Moving Integrated Pest Management Forward in the City of Boulder

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Table of Contents

1 Executive Summary 5
1.A Project Overview 5
1.B Key Findings and Recommendations 5
1.B.1 IPM Policy 6
1.B.2 IPM Plan 6
1.B.3 Approved Pesticide List Process 7
1.B.4 IPM Committee 7
1.B.5 Contracts 7
1.B.6 Budget 8
1.B.7 Management 9
1.B.8 IPM Coordinator 9
1.B.9 Staff 9
1.B.10 Legal Compliance 10
1.B.11 Open Space and Mountain Parks Department (OSMP) and Urban Resources IPM/Natural Lands (UR IPM) 10
1.B.12 Parks and Recreation Urban Forestry, Horticulture and Urban Parks Division, and Public Works 11
1.B.13 Facilities 12
2 Project Introduction 13
2.A Purpose and Goals 13
2.B Study Approach 13
2.B.1 Research 13
2.B.2 Interviews 13
2.B.3 Site Visits 14
2.B.4 Outreach 14
2.C Evaluation Criteria 14
3 Overview of IPM Principles and Practices 18
3.A History of IPM 18
3.B Pesticide Effects on Wildlife, Environment and Public Health 19
4 IPM in Boulder 22
4.A Boulder's Pests 22
4.B Boulder's IPM Effort 23
5 Evaluation and Recommendations - Infrastructure 26
5.A IPM Guidance Document 26
5.B IPM Plan 29
5.C Approved Pesticide Use Process 30
5.D IPM Committee 34
5.E Contracts 35
5.F Budget 37
5.G Management 39
5.H IPM Coordinator 40
5.I Staff 41
6 Evaluation and Recommendations – Legal Compliance 43
7 Evaluation and Recommendations - Open Space and Mountain Parks, and Urban Resources IPM/Natural Lands 47

7.A Practices, OSMP 48
7.B Practices, UR IPM 49
7.C Specific Site Characteristics, Natural Lands 50
7.D Recommendations, Natural Lands 51
7.E Agricultural Lands 51
7.F Summary of Findings and General Recommendations for OSMP and UR IPM 52
8 Evaluation and Recommendations - Parks and Recreation Urban Forestry, Horticulture and Urban Parks Divisions, and Public Works 54
8.A Turf 54
8.A.1 Site and Soil Test Analysis by Property 57
8.A.2 Flatirons Golf Course 58
8.A.3 Turfgrass Recommendations 58
8.B Urban Resources Division, Urban Forestry and Horticulture Workgroups 60
8.B.1 Urban Forestry Workgroup 60
8.B.2 Horticulture Workgroup 62
8.B.3 Public Works 63
9 Evaluation and Recommendations - Facilities 65
9.A Structures/City Facilities 65
10 Evaluation and Recommendations – Community Engagement 67
10.A Increasing Public Awareness and Understanding of Boulder's IPM Program. 67
10.B Encouraging Pesticide Reduction on Private Commercial and Residential Property 68
11 Evaluation and Recommendations – Data Collection, Evaluation, Reporting and Outcomes 70
11.A. Data Collection 70
11.B. Reporting and Transparency 71
11.C. Evaluation and Outcomes 72
12 Prioritized Recommendations 73
Appendix A: Summary "State of the Science" and Program Comparison 79
Appendix B: City of Boulder IPM Policy with Recommendations 98
Appendix C. Potential Model for Evaluating Pesticides 107
Required Infrastructure 107
Potential Pesticide Approval/Disapproval Process 108
Appendix D. Natural, Organic Turf Management Program 112
Appendix E. Conventional vs. Natural Turf Management Cost Comparison 134
Introduction 135
Background 135
Sources of Data 136
Economic Assumptions 136
Irrigation 136
Soil Biology 137
Appendix F. Potential Grant Funding Sources 144
Appendix G. Example IPM Plan Template 145
Appendix H. Example IPM Contract for Structural Pest Control 152
Appendix I. Pesticide and Non-Chemical Data, Soil Test Analysis 159

A. Chemical and Non-Chemical Treatments by Department/Division 159
1. Open Space and Mountain Parks 159
2. Urban Resources 160
B. Soil Test Results by Site..... 161
1. Jewell Tall Grass..... 162
2. Dunn II Sites 163
3. Greenleaf Park 164
4. Wonderland Lake..... 165
5. Columbine..... 165
6. Shanahan Ridge 165
7. Central Park 166
8. Municipal Campus 166
9. Stazio I, Stazio II and Mapleton 167
10. Maxwell 168
11. Harlow Platts..... 169
12. North Dam 170
Appendix J. References 172

1 Executive Summary

1.A Project Overview

The purpose of this study is to review the City of Boulder's Integrated Pest Management (IPM) policy and processes, and provide guidance for improving pest management practices and continuing to implement ongoing reductions in pesticide use. This report provides recommendations for improving the city's infrastructure for implementing the Boulder IPM policy and suggested solutions for specific pest problems the city is currently facing.

IPM is a decision-making process that identifies and reduces risks to health and environment from pest management activities including pesticide use, as well as risks from pests which include insects, pathogens, weeds, rodents and other vertebrates. IPM is a continuum, ranging from basic approaches such as monitoring pest populations, and acting only when populations exceed a predetermined threshold, to prevention-based systems where there is little need for intervention because pests rarely exceed acceptable levels. The City of Boulder's goals include achieving high-continuum IPM, implementing approaches that prevent pest problems, eliminating pesticide use wherever feasible and using least-toxic products when elimination is not feasible.

In the fall of 2010, the city hired consultants with IPM expertise. Their charge was to review the city's IPM program and provide recommendations for improvement. The consultants included technical experts Dr. Thomas Green of the IPM Institute of North America, Dr. Susan Kegley of the Pesticide Research Institute and Mr. Chip Osborne of Osborne Organics. Ms. Vicki Kalkirtz of the IPM Institute provided administrative support, research assistance and coordination with Boulder and with comparison cities.

This study includes a comparison of Boulder to other cities and governmental units that have progressive IPM policies, pesticide bans and/or successful IPM programs. The consultants visited city properties and facilities in Boulder that staff felt were representative of their IPM programs as well as those that were in need of assistance. A desk audit of Boulder's policy, procedures, pesticide application records, contracts and other pertinent information was also conducted. The assessment included here represents the first phase of the overall project. The second phase includes assisting the city with implementation of the recommendations.

1.B Key Findings and Recommendations

Boulder's pest problems include weeds on 45,288 acres of land plus ants, dandelions, ticks, tree insects and diseases, and vertebrates including rats, pocket gophers, prairie dogs and voles. Pests in and around buildings include ants, American and German cockroaches, flies, mice, rats and wasps. Additional pests are managed on agricultural lands owned by the city and leased to farmers.

The City of Boulder has implemented a series of formal steps to reduce risks to health and environment from pest management activities. In 1981, Boulder passed a pesticide ordinance mandating pesticide safety practices above and beyond those required by

federal and state laws and regulations. The city adopted an IPM policy in 1993 to protect public health and environment. The policy limits pesticide use on city-owned or managed properties to circumstances where non-chemical practices have been ineffective or not economically feasible. In 2000, City Council adopted environmental sustainability as one of its four 2000/2001 council goals. It then enacted an Environmental Management System (EMS) pilot program to make Boulder a nationwide environmental leader.

The City of Boulder has achieved considerable success in reducing pesticide use and toxicity. We estimate less than 5% of municipalities in the US have adopted IPM policies, hired qualified IPM coordinators or documented and reported pesticide use to the public, let alone achieved the substantial pesticide use reductions attained by Boulder management and staff since 1993. For example, by 2001, Boulder staff had reduced pesticide use in urban forestry by 62%, and eliminated nearly all pesticide use on turf. Where it is not feasible to eliminate chemical methods, Boulder maintains a list of pre-approved pesticides designed to minimize impacts on people, non-target organisms and the environment.

Opportunities for improvement remain. A key focus of this project is to identify additional opportunities to further reduce pesticide use, eliminating use where possible, while also reducing pest problems and pest-related threats to health and environment.

1.B.1 IPM Policy

An IPM policy is a formal commitment to IPM and general description of approaches to be implemented to reduce risks from pests and pest management activities. The City of Boulder's IPM Policy is a detailed, comprehensive foundation for a solid program. The scope covers all appropriate facilities and activities. Currently, implementation of the IPM policy is not consistent, with some departments relatively advanced and others not yet engaged. Boulder should develop a comprehensive checklist of IPM policy elements and realistic timeline with prioritized action steps for improving consistency of IPM policy implementation across all city departments, properties, contractors and lessees including IPM for structural pests. Priorities should include addressing contractor and tenant compliance with the IPM policy including posting of pesticide applications, ensuring proper sanitation and exclusion, and proper use of rodenticide and live-traps in facilities rented to tenants.

1.B.2 IPM Plan

A written plan for implementing the IPM policy is instrumental for detailing procedures to be followed to prevent and respond to pest problems, evaluating progress and for sustaining the program through management and staff transitions. The Boulder IPM policy states that each department or division must have an IPM plan, and submit its plan to the IPM coordinator for review each year. At this time, departments and divisions do not have individual IPM plans, but many do have Best Management Practices (BMPs) lists or management plans that include some IPM elements. The city should select one or two departments or divisions to complete IPM plans meeting the IPM policy specifications and use those as models for additional plans. Remaining plans can be scheduled to be in place over a two year period, with all nine departmental/divisional

plans, plus a plan for structural pest control contractors, to be in place by 2014. A plan addressing structural pests should be a top priority to help address deficiencies identified in that arena.

1.B.3 Approved Pesticide List Process

The Boulder IPM program includes a pre-approved list of pesticides acceptable for use on city properties developed by the IPM Task Force in 2006. Both staff and the public have expressed interest in improving the process of approving new pesticide products and/or removing a product from the current list. Currently, lesser risk products are available that would be effective alternatives to more hazardous products currently on the list. We recommend that Boulder revise the formal pesticide approval process to align approvals with well-defined, comprehensive, up-to-date, science-based criteria based on product hazard tiers and exposure potential, using or adapting the model proposed in Appendix C. These criteria should be created with public input, recognizing that community, management and staff consensus on the criteria is ideal but may not be completely achievable.

1.B.4 IPM Committee

An organizational structure that provides for communication and collaboration between responsible entities within the organization is critical to success, especially in organizations with multiple entities responsible for different aspects of pest management. Boulder maintains an Interdepartmental IPM Review Group which is required by the IPM policy to meet at least quarterly to discuss IPM goals, evaluate and review plans, exchange information and educational opportunities, and make policy recommendations. While staff members working on IPM projects are in regular contact, the IPM Review Group does not currently meet on a formal basis at regular intervals. Boulder also formed an IPM Subcommittee to review pesticide products proposed for addition to the approved product list. Currently, the IPM Subcommittee does not meet on a regular basis, only when the need to add a product to the approved list arises. We suggest the city replace the Interdepartmental IPM Review Group with an IPM Technical Advisory Committee (TAC) of IPM representatives from each city department, chaired by the city IPM coordinator. Ideally, the TAC should meet monthly to discuss new and ongoing pest problems, share information and collaborate on problem-solving, completing the IPM plan template and developing, evaluating and updating IPM plans. Meetings should be open to the public and include an opportunity for public comment, but not necessarily provide for public involvement in every agenda item. These meetings can also provide a forum for presentations on IPM topics from both staff and outside experts. The role of the IPM Subcommittee should be clarified when the pesticide approval process is revised.

1.B.5 Contracts

Written contracts for services that staff cannot provide, such as structural pest control, are essential for accountability and performance evaluation. Contract provisions should detail overall goals; scope including sites and pests to be managed; qualifications for individuals providing contracted services; visit frequency and schedule; recordkeeping requirements; and general specifications including compliance with policies and ordinances. Contracts should be current, i.e., revised and renewed after expiration. Boulder's IPM Policy stipulates that all contractors conducting pest management on city

property are required to adhere to the city's IPM policy and plan(s) for sites serviced by the contractor. Contractors are to provide an IPM plan for their services, or have the city provide a plan. Requests for proposals (RFPs) stipulate that contractors must follow the IPM policy. Currently, written contracts are not in place with all contractors providing pest management-related services, and IPM plans have not been provided by or to all contractors as required by the IPM policy. City oversight of contractors has room for improvement. Although the IPM policy stipulates that its provisions apply to city facilities leased to others, tenants are currently responsible for pest management in those facilities and may contract with service providers. Lease terms do not currently include IPM, or stipulate the provisions in the IPM policy that apply to these facilities.

We suggest that the city review and revise the current contractor selection process to include a request for qualifications (RFQ) that conforms to the IPM policy and pesticide ordinance. Include contractor development of a sample IPM plan for one facility or site as part of the proposal review process. Develop an IPM-based contract compliant with the IPM policy and pesticide ordinance, and secure adequate training for the IPM coordinator and/or departmental managers to oversee contractor performance, or secure outside expertise to provide periodic review of contractor performance vs. contract stipulations.

1.B.6 Budget

An ideal budget should be adequate to meet goals stated in the IPM guidance document including overall program management, coordination and evaluation, full implementation of IPM plans for all sites and facilities, staff continuing education, competent contractors and continuous improvement. IPM programs, while cost-effective in the long term, necessarily involve start-up costs including training, research into best practices and options, plan and process development, maintenance to improve exclusion, documentation and evaluation. Some ongoing costs, including the cost of staff Full-Time Equivalents (FTEs) for program management and coordination, can be at least partially offset by reductions in pesticide costs, reductions in staff time spent dealing with pest complaints, improvements in employee health and satisfaction, reduced liability and other benefits listed throughout this report. Most staff positions include multiple responsibilities in addition to IPM-related roles, complicating budget determinations. Estimates provided for this evaluation indicate annual pest management-related expenditures of at least $671,000 for Parks and Recreation, $100,000 for Public Works and $200,000 for OSMP.

We recommend that the city increase or divert resources to address priority risks including inadequate exclusion and sanitation, and improper pest control practices in food service and other facilities to reduce risk of human diseases from pests and pathogens. Address inability to reach all priority OSMP sites each year, which results in higher costs in future years to address larger seed banks and weed spread to larger areas. Evaluate the use of volunteers for opportunities for improvement. Staff has indicated the use of volunteers is generally not as effective as it could be, e.g., initial response is often good but participation by volunteers is not sustained in many cases. A shared community educator could assist with communications including posting, as well as more effectively addressing pesticide use and risks generated by business and resident use. A shared grant

funds development position would likely more than pay for itself given state, federal and private sector funding available to support invasives management and natural areas restoration.

1.B.7 Management

Organization and staff commitment to the IPM program is essential for success. A management structure that has one committed staff person in charge of overseeing the IPM program and sufficient well-trained staff to implement the IPM plan is most effective. Support from upper-level management is critical for the program's effectiveness. City management staff has committed significant time and funding resources to this ten-year evaluation, including this report, and has provided substantive input on the evaluation process and report drafts. Management has expressed a strong commitment to fully implementing Boulder's IPM Policy, to continual improvement in the pest and pesticide arena, and to maintaining Boulder in a leadership position nationally.

Management structure, experience and commitment are sufficient for continued progress. The evaluation process Boulder is undertaking should help improve awareness and understanding of constraints facing both management and staff among city employees and the community. Addressing other recommendations including regular TAC meetings and resumption of annual IPM reports should help communications on an ongoing basis. Strong leadership will likely be needed to implement effective improvements, including in the pesticide approval process, given that a number of Boulder's citizens would strongly prefer that no pesticides be used, and others would prefer no dandelions, a challenge faced by every municipality.

1.B.8 IPM Coordinator

The IPM coordinator should have experience in IPM and be up-to-date in knowledge of BMPs, trends in IPM, local issues affecting the IPM program, and should have management experience and the authority necessary to do the job. The city's IPM Policy specifies an IPM coordinator position and roles to be located in the Department of Community Planning and Sustainability. This position has been vacant for long periods of time since the IPM policy was adopted in 1993. The position was filled in 2009 with an experienced entomologist and has recently been increased to 0.75 FTE. The city should continue to provide training opportunities for the IPM coordinator and supplement coordinator expertise with collaborators and/or contractors to assist with priority improvements, e.g., addressing structural pest management deficiencies, transitioning to natural turf, improving record keeping, evaluation of opportunities for improvement on agricultural acres, golf course and other sites. As resources allow, consider increasing the position to 1.0 FTE and/or providing additional assistance for specific tasks that can be delegated.

1.B.9 Staff

Boulder technical staff is extremely knowledgeable in their areas of expertise and on pest management issues specific to the area. Staff has an accomplished track record of addressing pest issues, particularly in landscape, forestry, turf and open spaces and is very committed to meeting the needs of city management and community members.

There is generally long tenure with low turnover. As in many publicly funded programs, staff effectiveness is constrained by inadequate staffing to reach all priority locations and an insufficient budget to implement non-chemical measures to the degree possible. This is not unusual in many municipalities due to budgets cuts and funding constraints. As resources allow, Boulder should expand opportunities for staff continuing education and networking by budgeting for one annual or every-other-year opportunity such as a national or regional conferences. Increase opportunities for staff to communicate directly with management and citizens, and for Boulder to highlight its investment in staff expertise, e.g., by presentations at management and public meetings. Improve opportunities for recognition of individual staff members and teams for outstanding contributions to Boulder's pesticide and pest risk reduction goals.

1.B.10 Legal Compliance

Based on our limited observations and more extensive document review, Boulder staff appears to meet or exceed all legal requirements for applicator training, licensing and certification. There is currently no procedure in place for checking contractor compliance status. Based on application records provided and observations during site visits, contractors, tenants and staff managing city-owned buildings have opportunities to make improvements in posting, notification and record keeping. In one case, a contractor did not post signs for outdoor rodenticide applications or maintain compliant records of applications. The city's approved product list, policy and IPM plans need to be updated to include for stinging insects with an appropriate protocol for posting and notification. We recommend that Boulder create a checklist and timeline for staff and tenants to meet Boulder pesticide provisions and integrate this with the IPM policy checklist/timeline. Bringing the contractor and tenants into compliance with the ordinance should be a top priority to improve pesticide safety and reduce liability. Incorporate IPM policy and pesticide ordinance compliance education into community outreach including on the website.

1.B.11 Open Space and Mountain Parks Department (OSMP) and Urban Resources IPM/Natural Lands (UR IPM)

OSMP manages 35,000 highly diverse acres including forest, grasslands and agricultural lands producing livestock, forage and small grains, with interests in an additional 10,000 acres. UR IPM manages approximately 1000 acres of natural lands associated with the city park system including grasslands, wetlands and riparian areas. OSMP and UR staff have compiled detailed draft plans consisting of BMPs by species for priority weed plants. Lead staff is extremely knowledgeable about invasives and BMPs. They are aware of published and emerging research on alternatives to chemical controls and are networked with scientists conducting that research and with colleagues in their field. They are very committed to maintaining biodiversity including historic natural environments, and understand the need to balance ideal outcomes, BMPs, budget constraints and community concerns about pesticide use.

Mechanical, cultural and biological controls are the primary strategies for natural land vegetation management, with a number of spectacular successes including a large scale volunteer effort to eradicate Mediterranean sage using AmeriCorps volunteers on 2000 acres. A seven-acre property on OSMP land and leased to a farmer transitioned to

organic in 2011. Non-chemical methods are applied to 70 to 80% of treated acres each year. OSMP pesticide use averages 64 gallons of formulated product per year, with 80% of that amount applied to agricultural lands. The majority of non-agricultural chemical applications made by OSMP and UR IPM are spot treatments, i.e., applied to very limited areas using low-volume methods such as brushing herbicide on freshly cut tree stumps, or spot-spraying individual weeds with a backpack sprayer. Records are kept of all non-chemical and chemical applications including site, target insect or weed, product, rate and area treated.

We suggest that the city continue its emphasis on non-chemical methods and allow for a greater percentage of OSMP and UR IPM staff time to be spent on re-vegetation to reduce opportunities for weed establishment and growth. Where feasible, increase seeding rates to establish a strong foundation of desired vegetation. As resources allow, increase staff resources and budget for natural lands management including staff continuing education and re-vegetation and restoration. Convert one or more seasonal positions to 12-month positions. Evaluate the use of volunteers for opportunities for improvement.

Given that agricultural lands account for 80% of overall OSMP pesticide use, the logical focus for Boulder to achieve significant reductions is agriculture. While agricultural lands were not evaluated in detail for this report, we recommend that the city continue to review procedures for chemical use by agricultural tenants and explore methods for reducing chemical use including continuing a transition to organic and low-input production.

1.B.12 Parks and Recreation Urban Forestry, Horticulture and Urban Parks Division, and Public Works

Sites managed by these departments include turfgrass, landscaped beds, trees in city parks and in street rights-of-way, roadsides and the Flatirons Golf Course. Over the past eighteen years the City of Boulder Parks and Recreation Department has made an effort to minimize the use of pesticides leading to the elimination of herbicides on all managed turf for the last ten years. When herbicides are withheld, practices have to be put in place to keep weed pests from becoming a problem. A proactive turf management program that relies on creating healthy soils, appropriate chemical-free inputs and re-focused emphasis on cultural practices should be expanded to additional sites and practices, gradually transitioning all turf management from occasional use of synthetic chemicals including fertilizers to a natural, all organic-based program. For athletic facilities and sports turf, prioritize and select properties for transition. Continue progress in monitoring and managing introduced tree pests including ensuring adequate species diversity and collaborations with other experts. Improve management of traffic medians, sidewalk areas and landscape beds to reduce the use of glyphosate including use of topical burn-down products to control weeds at a very early stage of growth. Focus on designing these landscape features including evaluating public acceptance of alternative designs that prevent and avoid weeds.

1.B.13 Facilities

The City of Boulder maintains a total of 320 facilities managed by several departments and divisions. Facility maintenance and sanitation is generally fair to good with some exceptions and critical needs for improvement, particularly for facilities with food service operations. Some city staff had inventories of pesticide products for structural pests and stinging insects not included on the approved list. Some products were improperly stored. The city is currently upgrading 66 city facilities for energy efficiency with the Energy Performance Contract through a partnership with the Governor's Energy Office (GEO). These upgrades, including sealing cracks, adding door sweeps and upgrading windows, will ultimately assist with pest prevention. All facilities should be inspected to ensure that there are no human health risks from rodenticides or live-trap use, and that proper exclusion and sanitation is being practiced, especially in food service areas. Secure expert assistance to inspect all city facilities as needed. Modify facility leases to include specifications following the IPM policy and allowing for proper oversight and intervention if tenants are not meeting stipulations. Improve contractor selection by implementing a request for qualifications and an IPM-based contract, with competent oversight to ensure compliance. Replace current pesticides for stinging insects, ants and cockroaches with least-toxic options, and add those options to the approved list. Bring all departments with facilities in compliance with the IPM policy including using non-chemical measures as the primary pest management strategy. Include structural pest management training in continuing education for the IPM coordinator and key facility staff including maintenance, sanitation and food service.

2 Project Introduction

2.A Purpose and Goals

The purpose of this study is to review the City of Boulder's IPM policy and processes in comparison to current best practices, and provide guidance for improving pest management practices and ongoing reductions in pesticide use and risk. This report provides recommendations for improving the city's infrastructure to implement the Boulder IPM policy, suggestions for specific pest problems the city is currently facing and proposals for tracking progress.

2.B Study Approach

To provide for planned periodic review, and in response to recent citizen and staff concerns about the IPM policy and process for evaluating pesticide products, in the fall of 2010 the City of Boulder hired consultants with IPM expertise. The charge to the consultants was to review the city's IPM program and provide recommendations for improvement.

The consultants include technical experts Dr. Thomas Green of the IPM Institute of North America, Dr. Susan Kegley of the Pesticide Research Institute and Mr. Chip Osborne of Osborne Organics. Ms. Vicki Kalkirtz of the IPM Institute is providing administrative support, research assistance and coordination with Boulder and with comparison cities.

This study includes a comparison of Boulder to other cities and governmental units that have progressive IPM policies, pesticide bans or successful IPM programs. The consultants visited sites in Boulder that staff felt were representative of their IPM programs as well as those that were in need of assistance. A desk audit of Boulder's policy, procedures, pesticide application records, contracts and other pertinent information was also conducted. The assessment included here represents the first phase of the overall project. The second phase includes assisting the city with implementation of the recommendations.

2.B.1 Research

In this first phase, the consultant team reviewed leading programs in other locales, conducted site visits in Boulder, interviewed city staff and reviewed documentation including the IPM policy, IPM plans, pest complaints and pesticide use. IPM programs at four additional cities, one water district and the University of Colorado were also reviewed for comparison. Elements considered included plant health, soil quality, pesticide risk assessment and mitigation, sanitation, exclusion and additional preventive strategies for insect, wildlife and rodent pests.

2.B.2 Interviews

Relevant staff members from Boulder and key individuals from the comparison cities were interviewed by consultants and the project coordinator. Staff members had the opportunity to discuss concerns, strengths and weaknesses of the IPM program and methods directly with the consultants. Individuals from comparison cities were able to

provide crucial information regarding their IPM programs. Consultants also worked closely with Boulder's IPM coordinator to gather information.

2.B.3 Site Visits

Each consultant and the project manager visited the City of Boulder in the fall of 2010. The following sites were visited: Municipal Complex, Foothills Community Park, Beach Park, Chatauqua Park, Valmont City Park, Flatirons Golf Course, Baseline Area, Dowdy Draw, Shanahan Ridge Park, Greenleaf Park, the north dam of the Boulder Reservoir and the Recreation Center. These site visits allowed the consultants to view the many IPM issues firsthand as well as meet with the staff in person. An inspection of several structural sites including the East Senior Center, Fire Station Six, Pearl St. Mall, Downtown Municipal Complex, Broadway Bridge Storage, the Tea House and Museum was conducted by Dr. Thomas Green to assist in creating a structural IPM program and provide advice for dealing with persistent pest problems.

2.B.4 Outreach

A brief presentation was made on the evaluation at a public meeting by city staff and Dr. Green, followed by an active question and answer and discussion session.

2.C Evaluation Criteria

The following criteria, developed for the Green Shield Certification program for public agency programs and based on best practices for IPM programs, were used to structure the evaluation:

- Infrastructure
    a. IPM guidance document including policies, ordinances or other regulations.
        i. Formally adopted.
        ii. Complete scope (turf, landscape, forestry, natural lands, agricultural lands, rights of way, structural facilities, anti-microbials and any other relevant areas).
        iii. Address key opportunities to reduce risk.
        iv. Fully implemented as written.
        v. Effectively reduces risk.
        vi. Reviewed and revised regularly, reflects current conditions.

    b. IPM plan
        i. Complete scope (turf, landscape, facilities; prevention, monitoring, intervention).
        ii. BMPs complete, state of art.
        iii. Fully implemented as written.
        iv. Reviewed and revised regularly, reflect current conditions.

c. Pesticide review process, approved product list.
    i. Science-based decision-making process.
    ii. Coordinated among departments.
    iii. Transparent reporting.

d. IPM committee
    i. Complete scope.
    ii. Representative membership.
    iii. Community representation.
    iv. Meets regularly.
    v. Effectively addresses issues.

e. Contracts
    i. In place for all appropriate services.
    ii. Compliant with IPM policy, plan.
    iii. Reflect current conditions.
    iv. Adequate oversight of contractors.

f. Budget
    i. Adequate to meet stated goals and best practice standards.

g. Management
    i. Effective in roles.

h. IPM coordinator
    i. Appropriate experience.
    ii. Adequate training.
    iii. Adequate continuing education.
    iv. Sufficient FTEs, open positions filled promptly.
    v. Effective in role.
    vi. Proper authority.
    vii. Adequate supervision.

i. Staff
    i. Staff in all appropriate departments engaged.
    ii. Appropriate experience.
    iii. Adequate training.
    iv. Effective in roles.
    v. Sufficient FTEs, open positions filled promptly.
    vi. Turnover minimal.

vii. Adequate continuing education.
viii. Effective communication, collaboration.

- Implementation
  a. Legal Compliance
     i. Staff, contractors meet pesticide applicator requirements.
     ii. Posting, notification of pesticide applications.
     iii. Right to know (product labels, MSDS).
     iv. Pesticide storage.
     v. Pesticide drift.
     vi. Other, e.g. invasive species mandates.

  b. Conditions, practices at specific sites and in specific departments and divisions (see Chapter Four for divisions)
     i. Open Space and Mountain Parks
     ii. Parks and Recreation
     iii. Public Works

  c. Community Engagement
     i. Posting, notification adequate.
     ii. Pest complaint reporting effective.
     iii. Program, processes transparent.
     iv. Representation on IPM committee.
     v. Ready access to program information.
     vi. Effectively educates/engages citizens regarding their roles including compliance with applicable regulations.
     vii. Promotes IPM, pest and pesticide risk reduction on private property.

  d. Data collection, evaluation, reporting
     i. Turf, landscape, facilities tested/monitored/inspected regularly for prevention, fit for intended use.
     ii. Pesticide application data collected, completed and analyzed.
     iii. Staff training records complete.
     iv. Citizen, staff feedback documented.
     v. Regular review identifies, prioritizes opportunities for improvement.
     vi. Improvements implemented.
     vii. Progress against goals reported.

- Outcomes
    a. Pest risk reduction
        i. Turf, landscape, facility assets meet intended uses.
        ii. Pest complaints minimal.

    b. Pesticide risk reduction
        i. Use minimal, tied to documented need.
        ii. Least-risk products are used when feasible.

    c. Prevention
        i. Plant and soil health adequate to resist pests where possible.
        ii. Right plant in right place to minimize stress.
        iii. Equipment inspected and cleaned prior to transport.
        iv. Facility maintenance and sanitation adequate to deny food and shelter.

    d. Intervention
        i. Need to intervene minimal.
        ii. Adequate process to identify least-risk options.

    e. Community Member Satisfaction

3 Overview of IPM Principles and Practices

3.A History of IPM

IPM has a long history of documented successes in reducing impacts of pests and pesticide use in community, agricultural and managed landscape environments. IPM is a common-sense approach to addressing pest problems focusing on knowledge of pest biology and ecology, monitoring and inspection, and prevention, including optimizing plant health and denying food, water and shelter to pests through sanitation and exclusion. As a last resort, when reasonable non-chemical measures have not been successful, pesticides that have been carefully pre-selected for lowest toxicity and potential for exposure may be used.

IPM is a continuum of practices, from basic monitoring and use of pest activity thresholds to determine when action is needed, to the ultimate sustainable, prevention-based system at the high end of the continuum that requires little intervention because pest problems are minimal. IPM differs from organic in that pesticides containing synthetic ingredients are permitted. Organic systems also aim for long-term sustainability and minimal intervention but synthetic inputs are generally prohibited.

Both IPM and organic systems have their roots in practices employed in agriculture for hundreds of years as farmers experimented with ways to reduce the impacts of insects, diseases, weeds and wildlife in their crops. Early IPM/organic practices include selecting plant varieties resistant to pests, adjusting planting times to avoid high pest populations, mechanical controls including hand removal, conservation of natural predators and parasites, and use of ashes, lime, red pepper, sulfur and tobacco to kill or repel pests.

IPM in community settings developed and accelerated as human populations began to concentrate in towns and cities, leading to concentrations of pests including cockroaches and rodents. In 1800, only 1.7% of the world's population lived in towns. By 2007, this number grew to 50%, and to 87% for the US.

Commercial production of pesticides is a relatively recent development, with manufacture of the insecticide pyrethrum from chrysanthemums beginning in California in 1870. Arsenic and lead-based pesticides were widely used in the first half of the 19th century. Identification and manufacture of synthetic pesticides soon followed, including the discovery of the insecticidal properties of DDT in 1939. By 1935, 50 million lbs. of pesticides were being used annually in the US.

Negative effects resulting from increasing reliance on pesticides started to become apparent in the 1940s, with the first documented development of resistance of insects to arsenic-based insecticides. Codling moth, a pest of apples, was no longer controlled by repeated applications of these pesticides. Apple exports from the US were rejected for excessive arsenic residues. New pests emerged as they became resistant to commonly used pesticides, while beneficial insects that typically kept pest populations in check remained susceptible. Fertility problems were documented in pesticide manufacturing workers.

The concept of integrated control, using multiple methods to reduce overreliance on pesticides, was introduced in 1952.[1] Rachel Carson's *Silent Spring*, which documented pesticide impacts on humans, wildlife and ecosystems, was published in 1962. Bald eagle populations in the continental US declined to 416 nesting pairs in 1963 due to the effects of DDT and other persistent pesticides. In 1972, the Environmental Protection Agency (EPA) was formed, DDT use was banned in the US and President Nixon mandated the development and promotion of IPM.

After peaking at a total annual use of 1.24 billion lbs. in 1999, conventional pesticide use in the US began to decline, with 1.13 billion lbs. used in 2007.[2] The California Department of Pesticide Regulation reported a decline in the use of the most toxic pesticide classes by 8 to 19% in 2009 vs. 2008.[3] About 36% of US pesticide expenditures in 2006-2007 were by users in agriculture, with the balance in industrial, commercial or government, or home and garden.

3.B Pesticide Effects on Wildlife, Environment and Public Health

US EPA regulates commercial availability and use of pesticides with a goal of protecting public health and the environment. However, regulatory decisions are based on risk assessment, and a balancing of costs with benefits, and are not adequate to prevent all harm from pesticides. Pesticides, whether natural or synthetic in origin, should be considered a "last resort" option for a number of important reasons:

- EPA regulation has often proved insufficient, evidenced by the frequency with which pesticides and specific pesticide uses approved by EPA have subsequently been withdrawn from the market or been restricted due to unanticipated health and environmental impacts. Pesticide regulation is also limited in that toxicity testing is most often performed only on the active ingredient, rather than the formulated product that includes inert ingredients; cumulative effects from repeat exposure from multiple sources are not taken into account; synergistic interactions with other pesticides, pollutants, pharmaceuticals and other compounds are not fully considered; inadequate data are available for evaluating neurological and endocrine-disrupting effects; low level exposures are not fully evaluated; and pesticide impacts on health and environment are not adequately tracked, analyzed and reported.

- Pesticide use has resulted in widespread contamination of natural resources. In 2006, the US Geological Survey reported results of the National Water-Quality Assessment (NAWQA) Program and indicated that during the 1992-2001 study period, at least one pesticide was found in all streams studied. Multiple pesticides were detected in 97% of streams in both agricultural and

[1] Michelbacher, A. E. and O. G. Bacon. 1952. J. Econ. Entomol. 45: 1050-1027
[2] Grube, A., D. Donaldson, T. Kiely and L. Wu. 2010. Pesticide Industry Sales and Usage. US EPA. 41 pp. http://www.epa.gov/opp00001/pestsales/07pestsales/market_estimates06-07.pdf
[3] California Department of Pesticide Regulation. 2010. Summary of Pesticide Use Report Data 2009. 634 pp. http://www.cdpr.ca.gov/docs/pur/pur09rep/comrpt09.pdf

urban watersheds, and above levels of concern in 87% at urban monitoring sites.[4] Pesticides were also detected in 100% of fish sampled, and in 33% of major aquifers sampled. In 2003, the Centers for Disease Control and Prevention reported an average of 91 chemical contaminants in fluid and tissue samples from adults in the US, including 17 pesticides or pesticide-breakdown products.[5]

- Pesticides have been associated with adult cancers such as leukemia, brain cancer, non-Hodgkin's lymphoma and soft-tissue sarcoma.[6] Other studies focusing on specific pesticide ingredients and products have also shown adverse health effects. For example, exposure to paraquat and rotenone have recently been linked to Parkinsons disease.[7]

- Pesticides have been shown to have adverse effects on both terrestrial and aquatic wildlife. For example, Storrs and Kiesecker found that amphibians exposed to low levels of atrazine (30 ppb) were more likely to die after 30 days than those exposed to higher concentrations. This low level is the same amount that is allowed in drinking water by the EPA.[8]

- Pesticide resistance and emergence of secondary pests due to pesticide impacts on natural controls add to the arguments for using non-chemical options whenever possible.

These examples illustrate the potential for harm from reliance on pesticides as a primary approach to managing pests.

High-continuum IPM is an effective strategy for reducing reliance on pesticides in both agricultural and community settings. For example, in 2005, a study of families in East Harlem, NY found that IPM provides efficient and cost-effective cockroach control in multi-family housing. Those that used structural IPM techniques for cockroach control found a 50% reduction with lower long-term costs, while those without had a slight increase in cockroach populations.[9] IPM has delivered a 95% reduction in cockroach infestations and associated allergens,[10] a 93% reduction in pesticide use in federal

[4] USGS Fact Sheet "Pesticides in the Nation's Streams and Groundwater 1992-200: A summary" 2006-3028: http://pubs.usgs.gov/fs/2006/3028/

[5] CDC (Centers for Disease Control and Prevention). 2003. *Second national report on human exposure to environmental chemicals.* NCEH Pub. No. 03-0022.

[6] Pesticides and Childhood Cancer By Shelia Hoar Zahm and Mary H. Ward, Occupational Epidemiology Branch, Division of Cancer Etiology, National Cancer Institute, Rockville, Maryland Environmental Health Perspectives 106, Supplement 3, June 1998

[7] Tanner CM, Kamel F, Ross GW, Hoppin JA, Goldman SM, et al. 2011 Rotenone, Paraquat and Parkinson's Disease. Environ Health Perspect doi:10.1289/ehp.1002839.

[8] Storrs SI, Kiesecker JM 2004. Survivorship Patterns of Larval Amphibians Exposed to Low Concentrations of Atrazine. Environ Health Perspect 112:1054-1057. doi:10.1289/ehp.6821

[9] Brenner B.L, Markowitz S., Rivera M., Romero H., Weeks M., Sanchez E., Deych E., Garg, A. Godbold J., Wolff M. S., Landrigan P.J., Berkowitz G. 2003. Environmental Health Perspectives. 111:13. 1649-53. http://ehpnet1.niehs.nih.gov/press/cockroach.html

[10] Environmental Health Watch's Collaboration with Cuyahogo Housing Authority Demonstrates the Difference Integrated Pest Management Can Make. IPM Case Study. EPA. www.ehw.org/Asthma/ASTH_HUDRoach_Sum.htm.

buildings over 10 years,[11] and a 30% decrease in pest management costs in public building and grounds.[12]

Many cities, states, provinces and other units of government have taken specific actions to reduce pesticide use and risks. Approximately 154 municipalities in Canada have passed laws restricting landscape pesticide use on private land over the past decade. Quebec became the first province to restrict pesticide use in 2003, banning 20 chemicals from sale and use throughout the province. In 2009, Ontario banned the use of 80 pesticides for cosmetic purposes.

In the US, Boulder, New York City, Wellesley, Mass., and in California, the Cities and Counties of San Francisco and Santa Clara and the Marin Municipal Water District have been leaders in implementing IPM programs, and tracking and reducing pesticide use.

[11] Green A., Breisch N. L 2002. J Econ. Entomol. 95:1. 1-13

[12] Washington State Department of Ecology. 1999, Citing U.S. EPA. 1998. The City of Santa Monica's Environmental Purchasing - A Case Study. EPA

4 IPM in Boulder

4.A Boulder's Pests

Boulder's pest problems include noxious and other weeds on the more than 45,288 acres of land managed by the city, plus ants, dandelions, ticks, tree insects and diseases, vertebrates including rats, pocket gophers, voles and aquatic nuisance species. Prairie dogs are carefully managed by Boulder staff and are an integral part of the local ecosystem. Pests in and around structures include ants, American and German cockroaches, flies, mice, rats and wasps. These pests are problems in both city-occupied facilities and in structures and portions of structures leased to tenants. Additional pests are managed on agricultural lands owned by the city and leased to farmers. Pest management activities are conducted by three departments and multiple divisions (Figure 1), tenants in city-owned facilities, farmers on leased city-owned agricultural land, and contractors both hired by the city and by tenants.

Figure 1. Simplified organizational chart illustrating departments and divisions with pest management responsibilities. (Prepared by Matt Claussen, urban resources manager.)

Most organisms that achieve pest status by interfering with the activity of humans also have beneficial properties. For example, invasive plants not native to the Boulder area may provide food or habitat for wildlife, but can also threaten biodiversity and lead to local extinction of native species. If left unmanaged, invasives can crowd out native vegetation, and deprive wildlife, insects and other organisms of resources provided by native plants. Introduced plant diseases and insect pests can also cause or contribute to local extinctions and population shifts. Most introduced species that are successful in new habitats are "r" selected, which have evolved for rapid colonization of new areas. Introduced species most often arrive without their complement of natural enemies and thus reproduce at rates much greater than in their native habitats.

A number of pests found in Boulder are important for their potential to cause disease in humans. These include mice which can transmit hantavirus, ticks which can transmit Colorado tick fever and other diseases, and fleas which are associated with rats and gophers and can transmit bubonic plague. About 200 cases of Colorado tick fever are reported in Colorado each year. Plague has been reported in prairie dogs and cats in Boulder County. Several human deaths have been reported from hantavirus and plague in Colorado during the past decade.

