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BMP Water Use – Organic Amendment Use

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Eagles Pride GC

OVERVIEW

- Audubon International Stewardship Network - Overview
- Review of BMP Irrigation for Water Conservation
- Organic Amendment Use Pos & Neg
- Case Study Components – Where we are and where we are going

AUDUBON INTERNATIONAL

- Stewardship Network
- Fellow Professionals collaborate w/ you environ. stewardship Mgmt & Planning
- Environmental Plan, H2O Quality, H2O Conser, Wildlife Habitat Mgmt BMP & IPMP, Education & Outreach

Audubon International

AUDUBON INTERNATIONAL

- Local Experience & International Expertise
- ACSP Certification, Audubon International Signature Program, Sustainable Comm., Treasuring Home Int., Adopt School, Advisory Group

BMP IRRIGATION

- Water Source/Reuse
- Water Conservation Mgmt, Plant selection
- Irrigation performance
- Irrigation repair & mnt
- Irrigation Oper. - ET
- Turf Care procedures Mow ht, Cultivation, OM mgmt, Fertility

BMP IRRIGATION

- Cultivation to dilute layers, OM & Sand Matrix
- OM Amendment
- OM: ↑ H_2O Hold ↑ porosity, ↑ wear tolerance,Buffer pH ↑ CEC, ↑ N,P,K, ↓Disease & Chem

OM AMENDMENTS

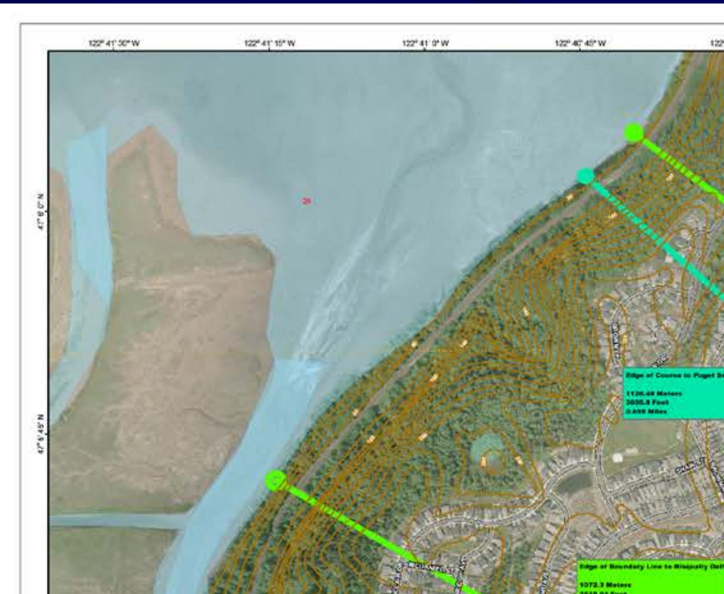
- **Benefits**
- H_2O holding, CEC, N, P, K, Micronutrients, Wear tolerance, Drought Tolerance
- Microbiology – Mineralization, Peds, Disease incidence & severity, Recycling
- Reduce Chemicals

- **Challenges**
- Drainage problems, C:N ≥ 10-15:1, 1/8" Size, Contaminants, Pathogens, Return on Investment- Cost Eff?
- Complex Science Micro-ecology?
- Logistical – H_2O/Dry, transport, application

ENVIRONMENTAL MGMT PLAN

- 1995 irrigation w/o weather station, ET
- *Poa annua*, Bent, Rye
- Well source irrigation
- No Irr. Tech, No Hand H2O, Overwatering
- Directives for sustainability & Net 0 environ. stewardship

NEIGHBORS & H2O QUALITY


122° 41' 30" W
122° 41' 15" W
122° 41' 0" W
122° 40' 45" W

RESOURCE OR WASTE?

