ORGANIC AND ECOLOGICAL

GROUNDS MAINTENANCE

FOR MULTIPLE HOUSING

By: Marius Ois, Dipl.Ing., OALA, FCSLA

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EXECUTIVE SUMMARY

The contents of this study represent a critical assessment of current knowledge, understanding and trends.

Purpose of this Project

The purpose of this document is to examine conventional grounds maintenance practices and to report on new methods of maintaining the grounds for housing developments. This information will help owners and managers to recognize the need for change and will serve as a guide in the development of revised quality standards and maintenance programs.

Emphasis is put on sustainable, ecological maintenance instead of conventional 'curb appeal'. This new approach will promote healthy landscapes and a prolonged life of the built landscape.

The Report

The report provides a comparison of conventional and ecological maintenance. It lists and analyses current information on the various maintenance approaches. Much of this information had to be gathered from sources not directly related to housing management, and was adapted for use and application in the housing management sector. Credit is given to established programs in the municipal and commercial sectors, where ecological maintenance practices are either in place or in an evolutionary stage.

Objectives

The report provides a brief historical outline of current maintenance practices. By examining technical causes of failures, ineffectiveness, costs, as well as successes, the study exposes weaknesses in the system and highlights opportunities for change.

The goal is to eventually convert all conventional maintenance practices in housing developments to complete ecological practices. With the information made available in the study, property managers will be able to establish new quality standards and write performance specifications to meet the needs of each individual site.

The technical information in this report can also be utilized in the training of maintenance personnel, and will serve owners, site planners, property managers and educators as a reference source.

Testing

Revised maintenance programs now in place are evolutionary in scope rather than the sudden result of a new idea or fad. The report lists a number of examples where owners adopted a step by step approach, analyzing the results as the work progressed. Little scientific testing of the new system has been done because the benefits of these new methods were obvious. Where the new program was successfully implemented, it was fully accepted by all concerned.

In the case of the Metropolitan Toronto Housing Company Ltd., its pilot project is still in the implementation stage will be evaluated upon its completion in 1996. As stated in the report, a change-over from the conventional to an ecological approach is a weaning process, and as such, will require a certain transition period in order to be fully successful.

Conclusions

As a new landscape management language emerges, and as the management of housing sites is facing a conserver future, it is imperative that expectations, quality standards and performance criteria undergo scrutiny and change. New maintenance programs and specifications will evolve, based on the research data and evidence offered in this report.

Description of THE SYSTEM

THE SYSTEM, as described in detail in **Section 2.0 Ecological Grounds Maintenance**, is the result of the evaluation of the various existing methods of grounds maintenance, available materials and feedback from many qualified sources.

When analyzing conventional maintenance programs, it becomes clear that changes are timely and necessary. Existing programs tend to depend on out-dated quality standards and on contractors' ability to perform. Change from the status quo may be disturbing or viewed as radical. In order for THE SYSTEM to gain acceptance, all those concerned with landscape maintenance, as well as the public at large, must be educated on its long term ecological and monetary benefits.

THE SYSTEM is a comprehensive approach, requiring complete dedication, in order to make it truly successful. To benefit fully from this system, changes to the maintenance programs, in particular for housing sites, must be geared to the special requirements of each site, i.e. the specifications must be customized rather than applied with a wide brush.

The impact of THE SYSTEM on the way things are done in maintenance is considerable. It requires complete re-thinking and full acceptance of a different approach. While it fits the 3R requirements of a conserver society, it also protects the environment from excessive and often unnecessary exposure to chemicals. It promotes the "back-to-basics" approach and ensures that good horticultural practices are adhered to. THE SYSTEM really protects the investment, not only for appearances' sake, but in the long term.

Background Statement (the need for the project and its benefits)

In a conserver society, professional grounds keepers must keep abreast of new developments in the industry, as in any other discipline. As indicated in this study, municipalities and owners of commercial, industrial and other properties have, to a certain extent, already embraced this new ecological concept. Maintenance of housing developments, however, still appears to be reticent to changes. This may be due to out-dated quality standards, to contractors' hesitation to adopt new programs, or in some cases, in a lack of education of property management staff in this very specialized field.

Conscientious use of decreasing resources, economic considerations in a changing world, utilization and re-use of existing resources, make it mandatory that better ways be sought.

The report outlines in more detail the benefits of THE SYSTEM. The most apparent benefits are:

- protection of the urban environment;
- improved human and plant health;
- decrease on the reliance of pesticides, herbicides and chemical soil additives;
- improved development of plants;
- reduction of waste;
- re-use of existing resources;
- cost savings in labour and materials.

Credit Note

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RÉSUMÉ

Cette étude se veut une évaluation critique des connaissances et tendances courantes.

But de l'étude

Le but de cette étude est d'analyser les méthodes classiques d'entretien paysager et de faire un compte rendu des nouvelles techniques d'entretien des aménagements résidentiels. Les informations consignées ici permettront aux maîtres d'ouvrage et aux gestionnaires de reconnaître le besoin de changement et serviront de guide au moment de la révision de normes et de programmes d'entretien de qualité.

L'accent est mis sur l'entretien écologique et non sur l'aménagement paysager purement esthétique. Cette nouvelle approche favorisera des aménagements sains et permettra de prolonger la durée du milieu bâti.

Rapport

Le rapport établit la comparaison entre l'entretien classique et l'entretien écologique. Il énumère et analyse les informations actuelles au sujet des divers types d'entretien. Beaucoup des informations proviennent de sources qui ne sont pas directement reliées à la gestion d'habitations; c'est pourquoi il a fallu les y adapter. Il fait état des programmes établis tant au niveau municipal que dans le secteur commercial, où des techniques d'entretien écologique sont déjà bien encrées ou en évolution.

Objectifs

Le rapport trace un bref historique des pratiques d'entretien courantes. En examinant les causes techniques de leur échec, de leur inefficacité, de leur coût élevé, ou encore de leur succès, l'étude expose les faiblesses des méthodes et fait ressortir les occasions de changement.

Le but consiste à remplacer les pratiques d'entretien classiques des aménagements résidentiels par des techniques écologiques. Grâce aux informations que livre cette étude, les gestionnaires immobiliers seront en mesure d'établir de nouvelles normes de qualité et des devis de performance qui répondront aux exigences de chaque site.

Les informations techniques contenues dans ce rapport peuvent également servir à titre de référence lors de la formation du personnel d'entretien et être utiles aux maîtres d'ouvrage, aux aménageurs, aux gestionnaires immobiliers et aux éducateurs.

Essais

Les programmes d'entretien améliorés en place sont en évolution et non le fruit d'un résultat inattendu, d'une idée nouvelle ou d'un engouement quelconque. Le rapport contient un nombre d'exemples où les maîtres d'ouvrage ont adopté une approche systématique, après avoir analysé les résultats obtenus au cours de l'exécution des travaux. Peu d'expériences scientifiques ont été réalisées afin de déterminer les bienfaits de ces

nouvelles méthodes car ils sont évidents. Lorsque le nouveau programme a été mis en oeuvre avec succès, il a été reçu favorablement par tous les interessés.

Dans le cas de la Metropolitan Toronto Housing Company Ltd., son projet témoin en est présentement au stade de la mise en oeuvre et sera en 1996, évalué après son achèvement. Tel qu'énoncé dans le rapport, le remplacement d'une méthode classique par une méthode écologique requiert une période de transition avant d'être pleinement réussi.

Conclusions

Comme une nouvelle terminologie de l'aménagement paysager semble émerger et que la gestion d'habitations semble devoir connaître un avenir des plus écologiques, il est urgent que les attentes, la qualité des normes et les critères de performance soient examinés de près et modifiés. De nouveaux programmes d'entretien et devis seront élaborés en fonction des résultats de recherches et des faits contenus dans ce rapport.

Description du système

Il y a une description détaillée du système à la section 2.0 intitulée **Ecological Grounds Maintenance.** C'est le résultat d'une évaluation de diverses méthodes d'entretien paysager, des matériaux que l'on peut se procurer et des réactions provenant de diverses sources qualifiées.

En analysant les programmes d'entretien classiques, il devient évident que les changements sont nécessaires et opportuns. Les programmes actuels comptent sur des normes de qualité dépassées et sur la capacité des entrepreneurs. Choisir autre chose que le status quo peut paraître dérangeant ou être perçu comme radical. Afin que le système soit accepté, tous ceux qui s'intéressent à l'entretien paysager, tout comme la population dans l'ensemble, devront en connaître les répercussions écologiques ainsi que les avantages financiers.

Le système permet d'adopter une perspective d'ensemble. Il faut s'y consacrer entièrement afin qu'il soit vraiment un succès. Pour en profiter entièrement, les changements apportés aux programmes d'entretien, particulièrement pour les sites à vocation résidentielle, doivent être adaptés aux exigences particulières de chaque site et non à des exigences générales.

Les répercussions du système sur l'entretien sont considérables. Il faut tout repenser et accepter pleinement de travailler selon une approche différente. Le système répond aux exigences des trois «R» d'une écosociété. De plus, il protège l'environnement contre une exposition souvent inutile aux produits chimiques. Il préconise le «retour aux sources» et veille au respect des règles d'horticulture judicieuses. Le système protège véritablement l'investissement, non seulement l'aspect esthétique, mais également à long terme.

Énoncés de base (utilité du projet et avantages)

Dans une écosociété, les services d'entretien doivent se tenir au courant de l'évolution au sein du secteur, comme dans toute autre discipline. Tel que l'indique la présente étude, les municipalités et les propriétaires de bâtiments commerciaux, industriels et autres ont déjà, jusqu'à un certain point, souscrit à ce nouveau concept écologique. Toutefois, le domaine de l'entretien des aménagements résidentiels semble être encore réticent aux changements. C'est peut-être à cause des normes de qualité périmées, de l'hésitation des entrepreneurs à adopter de nouveaux programmes ou, dans certains cas, du manque de connaissances du personnel de gestion immobilière dans ce domaine très spécialisé.

L'utilisation rationnelle des ressources qui s'appauvrissent, les perspectives économiques d'un monde en changement, l'utilisation répétée des ressources existantes motivent obligatoirement la recherche de nouvelles solutions.

Le rapport expose les grandes lignes des avantages du système. Les principaux avantages sont :

. la protection de l'environnement urbain;
. l'amélioration de l'état de santé des humains et des plantes;
. la diminution de l'utilisation de pesticides, d'herbicides et d'engrais chimique;
. le développement amélioré des plantes;
. la réduction des déchets;
. la réutilisation des ressources existantes;
. les économies en main-d'oeuvre et en matériaux.

Note

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FOREWORD

Living is polluting.

We are all responsible for today's ecological crisis. It is therefore our responsibility to clean-up the planet and develop sustainable ways of creating a more liveable environment.

There is little point in preaching to people unless they have the will and means to make practical changes. This means developing a framework that will encourage more people to adopt a greener lifestyle.

Until very recently, the overwhelming preoccupations of this era have been progress, growth and expansion, with cash value being the only way of measuring the relative advantages of change. While there are still many for whom cash value is of primary concern, more and more people are growing uneasy about the state of the world.

Many things have to change if we are to ensure that life remains worth living, both for humans and all of the planet's life forms. In practical terms, this means using resources as carefully and sparingly as possible, in the management of the land.

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1.0 INTRODUCTION

1.1 GROUNDS MAINTENANCE - A NEW APPROACH

Environmentally sound property management decisions, and appropriate adjustments to the competitive marketplace, require a completely new approach to grounds maintenance. Reliance on conventional maintenance methods, outdated performance specifications, current skills of the maintenance trades, and on recommendations of equipment and product manufacturers, is no longer sufficient. Too much is at stake: cost-effectiveness, protection of the investment and stewardship of the environment. Conventional methods of grounds maintenance no longer fit into the framework of the environmental/ecological thinking of the nineties and performance and quality standards will have to adapt to the new philosophy. The new approach proposed for grounds maintenance is simply the logical conclusion following the assessment of recurring high maintenance expenditures and their impact on the environment, on property management and on people in general.

Conventional grounds maintenance is energy-dependent and costly. Ecological grounds maintenance instead is less energy-dependent, therefore less costly, and can reverse the effects of conventional practices which have often resulted in a sterile landscape.

Urban planning, ecology and cultural aspects need to be combined in order to achieve optimum quality of open space maintenance. Landscaped spaces are bioclimatic, social and cultural facilities and are interdependent ecological entities. They satisfy the social and cultural needs of their users. They must therefore be planned and maintained to reflect and satisfy these needs.

Ecological maintenance may mean reduced maintenance, but it should not be interpreted as simply doing less. The reduction or even the elimination of certain procedures or materials will depend on certain conditions and require appropriate action. Reduced maintenance effort alone will result in a quick failure and collapse of the landscape.

Standard, common sense horticultural practices are the best means of getting optimum performance from the built landscape. Promotion of healthy growth is a prime objective. Often there are no short cuts to efficient maintenance and without the use of artificial, chemical or mechanical aids some extra effort may be required to accomplish the task.
Ecological maintenance depends on the successful implementation of alternative methods, on the recognition of the needs of the landscape in view of environmental and ecological considerations, and on the full commitment of property management.

Conventional landscape maintenance is generally highly energy-dependent and necessitates large inputs of energy, chemical fertilizers, herbicides and pesticides. While conventionally maintained sites may have the desired curb appeal, this input intensive form of landscape maintenance is not ecologically sustainable.

1.2 THE LINK TO THE PLANNING PROCESS

Ecological maintenance is the logical byproduct of the ecological planning process. The planner of a new development must be aware of the ecological land management principles, and must incorporate these in the development of his planning concepts. He must also be aware of the impact of the design on the grounds maintenance process, in particular on the ecological maintenance process, which ensures the nurturing, protection and natural development of the built landscape. Where these principles have not been applied during the planning process, certain preparatory work is required to ready the site for ecological maintenance.

Planning and Maintenance

It is the duty of the landscaper to minimize negative impacts on nature by employing appropriate landscape/technical/horticultural measures such as soil improvements, suitable plant use and maintenance. The question of what is appropriate may not always be evident. The three mentioned factors (soil, plant use and maintenance) form an ecologically inseparable unit.

The mistakes made during the initial installation of the landscape are usually followed by mistakes made during the maintenance process. The subsoil is compacted during construction and the top soil, applied later by heavy trucks, graders and bulldozers becomes equally compacted - a tough beginning for newly laid sod and planted trees and shrubs! The maintenance crew also contributes to the poor state of the soil by further compacting it with heavy maintenance vehicles and equipment and by using chemicals which render it lifeless and sterile.

Proper use of plant material is ecologically important. The goal of the planner should be to use suitable plants to achieve a maximum vegetation mass with minimum maintenance requirements. The planner is seldom aware of the actual predominant soil conditions the plants are to be set in as he may not have any knowledge regarding the physical and chemical properties of the soil. Soil improvements called for in the specifications usually are not adequate to provide the necessary nutrients for the plants much beyond their first two years of development.

From an ecological point of view, an ideal state will have been achieved when the vegetation and soil complement each other. The soil is at it's optimum when it is completely covered with vegetation. Every bare area is like an open wound and nature, when left alone, will fill in the bare spots with vegetation. Unfortunately, conventional maintenance procedures interfere with nature's tendency to heal spontaneously. The choice of trees and shrubs in any particular area will determine which ground cover is most appropriate as it affects maintenance. Ideally, this would consist of a layer of vegetation together with plant specimens and lead to a symbiosis of plants and soil with optimum growing conditions and little maintenance requirements. Recycling, i.e., decomposition, hydrology, production of humus, reduction of deleterious materials and creation of organisms are part of the natural cycle in soil conservation.

Conventional methods used for planting in urban area are not necessarily in nature's best interest. Shrubs are often planted close together for instant effect and in a few years, they become top-heavy and leave the ground

exposed. Improper pruning will not help in this instance. Maintenance crews tend to eliminate all natural ground cover and rake the area clean. Chemical weed control further precipitates sterilization of the soil. The time has come to change these procedures, starting at the planning stage and continuing right through to an environmentally friendly maintenance program.

