, disturbance alters the ecological function of the area. For example, nutrient recycling is retarded or impaired, and hydrological characteristics are altered. Non-disturbance is positive and should be a priority of the development team. Both site structure and function can be maintained by prudent clearing and construction practices.

The following identifies components of a construction management program for the project. When followed, it should minimize site disturbance and provide the foundation for enhancement of the habitat and wildlife on the property.

1. **Clearly identify all jurisdictional limits.** This may include streams and wetlands; buffer areas; Waters of the United States; wildlife management or protection areas; pipelines or other rights-of-way. Also, the internally designated core natural areas and buffer.

2. **Define protocols and locations for clearing vegetation on the project plans**. These areas include the following: storage area for wood chips; storage area for soil; area for removal of all vegetation between the marked limits; area for removal of all undesirable vegetation; service roads; limits of second phase clearance; and wooded zones, wetlands, buffers, and corridors.

3. **Clearing should be iterative**. For the golf course, the first phase of clearing will generally include the initial center lines and an approximate 100 foot wide strip, with 50 ft cleared on either side of the center line. Phase II includes selective clearing, and will begin only after Phase I has been inspected and approved by the team.

Phase III includes selective removal of remaining vegetation, depending upon the requirements of each golf hole. Throughout the clearing process all specimen trees that have been marked will remain, unless specifically directed by the Project Manager and Audubon International.

4. **Identify clearing lines with uniform, color coding**. Care needs to be taken so that flagging does not fade, causing the different colors to be indistinguishable. These areas are defined by the Project Manager with input from Audubon International, Golf Course Architect, Landscape Architects, and associated team members.

5. **Preserve specimen trees.** Many specimen trees within the area of proposed encroachment should be tagged, based on a combination of the following factors:
   - Form (preference towards unique specimens);
   - Health (preference for those with relatively little evidence of heart rot or other damage);
   - Representation (attempt to ensure any native species which are locally less abundant continue to be represented within the retained stand); and
   - Value for wildlife.

6. **Protect specimen trees**. In many cases, the final determination of what can be preserved successfully will not be made until clearing begins. To ensure the greatest opportunity for the successful retention of these trees, the following practices will be employed:
   - Trees to be retained are to be clearly marked prior to the onset of clearing within an area.
   - Grading, and any vehicular movement is to be kept to an absolute minimum within the drip-line of the base of trees to be preserved. This can be achieved by the placement of temporary construction fencing (orange ‘snow-fence’) around such trees.
   - In transplanting saplings to these areas, an emphasis is placed on mast trees and shrubs (those which produce nuts and acorns), and also fruiting shrubs. These are valuable food sources for a variety of wildlife.

7. **Maintain or restore edge conditions of preservation areas within and adjacent to cleared areas**. Construction activity (actual clearing as well as haul road activity)

should be kept within the specified boundaries, and follow the prescribed pattern of clearing. Tree harvesting is to occur in a selective fashion, with an attempt to maintain as many saplings as possible. Regrading is also to be kept to an absolute minimum within these transitional areas. Where minor regrading is necessary, native topsoil should be re-instated. The above-noted measures are meant to encourage the development of a natural edge. Plantings along these edges should allow for the rapid establishment of appropriate native species.

8. **Identify and follow haul routes at all times.** Unacceptable environmental damage may occur if vehicles (including ATVs and sales staff vehicles) deviate from the haul roads. For example, soil compaction may occur and cause stress to plants; habitat may be destroyed; foraging and nesting sites may be damaged.

9. **Prepare and implement an erosion (wind and water) prevention and sediment control plan.** The plan should be used each time the golf course or community undergoes any type of construction or re-construction.

10. **Identify areas for soil storage and burn/rubbish piles**. Service roads to the storage areas should be identified.

11. **Respect all wildlife as an important part of the ecosystem.**
    - Avoid harming wildlife, both plants and animals.
    - Call for help in removing animals you are not comfortable with.

12. **No littering.** Contain trash and remove it to an approved disposal site.

13. **Do not wash out concrete equipment in drainage ditches or storm drains.** Conduct concrete wash out in contained areas, allow materials to harden, and remove them to an approved disposal site.

14. **Develop an education program for construction workers.** A 15 to 20 minute session with the contractor, including the supervisors and operators, provides a common vision for the property. An effective way to present this is with a brochure. It should highlight (by ‘bulleted’ points) the major protection areas, and what the contractors should and should not do in particular areas.

15. **Direct surface and subsurface drainage from greens over vegetative buffers, through vegetative swales, or into sumps, or similar devices before discharging to water.** The use of these devices protect surface waters (i.e., protect them from unwanted chemical inputs). Many different means to this end exist, we want to find the means that make the most sense for the specific property.

16. **Route drainage from fairways and roadways away from direct input to surface waters.** This is to protect the resource from unwanted inputs, and it also protects the property owner. The use of vegetated swales to direct runoff waters, or buffers constructed from native plant materials, or artificial wetlands for secondary treatment are effective in minimizing the effect from the direct input of drainage waters.

17. **Establish the Natural Resource Management Center footprint**. The location should be maximized for efficiency of operations; safe operations of equipment; correct siting of washpads, pesticide storage and mixing areas, fuel islands, equipment maintenance, etc. to minimize the potential for negative incidents; and ease of deliveries.

18. **Build bridge crossings so that the impact to the environment is minimized during construction.** Erosion barriers described in the Storm Water Pollution Prevention Plan (silt fence, compost filter socks, and sedimentation ponds where needed) will be in place for bridge crossings. Bridge construction will be conducted so that construction equipment does not enter a stream, wetland or other water body; rather, only the location of the footings will disturb the bottom areas. The bridges are built with the bridge itself as the work platform. Clearing should be by hand to avoid damaging the wetland with heavy equipment.

19. **Clearing for the cart path should follow the guidelines for clearing of the golf course**. The cart path should be routed to avoid sensitive areas and areas that have been identified for protection (e.g., specimen trees). Erosion barriers described in the Storm Water Pollution Prevention Plan (e.g., compost filter sock, silt fence, and sedimentation ponds where needed) will be in place for construction. Construction will be conducted so that construction equipment does not enter sensitive areas, or disturb areas that are otherwise undisturbed.

20. **Establish a nursery on the site.** Natural vegetation that is removed from the site should be appropriately potted and held in the nursery until it is time to revegetate the property. The nursery needs to be in an area that has electricity and water, and that is convenient to revegetation locations.

21. **Follow guidelines for on-site fuel storage.** Fuel tanks that are temporarily stored on site must be properly located and protected to minimize the possibility of spills and environmental impacts.
    - Fuel or chemical storage tanks should not be placed within 50 feet of any environmentally sensitive areas. These areas include lakes, creeks, wetlands, stormwater treatment structures, etc.
    - All storage tanks are required to have secondary containment. At a minimum, an earthen berm must be constructed around the tank. This berm must be sized to contain at least a third of the total tank volume in case of a tank rupture or equipment failure.

22. **In case of a fuel or chemical spill, follow appropriate response procedures for containment and cleanup.**
    - Report spills to on-site supervisor.
    - In the case of a fuel or chemical spill, immediately contact appropriate staff to arrange containment and cleanup.
    - If possible, collect information such as type of fuel or chemical, estimated volume of spill, and any other hazardous/safety information.

4.0 BEST MANAGEMENT PRACTICES TO PROTECT ENVIRONMENTALLY SENSITIVE AREAS

Best Management Practices are approaches to landscape management which act to prevent the movement of stormwater, sediments, and chemicals (e.g., nutrients or pesticides) into environmentally sensitive areas such as wetlands or from migrating downward into groundwater. Through the use of Best Management Practices (BMPs), developmental impacts from Silo Ridge Resort Community to the environment can be minimized.

The process of managing the property in an environmentally sensitive and responsible manner involves the following:

1. **Establishing Special Management Zones.** Special Management Zones are defined as areas that have distinct management practices that coincide with their position in the watershed, and are based on the analysis of resources and habitat protection requirements (See Section 4.1 for details).

2. **Use Natural Systems Engineering.** Natural Systems Engineering is an approach to stormwater management that maximizes the use of natural systems to treat water. This type of stormwater management is very effective because it increases the lag time of stormwater runoff and therefore reduces the quantity of water in channels at any given time. Natural drainage systems have proved effective in significantly reducing pollutant loads in runoff, with reductions of 59 to 91%. When properly designed, open and natural drainage systems also can provide valuable habitat areas. The more natural the drainage system, the more valuable it will be for wildlife and water quality. Vegetated swales, stormwater ponds, marshes, and wetlands can serve as habitat for many creatures, including wetland birds and other waterfowl.

3. **Establish Best Management Practices 'Trains' for maximum environmental protection.** The most effective way to protect surface water and groundwater is by using a comprehensive systems approach that includes integration of preventive practices and structural controls (Smart & Peacock 2002). Preventive measures include nonstructural practices that minimize or prevent the generation of runoff and the contamination of runoff by pollutants; for example, using seeded compost

"blankets" and organic fertilizers. Structural controls are capital improvements designed to remove, filter, detain, or reroute potential contaminants carried in surface water. Because water is the primary movement mechanism for contaminants, protection of water resources also provides protection for sensitive areas and species.

This comprehensive systems approach, used throughout the project emphasizes optimum site planning and the use of natural drainage systems, and is considered a "Best Management Practices (BMPs) Train" in which the individual BMPs are considered the cars. The more BMPs incorporated into the system the better the performance of the treatment train. The first "cars" include preventative BMPs to minimize generation of runoff (e.g., irrigation management, pesticide selection) and the final cars generally include structural controls (See Section 4.2 for details).

4.1 BUFFERS AND SPECIAL MANAGEMENT ZONES AT SILO RIDGE RESORT COMMUNITY

The process of managing in the project in an environmentally sensitive and responsible manner involves establishing buffers and management zones throughout the golf course and community.

4.1.1 Buffers

Buffers at the community have been established voluntarily and by regulation, and are dependent on the water body.

- ***Freshwater wetland*** - the wetland in the southeast corner of the property is regulated by NYSDEC. There is a 100-ft buffer around the wetland.

- ***Regulated Streams*** - One stream, Cascade Brook, in the northeast corner of the site is regulated. There is a 50-foot buffer on either side of the stream.

- ***Steep Ridge Area and Vernal Pools -*** The steep ridge area, including the vernal pools, is to be managed as a conservation area with no use of chemicals or development occurring within the area.

- ***Other water bodies*** - Where there are no regulations governing buffer widths around water bodies, there will be Special Management Zones that will include a 25 foot no-spray buffer and a 25 foot limited spray buffer. These are described in detail below under Section 4.1.2, Special Management Zones.

- ***Spring seep at the toe of the slope*** - A protective buffer will be in place.

4.1.2 Special Management Zones

Special management zones are defined as areas on the site that have distinct management practices that coincide with their position in the watershed, and are based on the drainage basin analyses conducted for the watershed. Special management zones work hand-in-hand with establishment of Best Management Practices and Integrated Pest Management. Special management zones are described below and shown in **Figure 4-1**:

4.1.2.1. ***Management Zone A - No Spray Zones***. No spray zones are established around each water body 25 feet landward from normal water elevation (**Figure 4-2**). No pesticides will be used in these areas, and organic fertilizers only will be used.

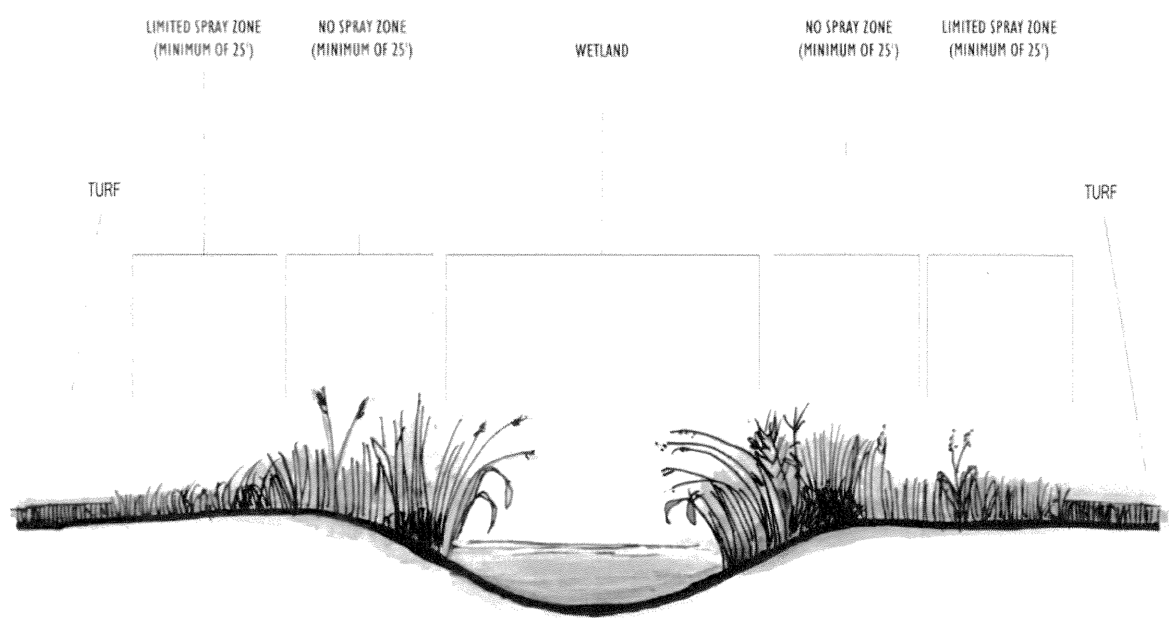
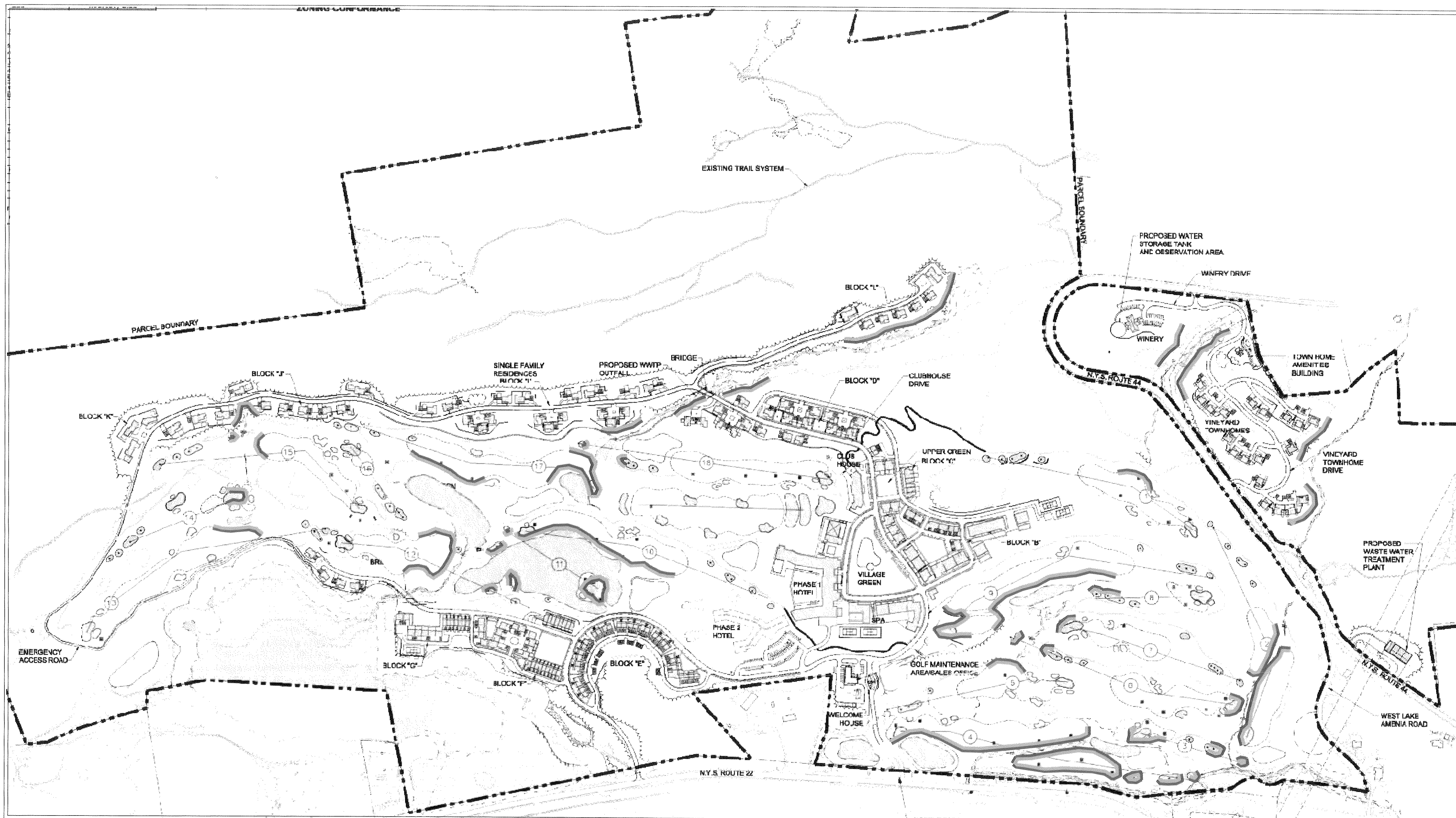


Figure 4-2. Illustration of Special Management Zones



AUDUBON INTERNATIONAL

Figure 4-1. Special Management Zones at Silo Ridge Resort Community - Traditional Neighborhood Alternative Site Plan

4.1.2.2. ***Management Zone B – Limited Spray Zones.*** Limited spray zones are established around each water body, beginning 25 feet landward from normal water elevation and extending 50 feet landward from normal water elevation. A limited set of pesticides may be used in this zone, and organic fertilizers or 'spoon feeding' will be used. Pesticides that can be used are identified in **Table 6-8.** Additionally, a shroud will be used on spray equipment to avoid drift.

4.1.2.3. ***Management Zone C – Bridge Crossings.*** Bridge Crossings are specialized management zones for the construction of bridges associated with the cart path. Bridge construction will be conducted so that construction equipment does not enter a stream. The bridges are to be built on piles with the bridge itself serving as the work platform.

4.2 BEST MANAGEMENT PRACTICES TO PROTECT ENVIRONMENTALLY SENSITIVE AREAS

Best Management Practices are those drainage facilities or cultural approaches to management which act to prevent the movement of sediments, nutrients or pesticides into environmentally sensitive areas. Through the use of Best Management Practices (BMPs) and management zones, turfgrass management can coexist in harmony within a natural setting.

The goals of BMPs are as follows: 1) to reduce the off-site transport of sediment, nutrients and pesticides; 2) to control the rate, method and type of chemicals being applied; and 3) to reduce the total chemical load by use of Integrated Pest Management.

The quantity and quality of water moving from the project can be protected by appropriate watershed controls and management practices. Because water is the primary movement mechanism for contaminants, protection of water resources also provides protection for sensitive areas and species. Surface water is the focus of watershed protection because recent research on the environmental impact of nutrients and pesticides applied to golf courses has indicated that for the majority of the acreage under turf management, surface runoff is a much greater concern than leaching. While leaching of certain materials does occur at low levels and under specific environmental and climatic conditions, more materials are transported in surface runoff than through leaching (USGA Turfgrass and Environmental Research Summary, 1995- 2005).

BMPs include preventive and structural controls which constitute the building blocks of the watershed protection program. Preventative measures include nonstructural practices that minimize or prevent the generation of runoff and the contamination of runoff by pollutants; for example, using organic fertilizers. Structural controls are capital improvements designed to remove, filter, detain, or reroute potential contaminants carried in surface water. The most effective way to manage surface water is by using a comprehensive systems approach that includes integration of preventative practices and structural controls (Eaker, 1994).

This comprehensive systems approach, used throughout the project stresses optimum site planning and the use of natural drainage systems. This type of a stormwater management system is considered a "Best Management Practices (BMPs) Train" in which the individual BMPs are considered the cars. In most cases, the more BMPs incorporated into the system the better the performance of the treatment train (**Figure 4-3**). The first cars might include BMPs to minimize generation of runoff (e.g., irrigation management) and pollutants (e.g., IPM) and the final car could include retention in a pond (Eaker, 1994).

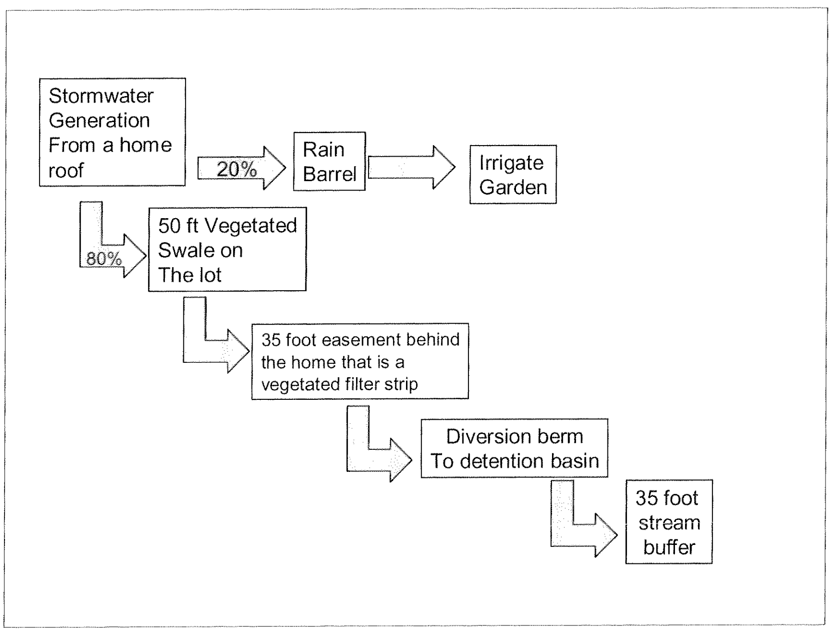


Figure 4-3. An example of a BMP train, showing the multiple steps used to effectively treat stormwater.

4.2.1 Source Prevention BMPs for Silo Ridge Resort Community

Preventative measures are considered the 'first line of defense' in an integrated storm water management system. The preventative measures used at the project include land use controls and source prevention practices and include use of resistant crop varieties, cultural control of pests, proper irrigation water management, good nutrient management techniques (which will include: soil testing and plant analysis to determine fertilizer requirements; proper timing and placement of fertilizers; and the use of slow release fertilizers), biological control of pests, risk analysis for pesticide selection, rotation of pesticides, correct application of pesticides, and correct pesticide container disposal.

Source Prevention BMPs are briefly described below:

> ***Resistant Turf Varieties*** - use of plant varieties that are resistant to insects, nematodes, diseases, etc., in order to reduce pesticide use. Care has been taken in the selection of the turfgrass species and cultivars best adapted for the edaphic and climatic conditions of this site.
>
> ***Cultural Control of Pests*** - using cultural practices to minimize the need for pesticides. Details of the proper cultural practices including mowing, fertilization, irrigation, and cultivation practices are included in this plan to take advantage of every aspect of cultural control of pest problems.
>
> ***Proper Irrigation Water Management*** - determining and controlling the rate, amount, and timing of irrigation water application in order to minimize soil erosion, runoff, and fertilizer and pesticide movement. The irrigation system will be designed to have an average application rate below the infiltration capacity of the soil so that no surface pooling will occur and maximum efficiency of water percolation will occur. All irrigation will be based on a water balance method which takes into account plant water use, environmental conditions, soil drainage and natural rainfall (See Section 7.0, 'Water Conservation Management').
>
> ***Soil Testing and Plant Analysis*** - testing is used to determine the amount of fertilizer that is needed by the plant so that over fertilization and subsequent losses of nutrients is avoided. All initial fertilizer recommendations will be based on soil testing. All subsequent fertilization programs will be finalized based on an analysis of soil samples and tissue analyses.
>
> ***Timing and Placement of Fertilizers*** - timing and placement of fertilizers for maximum utilization by plants and minimum leaching or movement by surface runoff. Every

precaution in fertilization timing, including scheduling to avoid potential rainfall which could produce runoff and/or leaching, verification of application rate through proper calibration of equipment, and choice of materials will be employed by the golf course superintendent and Natural Resources Manager.

Slow Release Fertilizer - applying slow release fertilizers to minimize nitrogen losses from soils prone to leaching. All fertilization programs include slow release fertilizers.

Biological Control of Pests - use of natural enemies either native or introduced as part of an Integrated Pest Management (IPM) program which can reduce the use of pesticides. Biological controls which provide effective pest management for turfgrasses are limited; however, they will be implemented as necessary and practical.

Pesticide Selection - using a risk-based process to select pesticides which are less toxic, persistent, soluble and volatile whenever feasible. All pesticides selected for use on this site have been analyzed for their potential to be sources of nonpoint pollution. Only materials which have a reasonable margin of safety have been included in the recommended list.

Rotation of Pesticides - rotating pesticides to avoid developing pest populations which are resistant to specific chemicals or classes of chemicals.

Correct Application of Pesticides - spraying when conditions for drift are minimal. Avoiding application when heavy rain is forecast. Irrigating with appropriate volumes of water when specified. Using shrouded sprayers around sensitive areas. All of these conditions as well as proper calibration of equipment will be scrutinized at every pesticide application by the golf course superintendent.

Correct Pesticide Container Disposal - following accepted methods for pesticide container disposal. This will be a routine practice under the supervision of the golf course superintendent.

4.2.2 Land Use Control BMPs for Silo Ridge Resort Community

All drainage will be treated with land use control BMPs including, for example, subsurface drainage, land absorption areas (vegetated filter strips), grassed waterway or outlet, and critical area plantings briefly described below:

Subsurface Drainage - collect infiltrated surface water from greens and drain into vegetative areas for filtration will help control the potential loss of nutrients and pesticides from the golf course.

Land Absorption Area (vegetated filter strips) - providing an adequate land absorption area for drainage or runoff filtration so that soil and plants absorb nutrients. Surface drainage on the golf course and in the community is filtered through turf or grasses. All drainage from impervious surfaces is directed into areas which have vegetative cover.

Paired Wet Retention Ponds - detention with associated filtration through plant material within the basin prior to discharge is used to reduce runoff quantity and nutrient and pesticide discharge. See engineering design for the types of detention and retention practices that will be used at the project.

Grassed Waterway or Outlet - a natural or constructed waterway or outlet maintained with vegetative cover in order to prevent soil erosion and filter nutrients. Dry ponds, roadside swales and golf course fairways serve in this capacity.

Critical Area Planting - planting vegetation to stabilize the soil and reduce erosion and runoff. Turfgrasses are the premium choice of plants for this purpose.

4.2.2.1. Vegetative practices.

Vegetative Filtration. Common examples of vegetative filters used throughout the project are vegetated filter strips and swales. Vegetative filters act as natural biofilters to reduce storm water flow and pollutant load, and turf areas are effective filters. Turf uses the natural processes of infiltration, filtration and biological uptake to reduce flows and pollutant loadings. Vegetated filter strips remove sediment and attached chemicals, organic material, trace metals, and nutrients (nitrogen and phosphorus). Sediment removal rates are generally greater than 70% and nutrient removal is typically greater than 50% (USEPA, 1993). The length of the vegetated filter strip is an important variable influencing effectiveness because contact time between runoff and vegetation in the filter strip increases with increasing filter strip length. Some sources suggest a minimum of 50 ft of vegetative buffer for maximum effectiveness (Dillaha et al., 1989), and other studies have shown that 15 to 25 feet of turf is an effective filter (e.g. Doyle et al., 1977; Baird et al., 1996). Effectiveness of vegetative measures is shown in **Figure 4-4** and given in the **Table 4-1,** and is discussed in more detail in Section 4.3.

Grassed Swales. Vegetated swales will be used to permit filtering and infiltration of storm water. The grasses for these swales are to be of the water tolerant and erosion resistant type. These types of swales are to be used in gentle slopes where slower velocities will enhance the filtering and infiltration processes. Swales are effective in routing water to maximize contact time of water and vegetation. An example is the routing of water from the under-drains of greens. Filtration can be greatly increased by carefully choosing the route of water from the under-drain. If space is limited, drainage water could be directed to flow along a path that maximizes the distance of contact with vegetation, rather than be directly routed to the lowest point. The effectiveness of swales in reducing flows and pollutants is similar to filter strips.

Vegetated Filter Strips. Filter strips are manmade or naturally occurring flat areas which are established at the perimeter of the disturbed or impervious areas to intercept runoff as sheet flow and remove particulates and contaminants. Either grassed or wooded (forested) areas can function as filter strips. The project shall include dense growing turf or grasses composed of the fringe mix filter strips which will be incorporated into the golf course "rough" areas and the perimeter of the impervious areas. In order to be an effective BMP, filter strips should have a minimum width of 25 feet, with slopes not to exceed 15%.

Maintenance of vegetative filters at the project requires management to achieve dense, hearty vegetation. When turf is used as the filtration medium, cultural activities will focus on producing healthy turf with a minimum of maintenance activities. The height of the turf should be allowed to grow to the highest end of the optimum range for more effective filtration, fertilization in these areas will occur twice per year (see **Sections 5.3.2 and 6.2.2**).

4.3 EFFECTIVENESS OF BMPS

The effectiveness of pollutant removal is a function of three interrelated factors: 1) the removal mechanisms used by the BMP, which include physical, chemical, and biological processes; 2) the fraction of runoff treated by the BMP; and 3) the nature of the pollutant being removed. Thus, an effective BMP train is one that treats 100% of runoff by physical, chemical, and biological processes. **Figure 4-4 and Table 4-1** show relative removal efficiencies of infiltration basins, vegetated filter strips, grass swales, wet ponds, and storm water wetlands for four variables (total suspended solids, total phosphorus, total nitrogen, and chemical oxygen demand). By including as many removal mechanisms as possible the probability of success for removal of a particular pollutant is increased.

BMPs that utilize settling and filtering processes are relatively effective at removing sediment and pollutants that are bound to sediment particles (**Figure 4-4**). Turf buffers are very effective filters that allow drainage of water from the course and, at the same time, effective filtering to improve water quality. Turf density, leaf texture and canopy height are physical factors which restrain soil erosion and sediment loss by dissipating impact energy from rain and irrigation water droplets providing a resistance to surface movement of water over turf. Ponds and infiltration BMPs can achieve 60 to 100% removal efficiencies for sediment. Infiltration BMPs are capable of similar removal efficiencies for sediment, but are subject to clogging if sediment inputs are excessive. Wet ponds and extended-detention ponds with shallow marshes have a moderate to high capability for removing both soluble and particulate pollutants because they utilize settling and biological uptake.

4.3.1 Turfgrass Used as a Vegetative Filter

One of the most effective BMPs for protection of surface water is use of turf as a vegetative filter in swales and filter strips. Areas of turfgrass are extremely effective in reducing soil losses compared to other cropping systems. In a comparison of soil loss from conventional agriculture with soil loss from turf, measured soil loss from tobacco production (4210 lbs/acre) was 842 times higher than from turf areas (5 lbs/acre) even with a slope of 16% on a silt loam soil (Gross et al., 1987; Gross et al., 1990). Where polluted runoff from agricultural areas has occurred, establishment of turf buffer strips of only 15 feet have been shown to improve water quality (Doyle et al., 1977).

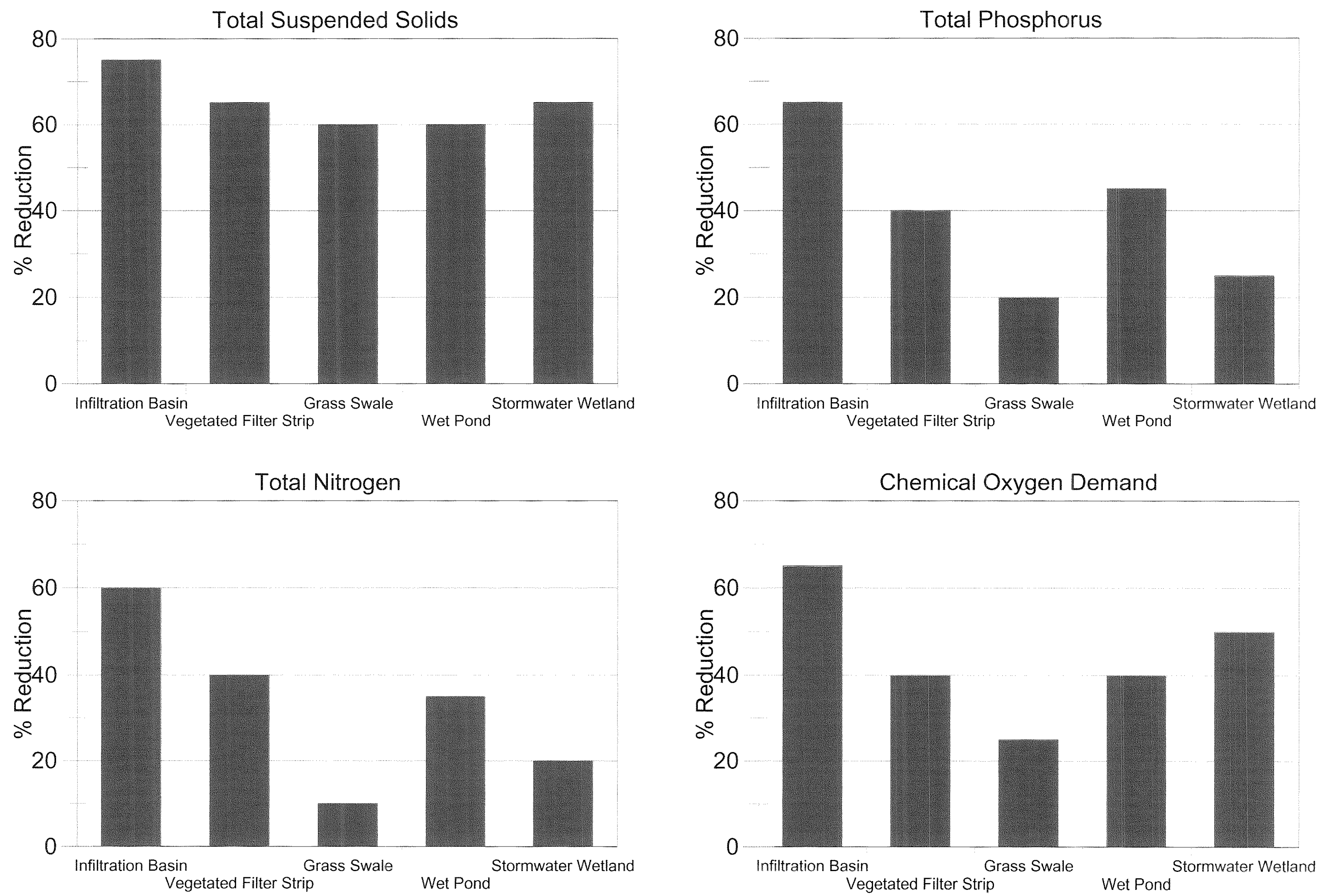


Figure 4-4. Relative Effectiveness of Best Management Practices to Protect Surface Waters.
(U.S. Environmental Protection Agency, *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*, 1993)

Table 4-1. Storm Water Pollutant Removal Efficiencies, Urban BMP Designs†						
BMP esign	otal Sus en e Se iment SS	otal P os orous P	otal itrogen	inc n	ea P	Biological gen eman B
E tended Detention Pond						
Design 2	75%	50%	35%	55%	55%	40%
Design 3	80%	70%	55%	75%	75%	50%
Wet Pond						
Design 4	55%	35%	25%	25%	45%	25%
Design 5	75%	55%	40%	40%	70%	40%
Water uality Basin						
Design 7	70%	50%	50%	50%	50%	70%
Filter Strip						
Design 11	40%	20%	20%	40%	40%	20%
Design 12	90%	50%	50%	90%	90%	70%
Design 12A	80%	40%	40%	80%	80%	60%
rassed Swale						
Design 13	20%	20%	20%	10%	10%	20%
Design 14	30%	30%	30%	20%	20%	30%

Extended Detention Basins

Design 2: "First flush" runoff volume produced by 1.0 inch, detained for 24 hours.

Design 3: Runoff volume produced by 1.0 inch storm detained for 24 hours or more with shallow marsh added in bottom stages.

Wet Pond

Design 4: Permanent pool equal to 0.5 inches of runoff per watershed ac.

Design 5: Permanent pool equal to 2.5 times the volume of runoff from the mean storm (0.5 inches).

Water Quality Basin

Design 7: Infiltration basin which filtrates "first flush" of 0.5 inch runoff/impervious acre.

Filter Strips

Design 11: 25 to 50 foot turf strip.

Design 12: 100 foot wooded strip.

Design 12A: 25 to 50 foot wooded strip.

Grassed Swale

Design 13: High slopes with check dams.

Design 14: Low gradient (less than 5%) with check dam.

† Sources: Schueler 1987 and NYSDEC, 1993.

Recent studies at Oklahoma State University have shown that turfgrass buffers of 16 ft effectively reduce concentrations of chemicals in runoff waters (Baird et al., 1996). Wauchope (1978) noted that in cases where water quality has declined due to agricultural practices leading to loss of nutrients and erosion, grass buffer strips placed between treated fields and surface waters have significantly reduced the problem. This is related to the architecture of the turf canopy and the fibrous nature of the turf root system.

Turf density, leaf texture and canopy height are physical factors which restrain soil erosion and sediment loss by dissipating impact energy from rain and irrigation water droplets providing a resistance to surface movement of water over turf. Turfgrasses have an extensive fibrous root system with 80% of the root mass found in the upper 2 inches of the soil profile (Welterlen et al., 1989). Therefore it is a combination of the turf canopy and root mass which have a strong soil stabilizing effect.

4.4 Maintenance of Best Management Practices Facilities

Periodic long-term inspection and maintenance of the proposed BMPs for the project will be essential to ensure that they will function as designed. The superintendent and maintenance crew will be responsible for the inspection and maintenance of the BMPs.

4.4.1 Wet Detention Ponds

Inspections. Wet ponds will be inspected periodically for the first few months after construction and on an annual basis thereafter. Wet ponds will be inspected following major storm events.

Inspection priorities include checking the embankment for subsidence, erosion, cracking, tree growth, and the presence of burrowing animals such as muskrats, all of which can cause an impoundment to fail. Also, inspect the condition of the emergency spillway and drain; the accumulation of sediment; clogging of the barrel and outlet; the adequacy of erosion control measures in the contributory drainage; and the adequacy of channel erosion control measures at the outlet.

Mowing. Establishment of trees and (woody) shrubs will be prevented on embankments, emergency spillways, and buffer areas through periodic mowing (at least twice a year). More frequent mowing may be desirable if the retention pond is in a residential area or if it is to be used for recreational purposes.

Debris and Litter Removal. Debris and litter will be removed periodically from the pond and surrounding buffer areas. Debris around the riser and outlet, if installed, will be removed as necessary to prevent clogging.

Nuisance Control. In some instances, insects, weeds, odors and algae may become a problem or nuisance in wet ponds. Problems such as these are rare except under extremely dry weather conditions. Even under dry weather, nuisance conditions such as these are best controlled with biological controls rather than application of chemicals. Biological control usually involves the introduction of minnows and other fish to prey on insect larvae in the wet pond.

Structural Repairs and Replacement (if part of the wet detention pond). Various inlet/outlet devices and standpipe or riser structures will deteriorate with time and may have to be replaced. Indications are that concrete barrels and risers will last from 50 to 75 years or longer, while corrugated steel pipes may have a useful life of from 15 to 25 years (NYSDEC, 1993).

Erosion Control. Eroding soils in drainage areas that are contributory to retention/wet ponds will be stabilized immediately with vegetative practices or other erosion control practices. Soil may slump and erode from buffer areas surrounding wet ponds, side-slopes, the emergency spillway, and wet pond impoundments or embankment. When this occurs, the problem area may have to be regraded and vegetation may have to be re-established to stabilize the soil. If dislodged by stormwater discharges, rip-rap protecting the channel downstream from an outlet structure may have to be repositioned and stabilized.

Sediment Removal. The frequency of sediment removal from a wet pond will vary on the basis of watershed stability. Accumulated sediment in a wet pond will be removed when 10% of the pond capacity has been lost due to sedimentation. This normally will require a clean-out cycle of ten to twenty years. Installation of and periodic removal of sediment from a forebay are cost-effective ways of extending the clean-out cycle.

4.4.2 rassed Swales

Swale maintenance is largely aimed at keeping the grass cover dense and vigorous (see **Sections 5.3 and 6.2**). This primarily involves periodic mowing, occasional spot reseeding, and weed control. Watering may also be necessary in times of drought, particularly in the first few months after establishment. In addition, excessive sediment buildup behind check dams will be removed as necessary.

4.4.3 Vegetative Filter Strips

Maintenance required for a filter strip depends on whether or not natural vegetative succession is allowed to proceed. Maintenance tasks and costs are both sharply reduced for these "natural" filter strips. However, corrective maintenance is still needed around the edge of the strip to prevent concentrated flows from forming.

Shorter filter strips must be managed as a lawn or short grass meadow. These strips will be mowed at least 2-3 times a year to suppress weeds and interrupt natural succession (see **Sections 5.3.1 and 6.2.1**). Periodic spot repairs, watering and fertilization may be required to maintain a dense, vigorous growth of vegetation. Accumulated sediments deposited near the top of the strip will need to be manually removed over time to keep the original grade.

At a minimum, all filter strips will be inspected on an annual basis. Strips will be examined for damage by foot or vehicular traffic, encroachment, gully erosion, density of vegetation, and evidence of concentrated flows through or around the strip. Extra strip maintenance must be devoted in the first few months and years to make sure the strip becomes adequately established. This may involve extra watering, fertilization and reseeding. (Schueler, 1987).

.0 INTEGRATED PEST MANAGEMENT FOR T E COMMUNITY

The following section refers to the non-golf course areas of Silo Ridge Resort Community.

5.1 NATIVE LANDSCAPES

Audubon International believes that sustainable resource management requires the use of native and naturalized plants. The following provides a more detailed discussion on native and invasive plant species and the benefits of incorporating native plants into landscaping practices.

5.1.1 Native and Invasive Species

The Audubon International Signature Program encourages the use of native plants when revegetating disturbed areas and in landscaping plans. AI also prohibits the introduction of an invasive species to the property in the Signature Program. Because a plant occurs on the property does not mean it is native to the region, the State, much less the United States. Thus, the following provides a brief definition of native, exotic, naturalized, and invasive exotic species and some pertinent information on the problems caused by invasive plant species and the benefits of using native species. This information was gathered from a variety of sources - primarily websites for the National Invasive Species Council (www.Invasivespeciesinfo.gov), the Florida Exotic Pest Plant Council (NCEPPC) (www.fleppc.org), Southeast Exotic Pest Plant council (http://www.se-eppc.org), and Natural Resources Conservation Service (http://plants.usda.gov/cgi_bin/topics.cgi?earl=noxious.cgi).

Native is a species whose natural range included the development area at the time of European contact (FLEPPC, 2005 and NPSNM, 2005).

- An exotic is a species introduced accidently or purposely to an area outside of its native range (FLEPPC, 2005).

- A naturalized exotic is a species that sustains itself outside of cultivation, outside of its native range (FLEPPC, 2005).

- An invasive exotic is an exotic species that has naturalized and is expanding on its own in natural communities and disrupting naturally occurring native communities. Its introduction can cause economic as well as environmental harm (FLEPPC, 2005, NPSNM, 2005, and NISC, 2005).

Not all exotic or naturalized species become invasive. However, those that do can cause substantial environmental and economic harm. A few points for consideration include:

- Invasive species are harmful in that they decrease biodiversity, cause a reduction of habitat and food sources for natives insect and animal species, and cause changes to natural ecosystems.

- One study estimates that the total costs of invasive species in the United States amount to more than $100 billion each year (Pimentel et al., 1999) (www.Invasivespeciesinfo.gov).

- Invasive species impact nearly half of the species currently listed as Threatened or Endangered under the U.S. Federal Endangered Species Act (www.Invasivespeciesinfo.gov).

It is important to recognize the benefits of using native plant species. These often include most of the following:

- Requires less water once established
- More resistant to pests and disease because plants co-evolved with local pests
- Provides food and cover for native wildlife species
- Requires less maintenance, fertilizers, pesticides
- Adapted to climate and soil conditions
- Protect water quality by preventing erosion
- Promotes biodiversity
- Provides animals with the same food and cover plants they evolved with

Many resources are available to identify whether a plant species is native to a region and whether a native plant is commercially available. Two good resources are the USDA's National Plant Data Center (www.plants.usda.gov) and Audubon International's Sustainable Communities Campaign: Surf Your Region & Surf For Native Plants website (http://www.auduboncommunities.org/regional/search/). Many states have a Native Plant Society that can also be a good resource for locating commercially available native plants. Local extension agents throughout the state or a university such as Cornell may be helpful as well.

In addition, sustainable community principles urge the introduction of as many native species as possible into a restoration area and in landscape plans. This maximizes plant and, subsequently, animal biodiversity. A list of native plant species is provided in **Appendix V**. It is recommended that they be used as much as possible in all restoration areas of the project. Some may not be available commercially, but local seed collectors will be able to provide small amounts of seed for some species in most years. A variety of native plants are available at nurseries for use in landscaping homes as well as around common areas.

Native wildflower seed mixes are available in the region. These mixes could be used instead of turfgrasses in areas that must be cleared and then re-vegetated. These areas could include roadways, parks, and open space.

For those areas of native vegetation that do need to be disturbed such as roadways, it is recommended that key plants be saved for re-use whenever an area is scheduled for major grading or shaping. Key species that can be re-used include any of the native tree and shrub species that transplant well. This could be placed in an area slated for development in a later phase and has access to water for irrigation. Selected specimens can be maintained until it is the appropriate time for transplanting.

