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Acknowledgments

We wish to extend a warm thanks to our sponsor, the Office of Campus Energy and Sustainability for their encouragement and support, to Mr. John Sebby and Mr. Joseph Clair for providing data, Brickman for conducting our chemical soil tests, the facilities workers for their input, and to Professor Blake Davis for his experience and guidance as the IPRO 326 mentor.

SECTION 1: ABSTRACT

!PRO 326 is a student initiated inter-professional project that has focused on identifying inefficient and unsustainable aspects of the current landscape management practices at the IIT Main Campus, and providing some solutions to these problems. The IPRO is the product of the joint brainstorming of twelve dedicated students ranging from architecture, physics, biology, civil engineering, to applied math, who over the semester have observed the efforts to restore the campus landscape after each winter. Each student did a thorough analysis of a test plot, and soil, plant, and survey results were used to conclude that the three meta-problems on campus are flooding, high traffic areas, and the snow removal process. We believe that with the resolution of these three meta-problems will follow the decimation of many other smaller problems.

SECTION 2: BACKGROUND, OBJECTIVE, AND PROBLEM

THE 1999 CAMPUS MASTER PLAN*(APPENDIX B)

In 1999, a group of acclaimed landscape architects headed by Peter Lindsay Schaudt Landscape Architecture, Inc., Chandra Goldsmith, and Michael Van Valkenburgh Associates, Inc. completed a new master plan for the IIT Main Campus west of State Street. These architects were commissioned to suggest ways to improve IIT's landscape, which was in need of intervention after the effects of the Dutch elm disease and years of neglect due to lack of both resources and a cohesive plan for future development and maintenance. The plan, which will hereby be referred to as the 1999 Master, made a number of recommendations to effect positive change in the IIT campus landscape. These recommendations fell into two main categories for improvement: (1) the continuity of the landscape (i.e., how connected the "disparate and spatially separate parts" of the campus are) and (2) the "variety of landscape experience" contained on campus.

While the 1999 Master was mainly focused on the social, historical, and architectural implications of these improvements, we have found that its recommendations are quite compatible with our vision of an ecologically sustainable campus. We thus decided to use the plan as a point of departure for our own suggestions.

SUMMARY OF TYPICAL SEASONAL MAINTENANCE PROCEDURE – 2009

The Facilities office provided us[1]. with a breakdown of landscaping maintenance tasks by season along with the costs associated for 2009, and we highlight some of the key activities below. Unless otherwise specified, the Brickman landscaping company carries out the listed tasks.

SPRING – The April and May months are devoted to rejuvenating the campus landscape, a considerable part of which dies from the accrued salt and snow removal damage. The fertilizer currently in use also contains herbicide, which is the bed pre-emergent. Dispersing the herbicide in April is done to prevent weeds from developing past the seed stage.[2] The University employs two different fertilizers, one that is only a fertilizer, and another that contains a pre-emergent/fertilizer mix. The beds are weeded for any existing weeds, and the existing perennials are cared for. Remnants of the winter season are discarded in a general spring clean up, and the Pritzker grove soil is aerated.

FIGURE 5: NO ~~MARKERS FOR~~MARKERS FOR HOW FAR

The grass along the sidewalk curbs that experienced significant salt and snow removal damage is removed and either reseeded or replaced with fresh sod (figure 1). Depending on the severity of the previous winter, grass replacement could range from the areas around Crown Hall and along most of State Street, to along 33rd street in the direction of the main building.

SUMMER – The June, July, and August months are devoted mainly to dispersal of more bed-pre-emergent, the maintenance of the freshly placed sod/reseeded grass, pruning the ornamental shrubs, trees, and annuals, and applying Round Up Total Kill™ weed controller to locations that require extra weed control. In 2009 pruning carried over into September.

FIGURE 1: RE-SEEDING THE DEAD GRASS CURBS

FALL – The September and October months are spent mowing and trimming the turf, weeding necessary beds, and cleaning the curb and sidewalks areas. Depending on when winter effect is projected to hit, October is spent winterizing the turf, and when the leaves begin to fall, they are promptly collected with leaf blowers.

WINTER –For the previous two years, plastic curb fences line the eastern side of State street to prevent vehicle toxin and salt damage from reaching the grass. Little work occurs in landscape maintenance, and most efforts center on salting the sidewalks and roads and snow plowing, all of which are conducted by the facilities workers.

THROUGHOUT THE YEAR – The facilities workers are responsible for general clean up and year-round maintenance. They also oversee the sprinkler systems during the summer, late spring, and early fall months. They and Brickman are also involved in continual travel and supervision of the sites, vine maintenance, pruning of the ground covers, and maintaining the vines that grow along State Street Village and Siegel Hall.

THE PROBLEM

Prior to Spring 2010, Ryan Roeth and Irina Papuc spent two years observing the aforementioned activities and documenting the maintenance schedule in a series of photographs, some of which are included in appendix D (CD). From these initial observations, IPRO 326 brainstorming, soil test, surveys, and plant research results, we concluded that all observable problems might be grouped into three meta-problem categories; flooding, snow removal procedure, and high traffic areas. The meta-problems are the causes for the recurring campus issues we noted: foot paths, vehicle damage, dead grass patches.