Much like many of the illnesses that can be associated with pesticide use, many pest-related diseases have symptoms which are non-specific, and difficult to trace to the actual cause. For example, Colorado tick fever is thought to be underreported due to similarity of most cases with flu-like symptoms from other viral pathogens. Exposure to rodents and cockroaches can cause asthma and trigger asthma attacks. Cockroaches, flies and rodents can transmit pathogens that cause non-specific symptoms similar to those resulting from exposure to cold and flu viruses.

Some landscape pest issues affect ability of specific sites to meet intended uses, e.g., broadleaf weeds can decrease traction on athletic fields. Weeds on golf courses can affect play. Other pest issues are primarily aesthetic, e.g., dandelions in parks and traffic medians.

4.B Boulder's IPM Effort

The City of Boulder approved a pesticide ordinance in 1981 which mandated pesticide safety practices by commercial applicators and city staff. The city adopted an IPM policy in 1993 with stated goals of protecting public health and environment. The policy acknowledges the potential harmful effects of pesticides and provides direction to reduce, and where possible eliminate the use of chemical pest control strategies. The IPM policy limits pesticide use on city-owned or managed properties to circumstances where non-chemical pest management practices have been shown to be ineffective or not economically feasible. City staff must balance these policy guidelines with the public's expectations for adequate pest control, budgetary and staffing constraints, and in some cases, state mandates that require the elimination of specific invasive weed species.

Boulder maintains a list of approved pesticides for use where it is not possible to eliminate chemical methods. This list is intended to address toxicity and application techniques to avoid impacts to people, non-target organisms and the environment.

By 2001, pesticide use on athletic fields had been reduced by 22%, in urban forestry by 62% and on streets/bikeways by 20%. Most departments currently use few if any pesticides. No herbicides have been used on turf in parks since 2001. Athletic field complexes have not been treated with herbicides since 2003 and very little product has been used by the Urban Forestry Department. One purpose of this project is to identify additional opportunities to reduce pesticide use further, and eliminate use where possible.

Boulder has demonstrated a continuous commitment to improving protection of human health and the environment since its 1981 ordinance. In 2000, City Council adopted environmental sustainability as one of its four 2000/2001 council goals. It then enacted an Environmental Management System (EMS) pilot program to make Boulder a nationwide environmental leader. The IPM policy was last updated in 2002.

In 2001, the city completed an environmental management audit of its IPM operations. The audit compared Boulder's policies and practices to accepted BMPs and other IPM programs in 14 cities. The audit identified new opportunities for Boulder to become a leading role model for exemplary practices, including periodic review and evaluation of the city's program relative to the state of the art and science of IPM.

The City Manager created an IPM Task Force in October of 2002 in response to the environmental audit of the previous year. The 16-member Task Force included city staff, advisory board members, representatives from environmental groups and scientists. They reviewed the impacts of a pesticide ban on city lands, determined when pesticides should be used on city property and evaluated BMPs in use. The task force recommended a process for IPM decision-making, guidelines for the use of pesticides and a list of banned pesticides. These recommendations were implemented in 2003 and continued to be followed by staff.

In 2006, the IPM Task Force reviewed pesticides already in use or being considered for use in the city, with the goal of developing an Approved Pesticide List and a process to update it. An IPM Subcommittee, comprised of one representative each from the Environmental Advisory Board (EAB), Open Space Board of Trustees (OSBT) and Parks and Recreation Board (PRAB), was formed to review requests for adding products to the approved list. When staff sees the need to add a product to the list, they notify the IPM coordinator who is to research the product with the assistance of a toxicologist and provide a packet of information about the product to the Subcommittee. The Sub-committee reviews the information during a public hearing and votes on each product. The results of the meeting are sent to the City Manager, who reviews the IPM Subcommittee's recommendations and makes the final decision on additions to the approved product list.

Pesticides currently on the approved list include disinfectants, insecticides, fungicides, herbicides and rodenticides. Specific active ingredients include the herbicides glyphosate, fenoxoprop-P-ethyl, imazamox, corn gluten meal, metsulfuron, 2,4-D, imazapic, clopyralid, aminopyralid, picloram, pendimethalin, carfentrazone-ethyl, acetic acid, and triclopyr; the insecticides pyrethrins, azadirachtin (neem), imidacloprid, deltamethrin, permethrin, Bt, horticultural oils, and spinosad; the fungicides iprodione, chlorothalonil, azoxystrobin, and thiophanate; and the rodenticides zinc phosphide, aluminum phosphide, and bromadialone. Potential hazards associated with some of these products and noted on pesticide labels and Material Safety Data Sheets (MSDS) include cancer, neurotoxicity, endocrine disruption and developmental toxicity. Some but not all of the products on the list are used by Boulder staff, contractors and tenants. Some products have very limited allowed uses, and many applications are made in such a way as to greatly reduce potential for exposure, e.g., spot, wick, stump treatments, soil or tree injections.

Disinfectant/anti-microbial use is not addressed in this report; these uses are typically addressed in "green cleaning" programs which may be an opportunity for Boulder both in city facilities and by residents. The anti-microbial pesticide category (e.g., bleach), includes more products acutely toxic to humans and other mammals than any other single category including insecticides.

This process for reviewing pesticide products has been conducted twice, most recently in April of 2010. The addition of nine pesticide products were requested by staff, with eight recommended for approval by the Subcommittee. During the public hearing, members of the Subcommittee expressed concerns with the Approved Pesticide List process. They noted: "a lack of technical expertise for decision making and that the criteria for assessing the products were not clear, nor were the guidelines for assessing the impacts of the pesticides on public health and the environment." In addition, there was strong public opposition to adding certain products to the Approved Pesticide List. In response to these concerns, the city manager decided that none of the products would be added to the list and no other changes would be made until the process for evaluating products and adding them to the list was reviewed and revised. This study was prompted in part as a result of concerns about the Approved Pesticide List approval process and public concerns regarding pesticide use on city property.

Submission of the first draft report from the consultants in December 2010 led to the development and approval of interim guidelines in April 2011 allowing the use of less toxic alternatives to products on the approved list for the 2011 season (*Update on the interim Integrated Pest Management (IPM) guidelines for the 2011 season,* http://www.bouldercolorado.gov/files/City%20Council/IP/2011/04_20_2011_IP/Combined_IP_04202011.pdf).

5 Evaluation and Recommendations - Infrastructure

IPM programs that emphasize prevention and use of cultural, mechanical and least-toxic pest controls are growing in number as communities, businesses and individuals recognize that IPM reduces pest complaints and pesticide use, both of which can adversely affect human health and the environment. Successful programs have a common set of characteristics that allow for effective control of pests while minimizing pesticide use and impacts on human health and environment. Continued success depends on a strong organizational commitment, an effective infrastructure including professional development and mentoring of a committed and well-trained staff, best practices, and a focus on prevention and continual evaluation and improvement.

A well-defined infrastructure that provides a foundation for decision-making is essential for a credible, consistent and effective IPM program. Such infrastructure ensures that the commitment to IPM is maintained over time and provides a mechanism for continuous improvement of the program.

In this and the following chapters, we compare Boulder's current IPM program to IPM Best Practices in infrastructure, implementation, outcomes and evaluation, following the criteria identified in Chapter Two. Best practices were developed from existing evaluation programs including IPM STAR and Green Shield Certified, information from comparison cities and organizations (Appendix A) and the consultants' experience with other cities and programs.

5.A IPM Guidance Document

Best Practices: *A formally adopted guidance document such as a law, ordinance, regulation or policy that describes the organization's commitment to IPM and their approach to reducing risk from pests and pest management activities is the foundation of an IPM program. This document provides an overarching structure that describes the commitment to pest management and pesticide use and risk reduction, sets clear expectations for staff and contractors, and affords transparency, predictability and assurance to the public. The document should address the full scope of pest management activities for the organization, include all facilities under the control of the organization, and set the overall course for managing turf, landscapes and structures to minimize pest problems and the need for intervention, including microbial hazards. The document should be fully implemented as written, or a timeline should be in place to do so. The document should be reviewed and revised on a regular basis to ensure that it reflects and responds to current conditions. Other cities with comprehensive IPM policies that are fully implemented include the City of New York and the City/County of San Francisco.*

Boulder: In 1981, Boulder passed a pesticide ordinance addressing pesticide safety not covered by federal and Colorado statutes. Compliance with this ordinance is addressed in the following chapter.

Boulder also implemented a detailed and comprehensive IPM policy in 1993 with the intention of reducing pesticide use. The policy has been formally adopted and applies to

all pest control activities and pesticide use in buildings, related facilities, grounds and open space, and all other property owned or managed by the City of Boulder. The policy applies to activities conducted by city staff or contractors, and to all pesticides. It also states that all city officers, employees and contractors must follow the policy. The policy is to be reviewed periodically to reflect current conditions. It was last updated in 2002.

All departments/divisions are required to adhere to the IPM policy including Downtown and University Hill Management Division, Fire, Housing and Human Services, Open Space and Mountain Parks, Parks and Recreation (including Athletics, Boulder Reservoir, Urban Resources, Flatirons Golf Course, Forestry, Recreation Centers and Urban Parks), Public Works (including Airport, Facilities and Asset Management (FAM), Greenways, Transportation and Utilities Maintenance, and Water and Waste Water Treatment Plants), as well as leased and rented facilities.

The City of Boulder's IPM Policy is a detailed, comprehensive document that provides an excellent basis for a solid program. The scope covers all appropriate facilities and activities. As per the policy (with policy section reference—see Appendix B),

- All contractors have been provided with a copy of the policy. (I.)
- Non-chemical measures are the primary strategy used by Boulder staff in most departments/divisions. (II.)
- Substantial reduction in pesticide use has been documented in several departments/divisions. (II.)
- An IPM coordinator is in place and is actively working to coordinate city departments, develop recommendations on strategies, assist with training needs and provide outreach to citizens regarding IPM. (IV.)
- Several departments/divisions have actively sought out and experimented with innovative, reduced-risk treatment options, including non-chemical options. (VI.D.)
- Staff complies with pre- and post-application posting requirements for pesticide applications including soil and trunk injections, spot spraying and hand wicking (VI.D.)
- Information on chemical and non-chemical treatments is provided on the Community Planning and Sustainability website. (VI.E.)

Currently, implementation of the IPM policy is not consistent, with some departments relatively advanced and others not yet engaged. The fact that the IPM coordinator position had been vacant for long intervals since the policy was created is likely a contributing factor. Specific elements of the policy not yet implemented (and policy section reference) include:

- The policy has likely not been applied to all disinfectants that make a pesticidal claim (for microbial pests). (III. C.) This report does not address disinfectants.
- The IPM Annual Report has not been completed annually. (IV.A.)
- The city weed management plan has not yet been completed. (IV.)
- Departments/divisions do not have complete or current IPM plans. (V.A.)
- Several departments/divisions do not have a departmental/divisional IPM coordinator or representative to the Interdepartmental IPM Review Group. (IV.B.)

- The Interdepartmental IPM Review Group does not have a formal meeting schedule. (IV.B.)
- Not all departments are currently keeping accurate records of chemical and non-chemical treatments. Some records are missing elements required by the IPM Policy. (V.B.)
- City and/or departmental/divisional IPM coordinator(s) are not approving all pest management treatments by contractors for structural pest management applications. (V.C.)
- Initial data collection specified in the policy has not been completed for all departments/divisions. (VI.A.)
- Not all pesticide products used are selected as per strategies in the policy (VI.D.5.) and not all applications are posted 24 hours in advance, specifically applications in city facilities and in facilities leased to tenants. (VI.D.5.h)
- IPM program information on the Department of Community Planning and Sustainability website does not yet include Annual IPM Reports or departmental/divisional IPM plans. (VI.E.)
- Not all contractors currently being used provide IPM plans, or have been provided by staff with IPM plans, and some do not appear to maintain records as required by the policy. (VII)
- No current timeline is in place to fully implement the policy.

Recommendations: Develop a comprehensive checklist of IPM policy elements and realistic timeline with prioritized action steps for improving consistency of IPM policy implementation across all city departments, properties, contractors and lessees including IPM for structural pests. Given the complete and detailed nature of the policy, a timeline built around bringing the city in full compliance with the policy will address many of the recommendations from this report.

a. Priorities should include working with contractors and tenants to provide education on the city's IPM policy and requirements and to ensure compliance.

b. Fully constituting the Interdepartmental Review Group with representation from IPM coordinators appointed for all departments/divisions is a low-cost measure that will improve coordination, focus on policy goals and mechanics and shared learning. Initial agenda items should include reviewing and updating the IPM policy, prioritizing departments/divisions for IPM plan development and completing the checklist and timeline.

c. Additional recommendations for improving the IPM policy are included in Appendix B. These include transitioning current committees to an IPM technical advisory committee and requiring contractors to provide an IPM plan for sites and pests for which they are contracting to perform services, if a plan is not provided to them by staff.

Costs: Staff time for meetings and tasks including reviewing and updating the policy, drafting a complete timeline for fully implementing the IPM policy, reviewing additional

recommendations and selecting appropriate recommendations for implementation, and developing/updating IPM plans.

Benefits: Improved credibility with staff, contractors, tenants and the public; reduced liability from pest, pesticide and food safety risks to staff, tenants, contractors and the public; improved fire safety; lower energy costs; improved employee, tenant and citizen satisfaction; potentially fewer staff absences due to pest- or pesticide-related illness.

5.B IPM Plan

Best Practices: *A written plan for implementing the IPM guidance document is critical to consolidating and organizing key information in one place, and to identifying and filling knowledge gaps. A written plan facilitates consistent communication and implementation, new staff training and program continuity during staff transitions.*

The plan should address the full scope of pest management activities for the organization, including approaches to managing turf, landscaping, natural areas, agricultural lands, structure, etc. to prevent problems with weeds, insects, diseases and vertebrate pests. The plan should list all key pests, those that drive pest management decisions and activities, action thresholds for those pests, and a hierarchy of measures to be used to monitor and keep pests below thresholds, with non-chemical preventive techniques as the first line of defense. The plan should document sites to be managed under the plan, and any special measures or considerations for sensitive areas. The plan should detail roles and responsibilities, and include procedures for recordkeeping, data analysis and evaluation.

Many plans provide a process for phasing in an IPM approach over time. The plan should be fully implemented and on-schedule for completing the phased-in approach. The plan should be reviewed and updated on a regular basis to reflect current conditions, integrate emerging technologies and deal with issues that arise. An ideal plan represents the state of the art in pest prevention, best practices for intervention when needed, and pesticide use and risk reduction.

Boulder: The Boulder IPM Policy states that each department or division required to follow the policy must have a departmental or divisional IPM plan. The plan must be submitted to the IPM coordinator and reviewed each year. At this time, departments and divisions do not have individual IPM plans, but many do have BMP or management plans which contain some of the IPM plan elements required by the Boulder policy. The IPM policy requires annual reviews of IPM plans for each department.

Recommendations: Select one or two departments/divisions to complete IPM plans meeting the IPM policy specifications by the end of 2012 and use those as models for additional plans. Schedule remaining plans to be in place over a two year period, with all nine departmental/divisional plans, plus a plan for structural pest control contractors, to be in place by 2014. A plan addressing structural pests should be a top priority to help address deficiencies identified in that arena.

Costs: Staff time for developing/updating IPM plans, estimated at an average of 80 hours or 0.04 FTE per plan. A plan template can reduce duplication of effort (see example, Appendix G).

Benefits: Written IPM plans improve transparency, consistency, conformance to the IPM policy, ability to evaluate performance vs. plan and continuity. Having a current IPM plan in place reduces costs by reducing the learning curve during staff transitions.

5.C Approved Pesticide Use Process

Best Practices: *A science-based process for reviewing and approving pesticides for use in the IPM program should be a component of the IPM program, with the result being a list of "approved" pesticide uses the organization has determined would be acceptable.*

Most municipalities and other government bodies defer to US EPA and permit use of any EPA-registered products, or products which are defined as minimum risk and exempt from registration under section 25b of the Federal Insecticide, Fungicide and Rodenticide Act [FIFRA]) products. As described in Chapter 3 of this report, this is not a "best practice." There are a number of limitations to this approach, and additional opportunities exist beyond following label instructions to reduce pesticide risk without increasing risk from pests.

A limited number of governmental bodies have successfully pursued these opportunities, adopting more restrictive criteria. Examples documented in Appendix A include a ban on use of pesticides for cosmetic purposes adopted by the Province of Ontario in 2009, New York City's Local Law 38 limiting pesticide uses on city property, and the City/County of San Francisco's model approach to determining which products can be used on city-owned properties that is also used in some form in other cities including Seattle and the City of Palo Alto and Santa Clara County in California.[13] *The Marin Municipal Water District in Marin County, CA has taken the approach of conducting an Environmental Impact Report (EIR) for vegetation management activities that involved a thorough risk assessment of each chemical that could be used on the property and the development of application guidelines that would minimize risks from routine use and accidental spills. The EIR is not yet complete, and in the interim has not operated as intended to date, resulting in a* de facto *ban on herbicide use in the interim.*

Additional approaches include recent restrictions placed on pesticide products and uses on all school grounds in New York State and kindergarten through eighth grade schools in Connecticut, and broad bans on pesticide use on city property in Cleveland Heights, Ohio, and Marblehead, Mass. Marblehead allows Organic Materials Review Institute (OMRI)-approved or equivalent products. Marblehead also banned synthetic fertilizers and mandated an organic turf program, to avoid unattractive, under-performing turf which can occur when synthetic inputs are removed without proactive efforts to establish healthy turf and provide necessary inputs from non-synthetic sources. Governments have

[13] Santa Clara County IPM Ordinance, http://www.sccgov.org/scc_ordinance/TOC074.HTM.

also invested in educational programs to improve the ability of managers to achieve satisfactory results under restrictions. For example, "Adjusting to Pesticide Ban Legislation: K-8 Grounds Turfgrass Management Workshop," presented in June 2011 by the University of Connecticut, funded partially by a US EPA grant, was attended by more than 100 participants.

All programs that have placed additional restrictions above and beyond FIFRA regulations include exceptions and/or procedures to obtain exemptions, e.g., to address public health threats. For example, Marblehead allows for public health director discretion in selection of pesticides for public health pests as long as any applications are consistent with an IPM approach including monitoring, thresholds and selection of least-risk options. An advisory board is empowered to grant additional waivers and has permitted limited applications to trees on school grounds and is considering a waiver for a chelated-iron-based herbicide.

Boulder: Boulder currently has a list of approved pesticides for use on city-owned land that was developed by the IPM Task Force in 2006. The city also has an assessment tool used to determine if a pesticide application is justified. The approved pesticide list is an important component of Boulder's IPM policy.

The process for adding a product to the approved list begins with staff recognizing the need for a more effective product. When staff sees a need for addition of a pesticide to the approved list, they make a request for the Subcommittee to approve a new pesticide. Staff must justify the need for the requested pesticide according to the following criteria:

- Are there effective, less-toxic methods available for control of this pest?
- Is this pesticide the least toxic product available for this pest problem?
- Have restrictions on use been adequately addressed to mitigate environmental and/or health concerns with this product?

The IPM coordinator then requests a toxicological and environmental fate review of the requested pesticide products, in which the inherent hazards of the pesticide are documented, including acute toxicity, carcinogenicity, developmental and reproductive toxicity, ecological toxicity, and ability to disrupt endocrine function in humans and/or wildlife. The review also provides information on factors contributing to exposure potential, including persistence of the pesticide in the environment, water solubility and soil mobility that may contribute to water pollution potential, as well as an evaluation of drift potential based on volatility and formulation.

The IPM Subcommittee reviews the proposed pesticide additions and votes on whether or not to include them on the approved list at a public hearing. The results of the subcommittee meeting are then brought to the city manager, who makes the final decision. The boards that make up the IPM Subcommittee receive IPM updates at their respective meeting. The Subcommittee meeting is designated only for adding or removing pesticides from the approved list, not for discussing other IPM-related business.

The City Manager did not approve recommendations made by the IPM Subcommittee at their most recent 2010 meeting. The current approved products list is incomplete, lacking least-toxic products needed to manage structural pests. The list is out-of-date, lacking lower toxicity products which are effective alternatives to products currently on the list. The result is uncertainty for the public regarding potential risks to their health and the environment and an increased likelihood that pests that might have been controlled with minimal use of a new pesticide would gain a foothold during the period of delay.

There is a clear need to revise and improve the existing approved pesticide list process with input from and agreement by staff, the public and City Council to the extent possible. Potential options include those described above.

One potentially applicable/adaptable model is the process used by the City of San Francisco. The process is explained in detail in Appendix A. Briefly, staff requests for new pesticide products are sent out to a consultant for an evaluation of the human toxicity, ecotoxicity and environmental fate of the active ingredients and any known inert ingredients. A product hazard tier is assigned (based on the toxicity and physical properties of the chemical) that reflects the inherent hazard of the active ingredients, any known inert ingredients and the formulated product. Tier I is the highest hazard, Tier II is medium and Tier III is low hazard. Any product that is placed in Hazard Tier 1 can only be approved for use in exceptional, limited circumstances (such as a severe pest outbreak) or under conditions that guarantee low exposure potential (such as ant and roach bait stations). The product is then evaluated for exposure potential, effectiveness and need. Finally, it is placed on the allowed or limited use list.

City staff reviews the list of products each year and holds a public meeting to obtain comments and suggestions by the public. Following the strict, previously agreed-upon evaluation criteria noted above assists in alleviating public concerns about particular products.

Any exemptions to the list must follow a strict protocol. Any city staff or contractors must apply to use a product that is not on the reduced risk pesticide list or one that is on the list but is used differently than described in the pesticide limitations column. The IPM coordinator for the city department must fill out the Pesticide Exemption Request Form. Only those with a well-documented need for the product or for trial use of the new or reduced risk product will be considered. If the product is approved, they must justify the use of the pesticide at the annual public hearing. A product must also be justified if there is a higher risk and it is listed as most limited use in the SF reduced-risk pesticide list.

Other cities use a similar process. For example, the City of Palo Alto conducts a scientific review of each product being considered for use. San Francisco and Palo Alto share reviews to reduce costs. Palo Alto does not use an approved list of pesticide products; rather they maintain a short list of “do-not-use” products that reviews indicate are especially problematic, including several insecticides and rodenticides. There are no

herbicides or fungicides on the list. Palo Alto city staff meets annually to set IPM goals for the year ahead based on existing pest problems. All IPM program and pesticide use information is publicly available by pest, location and pesticide.

Recommendations: Revise the formal pesticide approval process to align approvals with well-defined, updated, science-based criteria based on product hazard tiers and exposure potential, using or adapting the model proposed in Appendix C. These criteria should be created with public input, recognizing that community, management and staff consensus on the criteria is ideal but may not be completely achievable.

Costs: *Staff Time:* IPM coordinator: 40-50 hours per year in the first two years, 25 hours per year after initial setup of IPM-TAC and pesticide approval process. Staff representing their departments on the IPM-TAC: 30 hours for each representative in the first year; 20 hours per year thereafter.

Pesticide Reviews: Pesticide reviews at the level of detail described in Appendix C can be completed for $450–$750 each. If a full literature search is requested,[14] a review can be done for $1,500-$2,500 each. Costs can be minimized by cost-sharing with other cities that agree to participate. San Francisco, Palo Alto and Seattle would be likely candidates and both San Francisco and Palo Alto have expressed interest in participating. Lower cost options include collaborating with the University of Colorado or other public sector scientists to complete reviews.

Benefits: Revision and improvement of the process for inclusion of a pesticide on an approved list has several benefits:

- The structured pesticide review process and hazard tier ranking system would be based on existing scientific data that includes both US EPA-evaluated studies conducted by the manufacturer and any available peer-reviewed studies.

- The combination of using Boulder's existing decision-making flow chart and pesticide reviews based on the product hazard tier system would provide an overarching framework that ensures that pesticides are used only when absolutely necessary and least-toxic pesticide products are selected in those cases. This approach would ensure that Boulder maintains a precautionary approach to pest management. Additional protections could be implemented if desired, by limiting the amounts of pesticides used by each department in a given year, using a system that takes into account the need to respond to variability in weather and to complete specific projects that may be time-limited. Taken together, these strategies will give the public greater confidence that pesticides are not the first approach, but are only used when other less-toxic pest management tools are clearly inadequate for solving the problem.

[14] Questions sometimes remain about the quality of data submitted by pesticide manufacturers and/or applicability of the toxicity tests to specific situations. In these cases, additional literature studies are typically available that can provide scientific evidence for adverse effects if they exist.

- The work of pest management would become more predictable for staff, who would have greater flexibility in making their own decisions about where and when to use a pesticide if it becomes necessary.

The process provides an ongoing method for reducing the toxicity burden of pesticides used in the IPM program and an avenue to revisit decisions on approved pesticides. This is helpful when a new, less-toxic product is introduced with potential to replace a product already on the list or when new hazards are discovered about an existing product on the list.

5.D IPM Committee

Best Practices*: An organizational structure that provides for communication and collaboration between responsible entities within the organization is also critical to success, especially in organizations with multiple entities responsible for different aspects of pest management. To ensure that the full scope of pest management issues are effectively dealt with, the IPM Committee should be comprised of representatives from all organizational entities as well as community members. Regular meetings should be held that effectively address the issues arising within the IPM program. Specific tasks for the committee should be outlined in a written charge to be reviewed and updated annually.*

Frequent, regular meetings of representatives of all departments have worked well in other cities for continuing education, sharing expertise and information among staff and with the public, and developing, refining and meeting objectives and timelines. For example, in San Francisco, monthly meetings open with an informative presentation followed by discussion and work on specific agenda items. Meetings are open to the public and public comment is permitted at some meetings at specific times on the agenda.

Boulder: Boulder maintains an Interdepartmental IPM Review Group which is required by Boulder's IPM Policy. This group is required by the policy to meet at least quarterly to discuss IPM goals, evaluate and review plans and opportunities for information exchange, education and cooperation. The Interdepartmental IPM Review Group is also charged with making policy recommendations to advance the objectives of the IPM policy to reduce pesticide use. The IPM coordinator organizes this group that includes department IPM representatives and other interested city staff. Members typically include representatives from Parks and Recreation, Urban Resources, Open Space and Mountain Parks, Urban Forestry, Flatirons Golf Course and Public Works and Utilities maintenance. Others may attend depending on the topic of the meeting. While staff working on IPM projects is in regular contact, the IPM Review Group does not meet on a formal basis at regular intervals.

Boulder formed an IPM Subcommittee to review pesticide products proposed for addition to the approved product list. The Subcommittee includes one member each from the Environmental Advisory Board, the Parks and Recreation Advisory Board and the Open Space Board of Trustees. Board members are citizens, not city staff, appointed by the City Council. Subcommittee members don't necessarily have any experience with IPM

or pesticide products. Depending on the frequency of meetings, each session of the Subcommittee may have different members since board members generally have five-year terms. Currently, the IPM Subcommittee does not meet on a regular basis, only when the need to add a product to the approved list arises. Boulder also maintains a scientific advisory group and a stakeholder group.

The IPM Subcommittee was first convened in 2007. Fourteen pesticides were voted unanimously to be added to the Approved Pesticide List. The second meeting of the subcommittee was held in 2010 with nine products requested, eight of which were recommended for approval. Members of the public in attendance voiced concerns regarding these products. The City Manager determined that none of the products would be added until a review of the process was completed.

Recommendations: Reevaluate the need for the IPM Subcommittee based on the outcome of revisions to the pesticide approval process. In addition, replace the Interdepartmental IPM Review Group with a new IPM Technical Advisory Committee (TAC) of the IPM representatives from each city department to be chaired by the city IPM coordinator. The TAC name better reflects the expanded roles we propose for this group. In addition to assuming the current responsibilities of the IPM Review Group, the TAC should ideally meet monthly to discuss new and ongoing pest problems, share information and collaborate on problem-solving and on completing the IPM plan template, IPM plans and plan updates. We have also detailed a proposed role for the TAC in a revised pesticide approval process (Appendix C) which includes discussion and nomination of pesticides for review for addition/removal from the city's approved list, and development of recommendations to the IPM Subcommittee following review. Meetings should be open to the public but not necessarily provide for public involvement in every agenda item. TAC meetings are designed to improve communication and collaboration within the departments. These meetings can also provide a forum for presentations on IPM topics from both staff and outside experts.

Costs: Approximately four hours per month per staff representative, on average, for meeting preparation, attendance and follow up. Much of the meeting preparation time would be for assignments, e.g., preparation/updating of IPM plans, covered in other recommendations in this report.

Benefits: Reduced duplication of effort, increased awareness of common challenges and solutions, enhanced continuing education, efficient use of existing expertise and resources, improved focus on priorities and greater accountability regarding timelines.

5.E Contracts

Best Practices: *Written contracts for the implementation of required services that staff cannot provide, such as structural pest control, are essential for accountability and performance evaluation. Contract provisions should detail overall goals; scope including sites and pests to be managed; qualifications for individuals providing contracted services; visit frequency and schedule; recordkeeping requirements; and*

general specifications including compliance with policies and ordinances. Contracts should be current, i.e., revised and renewed after expiration. All contracts should undergo legal review for compliance with regulations including tax statutes distinguishing contractors vs. employees, and for appropriate liability risk management. For instance, the City of Boulder may request to be listed on the contractor's liability policy as an additional insured.

Contractors should be fully informed of the contract specifications and be required to document their qualifications for meeting the specifications during the bidding process. The contractor should provide an IPM plan addressing the facilities and pests to be covered under the contract. A number of municipalities including the City/County of San Francisco require potential bidders to submit a plan for a sample site as part of the bidding process. Potential bidders are invited to review the site selected to help them prepare the plan. The City of New York has a similar RFQ process for pest management providers. All pest management providers servicing NYC schools must be Green Shield Certified and adhere to IPM protocols.

The contracting party should have adequate staff or contracted expertise review contractor performance on a regular basis to ensure contract specifications are being met. A sample contract is provided in Appendix H. Additional resources are located at http://www.ipminstitute.org/Public_Agency_Commercial_Facility_IPM/Public_Agency_Com_Facility_IPM.htm, including a sample request for qualifications (RFQ) for structural pest management services (http://www.ipminstitute.org/Articles/San%20Fran%2007%20RFP83518%20CCSF.pdf.)

Boulder: The city IPM policy stipulates that all contractors conducting pest management on City of Boulder property are required to adhere to the city's IPM policy and plan(s) for sites serviced by the contractor. Contractors are to provide an IPM plan for their services, or have the city provide a plan. Requests for Proposals (RFPs) stipulate that contractors must follow the IPM policy.

Most departments currently use contractors for some pest-related work. OSMP gives contractors detailed instructions for pesticide use, applications and target pests.

The structural pest control service provider performed scheduled services to the following Parks and Recreation properties in 2010: Boulder Creek P&R Project, Forestry Building, Park Ops, Reynolds Library exterior, West Senior Center exterior, Tantra Park shop, Tom Watson and Valmont Storage. Facilities and Maintenance reported the following scheduled applications in 2010: South Boulder Recreation Center, City of Boulder Park Ops, City of Boulder storage, East Boulder Community Center – Park, West Boulder Senior Center – Exterior, Tom Watson Park, Reynolds Branch Library, City of Boulder Parks – Tantra, City of Boulder Main Library, City of Boulder – Forestry Building and Foothills Community Park office.

Currently, no written contract is in place with the structural pest control contractor, and no IPM plan has been provided by or to the contractor as required by the IPM policy.

Documentation provided for this evaluation included invoices for services provided which do not provide the detail required by the IPM policy including target pest, pest population levels or thresholds, etc. City oversight of the contractor is inadequate. If contracts are not required for tasks under a certain dollar amount, an alternate process needs to be in place to ensure service providers completing non-contract work comply with the IPM policy and pesticide ordinance.

Although the IPM policy stipulates that its provisions apply to city facilities leased to others, tenants are currently responsible for pest management in those facilities and may contract with service providers. Lease terms do not currently include IPM, or stipulate the provisions in the Boulder IPM policy that apply to these facilities.

We did not review contracts or performance of other contractors such as those completing projects for OSMP or Urban Forestry staff.

Recommendations: Review and revise the current contractor selection process to include an RFQ that conforms to the IPM policy and pesticide ordinance. Include contractor development of a sample IPM plan for one facility as part of the proposal review process. Develop an IPM-based contract compliant with the policy and pesticide ordinance, and secure adequate training for the IPM coordinator and/or departmental managers to provide contractor oversight, or secure outside expertise to provide periodic review of contractor performance vs. contract. Alternate arrangements need to be in place to ensure service provider compliance with the policy for work where a contract is not required, e.g., bids under $10,000, such as a requirement that all bids contain specific language guaranteeing compliance with the provisions of the IPM policy.

Costs: Approximately 80 hours or 0.04 FTE to adapt existing model RFQ and contract documents to Boulder IPM policy and pesticide ordinance specifications, post RFQ, educate potential bidders, review proposals and select successful bidder(s). Approximately 20 hours or 0.01 FTE for initial staff training, and 20 hours or 0.1 FTE annually for staff time to oversee contractor performance.

Benefits: Improved contractor performance and compliance, reduced liability from pesticide risk and pest-related disease risk, reduced pesticide use, fewer pest complaints and improved employee satisfaction from reduction in pests.

5.F Budget

Best Practices: *An ideal budget should be adequate to meet goals stated in the IPM guidance documents including overall program management, coordination and evaluation, full implementation of IPM plans for all sites and facilities, staff continuing education, competent contractors and continuous improvement. IPM programs, while generally cost-effective in the long term, necessarily involve start-up costs including training, research into best practices and options, plan and process development, maintenance to improve exclusion, documentation and evaluation. Ongoing costs, including the cost of staff FTEs for program management and coordination, can be offset*

by reductions in pesticide costs, reductions in staff time spent dealing with pest complaints, improvements in employee health and satisfaction, reduced liability and/or other benefits listed throughout this report. Therefore, in reality, IPM program development is most often constrained by available resources and must be phased in along a timeline of activities prioritizing activities to address the most pressing risks, low hanging fruit (activities that can generate the greatest return for the least investment) and activities that if delayed, will increase costs in the future. Reductions in pesticide costs are often not achievable in programs at the high end of the IPM continuum where pesticide use is minimal, and alternatives including reduced-risk pesticide products, can often be more expensive.

Boulder: Detailed, comprehensive and consolidated budget information for Boulder's IPM effort has not been developed and will not be for the purposes of this report. Most staff positions include multiple responsibilities in addition to IPM-related roles, complicating budget determinations. Rough estimates provided for this evaluation indicate annual pest-management-related expenditures of at least $671,000 for Parks and Recreation, $100,000 for Public Works and $200,000 for OSMP.

The City of Boulder utilizes a three-tiered system to determine funding priorities. All proposals are placed into either the fiscally constrained, action plan or vision plan categories. The fiscally constrained category represents opportunities under existing budgets, including reprioritizing current resources. The action plan category represents opportunities with potential to be developed when funding becomes available from current revenue sources or if new sources are approved. Finally, the vision plan includes the complete set of services desired by the community and aligned with local values and policies under unlimited resources. A table outlining each recommendation within the budgeting categories used by the City of Boulder is included in this report on page 66.

Recommendations: Increase or divert resources to address priority risks including inadequate exclusion and sanitation, and improper pest control practices in food service and other facilities to reduce risk of human diseases from pests and pathogens. Although structural pest management and specifically food service is a small part of the overall IPM program, addressing these sites is critical due to the immediate public health risk. Address low-hanging fruit including properly installing effective door sweeps which can reduce pest complaints by 65%, and also reduce heating and cooling losses, keep dirt out and reduce oxygen flow in the event of fire. Address inability to reach all priority sites each year, which results in higher costs in future years to address larger seed banks and dissemination to larger areas.

Additional resources could accelerate progress in fully implementing the city's IPM program. Key opportunities exist to secure federal and state grants, and private sector contributions, and to expand collaboration with public and private sector organizations on research and demonstration projects. For example, near-term opportunities may exist to collaborate on funding development and implementation of structural IPM in city facilities with the University of Colorado. City staff indicated state funding opportunities for invasive species management and restoration have not been tapped to the extent

possible. Example potential funding opportunities are listed in Appendix F. The Foundation Center (www.foundationcenter.org) provides a searchable database of private foundations. Grants.gov (www.grants.gov) provides a daily list of grant opportunities by email. City staff expertise is more than sufficient to establish credibility with third-party funders. However initial success in securing funding from a new third-party can be enhanced by collaborating with an entity that already has an established relationship with the funder.

Priority opportunities for applying additional budget resources include restoration and re-vegetation to prevent establishment of weeds, transitioning seasonal positions to permanent to reduce recruitment and training time, and improve level of performance. Evaluate the use of volunteers for opportunities for improvement. Staff has indicated the use of volunteers is generally not as effective as it could be, e.g., initial response is often good but participation by volunteers is not sustained. A shared community educator could assist with communications including posting, as well as more effectively addressing pesticide use and risks generated by business and resident use. A shared grant funds development position would likely more than pay for itself given state, federal and private sector funding available to support invasives management and natural areas restoration.

Costs: Cost estimates are provided for each recommendation throughout this report. Adding a part-time development person to tap federal, state and private funding sources for pest and pesticide risk reduction would likely have a positive return on investment and help Boulder accelerate its progress.

Benefits: Sufficient funding should result in facility and site condition that is adequate for intended uses, without impairments related to pests or pesticides, and a documented reduction in pesticide use and pest complaints.

5.G Management

Best Practices: *Organization and staff commitment to the IPM program is essential for success. A management structure that has a committed staff person in charge of overseeing the IPM program and sufficient well-trained staff to implement the IPM plan is most effective. Support from upper-level management is critical for the program's effectiveness. For example, management needs to support priority recommendations for improvement identified by the IPM coordinator, who in many cases will not have the authority to direct the actions of staff in the affected department or division, or contractors or tenants. City management must also be capable of implementing sound, science-based decisions in the face of opposition from vocal community members.*

Boulder: The IPM coordinator in Boulder currently reports to the manager of the Comprehensive Planning Division in the Community Planning and Sustainability Department. City management staff has committed significant time and funding resources to this ten-year evaluation including this report, and has provided substantive input on the evaluation process and report drafts. Management has expressed a strong

commitment to fully implementing Boulder's IPM program as per the guidance documents, to continual improvement in the pest and pesticide arena, and to maintaining Boulder in a leadership position nationally.

Opportunities exist for improving communication and mutual understanding of efforts, roles, responsibilities and resources between management and staff. Staff indicated a strong desire to improve management awareness and understanding of the challenges they face in implementing their responsibilities.

Management needs to stay up-to-date on the roles of operational IPM staff, their day-to-day activities and challenges they face in balancing IPM policy objectives, state mandates, budget constraints, community concerns and other pressures while achieving acceptable site and facility conditions. These challenges include improvements, e.g., in the pesticide approval process, and the ability of management staff to approve and implement those improvements if consensus is not reached including with members of the community.

Recommendations: Management structure, experience and commitment are sufficient for continued progress. The comprehensive and transparent evaluation process Boulder is undertaking should help improve awareness and understanding of constraints facing both management and staff among city employees and the community. In addition, addressing other recommendations including regular TAC meetings and resumption of annual IPM reports should help communications on an ongoing basis. Occasional management participation/observation of TAC meetings, management ride-alongs with field staff and staff presentations on IPM annual reports and project successes at management and city council meetings are potential opportunities to improve mutual understanding. Strong leadership will likely be needed to implement effective improvements, including in the pesticide approval process, given that some of Boulder's citizens would strongly prefer that no pesticides be used, and others would prefer no dandelions, a challenge faced by every municipality.

Costs: Costs are minimal including personnel time to participate in staff/management meetings, observe field staff at work.

Benefits: Improved communication, greater appreciation of challenges and constraints faced by staff and management, improved employee satisfaction.

5.H IPM Coordinator

Best Practices: *The IPM coordinator should have experience in IPM and be up-to-date in knowledge of BMPs, trends in IPM and local issues affecting the IPM program. The coordinator should take advantage of continuing education opportunities to stay abreast of new developments in the field. The coordinator should have management experience (hiring, staff oversight and performance review, project management, budgeting) and the authority necessary to do the job. The coordinator needs support from a chain of*

command that will ensure priority recommendations are implemented by staff, tenants and contractors over which the IPM coordinator has no direct authority.

Boulder: The city's IPM policy specifies an IPM coordinator position and roles to be located in the Department of Community Planning and Sustainability. In the past, this position as been 0.5 FTE. This position has been vacant for long periods of time since the policy was adopted in 1993. For several years, this position was held temporarily by individuals whose primary responsibilities were in other departments or positions. The position was filled in 2009 by an experienced entomologist and has recently been increased to 0.75 FTE.

Recommendations: Continue to provide training opportunities for the IPM coordinator and supplement coordinator expertise with collaborators and/or contractors to assist with priority improvements, e.g., addressing structural pest management deficiencies, transitioning to natural turf, improving record keeping, evaluation of opportunities for improvement on agricultural acres, golf course and other sites. As resources allow, consider increasing the position to 1.0 FTE and/or providing additional assistance for specific tasks that can be delegated such as scheduling meetings, preparing agendas, maintaining minutes, help with preparation of the annual report and assisting departments/divisions with preparation of their IPM plans.

Costs: Up to 0.25 FTE at IPM coordinator level, up to 0.5 FTE at assistant level.

Benefits: Faster progress in fully implementing the IPM policy.