5.1.2 Invasive Species Management

Control or management of invasive plant species could include a number of options as suggested by Geum, 2006 and a variety of other sources. However, a management approach should look at the entire system rather than just focusing on eradication of a single species to be most effective. The extent of infestation of one or more species will also dictate what management activity may be most appropriate for a site. Early detection and a quick response is the most effective way to control encroachment of invasive species.

Small-scale infestations usually have a greater chance for success. Removal or pulling of younger plants prior to seeding is effective in addition to other tools such as cutting and use of nonselective herbicides.

Management of any medium to large-scale infestations of invasive plants usually requires a long-term approach to management as seeds from these species will remain viable in the soils for some time. Also, some of the species may be disturbance adapted species so disturbance of soil and vegetation should be minimized so as to not encourage further spread of this species (http://www.ipm.msu.edu/garlicMge.htm, 2006). Some of the more commonly used herbicides to control undesirable species include glyphosate, triclopyr and imazapyr (See Section 5.4 for risk assessment information). Additionally, once invasive plants have been removed, some areas will require plantings of native species so as to reduce the chances of the invasive species from reestablishing.

The Nature Conservancy (TNC) has prepared Element Stewardship Abstracts that compile a host of information related to invasive plant species including management options (http://tncweeds.ucdavis.edu/esadocs.html). These abstracts, referenced by individual author, are a compilation of available current management related information from many sources, including literature and researchers/managers, on species and communities that are most important to protect or control. These abstracts are available free via the internet to benefit all land managers and the website also includes photos of the various species. The reference for each of these primary invasive species known to occur on the project site are provided below with a brief description of the most effective management activities for that species. Geum, 2006 also provides a detailed description of recommended management approaches for removal of these various species. Their recommendations are based on several references including the TNC's Element Stewardship Abstracts. These two resources provide a good summary of the management options for these species. Those in the northern US which are most common include the following:

- **Purple loosestrife**: herbicide applications and biological control have been successful. For smaller-scale infestations, the plants are cut and the material

removed prior to flowering in July.
http://tncweeds.ucdavis.edu/esadocs/documnts/lythsal.pdf;
http://tncweeds.ucdavis.edu/moredocs/lytsa01.pdf

- **Japanese barberry**: Mechanical removal is effective and minimally intrusive. Glyphosate may be needed when physical removal of the plant is difficult.
  http://tncweeds.ucdavis.edu/moredocs/berthu01.pdf

- **Multi-flora rose**: Cutting followed by herbicide application such as glyphosate or 2,4-D seems to be the most effective management tool.
  http://tncweeds.ucdavis.edu/esadocs/documnts/rosamul.pdf

Cattails, though native, will require some management as they spread and out-compete other native wetlands species. The idea is not to eradicate cattails because they provide habitat for a variety of species such as red-winged blackbirds, however, managing the cattails so as to maintain vegetative biodiversity in the project wetlands is important.

The above herbicides have been approved for use in the State of New York, and have passed Audubon International's risk assessment as outlined in Appendix I.

5.2 TURFGRASS SELECTION

For the project, there are several choices for the turfgrass areas. Kentucky bluegrass, perennial ryegrass, tall fescue, fine-leaf fescue and bentgrasses are the most commonly grown species in New York. Cornell University's Cooperative Extension Service recommends three mixtures of grasses for turf use depending on site conditions as follows:

- ***Sunny, medium- to high-maintenance lawn:***
  65% Kentucky bluegrass blend (several different varieties)
  15% perennial ryegrass
  20% fine fescue
  Seed at 3 to 4 pounds per 1,000 square feet.

- ***Sunny, low-maintenance lawn:***

  65% fine fescue blend

  15% perennial ryegrass

  20% Kentucky bluegrass blend

  Seed at 4 to 5 pounds per 1,000 square feet.

  or

  100% tall fescue blend

  Seed at 7 to 10 pounds per 1,000 square feet.

- ***Shady areas:***

  100% fine fescue blend

  Seed at 4 to 5 pounds per 1,000 square feet.

Kentucky bluegrass does best in a sunny to lightly shaded site that is well drained and moist with neutral to slightly acidic soil and a moderate to high level of soil fertility. Tall fescue tolerates low soil fertility and persists well under low maintenance. It possesses good insect and disease tolerance and tolerates some shade. Fine-leaf fescues such as sheep's fescue, creeping red, Chewings and hard fescues are the best turfgrasses for dry, moderately shaded areas and infertile, acidic soils. The fine fescues require well drained, slightly dry soils and minimum levels of management. Perennial ryegrass has poor shade and drought tolerance, but good wear tolerance and establishes quickly. For landscape situations, a mixture of grasses is often planted since there can be a variety of soil drainage and shaded conditions in any one location. Over time, the different species which best tolerate these microclimate conditions will become the dominant ones. If using a mixture, avoid one which contains more than 15% perennial ryegrass since its quick establishment rate allows it to out-compete the other grasses in the mixture and suppress their growth.

5.3 CULTURAL PRACTICES

5.3.1 Mowing

Table 5-1. Recommended Mowing Heights for Turf Species and Cultivars Used at Silo Ridge Resort Community

Turf Species	Mowing Height
Kentucky bluegrass	
Low maintenance	2 to 2.5"
High maintenance	1.5 to 2.5"
Tall fescue	2.5 to 3"
Fine-leaf fescue	1.5 to 2"

Proper mowing practices are important in maintaining an attractive lawn. Both height and frequency of cut need to be adjusted based on turf species and cultivars. Frequency should be adjusted so that no more than 30% of the leaf blades are removed at anyone mowing. A sharp and well adjusted rotary or reel mower should be used. Mowing closer than recommended heights repeatedly will reduce the density and thin the turf, and should be avoided. Mowing too high and too infrequently will also be detrimental by allowing an excessive buildup of thatch. Heavy thatch can lead to winter injury and drought stress. Recommended mowing heights for each turfgrass species is found in **Table 5-1**.

Grass clippings can be left on a lawn that is mowed at the proper height and frequency. Under these conditions, clippings do not contribute to the thatch layer. Clippings should be left on lawns maintained with low to moderate fertility levels to help recycle nutrients. Remove clippings only if the amount is excessive (e.g., clumping occurs).

5.3.2 Fertilization

The most important aspect of the fertilization program at the Silo Ridge Resort Community is to ensure that the nutrients applied to the turf areas do not migrate to groundwater. Migration of the nutrients (primarily nitrogen and phosphorus) can result in pollution of resource particularly drinking water supplies. Minimizing nitrogen movement is directly related to best management practices that control nitrogen sources and irrigation. This is accomplished by applying the correct nitrogen source at the correct time, rate, and location and by applying the correct amount of irrigation at the correct time, rate and location.

When a fertilizer is applied in excess of what the plant can use or when the turf is not actively growing due to temperature, water, light, lack of an individual nutrient, etc., much of the application could be lost from the lawn. For these reasons, before a fertilizer is applied, the limiting growth factors for the turfgrass are considered. In addition, only a fertilizer containing the nutrients in the right form needed by the plant is used and applied at the right rate and frequency. Plants will respond to fertilizer only if it contains a nutrient that is deficient. The first step, then, in arriving at a sound fertilizer program is to have the soil analyzed to determine pH, calcium, magnesium, phosphorus and potassium availability and balance. From this information a valid pH correction and fertilizer program can be developed with the assurance that excess nutrients will not be applied.

Nitrogen is the nutrient used by grasses in the largest quantities. Its function is to stimulate vegetative growth and provide the grass with green color. It is recommended that nitrogen applications be a mixture of quickly available sources such as urea, ammonium nitrate, ammonium sulfate, mono- or di-ammonium phosphate and slowly available sources (SR) such as natural organic sources (Milorgranite, Nature Safe, etc.), isobutylidene diurea (IBDU), methylene ureas (MU) or coated ureas (SCU, Polyon, Poly-S, Sulfurkote-Il and others). They have the advantage of supplying a longer more uniform source of nitrogen, a lower salt index and reduced nitrogen leaching. By combining soluble nitrogen sources with the slow-release nitrogen products, availability can be extended to the grass without fear of nitrogen leaching into the groundwater. All granular products used here should contain 30 to 50% slow release nitrogen.

Test your soil. A soil test will tell you how much (if any) phosphorus (P) and potassium (K) fertilizer your lawn needs. The Dutchess County Cornell Cooperative Extension office or the Cornell Nutrient Analysis Laboratory can provide more information. If tests indicate that no P or K is needed, use nitrogen fertilizer sources that contain little or no P and K.

Adjust pH, if needed. Lawns should have a slightly acid pH, between 6.0 and 7.0. If the soil tests fall outside of this range, instructions for adding lime or sulfur to bring pH into this range from the soil test report should be followed.

Fall fertilization is the most important time. If phosphorus and potassium levels are adequate in the soil, nitrogen (N) is the most important nutrient for grass growth. **Table 5-2** provides a suggested fertilization schedule, although this may need to be adjusted based on site specific growing conditions such as rainfall and shade.

<table>
<tr><th colspan="8">Table 5-2. Suggested Fertilization Schedule for Lawns in Pounds of Nitrogen per 1000 sq.ft.</th></tr>
<tr><th></th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Nov</th></tr>
<tr><td>Low</td><td></td><td></td><td></td><td>Fe</td><td></td><td colspan="2">1.0 and/or 1.0</td></tr>
<tr><td>Medium</td><td></td><td colspan="2">1.0 or 1.0</td><td>Fe</td><td></td><td>1.0</td><td>1.0</td></tr>
<tr><td>High</td><td></td><td colspan="2">1.0 and/or 1.0</td><td>0.5 to 1.0
Fe</td><td>0.5 to 1.0</td><td>1.0</td><td>1.0</td></tr>
<tr><td colspan="8">Application rate should be 0.5 to 1 pound of nitrogen per 1000 sq.ft. A combination of slowly available and quickly available materials can be used to minimize runoff loss.
Apply iron to provide color without stimulating excessive growth. Ferrous sulfate (2 oz. in 3 to 5 gals of water per 1000 sq.ft.) or a chelated iron source may be used.</td></tr>
</table>

5.3.2.1. ***Nutrient Management BMPs for Water Quality Protection***.

- Base fertilization practices on a soil test as discussed earlier.
- Supplement the soil test with a plant tissue test when necessary especially to determine deficiencies.
- Core or aerify compacted soil to reduce runoff and aid phosphorus and lime in entering the soil.
- Minimize fertilizer rates on slopes or near shallow water tables (use no more than 0.25 to 0.5 lbs. of nitrogen per 1000 sq.ft.).
- Maintain a buffer zone of low maintenance grasses around bodies of water.
- Consider using Fe as a supplement to nitrogen for a greening response.
- Use a fertilizer that contains slowly available sources of nitrogen.
- Time applications carefully. Do not apply fertilizer before a heavy rainfall..
- Irrigate lightly (0.25 to 0.5 inch) after each application of quick-release fertilizer so it washes off the foliage and microbes can degrade and use the fertilizer.
- Avoid over-irrigation which produces runoff.

- Recycle grass clippings to reduce the amount of fertilizer needed to produce healthy turf.
- Use a drop spreader near bodies of water or around impervious surfaces so that the fertilizer is applied only to the turf.
- Sweep or blow fertilizer off impenetrable surfaces and back onto turf.

5.3.3 Irrigation

Most lawns in New York rarely require watering, except possibly for a few weeks in summer. To not irrigate during these weeks does not mean a healthy turf cannot be maintained. But it does mean careful preparation before this period of moisture stress. Poor watering practices can do more harm to the lawn than good, and it can carry pollutants out of the yard and into surface waters and groundwater.

While nighttime watering is most efficient, the preferred time to irrigate is early morning between 4 a.m. and 8 a.m. Evaporation is low at this time so more of the water makes it into the soil. Also, leaves will begin drying quickly in the morning sun, reducing the chances of diseases. Avoid watering on cloudy days.

The amount to irrigate depends on the soil type, cutting height, use, temperature, wind and a host of other factors. But in general, a healthy lawn loses about 1 inch of water per week during summer. (The water lost from the soil through the leaves and through the surface of the soil is called evapotranspiration, or ET.)

If the lawn receives an inch of rainfall every week through summer normally there will be little moisture stress. If less rainfall occurs, the difference can be provided through sprinklers or an irrigation system. The water application rate should supplement what occurs as rain. For example, if the lawn receives ½ inch of rain one week, only apply another half inch.

From a water conservation perspective, an even better way to determine how to irrigate is on an as-needed basis. Grass blades will begin to wilt (e.g., fold, turn bluish-green in color) as the moisture begins to be depleted in the soil. If 30 to 50% of the lawn shows signs of slight wilting, it is time to irrigate with 3/4 inch of water. The turf will fully recover within 24 hours. The turf should not be watered again until it shows signs of wilting. Most turfgrasses are going to require 0.5 to 1.5 inches of water per week either from rain or irrigation to keep them at the highest maintenance level.

For more detailed information about lawn watering, the Northeast Regional Climate Center has a lawn watering decision aide available on-line at http://www.nrcc.cornell.edu/lawn_water/.

5.3.4 Cultivation

To help develop and sustain quality turf cultivation including vertical mowing and aerifying may need to be used. These operations physically alter the plant's environment by removing and or relocating soil and organic materials, providing better oxygen exchange and or altering turf growth habit. These cultural practices will be performed only when turfgrasses are actively growing normally in the spring or fall.

5.3.4.1. *Vertical Mowing.* Usually only lawns dominated by Kentucky bluegrass will require vertical mowing. When done on a timely basis, vertical mowing can be used to reduce thatch. Vertical mowing can also be used to break apart aerifier cores.

5.3.4.2. *Aerifying.* The main purpose of aerification is to relieve compaction which in turn improves surface water infiltration, allows for good root penetration, provides for easier air exchange in the soil, improves nutrient uptake, enhances thatch degradation and increases turfgrass vigor. Coring involves removing plugs from the soil profile, thus allowing for lateral expansion of the remaining soil thereby relieving soil compaction. This is accomplished using an aerifier equipped with hollow coring tines.

5.4 Pest Management

There are numerous pest problems which can affect any of these turfgrass species. There is no such thing as a "pest free" yard or landscape.

Since identification of specific pest problems can be difficult, it is often necessary to have the pest management performed by an individual who is specifically trained in this area. For more information about regional pest problems and current data on pest outbreaks and management a decision making tool is available on-line at http://www.nrcc.cornell.edu/grass/.

At the project, ***Pesticides can only be applied by an individual who is licensed by the New York State Department of Environmental Conservation to apply materials.***

Pesticides have been approved for use at this location. Selection has been based on a risk assessment protocol described below and in detail in **Appendix I.**

The objectives of pesticide selection are to:

1. Identify those pesticides (fungicides, insecticides, and herbicides) which, when applied to the project site in accordance with label specifications, will pose only negligible risk to human health or the environment;

2. Establish a list of pesticides for use at the community which are restricted, to the maximum extent practical, to only those pesticides determined to pose negligible risk to human health and the environment; and

3. Identify special restrictions for the limited use of specific pesticides when their use, in the absence of such restrictions, could pose more than a negligible risk to human health and/or the environment.

Only those pesticides found to have a negligible risk associated with their use on the landscape (i.e., the maximum anticipated concentration is less than the effects criteria), were selected for use on the course, unless no other pesticide currently is available to control the target pest. The results of the risk assessment are summarized in **Table 5-3** and supporting data are presented in **Appendix I**.

Table 5-3. Pesticides Approved for Turf and Landscape Areas		
Insecticides	**Herbicides**	**Fungicides**
acephate	2,4-D amine	azoxystrobin
azadirachtin	bentazon	boscalid
bifenthrin	carfentrazone	fenarimol
carbaryl	clopyralid	fludioxanil
clothianidin	dicamba	flutalanil
fipronil	dithiopyr	fosetyl-AL
halofenozide	fenoxaprop	iprodione
imidacloprid	glyphosate	mefenoxam
spinosad	halosulfuron	myclobutanil
Bacillus thuringiensis (*Bt*) (biological)	imazapyr	polyoxin D
Beauvaria bassiana (biological)	mecoprop (MCPP)	propiconazole
	pendimethalin	triadimefon
	prodiamine	trifloxystrobin
	quinclorac	vinclozolin
	sulfentrazone	
	triclopyr	

5.4.1 Weed Management

The best approach to weed control is a healthy, vigorous turf. Weed problems in a lawn indicate that the turf has been weakened by improper management practices or damage from pests. Proper management practices can eliminate many weed problems. If weeds are a persistent problem, herbicides which are specifically labeled for each grass can be used.

Preemergence herbicides control weeds by forming a barrier at the soil line to inhibit weed growth after germination. Examples of these type weeds include crabgrass and annual bluegrass. To be the most effective, timing of application of preemergence herbicides should be around April 1 to April 15. Postemergence herbicides may be needed for control of annual and perennial broadleaf weeds such as clover.

Materials which are safe for use to control weeds include products containing the ingredients listed in **Table 5-4**.

Table 5-4. Materials Which Can be Used to Control Weeds at Silo Ridge Resort Community

	Kentucky bluegrass, tall fescue and mixtures	Fine fescues and mixtures
Preemergence Weeds	dithiopyr, pendimethalin, prodiamine	pendimethalin, prodiamine
Postemergence Weeds	2,4-D, bentazon, carfentrazone, clopyralid, dicamba, fenoxaprop, halosulfuron, MCPP, quinclorac, sulfentrazone (Kentucky bluegrass only), triclopyr	2,4-D, bentazon, carfentrazone, dicamba, fenoxaprop, halosulfuron, MCPP

5.4.2 Insect Management

Insect problems will be minimal and will include, primarily, root feeding grubs. Insecticides may be divided into two broad categories: (a) conventional or chemical or synthetic materials; and (b) biorational. Conventional or chemical insecticides have a broad spectrum of activity and are more detrimental to natural enemies. In contrast, insecticides that are more selective because they are most effective against insects with certain feeding habits, at certain life stages, or within certain taxonomic groups, are referred to as "biorational" pesticides.

Biorational pesticides are generally less toxic and more selective, and are generally less harmful to natural enemies and the environment. These include microbial-based insecticides such as

Bacillus thuringiensis products, chemicals such as pheromones that modify insect behavior, insect growth regulators and insecticidal soaps.

While nonchemical treatments such as parasitic nematodes and bacteria for insect control are available, they do not give the degree of consistency, reliability and versatility and are proven ineffective in many circumstances (Potter, 1993). Biorational materials which could be considered for use include:

1. **Milky spore disease**, a bacteria that infects Japanese beetle grubs and has been applied extensively on turfgrass in the Northeast for many years. It is of questionable value in New York because (a) the bacteria is most infective to Japanese beetle grubs and is of limited value against other common grub species infesting turfgrasses in New York; (b) soil temperatures in New York are often too cool for rapid disease buildup; and ©) milky disease bacteria can only multiply within the living bodies of grubs; thus one must be willing to tolerate a period of relatively high grub populations to obtain disease levels sufficient to control grubs;

2. ***Beauvaria bassiana*** for control of armyworms & cutworms, and sod webworms.

3. The use of **entomogenous (insect parasitic) nematodes** as a control cannot be given unqualified endorsement at this time. Nematodes have provided grub control equal or superior to that of currently labeled turf insecticides, but the number of failures is sufficient to caution their use. Failures have been traced to the use of nematodes in poor physical conditions; the use of nematode strains not well suited for control of grubs; and soil conditions that prevent nematodes from surviving, reproducing, or persisting in the field.

4 **Conserve (Spinosad)** - this is a naturally occurring insecticide with activity on armyworms & cutworms and sod webworms

Materials which can be used for the major insect pest problems include products containing the ingredients listed in **Table 5-5**.

Table 5-5. Materials Which Can Be Used for Major Insect Pest Problems at Silo Ridge Resort Community	
Pest	**Product Ingredient**
Billbugs	bifenthrin, carbaryl, clothianidin, imidacloprid
Chinchbugs	acephate, *Beauvaria bassiana*, bifenthrin, carbaryl, clothianidin, fipronil, imidacloprid
White grubs	carbaryl, halofenozide, imidacloprid
Armyworms and cutworms	acephate, azadirachtin, *Bt* products, carbaryl, clothianidin, entomogenous nematodes, halofenozide, spinosad,

5.4.3 Disease Management

Sound disease management includes maintaining proper mowing heights, fertility levels and being judicious with irrigation. However, even under ideal conditions, disease problems can become severe. Fungicides are expensive to apply and should be considered only when the problem becomes so severe a significant loss of turf might occur.

Materials which can be used for the major turf diseases include products containing the ingredients listed in **Table 5-6**.

Table 5-6. Materials Which Can Be Used for Major Turf Diseases at Silo Ridge Resort Community	
Disease	**Product Ingredient**
Leaf spot and melting out	azoxystrobin, iprodione, trifloxystrobin,
Dollarspot	boscalid, iprodione, myclobutanil, propiconazole, triadimefon, vinclozolin
Brown patch	azoxystrobin, fenarimol, fludioxanil, flutalanil, iprodione, myclobutanil, polyoxin D, propiconazole, trifloxystrobin, vinclozolin
Gray leaf spot	azoxystrobin, propiconazole, triadimefon, trifloxystrobin

Table 5-6. Materials Which Can Be Used for Major Turf Diseases at Silo Ridge Resort Community

Disease	Product Ingredient
Pythium blight	azoxystrobin, fosetyl-Al, mefenoxam
Red thread	azoxystrobin, fenarimol, flutalanil, iprodione, myclobutanil, polyoxin D, propiconazole, triadimefon, vinclozolin
Rust	azoxystrobin, myclobutanil, propiconazole, triadimefon, trifloxystrobin
Snow mold	azoxystrobin, fenarimol, fludioxanil, iprodione, myclobutanil, polyoxin D, propiconazole, triadimefon, trifloxystrobin, vinclozolin

5.5 WATER CONSERVATION

5.5.1 Irrigation

Irrigation is used to supplement, not substitute for, rainfall. At the project site, irrigation is one of the cultural practices used, and irrigation management includes water conservation practices. Lack of adequate moisture can result in three possible consequences for the turf as follows: 1) stress; 2) dormancy; or 3) death. Providing the correct amount of water at the appropriate time is important so that the turf and other landscaping remains healthy and vigorous.

To provide the proper amount of moisture at the right time requires that there be adequate recording of climatic conditions so that determination can be made if soil moisture reserves are adequate or if an irrigation event should be scheduled.

5.5.2 Irrigation Water Management

5.5.2.1. ***Potential Irrigation Requirements***. The best method of determining whether the proper amount of water has been applied is to determine the depth of water penetration following irrigation by checking with a probe or trowel. If water has not penetrated to the desired depth by six to eight hours after an irrigation, then the irrigation time should be increased. If water has moved well beyond the desired irrigation depth, then the irrigation time should be decreased. Table 5-7 lists the potential irrigation requirement based on average historical rainfall and potential evapotranspiration data. This would be considered a maximum requirement and for water conservation purposes, allowing the turf to undergo temporal short-term drought stress does not normally affect turf performance or result in significant loss of grass.

Table 5-7. Monthly Potential Turfgrass Irrigation Requirements for Silo Ridge Lawns Based on Average Rainfall and Moisture Availability

Month	Precipi-tation[a]	Available Moisture	PET[c]	Deficit	Irrigation Require-ment[e]	Irrigation volume required
	Inches per Week					
Jan	0.65	0.32	0.0	0	0	0
Feb	0.58	0.29	0.0	0	0	0
Mar	0.70	0.35	0.12	0	0	0
Apr	0.78	0.39	0.37	0	0	0
May	0.87	0.43	0.80	0.37	0.30	0.37
Jun	0.88	0.44	1.15	0.71	0.57	0.71
Jul	0.85	0.42	1.38	0.96	0.77	0.96
Aug	0.92	0.46	1.19	0.73	0.58	0.73
Sep	0.83	0.41	0.76	0.35	0.28	0.35
Oct	0.74	0.37	0.40	0.03	0.02	0.03
Nov	0.77	0.38	0.15	0	0	0
Dec	0.77	0.38	0	0	0	0

a - Based on weather records from Millbrook, NY over a 55 year average.

b - Assuming a 50% recharge.

c - Potential Evapotranspiration (PET) based on a modified Blaney Criddle formula.

d - Deficit is PET minus available moisture.

d - Irrigation requirement based on coefficient of 0.8.

e - Based on 80% Application Efficiency.

5.5.2.2. *Irrigation Management for Water Conservation Considerations*.

- Irrigation frequency will vary with environmental or climatic factors. Less frequent irrigation is needed in the summer when the roots of turf are deep. More frequent irrigation is needed when roots are shallow in the spring.
- Water should not be applied too quickly otherwise water may run off from sloped sites, turf where thatch has accumulated or turf grown on compacted soils. In these situations it is more effective to apply only a portion of the total water needed and to move to a sprinkler or switch to another station to irrigate other areas. After the water has infiltrated and percolated into the soil, apply another portion of the water and repeat the cycle until all the water is applied.
- A healthy durable turf that withstands minor drought is achieved by irrigating thoroughly but as infrequently as possible. A sure sign that turf will benefit from irrigation is a wilted appearance. One initial symptom of wilting is "footprinting", where footprints on the turf will not disappear within one hour. This symptom is soon followed by actual wilt, where the leaves of the turf lose an upright erect appearance and take on a grayish or purple-to-blue cast. Usually, only a few areas will appear wilted in the same general location of the turf; these areas serve as good indicator spots when assessing the need to water. Delay watering the entire turf area for another day or so by irrigating only the wilted areas.
- Allowing some subtle wilt stress to develop in a turf will not destroy the turf. Allowing the soil to dry to 50% of its available water between irrigation promotes deep rooting and helps plants to survive subsequent drought or heat stress. As drought stress becomes more severe, however, turf becomes more susceptible to traffic, insect and disease damage as well as weed invasion, especially at lower mowing heights.
- The most efficient time of day to water is late evening through early morning (between 10 pm and 8 am). Nighttime is generally less windy, cooler and more humid, resulting in less evaporation and a more efficient application of water. Contrary to popular belief, irrigating during this period does not stimulate disease development.
- Some turf, soil and environmental conditions may result in the need for more than one irrigation event per 24-hour period; accordingly these sites will need some irrigation during daylight hours. The tendency to water "heavily and infrequently" on these sites will result in an inefficient use of water since these sites typically have

rapid drainage. Thus, excess water is readily lost through drainage. Under these conditions, site specific watering (e.g., hand watering and syringing) is performed during daylight hours because of the need to visually identify areas where the water should be applied. Employees responsible for hand watering and syringing should be thoroughly trained regarding the most effective and efficient techniques for applying water during the day.

5.5.2.3. *Management Considerations in Water Conservation*.

- Maintain the soil pH between 6.0 and 7.0.
- Minimize soil compaction through turf cultivation.
- Minimize potential problems from pesticides toxic to the root system, particularly certain pre-emergence herbicides.
- Control potentially serious insect pests that feed on the root system.
- Maintain an adequate soil potassium (K) level.
- Avoid excessive nitrogen (N) fertilization that forces shoot growth at the expense of root development.
- Maintain as high a cutting height as possible consistent with the management level desired.
- Avoid an excessive thatch accumulation which encourages root development in the thatch/mat layer only.
- Avoid intense mechanical maintenance practices such as vertical cutting, and turf cultivation during summer stress periods.

.0 INTEGRATED PEST MANAGEMENT FOR T E GOLF COURSE

Integrated Pest Management (IPM) is a management program that uses information about turfgrass pest problems and environmental conditions which may precipitate these problems, and integrates these with turfgrass cultural practices and pest control measures to prevent or control unacceptable levels of pest damage (Ferrentino, 1990). It is a preventative approach incorporating a number of objectives including the following: 1) development of a healthy turf that can withstand pest pressure; 2) judicious and efficient use of chemicals; 3) enhancement of populations of natural, beneficial organisms; and 4) effective timing of handling pest problems at the most vulnerable stage, often resulting in reduced pesticide usage. It is an ecologically based system that uses biological and chemical approaches to control.

Like BMPs, IPM strategies have been incorporated into every aspect of this plan for Silo Ridge Golf Course, and have taken into consideration the entire scheme of golf course operations as they relate to environmental impact. Integrated Pest Management (IPM) programs rely on six basic approaches for plant and environmental protection. These include the following:

1. *Regulatory* - using certified seed and sod to prevent unwanted weed contamination and selecting the best adapted turfgrass species;
2. *Genetic* - selecting improved grasses which perform well in specific areas and show a resistance to pest problems;
3. *Cultural* - following recommendations made for proper primary and secondary cultural practices which will maintain the turf in the most healthy condition and influence its susceptibility and recovery from pest problems. Practices such as aerification, vertical mowing, topdressing, maintenance of proper soil nutrient levels, sound irrigation management and proper mowing techniques should produce a high quality turf;
4. *Physical* - cleaning equipment to prevent spreading of diseases and weeds from infected areas;
5. *Biological* - enhancing populations of natural antagonists and for a limited number of pest problems biological control can be used whereby natural enemies are introduced to effectively compete with the pest; and
6. *Chemical* - pesticides are a necessary and beneficial approach to turf pest problems, but use can be restricted in many cases to curative rather then preventive

applications, thus reducing environmental exposure. Pesticide selection is based on a risk assessment approach that strives to use only pesticides that are based on effectiveness, not toxic to non-target species, that act quickly and degrade quickly, are not soluble and not persistent. Few pesticide applications will be made on a regularly scheduled basis. Exceptions may include pre-emergence herbicides, insecticides to obtain control of chronic problems for timing when pests are the most vulnerable and fungicides used to control *Pythium* and patch diseases which cause damage before visual symptoms are noted. Additionally, materials must be applied strictly in accordance with label instructions, at labeled rates, under appropriate environmental conditions (i.e., no spraying on windy days or when rain is forecast), with a low-volume sprayer to reduce the possibility of drift, using shrouded sprayers around sensitive areas and materials will be rotated as to use to deter the development of resistant strains of pests which may require more frequent and/or higher rates of pesticide applications.

This approach includes six basic components as follows:

1. Monitoring of potential pest populations and their environment;
2. Determining pest injury levels and establishing treatment thresholds;
3. Decision making, developing and integrating all biological, cultural, and chemical control strategies;
4. Educating personnel on all biological and chemical control strategies;
5. Timing and spot treatment utilizing either chemical, biological or cultural methods; &
6. Evaluating the results of treatment.

Figure 6-1 is a flow chart for decision making based on IPM strategies.

One of the most critical components to IPM programs is course monitoring. A well-trained and experienced golf course superintendent will scout themselves and/or designate someone as an IPM scout to detect symptoms of pest problems on a daily basis. This approach coupled with compiling a site specific history, and consulting with other superintendents in the area and with specialists in turfgrass management make it a workable program.

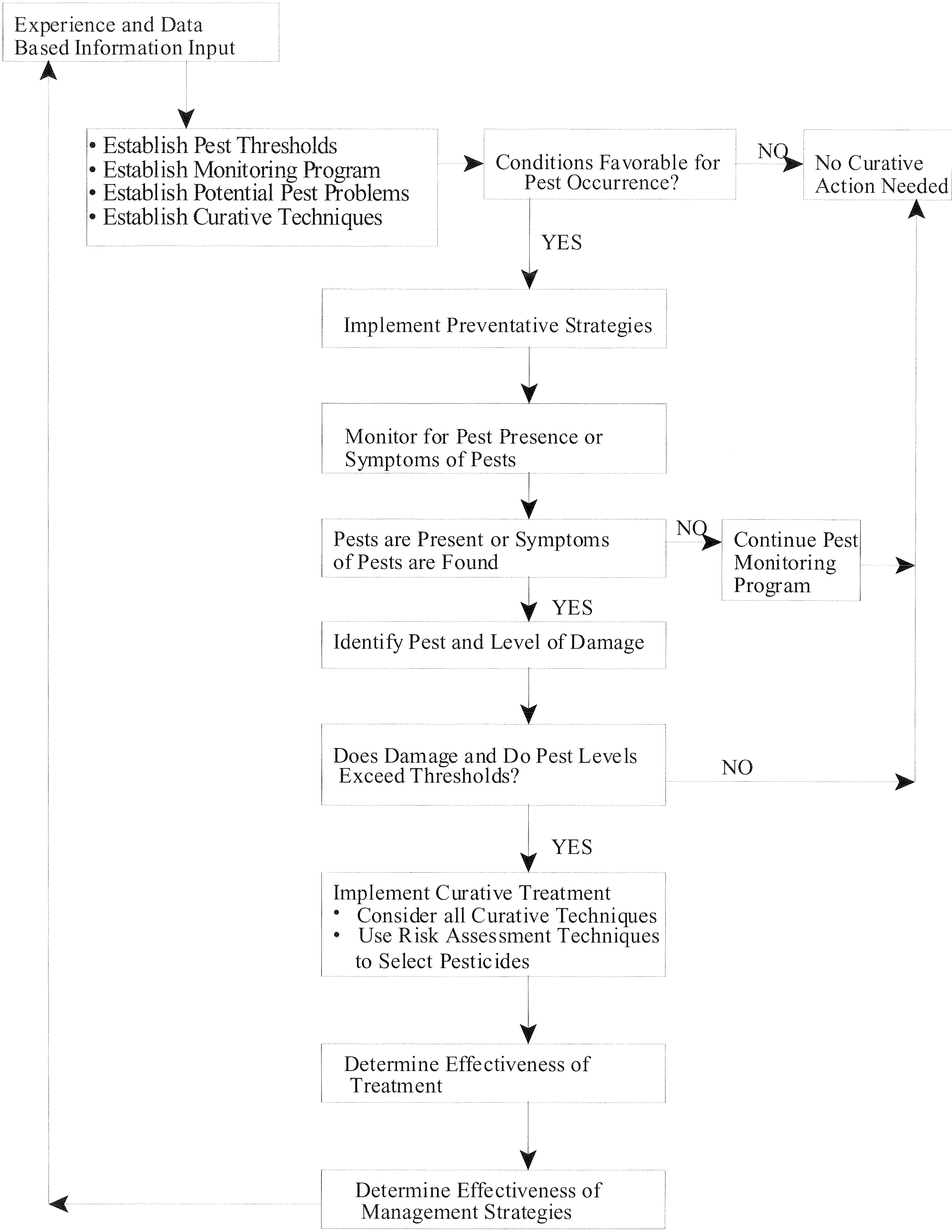


Figure 6-1. Integrated Pest Management Decision Flow Chart for Silo Ridge Golf Course.

Because the EPA periodically reevaluates the health and environmental risks of pesticides, the IPM plan will be reviewed each year and modified as necessary to reflect any changes in regulations and risk assessment.

6.1 AGRONOMIC CONSIDERATIONS AND REQUIREMENTS

Agronomic and cultural practices are important components in maintaining environmental integrity and enhancing the current conditions at Silo Ridge Golf Course. The land use design and extensive use of Management Zones, Best Management Practices, and Integrated Pest Management, as discussed above, coupled with state-of-the-art agronomic and cultural practices ensure environmental sensitivity of the golf course conservation area. Particular attention has been given to areas adjacent to freshwater wetlands and watercourses to protect the habitat and water quality.

The following sections discuss agronomic and cultural practices that are critical to maintaining environmental sensitivity at Silo Ridge Golf Course.

6.1.1 Soil Mixes and Modifications

While soil modification on large acreage is impractical, some soil modification is necessary. Changes in surface and subsurface drainage as a result of grading have been discussed under "Environmental Planning." Grading will result in a mixing of topsoil and subsoil and will require extensive soil testing for determination of nutrient levels prior to seeding/sodding.

6.1.1.1. *Putting Greens*. It is important that greens be constructed to withstand traffic and wear, and at the same time, protect environmental resources. Playing surfaces will be constructed with materials which provide good drainage and resist wear and compaction, and this will maximize the playability even immediately after rainfall or irrigation. It is also important that surface and subsurface drainage filtration areas so that water resources are protected. For these reasons, the greens will be constructed based on a United States Golf Association method as detailed in "USGA Recommendations for a Method of Putting Green Construction" at http://www.usga.org/turf/course_construction/green_articles/putting_green_guidelines.html.

This method of construction is based on soil physics principles of drainage and moisture retention within the soil profile. This unique system takes advantage of discontinuity within the soil profile which disrupts internal drainage until saturated conditions occur. By using a 4-inch layer of primarily one-quarter inch diameter gravel, overlaid with approximately 14 to 18 inches of a specified high sand content intermediate and/or root zone mixture, water will be retained in the soil profile for turfgrass use without immediate drainage until saturated conditions occur. Materials which may have a propensity to move in the soil solution are held for maximum attenuation times and if trace amounts are transported under saturated flow conditions, maximum dilution within the soil profile will occur. The entire putting green is under drained by a series of perforated pipes installed at the subgrade. These are spaced on no less than 15-foot centers and will have outflow directed to water quality basins for detention, buffer areas for filtration or through specially constructed filtration units. This type of system affords the best approach to irrigation management and controlled discharge of excessive rainfall from the more intensively managed areas of the golf course.

Successful construction of a USGA green requires these specifications to be rigidly followed for five basic values which are used as criteria for recommending the root zone mixture. These values are percentages of total porosity; capillary (micro-) pore space which contributes to the water holding capacity; non-capillary (macro-) pore space which adds aeration porosity; saturated conductivity (water permeability); and organic matter content. In addition, particle size and mechanical analyses are usually run as the percentage of sand, silt and clay as well as the different percentages of the sand fractions. These will

Table 6-1. Recommended Physical Parameters for a reen Constructed to the US A reen Section Method

Parameter	Minimum Allowed	Maximum Allowed
Total Porosity	35%	55%
Capillary Porosity	15%	30%
Noncapillary Porosity	15%	25%
Saturated Conductivity	6 to 12 inches/hr	12 to 24 inches/hr
Organic Matter Content	1% by weight	5% by weight
Particle size		
Medium & Coarse sands	60%	--
Fine sand	--	20%
Very fine sand	--	5%
Silt	--	5%
Clay	--	3%

determine how fast the soil will drain and its potential to resist compaction from traffic and wear. To meet the requirements, samples of materials to be used in construction will be sent to a qualified soil physical testing laboratory to determine the proper ratio for mixing of these materials to meet the recommendations listed in **Table 6-1**. Subsequent recommendations for pH adjustment of the root zone mixture and addition of fertilizers will depend on the final ratio of materials used and will be made based on chemical analyses of the mixture. The addition of any nutrients to the root zone mix will be made during the blending process prior to the mix being installed in the putting green cavity.

6.1.1.2. ***Tees***. Tees are the most trafficked areas on the golf course. Tees will be constructed in the same manner as the putting greens. The higher height of cut on the tee surface provides a much deeper root system in the soil profile and imparts considerably better wear tolerance than is usually observed on putting greens. Typically tee areas are not as intensively managed as greens and the nutrient and pesticide requirements are lower. Surface runoff and subsurface drainage will be directed into appropriate filtration areas, which may include adjacent roughs, out of play areas, or other vegetative areas.

6.1.1.3. ***Fairways and Roughs***. Soil modification of fairways and roughs is not practical since this encompasses a significant portion of the acreage involved with the golf course development. Soil samples will be analyzed from as many locations as necessary once final grading begins so that pre-planting fertilization recommendations can be made.

6.1.2 Turfgrass and rass Species Selection

6.1.2.1. ***General information***. Over the years extensive turfgrass breeding programs and research have resulted in grass varieties that are exceptionally well-suited for golf course turf. Cultivars selected for use at Silo Ridge Golf Course will be those that are efficient in water use and low in susceptibility to insects, disease and weed infestation.

In addition, the natural characteristics of the turfgrasses limit movement of pesticides and fertilizers into underlying soils, surface water, and ground water. Thatch produced by the turf acts as an organic filter to chemically bind pesticides that might otherwise enter the local surface and ground waters. Producing a healthy turf, which is needed for a golf course, has the added benefit of immobilization and microbial degradation of pesticides retained in the thatch layer. In addition, turfgrass root systems are quite extensive and fibrous, and are able to adsorb and absorb applied pesticides that might penetrate the canopy and thatch and reach the roots. Thus, a healthy turf results in effective nutrient and pesticide retention and control.

6.1.2.2. ***Greens, Tees and Fairways***. These will be seeded with bentgrass. Over the past ten years a number of new creeping bentgrass cultivars have been developed which show markedly increased resistance to disease and insect problems, a finer-textured more upright growth habit with less grain, rapid establishment, excellent wear tolerance and good recuperative rates and improved water use efficiency. At the same time the amount of water, nutrients, and pesticides necessary to produce a high quality turf has been reduced. Greens will be seeded with creeping bentgrass. Tees and fairways will be seeded with a creeping and colonial bentgrass mixture consisting of 80% creeping bentgrass and 20% colonial bentgrass. Seeding rates will be 44 lbs per acre.

6.1.2.3. ***Roughs and Turf Buffers***. These will be seeded with a mixture of grasses. Near roughs will be seeded with a mixture of 25% Kentucky bluegrass, 30% chewings fescue, 15% creeping red fescue, 15% hard fescue and 15% perennial ryegrass. The seeding rate will be 160 lbs. per acre. The far rough and bunkers and turf buffer areas will be seeded to a mixture of 40% chewings fescue, 30% sheeps fescue and 30% hard fescue at a seeding rate of 220 lbs. per acre. The perennial ryegrass and fine fescue cultivars should be endophyte enhanced. This endophyte enhancement has been shown to display good resistance to leaf feeding insects.

6.1.2.4. ***Native Grass Areas***. These will be seeded to a mixture of warm-season grasses comprised of big bluestem, little bluestem, switchgrass and indiangrass. Several cool-season grasses depending on seed availability will be sown with the warm-season species to provide early germination for erosion control. These may include species such as Canadian wild rye, junegrass and needlegrass. Seeding will be done in the spring at seeding rates between 15 to 20 lbs. per acre. Some forbs such as Black-eyed Susan and Daisy will be sown with the grasses at a grass to forb ratio of 8:2 or 9:1. The seeds will be drilled to ensure proper cover. Some fertilization will be required during the establishment phase, however, nitrogen treatments will not exceed 60 lbs. N per acre in a single year. Fertilization will not be required once the warm-season grasses establish. Occasional mowing at a 6 inch height of cut will take place to control weeds and allow light to reach the surface while the warm-season grasses are establishing. This may take up to one year from time of seeding. The native grass areas once established will be mowed no more than once per year. This will take place before April, which is prior to when nesting birds occupy the site.

6.1.3 Construction

Soil erosion is most likely to occur during the construction and grow-in phases of golf course development. The major pathway for phosphorus loss is soil erosion, as sediment is the carrier (see Water Quality Management section). Therefore, any technique effective in reducing soil erosion will also reduce phosphorus losses. Use of buffer strips, grass waterways, and berms, the sodding of steep slopes and the use of silt screens are examples of structural techniques for erosion control that will be used during construction and grow-in.

Final plant bed preparation will ensure surfaces are reasonably free of large dirt clods, roots and other debris that would interfere with sodding and seeding and subsequent maintenance operations. Initial pH correction, if necessary, and fertilization will be based on soil test recommendations and will be applied prior to planting. Care will be taken in fertilization because of the potential for runoff at this time. Sod will be installed on the downward slopes of areas of roughs prior to seeding of any tees, greens or fairways, at least to the extent that stormwater runoff from the seeded areas will be filtered through the sodded turf areas before entering any wetland or watercourse.

Once the course has been planted, the future of the project will depend on how well it is grown-in and maintained. The objective of the grow-in program is the rapid establishment of a high quality turf cover to minimize water erosion and weed infestation.

The judicious use of water and fertilizer is essential for a quality turf cover. While areas must be kept continuously moist, they must not be kept excessively wet, otherwise the potential for erosion is increased. On and around buffers where irrigation may not be available, a mulch might be used to preserve topsoil and provide favorable moisture conditions for seedling establishment.

Since efficient water use and conservation of irrigation water are the responsibility of the superintendent and irrigation technician, they will need to be well acquainted with the capabilities of the irrigation system. In addition, they will be in charge of the growing-in program.

The following represents considerations during the construction phase:

1. A construction sequencing plan and time schedule in which the site is divided into several areas has been developed for building the golf course to better manage disturbed soils and protect environmentally sensitive areas such as wetlands and water courses.

2. Woody vegetation (trees and shrubs) will be chipped and the chips stockpiled for composting which can later be used for incorporation into the soil. Chips that cannot be fully composted prior to finish grading will be removed to a designated area on the property where they can be safely composted and used by the golf course at a later time.

3. Construction and environmental monitoring will be carried out during the construction phase in order that the specifications are followed including overseeing the maintenance of soil erosion control structures and providing guidance for composting wood chips.

4. Soil that is exposed and left unprotected for an extended period of time during construction and before seeding the permanent grasses will be sown to annual ryegrass if before May 25 or to millet if after May 25. This temporary cover will be removed before final seedbed preparation and/or seeding. If the final preparation of the seedbed has been completed, the stubble can be left in place and the permanent seed mixture sown into the stubble.

5. The greens and tees will be provided with good air circulation. This is accomplished by removing some understory and selected trees in woodlands bordering the greens and tees which if not done can create barriers to air movement. Also, a sufficient distance will be left between greens and the tree lines so that light reaching the turf surface is not limiting growth. Good air circulation is extremely important in reducing temperature and humidity at the turf surface and results in reduced

incidence of disease and in a more dense and healthier stand of grass. This will substantially reduce fungicide use.

6. The irrigation system including the pumps will be installed during construction and in place and operating before seeding the rough, fairways, tees and greens with the permanent species.

7. A seeding method that includes covering the seed to ensure good seed/soil contact will be used. This is accomplished by using a cultipacker seeder or by some other suitable means. The cultipacker seeder or other seeding equipment will be run at a right angle to all slopes. This method results in maximum germination, minimum seedling loss and reduced water velocity moving down slope thereby further reducing the risk of soil erosion.

8. Seedings made on slopes greater than 3% with the permanent seed mixtures in areas where seeding is outside the August 15 to September 30 dates and with no irrigation will be mulched with a straw mulch at a rate of 2 tons per acre along with seeding 60 lbs. of a perennial ryegrass blend per acre. The mulch will be anchored by discing the straw into the surface with an open disc, a mulching coulter or some other suitable means.