OM AMENDMENT RESEARCH

- **Compost** Appl Daily or Weekly = 1 month Fungicide Application Disease incidence & Severity
- Compost = ↓ Fert.
- H_2O Holding ↑
- C:N 30:1, ½" size
- Wide Variability
- Disease suppression 0%-95% Range
- Fertility Research Science - Production Agriculture
- Micro Ecology infancy
- Most Science on Tropical & Food crops
- Most Anectodal

CASE STUDY RESULTS

- Gap Analysis Plan-Weather Station, ET
- Cultivation & Topdress Sand & OM
- Document Pictures & Water Quality Tests
- Irrigation H_2O Use, ↓32.7%, 11.8 MG
- Soil Biota Study & OM Feasibility Study

CASE STUDY RESULTS

- No Mgmt Zones, Naturalized Areas
- Fine Fescue Conversion 133 A Rough
- Hand H_2O w/ moisture meters
- Mow Ht. Physiological Optimum

CASE STUDY RESULTS

- Compost blend 25% - 50% w/Sand Test
- Compost Tea Test
- Disease Incidence & Severity Test OM v Fungicides
- Soil & Foliar Testing for Nutrient Mgmt
- Water Qual. Testing

SOIL BIOTA STUDY

- **GIS map** w/soil test
- **Soil Quality**: Physical porosity, Blk Density, inf & perc texture, conductivity, OM%
- Chem – CEC, pH, N P,K,Ca,Mg,S, micros
- **Total Gross Estimate Microbial Biomass** - Substrate Induced Respiration Test (SIR)
- **Nematode Fauna Analysis** – Species & Diversity (indirect)
- **Direct Microscopy**: florocine dye (FITC)-Fungi : Bacteria pop ratio
- **Functional Micro Tests** Pathogen Control, Nutrient Cycling, Aggregation Assessment, Biological Enzyme Assay

CASE STUDY UPDATE

- Public Relations - Golfer & Public Ed
- Statistical Science Based Research for Ecosystem Dynamics
- Agronomic & BMP Developed Based on Science & Results
- Outreach & Education

CONCLUSIONS

- OM is a potential tool for BMP IPM & Water Conservation Mgmt
- Future Results ?
- OM Amendment Science infancy There is a lot we do not know
- Outreach & Education Critical to Success

October 3, 2012

POTENTIAL APPLICATION OF GREEN WASTE COMPOST RECYCLING AND USE AT EAGLES PRIDE GOLF COURSE

Research Report

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I. Overview

Recycling of green waste material back onto the golf course is one of many methods of biological management of fungal diseases, augmentation of the fertility management program, and potentially applicable for enhancement of soil water holding capacity of rootzone soils. Two methods of compost application are under consideration for applicability, feasibility, and risk- benefit analysis. The goal of this report is to provide a scientific basis for decision making regarding use of compost as part of the Best Management Practices Integrated Pest Management Plan and Environmental Management Plan for JBLM Eagles Pride Golf Course. The conclusions and recommendations made are based on a survey of research literature review, surveys of golf courses that are using or have used compost topdressings and/or compost teas, and feasibility for use and application at JBLM.

II. Report Summary

A review of the research finds most compost related disease suppression research was not done on turf (5, 6, 7, 8, 16, 19). Virtually all research results including those done on turf show inconsistent performance from site to site, batch to batch, and year to year (1, 6, 9, 11, 16). The variability in disease suppression makes commercially acceptable disease control using compost amendments or compost tea applications unacceptable (6, 16). Much of the unpredictable nature of compost amendments can be attributed to an overall lack of understanding of the microbiology and physical/chemical properties of these materials and to the diversity of compost sources used in the composting process. There is also no scientific research based foundation or history established for rootzone soil microbial ecosystems like there is for rootzone soil fertility management. Due to this fact the soil biota testing procedures and data currently available cannot provide forecasting predictions or recommendations relative to microbial ecosystem health, activity regarding nutritional or pathological expectations, or microbial rootzone management procedures (6, 9).

Significant differences are also seen between compost application laboratory results compared to field results relative to disease suppression. Many research examples exist where biological control is as effective as fungicides in laboratory tests but inconsistent and unpredictable in turf field tests (6). Disease suppression research results on turf vary widely ranging between zero to 94% depending on target disease, compost feedstock, and the manner and degree which the material has been composted (11). The most pervasive and serious turf disease at Eagles Pride is pink snow mold (*Microdochium nivale).* Research from Ohio State University done at North Shore Country Club showed no snow mold suppression (1, 2). No research reports were found showing snow mold disease suppression using compost application trials.