Ecological maintenance is not restricted to grass, trees, flowers and shrubs, but must encompass the entire sphere of outdoor caretaking. This may involve recycling of organic waste from maintenance operations and residents' organic garbage being turned into compost or mulch. It also entails the use of environmentally friendly materials such as low toxin paints for fences and outdoor furniture, and a reduction of air and noise pollution.

All the components necessary for a healthy environment must be included when considering a comprehensive ecological maintenance approach, from the energy equation to recycling. The outcome will be a healthy urban living environment as well as a lasting and thriving city landscape.

Ecological Landscape Planning

Ecosystems, as a rule, are healthier and more stable when there is a variety of animal and plant life able to thrive under natural conditions. The goal of ecological balance is to protect, to use, to maintain and to develop landscaped spaces so that the natural equilibrium remains intact.

The planner should use nature as a model. Although function and aesthetics play a major role in landscape developments, the developed green spaces must be designed to satisfy ecological and horticultural needs. The subsequent ground maintenance is in inseparable part of any landscape plan.

1.3 FACTORS THAT DETERMINE THE NEW APPROACH

A considerable amount of knowledge has been acquired on the subject of ecological maintenance in recent years. The general public's acceptance of environmentally friendly approaches to our everyday living is due largely to the many articles and research published on the subject, media coverage and to environmental awareness in schools and in the workplace. However, where grounds maintenance for multiple housing is concerned, methods and procedures have not changed to reflect the new awareness.

In order to achieve state-of-the-art organic grounds maintenance standards, all available data and information on environmental concerns, waste reduction and a liveable environment as it relates to the management of housing sites need to be reviewed and assessed.

Like any new invention or idea that challenges established procedures and business concerns, the ecological maintenance approach has run into opposition from the establishment. That is to be expected. It is also to be expected that the establishment will continue to oppose, regardless of practical reasoning or objective discussion on the subject. Too much appears to be at stake. Full acceptance of an ecological maintenance program may be slow and its introduction must be carefully orchestrated, taking into account the requirements and analysis of each individual site.

It has taken ten years of battle and the introduction of federal legislation to rid most of the European countries of herbicides in urban areas and to adapt to a more ecological land management approach. There, the ecological approach is now a matter of fact and the property and land management industry have survived!

Proponents of the status quo shrug off concerns about negative effects of pesticides to the environment and humans by citing the low rate of death caused by their uses in comparison to hazards such as swimming deaths, for example. They label those with different views "gung-ho" environmentalists and pressure groups, and claim that, with proper safety precautions and careful use of pesticides, all problems of lawn and landscape maintenance will be solved.

The fact is that most pesticides, although government approved, are toxic and must be handled with care. One needs only to take a look at the product labels to understand that truth. Why are respirators, gloves, goggles, face shields and special clothing needed when applying these products? Why is it necessary to obtain a special license for the application of these products? Has the industry done any tests that would prove conclusively that there are no damaging effects on the soil structure and to the micro-organisms which live in that soil? Have they produced research that proves beyond a doubt that leaching into ground water has no adverse effect on wild life or on humans? It is well known that dependency on pesticides costs dearly in terms of recurring monetary expenditures: "Americans spent $6.4 billion last year on lawn-care products, up 13% from 1989" (Time Magazine, June 3, 1991).

The Energy Equation

The problems caused by burning fossil fuel as an energy source are well documented. Related is the problem of the ever increasing cost of energy, be it in the form of fossil fuel or nuclear power. It makes sense therefore to equate reduced energy consumption with ecological/economical well being.

Benefits of energy efficiency

One benefits immediately from energy efficiency by spending less, or at least getting more useable energy for the money.

Environmental benefits are achieved by reduced emissions of greenhouse gases responsible for the warming the atmosphere.

Many energy dependent machinery produce emissions which are unhealthy for humans, as well as raise the level of noise pollution. Lesser dependence on this equipment makes for a healthier and more liveable and enjoyable environment.

Energy efficiency and conservation projects may employ more people than a high-tech approach. But, while appearing more efficient, the high-tech approach may work out to be as costly as the one using more manpower, but requiring less chemical products and energy dependent machinery.

Saving Water

The availability of water in Canadian urban centres has never appeared to be a major problem, except for the occasionally imposed use restrictions during the dry, hot summer months. However, consumers should be made aware of the true cost of providing that supply. Many of the problems associated with water and sewage services are becoming increasingly more complex and costly.

Waste of potable water in the urban environment for landscape maintenance carries a considerable cost factor. It also sets a poor example to the individual citizen who needs much encouragement and motivation to practice water conservation.

Dependence on Machinery

Today's grounds maintenance procedures depend largely on the deployment of machinery designed to reduce manual labour, in order to increase efficiency. With the introduction of new equipment and gadgets comes problems which are detrimental to both the landscape and to the maintenance personnel. The weight of tractors used for lawn mowing, aeration, fertilizing or pest control contribute to the compaction of the soil, creating an impenetrable layer that causes surface water run-off, resulting in erosion. As well, the rain water that would normally have been absorbed into the ground is lost and additional water must be applied through means of irrigation. As a result of the compaction that has occurred, costly anti-compaction procedures must be employed to alleviate the problems.

The use of string trimmers at the base of trees and shrubs causes damage to the bark and cambium of the plants, inviting pests and diseases, and may also result in structural damage to the plants. Prolonged application of these methods may eventually require the costly replacement of the plants.

Maintenance machinery operators can suffer considerable adverse health effects. Noisy two-cycle motors can contribute to hearing loss; faulty spray equipment exposes the operator, and possibly others, to poisonous solutions. Today's maintenance operator must be familiar with the safe operation of the equipment, effects of chemicals, dangers of operation, and safety procedures -all to protect himself and others from the impact of equipment and chemicals usage. What an effort to keep the landscape tidy and to nurture the plants!

With fewer gadgets and a lesser use of heavy construction-type equipment, the landscape will thrive and maintenance will become a less dangerous task. Furthermore, less dependency on energy consuming equipment is environmentally beneficial and may result in cost savings.

Healthy Landscape

For an organic and ecological grounds maintenance program to be successful, it must incorporate certain measures to reflect the needs of a healthy landscape. These are as follows:

Conservation

The control over weeds, pests and diseases can be accomplished by creating a healthy landscape. In order to achieve this objective, the requirements of the ecosystem, fulfilment of the needs for a healthy environment and protection of the landscape must be taken into consideration.

Reduction and/or elimination of environment pollutants

1. The chemical components of herbicides, pesticides and even fertilizers can kill off soil life and ruin the its structure. A healthy, chemical free soil, rich with micro-organisms is essential for the proper development of plant life. Excessive nitrogen in fertilizers applied to the ground tends to leach through the soil, seeping into the ground water, streams and ponds and resulting in algae overgrowth. This reduces the oxygen in the water and makes it uninhabitable for fish and other water life forms. Although 7,000 species of earthworms have been identified in the world, only three, the garden worm, the red worm, and the night crawler are the most common types. Earthworms do not feed on living plants but are effective in reducing the accumulation of organic residues on the soil surface. Thus, pesticides which reduce the earthworm populations can result in increased thatch accumulation (Turf & Recreation Magazine, March 1994). Herbicides, due to their known danger to human health, have already been banned in most European countries and by several Canadian agencies.

2. Environmental pollution has become a major concern for society. Acid rain, air pollution from industry, burning of fossil fuel, heavy metals and residue from pesticides and chemical fertilizers in

soil and water, as well as acid-forming polluting gases all have contributed to the damage to our environment. More and more research results have become available pointing to the causes and effects.

Atmospheric pollutants are carried through precipitation into the soils where they, because of higher acidity, cause changes in the soil structure, fauna, flora and in natural water bodies. Transportation of fertilizers or pesticides by water or erosion can lead to pollution of lakes, streams and water tables, while de-icing salts in winter can have adverse effects on soil and vegetation.

3. Amongst the emissions that damage vegetation, sulphur dioxide (SO_2) is predominant. It reduces the growth potential of plants. Nitrogenoxides (NO_x) cause phytotoxic effects such as damage to plant foliage near vehicular traffic routes. Changes in foliage pigments influence the metabolism which retards photosynthesis.

Avoidance of Thatch

Formation of thatch in lawns increases insect and disease problems. It makes turf prone to scalping and decrease heat and cold tolerance. Thatch can become a major problem if the wrong maintenance methods are applied favouring its development. Thatch formation increases as soil pH decreases. Acid soils reduce the microbial activities thus impeding the breakdown of thatch (Carbonneau, 1994).

Fertilization stimulates turf grass growth. Excessive fertilization will force grass to grow more quickly than micro-organisms can break down the grass clippings left on the ground.

Fungicides use may increase thatch formation. Fungicides not only kill disease causing organisms but they also kill non-target micro-organisms which break down thatch.

Waste reduction

Waste reduction is a necessary consideration in the organic/ecological maintenance approach. Ontario's Waste Reduction Action Plan announced in February 1991 clears the path for the introduction of future initiatives. In the process of grounds maintenance leaves, felled branches and collected debris contribute to the waste disposal problem. The conversion or reduction of these waste materials should be a high priority in designing ecologically efficient grounds maintenance programs.

Recycling

Much of the waste collected on a landscaped site is suited for recycling. Leaves, grass clippings and other organic waste from the maintenance operations can be composted and re-used as soil additives for new plantings, in planting beds and for lawn top dressing or as soil additive for new plantings. Manual brush clippers can turn refuse into mulch material suitable for planting beds.

Cost savings

In view of the ever increasing maintenance expenditures caused by the high cost of waste disposal and the repeated application of water and chemicals, considerable savings can be achieved if sound ecological maintenance procedures were practised.

Good citizen

World-wide recognition of the damage caused by poor management of the environment calls for the contribution of every individual and organization to influence the direction taken in the protection of the environment.

De-icing Salts

Over the past fifty years the amount of salt used for de-icing roadways in winter has increased with the amount of traffic flow and concern for public safety. Most de-icing salts are unrefined rock salt containing approximately 98.5% sodium chloride, 1.2% calcium sulphate, 0.1% magnesium chloride and 0.2% rock. Salt causes plant injury if excessive amounts accumulates in the soil near the root system. This frequently happens when salt laden snow is plowed from streets, sidewalks and other paved areas onto adjacent landscapes.

Rock salt readily absorbs much of the water that would normally be available to the roots, resulting in drought-like conditions for the vegetation. Chloride ions are absorbed by the roots, carried to the actively growing plant portions, where they accumulate at toxic levels. In leaves, this toxic build-up results in a characteristic marginal scorch.

Excessive sodium in soil decreases plant health and vigour in several ways: sodium can cause soil to loose its capacity to aggregate into clumps and as a result, easily becomes compacted. Excess sodium also lowers the availability of potassium. Potassium deficiencies are common in plants suffering from salt injuries.

Salt spray deposited directly on plants from passing cars is another problem. These deposits may directly enter the plant cells. When this happens, buds and small twigs of some plants species lose their their cold hardiness and are more likely to suffer from freezing. Affected plants, being under stress, suffer reduced vigour, are more susceptible to attack by insects and diseases and are more sensitive to environmental factions such as air pollution.

The damage mentioned can be eliminated by not using de-icing salt at all. Safety considerations preclude the banning of road salts in certain Canadian regions. However, as has been shown in various other jurisdictions, and in particular in all cities in Germany, where no road salt use is permitted (with the rare exception of use on stairs, ramps or streetcar switches) most regions have proven that they can survive the winter months without the use of road salts.

1. Calcium chloride is reported to be less toxic than sodium chloride, but it is also considerably more expensive. Serious concerns about

handling and storing calcium chloride precludes its use by many agencies.

2. A reasonable alternative to salt is urea formaldehyde for use in and around landscape areas. Urea is also a slow release chemical fertilizer. Although it is of chemical origin, it is a lesser of two evils, with run-off or over-spray not resulting in typical salt damage, but instead fertilizing the landscaped areas. The disadvantage is that it is not effective in extremely cold temperatures.

3. In many cases, sand, light gravel or cinder provide adequate traction for pedestrian or vehicular traffic without the falsely perceived feeling of safety that a salted road or drive tends to give the user.

4. Avoid piling salt and snow around plants or in areas where when the snow melts will drain into soft landscaped areas. If possible, when weather permits, flush the area around the roots with clean water.

5. Select plants resistant to salt injury when trees and shrubs are to be planted where exposure to salt is unavoidable.

Soils

Soil plays a major role in the storage of pollutants. Notable are heavy metals. Residues of de-icing salts in the soil lead to detoriation of the soil structure which impacts negatively on the development of vegetation.

In the case of chemical fertilizers and pesticides application, the intended effect also produces uncontrollable and unintended side effects on organisms. In terms of influencing soil life, the effect of a substance on the complicated structure of the various types of soil micro-organisms must be emphasized. It is well know that a disruption of the microbiologic balance in the soil will result in negative changes in the soil fertility.

Large quantities of chemical residues can be bound to the soil colloids and may not have direct influence on the biological processes in the soil. This adsorption is, however, dependent on the chemical structure of the chemical substance. It appears that these foreign chemical residues can be broken down. The resulting products are metabolites which have lost the original effect (i.e., the do not act any more as herbicides, fungicides or insecticides), but they retain their biologically active properties. It must also be noted that any added foreign matter to the soil is being transported from one ecosystem to the other.

Summary

Substances with damaging effects on the environment can lead to changes in the ecosystem. Such pollutants are acid forming gases, photochemical/secondary products, motor vehicle emissions, heavy metals, de-icing salts, pesticides, etc. Effects of pollutants are not results of chemicals applied in the environment, but are the product of a combination of influences on the environment.

Ecologically motivated maintenance practice requires a different mind set. Understanding and awareness of the underlying reasons make it easier to justify the new approach, they are:

1. Attain a balance between economy and ecology

2. Apply the principles of hygiene to humans as well as to the management of the landscape

3. Strengthen the ecosystem e.g. soil structure, to enhance the defence systems of plant material

4. Introduce biotic factors such as organisms, hormones and biochemical matter into the landscape, to promote and protect built landscape and shield if against adverse conditions.

5. Refuse the urge to immediately fight any minor damage or disruption.

6. Take the time to compare and consider all available remedy options.

7. Practice prevention: frequent monitoring and appropriate maintenance programs allow little room for the spread or

establishment of diseases and parasites.

8. Eliminate the use of chemicals, where possible. If control and combatting of diseases is required, use biological products.

9. Protect plant life. Spraying, dusting, etc., is unhealthy and is only a temporary, quick fix solution. The real challenge is to grow healthy plants. The reduction of humus (matter in the process of decomposition) and its life forms is the result of fertilizer, pesticide and herbicide applications as well as compaction. This in turn lowers the antipathogenic potential of plants, making them more susceptible to attacks from damaging organisms.

10. Protect and improve the soil. This is the base for all plants - the main source of food and strength.

11. Reduce the use of energy consuming, polluting machinery in the landscape by using more skilled labour. Standard, common sense horticultural practices are the best means of getting optimum performance from the built landscape.