9. Soil samples will be collected from different areas of the golf course based on soil type and vegetation prior to seedbed preparation to determine soil pH and limestone requirements as well as other nutrients including phosphorus and potassium.

10. A system of no-till seeding will be employed to introduce the fine leaf fescues and native grasses into existing grassy locations which are not slated for cuts and fills or left undisturbed thereby reducing removal of existing vegetation. These areas along with other areas in which existing vegetation is left undisturbed will act as buffers to slow runoff velocities and capture sediment from soil erosion during construction.

6.1.4 Basic rowing-in Program

6.1.4.1. ***Watering***. Planted areas should be kept continuously moist throughout the germination or rooting period in the case of sod for approximately two to three weeks. This means frequent, light watering rather than soaking the soil when it becomes dry. Water should not be allowed to puddle or run off the surfaces. After germination or when root growth secures anchors sod, watering frequency should be decreased with application volumes increased. This will ensure adequate soil moisture at depths to optimize root growth of the new seedlings.

6.1.4.2. ***Fertilizing***. Pre-plant fertilizer and liming recommendations should be based on soil samples taken after final grading. These should incorporate P, K and other nutrients at recommended levels and N at 45 lbs./acre with 50% of this from a slow release source. Periodic fertilizer treatments will be made during grass establishment with a soluble nitrogen source applied at a rate not to exceed 20 lbs. N per acre or with a combination of soluble and 50% slowly available nitrogen from a form such as IBDU, SCU or a natural organic product such as Milorganite, Nature Safe or similar material until the grass is well established and a dense stand of grass is achieved. The period between fertilizer treatments will be 2 to 4 weeks depending on time of year, rate of growth, source of nitrogen used and development of the grass obtained after each fertilizer treatment. It is important that a grass stand be achieved in a short period of time to reduce soil erosion. Fertilizer treatments at this stage of growth, particularly with nitrogen, are extremely important in achieving this goal. Once the stand of grass is mature, then fertilizer rates will be reduced. Once the turfgrass on the course has matured, the management objective becomes slower growth with good color, density, and playability.

6.1.4.3. ***Mowing***. To help control weeds and promote lateral growth, mowing should begin when the creeping bentgrass is approximately 1 inch in height for tees and fairways and ½ inch for greens. Mowing at these heights should be done for the first 2 or 3 mowings and then the height reduced to the heights recommended in **Table 6-2**. This will encourage lateral spread, increase density, and maintain a fine texture. The mowing should be frequent enough so that no more than one-third of the top growth is removed at any one clipping. For roughs, once the grass seedlings reach a height of 3.0 inches, mow down to 2 inches and maintain at this height.

6.1.4.4. ***Rolling***. To provide a smooth, firm surface for future operation of mowing equipment and golf carts, all areas may need to be rolled a few times. The first rolling should not occur until the grass covers approximately 25 to 50% of the area.

6.1.4.5. ***Developing Tee and Putting Surfaces***. During the growing-in period, tees and greens will need topdressing and rolling and perhaps aerifying and/or vertical mowing a number of times to produce smooth, true and firm surfaces. Topdressing material should be identical to the material used in the root zone mix.

6.1.4.6. ***Pest Control***. The course should be inspected daily for pests. When control is necessary, label directions and precautions utilizing materials approved in this plan will be followed as well as any restrictions as defined under Golf Course Cultural Practices.

6.2 OLF COURSE CULTURAL PRACTICES

The primary cultural practices that produce and sustain a healthy turf are mowing, irrigation and fertilization. These three operations, alone or in combination, often cause changes in the root and canopy micro-environment. These changes can have either a positive or negative effect. Thus, it is essential that these practices are executed in a proper and timely manner to insure turfgrass quality and playability. The best deterrent to weed, insect and disease infestation is a healthy turf. Thus, maintaining hearty grasses will minimize the need to apply fertilizers and pesticides.

6.2.1 Mowing

Mowing is the most basic maintenance operation on a golf course. Without regular mowing at the appropriate heights of cut, the course would become unplayable. With good mowing practices, density, texture, color, root development, wear tolerance and other aspects of turf quality are enhanced. Proper mowing practices also can reduce the amount of irrigation needed. Taller grass can have a significantly higher evapotranspiration rate and thus a greater need for water. Mowing grass too short stresses the turf which not only produces a need for more water, but can cause the weakened turf to be more susceptible to weed, insect and disease infestation. Recommended mowing practices are presented in **Table 6-2**.

Table 6-2. Recommended Mowing Practices for the Turf Areas at Silo Ridge olf Course				
Mowing	**reens**	**Tees**	**Fairways**	**Roughs**
Height (inches)	1/8 - 3/16 (0.125 - 0.1875)	3/8 - 5/8 (0.375 - 0.625)	½ - 1.0 (0.5 - 1.0)	1½ - 2 (1.5 - 2)
Frequency	Daily	2 to 4 times per week	2 to 3 times per week	7 to 14 days
Clippings	Remove	Remove	Return or Remove*	Return
*Remove only if excessive.				

Grass variety and turf use have the greatest influence on mowing height. Each turfgrass has a mowing tolerance range within which it can be expected to provide outstanding turf. The best approach is to use the highest mowing height acceptable for the various playing surfaces. However, if fast greens are required for tournament play, mowing can be lowered below recommended minimums for a short period of time. On the other hand, another possibility is to continue mowing at the higher height and double cut twice; this operation will produce the same green speed as the lower cut. In addition, during the summer months when stress is likely to occur, do not lower the height of cut. If the membership demands faster green speeds, try double cutting once or twice per week before lowering the height of cut. Additionally, rolling several times per week can improve speed without lowering the height of cut.

Mowing height and growth rate have the most influence on mowing frequency. As a rule-of-thumb, mowing should be done often enough so that no more that one-third of the leaf is removed at any cutting. Frequent mowing is best because it minimizes the negative effect on photosynthesis, and helps maintain a high percentage of leaf surface which is necessary for healthy root development.

If mowing is scheduled at appropriate intervals and the grass clippings are dispersed uniformly, leaving the clippings on the fairways and roughs should not cause problems. Research has indicated that returning clippings to the surface does not greatly increase thatch buildup on turf that is otherwise properly managed. Clippings decompose rapidly, thus returning some fertilizer and organic matter to the soil, and they also help conserve moisture and insulate the soil.

Clippings are always removed from greens and tees to prevent interference with the play. Collected clippings may be spread over roughs and the practice range.

6.2.2 Nutrient Management

The most important aspect of the nutrient management program at Silo Ridge Golf Course is to ensure that the nutrients applied to the golf course turf and landscape areas do not migrate to surface or ground water. Migration of the nutrients (primarily nitrogen and phosphorus) can result in pollution of resources, most notably eutrophication. Nitrogen and phosphorus are the elements most often associated with the eutrophication of lakes and streams (Jones & Bachmann 1976; Wetzel 1982). Eutrophication of water bodies may result in algal blooms, aquatic plant infestations, reduction in depth, and a marked decrease in overall water quality (see Water Quality Management section).

Attention must be given to protect ground water resources at Silo Ridge Golf Course from contamination by nitrate-nitrogen. Quickly available nitrogen fertilizer applied to the golf course will be in the ammonium and nitrate forms, and most of the ammonium will be converted by soil microorganisms to nitrate, provided there is adequate aeration and optimum soil pH. From an environmental perspective, nitrate is highly mobile and is thus readily available for plant uptake; however, the mobile nature of nitrate also allows it to be leached into ground water. The Federal drinking water standard for nitrate is 10 mg/l. However, nitrate concentrations should be less than 0.75 mg/l to protective of the freshwater ecosystems at the site.

A review of the published research on nitrogen fertilizers applied to turfgrasses (Petrovic, 1990) determined that nitrate-nitrogen concentrations in soil water leaching through the surface soil exceeds drinking water standards of 10 ppm only on sandy soils when one of the following conditions exist: 1) high levels of soluble nitrogen are applied, greater than 3 lbs. N/1000 sq.ft. at one time; or 2) very frequent (daily) irrigation is practiced coupled with application of water soluble nitrogen sources. Minimizing nitrate movement is directly related to best management practices that control nitrogen sources and irrigation. This is accomplished by applying the correct nitrogen source at the correct time, rate, and location and by applying the correct amount of irrigation at the correct time, rate and location. Reports by Walker and Branham (1992) concluded that several management options are available to minimize or eliminate any threat to ground or surface water by 1) limiting irrigation to replacement of soil moisture; 2) using slow release nitrogen sources; 3) timing fertilizer applications in relation to active uptake; and 4) use of realistic nitrogen application rates. Leaching of nitrate nitrogen can be safely regulated by making controlled applications (spoon feeding or fertigation; Snyder et al. 1981, 1984, 1989), using controlled materials (slow-release or organic forms) or using a combination of these approaches. All of these factors are part of the management program for Silo Ridge Golf Course and when addressed should reduce or eliminate nonpoint source losses of nutrients from the golf course.

When a fertilizer is applied in excess of what the plant can use or when the turf is not actively growing due to temperature, water, light, lack of an individual nutrient, etc., much of the application could be lost from the golf course. For these reasons, before a fertilizer is applied, the limiting growth factors for the turfgrass should be considered. In addition, only a fertilizer containing the nutrients in the right form needed by the plant should be used and applied at the right rate and frequency. Plants will respond to fertilizer only if it contains a nutrient that is deficient.

The first step, then, in arriving at a sound fertilizer program at Silo Ridge Golf Course is to have the soil analyzed to determine pH, calcium, magnesium, phosphorus and potassium availability and balance. From this information a valid lime and fertilizer program can be developed with the assurance that excess nutrients will not be applied.

Nitrogen is the nutrient used by grasses in the largest quantities. Its function is to stimulate vegetative growth and provide the grass with green color. Nitrogen fertilization will be determined by color, density and rate of growth (clipping yields) of grass and tissue analyses. Controlled applications can be made by using soluble fertilizers and applying the materials with sprayers that have been calibrated to put out an accurate amount of material per acre. The superintendent can personally control the rate and frequency of fertilizer application, and thereby reduce the tendency to apply excessive amounts of nitrate and ammonium forms of nitrogen on an infrequent basis.

Materials such as natural organic sources (Milorgranite, Nature Safe, etc.), isobutylidene diurea (IBDU), methylene ureas (MU) and coated ureas (SCU, Polyon, Poly-S, Sulfurkote-II and others) are all slow-release (SR) nitrogen sources. They have the advantage of supplying a longer more uniform source of nitrogen, a lower salt index and reduced nitrogen leaching. By combining soluble nitrogen sources with the slow-release nitrogen products, availability can be extended to the grass without fear of nitrogen leaching into the groundwater.

6.2.2.1. *Basic Fertilizer Program*. All cool-season grasses such as creeping and colonial bentgrass, Kentucky bluegrass and fine fescues can be grown within a wide soil pH range. However, for optimum soil microbial activity and improved nutrient availability it is preferred to keep the pH in the 6.0 to 6.5 range.

The following discussion provides a general overview of nitrogen, phosphorus and potassium applications on various playing surfaces. Slow release sources of nitrogen are included in the fertilizer program and organic sources are encouraged if there is a need for additional phosphorus to be applied. Adjustments to the rates provided here will be made based on analyses which will include color, density and rate of growth (clipping yields) of grass and tissue analyses. It is also important to maintain a calcium to magnesium ratio of 10:1.

> ***Greens***. If the soil test shows that either dolomite for soil pH correction and/or phosphorus are needed, they should be applied during the aerifying operation so that as much as possible can be worked into the root zone. The addition of potassium should be made in three to four applications per year and applied at the rate of ½ to 1 pound per 1000 square feet. Slow release sources of nitrogen should be applied at the rate of ½ to 1.0 pound per 1000 square feet along with a soluble source (**Tables 6-3 and 6-4**). If spoon-feeding is being used, small increments of all nutrients can be applied every week or two. Exact application rates must be determined by the superintendent.
>
> ***Tees***. If phosphorus and dolomite are needed, the tee surfaces should be treated in the same manner as the greens, described above. Nitrogen and potassium should be applied at about the same rate as for the putting greens (**Tables 6-3 and 6-4**).

Table 6-3. eneral Fertilizer Applications on reens and Tees at Silo Ridge olf Course†			
Area	Nitrogen (lb/1000ft /yr)	Phosphorus¶ (lb/1000ft /yr)	Potassium (lb/1000ft /yr)
Greens	3 to 6	1 to 3	2 to 5
Tees	3 to 6	1 to 3	2 to 5

† Adjustments should be made based upon testing results and turf response.
¶ Only if the soil test analysis shows a deficiency.

Table 6-4. Suggested Fertilizer Schedule for reens and Tees for Silo Ridge olf Course†							
reens & Tees	Apr*	May	June	July	Aug	Sep*	Total
Nitrogen ($lb/1000ft^2/yr$)	WS 0.5	WS 0.5	Spoon feed 0.5	Spoon feed 0.5	Spoon feed 0.5	SR 1.0	4.5
	SR 0.5	SR 0.5					
Phosphorus¶ ($lb/1000ft^2/yr$)	0.25		0.4	0.4	0.4		1.45
Potassium ($lb/1000ft^2/yr$)	0.5	0.5	0.8	0.8	0.8	0.5	3.9

† Adjustments should be made based upon testing results and turf response.
* application may be reduced or eliminated after first several years.
WS = Water soluble, SR = Slow release or natural organic
¶ Only if soil test analysis shows a deficiency

Fairways. Dolomite and phosphorus applications would be based on soil test results and no individual application of nitrogen or potassium should exceed 40 pounds per acre with ½ the nitrogen from a slow release source (**Tables 6-5 and 6-6**).

Roughs. Roughs should be fertilized two times per year. Dolomite and phosphorus applications should be based on soil test results. Individual applications of nitrogen and potassium should not exceed 40 pounds per acre with ½ the nitrogen from a slow release source (**Tables 6-5 and 6-6**).

Table 6-5. eneral Fertilizer Applications on Fairways and Roughs at Silo Ridge olf Course†			
Area	Nitrogen (lb/acre/yr)	Phosphorus¶ (lb/acre/yr)	Potassium (lb/acre/yr)
Fairways	90 to 135	27 to 54	90 to 135
Roughs	45 to 90	0 to 45	45 to 90

† Adjustments should be made based upon testing results and turf response.
¶ Only if soil test analysis shows a deficiency

Table 6-6. Suggested Fertilizer Schedule for Fairways and Roughs (Pounds per acre per application) for Silo Ridge olf Course						
Fairways	May	June	July	Aug	Sep	Total
Nitrogen (lb/acre/yr)	SR 17.5	NO 22	NO 22	NO 22	SR 17	100
Phosphorus¶ (lb/acre/yr)		9	9	9		27
Potassium (lb/acre/yr)		17	17	17		51
Roughs	May	June	July	Aug	Sep	Total
Nitrogen (lb/acre/yr)		SR 22		SR 22		44
Phosphorus¶ (lb/acre/yr)	22.5					22.5
Potassium (lb/acre/yr)	45				45	90

† Adjustments should be made based upon testing results and turf response.
WS = Water soluble, SR = Slow release or natural organic
¶ Only if soil test analysis shows a deficiency

6.2.2.2. ***Fertigation.*** Fertigation is the process of fertilizing at low rates through the irrigation system. Fertigation can be used to apply low rates of fertilizer to supplement or substitute the proposed schedules listed previously. Snyder et al. (1989) in studies conducted in south Florida (where due to soil and weather conditions it is difficult to maintain balanced nutrition) concluded that turfgrass nitrogen uptake and subsequent plant growth was more uniform and the potential for leaching greatly reduced by fertigation compared to conventional fertilizer application. The use of these systems is becoming more popular in the NE US. It has not been decided whether a fertigation system will be used at Silo Ridge Golf Course. Any type of fertilizer can be used in the fertigation system including controlled release materials such as CoRoN 28-0-0 which is a controlled-release liquid nitrogen fertilizer with 70% of nitrogen coming from controlled release and 30% from water soluble urea. Other brands of fertilizer with similar slow-release nitrogen characteristics as CoRoN 28-0-0 may be used in the fertigation system, depending on the turf needs and site conditions. A state-of-the-art computerized irrigation system that has individual head control for each of the sprinklers allow for maximum flexibility as to adjustment of not only irrigation needs, but also of fertilization. It is integrated with the weather station located on site and estimates water needs based on the evapotranspiration of the turf.

Studies in Florida have focused on comparing nitrogen loss under sensitive soil conditions using various nitrogen sources and fertilizer application techniques. Snyder et al. (1981) found that the greatest amount of nitrogen leaching occurred from using a completely water soluble nitrogen source, 9.3% of the total applied, compared to slow release sources which ranged from 0.1 to 5.5% of the total applied on bermudagrass maintained under fairway conditions. Nitrate-N concentrations in the leachate water averaged only 1.4 ppm at the highest for the slowly available materials compared to 2.4 ppm for the water soluble sources. Other studies by Snyder et al. (1984) found that during periods of excessive irrigation and/or high rainfall, nitrogen leaching can be reduced by daily "fertigation", fertilizing at low nitrogen rates (⅛ lb of N/1000 sq.ft.) through the irrigation system as compared to applying soluble nitrogen tri-weekly at a rate equivalent to that applied by fertigation during a 3-week period. Subsequent work by Snyder et al. (1989) documented that working on a sand soil with a high percolation rate, nitrogen leaching was reduced by over 80% with the use of fertigation compared to conventional applications of granular soluble carriers. They concluded that turfgrass nitrogen uptake and subsequent plant growth was more uniform and the potential for leaching greatly reduced by fertigation compared to conventional fertilizer application. **Figure 6-2** show comparisons of fertigation versus conventional fertilization and irrigation for nitrogen losses. Fertigation provides a way to gradually feed the turf without having large quantities of nitrogen free in the environment at any one time.

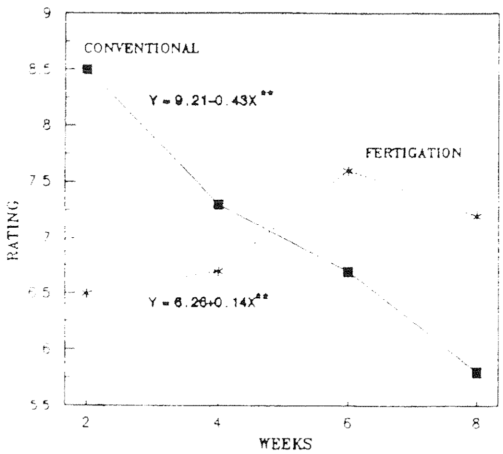


Fig. 1. Bermudagrass quality rating with time after N application by the Conventional method and with N applied by Fertigation.

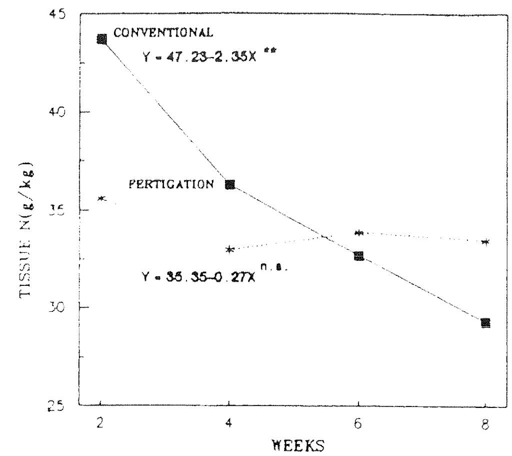


Fig. 2. Bermudagrass tissue N with time after N application by the Conventional method and with N applied by Fertigaton.

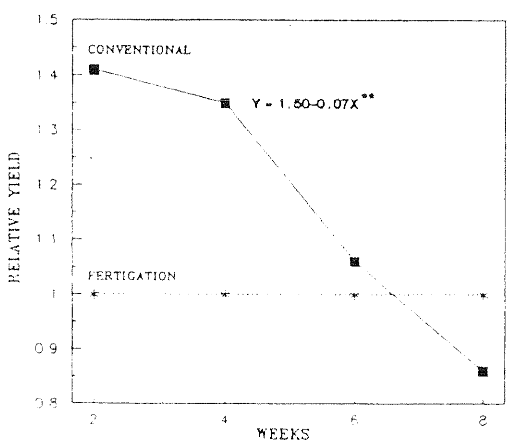


Fig. 3. Relative yield (Conventional/Fertigation) with time after N application by the Conventional method.

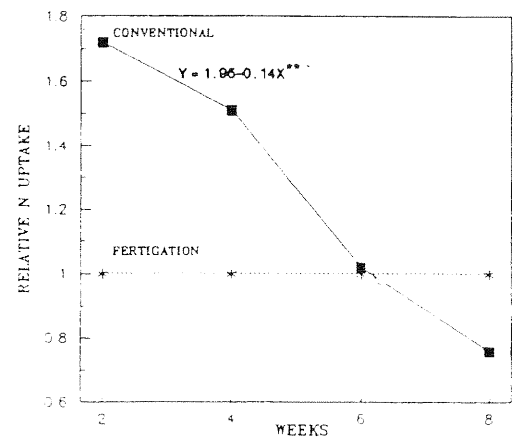


Fig. 4. Relative N uptake (Conventional/Fertigation) with time after N application by the Conventional method

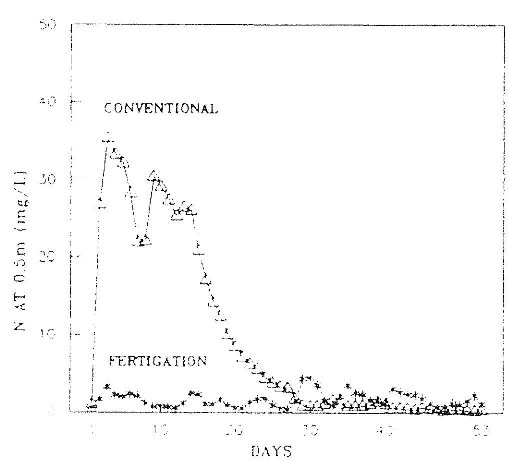


Fig. 5. Nitrogen at 0.5 meter depth with time after N application by the Conventional method and with N applied by Fertigation.

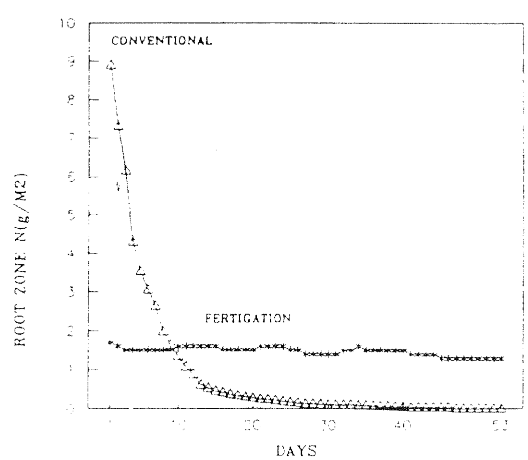


Fig. 6. Calculated rootzone N, expressed on an area basis (g/m2), with time after N application by the Conventional method and with N applied by Fertigation.

FOOTNOTE. ** and n.s. refer to significance at 0.01 and not significant, respectively.

Figure 6-2. Comparison of Fertigation versus Conventional Fertilization and Irrigation for Nitrogen Losses.

6.2.3 Supplementary Cultural Practices

To help develop and sustain quality turf, spiking, vertical mowing, aerifying, topdressing and rolling are used. These operations physically alter the plant's environment by removing and or relocating soil and organic materials or altering turf growth habit. These cultural practices should be performed only when turfgrasses are actively growing.

6.2.3.1. ***Spiking***. Spiking is most useful in breaking up soil surface compaction and improving moisture infiltration and gas exchange. In addition, it is useful in lifting the blades of grass before mowing to aid in preventing the turf from thatching.

6.2.3.2. ***Vertical Mowing***. When done on a timely basis, vertical mowing can be used to remove mower induced grain on greens and reduce thatch. In addition, vertical mowing can be used to thin turf so that a better job of reel mowing can be done. Also, vertical mowing is used to separate the soil from aerifier cores and mix the soil with the sand used to fill the aerifier holes and topdress the playing surface.

6.2.3.3. ***Aerifying***. The main purpose of aerification is to relieve surface compaction which in turn improves surface water infiltration, allows for good root penetration, provides for easier air exchange in the soil, improves nutrient uptake, removes excess thatch and increases turfgrass vigor. Two types of aerification are used. Coring involves removing plugs from the soil profile, thus allowing for lateral expansion of the remaining soil thereby relieving soil compaction. This is accomplished using an aerifier equipped with hollow coring tines. Using solid coring tines, or water injection can provide benefits to the soil by improving infiltration and soil aeration, but they do not relieve soil compaction. Both approaches are normally incorporated into management strategies. Core aerification on putting greens is commonly followed with topdressing.

6.2.3.4. ***Topdressing***. Topdressing aids in thatch decomposition, lessens grain development in the turf, stimulates new shoot growth, encourages stolon rooting and makes the ball roll true and faster. Although a small amount of thatch (¼ - ½ inch thick) is desirable to provide a certain amount of resiliency, thatch is the greatest single limiting factor in the development of fast, uniform greens. Although topdressing does not prevent the development of stems and roots which contribute to thatch buildup, it does keep the thatch separated to prevent dense, compacted mats from forming. By mixing suitable topdressing materials with the organic material, thatch layers, as such, will not develop and will decompose faster.

6.2.3.5. ***Rolling***. New light weight self propelled rolling equipment has made rolling a viable practice for smoothing the turf surface and improving green speed. It is frequently used in the summer months to allow a higher height of cut for improved stress tolerance while increasing green speeds. However, recent research has shown it can be overdone. Rolling more often than once or twice a week can lead to excess wear and compaction.

6.3 BASIC ANNUAL MAINTENANCE UIDE FOR SILO RIDGE OLF COURSE

The following remarks supplement the Basic Annual Maintenance Guide (**Table 6-7**) on the following pages. It should be noted that this basic program will need to be adjusted and fine tuned by the superintendent based on specific situations encountered at Silo Ridge Golf Course.

1. **Soil Analysis**: Sample representative greens, tees, fairways and roughs for analysis and recommendations. The primary purpose of soil testing is to insure nutrient availability and balance for good growth of the grass.

2. **Calibration of Equipment**: All spreaders and sprayers must be repaired, if needed, and calibrated for proper distribution of fertilizers and pesticides.

3. **Mowing**: Mowing is the most important and most time consuming maintenance operation on a golf course. Without regular mowing at the appropriate heights of cut, the course would become unplayable. With good mowing practices, density, texture, color, root development, wear tolerance and other aspects of turf quality are enhanced.

4. **Fertilizing**: The fertilizer program will be based on soil test results for pH, calcium, magnesium, phosphorus and potassium. Nitrogen fertilization will be determined by color, density and rate of growth (clipping yields) of the grass and tissue N content.

5. **Irrigation Program**: The irrigation regime is determined by a ET rates (see Water Conservation section). However, each time water is applied the system should

operate to wet the soil to the depth of rooting. When greens are stressed, hand water or syringe during the heat of the day in addition to regular night irrigation.

6. **Spiking**: This procedure is needed to relieve surface compaction and insure good gas exchange (oxygen and carbon dioxide).

7. **Vertical Mowing**: During the growing season, this operation is needed to reduce mower induced grain and thatch buildup, and to provide a smoother, faster putting surface.

8. **Aerifying**: Aerifying surfaces relieves compaction, increases soil and surface air exchange and improves fertilizer and water movement into the soil. This includes both coring and injection aerification practices.

9. **Topdressing**: In addition to following coring, topdressing should be applied once or twice per month during the growing season at the rate of one-quarter cubic yard per 1000 square feet. This practice not only helps control thatch, but also helps provide a smooth, true surface for mowing and accurate ball roll.

10. **Liming**: Apply dolomitic limestone to any area where soil test results indicate a need.

11. **Nematode Control**: May be needed infrequently. A soil nematode analysis will determine population levels and suggest treatment.

12. **Wetting Agent Applications**: If localized dry spots appear on the greens, apply a good quality wetting agent and water immediately to prevent yellowing of the grass.

13. **Raking and Edging Bunkers**: Bunkers need to be raked daily and edged a minimum of once per month.

14. **Weed Control**: Monitor for the presence of weeds. If the population becomes so large that it effects the playing surface, use the appropriate herbicide. Also see section on weed control in 'Specific Local Problems'.

15. **Insect Control**: Monitor daily for beetles, grubs, caterpillars and other insect pests. However, do not treat unless the pest is found, identified and present in damaging numbers or a chronic problem has been documented. Also see section on insect control in 'Specific Local Problems'.

16. **Disease Control**: During periods when disease or conditions favoring a disease outbreak are prevalent, inspect the surfaces daily and treat only as necessary. Also see section on disease control in 'Specific Local Problems'.

Table 6-7. Basic Annual Maintenance uide
Silo Ridge olf Course

OPERATION	J	F	M	A	M	J	J	A	S	O	N	D	Remarks
eneral													
Soil Analysis					X								1
Calibrate Equipment	X	X	X	X	X	X	X	X	X	X	X	X	2
reens:													
Mowing			X	X	X	X	X	X	X	X	X	X	3
Fertilizing				X	X	X	X	X	X				4
Irrigating				X	X	X	X	X	X	X			5
Spiking				X	X	X	X	X	X				6
Vertical Mowing				X	X	X			X	X			7
Aerifying			X		X		X		X	X			8
Topdressing			X	X	X	X		X	X	X		X	9
Liming					X								10
Disease Control			X	X	X	X	X	X	X	X			16
Weed Control				X	X	X	X	X	X				14
Insect Control					X	X	X	X	X				15, 11
Wetting Agents					X	X	X	X	X				12
Tees:													
Mowing			X	X	X	X	X	X	X	X	X		3
Fertilizing					X	X	X	X	X	X			4
Irrigating				X	X	X	X	X	X				5

Table 6-7. Basic Annual Maintenance uide
Silo Ridge olf Course

OPERATION	J	F	M	A	M	J	J	A	S	O	N	D	Remarks
Spiking				X	X	X	X	X	X				6
Vertical Mowing					X	X			X				7
Aerifying			X		X				X				8
Topdressing					X	X			X				9
Disease Control			X	X	X	X	X	X	X	X			16
Weed Control				X	X	X	X	X	X				14
Insect Control					X	X	X	X	X				15
Liming				X									10
Fairways:													
Mowing			X	X	X	X	X	X	X	X	X		3
Fertilizing					X	X		X	X				4
Irrigating					X	X	X	X	X				5
Aerifying						X							8
Disease Control						X	X	X	X				16
Weed Control				X	X	X	X	X	X				14
Insect Control					X	X	X	X	X				15
Liming					X								10
Roughs:													
Mowing				X	X	X	X	X	X	X	X		3
Fertilizing					X				X				4
Irrigating					X	X	X	X	X				5
Liming						X							10
Bunkers:													
Raking & Edging			X	X	X	X	X	X	X	X	X		13

6.4 PESTICIDE SELECTION

The objectives of pesticide selection are to:

1. Identify those pesticides (fungicides, insecticides, and herbicides) which, when applied in accordance with label specifications, will pose only negligible risk to human health or the environment,

2. Establish a list of pesticides for use at the golf course restricted, to the maximum extent practical, to only those pesticides determined to pose negligible risk to human health and the environment, and

3. Identify special restrictions for the limited use of specific pesticides when their use, in the absence of such restrictions, could pose more than a negligible risk to human health and/or the environment.

The U.S. Environmental Protection Agency (EPA) has established a procedure for assessing the risk of pesticide use to human health and the environment (Urban and Cook, 1986 and Touart, 1995). The risk assessment procedure is designed to provide a comparison of maximum anticipated pesticide concentrations in ground and surface waters against specific standards defining toxicity (i.e., effects criteria). If the maximum anticipated concentration of a given pesticide exceeds the effects criteria for that pesticide, it is presumed that a risk of impact exists. Likewise, if the maximum anticipated concentration of a given pesticide is less than the effects criteria for that pesticide, it is presumed that only a negligible risk of impact exists. The sensitivity of the assessment depends on the assumptions used in estimating maximum anticipated concentration and the setting of the effects criteria. A high sensitivity assessment (i.e., one which produces a conservative or "worst case" risk designation) is one which is based on "worst case" assumptions with regard to application rates and environmental conditions and incorporates low effects criteria. A less sensitive assessment is one which is based on less than "worst case" assumptions with regard to application rates and/or environmental conditions and incorporates higher effects criteria. This procedure represents a rational approach to assessing the risks associated with pesticide use in that it is based on both sound science concerning toxicity and reality concerning actual use practices and environmental conditions.

In selecting pesticides for use at Silo Ridge Golf Course, a high sensitivity, single-step risk assessment was conducted. This single-step assessment was conducted using the "worst case" assumptions used under Tier 1 of the EPA-supported assessment procedure, and the effects criteria) were conservatively set to evaluate the acute and chronic aquatic toxicity and human health toxicity. Toxicity was evaluated with US EPA approved screening models for pesticides (GEENEC and SCI-GROW; USEPA 1995; see **Appendix I** for details). Exposure concentrations (model output) generated from each of these models are considered by EPA to be reasonable, conservative estimates of pesticide concentrations. Once exposure concentrations (model output) were determined, acute and chronic aquatic toxicity and human health toxicity were evaluated as follows:

1. Acute Aquatic = Peak runoff [a] / LC_{50}
2. Chronic Aquatic = (Avg 21-day runoff)[a] / (LC_{50} * 0.1)[b]
   where:
   [a] peak runoff and average 21-day runoff are from "worst case" expected concentrations as determined by the US EPA model GEENEC
   [b] the chronic toxicity is estimated using LC_{50}*0.1; this is a conservative factor that estimates chronic values (Suter et al., 1981; Warren-Hicks et al., 1989,1995)
3. Human Health = model output [c]/HAL [d]
   where:
   [c] the model output is from the US EPA model SCI-GROW
   [d] HALs are the US EPA Health Advisory Levels for each chemical.

Negligible risk is assumed if the quotients for the equations are less than 1. If the quotient for expected risk (i.e., results for equations 1, 2, & 3 above) is greater than 1, then potential for risk is assumed. Pesticides selected for use at the project had quotients less than 1.0. Only those pesticides found to have a negligible risk associated with their use on the golf course (i.e., the maximum anticipated concentration is less than the effects criteria), were selected for use on the course.

The following steps were taken to select pesticides that are the most appropriate for Silo Ridge Golf Course.

1. Identify pests that are likely to be a problem at the golf course (Sections 6.5.1, 6.5.2, and 6.5.3).
2. Identify a suite of pesticides that effectively and efficiently treat the pest problems and that are registered for use in New York (listed in Appendix I).
3. Evaluate each pesticide with an EPA approved Tier I risk assessment so that selection may be protective of the environment (results given in Appendix I).
4. Select pesticides that may be used at the golf course based on the results of the risk assessment (Summary Table 6-8, Fungicides are given in Table 6-10; Insecticides are given in Table 6-13; and Herbicides are given in 6-16).
5. Implement Integrated Pest Management practices to minimize the need for pesticides (Section 6.5).
6. Evaluate the pesticides on site with the ongoing monitoring program (See Section 8).

The list of approved pesticides are given in **Table 6-8**. **Table 6-9** lists pesticides that can be used in the Special Management Zones. The specific pesticides selected for use at Silo Ridge Golf Course are listed in **Tables 6-10** (fungicides), **6-13** (insecticides), and **6-16** (herbicides). These tables identify the selected pesticide by target pest and define a use hierarchy based on an Environmental Impact Quotient (EIQ). The EIQ represents a pesticide ranking based on factors which define impact potential relative to other pesticides and pest control strategies. The EIQ is described in Kovach et al. (1992) and updates to the listing are posted on the internet. Within the tables pesticides are ranked for use according to their EIQ wherever an EIQ has been determined. Those with a lower EIQ are preferred over those with a higher EIQ. Note that the EIQ neither replaces nor supersedes the results of the risk assessment, it merely supplements those results for the purpose of ranking preferences.

Table 6-8. Pesticides† Approved for Use at Silo Ridge olf Course.
dated

Fungicides	Insecticides	Herbicides	Plant rowth Regulators
azoxystrobin	acephate	2,4-D amine	paclobutrazol
etridiazole	azadirachtin	bensulide	trinexapac
fenarimol	bifenthrin	bentazon	
fosetyl-Al	carbaryl	carfentrazone	
flutalanil	fipronil	clopyralid	
fludioxanil	halofenozide	dicamba	
iprodione	imidacloprid	dithiopyr	
metalaxyl/mefenoxam	spinosad	ethofumasate	
myclobutanil		fenoxaprop	
polyoxin D		fluroxypyr	
propamocarb		glyphosate	
propiconazole		halosulfuron	
pryraclostrobin		MCPA	
thiophanate methyl		mecoprop	
triadimefon		oxadiazon	
trifloxystrobin		pendimethalin	
vinclozolin		prodiamine	
		quinclorac	
		rimsulfuron	
		sulfentrazone	
		triclopyr	

† All materials must be applied at rates and under conditions prescribed by the label.

6.4.1 Pesticides That Can Be Used in Special Management Zones

Selected pesticides that can be used in Special Management Zones are given in **Table 6-9**. These restrictions supplement the basic restrictions specified on manufactures' labels. The use of any pesticide with a HAL or with a LC_{50} of less than 50 ppb is to be prohibited within the Special Management Zones defined under Section 4.1 (i.e., within 50 feet of a wetland or watercourse).

Table 6-9. Pesticides† That May be Used in Special Management Zones dated

Fungicides	Insecticides	Herbicides
azoxystrobin fosetyl-Al flutalanil fludioxanil iprodione metalaxyl/mefenoxam myclobutanil propamocarb propiconazole	imidacloprid spinosad	bentazon carfentrazone clopyralid dicamba ethofumasate fluroxypyr glyphosate halosulfuron pendimethalin quinclorac rimsulfuron sulfentrazone triclopyr

† All materials must be applied at rates and under conditions prescribed by the label.

6.5 Specific Local Problems

As a component of IPM, the golf course superintendent must make decisions about pest problems and develop control recommendations including the judicious use of pesticides. **Figure 6-1** is the suggested flow chart for decision making at Silo Ridge Golf Course based on IPM strategies (see Integrated Pest Management section). Strategies include identifying an anticipated pest complex; monitoring conditions which affect the interrelationship of disease infection and expression of symptoms, noting temperature ranges when diseases most prevalent on cool-season grasses are active; and identifying timing for optimum insect and weed control. As part of the strategy, pesticides approved based on the pesticide analysis previously noted in this plan are suggested for use with each specific pest given limitations based on the labeling and risk assessment.

All recommendations are consistent with those from the Cornell University Cooperative Extension Service except more stringent requirements have been applied regarding pest management decisions for pesticide use.

6.5.1 Disease Control

Disease control is discussed in terms of cultural control and then guidelines for disease management are given. Disease incidence is closely linked to environmental factors primarily temperature, humidity, amount of sunshine, and longevity of leaf wetness. The temperature ranges which favor development and growth of turfgrass pathogens are given in **Figure 6-3**. As part of IPM strategies, logging of daily temperature information is critical to observe when disease development is favored. While this approach is helpful for many diseases, there are several in which infection and expression of symptoms are distinctly different (**Figure 6-4**). For these specific pests, a preventative approach is suggested. Fungicides which are recommended for use at Silo Ridge Golf Course are listed in **Table 6-10.** Selection is by the risk assessment process that is detailed in the Pesticide Selection section. Also considered in this selection process was concern over development of pesticide resistance among disease organisms.

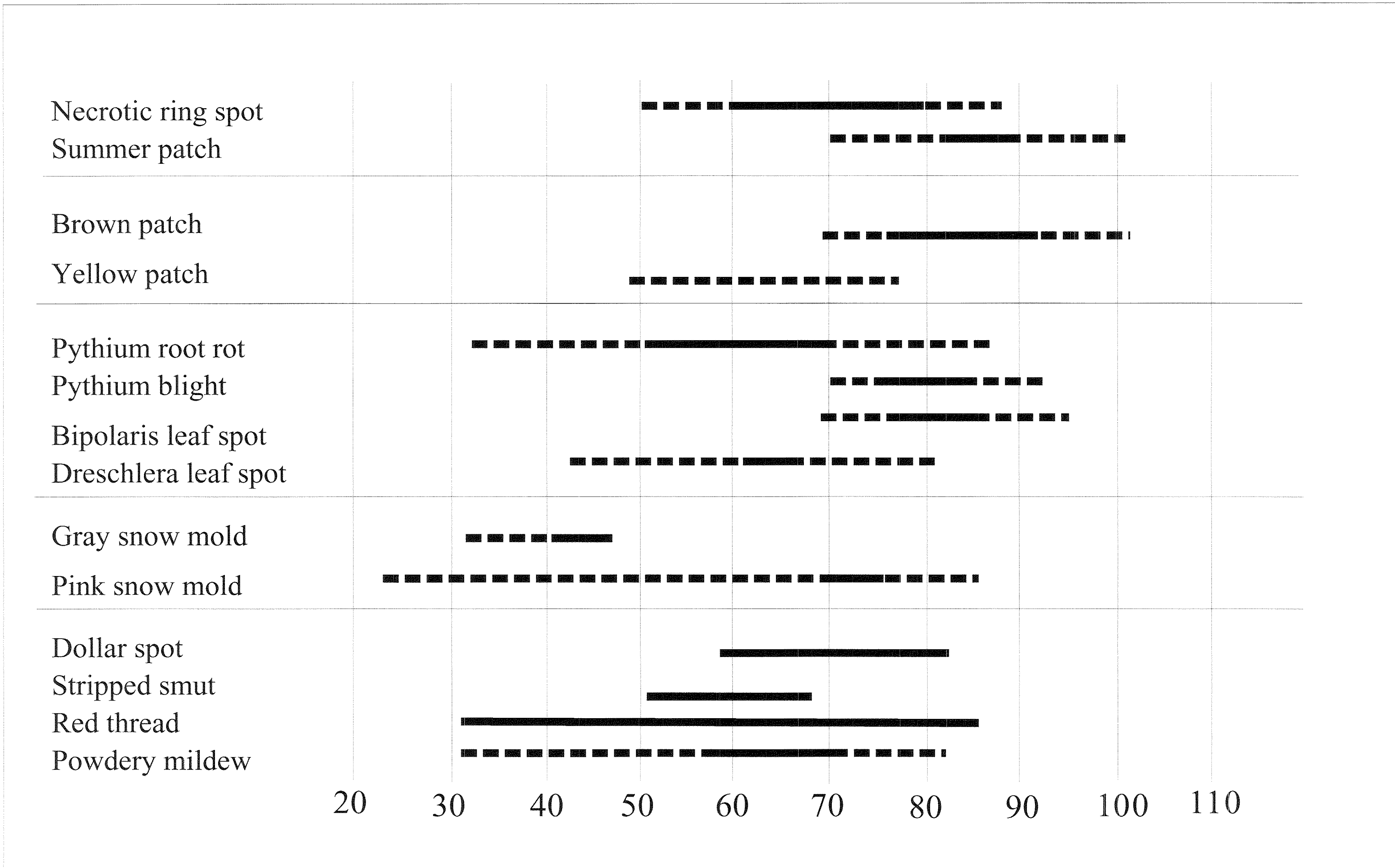


Figure 6-3. Turf Disease Pathogens Growth Temperature Ranges (°F). Solid lines note when disease is most active.

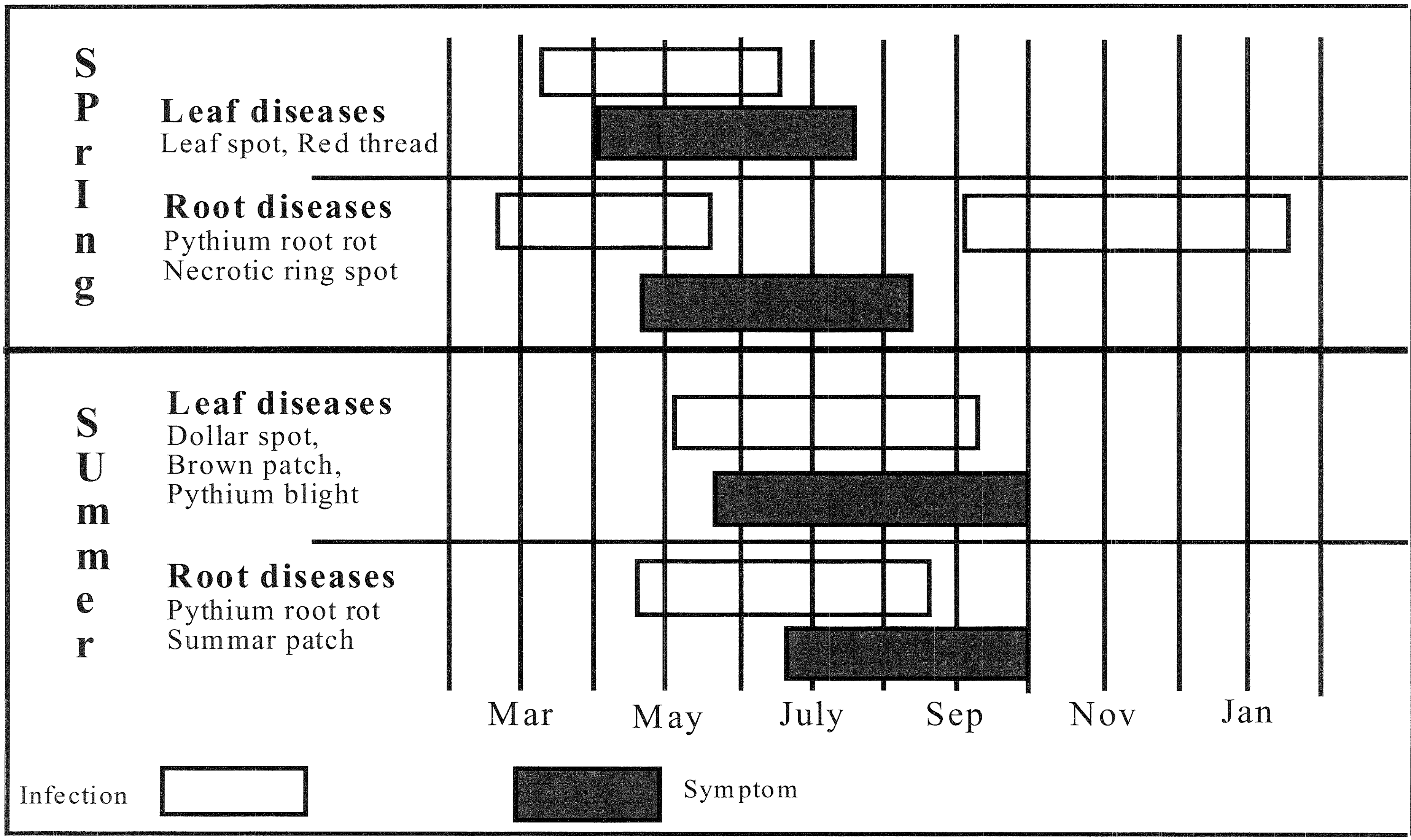


Figure 6-4. Disease Infection and Symptom Relationships.