Disease suppression results are documented for Dollar spot (*Scelotinia homoeocarpa),* Brown patch *(Rhizoctonia solani*), Pythium root rot and blight (*Pythium graminicola, P. aristosporum, P. aphanidermatum*), Red thread (*Laetisaria fuciformis)*, and Typhula blight (*Typhula incarnate, T. ishikariensis var. ishikariensis)*, Take All Patch (*Gaeumannomyces graminis var. avenae)*, and Necrotic ring spot (*Ophiosphaerella korrae)*. The mode of action for disease suppression appears to be from antagonistic metabolic competition between microbial communities in the compost and the pathogens and/or direct antibiotic effects from compost application (6, 11). Compost application clearly has a nutrient stimulation effect which influences disease incidence and severity and may also stimulate microbial populations that suppress disease (8).

Research results has consistently shown compost application or soil amendments for turfgrass does a) improve moisture holding capacity of rootzone soils (8, 11), b) buffers rootzone soil pH, c) provides a plant available nutrient source and reservoir (i.e. CEC) (8), provides micronutrients (8), provides slow release nitrogen (3, 8, 11), provides an organic matter source (8, 11). Since microbial soil biota and compost amendment research is in its infancy it does appear that compost application has a potential to provide a rational means of extending and augmenting the efficacy of fungicides and fertilizers while at the same time reducing the environmental load of pesticides and fertilizers (11).

The challenges of implementing a compost amendment/application program at Eagles Pride are in ensuring a consistent compost source that is a) aged (i.e. composted or decomposed refers to giving the compost adequate time under proper moisture and oxygen levels to permit microbial decomposition) enough for achieving significant disease suppression activity (i.e. C:N ≤ 7- 10: 1 but no greater than 15:1 (1, 9, 11)), b) that has a maximum particle size of 1/8” (0.125”) – 1/4” (0.25”) (1, 11, 18), that has a pH range between 5.7-7.5 (1), c) that has none to only trace amounts of ammonium, sulfide, and nitrite, d) that has low concentrations of soluble salts especially sodium, chloride, and bicarbonate (1), e) that has biosolids that meet US EPA’s Part 503 technical rule for biosolids (1), f) that is contaminant free (i.e. no weed seeds, plant parts, pathogens, stones, plastic, glass, wood, nails, etc.), g) and that has dry compost with low enough moisture levels to avoid excessive clumping. Compost that is inadequately dried cannot be uniformly blended with sand or applied evenly for rootzone soil incorporation which is required for consistent application rates. Another challenge to compost application implementation is the transportation of tree & vegetation related debris from Eagles Pride to the compost processing facility at Earthworks, and transporting and storing the compost for application at Eagles Pride. These issues are dealt with in detail within this report.

III. Applicability and Feasibility

A. Compost Source

Earthworks have informed us that they are not able to meet the 1/8” particle size requirement. Having 1/8” particle size is ideal for blending with sand for topdressing turf.

The current Earthworks compost carbon: nitrogen (C:N) ratio is 30:1. We are told Earthworks is unable under their current procedures and organic material sources to eliminate the high cellulose containing material or to compost it enough to get C:N ratio within our turf requirements. Having a longer compost maturation time may be another way of resolving this problem since research shows a significant disease suppression effect on compost as is ages beyond 3 months up to 3-4 years. When C:N ratios exceed 10:1 any available nitrogen released by the compost is used by microbes causing nitrogen deficiency in the turf. Washington State University suggested we could go as high as 15:1 but turf fertility research shows organic material applied to turf above 10:1 C:N requires additional N application to maintain healthy turf (1).

Research shows the most benefits from compost applied to turf are from green waste compost blended with biosolids (i.e. manure) (6). Earthworks is currently blending biosolids in their compost which means the optimal nitrogen sources for compost are already included in the current process.

Research is ongoing to determine feasibility and cost options for implementing a compost tea trial at Eagles Pride.

B. **Equipment Needs –**
Purchase of an E-50 mini - excavator (5 metric ton) with 3 tined grapple (bucket with thumb) and long arm boom (required for 10' high pile and bin loading heights) has been forwarded to the Qualified Recycling Program (QRP) board as part of our EMS Plan. This equipment is needed to remove the existing piles of tree materials from Eagles Pride for transport to Earthworks for processing into compost. These piles present a potential fire hazard and vector attractant on the property if not removed. Purchase of a large area fairway topdressing machine and fairway aeration machine has also been forwarded to the QRP board since these machines are needed to apply compost blended with sand and incorporated the material into the rootzone soil in large quantities as outlined in the EMS Feasibility and Gap Analysis report.