12. Eliminate or sharply reduce the use of and dependency on de-icing road salts.

1.4 CONVENTIONAL MAINTENANCE PRACTICES

Grounds maintenance is generally seen as the necessary means to:

- protect the investment
- improve the appearance of the grounds
- get the most of the maintenance dollars

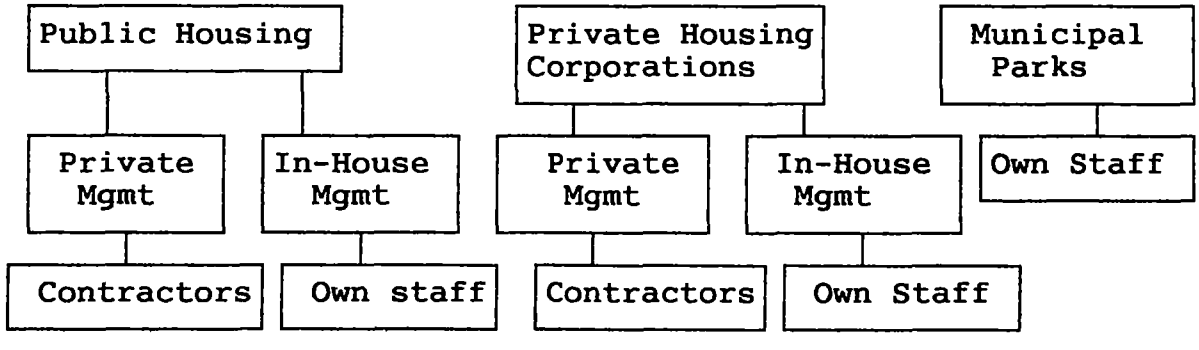
The current practice is that when completed, the project site is taken over by Property Management. For public housing agencies and government owned property this usually means a self-sufficient, independent branch, division or department within the agency. Privately owned property is managed through property management firms, or for large private real estate corporations, by staff of a separate property management department.

Grounds or landscape maintenance then becomes part of the overall maintenance assignment of the Property Manager, which includes the maintenance of the buildings, i.e., HVAC, roofs, garages, elevators, etc., as well as the grounds.

Unlike mechanical systems (e.g. elevators), where the maintenance services are prescribed in manuals provided by the manufacturers, landscape maintenance procedures vary considerably from site to site. These procedures will depend on the set maintenance quality standards, community standards and quality and complexity of the existing design.

While some property owners prefer to have the landscape maintenance tasks executed by their own staff, for the majority of project sites, particularly in the multiple housing sector, contractors are retained and for the most part, left to their devices as to the manner in which maintenance is conducted.

Distribution of Grounds Maintenance Tasks



Examples of Conventional Maintenance Standards

Purpose:	To maintain a safe and attractive turf cover on all unsurfaced areas at the level dictated by public use (Ann Arbor, Michigan).
CLASS A	**PREMIUM**
MAINTENANCE ITEM	Most intensive grass area where high degree of care is required to sustain turf cover and/or where high quality appearance is required
Mowing	Weekly, average height 40 to 50 mm
Fertilizer	Twice per year, spring and fall
Weed Control	Chemical application twice annually
Aeration	Minimum of once per year in fall
Reseeding/sodding	Done as needed, at least once per year
Leaf Removal	Annually
CLASS B	**PLAY**
MAINTENANCE ITEM	Usual grass areas in parks where user activity takes place on the turf; street medians and islands in residential and commercial neighbourhoods
Mowing	Once every 7 - 10 working days, 40 to 50 mm average height
Fertilizer	As needed with renovation
Weed Control	Chemical application annually
Aeration	Every 3 years
Reseeding/sodding	Annually when needed
Leaf Removal	Annually where applicable

CLASS C	**FIELD**
MAINTENANCE ITEM	Pastoral effect, no or very little activity; also street rights-of way
Mowing	Once every month, 100 - 150 mm average height
Fertilizer	None
Weed Control	Mowing Only
Aeration	None
Reseeding/sodding	Bare spots, year following discovery
Leaf Removal	None

CLASS D	**MEADOW**
MAINTENANCE ITEM	Natural or naturalistic
Mowing	No mowing
Fertilizer	None
Weed Control	None
Aeration	None
Reseeding/sodding	None
Leaf Removal	None

1.5 SEMI-ECOLOGICAL MAINTENANCE PROGRAMS

Arising out of the international concern for the environment, the seed for an action agenda for sustainable development was sown. Various government levels and N.G.O.'s have discussed the options for a sustainable future with the result that the necessity for the three R's - recycle, re-use, reduce, were accepted by governments and adopted as environmental policy by the Ontario Government (Ontario Ministry of Environment & Energy, 1994).

Various programs and incentives at lower government levels ensued. Municipalities, mostly through their Works and Environment Departments, set up programs and provided manpower for the training and dissemination of information.

Program Incentives

Many of the incentives deal directly with grounds maintenance and information pertaining to them is being distributed in various publications and flyers. The following are some examples:

Region of Waterloo (City of Waterloo)

- Healthy Lawns and Gardens with Less Water
- Multi-dwelling Composting Demonstration Report

Metropolitan Toronto

- Composting Information Flyers
- Seasonal Information on Organic Lawn Care (flyers)
- Composting Pilot Project for a 3-tier Program, Involving 14 Multiple Housing Project Sites.

Recycling Council of Ontario

- Composting Made Easy (flyer)

Ontario Waste Management Corporation

- Enviro-Dial

Environment Canada

- What You Can Do For Your Environment (information booklet)

There are many other excellent examples of information and educational material available on the subject. This type of information was developed with the general public in mind.

The aim of the 3R programs is to encourage mainly single dwelling households and to some extent, multiple-housing projects, to reduce waste through composting.

At the municipal government level, more and more parks and works departments are in the process of changing their conventional maintenance practices. There is an increasing trend towards the decrease or elimination of herbicides and the mowing of grass at less frequent intervals. Municipal leaf collection programs have resulted in the abundant availability of compost, which is being used as mulch and additives to the regular nutrient treatments for lawns, trees and shrubs (In Ontario, Regulation 101/94 requires municipalities to implement programs which include collection of home leaf and yard waste and composting).

At the time of writing, there are no known ecological or semi-ecological maintenance programs at the multiple-housing level in Ontario, with the exception of the one started by the Metropolitan Toronto Housing Company Ltd. in 1992.

This initiative came about when the 5 year contracts for the grounds maintenance for 100 MTHCL housing projects sites were about to expire. The management saw at that time an opportunity to improve its present, conventional maintenance practices.

The new, 1992-1995 grounds maintenance contracts were completely re-written. The major changes were in these areas:

Lawn Mowing	Reduced frequency, according to growing rates, leaving the grass at 70 mm height during the summer months.
Fertilizing	Reduced application and reduced rates of fertilizer.
Lawn Trimming	Deletion of edging procedures.
Pruning of Shrubs	Limited to the removal of old growth, no annual trimming.
Shrub Planting Beds	Elimination of leaf raking in planting beds. Restrict turn over of planting beds to once annually.
Herbicides	Elimination of herbicides applications in planting bed. Herbicide application for lawn on a needs basis (at Manager, instead of regular and periodic applications.
New	Installation of compost bins and provision of compost heap locations.

1.6 QUALITY AND PERFORMANCE STANDARDS

Government

Government agencies tend to establish their own quality standards, issued in the form of maintenance manuals. These serve as directives to their own staff and to contractors.

The manuals are usually quite extensive in terms of prescribed procedures, tools and materials to be used. Some even describe the man-hours required to perform each task. Furthermore they usually include performance specifications. For instance, the manuals used by the Ontario Ministry of Housing and the Metro Toronto Housing Authority offer considerably detailed information, and are up-dated at more or less regular intervals. The owners of larger housing portfolios, as well as Parks Departments and agencies like Ontario Hydro have their own human resources to develop their quality standards based on their own specific requirements.

It can be said, however, that the quality standards and performance specifications are principally identical, with only minor variations in terms of frequency of fertilizer applications, chemical composition and rate of application. In other words, all grounds maintenance procedures are to protect the investment, to improve the appearance, and to get the most of the maintenance dollars.

Attempts are being made by property departments of municipalities and similar agencies to follow more environmentally friendly procedures. The reason for this is public pressure and the realization that recycling is a concept that can be applied to grounds maintenance, as previously noted.

Several municipalities have completely or partially banned the use of herbicides, and have incorporated the use of compost in their maintenance programs. Parks departments in particular, are experimenting with the concept of naturalization, giving certain large lawn areas minimal attention, such as mowing only once a year.

Private Management

Government managed sites are maintained on the basis of appearance and cost, with attempts to integrate new trends. The latter is generally not a fact in privately managed landscaped sites. Here, appearance and costs are the only determining factors. Virtually nothing has changed during the past twenty-five years. Lawns and planting beds are kept neat and tidy for "curb appeal". Golf course type lawns are the objective, and shrub beds are kept clean by being subjected to frequent and unnecessary "trimming". In order to save on manual labour, this approach relies more and more on the use of chemicals and high-tech, motorized equipment. This method does give the expected short term results, however environmental damage and continuing decay and disintegration of the planned landscape are evident (see discussion of these results in the 1.1 to 1.4).

In many cases, the grounds upkeep is left completely to the contractors, who offer their own performance procedures, which may suit their own needs, but which may not always be to the benefit of the site, the original site design intent, the occupants or the owners.

Summary

Except for some initiatives on the part of government property management, a truly ecological grounds maintenance concept has yet to be developed. This requires a complete rethinking and the rewriting of existing maintenance manuals. Present maintenance procedures, up-dated or not, are based on maintenance concepts and standards established decades ago, ergo out-of date. Then, herbicides were the answer to the fast elimination of unwanted "weeds". Chemical fertilizers, as efficient nutrients, were more expedient than bulky and smelly organic materials. Heavy, gasoline-powered machinery were thought to reduce costly labour. But all this at a cost to the environment and in the long run, to the detriment of the landscape which these procedures were meant to protect and enhance. We have now come to recognize and understand that a new and ecologically conscientious approach to maintenance will be beneficial to the landscape, the owners and the users.

1.7 BASIS FOR PERFORMANCE SPECIFICATIONS

Any task that requires execution must be guided by specific descriptions of the scope of work, materials to be used, and methods of installation and execution.

For instance The National Master Specification serves as a resource tool for writing project specifications for both private and government work. It is used for technical reference for products, labour and contract information. Other agencies and governments have developed similar task descriptions, in each case describing in detail, Part I - General; Part II - Products; Part III - Execution.

This methodical approach leads to clear, precise and sufficient detailing to achieved the desired results.

In regards to landscape maintenance, methodical specifications based on a model similar to the one used in construction is not yet the norm. There are numerous types of landscape maintenance instructions in circulation. The set-up and approach varies considerably from one jurisdiction to another. Many government agencies have developed their own specifications, similar to or following the NMS format, while the private sector offers much diversification and flexibility in its approach.

Recurring Maintenance

The primary maintenance functions are on a recurring basis, usually expressed in annual tasks, and which may vary in frequency of application and scheduling. Recurring maintenance is essential for the protection of the inventory and to ensure healthy plant development. The intensity and extent of maintenance depend on the objective and quality standards established by the owners or on a larger scale, the community i.e. the Municipality.

Improvement Maintenance

The need for this stage of maintenance may not be known or evident when recurring maintenance is planned. This need will vary depending on the age of the project, quality of original installation, quality of design and past and current maintenance. The extent of use plays a major role in determining the need for improvement work, i.e. a densely built housing site will show more wear and tear than for instance a public park in the suburbs.

The success of maintenance will depend largely on the given accurate description of the tasks. This is particularly important for ecological maintenance, as it involves the use of specific materials and application methods. Any substitutions or changes, or vague descriptions cannot be allowed, as they will diminish the meaning of the ecological methods.

Therefore only the following three types of specifications should be considered for ecological maintenance:

1. NMS Format:
   Description in Part I - General; Part II - Products; Part III - Execution. They describe frequencies, application rates, time of execution etc.

2. Description of Specific Tasks:
   This type of specifications list all tasks and areas and describes them individually in detail. For instance LAWN AREAS contains subsections which include Watering, Mowing, Edges, Weed Control, Fertilizing, Trash Pick-Up, Aerating. A separate section or appendix describes specified frequencies for the areas and the particular functions.

3. The European Model:
   Specifications can be written in such a way that they can also be used as tender forms: they describe the item (mowing of lawns), the performance specifications (time of mowing, height, use of clippings etc.), list quantities, unit costs and the item costs.

For ecological ground maintenance purposes, each of the above formats can be maintained, while the text will have to be amended or changed as indicated in the sample specifications contained in the Appendix. The reasons for this are primarily the varying local quality standards, different levels of existing site conditions and the need for allowing appropriate transition periods between the conventional and the new maintenance program.

2.0 ECOLOGICAL GROUNDS MAINTENANCE

2.1 REVISED TASK OUTLINE

A comprehensive ecological maintenance program for housing sites requires major revisions to conventional maintenance practices. It requires also re-thinking and accepting completely new quality standards.

Based on the European example, ecological landscape maintenance will eventually become the norm, even in North America.

Conversion will initially demand understanding and tolerance from owners, residents, maintenance staff and contractors. Eventually the public will get used to the new quality standards, and will learn to accept them in view of the many ecological as well as economic benefits.

The new program will look like this:

1. **Lawns**

Lawn Mowing

- reduced frequencies;
- turning little used lawn areas into meadows (mowing once or twice per year);
- total elimination of herbicides;
- pest control by using non-chemical materials;
- improve soil drainage, improve maintenance (mowing, proper watering, appropriate plant food applications, hygiene), better monitoring of soil conditions, and regulating Ph levels.

Watering

- avoid frequent watering, in favour of occasional soaking to 150 mm depth (for best results install an automatic lawn sprinkler system);
- avoid over-watering as this compacts the soil and leads to acidification.

Fertilization

- replace synthetic fertilizers with organic or combined fertilizers;
- reduce frequency of applications, to one application of organic fertilizer which will provide plant food for 4 to 6 months;
- grass clippings, provided that they are short and fine, will provide additional plant food;
- use compost, where available, as top dressing and nutrient supplement.

Lawn weed control

- do not use herbicides;
- apply non-chemical weed killers only to areas affected by heavy weed infestation.

Alternatives to lawn

- convert certain grassed areas (slopes, little used lawns or lawns in shade), into meadows or wildflower areas, or use ground cover planting instead.

2. **Planting beds**

Cultivating

- eliminate regular digging and cultivating;
- leaves should be left where they fall. They provide natural mulch, resulting in better soil conditions, retention of soil moisture and important micro-organisms.

Edging

- eliminate edging of planting beds;
- provide a natural transition between lawns and planting areas.

Trimming

- eliminate all trimming of branches;
- prune shrubs only to rejuvenate and to remove dead growth.

Weed control

- do not apply herbicides (in a healthy, vigorously growing shrub bed with natural mulch, weeds do not get a chance to establish themselves);
- in the initial stages of the new program, and before a natural mulch cover has established itself, use fatty acid type weed killers (Spectrum) where needed;

Fertilizing

- restrict the use of chemical fertilizers (fertilization can be provided through the natural cycle of decomposing leaves - certain flowering shrub or flower display areas can be supplemented with the occasional application of organic fertilizers).

Removal and disposal

- feed cut branches and twigs through wood chipper;
- store chips on site and use as mulch;
- cut larger branches into log-size for firewood.

3. **Trees**

Pruning

- reduce pruning to cutting of dead branches or branches that interfere with other plants, with structures or with traffic.

Saucers

- do not maintain open saucers around trees located in lawn areas. Grass at the base of trees protect the soil from drying out, and eliminates certain maintenance procedures necessary to maintain a tree saucer.

Fertilizing

- do not fertilize, fertilizer stakes or drilled holes filled with fertilizer provide food only in the immediate area of the hole, leaving dark green grass spots around the tree. Using the examples of trees in nature (forest, conservation areas), a tree can develop quite well without human coaching.

Removal of branches and limbs

- feed cut branches and twigs through wood chipper;
- cut larger branches and limbs into log-size for firewood.

4. **Paved areas**

Weeding

- hand pull or use localized application of infrared equipment or gas fuelled flame throwers.

Ice & snow melting

- avoid use of Calcium Chloride or Sodium Chloride, instead, use sand mixed with above or apply urea.

2.2 PRINCIPLES OF ECOLOGICAL GROUNDS MAINTENANCE

The best way to maintain and to protect a healthy landscape is to apply natural and horticulturally appropriate methods of grounds management. As simple and as logical as this may sound, a thorough review of conventional maintenance practices will reveal that despite the high energy input, today's built landscapes are not in a healthy state.