5.I Staff

Best Practices: *Staff responsible for implementing the IPM plan should have the appropriate experience and adequate training to do the job. Staff in all contributing departments should be fully engaged and involved in IPM planning and decision making, and effective communication and collaboration between departments should occur. The organization should ensure that sufficient FTEs are available to do the required work, open positions are filled promptly and turnover is minimal. Staff should participate in continuing education on a regular basis to maintain their currency in the field of IPM.*

Boulder: City technical staff is extremely knowledgeable in their areas of expertise and on pest management issues specific to Boulder. Staff has an accomplished track record of addressing pest issues, particularly in landscape, turf and open spaces and is very committed to meeting the needs of City management and community members. There is generally long tenure with low turnover. While staff members are familiar with the state of the science in their disciplines, some reported inadequate budgets for continuing education, e.g., for attending conferences in their field to learn from experts and establish networks with colleagues facing similar challenges.

Recommendations: Improve opportunities for staff continuing education and networking by budgeting for one annual or every-other-year opportunity such as national

or regional conferences. Increase opportunities for staff to communicate directly with management and citizens, and for Boulder to highlight its investment in expertise, e.g., by presentations at management and public meetings. Improve opportunities for recognition of individual staff members and teams for outstanding contributions to Boulder's IPM program and goals for protecting health and environment.

Costs: Ensure that staff continues to receive opportunities for training and to attend conferences. Expand the budget for continuing education as funding allows.

Benefits: Improved staff expertise, particularly regarding new developments not yet published in trade or professional journals; greater employee satisfaction; improved networking and more effective relationships with leading researchers and implementers in specific fields; maintenance of Boulder's national leadership position in IPM and health and environmental risk reduction.

6 Evaluation and Recommendations – Legal Compliance

IPM program operations are generally impacted by a range of legal requirements in addition to any policy obligations. Federal, state and local regulations address elements including pesticide applicator training, licensing and certification; posting and notification requirements; right-to-know access to pesticide product labels, Material Safety Data Sheets (MSDS) and other documents; pesticide storage and disposal; off-target movement of pesticides or drift; protection of endangered species; and management of noxious or invasive organisms.

Best Practices: *All staff, contractors and supervisory personnel responsible for implementing IPM should meet legal qualifications for the work they will be expected to do, including pesticide applications. Pesticide applicators, handlers and supervisors of those staff should be knowledgeable about all legal requirements pertaining to pesticide applications, including those addressing possession/retention of labels and MSDS, posting and notification, pesticide storage and disposal including disposal of empty containers, and prevention of off-site pesticide movement (drift or runoff). Staff should also be aware of any additional regulations that apply to their work, such as noxious weed mandates, endangered species regulations and local ordinances.*

Boulder: In 1981, Boulder passed a pesticide ordinance addressing pesticide safety not covered by federal and Colorado statutes (http://www.colocode.com/boulder2/chapter6-10.htm). Key provisions include:

- Commercial applicators must maintain application records and provide a complete copy to the contracting party immediately following the application.

- For "airborne application" which includes misting, fogging or spraying plant materials greater than five feet in height, to city park or open space property, signs shall be posted at each trailhead, street access or sidewalk entry point and any additional common access points. The ordinance specifies size, height and dark lettering on a bright yellow background. Such notices are also required to be provided to adjacent property owners for airborne applications made by property owners or commercial applicators.

- Users applying pesticides outdoors must display a warning sign for at least 24 hours following each application. Individual spraying of weeds (less than three feet distance) and spot treatments of less than one-hundred square feet on a lot are exempt from this posting requirement.

- Additional provisions address spill prevention, protection of city water supplies from contamination during pesticide mixing and filling operations.

All state and federal posting and notification requirements appear to be met and exceeded. City divisions, contractors and others covered by the ordinance and not yet fully engaged in the IPM effort are likely not in full compliance with the ordinance.

Based on applications observed during our visit, e.g., unsecured rodenticide bait boxes placed outdoors, a contractor does not appear to be following Boulder's pesticide ordinance regarding posting and notification, and does not appear to provide complete records to the city or tenants as per the policy. The ordinance states that "airborne applications or tree spraying (over five feet in height) requires notification before and after application" and that "all pesticide use requires notification immediately after application except for spot treatments of individual weeds or treatment of areas less than 100 square feet on a lot." Notification of all outdoor pesticide use requires a "sign that must be posted immediately after application and remain posted for 24 hours." There are currently inadequate products on the approved list for treatment of stinging insects and a notification process will be developed in 2012. Some products were added under the interim guidance approved by the city in 2011.

Boulder staff and contractors appear to meet or exceed all legal requirements for applicator training, licensing and certification. According to state law, city staff is not required to have Colorado pesticide application licenses. However, most IPM managers have current qualified supervisor licenses. Additionally, interdepartmental safety training for full time and seasonal staff who works under the supervision of licensed staff is held on a regular basis. It is assumed that any contractors are properly licensed but there is currently no procedure in place for checking their status.

Staff follows a strict written protocol for pesticide notification procedures based on local, state and federal laws. Posting and notification of pesticide applications by staff goes above and beyond current ordinances and laws. Notification signs for outdoor applications are posted for all pesticide applications on public property at least 24 hours in advance and post-application notices are on site for 24 hours after the application. All pesticide and fertilizer applications are also posted on the phone line, IPM hotline and the RSS feed the Friday before any application is planned for the following week. All residents on the Chemically Sensitive Registry are notified for applications that occur near their residence. Outdoor applications are included on the RSS feed and IPM hotline. Any applications occurring outdoors have notification signs posted at the access points to the area. Some notifications cause concern for citizens as they see the signs and assume large-scale spraying when in fact the applications are nearly always low-impact stump painting or spot sprays. This results in citizen complaints about pesticide use even where use and potential for exposure is very minimal.

In the majority of cases, staff meets and exceeds the following ordinance for outdoor pesticide applications: "Outdoor Pesticide Applications: Requirements for outdoor pesticide applications depend on the type of application. The only type of application that requires pre-notification is airborne applications, which is defined as the application of pesticides by misting or spraying plant materials that are greater than five-feet in height (BRC Section 6-10-11). Current policy is to pre-notify for all applications, including tree trunk and soil injections. All occupants on all adjacent properties must be given at least 24-hours notice prior to application and the notice is valid for up to seven-days. If a property adjacent to the airborne pesticide application is a commercial property or a multi-family residential dwelling, then the applicator of pesticides must make a

reasonable attempt to notify the owner or manager of the property at least 48-hours prior to pesticide application. The manager or owner must post a notice in a prominent place indicating that the adjacent property will be treated. The city's code does not require prior notification for non-airborne, outdoor pesticide applications, which is defined as applications under five feet in height, including ground application. Post-application notification is required at the time of pesticide application and the warning sign must be posted for at least 24-hours or longer if suggested or required by the label of the pesticide manufacturer. Spot treatment of weeds on a total area of less than 100-square feet is exempted from post-application notification."

Staff uses the following written protocol for all indoor pesticide applications on city-owned properties: "Tenants are to be given at least 48-hours and not more than seven-day notice by the property owner prior to an indoor pesticide application. Notice can be given by mail, personal delivery, doorknob hangers or by putting notices under doors. The notice must minimally contain the proposed date and time of the pesticide application, the dwelling or unit room number, the pesticide to be used, the contact names and telephone numbers of the pesticide applicator and the property owner. For treatment to common areas, the notice must be posted at a common point of entry to that area. Businesses planning a pesticide application must "provide reasonable notification of such application sufficient to allow an opportunity to avoid exposure to all persons having their principal place of employment at a work site prior to any pesticide application to any part of the work site where such employee would, upon reasonable inquiry, be expected to work within twenty-four hours following the pesticide application" (BRC Section 6-10-7).

All departments have appropriate right-to-know posters and other information posted. MSDS labels are available to staff and citizens for all products used. The IPM coordinator has a book with all of the pesticide product labels, as does each department. Copies are also available in pertinent vehicles. Each department is expected to store any pesticide products in a locked, ventilated storage facility with limited access.

Staff is knowledgeable about the State of Colorado Noxious Weed Management Program that divides weeds into three lists, A, B and C. All List A species are designated for eradication and must be managed as such. List B and C species must have management plans to reduce populations and prevent spread. New species are added to the lists annually. These regulations appear to be followed by Urban Resources and OSMP. They have BMPs and management plans for these species and carefully document their progress using GIS mapping. Documentation includes mapping of the species and records of pesticide use, and mechanical and cultural controls.

Pesticide drift protocols vary by department, but are not written or provided in formal training. Urban Resources follows the label requirements, does not spray if the wind is greater than ten mph and utilizes some additional application techniques such as spot spraying, low pressure, nozzles angled toward the ground, not spraying when temperatures are high with low humidity or during temperature inversions, and keeping the application close to the ground. OSMP follows these procedures and uses a seven

mph maximum wind speed for applications. The IPM application methods employed by staff in all of the departments generally reduces the risk of pesticide drift.

Recommendations: Create a checklist and timeline for compliance with all Boulder pesticide ordinance provisions and integrate this with the IPM policy checklist/timeline. Bringing all contractors and tenants into compliance with the pesticide ordinance should be a top priority to improve pesticide safety and reduce liability. Incorporate ordinance compliance education into community outreach, including on the website.

Cost: Estimated 40 hours in staff time to create checklist/timeline and review legal compliance with departments/divisions not fully engaged, contractors and tenants.

Benefits: Reduce pesticide risk including risk of accidental and non-target ingestion of rodenticide. Reduce liability.

7 Evaluation and Recommendations - Open Space and Mountain Parks, and Urban Resources IPM/Natural Lands

Best Practices: *Organizations should maintain current, detailed inventories of all sites, and accurate assessments of managed sites including ability to meet intended uses which may include recreation, agriculture, forestry, contributions to air and water quality and species diversity, and preservation of native ecosystems and species. At a minimum, staff expertise and budgets for staff, equipment and supplies should be adequate to maintain the condition of managed sites to meet intended uses. Resources should also allow for improvement in condition over time, understanding that budgets will fluctuate from year to year depending on external factors including economic growth. Application of staff time and other resources at specific sites should be prioritized according to factors such as level of impairment in meeting intended uses, feasibility of achieving desired results with resources available and cost/benefit of acting now vs. deferring action to a later date. Operations should be consistent with an overall IPM policy committing to maintaining resource quality while minimizing the impacts of pest management, and current written plans should detail how pest management will be performed in conformance with the policy and needs of specific sites.*

Boulder: The City of Boulder Open Space and Mountain Parks Department (OSMP) owns or has interests in 45,288 highly diverse acres including forest, grasslands and agricultural lands producing livestock, forage and small grains, and manages 35,219 of those acres. The Urban Resources IPM and Conservation Workgroup (Urban Resources IPM/Natural Lands or UR IPM) which is housed within the Parks and Recreation Department manages approximately 1000 acres of natural land associated with the park system, including natural areas at Coot Lake, Boulder Reservoir and parks sites. Due to the similarities among the two programs, we have included both in this chapter.

City natural resource specialist staff members leading OSMP and UR IPM are extremely knowledgeable about noxious weeds and BMPs. They are aware of published and to a lesser extent emerging research on alternatives to chemical controls and are networked with scientists conducting that research and with colleagues in their field. BMPs are updated every three years. Annual literature searches are completed for new and unfamiliar noxious weeds identified at OSMP or UR IPM sites. Staff is very committed to maintaining biodiversity including historic natural environments, and understands the need to balance ideal desired outcomes, budget constraints and community concerns about pesticide use.

Invasive species management and habitat restoration are priorities to protect natural resources and meet state mandates. OSMP and UR IPM have compiled a detailed draft plan consisting of BMPs by species for priority weed plants. Staff has carefully documented, prioritized and mapped an extensive list of invasive species and sites at risk. Criteria for prioritization are extensive and science-based and include presence of Colorado A List species, quality of native vegetation, presence of water resources including wetlands, wildlife species and potential for successful outcomes.

7.A Practices, OSMP

OSMP has completed a series of management plans including a *Forest Ecosystem Management Plan* in 1999, a *Visitor Master Plan* in 2005 and a *Grassland Ecosystem Management Plan* in 2010. These documents detail how the city will manage OSMP sites to optimize recreation and natural resources conservation.

OSMP's *Ecological Best Management Practices for Trail Planning and Design, Construction, Maintenance, and Closure*, along with the Department's IPM Treatment Reports for 2008, 2009 and 2010 form the basis for the following summary.

- OSMP's BMPs have been developed to address natural resources including plants, animals, soils, geological formations and water. The BMPs in the report assist in protecting the natural environment as it may be impacted by trail construction and maintenance. In addition, OSMP *Visitor Master Plan* has four goals that are supported by this document:
    1. Enhance visitor experience
    2. Improve access
    3. Enjoy and protect
    4. Partner with the community

- Management of invasive and noxious weeds that move in to disturbed trail areas are a priority that is responsive to state law. When weeds move in to these disturbed areas, they can and do spread into the surrounding grassland or other areas if left uncontrolled. OSMP is under a mandate from the State of Colorado to eradicate weeds on the state A & B Lists with some exceptions.

- All trail construction and maintenance requirements and guidelines are clearly set out in the BMPs. This is defined so that there is the least negative impact on natural resources.

- Mechanical, chemical, biological and cultural IPM treatments are used to manage weeds on the grasslands, forest and trails. Chemical and cultural IPM treatments are used in the management of agricultural land.

- Non-chemical methods are applied to 70 to 80% of treated acres each year.

- OSMP staff works with Boulder County, USDA Natural Resources Conservation Service (NRCS) and others to preserve and promote use of native plant seed and other propagation material specific to Colorado's Front Range. They participate in an interagency group to collect and raise native plant species that may be unavailable commercially, and currently have five grass species at NRCS Plant Material Centers in Los Lunas, New Mexico and Meeker, Colorado. Negotiations are in progress with the Colorado State Forest Service to increase populations of native woody shrubs.

- OSMP pesticide use averages 64 gallons of formulated product per year, with 80% of that amount applied to agricultural lands. Pesticide use on non-cropland is minimal, with about 12.5 gallons of formulated product used per year on average and representing about 19% of total OSMP use. Forest and Conservation Reserve Program (CRP) land represents less than 10% of pesticide use on average. Chemical controls on non-cropland are predominantly applied to grasslands and exclusively for weeds.

- The majority of chemical applications are spot treatments, i.e., applied to very limited areas using low-volume methods such as brushing herbicide on freshly cut tree stumps or spot-spraying individual weeds with a backpack sprayer.

- Records are kept of all applications including site, target insect or weed, product, rate and area treated. Use is tracked by location type, e.g., grassland, forest, cropland. Non-chemical measures are also tracked and recorded. Basic comparisons are generated of use over time and per location type.

- OSMP depicts all chemical and mechanical treatments using a Geographic Information Systems (GIS) model of weed pressures that also generates acreages. This can inflate or deflate the interpretation of any given treatment. Long term monitoring and planning in relation to management is the primary goal for these data. The data are used here to look at averages and trends. Acreage and product fluctuates from year to year as individual weed species or areas are targeted for management in any given year. Please see Appendix I for pesticide use and non-chemical methods data.

7.B Practices, UR IPM

UR IPM's *Three Year Management Plan* (2008-2010) combined with *Urban Resources Integrated Pest Management and Conservation Crew's Summary of Crew Activities* from 2008 and 2009 serve as the basis for the following summary.

- Park properties are ranked in tiers based on developed criteria, with management strategies developed for the top 32 properties. In the fall of 2008, 782 acres were mapped for invasive weeds. The basic weed management program generally calls for three years of mechanical control strategies followed by a chemical application in year four if determined to be necessary. The weed management strategy is in place for weeds on the State of Colorado A and B Lists, with the greatest emphasis on A List weeds, as legally required by the state. Varying degrees of eradication and levels of management are evidenced. Mechanical control strategies are the dominant method of choice. Biological control agents are part of the control strategy when they are available and have shown good success. Cultural strategies such as re-vegetation are a key part of the overall program. Choosing whether to use mechanical or chemical control varies by weed species. Chemical control strategies include a schedule with protocol for

specific weed species. Chemical choice and timing of application varies by weed species.

- The IPM and Conservation Crew was created in 2004 to eradicate priority weed species with a focus on priority parks, restoration using mechanical, cultural and biological methods, and community education and outreach. Staff size was reduced from five to three due to budget constraints in 2009. Crew size increased to five in 2010 and decreased to four in 2011.

- Pesticide used in spray applications averaged 3.2 oz/acre in 2008, 2.2 oz/acre in 2009 and 0.58 oz/acre in 2010.

- Spot applications (limited to treatment of individual plants or small groups of plants) of pesticides increased in 2010 to 13.98 oz. vs. 5.8 oz in 2009. Acreage treated with spot applications increased as well from 2.6 acres in 2009 to 24 acres in 2010.

- Hours spent on mechanical controls, e.g., pulling weeds, increased from 2008 to 2010. In both 2008 and 2009, 4% of staff time was spent on cultural controls including re-vegetation of areas disrupted by IPM activities or barren areas. Time spent on cultural controls increased in 2010. In 2009, seeding rates used by UR IPM appeared to be on the low end of the recommended range.

- Time spent on community education and outreach dropped from 2.5% of staff time in 2008 to less than 1% in 2009 when staff numbers were reduced, and increased in 2010 to 2%, including staffing a table at the Farmer's Market.

- Biological controls have been used to some degree for the past ten years. They are not an approved method for dealing with weeds on the State of Colorado's A List. The department has met with some successes and some marginal gains. We encourage efforts in this area to continue as new science emerges.

7.C Specific Site Characteristics, Natural Lands

Soil test data were submitted for four OSMP locations: two Jewell sites and two Dunn II sites. The Jewell sites sampled were from a disturbed and undisturbed power line burial area. Dunn II sites were from a trailside and the adjoining grassland. Soil analyses were also completed for Wonderland Lake, Shanahan Ridge and Maxwell Lake Park, Harlow Platts and North Dam, all of which contain natural lands. Soil analyses are reported in Appendix I.

Soil testing is used to measure the amount of nutrients, humic matter and exchangeable acidity of soil. This helps to determine what types of plants will do well at the site, and if feasible, fertilizer and organic matter needs to be added to the soil. Fertilizer and other amendments are rarely practical on natural lands except where restoring limited-acreage disturbed sites, and can be detrimental by providing nutrients for weed growth. In

general, knowing exactly what nutrients or other inputs are needed saves time, money and environmental costs by enhancing ability to select appropriate plants, and/or only adding what is required for desirable plant health.

7.D Recommendations, Natural Lands

Recommendations: Recognizing the challenges present with Boulder's climate including limited rainfall, challenging soil conditions and impracticality of irrigation in most situations, continue an integrated approach prioritizing non-chemical methods. There is some potential to increasing seeding rates to establish a strong foundation of the desired vegetation. Where feasible, improve grass plant density within existing grasslands rather than re-establishing cover on predominately bare ground created by eliminating current vegetation. Continue collaborative efforts to collect and propagate native plant material, and to focus staff time on cultural methods to improve density of desired plants and prevent weed establishment, and where necessary, biological and mechanical interventions.

Cost: Additional labor for seed collection, propagation and distribution; additional costs for purchased seed and distribution.

Benefits: Increased seeding rates have potential to improve establishment and reduce weed competition. Cultural practices that provide for gradual improvement in plant density create a situation where the desirable species begin to develop a competitive advantage over some weeds.

7.E Agricultural Lands

Agricultural lands include farms purchased by the city with continued use for grazing cattle and forage production including corn, alfalfa and small grains. The original owners continue to manage production on a number of these sites. As of 2009, 24,000 acres of the 45,288 OSMP lands were considered grassland with agricultural potential, and 13,700 acres were leased for agricultural use. The majority of agricultural acres are used for livestock grazing or grass hay production. Only 3,200 acres are being used for crop production, with 500 of those used for annual crops.

Pesticide use on cropland accounts for 80% of overall OSMP use, primarily herbicides for weed management and secondarily insecticide use for alfalfa weevil, with rare fungicide applications for disease control. Five to eight hundred acres account for nearly all pesticide use on agricultural lands. These acres are primarily alfalfa, corn, wheat and barley and are not co-located with designated trail systems, limiting potential for exposure. Most hay and cropland receives commercial fertilizer.

Agricultural lands were not evaluated in detail for this report. Thoroughly evaluating opportunities to protect and enhance natural resources on city-owned farmland would likely uncover some low-hanging fruit that would generate substantial reductions in pesticide use and toxicity.

Farmland uses with much lower input requirements and/or potential for transition to organic have been identified with a long-term plan developed for an orderly transition adequately addressing economic and training needs of the current tenants and with their active involvement.

Recommendations: Given that agricultural lands account for 80% of overall OSMP pesticide use, the logical focus for Boulder to achieve significant reductions is agriculture. While agricultural lands were not evaluated in detail for this report, we recommend that the city continue the transition to organic agriculture on city properties. A seven-acre property on OSMP land and leased to a farmer transitioned to organic in 2011. This property represents one percent of all agricultural crop land managed by OSMP. There are plans to transition two more farms to the organic program in the next growing season; these farms have not yet been identified. Continue to review procedures for chemical use by agricultural tenants and explore methods for reducing chemical use.

Costs: Initial costs may include technical consulting services to provide guidance and direction for transition. Some advice is already available through local universities and other established contacts.

Benefits: Reduction in pesticide use and risk. An additional potential benefit would be the production of a marketable certified organic product should these properties be transitioned to certified organic.

7.F Summary of Findings and General Recommendations for OSMP and UR IPM

OSMP acreage has increased significantly, from 14,000 to 45,288 acres over the past 20 years. For both OSMP and UR IPM, lands under management have widely varying needs related to IPM ranging from none to extensive restoration and ongoing maintenance. IPM program effectiveness is constrained by inadequate staffing to reach all priority locations and an insufficient budget to implement non-chemical measures to the degree possible. As resources permit, staff should continue and increase participation in continuing education in key learning and networking opportunities including professional meetings and conferences where new research is presented and relationships can be established and maintained with colleagues facing similar challenges. It would be helpful to expand communication on an ongoing basis to increase community awareness specifically about the extent that non-chemical measures are employed, with limited area, targeted chemical applications used as last resort on non-cropland. Over-reliance on seasonal staff with high turnover from year to year increases training demands on permanent staff. As resources allow, increasing budgets for implementing restoration would improve opportunities for sustainable restoration including proper site preparation, soil amendments and seed to re-establish native plantings.

Recommendations: Increase staff resources and budget for OSMP and UR IPM. Increase budgets for continuing education and for restoration. Convert one or more seasonal positions to 12-month positions. Evaluate the use of volunteers for

opportunities for improvement especially in regard to sustaining volunteer participation on projects; staff reported initial high levels of volunteer participation on projects often tapered off rapidly. Continue evaluating opportunities to transition agricultural lands to lower input and organic production.

Costs: Converting two to three seasonal positions to 12-month fixed-term positions would represent a cost of 1.0 to 2.0 FTE. Continuing education budget of $10,000 per year would provide for participation in six to ten professional conferences or other training/networking events annually. Cost estimates for additional restoration can be developed by staff for priority sites which are not currently being reached.

Benefits: Transitioning seasonal positions to permanent will reduce recruitment and training time, and improve level of performance. Evaluating the use of volunteers for opportunities for improvement to maximize their potential could save professional staff's time and resources. A shared community educator could assist with communications including posting, as well as more effectively addressing pesticide use and risks generated by business and resident use. A shared grant funds development position would likely more than pay for itself given state, federal and private sector funding available to support invasives management and natural areas restoration.

8 Evaluation and Recommendations - Parks and Recreation Urban Forestry, Horticulture and Urban Parks Divisions, and Public Works

Boulder has many sites across several departments, divisions and workgroups that include turfgrass as a land cover. Analysis and recommendations for turf sites are addressed in this chapter including sites managed by Urban Resources and Urban Parks Divisions of the Parks and Recreation Department, and the Public Works Department. In addition, urban forestry and horticulture managed under Urban Resources are addressed in this chapter.

8.A Turf

Best Practices

General practices for natural turf management: *When transitioning from Best IPM Practices to a high-level IPM natural turf management program, the approach changes from reactionary to proactive. A simple definition of a natural program is implementing a series of preventive steps so that pests or cultural issues do not have the opportunity to negatively impact turf function and aesthetics. A system is created over time that allows for eliminating the dependence on control products.*

See Appendix D for detailed turf best practices including monitoring, cultural practices to maintain optimal soil and plant health, and pest management. Goals for a healthy turf management program include the following elements:

1. *Become a community leader in environmental sustainability with the expectation of helping to educate the community on what it takes to have a healthy, sustainable organic turf program in a public setting.*

2. *Maintain parks at a safe and aesthetically pleasing level for the community. Maintaining 5% or less weed pressure through the implementation of a comprehensive natural turf program is possible by focusing on healthy turf with minimal use of organic herbicides.*

3. *Maintain quality sports fields that can withstand 45+ hours of weekly play during the season, and create recreational and social opportunities on managed turf.*

4. *Create a sustainable system without a long-term increase in resource needs.*

5. *Design and maintain all turf areas to be safe, functional and aesthetically pleasing while using appropriate cultural, mechanical and biological practices to limit pest insects, diseases, weeds, soil compaction, sediment, fertilizer and pesticide runoff to water bodies. Include properly designed, installed and maintained irrigation systems to ensure uniform distribution and delivery of water while conserving water, protecting resources and meeting the cultural needs of each site.*

Natural turf management best practices for general use turf - parks, playgrounds and passive recreation areas: *Turfgrass areas are scouted during the growing season to*

assess plant health and look for conditions requiring action such as erosion, soil compaction, destructive insects, disease, mammalian pest damage and invasive weed populations. Appropriate corrective actions are identified and a timeline is established for implementation and evaluation. Mowing is performed as needed for functional recreation. Ideally, after establishment, natural rainfall should provide these turfgrass areas with enough water for plant survival; however this is not possible in all climates, high use or high visibility areas. Where required, irrigation should be based on need, with less frequent irrigation events supplying greater amounts of water per event to encourage deep rooting. Aeration (solid tine, hollow core and/or shatter) is conducted on general use turfgrass areas at least once every two years. Fertilizers and other soil amendments are added as necessary. When fertilizers are needed, slow and/or fast release forms of nitrogen are used depending on the program. Any herbicides used against persistent weeds (e.g., crabgrass, knotweed and broadleaf weeds) should be made with ingredients approved for organic production or meeting the criteria for approval, and be applied as a last resort and in full coordination with an annual over-seeding program so desirable turf seed is not damaged and turf density is maintained at a high level to keep weeds from re-establishing.

Natural turf management best practices, sports turf: *Selection of turfgrass varieties should be based on expected pests, site conditions and anticipated seasonal use. Turfgrass areas are irrigated to promote active growth and recovery after stress from normal wear and tear. Turf is aerated two to three times each year, at a depth of 3" using a solid, hollow core or shatter tine and top-dressed with sand in combination to prepare the seed bed, modify soil and smooth the field. Fertilizers and other soil amendments are made as necessary with slow and/or fast release forms of nitrogen depending on the program. Mowing height and frequency is adjusted to ensure that no more than 1/3 of the plant height is removed each time the grass is cut. Mowing height is in the 2"-3" range, but can be reduced for the first spring and final fall cuts. Irrigation should be based on need, with less frequent irrigation events supplying greater amounts of water per event to encourage deep rooting. Each turfgrass area is scouted monthly during the growing season to assess plant health and look for any conditions requiring action. The pre-determined threshold level for insects, plant diseases and weeds is established by the IPM coordinator and the turf manager. Any corrective responses are predominantly non-chemical and follow threshold values. Any herbicides used against persistent weeds (e.g., crabgrass, knotweed and broadleaf weeds) should be made with ingredients approved for organic production or meeting the criteria for approval, and be applied as a last resort and in full coordination with an annual over-seeding program so desirable turf seed is not damaged and turf density is maintained at a high level to keep weeds from re-establishing.*

As a footnote to the current industry standard definition of IPM, the widely accepted routine applications of pre-emergence products in turf programs for the control of undesirable weed seed are not IPM. This is a fundamental flaw in the implementation of these types of programs. It is important to remember that an IPM program is only as good as the protocol that is established and followed.

Boulder: Managed turfgrass is present in parks, on athletic fields, in traffic medians, greenways and facility lawns. Over the past 18 years the City of Boulder has minimized the use of pesticides on turf. There is a desire among some members of the community to move toward a further reduction and eventual elimination of pesticide use by the city. Staff has embraced BMPs to achieve that goal.

The desire to reduce pesticide use has led to the elimination of herbicides on managed turf for the last ten years. A proactive turf management program that relies on creating healthy soils, appropriate chemical-free inputs and re-focused emphasis on cultural practices has only been in place at Stazio I, Stazio II and East Mapleton. These fields have benefited from excellent cultural practices, although fertility is still managed synthetically which bypasses the concepts of healthy soils, biomass and natural nutrient cycling.

Boulder receives approximately 19 inches of precipitation per year on average, with much of that as snow. Irrigation is used to ensure turf plant survival in low-humidity, low-rainfall summer months to ensure vigorous turf and avoid opportunities for weed growth due to weak, thin turf plantings. The Parks Division is in the second year of a three-year capital improvement process to install a new irrigation controller system that relies on soil moisture sensors to estimate water needs for the condition and type of plant the irrigation zone is watering (shady turf area, sunny turf areas, low-water shrub beds, etc). They report improvements in both water conservation and plant health.

Parks staff experimented with topical burn-down products based on organically approved materials for weed control and reported results in *Herbicide Study Summer 2010*. Several products were tried with varying degrees of success and cost. Unlike several synthetic materials that are systemic in nature, there is no translocation with the natural-based products; therefore with mature weeds there is often re-growth from the root system.

A proactive healthy soils program has not been developed for all sites for several reasons, ranging from education and knowledge of alternative practices to budget and staffing issues. When control products such as herbicides are withheld, practices have to be put in place to keep pests from becoming a problem. Control products treat symptoms, but do not solve underlying problems. All control products (pesticides) kill, repel, or mitigate a pest, but do not grow grass. If a weed is taken out of the system, another will appear if grass is not actively encouraged to grow in its place. The current dandelion pressure after the elimination of herbicides is a good example of this phenomenon.

Summary of Findings

- Herbicides have not been applied on managed turf for ten years.

- A variety of BMPs are practiced but a comprehensive and proactive management plan has not been implemented to address growing weed pressures. BMPs currently in place at one or more turfgrass sites include regular scouting and use of thresholds, mapping of noxious and other priority weeds, mowing at a minimum of three inches, irrigating heavily with less frequency to encourage

deeper root growth, returning clippings, and prioritizing sites based on safety concerns, use types and frequency of use, and visibility. Weed management is addressed in the 2011 *Greenways Master Plan* which includes some turfgrass areas.

- The most pressing and noticeable problem/pest is the pressure from dandelions. The seed bank of dandelion seeds is substantial.

- Central Park and Municipal Campus received 3 lbs. N from applications of fertilizer and compost. and were over-seeded at a rate of 2 lbs./1000 sq. ft. in early spring as well as spot seeding throughout the season. No other properties were seeded.

- Recycled grass clippings were the only form of nutrients applied to Wonderland, Columbine, Shanahan Ridge and Greenleaf in 2010.

- The grass at all sites, with the exception of Stazio and Mapleton, is mown at three inches.

- A staff of five full time and six seasonal employees manages all aspects of at least 41 acres of athletic fields. A staff of ten seasonal employees and 3.5 full time employees manage all other urban parks. The developed park system has grown and staff has been reduced due to budget pressures. Employee workload has increased as a result of staff reductions.

- The workgroups do not have a dedicated IPM position. The responsibility for implementation and community outreach are added to the workload of existing staff.

- City staff has participated in basic natural turf training. The city is very fortunate to have knowledgeable turf and supervisory personnel managing turf areas.

- Extensive soil test data, already prepared by staff for some properties is available for use as a guideline for balancing soil chemistry and maximizing the potential for the biomass to assist in creating a healthy turf system.

8.A.1 Site and Soil Test Analysis by Property

Six urban park sites plus a site at Stazio Ball Fields were chosen by staff for detailed evaluation. The analysis presented in Appendix I is based on site visits, staff interviews and soil testing. Several sites were tested to demonstrate possible transitions and that staff can use as a guide for further expansion over time.

8.A.2 Flatirons Golf Course

Flatirons Golf Course was visited by consultants on two separate occasions. There is an effort underway to maintain the course in a manner that is safer for people and the environment. The course has been certified by the Audubon Cooperative Sanctuary Program for Golf Courses, which provides information and guidance to help golf courses preserve and enhance wildlife habitat, and protect natural resources.

As a result of reducing herbicide use, weed issues have arisen that staff would like to address. No soil test data were provided from the golf course. The grounds were found to be well maintained with minimal pesticide use on the course. It is not currently organically managed; some herbicides and synthetic fertilizers are applied and a comprehensive soil and turf health program has not been implemented. The use of synthetic fertilizers certainly supplies N, P and K, but does little to contribute to overall soil health.

An organic program could be implemented here by focusing on soil health with organic fertilizers and other soil remediation options. A thorough evaluation of the golf course is outside the scope of this project and budget. The process of transitioning a golf course is particularly complex. It involves not only strategies to deal with the withdrawal of control products, but transitioning fertility to work within the biomass.

A transition to natural and organic turf at the golf course would require a long-term program to assist the superintendent in addressing the issues that currently exist at the course.

8.A.3 Turfgrass Recommendations

The goal of these recommendations is to offer strategies that will allow the City of Boulder to move away from a synthetic and chemical approach to managed turf. For athletic facilities and sports turf, it would be wise to prioritize and select properties for transition. At the high end of the priority spectrum are the Stazio and Mapleton properties; public parks that may or may not contain a playing field within their footprint are lowest priorities.

Strengths and weaknesses of individual turf systems should be identified and any existing pest problems of concern addressed. The issues that appear at one site may not necessarily be an issue at another.

Sufficient support must be available for a successful transition to a natural program. In order to properly address the needs of an individual site, the city needs to be prepared to allocate a greater amount of financial resources, both for product input and labor. An example of this is Greenleaf Park which is extremely visible but not in particularly good condition. There are multiple issues here that need to be addressed. In order to properly empower staff with the time and tools to correct this particular situation, budgets must be increased or realigned to provide adequate resources. The programs presented herein take all of the above into account.

Recommendations: Transition all turf management from occasional use of synthetic chemicals to a natural, all organic-based program. Prioritize along the spectrum from high visibility and use athletic facilities and sports turf (Stazio Softball Fields, Mapleton Ball Fields and Pleasant View Sports Complex), various public parks that contain a playing field within their footprint, and finally less visible parks without playing fields and other lower visibility and use turf areas.

Non-synthetic pre-emergent herbicides are limited to a new chelated iron, selective product that has showed promise with dandelions and some other broadleaf weeds in turf. Iron is a natural material, but the chelating process is facilitated by reaction with a synthetic material, therefore it cannot be called totally natural or organic. At least one formulation includes an inert of toxicological concern. Boulder Parks staff is currently testing the product and its use has been approved under the 2011 interim guidelines.

Potential exists to reduce dandelion pressures with the use of this product as a rescue treatment and then begin an aggressive soil building, fertility and over-seeding program to increase turf density. Keep in mind that this or any control product will eradicate the weed, but it does not grow grass. The rescue treatment is utilized to reduce pressures and treat the symptom and then implement the program to solve the problem. It will take a commitment to support staff with the necessary financial and educational resources to move in this direction. Labor issues will also need to be addressed.

Different levels of management should reflect the priority level assigned to individual properties. Expectations for each property should be set and a program designed to meet those expectations. During this part of the process, detailed cost estimates need to be produced for individual property transitions.

There is a learning curve to a natural approach. Once the properties to transition are selected, a specific program can be implemented. Programs for the tested properties are being proposed for discussion and evaluation. It is best to begin on a small scale, as Boulder has done by focusing on Stazio and Mapleton. It will be necessary to provide assistance to the staff so that a systems approach to turf management can be developed that best suits the needs of the city.

Engage turf management staff in developing and implementing community outreach given a large percentage of pesticide and nutrient use on private residential and commercial property is on turf.

Costs: When a natural, organic approach to turf management replaces a conventional one, it is to be expected that costs will be temporarily higher. Because we are working during the transition period to build healthy soils, costs can be incurred that later will decline. Appendix E provides a cost comparison between the two programs that supports this. The programs represented are on the high end designed to produce the highest quality turf in the shortest time. Lower level programs will reflect lower cost.

Detailed costs of material inputs have been calculated for individual properties that were analyzed as part of this report. Specific schedules of inputs and cultural practices will be created after dialog with staff. There is a degree of flexibility in application timing that can be incorporated into individual programs to reduce labor. Information is included regarding time required by staff to perform typical processes that can be used as a guideline to calculate total man hours for each property. Additional staff time will be required to participate in community education regarding best practices and pesticide and fertilizer use reduction.

Benefits: The benefit to the City of Boulder and the end users of these properties would be a grass surface that exhibits the functional qualities of a good and healthy biomass and turf system. In addition to improving turf quality, repeated low dose exposures to synthetic pesticides, used as control products on the golf course, would be eliminated. Replacing highly water-soluble fertilizers with natural, organic products would reduce any threat of groundwater contamination.

8.B Urban Resources Division, Urban Forestry and Horticulture Workgroups

Best Practices: *Effective programs focus on maintaining optimum plant and soil health including preventive maintenance; use expert staff and/or contractors; monitor plant health, soil conditions and pest populations regularly; use science-based thresholds where available before acting against pests; and keep comprehensive records of plantings, inspections, maintenance and interventions. Cultural strategies are the primary defenses against pests including avoiding problem-prone plants, selecting species and varieties that are resistant to known and potential pests in the region, maintaining species diversity in perennial plantings to reduce impacts of new species-specific pests and placing plants in optimum placements to avoid stress. Staff is aware of potential threats from pests not yet in the region and monitor for those pests where appropriate.*

8.B.1 Urban Forestry Workgroup

Boulder: The Urban Forestry workgroup maintains approximately 26,000 street trees and 10,000 park trees with a total value of approximately $69 million. Forestry staff includes 4 FTEs: one city forester/horticulture manager and three forestry field technicians. The urban forest is one of the few city infrastructure assets that appreciates in value over time. Urban trees contribute to reductions in carbon dioxide, a greenhouse gas contributing to climate warming; reductions in other pollutants including SO_2, NO_2, CO and ozone; improvements in water quality; stormwater runoff reduction; energy saving through shading surfaces; increasing real estate values; extending life of paved surfaces and sociological benefits.

The greatest threat to urban forests is from introduced tree insect pests and diseases. Global travel and trade have spread pest species beyond their indigenous habitats and into areas lacking natural biological controls. These introductions carry with them the potential for massive ecological and economic damage. Examples from the recent past

include emerald ash borer, Asian longhorned beetle, *Sirex* woodwasp, gypsy moth, Japanese beetle and sudden oak death disease.

The best defense against these pests is early detection and eradication. Forestry staff works closely with the Colorado State Forest Service, federal Animal and Plant Health Inspections Services (APHIS), Colorado Department of Agriculture, Boulder County and other municipalities to monitor for introduced pests including trapping for emerald ash borer, Japanese beetle and gypsy moth. Staff is also coordinating with CSU to investigate red oak drippy blight, *Brennaria quercina*, suspected in observed declines in both street and park oak trees.

Annual citywide surveys performed by city staff have uncovered Dutch elm disease, thousand cankers disease of walnut, mountain pine beetle and *Ips* beetle in spruce. Pests monitored but not yet found in Boulder include Japanese beetle, emerald ash borer and Asian longhorned beetle.

Staff works closely with city and park planners to ensure proper species selection and spacing, qualifies stock and monitors contractors for proper planting techniques to promote a healthy growing environment. Staff strives to maintain diversity of tree species in tree plantings to prevent wide-scale dieback due to introduced insect/disease pests. Public education is conducted through resident service requests ("house calls" for public street trees), telephone consultation and news releases.

Tree removal is a primary IPM strategy to eradicate introduced pests before they become established. City staff removes diseased public trees promptly. City ordinance allows enforcement of the removal of diseased trees on private property. Since 2003, staff has removed or enforced removal of over 1300 black walnuts in the city of Boulder with thousand cankers disease. This disease was first discovered by staff from Boulder Urban Forestry and identified by a pathologist at CSU. Although black walnut in Boulder comprises less than 1% of the total tree canopy, the species is a $500 billion industry in the US. Staff has worked closely with CSU since 2005 on tree dissections and has lead over ten tours in Boulder to train local, state and federal personnel on symptoms, diagnosis and management.

Pesticide are used only when the health of high-value trees is threatened, alternatives are not available or not feasible, and low toxicity products such as insecticidal soap for brownheaded ash sawfly and/or application methods such as trunk or soil injection are available to limit exposure to humans and other non-targets.

Resistance to pesticides by scale insects, a problem in other Colorado communities, has been delayed in Boulder by limiting trunk and soil injections to two consecutive years, and delaying reuse until pest populations exceed thresholds. Neonicotinoid pesticides, potentially harmful to pollinators, are limited to trees not primary foraging species for honeybees. Forestry staff recently worked with a local beekeeper to safely lower several tree branch sections from trees with honeybee hives that were overhanging busy multi-

use paths. The hives were safely brought back to the Forestry wood lot where the bees can either continue to live or swarm naturally to a new location.