C. **Logistical and Cost Issues**
Storing Eagles Pride sand & compost materials for topdressing application is feasible at Earthworks. It is undetermined whether or if Earthworks could blend the compost with sand or if another contractor would need to do that once an acceptable compost material is found. Research is on going as part of feasibility and cost estimates for on-site and off-site blending and hauling between Earthworks and other contractors and back to Eagles Pride for application.

Eagles Pride does not currently have facilities to store sand in quantities needed to topdress fairways, tees, and greens. The two areas currently storing sand are not on concrete or paved surfaces nor do these areas have ecology block walls for sand containment. Estimates using 30% compost blended with sand and topdressed at Eagles Pride could use 560 to 1,120 cu yd of compost per year.

IV. Research Conclusions

A. Background and History

Compost use has been used in agriculture and horticulture since cultivation began (1, 6, 7, 12). With the advent of inorganic mineral sources and pesticides the fertility and pest management consistency achieved basically eliminated compost use in commercial turf management (6, 11). While chemical reduction is philosophically favored as an industry goal the consistency and cost effectiveness of compost use have made compost integration into modern turf management problematic. Reduction in chemical and fertilizer use has been significant at most golf courses since the 1970's when a conscientious focus on Integrated Pest Management and resource conservation as an integral part of environmental stewardship became the norm within the industry.

B. Research Conclusions

Disease suppression using nonaerated compost teas (NCT) significantly suppressed gray mold (*Botrytis cinerea*) on bean leaves, grape leaves, berries, lettuce, strawberry fruit, tomato foliage, and pepper foliage (16). There was wide variability of disease suppression results seen between different compost tea production parameters including aeration, compost source, nutrient additives, production duration, and spray adjuvants (6, 16, 19). No consistent benefits were seen to aerating, adding nutrients, or other commonly practices production methods used in compost tea making relative to disease suppression (19). Nutrient supplements use in compost tea generation resulted in nonselective growth stimulation of all microbial populations including human pathogens such as *E. Coli*, *Salmonella*, and fecal coliforms in both aerated (ACT) and nonaerated compost tea (NCT) and should be avoided when compost tea is used on fresh produce (5, 19). Repeat applications of fungicides found no changes whatsoever on rootzone soil microbiological communities based on plating tests, BIOLOG tests for metabolic profiles, fatty acid microbial profiles, or tests for total microbial metabolic activity. Repeat applications of fungicides found no changes in total numbers of fungi on leaf blades however the application of fungicides did change the composition in favor of yeasts relative to filamentous fungi (4).

A working definition of compost is a solid particulate organic material that is the result of composting, that has been sanitized and stabilized, and that confers beneficial effects when added to soil and/or used in conjunction with plants. Composting can be defined as a process of controlled biological decomposition of biodegradable materials under managed conditions that are primarily aerobic and that allow the development of thermophillic temperatures as a result of biologically produced heat, in order to achieve compost that is sanitary, uniform, and stable. Manures can be defined as animal excrement that may contain large amounts of bedding. True composts have gone through the decomposition process of composting compared to fresh, stacked, or stored manures that have not undergone aerobic composting. Compost extract and compost tea have in the past been used interchangeably. Compost extract is defined in the literature to define water extracts prepared using a wide range of different methods typically processed for less than 1 hour (6, 19).