Trees shrubs and lawns, particularly in housing developments, are in a repetitive cycle of recurring maintenance. In most cases, methods of maintenance have not changed for years. This repetitive approach does not recognize the needs of the live components in the built landscape. It also leaves little opportunity for individual treatment of special areas or for the application of innovative or alternative methods of maintenance.

Ecological maintenance on the other hand recognizes the needs of the entire urban ecosystem and provides the necessary framework for healthy soil conditions, healthy plant life and vigorous plant development. This recognition leads to a better understanding of the effects and damages conventional maintenance practices may cause. How ecological maintenance affects specific components of the landscape can be demonstrated as follows:

Healthy Lawns

The best weed control is the practice of maintaining a healthy lawn - create health to prevent illness. A healthy lawn is not only dependent on the maintenance it receives, but even more so it depends on the healthy condition of its growing medium, the soil. We must also realize that chemical fertilizers applied on a regular basis can kill off soil life and change or ruin the soil structure if there is not sufficient humus available to buffer their effects. Quick release nitrogen can leach through porous or sandy soil and, depending on the soil type, only half of it may benefit the grass plants. Excess nitrogen seeps into the ground water, streams and ponds, resulting in poisoned wells, algae build-up in open water bodies and in the reduction of the water's oxygen. Chemical fertilizers also tends to make soils more acid.

Available Natural Plant Foods and Alternatives

1. Grass Clippings

   A good source of plant nutrients are dead or decaying grass clippings which represent a fertilizer ratio of 4-1-3.

NUTRIENT CONTENT OF CLIPPINGS

	Normal Range
Nitrogen (%)	2.5 - 6.0
Phosphorus (%)	0.15 - 0.55
Potassium (%)	0.99 - 4.0
Calcium (%)	0.20 - 4.50
Magnesium (%)	0.15 - 1.0
Manganese (ppm)	20 - 100
Copper (ppm)	10 - 100
Zinc (ppm)	5 - 30
Boron (ppm)	3 - 30

Source:
O.M.A.F. 383 Production Recommendations for Ornamentals & Turf.

2. Compost

The use of compost as a soil supplement and fertilizer makes sense since it it a recycled product, derived from waste (municipal waste, sludge, leaf and yard waste - see separate section on compost).

Why should waste derived compost be used:

Waste derived composts are an inexpensive source of high quality bulk organic matter.

Waste derived composts are uniform and consistent. Their organic matter content, pH, nutrient content, etc. will remain extremely consistent from load to load, unlike many sources of top soil.

Waste derived composts can contain large amounts of plant nutrients. Municipal solid waste and sludge composts are rich in macro nutrients such as nitrogen, phosphorus and potassium, as well as essential micro nutrients. The composts usually contains 1 to 2 percent nitrogen, which is the most commonly applied plant nutrient (fertilizer). Much of that nitrogen is in an organic form which will remain in the soil for long periods of time. Waste derived composts are also rich micro nutrients which are not contained in many commonly used fertilizers.

Waste derived composts are also rich in organic matter. Commonly their organic matter content is between 50 and 70 percent. Organic matter does many things to benefit the soil. It will lower the bulk density of heavy soils, increase the water holding capacity of lighter soils, make the soil more friable (workable), increase the cation exchange capacity (CEC) and can increase the percolation rate (drainage) of the soil. Organic matter is also rich in Humic acid, which converts nutrients in the soil into plant available forms of food. Humic acid is formed when organic matter if broken down by certain micro organisms.

Waste derived composts, in both bagged or bulk form, are becoming increasingly available.

Waste derived composts are extremely versatile. They can be used as top dressing, soil amendment, component of athletic field construction mixes, component of divot mixes and as a medium to pre-germinate seeds.

3. Organic supplements

Healthy lawns are the result of the right combination of nutrient supplements, sufficient water and healthy soil. Soil supplements not only offer direct benefits to the plants but more importantly, improve the soil condition which is imperative for good plant development. Organic supplements are either a soil conditioner (peat moss) or they serve combined functions of soil conditioner and nutrient supplier (manure).

4. Weed Control

Nature intends the soil surface to be covered with plant growth.

By changing poor soil conditions, improving mowing, watering and fertilizing habits, the lawn will be able to reach a point where chemical weed killers are not needed.

Acceptance of certain non-grassy plants (weeds) in a lawn is very much dependent on society's values and standards. The values may change over time. Case in point: Europe of the 80's and 90's has turned away from the obsession for neatly trimmed hedges and lawns and intolerance to weeds. Both this obsession and intolerance are still very much in evidence in North America.

5. Grub Control

Grubs in established lawns may be controlled by using the following:
- Parasitic Nematodes (Steinerma carposcapsae, S. glaseri);
- Diatomaceous earth (razor sharp dust from fossilized skeletons of algae);

Sod webworms can be controlled by using the following:
- Shafer's insecticidal soap or dish washing soap.

Chinch bugs can be controlled by the following methods:
- control thatch development;
- apply diamataceous earth;
- soap and water;
- gypsum (50 lbs per 2,500 sq. ft.).

6. Natural Disease Prevention

Preventative maintenance procedures must include:
- seed a mixture of grasses rather than one single variety;
- use disease resistant grass and plant varieties;
- do not overwater, consider drain tiles or regrading (diseases are not a problem in arid regions);
- water sufficiently;
- make sure there is a free flow of air;
- remove thatch where evident;
- apply soap solutions occasionally to break up thatch and for sod webworms and chinch bugs control.

7. Renovating Lawn Areas

Renovating Lawns with Waste Derived Composts - Step by Step:

a. Mechanically till the entire lawn, turning the soil and destroying the remaining vegetation. A rototiller or farm disk are the best pieces of equipment to use. Killing the existing turf cover with a non-selective herbicide may be worthwhile if weed infestation if significant.

b. Apply 50 mm of compost over the entire lawn. More product can be used in areas which have received the most wear.

c. Incorporate the compost into the lawn to a depth of 100 to 200 mm. Normally the deeper you can incorporate the material the better. Work the soil until it is thoroughly mixed and lump free.

d. Shape and smooth the soil using a raking device. Firm the lawn using a light roller. Establish a crown if required for better drainage.

e. Seed or sod and water the lawn.

8. Topdressing

This is done in conjunction with aerification and reseeding. Fill holes with topdressing material.

Topdressing Lawns with Waste-Derived Composts - Step by Step:

a. Heavily core-aerify entire area, concentrating on most heavily worn areas.

b. Apply approximately 25 mm of a mixture consisting of 50/50 sand and screened compost. The most uniform and efficient way to apply the compost is with a topdressing unit or manure spreader.

c. Smooth the turf surface using a raking device or using a weighted drag mat. The raking/dragging will break up the soil plugs, incorporate the sand/screened compost mixture and backfill the holes.

d. Seed and water the topdressed area. It is important not to leave the grass seed on the soil surface. It should be mixed into the soil/compost layer.

9. Alternative Lawn Maintenance Procedures

a. Delete grass areas in mass plantings of trees and shrubs. Replace with mulch or ground cover planting.

b. Reduce weed growth and preserve soil moisture by mulching or by introducing ground cover planting.

c. Facilitate mowing next to buildings and planting beds by installing paved mowing strips.

d. Eliminate planting bed edges and encourage a natural transition between grass and shrub areas.

e. Permit a certain controlled amount of weeds in grass or planting areas.

f. Distinguish between high use/high visibility areas and low use/natural areas.

g. In general, do less!

2.3 LONG TERM BENEFITS

Housing agencies need information on new grounds maintenance approaches based on sound horticultural/biological principles, proper materials handling and available technologies.

Housing agencies rely on their maintenance managers to help them establish new up to date programs and methodologies for these programs. To assist individual maintenance managers, a comprehensive, critical review of existing programs is imperative. With the increasing volume of information becoming available on ecological grounds maintenance and the public interest in more environment-friendly approaches, this study will help to compare, evaluate and choose appropriate methodologies for the maintenance of the urban landscape. In anticipation of the move towards a greater reliance on recycling technology, the overall objective is to assess the available data on ecological grounds maintenance, its fundamentals and practical applications. The development of a practical guide book for the use by those engaged in managing the grounds of housing developments will be the outcome of this assessment.

The concepts of urban forests, planting designs based on natural succession and alternative grassland management strategies provide benefits in a more diverse environment, greater economic and environmental productivity and enhanced social, educational and aesthetic values (Hough).

Housing sites are not enclosed environments, but are connected to urban and rural areas through natural and manmade natural corridors. These corridors have greatly influenced the migration and perpetuation of wild live and plant form in cities. Ecologically designed and maintained housing sites thus maintain a link between natural habitat, parks and the open countryside.

The land can be brought back to productive use. For instance, under utilized grasslands can be turned into meadows which offer a diversity in plant live and habitat for birds. Under utilized open spaces can be turned into allotment gardens, which offer recreational gardening and at the same time remove these spaces out of the general cycle of required costly maintenance. These allotment gardens will also receive compost that has been generated from the site's maintenance operations.

This new approach to urban landscape planning and maintenance will lead to lower maintenance costs and sustainment.

The conventional maintenance regime is high in energy and resources and aims to achieve standardized results. Types of landscapes subjected to intense human pressure and those with intended prestige objectives demand a high level of maintenance. This however is self-defeating when universally applied to include areas which clearly do not need this level of attention.

Full application of the recommended strategies and ecological planning standards will result in considerable changes in the planning and maintenance procedures.

Design Considerations:

- changes in the choice of plant species, e.g., use of hardy disease-resistant plants, native plants, more varieties;
- utilization of more organic materials for soil conditioning or soil improvements;
- utilization of recycled materials;
- emphasis on less energy-consuming procedures in construction and maintenance;
- use of landscaped areas for gardening, growing plants for food production, compost generation and fuel;
- plan for an integrated maintenance program as an essential component of the design process;
- choose turf grass species and varieties which are less maintenance dependent, are more drought resistant, develop strong root systems and have a limited height.

Other Benefits:

- healthier environment for the users/occupants;
- guidelines and examples that can be followed by developers and property managers of institutions, commercial developments or municipal parks departments;
- increased use of recycled and organic materials will strengthen the environment-friendly industries, such as organic fertilizer producers;
- viable commercial and large-scale ecological applications will serve as model to private home owners.

Economic Benefits:

- increased cost-effectiveness due to reduced labour and material input;
- reduced liability costs;
- savings due to use of re-cycled materials;
- intangible economic benefits due to improved human health and well-being;
- reduced water consumption costs due to improved maintenance procedures.

2.4 ORGANIC AND OTHER NON-HAZARDOUS ALTERNATIVES

METHODS AND APPLICATIONS

The arguments for applying organic approaches to landscape maintenance are simple and logical. In many European countries, the use of chemicals in any form on public open spaces and in housing developments has been prohibited or severely restricted, and the approach towards 'natural' maintenance has been the way to go for the last decade. Grounds maintenance in North America particularly in housing developments, is still maintenance-intensive and dependent on regular chemical applications. By going 'organic' the particular site and the urban environment in general, would benefit without much extra effort. Clean air, clean ground water and a healthy soil are generally accepted criteria for the management of our landscaped areas. Organic fertilizing is a natural process, enhancing the potential of soil fertility, the humus level and with that, soil stability. The multiple components of an organic fertilizer are welcome nutrients by the billions of microorganisms in the soil as well as by larger inhabitants. These soil inhabitants are essential for the transformation of nutrients into a form which is absorbable by the plants.

Symptoms such as die-back and/or poor development of vegetation are warning signals that the main foundation for plant life, the soil, requires much more attention than it is currently receiving. Plants will be able to resist the damaging effects of exhausts, industrial emissions, exposure to insect damage and illness only if the soil is in an optimal state of health, physically and biologically .

.1 Using Plants to Protect Other Plants

Protecting plants from unwanted insects by using other plants is the natural, chemical-free way to manage the landscape. This may not eliminate all the bugs, and should not, as many of them are beneficial. It is a known fact that plants produce more foliage than they require and therefore can withstand some pruning. The natural pruning by insects can improve yields and increase the vitamin content of fruit in certain plants.

Planting Practices

A certain relationship exist between plants, and between insects and plants. **Companion planting** is the usual name given to the practice of planting according to these relationships, but actually four different practices are involved:

a. **Mixed**
Plant several different plants together, as in nature, so that insects are confused by the multitude of "smells" and have more difficulty finding the plant they prefer to eat and lay their eggs on.

b. **Repellant**
Certain plants, such as marigolds, mints and garlic are offensive to some insects and will deter them from attacking other nearby plants.

c. **Companion**
Combining plant species will result in better and healthier vegetation and crops.

d. **Trap**
Lure plants are located near a plant you want protected. Insects are attracted to the lure and can then be handpicked and destroyed.

.2 **Soil Improvements**

Initially, the shock caused by the sudden switch to an all-organic treatment may be perceived as a failure of the program because of the poor showing of lawns and planting areas. It is advisable, therefore, to prepare these areas beforehand. After many years of dependence on regular chemical fertilizers and herbicide applications, the soil will have become void of micro-organisms and naturally present nutrients. In its early stage, an organic program, or do-less approach, tends to allow the introduction of hardy weeds. As well, the conventional artificially created healthy appearance of a bright green lawn will deteriorate without the regular applications of large doses of fertilizers and herbicides. The chemical dependence which kept the landscape in apparent health is a vicious circle which must be broken,thus it is essential to re-create and maintain a healthy soil to promote a naturally vibrant landscape.

A healthy soil is the foundation for the development of strong, disease and pest-resistant plants, and ultimately for the success of the landscaped site. Many factors can adversely affect the soil including excessive or long-term exposure to chemical additives; ice-melting salts; remnants of stored harmful substances; drought; poor drainage; soil compaction. When this is the case, the soil requires a retrofit program. The extent of soil renovation required to repair the damage caused by environmental stresses will be determined by the results of soil testing and analysis.

Improving existing soil conditions and continuing emphasis on maintaining the soil at peak performance is of primary importance. Soil that is full of micro-organisms, can retain moisture without becoming over-saturated, and is loose and soft due to air-entrainment, is capable of supporting healthy growth, allowing grass roots to penetrate deep into the upper soil layer (topsoil), develop rhizomes, and regenerate. Loose subsoil will permit the roots of trees and shrubs to grow deeper in order to absorb the necessary moisture and nutrients available at lower levels.

Old established lawns can be kept green forever if regular doses of fertilizer and water are applied. The ecological approach, however, demands that grassed areas should survive and thrive without being dependent on this maintenance-intensive procedure. The most common

and practical method for improving soil condition is to aerate. More intensive approaches may be necessary depending on the condition of the soil and vegetation, including soil structure repair using vibratory soil plows operating at 200 to 600 mm depth to fracture compacted topsoil and subsoil (Schaller). This increases the porosity of the soil, resulting in improved drainage and water retention, more extensive root development and greater nutrient and oxygen penetration.

Organic matter in the soil, most commonly known as humus, is the catalyst for healthy plant production. All plants are capable of growing in pure mineral medium, provided that all the nutrients are available (as is the case with hydroponic gardening), but soils with a humus content generally deliver a better quality of vegetation. Humus comes in many forms: compost, manure, peat moss, etc. Manure releases nutrients at approximately the same rate that developing plants require. Peat moss, on the other hand, while relatively low in available nutrients, has a stimulating effect on the bacteria in the soil. The higher the biological activity, the more nutrients released in the soil. This release of existing nutrients subsequently reduces the traditional reliance on the application of fertilizers. The activity of the micro-organisms in the soil also causes it to be more stable in its structure, making it more resistant to compaction. Furthermore, organic substances in the soil can absorb from 3 to 5 times its weight in water and this water can then be at the plants' disposal during drought periods (Schaller).