FLOODING – Soil compaction as a result of foot and vehicle traffic, steam lines, and vegetation choice causes flooding in the spring season and during other high rain periods. Three of the most flood-prone areas were observed: the fraternity quad, the sidewalk in front of State Street

FIGURE 2 – KENTUCKY BLUE GRASS VERSUS MIDWESTERN PRAIRIE GRASS ROOT CROSS-SECTIONS

Village, and the grass patch between the Life Sciences and Engineering 1 buildings. Below follow some words on the flooding causes.

FOOT AND VEHICLE TRAFFIC: IIT suffers from numerous foot paths and landscaping damage as a result of students cutting across the lawn in an effort to quickly move to and from classes. As a result, the grass is often very thin and worn away, or where there is heavy traffic, simply a thin dirt path. When there is snow or rainfall, these areas become even further damaged from the moisture and leads to mud that is then tracked across sidewalks and into buildings. In addition to students damaging grass, a number of vehicles are often driven around campus, which sometimes cut the corners of the sidewalk, or overhang across the sidewalk completely. When this happens, the weight of these vehicles creates a muddy rut where grass ought to be. Often the tires spread mud on the sidewalk where students continue to track it around campus and in buildings. Both the students and the vehicles damage and kill the grass off and create undesirable paths. For many students, it represents more than simply a footpath or tire mark, but a sign of disrespect towards our campus and its landscape. As will follow later in the report, foot traffic and salt lead to soil compaction.

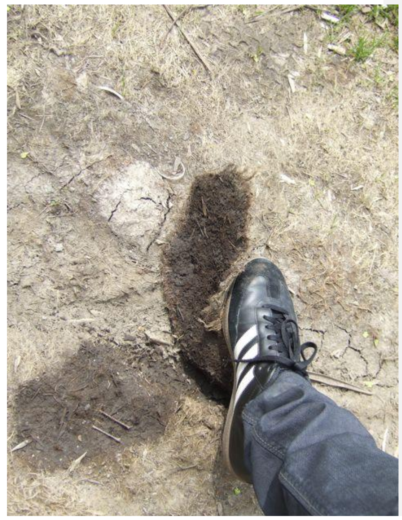

FIGURE 3: DETACHED GRASS IN FRONT OF SSV NORTH

VEGETATION CHOICE: Vegetation choice are one of the causes to flooding problems because in comparison to many of the native Illinois prairie plants, Kentucky blue grass roots dwindle in size and surface area. The lack of prominent roots also contributes to soil erosion and we have observed that especially around the sidewalks and curbs, the grass sometimes detaches from the soil (figure 3). Without the sponge-like qualities of roots to hold the grass to the soil and drain excess moisture, the rainwater is free to draining off the soil surfaces and in the sidewalk cracks. The flood-prone areas in the quad, front of SSV, and by LS and E1 contain Kentucky blue grass.

STEAM LINES: In our first meeting with the facilities workers,[3] it was pointed out that a major steam line is buried underneath the center of the fraternity quad, and that due to poor pipe insulation, steam leaches into the soil, moistens it, and the high foot traffic mentioned above then contributes to further soil compaction (figure 4).

SNOW REMOVAL PROCEDURE – After discussing our problems with the facilities workers and studying the current snow removal process, we reasoned that much of the dead grass and plants along site borders results from that process. The current methodology consists of salting the roads and sidewalks with two salt types: calcium chloride and magnesium chloride (see results section). We gathered from the facilities interviews that the calcium chloride mix is the stronger of the two salts and is used in the snowier areas, while the magnesium base salt was cited as a healthier option for lighter areas. As reported by facilities, IIT uses over 100 tons of rock salt on campus during an average winter season[4]. These salts can be a major pollutant due to runoff and can cause high sodium and chloride concentrations in ponds, lakes, and rivers. This can cause unnecessary fish kills and changes to water chemistry.

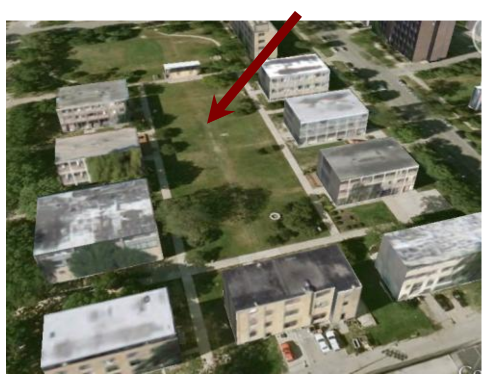

FIGURE 4: STEAM LINE DAMAGE, FRATERNITY QUAD, GOOGLE

Additionally, these kinds of salts have been shown to harm plants. They interfere with the osmotic balance of cells, making it impossible for cells, and ultimately entire plants, to properly regulate the absorption of water. Plants exposed to excessive salt show symptoms of dehydration. Their uptake of water and nutrients is inhibited, growth slows, and leaves and grasses turn brown, sometimes known as "salt burn." When the soil becomes salty, the germination of seeds slows or stops entirely. If salt is continuously introduced into the soil, the soil structure changes; it becomes poorly aerated and alkaline and becomes much less hospitable to many plant species. We chose a January day and mapped out all observable flooding and salt damage around campus on that day (graph BLAH). The criterion for salt damage and flooding was visible white/light blue crusty salt residue on the ground and puddles, respectively.