Compost tea is the term given by an increasing number of horticulturalists to the filtered product of compost fermented in water and refers to a product produced by re-circulating water through loose compost or a porous bag or box of compost suspended over or within a tank with the intention of maintaining aerobic conditions. Aerated compost tea (ACT) refers to any method in which the water extract is actively aerated during the fermentation process. Non-aerated compost tea (NCT) will refer to methods where the water extract is not aerated or receives minimal aeration during fermentation apart from the initial mixing (6, 19). Integrated crop protection strategies are commonly used in sustainable agriculture and horticultural systems. These strategies aim to prevent or minimize the development of pest, disease, or weeds. In practice integrated crop protection strategies normally combine indirect (preventative or anticipatory) and direct (or reactive) approaches. Soil health is central to any sustainable farming system where reliance on synthetic fertilizers and pesticides is minimized, but its potential has not yet been fully explored. Soil health has physical, chemical, and biological components and is concerned with the idea that soil is a living dynamic organism that functions in a holistic way depending on its condition or state. The biological component of soil health depends on the numbers, diversity, and health of the macro, meso, and microfauna and microflora present. It has been formally defined as the capacity of a soil to function within ecosystem boundaries, to sustain biological productivity, maintain environmental quality, and promote plant and animal health. Soil health can be considered a part of ecosystem health and is associated with biological diversity and stability. It is likely that there are links between soil health, the ability of the microbiological community to suppress plant pathogens, and also disease incidence and severity. The majority of recent work relating to uncomposted materials, composts, manures, and compost extracts for prevention and control of pests and diseases relates to container-produced plants and most of that concerns ornamentals. There is increasing interest in the potential for composts and similar materials to help prevent and control pests and diseases in field crops and information concerning these applications is slowly increasing. The impact of crop residues from green manures on crop health and plant disease incidence is highly variable depending on the type of crop residue, the crop and cropping system, soil type, climate, and so on. Results of glass house tests on field beans showed that green manures of a range of cover crops tested differed significantly in their suppression of root-rot and damage to bean growth, red clover, and bell pepper. Nurserymen using composted tree bark found growth of ornamental plants improved and crop losses due to disease were reduced. Compost amended substrates can be as effective as if they were treated with modern synthetic fungicides in rhododendron phytophthora root rot. There is increasing examples of disease suppression following application of composts to field soils, but our understanding of the mechanisms behind suppression in field soils is less well developed than that in container production systems. There is considerable inconsistency in the level of disease suppression reported in field soils, probably due to the different experimental conditions and differences in compost types used. Composted cattle manure and municipal sludge/sewerage sludge biosolids have been shown to suppress a range of soil-borne and root diseases caused by pathogens including *Pythium*, *Rhizoctonia*, and *Fusarium* when uses as components in container media. It is recognized that suppressiveness of individual composts as components of container media may not be replicated in field soils.

This may be partly because the environment in which host, pathogens, and beneficial organisms live is more variable and more difficult to control. Disease suppression occurs as a result of indirect effects (through improved soil health) and direct effects on plant pathogens and beneficial microorganisms. The main factors that directly affect disease suppressivity differ depending on the type of organic amendments added to soil. The nature, degree of decomposition, C:N ratio, time of application (in relation to sowing/crop development stage), and quantity of fresh organic residues are crucial in determining their effects on both pathogen and beneficial soil microorganisms. Some workers have reported poor disease control or increased disease following the application of composts. Composts prepared from heterogeneous wastes vary in salinity, N availability, and degree of decomposition and may lead to marked increases in disease incidence and severity (6). Mechanisms described for activity of biocontrol agents against soil borne pathogens include: 1) competition for nutrients (C and/or Fe), 2) antibiosis, 3) hyperparasitism, 4) induced protection, 5) microbiostasis (competition and/or antibiosis), 6) microorganisms that produce antibiotics and those that induce systemic resistance in plants to specific pathogens, 7) compost stimulation of plant growth resulting or suppression of plant growth affecting disease incidence and/or severity. Composts with the most disease suppressive activity are found when compost is exposed to high temperatures (30 minutes at 55 ºC) to kill pathogens followed by a curing period when beneficial microorganisms may recolonize from the outsides and when compost moisture content is kept ideally between 40%-50% for successful colonization of disease suppressive microorganisms. Very little information exists on the biology of compost-amended soils or on the activity of bacterial antagonists in composts or compost amended substrates. Very little is known about the importance of total microbial numbers or species diversity in relation to the efficacy of compost extracts and teas (6, 19). Induced resistance, antibiosis, and competition are thought to be the main means by which live microorganisms bring about disease suppression. Considerable work is required to develop protocols that can be used to ensure predictable and reliable pest and disease suppression or control from organic amendments on economically important temperate crops in different soil types. Many of the recent reports of improved plant growth or successful disease control using compost teas are based on anecdotal information or commercially sensitive data held by private companies. There is a strong need for independent research to demonstrate the effects of compost teas and to elucidate the mechanisms behind reports of disease suppression or improved plant growth. (6, 19).

The only replicated research study for turf found in the literature review showed significant disease suppression using microbial inoculants (*Trichoderma harzianum* (Biotrek 22G™) showed increasing effectiveness as frequency of applications increase. Weekly applications were more effective than those made every two weeks for dollar spot. Weekly applications of microbial inoculants were equivalent to monthly applications of propiconazole fungicide relative to dollar spot disease suppression efficacy (6, 7). There is no definitive evidence to support the hypothesis of microorganism nutrient competition as a mechanism for biological control. Likewise there is no proof that hyper parasitism is a process that plays a significant role in biological control of turfgrass diseases.