Table 6-10. Fungicides† Recommended for Control of Specific Turfgrass Diseases at Silo Ridge olf Course.
dated

Disease	reens/Tees	Fairways/Roughs
Anthracnose	① azoxystrobin, myclobutanil, propiconazole, trifloxystrobin ② fenarimol ③ triadimefon, ④ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086	① azoxystrobin, myclobutanil, propiconazole, trifloxystrobin ② fenarimol ③ triadimefon, ④ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086
Brown Patch	① azoxystrobin, myclobutanil, polyoxin D, propiconazole, trifloxystrobin ②vinclozolin ③ fenarimol, iprodione ④ flutalanil, triadimefon ⑤ thiophanate-methyl Biologicals: *Trichoderma harzianum*	① azoxystrobin, myclobutanil, polyoxin D, propiconazole, trifloxystrobin ②vinclozolin ③ fenarimol, iprodione ④ flutalanil, triadimefon ⑤ thiophanate-methyl Biologicals: *Trichoderma harzianum*
Copper Spot	① myclobutanil ② fenarimol, iprodione ③ triadimefon ④ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086	① myclobutanil ② fenarimol, iprodione ③ triadimefon ④ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086
Dollar Spot	① myclobutanil, propiconazole ② vinclozolin ③ fenarimol, iprodione ③ triadimefon ④ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086, *Trichoderma harzianum*, *Pseudomonas aureofaciens* Strain Tx-1	① myclobutanil, propiconazole ② vinclozolin ③ fenarimol, iprodione ③ triadimefon ④ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086, *Trichoderma harzianum*, *Pseudomonas aureofaciens* Strain Tx
Downey Mildew	①mefenoxam ② fosetyl-Al	①mefenoxam ② fosetyl-Al

Table 6-10. Fungicides† Recommended for Control of Specific Turfgrass Diseases at Silo Ridge olf Course. dated		
Disease	**reens/Tees**	**Fairways/Roughs**
Microdochium patch	① azoxystrobin, fludioxanil, myclobutanil, Polyoxin D, propiconazole, trifloxystrobin ② vinclozolin ③ fenarimol, iprodione ④ triadimefon ⑤ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086	① azoxystrobin, fludioxanil, myclobutanil, Polyoxin D, propiconazole, trifloxystrobin ② vinclozolin ③ fenarimol, iprodione ④ triadimefon ⑤ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086
Bipolaris and Dreschlera Leaf Spots	①azoxystrobin, Polyoxin D, trifloxystrobin ②vinclozolin ③iprodione Biologicals: *Bacillus licheniformis* Strain 3086	①azoxystrobin, Polyoxin D, trifloxystrobin ②vinclozolin ③iprodione Biologicals: *Bacillus licheniformis* Strain 3086
Necrotic Ring Spot	① azoxystrobin, myclobutanil, propiconazole ② fenarimol, iprodione ③ thiophanate-methyl	① azoxystrobin, myclobutanil, propiconazole ② fenarimol, iprodione ③ thiophanate-methyl
Powdery Mildew	① myclobutanil, propiconazole ② fenarimol ③ triadimefon ④ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086	① myclobutanil, propiconazole ② fenarimol ③ triadimefon ④ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086
Pythium Blight	① azoxystrobin, ② mefenoxam, metalaxyl ③ etridiazole, fosetyl-Al, propamocarb Biologicals: *Trichoderma harzianum*	① azoxystrobin, ② mefenoxam, metalaxyl ③ etridiazole, fosetyl-Al, propamocarb Biologicals: *Trichoderma harzianum*
Pythium Root Rot	① azoxystrobin ② mefenoxam, metalaxyl ③ fosetyl-Al, propamocarb	① azoxystrobin ② mefenoxam, metalaxyl ③ fosetyl-Al, propamocarb

Table 6-10. Fungicides† Recommended for Control of Specific Turfgrass Diseases at Silo Ridge olf Course. dated		
Disease	**reens/Tees**	**Fairways/Roughs**
Red Thread	① azoxystrobin, myclobutanil, Polyoxin D, propiconazole, trifloxystrobin ② vinclozolin ③ fenarimol, iprodione, ④ flutalanil triadimefon ⑤ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086	① azoxystrobin, myclobutanil, Polyoxin D, propiconazole, trifloxystrobin ② vinclozolin ③ fenarimol, iprodione, ④ flutalanil triadimefon ⑤ thiophanate-methyl Biologicals: *Bacillus licheniformis* Strain 3086
Rust	① azoxystrobin, myclobutanil, propiconazole, trifloxystrobin ② vinclozolin ③ triadimefon ④ thiophanate-methyl	① azoxystrobin, myclobutanil, propiconazole, trifloxystrobin ② vinclozolin ③ triadimefon ④ thiophanate-methyl
Summer Patch	① azoxystrobin, fludioxanil, myclobutanil, propiconazole, trifloxystrobin ② fenarimol, iprodione ③ triadimefon ④ thiophanate-methyl	① azoxystrobin, fludioxanil, myclobutanil, propiconazole, trifloxystrobin ② fenarimol, iprodione ③ triadimefon ④ thiophanate-methyl
Take-all Patch	① azoxystrobin ② fenarimol	① azoxystrobin ② fenarimol
Typhula Blight	① azoxystrobin, fludioxanil, propiconazole, Polyoxin D ② vinclozolin ③ fenarimol, iprodione, ④ flutalanil, triadimefon Biologicals: *Bacillus licheniformis* Strain 3086	① azoxystrobin, fludioxanil, propiconazole, Polyoxin D ② vinclozolin ③ fenarimol, iprodione, ④ flutalanil, triadimefon Biologicals: *Bacillus licheniformis* Strain 3086

Table 6-10. Fungicides† Recommended for Control of Specific Turfgrass Diseases at Silo Ridge olf Course. dated		
Disease	**reens/Tees**	**Fairways/Roughs**
Yellow Patch	① azoxystrobin, myclobutanil, propiconazole, Polyoxin D, trifloxystrobin ② vinclozolin ③ fenarimol, iprodione ④ flutaolanil, triadimefon ⑤ thiophanate-methyl Biologicals: *Trichoderma harzianum*	① azoxystrobin, myclobutanil, propiconazole, Polyoxin D, trifloxystrobin ② vinclozolin ③ fenarimol, iprodione ④ flutalanil, triadimefon ⑤ thiophanate-methyl Biologicals: *Trichoderma harzianum*

† All materials must be applied at rates and under conditions prescribed by the label.
* Ecological risk assessment protocols were used to select pesticides, see Pesticide Selection section. Pesticides are numbered based on EIQ protocols, and pesticides with lowest number are preferred, see Pesticide Use Restrictions section.
[a] Pesticides without a number don't have EIQ assigned by Cornell University.

The development of fungicide resistance can be minimized by (1) alternating fungicides with different modes of action; (2) using fungicides with different modes of action in mixtures; or (3) alternating or mixing systemic fungicides with contact fungicides to give the desired disease control. Systemic fungicides listed in **Table 6-11** within each fungicide class have the same mode of action. Those in different fungicide classes have different modes of action. Therefore, broad-spectrum systemic fungicides that control many different turfgrass diseases should always be mixed or alternated between fungicide classes and never within a fungicide class. Likewise, fungicides specific for *Pythium* diseases should always be mixed or alternated between classes.

Table 6-11. Major Chemical roups of Turfgrass Fungicides		
Chemical Family	**Common Name**	**Comments**
Benzimidazole	thiophanate-methyl	Acropetal penetrant fungicide. Mode of action: fungicide binds tubulin subunits that result in mitotic arrest.

Table 6-11. Major Chemical roups of Turfgrass Fungicides		
Chemical Family	**Common Name**	**Comments**
Carboximides	flutalanil	Acropetal penetrant fungicide. Basidiomycetes control. Mode of action: blocks activity of certain respiratory enzymes.
Demethylation inhibitors (DMIs)	fenarimol myclobutanil propiconazole triadimefon	Broad-spectrum, acropetal penetrant fungicide. Mode of action: inhibits sterol (ergosterol) synthesis in fungal cell membrane.
Dicarboximides	iprodione vinclozolin	Broad-spectrum, acropetal penetrant fungicide. Mode of action: affects DNA synthesis and lipid metabolism.
Dithiocarbamates and carbamates	propamocarb	Pretectant fungicide. Mode of action: mancozeb - enzyme inactivation; propamocarb - alters cell membrane function.
Phenylamides	mefenoxam	Acropetal penetrant fungicide. Mode of action: inhibits RNA synthesis.
Phosphonates	fosetyl-Al	Systemic fungicide. Mode of action: direct fungitoxic effect.
Strobilurins	azoxystrobin trifloxystrobin	azoxystrobin - Broad-spectrum, acropetal penetrant fungicide. trifloxystrobin - Broad-spectrum, localized (mesostemic).

Anthracnose. This disease is more severe under low nitrogen levels and is particularly severe on turf exposed to soil compaction and excess thatch. Creeping bentgrass is less susceptible than annual bluegrass. Controlling annual bluegrass will minimize turf problems. Daily scouting during periods of warm weather is highly recommended.

Brown Patch. Controlling thatch levels and avoiding excess nitrogen will aid in controlling disease incidence. Use of several natural organic fertilizer/composts in the fertilization/ topdressing programs have been shown to reduce the incidence of brown patch by up to 75% (Nelson, 1990). Daily scouting during periods of warm weather is highly recommended.

Copper Spot. Disease is severe on turf fertilized with high levels of nitrogen (>½ lb. N/1000 sq.ft./month). Increase air circulation and decrease shade. Apply lime to keep pH in the 6.0 to 7.0 range.

Dollar Spot. Favored by low nitrogen levels and dry conditions. Use of several natural organic fertilizers/ composts has also been shown to reduce incidence by up to 45% (Nelson, 1990). This disease is slow to develop and cause damage, therefore daily scouting during the months which favor disease development should preclude treatment except on a curative basis.

Downey Mildew. Avoid excess N and excess watering. Iron sulfate may mask symptoms.

Fusarium Blight. Avoid excess N and keep adequate soils levels of P and K. Avoid drought. Keep leaf blades dry. Avoid irrigation in late afternoon and in evening.

Leaf Spots - Bipolaris and Dreschlera. Cooler temperatures favor development, primarily during April and May. Avoiding heavy spring fertilization can reduce the damage and water to avoid drought stress.

Necrotic Ring Spot. This disease occurs in cool-wet weather and is most severe with excessive soluble nitrogen fertilization and over- or under-watering. Therefore, this is an exception to scouting and spot treatment approach in that a preventative strategy must be employed on areas with a history of disease development.

Microdochium patch. This is most prevalent during cold temperatures (32 to 40°F) and wet conditions. Avoiding late fall nitrogen applications can reduce the severity.

Powdery Mildew. Reduce shade to increase air circulation. Avoid excess N.

Pythium Blight. This is a rapidly developing and devastating disease. It is favored by excessive nitrogen fertilization and very wet and hot weather. An attack can result in the death of an entire green, tee or fairway in a matter of hours. Because of the severity, a preventative approach is taken during weather conditions which favor disease development or curative upon detection of any disease incidence.

Pythium Root Rot. Improve drainage. Reduce shade.

Red Thread. Avoid N deficiency and low pH. Maintain moderate levels of P and K. Reduce shade and increase air circulation to enhance drying of turf.

Rust. Disease is severe on turf grown under low fertility. Maintain moderate and balanced fertility throughout the growing season. Reduce shade and increase air circulation. Increase mowing height. Avoid drought stress.

Summer Patch. More common on Kentucky bluegrass. Over fertilization with nitrogen and excessive irrigation increase the likelihood of disease development. Damage to the plant occurs in April and May, prior to symptom development (**Figure 6-4**).
A preventative fungicide program is suggested on areas with a history of Summer Patch programs.

Take-all Patch. Avoid heavy lime applications. Lower pH in top inch of soil using an acid-forming fertilizer such as ammonium sulfate. Improve drainage.

Typhula Blight or Gray Snow Mold. This requires snow cover for the disease to develop. Winters with little or no snow fall usually have a low incidence of disease. Avoiding over fertilization with nitrogen in the mid-fall reduces the severity. A preventative fungicide program should be used before long lasting snow cover to ensure minimal turf damage. Peak snow cover occurs in December, January and February in this location.

Yellow Patch. Avoid excess N. Maintain moderate to high levels of K according to soil tests. Reduce shade and increase air circulation. Reduce thatch thickness to 1/4 inch or less.

6.5.1.1. *Guidelines for Disease Management*. No annual fungicide program can, nor should, be developed for Silo Ridge Golf Course. Under the IPM approach, many diseases are treated curatively and not on a preventative basis. The need for excessive preventative and curative applications is minimized by sound cultural programs, practicing routine scouting and monitoring of turf and environmental conditions.

Research into the use of introduced biological control agents has yielded only minimal results in effectiveness. This is because there are three basic components to biocontrol systems. These are as follows:

1. A highly effective biocontrol strain or other material must be obtained or produced;
2. Inexpensive production and formulation of the biocontrol agent or other material in question must be developed; and
3. Delivery and application methods that permit the full expression of the biocontrol agent.

Several bacteria (*Bacillus licheniformis* Strain 3086 and *Pseudomonas aureofaciens* Tx-1) and a fungus, *Trichoderma harzianum* is labeled as a biological control agent for turfgrass. When added to turf, the granular formulation results in establishment of the organism on roots and suppresses diseases such as *Sclerotinia homoeocarpa* (dollar spot), and *Magnaporthe poae* (summer patch). However, the pathogens may survive in sufficient numbers to cause disease. Once the pathogens are established on the foliage, the soil-applied biocontrol agent no longer can protect the plant. The granular formulation can therefore result in disease reduction, but it must be used in conjunction with compatible chemical fungicides. The use of this biological control will be evaluated on putting greens at Silo Ridge Golf Course to determine its effectiveness at suppressing disease.

The following guidelines under which disease management by use of fungicides may be initiated are provided for each area of the golf course for specific diseases:

> *Anthracnose*. On greens and tees, curative upon detection of any incidence. On fairways, treatment upon detection of 2 to 3 incidences which are 2 to 4 inches in diameter per 100 sq.ft.

Brown Patch. On greens and tees, curative treatment upon detection of any incidence. On fairways, treatment upon detection of 2 to 3 incidences which are 2 to 4 inches in diameter per 100 sq.ft. In roughs, only when incidences exceed 4 to 6 per 100 sq.ft. and are 4 to 6 inches in diameter and weather conditions are favorable for further disease development per **Figure 6-3**.

Copper Spot. On greens and tees, curative treatment upon detection of any incidence. On fairways, treatment upon detection of 2 to 3 incidences which are ½ to 1 inch in diameter per 100 sq.ft.

Dollar Spot. On greens and tees, curative treatment upon detection of any incidence. On fairways, treatment upon detection of 2 or more incidences which are greater than 0.5-inch diameter per square foot. In roughs, only when incidences with a diameter greater than 0.75 inch exceed 4 to 6 per sq.ft. and weather conditions are favorable for further disease development per **Figure 6-3**.

Downey Mildew. Curative upon any detection in any turf area.

Leaf Spots. On greens and tees, curative treatment upon detection of any incidence which is forming patches or thinning the turf. On fairways, when incidences of patches exceed 2 to 3 per sq.ft. or when the turf appears to be thinning. In rough, only when incidences appear to be thinning the turf.

Microdochium patch. On greens and tees, curative treatment upon detection of any incidence. On fairways, treatment upon detection of 2 to 3 incidences which are ½ to 1 inch in diameter per 100 sq.ft.

Necrotic Ringspot. Preventative treatments must be applied to greens and tees which have a previous history of infection when cool-wet weather occurs. On fairways and roughs, treatment should occur upon detection of any incidence.

Pink Snow Mold. On all areas, curative upon detection of any incidence prior to any snowfall. Preventative prior to snowfall which will provide prolonged cover.

Powdery Mildew. Curative upon detection on any turf area.

Pythium Root Rot and Pythium Blight. Upon detection of any incidence on any area. This disease is easily spread if in the blight stage. The root rot form is exceptionally damaging since it requires long recovery periods, often during summer months when temperature conditions are not favorable for root growth.

Red Thread. On greens and tees, curative treatment upon detection of any incidence. On fairways and roughs, treatment upon detection of 2 to 3 incidences which are 1 to 2 inches in diameter per 100 sq.ft..

Summer Patch. Curative on any area where incidence is noted. Preventative on areas which have a previous history in April and May, prior to symptom development (**see Figure 6-4**).

Take-all Patch. Curative upon detection on any turf area.

Typhula Blight or Gray Snow Mold. Preventative prior to snowfall.

Yellow Patch. On greens and tees, curative treatment upon detection of any incidence. On fairways and roughs, treatment upon detection of 2 to 3 incidences which are 2 to 4 inches in diameter per 100 sq.ft..

6.5.1.2. ***Fungicide Resistance.*** Continual use of fungicides with similar control mechanisms can result in fungi that are resistant to some chemicals. Poor or ineffective disease control can be expected when this occurs. The chances of this happening can be reduced by mixing or alternating fungicides with different modes of action. The types of fungicides and their sites of action are noted in **Table 6-11**. Fungicides should be rotated among those with different modes of action every third application.

6.5.2 Insect Control

The management of insect pests rarely relies on a single control practice; usually a variety of tactics are integrated to maintain pests at acceptable levels. The goal of IPM is not to eliminate all pests; rather the aim is to reduce pest populations to less than damaging numbers. The decision to use an insecticide, or take some other action, against an insect infestation requires an understanding of the level of damage or insect infestation which can be tolerated without an unacceptable loss. Suggested thresholds for specific areas of the golf course before chemical treatment is necessary are given in **Table 6-12** and have been adapted from Hellman (1992), Bhowmik et al. (1991) and Villani (1992). Sampling is essential and must be conducted by a trained individual at regular intervals throughout the growing season.

Insect problems at this course will be minimal and will include, primarily, root feeding grubs. Routine scouting and sampling of turf for adults and grubs can isolate areas of concern and target control measures.

Table 6-12. Suggested Thresholds for Treatment of Insect Problems at Silo Ridge olf Course.

Insects	reens and Tees (#/sq.yd.)	Fairways and Roughs (#/sq.ft.)	#/cup cutter core
Grubs			
Japanese beetle	4	4 to 10	any
European chafer	4	4 to 6	any
Asiatic garden beetle	5	5 to 18	2
Oriental beetle	5	5 to 7	any
Hyperodes weevil	30	30 to 50	10
Billbugs	5	5 to 18	1
Black Turfgrass Ataenius Beetle	6	6 to 12	3 to 5
Cutworms	4	4 to 8	1
Sod Webworms, Fall Armyworms	5	3 to 5	1

Insecticides may be divided into two broad categories: (a) conventional or chemical or synthetic materials; and (b) biorational. Conventional or chemical insecticides have a broad spectrum of activity and are more detrimental to natural enemies. In contrast, insecticides that are more selective because they are most effective against insects with certain feeding habits, at certain life stages, or within certain taxonomic groups, are referred to as "biorational" pesticides.

Biorational pesticides are generally less toxic and more selective, and are generally less harmful to natural enemies and the environment. These include microbial-based insecticides such as Bacillus thuringiensis products, chemicals such as pheromones that modify insect behavior, insect growth regulators and insecticidal soaps.

While nonchemical treatments such as parasitic nematodes and bacteria for insect control are available, they do not give the degree of consistency, reliability and versatility and are proven ineffective in many circumstances (Potter, 1993). Biorational materials which could be considered for use in New York include: 1) Milky spore disease, a bacteria that infects Japanese beetle grubs and has been applied extensively on turfgrass in the Northeast for many years, but is of questionable value in New York state because (a) the bacteria is most infective to Japanese beetle grubs and is of limited value against other common grub species infesting turfgrass in New York; (b) soil temperatures in New York are often too cool for rapid disease buildup; and ©) milky disease bacteria can only multiply within the living bodies of grubs; thus one must be willing to tolerate a period of relatively high grub populations to obtain disease levels sufficient to control grubs. The use of entomogenous (insect parasitic) nematodes as a control cannot be given unqualified endorsement at this time. Nematodes have provided grub control equal or superior to that of currently labeled turf insecticides, but the number of failures is sufficient to caution their use. Failures have been traced to the use of nematodes in poor physical conditions; the use of nematode strains not well suited for control of grubs; and soil conditions that prevent nematodes from surviving, reproducing, or persisting in the field.

Insecticides which are recommended and approved based on the selection guidelines previously noted are listed in **Table 6-13**.

Table 6-13. Insecticides† Recommended for Control of Specific Turfgrass Insects at Silo Ridge olf Course.
(Updated 5/22/07)

Insect	reens/Tees	Fairways/Roughs
Annual bluegrass and *Hyperodes* weevils	① bifenthrin, halofenozide, imidacloprid ② carbaryl	① bifenthrin, halofenozide, imidacloprid ② carbaryl
Black turfgrass ataenius	① bifenthrin, halofenozide, imidacloprid ② carbaryl (larvae only)	① bifenthrin, halofenozide, imidacloprid ② carbaryl (larvae only)
European crane flies	① imidacloprid ② carbaryl	① imidacloprid ② carbaryl
White grubs	① azadirachtin, bifenthrin, halofenozide, imidacloprid ② acephate, carbaryl Biologicals: *Beauveria bassiana*	① azadirachtin, bifenthrin, halofenozide, imidacloprid ② acephate, carbaryl Biologicals: *Beauveria bassiana*
Armyworms, Cutworms Sod webworms	① azadirachtin, bifenthrin, spinosad ② acephate, carbaryl Biologicals: *Bacillus thuringiensis*, *Beauveria bassiana*	① azadirachtin, bifenthrin, spinosad ② acephate, carbaryl Biologicals: *Bacillus thuringiensis*, *Beauveria bassiana*

†All materials must be applied at rates and under conditions prescribed by the label.
* Ecological risk assessment protocols were used to select pesticides, see Pesticide Selection section. Pesticides are numbered based on Environmental Impact Quotient protocols, and pesticides with the lowest number are preferred, see Pesticide Use Restrictions section.

Hyperodes Weevil. This insect attacks only the annual bluegrass plant. Therefore if the annual bluegrass weed control program is effective a minimum of damage will occur with this insect. Sampling of the adult population in the spring can determine if selected areas need to be treated.

White Grubs. Several species of insects have larval forms as white grubs that feed on the turfgrass roots at the soil/thatch interface. They can be extremely destructive, especially in the advanced larval stage. The key to successful control is identifying threshold levels and treating when larvae are in the earliest stages: July for May or June beetles, and August or September for most others (**Figure 6-5**). Recent surveys and reports indicate that the distribution of white grubs is changing in the Northeast. The European chafer is much more widespread than had previously been noted being found in damaging numbers on turf in eastern New York. This insect is more damaging than most other grub species in part because it tolerates cooler soil temperatures and returns to the root zone to feed in the spring earlier than other species. It also remains in the root zone longer in the fall. In addition, it is less vulnerable to insecticides than most other species, in part because it is a larger grub. However, it predominantly has a 1-year life cycle so control of egg-hatch in the fall will successfully control the problem. The highest populations of grubs are found out to a radius of about 75 feet from the trees to which adult beetles have flown. Fewer grubs are found at locations farther from trees. Scouting should concentrate in heavily shaded areas. This has led to a risk rating system for European chafer larvae on residential lawn areas which can be transferred to golf course roughs. The following table (**Table 6-14**) will be used to categorize relative risk of European chafer problems in the roughs at Silo Ridge Golf Course and the need for scouting/monitoring.

Table 6-14. Risk Rating System for European Chafer Larvae in Roughs†

% of Turf in Shade	% of Turf that is Kentucky Bluegrass	Risk Category	Need to Sample?
> 60%	< 30%	1	no
> 60%	30 - 60%	2	no
30 - 60 %	< 30%	3	no
30 - 60%	30 - 60%	4	marginal
>60%	> 60%	5	yes
30 - 60%	> 60%	6	yes
< 30%	< 30%	7	yes
< 30%	30 - 60 %	8	yes
< 30%	> 60%	9	yes

†Adapted from Villani and Nyrop, 1997 Cornell IPM Annual Report.

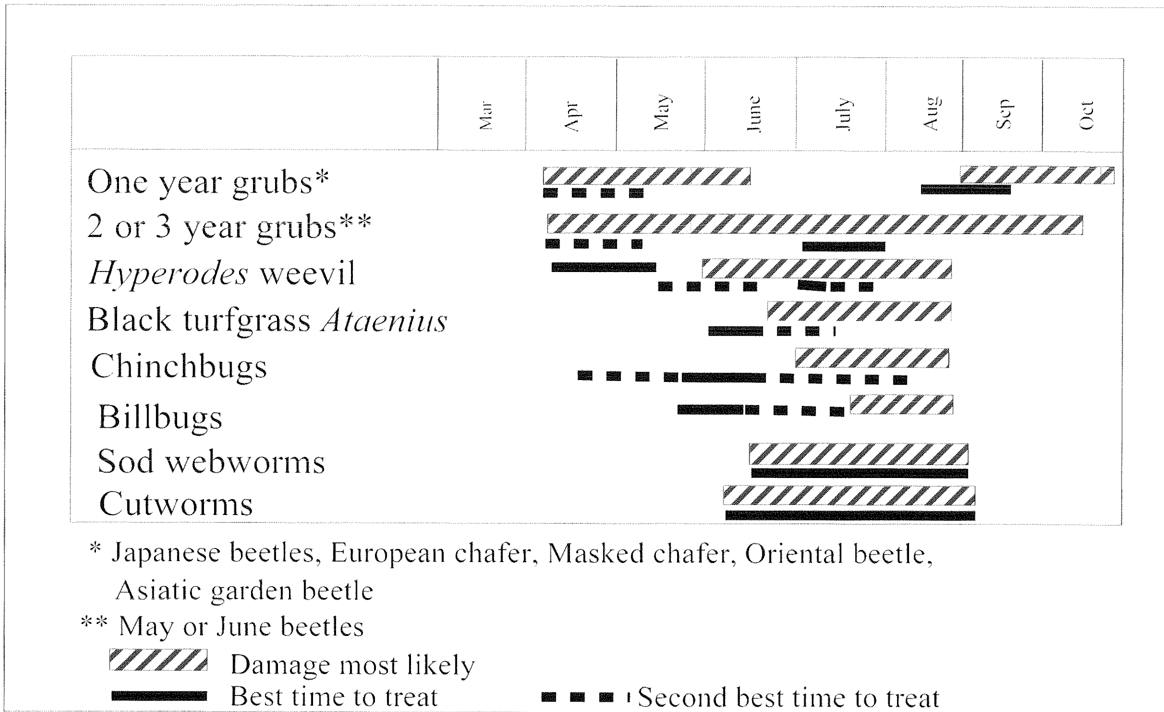


Figure 6-5. Timing of Insecticide Applications for Optimum Efficacy at Silo Ridge Golf Course.

Timing of insecticide application for most materials should be when larvae are still active at the soil surface (**Figure 6-5**). The exception is the use of imidacloprid which can be applied early in the season and will be effective when egg-hatch occurs in the fall. There is a serious concern that this product can be overused and it should be restricted to only those areas where scouting has indicated a major infestation is expected.

Armyworms and Cutworms. These are caterpillar larvae of several species of moths. They can be very destructive if not diagnosed and treated early. The adult moths are inactive in the daytime and can be observed resting on the turfgrass, weeds, or on the leaves and stems of trees or shrubs. Likewise, the larvae are night feeders on the leaves of the grass. Scouting for both adults and larvae burrowed down in the grass can determine if damaging numbers are present. While summer months are when the moth activity is most active, several species have 2 or 3 life cycles per year. Monitoring is critical to ensuring timely treatment. Evening treatment is required since that is when the larvae are active.

European crane flies - Crane fly pests of turfgrass were detected in NY for the first time in 2004. The larvae are the damaging life stage, commonly referred to as "leatherjackets." Two species were detected in western NY, *Tipula paludosa* (the European Crane Fly) and *Tipula oleracea* (variously known as the "Marsh" or "Giant Common" Crane Fly. Both species are native to Europe but have become established in the Pacific Northwest and British Columbia where they were first detected in 1965. *Tipula paludosa* was previously established in Nova Scotia (1955). More recently, *T. paludosa* has established and become widespread in southern Ontario where it was first detected in 1996. In NY, populations were thought to be limited to Erie and Niagara counties, but in September 2005 populations were confirmed northwest of Syracuse, >150 miles to the east.

There are several species of native and non-injurious crane flies in NY that inhabit grassy habitats and can be found emerging from turfgrass. Like many of them, exotic crane fly adults resemble oversized mosquitoes, but they do not feed and are only weak fliers.

Adults are 2.5-3.0 cm long, pupae 3.0-3.5 cm, mature larvae 3-4 cm and eggs 1.0 x 0.5 mm. *Tipula paludosa* completes one generation a year, with the emergence of adults occurring over a period of 2-3 weeks, usually in September. Adult females will emerge, mate and lay most of their eggs all within the first day of their brief reproductive lives. Each will deposit up to 200-300 black eggs at or near the soil surface; these will hatch in about 10 days. Larvae develop through four instars before they pupate. Active larvae mostly inhabit the top 3 cm of the soil where they feed on root hairs, roots and crowns of grass hosts. On warm humid nights, especially in the spring, larger larvae may emerge to forage on stems and grass blades on the soil surface. Larvae usually achieve third instar by the time cold temperatures force them to overwinter. Most damage is attributed to the rapidly growing fourth instars in spring. By mid-June, larvae have achieved their maximum size and move 3-5 cm deep in the soil. They remain in a non-feeding stage until pupation, which ends when pupae wriggle to the surface so the adult fly can emerge. The empty pupal cases (exuviae, or the "jackets" of the leatherjackets) look like small grey-black twigs protruding from the sward where they can be spotted on low-mown turf such as fairways, putting greens and tee boxes.

The biology of *T. oleracea* is thought to be quite similar to *T. paludosa*. The major difference is that *T. oleracea* completes two generations a year, emerging in two peaks, one in spring and the other in fall coinciding with *T. paludosa*. Eggs of both species are sensitive to moisture and require wet conditions to hatch and survive. Larvae also do best under moist conditions. Overall, mild winters and cool summers favor crane fly populations, as do areas with thatch buildup and poor drainage.

Leatherjackets are serious pests of both low and high maintenance turf on both golf course fairways and roughs. Injury is expressed as yellowing spots and bare patches. This is caused by disruption of the rooting zone, similar to white grub damage, and by foliar feeding on crowns and leaf blades, similar to black cutworm damage. Early to mid-May is when injury is most likely to be expressed because large larvae are feeding rapidly as they approach the end of development. Injury is most easily confirmed by searching for larvae. Birds are major predators, and the peck-holes from foraging crows, starlings and other species are easily detected, and by themselves can be troublesome in high maintenance turf areas such as golf course greens.

To detect the presence of these exotic species, the leathery pupal cases can be monitored on tees, greens and fairways where they protrude from the low-mown turf. At peak emergence times adults are very abundant and noticeable as they flit about low in the grass. They may also congregate during the day on the sides of buildings, sliding doors, window screens and fences. Because adults lay eggs so soon after emergence, they do not move far. Therefore, sites with abundant adults, larvae or pupal cases should be monitored as an indication of sites where eggs of the next generation are likely to be laid. If a crane fly infestation is suspected, send adults, larvae or pupal cases to a specialist for proper identification. Observations on the abundance of those life stages could help diagnose the problem, since it is not yet possible to reliably distinguish larvae and pupae from native crane fly species.

If signs of insect activity and turfgrass injury suggest leatherjackets, core sampling is the best way to detect and sample larvae. European crane fly larvae can be monitored in the late fall or early spring. Take samples with a cup cutter and rip apart the core to look for larvae. If the goal is simply to detect the presence of larvae, disclosing solutions (such as dish soap solutions) are an alternative; when these irritants are poured onto the turf, larvae will be driven to the surface where they can be seen. This method greatly underestimates the population densities, however. Adults are best captured with a sweep net, but they can also be seen flitting about in grassy areas or perching on nearby vegetation.

Control tactics should be directed against the larvae because adults are hard to target and short-lived. Depending on the overall health of the turf, suggested thresholds are 15-50 larvae per sq.ft. Even if fall thresholds are surpassed, it is important to keep in mind that leatherjackets can suffer very high mortality between late fall and early spring due to predation by birds and other vertebrates.

Because of their relative sensitivity to dry conditions, careful management of soil moisture levels may be a key cultural control tactic to reduce populations. Some strategies are to carefully manipulate the timing and frequency of irrigation, particularly during the oviposition period, to better drain chronically infested areas, and to allow the sward to dry (i.e. avoiding irrigation) in the fall. Other recommendations to alleviate problems are to maintain a vigorous stand that is more tolerant to infestation, and to rake up larvae at night when they emerge to feed at the soil surface.

If necessary, preventative applications of insecticides should be made in the fall (October) during oviposition or while larvae are smaller and active at the soil surface. If populations of both species occur at the same site, a late fall treatment may also be best because larvae of both species can be targeted at one time. Otherwise curative applications for European crane fly can be made in early spring once feeding damage is detected. Among the many registered chemical insecticides, carbaryl is considered the industry standard for curative control, while imidacloprid is a good option for preventative control. In addition to registered chemical insecticides, a registered biological control option is *Beauveria bassiana*, an entomopathogenic fungus. The entomopathogenic nematode, *Steinernema carpocapsae*, is a biological alternative that has been promoted in the Northwest.

6.5.3 Weed Control

The most effective weed control is a dense healthy turf. Therefore, after the first year and the turf is fully established weed problems will be minimal. Paying strict attention to optimum cultural practices to maintain an aggressive turf is the first requisite in weed control. **Table 6-15** provides guidelines under which weed management by use of herbicides may be initiated are provided for each area of the golf course.

Table 6-15. uidelines for Initiation of Weed Control at Various Locations at Silo Ridge olf Course

olf Course Area	rassy Weeds (%)	Broadleaf Weeds (%)
Greens	0-1	0-1
Tees	2-6	1-4
Fairways	3-8	2-7
Roughs	7-12	8-13

Annual Bluegrass. While the common name implies this is an annual weed problem, the sub-specie (*Poa annua* spp. *reptans*) of this pest problem is actually a perennial. Growth and persistence of annual bluegrass is favored by compacted and/or wet soils, high soil pH, and high soil phosphorus levels. Keeping cultural practices current to prevent these conditions and favor the growth of the preferred grasses will minimize the competition.

Clover and other broadleaf weeds. Clover can be a problem in any area because of its aggressive nature. Other broadleaf weeds will only invade weakened or thin turf, especially if they are annuals.

Crabgrass and other grassy weeds. Crabgrass is an annual grassy weed that invades thin turf. Crabgrass seed require light for germination. Thus an effective control is to maintain a dense stand of grass. Based on site history and a seed source from the surrounding area if it is determined that an herbicide is needed for control, crabgrass seed is known to germination when soil temperatures reach 53 to 58°F at a 4-inch depth. Thus, timing of the herbicide application should be just prior to soil temperatures reaching this range. Other annual grassy weed problems can also often be controlled with the same materials used for crabgrass. For perennial grassy weed problems, they can be more problematic with fewer selective materials available. In many instances small areas may need to be handled by using a nonselective material and then resodding or reseeding the area.

Herbicides which are recommended and approved based on the selection guidelines previously noted are listed in **Table 6-16**.

Table 6-16. Herbicides† Recommended for Control of Specific Turfgrass Weeds at Silo Ridge olf Course (Updated 5/22/07)

Weed	reens	Tees/Fairways	Roughs
Annual bluegrass	①paclobutrazol ②ethofumasate ③bensulide, bensulide+oxadiazon	① dithiopyr, paclobutrazol ② ethofumasate ③ bensulide, bensulide+oxadiazon	① dithiopyr, paclobutrazol ② ethofumasate ③ bensulide, bensulide+oxadiazon
Broadleaf weeds and sedges	① 2,4-D + dicamba + MCPP (bentgrass formula), ② MCPA + clopyralid + triclopyr	① carfentrazone, fluroxypyr, sulfentrazone ②carfentrazone + 2,4-D + MCPP + dicamba, sulfentrazone + 2,4-D + dicamba + MCPP ③MCPA + clopyralid + triclopyr	① carfentrazone, clopyralid, dicamba, fluroxypyr, halosulfuron, 2,4-D + triclopyr, triclopyr, triclopyr+clopyralid ② bentazon, ③MCPP, 2,4-D + dicamba + MCPP, sulfentrazone + 2,4-D + dicamba + MCPP, carfentrazone+2,4-D+MCPP+dicamba

Table 6-16. Herbicides† Recommended for Control of Specific Turfgrass Weeds at Silo Ridge olf Course (Updated 5/22/07)			
Weed	**reens**	**Tees/Fairways**	**Roughs**
Annual grassy weeds	①bensulide	① dithiopyr, paclobutrazol ② ethofumasate ③ bensulide	① dithiopyr, fenoxaprop, prodiamine, ② oxadiazon, pendimethalin, ③ bensulide, bensulide+oxadiazon, No EIQ: quinclorac
†All materials must be applied at rates and under conditions prescribed by the label. * Ecological risk assessment protocols were used to select pesticides, see Pesticide Selection section.			

6.6 SCOUTING PROGRAM FOR SILO RIDGE OLF COURSE

The IPM scouting plan for Silo Ridge Golf Course relies on the following tenets. In developing the program, there are specific items which need to be addressed in order to ensure the program will be successful. The superintendent must ensure that the following steps are followed:

1. Assign individual(s) to conduct the scouting, record the results, evaluate the information and make the decisions once the information is recorded. This may be done in a team approach with the scout consulting with specific members of the staff, or it may be an individual.

2. Provide proper education and training to all involved in any aspect of the IPM program. This should include formal seminars, workshops, conferences, short courses, and training for the superintendent and assistant superintendent. State, regional, and national conferences are excellent formats from which to obtain these types of programs. In-house training sessions for the maintenance crew should be held to inform them of IPM strategies.

3. Review, at least annually, the complete program and evaluate its effectiveness. Changes will constantly be made as the golf course matures, changes in design are made, or as new information concerning handling of turf management or pest problems becomes available.

Tools necessary to conduct the scouting program will be determined by the level of intensity of the scouting. At a minimum the following items are required: hand lens (10x), collection vials, soil probe, paper bags, pocket knife, small ruler, small spade, notebook, cup cutter, field identification guides, tweezers, and small camera.

6.6.1 Degree-day and Prediction Modeling Monitoring

Climatic conditions should be monitored on-site. An automated weather station should be installed to record measure maximum and minimum air and soil temperatures, rainfall, solar radiation, and relative humidity. Temperatures can be used with a simple computer model to calculate degree days. These degree days can be used to determine if the phenology model database triggers scouting or treatment for particular pest problems. These models should be tested for one or more seasons after the golf course is established to see how closely field observations match model data.

Table 6-17. Degree Day Accumulations Required for Each Stage of Development for Specific Pest Problems at Silo Ridge olf Course.

Pest and Stage of Development	Degree-Day Accumulations (Base 50°F)
Annual bluegrass weevil	1,000 to 1,150
Armyworm	
Eggs	113.4
Larvae	498.6
Pupae	297.0
Generation Time (Egg to Adult)	909.0
Pre-egg laying adults	126.0
Generation Time (Egg to Egg)	1035.0

Table 6-17. Degree Day Accumulations Required for Each Stage of Development for Specific Pest Problems at Silo Ridge olf Course.

Pest and Stage of Development	Degree-Day Accumulations (Base 50°F)
Bluegrass billbug	
First adult activity	280 - 352
30% first activity level	560 - 624
Sod Webworm	
50% adult emergence	380-488
First generation to second generation	974-1098
Second generation to third generation	1314-1343
Smooth Crabgrass	
First emergence	76-140
Initial major emergence	252-414
25% emergence	558
50% emergence	801
75% emergence	1107
95% emergence	1701

6.6.1.1. ***Disease Prediction Models.***

- Anthracnose severity index - Based on hours of leaf wetness (L), which equates to saturated relative humidity and average daily temperature (T). Points are accumulated daily using this equation:
  - $ASI = 4.0233 - 0.0233L - 0.5308T - 0.0013 L^2 + 0.0197 T^2 + 0.0155LT$

  Infection can occur whenever ASI>2.
- Pythium blight - Model 1: "150" rule. Recommends fungicide applications whenever relative humidity (RH) + temperature (°F) > 150.
  - Model 2: Temperature maximum > 86°F and minimum >68°F and at least 14 hours of relative humidity (RH) > 90% in the previous 24 hours.
  - Model 3: Temperature > 70°F for more than 18 hours with minimum temperature in previous 24 hours > 68°F, risk is high.
- Rhizoctonia blight (Brown patch) -
  - Relative humidity: > 95% for 10 hr. or more
  - Soil temperatures: mean > 70°F; minimum > 64°F
  - Air temperatures: mean > 68°F; minimum > 59°F

– Rainfall/Irrigation: 0.1 inches received in the 36 hours preceding the tenth hour of high relative humidity

6.6.2 Activities for the Scouting Program for Silo Ridge olf Course

6.6.2.1. *Daily.*

General

- Record data from weather station. Calculate degree days.
- Refer to models for Anthracnose, Brown Patch and Pythium for calculation of degree of risk of disease outbreak. Refer to models for insects and weeds and for possibility of problems and windows for pesticide application.

Greens and Tees

- Quality of cut - while this is dependent on species and cultivars of grass, cutting height, mowing speeds, clips per inch and type of mower, it is an excellent indicator of the overall health of the turf. Additionally, since mowing creates an open wound, it is desirable it heal quickly, and torn or ragged edge is indicative of poor cutting quality which will need to be addressed.
- Soil moisture - whether using a soil moisture meter, simply pulling a core with a probe, the soil moisture should be wet, but not saturated, to prevent moisture stress. This is a gauge form which to help guide the irrigation program.
- Diseases - this is especially critical during periods of warm, moist weather as these are important requisites for disease development. Early morning is the best time for walking the green by separating paths into six foot segments to note any small spots or white threads of fungal hyphae. A closer examination with the hand lens or a sample to take to the field laboratory for microscopic analysis can be collected to confirm disease presence.
- Weeds - similar to inspection for disease problems, look for any differences in color or texture of leaves, particularly in thin turf areas or where ball marks have damaged the turf. With this approach, many weeds can be hand picked or mechanically controlled before they become mature enough to create a problem.
- Insects - leaf eating insects should be detectable in the same manner as looking for disease and weed problems. On closely mowed turf, a scouting of the surface and

thatch layer should be sufficient. Specific insect problems as noted in the Insect Control section should be intensively scouted during the peak activity periods noted.

6.6.2.2. *Weekly or Bimonthly.*

All Areas

- Soil temperature - root growth, seed germination (including weeds), disease and insect activity and other factors which impact turf growth are tied closely to soil temperatures.
- Plant tissue analysis - will help guide fertilization programs.

Ponds and Lakes

- Identify aquatic growth that is over-abundant or a nuisance. Scouting should begin in the spring (when water temperatures warm) and end in fall (when water temperatures decrease). Early detection will allow appropriate treatment. Biological controls are a good alternative to chemical treatment of submerged aquatic plants. If chemicals are required, treat only one-third of the lake/pond at a time.
- Should plant problems continue and recur each year, steps should be taken to determine the reason for the nuisance conditions. Once determined, then effective solutions can be implemented.

Greens and Tees

- Scout for signs of algae, molds or moss. They can be observed growing in the mat layer on the soil surface or in the soil profile. Their growth is encouraged by soil acidity and saturated soil profiles. When this scum appears, a light dusting of hydrated lime at 2 to 5 pounds per 1000 sq.ft. will kill the algae. Plugging or sodding along with topdressing can be done if necessary as soon as the soil dries out. Vertical mowing can also be performed to break up the scum formed once it has dried if it has formed a thick layer.
- Check for hydrophobic soil conditions by inspecting for areas that turn blue or gray. This condition may be caused by excessive surface compaction or because of the coating of the sand soil particles with a hydrophobic layer of organic matter. A soil probe can be used to extract a column of soil and water droplets can be placed at 2-inch increments along the soil column. If the water beads and does not infiltrate

into the soil, a true hydrophobic condition exists. Spot aerification, along with lime and fertilizer and use of a wetting agent can help rectify this problem.

Fairways

- Scout for visual signs of disease, weed and insect problems at least weekly. Dividing the fairways into 15 to 20 foot strips and observing while riding in a golf cart or utility vehicle, scout for signs of pest problems. If symptoms are present, use the thresholds predetermined for a decision on whether to treat with a pesticide. Scouting for insects could include use of pitfall traps, light traps, pheromone traps, cup cutter samples or drenching with soap solutions to flush them to the surface. Once detected, use a grid to quantify the numbers present per sq.ft. or sq.yd. for threshold determination.
- Mapping of the pest problems observed should be done on a grid system of specific locations on the course to develop a history of pest infestation. This will be useful for future control options.