When the snow piles, the line between vegetation and concrete fades, and the plow sometimes misses its target (figure 5). Facilities expressed a lack of clear markers as primary contributor to grass border damage.

HIGH TRAFFIC AREAS Desire lines are high foot traffic areas of dead grass that are one step below formal sidewalk paths. Students and faculty members informally carve them on their daily walks across campus, and they can serve as a guide for what people have considered to be the shortest and most time-efficient way to get from point A to point B. If the purpose of sidewalks is this, then the footpaths mapped out below could serve as guidelines for the placement of some permanent sidewalks in the near future. For comparison we include the footpath proposals in the 1999 Master Plan, several of which are in common with current foot path concerns.

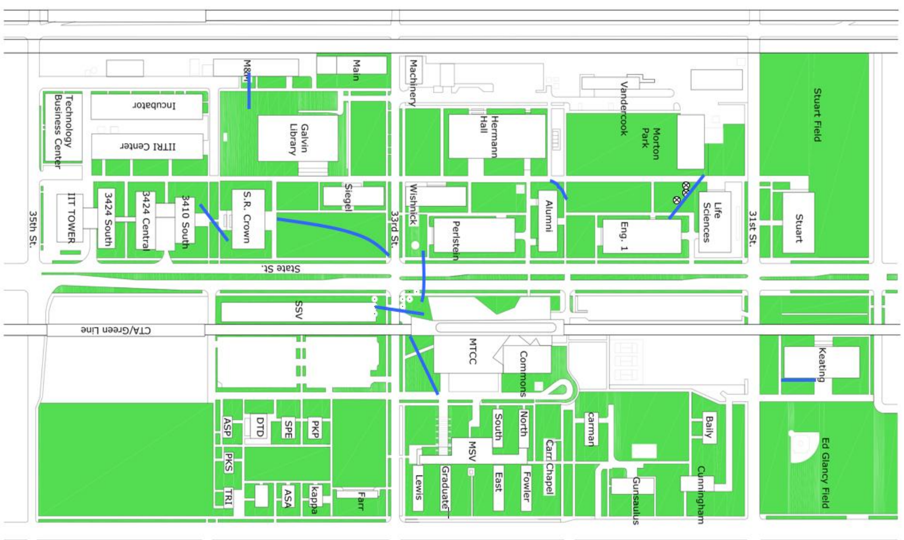

FIGURE 7: CURRENT FOOT PATH LOCATIONS DUE TO HIGH PEDESTRIAN TRAFFIC (BLUE)

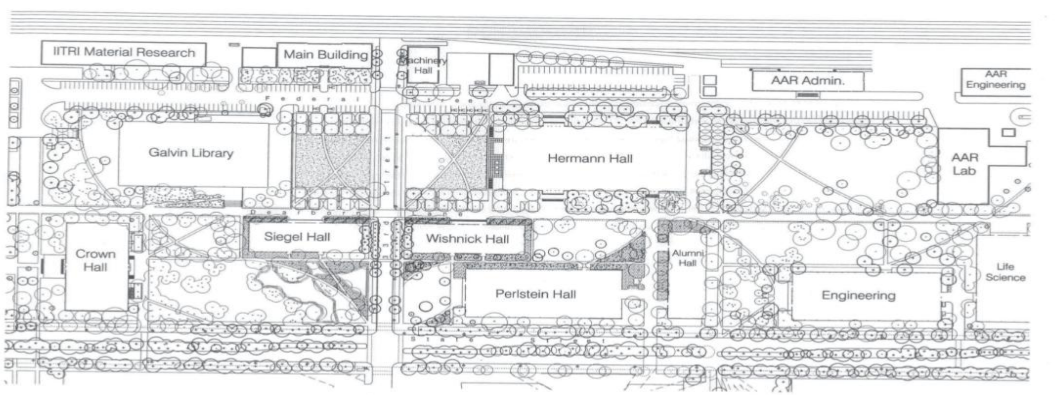

FIGURE 6: 1999 MASTER PLAN FOOT PATH PROPOSALS (APPENDIX B)

SECTION 3: ORGANIZATION AND APPROACH

HOW WE WENT ABOUT RESEARCHING THE PROBLEM

For organizational purposes, we prepared three sets of charts to guide us through the semester. The first was a *Gantt chart*, which highlighted the major team goals and their respective deadlines (table 1). This chart changed over the course of the semester when we required other documentation such as soil tests and survey results. After reviewing this chart as a team, we decided to break into three sub-teams, the plants team, problems team, and solutions team, each consisting of three or four people voluntarily chosen by interest. Each team's respective tasks were conveyed in three *mind maps* (appendix F).

The plants team was responsible for researching the local flora, climate conditions, soil chemistry, and cataloging native hardy plants for a facilities recommendation document (appendix F).