.3 Reducing Maintenance-Intensive Areas

Healthy, attractive and functional lawn areas require on-going attention commensurate with the owner's expectations and quality standards. Even an ecologically maintained lawn relies on certain procedures, although less extensive than with the conventional approach. One may consider taking certain maintenance areas out of the cycle of maintenance dependency by re-assigning them for other uses. Examples in most European public open spaces and housing developments with reduced lawn areas, in particular small areas which are most maintenance-intensive, proved very successful. This can be accomplished by changing the areas to mass groundcover plantings which, when fully developed, require little or no maintenance. Examples of successful substitutes for grass include the following:

Botanical Name	Common Name	Hardiness Zone
Aegopodium	Goutweed	
Ajuga reptans	Carpet Bugle	
Arctstaphylos uva-ursi	Bearberry	4 - 9
Convallaria	Lily-of-the-Valley	
Cotoneaster apiculatus	Cranberry Cotoneaster	4B - 9
Cotoneaster horizontalis	Rockspray Cotoneaster	6 - 9
Cotoneaster dammeri	Bearberry Cotoneaster	4 - 9
Euonymus fortunei 'Coloratus'	Wintercreeper Euonymus	5 - 9
Hedera helix	English Ivy	6 - 9
Pachysandra terminalis	Japanese Spurge	
Spiraea nipponica	Snowmound Spirea	4 - 9
Symphoricarpos albus	Snowberry	2 - 9
Vinca minor	Periwinkle	3 - 9

A solid groundcover does not give weeds a chance to establish themselves. It shades the soil thus providing the ideal conditions for thriving plants. Weeds, on the other hand, usually thrive in poor, dry, exposed soils where cultivated plants generally have difficulty growing.

.4 Re-Design of High Traffic Areas

Where vegetative areas, in particular lawn areas suffer from soil compaction or wear and tear due to foot traffic, serious consideration should be given to examining the traffic patters. This may lead to the widening of existing walkways or to the construction of new ones. Repeated re-sodding of certain areas is a sure sign of inefficient of site design. The needs of the users and the reflected patterns on the site must be identified. This may eventually show a need for partial or complete site re-design, including either redirecting the traffic onto the existing paved areas (providing low directional fencing, planting masses or graded ^Xx,]d,D") or by paving over high traffic lawn areas. These new paved areas could be hard surface concrete pavement, unitstone pavement or flagstone. Other durable surfaces consisting of granular bases with a surface layer of finer granular material, possibly with additives that bind the surface material together (e.g.,"Stabilizer", clay or limestone) provide an effective, less costly, more efficient and more ecologically appropriate alternative.

.5 Pest and Disease Control

Controlling insect pests and diseases by either horticultural, biological or chemical methods can only be truly effective if their respective specific stages of development are known and the origin of the disease has been determined. Chemical control currently appears to be the first choice of property managers. At present, ecologically sound methods of control seem to be gaining acceptance only at the home market level.

Pest control in grounds maintenance for housing development differs from agricultural pest control. Although it is widely known that pesticide application is harmful to the environment, the food production industry is largely dependent on chemical pest control in order to produce crops on a large scale. The economy dictates that food producers reap maximum yields from their crops and any loss of the potential harvest to even the slightest pest or disease infestation could be disastrous to their subsistence. Grounds maintenance for housing sites is instead dictated by quality standards, i.e. expectations of appearance and by the need to protect the built landscape. Since grounds maintenance does not require its vegetation to yield produce, a 100% chemical-free maintenance of non-agricultural landscape is attainable.

a. Control through Appropriate Horticultural Methods

Disease and pest attacks are often associated with plant stress. When this happens the first thing to do is to analyze the vegetation involved, its environment and the current maintenance program. Adjustments in these areas will most often result in a healthy landscape. Maintaining pest resistant plants can be achieved by doing the following:

- physically removing insect-infested, diseased, dying and dead plants;
- providing sufficient surface run-off and avoiding snow compaction on lawn areas, preventing spring snow melt damage;
- introducing bird feeders and protecting bird nests, as birds feed on many of the insects which are harmful to plants;
- utilizing compost topdressing on lawns to biologically suppress turf grass diseases;
- removing thatch in lawns, thus eliminating the conditions conducive to fungus-type ailments;
- using organic fertilizers to build up a vigorous soil environment;
- improving soil conditions (see 2. Soil Improvements).

b. **Alternative Pest Control Methods**

- Instead of spraying larger trees,because of the large amount of spray material needed, use commercially available tree trunk implants without the risk of contaminating non-target plants or wildlife;
- non-hazardous alternatives in the form of natural recipes or home remedies normally applicable to home gardens are not feasible on a large scale and are therefore not practical for use on multiple housing sites;
- monitor the use of insecticides of chemical or alternative origin, as some of them may be harmful to beneficial insects. By reducing the populations of predator (beneficial) mites, pest-type mite numbers will increase;
- when applying any type of pesticide, environmentally friendly or not, apply only when and where needed to terminate the insect or disease. Correct diagnosis of the ailment is essential, and a knowledge of the life cycle of the insect of disease is crucial in order to apply the remedy at the most appropriate time. Application of full spectrum-type remedies at inappropriate times such as may be specified in standard maintenance schedules, is both ineffective and irresponsible.

.6 **Insect and Fungus Control**

The first reaction to the discovery of pests in the landscape is for maintenance personnel to reach for chemical pesticides. They usually work, but reasons mentioned earlier, alternatives must be considered, and are available.

A healthy landscape within an ecosystem that offers a variety of life forms will require little human maintenance effort. Introduction of chemical pest control tends to break the natural life cycles and makes the landscape dependent on continuing doses of sprays and powders.

Infestations may occur, however, during the transition from chemical to organic maintenance. During this transition period, it is particularly important that the site be monitored on a regular and frequent basis to detect any signs of trouble.

a. **Natural Prevention**

Birds of the Fringillidae family, including cardinals, finches, buntings and sparrows feed mainly on weeds and insects. To support a bird population, the landscape must offer a variety of plants for safe nesting and for food. Some insects also prey on unwanted insects. These are commercially available and include ladybugs and beneficial nematodes.

b. **Horticultural correctness**

Many of today's pest problems in the cultivated landscape are due to improper maintenance or high maintenance dependency. For instance, golf course greens are artificially created and high maintenance/energy dependent installations. They suffer from various types of diseases, fungi and insect attacks while landscapes which are under less stress survive relatively well.

Proper watering practices, in particular for roses, prevent fungus development. Excessive moisture is often the cause for the fungi. Preventive maintenance insures that there is no repeat of the problem. For instance, diseased branches or foliage must be disposed of. This diseased material may not, however, be composted, as the fungi may survive the composting process and reinfect the soil and plants to which it is applied.

Plantings may have to be rearranged, i.e. roses should be located in an airy, sunny location. Over fertilized landscapes tend to be more subject to disease and insect attacks. Above all, early detection through frequent monitoring should help to prevent any serious trouble.

ORGANIC INSECTICIDES AND FUNGICIDES

Insecticidal Soap (Liquid)

- controls aphids, earwigs, mealy bugs, mites, sawfly larvae, white flies and others;
- harmless to beneficial insects;
- manufactured by Green Cross, Safer and Wilson. **Do not use household detergent.**

Organic Insect Killer (Liquid)

- controls most species of caterpillars;
- harmless to beneficial insects. Contains Thuricide derived from bacillus thuringiensis (B.T.);
- manufactured by CIL.

Pyrethrins Plus Piperonyl Butoxide (Liquid)

- controls flea beetles, leafhoppers, Colorado potato beetles, rose chafers and tarnished plant bugs;
- harmful to beneficial insects;
- breaks down rapidly after application;
- manufactured by Green Cross, Safer and Wilson.

Rotenone (Spray or Dust)

- controls Colorado potato beetles, corn borers, cucumber beetles, currant and raspberry sawfly, currant sawfly, raspberry fruit worm, flea beetles and leafhoppers;
- harmful to beneficial insects and fish;
- breaks down rapidly after application;
- spray and dust manufactured by Green Cross and Wilson, Dust also manufactured by CIL, Co-op and Safer.

N.B. Pyrethrins and Rotenone kill many harmful and beneficial insects and should only be used to control severe insect infestations. "Spot" treatments, directly on harmful insects, will limit the fatal effect to beneficial insect.

DIO Slug Killer (Dust)

- attracts and kills slugs and earwigs;
- harmless to beneficial insects and dogs - contains diatomaceous

earth (silicon dioxide);

- manufactured by Wilson.

N.B. Another type of slug killer, metaldehyde bait, is **not** safe for dogs.

Dormant Oil (Spray)

- kills overwhelming mites and scale insects on trees and shrubs when applied in spring before leaf buds open - do not apply when frost is expected.

- harmless to beneficial insects.

- manufactured by CIL, Green Cross and Wilson.

N.B. Do not use motor oil.

Lime Sulphur (Fungicide/Insecticide)

- controls overwintering spores of peach leaf curl and plum black knot diseases, also black spot on roses, anthracnose, cane and spur blight on raspberries, mildew and rust on currants and gooseberries;

- kills overwintering mites, aphids and scale insects.

- harmless to beneficial insects when applied properly. Apply before leaf buds break in spring and only on plants listed on the label. Can also be used against certain diseases during the summer if the label directions are carefully followed. Otherwise damage to plants may occur;

- manufactured by Green Cross and Wilson.

Sulphur Fungicide (Spray or Dust)

- controls black spot on roses, apple scab, brown rot and black of fruit stone, rust and powdery mildew;

- harmless to beneficial insects, except predacious mites. Injury to plants may occur if applied at temperatures above 24 degrees Celsius.

- manufactured by Safer and Wilson.

N.B. To obtain good results, follow the label directions closely. Because beneficial insects need the harmful ones as a food supply, it is good to tolerate small numbers. Small numbers can be collected in a container and destroyed afterwards. Spraying or dusting should be done only if really necessary.

.7 Healthy Lawns and Plants

Healthy lawns and vigorously growing planting areas do not require the attention presently paid to weed control. Weeds, as mentioned earlier, thrive in poor soils and amongst weak vegetation. When the soil is in its optimum state and in close harmony with planted vegetation, weeds and other ailments such as fungi are no a problem. With the proper management of soil and vegetation, and the resulting community of healthy plants dominating the landscape, much of the common weed problems are therefore eliminated. This being said, herbicides are not necessary in an ecological maintenance program and should only be considered in extreme cases and to a limited extent during the transition from the conventional maintenance program to the ecological model.

In most western European countries, the use of herbicides has been restricted or eliminated entirely over the course of the last twenty years. On site observations confirm the success of this ecological approach. Although initially there was much resistance to this new approach, now, many years later, with the aid of government legislation, organic/ecological site planning and landscape management has become the accepted norm.

Herbicides, beside being hazardous to plants, animal and humans, are also expensive to use. If eliminated, there would be a considerable reduction in the cost of maintenance. The use of herbicides within an ecological maintenance program may be tolerated only under special circumstances. If there is a major infestation of a certain weed which has resisted organic weed killers, or which has persisted despite proper horticultural/ecological maintenance practices, only then should chemical herbicides be considered as a last line of defence.

In the event that a grassed or planted area exceed a certain weed tolerance level, and only after all other alternatives have been exhausted, should chemical be applied. For example, if a lawn area is infested by weeds consisting of more than 25% of the vegetative cover, the weeds must be identified and the appropriate herbicide must be applied at the appropriate time, and only to the affected area(s).

For proper chemical weed control, it is strongly suggested that official guides be followed such as those published by government agencies e.g. **Guide to Weed Control, Ontario Ministry of Agriculture and Food, Publication 75.** This guide outlines in simple terms how to maintain a weed-free lawn:

> "The major species of broadleaf weeds infesting lawns in Ontario are dandelion, plantain, black medick, chickweed, prostrate knotweed, mallow, henbit, ground-ivy and white clover. The major grassy weeds are crabgrass, annual bluegrass, quackgrass, orchard grass and bentgrass."
>
> "One of the primary ways that a weed-free lawn can be maintained cheaply and with a minimum of effort, is through an effective lawn maintenance strategy which takes advantage of the vigorous growth of turf grass, and therefore is the key to keeping the lawn areas

free of weed. Most weeds cannot compete in a dense healthy turf, so the maintenance of such a stand is of primary importance in producing a weed-free area. Practices that tend to encourage vigorous grass growth will discourage weed infestations. Such practices include proper irrigation and/or drainage, use of fertilizers, insect and disease control, and the use of the correct turf grass for the situation."

Good horticultural practices are the basis for a healthy landscape. Executing maintenance tasks in an appropriate and conscientious manner will result in reduced problems with weeds, diseases and other pests.

a. **Mowing**

Mowing is necessary to stimulate new growth and is also needed to keep the grass at a length that will no retain excessive moisture which could serve as a breeding ground for fungi and rot-type ailments. Ideally, the commonly grown fescues, bluegrasses and perennial ryegrasses should be kept at the height of 4 to 6 cm. Shorter grass tends to allow the ground to dry out much quicker, leaving the grass in a weakened state. Anytime the grass is weak, an invasion of weeds may occur. Mowing too frequently may also reduce the carbohydrate reserves of the turf, therefore reducing its competitiveness.

b. **Fertilizing**

Fertilizing may be required depending upon the condition of the soil and how readily existing nutrients are available to the lawn. The strength and rates of applications will depend entirely on the specific soil condition of the area in question and on the type of lawn, i.e. decorative lawn, meadow, playfield. Ideally, a true ecological landscape maintenance program should not require fertilizer at all. In the symbiotic relationship between soil environment and vegetation, there exists a constant cyclical ecological balance. The following is a comparison of two scenarios highlighting natural sustainability and imposed maintenance in a natural woodlot:

Natural Sustainability (undisturbed): Leaves fall from the trees; the leaves decompose with the help of the plentiful micro-organisms; nutrients are returned to the soil; rainwater is retained in adequate amounts in the soil because of the absorptive quality of the humus-rich soil; nutrients are readily available; the trees grow strong and healthy.

Imposed Maintenance (human intervention): Large areas are cleared; debris such as fallen leaves or branches are removed and disposed of; foot traffic compacts the soil; rainwater has difficulty penetrating the soil due to the velocity of run-off and lack of soil porosity; pesticides are applied to protect weakened, vulnerably vegetation; micro-organisms die; application of fertilizer becomes necessary.

This generic model illustrates in the simplest of terms how a landscape area can quickly become dependent on the application of fertilizers. This logic can be applied to any other landscaped area.

c. **Watering**

A lack of water may injure, induce dormancy or even kill turf. In its weakened state, the turf become susceptible to the introduction of weed growth. The application of 3 cm of water at weekly intervals will encourage deep root growth. Frequent light sprinkling does more damage than good because it promotes only shallow root growth. Unwanted grass species with naturally shallow root systems, such as crabgrass, thrive under these conditions. It is also important to remember to provide additional irrigation around trees and shrubs because of the competition for available water.

.8 Organic Fertilizers

With the introduction of chemical fertilizers, in particular since the last World War, organic matter has lost its role as a primary source of essential plant nutrients for forming operations. This change has also affected the urban horticulture and landscape operations. The chemical industry has the capability to produce relatively inexpensive, concentrated fertilizers aimed at meeting the nutritive requirements of plants (Avnimelch, 1986). The lower cost and subsequent reduced demand for manure has resulted in declined availability and use of manure and other organic amendments.

It has generally been assumed that the release of plant-available nutrients is the same in fertilizers and in organic amendments. This is a faulty assumption, since the bulk of the nutrients in fertilizers is water soluble and therefore readily available to the plants. For nitrogen (N) fertilizers, this is an important point since one can expect that significant losses of the fertilizer N will result from volatilization of ammonia (NH_3), and losses to nitrate (NO_3) due to leaching. Higher loadings of fertilizers are required to ensure sufficient nutrients for crops while compensating for these losses (Ortech).