6.6.2.3. *Monthly.*

All Areas

- Sample the soil profile to check for layering. Examine the condition of the roots (should be white and fibrous), smell for indications of anaerobic conditions, probe to check for soil compaction, and measure thatch amounts. A soil analysis in areas where the turf is not performing well for pH and soluble salts can be useful.
- Spot check irrigation system uniformity on at least 4 to 5 greens. Use containers spaced two feet apart from sprinkler head-to-head in a straight line. Operate the system for 15 minutes and check volumes in each container. Multiply by 4 to gauge the irrigation system inches per hour and determine if it is within specification guidelines.

6.6.2.4. *Semi-Annual.*

All Areas

- Soil test for nutrient levels including macro nutrients, micro nutrients, pH and soluble salts.

- Scout for drainage and seepage problems. Presence of moss or algae is a certain sign of poor drainage. Puddled soil and signs of scald note excessive soil wetness. If seepage is suspected, dig a hole two feet deep with a spade or post hole digger and allow 24 hours for it to refill. If it does so it indicates seepage from below ground either vertically or laterally. Installation of drainage lines may be a way to resolve this problem.
- Monitoring in both mornings and afternoons will determine if tree shade azimuths are creating low light conditions for grass growth and the need to thin trees. This could also help determine wind movement patterns which are important in drying turf areas and preventing disease problems.

6.6.3 Record Keeping

Recording the information collected during the scouting on forms such as those which are in **Appendix II** will help build a record for each area on the course. This will be useful in determining if certain pest problems are recurring. This approach will allow subsequent "fine-tuning" of the IPM program as the course matures.

6.7 Managing the Program - Personnel

The success of this golf course Integrated Pest Management plan depends, to a large extent, on the manner in which the program is carried out. Since Silo Ridge Golf Course is located in a locale that has environmentally sensitive areas, it is imperative that the selection of personnel be made very carefully. The golf course will need a cadre of highly qualified key people to see that daily operations are carried out properly and in a timely manner.

6.7.1 Superintendent

Because turfgrass management has become more scientific in the past few years, it is desirable for the superintendent to have a degree in agronomy, horticulture, plant or soil sciences, as well as experience in all phases of golf course management. Since it is their management ability and day-to-day decisions based on sound agronomic principles and practices that make a successful program, they should have a thorough knowledge of Best Management Practices (BMP), exhibit an understanding of the principles of Integrated Pest Management (IPM), and have a license to apply restricted use pesticides. A participating knowledge of the game of golf and the ability to train and effectively supervise employees are also important.

6.7.2 Assistant Superintendent

Similarly, the assistant should also have a degree in agronomy, horticulture, plant or soil sciences. They should be licensed in pesticide usage, have a working knowledge of golf course maintenance practices and the ability to schedule and supervise work to achieve the most efficient utilization of employees and equipment.

6.7.3 Irrigation Technician

Because of the highly sophisticated irrigation system to be used on the course and the importance of proper monitoring of water usage, the selection of this technician is critical. The person employed must have a working knowledge of computerized control systems as well as basic electricity, hydraulics, valves, pumps, sprinkler heads, etc. Since efficient water use and conservation of irrigation water are the responsibility of the system operator, a knowledge of turfgrass water requirements and the capabilities of the irrigation system will be needed, also.

6.7.4 Pesticide Technician

Because the appropriate use of pesticides depends not only on proper selection, but also on proper equipment maintenance and calibration and application techniques, it is strongly recommended that this person is licensed in restricted pesticide usage and experienced in handling pesticides.

6.7.5 Mechanic

The success of all cultural practices is dependent, to a large degree, on the condition of the equipment and tools used. Therefore, it is essential to have a person knowledgeable and capable in the maintenance and repair of the various types of equipment used on golf courses. Their responsibilities include not only keeping all equipment in operational condition at all times, but also includes keeping the service area and maintenance building clean and in accordance with all environmental regulations.

6.8 PESTICIDE SAFETY

An important part of pesticide safety is the maintenance facility that includes appropriate storage, handling, washing and mixing areas. See Maintenance Facility section for more information about the maintenance facility and pesticides.

6.8.1 Storage

Pesticides will need to be stored in a separate room designated for these materials only and located away from water sources (ponds, streams). The room will be kept locked and posted as required by law, including the courses, 'Hazard Communication Program' (See samples in **Appendix III**). All pesticides will be stored in their original containers with visible labels.

To be prepared for spills and/or leaks, absorbent floor-sweep materials, sawdust or cat litter and activated charcoal will be kept on hand. An inventory of pesticides and other chemicals will be kept, and MSDS and labels for each pesticide used will be readily accessible. A fire extinguisher, protective clothing, respirator and first aid supplies will be kept in an attainable place and in ready condition. Water will be available for both routine and emergency chemical removal, including showers and eye wash facilities.

6.8.2 Handling and Application

When handling pesticides, special attention will be given to warnings and precautions on the label. Applicators should always wear personal protective gear which includes: rubber gloves, goggles or face shields, respirators, protective clothing, and rubber boots when mixing and applying pesticides. Mixing and loading will be done in a designated area so that any spills can be handled effectively.

Chemicals should always be measured out below eye level; and applicators should not stand directly over the tank when adding chemicals, as they frequently splash and emit dusts.

Before mixing chemicals together, their compatibility will be checked as chemical incompatibility could result in reduced effectiveness, increased toxicity to the applicator, or phytotoxicity to the turfgrass. The "quart jar method" should be used to determine compatibility. Spray adjuvants (such as wetting agents, emulsifiers, foaming agents and stickers) should be used in accordance with label recommendations.

6.8.3 Disposal

Empty bottles, drums or cans will be disposed of according to the label which usually states to triple rinse and recycle, recondition or puncture and dispose. Containers should be rinsed before spraying so that the rinsate can be put into the spray tank. When a container has an expired shelf life or is damaged, the manufacturer, supplier or local state agency will be contacted for assistance in disposal.

6.8.4 Pesticide Record Keeping

Proper records of all pesticide applications will be kept according to government requirements. These records will help establish proof of proper use, facilitate comparison of results of different applications and/or find cause of an error. Records should include the following information:

1. Data and time of application.
2. Name of applicator.
3. Person directing or authorizing the application.
4. Weather conditions.
5. Target pest.
6. Pesticide Used (trade name, active ingredient, amount of formulation, amount of water).
7. Adjuvant/Surfactant and amount applied, if used.
8. The area of golf course ornamental plantings number of acres or square feet treated.
9. Total amount of pesticide used.
10. Application equipment.
11. Additional remarks, such as severity of the infestation.

A sample pesticide use record is included in **Appendix II.**

6.9 SPILL PREVENTION AND RESPONSE

6.9.1 Prevention

1. Mixing of chemicals occurs only at the designated chemical mixing area that is designed to contain any spillage until it is properly treated with the filtration unit.
2. Prescribed routes for the transport of mixed, diluted chemicals. Routes are chosen to minimize the likelihood of spills (e.g., steep slopes are avoided) and to avoid sensitive areas (e.g., wetlands), and the routes are known to the applicators.
3. Chemicals used on the course are dilute. The only concentrated chemicals at the course are stored in a locked storage facility, and are mixed only in a specially designed mixing area.
4. The least toxic materials with the shortest half-life and greatest affinity for soils are used at the course. Thus the affect from any release is minimized.

6.9.2 Training

1. Current pesticide operators license will be maintained by the Golf Course Superintendent, Assistant Superintendent, and the Pesticide Spray Technician.
2. Safety plans including proper handling and storage as indicated on Material Safety Data Sheets (MSDS) will be followed.
3. Training in proper storage, handling, mixing and containment of spills of chemicals will be conducted.

6.9.3 Containment

1. Spill containment materials are readily available. Commercially available spill containment kits (containing for example, foam pillows and absorbent material) are kept readily available in the chemical mixing area and in the chemical storage area. Any used kits are correctly disposed of based on the type of chemical.
2. A spill or hose leak on the course will result in the following actions.
   - spray technician contacts the superintendent or assistant superintendent.

- appropriate containment measures are immediately instituted; e.g., use containment kit, create a berm with a shovel, and isolate the area.
- contact appropriate local and state officials.

3. Based on the amount of dilute (mixed) chemical released the following will occur:
   - <10 gallons. Follow actions as listed above.
   - 10 - 50 gallons. Follow actions as listed above. Additional actions will depend on the chemical's toxicity and location of release.
   - >50 gallons. Follow actions listed above. Monitor down-gradient and in potentially affected waters. Monitoring duration will depend on degradation properties of the chemical, but will include sampling at the time of release, and at appropriate intervals. Results of the monitoring will dictate future actions.

7.0 WATER CONSERVATION MANAGEMENT

7.1 WATER CONSERVATION

7.1.1 Irrigation

Lack of adequate moisture can result in three possible consequences for the turf as follows: 1) stress; 2) dormancy; or 3) death. Since the golf course as a recreational facility must provide reasonable quality as to the condition of the playing surface, in this location irrigation is one of the primary cultural practices which will be used and irrigation management must include water conservation practices.

Irrigation is used to supplement, not substitute, for rainfall. This requires that there be adequate recording of climatic conditions so that determination can be made if soil moisture reserves are adequate or if an irrigation event should be scheduled.

7.1.2 Irrigation Water Management

Because of the many variables to consider, i.e., slope, soil types, rooting depth, etc., even with the most sophisticated irrigation system available, experience has proven, fine-tuning of the irrigation program by the golf course superintendent and irrigation technician is essential.

Knowledge of the water reserve in the root zone is a key input required for determining irrigation needs. On greens, approximately 75% of the root system may occur in the top 4 inches of soil. On tees, fairways and roughs the depth of rooting can vary from 6 to 12 inches, depending on how these surfaces are managed. Therefore, with knowledge of soil water storage, actual daily rainfall and calculated daily evapotranspiration (ET) information it is possible to determine when the available soil moisture is depleted and irrigation required. A weather station located at the maintenance facility will record information necessary to calculate the daily ET. The amount of irrigation plus rainfall necessary to sustain the turf in an actively growing condition is for most of the golf course is approximately 70 to 80% of evaporation from an open pan of water.

Even though average annual rainfall for the Millbrook/Amenia area is over 40 inches, a deficit does occur during the summer months when Evapotranspiration (ET) exceeds rainfall (**Table 7-1**). However, based on average rainfall, supplemental irrigation will only be needed on the largest acreage for 5 to 6 months a year with the maximum in June, July and August.

Table 7-1. Turfgrass Irrigation Requirements for Silo Ridge olf Course Based on Average Rainfall and Moisture Availability for Putting reens and Tees

Month	Precipi-tation[a]	Available Moisture	PET[c]	Deficit	Irrigation Require-ment[e]	Irrigation volume required[f]
	Inches per Week					
Jan	0.65	0.32	0.0	0	0	0
Feb	0.58	0.29	0.0	0	0	0
Mar	0.70	0.35	0.12	0	0	0
Apr	0.78	0.39	0.37	0	0	0
May	0.87	0.43	0.80	0.37	0.37	0.46
Jun	0.88	0.44	1.15	0.71	0.89	1.11
Jul	0.85	0.42	1.38	0.96	1.20	1.50
Aug	0.92	0.46	1.19	0.73	0.91	1.14
Sep	0.83	0.41	0.76	0.35	0.35	0.43
Oct	0.74	0.37	0.40	0.03	0.03	0.04
Nov	0.77	0.38	0.15	0	0	0
Dec	0.77	0.38	0.00	0	0	0

a - Based on weather records from Millbrook, NY over a 55 year average.
b - Assuming a 50% recharge.
c - Potential Evapotranspiration (PET) based on a modified Blaney Criddle formula.
d - Deficit is available moisture minus PET
e - Irrigation requirement based on a coefficient of 1.0 for Mar-May, 1.25 for Jun-Aug, and 1.0 for Sep-Nov.
f - Based on 80% Application Efficiency.

Table 7-2. Turfgrass Irrigation Requirements for Silo Ridge olf Course Based on Average Rainfall and Moisture Availability for Fairways

Month	Precipi-tation[a]	Available Moisture	PET[c]	Deficit	Irrigation Require-ment[e]	Irrigation volume required
	Inches per Week					
Jan	0.65	0.32	0.0	0	0	0
Feb	0.58	0.29	0.0	0	0	0
Mar	0.70	0.35	0.12	0	0	0
Apr	0.78	0.39	0.37	0	0	0
May	0.87	0.43	0.80	0.37	0.30	0.37
Jun	0.88	0.44	1.15	0.71	0.57	0.71
Jul	0.85	0.42	1.38	0.96	0.77	0.96
Aug	0.92	0.46	1.19	0.73	0.58	0.73
Sep	0.83	0.41	0.76	0.35	0.28	0.35
Oct	0.74	0.37	0.40	0.03	0.02	0.03
Nov	0.77	0.38	0.15	0	0	0
Dec	0.77	0.38	0	0	0	0

a - Based on weather records from Millbrook, NY over a 55 year average.
b - Assuming a 50% recharge.
c - Potential Evapotranspiration (PET) based on a modified Blaney Criddle formula.
d - Deficit is PET minus available moisture.
d - Irrigation requirement based on coefficient of 0.8.
e - Based on 80% Application Efficiency.

Table 7-3. Turfgrass Irrigation Requirements for Silo Ridge olf Course Based on Average Rainfall and Moisture Availability for Putting reens and Tees under Extended Drought Conditions

Month	Precipi-tation[a]	Available Moisture	PET[c]	Deficit	Irrigation Require-ment[e]	Irrigation volume required[f]
	Inches per Week					
Jan	0.65	0.32	0	0	0	0
Feb	0.58	0.29	0	0	0	0
Mar	0.70	0.35	0.12	0	0	0
Apr	0.78	0.43	0.37	0	0	0
May	0.87	0	0.80	0.80	0.80	1.0
Jun	0.88	0	1.15	1.15	1.44	1.80
Jul	0.85	0	1.38	1.38	1.73	2.16
Aug	0.92	0	1.19	1.19	1.49	1.86
Sep	0.83	0	0.76	0.76	0.76	0.95
Oct	0.74	0.37	0.40	0.03	0.03	0.04
Nov	0.77	0.38	0.15	0	0	0
Dec	0.77	0.38	0	0	0	0

a - Based on weather records from Millbrook, NY over a 55 year average.

b - Assuming no recharge during May through Sep.

c - Potential Evapotranspiration (PET) based on a modified Blaney Criddle formula.

d - Deficit is available moisture minus PET multiplied by a coefficient of 1.0 for Mar-May, 1.25 for Jun-Aug, and 1.0 for Sep-Nov.

e - Irrigation requirement based on a crop coefficient of 1.0 for Mar-May, 1.25 for Jun-Aug, and 1.0 for Sep-Nov.

f - Based on 80% Application Efficiency.

Table 7-4. Turfgrass Irrigation Requirements for Silo Ridge olf Course Based on Average Rainfall and Moisture Availability for Fairways under Extended Drought Conditions

Month	Precipi-tation[a]	Available Moisture	PET[c]	Deficit	Irrigation Require-ment[e]	Irrigation volume required[f]
	Inches per Week					
Jan	0.65	0.32	0	0	0	0
Feb	0.58	0.29	0	0	0	0
Mar	0.70	0.35	0.12	0	0	0
Apr	0.78	0.39	0.37	0	0	0
May	0.87	0	0.80	0.80	0.64	0.80
Jun	0.88	0	1.15	1.15	0.92	1.15
Jul	0.85	0	1.38	1.38	1.10	1.10
Aug	0.92	0	1.19	1.19	0.95	0.95
Sep	0.83	0	0.76	0.76	0.61	0.61
Oct	0.74	0.37	0.40	0.03	0	0
Nov	0.77	0.38	0.15	0	0	0
Dec	0.77	0.38	0	0	0	0

a - Based on weather records from Millbrook, NY over a 55 year average.
b - Assuming no recharge during May through September.
c - Potential Evapotranspiration (PET) based on a modified Blaney Criddle formula.
d - Deficit calculated as PET minus available water.
e - Irrigation requirement based on a coefficient of 0.8.
f - Based on 80% Application Efficiency.

To insure there is always adequate moisture for growth and development, the amount of water to apply at each irrigation should be the depth required to replace that extracted by the turf since the last irrigation or rainfall. This is normally at 50% depletion of the soil water holding capacity in the irrigated zone. However, the amount of water to apply per irrigation must be increased because of irrigation application efficiency losses. Any additional irrigation would be a waste of water and could move nutrients and pesticides past the grass root zone.

Given the imperfect nature of any irrigation system, there is the possibility of different areas of the course being over watered, correctly watered and under watered. Therefore, only through careful study and trial and error can the superintendent and irrigation technician achieve the most appropriate balance, preferably on the drier side.

The best method of determining whether the proper amount of water has been applied is to determine the depth of water penetration following irrigation by coring with a soils tube. If water has not penetrated to the desired depth by six to eight hours after an irrigation, then the irrigation time should be increased. If water has moved well beyond the desired irrigation depth, then the irrigation time should be decreased.

To avoid runoff, the application rate must not exceed the soil infiltration rate. If necessary, the irrigation system can be cycled to ensure proper infiltration. In addition, one of the primary responsibilities of the golf course superintendent and irrigation technician will be to monitor the heads frequently to be sure all heads are operating properly and that no head is inadvertently applying water to an environmentally sensitive area.

These conditions apply for what is the largest acreage which is the fairways. For greens and tees, irrigation must preclude any deficits which would place the turf under any stress, since these are heavily trafficked areas and optimum recovery is necessary.

7.1.2.1. *Irrigation Management for Water Conservation Considerations.*

- Irrigation frequency will vary with environmental or climatic factors. Less frequent irrigation is needed in the summer when the roots of turf are deep. More frequent irrigation is needed when roots are shallow in the spring.
- Water should not be applied too quickly otherwise water may run off from sloped sites, turf where thatch has accumulated or turf grown on compacted soils. In these

situations it is more effective to apply only a portion of the total water needed and to move to a sprinkler or switch to another station to irrigate other areas of the golf course. After the water has infiltrated and percolated into the soil, apply another portion of the water and repeat the cycle until all the water is applied.

- A healthy durable turf that withstands minor drought is achieved by irrigating thoroughly but as infrequently as possible. A sure sign that turf will benefit from irrigation is a wilted appearance. One initial symptom of wilting is "footprinting", where footprints on the turf will not disappear within one hour. This symptom is soon followed by actual wilt, where the leaves of the turf lose an upright erect appearance and take on a grayish or purple-to-blue cast. Usually, only a few areas will appear wilted in the same general location of the turf; these areas serve as good indicator spots when assessing the need to water. Delay watering the entire turf area for another day or so by irrigating only the wilted areas.
- Allowing some subtle wilt stress to develop in a turf will not destroy the turf. Allowing the soil to dry to 50% of its available water between irrigation promotes deep rooting and helps plants to survive subsequent drought or heat stress. As drought stress becomes more severe, however, turf becomes more susceptible to traffic, insect and disease damage as well as weed invasion, especially at lower mowing heights. Thus, wilt stress should be minimized for playing surfaces that are mowed at very low heights (i.e. putting greens) or receive high amounts of traffic from play or vehicles.
- The most efficient time of day to water is late evening through early morning (between 10 pm and 8 am). Nighttime is generally less windy, cooler and more humid, resulting in less evaporation and a more efficient application of water. Contrary to popular belief, irrigating during this period does not stimulate disease development.
- Some turf, soil and environmental conditions may result in the need for more than one irrigation event per 24-hour period; accordingly these sites will need some irrigation during daylight hours. The tendency to water "heavily and infrequently" on these sites will result in an inefficient use of water since these sites typically have rapid drainage. Thus, excess water is readily lost through drainage. Under these conditions, site specific watering (e.g., hand watering and syringing) is performed during daylight hours because of the need to visually identify areas where the water should be applied. Employees responsible for hand watering and syringing should

be thoroughly trained regarding the most effective and efficient techniques for applying water during the day.

7.1.2.2. *Golf Course Management Considerations in Water Conservation*.

- Maintain the soil pH between 6.0 and 7.0.
- Minimize soil compaction through turf cultivation.
- Minimize potential problems from pesticides toxic to the root system, particularly certain preemergence herbicides.
- Control potentially serious insect, disease and nematode pests that feed on the root system.
- Maintain an adequate soil potassium (K) level.
- Avoid excessive nitrogen (N) fertilization especially of cool-season grasses that forces shoot growth at the expense of root development.
- Maintain as high a cutting height as possible within the confines of the particular use on putting greens, tees, or fairways.
- Avoid an excessive thatch accumulation which encourages root development in the thatch/mat layer only.
- Avoid intense mechanical maintenance practices such as topdressing, vertical cutting, and turf cultivation, during summer stress periods.

7.1.3 Weather Station

The weather station, to be a valuable tool in calculating ET, will monitor and record the following parameters: 1) air temperature; 2) soil temperature; 3) wind speed; 4) wind direction; 5) barometric pressure; 6) rainfall; 7) humidity; and 8) solar radiation. These are linked with a computer programmed to calculate irrigation requirements based on these parameters. This information is then used by the superintendent and irrigation technician to determine irrigation system operation to apply the amount necessary to replace soil moisture.

In addition to the weather station being used in irrigation water management, the system will record information which can be used in other parts of the IPM program. Information will be used in models for predicting disease development and in calculating degree days for insecticide application and in determining windows of timing for preemergence herbicide application.

7.1.4 Irrigation System

Irrigation system design and operational strategy must fulfill all environmental requirements for protecting wetlands, surface water and ground water on and around the golf courses. In addition, the irrigation system will be designed to meet the water requirements of the turf by supplementing natural rainfall. Irrigation will be managed with a computer controlled system. Irrigation is based on measuring weather conditions as described under "Irrigation Water Management."

7.2 WATER QUALITY MANAGEMENT

Maintaining water quality is important. BMP 'Trains' for surface water protection (see Section 4.2) are designed to provide maximum protection to surface waters, and to groundwater. BMPs coupled with special management zones (See Section 4.1) and careful selection of materials (See Section 6.4) for use on the golf course provide protection to waters from unwanted chemical loadings and maintain the habitat potential for wildlife. A review of scientific studies of nutrients and pesticides in surface and groundwater is presented in **Appendix IV.**

Education and notification of golfers, residents and guests of environmentally sensitive areas is also an important part of the overall management strategy for the surface waters. Appropriate signs identify areas that are ecologically sensitive.

7.2.1 Surface Water and Construction

Concern with surface runoff is critical during construction, particularly during the period when the bare soil and thin turf cover makes the site most vulnerable. The construction practices identified in Section 3 along with permit requirements should provide protection during construction.

7.2.1.1. *Construction.* Clearing for development will include installation of erosion control barriers between the areas being cleared for fairways and the streams and ponds. These will include silt fencing, and sedimentation ponds, and locations will be determined and shown in the erosion control plan for the project. These will remain in place after turf buffer strips are established and until all cleared areas have adequate turf cover to prevent erosion. As discussed previously, the effectiveness of turf as a buffer is related to the fibrous nature of the turf root system and the architecture of the turf canopy. Buffer strips should be fully established with a one-inch height of cut before removal of erosion barriers. As the turf matures, potential runoff problems should diminish.

During future construction projects, installation of erosion barriers described above should be standard practice.

Care will have to be taken during the grow-in phase with irrigation management to prevent runoff and sediment movement into wetlands areas and allow the buffer areas to adequately filter any possible surface nutrient/sediment movement.

Studies at the Pennsylvania State University and the University of Maryland have shown that for significant runoff to occur on turf areas with slopes up to 14%, rainfall or simulated rainfall had to exceed 3 inches/hour. Grassed areas are extremely effective in reducing soil losses compared to other cropping systems with measured soil losses of only 0.03 tons/acre on grassed areas with a slope of 16% on a silt loam soil. Additionally, any runoff from turf areas will be directed into a buffer area, vegetated sale, or other BMP for filtration, therefore there should be no negative impact on water quality in the streams, ponds and wetlands.

Controls put in place during clearing should remain in place after buffer strips are established and until all cleared areas have adequate vegetative cover to prevent erosion. Turf buffer strips are an integral part of maintenance of surface water quality (American Water Works Association, 1991; Eaker, 1994). Care will have to be taken during this time period to prevent runoff and sediment movement into stream and pond areas and allow the buffer areas to adequately filter any possible surface nutrient/sediment movement.

7.2.2 Post Construction Effects

The main concerns with surface water and groundwater is the transport of sediments, nutrients and pesticides from more intensively maintained turf areas will impact water quality. The proposed golf course design with the BMPs and special management zones makes it difficult for runoff contaminants to adversely affect surface water quality or associated wildlife because all runoff from impervious surfaces will be filtered through areas which have a vegetative cover. Additionally, established special management zones prohibit or limit the use of pesticides and fertilizers adjacent to sensitive ecological resources; thus, providing protection to these resources.

7.2.3 Subsurface Drainage

The factors that protect surface water and groundwater also form the basis for protection of subsurface waters. Design factors will ensure that there is adequate on-site retention. Subsurface drainage is directed into buffer areas for filtration purposes. This is most critical with golf course putting green drainage lines which may contain trace amounts of nutrients and pesticides.

Careful management of nitrate, as described in the Golf Course IPM Section (Section 6.2) of this document, will be required. Management along with effective implementation of Best Management Practices can effectively eliminate problems associated with nutrient loss during runoff or leaching (see above, Surface water, Nutrients and pesticides, nitrogen). Careful management of materials (as indicated in this management document) will also reduce the losses of pesticides and nutrients to groundwater.

7.2.4 Riparian and Pond Management Program

An active riparian and water body (streams, wetlands, ponds) management program will be in place at the project. This management program will be incorporated into the overall maintenance program for the golf course and community to ensure that maintenance activities focus not only on maintaining recreational amenities, but also on maintaining the health and functional characteristics of water resources. Critical elements of the riparian management plan include periodic monitoring, maintenance of proposed vegetative conditions, restoration or repair of damaged areas, and record keeping.

7.2.4.1. ***Monitoring.*** All wetland and waterbodies on the site will be inspected twice annually: once in the spring and once in the autumn. Inspections will focus on examining the condition of vegetation, the color and clarity of surface waters, and the water quality of the resource. In conjunction with the inspections, the condition of vegetated buffer strips will be inspected for the presence of debris, the integrity of vegetative cover, and the existence of channels or other indicators of concentrated stormwater flow.

7.2.4.2. *Maintenance of Vegetative Conditions.* Vegetative conditions established during construction are to be maintained in the future. These conditions include the wetland areas (littoral shelves) near the lakes and ponds and the herbaceous composition of the buffer filter strips. Cut material will be hand removed from the wetlands. No machinery will be used at any time within the wetland areas of the site. The herbaceous cover of the buffer filter strips will be maintained by mowing at a frequency of twice per year. In New York information on invasive species can be found at www.ipcnys.org. For additional information on identification and control of invasive exotics, see http://www.invasive.org.

7.2.4.3. *Restoration and Repair of Damaged Areas.* Observed damage to existing topography and ground cover conditions will be remedied immediately. Such damage may include, such things as siltation, erosion, and compaction or trampling by golfers. Accumulated silts will be removed, eroded channels will be filled, and compacted areas will be raked. All such repairs will be conducted using hand tools only unless a mechanical tool 'arm' can reach into the wetland to perform a task. Damaged ground cover vegetation will be restored by seeding or planting depending on the vegetation damaged. Channels which form within the buffer filter strips will be filled and immediately reseeded. If additional grading is necessary to prevent the reformation of the channel, such grade adjustments will be implemented to restore sheet flows. Additional level spreaders will be installed as necessary. Trash, golf balls, and other debris will be removed from wetlands and buffers when observed.

7.2.4.4. *Record Keeping.* An annual record of all riparian and pond inspections and remedial actions will be maintained as part of the maintenance records for the golf course. These records will include the dates of inspection, inspection findings for each riparian and pond area and filter strip location, a description of each remedial action taken, and the dates of such actions.

7.2.5 Pond and Lake Management

In a water body, there are several characteristics that are important to its overall health and stability, and thus important to good water quality management. This section is provided to give an overview of the management of lakes and ponds. In a pond or lake, water quality is of primary importance and along with light and physical conditions, dictates the abundance of algae.

7.2.5.1. ***Management Strategies.*** Aquatic sites are dynamic and responsive and as the availability and nature of the resources change, so will the species diversity and/or amounts of aquatic vegetation. However, at some point a healthy aquatic plant population may actually become an aquatic weed situation detrimental to a stream, lake or pond's ecosystem balance.

The physical environment of the pond or lake coupled with water quality will determine the response of the aquatic ecosystem and influence whether or not aquatic plants will become weed problems. The primary factors involved at any location are the following:

1. **Light** - the quality and amount of light is an important physical requirement for all aquatic plants. Water clarity will be an important, influencing factor for growth of algae and submerged vegetation;

2. **Nutrients** - while aquatic plants have the same nutrient requirements as land plants, many species can absorb nutrients directly from the water. This means river and canals can be used as aquatic filters in certain instances. Freshwater systems are particularly sensitive to phosphorus;

3. **ases** - both oxygen and carbon dioxide are vital to aquatic plants. Daily fluctuations may occur in water oxygen levels in response to photosynthesis. Dissolved oxygen levels at night can be low enough to cause fish kills and extremely low oxygen levels can occur in rivers and canals with extraordinarily dense aquatic vegetation. Low oxygen levels may also occur with decomposition of dead plants by bacteria and fungi, especially after treatment with a herbicide.

4. **Temperature** - water serves as an excellent buffer against rapid temperature changes and plants growing under water are insulated from the shocks of extreme temperature changes.

Aquatic plants are of four main types including algae, floating, emergent, and submerged. Each has distinct growth characteristics resulting in varying control techniques. However, additional factors besides growth habit must be considered in control practices. Besides proper identification of the plant species, the relative abundance, location within the river or canal, and age of infestation are important, since these may determine the extent of the problem and how and when to proceed with control measure. Use of the site and fate of the water will determine the appropriate control. Time of year will determine how effective different treatment approaches will be. There are a number of distinct strategies for aquatic weed control. These are summarized in **Table 7-5** below:

Table 7-5. Standard Aquatic Nuisance Plant Control Methods

Method	Description
Prevention	Eliminate nutrient loading. Install aerators to increase water movement and oxygen.
Physical Removal	Hand harvest aquatic vegetation by pulling. rolling, cutting, or digging.
Mechanical Removal	Use specialized mechanical equipment to cut and harvest aquatic weeds.
Environmental Controls	
Bottom barriers	Made of plastic, rubber, or fiberglass, these can be used to inhibit or prevent rooted growth in selected areas.
Shading	Use of black plastic, soluble dyes, or artificial structures will inhibit or shade out aquatic plant growth. Trees can be used to permanently shade certain areas.
Drawdown	Periodic lowering of water levels will expose bottom sediments; can control some weeds by desiccating or freezing.
Dredging	Remove existing rooted plants and nutrient rich sediments to reduce nutrient accumulations and create greater water depth to control aquatic growth.
Biological Controls	
Triploid Grass Carp	Triploid, sterile grass carp is a cost-effective solution control method best suited to small ponds where submerged aquatic plants require control. Grass carp are generally effective on most submerged aquatic plants , and they are less effective on algae, floating and emergent plant groups.

Table 7-5. Standard Aquatic Nuisance Plant Control Methods	
Method	**Description**
Insects	Adults and/or larvae of certain moths and weevils have been introduced to selectively eat plant populations. This method has worked for water hyacinth and alligator weed.
Plant Diseases	Introduction of pathogens such as bacteria, viruses, fungi, and other micro-organisms is a new approach that is working on many courses.
Chemical Controls	The use of chemicals is the most common and versatile management strategy for controlling nuisance aquatic plant populations. However, chemical management often treats the symptom and not causes of weed and algae populations. Chemical controls should be used in conjunction with strategies to control the problem.

Chemical control of aquatic weeds can be considered for certain weed species under specific conditions, but should be considered only as a last measure. Information on the effectiveness of herbicides for aquatic weed control is included in **Table 7-6**. While each of the materials listed is legally labeled as an aquatic herbicide, specific restrictions may be imposed on each chemical or even by manufacturers on specific brand names. At all times, the label must be rigidly followed when using these materials. Additionally, even under specifically allowed and controlled conditions for application, restrictions on use of the water subsequent to application may apply. Examples of these restrictions are given in **Table 7-7**. However, additional or more specific information may be given on the product label.

The application rate of each of the herbicides used for aquatic weed control will vary depending on the amount of active ingredient required to effectively control the targeted weeds and the formulation. Retention time and volume are also other considerations. With each herbicide information is available about use precautions and toxicological properties. Of primary concern is the effect of these materials on non-target plants which may have been intentionally planted as wildlife habitat and the effect on non-target wildlife. Effects on non-target plants must be evaluated by a specialist in aquatic management who can accurately identify the vegetation and mechanism of action of the specific herbicide in question.

Table 7-6. Effectiveness of Herbicides for Aquatic Weed Control in Ponds (Richardson and Getsinger 2005). Effectiveness of control is as follows: NR = Not recommended; P = Poor; F = Fair; G = Good; E = Excellent; ID= Insufficient data.

	2,4-D	carfentr azone	copper cmpds	diquat	endothall		fluridone	glyphosate	imazapyr	peroxide cmpds	triclopyr
					aquathol	hydrothal*					
FLOATING PLANTS											
Duckweed	P	G	P	G	NR	NR	E	NR	NR	NR	P
Waterhyacinth	E	G	NR	G	NR	NR	F	G	G	NR	E
Watermeal	NR	G	NR	P	NR	NR	G	NR	NR	NR	NR
SUBMERGED PLANTS											
Bladderwort	P	ID	NR	G	P	P	E	NR	NR	NR	P
Brazilian elodea	NR	ID	F	E	P	P	E	NR	NR	NR	NR
Coontail	G	ID	NR	E	E	E	E	NR	NR	NR	G
Eurasian watermilfoil	E	ID	NR	G	E	NR	E	NR	NR	NR	E
Hydrilla	NR	ID	F	E	E	E	E	NR	NR	NR	NR
Naiad, brittle	NR	ID	NR	E	E	E	E	NR	NR	NR	NR
Naiad, Southern	NR	ID	NR	P	P	P	G	NR	NR	NR	NR
Parrotsfeather	E	ID	NR	G	E	E	E	NR	NR	NR	E
Pondweed species	NR	ID	NR	E	E	E	E	NR	NR	NR	NR
Proliferating Spikerush	NR	ID	NR	NR	NR	NR	E	NR	NR	NR	NR
Variable leaf milfoil	E	ID	NR	E	E	E	G	NR	NR	NR	E

Table 7-6. Effectiveness of Herbicides for Aquatic Weed Control in Ponds (Richardson and Getsinger 2005). Effectiveness of control is as follows: NR = Not recommended; P = Poor; F = Fair; G = Good; E = Excellent; ID= Insufficient data.

	2,4-D	carfentrazone	copper cmpds	diquat	endothall		fluridone	glyphosate	imazapyr	peroxide cmpds	triclopyr
					aquathol	hydrothal*					
EMERGED PLANTS											
Alligatorweed	P	F	NR	NR	NR	NR	F	G	G	NR	G
American lotus	G	NR	NR	NR	NR	NR	G	E	G	NR	G
Cattail	F	NR	NR	F	NR	NR	G	E	E	NR	F
Common Reed	NR	NR	NR	NR	NR	NR	NR	G	E	NR	NR
Creeping waterprimrose	E	F	NR	NR	NR	NR	F	E	E	NR	E
Fragrant waterlily	G	NR	NR	NR	NR	NR	G	E	E	NR	G
Rush	NR	NR	NR	NR	NR	NR	NR	G	G	NR	NR
Spadderdock	P	NR	NR	NR	NR	NR	G	E	E	NR	F
Waterpennywort	G	NR	NR	F	NR	NR	G	E	E	NR	G
Most grasses	NR	NR	NR	F	NR	NR	F	E	E	NR	NR
FILAMENTOUS ALGAE	NR	NR	G	E	NR	E	NR	NR	NRG	G	NR

Effectiveness of control is as follows: NR = Not recommended; P = Poor; F = Fair; G = Good; E = Excellent
* hydrothal is not to be used for aquatic control. The toxicity of this formulation precludes it from use.

- ***Carfentrazone***. The toxicity data in Table 7-8 indicates that expected concentrations from the application of carfentrazone are well below acute and chronic concentrations.

  In a review report for the active substance carfentrazone-ethyl, the Standing Committee on the Food Chain and Animal Health of the European Commission concluded that under the proposed and supported conditions of use there are no unacceptable effects on the environment....provided that the potential for groundwater contamination is taken into account (European Commission 2003).

- ***Copper Sulfate.*** The toxicity data in Table 7-8 indicates that expected concentrations from the application of copper sulfate are below acute concentrations. However, toxicity of copper compounds to aquatic animals varies with the species and the physical and chemical characteristics of the water. Its toxicity to fish generally decreases as water hardness increases; thus, it is important to know basic water chemistry, and in particular the hardness of the water.

- ***Diquat***. The toxicity data in Table 7-8 indicates that expected concentrations from the application of diquat are below acute and chronic concentrations. Typical concentrations used to control aquatic macrophytes range from 180 to 370 ppb. At these levels, the acute toxicity is four times greater than anticipated diquat concentrations. Also, diquat concentrations decrease quite rapidly; approximately 60% after four days exposure to a hydrosoil (Hiltibran et al 1972).

- ***Endothall***. The toxicity data in Table 7-8 are for Aquathol (dipotassium endothall salt). The amine formulation (Hydrothol) has the potential to impact aquatic biota and its use is not allowed at Audubon International Signature Sanctuaries. Table 7-8 indicates that expected concentrations from the application of Aquathol are well below acute and chronic concentrations.

  A risk assessment conducted by Washington State Department of Ecology (2001) concluded that:

  1. Aquathol® K (dipotassium endothall salt), disodium endothall salt and endothall acid will not effect the biota acutely or chronically when applied at

concentrations (3.5 mg a.e./L = 5.0 mg dipotassium endothall salt/L) recommended on the label; and

2. Hydrothol® 191 [mono(dimethylalkylamine) salt of endothall will have an acute or chronic impact on the biota when applied at concentrations (5.0 mg a.e./L = 21 mg product/L) recommended on the label.

Paul et al (1994) studied early life stages of fish and concluded that Endothall seems to have an adequate margin of safety between application rates used for aquatic macrophyte control and concentrations which are toxic to early life stages of fish. They reported a 48-h LC50 for largemouth bass of 280 mg/ℓ, for smallmouth bass of 60 mg/ℓ and for walleye, 30 mg/ℓ. These concentrations are six times lower than the maximum labeled application rate of 5 mg/ℓ for Aquathol K. They reported NOAEC concentrations of 50, 23 and 5.7 mg/ℓ for largemouth bass, smallmouth bass and walleye, respectively

- ***Fluridone***. The toxicity data in Table 7-8 indicates that expected concentrations from the application of fluridone are well below acute and chronic concentrations.

Paul et al (1994) studied early life stages of fish and concluded that Fluridone seems to have an adequate margin of safety between application rates used for aquatic macrophyte control and concentrations which are toxic to early life stages of fish. They reported a 48-h LC_{50} concentrations of 16, 11 and 2.8 mg/ℓ for largemouth bass, smallmouth bass and walleye. The LC_{50} of 2.8 mg/ℓ is an order of magnitude greater than the maximum labeled application rate of 0.15 mg/ℓ (Sonar AS label EPA Reg. No. 62719-124).

- ***Glyphosate***. The toxicity data in Table 7-8 indicates that expected concentrations from the application of glyphosate are well below acute and chronic concentrations. Expected concentrations in the water from routine applications should be approximately 47 times lower than the acute concentration for the most sensitive species.

Technical glyphosate is classified as practically nontoxic to fish and may be slightly toxic to aquatic invertebrates. There is a very low potential for the compound to build up in the tissues of aquatic invertebrates or other aquatic organisms.

- ***Imazapyr***. The toxicity data in Table 7-8 indicates that expected concentrations from the application of imazapyr are well below acute and chronic concentrations. Expected ambient concentrations associated with macrophyte control are expected to be approximately 200 times lower than the chronic toxicity end point.

  Effects of Imazapyr were studied on benthic macroinvertebrates in a logged pond Cypress dome in Florida (Fowlkes et al 2003). This study utilized *in situ* microcosm experiments to assess the effects of a concentration gradient of the herbicide imazapyr (0.184, 1.84, and 18.4 mg/L, equivalent to 1, 10, and 100 times the expected environmental concentration from a normal application rate) on the macroinvertebrate community of a logged pond cypress dome using changes in macroinvertebrate composition, chironomid biomass, and chironomid head-capsule deformities. The lack of statistical difference ($p < 0.05$) in macroinvertebrate community composition, chironomid deformity rate, and chironomid biomass between treatments suggests that imazapyr did not affect the macroinvertebrate community at the concentrations tested.

  In a memo describing the potential effects from imazapyr, the US EPA indicated that imazapyr has very low aquatic toxicity to fish and aquatic invertebrates and there should be no direct effect on listed fish, nor on their invertebrate food supply (Turner 2003). Both imazapyr and imazapyr isopropylamine exhibit low toxicity to both aquatic and terrestrial animals. Aquatic toxicity data show that imazapyr is practically non-toxic on an acute basis; no-observed-effect-levels are well above 100 ppm, along with median effect levels. Such low toxicity is considered "no effect" for direct effects on aquatic animals. Chronic toxicity to aquatic animals is also very low (Turner 2003).

- ***Triclopyr***. The toxicity data in Table 7-8 indicates that expected concentrations from the application of triclopyr are well below acute and chronic concentrations.

Expected ambient concentrations associated with macrophyte control are expected to be approximately 20,000 times lower than the chronic toxicity end point.

The parent compound and amine salt are classified as practically nontoxic to fish; the compound has little if any potential to accumulate in aquatic organisms. The bioconcentration factor for triclopyr in whole bluegill sunfish is only 1.08.

Table 7-7. Waiting Period in Days Before Using Water after Application of Herbicides for Aquatic Weed Control (From Richardson and etsinger 2005). Read and follow label directions.

Common name	Irrigation	Fish Consumption	Watering Livestock	Swimming
2,4-D	Water use restrictions vary by formulation and manufacturer. Read and follow the label.			
carfentrazone	1 to 14	no restrictions	0 to 1	no restrictions
copper	no restrictions	no restrictions	no restrictions	no restrictions
diquat	3 to 5	no restrictions	1	no restrictions
endothall (See label)	7 to 25	3	no restrictions to 25	no restrictions to 1
fluridone	7 to 30	no restrictions	no restrictions	no restrictions
glyphosate	no restrictions	no restrictions	no restrictions	no restrictions
imazapyr	120	no restrictions	no restrictions	no restrictions
peroxides	no restrictions	no restrictions	no restrictions	no restrictions
triclopyr	120	no restrictions	next growing season for lactating dairy animals	no restrictions

Table 7-8. Aquatic herbicide information for pond management.

Pesticide	Reduced Risk	Maximum (lbs ai/acre)	water metabolic rate (days)	Typical Concentrations in water at recommended application rates ppb	LC_{50} ppb	LC_{50} organism	LD_{50} ppb	LD_{50} organism	Chronic ppb	Chronic organism
Herbicides										
carfentrazone	yes	0.05 to 0.2 lb/ac	5	1 to 6	2,000 9,800 1,600 16,000	Lepomis Daphnia magna Oncorhynchus mykiss Salmo	>2,250,000	Colinus virginianus, Anas platyrhynchos	110 220 7,400	Salmo Daphnia magna Chironomus riparius
copper sulfate		0.5 to 1 ppm	immediate	155 to 400	>1000 884,000	Salmo Lepomis	600,000 >1,000,000	Anas platyrhynchos Phasianus colchicus		
diquat		0.18 to 0.37 ppm	30	180 to 370	12,300 1,600 28,000 11,000	Salmo trutta Stizostedion Micropterus dolomieu Micropterus salmoides	564,000 2,932,000	Anas platyrhynchos Colinus virginianus	1,800 1,600 480	Micropterus salmoides Micropterus dolomieu Stizostedion vitreum
endothall (Aquathol)		0.5 to 5 ppm	7	500 to 5000	30,000 280,000 60,000	Stizostedion Micropterus salmoides Micropterus dolomieu	>5,000,000 >5,000,000	Colinus virginianus Anas platyrhynchos	50,000 5,700 23,000	Micropterus salmoides Stizostedion vitreum Micropterus dolomieu
fluridone		0.1 to 4 lb/ac	20	12 to 15	11,700 12,55 2,800 11,000 16,000 6,300	Salmo gairdnerri Lepomis Stizostedion Micropterus dolomieu Micropterus salmoides Daphnia magna	>5,000,000 >5,000,000	Colinus virginianus Anas platyrhynchos	960 9600 780 4500	Pimphales Micropterus salmoides Stizostedion vitreum Micropterus dolomieu
glyphosate	yes	1.25%	3.7	360 to 1,800	86,000 120,000 780,000	Salmo trutta Lepomis Daphnia magna	>4,500,000	Colinus virginianus, Anas platyrhynchos	>25700	Pimphales
imazapyr		1 to 6 pt/acre	4	180	>100,000	Salmo trutta, Lepomis, Ictaluras, Daphnia	>2,150,000	Colinus virginianus, Anas platyrhynchos	>97,100 43,100	Daphnia magna Oncorhynchus mykiss
triclopyr		1.5 to 6 lb/acre	0.58	1 to 4	117,000 148,000 1,170,000	Oncorhynchus mykiss Lepomis Daphnia	1,698,000 2,935,000	Anas platyrhynchos Colinus virginianus,	87,000 104,000	Daphnia magna Pimphales

Table 7-8. Aquatic herbicide information for pond management.