Adjacent property owners may hire contractors for chemical treatment of public right-of-way trees with the guidance and authorization of city forestry staff.

8.B.2 Horticulture Workgroup

Boulder: City parks include 364 landscaped beds covering a total area of five acres including flower beds, mulched beds, shrub beds and gravel fines areas. These are managed by two full-time horticulture field staff positions, one of which is currently vacant.

In 2010, horticulture staff evaluated three organic topical burndown herbicides, Roundup (glyphosate) and a control plot to determine which product would work best in landscape beds in city parks where weed control is an ongoing concern. The organic herbicides used were Nature's Avenger (citric acid, as a concentrate 3:1 ratio), ready-to-use formulations of Perfectly Natural (8% citric acid and 8% clove oil) and Agricultural Vinegar (20%). Agricultural Vinegar carries a Danger signal word on the product label, indicating very high acute toxicity due to potential effects to eyes and skin; Roundup carries a Caution signal word indicating lesser acute toxicity.

Key findings included:

- Burndown with the organic products ranged from 90% (Agricultural Vinegar) to 25% (Perfectly Natural) within 24 hours. Regrowth occurred within three to six days.

- Roundup took ten to 12 days to show burndown but resulted in 95% kill.

- Costs per gallon of mixed product ranged from a high of $36 for Agricultural Vinegar to $3 for Roundup.

- Weekly spraying with the most effective organic product, Agricultural Vinegar, would be required for at least several weeks to maintain the landscape beds in the same condition as Roundup applied twice during the growing season. Roundup use would greatly reduce product costs, staff time and park area closures compared to the organic products. Weed resistance to Roundup and other herbicides is likely to occur with repeated use.

Recommendations: Continue to pursue designs for landscape bed construction and renovation that minimize opportunities for weeds. Continue experimentation with minimum-risk topical burndown herbicides, including treating weeds when very young and more susceptible. Continue to monitor new products and costs which will likely decrease as additional products enter the market and efficiencies are improved in the production process.

Costs: Staff time will be required to investigate, develop and implement design changes to prevent weeds. These costs may be offset by reduced staff time required for weed management in redesigned planting beds. Costs for minimum risk topical burndown herbicides are currently greater than for products containing glyphosate, and use requires more labor due to increased frequency of applications.

Benefits: Attractive landscaped beds, reduced potential for weed resistance and adverse health and environmental effects of repeated use of herbicides.

8.B.3 Public Works

Best practices are similar to those for horticulture above. In Boulder, Public Works use of glyphosate on traffic medians (and paved areas) was suspended early in the 2010 season and resumed during 2011.

Recommendations: Continue current strategies and tactics, including communication with community members about need and application techniques used to limit potential for exposure when a pesticide intervention is warranted. Improve management of traffic medians and sidewalk areas to reduce the use of glyphosate for post-emergence weed control. These sites include turf and also other ornamentals.

a. Design areas for low-input maintenance including selecting plants that are more competitive against weeds or mask weed presence, or hardscaping. Review current design guidelines for opportunities to prevent and avoid weeds.

b. Topical burndown products are available. A topical burn herbicide is one that destroys visible plant tissue, but unlike the conventional herbicides (glyphosate) has no systemic action. After causing the death of plant tissue, the burn products have no further action on the roots. If the weed is young and has very little carbohydrate storage in the roots, often it will be eradicated and will not reappear. More mature weeds may regenerate after a spray. The systemic action of conventional materials causes the death of the weed down through the plant and roots. Unlike the synthetic material of choice that is systemic in nature, there is no translocation with the natural based products, therefore with mature weeds there is often re-growth from the root system.

c. In order to experience success with alternative materials, procedure and scheduling of applications needs to change. Rather than allow the weed to become mature and then treat, the weed must be sprayed when young. A procedure of addressing the situation earlier in the life cycle of the weed is necessary.

d. With either product there is no effect on weed seed that exists in the soil.

e. A growing number of weeds are resistant to glyphosate, which will reduce efficacy over time, requiring more frequent sprays with more costly products, and potentially providing less control.

Cost: The cost per unit or area treated with the alternative products is more than with the synthetic materials. Less visible costs of the synthetic product include weed resistance and the potential adverse health and environmental effects of repeated use. There is a case to be made for investing additional resources to avoid the negative consequences.

There will be a cost differential in the purchase of and the labor required for the application of alternative materials. There will also be some education necessary for staff on the proper use of these products. At this time, it is not possible to give exact costs that might be incurred by using transitional materials.

Benefits: Continued attractive planted areas meeting intended uses. Reduction in risks associated with pesticide use including development of resistance. Reduction in need for fertilizer applications due to natural nutrient cycling.

9 Evaluation and Recommendations - Facilities

9.A Structures/City Facilities

Best Practices*: Effective IPM for structural pest management is critical for food and fire safety, liability reduction and pest/pesticide risk reduction from pest-related diseases and unnecessary pesticide exposure. Rodents chew on wires, creating potential for short circuits and fire. Rodents, cockroaches, flies and other pests transmit pathogens which can cause diseases with non-specific symptoms which are difficult to trace to the cause. Focusing on resolving why pests are present and denying pests access to food, water and shelter are the key to effective, high-continuum IPM. Excluding pests also supports energy conservation goals by sealing gaps through which heated or air-conditioned air escapes, and improves sanitation by keeping dirt out. Cities and government units with good structural IPM programs such as the City of New York, University of Colorado at Boulder and City/County of San Francisco have IPM policies that are fully implemented throughout their structural departments. Staff is well trained regarding IPM practices, provides adequate oversight to any contractors and often performs IPM practices such as inspection, diagnosis of underlying problems encouraging pest problems, maintenance to exclude pests such as sealing and installing door sweeps, and instructing staff on improving sanitation. Those that use contractors such as City/County of San Francisco, use requests for qualifications rather than requests for bids, and use contracts that specify IPM including pesticide product use restrictions. IPM coordinators or managers provide oversight of departmental IPM by reviewing IPM plans, contractors and procedures pertaining to structural pest management.*

Boulder: The City maintains 320 facilities with a total value of $620 million. Responsibilities for these facilities are distributed across several departments including Facilities and Asset Management, Parks and Recreation, Library, Fire Department, Police, OSMP, Public Works, Downtown and University Hill Management District and Health and Human Services. Facility maintenance and sanitation is generally fair to good with some exceptions and priority needs for improvements, particularly for facilities with food service operations.

The City of Boulder is currently upgrading 66 city facilities for energy efficiency with the Energy Performance Contract through a partnership with the Governor's Energy Office (GEO). These upgrades, including sealing cracks, adding door sweeps and upgrading windows, will ultimately assist with pest prevention.

During a limited number of site visits to facilities, we observed multiple opportunities to improve sanitation and exclusion that would help to prevent issues with rodents and insects. Some city staff had inventories of pesticide products for structural pests and stinging insects not included on the approved list. Some products were improperly stored.

The IPM coordinator lacks structural pest management expertise and is not currently reviewing or approving pesticide applications by contractors to city-owned facilities including rodenticides and insecticides for structural pests. Contractor selection and

oversight is inadequate to ensure effective pest management and safer practices and products. The tenant is responsible for pest management of the facilities that are rented to them for businesses including food service. These tenants should be required to follow the IPM policy and the IPM coordinator should ensure that tenants are educated about and following the IPM policy and are hiring contractors that have been properly trained and using products that are on the Approved Pesticide List.

Recommendations: Immediately inspect facilities to ensure that there are no human health risks from rodenticides or live-trap use, and that proper exclusion and sanitation is being practiced. Secure expert assistance to inspect all city facilities as needed. Modify facility leases to include specifications regarding following the IPM policy and allowing for proper oversight and intervention if tenants are not meeting stipulations. Improve contractor selection by implementing a request for qualifications and an IPM-based contract, with competent oversight to ensure compliance. Evaluate current and alternative pesticides for stinging insects, ants and cockroaches, and add options meeting criteria for least toxic to the approved list. Bring all departments with facilities in compliance with the IPM policy including using non-chemical measures as the primary pest management strategy. Include structural pest management training in continuing education for the IPM coordinator and key facility staff including maintenance, sanitation and food service.

Costs: Upfront costs include costs for inspections and remediation, and for improvements in leases, contracts and requests for qualifications. Ongoing costs are not likely to increase once minimal requirements for adequate exclusion and sanitation are met. Recent facility improvements to address energy efficiency, e.g., improving sealing around windows and doors, may also reduce pest problems. Costs can be minimized by collaborating with efforts at the University and school system. Costs for contractor qualification and oversight can be reduced by extending a preference in city contracts to contractors participating in existing third-party certification programs including the NOFA Landcare Accreditation and Green Shield Certified.

Benefits: Reduced liability from pest and pesticide risks, improved fire safety, lower energy costs, fewer staff absences due to illness and improved employee satisfaction. Written IPM plans improve continuity and reduce learning curve during staff transitions.

10 Evaluation and Recommendations – Community Engagement

10.A Increasing Public Awareness and Understanding of Boulder's IPM Program

Best Practices: *Best practices for engaging with the public include websites, RSS feeds, listservs, social media, community events with opportunities for engagement, public participation in decision-making processes and partnering with local organizations. New York City has staff people dedicated to engaging the public in the Rat Indexing Initiative. They also report partnering with local organizations with similar interests for additional outreach opportunities. City/County of San Francisco includes the public in their meetings and has representation from local organizations to gain buy-in from the public. Both cities have extensive websites with annual reports, extensive IPM information and notification of meetings.*

Boulder: The IPM Subcommittee is comprised of members of citizen advisory boards, who are community members appointed by the City Council. Other public participation opportunities include public comments at meetings, online, directly to the IPM coordinator or to staff they encounter in Boulder. Some meetings, such as the process to add pesticides to the approved list, are open to the public as per the IPM policy. The Interdepartmental IPM Review Group is not open to the public.

The City of Boulder's website contains public meeting announcements, general IPM information, the IPM policy, notification policies, application updates and some tips for homeowners. Information about the IPM program is also available via RSS feed and IPM hotline. Those that are interested in further information can request it from the IPM coordinator. Additional information available on the Boulder IPM website provides a few brief tips about pesticide use for citizens. The IPM coordinator personally provides meeting announcements to those citizens that are most engaged and interested in pesticide use in Boulder.

Currently, posting at the site of the application or at entry points to the site treated is limited primarily to chemical treatments and some treatments with materials approved for organic production. Some organic, biopesticide and fertilizer applications are posted with a green-colored sign. Posting more information about non-chemical treatments would more fully inform community members about the extent of non-chemical approaches and educate residents and visitors about potential for non-chemical options in their own home and work environments. This would not necessarily include posting a notification for each non-chemical treatment, but some signage about non-chemical efforts would assist in educating the public about the lengths to which Boulder has gone to reduce pesticide use. Permitting site-of-application posting for limited-area treatments with very low drift potential in lieu of posting at all entrances to a site would save considerable staff time without compromising safety. Activities with very low drift potential include spot spray treatments targeting individual plants and cut stump treatments located more than 500 feet from a trail.

Recommendations: Adding IPM items to the Boulder website including BMPs, IPM plans, annual reports, pesticide use data and the approved product list with the limited circumstances in which they are allowed to be used could help alleviate some citizen concerns. The website could also include meeting minutes from Interdepartmental Committee meetings and other related IPM meetings for easy access to those unable to attend.

Improve notification and posting of pest management activities to include posting of all treatments including mechanical, cultural, biological and pesticide measures to more fully inform residents and visitors of the extent non-chemical measures are currently used. Revise posting policy to permit site-of-application posting for limited area applications with little or no potential for drift.

Costs: Costs include staff time required to evaluate the current website for specific opportunities to improve information content and posting content; developing format/text for non-chemical treatment postings and staff time required to post. Cost would be offset to some extent by reducing the current burden on staff for posting at site entrances by allowing site-of application posting for applications with minimal drift potential.

Benefits: Improved resident/visitor education regarding IPM activities, reduced staff time vs. current policy of posting all applications at site entrances.

10.B Encouraging Pesticide Reduction on Private Commercial and Residential Property

Best practices: *New York City provides training to residents and businesses for cockroach, rodent, and bedbug IPM including training events and downloadable materials. They also reported partnering with local organizations with similar interests for additional outreach opportunities. The City of Toronto created demonstration gardens to encourage and educate their citizens about organic gardening.*

Boulder: City of Boulder business and resident use of fertilizer and pesticide represents a potentially large and untapped opportunity to improve health and environmental outcomes. Efforts to engage the community in pesticide risk reduction were encouraged by several citizens at the November 30, 2010 public meeting.

Recommendation: Begin to seek new resources to develop a program focused on reducing pesticide use by businesses and residents, and reducing pest and pesticide risks. Successful models exist from other regions including the San Francisco Bay Area (www.ourwaterourworld) that could be adapted to Boulder with additional resources. Residents could be encouraged to contract for pest-management related services with participants in existing third-party certification programs including the NOFA Landcare Accreditation and Green Shield Certified.

Costs: The city has initiated work on a program with Colorado University including support from student interns, staff and faculty. Building and operating a sustainable

program would likely require at least 0.5 FTE and budget for equipment, supplies and local travel. Such a program would be a strong candidate for funds from private and public grant programs.

Benefits: Greater reductions in pesticide use and impacts by expanding focus to include residents and businesses which represent the greatest volume of nutrient and pesticide use within city boundaries.

11 Evaluation and Recommendations – Data Collection, Evaluation, Reporting and Outcomes

11.A. Data Collection

Best Practices: *Many municipalities utilize a centralized database, created either in-house or purchased, in which all departments submit the same information for optimal compliance and data analysis. Information for pesticide product applications includes product name, EPA registration number, active ingredient, concentration, signal word, target species, weather information, location, amount applied, method of application, applicator's name, notification requirements, date, time, reason for application. Other IPM-related information collected includes biological, mechanical and cultural controls, hours spent, monitoring information (placement, product, target species, date, etc.) and pest complaints. This information is centrally located and thus easy to compile for yearly reports, ensure compliance and other analysis opportunities. Cities such as New York and San Francisco have customized software for collecting information, while others such as Toronto and the University of Colorado at Boulder have unified spreadsheets that are filled out by departments and maintained by the IPM coordinator or manager.*

Boulder: Currently, not all departments are tracking and reporting pest management activities and pesticide applications. Departments that are reporting are not using a consistent format, making overall tracking and reporting difficult and time consuming. Data received by the consultants was inconsistent across departments, making it difficult to compare hours spent on different control methods. Useful analyses are not currently available, including pesticide use per department, by toxicity, per site, per target pest. These analyses could help prioritize opportunities to reduce use and toxicity. Incorporating biological, mechanical and cultural measures, hours and acres, as is currently being done by OSMP and UR IPM, would be very helpful for educating the community as to the extent to which these are the primary approaches to pest management.

Recommendation: Evaluate current software used by city staff to manage work orders, create or adapt a relational database, or purchase commercially available pesticide application recordkeeping software to track pest management activities.

Costs: Most commercial software specific to pest management activities has been developed for agriculture or for structural pest control companies. Consider investigating options in current use in Boulder or by other urban IPM programs including costs. Costs could potentially be reduced by adapting databases used by others. Additional costs include staff training on using a new system, and staff time for data entry and report generation, estimated by staff to be approximately 40 hours per workgroup per year.

Benefits: Reductions in staff time by increasing efficiency in developing reports for those workgroups currently reporting pest management activity; consistent reporting across all departments; greatly improved ability to identify and focus on pests or weeds driving the greatest pesticide use and toxicity and requiring the greatest application of resources to manage; improved ability to communicate information to city management, Council and

community members. Improving the current spreadsheet system would also facilitate tracking different units and formulations, e.g., gallons vs. grams, not currently managed well. If Boulder were to adopt a pesticide hazard rating system more similar to San Francisco, pesticide use could also be tracked by product hazard tier.

11.B. Reporting and Transparency

Best Practices: *Successful IPM programs have IPM activity and pesticide use reporting that is transparent, collected and reported on a regular basis, and readily accessible to the public. IPM programs such as New York, San Francisco and Toronto have annual reports that are made available to the public outlining pesticide reduction goals, usage, non-chemical activities and any new developments or goals for the next year. Their annual reports are available on their website and upon request.*

Boulder: Current reporting is ad hoc, does not occur on a regular basis, and does not include all key bottom line outcomes including number of pest complaints/problems, number of complaints addressed with or without a pesticide application, number of pesticide applications per target pest and toxicity, application method, site and area treated, volume applied, acres treated with mechanical, cultural and biological measures, rationale for treatment, and program operating costs and benefits. A short list of key metrics and template for reporting those for all departments would simplify the process and facilitate comprehensive annual reporting.

The lack of regular reporting removes the opportunity for identifying and prioritizing opportunities for improvement or reporting on improvements or accomplishments made over the past year. This is a missed opportunity for the city to highlight positive developments with pesticide reductions and IPM accomplishments. Goals can be reported and progress discussed in these reports. Citizens and staff would have the opportunity to provide feedback.

Recommendations: Report annually on a set of metrics including status of program implementation vs. timeline, pest pressure and mechanical, cultural, biological and chemical inputs and costs.

Costs: Approximately 40 hours of staff time to develop list of metrics, reporting forms, report template. Reporting could be enhanced by using existing work order software, a relational database or commercially available pesticide use/IPM activity reporting software referenced in the recommendation above. Approximately 20 to 40 hours per year per department for preparation/submission of data for compilation by the IPM coordinator or outreach staff person. Approximately 40 staff hours for compilation and completion of the annual report including narrative.

Benefits: Regular, complete, consistent annual reports. Improved efficiency and reduction in time required to complete reporting for each department and for compilation for those departments currently reporting. Improved communication with the public, other stakeholders and funders. Improved accountability and ability to focus on areas of

greatest potential impact reduction. Time savings will accrue after the template is in place and staff has been trained in its use.

11.C. Evaluation and Outcomes

Pesticide Risk Reduction
The City of Boulder has achieved substantial reductions in pesticide use and risk since the inception of the pesticide ordinance in 1981 and the IPM policy in 1993. Opportunities for use reduction remain, including in departments/divisions not yet fully engaged, agricultural lands, and in resident and business use. Further opportunities for risk reduction lie in improving the current process for identifying lesser risk alternatives for pesticide products currently approved for use, and in addressing products in use not yet included on the approved list.

The city's landscape and facility assets generally meet conditions required for intended uses. Exceptions include some turf areas, facilities including tenant-occupied facilities, and some priority natural areas and parks that have issues that cannot be fully addressed due to current constraints on budget and staff time. Improvements in recordkeeping and reporting will improve Boulder's ability to document and communicate these and ongoing improvements.

Citizen Satisfaction
Inconsistent and incomplete reporting hamper citizen awareness and appreciation for efforts made to date, including a number of spectacular successes in reducing pesticide use and risk. A vocal segment of Boulder's population would like to see pesticide use further reduced and eliminated where possible; staff report they can often reach agreement that current tactics, e.g., stump treatment, are effective and greatly limit risk when they have the time to interact and explain.

A less vocal group of citizens are dissatisfied with dandelions and other weeds in city parks; these concerns could be at least partially addressed by an investment in natural turf management vs. simply pesticide elimination without addressing underlying conditions that lead to weeds.

Recommendations included in this report address opportunities to improve communications and satisfaction on both pesticide use/risk reduction, and meeting citizen needs/desires for improvements in pest management and facility condition.

12 Prioritized Recommendations

This section includes a table that outlines recommendation in priority order with the City of Boulder's funding priority categories as described in the *City Plans and Projects Handbook*.

Prioritized Recommendations

Priority	Recommendation	Fiscally Constrained	Action Plan (moderate funds)	Vision Plan (unlimited funds)
1	9.A. Facilities/Structures	A designated facilities person that is trained in structural IPM conducts monthly visits to leased facilities to ensure pest management and food safety are adequate.	IPM coordinator and/or facilities person increases continuing IPM education so they can provide more effective oversight of staff, contractors and tenants. This includes developing an IPM plan or RFQ for contracted services and an IPM contract and scope of work and a written IPM plan.	A full-time structural IPM coordinator who works with city owned/occupied/leased facilities to implement a full-blown IPM program. This would include an IPM RFQ, IPM contract, IPM plan, ongoing staff and tenant training on IPM including sanitation, exclusion and pesticide use/toxicity reduction. The coordinator would also conduct regular trainings open to all citizens and business in Boulder regarding IPM and pest/pesticide risk reduction.
2	6. Legal Compliance	IPM coordinator meets with contractor to review regulations and current practices; resolve sny outstanding legal compliance issues not already addressed.	IPM coordinator and/or facility person goes through pesticide applicator training to improve understanding of legal requirements. Reviews contractor and staff performance annually including site visits to check compliance.	The coordinator and/or facilities person would conduct regular trainings on compliance open to all citizens and business in Boulder regarding IPM and pest/pesticide risk reduction.
3	5.C. Approved Pesticide List Process	Revise current pesticide approval process within the current framework using well-defined, updated science-based criteria determined by	Create a new pesticide approval process based on product hazard tiers and exposure potential by using or adapting the model provided using the newly	

Prioritized Recommendations

Priority	Recommendation	Fiscally Constrained	Action Plan (moderate funds)	Vision Plan (unlimited funds)
		management with staff and public input.	created TAC.	
4	5.A. IPM Policy	Update policy to reflect current policies and strategies. Identify key issues of the IPM policy and create timeline with prioritized action steps for improving consistency of IPM policy implementation.	Work with tenants not in compliance with the IPM policy; this may include re-writing leases when possible. Fully constitute the Interdepartmental Review Group with representation from IPM representatives appointed for all departments/divisions.	Fully implement IPM policy across all departments, city properties and tenants. This includes transitioning current committees to an IPM Technical Advisory Committee and requiring contractors to provide an IPM plan for sites and pests for which they are contracting to perform services.
5	10.A. Increasing Public Awareness and Understanding of Boulder's IPM Program	Add more information to the city's website about the IPM program including BMPs, meeting minutes, IPM plans, annual reports, pesticide use data, non-chemical treatments, the approved product list including use restrictions. Revise posting policy to permit site-of-application posting for limited area applications with little or no potential for drift.	Create permanent signage at major trail heads or other areas that community members have expressed the most concern over that outline chemical and non-chemical pest and weed management techniques. Include reports and maps of mechanical and other controls to better inform the public of IPM in Boulder's public spaces.	Posting all treatments including mechanical, cultural, biological and pesticide measures to more fully inform residents and visitors of the extent to which non-chemical measures are currently used. Create brochures and other new outreach material about the city's program.
6	11.B. Reporting and Transparency	Report annually on a set of metrics including status of program implementation vs. timeline, pest pressure and mechanical, cultural, biological and chemical inputs and costs. Post report and additional		

Prioritized Recommendations

Priority	Recommendation	Fiscally Constrained	Action Plan (moderate funds)	Vision Plan (unlimited funds)
		information on the city's website.		
7	5.B. IPM Plan	One department (we suggest OSMP) creates an IPM plan that meets the IPM policy requirements. This plan can then be used as a template for other departments or divisions. The plan should address the full scope of pest management activities including listing all key pests, action thresholds, pest management and preventive techniques for each pest, detail roles and responsibilities and include procedures for recordkeeping, data analysis and evaluation.	Two additional departments or divisions (we suggest Facilities, and Parks and Recreation) create an IPM plan. A plan addressing structural pests should be a top priority to help address deficiencies identified in that arena.	All departments and divisions have IPM plans in place.
8	5.G. Management	Management occasionally participates/observes TAC meetings, conducts ride-alongs with field staff and staff presentations on IPM annual reports and project successes at management and city council meetings to improve mutual understanding.		
9	5.D. IPM Committee	Better organize all groups, boards and stakeholders that are currently involved in IPM and pesticide reduction issues. Fully constitute the Interdepartmental Review Group with participation by IPM representatives	Create an IPM Technical Advisory Committee that is made up of the IPM Subcommittee and Interdepartmental IPM Review Group that would meet quarterly and be headed by the IPM coordinator.	Expand IPM TAC to include community members including school district, contractors and local landscape providers. This would be an effective peer group for city departments and businesses in the city with large

Prioritized Recommendations

Priority	Recommendation	Fiscally Constrained	Action Plan (moderate funds)	Vision Plan (unlimited funds)
		appointed for all departments/divisions with a regular quarterly meeting schedule to better share information.		potential impacts on health and environment related to pest management.
10	5.E. Contracts	Review your IPM policy with all current pest management contractors. Address issues such as legal compliance, scope of sites and pests to be managed, qualifications, frequency and schedule, recordkeeping requirements and compliance with policies and ordinances.	Develop an IPM-based RFQ and contract for new contractors that adheres to Boulder's IPM Policy. The RFQ should also specify that they include an IPM plan; a contractor-developed plan is a good tool for assessing competence.	Provide training and continuing education for IPM coordinator or outside expert to ensure competent contractor oversight.
11	5.H. IPM Coordinator	Supplement IPM coordinator and department IPM lead expertise with collaborators to assist with priority improvements with facility IPM and with contractor oversight to improve compliance with regulations and address immediate public health concerns.	Provide additional training opportunities for IPM coordinator and provide assistance for better oversight of the IPM program in all departments such as addressing structural pest management deficiencies, developing a weed policy and state-mandated plan, transitioning to natural turf, improving record keeping, evaluation of opportunities for improvement on agricultural acres, golf course and other sites.	Increase IPM coordinator position to 1.0 FTE to fully implement IPM policy throughout all departments.
12	5. I. Staff	Create opportunities for recognition of individual staff members and teams for outstanding contributions to	Create opportunities for continuing education and networking by allowing for every-other-year national or	Increase opportunities for continuing education and networking by allowing for annual national or regional

Prioritized Recommendations

Priority	Recommendation	Fiscally Constrained	Action Plan (moderate funds)	Vision Plan (unlimited funds)
		Boulder's pesticide and pest risk reduction goals.	regional IPM conferences for key IPM staff members. Create a 0.5 FTE volunteer coordinator position to utilize volunteers across all departments.	IPM conferences for all IPM staff members. Create a 1.0 FTE volunteer coordinator position to make better use of volunteers across all departments.
13	5.F. Budget	With current budget, re-allocate resources to ensure that IPM policy is adhered to in each department and all public health and compliance issues are addressed.	Increase staffing for key departments to adequately address the most pressing IPM issues such as creating a functioning structural IPM program and meeting more of the priority needs identified for natural lands by OSMP and UR IPM staff.	Fully staffed in all departments and divisions to reach all IPM goals.
14	7. Open Space and Mountain Parks and Urban Resources IPM. Natural, agricultural lands.	Continue integrated approach emphasizing non-chemical methods including re-vegetation at priority sites and efforts to increase use of native plant material. Improve the use of volunteers for mechanical and cultural practices.	Increase staff numbers to allow for more time to be spent on the cultural practices of re-vegetation at most sites. Increase the budget for continuing education and restoration for key staff members. Evaluate opportunities to transition agricultural lands to lower input and organic production.	Fully staff the department to allow for more time to be spent on the cultural practices of re-vegetation at all sites. Increase the budget for continuing education so all IPM staff can attend IPM events. Transition all feasible agricultural lands to lower input and organic production.
15	8. Parks and Recreation Urban Forestry, Horticulture and Urban Parks Division, Public Works. Turf, urban forest landscaped beds.	Continue successes in reducing of synthetic chemicals. Design new and renovated beds, medians and other landscape features to prevent and avoid weeds. Use burndown products approved for organic production when weeds are young and fewer applications are	Prioritize and select athletic facilities and sports turf for transition to organic management. Select those most appropriate for the initial transition.	Transition all turf (including golf course and athletic facilities) to organic fertilizers and mechanical/cultural controls of weeds.

Prioritized Recommendations

Priority	Recommendation	Fiscally Constrained	Action Plan (moderate funds)	Vision Plan (unlimited funds)
		needed for kill.		
16	11.A. Data Collection	Evaluate current software used for managing work orders for potential to incorporate IPM activities, or create a streamlined form and system for entering pesticide application records across departments. This could be accomplished with Excel documents or other readily available software.	Adapt current work order system software or create an in-house database using Access or other easily acquired database software that can easily create reports to view pesticide application and non-chemical methods trends. This should be streamlined across departments.	Create or adapt a relational database or purchase commercially available software to track pest management activities.
17	10.B. Encouraging Pesticide Reduction on Private, Commercial and Residential Property	Share more information with the public about reducing pesticide use on the website, community events, news outlets and other available avenues.	Develop a program focused on reducing pesticide use by businesses and residents, and reducing pest and pesticide risks. Successful models exist from other regions that could be adapted to Boulder with additional resources. Encourage residents to contract for pest-management related services with participants in existing third-party certification programs. Hold annual meetings and training sessions for community members about IPM techniques and ways to reduce pesticide use in their homes and businesses. Include key staff from OSMP, UR IPM, Urban Forestry in development and implementation.	Hold several meetings and training sessions throughout the year for community members about IPM techniques and ways to reduce pesticide use in their homes and businesses.

Appendix A: Summary "State of the Science" and Program Comparison

IPM programs at three additional cities, one water district and the University of Colorado were reviewed for this comparison. A summary table (Table A.1.) presents elements considered including plant health, soil quality, pesticide risk assessment and mitigation, sanitation, exclusion and additional preventive strategies for insect, wildlife and rodent pests.

Table A.1. Comparison of IPM Programs

	Date Initiated	IPM Policy	IPM Plan	IPM Coordinator	Pesticide Evaluation Process	Ordinances	Acres	Budget	Number of Employees
Boulder	1993	Yes	Yes	IPM coordinator in the Community Planning and Sustainability Department.	IPM Subcommittee reviews requests and research from staff, a toxicologist and the IPM coordinator on as-needed basis. City Manager reviews and makes final determination.	Yes	16,256 acres of land 43,288 acres of open space 320 facilities	See Table A.2 below.	See Table A.2 below.
San Francisco	1996, Tiered system in 1999	Yes	Yes	Integrated Pest Management Project Manager in the Department of the Environment. Each pertinent department has an IPM coordinator.	Tiered system with extensive yearly review process.	Yes	29,888 acres of land	$100,000 for Department of Environment to coordinate and facilitate city-wide program.	0.8 FTE in Department of Environment, 7 IPM coordinators in other departments.
New York Structural Pest and Rodent Program	Local Law 37 in 2005, RII in 2006	Yes	Yes	Department of Health and Mental Hygiene, Office of Veterinary and Pest Control Services.	Local Law 37 bans use of certain pesticides. Only products that don't violate LL 37 are used. A committee reviews any exceptions twice yearly.	Local Law 37	300,096 acres of land in NYC 29,000 acres of park land	RII Personnel: $7,072,192 RII Non-Personnel: $553,993	154 full time, 19 part time.

Table A.1. Comparison of IPM Programs

	Date Initiated	IPM Policy	IPM Plan	IPM Coordinator	Pesticide Evaluation Process	Ordinances	Acres	Budget	Number of Employees
University of Colorado, landscape beds and facilities	2002 IPM Policy, 2010 Landscape Task Force	Yes	Same as policy	IPM coordinator housed in the Environmental Services Department. Each pertinent department has an IPM Liaison.	No process for evaluating pesticides, but looking at complying with LEED standards.	Not applicable	General areas: 165 acres (70 turf, shrub/rock beds 18, native 26, hardscape 56). Housing: 132 acres (49.1 turf, shrub/rock 6.5, 76.4 other) Structural: 8.5 million square feet	Turf: $108,525. Beds: $229,253. Asking for ___ for new organic program. Structural: $409,004, half is billable to departments	26 full time for turf, 15 for grounds, 1 for parking lots, 5 for athletic department. Structural: 3.45 FTE (1.05 of that is student labor) .2 FTE in administration (though not accurate, closer to 1.0)
Toronto, pesticide use restrictions	2003 City Bylaw, 2009 Ontario Bylaw	Yes	Same as policy	No, Division heads are responsible for complying with IPM policy and bylaws.	Class system from Ontario ban. Very limited use of pesticides allowed for cosmetic uses.	City-wide, then province-wide ban on cosmetic use of pesticides.	155,648 acres of land. 17,287 acres of turf, 19,879 acres of parkland (7,625 natural, 10,763 maintained)	Not available	Not available

Table A.1. Comparison of IPM Programs

	Date Initiated	IPM Policy	IPM Plan	IPM Coordinator	Pesticide Evaluation Process	Ordinances	Acres	Budget	Number of Employees
Marin County Municipal Water District, natural lands IPM program	2003	Yes	Yes	No	Approved list developed when management plan was updated. Used a consultant for risk assessment.	Not Applicable	21,250 acres of land	$500,000	12 full time, 2 AmeriCorp Interns, 0-6 seasonal. None are exclusively IPM.

Table A.2			
Department	**Workgroup/Division**	**Staffing***	**Estimated Budget***
Parks and Recreation	Athletic Field Maintenance Workgroup	5 FTE standard maintenance 6 FTE seasonal 75% is IPM work	$180,000 PE
	Boulder Reservoir Workgroup	0.1 FTE management 0.25 FTE standard maintenance 3FTE seasonal staff Plus jail crew and volunteers	$27,950
	Urban Parks	3.5 FTE standard maintenance (2 turf and 2 horticulture) 10 FTE seasonal (6 turf, 2 horticulture, 2 sites) 0.1 FTE jail crew and volunteers	$267,000 $28,000 Jail and volunteers
	Golf Course	4 FTE full time 8 FTE seasonal Plus volunteers, community service workers	$150,000
	Urban Resources	¾ - 1 FTE management divided among several staff 3-4 FTE seasonal (40% of time on IPM)	$80,000
	Urban Forestry	1 FTE standard maintenance divided among several individuals 2 FTE seasonal staff	$75,000
Public Works		0.05 FTE management .50 FTE full time 4-6 FTE seasonal	$100,000
OSMP		1.75 FTE non-management 5 7-month seasonal In-house mower Plus jail crews and volunteers	$190,000
IPM coordinator		0.75 FTE	$250,000 for mosquito control program
*Estimates based on portion of time/responsibilities for IPM activities.			

City/County of San Francisco

History: The City of San Francisco passed an IPM ordinance in 1996 with the goal of reducing pesticide use on city property and using an IPM approach for solving pest problems. In 1999, they created the tiered pesticide rating system to thoroughly evaluate each pesticide that is approved for use in the city. This tiered rating system has since been used as a model for other pesticide programs such as the City of Seattle and the US Green Building Council's

LEED certification system and has been suggested for the Stewardship Index for Specialty Crops' Off-Farm Pesticide Metric. San Francisco has been extremely successful at reducing pesticide use on city property since the inception of the program.

Internal Communication: The IPM program in San Francisco operates with excellent communication within departments. An Integrated Pest Management Project Manager coordinates the program and each applicable department has an IPM coordinator that directs the IPM activities. Each department has its own training for staff. Pestec (a Green Shield Certified pest management company) is used for structural pest management for all city facilities; landscape work is typically done by city employees though some projects are outsourced to outside contractors.

Monthly meetings of a Technical Advisory Committee include presentations by IPM experts and are open to the public. Yearly or bi-yearly IPM conferences are held with full participation at each one so far. In the future, they will be held every other year due to budget constraints. The monthly meetings and yearly conferences have been excellent ways of sharing information within departments and with the public. The transparency of the processes and educational components are especially important to gain the trust and buy-in of community members.

Product Evaluation and Use: The tiered product evaluation system developed by the City of San Francisco determines which products present the least hazard and which are approved for use on city property. The following criteria are examined for each product: acute toxicity, special hazards, carcinogenic effects, reproductive toxicity, endocrine disruption, water pollution, hazard to birds, fish, bees and wildlife, persistence, soil mobility and PBTs (see Table A.3. below). A product is then evaluated for exposure potential, effectiveness and need. Finally, it is placed on the allowed or limited use list. Tier I is the highest hazard, tier II is medium and tier III is low hazard.

Table A.3. City of San Francisco Tiered Rating System Criteria, Sources and Ratings. From City of San Francisco.

Criterion	Sources	Rating		
		-	0	+
Signal Word	Acute toxicity: Product label signal words	Danger		Warning or Caution
Restricted Use	Special hazards: Product label use restricted to professionals	Yes		No
Cancer	Designation of ingredient by US EPA, State of CA, National Toxicology Program or International Agency for Research on Cancer	Known, likely, probable	Possible	No evidence, not likely, not listed
Reproductive	Designation of ingredient by State of CA	Listed		Not listed
Endocrine	Designation of ingredient by	EC category 1 or		EC category 3

	European Commission	2		or not listed
Water Pollution	Ingredient listed under Clean Water Act Section 303(d)	Listed		Not listed
Bird Hazard	Product label: presence and wording of bird hazard statement	Extremely/highly toxic	Toxic	May be toxic or no warning
Aquatic Hazard	Product label: presence and wording of fish hazard statement	Extremely/highly toxic	Toxic	May be toxic or no warning
Bee Hazard	Product label: presence and wording of bee hazard statement	Extremely/highly toxic	Toxic	May be toxic or no warning
Wildlife Hazard	Product label: presence and wording of wildlife hazard statement	Extremely/highly toxic	Toxic	May be toxic or no warning
Persistence	OSU Pesticide Properties Database: Average soil half-life	>99 days	30-99 days	<30 days
Soil Mobility	OSU Pesticide Properties Database: soil mobility score	High or very high	Moderate	Low to extremely low
PBT	Persistent, Bioaccumulative, Toxic Substances (PBTs): US EPA Waste Minimization Priority Chemicals	Listed		Not listed

The city reviews the list of products each year and holds a public meeting, typically in November to obtain comments and suggestions by the public. They are able to add or remove products to the list during the yearly review, allowing them to stay current with new technologies and IPM techniques. Following the strict evaluation criteria noted above assists in alleviating community concerns about particular products.

Any exemptions to the list must follow a strict protocol. Any city staff or contractors must apply to use a product that is not on the reduced risk pesticide list or on the list but is used differently than described in the pesticide limitations column. The IPM coordinator for the city department must fill out the Pesticide Exemption Request Form. Only those with a well-documented need for the product or for trial use of the new or reduced risk product will be considered. If the product is approved, they must justify the use of the pesticide at the annual public hearing. A product must also be justified if it is higher risk and listed as most limited use in the SF reduced-risk pesticide list. All departments follow IPM protocols and use the least-toxic products available only as a last resort.

Public Participation and Community Involvement: The public has been supportive of the IPM program overall. Monthly Technical Advisory Committee (TAC) meetings are open to the public and they often participate. The public can sign up for email alerts for new information about the program, events and news about IPM. Educating the public about IPM has been an important component of gaining support.

The City of San Francisco's Department of the Environment's website is very well designed, easy to navigate and filled with useful information including yearly reports, the pesticide list, procedure for evaluating pesticides, advice for choosing pest management companies and occasional IPM newsletters. This is a main point of contact with the public as well as a portal for internal information sharing.

The city partners with local organizations to get the word out to the public about their IPM policy and updates. Often times if constituents point to a particular product they are concerned about, the city can turn to one of their partner organizations such as the Pesticide Action Network as a resource and supporting organization. They are often able to use such partnerships to quell concerns about products or procedures. They have found partnering with local organizations to be quite helpful and a large part of their success.

Barriers to Implementation and Success: The biggest barrier has been effective communication with the public. Some members of the community are against any pesticide use at all and they often have a difficult time alleviating their concerns. They use their partnerships with other organizations and their public processes to ease concerns with the public.

Successes of the Program: The City of San Francisco has been extremely successful in reducing pesticide use on city properties since the inception of the ordinance. They have achieved an 81% reduction in total pounds of pesticide product, 88% reduction in gallons of product, and 76% reduction in lbs of active ingredient since the inception of the project in 1996. Many of their successes can be attributed to the strength of their IPM ordinance and plan, the tiered pesticide product evaluation process and the use of the citywide pest control contractor, Pestec. Eighty-eight of Pestec's site visits used absolutely no pesticidal products. Their strong program combined with community buy-in has created an extremely successful program that has become a model for other cities and programs around the country.

New York City

History: In May 2005, the City of New York passed Local Law 37 that set a goal of reducing the use of pesticides on city owned or leased properties and promoting the use of safer and more effective pest management strategies through IPM. Local Law 37 bans the use of certain types of pesticides deemed most toxic, encourages the use of IPM, and requires rigorous application postings, public education and detailed record keeping. All pertinent city departments use IPM techniques to reduce the use of pesticides.

An excellent example of New York City's IPM policy is the Rat Indexing Initiative. The Bronx Rat Indexing Initiative (RII) was established in 2006 with the intent of reducing rat populations through inspections, mapping and IPM techniques. Most rodent infestations stem from sanitation and exclusion issues, and New York was looking for ways to communicate with the public and reduce rodent populations. It began as a complaint based program where inspectors would visit properties based on tips and complaints from neighbors. The RII evolved into a block by block indexing program where inspectors visit each property with a visual inspection armed with GPS devices so they can quickly and

easily map the borough's rodent problem. The program has expanded to Manhattan in 2010, with the intention to include all five boroughs in the next few years. In 2010 the NYC Rat Indexing Initiative received Green Shield Certified certification from the IPM Institute of North America.