Tasks	Start Date	Duration (days)	End Date
Read Cradle to Cradle	1/12/10	9	1/21/10
Project Plan (midnight, February 5th)	**1/21/10**	**15**	**2/5/10**
Research on Soil, Climate and Local Plants	1/21/10	35	2/25/10
Creat problem area & activity maps of campus	1/21/10	40	3/2/10
Gather problem areas Information	1/21/10	45	3/7/10
Organize surveys for students, faculty, and staff	2/2/10	50	3/24/10
Midterm Review (5:45pm - 6:00pm, February 24th)	**2/10/10**	**14**	**2/24/10**
Study the 1999 IIT Landscaping Master Plan	2/23/10	7	3/2/10
Identify testplots on campus and each team member research on one test plot	3/2/10	30	4/1/10
Identify major problems	3/4/10	35	4/8/10
Research on Possible Solutions	3/4/10	35	4/8/10
Brainstorming Solutions for the Problems	3/4/10	45	4/18/10
Ethics Relective Report (midnight, March 26th)	**3/12/10**	**14**	**3/26/10**
Compare and Finalize Solution Proposals	3/26/10	21	4/16/10
Final Project Report First Draft (midnight, April 9th)	**3/23/10**	**17**	**4/9/10**
Abstract/Brochure (10:00 am, April 19th)	**4/8/10**	**11**	**4/19/10**
Poster (10:00 am, April 19th)	**4/8/10**	**11**	**4/19/10**
Final Presentation (10:00 am, April 22rd)	**4/13/10**	**9**	**4/22/10**
Final Project Report Final Version (midnight, April 30th)	**3/23/10**	**38**	**4/30/10**

TABLE 1: GANTT CHART FOR OVERALL TEAM GOALS. COLORS INDICATE THE CATEGORIZATION OF TASKS: BLUE = RESEARCH; YELLOW = BRAINSTORMING; RED = SOLUTIONS. S

Kyle Duke			survey questions for his group	rough draft of survey	mud/flooding on campus update	update maps	hatches or colors	survey holders	master plan
Ying Xiao	Annual rainfall chart temperature range chart, wind map	Present photo documentation of respective landscape zone	Gather existing tree data. Classificatio(see mind map) Midwestern zone solar activity, humidity level, storm, hurricane, heavy rain frequency, read up on Soil classification system (sandy, loamy, clayish, etc.)	Update on tree research, with pros, cons hardiness, etc. listed. Assessment of current trees (John Sebby information)	Update on tree research, with pros, cons hardiness, etc. listed	Combined all the climate information into a package and uploaded on iGroups. Had a team meeting with sub-team and talked about our goal to achieve and want we need to focus on.	Read 1999 Master Plan	Continue reading the Master Plan and made a "progress toward goals" slide for midterm presentatio with Trevor.	Finished Peer Review and set up the survey tubes around the campus on Saturday (2/27/10). Researchec green ash, swamp white oak and northern red oak on the Master Plan and uploaded on iGroups.
Juliana Masci		Present photo documentation of respective landscape zone	Gather existing shrub data. Classificatio (see mind map) Drought frequency assessment, pollution data for Chicago, Illinois, and the Midwest (separate maps)	Update on shrub research, with pros, cons hardiness, etc. listed	Update on shrub research, with pros, cons hardiness, etc. listed		1999 Master Plan Perennials	Current Map trees	advertisem slide for student life

TABLE 2: PART OF THE TO-DO LIST WE USED TO ORGANIZE INDIVIDUAL TASKS ON A DAILY BASIS—COLORS INDICATE THE COMPLETION STATUS OF THE TASK (YELLOW = COMPLETED)

The problems team was tasked with studying four key areas: Student, faculty, and staff feedback, correspondence with the OCES (Joseph Clair and John Sebby), studying the social use of the campus (recreational needs), and compiling a list of maintenance tasks (the problem) by analysis of the Brickman document obtained from facilities (appendix F).

The solutions team acted as liaison between the OCES and IPRO 326, communicated with Scott Beslow, a graduate civil engineering student working on his thesis about the rain water management problem on campus, and brainstorming solutions as the problems from the other sub-teams surfaced (appendix BLAH, table BLAH). To keep track of individual efforts, a to-do list spreadsheet was posted on google docs in the team email account where each member updated their work by filling a small highlighted square for each Tuesday and Thursday of the week (figure BLAH).