Pesticide	
Herbicides	
carfentrazone	EPA fact sheet, 1998; USDA fact sheet; EPA 2000; European Commission 2003, Review report for the active substance carfentrazone-ethyl.
copper sulfate	EXTOXNET
diquat	Extoxnet;solubility, Koc, half life from USDA, ARS Pesticide Properties database, Web based 2006; Paul et al, 1994; EPA 2000
endothall (Aquathol)	Univ of Florida, IFAS, Aquatic Herbicides, 2003; Paul et al 1994; Dept of Ecology, Washington State, 2001Herbicide Risk Assessment for the Aquatic Plant Management Final Supplemental Environmental Impact Statement, publication 00-10-044.
fluridone	Fluridone Herbicide Profile, Cornell University 2006; Univ of Florida, IFAS, Aquatic Herbicides, 2003; Paul et al 1994
glyphosate	solubility, Koc, half life from USDA, ARS Pesticide Properties database, Web based 2006; EXTOXNET; UF IFAS circular 1011
imazapyr	from UC Davis info; The Nature Conservancy, 2004; solubility, Koc, half life from USDA, ARS Pesticide Properties database, Web based 2006; EPA 2003
triclopyr	solubility, Koc, half life from USDA, ARS Pesticide Properties database, Web based 2006; EXTOXNET; UF IFAS circular 1011; RED USEPA 1997

8.0 ENVIRONMENTAL MONITORING PROGRAM

The Environmental Monitoring Program at the project will include monitoring of surface water and ground water. The monitoring plan, based on sound, scientific principles will:

- Provide data that will establish environmental conditions, thus providing a basis for measuring compliance with environmental regulations, and
- Ensure that Integrated Pest Management is functioning properly.

An adaptation from a model proposed by Madhun and Freed (1990) notes that there are four basic types of monitoring which can occur: 1) *Reconnaissance* - periodic observation to disclose changes or trends. With IPM employed this is an integral part of this program; 2) *Surveillance* - to comply with an enforcement program. Pesticide application licensing programs require record-keeping which may be monitored at any time. This will be required by law and serves as a record of a part of the cultural program; 3) *Subjective* - spot-checking for broad or open-ended exploration of problems. A superintendent with training and experience in the golf course management industry has the background and resources to investigate problems and make intelligent decisions; and 4) *Objective* - to provide data for use in developing or confirming the results of on-going programs. Monitoring operations at the project focus on maintaining environmental quality and obtaining information on which to make adjustments in cultural programs using all of these approaches.

Results of the Environmental Monitoring Program provide feedback to the golf course superintendent, and thus provide a useful management tool. For example, the results of the program are used in determining the correct application rates and timing of pesticides and fertilizers, and the optimum operation of irrigation programs.

The Environmental Monitoring Program is established in phases that coincide with development. Phase I defines the pre-construction, construction, and development phase, and Phase II is the post-development, operational time frame. Even though construction will be occurring, Phase II will begin with either golf course grow-in of turf or community landscapes.

8.1 PHASE I: SURFACE WATER AND ROUNDWATER QUALITY DURING PRE-CONSTRUCTION AND CONSTRUCTION PERIOD

The goal of Phase I is to assess pre-construction and construction activities on surface water and groundwater quality.

8.1.1 Sample Locations

8.1.1.1. ***Surface Water.*** Surface water will be sampled at the locations described below and shown on **Figure 8-1** (SW means surface water):

- Sample Station SW-1. Amenia/Cascade Creek just before discharge from the property.
- Sample Station SW-2. Stream just before the confluence with the NYSDEC wetland.
- Sample Station SW-3. Stream just before the confluence with the NYSDEC wetland near golf hole 13.
- Sample Station SW-4. Pond near the green for golf hole 17.
- Sample Station SW-5. Pond near the island green at golf hole number 11.
- Sample Station SW-6. Pond between golf holes 8 and 9.
- Sample Station SW-7. Amenia/Cascade Creek at the inflow point to the property.

Obtaining water samples from the same location is important so that comparisons can be made. Sample stations will be located with GPS and identified on maps, and photographed so that stations are easily located during subsequent sampling efforts.

8.1.1.2. ***Groundwater.*** Groundwater will be sampled at the locations that are described below and shown on **Figure 8-1** (GW means groundwater):

- Sample Station GW-1. Between the pond and golf hole 4; near SW-1.
- Sample Station GW-2. Between homes and the wetland, near SW-2.
- Sample Station GW-3. Between the wetland and golf hole 13.

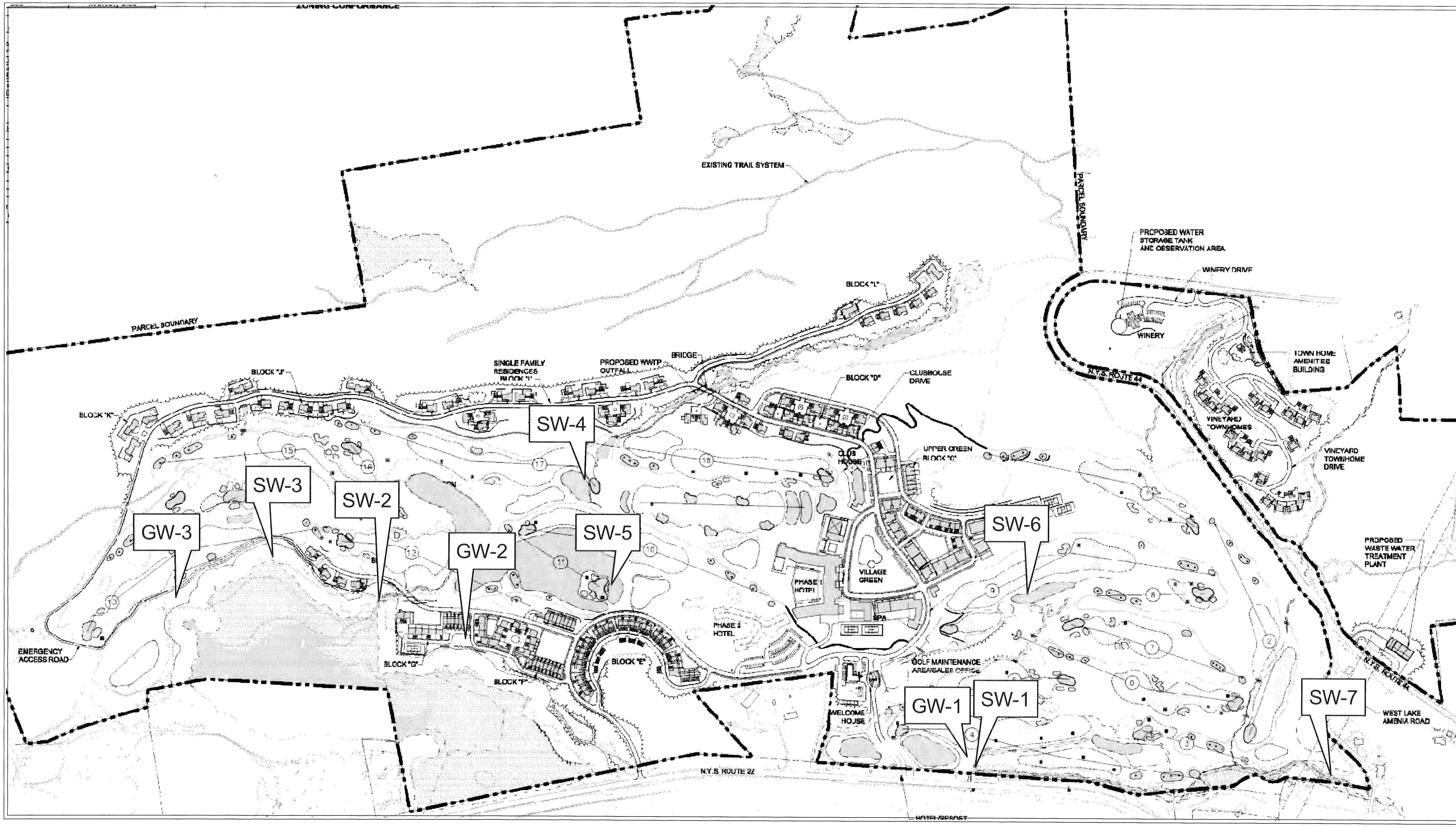


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Figure 8-1. Silo Ridge Resort Community - Traditional Neighborhood Alternative
Showing Sampling Locations for Surface Water (SW) and Ground Water (GW).

New 2" monitor wells will be installed. The wells will be constructed according to New York regulations, under the direction of a hydro-geologist. Groundwater sample stations will be field marked, located with GPS and identified on maps, and photographed.

8.1.2 Sample Frequency

8.1.2.1. *Surface Water.*

Pond Sampling. Ponds (locations SW-4, 5, and 6) will be sampled once per month in June, July, August and September.

Stream Sampling. Stream sample locations (SW-1, 2, and 3) will be sampled eight times per year between the months of April and November. The sampling program will include collection of four base flow and four storm flow samples (i.e. sampling during wet and dry weather). An attempt to sample streams in both the base- and storm-flow will be made every two months from April to November. That is, samples will be collected in April/May; June/July; August/September; and October/November. Precipitation patterns in any given year may dictate that fewer than four storm flow samples are collected. However, a minimum of two storm water samples will be collected annually from the stream locations during the portion of the year when the project is applying pesticides.

Samples will be collected during base flow or dry periods are defined as no rain in the previous 3 days. Should water not be available on a given sample date, one additional attempt will be made to obtain a sample within the time period.

8.1.2.2. ***Groundwater.*** Groundwater samples will be collected four times per year at the time of sampling the surface water base flow.

8.1.3 Sample Variables

Water will be analyzed for the variables listed in **Table 8-1**.

Pesticides are included in the monitoring program if their "risk ratio" exceeds 0.5. The "risk ratio" is the quotient of the maximum anticipated concentration of the pesticide divided by its effects criteria (see Section 6.4 for a description of the maximum anticipated concentration and effects criteria). A risk ratio of a given pesticide which is greater than 1.0 indicates that the maximum anticipated concentration exceeds the effects criteria; meaning that the use of that pesticide at the project represents more than a negligible risk. A risk ratio of less than 1.0 indicates that the use of that pesticide at the project represents only negligible risk. By including as analytes all pesticides whose risk ratio is greater than one-half the point at which risk is presumed to be more than negligible, the monitoring program design ensures that all potentially risky pesticides are monitored for.

Pesticides will be analyzed one time in Phase I because during this phase no pesticides will be used at the golf course. Samples are taken and analyzed to provide a baseline.

Table 8-1. Variables to be Analyzed (x) in Surface- and round- Water at Silo Ridge Resort Community

Variable	PHASE I Environmental Monitoring Program			PHASE II Environmental Monitoring Program		
	Surface Water		round Water	Surface Water		round Water
	Pond	Stream		Pond	Stream	
Field Analyses						
pH	X	X	X	X	X	X
Water Temperature	X	X	X	X	X	X
Specific Conductance	X	X	X	X	X	X
Dissolved Oxygen	X	X		X	X	
Secchi Disk	X			X		
Laboratory Analyses						
Nitrate-Nitrite Nitrogen	X	X	X	X	X	X
Total Nitrogen	X	X	X	X	X	X
Total Phosphorus	X	X	X	X	X	X
Chlorophyll a	X			X		
Chloride	X	X	X	X	X	X

Table 8-1. Variables to be Analyzed (x) in Surface- and round- Water at Silo Ridge Resort Community						
	PHASE I Environmental Monitoring Program			PHASE II Environmental Monitoring Program		
	Surface Water		round Water	Surface Water		round Water
Variable	Pond	Stream		Pond	Stream	
Turbidity	X	X	X	X	X	X
Pesticides						
azoxystrobin	X	X	X	X	X	X
bensulide	X	X	X	X	X	X
bifenthrin	X	X	X	X	X	X
etridiazole	X	X	X	X	X	X
fenarimol	X	X	X	X	X	X
flutalonil	X	X	X	X	X	X
fipronil	X	X	X	X	X	X
iprodione	X	X	X	X	X	X
MCPA	X	X	X	X	X	X
pendimethalin	X	X	X	X	X	X
pryraclostrobin	X	X	X	X	X	X
triadimefon	X	X	X	X	X	X
trifloxystrobin	X	X	X	X	X	X

[a] Pesticides will be analyzed for once in Phase I of the monitoring program.

8.1.4 Field Methods

Variables, container type, preservation and holding times for water samples are given in **Table 8-2**.

8.1.4.1. ***Surface Water.*** A number of variables will be measured on-site, including pH, water temperature, dissolved oxygen, and specific conductance. pH will be measured with a pH probe that has been calibrated just prior to use. Specific conductance will be measured with a calibrated specific conductance meter. Dissolved oxygen will be measured with a dissolved oxygen probe adjusted for altitude. Water temperature will be measured with a temperature probe attached to the specific conductance meter or to the dissolved oxygen meter.

Pond water will be sampled by obtaining 'discrete' grab samples of water. Discrete samples will be taken from approximately 6 inches below the surface. Water is transferred to sample containers that include proper preservatives and labels. The sample containers are immediately placed in a cooler with ice and are taken to a laboratory for analysis.

Stream water will be sampled by obtaining 'discrete' grab samples of water. Discrete grab samples are taken at a selected location, depth and time, and then analyzed for the constituents of interest. Stream water will be obtained from the center of flow at mid-depth and analyzed for the variables listed in **Table 8-1**. Water will be collected in sample bottles that face upstream, and water is transferred to sample containers that include proper preservatives and labels. The sample containers are immediately placed in a cooler with ice and are taken to a laboratory for analysis.

A chain-of-custody program is followed to assure that proper transportation and storage practices are documented and that the appropriate analyses are being conducted.

A field sampling log of surface water sampling and observations will be maintained. The log book documents site conditions, including stream water depth, observations, weather conditions, and field measurements. An example of a page from a field log is given in **Appendix II**.

8.1.4.2. *Groundwater.* Groundwater elevation is determined for each well on each sampling date. After measuring water elevation, the standing water in the well is removed, and replaced by fresh formation water. The quantity of water removed is determined from the well volume and recharge rate. In general, high-yield wells are purged of three well casing volumes of water and low-yield wells are pumped to dryness. Each well is purged using a portable pump that is cleaned between well sampling. Water is suitable for sampling when three consecutive measures of water have stable pH, temperature and specific conductance readings.

Wells are allowed to recharge after purging to allow the system to equilibrate. Depth to the water table is re-measured, recorded and water samples are extracted. Extraction occurs with a pump, or a dedicated Teflon® bailer. Water temperature, pH, and specific conductance are measured in water that will not be used for laboratory analyses. Water samples are taken and decanted or drained into an appropriate sample container that has the proper preservatives and is labeled. Samples are transferred from the sample device to the sample container in a manner that will minimize turbulence and the loss of volatile compounds. Samples are immediately placed in a cooler with ice and transported to the analytical laboratory. Whenever non-dedicated equipment is used, standard cleaning procedures will be instituted. Special attention will be given to thoroughly cleaning samplers, tubing, and other equipment. And, to ensure that the sample is not contaminated, blanks will be collected and analyzed.

A chain-of-custody program is followed to assure that proper transportation and storage practices are documented and that the appropriate analyses are being conducted.

A field sampling log on groundwater sampling and observations will be maintained. The log book documents site conditions, including water depth, observations, weather conditions, and field measurements. An example of a page from a field log is given in **Appendix II.**

Table 8-2. Variables, Container Type, Preservation, and Holding Times for Water Samples in Surface- and round-Water at Silo Ridge Resort Community.

Variable	Container Type	Preservation	Holding Time	Method/ Target Detection Limit
pH	not applicable	not applicable	not applicable	EPA 150.1
Water Temperature	not applicable	not applicable	not applicable	EPA 170.1
Dissolved Oxygen	not applicable	not applicable	not applicable	EPA 360.1
Specific Conductance	not applicable	not applicable	not applicable	EPA 120.1
Secchi Disk	not applicable	not applicable	not applicable	Standard Limnological Practice
Nitrate-Nitrite-N	P, G[b]	Cool, 4°C	48 h	EPA 353.1, 353.2
Total Nitrogen	P, G	Cool, 4°C	28 d	EPA 351
Total Phosphorus	P, G	Cool, 4° C, H_2SO_4 to pH <2	28 d	EPA 365.4

Table 8-2. Variables, Container Type, Preservation, and Holding Times for Water Samples in Surface- and round-Water at Silo Ridge Resort Community.

Variable	Container Type	Preservation	Holding Time	Method/ Target Detection Limit
Chloride	P, G	Cool, 4°C	28 d	EPA 325.3
Chlorophyll a	P, G	Cool, 4°C	Filter 24 hr	SM-10200 H
Turbidity	P, G	Cool, 4°C	48 h	EPA 180.1
Pesticides				
azoxystrobin	G	Cool, 4°C	7 d	UL[a] L-302
bensulide	G	Cool, 4°C	7 d	UL L-302
bifenthrin	G	Cool, 4°C	7 d	UL S-150
etridiazole	G	Cool, 4°C	7 d	UL S-150
fenarimol	G	Cool, 4°C	7 d	UL S-150
flutalonil	G	Cool, 4°C	7 d	UL S-150
fipronil	G	Cool, 4°C	7 d	UL
iprodione	G	Cool, 4°C	7 d	UL S-150
MCPA	G	Cool, 4°C	7 d	UL 515.3
pendimethalin	G	Cool, 4°C	7 d	UL S-150
pryraclostrobin	G	Cool, 4°C	7 d	UL L-302
triadimefon	G	Cool, 4°C	7 d	UL L-302
trifloxystrobin	G	Cool, 4°C	7 d	UL L-302

From: USEPA and Standard Methods for the examination of water and wastewater

[a] UL indicates UL Laboratories. Appendix VI has contact information.

[b] note that container types are 'G' for glass and 'P' for plastic.

8.1.5 Laboratory Methods

The Laboratory used for sample analysis must retain certification by the Environmental Protection Agency (EPA) or its designated State Agency to conduct chemical analyses on surface water and drinking water. Certification of the laboratory is maintained by successful performance of the EPA Water Pollution Study and EPA Water Supply Study. Sample analyses will follow accepted, standard methods as defined in the laboratories accreditation and detailed in their Quality Assurance and Quality Control procedures.

In cases where standard methods are not available, the Laboratory will execute method development and follow closely related standard practices, and demonstrate accuracy and precision of the method with at least a 5-point standard curve, sample spikes, and duplicate analyses.

8.2 PHASE II: SURFACE WATER AND ROUNDWATER QUALITY DURING OLF COURSE AND COMMUNITY OPERATIONS

The goal of Phase II is to monitor surface water and groundwater quality during Silo Ridge Resort Community operations.

8.2.1 Sample Locations

8.2.1.1. ***Surface Water.*** Surface water will be sampled at locations described in Phase I monitoring program. Locations on the property are given in **Figure 8-1**.

8.2.1.2. ***Groundwater.*** Groundwater will be sampled at the locations that are identified in the Phase I monitoring program. Locations of groundwater wells are shown on **Figure 8-1**.

8.2.2 Sample Frequency

8.2.2.1. ***Surface Water.*** Surface water will be sampled as given in Phase I.

8.2.2.2. ***Groundwater.*** Ground water will be sampled as given in Phase I.

8.2.2.3. ***Sample Frequency in Future Years.*** Sampling will be reduced after four years of operation, provided that no detections or changes in water quality triggering a management response (see Section 8.5) have occurred. The monitoring will occur during the following times:

Water Type	Sample Dates
Pond Water	June, August
Stream Water - Base Flow	April/May August/September
Stream Water - Storm Flow	June/July October/November
Groundwater	April/May August/September (At the time of base flow sampling)

8.2.3 Sample Variables

Surface water and groundwater will be analyzed for the variables listed in **Table 8-1**.

8.2.4 Field Methods

Variables, container type, preservation and holding times for water samples are given in **Table 8-2**.

8.2.4.1. ***Surface Water.*** Surface water sampling will follow the protocols outlined in Phase I.

8.2.4.2. ***Groundwater.*** Groundwater sampling will follow the protocols outlined in Phase I.

8.2.5 Laboratory Methods

Laboratories used for sample analysis will follow the protocols outlined in Phase I.

8.3 DATA STORAGE

Data generated from this monitoring program will be maintained by the superintendent along with other course records and data on pesticide and fertilizer use, personnel, and training. This information will be provided annually to the Signature Program Office of Audubon International.

Monitoring data from field sampling and from laboratory analyses will be entered into a computer spreadsheet (e.g., EXCEL). Data analyses will be performed with this data set. The data set will be printed after each update and the printed data will be stored in a notebook. A backup of the computer spreadsheet data will be maintained. Field data sheets will be maintained in a notebook. A summary of the results of the surface and groundwater samples, with a list of any remedial actions that were taken will be kept.

The golf course superintendent will maintain records of cultural activities at the course. Items will include application schedules of all pesticides and fertilizers applied to the golf course as outlined in the Pesticide section of this Plan. Information will include the date of application, rate of application, product used, and specific location where the material was applied. Scouting records as part of the IPM program will also be kept.

8.4 DATA ANALYSIS

Data generated in the monitoring program will be compared to background concentrations and surface water and groundwater standards.

Pesticide analysis data will be compared with toxicological triggers as specified in **Table 8-3**. In Phase II, concentrations of water variables will be compared with background concentrations to determine changes from background conditions.

Data will also be compared with the USEPA pesticide Health Advisories Limits (HAL's, given in **Appendix I, Table I-1**) that have been reduced by a factor of 0.5. This is a very conservative factor given that HALs have a margin of safety of 100 to 1000 already built into the HAL number.

Protection of aquatic life will be evaluated by comparing measured concentrations against LC_{50} data (**Appendix I, Table I-1**) that have been reduced by a factor of 10. LC_{50} data exist for most of the chemicals, and the lowest LC_{50} obtained for the pesticide was divided by a correction factor of 10 to obtain a screening criteria (Suter et al., 1989; Warren-Hicks et al., 1989, 1995). This is a conservative factor that serves as an estimate for chronic values.

A trophic state index (TSI; Carlson 1977) will be calculated for the ponds that are sampled. The TSI will be compared over time to assess the health of the ponds.

8.5 CRITERIA FOR MANAGEMENT RESPONSE

Criteria for management response are summarized in **Table 8-3**.

8.5.1 Non-Pesticide Analytes

If concentrations of non-pesticide variables exceed applicable Water Quality Criteria, or if measured concentrations of nutrients exceed the standard deviation of background levels by more than two-times, then the media will be resampled and a review of management practices, site conditions and weather conditions will be implemented to determine reasons for increased concentrations. The immediate action will also include a reduction in fertilizer use and/or an increased proportion of slow-release fertilizers. Following the review cited above, these immediate restrictions may be lifted or modified, as appropriate. Records of all actions taken will be maintained by the superintendent.

8.5.2 Pesticide Concentrations Below Response Level values

If a pesticide listed in **Table 8-1** is detected in samples at concentrations below Response Levels [i.e., one-half the USEPA Health Advisory Limits (HAL x 0.5) or one-tenth the LC_{50} for the most sensitive aquatic organism (LC_{50} x 0.1), whichever is lower] the following responses will be implemented:

1. The sample station from which the detection was obtained will be resampled immediately upon receipt of the data from the laboratory and reanalyzed for the pesticide.
2. If the results of the resampling indicate a detection of the pesticide, a review of the application, weather conditions after its application, and possible alternative control measures will be conducted and adjustments to the application protocol will be made based on the results of this review. Also, management responses 3 and 4 below will be implemented. If the results of the resampling indicate no detection of the pesticide, no further management response will be implemented.
3. The sample station from which the detection was obtained will be resampled and analyzed for all pesticides applied to the golf course or community within one year prior to the sampling event.
4. All samples collected from the sampling station from which the detection was obtained, for a period of one year from the date of the detection, will be analyzed for all pesticides applied to the golf course or community within one year prior to the sampling event.

8.5.3 Pesticide Concentrations Above Response Level values

If a pesticide listed in **Table 8-1** is detected in samples at concentrations above a Response Level [as determined by the USEPA Health Advisories Limits (HAL x 0.5) or by the aquatic toxicity as measured by LC_{50} x 0.1, whichever is lower], the following responses will result:

1. The pesticide immediately will be removed from the list of recommended pesticides and its use at Silo Ridge Resort Community will be terminated.
2. The sample station from which the toxicologically significant detection was obtained will be resampled twice (once immediately upon receipt of the data from the laboratory and once approximately ten days after receipt of the data) and reanalyzed for the detected pesticide.
3. If the results of the resampling indicate a detection of the pesticide but at a concentration below the toxicologically significant level, a review of the application, weather conditions after its application, and possible alternative control measures will be conducted; use of the pesticide at the golf course may be reinstated, with adjustments in the application protocol being made based on the results of this

review; and management responses 4 and 5 below will be implemented. If the results of the resampling indicate no detection of the pesticide, no further management response will be implemented, unless required by law.

4. The sample station from which the detection was obtained will be resampled and analyzed for all pesticides applied to the golf course or community within one year prior to the sampling event.
5. All samples collected from the sampling station from which the detection was obtained, for a period of one year from the date of the detection, will be analyzed for all pesticides applied to the golf course or community within one year prior to the sampling event.

Table 8-3. Response Thresholds for Variables at Silo Ridge Resort Community.

Variable	Surface Water	round Water
pH	Outside of 6.5 to 8.5	Outside of 6.5 to 8.5
Dissolved Oxygen	below 4 mg/L	NA[a]
Nitrate-Nitrogen	Water standard or two standard deviations above the baseline mean, whichever is lower.	5 ppm or two standard deviations above the baseline mean, whichever is lower.
Total Nitrogen	Water standard or two standard deviations above the baseline mean, whichever is lower.	5 ppm or two standard deviations above the baseline mean, whichever is lower.
Total Phosphorus	Water standard or two standard deviations above the baseline mean, whichever is lower.	Standard or two standard deviations above the baseline mean, whichever is lower.
Chloride	two standard deviations above the baseline mean	250 ppm
Turbidity	no increase from baseline	NA
azoxystrobin	LC_{50} x 0.1 = 25.9 µg/ℓ	LC_{50} x 0.1 = 25.9 µg/ℓ
bensulide	HAL x 0.5 = 17.5 µg/ℓ	HAL x 0.5 = 17.5 µg/ℓ
bifenthrin	LC_{50} x 0.1 = 0.07 µg/ℓ	LC_{50} x 0.1 = 0.07 µg/ℓ
etridiazole	HAL x 0.5 = 5.5 µg/ℓ	HAL x 0.5 = 5.5 µg/ℓ
fenarimol	HAL x 0.5 = 2.1 µg/ℓ	HAL x 0.5 = 2.1µg/ℓ
flutalonil	LC_{50} x 0.1 = 250 µg/ℓ	LC_{50} x 0.1 = 250 µg/ℓ
fipronil	HAL x 0.5 = 0.7 µg/ℓ	HAL x 0.5 = 0.7µg/ℓ

Table 8-3. Response Thresholds for Variables at Silo Ridge Resort Community.		
Variable	**Surface Water**	**round Water**
iprodione	HAL x 0.5 = 40 µg/ℓ	HAL x 0.5 = 40 µg/ℓ
MCPA	HAL x 0.5 = 15 µg/ℓ	HAL x 0.5 = 15µg/ℓ
pendimethalin	LC_{50} x 0.1 = 26 µg/ℓ	LC_{50} x 0.1 = 26 µg/ℓ
pryraclostrobin	LC_{50} x 0.1 = 3 µg/ℓ	LC_{50} x 0.1 = 3 µg/ℓ
triadimefon	HAL x 0.5 = 14 µg/ℓ	HAL x 0.5 = 14 µg/ℓ
trifloxystrobin	LC_{50} x 0.1 = 7 µg/ℓ	LC_{50} x 0.1 = 7 µg/ℓ
Pesticides - Levels are either the USEPA Health Advisories Limits (HAL x 0.5) or the aquatic toxicity (LC_{50} x 0.1), whichever is lower. The HAL and LC_{50} concentrations are in Appendix I.		
[a] NA means not applicable because the variables are not analyzed as per this plan.		

8.6 FIELD QUALITY CONTROL AND ENERAL WATER SAMPLING CONSIDERATIONS

The field quality assurance program for the project is a systematic process which, together with the laboratory quality assurance programs, ensures a specified degree of confidence in the data collected for an environmental survey. The field quality assurance program involves a series of steps, procedures and practices which are described below.

8.6.1 eneral Measures

a. All equipment, apparatus and instruments should be kept clean and in good working condition.

b. Records should be kept of all repairs to the instruments and apparatus and of any irregular incidents or experiences which may affect the measures taken.

c. It is essential that standardized and approved methodologies be used by field personnel.

8.6.2 Prevention of Sample Contamination

The quality of data generated in a laboratory depends primarily on the integrity of the samples that arrive at the laboratory. Consequently, the field personnel must take appropriate measures to protect samples from deterioration and contamination.

a. Field measurements should always be made on a separate sub-sample, which is then discarded once the measurements have been made. They should never be made on the same water sample which is returned to the analytical laboratory for chemical analysis.
b. Sample bottles, new or used, must be cleaned according to recommended procedures.
c. Only the recommended type of sample bottle for each parameter should be used.
d. Water sample bottles should be employed for water samples only.
e. Recommended preservation methods must be used. All preservatives must be of an analytical grade.
f. Solvent-rinsed Teflon liners can be used to prevent contamination from the bottle caps of water samples which are to be analyzed for organic compounds.
g. The inner portion of sample bottles and caps should not be touched with bare hands, gloves, mitts, etc.
h. Sample bottles must be kept in a clean environment, away from dust, dirt, fumes, and grime. Vehicle cleanliness is important.
I. All foreign and especially metal objects must be kept out of contact with acids and water samples. Petroleum products and exhaust fumes should be kept away from samples.
j. Specific conductance should never be measured in sample water that was first used for pH measurements. Potassium chloride diffusing from the pH probe alters the conductivity of the sample.
k. Samples must never be permitted to stand in the sun; they should be stored in an ice chest.
l. Samples must be shipped to the laboratory without delay.
m. The sample collector should keep their hands clean and refrain from smoking while working with water samples.

8.6.3 Field Quality Control

Table 8-4. Number and Types of Samples Taken for Field Quality Control	
Sample Blank	1 per 12 samples
Replicate	1 per quarter per medium

Quality control is an essential element of a field quality assurance program. In addition to standardized field procedures, field quality control requires the submission of blank and duplicate samples to check contamination, sample containers, or any equipment that is used in sample collection or handling, and to detect other systematic and random errors occurring from the time of sampling to the time of analysis. Replicate samples must also be collected to check the reproducibility of the sampling. The timing and the frequency of blank, duplicate, and replicate samples are listed in **Table 8-4.**

8.6.3.1. ***Sample Blanks.*** A daily "sample blank" is prepared in the field at the end of each day's sampling. One blank is prepared for every 12 water samples. A sample blank is prepared by filling appropriate sample bottles with ultrapure distilled water using field sampling equipment, adding preservative in the same manner as it was added to the water samples, capping the bottles tightly, and transporting them to the laboratory in the same manner as the water samples.

8.6.3.2. ***Replicates.*** Two samples are taken simultaneously in a given location. The samples are taken to measure the cross-sectional variations in the concentration of the parameters of interest in the system. One sample per environmental medium per quarter will be replicated.

9.0 T E NATURAL RESOURCE MANAGEMENT CENTER
(Maintenance Facility)

The maintenance department is responsible for irrigation, mowing, fertilization, pesticide application and general upkeep of the golf course grounds. The maintenance area is where pesticides are loaded into application equipment, mowers and other pieces of equipment are serviced, and pesticides, fuel, fertilizer, and cleaning solvents are stored. This is where there is potential for pollution of soil, surface water, or ground water. Contamination can occur when pesticides are spilled, containers or equipment cleaned and the rinse water dumped on the ground or discharged into surface water, or improperly cleaned containers are stockpiled or buried. Proper management of the maintenance area is an important part of responsible chemical and pesticide use.

Management practices at the project should be implemented at these maintenance areas that will prevent the contamination of natural resources by the materials that are stored or handled at these sites. The general approach to management of golf course maintenance facilities involves three principles that are:

- Isolate all potential contaminants from soil and water.
- Do not discharge any material other than clean stormwater onto the ground or into surface water bodies.
- Minimize irrigation, fertilizer, and pesticide use requirements through use of Integrated Pest Management and native or naturalized vegetation wherever practicable.

The first principle involves identifying all the materials stored or handled in a golf course maintenance area along with current practices that could cause environmental contamination. The next step is to develop management practices which isolate those materials from soil and water during storage, handling, and disposal. Storing these materials in covered, lockable storage areas, handling them over impermeable surfaces, cleaning up spills promptly and properly, recycling these materials where possible, and otherwise properly managing wastes will keep these materials from contaminating soil or water.

The second principle is an extension of the first. It includes preventing contamination of stormwater and eliminating the discharge of materials such as equipment wash water to ground or surface waters. Discharges to surface or ground water should be eliminated through the containment and collection of equipment wash waters and proper management of collected material.

The third principle, that of minimizing fertilizer, pesticide and irrigation use through use of native vegetation and Integrated Pest Management directly impacts the amount of material handled annually, reduces the annual maintenance budget and encourages good environmental stewardship.

9.1 BEST MANAGEMENT PRACTICES FOR THE MAINTENANCE FACILITY

The maintenance facility at Silo Ridge Golf Course should incorporate the following to be as environmentally compatible as possible, and should include Best Management Practices found in **Appendix VII**.

9.1.1 Pesticide Storage and Mixing

Pesticide storage and mixing are in a separate room or building designated for these materials only, and it is located away from water sources (wells, ponds). The building should have a concrete floor with a poured concrete lip extending upward into the concrete block walls. The center of the building should be the lowest, and the floor should be sloped to the center. A concrete sump should be located at the low point. This area is for mixing and should provide excellent containment for any inadvertent spills. The building is kept locked and posted as required by law, including the courses "Hazard Communication Program". Good ventilation should be provided by continuous circulation fans and chemicals should be kept away from direct contact with the concrete floor. Storage is on non-wooden shelving. Other features to include are switches for lights and the fuse box on the outside, explosion proof lights and fans, and a "lip" at the entrance that moves rainwater away from the interior of the facility. All pesticides will be stored in their original containers with visible labels.

To be prepared for spills and/or leaks, absorbent floor-sweep materials, sawdust or cat litter and activated charcoal will be kept on hand. An inventory of pesticides and other chemicals will be kept, and MSDS and labels for each pesticide used will be readily accessible. An emergency equipment box is located on the outside of the building. Typically this is a wooden box (perhaps 3 ft by 3 ft with a sloping roof) that stores items for emergency use. Such things as a fire extinguisher, respirator, first aid supplies, goggles, respirators, gloves, rubber boots, and a coverall (perhaps a tyvek suit). These items are placed in the locked box on the outside of the building so they are available in case they are needed.

Water should be available for both routine and emergency chemical removal, including showers and eye wash facilities.

Mixing and loading will be done in the pesticide storage building near the center area where the sloping concrete should provide excellent containment for any inadvertent spills. A sump is located at the base of the sloped area, thus facilitating clean-up of spills or overfill. A system of rinse water tanks will be used to store excess water from the filling or rinsing of sprayers. This is an effective way to deal with the rinse water. The rinse water is pumped into the holding tanks and reused as make-up water the next time that type of material is applied. Three different tanks are used, one for herbicides, one for insecticides and one for fungicides. The rinse water from herbicide applications is pumped to the herbicide tank, rinse water from insecticide applications is pumped to the insecticide tank, and rinse water from fungicide applications is pumped to the fungicide tank. The tanks are located above the mixing/wash area on metal or non-absorbent shelves.

Before mixing chemicals together, their compatibility will be checked as chemical incompatibility could result in reduced effectiveness, increased toxicity to the applicator, or phytotoxicity to the turfgrass. The "quart jar method" should be used to determine compatibility. Spray adjuvants (such as wetting agents, emulsifiers, foaming agents and stickers) should be used in accordance with label recommendations.

Care will be taken to mix only the amount of pesticide needed for the application. As soon as pesticides are loaded, all equipment and apparel used will be washed, rinsed and air dried. Water used in the cleaning process will be dumped into the spray tank.

After the pesticide is applied, the sprayer tank, boom and nozzles will be washed in the designated area where the tank will be refilled with water; and this material (which will have an extremely low concentration of pesticide) will be stored in the holding tanks as described above.

9.1.1.1. *General Considerations.*

- The pesticide storage facility should have a complete alarm system, with battery backup, for burglary and fire.
- Locks and bolts used at the control center should be of the highest quality materials available.
- Materials used inside the control center are comprised of high quality durable plastic, aluminum or concrete to avoid absorption of chemical residues or vapors.
- Install an explosion proof fan and explosion proof light.
- A ventilation design must be an integral part of the control center.
- All pesticides stored on non-absorbent shelving are located at least 6" off the floor.
- All pesticides are segregated by liquid, powder or granular class.
- All powders and granules are stored above liquids.
- All shelving must be sturdy and secured to avoid sagging and falling.
- The entire floor of the control center should be sloped to the center of the room with a recessed sump located at its center.
- A light and fan switch should be located outside of the door entering the control center.
- A sink with potable water and spigot and hand blower (not paper towels) with the drainage funneled back into the sump.
- A mixing table should be attached to the sink at a slightly higher elevation to allow overspill to be washed into the sink.
- A portable eye wash bottle will be located over the sink; immediately outside an eye wash/shower station supplied by potable water should be installed.
- A refill hose should be located above the sump to allow proper and timely filling of spray tanks with water.
- Only qualified personnel will be allowed access to the control center.

9.1.2 Wash Pad

Equipment wash areas have the potential to cause environmental problems; particularly, the runoff associated with wash water and debris. Pesticides can be a serious concern to the environment, and by washing the pesticide spray equipment in the pesticide storage building Silo Ridge Golf Course will avoid many of the concerns.

Washing equipment other than pesticide application equipment will take place at a specially constructed wash pad. The wash pad is a concrete pad that is covered and sloped to a center collection area. Grass clippings and sediments are collected in the central collection area. Water is then recycled or discharged to an area for appropriate treatment.

9.1.2.1. *General Considerations.*

- All water used to wash equipment should have materials such as grease, oil and gasoline removed from the water before disposal.
- Pesticide equipment will not be washed off in this area (done at the IPM Control Center).
- A roof should cover the wash-down area to keep rain off the pad and prevent excessive water from going into the recycling system.
- The pad should be elevated along the outer edges to direct rain water away from the area, but the center area should be recessed from normal ground level to allow for wash water to be collected for recycling and the roof should be high enough to allow golf course equipment the proper amount of clearance, yet low enough to meet any aesthetic requirements (visibility to homeowners, etc.).
- Several air hoses attached to posts prior to the wash-down pad can be used to remove excessive grass residue off equipment prior to moving onto the wash-down pad which will reduce the amount of grass clippings/debris entering the water recycle system.
- The pad should have a screen basket system to prevent an excess of grass clippings and debris from entering the recycling system. Grass clippings will be composted and recycled on the golf course.

- Hoses with attachable spray bottles of liquid wax at the wash-down pad can be utilized so valuable equipment can receive a brief application of liquid wax (cut with water) after each use.
- Concrete in the pad should be impermeable to prevent leaching of any contaminates.
- Installing lightning protection in this area is vital for worker and equipment protection.

9.1.3 Fuel Island

- Cover the fuel island to minimize the effect of sunlight on the equipment as well as possible increased evaporation of fuel and provide protection for employees. The roof should be high enough to allow golf course equipment the proper amount of clearance, yet low enough to meet any aesthetic requirements (visibility to homeowners, etc.).
- Install adequate lighting around and beneath the roof to allow for operation during periods of darkness or inadequate light.
- Install lightning protection on the fuel island roof.
- If possible, all fuel storage and carrying mechanisms should be above ground devices.
- Fuel should be stored in above ground, double vaulted tanks from a reputable manufacturer.
- The pad should be elevated along the outer edges to direct rain water away from the area, but the center area should be recessed from normal ground level to allow for containment in the event of a fuel spill; the recession should be deep enough to contain a few hundred gallons of spillage but not so severe that it presents difficulty for equipment entering and leaving the fuel island.
- Concrete in the pad should be impermeable to prevent leaching of any contaminates.
- Prior to construction of the fuel island the Fire Marshall and other appropriate authorities should review the specifications.

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APPENDIX I

Analysis of Pesticides for Use at Silo Ridge Resort Community – Traditional Neighborhood Alternative

Table I-1. Characteristics of the Pesticides That Were Evaluated for Silo Ridge Resort Community (a)

Pesticide	Reduced Risk Pesticides	Maximum Applicationb (lbs ai/acre)	Maximum Number of Applications (yr)	Area of course treated (acres)	Water Solubility mg/l	interval between applications (days)c	soil metabolic half life (days)	Soil Adsorption Koc	Is pesticide wetted (Y/N)	Buffer width (ft)	method of application (as/gs/g)d	use rate for year (lbs ai)e	Health Advisory ppb
Fungicides													
azoxystrobin	yes	0.54	3	40	6.7	21	21	581	n	25	gs	64.8	1260
boscalid	yes	0.35	3	40	4.64	100	150	809	n	25	gs	42	2450
etridiazole		4.1	3	40	117.1	20	20	1700	n	25	gs	492	11.2
fenarimol		2.72	1	40	13.7	100	250	748	n	25	gs	108.8	4.2
fludioxanil	yes	0.68	3	40	1.83	100	125	145405	n	25	gs	81.6	210
flutalonil		4.2	3	40	8.01	14	233	735	n	25	gs	504	4410
fosetyl-Al		17.4	3	40	110,000.0	1	0.04	1,703	n	25	gs	2088	21000
iprodione		5.4	3	40	12.2	84	84	373	n	25	gs	648	80
metalaxyl/metalaxyl-	yes	1.35	1	40	7,100.0	42	42	165	n	25	gs	54	600
myclobutanil		0.65	3	40	124	14	35	517	n	25	gs	78	200
PCNB		20.4	1	40	0.39	39	39	2480	n	25	gs	816	2.1
polyoxin D	yes	0.26	3	40	8590	50	2	1000	n	25	gs	31.2	
propamocarb		7.2	3	40	1,005,000.0	39	39	535	n	25	gs	864	770
propiconazole		0.85	3	40	150.0	100	214	1,086	n	25	gs	102	70
pryraclostrobin	yes	0.5	1	40	1.9	32	32	11000	n	25	gs	20	21000
thiophanate-methyl		11	1	40	3.5	1	0.6	1830	n	25	gs	440	56
triadimefon		4.1	3	40	70	26	26	300	n	25	gs	492	28
trifloxystrobin	yes	0.34	1	40	0.61	7	7	2377	n	25	gs	13.6	350
vinclozalin		2.72	3	40	3.4	12	12	260	n	25	gs	326.4	17.5
Herbicides													
2,4-D amine		1	3	40	44,558.0	10	10	56	n	25	gs	120	35
benefin		3	1	40	0.1	40	40	9000	n	25	gs	120	21
bensulide		10	1	40	25	90	90	3900	n	25	gs	400	35
bentazon		2	3	40	570.0	13	13	51	n	25	gs	240	200
carfentrazone	yes	0.31	3	40	22.0	1	0.5	23	n	25	gs	37.2	210
clopyralid		0.5	3	40	143000	34	34	5.15	n	25	gs	60	3500
dicamba		0.5	3	40	5,500.0	14	14	13	n	25	gs	60	4000
diquat		1	3	40	718000	100	1000	2184750	n	25	gs	120	35
dithiopyr		0.5	3	40	1.38	100	871	1043	n	25	gs	60	25
ethofumesate		1	3	40	50	70	70	147	n	25	gs	120	140
fenoxaprop		0.17	3	40	0.9	5	12	9490	n	25	25	20.4	18
fluroxypyr		0.5	3	40	6500	3	3	24600	n	25	gs	60	5600
glyphosate	yes	4	3	40	10,500.0	12	12	21,699	n	25	gs	480	14000
halosulfuron		0.06	3	40	1,650.0	51	51	124	n	25	gs	7.2	210
imazapyr		1.5	3	40	9740	11	11	125	n	25	gs	180	20000
MCPA		2	3	40	294000	15	15	74	n	25	gs	240	30
mecoprop (MCPP)		2	3	40	250,000.0	8	8.2	31	n	25	gs	240	7
oxadiazon		3	3	40	0.7	60	60	3,200	n	25	gs	360	4
pendimethalin		3	3	40	0.33	90	90	15744	n	25	gs	360	70
prodiamine		1	3	40	0.2	106	106	274	n	25	gs	120	
quinclorac		0.75	3	40	64.0	100	168	36	n	25	gs	90	14000
rimsulfuron		0.065	3	40	7300	24.3	24.3	46.6	n	25	gs	7.8	5726
sulfentrazone		0.375	3	40	0.0078	100	541	43	n	25	gs	45	980
triclopyr		1	1	40	5900	39	39	47.7	n	25	gs	40	400
trifluralin		1.5	1	40	0.221	100	181	8765	n	gs	25	60	10

Table I-1. Characteristics of the Pesticides That Were Evaluated for Silo Ridge Resort Community (a)

Pesticide	Reduced Risk Pesticides	Maximum Applicationb (lbs ai/acre)	Maximum Number of Applications (yr)	Area of course treated (acres)	Water Solubility mg/l	interval between applications (days)c	soil metabolic half life (days)	Soil Adsorption Koc	Is pesticide wetted (Y/N)	Buffer width (ft)	method of application (as/gs/g)d	use rate for year (lbs ai)e	Health Advisory ppb
Insecticides													
acephate		5	1	40	790000	3	3	2	n	25	gs	200	2.8
azadirachtin		0.044	1	40	260.0	26	26	7	n	25	gs	1.76	
bifenthrin		0.22	1	40	0.0001	95	95	13000	n	25	gs	8.8	10
carbaryl		6.5	1	40	9.1	16	16	211	n	25	gs	260	4000
clothianidin		0.41	1	40	327	100	830	215	n	25	gs	16.4	686
cyfluthrin		0.2	1	40	0.0066	33	33	64300	n	25	gs	8	200
deltamethrin		0.13	1	40	0.0002	13	13	460000	n	25	gs	5.2	70
fenamiphos		15	1	40	345	0.85	0.85	754	n	25	gs	600	0.7
fipronil	yes	0.025	1	40	3.78	100	142	577	n	25	gs	1	0.14
halofenozide		0.9	1	40	12.3	100	219	2	n	25	gs	36	
imidacloprid		0.4	1	40	510.0	100	191	189	n	25	gs	16	400
lambda-cyhalothrin	yes	0.14	1	40	0.005	25	25	157000	n	25	gs	5.6	7
permethrin		0.9	1	40	0.02	13	13	100000	n	25	gs	36	400
spinosyn	yes	0.4	1	40	235.0	14	14	34,600	n	25	gs	16	187.6
Plant Growth Regulators													
paclobutrazol		0.75	3	40	35	112	112	354	n	25	gs	90	91
trinexapac-ethyl		0.34	3	40	10200	0.33	0.33	280	n	25	gs	40.8	

a We assume normal weather conditions and player traffic.
b Maximum recommended application rate (lb ai/acre)
c means that the shortest time between applications was used.
d as is aerial spray, gs is ground spray, g is granular
e total yearly use was calculated by Application rate x Area Treated x number of applications.