The value or organic matter amendments to soil from manures, sludges or composts is highly relevant to waste management initiatives. Organic matter constitutes a significant portion of wastes generated, and they represent essential resources that can be recovered, recycled and processed. Apart from composting, a variety of organic residues such as sewage sludge, processed manures and food processing wastes have been utilized in horticulture, agriculture and lands reclamation (Hoke, 1983; Schaller, 1992; Doran, 1991). The Ontario Ministry of the Environment has estimated that yard waste alone accounts over 16% of the provincial waste stream (Resource Integration System and VHB Research and Consulting Inc., 1991). This is material which could be diverted to compost production.

a. **What is Organic Fertilizer**

According to Agriculture Canada (Fertilizers Act), only products that are solely derived from organic matter may be identified or described as "organic". Organic matter is defined as the partially humified remains of animals and plants.

Definitions as per Agriculture Canada, Forest and Inspection Branch, Trade Memorandum T-4-106, April 20th, 1990:

Organic based If a fertilizer contains at least 15 per cent organic matter, it may be described as "organic based". The fertilizer analysis must carry a guarantee for the minimum amount of organic matter.

Natural Agriculture Canada defines "natural" as materials that are directly mined from mineral deposits and only subjected to physical processes such as crushing and drying. This material can be described as "derived from naturally occurring sources".

Environmentally Beneficial Any product represented as "environmentally sound", etc. must identify the rationale for the claim and list all ingredients in order to allow the consumer to determine the validity of the statement.

b. **Advantages of Organic Fertilizers**

Scientists currently consider that plants require from 17 to 20 essential elements for successful growth. In our fertilization practices, we generally apply the macro-nutrients nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O). It is generally assumed that elements such as calcium, copper and zinc are in sufficient supply in the soil.

In the turf industry, the common practice is to apply high rates of NPK, especially nitrogen to keep the grass looking green. Unfortunately, high rates of chemical nitrogen forces grass to take up all of the salt from the soil solution to minimize root damage. Abnormal growth is the result of this phenomenon.

Another aspect of the turf management is the increased incident of disease that results from using agricultural chemicals. Excessive amounts of applied nitrogen creates nutrient imbalances, resulting in greater susceptibility to disease. Nitrogen is assimilated by plants in the form of ammonium and nitrate. Ammonium and nitrogen can be readily converted in the plant through protein whereas nitrate can be stored; the nitrate acts as a nutrient source of pathogens. Organic fertilizers insures that more of the nitrogen that is assimilated by plants is in the ammonium form.

Adding organic matter to the soil creates a more balanced soil environment. This allows the beneficial soil organisms to keep a balanced microbial population, thereby keeping disease-causing organisms in check. Another benefit or organic fertilizers is their

slow release of nutrients over the growing season as the plant requires it. Water soluble chemical fertilizers, on the other hand, are quickly available but their effect is short-lived.

c. Organic Fertilizing of Lawns and Planting Beds

The growth mass of healthy lawn areas has a nitrogen content of 3 to 5% in the dry mass. This nitrogen is relatively easily available and of lasting effect. To promote nutrient recycling, the clippings should remain on the lawn. This may result in a fertilizing effect of 5 to 8 g/m^2 per year, and must be taken into consideration when programming the yearly needs of lawn nutrients.

Mown lawn areas require 10 to 15 g nitrogen per spare meter per year, while deciduous trees and shrubs can be kept healthy with 30 g nitrogen per square meter per year (Kessel, 1992). This can be applied throughout the vegetation period, in small amounts or at specific times, depending of the results of soil testing. The advantage of organic fertilizing is that the soil bacteria unlock the fertilizer in successive and small amounts, usually to an extent that can be absorbed by the vegetation. Organic fertilizer is best applied in a granular form. Slow, controlled-released of nitrogen, typical of organic fertilizers, protects vegetation from burning, encourages consistent growth patterns and lessens plant susceptibility to disease.

The nutrient ratio for maintained lawns should be established as an annual average at:

N	:	P_2O_5	:	K_2O	:	MgO
1	:	0.2 to 0.4	:	0.5 to 0.8	:	0.1 to 0.2

(From Neue Landschaft Magazine 10/93)

d. Organic Amendments

In the box below are examples of organic materials currently available as fertilizers in Canada. In the past, people have shunned organic fertilizers because of their strong smell and poor spreadability. However, these problems were virtually eliminated with improved pelletizing techniques. The major drawbacks are their bulkiness and low analysis. Lower strength fertilizers require heavier application rates than higher analysis products. For example, to obtain one pound of actual nitrogen per 1000 sq. ft. using 20-5-10, you would need to spread five pounds of product. In contrast, if you use 5-2-4, you need to apply 20 pounds per 1000 sq. ft. This extra work can be a problem for a lawncare company when "time is money", during the busy season.

List of Organic Amendments

	N	P_2O_5	K_2O
Sewage Sludge	6	3	0
Canola	6	2	1
Blood Meal	12	0	0
Feather Meal	12	0	0
Fish Meal	12	0	0
Turkey Manure Com.	5	1	1
Bone Meal	2	11	0
Kelp Meal	1	.5	4
Blood Bone Kelp	5	4	1

e. Combination Fertilizers

A number of chemical fertilizer companies have responded to the growing demand for organic fertilizers by making combination products. These products generally fall into two categories: the "Natural Source Fertilizer", and the "Organic-Based Fertilizer".

The **"Natural Source"** fertilizer is made from a combination of organic sources and naturally occurring minerals that have not been processed. These minerals such as potassium chloride or rock phosphate are combined with organic materials such as blood meal or bone meal to create these products. A higher minimum analysis can be achieved by using minerals than can be achieved organically and it can be done at a much lower price. These fertilizers are generally safer for the environment than straight chemical fertilizers or combination chemical fertilizers but are usually very short on organic matter. They cannot provide the balance of minor nutrients and trace elements that is contained in the organic matter, and very little carbon. This lack of organic matter makes them little better than chemical fertilizers and a great deal more expensive. The second problem with them is the fact that not all minerals that occur in nature are safe for plants. There is a serious concern with the use of minerals such as potassium chloride as a source of potassium. "Natural Source" fertilizers face many of the same limitations as chemical fertilizers do and they sell for about the same price as a true organic.

The **"Organic Based"** fertilizer is a combination chemical organic fertilizer that contains a minimum of perhaps 10% organic matter. It combines chemical sources such as urea and mono ammonium phosphate with organic sources such as blood meal and bone meal. Many of these products are little better than straight chemical fertilizers, but sold at much higher prices. They can achieve analysis levels that are impossible organically, but they do not provide the broad range of nutrients that are contained in a true organic fertilizer. They contain very little organic matter and will not make a significant impact on long term fertility. "Organic Based" fertilizers are often sold as being a true organic fertilizer which

misleads some retailers and consumers into believing they are the same thing.

Organic fertilizers can be more than a product of one particular source, e.g. blood meal, bone meal. They can be derived from various sources, or can be "grown", much as Organic Green by Son-Shine Industries of Bow Island, Alberta. This particular fertilizer is a combination of dehydrated alfalfa and several other organic meals. It is easy to store, easy to apply and "easy on the nose". It has the advantage of a slow controlled nutrient release over a period of three to four months. Besides N.P.K. there are trace elements which are necessary for good plant development.

This type of fertilizer, unlike synthetic ones, has a lasting organic bulk, which improves the soil quality and soil structure, not unlike peat moss or cattle manure. A likely alternative to synthetic fertilizers, in particular in commercial and multiple housing maintenance applications.

Other known organic fertilizers are Nutritive Sustane 5-2-4, derived from turkey manure or Nutrite 9-3-4 containing feather meal, bone meal, sulphate of potash and kelp meal.

f. **Manure**

Historically, cattle manure has been the primary soil improver in agriculture and horticulture. With the introduction of synthetic fertilizer, this true organic fertilizer/soil improver lost its market share. The use of well rotted cattle manure in landscape construction still is a feasible, if not desirable way of improving soil, however in the area of grounds maintenance it has little use.

More acceptable and practical is manure which has been processed and dried, so that is can be transported in bags like synthetic fertilizers. At the present time, the higher cost, bulk and storage requirements, make this material an unlikely competitor to synthetic or Organic-Green type fertilizers.

The need for maintaining a humus-rich growing medium
(Schaller, 1992)

With the increasing interest in organic fertilizer, the industry will have to offer a wider and more affordable choice of organic fertilizer. The most obvious material would be processed manure, since it is available in large quantities and because it has been the obvious choice in agriculture and horticulture for centuries. Manure does not only serve as a fertilizer, but perhaps more importantly, is a source of humus in the soil. Humus is the pivotal point for plant growth. In this context, these points must be considered with designing a maintenance program;

- all plants can be grown in a mineral medium, provided that there are sufficient nutrients (e.g. hydroponics). It is a know fact that soils with high humus content produce higher yields.

- the use of organic fertilizers in landscape maintenance is limited because of its high cost caused by storage, transportation and handling.

- the dwindling soil fertility cannot be reproduced by adding mineral fertilizers alone.

- organic substances are capable of absorbing 3 to 4 times their weight. Because of the soil's water absorption capability, erosion is decreased considerably.

- humus raises the level of the availability and utilization of nutrients.

- added humus mass stimulates activities of bacteria. The higher the biological activity, the more nutrients nutrients become available and the less mineral fertilizers are needed.

- the activities of micro-organisms reduce compaction and siltation of the soil.

- products of metabolism of micro-organisms stimulate plant growth.

- organic fertilizers contain nutrient humus (food for micro-organisms) and long-lasting humus to about equal parts. Peatmoss consists of a long-lasting humus, while green clippings provide only nutrient humus.

- the annual rate of reduction of long-lasting humus is 2 to 3%. On the average this translate to losses of 3,000 to 4,000 kg per ha. In order to maintain the original fertility condition, the lost humus must be replenished.

g. Comparisons Between Organic And Chemical Fertilizer

A study was conducted by Son-Shine Industries (Doran, 1991) to compare the results and effectiveness of CIL 30-3-4 fertilizer and Son-Shine Ind. Organic Green 6-3-1. There were five replications of turf test plots with the following treatments:

- Control
- CIL 20-3-4, 1 lb. N/1000 ft^2 applied every 6 weeks
- Organic Green, 1 lb. N/1000 ft^2 applied every 6 weeks
- Organic Green, 0.75 lb. N/1000 ft^2 applied every 6 weeks
- Organic Green, 0.50 lb N/1000 ft^2 applied every 6 weeks

Results:

The overall productivity (per kg. of clippings per plot) results show that while there was a trend for the 6-3-1 at 1 lb./1000 ft^2 to be the best performer, statistically there was no difference between any of the fertilizer treatment, while Control (no fertilizer) was statistically lower than all of the treatments.

The 6-3-1 at 1 lb. N, 6-3-1 at 0.75 lb. N and the CIL at 1 lb. were significantly higher than the Control productivity (per <0.01)

The overall colour ratings for the fertilizer treatments were all statistically higher ($p<0.05$) than the Control, but were not statistically different from each other.

Applying Organic Green at a rate of 3.4 lb. N per 1000 ft.^{2} prior to setting out plants in a garden resulted in significantly height plant heights for beans (+94.9%), carrots (+63.8%), marigolds (+13.8%), potatoes (+25.3%) and spinach (+129.4%), furthermore, the weight of potatoes per plant in September was 50.7% higher in the fertilizer treated test plot.

h. **Benefits**

Scientists currently consider that plants require from 17-20 essential elements for successful growth. In our fertilization practices, we generally only apply the macronutrients nitrogen, phosphorous and potassium. It is generally assumed that elements such as calcium, copper and zinc are in sufficient supply in the soil.

In the turf industry the common practice is to apply high rates of NPK, especially nitrogen to keep the grass looking green. Unfortunately high rates of chemical nitrogen fertilizer forces the grass to take up all of the salt from the soil solution to minimize root damage; abnormal growth is the result of this phenomenon.

Another aspect of the turf management is the increased incidence of disease that result from using agricultural chemicals; this has been termed "agriclogenic" plant disease. Nitrogen fertilizer has been implicated in increasing the disease susceptibility of plants by creating nutrient imbalances. In this review, Huber and Watson conclude that: "although a wide range of interactions of pathogens and their hosts are involved, it is generally the form of nitrogen available to the host of pathogen that affects disease severity or resistance, rather than the amount of nitrogen".

Nitrogen is assimilated by plants in the form of ammonium and nitrate. Ammonium nitrogen can be readily converted in the plant to protein whereas nitrate can be stored; the nitrate acts as a nutrient source of pathogens. Organic fertilizers will ensure that more of the nitrogen that is assimilated by plants is in the ammonium form.

Adding organic matter to the soil creates a more balanced soil environment which allows beneficial soil organisms to keep a balanced microbial population and thereby to keep disease causing organisms in check. For example by using organic manures in avocado plantations in Australia, root rot could be controlled, while growers using mineral fertilizers were suffering losses.

Another benefit of organic fertilizers is their slow release of nutrients over the growing season as the plant requires it. Water soluble chemical fertilizers can outperform chemical fertilizers when equal nutrient are added.

.9 Composting

The value of composting has been recognized by horticulturists and gardeners for centuries. This simple process of turning food and yard waste into a nutrient rich soil conditioner also means less waste going to landfill.

In the context of ecological and organic landscape maintenance, compost has its own specific role. Without going further into the details of what is compost, as this has been dealt with sufficiently in the various recent publications by municipalities and other agencies, this document will only highlight the importance of compost in relation to maintenance practices in housing projects.

a. Present Use

Besides giving advice on home composting, municipalities such as Metro Toronto provide incentives and guidance to property management of housing developments. As a result, several co-op housing corporations and similar agencies have developed composting programs. The most favourable method is to contain food and yard waste in special bins. This speeds up the composting process (Hot Pile).

b. Observations

i. The bin system is quite labour intensive. It requires that rules of placing certain layers of material in the appropriate order be followed. It requires cleanliness so as not to attract vermin and rodents. It requires aerification and, in dry conditions, watering.

ii. The open bin system is also limited by the sizes of the bins. Even the larger bins are insufficient in size for multiple housing projects.

iii. Too much food waste tends to be problematic, as the material tends to rot due to high water content, resulting in seepage beyond the confinement of the bins.

iv. Some agencies found that a system of enclosed, portable bins, is more practical, resulting in a much cleaner site, provided that the bins be emptied daily onto a central composting site, away from dwelling units and traffic. There the bins content can be mixed with yard waste such as leaves, lawn clippings etc.

v. Investigate the main sources of organic refuse collection from the site, throughout the year. This will determine the location and size of the leaf compost area and that of compost bin for garden

waste. In the event that a residents' kitchen waste program is developed, the size and number of collection bins and their location must be determined. The bins must be located near the main source of the waste origin, downwind from dwellings and outdoor sitting areas, and should be placed in the shade to ensure a proper composting process.

vi. Before establishing a compost location on a site, the necessary tasks of compost treatment must be considered:

- mixing
- chopping and crushing
- stockpiling
- sieving
- reuse on site or transport to sites where needed

This requires a site which permits access as well as room for turning and mixing. For proper decomposition of the material, sufficient nutrients (nitrogen and carbon) must be present for the micro-organisms to become active. The ideal proportion of C to N should be 30/40:1 (Alexander, 1977). This creates a temperature of 60° to 70°C in the stockpile. This temperature destroys the germination capacity of weed seeds, and decomposes the green vegetative mass. A proportion of carbon to nitrogen higher than 40:1 slows down the composting process (Mayer, Ont. Regulation 101/94).

Air and water contribute to the success or failure of the composting process. Too much water will result in rotting, causing an undesirable smell and producing a limited-use final product. Oxygen is also an important element required by the organisms responsible for the decomposition process. Therefore, it is essential that the compost remains loose, introducing air through the mixing process.

c. **Leaf Composting**

Many municipalities and other agencies (e.g. the Metro Toronto Zoo), utilize the most common composting system -compost piles. This requires space as well as staff and mechanical equipment to control the size of piles, to ensure regular turn-over cycles, and general maintenance of these piles. This system seems to be the most useful method of compost creation on a larger housing site, provided that there is sufficient space for it.