The turfgrass industry has been slow to embrace biological control technologies because chemical options are reliable, consistent, easier to store and apply, have a broader spectrum of activity over a broader range of environmental conditions, and are cost effective. (11, 12). Application of organic amendments as natural organic fertilizers (i.e. dehydrated sludges, composted and uncomposted plant and animal meals, composted animal manures) resulted in reduced thatch buildup, reduced soil compaction, reduced nitrate and pesticide movement, increased levels of soil organic matter, and reductions in the incidence and severity of some diseases ranging from 0% to 99% (i.e. dollar spot, pythium root rot, rhizoctonia (brown patch), red thread, Typhula blight, necrotic ringspot) (11).

Reed Sedge Peat application and composted amendments (i.e. animal manures, municipal biosolids, leaf and yard wastes, grass clippings, food residuals, and mixed solid waste) applied in sod production fields over 15 years as a topdressing or compost tea has shown a potential for reducing severity and incidence of the same diseases that are affected by natural organic fertilizers. Variable and some times negative turfgrass results (i.e. disease incidence and severity increase) following application of these amendments has been seen (11, 12, 13). The suppressive activity of compost extracts to some pathogens was dependent on adequate microbial population levels, a specific microbial community composition, and the presence of pathogen-suppressive microbial metabolites in the extracts. Very little is known about the mechanisms by which compost extracts control plant diseases. Efficacy of extracts varies depending on the target pathogen. Only a limited number of composts have produced extracts with significant levels of turfgrass disease suppression. Compost turfgrass disease suppression is dependent on the percentage of antagonistic microbes found in the compost feeder material. The percentage of microbes found to have biocontrol potential varies from 40.6% in non-turfgrass soil to 100% from yard waste compost. One of the greatest obstacles to widespread use of compost amendments for turfgrass disease control has been the inconsistent performance from site to site, batch to batch, and year to year. Much of the unpredictable nature of compost amendments can be attributed to our overall lack of understanding of the microbiology and physical/chemical properties of these materials. No information is currently available on the compatibilities of organic amendments or other microbiological components of organic amendments with pesticide applications (9, 11, 12, 13).

Leaf composts showed strong Pythium damping off disease suppression when cotton seeds were sown in leaf compost. Disease suppression came from seed-colonizing fatty-acid metabolizing bacteria in the Pythium suppressive compost (7). Comparing applications of 100% composted biosolids; a blend of composted biosolids and yard waste, and non-top dressed control found compost topdressings significantly increased turfgrass color, growth, and foliar nitrogen concentrations. Color enhancement lasted for up to 8 weeks for composted biosolid applications and up to 5 weeks for plots receiving the blend of composts (3).

V. Recommendations

The following outline recommendations for implementation of compost application at Eagles Pride Golf Course.

1. Implement a three year Rootzone Soil Biota survey in collaboration with Washington State University to establish a scientific research data based foundation relative to the current condition of Eagles Pride Golf Course soils. A request for funding of this study has been forwarded to the QRP board in the EMS Feasibility and Gap Analysis Report. The first step for the study will be to map the course by physical soil type to assess similarities and differences for establishing biota test sites for the study. Fertility chemical analysis will be used as a second form of foundational data to develop a mapping profile for the site. The second step will be to develop testing strategies and timelines for biota assessment. The third step will be to continue testing after compost application has begun to compare results seen on site with laboratory test data to develop a model to be used for developing effective management procedures and predictive model data based on microbial populations.
2. Locate a source for compost that will meet our physical, chemical, and biological parameters either on site or from another contractor off site.
3. Locate a source for compost blending with topdressing sand either on site or from another contractor off site. If an acceptable source is found and cost effective blending funding approved then implementation of compost application in conjunction with BMP sand topdressing of fairways, tees, and green complexes can begin.
4. Locate a compost tea feed stock source and contractor to blend and transport with cost estimates to assess implementation feasibility. Identify a location for trial testing implementation of compost tea application.
5. Field assessment should be done weekly to monitor and document results to gauge feasibility for continuing compost applications, and to develop the most cost effective procedures to achieve chemical and fertilizer use reduction goals.

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