TEAM STRUCTURE

BLOG MASTER……………………….	Jon Skinner
FACEBOOK PAGE MASTER……………	Mitch Blosky
IGROUPS MODERATOR………………	Ying Xiao
MINUTES TAKER………………………	Ryan Roeth
AGENDA MAKER…………………….	Irina Papuc
TIME KEEPER…………………………	Jon Skinner
PLANTS SUBTEAM LEADER…………….	John Stecyk
PROBLEMS SUBTEAM LEADER………….	Mitch Blosky
SOLUTIONS SUBTEAM LEADER…………	Ryan Roeth
PLANT SUBTEAM BINDER ORGANIZER…..	Julie Masci
PROBLEMS SUBTEAM BINDER ORGANIZER.	Naguib Azab
PROBLEMS SUBTEAM BINDER ORGANIZER.	Edgar Rodriguez

Members of the team were assigned various responsibilities, as listed in figure BLAH. This distribution of responsibility was done with the intention of involving everyone within the greater overall team goals. The blog master, Jon Skinner, created and updated a blog, IPRO 326: Waste Equals Food (BLAH BLAH) as a communication device between the team and our sponsor, the OCES. Mitch Blosky, the Facebook page master, created a Facebook page which gathered student feedback, sent out alerts about the surveys, and posted photographs as conversation-starters to facilitate student body involvement in our decision-making process. Ying Xiao was designated our IGROUPS page moderator to organize the site, Ryan Roeth took minutes of each minute for upload and revision on the IGROUPS site, and Irina Papuc set the agenda for each class meeting. A student was chosen as leader of each sub-team to print out documents, keep track of progress, and suggest new directions. Each sub teams' responsibilities and achievements are summarized below.

PLANTS TEAM – The Plants team began by reading about the local climate and dividing each person into a plant type: grasses, perennials, ground covers, and trees. Each person independently read about the plants on campus and explored hardier options to include in a plant database (Appendix A). The Plants team obtained and read the 1999 Master plan proposal and looked into the feasibility of the recommendations, such as the footpaths and some perennial plants. Soil chemistry such as mega and micronutrients were studied, as well as the chemical compositions of the fertilizer currently used on campus. Bioswales, rain gardens and their application and success in combating flooding concerns in Portland Oregon were assessed with the help of original photographs from one of the plants team members, an Oregon native.

PROBLEMS TEAM – The Problems team worked to gather and document as much data as they could regarding each problem presented. They achieved this through several different methods. They began by obtaining a map of the campus, which they divided into 4 zones. With this map, they started to plot each area on the campus where problems such as salt damage, foot paths, and flooding, were prevalent. Through these mapped areas, they were able to discover the most problematic zones, and the IPRO team as a whole shifted their attention to these zones. The Problems team also sought the opinion of different users on the campus. They created several different site-specific surveys that asked questions about the problems with the landscape, and distributed them both across campus and online. Additionally, the group sought to use social networking sites to allow students, faculty, and IIT visitors to have input for identifying problems. Through the survey results, the team gathered valuable outside information and opinions that IPRO 326 may have not considered themselves. Lastly, the team took a look at the landscaping contract that IIT currently possesses. One of the leading concerns was that IIT was spending too much money annually on replacing landscaping and it was hoped IPRO 326 could find a solution to help make IIT's landscaping more sustainable and cost-effective.

SOLUTIONS TEAM – The Solutions team was tasked with anticipating the major problems with the campus landscape, and then researching and developing solutions to those problems. The team began by mapping conditions on campus, and estimating the causes and severity of issues such as high salt content in the soil, high levels of foot/vehicular traffic, low levels of essential soil nutrients, and inadequate drainage. To come up with a spectrum of possible solutions to these problems, the Solutions team researched salt-tolerant plants (in conjunction with the Plants team), permeable pavement systems, alternatives to salt as a deicing agent, solutions for highly trafficked zones, and sustainable soil amendment and management programs. These activities were augmented midway through the semester when the Solutions and Plants teams combined and began focusing towards solutions to specific problems as defined by the efforts of the Problems team, research conducted by each team, and meetings with the IIT Facilities workers. ~~RYAN M. ROETH~~

SECTION 4: RESULTS (ANALYSIS AND FINDINGS)

TEST PLOTS – LIVING LAB COMPONENT

In an effort to better understand the problems highlighted in section two, twelve test plots were chosen around campus that contained the three universal meta-problems previously discussed. Each member of IPRO 326 was responsible for photographing their plot and pointing out problems and the causes of these problems as they pertain to the test plot. The recommendations that follow in this section stemmed from these individual plot studies and a summary of each plot follows below.

Test Plot A: Foot path along Keating hall – Jon Skinner
Reason for choice: A well-established high traffic area

Test Plot D: Annual flower bed – Tryphaena Manoharan
Reason for choice: A frequently re-seeded and replanted annual flower bed with mixed perennials

Test Plot F: Flooding are in frat quad – Kyle Duke
Reason for choice: One of the three highly flood-prone areas on campus

Test Plot E: Control grass plot – N/A
Reason for choice: To compare soil test results to a "normal" plot of soil

Test Plot G: Strip in front of State Street Village – Ying Xiao
Reason for choice: Combination of erosion, flooding, and salt damage

Test Plot Q1: Dead grass strip in front of E1 – Ryan Roeth
Reason for choice: High traffic area

Test Plot Q2: Siegel field – Trevor O'Keefe
Reason for choice: Flooding and high traffic area

Test Plot I: Footpath between LS and E1 – Irina Papuc
Reason for choice: High traffic and poorly drained area

Test Plot I2: Dead grass location in Morton Park – Mitch Blosky
Reason for choice: High traffic area/groundcover exploration

Test Plot K/N: Typical grass plot – Edgar Rodriguez
Reason for choice: To explore application for typical IIT sites
We hope that some of these plots can serve as "living labs" in near future as literal test plots to test the recommendations outlined below. These recommendations were guided by the soil test results, fertilizer research, the Harvard university compost case study, student/faculty feedback results, and the facilities meeting minutes.