* indicates reduced risk pesticide. EPA gives priority in its registration program for conventional chemical pesticides to pesticides that meet reduced risk criteria: low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants), low potential for groundwater contamination, lower use rates, low pest resistance potential, and compatibility with Integrated Pest Management.

Table I-2. Results of the Risk Assessment to Select Pesticides for Silo Ridge Resort Community

Pesticide	Reduced Risk Pesticides	Health Advisory ppb	LC50 ppb	GEENEC Output Peak Runoff ppb	GEENEC Output Avg 4 day Runoff ppb	GEENEC Output Avg 21 day Runoff ppb	GEENEC Output Avg 60 day Runoff ppb	Sci-Grow Output Drinking H2O ppb	Tier 1: Acute Aquatic	Tier 1: Chronic Aquatic	Tier1: Health
Fungicides											
azoxystrobin	yes	1260	259	25.67	24.91	21.14	15.04	0.074	0.099	0.816	0.0001
boscalid	yes	2450	2700	17.6	17.47	16.75	15.25	0.165	0.007	0.062	0.0001
etridiazole		11.2	770	93.36	90.19	74.5	50.54	0.251	0.121	0.968	0.0224
fenarimol		4.2	900	69.91	69.51	67.29	62.6	2.03	0.078	0.748	0.4833
fludioxanil	yes	210	47000	3.61	2.61	0.79	0.28	0.012	0.000	0.000	0.0001
flutalonil		4410	2500	250.15	248.69	240.6	223.49	3.06	0.100	0.962	0.0007
fosetyl-Al		21000	75800	106.98	66.34	16.04	5.62	0.0000153	0.001	0.002	0.0000
iprodione		80	3100	321.24	318.41	302.9	271.11	4.12	0.104	0.977	0.0515
metalaxyl/metalaxyl-	yes	600	28000	68.35	67.41	62.36	52.59	1.15	0.002	0.022	0.0019
myclobutanil		200	2400	33.27	32.65	29.39	23.43	0.16	0.014	0.122	0.0008
PCNB		2.1	100	207.39	202.54	177.54	134.52	1.29	2.074	17.754	0.6143
polyoxin D	yes		4080	4.9	3.76	1.3	0.46	0.000599	0.001	0.003	0.0000
propamocarb		770	106000	365.19	358.95	325.9	264.9	1.9	0.003	0.031	0.0025
propiconazole		70	830	37.73	37.45	35.95	32.83	0.337	0.045	0.433	0.0048
pryraclostrobin	yes	21000	19.6	2.67	2.5	1.75	0.93	0.009	0.136	0.893	0.0000
thiophanate-methyl		56	7800	64.32	39.89	9.64	3.38	0.00194	0.008	0.012	0.0000
triadimefon		28	4100	253.28	247.38	217.01	164.44	1.18	0.062	0.529	0.0421
trifloxystrobin	yes	350	14	3.71	3.07	1.33	0.49	0.0076	0.265	0.950	0.0000
vinclozalin		17.5	2840	165.13	157.31	121.09	73.03	0.304	0.058	0.426	0.0174
Herbicides											
2,4-D amine		35	1600	78.18	73.87	54.6	30.99	0.151	0.049	0.341	0.0043
benefin		21	65	16.01	15.32	12.06	7.57	0.057	0.246	1.855	0.0027
bensulide		35	720	79.1	77.53	69.3	54.62	69.71	0.110	0.963	1.9917
bentazon		200	64000	162.71	155.73	122.82	76.82	0.599	0.003	0.019	0.0030
carfentrazone	yes	210	1600	7.37	4.55	1.1	0.39	0.000595	0.005	0.007	0.0000
clopyralid		3500	750000	46.89	46.11	41.97	34.22	3.91	0.000	0.001	0.0011
dicamba		4000	3900	43.65	41.92	33.63	21.68	0.341	0.011	0.086	0.0001
diquat		35	140	3.32	1.47	0.3	0.1	0.018	0.024	0.021	0.0005
dithiopyr		25	460					0.49	0.000	0.000	0.0196
ethofumesate		140	2500	76.96	76.26	72.43	64.6	1.77	0.031	0.290	0.0126
fenoxaprop		18	310	1.48	1.37	0.91	0.46	0.00301	0.005	0.029	0.0002
fluroxypyr		5600	14300	2.47	1.94	0.7	0.25	0.009	0.000	0.000	0.0000
glyphosate	yes	14000	1300	28.71	25.67	14.62	6.3	0.072	0.022	0.112	0.0000
halosulfuron		210	21000	4.73	4.68	4.37	3.77	0.0852	0.000	0.002	0.0004
imazapyr		20000	2706	107.08	101.64	76.87	45.12	0.203	0.040	0.284	0.0000
MCPA		30	1440	159.2	153.23	124.37	81.78	0.66	0.111	0.864	0.0220
mecoprop (MCPP)		7	92000	157.27	146.59	101.4	52.67	0.195	0.002	0.011	0.0279
oxadiazon		4	880	26.66	26.11	23.23	18.13	0.173	0.030	0.264	0.0433
pendimethalin		70	260	25.62	24.22	17.86	10.2	0.054	0.099	0.687	0.0008
prodiamine			3180	66.21	65.75	63.19	57.83	1.37	0.021	0.199	
quinclorac		14000	31600	82.7	82.4	80.71	77.03	2.15	0.003	0.026	0.0002
rimsulfuron		5726	390000	5.59	5.46	4.78	3.6	0.0696	0.000	0.000	0.0000
sulfentrazone		980	60400	7.8	7.8	7.8	7.8	46.8	0.000	0.001	0.0478
triclopyr		400	148000	51.48	50.3	42.59	30.19	2.31	0.000	0.003	0.0058
trifluralin		10	8.4	8.37	8.11	6.78	4.73	0.0309	0.996	8.071	0.0031

Table I-2. Results of the Risk Assessment to Select Pesticides for Silo Ridge Resort Community

Pesticide	Reduced Risk Pesticides	Health Advisory ppb	LC50 ppb	GEENEC Output Peak Runoff ppb	Avg 4 day Runoff ppb	Avg 21 day Runoff ppb	Avg 60 day Runoff ppb	Sci-Grow Output Drinking H2O ppb	Tier 1: Acute Aquatic	Tier 1: Chronic Aquatic	Tier1: Health
Insecticides											
acephate		2.8	1340	176.01	146.84	65.03	24.41	0.0402	0.131	0.485	0.0144
azadirachtin			5000	3.48	3.4	3.01	2.32	0.115	0.001	0.006	0.0000
bifenthrin		10	0.1	0.009	0.009	0.009	0	0.00264	0.090	0.900	0.0003
carbaryl		4000	10000	267.27	248.84	171.24	88.4	0.853	0.027	0.171	0.0002
clothianidin		686	105000	31.55	31.49	31.12	30.33	4.19	0.000	0.003	0.0061
cyfluthrin		200	0.05	0.65	0.536	0.229	0.086	0.0024	13.000	45.800	0.0000
deltamethrin		70	0.01	0.2	0.134	0.029	0.01	0.00156	20.000	29.000	0.0000
fenamiphos		0.7	4.5	146.1	90.38	21.89	7.67	0.00556	32.467	48.644	0.0079
fipronil	yes	0.14	17.5	1.08	1.07	1.03	0.95	0.0117	0.062	0.589	0.0836
halofenozide			3600	81.29	81.08	79.87	77.18	316	0.023	0.222	0.0000
imidacloprid		400	10400	26.58	26.47	25.85	24.5	1.08	0.003	0.025	0.0027
lambda-cyhalothrin	yes	7	0.076	0.362	0.254	0.073	0.0259	0.00168	4.763	9.605	0.0002
permethrin		400	0.1	2.42	1.82	0.6	0.21	0.0108	24.200	60.000	0.0000
spinosyn	yes	187.6	5900	2.22	1.93	0.98	0.39	0.0048	0.000	0.002	0.0000
Plant Growth Regulators											
paclobutrazol		91	16200	45.64	45.32	43.54	39.83	0.794	0.003	0.027	0.0087
trinexapac-ethyl			35000	5.69	3.52	0.85	0.3	0.000076	0.000	0.000	0.0000

a We assume normal weather conditions and player traffic.
b Maximum recommended application rate (lb ai/acre)
c means that the shortest time between applications was used.
d as is aerial spray, gs is ground spray, g is granular
e total yearly use was calculated by Application rate x Area Treated x number of applications.

* indicates reduced risk pesticide. EPA gives priority in its registration program for conventional chemical pesticides to pesticides that meet reduced risk criteria: low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants), low potential for groundwater contamination, lower use rates, low pest resistance potential, and compatibility with Integrated Pest Management.

Table I-3. Environmental Impact Quotients for Pesticides That Were Evaluated for Silo Ridge Resort Community

Pesticide	EIQ	EIQ FUR
Fungicides		
azoxystrobin	15.2	8.21
boscalid	43.67	15.28
etridiazole	32.8	134.48
fenarimol	22.4	60.93
fludioxanil	26.12	17.76
flutalonil	24.4	102.48
fosetyl-Al	11.3	196.62
iprodione	11	59.40
metalaxyl/metalaxyl-M	29.4	39.69
myclobutanil	33	21.45
PCNB	35	714.00
polyoxin D	9.33	2.43
propamocarb	21.5	154.80
propiconazole	27.5	23.38
pryraclostrobin	31.45	15.73
thiophanate-methyl	22.42	246.62
triadimefon	30.7	125.87
trifloxystrobin	30.9	10.51
vinclozalin	13.3	36.18
Herbicides		
2,4-D amine	18.67	18.67
benefin	16	48.00
bensulide	26	260.00
bentazon	20.3	40.60
carfentrazone	21.5	6.67
clopyralid	18.1	9.05
dicamba	28	14.00
diquat	31.7	31.70
dithiopyr	22	11.00
ethofumesate	30	30.00
fenoxaprop	23.7	4.03
fluroxypyr	13.33	6.67
glyphosate	15.3	61.20
halosulfuron	17	1.02
imazapyr	18	27.00
MCPA	36.7	73.40
mecoprop (MCPP)	21	42.00
oxadiazon	26.7	80.10
pendimethalin	29.7	89.10
prodiamine	16.17	16.17
quinclorac		
rimsulfuron	15.8	1.03
sulfentrazone	14.67	5.50
triclopyr	9	9.00
trifluralin	18.8	28.20
Insecticides		
acephate	23.4	117.00
azadirachtin	12.8	0.56
bifenthrin	87.8	19.32
carbaryl	21.7	141.05
clothianidin	31.8	13.04
cyfluthrin	39.6	7.92
deltamethrin	25.7	3.34
fenamiphos	71.3	1069.50
fipronil	90.92	2.27
halofenozide	26.18	23.56
imidacloprid	34.9	13.96
lambda-cyhalothrin	24.4	3.42
permethrin	88.7	79.83
spinosyn	17.7	7.08
Plant Growth Regulators		
paclobutrazol	28.7	21.53
trinexapac-ethyl		

EIQ is the Environmental Impact Quotient
EIQ-FUR is the Environmental Impact Quotient Field Use Rating

ECOLOGICAL AND HUMAN HEALTH RISK ASSESSMENT APPROACHES AND FINDINGS

Pesticides were evaluated for use at Silo Ridge Resort Community using standard risk assessment techniques that were developed by the US Environmental Protection Agency (1992). Through this risk assessment process, pesticides with the least potential for toxic effects were selected for use at Silo Ridge Resort Community.

The EPA endorses a tiered approach to risk assessment. In this assessment, only a Tier 1 assessment was performed. Any chemicals showing the potential for toxic effects in the Tier I assessment were rejected for use at the golf course. A description of the Tier I method follows.

Tier 1, the screening level risk assessment, incorporates conservative estimates of pesticide application rates, along with conservative exposure and risk characterization methods, to provide estimates of the potential of chemical risk. The Screening Concentration in Ground Water (SCI-GROW) and the Generic Expected Environmental Concentration Program (GENEEC) was used to estimate exposure concentrations of the pesticides. These models were developed by EPA's Office of Pesticides and are considered the current best models for screening pesticides impacts to the environment (Parker and Rieder 1997, Barrett, 1997). Exposure concentration estimates were compared with ecological (LC_{50}) and human health indicators of risk. For those pesticides shown to have a potential for effect in the Tier 1 assessment, a Tier 2 risk assessment may be implemented, or the pesticide was dropped and will not be used at the golf course. Tier 2 uses high quality data and more accurate methods to generate estimates of pesticide risk. If further evaluation is needed, a Tier 3 assessment is conducted. In Tier 3, site-specific data for use in the exposure models is generated. Typically, this equates to site surveys, collection of soil and water samples, and possible toxicity testing of site-specific materials. Tier 3 analyses are expensive and generally not conducted in the selection process. Rather than conduct a Tier 3 risk assessment, a pesticide would simply not be used at the golf course.

The major components (**see Figure I-1**) of a pesticide risk assessment are described below (problem formulation, exposure assessment, effects assessment, and risk characterization). Each of these components is implemented within each tier of the risk assessment process. However, the methods, data requirements, and interpretation of the risk process is tier specific. After an initial description of the risk assessment components, the specific methods appropriate to each tier are described.

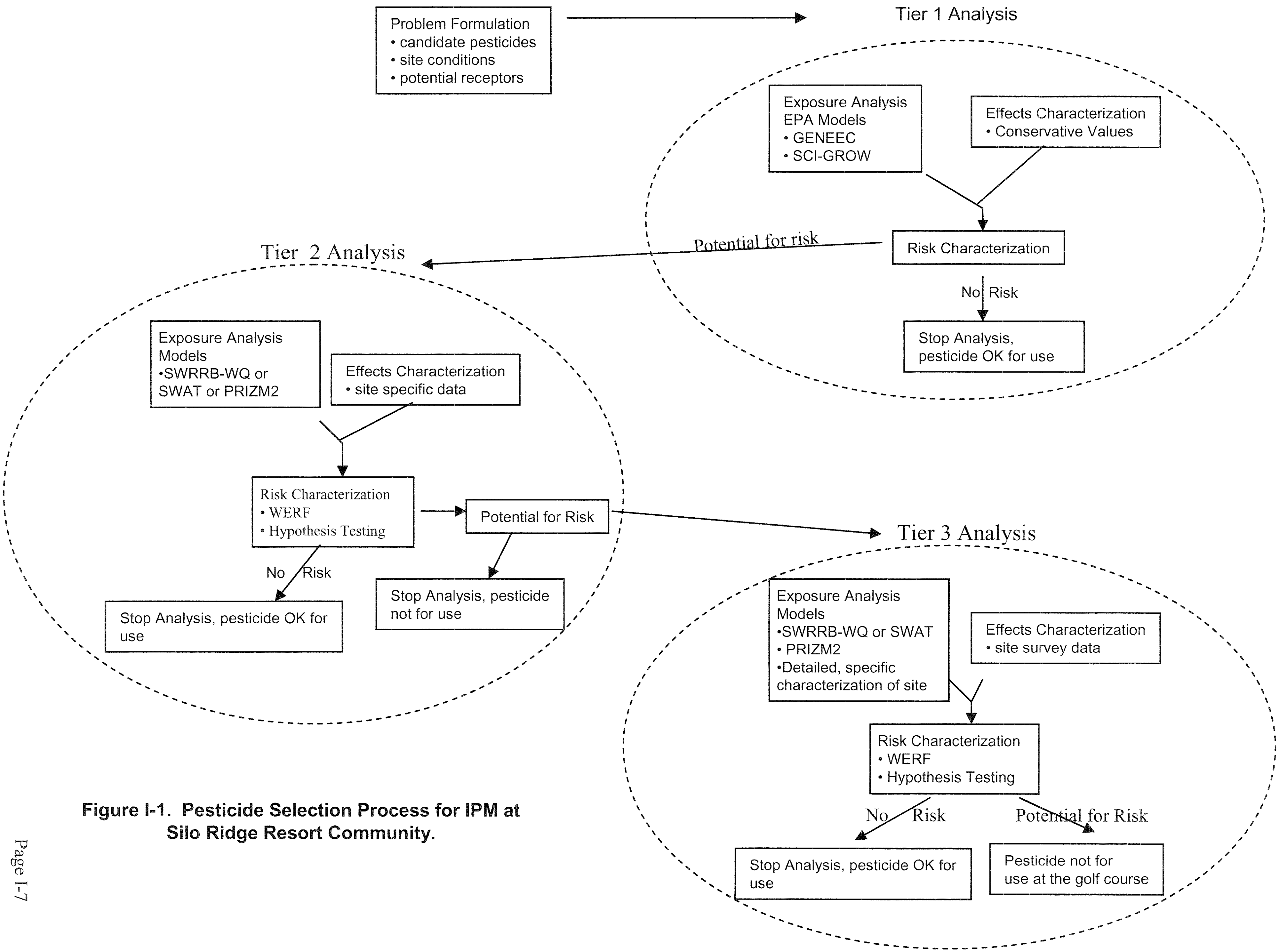


Figure I-1. Pesticide Selection Process for IPM at Silo Ridge Resort Community.

The Planning Stage: Problem Formulation

The objective of a pesticide risk assessment is to provide rigorous scientific information about the potential toxic effects of pesticides. Using the outputs from the assessment pesticides were selected that will minimize any potential environmental or human health impacts of pesticides that may runoff into drinking water sources or water bodies containing aquatic life.

In addition, the assessment will provide golf course superintendents with information useful for selecting effective pesticide application rates and practices, while minimizing any adverse impacts to human or environmental health.

The problem formulation stage is the general planning stage for the assessment. The major information gathered in this stage includes the following:

1. A list of candidate pesticides for use at a specific golf course - these pesticides will be evaluated in the tiered risk assessment process described below.

2. A detailed description of the golf course site and surrounding areas, including topography, drinking water supplies and water bodies potentially receiving runoff from the site.

3. A list of potential receptors (e.g., those animals or human communities potentially impacted from pesticide runoff or ground water flow). Information should include routes of exposure for specific chemicals and information on the signs and symptoms of pesticide toxicity. A literature review of the concentrations of specific pesticides shown to cause toxicity to humans and biota is also required.

4. A chemical description of the candidate pesticides including chemical structure, partition coefficients (Koc), half life, degradation rate, and volatility.

5. Supporting information useful for evaluating the exposure concentrations of the pesticide and risk of the pesticide to human and environmental health. Typical information includes representative meteorological data, health affects levels (HAL), and environmental screening criteria (e.g., LC_{50} of a sensitive local species).

During this stage, a list of pesticides that are candidates for use at a specific golf course was selected and all relevant information required to successfully conduct the risk assessment (see above) was gathered. In addition, the criteria used to judge the potential risks posed by the pesticides under consideration were defined. The criteria generally represent a concentration in the drinking water supplies or surrounding water bodies that pose a risk to human or ecological health. Selection of specific criteria are dependent upon the risk tiers (described below). More conservative criteria are used in the early tiers.

Exposure Assessment

The exposure assessment provides information on the concentration of pesticide in drinking water and surface water that results from application of pesticide at the golf course. These expected concentrations are used to judge the relative risk of the pesticide to human and environmental health. The objective of the exposure assessment is to (1) quantify the amount and timing of pesticide release into the environment, (2) estimate the fate and transport of the pesticide within the golf course boundary and onto surrounding areas, and (3) quantify the exposure of individuals and biota to the resulting concentrations of pesticides in drinking water supplies and receiving water bodies. The specific methods used to generate the exposure concentrations are dependent upon the risk assessment tier under evaluation. In Tier 1, the exposure concentrations are generated in a manner that provides the most conservative concentration estimate (the highest concentration) that could reasonably be thought to occur. In Tier 2 and Tier 3, more accurate estimates of the exposure concentration are generated using detailed site-specific information in the exposure estimates.

Background concentrations of pesticides in groundwater and surface waters are checked (see Environmental Monitoring section). These background concentrations allow separation of the relative pesticide risk caused by those pesticides used at the golf course from other sources of pesticides.

Prior to golf course construction and operation, exposure concentrations can only be calculated with the use of ground water flow and surface water runoff models. After golf course operation has begun, water samples from groundwater and surface receiving waters can be obtained from laboratory chemical analysis.

Ecological considerations of pesticide exposure include bioaccumulation of pesticides up the food chain to higher trophic levels. In this context, the potential exposure of carnivores such as birds and foxes to magnified pesticide concentrations are also be considered.

Effects Characterization

Effects characterization involves generating a list of all organisms that may be exposed to pesticide concentrations resulting from golf course application. In addition, a review of the literature to establish toxic pesticide concentrations for each organism is conducted. For biota, LC_{50}, IC_{25}, or EC_{50} values generated from laboratory bioassay tests are recorded. For humans, health effects criteria, including drinking water and fish consumption levels, are generated. These data are used in combination with the exposure levels to generate estimates of risk. In addition, information gathered in the literature reviews provides a scientific basis for any potential risk to human health or the environment that may be found as a result of the risk assessment.

Risk Characterization

Information on exposure levels and effects are combined in the risk characterization stage to generate estimates of the potential risk of pesticide application to the golf course. The methods used in this stage are dependent upon the risk assessment tier under consideration. In Tier 1, conservative assumptions are used that effectively generate the highest probability of finding pesticide risk. If, using these conservative assumptions a pesticide is shown to have negligible risk levels, the risk assessment is ended. However, if the pesticide is shown to have the potential for environmental or human health risk we have options. First, if surrogate pesticides are available the pesticide under evaluation could be dropped from further consideration. Or, the team could elect to proceed to Tier 2. The Tier 2 methods provide more accurate estimates of pesticide risk, but are more costly and require higher quality data to generate the risk estimates. At the end of the Tier 2 assessment, the golf course team faces a similar decision. Again, the pesticide could be shown to have negligible risk or to have the potential for environmental or human health risk. If the potential for effects is present, two choices exist, elect to drop the pesticide from further consideration or proceed to Tier 3. Unlike the prior tiers, Tier 3 requires that extensive site-specific data be generated for use in the risk methodology. These site surveys are generally expensive.

The screening level risk assessment generates the highest risk levels possible for a specific pesticide. A quotient is calculated that compares the maximum expected exposure concentration of the pesticide in the media of interest (drinking water, fish tissue, sediments, surface water) to a conservative benchmark dose representing a threshold for effect (i.e., EPA's water quality criteria, HAL, etc.). If the quotient is greater than 1 (one) the potential for risk is assumed.

Expected Risk = Maximum Expected Concentration / Effects Criteria

In a Tier 1 assessment, the maximum expected concentration of the pesticide and conservative estimates of effects are combined to generate the risk estimates. The tier 1 results are used for screening those pesticides with no obvious human or environmental risk from those that require further study. The effects criteria represent a value that is protective of human or environmental health on a broad scale. Effects are evaluated for acute aquatic, chronic aquatic and human health.

Expected Risk was calculated as follows for each effects criteria:

Acute Aquatic	=	GEENEC (Peak Runoff)/LC_{50},
Chronic Aquatic	=	GEENEC (Avg 21 day runoff)/(LC_{50} * 0.1)
Human Health	=	SCI-GROW output/HAL

For exposure estimation at Tier 1, conservative screening models to generate the maximum expected pesticide concentration in drinking water or surface water at golf courses were used. These models are SCI-GROW (ground water) and GENEEC (surface water). These models were developed by EPA's Office of Pesticides and are considered the current best models for screening pesticides impacts to the environment (Parker and Rieder 1997, Barrett, 1997). Also, these models have been adopted by the joint EPA task group on pesticide exposure modeling (for more detail on the models or the joint task group see http://www.femvtf.com on the world wide web). This task group is made up of EPA and industry personnel.

The SCI-GROW estimates are based on environmental fate properties of the pesticide, the application rate, and the existing body of data from EPA-required small-scale prospective ground water monitoring studies for all pesticides. Site-specific soil properties can be added to the model to increase the relevance of the model predictions. GENEEC assumes that runoff is sufficient to remove 10% of the dissolved pesticide from a 10 hectare field. The required inputs include application rate (lbs active ingredient./acre), the maximum number of applications per year, absorption rate of dissolved pesticide to soil organic matter, and others.

Tier 2: Risk Assessment

For those pesticides shown to have a potential for effect in the Tier 1 assessment, a Tier 2 risk assessment may be implemented. Tier 2 uses high quality data and more accurate methods to generate estimates of pesticide risk. In addition, uncertainty analysis of both the model predictions of pesticide concentrations and effects criteria are used in the analysis to provide a scientifically valid method for assessing pesticide risk.

Tier 2 exposure models include PRZM2 (ground water, EPA 1993) and the Simulator for Water Resources in Rural Basins-Water Quality (SWRRBWQ, surface water runoff, Arnold and Williams 1994; Arnold et al. 1989; Williams et al., 1985). SWRRBWQ is a model that uses GLEAMS pesticide fate component, CREAMS daily rainfall hydrology model, and SCS technology for estimating peak runoff rates and newly developed sediment yield equations to simulate hydrologic and related processes in rural basins (Williams et al 1985; Arnold and Williams 1994). The objective of the model is to predict the effect of management decisions on water, sediment, nutrient, and pesticide yields at the outlet of a sub-basin or basin. SWRRBWQ is a comprehensive, continuous simulation model covering aspects of the hydrologic cycle, pond and reservoir storage, sedimentation, crop growth, nutrient cycling, and pesticide fate. This model was developed for row crop agricultural and has recently been evaluated for turf situations (Smart and Warren-Hicks 1996; Warren-Hicks et al. 1996).

Although other models are available for use, PRZM2 has become the model of choice for the EPA's Office of Pesticides for predicting transport and transformation of pesticides throughout the crop root and unsaturated zones. The model has a built-in Monte Carlo simulator for conducting an uncertainty analysis of sensitive model input parameters.

Exposure models in Tier 2 require a great deal more data to implement than the screening level models of Tier 1. For example, PRZM2 requires over 100 input parameters, including site-specific meteorological data, for successful implementation. Of course, many times the input values for a specific golf course are not available. At Tier 2, when input parameters are uncertain we employ generic values for the soil systems under evaluation. [note: Tier 3 requires site-specific studies to generate accurate input parameters].

Exposure estimates at Tier 2 are generated taking into account the uncertainty in the model inputs and the generic inaccuracy of the model. An uncertainty analysis that propagates the uncertainty of the model inputs into the expected error in prediction is called a Monte Carlo analysis. PRZM2 has a built-in algorithm for implementing the Monte Carlo analysis. The model allows a Monte Carlo uncertainty analysis to be implemented on those parameters that have the most influence on the predicted exposure concentrations. Therefore, the expected exposure concentration generated by the model (the mean value) and the uncertainty in the predictions (represented by a prediction interval or standard deviation) in the risk estimation procedure can be used. Unfortunately, SWRRBWQ does not have a built-in Monte Carlo procedure. Therefore, a prediction uncertainty must be generated manually by running the model several times using different values of sensitive input parameters. The range of model predictions are used to generate a prediction interval of the exposure estimates. Prior work with SWRRBWQ (Smart and Warren-Hicks 1996; Warren-Hicks et al. 1996) has shown that SWRRBWQ produces realistic predictions of pesticides in surface water runoff and that the described method of generating prediction intervals is sufficient in most applications.

Estimates of risk at Tier 2 can be evaluated using the following procedures:

1. For ecological risk, community level risk curves can be generated using the Water Environment Research Foundation's (WERF's) Aquatic Ecological Risk Procedures and Software (Parkhurst et al. 1995, Warren-Hicks and Parkhurst 1995). This method combines the distribution of exposure concentrations with a community level risk curve developed from laboratory toxicity test data to generate the probability of impact of one or more pesticides to the environment. This method is appropriate when sufficient laboratory toxicity data are available for a specific pesticide. In many cases, both acute and chronic community curves can be generated.

2. For both human health and environmental criteria, hypothesis testing can be employed. Here, we use the uncertainty in the exposure concentrations and risk criteria to statistically evaluate if a potential for risk is apparent. We test the hypothesis:

H_0: exposure concentration > risk criterion
H_1: exposure concentration < risk criterion

The test is a one-tailed evaluation of risk. The only concern is if the exposure criterion is greater than the risk criterion.

In this approach, an attempt is made to use more realistic risk criterion than employed in Tier 1. The WERF method provides methods for generating realistic criterion for environmental impacts. For human health impacts, the geometric mean of the health effects criterion published for a particular pesticide is used.

Tier 3: Assessment

The Tier 3 methods are identical to the Tier 2 methods. However, at Tier 3 an attempt to generate excellent site-specific data for use in the exposure models is used. Typically, this equates to site surveys, collection of soil and water samples, and possible toxicity testing of site-specific materials. The risk characterization methods are identical, but the confidence in the analytical results is increased over the Tier 1 and Tier 2 results. These surveys are typically very time consuming and expensive, and we often exclude the pesticide from further consideration rather than attempt to gather the data needed for a Tier 3 analysis.

APPENDIX II

IPM and Scouting Report Forms
and
Data Reporting Forms

SURFACE WATER SAMPLE SHEET

General Information

1. Sample Station ID ______________________________
2. Station Description ______________________________

   ____
3. Date Collected ______________________________
4. Time Collected ______________________________
5. Collector (Sampler) ______________________________
6. Weather ______________________________
7. Rain within past 3 days? (circle one) heavy medium light dry
8. Observations (turbidity, algae, fish, wildlife, odor, etc.)

Field Analyses

1. Air Temperature (F) ______________________________
2. Water Temperature (F) ______________________________
3. DO (mg/l) ______________________________
4. Conductivity (mS/cm) ______________________________
5. pH ______________________________
6. TDS (mg/l) ______________________________

Ground Water Field Sampling Sheet

Well Number: __________ Samplers: ____

Description: ____

Weather: ____

Date of Sampling: Day __________ Month ________________ Year ______

Time of Sampling: Hour __________ Minute ____________

Field Measurements

Water Temp (°C) ____________________ Air Temp (°C) ____________________________

pH ______________________________ Specific Cond (µS) __________________________

Depth of Water at which sample was taken (m): ___________________________

Calibration of Instruments

Specific Conductance: Meter ________________ Meter Reading in KC1 soln: _____________

pH Meter Model: ___________________________ Calibration buffers used: ________________

Sample Apparatus: ____

Mode of Transport: ____

Shipping Date: ____

Remarks:

____

____

____

Turf IPM Field History Report Form

Hole Number ________ Scout ______________________________ Date: ________

Site	Turf Species	Area	Mowing Schedule	Soil Analysis			Soil Drainage	Fertilization (N/1000 sq.ft.)				Irrigation Schedule
				pH	P	K		Spring	Summer	Fall	Winter	
Green												
Tee												
Fairway												
Rough												
Driving range												
Nursery green												
Practice green												

Comments on specific topics such as shade, weather, irrigation, etc.

____

____

____

Turf IPM Field Infestation Report

Hole __________ Scout ______________________________ Date __________

Site (turf species)	Mowing Height	Soil Moisture	Weeds Species No. or %	Diseases Kind %	Insects Species No. or %	Nematodes Species No. or %
Green						
Tee						
Fairway						
Rough						
			1. Crabgrass 2. Other grasses 3. Broadleaves 4. Sedges 5. Others	1. Dollar spot 2. Brown patch 3. Pythium 4. Leaf spot 5. Other	1. Sod webworms 2. Grubs 3. Hyperodes Weevils	1. Sting 2. Lance 3. Ring. 4. Stubby-root 5. Others

APPENDIX III

Example of a
Hazardous Communication Program

HAZARD COMMUNICATION PROGRAM

____

(NAME OR COMPANY)

____

(LOCATION-DIVISION)

It is the intent of ______________________, ______________________________
(Name of Company) (Address-Location-Division)

to comply with the requirements of the Hazard Communication Standard in our continuing effort to provide a healthy and safe workplace for our employees.

This program is designed to provide employee information and training (1) the hazardous chemicals known to be in the workplace, (2) the methods that will be employed to protect workers, (3) the precautionary methods employees must follow to protect themselves from hazardous chemicals, (4) the detection of a release of hazardous chemicals and (5) emergency procedures to follow should there be a release of hazardous chemicals and/or employee exposure to them.

WRITTEN HAZARD COMMUNICATION PROGRAM: Copies of the written Hazard Communication Program are available from the office of______________________________.
(Name of Office or Person)
program is reviewed annually and is updated as needed. All present or new employees will be given a copy of the program. Employees and/or their authorized representative may obtain an additional copy of the program during normal working ours at a cost of $0.10 per page.

MATERIAL SAFETY DATA SHEETS: Following is a listing of all hazardous chemicals known to be in the workplace; the location(s) of the chemical are also provided:

	HAZARDOUS CHEMICAL	LOCATION	USE
1.			
2.	(List all known or suspected hazardous chemicals.)		
3.	(If you do not have copies or all MSDS's, you will need to contact your suppliers for the necessary copies).		

A Material Safety Data Sheet (MSDS) and/or label of each hazardous chemical is filed in the office of ____. Employees
(Name of Office or Person)
and/or their representative may obtain a single copy of an MSDS and/or label during normal working hours at a cost of $0.10 per page. The relevant information on the MSDS will be shared with employees during the hazard communication training program. The MSDS will be available in the workplace to all employees who are urged to review them whenever they have a question regarding the chemical.

NOTIFICATION OF OTHER EMPLOYERS: When other employers bring a work crew onto our property they will be supplied with a copy of the Hazard Communication Program and with copies of the MSDS for hazardous chemicals which could be encountered in their work area. It shall be their responsibility to train their employees, provide personal protective equipment and handle employee emergencies. Any releases or spills of hazardous chemicals shall within minutes, be brought to the immediate attention of ____________________________.
(Name of Office, Person or Position Title)

USE OF LABELS: Whenever possible hazardous chemicals will be kept in their original containers. Should an original container ever become defective (leak) the chemical will be transferred to a similar type container. The label will be transferred to the replacement container and be securely attached. If the label is non-transferrable, a replacement label with all significant information will be prepared and be securely and prominently placed on the new container. This container of a chemical will be used for its intended use as soon as possible.

Placards will be placed on all containers in which hazardous chemicals are used, such as storage tanks for chemicals, solvent tanks for cleaning parts, etc.

EMPLOYEE INFORMATION AND TRAINING: All employees will be provided with information and training on hazardous chemicals in their workplace:

- ✓ At the time of their initial employment.
- ✓ Whenever a new hazardous chemical is brought into their workplace.
- ✓ At least annually.

All affected employees are required to participate in this training. The training will be provided or arranged by ____.
(Name of Office or Person or Position Title)

The employees will be provided with the following information:

- ✓ The requirements of the Hazard Communication Standard.
- ✓ Operations in their work area where hazardous chemicals are present, used or stored.
- ✓ Location and availability of the written Hazard Communication Program and MSDS files.

Employee training will include:

- ✓ Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.)
- ✓ The physical and health hazards of the chemicals in the work area.
- ✓ The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used and
- ✓ The details of the hazard communication program developed by the employer, including an explanation of the labeling system and the Material Safety Data Sheet, and how employees can obtain and use the appropriate hazard information.

HAZARD CHEMICAL RELEASE, SPILL OR EXPOSURE

Employees will immediately, within minutes, notify their immediate supervisor of any release, spill or human exposure to a hazardous chemical. If it is a significant release into the atmosphere, a spill on non-owned property or into a surface or ground water supply, notify the local emergency service agency and/or fire department (telephone 911) and/or the State Emergency Response Commission.

If a person or persons are exposed to a hazardous chemical, emergency treatment as specified by the MSDS or label will be immediately applied and whenever a question of further medical treatment may be required, the individual(s) will be transported to

____

(Name of Doctor or Emergency Treatment Center)

A copy of the MSDS and/or label will be transmitted with the exposed individual(s).

The supervisor of an area in which a hazardous chemical release, spill or exposure occurs will, immediately after emergency action, notify ________________________________ of the event.
(Name of Office or Person)

EMPLOYEE REQUIREMENTS: Employees are required to follow all standard operating procedures in the handling of hazardous chemicals, including the use of protective equipment. Failure to do so shall provide sufficient reason for reprimands, suspension or termination of employment.

INFORMING OUTSIDE CONTRACTORS

There may be instances where tasks will be performed by contractors that are not company employees. Should there be a hazardous substance in the work area, it is the obligation or our company to make the contractor aware of the situation. This may be accomplished by:

1. A list hazardous substances in the work area.

2. A diagram of the work area with the locations designated where hazardous substances are used and/or stored.

The contractor will be advised that MSDS are on file and available upon request. The contractor will sign an acknowledgment of receipt of information.

ACKNOWLEDGMENT OF RECEIPT

DATE:______________________________

ON THE ABOVE DATE, I ____

(CONTRACTOR'S NAME)

RECEIVED A LIST OF HAZARDOUS SUBSTANCES USED AND/OR STORED IN THE WORK AREA FROM ____.

I UNDERSTAND THAT MSDS ARE AVAILABLE FOR ALL SUBSTANCES LISTED, UPON REQUEST. I ALSO MAY OBTAIN A DIAGRAM OF THE WORK AREA DESIGNATION USE AND/OR STORAGE OF HAZARDOUS SUBSTANCES.

____

(CONTRACTOR'S SIGNATURE)

HAZARDS OF NON-ROUTINE TASKS

A non-routine task is defined as one or more of the following:

1. A task not done frequently
2. A task not listed on your job description
3. A task for which you are not trained

Should your Supervisor/Foreman call upon you to perform a non-routine task involving hazardous chemical handling or working in an area where hazardous chemicals are used or stored, the following steps will be taken by the him\her:

1. Give the employee a complete description of the task
2. Brief on hazardous chemicals in the work place
3. Brief on the effects the chemicals may have on the person
4. Determine if the employee is allergic to the chemicals present
5. Brief on proper handling of the chemicals
6. Brief an first aid procedures to take concerning the chemicals
7. State that there will be mandatory use of safety equipment
8. The Supervisor/Foremen will closely monitor the employee while working in the area of hazardous chemicals.

RECOMMENDED POSTERS AND RECORDS
IN MAINTENANCE AREA

1. OSHA JOB SAFETY AND PROTECTION POSTER
U.S. Department of Labor
Occupational Safety and Health Administration

2. EQUAL EMPLOYMENT OPPORTUNITY POSTER
Equal Employment Opportunity Commission

3. WORKERS' COMPENSATION POSTER
Obtain from Insurance carrier

4. BE SAGE WITH PESTICIDES POSTER
Environmental Protection Agency

5. RIGHT-TO-KNOW LAW POSTER
Toxic Substances Information Center

6. MATERIAL SAFETY DATA SHEETS (MSDS)
Obtain from distributor for each hazardous chemical used and/or stored.

7. PESTICIDE LABELS
Obtain from distributor of each pesticide used and/or stored.

8. HAZARD COMMUNICATION PROGRAM
A written program prepared by the course.

9. RESTRICTED USE PESTICIDE APPLICATION RECORD
Date and location of application.
Product name and quantity (pounds or gallons) of pesticide applied
Area treated and application rate method of application

10. RESTRICTED PESTICIDE CERTIFICATION LICENSE
Required only for individuals purchasing and using restricted pesticides.

APPENDIX IV

Summary of Studies on Water Quality and Nutrients and Pesticides

REVIEW OF OLF COURSE WATER QUALITY STUDIES

Interest in the environmental impact of golf courses on water quality is not new. For the past 30 years, various research studies looked at the movement of specific chemicals under differing golf course conditions, especially on sand-based root zone mix putting greens and for nitrogen source losses under a variety soil conditions. All of these studies were efforts to first document what was actually happening and then second to develop Best Management Practices to eliminate or minimize problems.

While there are numerous scientific studies which have been conducted at universities around the US and beyond to look at pesticide and nitrogen fate, many are often are criticized because they are not conducted at golf facilities where day to day conditions dictate the management practices the superintendent faces to keep the course playable. While these "academic" type of studies are critical to developing an understanding of the many complex factors which affect how pesticides and nitrogen behave, the ultimate concern is what are the water quality conditions at actual golf course facilities. The following summarizes the major studies which have been published, either in peer reviewed scientific journals or scientifically rigorous conditions specifically for environmental regulatory or health agencies.

New England

One of the first studies which documented water quality conditions on golf courses was published in 1990 in the journal Ground Water Monitoring Research (Cohen et al., 1990). This study was undertaken under the auspices of the Environmental Protection Agency. Groundwater quality was monitored at nineteen wells on four golf courses on Cape Cod in Massachusetts. This location was chosen because of fragile ecological conditions - sandy soil profile, high rainfall totals, shallow groundwater. The golf courses chosen were all more than 30 years old so they had a long history of fertilizer and pesticide use. Sampling sites were clustered around areas where the highest amounts of materials were used, greens and tees, and then under the fairways.

Summary of Findings: The wells were monitored for 17 pesticides. Of these, 7 of the 17 chemicals were never detected in water samples. Of the 10 materials which were detected, on chlordane (which is no longer used on golf courses) exceeded Health Guidance Levels (HGL). Of the 12 materials which were legally registered for use at the time the study was conducted, none were found in concentrations greater than 1/5 of the HGL. Nitrate-N concentrations were generally below the 10 ppm federal (and World Health Organization) Maximum Contaminant Level (MCL). Based on the spatial and temporal data collected, nitrate-N concentrations decreased in response to lower application rates and use of slow-release fertilizer formulations.

This pioneering study answered a lot of questions. It also opened up a lot of discussion based on the authors' conclusions that: t his was one study with one set of pesticides in one hydrogeological setting. This was what drove the initiative to start more closely documenting both surface water and groundwater conditions at other golf course locations.

What was highly significant in this study was the observation that "turf management practices are closely related to nitrate concentrations in groundwater. Rate and frequency of fertilizer application as well as type of fertilizer used appeared to be significant factors in ground water nitrate-nitrogen concentrations beneath managed areas". While everyone in turf management has preached this for years and intuitively it certainly makes sense, having scientific proof lends much more credibility to what can be accomplished.

Florida

In 1996, the US Geological Survey released a report which was prepared in cooperation with the Florida Department of Environmental Protection and Hillsborough County in Florida (Swancar, 1996). This report was based on a 4 ½ year study of pesticide occurrence in ground water, surface water and irrigation water on golf courses in Florida. This study was much more exhaustive in scope than the Cape Cod Study . Three pairs of golf courses were selected to determine the effect of irrigation with reclaimed water on pesticide leaching. Each pair consisted of one golf course using ground water for irrigation and one using reclaimed water. Pairs were located in the same area an had similar pesticide use. Three additional golf courses were added in the second year of the study to obtain data on pesticides in other areas of the state. On these nine golf courses, water samples from a total of 39 shallow wells, three irrigation systems, six golf course ponds, two reclaimed water-storage ponds and three wastewater-treatments plants were analyzed.

This study found that pesticides were detected in ground water samples on seven of the nine golf courses. However, 45% of all occurrences were at barely detectable (trace) levels and 92% of the occurrences were under the MCL or HGL. Surface water samples showed similar results with 60% of the occurrences at trace levels and 95% of the occurrences were below the MCL or HGL. In fact, only three surface water samples out of 61 samples which had detections of materials had levels above the MCL, and all three were on the same golf course pond. Samples taken directly from deeper irrigation wells on two golf courses contained no pesticides above detection limits.

Criticisms of water quality data comparisons often come from ecologists. They assert that water quality samples are only compared with human health comparisons, and not with ecological standards. Based on the pesticide detections found in this study, water quality sample data using an aquatic community ecological risk model was assessed. When looking at the range of pesticide concentrations in surface water and comparing it to the concentration of that pesticide which would put 5% of the genera of aquatic organisms at risk none of the pesticide detections were even close (Table 1). The one of most concern, chlorpyrifos (Dursban) was still 9X lower in concentration than would put the ecological integrity at risk. Thus, even though detections are occasionally noted, their environmental impact is rare.

Table 1. A Comparison of Pesticide Risk Concentrations to Actual Field Data.		
Pesticide	**Concentration to affect 5% of aquatic genera (ppb)**	**Concentrations Found in Florida study (ppb)**
acephate (Orthene)	1,352	1.5 to 20.1
bensulide (Betasan)	377	not detected
chlorothalonil (Daconil)	5	not detected
chlorpyrifos (Dursban)	0.9	0.1
simazine	2,730	0.08 to 38

New Jersey

A study was conducted in 1999 at Ocean County Golf Course at Atlantis in Little Egg Harbor (Meyer, 2000). Samples were obtained from surface water in and around the Atlantis Golf Course on a weekly basis from April through October. Students from Georgian Court College in Lakewood, NJ collected the samples and the Pesticide Residue Laboratory of the Pesticide Control Program at the NJ Department of Environmental Protection analyzed all of the water samples.