As a housing project ages, trees and shrubs also mature, creating annually increasing quantities or leaves in the fall. This can be a problem at older sites with large trees, and where managing compost piles may become a problem due to space requirements. Alternate methods of reducing the leaf quantity and bulk are:

- as it has been done in many European countries, leaves are left where they fall, in planting beds, ultimately creating a natural mulch.

- dry leaves can easily be reduced in quantity and bulk by shredding the leaves in mechanical shredders before moving them onto the compost pile.

d. **Use of Compost**

Well rotted compost can be used in many ways, however it may never be used as a pure substitute for planting soil because it is too rich, too moist and too loose.

An important prerequisite for finding buyers for compost is a high quality product. Promotion of this material as a soil additive, fertilizer or mulch material is imperative. Compost is largely a by-product of maintenance operations but its use is not necessarily restricted to maintenance. In the future, compost will play a major role for soil improvements specified for new plantings. Compost will be substituted for topsoil, a non-renewable resource, in some applications.

The following applications are best suited for compost use:

- Soil Additive: depending on type of compost (subject to origin) and subject to the type and quality of the existing soil, add to planting mix for new tree and shrub installations
  In existing flower beds or portable planters.

  Instead of excavating a tree pit or shrub planting bed, hauling away the material and backfilling with top soil, the following practice in landscape development will become the norm:

- excavate, and depending of the type of soil, pH value and chemical content, mix the existing soil with 15% vol. compost and backfill.

- Top Dressing: annual application of 50mm compost improves soil conditions, activates microorganisms and provides plant food.

- Winter Protection: application in rose planting beds, covering the grafted part, after pruning of the roses in late fall.

- Fertilizer: as top dressing on lawns and planting areas, compost provides nutrients.

e. **Building a compost pile**

i. The most suitable shape for the stockpile is trapezoidal, at approximately 1.5m high X 2m to 3m width, with the length as determined by the amount of material collected. This method of stockpiling is also referred to as the windrows method. All materials should be shredded with specially designed shredders or wood chippers before the material is added to the pile.

ii. The entire pile should be turned three times within a period of 16 weeks. This can be done with a front-end loader. The compost should then be sieved to achieve a workable compost end

product. The sieve mesh should be 0 to 20mm in size. Excess material, in the form of larger particles, can be either discarded, or where feasible, should be re-chopped or re-shredded.

Compost use, according to Ontario Regulation 101/94
Ministry of Environment and Energy

Table 6.1: Determining How Compost Containing Certain Materials Can Be Used

Material	Maximum concentration for regular compost (dry weight)	Maximum concentration for controlled compost (ppm dry weight)	Maximum concentration in the soil resulting from the use of controlled compost (ppm dry weight)
1	2	3	4
Arsenic	10 ppm	20 ppm	14 ppm
Cadmium	3 ppm	4 ppm	1.6 ppm
Chromium	50 ppm	50 ppm	120 ppm
Cobalt	25 ppm	25 ppm	20 ppm
Copper	60 ppm	100 ppm	100 ppm
Lead	150 ppm	500 ppm	60 ppm
Mercury	0.15 ppm	0.5 ppm	0.5 ppm
Molybdenum	2 ppm	3 ppm	4 ppm
Nickel	60 ppm	60 ppm	32 ppm
Selenium	2 ppm	2 ppm	1.6 ppm
Zinc	500 ppm	500 ppm	220 ppm
Plastic which will not fit through a size 8 mesh	1 %	1 %	not applicable
Non-biodegradable material (other than plastic) which will not fit through a size 8 mesh.	2 %	2 %	not applicable

Unrestricted use

If, according to the analysis, the concentrations of the substances in Column 1 (Material) of Table 6.1 are less than the concentrations in Column 2 (Maximum concentration for regular compost), then the compost is not subject to Part V of the Environmental Protection Act and its use is unrestricted. In effect, the finished compost is considered a product and not a waste.

Controlled Compost (considered waste)

If, according to the analysis, the compost is a waste and the concentrations of substances in Column 1 (Materiel) of Table 6.1 do not exceed the concentration in Column 3 (Maximum concentration for controlled compost), then it is determined to be controlled compost.

Waste requiring Permits

If, according to the analysis, the compost contains any substance listed in Column 1 (Material) of Table 6.1 greater than the concentration in Column 3 (Maximum concentration for controlled compost), then it is not exempt and may only be used on sites which have received the appropriate approvals under Part V of the Environmental Protection Act.

Typical Total Nitrogen Content and Total Carbon:Nitrogen Ratios of Organic Materials

(Ontario Ministry of Environment & Energy, Ontario Regulation 101/94)

Material	C/N Ratio (wet wt.)	Source
Grass Clippings (Fresh)	20	Illinois Dept. of Energy and Natural Resources, 1989
Weeds (fresh)	25	Illinois Dept. of Energy and Natural Resources, 1989
Leaves (freshly fallen)	40 - 80	Illinois Dept. of Energy and Natural Resources, 1989
Leaves (dry)	80	Michigan Dept. of Natural Resources (No Date)
Wood Chips	700	Michigan Dept. of Natural Resources (No Date)
Sawdust	500	Illinois Dept. of Energy and Natural Resources, 1989
Straw (dry)	100	Michigan Dept. of Natural Resources (No Date)
Food Wastes	15	Kayhanian, M., and Tchobanoglaus, G., 1992
Fruit Wastes	35	Wilson, G., 1986
Grass Clippings & Garden Weeds	19	Wilson G., 1986
Paper	>500	Anderson, J., 1990

f. Community Composting

Besides compost production from landscape maintenance operations, a large component of compost may be generated from households. It is estimated that 30% of waste produced by residents in housing developments is compostable.

While some municipalities like Metropolitan Toronto encourage citizens to participate in their community composting programs, others like the city of Waterloo, have initiated demonstration programs. The York University Housing Corporation has also developed a centralized system of residents' kitchen waste collection. The MTHCL pilot program for ecological maintenance originally included tenant kitchen waste collection, but it was withdrawn pending further examination of its viability.

There are three methods of community or backyard waste collection and composting:

i. Bin Composting

This may consist of two or three bin composters. These bins are located throughout a housing site. Size, number and placement depend on site layout, number of residents, quantity of compostable material generated and the system for compostable garbage pick-up.

General Recommendations (Farkas, Liz, Multi-unit Dwelling Composting Demonstration Project, City of Waterloo, June 1991 - May 1992):

- At each location, a minimum of two single-bin composters or one two-bin composter should be provided.

- At complexes with medium participation and little yard waste, a two-bin composter is likely adequate for 25 to 30 dwelling units or for every garbage dumpster.

- At complexes with medium to high participation and some yard waste, a three-bin composter is likely adequate for every 25 to 30 units or for every garbage dumpster.

- At complexes that are spread out over a large area, paralleling the garbage system is very important. Two bin composters at each dumpster (assuming no curb side collection) is ideal.

- At apartment buildings with chute garbage systems, paralleling the recycling system as closely as possible is desirable if organics cannot be collected daily (they would have to be collected daily).

- Durability of the composters should be very high. They often become popular play area with children climbing on them. They are heavily used compared to a regular home

composter and should be much stronger and durable.

- It is important to involve as many residents as possible in the composter siting process. If they are satisfied that the location is reasonable and conveniently located, they are more likely to participate. Caution: sometimes residents overlook important siting criteria and should be guided carefully through this process.

- Many of the existing commercially available composters do not meet the requirements of multi-unit composting in terms of size and durability.

ii. Central Compost Material Collection

This method involves a central collection location, similar to the system of glass or paper collection. The materials are collected and deposited by property management crews in large bins and then taken to a central compost site.

iii. Municipal Collection/Leaf and Yard Waste

Many municipalities have introduced a leaf and yard waste pick-up for municipal composting. This relatively new system has met with success as well, in some cases, as failure. In some jurisdiction good compost was produced and the material put to good use. In others, difficulties were encountered with the compost management. Government regulations and legislations such as Ontario Regulation 101/94, will eventually result in properly managed pick-up systems and collection sites and the development of a new industry.

.10 Road and Pavement Maintenance

Repair of pavement is a regular maintenance task, but much time and effort is also spent on removing weeds from pavement cracks and joints. Weeds can be removed manually, mechanically or through stop application of contact herbicide. These methods are time consuming and the latter is harmful to the environment. For many years now, the two methods of weed removal mentioned below have been applied successfully in Europe and have become an acceptable standard procedure. Eventually, property managers in North America will see the benefits of these methods and will include them in their grounds maintenance programs.

a. Infrared Radiation

The application of infrared rays causes the penetration of the natural protective shield of the foliage and, at a temperature of 65°C, blocks the plant's protein cells resulting in the cessation of the photosynthesis process. This method also kills the seeds that are present on all surfaces it is applied to. The equipment usually consists of a push-type apparatus, similar to a lawn mower or of a back pack unit used for smaller areas.

b. Use of Small Scale Flame Thrower

This technique involves the application of direct heat to the surface to be treated. Assorted types of equipment provide a flame directed at the vegetative growth to be eliminated, while others combine heat with a blower.

These methods of control of unwanted vegetation material are most suited to areas comprised of granular base and granular surface material such as baseball infields, running tracks or other waterbound granular surfaces. It is also suitable for vegetation control on precast concrete paver surfaces like walkways and driveways. Elimination of vegetative growth in pavements, usually in cracks or joints between pavers is an important maintenance task. Herbicides have been effective and are therefore presently the preferred choice in North America. The application of infrared and heat methods are excellent and economically sound ways to rid pavements of undesirable vegetation.

.11 Cost Considerations

Economics dictate much of our lives and subsequently have an impact on ground maintenance. Cost consideration, combined with set quality standards and expectations have guided the methods of conventional grounds maintenance. Information on the cost of ecological grounds maintenance was the most difficult component to research for this study. A wealth of documented information on American programs, in particular in areas of municipal composting and operations, is available (Ortec Inc. 1993). However, Canadian information has been difficult to locate. Data, when available, was incomplete due to the relatively short period of time larger scale alternative grounds maintenance programs have been operating.

In Europe, since the late 70's, environmental concerns were the driving forces behind a new ecological, environment friendly urban planning and maintenance way of thinking. Generally the concept of doing less, recycling and the elimination or reduced use of chemicals in the landscape eventually have led to an overall cost saving although this was not the original objective. No specific cost benefit studies were done at the time, nor where considered important. In fact, regardless of costs, only environmentally conscious maintenance programs were considered acceptable. To this date, this new approach to planning, conservation and maintenance has not been challenged and in fully entrenched in the management of municipal open spaces, housing developments, subdivisions, commercial and industrial properties and even to a large extent, in agriculture.

The following text highlights both the extra cost involved and the potential savings of an ecological maintenance program. It is virtually impossible to come up with a fair and objective comparison between conventional and ecological maintenance expenditures because so many variables are involved.

Comparative costs of maintenance

A landscape planning concept and maintenance strategies must consider important cost factors such as how much labour and material will be required to maintain a particular landscaped area. The following list of conventional maintenance requirements clearly shows that lawn areas, woodland treatment and planting areas require considerably less attention than particular landscape features. These relatively low maintenance areas will require even less maintenance when a full ecological program is followed:

Type of Open Space	No. of Hours/100 m^2	Index
Woodland	1.7	100
Shrubs	1.8	118
Groundcovers	8.0	475
Roses	15.2	1,075
Rose Gardens	18.8	1,291
Annuals	61.9	6,855
Perennial	29.9	1,842
Hedges	22.0	1,303
Lawns (overall maintenance)	3.3	210

(Source: Aannemerii Plantsoerien van de Gemeete, Rotterdam (Dept. of Parks, Rotterdam 1980)

a. **Fertilizing**

It is a fact that organic fertilizers are currently more costly in terms of nutrient value per weight, e.g. cost of nitrogen per pound:

Organic Green (Son-Shine Industries) 6-3-1 = $ 13.20/lb
CIL 20-3-4 = $ 5.00/lb
(Doran, 1991)

A direct cost comparison, however, does not give the entire picture:

i. An organic/ecological maintenance program will require much less fertilizer than a conventional maintenance program would, depending on the soil condition and the quality standards set by the owners.

ii. Fertilizers may only be used in limited quantities because, when available, compost may replace some of the nutrient requirements. If compost is being generated on the site, it will obviously be much less costly than imported compost. Furthermore, the nutrients derived from grass clippings must be included in the calculation of total nutrient requirements.

iii. Certain organic fertilizers such as the alfalfa-based products contain anti-fungal properties which may result in cost savings in the area of pest and disease control.

iv. Commercial organic fertilizers, which are in many ways equal to chemical fertilizers (storage, handling, weight, ease of spreading, lack of odour) will decline in price as their share of the market place grows.

v. Organic fertilizers are generally derived from a waste product, thus contributing to the natural re-cycling process (3 R's). When their use and storage are handled in a controlled manner, storage, disposal problems and groundwater pollution will be eliminated. These are benefits which are difficult to express in economic terms.

vi. As the conditions for plant development improve as a result of

a complete organic maintenance program, the amount of fertilizer required to meet set quality standards will be greatly reduced.

b. Weed Control

No specific cost survey information is available with regard with the elimination of herbicide application. It is clear that by not applying any herbicide there will be obvious savings in terms of both labour and material costs. These initial cost savings may be partially offset by the occasional application of spot treatment of specific weed infested areas.

While regular lawn mowing and a healthy lawn will take care of most weeds, there may be some manual weed removal necessary in planting beds. Considerable cost savings can be achieved when cultivating shrub planting beds and unnecessary pruning practices are discontinued.

Long term cost savings will be achieved when soil conditions improve, which in turn will result in healthier plants and reduce the frequency of plant replacement.

c. Composting

Establishing a compost bin or compost pile initially represent an extra cost in terms of set-up and maintenance. The current practice is to haul away and dispose of all organic refuse accumulated in the grounds maintenance operations. This practice has become an increasingly costly proposition in larger urban centres due to local regulations and high dumping fees. On site composting therefore make sense both economically and ecologically.

d. Shrub Planting Beds

Conventional maintenance calls for regular cultivating and edging of planting beds. These are labour intensive operations, and therefore, costly. Many landscape maintenance contractors, wether requested to do so or not, make it a habit to "trim" shrubs at regular intervals. This is a waste of effort which incurs unnecessary labour costs. As a result of this trimming, shrubs produce a vast number of new shoots which consequently must be controlled by further trimming. This approach leads to a weakening of the plants, making them vulnerable to pest and disease attacks. This does not even take into consideration the fact that "ritual" trimming does not permit plants to bloom properly or develop their natural form, as was intended in the original design. Pruning should only be done if (a) the plant requires rejuvenation (every 5 to 7 years) or (b) if the plant is interfering with vehicular or pedestrian access or with services such as overhead wires, and (c) is the plant has been affected by disease or die-back due to winter kill.

The elimination of edging and cultivating of planting beds, as well as the elimination of unnecessary pruning of shrubs will have the

following positive results:

i. Fallen leaves create a mulch on the soil surface which protects the soil from drying. It also promotes the ideal conditions for a stable soil balance and necessary micro-organism population.

ii. Natural development of shrub planting results in good spread, leaving little room for weeds to take hold. Instead of creating and maintaining a formal edge at the bed perimeter, the transition to lawn areas will become natural, reducing the chances of scalping during lawn mowing operations and, of course, this will also save the labour cost of edging.

e. **Pest and Disease Control**

It is difficult to establish or to forecast the actual cost of pest and disease control operations, both for conventional and ecological maintenance programs. The customary wholesale preventative application of pesticide is wasteful because it is usually not targeted at a specific problem, may be applied at the wrong time, and is often ineffective if a problem does exist. The need for pest and disease control depends largely on the unique needs of each project site. If it has been established that control is required, there are several organic materials on the market which have proved to be quite effective.