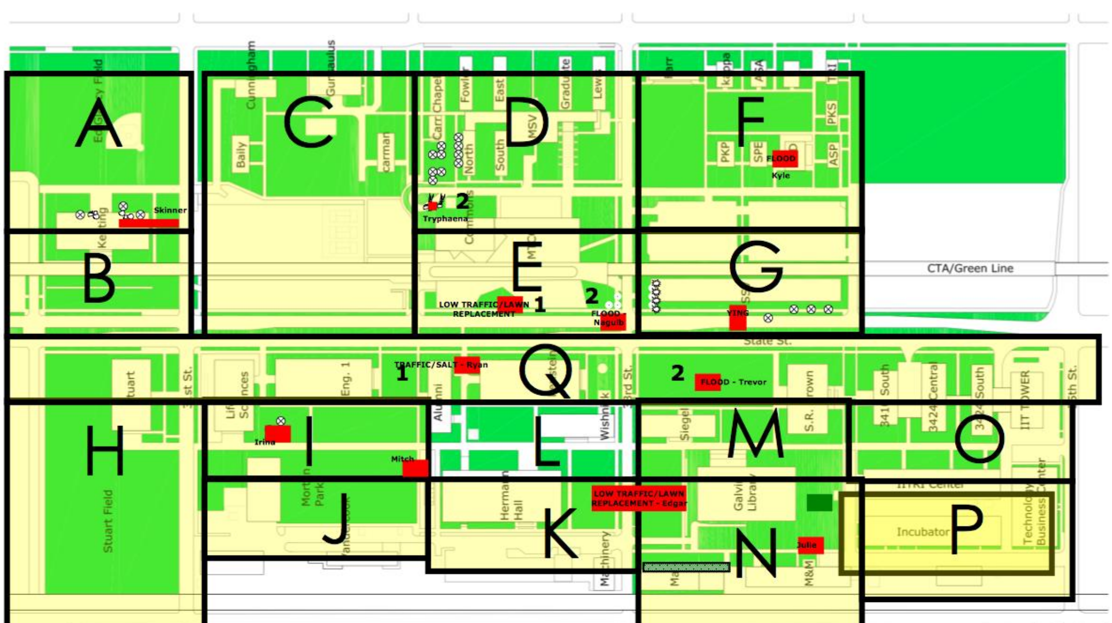

FIGURE 8: TEST PLOT ASSIGNMENT MAP – EACH PERSON WAS ASSIGNED ONE OF TWELVE TEST PLOTS (RED) WHICH ADDRESED THE THREE META-PROBLEMS OF FLOODING, SNOW REMOVAL DAMAGE, AND HIGH TRAFFIC AREAS

SOIL TEST RESULTS

~~To understand the soil composition, possible reasons for plant death, and quantify salt damage extent, we asked the Brickman landscaping company through the OCES to conduct a series of chemical soil tests (appendix E) on seven of the aforementioned test plots. The results confirmed several key points concerning the mega nutrients, micronutrients, salt content, pH levels, and organic content.~~At the request of IPRO 326, the Office of Campus Energy and Sustainability and the IIT Facilities Department directed Brickman (IIT's landscaping contractor) to conduct chemical laboratory testing of the soil on campus. Six locations from the above listed test plots were chosen based on expectations of results showing nutrient deficiencies caused by the application of salt and synthetic fertilizers and herbicides. In addition, two locations were selected (also from the above-listed plots) for testing as "control" plots, on the basis that these locations normally do not need to be replaced (although they are treated with fertilizer/herbicides), and are representative of a typical location on campus. These plots were located in the irregular quadrilateral west lawn of the MTCC; one of these was sourced from the middle of the field, while the other was taken from along the sidewalk (to test for the presence of salt). The soil test results showed several marked deficiencies in the IIT campus soil.

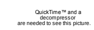

FIGURE 9: SAMPLE TEST PLOT

Findings

Mega Nutrients

The most important three soil nutrients for plants are Nitrogen (N), Phosphorous (P), and Potassium (K). These nutrients are essential for plant photosynthesis, growth and strength, and disease resistance. Our soil test results found lower than optimum levels of Potassium and Nitrogen, and surprisingly high levels of Phosphorous, in most of the test plots surveyed.

Nitrogen: Nitrogen is available to plants in two major forms: Ammonium (NH_3^+) and Nitrate (NO_3^-). As Nitrate is the more available form of N to plants (it is easier for them to absorb), it is in general desirable to have higher levels of Nitrate than Ammonium in soil; this was observed across all locations tested. Usually, Nitrate and Ammonium levels are reported separately in soil test results in either parts per million (ppm) or pounds per acre (lb./acre); in order to arrive at the total amount of N available to plants, the sum of these two values is taken. In healthy, robust soil, a typical presence of N in Nitrate and Ammonium forms is around 150 lb./acre, or 75 ppm. The average value of these compounds measured in IIT's soil was 13 ppm, which is extremely low.