The results from this study point out quite a few interesting facts:

First - the majority of the pesticide residues detected were not associated with the routine insect and disease control measures employed on the golf course - they were residues from previous use of DDT for control of soil-dwelling insects which moved into the ponds bound to particulate matter and malathion used by the county for mosquito control.

Second - when the NJ scientists made a comparison of the levels detected with environmental levels of concern (Table 2) just like in the FL study, the maximum levels detected, compared to the lowest aquatic reference level indicated no risk to the aquatic ecosystem in the ponds sampled.

Table 2. Comparison of Detections of Pesticides Currently in Use with Environmental Levels of Concern			
Pesticide	**Maximum Level Detected (ppb)**	**Environmental Level (ppm)**	**Ratio**
chlorothalonil	0.46 µg/l	250 µg/l/96 hr LC_{50} - rainbow trout	1/543
dichlorvos	0.34 µg/l	900 µg/l/96 hr LC_{50} - bluegill	1/2647
malathion	1.02 µg/l	64 µg/l/96 hr LC_{50} - walleye	1/63
metalaxyl	0.6 µg/l	>100,000 µg/l/96 hr LC_{50} - rainbow trout, carp, bluegill	1/166,667
methoxychlor	0.37 µg/l	17 µg/l/96 hr LC_{50} - Atlantic salmon	1/46
metolachlor	0.005	2000 µg/l/96 hr LC_{50} - rainbow trout	1/400,000

New York

Long Island has for many years now been concerned with its groundwater because it is a source of drinking water for many people. The island has a long history of farming and pesticide use. In October, 1997, the Suffolk County Department of Health Services teamed with the New York State Department of Environmental Conservation to conduct a comprehensive examination of pesticide impacts on groundwater. Like the FL study, this was much more extensive than the Cape Cod project. Groundwater impacts resulting from pesticide and fertilizer use were examined by testing 31 wells located at 18 Long Island golf courses. Only the dacthal metabolite TCPA was found above the MCL in the golf course monitoring, in *one well* in each county. Dacthal is no longer used in NY, one of the reasons being it was applied at a very high rate and was known to be very persistent in the environment unlike the currently labeled chemicals. As for fertilizer concerns, nitrate concentrations for the wells averaged 4.3 ppm and the median nitrate concentration was 2.6 ppm, well below the health standard for drinking water of 10 ppm. The authors of the study concluded:

> "The monitoring results indicate that turf management practices can effectively control impacts to groundwater at golf courses."

North Carolina

Beginning in 1994, a study conducted by North Carolina State University evaluated surface water quality at three golf courses in coastal North Carolina (Ryals, et al., 1998). Surface water at these sites was sampled every two weeks from January to December. Each course has a sandy loam soil and adjoining wetlands, saline marshes, or elevated water tables. They concluded from this study that

> "The data indicate that impact to the surface waters from the courses was minimal. Of the four pesticides (atrazine, chlorothalonil, chlorpyrifos and 2, 4-D) and two nutrients (nitrogen and phosphorus) surveyed, only 16 samples exceeded the US EPA HALs. [And these were from locations ***on*** the golf course]. All analyses of the samples collected from the outflows of the courses were below their detectable limits."

Now, 16 may sound like a large number of exceedances, except, they evaluated 1,578 samples so this is around 1% of the samples. But these were all nutrient problems, not pesticides, something which can be easily controlled. Additionally, all of the detectable pesticide levels were below environmental hazard levels (based on the LC_{50} value), and ***none*** of the samples collected from the natural areas surrounding the three courses or from the outflows showed detectable pesticide residue levels.

The Center for Marine Science at the University of North Carolina at Wilmington has also been investigating water quality as impacted by five golf courses in coastal North Carolina (Mallin and Wheeler, 2000). The authors of this study drew conclusions based on their interpretation of the data as follows:

1. "In general, nitrate levels were greater in streams leaving the courses compared with streams entering the courses, but concentrations varied considerably". Outflow site nitrate+nitrite concentration averaged over 1993-1997 from the five golf courses was 0.055, 0.107, 0.315, 0.321, and 1.462 ppm. Ecologists suggest that serious eutrophication does not occur until surface water has total N concentrations greater than 0.75 ppm and moderately enriched water only when it is greater than 1.25 ppm. Thus, only one golf course has a moderately enriched nitrogen condition from nitrates and none of them came close to the health level of 10 ppm. The authors of this study point out that there are some recent studies that indicate that in controlled conditions, nitrate levels this low have caused serious phytoplankton bloom formation in Neuse River estuary waters and that these levels may be associated with declines of seagrass thereby creating problems with coastal fish habitat. However, they sampled directly at the golf course, not in areas where dilution would appreciably lower the nitrate concentrations.
2. "Orthophosphate concentrations were elevated on midcourse sites on two courses (out of five), but were low in the outflow water except at one course."

3. "The golf courses studied were not significant sources of fecal coliform bacteria to nearby waterways; in fact, passage through some courses served to reduce coliform loads entering from upstream suburbs."
4. "Landscape management practices appeared to play a critical role in determining nutrient concentrations in the outfall and at mid-course sites."

Here is their overall conclusion:

> "Vegetated buffer zones, wet detention ponds, and wooded wetland areas led to considerably lower nutrient output than sites lacking such management practices and should be used whenever possible to protect nutrient-sensitive receiving waters."

The Nation

In 1999, an article entitled *Water Quality Impacts by Golf Courses* appeared in the Journal of Environmental Quality (Cohen, 1999). The authors examined water quality data from seventeen studies (36 golf courses). A total of 16,587 data points from pesticide, pesticide metabolite, pesticide solvent and nitrate analyses of surface water and groundwater were reviewed. What they found was remarkable:

- None of the authors of the individual studies concluded that toxicologically significant impacts were observed, although Health Advisory Levels (HALs), Maximum Contaminant Levels (MCLs) or Maximum Allowable Concentrations (MACs) were occasionally exceeded.
- The individual pesticide database entries that exceeded HALs/MCLs for groundwater were ***0.07%*** of the total.
- The individual pesticide database entries that exceeded HALs/MCLs for surface water were ***0.29%*** of the total.
- The MCL for nitrates in surface water was ***never*** exceeded.
- The MCL for nitrates in groundwater was exceeded in 3.6% of the samples; however most of the nitrate MCL exceedances were apparently ***due to prior agricultural land use***.

They concluded, as did the New York and New Jersey investigators, that:

> "widespread and/or repeated water quality impacts by golf courses are not happening at the sites studies."

Thus, based on all of the studies actually conducted on golf courses under their prevailing approaches to course management, Best Management Practices are highly effective in controlling environmental impact from applied materials.

APPENDIX V

Plant Lists for Silo Ridge Resort Community – Traditional Neighborhood Alternative

Appendix V-A: Partial Species List for Use in the Silo Ridge Resort Community from Harker et al. 1993

Appendix V-B: Invasive Exotic Plants in NY, 2006

APPENDIX V-A

Partial Species List for Use in the Silo Ridge Resort Community

from Harker et al. 1993

Appendix V: Partial Species List for Use in the Silo Ridge Resort Community

(from Harker et al. 1993)

The property at Silo Ridge Resort Community consists of Appalachian oak and northern hardwoods forest. The major groups are listed below with their characteristic species. Be aware that individual species listed may not be suitable on the project site. Local experts can provide advice about which of the species listed here are most important in the local area.

Appalachian Oak Forest

Appalachian Oak Forest is widespread throughout this region and has many variants. It occupies lower elevation slopes and ridges that are well drained and range from dry to dry-mesic. Before chestnut blight eliminated the American chestnut, it was one of the most important canopy trees in this community and the region.

Canopy

Characteristic Species

Castanea dentata	American chestnut
Quercus alba	northern white oak
Quercus coccinea	scarlet oak
Quercus prinus	chestnut oak
Quercus velutina	black oak

Associates

Acer rubrum	red maple
Carya glabra	pignut hickory
Carya alba	mockernut hickory
Liriodendron tulipifera	tuliptree
Nyssa sylvatica	black tupelo
Pinus echinata	short-leaf pine
Pinus rigida	pitch pine
Quercus rubra	northern red oak
Quercus stellata	post oak

Woody Understory

Amelanchier arborea	downy service-berry
Clethra acuminata	mountain sweet-pepperbush
Cornus florida	flowering dogwood

Appalachian Oak Forest

Woody Understory (continued)

Corylus cornuta	beaked hazalnut
Epigaea repens	trailing-arbutus
Gaultheria procumbens	eastern teaberry
Gaylussacia baccata	black huckleberry
Hamamelis virginiana	American witch-hazel
Kalmia latifolia	mountain-laurel
Oxydendrum arboreum	sourwood
Prunus pensylvanica	fire cherry
Pyrularia pubera	buffalo-nut
Quercus ilicifolia	bear oak
Rhododendrum calendulaceum	flame azalea
Rhododendrum maximum	great-laurel
Sassafras albidum	sassafras
Vaccinium corymbosum	highbush blueberry
Vaccinium stamineum	deerberry
Viburnum acerifolium	maple-leaf arrow-wood

Herbaceous Understory

Aureolaria laevigata	entire-leaf yellow false-foxglove
Chimaphila maculata	striped prince's-pine
Coreopsis major	greater tickseed
Galax urceolata	beetleweed
Goodyeara pubescens	downy rattlesnake-plantain
Heuchera longiflora	long-flower alumroot
Hieracium venosum	rattlesnake-weed
Lysimachia quadrifolia	whorled yellow-loosestrife
Maianthemum racemosum	feathery false Solomon's-seal
Medeola virginiana	Indian cucumber-root
Melanthium parviflorum	Appalachian bunchflower
Pedicularis canadensis	Canadian lousewort
Polygonatum biflorum	King Solomon's-seal
Prenanthes trifoliolata	gall-of-the-earth

Northern ardwoods Forest

Northern Hardwoods Forest occurs throughout this region at higher elevations but usually below Northern Conifer Forest. It is generally found on mesic sites with high rainfall, abundant fog, and low temperatures.

Canopy

Characteristic Species

Acer saccharum	sugar maple
Aesculus flava	yellow buckeye
Betula alleghaniensis	yellow birch
Fagus grandifolia	American beech

Associates

Acer rubrum	red maple
Fraxinus americana	white ash
Magnolia acuminata	cucumber magnolia
Prunus serotina	black cherry
Tilia americana	American basswood

Woody Understory

Acer pensylvanicum	striped maple
Acer spicatum	mountain maple
Amelanchier laevis	allegheny service-berry
Cornus alternifolia	alternate-leaf dogwood
Hydrangea arborescens	wild hydrangea
Ostrya virginiana	eastern hop-hornbeam
Rhododendron catawbiense	catawba rosebay
Sorbus americana	American mountain-ash
Viburnum lantanoides	hobblebush

Herbaceous Understory

Actaea pachypoda	white baneberry
Ageratina altissima	white snakeroot
Anemone quinquefolia	nightcaps
Arisaema triphyllum	jack-in-the-pulpit
Arnoglossum muehlenbergii	great Indian-plantain
Aster cordifolius	common blue wood aster

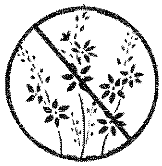
Northern ardwoods Forest

Herbaceous Understory (continued)

Aster divaricatus	white wood aster
Athyrium filix-femina	subarctic lady fern
Cardamine concatenata	cut-leaf toothwort
Carex debilis	white-edge sedge
Carex pensylvanica	Pennsylvania sedge
Caulophyllum thalictroides	blue cohosh
Cimicifuga americana	mountain bugbane
Claytonia caroliniana	Carolina springbeauty
Collinsonia canadensis	richweed
Dryopteris goldiana	Goldie's wood fern
Dryopteris intermedia	evergreen wood fern
Dryopteris marginalis	marginal wood fern
Erythronium umbilicatum	dimpled trout-lily
Hydrophyllum canadense	blunt-leaf waterleaf
Hydrophyllum virginianum	Shawnee-salad
Impatiens pallida	pale touch-me-not
Laportea canadensis	Canadian wood-nettle
Lilium superbum	Turk's-cap lily
Maianthemum racemosum	feathery false Solomon's-seal
Monarda didyma	scarlet beebalm
Osmorhiza claytonii	hairy sweet-cicely
Phacelia bipinnatifida	fern-leaf scorpion-weed
Prenanthes altissima	tall rattlesnake-root
Rudbeckia laciniata	green-head coneflower
Stellaria pubera	great chickweed
Streptopus roseus	rosy twistedstalk
Trillium erectum	stinking-Benjamin
Trillium grandiflorum	large-flower wakerobin
Trillium luteum	yellow wakerobin
Viola blanda	sweet white violet
Viola canadensis	Canadian white violet
Viola hastata	halberd-leaf yellow violet
Viola rostrata	long-spur violet

APPENDIX V-B

Invasive and Noxious Weed Plants of New York



Invasive and Noxious Weed Plants of New York

This list represents most of the species that are federally recognized as weeds or ecologically recognized as invasive. Though some of these plants are native, none of them should be planted deliberately since they can cause serious economic and ecological damage. If any of these species are present on your property, try to plan and implement a management strategy to control the species.

Plant name	**Category***
Acer platanoides (Norway maple)	LI
***Acer pseudo-platanus* (Sycamore maple)	LI
Agrostemma githago (corncockle)	W
Ailanthus altissima (stinktree)	GI
Alliaria petiolata (garlic mustard)	GI
Allium canadense (wild onion)	W
Allium vineale (wild garlic)	W
***Ampelopsis brevipedunculata* (porcelain berry)	LI
***Berberis thunbergii* (Japanese barberry)	LI
Berberis vulgaris (common or European barberry)	LI
***Celastrus orbiculatus* (oriental bittersweet)	LI
Centaurea maculosa (spotted knapweed)	GI
Centaurea repens (Russian knapweed)	W
Cirsium arvense (Canada thistle)	W
Convolvulus arvensis (field bindweed)	W
***Crataegus monogyna* (English hawthorn)	LI
Cuscuta spp. (dodder(non-native))	W

* **Category Key**

W - Federally recognized as a noxious weed species
GI - Ecologically recognized invasive species
AI - Ecologically recognized aquatic invasive species
LI - Invasive species commonly found as landscaping plants

Note: some of these species are commonly found in landscapes and the ones with ** can easily be purchased at a local nursery.

Plant name	**Category***
Cyanchum spp. (Black swallow-wort)	GI
***Cytisus scoparius* (Scotch broom)	LI
***Elaeagnus angustifolia* (Russian olive)	LI
***Elaeagnus umbellate* (autumn olive)	LI
Elytrigia repens (quackgrass)	W
***Euonymus alata* (winged euonymus)	LI
***Euphorbia cyparissias* (cypress spurge)	LI
Euphorbia esula (leafy spurge)	W
Galium spp. (bedstraw)	W
Heracleum mantegazzianum (giant hogweed)	GI
***Hypericum perforatum* (common St. Johnswort, goatweed)	LI
***Lespedeza cuneata* (silky or Himalayan bush clover)	GI
***Lonicera x bella* (Bell's honeysuckle)	LI
***Lonicera japonica* (Japanese honeysuckle)	LI
***Lonicera morrowii* (Morrow's honeysuckle)	LI
***Lonicera tatarica* (Tartarian honeysuckle)	LI
***Lonicera x bella* (Bell's honeysuckle)	LI
***Lonicera* "Rem Red" (Amur honeysuckle)	LI
***Lythrum salicaria* (purple loosestrife)	LI
Microstegium vimineum (Japanese stilt grass)	GI
Myriophyllum aquaticum (parrot feather)	AI
Myriophyllum spicatum (Eurasian water milfoil)	AI
Phragmites australis (Phragmites, Common Reed)	AI
***Pistia stratiotes* (water lettuce)	AI
Poa annua (annual bluegrass)	W

* **Category Key**

W - Federally recognized as a noxious weed species
GI - Ecologically recognized invasive species
AI - Ecologically recognized aquatic invasive species
LI - Invasive species commonly found as landscaping plants

Note: some of these species are commonly found in landscapes and the ones with ** can easily be purchased at a local nursery.

Plant name	**Category***
***Polygonum cuspidatum* (Japanese knotweed)	GI
Polygonum perfoliatum (Mile-a-minute vine)	GI
Potamogeton crispus (curly pondweed)	GI
Puereria lobata (Kudzu vine)	GI
***Rhamnus cathartica* (common buckthorn)	LI
***Rhamnus frangula* (glossy buckthorn; alder buckthorn)	LI
***Robinia pseudoacacia* (Black locust)	LI
***Rosa eglanteria* (eglantine, sweetbrier)	LI
***Rosa multiflora* (multiflora rose; baby rose)	LI
***Rosa rugosa* (Japanese rose)	LI
Solanum carolinense (Carolina horsenettle)	W
Trapa natans (water chestnut)	GI
***Vinca minor* (periwinkle)	LI
Wisteria sinensis (Chiense wisteria)	AI

* **Category Key**

W - Federally recognized as a noxious weed species
GI - Ecologically recognized invasive species
AI - Ecologically recognized aquatic invasive species
LI - Invasive species commonly found as landscaping plants

Note: some of these species are commonly found in landscapes and the ones with ** can easily be purchased at a local nursery.

For additional information about invasive and native plants in your area contact:

Invasive Plant Council
400 River Street, 1st Floor
Troy, NY 12180
(518) 271-0346
www.ipcnys.org

New York Flora Association
New York State Museum 3132 CEC,
Albany, NY 12230

The Finger Lakes Native Plant Society of Ithaca
532 Cayuga Heights Road
Ithaca, NY 14850

Niagara Frontier Botanical Society
Buffalo Museum of Science
1020 Humboldt Parkway,
Buffalo, NY 14211
www.acsu.buffalo.edu/~insrisg/botany/

New York Flora Association
3140 CEC
Albany, NY 12230

To find out whether a plant that is not on this list is invasive go to:
http://plants.usda.gov

APPENDIX VI

Underwriters Laboratory Information

Pesticides Analyzed as part of Scan 150, 302, and 515.3

Underwriters Laboratories, Inc.
Turfgrass Pesticide Monitoring Program

A cost-effective solution to environmental monitoring requirements can be realized by utilizing the turfgrass panel listed below.

Underwriters Laboratories, Inc.	
Contact	Jim Van Fleit
Direct Line	574-472-5535
Toll Free	800-332-4345
Address	111 S. Hill Street South Bend, IN 46617
Fax	574-233-8207

UL-S150					
Chemical	**MRL**	**Units**	**Chemical**	**MRL**	**Units**
Alachlor	0.1	ug/L	Etridiazole	0.1	ug/L
Aldrin	0.1	ug/L	Fenamiphos	0.1	ug/L
Ametryn	0.1	ug/L	Fenarimol	0.1	ug/L
Atrazine	0.1	ug/L	Fenoxaprop-ethyl	0.1	ug/L
Benfluralin	0.1	ug/L	Fluazifop-butyl	0.1	ug/L
Butylate	0.1	ug/L	Flurprimidol	0.1	ug/L
Chloroneb	0.1	ug/L	Flutolanil	0.1	ug/L
Chlorothalonil	0.1	ug/L	Heptachlor	0.1	ug/L
Chlorpyrifos	0.1	ug/L	Heptachlor epoxide	0.1	ug/L
Chlorpyrifos methyl	0.1	ug/L	Hexazinone	0.1	ug/L
Cyanazine	0.1	ug/L	Iprodione	0.1	ug/L
Cyfluthrin	0.5	ug/L	Isofenphos	0.1	ug/L
DCPA	0.1	ug/L	Metolachlor	0.1	ug/L
Deltamethrin	0.1	ug/L	Metribuzin	0.1	ug/L
Desethylatrazine	0.1	ug/L	Metsulfuron-methyl	5	ug/L
Desisopropylatrazine	0.1	ug/L	Molinate	0.1	ug/L
Diazinon	0.1	ug/L	Myclobutanil	0.1	ug/L
Dichlobenil	0.1	ug/L	Napropamide	0.1	ug/L
Dicofol	0.1	ug/L	Norflurazon	0.1	ug/L
Dieldrin	0.1	ug/L	Oxyfluorfen	0.1	ug/L
Diphenamid	0.1	ug/L	Pebulate	0.1	ug/L
Dithiopyr	0.1	ug/L	Pendimethalin	0.1	ug/L
EPTC	0.1	ug/L	Pentachloronitrobenzene	0.1	ug/L
Endosulfan I	0.1	ug/L	Profluralin	0.1	ug/L
Endosulfan II	0.1	ug/L	Prometon	0.1	ug/L
Endosulfan sulfate	0.1	ug/L	Prometryn	0.1	ug/L
Endrin	0.1	ug/L	Pronamide	0.1	ug/L
Esfenvalerate	0.1	ug/L	Propachlor	0.1	ug/L
Ethalfluralin	0.1	ug/L	Propiconazole isomer a	0.1	ug/L
Ethofumesate	0.1	ug/L	Propiconazole isomer b	0.1	ug/L

UL-S150					
Chemical	**MRL**	**Units**	**Chemical**	**MRL**	**Units**
Ethoprop	0.1	ug/L	Simazine	0.1	ug/L
Terbacil	0.1	ug/L	beta-BHC	0.1	ug/L
Thiobencarb	0.1	ug/L	delta-BHC	0.1	ug/L
Trichlorfon	5	ug/L	gamma-BHC (Lindane)	0.1	ug/L
Trifluralin	0.1	ug/L	lambda -Cyhalothrin	0.1	ug/L
Trinexapac-ethyl	1	ug/L	4,4'-DDD	0.1	ug/L
Vernolate	0.1	ug/L	4,4'-DDE	0.1	ug/L
Vinclozolin	0.1	ug/L	4,4'-DDT	0.1	ug/L
alpha-BHC	0.1	ug/L			

Turfgrass Pesticides - LC/MS by Method L302	
Parameter	**Reporting Limit**
Azoxystrobin	0.5 ug/L
Bendiocarb	0.5 ug/L
Bensulide	0.5 ug/L
Bentazon	0.5 ug/L
Bispyribac-sodium	0.5 ug/L
Boscalid	0.5 ug/L
Carbaryl	0.5 ug/L
Carfentrazone-ethyl	0.5 ug/L
Clopyralid	0.5 ug/L
Fenamiphos Sulfone	0.5 ug/L
Fenamiphos Sulfoxide	0.5 ug/L
Fludioxonil	0.5 ug/L
Fluometuron	0.5 ug/L
Halofenozide	0.5 ug/L
Halosulfuron methyl	0.5 ug/L
Imazapic	0.5 ug/L
Imidacloprid	0.5 ug/L
Metalaxyl	0.5 ug/L
Methoxyfenozide	0.5 ug/L
Oryzalin	0.5 ug/L
Paclobutrazol	0.5 ug/L
Prodiamine	0.5 ug/L
Pryraclostrobin	0.5 ug/L
Quinclorac	0.5 ug/L
Siduron, Total	0.5 ug/L
Triadimefon	0.5 ug/L
Triadimenol	0.5 ug/L
Trifloxystrobin	0.5 ug/L

UL- 515.3		
Chemical	**MRL**	**Units**
Acifluorfen	1	ug/L
Bentazon	0.5	ug/L
Chloramben	2	ug/L
DCPA acid metabolites	0.5	ug/L
Dalapon	1	ug/L
Dicamba	0.1	ug/L
Dichlorprop	2	ug/L
Dinoseb	0.1	ug/L
MCPA	0.5	ug/L
Mecoprop (MCPP)	0.5	ug/L
Pentachlorophenol	0.04	ug/L
Picloram	0.1	ug/L
Triclopyr	0.5	ug/L
2,4,5-T	0.5	ug/L
2,4,5-TP (Silvex)	0.1	ug/L
2,4-D	0.1	ug/L
2,4-DB	2	ug/L
3,5-Dichlorobenzoic acid	0.5	ug/L
4-Nitrophenol	2	ug/L

APPENDIX VII

Maintenance Facility Best Management Practices

NATURAL RESOURCE MANAGEMENT CENTER UIDELINES

The Natural Resource Management Center (NRMC) is the single most important building complex in regard to obtaining Audubon Signature Status. This complex is not only the working heart of the entire property, but is the place for employee training and is the most visible sign of the high environmental standards set by the Audubon Signature Program.

The Natural Resource Management Center should be designed by an experienced designer and an experienced and qualified Golf Course Superintendent. At the bare minimum, the Golf Course Superintendent should collaborate with a qualified local building architect on the NRMC design. It would be beneficial to visit other state-of-the-art NRMCs to gather ideas to increase design efficiency. The facility should be designed with the latest environmental regulations taken into consideration.

Each of the areas highlighted is aimed at reducing environmental liability and exposure. It is not meant to stifle your creativity but is offered to establish minimal guideline criteria for you to follow. Please note that these are **guidelines**, not requirements. Depending upon your geographic location, local regulations, etc. you can design your own NRMC but keep in mind, achieving Audubon Signature Status will require that each area detailed must be addressed. These **guidelines** are based on an average 18 hole golf course maintenance operation.

1. Design

A well-designed and constructed NRMC will provide many excellent benefits, including, but not limited to the following:

- Efficient storage and traffic flow of equipment and personnel throughout the entire complex
- Reduced time to manipulate equipment in and out of building
- Reduced damage and repair costs to equipment
- Maximum preventative maintenance on equipment
- Maximum cleanliness with minimal labor to sustain it
- Reduced electric bills and water bills
- Peak effectiveness with employee morale and safety
- Positive atmosphere for safety and operational training
- Reduced workers compensation claims (through planning and construction with worker safety in mind)
- Potential reduction in insurance premiums (due to reduced environmental liability)
- Opportunity to attract and/or retain top quality golf course employees, including management
- 5 to 15% increased efficiency of operation on the total golf course

2. Location

Location of the NRMC is important and could contribute to decreasing fuel consumption, maintenance crew travel time, and excessive equipment wear. Ideally the complex should be located as close as possible to the 1st and 10th tees. The NRMC location becomes even more productive if it can be near the center of the golf course. Designate the NRMC site as early as possible in the overall site development of the property and retain a minimum of 1.5 acres of usable land. The NRMC could require more space depending on the number of holes or total maintained turf acres. Different parameters need also to be considered relative to a golf course with home sites versus no home sites, public or private, heavy play or light play, etc.

3. Design by Zonal Concept

Because resources and capital funds are precious, every square inch of the NRMC must have a specific function, be efficient in relationship to all the other zones, and achieve the goal for which it was designed. Consider the following zones:

- Equipment Maintenance Area -- including equipment manager's office and parts storage
- Equipment storage
- Equipment washdown
- Fuel island
- Tool Storage - shovels, rakes, wheel barrel, etc.
- IPM (Integrated Plant Management) Control Center -- pesticide storage, mix & load, rinsate recycling building
- Fertilizer storage
- Soil storage
- Nursery green
- Composting area
- Soils laboratory -- can also serve as a resource library and storage for videos and supplies
- Master irrigation control room
- Irrigation parts storage
- Closet storage space (mops, brooms, vacuum, cleaning supplies for use in the NRMC
- Golf course supplies storage space (non-maintenance -- ropes, flag poles, cups, signs, etc.)
- Employee lunch room -- also serves as a training/meeting center
- Employee restrooms
- Employee locker room and showers
- Uniform storage area

- Office support staff area and files space
- Assistant golf course superintendent's office
- Golf course superintendent's office
- Employee and guest parking
- Waste disposal

4. Equipment Maintenance – Mechanics Workshop and Office Area

This area should be segregated from general employee activity areas and equipment storage. An experienced golf course equipment mechanic, along with the golf course superintendent, should be involved in designing this zone. Equipment is repaired and serviced in this area so adequate space for oil changes, reel grinding, and other service related jobs must be allocated. Seventeen to nineteen hundred square feet will provide sufficient space for repair and maintenance activities. A various assortment of lifts (portable, flush floor mounted and beam supported) can be distributed in the appropriate areas of this zone to facilitate moving all types of equipment and reduce the risk of back injury. An overhead lube center (grease/oil dispensers run by compressed air) which is connected to bulk drums is convenient, uses overhead rather than floor space, and allows storage of large drums out of general view and work area. Cabinets for storage of various shop necessities such as empty gas cans, towels and miscellaneous supplies, other than equipment parts, can be distributed throughout the shop area for convenience. Large work benches with underneath storage area provides for work space at waist level (as opposed to working from the floor) and can decrease the risk of back fatigue and injury. An adjoining air conditioned office with adequate parts storage bins, desk, computer, files and phone will utilize approximately 260 square feet and, consider including a shatter-proof window facing the shop area to allow the mechanic a full view of the shop from the office. A sink and blower type hand dryer needs to be available in the shop.

5. Equipment Storage

A complete list of equipment needed to properly maintain the golf course must be developed. The exact size of all the equipment is important to appropriate the right amount of space needed. The design should allow for all equipment to be driven in and out of the storage area without having to move other equipment. A superintendent who is experienced in the daily golf course maintenance program will be able to help design a floor plan for equipment storage to minimize unnecessary "shuffling." Backing and turning can shorten the life of equipment and increase the risk of damage to it and also increases the chance of employee injury.

Several overhead doors on both sides of the equipment storage area allows for a smooth transition of equipment entering and leaving the building and provides good air flow. Every piece of equipment should have a designated spot, delineated by yellow or white lines, with its name or number and should be parked in the same spot every day. This allows for immediate identification of equipment if it develops a leak (oil, hydraulics, etc.) and increases accountability for maintaining that equipment in premium operating condition. Overhead fans in the equipment storage zone facilitates air flow and helps reduce hidden moisture on equipment. Since this is not generally a work space, it is also an excellent zone for the shop compressor, eliminating the loud running sound in a personnel work area. The compressor should be located away from any wall that is adjacent to an inside wall where sound could penetrate and be disruptive.

6. Equipment Washdown Area

Depending on current regulations, and the size of the operation, a combined fuel island and equipment wash-down area may be very productive. But, if not, the following considerations should be taken into account:

- Water used to clean equipment should be potable water and not lake water (which could be detrimental to the equipment).
- All water used to wash equipment should be recycled and contaminating materials such as grease, oil and gasoline need to be filtered from this recycled water.
- Only water recycle systems with a proven track record should be utilized.
- Pesticide equipment should not be washed off in this area (done at the IPM Control Center).
- A roof should cover the wash-down area to keep rain off the pad and prevent excessive water from going into the recycling storage tanks; the roof also serves as a sun shade for the crew during clean up which helps reduce exposure to the sun .
- The pad should be elevated to direct rain water away from the wash-down area and the roof should be high enough to allow golf course equipment or fuel trucks the proper amount of clearance, yet low enough to meet any aesthetic requirements (visibility to homeowners, etc.).
- Several air hoses attached to posts prior to the wash-down pad can be used to remove excessive grass residue off equipment prior to moving onto the wash-down pad which will reduce the amount of grass clippings/debris entering the water recycle system.
- The pad should have triple screen baskets, weighing less than 40 pounds each, to prevent an excess of grass clippings and debris from entering the recycling system.
- Hoses with attachable spray bottles of liquid wax at the wash-down pad can be utilized so valuable equipment can receive a brief application of liquid wax (cut with water) after each use.
- Concrete in the pad should be impermeable to prevent leaching of any contaminates.
- Installing lightning protection in this area is vital for worker and equipment protection.

7. Fuel Island

This zone should be located at least 80 feet from the main building and preferably is combined, or works in conjunction with, the wash-down pad. Following is a list of critical items necessary for the safe and efficient operation of the fuel island zone:

- Cover the fuel island to minimize the effect of sunlight on the equipment as well as possible increased evaporation of fuel and provide protection for employees.
- Install adequate lighting around and beneath the roof to allow for operation during periods of darkness or inadequate light.
- Install lightning protection on the fuel island roof.
- If possible, all fuel storage and carrying mechanisms should be above ground devices.
- Fuel should be stored in above ground, double vaulted tanks from a reputable manufacturer.
- The fuel island pad should be recessed from normal ground level to allow for containment in the event of a fuel spill; the recession should be deep enough to contain a few hundred gallons of spillage but not so severe that it presents difficulty for equipment entering and leaving the fuel island.
- Prior to construction of the fuel island the Fire Marshall and other appropriate authorities should review the specifications.

8. olf Course Tool Storage

This building could be located in close proximity to the fuel island for the following reasons:

- As equipment is washed before being put away after each use, tools can be washed at the same time and conveniently stored close by.
- Separate storage at the fuel island prevents taking up valuable space in the main facility.
- As the crew heads out to the course, picking up tools at a central location facilitates traffic flow and efficiency.
- The average 18 hole golf course tool storage shed should be approximately 150 to 225 square feet .
- The segregated tool storage shed reduces loss of tools due to theft and misplacement.
- A skylight, adequate ventilation and 110 electric supply is sufficient.
- The building should have a good security lock.

9. IPM Control Center

(Formerly referred to as the chemical/pesticide storage building)

This is an important zone where pesticides will be stored, mixed, and recycled. The following features are critical to an efficient and environmentally sound IPM Control Center:

- The control center should be located at least 200 feet from the main body of the NRMC. Also, if possible, one end of the NRMC houses the fuel island and the opposite end houses the control center.
- The control center should be located at least 100 to 200 feet from any body of water or well.
- It should have a complete alarm system, with battery backup, for burglary and fire.
- Locks and bolts used at the control center should be of the highest quality materials available.
- Materials used inside the control center are comprised of high quality durable plastic, aluminum or concrete to avoid absorption of chemical residues or vapors.
- Install an explosion proof fan and explosion proof light.
- A ventilation design must be an integral part of the control center.
- All pesticides stored on non-absorbent shelving are located at least 6" off the floor.
- All pesticides are segregated by liquid, powder or granular class.
- All powders and granules are stored above liquids.
- All shelving must be sturdy and secured to avoid sagging and falling.
- The entire floor of the control center should be sloped to the center of the room with a recessed sump located at its center.
- IPM control center in weather proofed storage area and should be accessible at all times.
- A light and fan switch should be located outside of the door entering the control center.
- A sink with potable water and spigot and hand blower (not paper towels) with the drainage funneled back into the sump.
- A mixing table should be attached to the sink at a slightly higher elevation to allow overspill to be washed into the sink.
- A portable eye wash bottle should be located over the sink; immediately outside an eye wash/shower station supplied by potable water should be installed.
- A refill hose should be located above the sump to allow proper and timely filling of spray tanks with water.
- Only qualified personnel should be allowed access to the control center.
- It would be very beneficial to install a hot water heater in the control center to aid in the dissolving of water soluble products.

10. Fertilizer Storage Zone

This zone could share the same building as the IPM Control Center but needs to be segregated by a solid concrete wall and a solid metal door (preferably rust-proofed). If the building housing the fertilizer is metal then steps should be taken to protect the metal building from degradation by the fertilizer. The building should be big enough to allow a small forklift to deliver fertilizer by pallet. If not, a pallet jack could be used to place the fertilizer in the room. Spreaders could be hung on the wall and the use of a dehumidifier would be beneficial in protecting the fertilizer from water absorption.

11. Soil Storage Zone

This area could be immediately adjacent to the fertilizer storage zone and should have a roof, although it need not be any higher than 12 feet. It does not need to be tall enough for a 22-ton dump truck to deposit sand, topdressing or rock. More efficient use of the space is achieved by depositing the material immediately outside the storage bins and then pushing the material into the bin with a front-end loader. It is important to keep this area covered to prevent rain from dampening the material and wind from dispersing weed seeds into the topdressing. The block walls segregating the sand, topdressing and rock should be filled solid with concrete. If possible the opening should face away from prevailing rains or a durable dropcloth should be used to cover the opening. Ceiling fans might be installed overhead to help reduce moisture retention in the topdressing or sand.

12. Nursery reen

This area is developed to have a ready supply of the exact grass cultivar maintained on the actual greens playing surface. It can be used for the repair of damaged areas on greens surfaces. An average 18 hole course could utilize from 3,000 to 6,000 square feet for the nursery green. It receives the same cultural treatments as the course greens and should be located in close proximity to the NRMC. It can be used for training new greens mowers, cup cutters and for testing various new cultural products. It is also used as a valuable teaching tool for practice putting by the maintenance staff to demonstrate how a quality green and its cut interact. It also stresses the importance of a properly installed cup on the putting surface.

13. Composting Area

Setting aside an area for compost can reduce the amount of grass clippings and debris such as leaves that would normally go to a landfill. In some cases, with the right expertise, this composting can be used effectively for topdressing, non-putting surface areas, or could be given or sold to off-site vendors. Extensive research should be done before addressing this very beneficial process.

14. Soil Laboratory - Media Storage Center - Library

This room should be 50 to 90 square feet. It should contain the following:

- Lockable door
- Sink with faucet and cabinets (for on-site soils or other analysis using microscope, etc.)
- Separate lockable cabinet for storage of materials such as training videos
- Small bookcase to house technical trade books

15. Irrigation Control Room

This room should be 30 to 50 square feet and insulated. The computer for the golf course irrigation system and storage shelves or cabinets are housed here with a lockable door. If necessary, other limited access equipment could also be stored here such as a water heater.

16. Irrigation Parts Storage

Under normal circumstances irrigation parts such as pipes, controllers and heads should be stored in the pump house(s) if properly designed. If storage in the pump house(s) is not practical then an area should be designated that is large enough to house PVC, or other types of pipe, up to 30 feet in length. There should be adequate storage for items such as controllers, a variety of irrigation heads, wiring, tools, portable pumps, etc. This zone should also be designed to allow specialty equipment to pick up or deliver various irrigation type inventories.

17. Closet Storage Space

There should be at least 50 to 100 square feet of closet storage area. It will house mops, vacuum, cleaning supplies and equipment for use on the inner office spaces, restrooms, etc. Adequate space planning could provide office supplies storage also.

18. olf Course Supplies Storage

According to the size of the course, golf course supplies such as flag poles, flags, cups, signs, etc. are stored in this space and kept locked. 50 to 100 square feet should be adequate for this space.

19. Employee Lunch Room

This area should promote a relaxed atmosphere and serve as an adequate and professional training center (video training and technical seminars). The size of the crew and the number of holes in the golf operation will determine the appropriate size of the lunch room. Important items to be included are:

- Adequate tables and chairs for dining and training
- One to two microwave ovens - prevents long waits to heat up meals
- One adequate sized refrigerator - energy saver
- A cold drink vending machine
- A snack vending machine
- Bottled water with dispenser
- A pay phone
- A kitchen area with sink and water and sufficient cabinet area
- Coffee maker
- An erasable communication board
- Air conditioned, insulated and have overhead fans for good air flow
- An average 18 hole golf course crew would need approximately 300 to 400 square feet light attractive colors in semi-gloss for easy cleaning and to enhance the atmosphere and make the room appear more spacious

20. Employee Restroom/Locker Room/Shower

Design restrooms to promote superior personal hygiene, are easy to clean and adequate enough to service several employees simultaneously. The locker room should be immediately adjacent to the restrooms and incorporate full-length lockers with at least one shower. A semi-gloss, high quality paint should be used for ease of cleaning. A dry deck type material can be used on portions of the floor to prevent slippage and the spread of bacteria. The locker room and shower should be a minimum of 140 to 180 square feet and the restroom 120 - 150 square feet to adequately provide for average staffing of an 18 hole course. Both of these rooms should be insulated and air conditioned. Hand blowers should be used instead of paper towels. Another consideration would be to restrict water flow to the maximum necessary for adequate use. Automatic shut-offs on faucets help eliminate water waste and 1.5 gallon tanks on toilets also limit water use.

21. Uniform Storage Area

Adequate space (if available) should be provided for clean uniforms when they are delivered; a rack for hanging the appropriate amount of uniforms should be installed. 40 to 80 square feet should be set aside in an air conditioned space for this zone.

22. Support Staff Office Area

This area should be located to obtain maximum visibility of entrances and exits which are accessible to employees and guests, to view employee activity at the time clock and to monitor activity in the mechanics work area (since this is a high risk area). Adequate space should be planned for office equipment such as copier, desk/computer work area, fax machine, bookshelves, files and sufficient guest waiting area. If a radio system is to be used for communication between superintendent and maintenance staff, enough space should be allocated for a communication system and accessible to office support staff. A minimum of 120 to 150 square feet should provide adequate space for the support staff office area and should be light and professional appearing.

23. Assistant olf Course Superintendent - Office Area

This area should be a minimum of 110 to 140 square feet with a panoramic view of the mechanics work area. The walls should be thoroughly sound proofed including a solid core door and overhead fan for air circulation. Adequate space should be provided for library/resource materials and files, and work space should be large enough to provide for a computer. Decor should be well appointed with a professional appearance.

24. olf Course Superintendent - Office Area

This area should be a minimum of 125 to 160 square feet (not including an attached shower, restroom and sink as well as shelving for storage). The attached personal grooming station is provided to allow the Superintendent the opportunity, when coming in from the field, to prepare for special or unplanned events that require a professional appearance. Space should be allocated for desk, visitor seating, files and bookshelves for resource and reference materials. Decor should be well appointed with a professional appearance.

25. Employee and uest Parking

This is a designated area located at least 50 feet from any part of the NRMC. A properly designed parking area can improve employee morale, and sets the stage for running an efficient and organized operation. It also reduces the chance of damage to personal vehicles and makes it more difficult to remove company property (tools, etc.).

26. Waste Disposal

This area should be located away from normal employee activity but close enough to be reasonably functional. Proper access for waste pick-up vehicles should be incorporated in the design and location of this zone.

Prior to the final design of the NRMC the following specialists should be consulted to maximize the desired benefits in energy, water and waste management:

- A recycling expert
- An energy efficiency expert
- A water conservation expert
- Possibly a composting or waste management expert

APPENDIX VIII

The Audubon International Signature Program

Audubon International

Late in the 1980s, Audubon International created the Audubon Cooperative Sanctuary System, a program for schools, backyards, corporate and business properties, and golf courses. As enthusiasm, support, and visibility increased for these programs, requests for environmental assistance surfaced from a different area -- landowners of properties that were in the planning and development stages. In response to that need, The Audubon Signature Program was created to provide a comprehensive, integrated approach to environmental planning for proposed developments.

We recognize that working with nature, and not against it, makes both environmental and economic sense. Working with nature means making sound decisions about how to manage the land. It means finding out what will work with the land given its physical and chemical characteristics. It also means weaving nature into our vision of a landscape.

In order to attain our mission, Audubon International has created and manages programs that promote biological diversity, ecosystem management, ecological restoration, and sustainability. Through policy development and implementation, environmental education, conservation assistance, research, and environmental planning, Audubon International promotes stewardship action and positive environmental change.

Audubon International works with people in all walks of life and with all types of properties--backyards, a variety of corporate and business properties, school properties, golf courses, and other types of managed lands, as well as land that is targeted for development--to search for continuous environmental improvement in economically feasible ways.

Principles of Sustainability

The essence of the Audubon Signature Program is sustainability – using natural resources, without depleting them, in ways that will support human activity. Audubon International believes that progress must be redefined and become synonymous with sustainable. To that end, Audubon International created a set of principles to guide land management toward better compatibility and harmony with the environment. This guidance document is called the *Audubon Principles for Sustainable Resource Management*. In addition, the *Landscape Restoration Handbook*, written under the direction of Audubon International, includes the "Principles for Ecological Restoration" and "Principles for Natural Landscaping." These three documents provide the foundation for Audubon's philosophy of sustainable development and sustainable resource management.

The following list of principles establishes the foundation for Audubon International's belief in a more sustainable system of resource management.

We support resource management decisions that have the least impact on wildlife, water, and the ecosystems that sustain life.

- We support the use of renewable resources.
- When resources are not renewable, we support reducing, minimizing, or eliminating their use.
- We support human activities that identify and enhance existing resources as well as the exploration of new resources and technologies that may be used by future generations to maximize the positive impacts on the overall quality of the environment.
- We support human activities that conserve water and continually enhance water quality on a global basis.
- We support human activities and land use that sustains ecosystems and enhances biological diversity.
- We support resource management within natural limitations and opportunities defined by ecosystems and geographic boundaries.

oals of Audubon International Programs

The primary goals of Audubon International are to conserve and enhance biological diversity (bio-diversity), and promote sustainability, ecosystem management, and ecological restoration.

Bio-diversity is the variety of life in all its forms and processes including the diversity of genes, populations, natural community types, and ecosystems. Because bio-diversity increases ecosystems' productivity and long term growth, it is the cornerstone of defending and improving the environment. In order to identify and protect areas of rich biological diversity, we must work with all types of landowners to provide information, encouragement, and recognition for developing and managing land in ways that are sensitive to bio-diversity.

> ***Ecosystem management** is a method of managing the natural resources on earth.*

Sustainability means using natural resources, without depleting them, in ways that will support human activity. It means living in a way that does not negatively impact future generations. Sustainability is at least partially achieved when natural resources can be conserved, recycled, reused, or obtained from renewable resources. In addition, Audubon International believes that we must use current technology and continue to support research and development to provide sustainable alternatives for the future.

> ***Bio-diversity** is the variety of life in all its forms and processes.*

Ecosystem management is a method of managing the earth with the recognition that all land, water, and natural resources are interconnected. Ecosystem management focuses on the interrelationship between an ecological community and its environment. It is based on the premise that focusing on the management of a single resource (such as a tree, a bird, or a stream) may be a less effective way of addressing the health of the entire system that supports life on earth.

> ***Sustainability*** *means using natural resources indefinitely without depleting them.*

Ecological restoration and natural landscaping contribute to a sustainable world in a variety of ways including: creating a healthier mosaic of land uses; enhancing the diversity of plants and animals; improving water quality; minimizing erosion; creating lower maintenance landscapes thus reducing our dependency on water and chemical use; and promoting the concept that "natural" is a beautiful and positive part of our landscape.

> ***Ecological restoration*** *is an effort to return degraded lands and waters to their natural state.*