Since pest and disease control in landscape areas of housing projects can be selective and vary in degree, it is not considered a high cost operation for the average site with regular maintenance. If an ecological maintenance program has been adopted, pest and disease control applications will be required less frequently.

.12 Plant Health Care System

While grounds maintenance practices in the residential sector have practically not changed for a more environment-friendly approach, they have undergone significant changes in the municipal sector during the last 10 years. Environmental awareness of the 80's and budget constraints in the 90's have forced this sector to adopt new methods as a result of political pressures. In the absence of tighter regulations the residential sector has become more adept in the use of chemicals for the sake of "curb appeal".

Many municipalities have adopted a Plant Health Care Program (PHCP).This represents a set of cultural practices, which when consistently used in combination, will promote healthy, vigorous turf growth while having the smallest possible impact (B. Detzler, 1995). As a result of unnecessary pesticide applications and chemical fertilizer applications at regular intervals, needed or not, maintenance managers began to adopt a more total management approach to turf management, increasing and integrating optimum cultural practices with sound management practices.

On the basis of the experience of several municipalities, basic principles and facts must be recognizes:

a. The Plant Health Care Program is really nothing more than the application of good horticultural practices and common sense.

b. Fertilizer should be applied only as a remedy for soil deficiencies after such deficiencies have been established by regular soil testing (every 3 years).

c. The most common problem for high traffic lawn areas is compaction. The solution is aeration of high use areas on a rigorous 2 to 3 weeks schedule.

d. Since a healthy turf depends on good cultural practices, subsequently it is less prone to disease and insect problems, therefore pest control may be of lesser importance. Emphasis must be put on consistency of implementation which can only be achieved through a good management system.

e. The commonly applied maintenance routines, intervals, time of application or frequencies may become invalid in a PHCP. Instead, programs will take into consideration specifics of each site location, soil test results and subsequent nutrient and additive requirements, extent of soil compaction and moisture requirements. This approach relies heavily on the use of computers.

f. Good record keeping of past practices provides the basis for planning the next year's maintenance requirements for each landscaped area. Predictions are keyed to deadlines.

g. Trained and dedicated staff are absolutely necessary to ensure

professional implementation of the work.

h. The PHCP requires 3 to 4 years for it to become fully established and successful, involving a weaning process. During that transition period, management may be under pressure to revert to the old methods because of complaints that the site is not as attractive as it could be. Major problems are bound to arise if management is forced to give in to these pressures resulting in exactly the opposite of the desired intent, i.e. increased chemical applications.

i. The PHCP does not necessarily mean complete elimination of chemicals but will restrict their uses to instances where they are really needed. Pesticides are an important management tool and can be an insurance against complete destruction of turf or plants.

j. Quality turf can actually improve with PHCP without giving up perceived quality standards (accepting less in terms of appearance).

k. While the Integrated Pest Management (IPM) is reactive turf management, the Plant Health Care Program (PHCP) is a proactive turf management. IPM is based on responding on a symptom. PHCP insures that the symptom or problem never arise.

l. The Plant Health Care Program, presently making inroads in the municipal domain, is applicable to all levels and at any scale, including housing development.

2.5 CONCLUSIONS

By bringing urbanism and nature together, a new landscape management language emerges that has significance for the management of housing sites facing a conserver future. Judged by today's values and entrenched methods of doing things, many of the proposals for change may seem unworkable or at best unrealistic. Recognizing this, the purpose of this study has been to highlight the opportunities and advantages of change.

Modern landscape management has been governed by unlimited energy resources and by attitudes of mind that do not recognize the need to conserve. There are other problems that may make change difficult. Safety has also been a concern in populated areas such as housing estates. Vandalism is a real and ever present problem to be dealt with. These points will be raised by opponents to change which in turn may delay implementation of ecological maintenance. To overcome opposition, changes must be preceded by a) retraining of property managers, b) rewriting of budgets and administrative procedures and c) public information campaigns.

Without doubt, there are many practical reasons why some of the ideas contained in this study cannot be acted upon at this time. These reasons may include the varying size of the housing developments, the type and density of population, the location and the good will of housing managers.

The practical application of the principles outlined in this study will depend less on the good intentions and motives towards proper ecological management, but rather on what makes common sense. Those involved in managing and directing grounds and landscape maintenance cannot ignore the benefits of the ecological maintenance approach. What made sense one hundred years ago, before we became dependent on machinery and chemicals, still applies, i.e. obvious natural and horticulturally appropriate maintenance procedures to ensure good stewardship of our immediate living environment.

In a climate of increasing concern for the environment and conservation issues and ever shrinking budgets, it has become obvious that a different approach to the current management of our urban landscape is appropriate and timely.

Programs like the Plant Health Care Program (PHCP) have already been successfully adopted by many municipalities and some large corporate establishments are following suit.

Residential property management tends to be conservative and does not easily change from a system or program that, in their view, is workable and has been successful in the past. Instead of eventually being forced by political or financial pressures for sudden and drastic changes, owners and property managers should adopt a weaning approach, similar to what municipalities have experienced.

The first step towards and ecological maintenance program would be the development of revised performance specifications based on the facts and conclusion presented in this study.

3.0 APPENDIX

3.1 THE MTHCL ORGANIC LANDSCAPE MAINTENANCE PROGRAM

The Metropolitan Toronto Housing Company Limited administers a portfolio of one hundred multiple housing sites.

The MTHCL pilot program was started in the spring of 1993. The actual success or eventual problems may not be known before the end of the season. Even with the information gathered during this year, the actual results will not be known for some time. The reasons for this are as follows:

Despite the switch to no herbicides, less lawn mowing, limited pruning, and organic fertilizers, the actual results will not be available before the end of the season. Furthermore, the positive effects on the soil structure, improved growth and health of plant materials will only be noticeable in the second and third year of this program. It takes time for the soil to leach out all present chemicals and poisons from years of chemical deposits, and for the re-establishment of proper soil balance and micro-organisms which are so important for a healthy growth medium for plants.

However, it can safely be assumed, that the beneficial effects of an ecological maintenance program will progressively be noticeable in the form of healthier plants.

The immediate benefits are in cost and time savings. The MTHCL example shows savings due to the elimination of herbicides and deletion of certain manual procedures like edging, removal of leaves from the site. Detailed cost savings records have not been kept.

As it turned out, the contractor, used to conventional maintenance practices, expressed scepticism and had some difficulty adapting to the new methods. This, of course, made the transition to an organic program more difficult and hopefully is only a temporary delay for the full implementation of the program.

Comparisons of Performance Characteristics

The following task list compares identical grounds maintenance activities. The first column indicates conventional practices, while the second and third columns shows the revised methods of implementation for the current MTHCL interim maintenance program (semi-ecological) and for the pilot project which applies a total ecological approach.

The pilot project will be reviewed in 1996. Given a positive evaluation, it is intended that this new and updated maintenance program will be implemented for all MTHCL project sites.

HIGHLIGHTS OF RECURRING MTHCL LANDSCAPE MAINTENANCE PROCEDURES

COMPARISONS OF PERFORMANCE CHARACTERISTICS

Activity	Conventional Maintenance	Semi-Ecological (1992 - 1995 Term)	Organic/Ecological (Pilot Project)
Lawn Fertilizing	two or three times yearly ea. @ 13kg/100 sq.m, 10-6-4 sulphur coated fertilizer	twice yearly ea. @ 4.8 kg/100 sq.m, 10-6-4 fertilizer with max 35% watersoluble nitrogen	twice yearly; 1 applic. Sustane 5-2-4 organic fertilizer @ 7kg/100 sq.m, 1 applic. of 1cm screened compost
Lawn Weed Control	application of liquid herbicide, in May & Sept. & as required	apply herbicide in May & Sept. strict control of quantities used	apply herbicide only if the area is affected by weed infestation of at least 25% of vegetative cover
Lawn Mowing	maintain cutting height of 50mm throughout the season; mow weekly	maintain heights from 50 to 75mm, depending on season and as required	maintain heights from 50 to 75mm, depending on season and use of lawn; remove excessive clippings and place on compost site
Lawn Edging	provide a clean edge for all lawn areas after each lawn cutting; create a trough at planting bed edge	provide a clean edge at planting beds once per month, May to Sept.	no edging
Planting Beds & Spring Cleaning	remove & dispose of any leaves, litter & refuse	collect leaves, tree branches & remove from site	collect leaves & place on compost site; remove fallen branches & feed through wood chipper, place material on mulch storage site

Planting Bed Cultivating	provide a clean planting bed edge, cultivate beds after each grass cutting; remove weeds, (usually using herbicides to be done weekly)	cultivate to a depth of 75mm every two weeks; do not use herbicides for weed removal	cultivate to a depth of 75mm every two weeks; do not use herbicide for weed removal
Shrub Bed Fertilizing	apply 7-7-7 fertilizer @ 0.5 to 1.0 kg/10 sq.m	apply 5-20-10 fertilizer in spring @ 0.5 kg/10 sq.m	apply 14-7-14 ORGANIFORM fertilizer in April @ 0.5kg/10 sq.m
Pruning	prune trees & shrubs semi-annually, to be completed by June	prune trees & shrubs when dormant as required; remove all clippings and branches from site	prune trees & shrubs as required; feed clippings & branches through wood chipper & place on mulch site
Planting Winter Clean-up	rake, collect & dispose of any litter & leaves	rake, collect & dispose of all fallen leaves	rake, collect & dispose of all fallen leaves on compost site
Maintenance of Compost & Mulch Sites (storage sites and/or bins)			Keep compost & mulch sites in tidy condition; control rodents; compost leaves: transfer tenant compost material
Fertilizing of trees	holes around trees at 0.1 sq.m, filled with 14-07-14 fertilizer @ 70g/cm of tree trunk in May	deleted	deleted
De-thatching	once or twice per season	deleted	deleted
Pest & disease control	as required	as required	as required
Preparation of Site for Ecological Maintenance Change-over			education: directed at staff & tenants; provide compost & mulch storage sites; improve landscape deficiencies; improve soil conditions (soil tests); correct planting deficiencies; remove or break up thatch in lawn if required; provide tools & equipment for use by site staff & tenants; prepare task descriptions for site staff;

3.2 IMPACT AND RESULTS OF ECOLOGICAL MAINTENANCE PRACTICES IN THE CITY OF WIESBADEN, GERMANY

In the mid-70's to the mid-80's, the concern for the ecology and the environment was a highly debated public issue. As a result of these debates and mind searching, governments in most Western European countries enacted legislation for conservation and proper land management.

This issue was initially raised by lay ecologists, by politicians and NGOs. They criticized the conventional practices of urban development planning and urban landscape management. A revolution began in urban planning politics as professional planners and administrators confronted the issue. In general, nature was "in", chemicals were banned, conventional quality standards for landscape management were abandoned and ecological values prevailed.

This new thinking and new direction had a lasting impact on planning and management decision. The City of Wiesbaden was a pioneer in this field. It was the first city in that country to ban herbicides. Ten years later, the ecological practices are still in place. Private management, as well as individual households, have followed the City's example. The following are the principle practices employed by the City in its parks, schools, roads and all other public places:

1) total renunciation of herbicides;

2) elimination of the practices of cultivating, digging and fertilizing shrub planting beds;

3) reduced pruning and trimming of trees and shrubs;

4) reduced lawn mowing (one third of lawn areas have been converted to low maintenance areas, requiring only one or two cuts per year);

5) reduced fertilizer application;

6) increased use of compost;

7) weed control alternative for paved areas: infrared apparatus or gas powered flame throwers;

8) use "vibrating" harrow on gravel pavements for weed control. The harrow's action loosens and separated weeds from the surface.

These changes have resulted in considerable cost savings. The elimination of herbicides, of certain maintenance tasks such as raking, digging, cultivating, pruning, edging, etc. and the widespread use of compost have produced savings in terms of material and labour, while benefiting the urban ecology and ecosystems.

It is interesting and important to note that despite the major impact of these changes on planning and maintenance, no cost benefit analysis is available. Instead, these changes are seen as an evolutionary fact rather than a temporary fad. One must assume, therefore, that no justification for this ecologic approach is necessary.

In conclusion, based on the European example, the idea of ecological landscape maintenance has been fully accepted and has prevailed as the only true and appropriate method for environmentally compatible maintenance.

3.3 ORGANIC PRODUCTS AVAILABLE IN CANADA (1994) - PARTIAL LIST

The following is a partial and incomplete list of ecologically friendly alternatives to conventional fertilizers, herbicides and pesticides.

1. Organic Fertilizers

Ringer Commercial Green Fertilizers:
- Greens 10-2-6 / 6-1-3 / 8-2-3
- Turf 10-2-6
- L.S.F. 8-2-8 (late season fertilizer)
- Flower/Foliage 8-6-5

Organic Green Fertilizers (Sonshine Industries):
These fertilizers are made from alfalfa and a variety of organic meals such as meat and bone meal.
- Natural Lawn 6-3-1
- Organic Lawn Booster
- Garden Rich 5/3/1
- Natural Turf 7-1-5 / 7-3-1

Nutrite Fertilizers:
- Sustain 5-2-4 (derived from agricultural and forestry residues)
- Wright Fortified Natural Organics Plus Iron 18-3-6
- Pro-Organic Plus Iron 15-2-5
- 100% Natural Sources 9-3-4

Ecoval Fertilizers:

. 5-10-2	lawns
. 5-2-2 + FE	lawns
. 9-2-4	lawns
. 4-4-8 + FE	lawns and shrubs
. 5-3-8	flower beds
. 9-3-3	flower and vegetable gardens

Natural Organic Fertilizers and Commercially Available Manures:
This group includes a large variety of base products and producers. These products are usually derived from one particular source, available in either granular, powder or semi-moist humus/soil condition.

. Premier	Light Weight Cow Manure 1-1-1
. Ecoval	Bone & Blood Meal 7-11-0
. Ecoval	Bone Meal 2-14-0
. Organic Green	Fish Meal 2-11-0
. Nutrite	Bone Meal 2-11-9
. Nutrite	Blood Meal Granules 12-0-0
. Nutrite	Seaweed Meal 2-1-2
. Nutrite	Ascophyllum Kelp Meal 1-0-4

2. Commercially Available Organic Weed Killers

Topgun by Safer Limited:
This product can replace conventional herbicides for certain applications. It is a non selective weed killer which is made of a blend of fatty acids with herbicidal properties. This product is so mild that treated areas may be seeded or planted after only three days. It kills annual weeds such as red root, pigweed, lamb's quarters, corn spurry, mustards, spotted cat's ear, chickweed and round-leaved mallow.

Spectrum by Dow Elanco:
It consists of fatty acids with results similar to Topgun. It controls a full range of broadleaved and grassy weeds. It also controls a number of perennial including plantain.

3. Commercially Available Organic Products for Pest and Disease Control

Fungicides:
- Safer Garden Fungicide (also manufactured by Green Cross and Wilson)
- Safer Garden Sulphur Dust

Insecticides:
- Safer Trounce
- Safer's Insecticidal Soap (also manufactured by Green Cross and Wilson)
- Safer Rotenone Garden Dust (also manufactured by Green Cross and Wilson)
- Safer Aphid and Whitefly Killer
- CIL Organic Insect Killer
- CIL Dormant Oil (also manufactured by Green Cross and Wilson)

Systemic Tree Insecticide (non-organic):
- Nutrite Acecaps with Orthene - Implants in tree trunks requiring 83% less insecticide and kills only insect that eat plant tissue.

3.4 LIST OF INDIVIDUALS INTERVIEWED

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Liane McKenna, Director of Parks, City of Scarborough, Scarborough, Ontario
Ken Tilden, Landscape Architect, Ontario Ministry of Housing, North York, Ontario
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