Other departments also utilize IPM from a public health perspective, further demonstrating New York's commitment to reducing pesticide use and the associated risks. Schools and public housing are places where IPM techniques can have a huge impact on public health. Schools in New York City are charged with utilizing IPM techniques for dealing with pest management issues. Additionally, all pest management providers that service New York City School Districts must be Green Shield Certified. This ensures that schools are serviced with high quality pest management providers that utilize IPM techniques and only use the least toxic pesticides as a last resort. New York also focuses on providing IPM to low income housing and public schools to reduce exposure to allergens and toxins with the New York City Asthma Initiative that includes programs such as Community Integrated Pest Management that provide IPM pest management services to those with asthma.

Internal Communication: The City of New York has an IPM policy that all pertinent departments must abide by. An IPM plan is submitted to the Mayor's Office and City Council each January. All departments that use pesticides are required to keep detailed records of pesticide applications and other pest management efforts. Each pesticide application is added to the web-based New York City Pesticide Use Reporting System by city contractors or employees. This system was developed for the City of New York over five years with the help of their Department of Information Technology. The centralized reporting system makes it easy for the city to keep track of pesticide use and remain in compliance with Local Law 37. Pesticide application data is easily analyzed and made available to the public.

Local Law 37 also established a Pest Management Committee for agencies to share information and strategies about pest management throughout the city. It is made up of representatives from more than 15 agencies and public authorities. They serve as the pest management advisory committee and meet twice a year.

An important aspect of the RII is the intensive rodent IPM training for city employees. The Rat Indexing Initiative hosts three-day "New York City Rodent Academy" training sessions for city department managers twice a year to educate them about the program, train them on IPM techniques and rodent population reductions. Smaller training sessions continue year round for inspectors and other employees of the RII.

Product Evaluation and Use: Local Law 37 specifies that the following types of pesticides are banned from use on city owned and leased property: 1) Any pesticide ingredient classified as Toxicity Category I by the US EPA; 2) Any ingredient classified as a human carcinogen, likely to be carcinogenic to humans, a known/likely carcinogen, a probable human carcinogen, or a possible human carcinogen by the Office of Pesticide Programs of the US EPA; 3) Any pesticide ingredient classified by the California Office of Environmental Health Hazard Assessment as a developmental toxin.

A Waiver Review Committee evaluates any requests that city agencies may have for exemptions to the prohibited pesticides categories. The committee has individuals trained in IPM from different areas of the Department of Health and Mental Hygiene including licensed applicators, health educators, environmental epidemiologists, risk assessors and entomologists. Examples of products granted a waiver are baits and gels containing the prohibited active ingredients fipronil and hydramethylnon. These products can be applied in such a way that minimizes exposure.

The Rat Indexing Initiative utilizes a short list of rodenticides that are evaluated for use by their head rodentologist, Dr. Robert Corrigan. All rodenticides are used in secured, containerized bait stations to avoid contact with non-target species, humans or the environment. All of the products used meet Local Law 37 and Green Shield Certified's rigorous standards.

Public Participation and Community Involvement: All departments work closely with the public regarding IPM and public health. Outreach and education on many subjects such as recent bed bug outbreaks, asthma and general sanitation occur on a regular basis. These efforts include information lines, websites, brochures and marketing campaigns to inform the public about IPM techniques such as inspection, sanitation, exclusion and monitoring.

The Rat Indexing Initiative works very closely and effectively with the public to educate them about IPM and rodent control. As rodent issues often invoke emotional responses from residents, a key aspect of the Rat Indexing Initiative is effective communication and involvement from the public. While this program is unique in many ways, it lends its success to working with the public. Enforcement is one tool that is very effective for this particular program, but their hands-on involvement with the public keeps people informed and educated about IPM techniques for reducing rodent populations.

The Rat Indexing Initiative also works closely with media outlets to get the message out to residents about the program as well as reducing rat populations. As rodent issues are often a hot topic in New York, local newspapers, radio and TV stations consult with the experts at the RII for their news stories. They frequently send out press releases to inform the local community about the many positive results of their program, upcoming events and new information. There is a public relations position in the department that they utilize for assistance with distributing information.

The Rat Information Portal is a primary point of contact for the community. They can access a web-based GIS mapping system to see results of the inspections and rodent infestations, learn IPM techniques to rodent proof their properties and tips for choosing a pest management provider. Informational brochures are available on the website in the three most dominant languages in the Bronx – English, Spanish and Chinese.

The Rat Indexing Initiative partners with many local organizations to promote their program. They host a monthly "Rat Academy" at no cost with a free trashcan for attendees. These

have been very popular with residents and members of community garden groups. The local food movement has provided another platform for educating the public on IPM techniques and reducing rodent populations with reduced use of rodenticides. They look for partnerships in unconventional places as they often have common goals.

Working directly with the public in varied ways has been an excellent way to educate residents about IPM and rodent control. Representatives of the program perform inspections for community groups and teach them how to perform their own rodent inspections. This hands-on approach allows the public to take matters into their own hands and use IPM techniques to reduce rodent populations in their own neighborhoods. Pressure from neighbors has been an effective tool in gaining compliance by property owners. Each NYC borough is comprised of Community Boards. The outreach and education coordinator from the Department of Health and Mental Hygiene meets with each community board after the indexing of their area. The outreach coordinator is also available to conduct presentations and provide technical assistance for the neighborhood.

Successes of the Program: Local Law 37 has resulted in a reduction in pesticide use on city owned and leased properties. In 2009, there was a 39% reduction in pesticide use overall and a 32% reduction in rodenticide use. The RII has reduced the use of pesticides by focusing on IPM protocols on a property by property basis. A high compliance rate for the RII has resulted from repeated visits to properties, a desire to eradicate rodents and the hands-on approach.

Barriers to Implementation and Success: The greatest barrier to success of the program is sanitation issues in New York. Many streets have piles of garbage on them on a daily basis, creating irresistible food sources for rodents and other pests. Budget cuts have also nearly eliminated the ability of the program to do sanitation and exclusion work on individual properties. The city sends invoices to property owners if they have to perform sanitation and put out bait, but they are rarely paid. This limits the ability of the RII program to perform much needed sanitation on non-compliant property owners.

City of Toronto

History: In 2003, the City of Toronto's City Council passed the Pesticide Bylaw which banned the cosmetic use of pesticides on landscapes with the goal of improving public health by reducing exposure to pesticides. In 2009, Ontario passed a provincial bylaw banning cosmetic pesticide use in the province that overrode Toronto's municipal bylaw. The Ontario law strengthens the original bylaw by also banning the sale of many pesticides throughout the province, limiting exemptions and restricting use. Previously, residents were still able to buy products and apply them to their landscapes, which made the bylaw more difficult to enforce.

Internal Communications: The provincial bylaw limiting the use of pesticide products on public and private land dictates how the City of Toronto can conduct pest management. The city has an overarching Pesticide Use Policy that is dictated by the bylaw. They have taken the approach of "Integrated Plant Health" for their landscape and open space maintenance which focuses on the holistic health of the soil and plants to avoid pests and pesticide use. The Division Directors are responsible for complying with the Bylaws which limit pesticide

use and the Integrated Plant Health Plan that includes elements of Integrated Pest Management.

Any applications of the least toxic pesticidal products are recorded in a log that is compiled at the end of each year. This is done by hand and later included in a yearly report. The data collected includes amount applied, product name, number, formulation, mechanism for application, active ingredient, percent active ingredient, rate of application, site location, category location (park, sports field, etc.), target plant, target pest, quantity, area treated, time applied, temperature, wind direction, wind velocity, name and signature of applicator, applicator license number, date and any signage used. This data is used to ensure they are in compliance with their pesticide use policy and provincial bylaws.

Product Evaluation and Use: Ontario evaluates pesticidal products based on the classification system listed below. Only those deemed least risk are allowed for cosmetic used on landscapes. The pesticide classification system and exceptions are listed below.

Pesticide Classification *(From http://www.ene.gov.on.ca/en/news/2009/030401mb.php)*
To support the cosmetic pesticides ban, a pesticide classification system consisting of eleven classes of pesticides has been established. Please also refer to the Pesticide Classification Guideline for Ontario for the criteria for each class of pesticide.

- *Class 1 are manufacturing concentrates used in the manufacture of a pesticide product.*
- *Classes 2, 3 and 4 are commercial or restricted pesticides that can continue to be used by farmers and licensed exterminators for non-banned uses. If the pesticide contains a Class 9 pesticide, it may only be used for an exception to the ban (e.g., agriculture, forestry, golf courses).*
- *Classes 5 and 6 pesticides can be used by homeowners and include biopesticides and lower risk pesticides allowed for cosmetic uses.*
- *Class 7 includes dual-use pesticides (i.e. indoor/outdoor uses). Such pesticides will only be allowed to be used for non-cosmetic purposes. For example, they can be used indoors to kill pests or outdoors for public health or safety reasons, but cannot be used outdoors to kill weeds. Retailers must give information to notify purchasers that only certain uses of these pesticides are legal. In two years' time, consumers will also not have ready access to these products, and continue to receive notification about the legal uses.*
- *Class 8 are banned domestic products (e.g., pesticide-fertilizer combination products, weed and insect control products for lawns and gardens).*
- *Class 9 lists ingredients in pesticide products. These ingredients are banned for cosmetic use. Commercial or restricted products containing these ingredients may still be used by farmers or licensed exterminators for exceptions under the ban.*
- *Class 10 pesticides are ingredients in pesticide products. These are the only ingredients that may be used to control plants that are poisonous to the touch under the public health or safety exception.*

- *Class 11 lists ingredients that are biopesticides or lower risk pesticides. Licensed exterminators that use Class 11 pesticides are required to post a green notice sign to provide public notice of the use of these pesticides.*

Exceptions (From http://www.ene.gov.on.ca/en/news/2009/030401mb.php)

- ***Public health or safety:*** *Pesticides can be used to control plants that are poisonous to the touch, such as poison ivy; insects that bite, sting, are venomous or are disease carrying, like mosquitoes; and animals, insects or plants that may cause damage to a structure or infrastructure, such as termites.*
- ***Natural resources:*** *There is an exception, with Ministry of Natural Resources approval, to control invasive species that may be detrimental to health, the environment or the economy, or to protect a native plant, animal or a rare ecosystem.*
- ***Golf courses*** *are conditionally excepted from the ban provided they follow tough new rules. They must become accredited for Integrated Pest Management (IPM) by an approved accreditation body. IPM uses a variety of tools, including best practices, mechanical and biological methods, along with pesticides when necessary, to manage pest populations. Golf courses must prepare an annual report on how they minimized their pesticide use and make the report accessible to the public. Also, they must hold a public meeting annually to present the report.*
- ***Sports fields*** *are allowed a short term exception from the ban to host national or international level sports competitions. Written approval for the exception must be granted by the Minister of the Environment. Once the event concludes, the use of pesticides must end. Areas such as lawns and gardens around the sports fields are not excepted from the ban.*
- ***Specialty turf****: Pesticides can be used to maintain specialty turf used for lawn bowling, cricket, lawn tennis and croquet if certain conditions are met. Areas such as lawns and gardens around the specialty turf are not excepted from the ban. IPM and annual reporting conditions, similar to those imposed on golf courses, must be followed.*
- ***Trees****: Since trees are so important to protecting our climate, licensed exterminators can use conventional pesticides with the written opinion of a tree care professional that states that the use of the pesticide is necessary to protect the health of the tree. Homeowners and licensed exterminators can also buy and use biopesticides and lower risk pesticides (e.g., Btk - a biopesticide sprayed over Ontario cities for Gypsy moth control) to care for trees without requiring an opinion from a tree care professional.*
- ***Agriculture****: The use of pesticides is necessary for agriculture from an economic and operational perspective. Ontario farmers already have stringent rules on the use, handling, storage and application of pesticides, and these rules will continue. The exception does not apply to a farmer's household vegetable garden and lawn.*
- ***Forestry****: The use of pesticides in forestry is essential to protect trees from pests, and to control competing vegetation. Ontario's forestry workers must follow stringent rules on the use, handling, storage and application of pesticides. The exception applies to a range of forestry activities including harvest and reforestation.*

- ***Public works****: Under the health or safety exception, pesticides are allowed to be used to maintain safe conditions, and the security of and emergency access to public works. Public works include highways, railways, power works, gas works, water works and other utilities, transit/transportation corridors and the perimeter of nuclear facilities. The exception does not apply to the use of a pesticide on a portion of a highway to which pedestrians have access on a regular basis or where the public is invited to stop including picnic and rest areas.*

Public Participation and Community Involvement: Public participation for the bylaw primarily consisted of a public comment period that gave community members the chance to voice their concerns about the change in the bylaw. As it was a province-wide ban, all of Ontario was able to participate in the public comment period.

Successful compliance with the bylaws has been possible with an aggressive marketing campaign to ensure residents are aware of the pesticide ban. Toronto launched an extensive education campaign including spring and fall advertising in newspapers, transit hubs, recycling bins and magazines. They also produced brochures, fact sheets and technical guides that they distributed through point-of-purchase locations, civic centers, libraries and other community locations. Displays and information at public events, a telephone information line and website were other manners of distributing information to the public. City officials had regular discussions with the industry regarding compliance issues and promoted safe disposal of unused pesticides through Household Hazardous Waste depots. Toronto is a multicultural city, and they were able to reach all Torontonians by partnering with other community groups and agencies. Information provided by the city includes lawn and landscape pointers for residents to eliminate the use of cosmetic pesticides.

The Division of Parks and Recreation also involves the community by creating demonstration parks and gardens in each of the four divisions of the city. Demonstration parks show the community how to maintain their gardens and landscapes without the use of pesticides or chemical fertilizers. They include signage about the parks and have staff available for more information.

Successes of the Program: To collect data on the success of the program, Toronto Public Health collected and reviewed results of focus groups and surveys of residents. Results showed a reduction in pesticide use on residential lawns by 57% since 2003. One third of residents reported pesticide use in 2003, with only 16% reporting pesticide use in 2007. Compliance with the law is only possible with increased awareness. Results of focus groups and surveys also demonstrated that 67% of residents with lawns were aware of the cosmetic pesticide ban.

One advantage to this program is the ability to enforce compliance with the use of inspectors and fines. The new provincial ordinance increases fines substantially, removes most pesticides from stores and provides Provincial Offences Officers for enforcement. Support from Ontario increases the likelihood of compliance with the additional resources.

Toronto has had some success with outside funding for athletic fields. Athletic leagues often provide funding to improve sports fields and other athletic areas. This typically happens on a small scale and for specific fields. They do not typically apply for grants or other types of funding to assist with IPM or pesticide reduction implementation.

Barriers to Implementation and Success: The barriers to the success of their Integrated Plant Health program include inadequate funding and staff resources to manage their parks and landscapes. They are unable to regularly monitor their landscapes for weeds or pests, and typically deal with any pests on an as-needed basis. As they have been working with few chemical fertilizers and pesticides since 2003, most of their landscaped areas are well adapted due to their focused approach on plant and soil health.

Another barrier is non-compliance from contractors and homeowners that have banned pesticidal products in their possession from before the ban or from other provinces. Most investigations into non-compliance are a result of complaints from neighbors.

University of Colorado at Boulder

History: An IPM Policy was adopted by the University of Colorado at Boulder in 2002. This includes specific pest thresholds for each department's area of responsibility, record keeping protocols, duties of the IPM coordinator, guidelines for contractors and pest exclusion and prevention techniques for design and construction personnel. A structural pest management program has been in place since 1998, even though the policy was not officially adopted until 2002.

The University of Colorado at Boulder created a Turf Management Task Force in May of 2010 at the suggestions of students and faculty that want to discontinue the use of pesticides in their landscape. This plan is due for review at the end of 2010, though it is expected to be adopted in 2011 when they will begin the transition to organic management for landscapes and turf. Some athletic fields will be exempt from the organic policy to protect the health and safety of athletes.

Internal Communication: An IPM coordinator administers the structural pest management for the University. This position is located in the Environmental Services Department. Each pertinent department has an IPM Liaison that manages IPM duties and monthly record keeping for their department.

Some turf management is performed by outside contractors, but most is conducted in-house. Contractors are provided with copies of the IPM policy and must abide by it according to their contracts. An employee of the university accompanies each applicator to ensure they are following IPM protocols and applying products to the designated areas. Structural pest management is almost entirely performed by internal staff.

Product Evaluation and Use: The University currently has an approved list of products for landscape use that is very small and has been used for many years on a limited basis. These include MCPP and glyphosate.

Structural pest management strives to use the least toxic pesticides, only after all other non-chemical options have been exhausted. They do not have a list of approved products or a procedure for determining which ones they use. They do have an extensive IPM manual that outlines which techniques to utilize for common pests, including using heat treatments for bed bugs in student housing.

Public Participation and Community Involvement: The student population has been very involved in this program. Students and faculty have expressed an interest in becoming organic and have had a role in developing the draft report.

They have created a Pesticide Advisory Board that includes students, landscape architects, facility managers and other pertinent personnel that will review pesticide use, efficacy, test plots and best practices for landscapes. They meet at the end of each growing season to review the previous year and prepare accordingly for the next year.

The department is looking at ways to educate the student body and local community about pesticide use and IPM practices. They do have access to public relations personnel within the University to assist. The draft report includes an estimated budget for education and outreach of the program. As it has not yet been implemented, it is unclear what the education and outreach program will consist of.

Successes of the Program: The organic turf program has not yet been implemented. The structural IPM program has been successful in significantly reducing costs and pesticide use since its inception in 1998. Using in-house pest management, focusing on exclusion, sanitation and monitoring and sparingly using pesticide products has reduced costs of the structural IPM program. Pesticide products are used very minimally on landscape beds and structures on campus.

Barriers to Implementation and Success: The biggest barrier to becoming pesticide free for the University's landscape will be the ability to re-design some of the planting beds and finance the increased yearly costs of maintenance. It is estimated that implementation will cost $6 million for landscape re-design and an additional $300,000 per year for maintenance. There are also some concerns about dandelion and other weed seed sources from nearby areas encroaching on campus and disrupting efforts to become completely pesticide free. Barriers for the structural pest management program include gaining compliance from on-campus residents regarding sanitation and battling bed bugs.

Marin Municipal Water District

Because much of Boulder's maintained landscapes are natural lands and open space, we decided to include another example of an organization utilizing an IPM approach for comparison.

History

The Marin Municipal Water District (MMWD) provides water for much of Marin County in California, just north of San Francisco. MMWD lands contain the Mt. Tamalpais State Park, a destination for hikers, mountain bikers and naturalists and home to several rare and endangered species. Most of the water delivered to MMWD's 195,000 customers comes from rainfall runoff flowing to seven reservoirs in Marin County. MMWD staff manages over 21,000 acres of land, including 18,500 in the Mt. Tamalpais Watershed and 2,750 acres adjacent to the Nicasio and Soulajule reservoirs in west Marin. An additional 35,000 acres of privately-owned watershed land drains into these two reservoirs.

Much of the MMWD land abuts densely packed single-family homes in the towns of Fairfax, Ross, San Rafael, Mill Valley and San Anselmo. In such an area, fire safety is a great concern, making vegetation management necessary to protect homes from wildfires.

MMWD adopted an IPM policy in 2003, with a goal of controlling invasive weeds in the most environmentally friendly and cost-effective manner possible. The 2003 IPM policy was developed with extensive input from the public, including Marin Breast Cancer Watch, Marin Beyond Pesticides Coalition and the Pesticide Education Group. Oversight of the policy has been provided by the MMWD IPM committee, composed of senior management, licensed herbicide applicators, fisheries biologists and water quality experts.

The MMWD IPM policy specified a number of options for controlling weeds, and limited the use of herbicides to areas away from reservoirs and stream courses and areas in which other alternatives were not feasible. Conventional herbicides were permitted for use in accordance with MMWD's IPM policy, as follows:

- Herbicides are used only as a last resort and in combination with mowing, burning and hand removal;
- Inter-agency cooperation and public education critical;
- Approved herbicides restricted to a subset of San Francisco's "Reduced Risk" Pesticide List:
    - glyphosate (Roundup, Aquamaster)
    - triclopyr (Garlon 4, Pathfinder)
    - clopyralid (Transline)
- Five-year herbicide reduction plan and monitoring program in place for all treatment sites;
- Application methods restricted to spot treatment of re-sprouting stumps and cut-stump painting;
- Applications restricted to dry season and low-wind conditions;
- Trail heads posted during and at least 12 hours after applications;
- All applications conducted in compliance with environmental and worker safety regulations;
- Quarter mile use-restriction zone around reservoirs and 100 foot buffers around water-bearing drainages.

Over the years, MMWD tested other means of plant control, including goat grazing and new technologies that have relied on high-intensity heat/flame, water or foam (soap-based), as well as mowing, hand pulling, controlled burning, propane flaming and organically approved herbicides containing acetic acid, clove oil and pelargonic acid as active ingredients. None of these alternatives have proved to be effective at the scale necessary for managing all of the watershed lands.

In 2005, MMWD suspended the use of herbicides on the watershed pending the development of an updated vegetation management plan that involved an extensive assessment of both non-chemical and chemical approaches to weed management. An addendum to the existing Environmental Impact Report (EIR) for vegetation management on MMWD lands is currently under development, as of January 2011.

Internal Communication

There is a single Environmental Services Department in charge of conducting vegetation management on MMWD lands, simplifying communications among staff. Environmental Services staff report to the Environmental and Engineering Manager, who reports to the General Manager. The General Manager is under an elected five-member Board of Directors.

The Board establishes policy on the district's mission, goals and operations and represents the general public in deciding issues related to water supply. The board also has the authority to adopt ordinances that have the force of law within the district. The board reviews staff recommendations and decides which policies should be implemented in light of the district's mission and goals. The board also monitors the implementation of its policies.

Pesticide use information is collected by each department and logged into an excel spreadsheet. The use of limited herbicides, rodenticides and insecticides are included. Information included in their database includes application date, location, product commercial name, active ingredient, EPA registration number, quantity used, target pest and acreage or square feet treated. MMWD is currently looking at improving efforts to record non-chemical treatments. For weed eradication on wildland areas they are transitioning to software called GeoWeed.

Product Evaluation and Use

For the updated MMWD vegetation management plan, a list of candidate herbicides was evaluated and the least toxic among them were selected for a comprehensive risk assessment for potential use scenarios in the watershed. The risk assessment contained a review of US EPA and the peer-reviewed literature on the toxicology and environmental fate of the selected herbicide products and several adjuvants, including Aquamaster (glyphosate), Transline (clopyralid), Garlon 3 and 4 (triclopyr salt and ester), clove oil, pelargonic acid, and the adjuvants Competitor, Sylgard, and Blazon Blue dye. Roundup products were not evaluated due to the aquatic toxicity of the adjuvants used. Aquamaster contains only glyphosate and water. A variety of exposure scenarios were evaluated to determine likely potential exposures if herbicides were used for various vegetation management activities.

A more extensive set of herbicide use guidelines were proposed in the risk assessment (page 26, Chapter 2 of the MMWD herbicide risk assessment) to reduce the potential for adverse impacts if the District decides to utilize herbicide in their vegetation management program.

Public Participation and Community Involvement
A series of public workshops on the risk assessment and environmental review process were held to provide an opportunity for MMWD customers to ask questions about different weed control techniques, the herbicide risk assessments, and the overall plans for biodiversity management and fire safety. There is a small group of Marin County residents who are very concerned about the use of any herbicides on MMWD lands. At the public meetings and in other meetings with staff and the Board, this group strongly urged the District to utilize only mechanical methods of weed control. They proposed raising water delivery fees to fund the increase in cost of land management using only mechanical controls. While this is an option, Marin County is also facing the need for expanding their water supply, which would also add additional costs to water bills. Their current budget is $500,000 per year for fuelbreak construction/maintenance, weed control and hazard tree removal.

The MMWD staff also communicates frequently with the Marin County Open Space District, an organization that is responsible for vegetation management on neighboring properties.

Barriers to Implementation and Success
The development of the MMWD vegetation management plan is still in progress. In the interim, the MMWD Environmental Services staff is using only mechanical means of weed control. With their current budget, they are losing ground to invasive weed species, particularly Scotch broom, French broom and yellow star thistle, among others.

Successes of the Program
MMWD staff has managed to restore many of the lands to nearly pristine native bay-oak woodlands. Some of the earlier work (prior to 2005) involved using herbicides sparingly, but more recent work utilized only mechanical methods. The MMWD has been a leader in the use of IPM techniques for management of invasive weeds. They are currently experimenting with re-vegetation with native plants.

MMWD has also had some success in leveraging grant funding to supplement their annual budget. They have not pursued funding specifically for IPM, but some of their grant funded projects have IPM components. For example, they recently completed $500,000 in grant funded salmon habitat improvements which included some significant weed control undertakings.

Appendix B: City of Boulder IPM Policy with Recommendations

The City of Boulder adopted a detailed, comprehensive IPM Policy in 1993. The policy was updated in 2002. The policy is not yet fully implemented and would benefit from an update. We have the following recommendations:

1. Complete an attorney review for incorporation of terms for City facilities leased to tenants. Current language indicates the policy applies to all city-owned or managed properties, but does not specifically include tenants, or tenant-hired contractors, in City-owned properties in its provisions. Including tenants and their contractors would enable the City to intervene if deficiencies are found in City facilities occupied by tenants. One option would be for the City to provide pest control in all of its facilities, including facilities rented to tenants. A second would be to include terms in leases requiring tenants and their contractors to comply with the policy.

2. As part of the updating process, review the IPM coordinator position descriptions and IPM TAC and IPM Subcommittee charges for conformance to proposed changes to the policy.

3. Once the pesticide evaluation process is finalized, update the policy sections VI. IPM Procedure, D.5. to reflect the new process.

4. Additional comments are provided below in *bold italics*.

[BEGIN CURRENT POLICY AND RECOMMENDATIONS]

CITY OF BOULDER

****

POLICIES AND PROCEDURES

INTEGRATED PEST MANAGEMENT POLICY

EFFECTIVE DATE: April 24, 2002

Ronald A. Secrist, City Manager

I. SCOPE AND APPLICATION

This Integrated Pest Management (IPM) policy shall apply to all pest control activities and pesticide use in buildings and related facilities; grounds and open space; and other property owned or managed by the City of Boulder and conducted by city staff, ***tenants*** or contractors. City officers, employees, ***tenants*** and contractors are required to follow this policy. Departments that have employees monitoring or treating pest problems or managing any contractors who monitor and/or treat pest problems will receive a copy of the Integrated Pest Management policy. All ***tenants*** pest control contractors will receive a copy of this policy.

II. PURPOSE

The policy is intended to provide a basis for pest and vegetation management that will protect public health, as well as water quality, federal endangered and threatened species, and state, county and local species of concern. The goal of the city's IPM policy is to utilize the most environmentally sound approaches to pest management, and to reduce and eliminate, where possible, the volume and toxicity of chemical pest control treatments.

The objectives of this policy are to

- require planning and development of an IPM program for all departments and
- provide procedural guidelines for implementation.

III. DEFINITIONS

A. Integrated Pest Management (IPM): a decision making process which selects, integrates, and implements pest control strategies to prevent or control pest populations. Integrated Pest Management uses a "whole systems approach", looking at the target species as it relates to the entire ecosystem. In choosing control strategies, minimal impacts to human health, the environment, and non-target organisms are considered.

B. Pest: any insect, rodent, nematode, fungus, weed, or any other form of terrestrial or aquatic plant or animal life or virus, bacteria, or other micro-organism (except viruses, bacteria, or other micro-organisms on or in living man or other living animals) which the Administrator of the EPA declares to be pest under section 25(c)(1) [7 USCA 136w(c)(1)].

C. Pesticide: any substance or mixture of substances intended for destroying or repelling any pest. This includes without limitation fungicides, insecticides, nematicides, herbicides, and rodenticides and any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant. The following products are not pesticides:
1. Deodorizers, bleaching agents, disinfectants and substances for which no pesticidal claim is made in the sale or distribution thereof, and
2. Fertilizers and plant nutrients.

D. Reasonable Alternative: a feasible option for pest control which takes into account the economic, social, and environmental costs and benefits of the proposed choices.

IV. CITY IPM COORDINATOR

The City Manager has determined that there should be a central staff person to coordinate the Integrated Pest Management efforts of city departments. The IPM Coordinator shall be in the ~~Office of Environmental Affairs in the City Manager's Office~~ ***Department of Community Planning and Sustainability*** and responsibilities shall include, but are not limited to, the following items:

- Coordination with city departments on weed and pest control issues
- Publication of the annual IPM report

- Coordination of the ~~Interdepartmental IPM Review Group~~ ***IPM Technical Advisory Committee***
- Development of a city weed management plan, in accordance with state law
- Coordination of the development of departmental IPM plans
- Recommendations on IPM strategies
- Assist city departments with staff training needs
- Outreach to citizens regarding IPM

A. Annual IPM Report. The City IPM Coordinator will compile data from all participating city departments and submit an annual report to City Council and the City Manager. The report will detail the previous year's IPM efforts and shall contain information listed in Section V, Departmental/Divisional Obligations. Each department using pest control methods shall submit their information through their department IPM coordinator to the City IPM Coordinator. The report will include a review of new IPM strategies as well as trends in IPM techniques over time.

B. ~~Interdepartmental IPM Review Group~~ *IPM Technical Advisory Committee*. This group will be coordinated by the City IPM Coordinator and will include department IPM coordinators and other interested city staff. The Group shall meet at least ~~quarterly~~ ***monthly*** and meetings will include ***presentations on topics of interest;*** development of ***proposed*** annual City IPM goals***; maintenance of lists of federal endangered and threatened species, and state, county and local species of concern in Boulder; development,*** review and evaluation, and updating of each department or division plan; as well as opportunities for information exchange, education and cooperation. The ~~Interdepartmental IPM Review Group~~ ***IPM Technical Advisory Committee*** shall also review interdepartmental issues and make policy recommendations that advance the objectives of the IPM policy and reduce reliance on chemical pest control.

V. DEPARTMENTAL/DIVISIONAL OBLIGATIONS

The following departments/divisions conduct pest control operations that use or potentially use pesticides:

- Downtown and University Hill Management Division (including Parking Services)
- Fire
- Housing and Human Services
- Open Space/Mountain Parks
- Parks and Recreation (including Athletics, Boulder Reservoir, Environmental
- Resources, Flatirons Golf Course, Forestry, Recreation Centers and Urban Parks)
- Public Works (including Airport, Facilities and Asset Management (FAM),
- Greenways, Transportation & Utilities Maintenance and Water & Waste Water
- Treatment Plants)

A. Integrated Pest Management Plan. Each of these departments or divisions, and any

others using pest control methods in the future, shall use the procedures outlined in this policy to develop a departmental or divisional Integrated Pest Management Plan. This plan shall be submitted to the City IPM Coordinator by January 15, 2003. Plans will be reviewed annually and updated at least every five years. Departments shall designate at least one staff member as the departmental/divisional IPM coordinator or representative to the Interdepartmental IPM Review Group.

B. Record-keeping and Evaluation. Each department, division or work group shall keep accurate records of all Integrated Pest Management treatments used and the results. Information on all treatments (including non-chemical ones) shall include how, when, where and why the treatment was applied and the name of the applicator. This information will be submitted to the City IPM Coordinator yearly, as the basis for the Annual IPM Report. It should also be available for review at the ~~Interdepartmental IPM Review Group~~ ***IPM Technical Advisory Committee*** meetings. The City IPM Coordinator will review pest management treatments with city departments to evaluate the successes and failures of the IPM program, and to plan more efficient and effective pest management strategies.

The following information shall be maintained:
1. Target pest
2. Pest population levels or injury thresholds for treatment
3. Treatment selection criteria with final treatment decision (IPM hierarchy checklist)
4. Area treated (including type of location and size of area)
5. ***Mechanical, cultural, biological or p***~~P~~esticide ***treatment*** (including product trade name, active ingredient and EPA toxicity category ***for all pesticides***)
6. Quantity of product used
7. Treatment method used (i.e. bait, injection)
8. Location of application
9. Time and date of pesticide application
10. Name(s) and license number(s) of Pesticide Applicator(s)
11. Name of the department contact authorizing work
12. Material Safety Data Sheets (MSDS) and labels for all pesticides used

Application records shall be made available to the public upon request in accordance with all applicable state laws governing public access to information.

C. Contractor Notification. Every department bidding out contractual work for pest management must inform all bidders that the City has an Integrated Pest Management Policy and include its guidelines in bid specifics. Contractors are encouraged to submit bids that include nonchemical pest control methods. Bids with non-chemical approaches may be given preference.

The City will inform pest management contractors of the City's IPM Policy and plans and provide a written copy of this policy and other documents as appropriate (i.e. departmental plans or Best Management Practices). Project managers, departmental IPM coordinators or contacts, or the City IPM Coordinator shall approve all pest management treatments.

VI. INTEGRATED PEST MANAGEMENT (IPM) PROCEDURE

The City assumes that all pesticides are *potentially* hazardous to human and environmental health. Therefore, reasonable non-pesticide alternatives shall be given preference over chemical controls by following the IPM procedure. City staff will evaluate alternatives to chemical treatment including the cost-effectiveness of the treatments. For all pest control activities, the IPM procedure outlined below shall be followed.

A. Initial Data Collection, Mapping and Monitoring. Each department or division considering pest control measures shall collect baseline data on the pest ecosystem(s) to determine pest population(s) occurrence, size, density and presence of any natural enemy population(s); gather information on pest biology and different control techniques available; and document sensitive areas and conditions that may limit control options. Data shall be collected in a standardized manner that is repeatable. This information may be included in departmental or divisional IPM plans.

Ranking, inventory, mapping, monitoring and evaluation are methods used for determining pest management priorities. Maps and inventories depict infestations in terms of pest species, size, location and threats to resources. Departments/divisions shall monitor infestations or pest populations and evaluate treatments over time to assess the effectiveness of various treatment strategies and their effects on target and non-target organisms.

All monitoring methods and data shall be specified in the departmental or divisional IPM plan, systematically recorded, and available for review at the Interdepartmental IPM Review Group meetings. Departments shall coordinate and utilize standardized pest mapping protocols.

B. Establishing Threshold Levels. To determine if treatment is warranted, an acceptable threshold level of treatment for each target pest and site should be established. Departmental IPM plans will contain the threshold levels for common pests, determined by individual work groups, in conjunction with the City IPM Coordinator. In some instances, treatment may be required by federal or state law. The assessment will be based on the following:

1. The tolerable level of environmental, aesthetic and economic damage as a result of the pest population(s) and the tolerable level of risk to human health as a result of the pest population(s);

OR

2. The size or density of the pest population that must be present to cause unacceptable environmental, aesthetic and/or economic damage; and the size, density and type of pest population that must be present to create a human health risk.

C. Treatment Selection Criteria. Upon determining that treatment is necessary, the following criteria should be used to help select the appropriate IPM treatment strategy:
1. Least-disruptive of natural controls
2. Least-hazardous to human health
3. Least-toxic to non-target organisms

4. Least-damaging to the general environment
5. Most likely to produce a permanent reduction in the environment's ability to support target pests
6. Cost-effectiveness in the short- and long-term

D. Treatment Strategies. Each department or division, in consultation with the City IPM Coordinator, shall make its own determination about appropriate and effective treatments, based on site-specific requirements. Commitment to the most environmentally sound approach is expected, with non-chemical methods considered first.

Prevention, cultural control, mechanical control, biological control and chemical control are the techniques used in integrated pest management. In general, a combination of treatments is more effective than a single approach. Departments and divisions are encouraged to seek out and experiment with innovative IPM treatments (and combinations of treatments) and share this information at the Interdepartmental IPM Review Group meetings. The following treatments are listed in the order in which they should be executed:

1. Prevention. This is the most effective pest management strategy. By reducing the capacity of the ecosystem to support target pest populations through design and appropriate management, the opportunities for pest establishment can be reduced or eliminated.
a) Use strategies that reduce the preferred harborage, food, water or other essential requirements of pests.
b) Use weed-free materials for road and trail construction and maintenance.
c) Use landscape and structural design that is appropriate to the specific habitat, climate and maintenance the area will receive.
d) When designing projects, consider the potential impacts of pests and mitigate through the use of appropriate landscape design (water requirements, weed barriers, etc).

2. Cultural. Cultural control is the use of management activities that prevent pests from developing due to enhancement of desired conditions. Specific examples are the following:
a) Selection and placement of materials that provide life-support mechanisms for pest enemies and competitors.
b) Modification of pest habitat by reducing pest harborage, food supply and other life support requirements.
c) Vegetation management including irrigation, mulching, fertilization, aeration, seeding, pruning and thinning.
d) Waste management and proper food storage.
e) Barriers and traps.
f) Heat, cold, humidity, desiccation or light applied to affected regions.
g) Prescribed grazing.

3. Mechanical. Mechanical control is accomplished by using physical methods or mechanical equipment to control pest infestations.
a) Mowing or weed-whipping
b) Burning
c) Hand-pulling of weeds

d) Hand-removal of insect egg masses

4. Biological. Biological controls include the introduction or enhancement of natural enemy populations to target pests. Introduction of non-indigenous organisms has an associated risk factor and should be thoroughly evaluated prior to implementation.
Biological methods include
a) Conservation and augmentation of the pest's natural enemies
b) Introduction of host-specific enemy organisms

5. Chemical. Chemical control of pests is accomplished by using chemical compounds registered as pesticides. All pesticides shall be assumed to be *potentially* hazardous to human and environmental health.
a) The type, methods and timing of chemical treatment shall be determined **after** consideration has been given to protection of non-target organisms (including threatened or endangered species), protection of water quality, pest biology, soil types, anticipated adverse weather (winds, precipitation, etc) and temperature.
b) Initial review of potential chemicals shall begin with the least toxic compounds, i.e. chemicals in EPA Toxicity Categories III and IV. The use of compounds in EPA Toxicity Categories I and II shall be avoided if possible or used in situations where exposure to the active ingredient is limited (i.e. baits or soil/trunk injections).
c) If, after a thorough evaluation of alternatives, the only effective or practical chemical control is an EPA Toxicity Category I or II compound, the department or division IPM coordinator shall confer with the City IPM Coordinator, and, if practical, the ~~Interdepartmental IPM Review Group~~***IPM Technical Advisory Committee***, to review the decision-making process and make a recommendation to the department head for approval. This may be done on a yearly basis for specific pest treatments. The decision-making process and lack of alternatives shall be documented.
d) Staff will review the information available on potential chemicals for persistence in the soil and the potential impacts from persistence. These factors will be considered along with the potential for more frequent application of chemicals that do not persist in the environment.
e) If chemical treatment is warranted in a riparian area, applications will generally be plant specific and limited to wick applications. If broader applications are needed, the department or division IPM coordinator shall confer with the City IPM Coordinator, and, if practical, the Interdepartmental IPM Review Group, to review the decision-making process and make a recommendation to the department head for approval. This may be done on a yearly basis.
f) Potential chemical approaches
(1) pheromones and other attractants to confuse pests and/or act as bait
(2) insecticidal soaps
(3) juvenile hormones that arrest pest development
(4) repellants
(5) allelopathins
(6) sterilants or contraceptives to reduce breeding
(7) contact, stomach or other poisons
(8) fumigants

(9) combinations of above (baits with poisons)
(10) herbicides, insecticides
g) All pesticides shall be applied in conformance with label specifications and all applicable federal, state and municipal laws, regulations and ordinances.
h) All pesticide applications shall comply with the appropriate pre and post notification requirements, according to the City of Boulder's Pesticide Ordinance (Section 6-10-1 B.R.C. 1981). For all city pesticide applications, notification will be posted at least 24 hours in advance. This includes soil and trunk injections, spot spraying, hand-wicking and broadcast spraying on all city lands or property open to the public.

E. Education. Education is a critical component of an IPM program. The City IPM Coordinator will include IPM information on the Department of Community Planning and Sustainability's website. Information will include the Annual IPM Report, departmental IPM plans and other pertinent material. Individual departments, divisions and work groups may conduct additional specific educational activities.

VII. CONTRACTOR RESPONSIBILITIES & REQUIREMENTS

All contractors working for the City are required to abide by the City's IPM Policy. The contractor will return a signed statement to the IPM Coordinator or departmental contact certifying they have read and understand the policy prior to any work being done for the City. The contractor shall maintain records as listed in Section V, B.

The City periodically enters into contracts that authorize pest management, such as for building maintenance, project construction and maintenance, and weed and insect control. When the city signs a new contract or extends the term of an existing contract with a contractor that may include or authorize the application of pesticides, the department shall review its IPM plan with the City IPM Coordinator and update the plan to include the pesticide usage of the contractor.

Contractors who apply pesticides on City owned or managed property shall submit a plan to the contracting city department and the City IPM ~~Coordinator if the department has not provided a plan~~. Their plan shall include the following:

- Information addressing all the elements listed in Section VI, Integrated Pest Management (IPM) Procedure
- Types and estimated rates, to the extent possible, of the pesticides that the contractor may need to apply to City property during its contract
- An outline of the actions the contractor will take to meet the City IPM policy
- The primary IPM contact for the contractor

Contractors will provide background information on the decision-making process for treatment methods to the city upon request. The City department and City IPM Coordinator shall approve the plan before any chemical applications are made. Contractors shall notify their departmental contact when any biological or chemical treatments are conducted. The contractors shall comply with appropriate pre and post notification requirements, according

to the City of Boulder's Pesticide Ordinance (Section 6-10-1 B.R.C. 1981) and relevant internal city protocols.