Potassium: Potassium levels were below optimal level (201-250 ppm) in nearly all of the test plots. The areas particularly low in K were in front of the west side of the MTCC (plot E1) close to the sidewalk and along the sidewalk at Siegel (plot Q2).

Phosphorous: Very high levels of P were reported in the soil at IIT. Areas that were particularly high in P were in the fraternity quad (plot F), in front of the Engineering 1 building (plot Q1), and in the south lawn of Herman Hall (plot K1). These plots all had a P presence of over 60 ppm. (The optimal level of soil P is 14-26 ppm.) We suspect that in many of the test plots (excluding plot F), a previous soil test might have indicated low P levels, thus prompting the formulation of a "special formula" of fertilizer (i.e., the one mentioned by facilities in our meetings with them) containing high levels of P; if this is the case, the use of this fertilizer over the years could have led to a buildup of P to levels beyond what is needed in the soil.~~*Mega nutrients:* As the soil test report indicates, on the average, the test~~

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~~plot sampling returned low potassium and magnesium levels, indicating a need to revise the current fertilizer recipe to account for this nutrient depletion. The areas particularly low in potassium were in front of the east side of the MTCC (E1 border) and along the SSV strip (Q2). The areas particularly low in magnesium were the areas along the east end of the MTCC (E1 border) and the plot between Herman hall and Galvin library (K/N). On the other hand, very high levels of phosphorus were reported, particularly in the fraternity quad (F), in front of Engineering 1 (Q1), and in the plot next to Herman Hall (K1). Interestingly, in our research we learned that areas with less human interference and a greater plant diversity typically has higher levels of phosphorus, and plots F and K, both of which are relatively untouched compared to the highly maintained areas around state street, exhibit high phosphorus levels.~~

Micronutrients: On average manganese and magnesium w~~a~~ere~~s~~ very low, and there were excess amounts of zinc, copper, and iron. The areas particularly low in magnesium were the areas along the east end of the MTCC (E1 border) and the plot between Herman hall and Galvin library (K/N). Manganese levels were particularly high along the east end of the MTCC border, zinc levels were particularly high in the plot next to Herman hall and the annual flower bed in front of MSV (D), and copper levels were high in the flower bed and in front of SSV.

Salt content and soil pH: Overall, the level of soluble salts was satisfactory. However, the sodium level, a key component of winter salt, was listed as an "increasing problem," as was the soil pH. Two adjacent soil testing locations, one on the border of the east end of the MTCC (see figure BLAH), and another towards the interior of the same plot, were taken to compare the sodium levels in soil unaffected by salt damage and sodium levels in soil in direct contract with salt. The sodium levels were three times as high on the border, and in a side-by-side comparison of organic content between the two sites, the less salty plot had 0.4 ppm more organic matter than the salty plot.

Organic content: On average, the organic matter in ppm ranged between 4.0 and 5.0. The highest level was recorded at 8.8 ppm in the fraternity quad, which is once again not a surprise considering that the quad is left to grow without weeding, pest control, re-seeding, or annual grass replacement, which we believe allows the soil to develop its higher organic content.

Remediation suggestion: We recommend that facilities reconsider the fertilizer composition so that it can fill in the gaps this soil test results shows.

HARVARD UNIVERSITY CASE STUDY

Harvard's organic landscaping program began with a single 1-acre test plot as an attempt to test the potential benefits for customizable site-made compost. Harvard uses a "brewed-tea" method of application, where the compost is steeped in aerated water and other natural chemicals are added to create a desired nutrient mix[4]. Some of the other materials added to either the compost or directly to the tea include molasses, canned fish or fish oil, expired fruit, and apple cider vinegar. Each of these provides unique nutrients vital to healthy soil that would otherwise not be provided by yard-waste alone. Apart from its ability to be customized, the brewed-tea method has an advantage of ease of application, as all that is needed to apply it is a sprayer of any size.

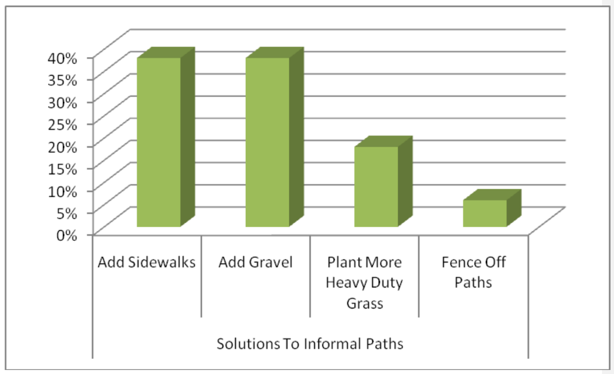
Harvard makes three types of ~~compost which they then mix~~compost that it then mixes in varying quantities to meet the needs of specific plants. The first type is bacterial compost, which is made up of things like used coffee grounds and herbaceous plants like removed weeds and hay. The second is fungal compost, consisting of dry leaves, shredded newspaper, and refuse from woody plants. The last is Nitrogen ~~compost which~~compost, which is made of grass clippings, vegetable waste, and manure. These three are mixed in varying quantities for the specific types of plants the tea will be used on. For example, a mix for woody plants would consist of 45% fungal, 30% bacterial, and 25% Nitrogen composts, while a mix for lawn may consist of 45% bacterial, 30% fungal, and 25% Nitrogen composts.