VIII. CONSTRUCTION AND INTERPRETATION
Employees who have questions concerning possible conflict between their interests and those of the City, or the interpretation and application of any of these rules, should direct their inquiries to their Department Director. The Department Director may refer the matter to the City Manager for final resolution.

IX. EXCEPTIONS/CHANGE
This policy supersedes all previous policies covering the same or similar topics. Any exception to this policy may be granted only by the City Manager. This policy may be reviewed and changed at any time.

Adopted 1993, updated April 2002.

[END CURRENT POLICY AND COMMENTS]

Appendix C. Potential Model for Evaluating Pesticides

We recommend the city evaluate the following detailed proposal for revising its current process.

Required Infrastructure

IPM Technical Advisory Committee. The process will require the creation of an internal Boulder City IPM Technical Advisory Committee (IPM-TAC) comprised of representatives from all departments conducting pest management activities including OSMP, Parks and Recreation (with one person specifically representing the Boulder City Golf Course), Housing and Human Services, Public Works and other departments and divisions as appropriate. We suggest that the initial work of the IPM-TAC be as follows:

1. All team members provide a brief overview and update of their own particular department's pest management issues to the rest of the team and current approaches they are using to address the problems. It will be helpful for all to learn how the different branches manage their pest problems.

2. Discussion of current pesticide use patterns (amounts, situations, locations), as well as situations in which it was not necessary to use pesticides to achieve pest control.

3. Discussion of goals for incorporation of a pesticide approval process. These goals might include:
   a. Further reduction of the amounts of pesticides used.
   b. Reduction in the toxicity of the pesticides used.
   c. Flexibility in mounting a rapid response to pest problems.
   d. Facilitation of staff planning for long-term pest management, e.g. for invasive vegetation, prairie dogs, etc.
   e. Development of a more systematic method for including or rejecting a pesticide.
   f. Greater transparency for the public in how pesticides are added to or removed from an approved list.

4. Discussion of how best to incorporate existing tools such as the flow chart for decision-making regarding when pesticide application is considered as an option, the site assessment tool and the current City of Boulder Approved Pesticide List.

5. Modify the 2002 IPM policy to include the formalized pesticide approval process.

We envision that the IPM-TAC might begin its work with a half-day meeting to flesh out the details outlined above. We also recommend inviting a City Council representative and selected members of the public to participate in this first meeting to air their perspectives, contribute their ideas and flag potential trouble-spots with the new policy. Once the structure and goals for the committee's work are in place, monthly or bi-monthly meetings of the IPM-TAC should suffice to discuss new pest problems, potential new pesticides and alternative solutions. We recommend that these meetings be open to the public, for full transparency, although the primary avenue for public comment will be a later meeting at which the IPM-TAC's recommendations will be discussed.

Potential Pesticide Approval/Disapproval Process

The recommended flow of events for the approval process is summarized below, with more detail provided in each section.

1) Staff submits product requests for consideration
2) Products are reviewed for inherent hazards of the active ingredient and "inerts" and the active ingredients are classified according to product hazard tiers used by the cities of San Francisco, Palo Alto, Seattle and the US Green Building Council.
3) Products are reviewed to determine exposure potential for the proposed uses.
4) IPM-TAC reviews data and makes a recommendation to include or reject the pesticide product as an approved pesticide and public comment is sought.
5) IPM Subcommittee votes to include or reject the pesticide product as an approved pesticide for use in the City of Boulder.
6) City pesticide use is reevaluated on a regular basis.

The logical place to start with pesticide reviews is the current approved list of pesticides. Many pesticide products and active ingredients on this list have already been reviewed by the City of San Francisco, City of Palo Alto and/or the City of Seattle IPM. We recommend collaborating with the IPM staff from these cities to reduce the cost burden of pesticide reviews.

Staff submit product requests for consideration. Field staff who are responsible for pest management submit a request to the IPM Coordinator. The request includes information on where the pesticide will likely be applied, the extent of use and a justification of the need for adding a new pesticide. Products are reviewed for inherent hazards of the active and inert ingredient.

Product name and intended use(s) are submitted by the IPM Coordinator to a person with expertise in pestdicide toxicology and exposure assessment for review (hereafter Reviewer). The Reviewer characterizes the hazards of all active ingredients and any "inert" ingredients that have been identified for the project, utilizing information from the pesticide label, the Materials Safety Data Sheet (MSDS), US EPA's risk assessment, the Federal Register, the peer-reviewed literature and any other sources of information providing valid data. The following information for the active ingredient and any "inerts" that have been identified is provided.

Mammalian toxicity

- Acute poisoning hazards posed by the product, including skin and eye irritation.
- Reproductive and developmental toxicity.
- Carcinogenicity
- Neurotoxicity
- Endocrine disrupting potential.

Ecotoxicity

- Acute toxicity to small mammals, birds, fish, aquatic invertebrates, pollinators and plants.
- Reproductive toxicity to birds.
- Indicators of chronic toxicity to pollinators.
- Other non-acute measures of toxicity available in the data sets or peer-reviewed literature.

Physical properties

- Half-life: a measure of persistence of a chemical in the environment.
- Water solubility: a measure of how readily a chemical will be transported in dissolved form in water.
- Soil adsorption coefficient, K_{oc}: a measure of the binding strength of pesticide to soil organic matter.
- Vapor pressure: a measure of the evaporation potential of the chemical.
- Octanol-water partition coefficient: a measure of the potential of a pesticide to bioaccumulate.

The physical properties are used to determine a Groundwater Ubiquity Score (GUS) or evaluated using California Department of Pesticide Regulations Specific Numeric Values (SNVs) process. Both of these methods provide a measure of groundwater contamination potential for the chemical.

Once the hazards are known, the pesticide active ingredient and products containing that ingredient are placed into a "hazard tier." Several cities (San Francisco, Palo Alto and Seattle) have developed and use a set of guidelines for ranking pesticide active ingredients and products according to hazard (see Appendix 1). Three product hazard tiers are defined in these guidelines:

1) Tier 1: Highest concern. At least one criterion placed in highest hazard category.
2) Tier 2: Moderate concern. At least one criterion placed in middle hazard category.
3) Tier 3: Lowest concern. No criteria flagged for Tier 1 or Tier 2.

The Reviewer provides a 2–5-page summary of the hazards of the chemical to the IPM Coordinator. Hazard data are also presented in spreadsheet form for both the active ingredient and the pesticide product. See Attachment A, Master Spreadsheet for an example of such a spreadsheet from the City of San Francisco.[15]

Product uses are reviewed to determine exposure potential. The proposed uses of the product are also examined by the Reviewer to estimate the potential for exposure of humans, wildlife (including pollinators), terrestrial plants and aquatic plants and animals. This evaluation requires information on where and how the pesticide may be used and utilizes the physical chemical properties that govern the pesticide's fate and transport in the environment. The potential for human and wildlife exposure, contamination of groundwater

[15] The format of this spreadsheet is currently under revision to improve readability.

and surface water, is evaluated in the context of the application method, timing and location of use.

Under consideration as a new part of the San Francisco process is the development of a "Risk Tier" system that provides a somewhat more quantitative estimate of whether exposures of concern are likely to occur based on the chemical hazards and exposure potential for the requested uses of the pesticide. We recommend incorporation of this system when it is complete.

IPM-TAC reviews data and makes a recommendation to include or reject the pesticide product as an approved pesticide. The Reviewer's report on the hazards and exposure potential is then brought to the IPM-TAC, which discusses the available information for the chemical and evaluates the pesticide for addition to or deletion from the list of approved pesticides, based on the following criteria:

- *The potential for human exposure or environmental release for each proposed product.*
- *The effectiveness of the proposed product.*
- *The need for the product and availability of less-toxic alternatives.*

Based on the information, the IPM TAC makes recommendations for additions to or deletions from the list of approved pesticides. If a decision is made to include a product in the approved list, it is categorized as one of the following (using San Francisco's ranking system):

- *A* *Allowed for use,* but always as a last resort, when non-chemical alternatives have been exhausted. "A" list products are generally the least hazardous pesticides on the list and contain only Tier 3 ingredients.
- *L* *Limited use,* with specific restrictions on allowable situations.
- *L** *Limited use, special concern.* These are pesticide products that pose the greatest health or environmental concerns, but which are nevertheless considered the least-hazardous chemical alternative for a particular purpose. Use of L* products must be justified at an annual public hearing.

A new list of approved pesticides is proposed annually at a public meeting where comments and suggestions are sought from the public. Also provided to the public at this meeting are data on the amounts of the different pesticides used over the course of the past year in the city to provide perspective on the scale of pesticide use in the city.

IPM Subcommittee makes final decision to include or reject the pesticide product as an approved pesticide for use in the City of Boulder. The proposed list, a summary of the public comments and the IPM TAC recommendations are then submitted to the IPM Subcommittee for final approval. Once a pesticide is approved for use, staff is free to use the product without further consultation, within the existing constraints of the IPM policy. For L

or L* products, limitations may be placed on the allowable amounts of pesticide that can be used.

Annual public meeting to receive feedback on the approved list. An annual public meeting should be scheduled to receive public comment on the IPM program overall and the current list of approved pesticides. The first of these meetings should focus on the new pesticide approval process to obtain feedback on the approved list process.

Appendix D. Natural, Organic Turf Management Program

Included in this section of the report is an explanation of the principles and protocols of natural turf management, detailed soil test data, site assessments, analysis of the current management program, and recommendations for beginning a natural approach to turf management. This section of the report is prepared with the idea that some of these properties may be incorporated into a complete natural, organic management program at some point in time, and all recommendations will be made with that in mind.

Discussing different management levels primarily refer to the cultural intensity required to maintain an individual grass area to the degree that meets expectations. Any recommendations will be made with that in mind. Cultural intensity is the amount of labor and material inputs required to meet those expectations. The level of management and cultural intensity will be a direct function of budget dollars that can be committed to a project. There is some generic preliminary cost information included within this report. That information is intended to be used as a guideline and has not been calculated as a result of a specific site analysis or soil test.

In some respects, programs can be tailored to make the best use of available resources, financial and otherwise. One fact is a given in either a conventional or natural grass management program; minimal product and labor inputs meet low expectations, while higher levels of inputs meet higher expectations. Programs can be designed that meet the needs of the grass relative to the level of expectation. Sports fields and highly managed turf, for example, usually require more cultural intensity than a park or grassland area.

When a natural management program is put in place, there is a window of time referred to as the transition period. It is during this timeframe when new products are put in place and specific cultural practices are followed. During the transition, the most important aspect is to focus on the soil, not just texture, chemistry and biomass. Addressing the living portion of the soil from the beginning gives us the greatest chance for a successful transition. The length of time for this process has a direct relationship to the intensity of conventional management practices that may be currently employed, the health of the soil, and the overall quality, uniformity, and density of the grass system.

Conventional turf management programs are generally centered on a synthetic product approach that continually treats symptoms. We are following a systems approach that is designed to put a series of preventative steps in place that will solve problems. This approach forms the basis for any natural management recommendations. The systems approach is based on three concepts. It involves natural, organic product where use is governed by soil testing, the acknowledgement that the soil biomass plays a critical role in fertility, and specific and sound cultural practices.

The goal of a natural management program is to create turf on a sports field or park that is both aesthetically pleasing and meets site objectives. If we are dealing with grasslands, a natural program must meet within reason, the goals and site objectives of the area. This approach will provide a playing surface, park, or open space area that will be healthy and free

from toxic chemicals. The products and program discussed will be designed to utilize materials and adopt cultural practices that will avoid any runoff or leaching of nutrients and control products into the water table.

This type of program is a "feed-the-soil" approach that centers on natural, organic fertilization, microbial inoculants, compost teas, microbial food sources, and topdressing as needed with high quality finished compost. It is a program that supports the natural processes that nature has already in put in motion. These inputs, along with very specific cultural practices, that include mowing, aeration, irrigation, and over-seeding are the basis of the program.

Our experience demonstrates that this approach will build a soil environment rich in microbiology that will produce strong, healthy grass that will be able to withstand many of the stresses that affect it. The system will be better able to withstand pressures from heavy usage, insects, weeds, and disease, as well as drought and heat stress, as long as good cultural practices continue to be followed and products are chosen to enhance and continually address the soil biology. While problems can arise in any grass system, they will be easier to alleviate with a soil that is healthy, and that has the proper microbiology in place.

Soil Texture

Soil is the foundation of our landscape. It is much more than just a functional medium to hold turfgrass and other plants upright. Soil is comprised of sand, silt, and clay mixed with varying amounts of organic matter, water, and air. The soil is very much alive. It is home to a microbial community that is made up of organisms both large and small. It is these microbes that give the soil its life. The makeup of soils in the Northeast generally falls within the following guidelines: forty-five percent mineral, twenty-five percent air, twenty-five percent water, and five percent organic matter.

All soil particles, from the microscopic sheets of clay to the largest grains of sand, should be surrounded on all sides by air. When soils have varying degrees of moisture, the water occupies the air space. The air and water portion is also referred to as pore space; therefore only one-half of healthy soil is solid particulate matter. Efforts in natural turf management are concentrated in the organic matter portion of the soil, as it is the home to the soil microbiology.

Topsoil, as the name implies, is the uppermost layer of soil. This surface layer of soil is usually darker than subsoil because of the accumulation of organic matter. In different parts of the United States we see very different depths of topsoil. It can range from six to eight inches in the Northeast to two feet in the Midwest. Loam is a textural classification. Texture refers to the relative amounts of sand, silt, and clay. A loam is technically a soil with between 7% and 27% clay, 28% and 50% silt, and less than 52% sand. The term loam can then be modified to sandy loam, sandy clay loam, clay loam, silty clay loam, or silt loam as the individual soil fractions change. The soils at the different sites are sandy loams and loamy sands.

The USDA Textural Triangle (Figure D.1. below) is the tool we use to determine soil textural classifications. After testing determines the relative percentages of sand, silt, and clay, the Textural Triangle is used to determine the soil texture by following the percentages to the intersecting point.

Sands
Sands are loose and single-grained (that is, not aggregated together). They feel gritty to the touch and are not sticky. Each individual sand grain is of sufficient size that it can easily be seen and felt. Sands cannot be formed into a cast by squeezing when dry. When moist, sands will form a very weak cast, as if molded by the hand that crumbles when touched. Soil materials that are classified as sands must contain 85-100% sand-sized particles, 0-15% silt-sized particles, and 0-10% clay-sized particles. Sands are referred to in the plural is that there are several USDA textures within this group. All of these textures fit the "sand" portion of the textural triangle, but they differ from each other in their relative proportions of the various sizes of sand grains.

Silt
Silt is similar to silt loam but contains even less sand and clay. Sand-sized particles, if present, are generally so small (either fine or very fine sand) that they are non-detectable to the fingers. Clay particles are present in such low percentages that little or no stickiness is imparted to the soil when moistened, but it instead feels smooth and rather silky. Silt-sized particles are somewhat plastic, and casts can be formed that will bear careful handling.

Clay
Clay is the finest textured of all the soil classes. Clay usually forms extremely hard clods or lumps when dry and is extremely sticky and plastic when wet. When containing the proper amount of moisture, it can be "ribboned out" to a remarkable degree by squeezing between thumb and forefinger, and may be rolled into a long, very thin wire.

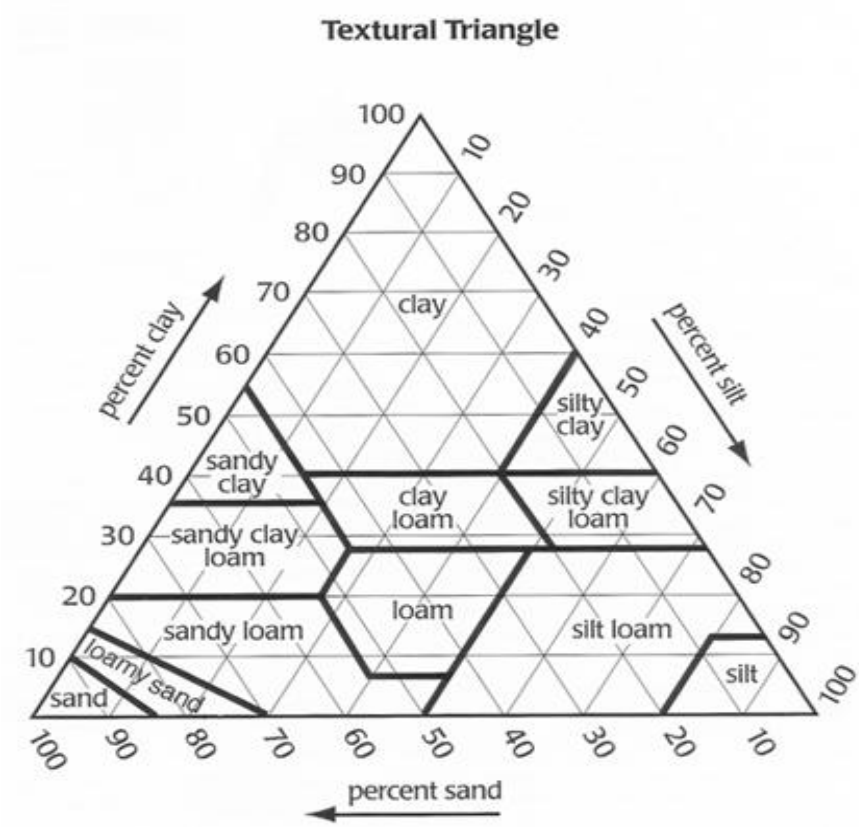

Figure D.1. USDA Soil Texture Triangle

Soil Chemistry Basics

pH

The first and probably most important aspect of soil chemistry is the relative acidity (or alkalinity) which is measured as pH. The pH scale runs from 1.0 to 14.0 with 7 being neutral. Cool-season (C3) turfgrasses prefer a pH in the 6.5 to 7.0 range. Establishment of pH within this range is important to the success of a natural management program. The nutrients that grass plants uses in the largest amounts are most readily available when the pH is within this range. The grass plant uses nitrogen in the largest amount, followed by potassium, and then phosphorus. When the pH is substantially below this range, there are less nutrients available to the grass plant (see Figure D.2. below). The most important and critical step in a natural program is to adjust the pH to the desired range. Unless the pH is close to the 6.5 to 7.0 range, the grass plant does not get the nutrients it needs with any degree of efficiency. Fertilizer can be repeatedly applied, but will not have the maximum benefit.

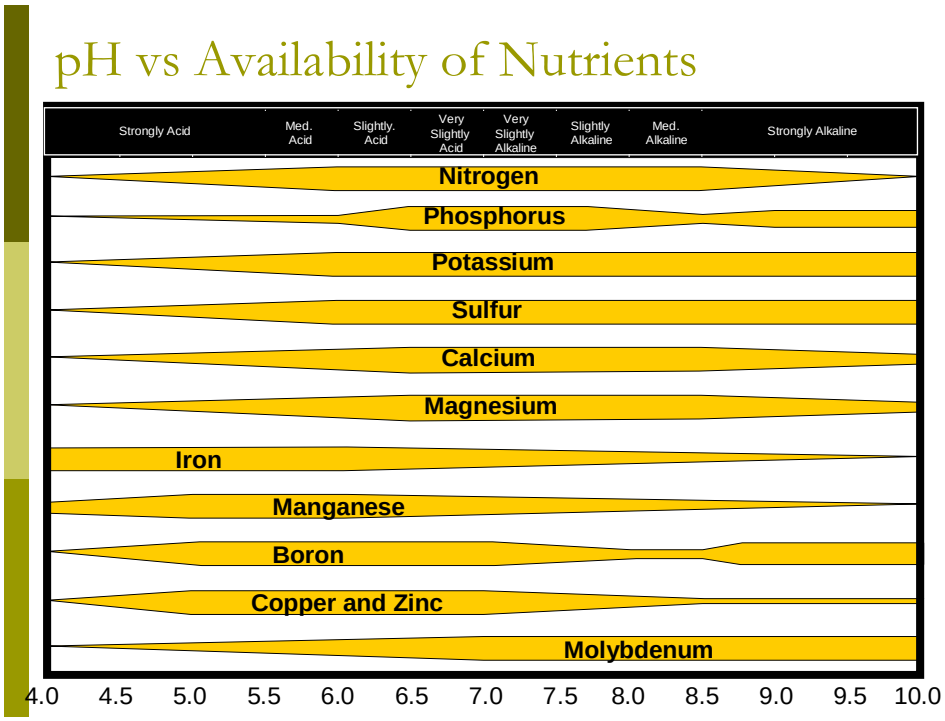

Figure D.2. pH vs. Availability of Nutrients

Lime is the preferred input for raising the pH. The calcium to magnesium ratio is considered when determining the type of lime to be used (calcitic or dolomitic). Our guidelines call for a 7:1 to 8:1 calcium to magnesium ratio. Calcitic lime is used for a specific purpose; it is higher in calcium and low in magnesium. It is somewhat more expensive than dolomitic lime, which has higher magnesium levels, but it will elevate the pH while raising calcium levels.

We recommend adhering to the generally accepted practice of not exceeding fifty pounds of lime per 1,000 square feet of turf in any one application. Recommendations for applications greater than fifty pounds will be split between spring and fall. Raising soil pH happens slowly; it can take up to 100 days for lime to break down and begin to elevate the pH. Avoid products that are marketed as soluble calcium to raise pH. A sustained movement towards a slightly acid soil is preferable to a rapid change in pH. Highly water-soluble products are less effective with heavy rains in the weeks following an application.

The pH adjustment is really a critical first step in a sound turf management program, conventional or natural. As described above, unless the pH is established within the desired range, the applied nutrients simply cannot be used efficiently, resulting in wasted resources.

The establishment of the proper pH by liming is usually an expense occurred in the first years of a natural program. Natural fertilizers do not tend to acidify the soil in the way conventional products do after repeated applications. One of the benefits of natural fertilizers and composts that are used to “feed the soil” is a natural buffering of the soil and pH

becomes stable in the desired range. Front range soils tend to run close to pH neutral. The samples collected in Boulder to date all exhibit pH in the desired range.

Nutrient Management

An approach using primarily synthetic, water-soluble fertilizers is directly "feeding" the grass plant. These products are broken down by soil moisture and are readily available to the plant. Natural, organic fertilizers work in a different way. Soil microbiology breaks down fertilizer and uses it as a food source. The microbes then make the nutrients available to the grass plant in a plant available form. It is this "feed the soil" approach that will be the basis for the recommendations on a nutrient program. In a natural program we do not focus on pounds of N in quite the same way as we do in conventional programs. A healthy soil, where the microbes are nourished with natural fertilizers, has the ability to cycle up to 2 lbs N to the grass plant on a monthly basis. This plateau is reached when sustainability is approached, generally three to four years into a complete natural turf management program.

All nutrient and cultural recommendations will ultimately affect the microbes, the basis creating and achieving good soil health and quality. Paying close attention to the soil, both soil chemistry and soil biology, is important in the transition process. There is a period of time involved in taking turf from a conventional program or an incomplete program (ph not established, etc.) to a natural one. That length of time varies with each different field or property.

Abbreviations

N	nitrogen
P	phosphorus
K	potassium
Ca	calcium
Mg	magnesium
ENR	estimated nitrogen release
CEC	cation exchange capacity
pH	measure of acidity
OM	organic matter

Organic Matter (OM) and Cation Exchange Capacity (CEC)

Organic Matter makes up a relatively small fraction of the soil. A typical agricultural soil has between 1% and 6% organic matter. A soil that supports turfgrass should have between 5% and 8% organic matter. Organic matter has a tremendous effect on most soil properties. Organic matter is the home for the microbial community that allows the system to function.

Organic matter is made up of living organisms, fresh residues, and well-decomposed residues. These three components of organic matter have been referred to as the living, the dead, and the very dead (Magdoff, University of Vermont). The living portion is comprised of a wide variety of microorganisms, including bacteria, fungi, protozoa and nematodes. Also included are plant roots, earthworms, insects and larger animals that spend time in the soil. The living portion represents about 15% of total organic matter. The fresh residues, or the dead portion, are comprised of recently deceased microorganisms, insects, earthworms

and compost if applied as a topdress. The dead portion also includes crop or plant residues, in the case of a turfgrass system, grass clippings left on the turf that are decomposed by saprophytes. Nutrient cycling happens here in the dead portion of OM. The very dead part of OM is humus. Humus is the end product of decomposition or the living and dead portions that ultimately can decompose no further. Humus is fully stable and is considered to be a long-term soil resource lasting many hundreds of years.

Humus is one of the central components that tie together the interrelated functions of soil chemistry, texture, and biology. As we begin to address and enrich soil organic matter, we are improving the humus content of the soil and all of the interactions that take place. When we get all of these aspects working in harmony, we begin to achieve what is now referred to as soil health. Conventional soil science has looked at soil chemistry, texture and biology separately. The emerging way of looking at soil is to try to achieve optimum levels in each of these areas and the result is referred to as soil quality or soil health. Many natural fertilizers are now including humates as part of the blend for the specific purpose of working to create a healthy soil. If not included in a fertilizer blend, humates can be applied separately in granular or liquid form.

The **Cation Exchange Capacity** is a measure of the nutrient holding capacity of the soil. The clay and humus (stabilized OM) portions of the soil contain negatively charged ions that attract and hold on to plus charged cations (nutrients). Older, well-aged OM (humus) contains the largest percentage of exchange sites. There are different clays that make up the soil profile, montmorillonite clays and koalinite clays; they each have different characteristics with regard to possessing the ions to attract nutrients. Different soil samples can demonstrate results that seem to contradict other results from the same general property. However, most often some soils are not native to the site, but rather brought in as a topsoil borrow to supplement existing soil on site.

Soil Biomass and Microorganism

Any discussion of nutrient management in a natural turf program would be incomplete if the soil biomass was not addressed. It is the foundation upon which a nutrient program is based. The soil microbes are at the heart of the "feed the soil" approach. It is the natural, organic fertilizer that is broken down by microbials to make nutrients plant available. Synthetic fertilizers by nature, with their high salt content, compromise the activity of much soil life. Microbes do not reproduce and function at healthy levels in soils that exhibit high salinity.

During the transition period from a conventional fertility management program to a natural one, it is important to address the role of the microbial community and choose products that science has shown enhance their development and function. The soil environment, specifically the OM, is the home for soil microbial life. The processes that take place in the microbial community are extremely complex, but at the most basic level it is a predatory relationship as they are competing for survival. Their existence depends on an aerobic soil of good texture, chemistry, and fertility. As a result of one organism consuming another, nutrients, particularly carbon and nitrogen are released. The nitrogen is in a plant available form that is ready to be taken up by the roots of the grass plant and the carbon is a soil energy

resource. During photosynthesis sugars and carbohydrates are produced as "food" for the plant. A portion of these substances are exudates, meaning they are exuded from the root system of the grass plant to the soil in the rhizosphere. The bacteria and mychorrizal fungi in particular, are nourished by these materials. That is why greater microbial colonization of the roots of grasses takes place. We do not see the same level of colonization on the roots of most broadleaf weeds.

It is the ability of the microbes to make the conversion from natural, organic sources of N to the inorganic N that allows natural fertility to work. The organic N from natural fertilizer or OM is converted to inorganic ammonium N by bacteria in the process of mineralization. It is also converted to nitrate N during the process of nitrification. Nitrate N has a negative charge making it soluble. It relatively quickly moves to the root zone of grass plants after it has been released from the bodies of the predator organisms. Ammonium N (reserve N) has a positive charge and is therefore held on the cation exchange sites. As higher level predators consume the bacteria, the N is then released in a plant available form. Higher level successional plants, like high production C3 grasses, use equal amounts of nitrate and ammonium.

A fertility program that is based on natural, organic fertilizer product, also includes materials such as compost and compost teas that support and maintain a healthy soil and microbial community. There are also microbial inoculants, liquid fish hydrolysates, seaweed, and humates that directly affect the health of the soil and its community of organisms in a positive way.

Compost tea directly addresses the introduction of large numbers of microbes to the soil environment. The benefits are many, especially during transition. At the present time there are some contractors that can provide this service. The most cost efficient approach to compost tea production is an in-house setup. Compost tea is one input that will change the way we deal with several of the management aspects of growing high quality turfgrass, in the backyard, on parks and athletic fields, or on commercial and institutional properties. Over the next few years it will become one of the foundations of a complete natural program. Application of a compost topdress is used to address the organic matter content of the soil as well as to introduce beneficial soil biology and a plant available nutrient source. The application of a topdress can be expensive depending on the compost supplier and freight costs. When we have reached our target goal of organic matter percentage, the topdress applications can be reduced or eliminated, except when doing a major over-seeding.

A turf system generally does not demonstrate the rapid depletion of organic matter the way we might expect in other areas of agricultural production. Compost tea, although valuable from the beginning of a natural, management program, becomes especially important when topdress applications are reduced or eliminated. Compost tea is relied on to supply the microorganisms and all of the benefits that come with them. Compost tea does not directly add organic matter to the soil in the way compost does, but because our organic matter has reached our target level, we get along fine with increased biology only.

Exactly what is compost tea and how it is actually made? Compost tea is a liquid extract of high-grade compost. More specifically, compost tea is a concentrated solution of microbial life produced by extracting beneficial microbes from vermi-compost (worm castings) or high-grade windrowed compost. If compost is brought in from a different geographic region, it is critically important to add a handful of soil or compost from the primary site or sites, a process called "brewing." Compost is suspended in a type of "tea bag" in gently agitating, de-chlorinated water. The agitation is provided by different types of pumps that not only move water, but infuse the water with oxygen. This aspect is critical as extracting must be in an aerobic environment to sustain the life of some of the species of microbes that are being extracted. The gently agitating water extracts the microbes. A nutrient source is added to the water at the beginning of the process to feed the microbes as they are being extracted, and they then multiply to very large numbers over the twenty-four hour extracting and brewing process.

Why is this solution an important asset for the turf manager? Aside from simply delivering large quantities of active biology to the soil profile, it does considerably more for us. It is a source of soil and foliar nutrients delivered in a biologically available form for both plant and microbial uptake. The beneficial microbiology will successfully compete with disease causing organisms and most times out-compete them, thereby suppressing a pathogen or disease problem before it gets to a point when turf damage occurs. The microbes have the ability to degrade and break down toxic materials and pesticides, produce essential plant growth hormones and fix nitrogen and mineralize plant available nutrients.

As compost tea is introduced to the turf system, we begin to create a biologically active soil profile. As the soil continually becomes more alive, we see direct and lasting benefits to the turfgrass. When a healthy, balanced soil profile with the proper biology to sustain turfgrass is in place, benefits are demonstrated in the nutritional area. This improves nutritional health and quality of the plant as well as the soil's ability to retain nitrogen and other nutrients like calcium, potassium and phosphorus. This also creates a condition in the soil where the beneficial biology has the ability to suppress disease causing and pest organisms.

Lastly, these techniques improve and create good soil structure that increases water infiltration, oxygen diffusion, and the water holding capacity of the soil. One of the attractive aspects of compost tea for the turf manager is the relatively low cost. At a rate of roughly fifteen to twenty-five gallons or more to the acre, it is a very economical way to take natural turf management to the next level. There was a time when spray equipment in the hands of the turf manager meant a pesticide application was imminent. Times are changing and that stigma will soon disappear.

Humates are metal (mineral) salts of humic or fulvic acids. Humus is a highly stable by product of organic matter decomposition. Humic acid is the most biologically active component of soil humus. The humus portion of the soil is relatively small. The organic matter percentage generally ranges from 3% to 8% with an optimum level in a turf system in the 6% to 8% range. Humus makes up 65% to 75% of the total organic matter. Humus plays an important role as a component of soil fertility. Its impact is far greater proportionally than

the percentage of the soil mass that it makes up. The molecules of humus are not rapidly degraded by microorganisms as many non-humic substances are. Humus is in fact, slow to decompose, and when in combination with soil minerals can persist for several hundred years.

With the emergence of conventional, synthetic N P K fertilizers, we (agriculture in general) have lost sight of the natural order of soil management. When it was discovered that the synthetics had the ability to rapidly stimulate plant growth, the turf industry jumped on the band wagon. The prolonged use of these products, in the absence of properly addressing soil health, can and has led to many problems with soil quality.

Humic substances that would be considered to be "fertilizer grade" are obtained from carbon containing mineral deposits in many parts of the world. Here in the United States there are several mines and deposits that contain good agricultural grade humic substances.

Naturally occurring humic substances from low grade lignites and leonardites (natures soil conditioners), are superior fertilizer ingredients. A major source of humic substances for fertilizer use is from leonardites. Leonardite is defined as a highly oxidized low grade lignite that contains a relatively high concentration of fulvic acids.

Humates, suitable for both granular and liquid applications, are readily available and can be purchased from a variety of sources. They can be purchased individually or as part of a proprietary blend of materials. The application of these products to a turf system addresses soil health and quality at its most basic level.

Some benefits include:

- Builds healthy soil.
- Increased organic matter which helps to reduce N loss through leaching.
- Contains carbon as an energy source for microbes.
- Improves soil structure, aggregation, water infiltration, aeration, and water-holding capacity.
- Increases nutrient availability to the grass plant.
- Facilitates mineral breakdown.
- Increases microbial activity.
- Helps with root growth and penetration, and chlorophyll density.

Compost and composting is a complex subject. It is far more than creating a pile of organic matter and watching it turn into a soil-like material. Composting is an exacting science when we want to produce a finished product of high quality. This discussion is intended to give an overview of product and process, and in no way should be thought to impart all of the information necessary to fully understand the subject.

Compost is the product of an aerobic process, whereby microorganisms break down and decompose various forms of organic matter. The organic matter is referred to as feedstock or substrate and this can be made up from a wide range of materials. Feedstock can be random

materials, or can meet a particular recipe. When we compost by recipe, the starting point in choosing materials is generally to follow a 20:1 to 30:1 carbon to nitrogen ratio. The microorganisms use the material as a food source throughout the decomposition process.

Soil microorganisms produce heat, carbon dioxide, water vapor, and humus as a result of their activity. Humus is a highly stable by-product of the decomposition process. It can make up sixty percent of finished compost. The process also stabilizes nutrients and pH, giving us a finished material rich in nutrients and microbial life, a high percentage of humus and organic matter and close to neutral pH. These qualities make humus an ideal soil amendment and topdress material for established turfgrass.

Composting is done at the municipal level in many areas as well as in the private sector. Composters are generally required in most states to conform to guidelines that deal with health issues, but at the present there are no national standards that deal with compost quality. A good understanding of the criteria that define compost quality and rely on your own assessment that should include proper testing is necessary. Whenever possible, information from the supplier to support the quality of the compost should be acquired.

Very briefly, compost quality is determined by several criteria. The finished material should have no offensive odor, there should be no recognizable remnants of the original feedstock and it should be finished or mature. Maturity can best be determined by biological testing. There are four phases to the composting process; Mesophilic, Thermophilic, Cooling Phase (second mesophilic), and Maturation Phase. These are defined by temperature ranges and there are different populations if microorganisms at each phase. The Maturation Phase can best be determined by testing and determining the microorganisms present.

Immature compost would be considered to be a product of inferior quality. It can, in fact, be very detrimental to a turf system and can cause turf damage. Once the composting process has begun, it naturally wants to complete itself. Immature compost will pull N from the soil to try to complete the process, resulting in a yellowing of the turf. As the N levels drop, chlorophyll production in the grass plant decreases, resulting in a plant that no longer has the resources necessary to undergo photosynthesis at a satisfactory level. As photosynthesis decreases, carbohydrate production drops off and the turf weakens.

Application rates are generally in the range of ½ to ¾ cubic yard/1000 square feet. You may hear of recommended rates of 1 cubic yard/1000 square feet, but that is on the heavy side. The depth of material should be between 1/4” and 3/8”. If the depth approaches ½” it is too heavy an application.

Compost as a topdress in a turf system helps to increase soil organic matter. When we are dealing with low OM percentages topdressing is the preferred practice for addressing the deficiency. This practice in itself gives good results, but when we can combine topdressing with cultivation (core aeration) the benefit is magnified because the compost is able to fall into the core holes and reach the root zone. When a compost application is combined with over-seeding, it enhances germination and establishment. Think of it as creating a seed bed

to receive the grass seed, not unlike a seed starting mix we might use to grow a tray of tomato seedlings for transplant. Compost, by virtue of its neutral pH and healthy microbial population, has the ability to help buffer the soil and counteract naturally acidic soils without the use of lime. As compost continues to decompose we experience nutrient release and get good greening of the turf, much the same way we do with a fertilizer application.

Compost is not a fertilizer, but in fact it is the microbial population that makes the nitrogen available to the grass plant. It is the beneficial microbes in compost, particularly fungi that give the grass what has been referred to as acquired immune resistance. The beneficial fungi have the ability to fight and suppress many fungal pathogens, and disease issues in turf become easier to deal with.

Topdressing with sand or a blend of primarily sand with 20% to 30% compost added will not give the same benefits as high quality compost. The conventional industry uses the sand based material, but natural programs are based on compost. Sand is used at times in our program for very specific purposes, but not as a general topdress.

Topdressing can be done at any time during the growing season. After application, the material breaks down and is assimilated into the turf within a matter of days. We do need a relatively short window when the field is not being used. This is only because the compost might be "muddy" after rain or irrigation. The three optimum times of the growing season for topdressing are mid to late-June, September, and late-October/early-November. The June and September windows are ideal to combine topdressing and over-seeding. The late fall application is to "set the turf up" for spring. Topdressing should always be combined with cultivation.

Transition Period

When turf management programs change, there is a period of time we refer to as the transition period. When we move from a conventional program to a natural one, the length of time involved in transition is in direct relation to the intensity of current and past management practices and the overall turf quality.

During transition it is important to address the soil and its biomass as well as those cultural practices that support it and the turf itself. The biggest issue will be to move the management of fertility from the conventional program to a natural one. After many years of conventional fertility management that has used synthetic, water-soluble fertilizers with high salt levels, the soil microbiology has been bypassed and somewhat compromised. The goal is to support and restore the soil to good health during this transition period so that the natural processes of fertility will take over and produce healthy turf. When a turf system is moved from a conventional to a natural program, do not expect to see a collapse or failure. As long as the transition process involves the whole system; soil biomass, natural product, and cultural practices, steady improvement is expected.

The products used in this approach, other than for lime and those associated with the cultural practices of cultivation and over-seeding should remain constant for three years. At that

point, sustainability will be achieved and a reassessment of the product requirements may be addressed.

It is important during this period that we establish a sound management plan that enables us to successfully move forward. The reality in the municipal sector is that there is not always money available in the amount desired or needed to implement any type of turf management program. In this approach, it is important to address the four P's; protocol, procedure, product and prioritization. It is the concept of prioritization that allows us to create levels of management and then to allocate often scarce financial resources to those areas of properties where the greatest impact will be made. This is critical, especially in the transition period, when the most aggressive with inputs and cultural practices are necessary.

How to Establish a Nutrient Budget

When we address fertility issues, it is important to look at the needs of the grass itself. Of the three major nutrients used by turfgrass, nitrogen is used in the largest amount. It is followed by potassium and phosphorus respectively. When nutrient budgets are set, they are based on nitrogen being delivered to the turf system.

When a turf area is used as a sports field, the turf is generally under some stress; grass plants get damaged and often can't reproduce rapidly enough to maintain maximum turf density. The recuperative capacity of the grass plants is governed by the genetic capabilities of individual species as well as nutrient availability. More available nutrients are necessary, specifically nitrogen, to sustain this type of turf system as opposed to what may be needed for a homeowner's lawn. Available nitrogen directly stimulates growth. A reasonable nutrient budget is in the 3 to 5 lb N range from all sources on an annual basis.

One of the basic differences between a natural program and a conventional one is that we do not get all N from fertilizer alone. N from fertilizer is important, but it is only a part of the equation. The contributory N produced from compost topdressing, liquid fertilizers, compost tea and humic substances, microbial inoculants, and grass clippings returned to the system. As product is used to initially improve soil health, it builds a system to provide readily available N naturally to the grass in the future. It is this concept that creates healthy turf at a lower cost three years down the road.

It is estimated that only 25% to 35% of the N from conventional water-soluble fertilizers actually benefits grass. The balance is lost to volatilization and leaching below the root zone. As this material leaches it can become a ground-water contaminant as well as runoff into fresh or saltwater bodies. With natural, organic product being a source of water-insoluble N, nearly 100% of the N reaches the intended target and provides a slow, steady release of nutrients over an extended time that "feeds the soil" and the soil microbial life in turn "feeds the plant." Fewer lbs. of N are generally required annually with organic fertilizer to get the same response of the turf that we customarily see with synthetics.

Fertilizer: **A Product Analysis**
Two types of fertilizer can be utilized in a nutrient management program; granular and liquid. Both are considered to be natural, organic fertilizers. The granular product may be made up of three different sources of nutrient. The source of the nitrogen (the nutrient used in the largest amount by turfgrass) is either plant, mineral, or manure based. The liquid product is a fish hydrolysate.

The difference between natural, organic fertilizers and conventional or synthetic fertilizers is simple. Synthetic fertilizer is inorganic. It is manufactured by a chemical process, which produces a highly water-soluble fertilizer. It breaks down on contact with soil moisture and is taken up by the grass plant very rapidly, creating a "quick green-up." There is a way to coat or encapsulate the fertilizer to slow down the breakdown. The fertilizer is taken up rapidly, works quickly, and then leaves the root zone. This process directly feeds the grass plant. Most synthetic fertilizer programs call for three to five applications annually.

Natural fertilizer products work in a completely different way. Nature has put in place a system that makes nutrients available to plant material. A good example of this is a mature forest. No one fertilizes a forest, yet plant material grows and is healthy and adequately "fed." Turfgrasses function in basically the same way, but because it is a closed system, fertilizer or compost topdress is added to supply nutrients in the way that fallen leaves decompose and supply nutrients in a forest.

Synthetic fertilizers, being water-soluble, move rapidly through the soil and can be major contributors to non point source pollution. With natural, organic fertilizers this does not happen. Fertilizer is broken down by soil microbes and used as a food source, making it naturally slow release. The major portion of the nitrogen source is water-insoluble nitrogen (WIN) and breaks down over time supplying a slow steady food-source. It does not move through the soil and create the same type of problems as synthetic products.

With so many different fertilizers and formulations on the market, it can be confusing trying to tell the difference between the products. It is possible to determine the type of fertilizer in the bag from the percentage of nitrogen in the analysis. The analysis is the three numbers on the bag that represent nitrogen, phosphorus, and potassium in that order. I t is stated as a percentage of each nutrient in 100 pounds of fertilizer. The reason that nitrogen is our benchmark is because it is the nutrient used in the largest amount by turfgrass. If the nitrogen number is less than 12, the product is most likely a natural, organic product. If the number is between 13 and 18 it is likely a bridge product that contain both synthetic and natural, organic sources of nitrogen. When the nitrogen percentage is greater than nineteen, the product is synthetic.

It is the microbial life in the soil that really makes nutrients available to the grass plant. A handful of soil contains billions of mostly beneficial living organisms that nature put in place for the sole purpose of growing plant material. It is these organisms that make nutrients (specifically nitrogen for turfgrass) available. Natural fertilizers are utilized to feed and nourish microbes, so they can make nitrogen available to the grass.

The nitrogen in natural fertilizers is in the organic form. It is important to note that plants can't use organic forms of nitrogen, they can only use it in the inorganic form. That is why synthetics work so rapidly. Natural fertilizers supply organic nitrogen to the microbes as a food source, and the microbes break it down and in turn release it to the grass in the inorganic form. Nitrogen is nitrogen whether synthetic or organic. Neither form is a plant food, but rather a catalyst in the larger process of photosynthesis, which is how the real food or carbohydrates are produced. Synthetic and natural fertilizers work in completely different ways, but produce exactly the same results. It is simply a matter of understanding how they work and getting the proper timing of the applications. Natural, organic forms of nutrients, because they are not water-soluble, do not run-off and contribute to non-point source pollution.

Granular fertilizers should be applied twice a year. Occasionally, fertilizer is applied three times annually, but at lower rates. When using the liquid fish hydrolysate as a fertilizer, we are using a relatively low dose of nitrogen. It is not the nitrogen that is of primary importance, but rather the proteins, enzymes, and amino acids preserved from the fish that directly nourish and stimulate the soil and in turn the grass. This builds a healthy soil environment that will support healthy grass. This type of product is relatively low cost and with the right equipment fairly easy to apply. In a tight budget situation this product can be very cost effective. For less than $100.00/acre we can deliver .2 to .4 lb N that has the equivalent benefit to the system of 1 lb N.

Fertilizer Specifics

There are several natural, organic fertilizers on the market with different analyses. They range from 4% to 12% N. There should be roughly ¾ of the N in the WIN form and the balance will be natural water-soluble N. This addresses both short and long term N needs. Our recommendation is to use a natural fertilizer with roughly a 1:1 N to K ratio. The percentage of N only matters when we are calculating the amount to use on a particular size property (refer to the calculation chart). The higher the N%, the smaller amount of product by weight we need to use. Simply put, we need twice as much fertilizer with 4% N as we do with a product that has 8% N.

Table D.1. % Nitrogen delivered in different formulations by weight of product used

4% N = 1 lb N	@	25 lbs / 1000 sq ft
5% N = 1 lb N	@	20 lbs / 1000 sq ft
6% N = 1 lb N	@	16.5 lbs / 1000 sq ft
7% N = 1 lb N	@	14.25 lbs / 1000 sq ft
8% N = 1 lb N	@	12.5 lbs / 1000 sq ft
4% N = ¾ lb N	@	18.75 lbs / 1000 sq ft
5% N = ¾ lb N	@	15 lbs / 1000 sq ft
6% N = ¾ lb N	@	12.5 lbs / 1000 sq ft
7% N = ¾ lb N	@	10.75 lbs / 1000 sq ft
8% N = ¾ lb N	@	9.5 lbs / 1000 sq ft

4% N = ½ lb N	@	12.5 lbs / 1000 sq ft
5% N = ½ lb N	@	10 lbs / 1000 sq ft
6% N = ½ lb N	@	8.25 lbs / 1000 sq ft
7% N = ½ lb N	@	7 lbs / 1000 sq ft
8% N = ½ lb N	@	6.25 lbs / 1000 sq ft

Cultural Practices for Parks and Athletic Fields
Irrigation
Irrigation schedules, on properties with systems in place, can be set to match the soil conditions. Parks, with higher clay percentages, will hold more water and for a longer time than the sandier soils.

Field capacity for each property must be determined for optimal irrigation. In terms of soil moisture, field capacity refers to the optimum amount of water that is held in the root zone of a particular soil. As previously discussed, the soil profile is 45% mineral, 5% OM, 25% air, and 25% moisture. This means that a handful of soil contains 50% solid matter and the balance is pore space. When a field is irrigated to the point of saturation, either by rainfall or an irrigation system, the pore space becomes filled with water. After a period of time (variable depending on soil texture and compaction), the free water drains below the root zone and the remaining soil moisture is known as field capacity. As a general rule, irrigation systems should water to field capacity and not be used again until needed. They can be set to deliver different rates and lengths of time that correspond to the season of the year and general weather and growing conditions.

The best way to irrigate is to deliver enough water at each irrigation to provide a deep thorough watering. At times of over-seeding it is best to provide relatively frequent, shallow irrigation. We want the seed to stay as continually moist as possible without being overly wet.

Natural turf growing in sandy loam needs only one inch of water per week maximum and turf growing in a loam soil needs one-half inch weekly during the warmer periods of the growing season when going through the transition process. That timeframe is usually mid-May to mid-September. Once a natural turf system is well underway, irrigation requirements drop to one inch per week during dry spells. Of course, those properties that do not have irrigation depend on natural rainfall. A natural turf system is better able to deal with dry spells and periods of minimal rainfall than a conventional system.

Cultivation
Compacted soil is the biggest enemy of turfgrass. Compaction favors weeds and discourages the growth of healthy grass. Turfgrass roots, as well as soil microbiology, are entirely dependent upon an aerobic soil environment. Aerobic soils are those soils with a reasonable amount of oxygen available.

Soil aggregation, refers primarily to a loose friable soil. All soil particles from the microscopic sheets of clay to the largest grains of sand should be surrounded on all sides by

air. This is referred to as pore space. When soil becomes compacted by heavy use, athletic play, mowing and other equipment, heavy rain or regular irrigation, or a fine textured soil that has a natural tendency to become compacted, the turfgrass begins to struggle and certain weeds proliferate. As the soil is compressed by mechanical means, the air portion of the soil is eliminated, oxygen is absent, and pore space is lost. This produces a particle touching a particle with nowhere for the grass roots to grow.

The roots of the grass plant should be long and fibrous, whereas some of the broadleaf weeds have shorter, thicker root systems. When soils become very compacted, the plant's roots can't penetrate and they become clubby. A short, clubby root system on a grass plant severely restricts the plant's ability to absorb nutrients, and it becomes weakened. The broadleaf weed begins to thrive, because it has a root system that is easily adapted to these conditions. Prostrate knotweed, broadleaf plantain and pineapple weed are three indicator weeds that are routinely found on compacted sports fields. All of these reproduce from seed, so once fully established in sizable numbers, it takes some time to replace them with viable turf. The same is basically true in a conventional program.

The process to loosen the soil is cultivation. In a turfgrass system, the type of cultivation we employ is referred to as aerification. When we aerate a field, we are loosening the soil, introducing oxygen, and reestablishing pore space. There are different methods of aeration, the two most common being core and shatter tine aeration.

As a part of the overall process in addressing the grass at the sites, aerification is central to future successes. Generally speaking, it is one of the least expensive things we can do, but it gives us the largest direct benefit.

Over-seeding

Turf density is a measure of the number of grass plants growing in one square foot of a field. Approaching maximum density, weeds begin to be suppressed. Regular over-seeding on an annual basis is the most effective strategy for keeping weed populations down. Broadleaf weeds will be out-competed by thick, healthy turf. Minimum turf density is an invitation for crabgrass and other weed pests. A bare spot the size if a silver dollar can become a crabgrass issue.

When over-seeding is combined with a compost topdress application and either a core or shatter tine aerification, the germination and establishment phases both improve. These cultural practices should be combined whenever possible.

Maintaining genetic diversity of cool-season grasses in a sports field is important. As the genetic base is broadened with newer cultivars, a proactive approach to potentially minimizing negative impacts of insect and disease pressures is demonstrated. We can take advantage of cultivars that contain natural endophytes (fungi that give some grasses resistance to surface grazing insects) and those that are bred to have disease resistance.

Table D.2. Time to germinate based on 50°F and above soil temperature

	50°F	70°F
Perennial ryegrass	7-10 days	5-8 days
Fescue sp.	12-15 days	7-12 days
Kentucky bluegrass	21-23 days	12-18 days

Table D.3. Effective seeding windows	
April	Fill bare spots and worn areas before spring weeds move in-want fast germination-50%+ perennial ryegrass.
Mid to end of June	General over-seeding introducing higher % of Kentucky bluegrass if desired.
September	General over-seeding introducing higher % of Kentucky bluegrass if desired.

Over-seeding is a critical part of a successful natural program. Site use and seasonal considerations are always part of the decision making process when we over-seed.

There are different mixtures of cool-season grasses available for municipal turf. Different producers will have percentages roughly along these lines. Various mixtures can be used for specific conditions and desired results at different times of the year.

50% Perennial ryegrass
50% Kentucky bluegrass

60% Perennial ryegrass
40% Kentucky bluegrass

33% Perennial ryegrass
33% Kentucky bluegrass
33% Creeping red fescue

30% Perennial ryegrass
70% Kentucky bluegrass

A general over-seeding rate is 3.5-9 lbs/1000 sq ft depending on the mixture

It is important to note that Kentucky bluegrass is a much smaller seed than perennial ryegrass or fine fescue, therefore 1 lb of blue is a lot more seed than 1 lb of the others

Species	Seeds/lb
Kentucky bluegrass	1,500,000
Perennial ryegrass	250,000
Fine fescue	400,000

Mowing
Mowing heights should be in the 3” range. The principle behind this mowing height is that there is more blade surface exposed to the sun, and photosynthesis takes place more

efficiently and to a greater degree. The C3 grasses (cool-season) are not efficient photosynthesizers. Higher mowing heights help to counter this inefficiency. As photosynthesis increases, more carbohydrates (the real plant food) are produced and the grass gets stronger and healthier with substantially more food resources and energy reserves. There is also a greater amount of exudates entering the rhozosphere to nourish the biomass. For every inch of increased mowing height a corresponding increase in carbohydrate production is produced. Clippings should generally be left on the field. There are some cutting weeks in the spring when removal might be an option.

Any time a field is not in regular use during the middle of the summer, raising the height of cut helps strengthen the turf. As fall approaches mowing heights can be reduced, because the threat of weed pressures lessen. As mowing heights become shorter in the fall, the grass plant still needs the surface area to photosynthesize, and it aggressively sends out tillers, stolons, or rhizomes to create it. As vertical extension is reduced, lateral extension increases. The net overall benefit is a thickening of the turf.

Schedule of Inputs and Cultural Practices

Table D.3. Sample Level 1 Program: Parks and Athletic Fields	
April 10-15	• Fertilize ¾ lb N/1000 • Aeration #1 • Seed to fill thin or bare areas
May 1-5	• Mowing generally begins-height of cut determined by Ball Roll
June 15	• Aeration #2 • Fertilize ¾ lb N/1000 • Humic acid (5 lbs/1000 granular or oz/1000 liquid) • Compost topdress if applicable • Over-seeding
July 15	• Fish hydrolysate (16 oz/1000) or compost tea (3/4 gal/1000) or both (most desirable)
August 25	• Fertilize ¾ lb N/1000 • Aeration #3 • General over-seeding
September 25	• Fertilize ¾ lb N
Late-October	• Final mowing at 2” • Aeration #4
*Frequency of aeration varies with prioritization of program levels and is determined by cost factors. If no compost topdress is used, increase N by ½ lb (1/4 lb each June and August). This schedule can be modified to suit budget constraints.	

Costs of Natural Programs Relative to the Level of Management

The costs for a Natural Turf Management Program outlined here are based on the current average price for organic fertilizers, soil amendments, and grass seed.

The numbers are presented in a four-tier approach with Level 1, 2, 3, and 4 programs. This is a way to match inputs (product and labor) with a program, as the prioritization of management practices is created.

The programs are based on an Annual Nutrient Budget, which varies with each program. The return of clippings delivers N to the system and contributes to the overall budget. Compost as a topdress, liquid fertilizers and compost teas have equivalent N/1000 values.

The costs of the Level 1 and 2 programs reflect the intensity of management during the transition period. This time varies, but two to three years is the generally accepted timeframe. After transition, costs decline as cultural intensity is reduced. It is at this point that the turf begins to become sustainable.

The prices in this section reflect the average cost of materials in your region. The labor portion varies with each situation, depending on whether the work is performed in-house or outsourced. These numbers are intended to give you a guide from which to develop a cost analysis. For in-house implementation, costs can be very accurately projected. In an out-sourced situation, the cost numbers plus a reasonable mark up can be combined with average labor costs per application to give an idea on a service provider's per acre charge. In any out-sourced situation, the only real cost information can only be obtained by drawing up an IFB and putting it out to the industry.

The Level 1 program is suitable for sports turf and not generally put in place for other municipal properties unless it is modified to address specific situations. It will produce extremely high quality turf in any situation. Level 4 management is reserved for those areas that are not considered to be of importance, but some fertility is desired. It is a program just above the turf system that receives little or no intervention except for mowing. Most municipal turf and parks fall into the Level 2 or 3 programs.

Table D.4. Cost estimates for programs. Costs reflect materials only.		
Level 1 Program 5 lbs N All Sources		
3 lbs N from granular product	$5.00/1lb N	$15.00/1000
1 Compost Topdress	$30.00/cu yd	$15.00/1000
2 over-seedings 5lbs/1000	$2.00/lb-$10.00/1000 x 2	$20.00/1000
*Other apps		$10.00/1000
Total		*$60.00/1000*
Level 2 Program 4 lbs N All Sources		
2.5 lbs N from granular product	$5.00/1lb N	$12.50/1000
1 over-seeding 5 lbs/1000	$2.00lb-$10.00/1000	$10.00/1000

*Other apps		$10.00/1000
Total		*$32.50/1000*
Level 3 Program 3 lbs N All Sources		
2 lbs N from granular product	$5.00/1lb N	$10.00/1000
Seeding to address thin /bare areas		$ 5.00/1000
*Other apps		$ 8.00/1000
Total		*$23.00/1000*
Level 4 Program 1 lb N		
1 lb N from granular product	$5.00/1000	$5.00/1000
Minimal seed		$5.00/1000
Total		$10.00/1000

The other applications line reflects product (liquid fish hydrolysates, humic acid, compost teas, mycorrhizal and microbial inoculants) that is important when addressing the transitional phase of a natural turf system. Because the health and quality of the soil environment is critical in the production of healthy turf, these products address this aspect from the beginning. They are intended to be presented in a menu approach, so that products from this group can be chosen based on regional availability.

Each of these products addresses the soil environment and nutrient availability in related ways. Our program ideally calls for humate products and compost teas to address the soil during transition. Compost tea may not be readily available at this time in all areas.

The liquid fish products are an extremely low cost way to make a big difference in municipal turf. As described in the fertilizer section, there are benefits to the system greater than just the N, P, K. If the ability is there to include this type of product in a program, the turf responds quite dramatically.

Individual average costs of the other applications:

Liquid fish hydrolysate	$1.75/1000
Liquid Humic acid	$2.50/1000
Compost tea	$3.00/1000
Mycorrhizal inoculant	$.50/1000

These are not all meant to be used repeatedly in any program. Compost tea and fish hydrolysates are ongoing, but humic products and microbial inoculants can be used in the transition process and then omitted, thereby realizing a reduction in costs in subsequent years.

Aeration Schedule

This aeration schedule matches the cultural intensity of the various levels of inputs.

Level 1 Program	3-5 times annually
Level 2 Program	2-3times annually

Level 3 Program	1-2 times annually
Level 4 Program	none

Appendix E. Conventional vs. Natural Turf Management Cost Comparison

A Cost Comparison of Conventional (Chemical) Turf Management and Natural (Organic) Turf Management for School Athletic Fields

A report prepared by
Grassroots Environmental Education
A non-profit organization

Written by
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Introduction

The mounting scientific evidence linking exposure to pesticides with human health problems, especially in developing children, has increased the demand for non-chemical turf management solutions for schools. One obstacle commonly cited by chemical management proponents is the purported higher cost of a natural turf program.

This report compares the annual maintenance costs for a typical 65,000 square foot high school football field using both conventional and natural management techniques. Both programs are mid-level turf management programs, typical of those currently being used at many schools across New York State.[16]

The analysis of data demonstrates that once established, a natural turf management program can result in savings of greater than 25% compared to a conventional turf management program (Figure E.1.).

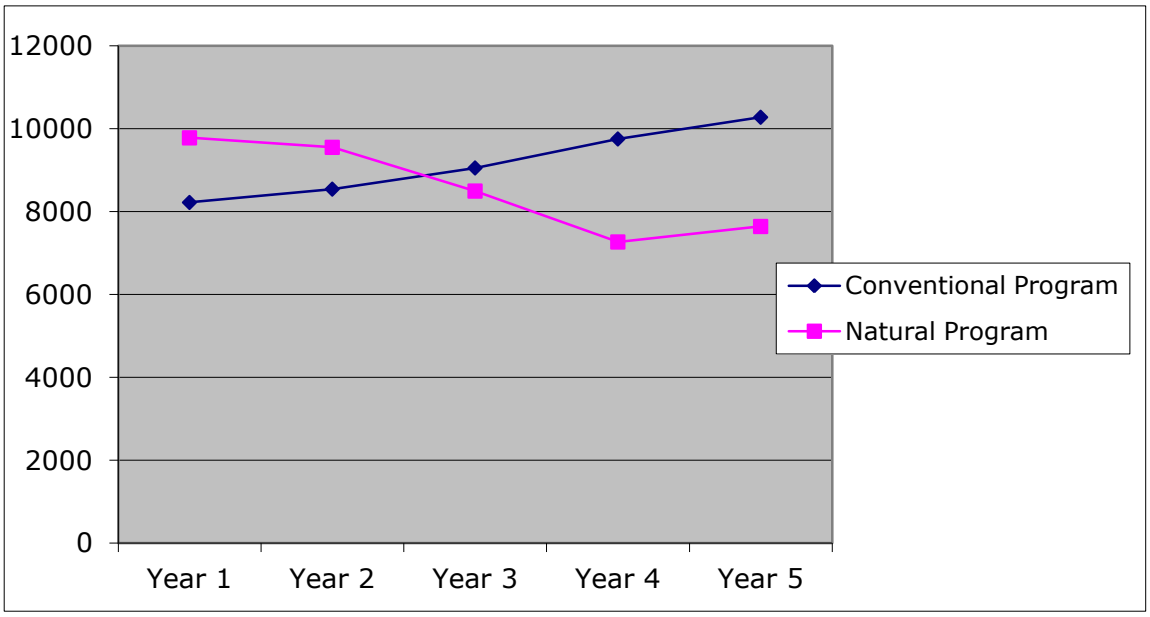

Figure E.1. A Comparison of Costs for Conventional and Natural Turf Programs Over A Five-Year Period

Background

Prior to 1950, all school playing fields were maintained organically. The widespread use of chemical pesticides to control weeds, insects and turf diseases on school playing fields began in the post-World War II era when chemical companies sought to establish markets for their products in the agricultural, consumer and municipal sectors. By the mid-1990s, former New

[16] We recognize that some schools will spend considerably less for field maintenance than our example, and some will spend much more. The turf management programs chosen for this comparison are designed to yield similar aesthetic results.

York State Attorney General Robert Abrams estimated that 87% of public schools in the state were using chemical pesticides on their fields.[17]

As awareness of the risks associated with pesticides has grown and demand for non-toxic solutions has increased, manufacturers and soil scientists have responded with a new generation of products and technologies that have changed the economics for natural turf management. Product innovation has resulted in more effective products, and advances in soil science have increased understanding of soil enhancement techniques. Virtually all major turf chemical manufacturers now offer an organic product line. Professional training and education have also increased, with most state extension services and professional organizations now offering training courses in natural turf maintenance.

Sources of Data

The products, costs, application rates and other data for our analysis have been obtained from various sources, including the Sport Turf Managers Association,[18] Iowa State University,[19] bid specifications from a coalition of public schools on Long Island,[20] bids and proposals from conventional turf management companies and documented costs for existing natural programs.

Economic Assumptions

This analysis is based on the cost of operating in-house turf programs. Sub-contracted programs typically cost 30-35% more. Both programs include fertilization, seeding and aeration. All product costs are based on quantity institutional purchases, with a calculated 7% annual cost increase. Labor costs have been calculated based on a municipal employee @ $40,000 including benefits, calculated at $20 per hour. Indirect costs for pesticide applicator licenses, training, storage/security and DEC compliance costs have been estimated at $500 per year. Fertilization for both programs has been calculated at the rate of 5 lbs of nitrogen (N) per 1000 SF. Grub and/or insect controls may or may not be necessary. Compost has been calculated at a cost of $40 per yard. Seeding rate is calculated at 5 lbs/1000 SF. Cost of water is estimated at $0.003212/gal.[21] [22]

Irrigation

Irrigation costs for turf maintenance are considerable, but are generally less for naturally maintained fields due to deep root growth and moisture retention by organic matter. Estimates of irrigation reduction for natural turf programs range from 33% to more than 50%. This analysis uses a conservative diminishing factor for irrigation reduction for the

[17] *Pesticides in Schools: Reducing the Risks*, Robert Abrams, Attorney General of New York State, March 1993.
[18] "2009 Field Maintenance Costing Spreadsheet" published by the STMA. Available online at www.stma.org/_files/_items/stma-mr-tab6-2946/docs/field%20maintenance%20costing%20spreadsheet.pdf
[19] "Generic Football Field Maintenance Program" by Dr. Dave Minner. Department of Horticulture, Iowa State University.
[20] "Invitation to Bid, Organic Lawn Care Field Maintenance and Supplies," Jericho Union Free School District, Jericho, NY on behalf of 31 school districts.
[21] Water usage computed using STMA recommended irrigation rate of one inch/week for Junior High football field. Iowa State University recommends 1.75 inches per week for football fields.
[22] Price computed using NUS Consulting International Water Report for 2008 average US water cost per m3 adjusted for inflation.

natural management program, starting with 100% in the first year as the field gets established down to 60% in the third year and beyond. Some school districts may experience greater savings.

Soil Biology

One of the most critical factors in the analysis – and the one most difficult to assess - is the availability and viability of microbiology on fields that have been maintained using conventional chemical programs. The microbiology that is essential for a successful natural turf management program can be destroyed or severely compromised by years of chemical applications. In this analysis, we have assumed a moderate level of soil biology as a starting point; the compost topdressing in years 1-3 is part of the rehabilitation process required to restore the soil to its natural, biologically active state.

Reducing Fertilization Costs

Once playing fields have been converted to a natural program and the percentage of organic matter (%OM) has reached the desired level (5.0-7.0), additional significant reductions in fertilization costs can be realized using compost tea and other nutrients (humic acid, fish hydrolysates) applied as topical spray, rather than using granular fertilizers.

The following chart shows the product cost benefits of switching to an organic nutrient spray program, and amortizing the $10-12,000 capital cost for equipment over three years (Fig. E.2.).

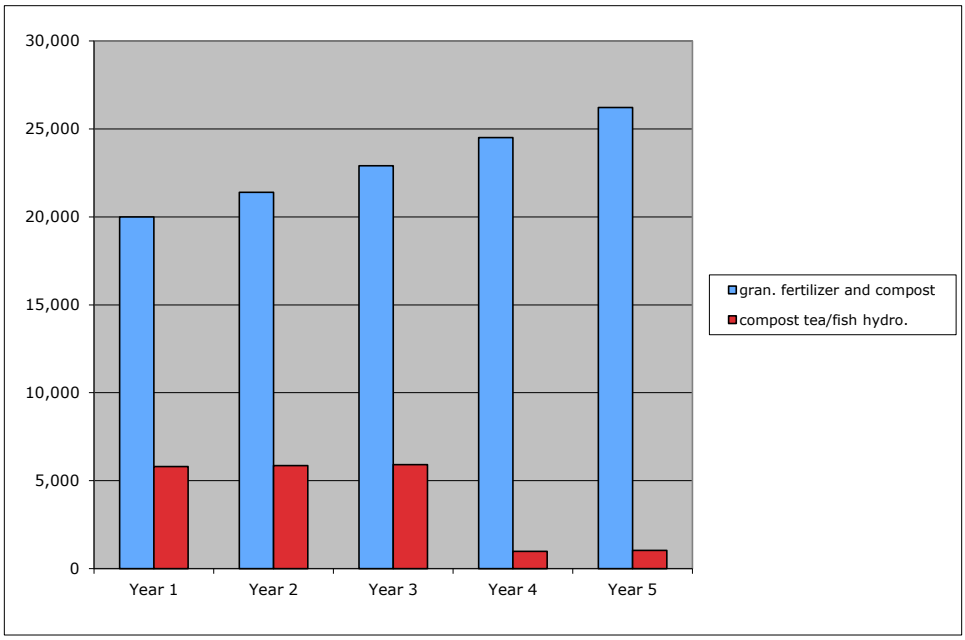

Figure E.2. Cost comparison of granular fertilizer and compost compared to spraying compost tea and fish hydrolysates in Marblehead, MA.[23]

[23] *To address concerns over the potential phosphorus content of compost tea (contained in the bodies of microbes) only high-quality vermicompost should be used for tea production. Animal manure teas, popular with farmers for generations, are not suitable for use on lawns or playing fields.*

Conclusion

This analysis demonstrates that the cost of a natural turf management program is incrementally higher in the first two years, but then decreases significantly as soil biology improves and water requirements diminish. Total expenditures over five years show a cost savings of more than 7% using natural turf management, and once established, annual cost savings of greater than 25% can be realized.

About the authors

Charles Osborne *is a professional turf consultant, working with municipalities and school districts in the Northeast to help them develop effective natural turf management programs. A professional grower with more than thirty years of experience in greenhouse and turf management, Mr. Osborne is the Chairman of the Town of Marblehead Recreation, Parks, and Forestry Commission where he oversees the management of the town's school and municipal fields.*

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COMPARISON OF CONVENTIONAL (CHEMICAL) AND NATURAL (ORGANIC) TURF MANAGEMENT PROGRAMS: YEAR ONE

CONVENTIONAL PROGRAM		**Year 1**	**Year 1**	**Year 1**
		cost	**cost**	**total**
		product	**labor**	
April	fert/pre-emergent	$250	$95	$345
May	fertilizer	$225	$95	$320
June	grub or insect	$325	$95	$420
June	post-emergent	$90	$150	$240
July	fertilizer	$225	$95	$320
Sep	fertilizer	$225	$95	$320
Nov	fertilizer	$225	$95	$320
June	seed	$700	$150	$850
Sep	seed	$700	$150	$850
aerate	3 times	$0	$375	$375
	irrigation	$3,212	$150	$3,362
	indirect costs			$500
	Total Cost			**$8,222**
NATURAL PROGRAM		**Year 1**	**Year 1**	**Year 1**
		cost	**cost**	**total**
		prod	**labor**	
April	fertilizer	$610	$115	$725
June	fertilizer	$610	$115	$725
June	liquid humate	$120	$100	$270
July	fish/compost tea	$100	$100	$250
Sep	fertilizer	$610	$115	$725
Jun	seed	$700	$150	$850
Sep	seed	$700	$150	$850
	aerate 3x	$0	$375	$375
Jun	topdress	$1,300	$350	$1,650
	irrigation	$3,212	$150	$3,362
	Total Cost			**$9,782**

COMPARISON OF CONVENTIONAL (CHEMICAL) AND NATURAL (ORGANIC) TURF MANAGEMENT PROGRAMS: YEAR TWO

CONVENTIONAL PROGRAM		Year 2	Year 2	Year 2
		cost	cost	total
		prod +7%	labor	
April	fert/pre-emergent	$267	$95	$362
May	fertilizer	$240	$95	$335
June	grub or insect	$347	$95	$335
June	post-emergent	$96	$150	$246
July	fertilizer	$240	$95	$335
Sep	fertilizer	$240	$95	$335
Nov	fertilizer	$240	$95	$335
June	seed	$750	$150	$900
Sep	seed	$750	$150	$900
aerate	3 times	$0	$375	$375
	irrigation	$3,436	$150	$3,586
	indirect costs			$500
	Total Cost			**$8,544**
NATURAL PROGRAM		Year 2	Year 2	year 2
		cost	cost	total
		prod+7%	labor	
April	fertilizer	$653	$115	$768
June	fertilizer	$653	$115	$768
June	liquid humate	$128	$100	$228
July	fish/compost tea	$107	$100	$207
Sep	fertilizer	$653	$115	$768
Jun	seed	$750	$150	$900
Sep	seed	$750	$150	$900
	aerate 3x	$0	$375	$375
Jun	topdress	$1,390	$350	$1,740
	irrigation	$2,749	$150	$2,899
	Total Cost			**$9,553**

COMPARISON OF CONVENTIONAL (CHEMICAL) AND NATURAL (ORGANIC) TURF MANAGEMENT PROGRAMS: YEAR THREE

CONVENTIONAL PROGRAM		Year 3	Year 3	Year 3
		cost	cost	total
		prod +7%	labor	
April	fert/pre-emergent	$285	$95	$380
May	fertilizer	$256	$95	$351
June	grub or insect	$371	$95	$467
June	post-emergent	$103	$150	$253
July	fertilizer	$256	$95	$351
Sep	fertilizer	$256	$95	$351
Nov	fertilizer	$256	$95	$351
June	seed	$775	$150	$925
Sep	seed	$775	$150	$925
aerate	3 times	$0	$375	$375
	irrigation	$3,676	$150	$3,826
	indirect costs			$500
	Total Cost			**$9,055**
NATURAL PROGRAM		Year 3	Year 3	Year 3
		cost	cost	total
		prod +7%	labor	
April	fertilizer	$699	$115	$814
June	fertilizer	$0	$0	$0
June	liquid humate	$137	$100	$237
July	fish/compost tea	$114	$100	$214
Sep	fertilizer	$699	$115	$814
Jun	seed	$775	$150	$925
Sep	seed	$775	$150	$925
	aerate 3x	$0	$375	$375
Jun	topdress	$1,487	$350	$1,837
	irrigation	$2,206	$150	$2,356
	Total Cost			**$8,497**

COMPARISON OF CONVENTIONAL (CHEMICAL) AND NATURAL (ORGANIC) TURF MANAGEMENT PROGRAMS: YEAR FOUR

CONVENTIONAL PROGRAM		Year 4	Year 4	Year 4
		cost	cost	total
		prod +7%	labor	
April	fert/pre-emergent	$305	$115	$420
May	fertilizer	$274	$115	$389
June	grub or insect	$416	$115	$531
June	post-emer	$110	$170	$280
July	fertilizer	$274	$115	$389
Sep	fertilizer	$274	$115	$389
Nov	fertilizer	$274	$115	$389
June	seed	$800	$170	$970
Sep	seed	$800	$170	$970
aerate	3 times	$0	$425	$425
	irrigation	$3,933	$170	$4,103
	indirect costs			$500
	Total Cost			**$9,755**
NATURAL PROGRAM		Year 4	Year 4	Year 4
		cost	labor	total
		prod +7%		
April	fertilizer	$0	$0	$0
June	fertilizer	$0	$0	$0
June	liquid humate	$150	$120	$270
July	fish/compost tea	$500	$720	$1,220
Sep	fertilizer	$748	$135	$883
Jun	seed	$800	$170	$970
Sep	seed	$800	$170	$970
	aerate 3x	$0	$425	$425
Jun	topdress	$0	$0	$0
	irrigation	$2,360	$170	$2,530
	Total Cost			**$7,268**

COMPARISON OF CONVENTIONAL (CHEMICAL) AND NATURAL (ORGANIC) TURF MANAGEMENT PROGRAMS: YEAR FIVE

CONVENTIONAL PROGRAM		Year 5	Year 5	Year 5
		Cost	cost	total
		prod + 7%	labor	
April	fert/pre-emergent	$326	$115	$441
May	fertilizer	$294	$115	$409
June	grub or insect	$445	$115	$560
June	post-emergent	$117	$170	$287
July	fertilizer	$294	$115	$409
Sep	fertilizer	$294	$115	$409
Nov	fertilizer	$294	$115	$409
June	seed	$856	$170	$1,026
Sep	seed	$856	$170	$1,026
aerate	3 times	$0	$425	$425
	irrigation	$4,208	$170	$4,378
	indirect costs			$500
	Total Cost			**$10,279**
NATURAL PROGRAM		Year 5	Year 5	Year 5
		cost	labor	total
		prod + 7%		
April	fertilizer	$0	$0	$0
June	fertilizer	$0	$0	$0
June	liquid humate	$160	$120	$280
July	fish/compost tea	$535	$720	$1,255
Sep	fertilizer	$800	$135	$935
Jun	seed	$856	$170	$1,026
Sep	seed	$856	$170	$1,026
	aerate 3x	$0	$425	$425
Jun	topdress	$0	$0	$0
	irrigation	$2,525	$170	$2,695
	Total Cost			**$7,642**

Appendix F. Potential Grant Funding Sources

1. **US EPA Pesticide Environmental Stewardship Program Regional Grants**
   Annual RFA, open to states and state agencies including state universities. Up to $50,000 per project. See http://www.epa.gov/pesticides/grants/proposals/2010-opp-pesp-rfp-0610.pdf for 2010 announcement.

2. **US EPA Pesticide Registration Improvement Act II**
   Annual RFA, open to municipalities and other applications. Up to $250,000 per project. See http://www.epa.gov/pesticides/grants/proposals/2010-opp-pria2-rfp-0303.pdf for 2010 announcement.

3. **USDA Natural Resources Conservation Service Conservation Innovation Grants**
   Annual RFA, open to municipalities, for environmental enhancement and protection in conjunction with agriculture. Up to $1 million per project. See http://www.nrcs.usda.gov/technical/cig/index.html for 2011 announcement. See also state competitions, up to $75,000 per project, not yet announced for FY 2011.

Appendix G. Example IPM Plan Template

[BEGIN EXAMPLE IPM PLAN TEMPLATE]

Revised: _____

YOUR FACILITY NAME HERE

IPM Plan

YOUR NAME
YOUR TITLE (e.g., Chief Operating Officer)
YOUR FACILITY NAME
YOUR ADDRESS
YOUR PHONE, FAX, EMAIL

INTRODUCTION
Pests are populations of living organism (animals, plants, or microorganism) that interfere with use of healthcare and other facilities for human purposes.

Integrated Pest Management (IPM) is an approach that establishes a sustainable approach to managing pests by combining biological, cultural, physical and, as a last resort, chemical tools in a way that minimizes economic, health and environmental risks.

YOUR FACILITY NAME HERE has adopted this Integrated Pest Management Plan for the buildings and grounds YOUR FACILITY NAME HERE manages. The plan outlines procedures to be followed to protect the health and safety of staff and visitors from pest and pesticide hazards. The plan is designed to voluntarily comply with policies and regulations promulgated by the Department of Agriculture for public buildings and health care facilities.

Objectives of this IPM plan include:

- Elimination of significant threats caused by pests to the health and safety of staff and the public.
- Prevention of loss or damage to structures or property by pests.
- Protection of environmental quality inside and outside buildings.

This IPM plan will be stored in the office of the IPM Coordinator.

IPM COORDINATOR
The Chief Operating Officer (COO) or designee shall be YOUR FACILITY NAME HERE'S IPM Coordinator and be responsible to implement the IPM plan and to coordinate pest management-related communications between YOUR FACILITY NAME HERE, its service providers, staff and visitors.

The COO shall designate an employee at each YOUR FACILITY NAME HERE-managed facility to serve as the IPM Site Coordinator for the site.

IPM COMMITTEE

YOUR FACILITY NAME HERE will maintain an IPM or other safety-related committee with responsibility for annual review of the IPM program and for assisting the IPM Coordinator in resolving pest-related issues. The committee will address IPM issues as needed and at least annually. Minutes will be taken of committee meetings and kept on file by the IPM Coordinator. Membership will include the IPM Coordinator and IPM Site Coordinators, and may also include community members.

POSTING AND NOTIFICATION OF PESTICIDE APPLICATIONS

The IPM Coordinator shall be responsible to annually notify staff of the procedures for requesting notification of planned and emergency applications of pesticides in facility buildings and on facility grounds.

When pesticide applications are scheduled in YOUR FACILITY NAME HERE-managed buildings or on grounds, YOUR FACILITY NAME HERE Service Providers and staff shall provide notification in accordance with law, including:

1. Posting in an appropriate area a pest control information sign with the date, time and location of the application, the product applied and the availability of adverse effects information, and including contact information for additional details.

2. Providing this information to all individuals working in the building.

3. Providing this information to all staff and visitors who have requested notification of individual applications of pesticides.

Where pests pose an immediate threat to the health and safety of visitors or employees, YOUR FACILITY NAME HERE may authorize an emergency pesticide application and shall notify by telephone any guardian who has requested such notification. Disinfectants, anti-microbials and self-contained or gel-type pesticide baits applied in inaccessible areas are exempt from posting, notification and the 7-hour reentry requirement.

RECORD KEEPING & PUBLIC ACCESS TO INFORMATION

YOUR FACILITY NAME HERE will maintain records of all Service Provider visits and pest control treatments for at least three (3) years. Information regarding pest management activities will be made available to the public at the YOUR FACILITY NAME HERE's administrative office. Requests to be notified of pesticide applications may also be made to this office.

TRAINING

All YOUR FACILITY NAME HERE staff will be provided with training on YOUR FACILITY NAME HERE's IPM policy at hire and during annual update training. Training will include the rationale for the IPM policy and program and specific elements including use of the pest-sighting log and prohibition on pesticide applications by non-certified individuals.

Additionally, designated staff including the IPM Coordinator, IPM Site Coordinators and those who conduct regular inspections of YOUR FACILITY NAME HERE facilities will receive advanced training on identifying pest infestations and pest-conducive conditions. This training will improve the ability of YOUR FACILITY NAME HERE staff to oversee Service Providers and YOUR FACILITY NAME HERE staff compliance with YOUR FACILITY NAME HERE's IPM policy and plan.

GENERAL IPM STRATEGIES

Pest management strategies may include education, exclusion, sanitation, maintenance, biological and mechanical controls, and pre-approved, site-appropriate pesticides.

An Integrated Pest Management decision at YOUR FACILITY NAME HERE shall consist of the following steps:

1. Identify pest species.

2. Estimate pest populations and compare to established action thresholds.

3. Select the appropriate management tactics based on current on-site information and the following procedure:

    - Structural and procedural modifications to reduce food, water, harborage and access used by pests.
    - Non-pesticide technologies such as trapping and monitoring devices.
    - Coordination among all facilities management programs that have a bearing on the pest control effort.
    - As a last resort, pesticide compounds, formulations and application methods that present the lowest potential hazard to humans and the environment.

4. Assess effectiveness of pest management.

5. Keep appropriate records.

Decisions concerning whether or not pesticides should be applied in a given situation will be based on a review of all available options. Efforts will be made to avoid the use of pesticides by adequate pest proofing of facilities, good sanitation practices, selection of pest-resistant plant materials, and appropriate horticultural practices.

When it is determined that a pesticide must be used in order to meet pest management objectives, the least-hazardous material, adequate for the job, will be chosen.

All pesticide storage, transportation, and application will be conducted in accordance with the requirement of the Federal Insecticide, Fungicide, and Rodenticide Act (7 United States Code136 et seq.), Environmental Protection Agency regulations in 40 CFR, Occupational Safety and Health Administration regulations, YOUR FACILITY NAME HERE policies and procedures, and local ordinances.

No person shall apply, store, or dispose of any pesticide on YOUR FACILITY NAME HERE-managed property without an appropriate pesticide applicator license. All pesticide applicators will be trained in the principles and practices of IPM and the use of pesticides approved for use by YOUR FACILITY NAME HERE. All applicators must comply with the IPM policy and follow appropriate regulations and label precautions when using pesticides in or around YOUR FACILITY NAME HERE facilities.

Pest-specific strategies will be included in the IPM Program Specifications provided to each service provider.

YOUR FACILITY NAME HERE SERVICE PROVIDER ROLES

YOUR FACILITY NAME HERE service providers including cleaning, pest control and landscape maintenance will be guided by written and signed contracts including YOUR FACILITY NAME HERE-developed IPM program specifications for structural pest control providers.

Service providers will be directed to provide special attention to pest-vulnerable areas including food storage, preparation and serving areas; washrooms; custodial closets; mechanical rooms and entryways into the building.

Service providers or other IPM experts will be asked to provide input on any YOUR FACILITY NAME HERE facility renovation or reconstruction projects including reviewing plans for pest-conducive conditions, suggesting pest-proofing measures and inspecting construction where applicable to prevent and avoid pest problems.

YOUR FACILITY NAME HERE STAFF ROLES

YOUR FACILITY NAME HERE administration will provide support to assist the IPM Coordinator in maintaining an IPM program that relies on minimal pesticide use. Such support will include efforts to promptly address any structural, horticultural, or sanitation changes recommended by the coordinator to reduce or prevent pest problems.

Furthermore, YOUR FACILITY NAME HERE administration will assist the Coordinator in developing and delivering materials and programs for staff, students, and the public to educate them about the importance of good sanitation and pest control.

The facility director is responsible for ensuring staff compliance with the IPM policy and plan, including the attached check list.

PEST-SPECIFIC STRATEGIES

The following strategies will be used for frequently encountered pests:

1. ANTS
    a. Ants will be identified to species to aid in locating nesting sites, preferred food, habits and appropriate baits when necessary.
    b. Ants inside buildings will be cleaned up with soapy water, including the areas ants are traversing to eliminate any pheromone recruiting trail, which ants deposit to help other ants find the location of food and water sources.
    c. Maintenance will be informed and the opening providing entry for ants into the building will be located and repaired.
    d. Building and room occupants will be informed of any action they need to take to prevent future problems, e.g., cleaning up spilled food or drink more promptly or thoroughly, storing food in sealed containers, repairing leaking or dripping pipes or faucets, etc.
    e. If the above steps fail to correct the problem, the contractor will inform the IPM Coordinator and discuss additional steps, such as more extensive repairs, changes in the food policy, changes in exterior landscaping to remove ant habitat, or the last resort option involving the selection of least-toxic pesticide baits or gels, preferably in manufactured tamper-resistant bait stations placed in areas inaccessible to children or other building occupants.

ADD MORE PESTS AS APPROPRIATE.

IPM CHECKLIST FOR YOUR FACILITY NAME HERE

Building:

Date:

Completed by:

Interior

____ 1. Pest problems, pest sighting and pest-conducive conditions are being reported to the facility director or their designee, and also to the pest sighting log located at the facility. These are minimal with no ongoing pest problems such as active mice infestations.

____ 2. Inspection aisles at least 4" wide are maintained between stored goods or appliances and walls, shelving units, etc. so that pest control and cleaning service providers can gain access for visual inspection and cleaning.

____ 3. Clutter is minimal including cardboard boxes, items not used for more than one year, etc., throughout the building including closets, cupboards, drawers, staff lockers.

____ 4. Potential pest food sources including snack food and craft materials are stored in tightly sealed containers, preferably plastic.

____ 5. Eating is limited to designated areas that can be thoroughly cleaned on a daily basis. Eating in rooms other than cafeterias our other designated areas is ok if necessary, but these eating areas should be limited within the room and receive special daily attention for cleaning.

____ 6. Toasters, refrigerators, ovens, microwaves, coffee pots and other food-related appliances and equipment are clean, including underneath, behind and on top.

____ 7. Surfaces in food preparation and serving areas are free of any grease deposits.

____ 8. Empty food/beverage containers to be recycled are rinsed before storage, stored refrigerated or stored in pest-proof containers.

____ 9. Food-contaminated dishes, utensils, surfaces are cleaned at the end of each day.

____ 10. Indoor garbage is kept in lined, covered containers and emptied daily.

____ 11. Wiping cloths are disposable or laundered daily.

____ 12. Upholstered furniture, couches, chairs, pillows, bean bags, cushions, or furnishings that cannot be moved for cleaning are not present, especially in areas where food is served, or are clean inside and out.

____ 13. Plants in buildings are healthy and not over watered.

____ 14. Pets are healthy and cages, tanks, etc are clean. Pet food is stored in tightly sealed containers, preferably plastic.

____ 15. Mops and mop buckets are properly stored (e.g., mops hung upside down, buckets empty).

Exterior

____ 1. Building foundations, eaves, walls and roofs are free of leaves, vines and debris, pest activity (including birds and squirrels), water puddling.

____ 2. Vegetation, shrubs and wood mulch are at least 12 inches away from exterior walls.

____ 3. Tree limbs and branches that might provide vertebrate pest access to structures are maintained at least 6 ft. away from structures (10 ft. if tree squirrels are a problem).

____ 4. Exterior doors throughout the building are kept shut when not in use.

____ 5. Window and vent screens are in good repair.

____ 6. Weather stripping and door sweeps on exterior doors are in good condition.

____ 7. Garbage cans, dumpsters and dumpster area are clean and in good condition, with lids that close, and are placed away from the building and building entranceway.

____ 8. Food waste from preparation and serving areas is in sealed plastic bags inside a dumpster or garbage can.

Appendix H. Example IPM Contract for Structural Pest Control

REVISED : _____

Structural Integrated Pest Management Program:

Contract Specifications for INSERT YOUR FACILITY NAME HERE

(Developed by the IPM Institute, Beyond Pesticides and Maryland Pesticide Network from a model authored by Dr. Albert Greene, U.S. General Services Agency)

Premises covered by this specification:

1. _____

2. _____

3. _____

4. _____

5. _____

(Attach additional list if necessary)

1. GENERAL
   A. Description of Program: This specification is part of a comprehensive Integrated Pest Management (IPM) program for the premises listed above. IPM is a process for achieving long-term, environmentally sound pest suppression and prevention through the use of a wide variety of technological and management practices. Control strategies in an IPM program include:
      - Structural and procedural modifications to reduce food, water, harborage and access used by pests.
      - Non-pesticide technologies such as trapping and monitoring devices.
      - Coordination among all facilities management programs that have a bearing on the pest control effort.
      - As a last resort, pesticide compounds, formulations and application methods that present the lowest potential hazard to humans and the environment.

   B. IPM Service Requirements: The Service Provider shall furnish all supervision, labor, materials, and equipment necessary to accomplish the monitoring, trapping, pesticide application, pest removal and pest prevention components of this IPM program. Any deviations from this program must be approved by the Chief Operating Officer (COO).

2. PESTS INCLUDED

The Service Provider shall adequately suppress all pest species that have the potential to affect public health, impede operations or damage property, including but not limited to:

- Indoor populations and invading individuals of rodents, insects, arachnids, and other arthropods.
- Outdoor populations of potentially indoor-infesting species that are within the property boundaries of the specified buildings.
- Nests of stinging insects within the property boundaries of the specified buildings.
- Termites and other wood-destroying organisms.
- Birds, bats, small mammals, and all other vertebrates.
- Mosquitoes.

3. PEST CONTROL PERSONNEL

Throughout the term of this contract, all personnel providing on-site pest control service must maintain certification as commercial pesticide applicators in the appropriate categories for the facilities listed above. Uncertified individuals working under the supervision of a certified applicator will not be permitted to provide service under this contract.

4. SERVICE PROVIDER IPM PLAN

The Service Provider shall submit to the COO an IPM Plan at least five (5) working days prior to the starting date of the contract. If aspects of the Plan are incomplete or disapproved by the COO, the Contractor shall have two (2) working days to submit revisions. The IPM Plan shall consist of three parts as follows:

A. Pesticide Labels and MSD Sheets: The Service Provider shall provide current Labels and Material Safety Data Sheets for all pesticides that will potentially be used in the pest control program.

B. Service Schedule(s): The Service Provider shall provide a schedule of routine pest control inspections for each building serviced under this contract, including frequencies of inspections, areas at each facility to be given special attention (e.g., food storage, preparation and serving areas; washrooms; custodial closets; mechanical rooms; entryways) and specific day(s) of the week on which the inspections will be performed.

C. Commercial Pesticide Applicator Licenses and Certificates: The Service Provider shall provide a photocopy of the State-issued Commercial Pesticide Applicator License for every Contractor performing on-site pest control service under this contract, and a photocopy of the State-issued Commercial Pesticide Applicator Certificate for every pest management professional (PMP) performing on-site pest control service.

The Service Provider shall receive the approval of the COO prior to implementing any subsequent changes to the approved Service Provider IPM Plan, including additional or replacement pest control products. The Service Provider will review and update the Service Provider IPM Plan annually, including updating MSDS/labels as needed.

4. RECORD KEEPING

The Service Provider shall be responsible for maintaining an IPM logbook or file for each building specified in this contract. These records shall be kept on-site and maintained on each visit by the PMP performing pest control service. Each logbook or file shall contain at least the following items:

A. IPM Plan: A copy of the Service Provider's approved IPM Plan, including pesticide Labels and MSDS sheets for all pesticides that will be potentially used in the building, service schedule for routine pest control inspections, and photocopies of the relevant Commercial Pesticide Applicator Licenses and Certificates.

B. Building Occupant Log Form: These forms will be used to advise the Service Provider of routine service requests and pest sightings by building occupants.

C. Service Provider's Report Forms: Customer copies of the Service Provider's signed and dated Service Report Form, documenting all information on services provided including pesticide applications required by State and local statute. This form must also indicate any recommendations made by the Service Provider for additional action advisable by the customer, e.g., structural or plumbing repairs required to limit pest access to the building or to food and water resources; improvements in sanitation, etc. A copy of this form must also be provided to the COO within one week of the service.

D. Service Provider Products and Devices: All bait stations, snap traps and glue boards or other devices left behind by the Service Provider are to be dated, numbered and listed on the Service Provider Report Form and checked on each subsequent visit until removed. All such devices shall be removed when full, dirty and no longer effective, or no longer needed.

5. MANNER AND TIME TO CONDUCT SERVICE

A. Time Frame of Service Visits: Frequent and complete communication between the Service Provider and the facility manager is critical for a successful outcome. Routine pest control services that do not adversely affect staff or patient health or productivity shall be performed during the regular building hours of operation. When it is necessary to perform work outside of the regularly scheduled service time set forth in the Service Provider IPM Plan, the Contractor shall notify the COO and/or facility manager at least one day in advance.

B. Safety and Health: All pest control work shall be in strict accordance with all applicable Federal, State, and local safety and health requirements. Where there is a conflict between applicable regulations, the most stringent will apply.

C. Special Entrance: Certain areas within some buildings may require special instructions for persons entering them. Any restrictions associated with these special areas will be explained by the COO. The Service Provider shall adhere to these restrictions and incorporate them into the Service Provider IPM Plan.

E. Uniforms: All Service Provider representatives working in or around the buildings specified in this contract shall wear distinctive uniforms identifying the name of their employer.

F. Vehicles: Vehicles used by the Service Provider shall be identified in accordance with State and local regulations.

6. SPECIAL REQUESTS AND EMERGENCY SERVICE

On occasion, the COO may request that the Service Provider perform corrective, special or emergency service(s) that are beyond routine service requests such as removal of a stinging insect nest. The Service Provider shall respond to these exceptional circumstances and complete the necessary work within twenty-four (24) hours after receipt of the request.

7. INSECT CONTROL

A. Emphasis on Non-Pesticide Methods: Non-pesticide methods of control shall be used wherever possible. For example:

1. Portable vacuums rather than pesticide sprays shall be the standard method for initial cleanouts of cockroach infestations, for swarming (winged) ants and termites, and for control of spiders in webs.

2. Trapping devices rather than pesticide sprays shall be the standard method for indoor fly control.

B. Application of Insecticides to Cracks and Crevices: As a general rule, all insecticides shall be applied as “crack and crevice” treatments only, defined in this contract as treatments in which the formulated insecticide is not visible to a bystander or accessible to children during or after the application process.

C. Application of Insecticides to Exposed Surfaces or as Space Sprays: Application of insecticides to exposed surfaces or as space sprays (“fogging”) shall be restricted to exceptional circumstances where no alternative measures are practical. The Service Provider shall obtain approval of the COO prior to any application of insecticide to an exposed surface or any space spray treatment. No surface application or space spray shall be made while staff, patients or visitors are present. The Service Provider shall take all necessary precautions to

ensure staff, patient and visitor safety, and all necessary steps to ensure the containment of the pesticide to the site of application.

D. Insecticide Bait Formulations: Bait formulations shall be the standard pesticide technology for cockroach and ant control, with alternate formulations restricted to unique situations where baits are not practical.

E. Monitoring: Sticky traps shall be used to guide and evaluate indoor insect control efforts wherever necessary.

8. RODENT CONTROL

A. Indoor Trapping: As a general rule, rodent control inside buildings shall be accomplished with trapping devices only. All such devices shall be concealed out of the general view and in protected areas so as not to be affected by routine cleaning and other operations. Trapping devices shall be checked on a schedule approved by the COO. The Service Provider shall be responsible for disposing of all trapped rodents and all rodent carcasses in an appropriate manner.

B. Use of Rodenticides: In exceptional circumstances, when rodenticides are deemed essential for adequate rodent control inside buildings, the Service Provider shall obtain approval of the COO prior to making any interior rodenticide treatment. All rodenticides, regardless of packaging, shall be placed either in locations not accessible to children, pets, wildlife and domestic animals, or in EPA-approved tamper-resistant bait boxes. As a general rule, rodenticide application outside buildings shall emphasize the direct treatment of rodent burrows wherever feasible.

C. Use of Bait Boxes: All bait boxes shall be maintained in accordance with EPA regulations, with an emphasis on the safety of non-target organisms. The Service Provider shall adhere to the following five points:

1. All bait boxes shall be placed out of the general view, in locations where they will not be disturbed by routine operations.

2. The lids of all bait boxes shall be securely locked or fastened shut.

3. All bait boxes shall be securely attached or anchored to floor, ground, wall, or other immovable surface, so that the box cannot be picked up or moved.

4. Bait shall always be secured in the feeding chamber of the box and never placed in the runway or entryways of the box.

5. All bait boxes shall be labeled on the inside with the Service Provider's business name and address, and dated by the Service Provider at the time of installation and each servicing.

10. USE OF PESTICIDES

The Service Provider shall be responsible for application of pesticides according to the label and all applicable regulations. All pesticides must be registered with the U.S. Environmental Protection Agency (EPA), State and/or local jurisdiction unless prior approval is given by the COO. Transport, handling, and use of all pesticides shall be in strict accordance with the manufacturer's label instructions and all applicable Federal, state, and local laws and regulations.

The Service Provider shall adhere to the following rules for pesticide use:

A. Rentry Time, Posting and Notification: Pesticides may not be applied where staff, patients or visitors will be present within seven hours after the application. At least seventy-two hours prior to a pesticide application, the Service Provider shall post an 8 ½ x 11" pest control information sign both at the site of the application and near the facility reception area where it will be seen by visitors entering the facility. This posting shall include the date, time and location of the application, the product applied, potential adverse effects from the Material Safety Data Sheet (MSDS) and the pesticide label, and include the Service Provider name, address and telephone. Service Provider shall also provide this information to the facility director who will use this information to notify staff and patients who have requested notification. Emergency applications, where pests pose an immediate threat to the health and safety of patients, visitors or employees, disinfectants, anti-microbials and self-contained or gel-type pesticide baits applied in inaccessible areas are exempt from posting, notification and the 7-hour reentry requirement.

B. Approved Products: No pesticide product shall be applied that has not been included in the Service Provider IPM Plan or approved in writing by the COO.

C. Pesticide Storage: The Service Provider shall not store any pesticide product in the buildings specified in this contract.

D. Application by Need: Pesticide application shall be according to need and not by schedule. As a general rule, application of pesticides in any inside or outside area shall not occur unless visual inspection or monitoring devices indicate the presence of pests in that specific area, and only after all non-toxic means have been exhausted and shown to be unsuccessful. Requests for preventive pesticide treatments in areas where surveillance indicates a potential insect or rodent infestation will be evaluated by the COO on a case-by-case basis. Written approval must be granted by the COO prior to any preventive pesticide application.

E. Minimization of Risk: When pesticide use is necessary, as a last resort the Service Provider shall employ the least hazardous material, most precise application technique and minimum quantity of pesticide necessary to achieve control.

11. SUMMARY

Service Provider agrees to the following:

___ 1. Review the INSERT YOUR FACILITY NAME HERE IPM Policy, IPM Plan and Contractions Specifications and discuss any deviations from these documents with the COO.

___ 2. Provide training for all employees serving facilities consistent with the INSERT YOUR FACILITY NAME HERE IPM Policy, IPM Plan and Contract Specifications.

___ 3. Provide a Service Provider IPM Plan including MSDS, labels, inspection schedule and applicator certifications and licenses to the COO for approval at least five days before the contract start date. Update the Service Provider IPM Plan annually.

___ 4. Provide a binder for each facility serviced including the IPM Plan, a pest sightings log and a section for service records.

___ 5. Provide service consistent with the INSERT YOUR FACILITY NAME HERE IPM Policy, Plan and Specifications, and obtain written approval from the COO before deviating from these documents.

Appendix I. Pesticide and Non-Chemical Data, Soil Test Analysis

A. Chemical and Non-Chemical Treatments by Department/Division

1. Open Space and Mountain Parks

2008

Chemical Treatments		
Grassland	440 acres	8.58 gals
Forest	100 acres	.92 gals
Total	540 acres	9.50 gals
Agriculture		
Alfalfa		
Herbicide	69 acres	1.80 gals
Insecticide	282 acres	8.96 gals
Corn/Silage sorghum		
Herbicide	101 acres	7.10 gals
Small grains		
Herbicide	133 acres	10.0 gals
Insecticide	193 acres	22.7 gals
Total	778 acres	50.56 gals
Mechanical Treatments		
Grassland/Forest/Trail	2930 acres	4409 hours
Cultural Treatments		
Agricultural/Cropland	294 acres	tillage
	44 acres	early hay cut
Native and Ag Croplands	130 acres	grazing cattle
Biological Treatments		
Insect release		

2009

Chemical Treatments		
Grassland	238 acres	9.80 gals
Forest	7.4 acres	1.04 gals
Restoration	1 acre	8.75 gals
Total	246.4 acres	19.59 gals
Agriculture		
Alfalfa		
Herbicide	99.1 acres	19.20 gals
Insecticide	332.6 acres	7.20 gals
Corn/Silage sorghum		
Herbicide	99 acres	5.6 gals

Small Grains		
Herbicide/Fungicide	83 acres	6.25 gals
Insecticide	175.9 acres	36.25 gals
Total	841.96 acres	74.50 gals
Mechanical		
Grassland/Forest/Trail	3762 acres	3121 hours
Agricultural/Cropland	254 acres	tillage
	44 acres	early hay cut
Native and Ag Croplands	142 acres	grazing cattle

Pesticide use trends include the following for OSMP and agricultural lands. Pesticide use increased in 2009 in many areas, particularly agricultural and grassland/forestlands. Increases are attributable to differences in weather conditions and disease presence, e.g., mold on barley in 2010; differences in pesticide formulations, e.g., Warrior II was applied in 2008 at lower rates per acre than product formulation applied in 2009; and specifics of particular projects, e.g., in 2009, 107 acres with very dense stands of Russian olives were spot treated with Garlon herbicide at 5.12 oz./acre vs. 383 less dense acres treated with 1.53 oz./acre the prior year.

2008

- Pesticide use on grassland & forest averaged 2.25 oz/ac.
- Pesticide use on alfalfa averaged 3.92 oz/ac.
- Pesticide use on corn/silage sorghum averaged 9 oz/ac.
- Pesticide use on small grains averaged 12.84 oz/ac.
- Pesticide use on all agricultural averaged 8.32 oz/ac.

2009

- Pesticide use on grassland & forest averaged 5.65 oz/ac (up 150%). This does not include use for restoration of 1.09 gallons on a single acre.
- Pesticide use on alfalfa averaged 7.83 oz/ac (up 100%).
- Pesticide use on corn/silage sorghum averaged 7.24 oz/ac (down 20%).
- Pesticide use on small grains averaged 21 oz/ac (up 69%).
- Pesticide use on all agricultural averaged 12 oz/ac (up 50%).
- Mechanical control in grasslands covered a greater acreage in 2009, but accounted for less total work hours than 2008.
- There were consistent mechanical strategies employed in agriculture.
- The largest pesticide use by OSMP involves agricultural lands.

2. Urban Resources

In 2008, a five-member crew spent 2802 hours (50%) out of a total of 5606 hours on IPM-related tasks. Of the 5606 hours, 139 (2.5%) were spent on community education and outreach.

IPM methods break down as follows:

Mechanical	1926 hours	68%
Chemical	660 hours	23%
Cultural	166 hours	4%

The chemical methods category is further broken down to 23% cut/stump applications and 68% backpack spot spray. The total amount of pesticide concentrate used was 324.2 oz. Of the 324.2 oz., 92 oz. were cut/stump applications and 232 oz. were sprayed on a total of 71.7 acres for an average of 3.2 oz/acre.

In 2009, a three-member crew spent 987 hours (25%) out of a total of 3944 hours on IPM-related tasks. Of the 3944 hours, 32 (<1%) were spent on community education and outreach.

IPM methods break down as follows:

Mechanical	735 hours	74%
Chemical	132 hours	13%
Cultural	44 hours	4%

The chemical methods category is further broken down to 78% cut/stump applications and 21% backpack spot spray. The total amount of pesticide concentrate used was 52.3 oz. Of the 52.3 oz., 5.8 oz. was sprayed over 2.6 acres for an average of 2.2 oz/acre.

Data for 2010 have just recently been released in draft form. The following information may need revision as the draft is finalized. In 2010, a five-member crew spent 2056 hours (38%) out of a total of 5660 hours on IPM-related tasks. Of the 5660 hours, 96.5 (1.7%) were spent on community education and outreach.

IPM methods break down as follows:

Mechanical	1500 hours	73%
Chemical	235 hours	11.5%
Cultural	280 hours	13.5%
Biological	41 hours	2%

The chemical methods category is further broken down to cut/stump and backpack spot spray. The total amount of pesticide concentrate used was 39.95 oz. Of the 39.95 oz., 13.98 oz. was sprayed over 24 acres for an average of 0.58 oz/acre.

B. Soil Test Results by Site

A compilation of the soil test results, as well as the original soil tests appear as part of this document. The following is an analysis of each individual test that points out where soil chemistry or biology could be improved. When a specific goal has been established to re-vegetate a site, generally improve grass or plant density, or increase desirable plant bio-diversity, the following information can then be used to establish the best soils

possible, given site restrictions, for the particular project. These four examples can then serve as a template for establishing baseline soil information at other properties in the future.

1. Jewell Tall Grass

Site Characteristics - This property is an important part of Boulder's southern grasslands and contains one of the oldest geologic surfaces of its kind in Colorado that supports a long-established mesic tallgrass community. A power company has an easement that runs through the grassland and contacted the city about trenching across the area to bury power lines. The easement has been relocated to the southernmost fence line of the property adjacent to a highway. The trench caused a disturbance of 1.5 miles. The trench is 4' to 5' wide and the remainder of the 25' easement is intact but was driven on as a staging area and suffers from mechanical stress. Soil samples were taken from this compacted area and within the trenching zone. Efforts were made to replace the excavated topsoil back on top when the trench was backfilled. Once the above ground power lines come down, native seed will be drilled into the disturbed area. A cover crop was planted in late fall 2010 within the trenched area to help reduce soil loss.

Goals - The goal is to restore the disturbed trench area to its former condition and to alleviate the mechanical stress that was created within the 25' easement.

Soil Analysis - The following soil samples were submitted. The Jewel Trench sample was from the excavated area and Jewel Tall Grass was from the undisturbed area within the easement.

Jewell Trench

- Soil texture is a Sandy clay loam.
- Sand, silt and clay are in good relative percentages.
- The cation exchange capacity (CEC) is on the low side at 11.7. This indicates that the clay present does not carry much negative charge.
- Ammonium nitrogen is low.
- pH is within the desired range.
- Organic matter is adequate at 4.6.
- Phosphorus is almost non-existent. At 1ppa there is not much there to support a developing root zone. There is actually less than 1ppa that is readily available.
- Calcium and magnesium are low.
- Organic matter is good at 4.6%.
- The total bacterial and fungal biomass numbers are good.
- The active portion of the biomass is low.
- The community of the various protozoa species is very low. This reflects directly on the low plant available nitrogen value (<25). As protozoa increase, they will prey on the ample bacterial community and nitrogen release will begin to return.
- Biosol as an input to condition the soil and infuse organisms would help with the biomass.

- Some application of fertilizer or amendment that would address P and Ca would be helpful. This becomes a function of budget and logistics as much as anything.
- Balancing soil chemistry and introducing biology (compost, compost tea, Biosol) will facilitate greater success in the germination and establishment of the grasses during the re-vegetation process.

Jewell Tall Grass

- Soil texture is a sandy loam.
- There is less clay here. It is the same soil as the trench; the difference is that during the backfill process clay in greater concentration ended up on top.
- CEC at 17.4 is higher due to the higher clay content.
- Ammonium nitrogen is low.
- Organic matter is lower at 3%.
- Phosphorus and Calcium are low.
- The biomass is essentially the same with the exception of better flagellate numbers. The lower numbers in the trench indicate disruption during excavation or backfill.
- The above recommendations apply here.

2. Dunn II Sites

Site Characteristics - The Dunn II Grassland is also within the area known as the southern grasslands and is dominated by needlegrass communities. In January 2010 a half-mile area of trail was rebuilt for the second time in two years. The trail corridor has a history of jointed goatgrass and chicory problems. The first attempt at rebuilding the trail encouraged *Kochia*. There was a substantial amount of imported soil brought to the site for the project. Its origin was a construction site and was available at no cost. There was concern among senior staff about the soil at the time. In March 2010, Biosol was used as a soil amendment on the sloped trail sides. Native seed was then drilled and non-natives were hand pulled or weed whipped from the disturbed area throughout the summer with marginal success.

Soil Analysis - The soil samples submitted were from two areas in the Dunn II Grassland. One was from the trailside restoration site and the other from the grassland.

Dunn II Grassland

- Soil texture is a sandy loam.
- CEC is good at 15.8.
- Both nitrate and ammonium nitrogen are low.
- Potassium is high, but not problematic.
- Other nutrient levels are good.
- The biomass is generally in a good balance. The native soil is slightly fungal dominated. The active portion of the fungal community could be improved, but logistics would determine this.

Dunn II Trailside

- Soil texture here is clay.
- Much of this soil was imported to the site.
- It is dramatically different than the native soil at the rest of the site which could lead to challenges here during the re-vegetation process.
- Humus is very low.
- Organic matter is almost non-existent at 1.4%. The generally accepted minimum for adequate growth is 3%.
- Calcium is extremely elevated at 9215 ppa and may be problematic.
- pH at 8.6 is very high and probably a concern.
- Calcium and pH levels can be traced to the imported soil's source.
- The biomass is extremely bacterial, nearly to the point of being detrimental to many plant species.
- The fungal biomass is very low, creating a limiting factor for this soil.
- Flagellates and amoeba are very low creating another limiting factor.
- In summary, the biomass, calcium and low organic matter here are concerns. Further discussion and information should happen to strategize and improve chances for success.
- The trailside soil has several issues as noted, most likely the reason for limited success to date.

3. Greenleaf Park

Site Characteristics - This property is in poor condition. It is a very visible neighborhood park and should be addressed if the budget allows. Serious drainage issues negatively affect turf health and appearance. Turf management is limited to mowing and trimming. The soil is extremely compacted and weed pressures are substantial. The turf is struggling and will continue to decline unless some type of management is undertaken.

Soil Analysis

- The soil texture is a sandy clay loam.
- The 21% clay contributes to the drainage issues.
- Sub-grade issues also contribute to drainage problems.
- The CEC is excellent as a result of the clay composition. Nutrients, if applied, will be held in the soil for an extended period.
- Humus as a portion of organic matter (OM) is very low.
- Nitrogen, particularly ammonium, is low.
- Phosphorus is very low and must be mitigated. There is not enough to facilitate the growth of a healthy grass root system, particularly during an over-seeding application. This can be accomplished over time through fertilizer and compost. A separate phosphorus application should not be necessary unless the fertilizer inputs fail to sufficiently increase the levels.
- Potassium is very high.
- Calcium is very high.
- Magnesium is low.

- The bio-assay indicates that the living portion of the soil is in relative balance and has the potential to be moved to a very strong and healthy position with the appropriate natural inputs.

4. Wonderland Lake

This is a 1.2 acre park that is located near the foothills. This was not part of our site visit due to the fire when we were in Boulder. It is heavily used by the neighborhood and is frequented by wildlife. The park tends to stay damp, as it is the lowest point in the area.

Soil Analysis

- Soil texture is a clay loam.
- Clay is very high at 37%.
- CEC is adequate at 16.7.
- Humus is low.
- Nitrogen is moderate.
- Phosphorus is on the low side and can be corrected by fertilizer applications.
- The other nutrients are generally balanced.
- Organic matter is very low at 3.9%. This turf would benefit from organic matter additions.
- The active portions of the fungal biomass need to be improved.

5. Columbine

Site Characteristics - This is a 4.4 acre park with 2.9 acres of managed turf. This was not part of our site visit. It is a flat parcel of land that contains a multi-use sports field in close proximity to a school, making it a particularly unlikely candidate for conventional turf management practices. It is irrigated and was aerated twice in 2010.

Soil Analysis

- Soil texture is a Sandy clay loam.
- CEC is good at 20.5.
- Humus is very low.
- Nitrogen is low.
- Phosphorus is low and can be corrected with fertilizer applications.
- The other nutrients are generally balanced.
- Both the active bacterial and fungal communities need to be elevated with the appropriate inputs.

6. Shanahan Ridge

Site Characteristics - This is a 2.3 acre neighborhood park that contains managed turf, ornamentals and a natural area. The grass is surprisingly dense and relatively weed-free considering the lack of management. It is nestled in a residential setting.

Soil Analysis

- Soil texture is a sandy loam. This soil is different from the other soils tested. There is substantially more sand here. Clay is also present in a substantial amount.
- CEC is good at 18.0.
- Nitrogen levels are low.
- Phosphorus is low, but can be elevated with a balanced fertilizer application.
- Potassium is high.
- Calcium and magnesium are at appropriate levels.
- Organic matter is good.
- The active fungal biomass needs improvement.

7. Central Park

Site Characteristics - This is a highly visible and heavily used downtown park. It is aggressively managed with regular applications of fertilizer and grass seed and is aerated on a regular schedule. Turf density is good and weeds, although present to some degree, are not overpowering.

Soil Analysis

- Soil texture is a sandy clay loam.
- Clay is high at 31%. This indicates the tendency for the soil to become compacted and to exhibit slow drainage.
- CEC is good at 21.3.
- Humus is very low.
- Potassium, calcium and magnesium are high. pH is high at 7.2, but not atypical for the region. Without knowing detailed input history, the elevated levels here are difficult to explain. They are not a problem, but rather indicate the nutrient-holding capacity of the soil. If desired, the fertility at this property could be addressed with a nitrogen input.
- The biomass appears healthy with all parameters in balance. The active fungal community should be improved. As with all of the other properties, when the biomass is improved and the numbers across the board increase through the implementation of a natural program, the turf improves, weeds decline and fertility begins to be supplied by the biomass.

8. Municipal Campus

Site Characteristics - Also in the heart of downtown, the Municipal Campus is a very visible property and has been managed as such. This area is in much the same condition as Central Park and they are both managed by a dedicated staff person. The properties speak for themselves. The attention paid here has produced turf that is both functional and aesthetically pleasing. There are some persistent weed issues that could be addressed.

Soil Analysis

- Soil texture is a sandy loam.
- There is less clay here than Central Park.
- CEC is good at 20.0.
- Humus is low.
- Ammonium, or reserve nitrogen, is low.
- Potassium is high, but not problematic.
- Soil chemistry is otherwise in balance.
- The soil here is more biologically active than any other property. As with most in the city, the active fungal community should be improved.

9. Stazio I, Stazio II and Mapleton

Site Characteristics - These are dedicated sports fields. The baseball field that we visited was in excellent condition. Turf density was very good and there was very little, if any, weed pressure evident. These properties have been managed in a more aggressive manner than the other properties. They were fertilized twice in 2010, April and August, with a synthetic 16-8-16 formulation at a rate of 1 lbN/1000 sq ft. They received one general over-seeding with a Perennial ryegrass/Kentucky bluegrass mix at a rate of 8 to 10 lbs/1000 sq ft to maintain turf density. They are mown at 2" 3 or 4 times a week. The fields are top-dressed annually and aerated 4 to 6 times a year or more in heavy wear areas.

Other than the synthetic fertilizer applications, the rest of the program is in line with an acceptable organic program. In order for the program to be organic, fertility would need to be moved to natural, organic product. The current synthetic product creates dependency and does not function as a food source for the biomass. Ultimately the goal in an organic program is to work aggressively within the biomass. Given that these properties are over 40 acres total and we only actually walked a 2 acre field, a more in-depth assessment of the other acreage would be necessary to develop a program of specific natural inputs. It should be assumed that there would be different programs created within the 41 total acres to meet individual needs unique to the sites. It would be short sighted to create a paper program without a more in-depth analysis.

Soil Analysis

Stazio I

- Soil texture is a sandy loam.
- Clay is at 19%.
- CEC is good at 18.9.
- Humus is low.
- Ammonium (reserve nitrogen) is low.
- Soil chemistry overall is balanced to the point that it meets the needs of sports turf.

- The biomass has become dominated by fungus. Improving the bacterial biomass should be a goal. The active portion of both the bacterial and fungal biomass should be improved.
- High ciliate numbers indicate recent anaerobic conditions in the soil. Given the frequency of aeration, this is probably a temporary condition.

Stazio II

- Soil texture is very similar to Stazio I. This is a sandy clay loam.
- CEC is good at 21.0.
- Humus is low.
- Ammonium nitrogen is low. Turfgrass prefers equal amounts of nitrate and ammonium nitrogen. Nitrate is soluble nitrogen, whereas ammonium is held in by the exchange sites. That is why we refer to ammonium as reserve nitrogen. Our goal would be to have as much reserve nitrogen as possible. This could be achieved by managing fertility with an organic form of nitrogen.
- Potassium is very high. This is directly related to the 16% potassium in the fertilizer currently being used. Grass does not require the excessive levels seen here. Fertilizers that are used for routine fertility management generally have potassium in an amount that is 50% to 75% of nitrogen. The product being used has a 1:1 N to K ratio.
- Organic matter is adequate, but could be improved. Switching the topdress mixture to a 50/50 compost to sand mix, rather than the current 80/20 sand to compost mix would be beneficial.
- The biomass is in place, but organism activity is low. This could be a function of fertilizer choice. Steps taken to improve the biomass will result in a healthier overall soil and improved nitrogen availability.

Mapleton:

Soil samples were not provided for Mapleton.

10. Maxwell

Site Characteristics - Maxwell Lake Park is an 8.5 acre site that contains natural grasslands, a pond, forest, a ditch corridor and trails. This property is the number one priority for the department. There are several species of noxious weeds on site that are documented with the main concern being myrtle spurge. During the last three years, there has been chemical control for Canada and Musk Thistle as well as Russian Olive. All other control has been mechanical. There is a problem with neighbors who have made no effort to mechanically control myrtle spurge.

Goals - The three-year plan calls for high density weeds to be reduced to moderate, the moderate density weeds to low density and the low density weeds to be eradicated. Part of this effort should include the introduction of desirable species that will begin to out-compete weed pressures once the new plants are fully established. The possibility of a release of the leafy spurge flea beetle might be considered as an ongoing biological

control strategy. Expectations would not be that this release would control the situation by itself.

Soil Analysis

- Soil texture indicates a high percentage of clay (31%).
- The soil is extremely fine-textured, typical of front range soils.
- The soil will exhibit a tendency to become compacted and to drain poorly after heavy rain events due to the very fine texture and density of the soil. It is the fine particles that can become compacted from environmental conditions as well as mechanical pressures.
- The soil has very low humus content.
- Phosphorus is slightly low.
- There is only moderate nutrient cycling taking place as a function of the biomass due to the low populations of protozoa which are the higher level predators responsible for nitrogen release.
- There is little or no mychorrizal colonization in the rhizosphere.
- The active portion of the bacterial and fungal biomass should be improved.

11. Harlow Platts

Site Characteristics - Harlow Platts encompasses 50 acres. The soil samples were taken over a 5 acre area. There is a pond, trails and a natural area that includes grasses, trees and shrubs. The area is surrounded by homes, a school, it contains water and has social trails running through it. These factors make this a poor candidate for chemical control measures. There is myrtle spurge and other weed pressures on site. There has been a substantial mechanical control effort over the past three years. Recent chemical use has not substantially damaged the soil here. There are some low biomass numbers, but not sufficiently low to say they were made worse by a chemical application.

Goals - To control and/or eradicate weeds as described above and to increase plant bio-diversity.

Soil Analysis

- High percentage of clay (31%).
- The soil is extremely fine-textured, typical of front range soils.
- The soil will exhibit a tendency to become compacted and to drain poorly after heavy rain events due to the very fine texture and density of the soil. It is the fine particles that can become compacted from environmental conditions as well as mechanical pressures.
- Low organic matter and correspondingly low humus content.
- Phosphorus is very low at 8 lbs/acre, which is sufficiently low enough to inhibit a good overseeding and establishment.
- Calcium is very low. The Ca:Mg ratio is only one-half of what it should be for the vigorous growth of successional grasses.

- There is a low supply of nitrogen being made available through the biomass. This is due to the low organic matter and relatively low numbers of protozoa.
- In order to make the best functional use of the biomass, greater numbers of bacteria and fungal organisms should be activated.
- Mychorrizal colonization is low and should be addressed with an inoculum.

12. North Dam

Site Characteristics - This is a prairie type area that includes grasslands, prairie dog colonies, roads, a wetland and ditch corridors. Two A List weeds are present, Mediterranean sage and Purple loosestrife. The biological control agent Larinus minutus is present on the loosestrife. White horehound has formed a monoculture in areas. Other than a chemical application for the control of loosestrife, all other control measures have been mechanical.

Goals - To control and/or eradicate weeds as described above and to increase plant bio-diversity. In addition it would be desirable to attempt to replace the growing monoculture of white horehound with desirable native species. In order to do this an aggressive re-vegetation effort would need to be undertaken. A seeding was done in the past with limited success. That may be due in part to soil conditions.

Soil Analysis

North Dam Moist:

- High percentage of clay (37%).
- The soil is extremely fine-textured, typical of front range soils.
- The soil will exhibit a tendency to become compacted and to drain poorly after heavy rain events due to the very fine texture and density of the soil. It is the fine particles that can become compacted from environmental conditions as well as mechanical pressures.
- Organic matter is very low at 2.5%. It is below the generally accepted low level for good soils.
- Humus is extremely low at 4 lbs/ac.
- Nitrate nitrogen is very low at 4 lbs/ac.
- Phosphorus is very low at 1 lb/ac. This level would be a limiting factor to a successful seeding operation. There is virtually no available phosphorus for initial root growth after germination.
- Even though the soil is becoming fungally dominated, the active portion of the bacterial and fungal biomass needs to be improved.
- Mychorrizal colonization is very limited. An inocululation could improve this.

North Dam Dry:

- Very high percentage of clay (45%). The USDA textural classification is actually clay. This indicates a soil that presents many challenges in the areas of non-weed species vegetative growth.

- Organic matter is very low at 2.1%. This is well below the generally accepted level for good growth of desirable plant species
- Humus is practically non-existent at 2 lbs/ac.
- Surprisingly the levels of NO3- and NH4+ are adequate.
- Phosphorus is very low at 6 lbs/ac and will be a limiting factor in the re-vegetation of grasses.
- Calcium is very high. It is almost three times the normal limit. The pH is high at 7.8 and is a reflection of the calcium.
- Protozoa numbers are very low and therefore there is very little nitrogen being made available through the biomass.
- Both the populations of active bacterial and fungal organisms should be improved.
- Mychorrizal colonization should be improved through an inocululation.

Appendix J. References

Personal Communications:
City of San Francisco: Personal Communications with Chris Geiger, Manager Green Purchasing and IPM Programs, December 15, 2010.

University of Colorado: Personal Communication with Don Inglis, December 13 2010.

City of New York: Personal Communication with Caroline Bragdon, Research Scientist, Division of Environmental Health, Department of Health and Mental Hygiene, December 15, 2010.

City of Toronto: Personal Communication with Doug Smith, Program Standards and Development Officer, Integrated Plant Health Care Section,
Parks, Forestry & Recreation, January 4, 2011.

Marin Municipal Water District: Personal Communication with Janet Klein, Vegetation Ecologist, January 18, 2011.