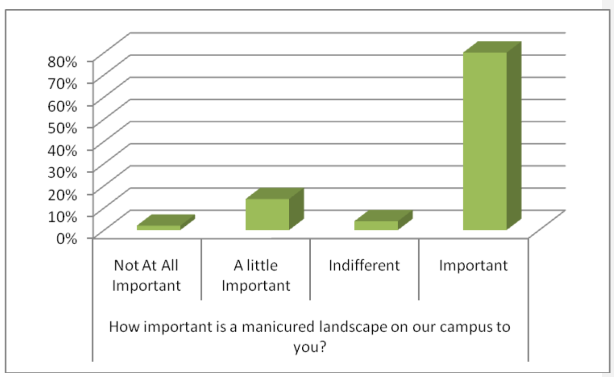
At the conclusion of the test, Harvard found 3-5" of increased root growth compared ~~with~~ to a control plot. This growth creates a significant increase in soil drainage and retention, helping to fight the problems of flooding and erosion. As of September~~,~~ 2009, Harvard had expanded ~~their~~ its program to cover 25 of ~~their~~ its 80 acres of lawn. Additionally, ~~they~~ it is estimated that doing so has saved ~~them~~ Harvard Facilities Operations approximately $45,000 a year ~~by~~ since it is no longer ~~needing~~ necessary to remove yard-waste to an off-site location or~~, as well as no longer needing to~~ purchase commercial compost ~~and~~ /fertilizer.

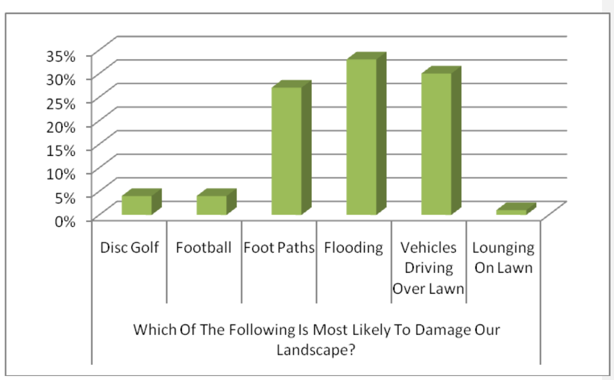
FEEDBACK RESULTS

STUDENT AND FACULTY SURVEYS:

During March the problems and solutions sub-teams lead a campaign to gather student, faculty, and facilities feedback. We built survey holders (appendix E) and placed them in high traffic areas around campus. Each survey holder contained a set of surveys with questions tailored to that locations, as well as a few generic questions. Notable results include the graphs to the right: the first highlights some solutions the public suggested for solving the foot path problem. Most people agreed that either sidewalks or gravel should be added. Graph two indicates how important an attractive landscape is to the student body. An overwhelming number of students cited beauty as important. Graph three confirms our choice of the three meta-problems of high traffic areas, flooding, and snow removal process (plows driving over plant life).







FACILITIES MEETINGS:

Facilities has been crucial for helping us find information and discussing problems associated with our landscaping. Our IPRO sat down with the facilities employees and discussed a number of problems around campus. First discussed were the issues associated with Siegel Field. Before the grade of that area was lowered, it had never had any serious flooding issues. But since then, the lower grade, insufficient drainage, and soil compacting due to athletic use has led to much of the field needing to be replaced year after year. Next discussed were some of the various options for ground covers for the shaded areas near trees. Until recently, these areas have largely been covered in mulch, but the facilities team tells us that mulch is not good for established trees. Because of that, facilities has been exploring the option of low-light plants to place in these areas.

One of the major problems our campus faces each winter is the use of rock salt, which kills grasses along sidewalks and streets. Facilities has tried several solutions for this to varying degrees of success. For rock salt laid down by the City of Chicago on the streets, facilities has begun erecting temporary plastic fences. These fences have shown immediate improvements, reducing the area affected by this salt by as much as 50% in some cases. Facilities has also tried some alternatives to their own salt use, including magnesium and calcium based salts. Magnesium salt has been found to be healthier for the grass as well as being a more effective deicer, but is unhealthy for staff to apply causing skin damage to arms and getting into lungs. It has also been shown to be worse for concrete over time than traditional salts. Traditional rock salt (sodium chloride) does not work at as low of temperatures, making it a less effective deicer. While being moderately healthier to apply, its effects on metal (including steel reinforcing in concrete) are well documented and result in it being the most damaging overall. Calcium Chloride works well, but tends to destroy blacktop paving like parking lots. Currently, facilities uses traditional rock salt on blacktops, Calcium Chloride on sidewalks, and has begun using Magnesium on sidewalks as well, though they have not transitioned completely to Mg yet.

One solution that has been proposed often is the use of permeable pavers for hard-scaping. Permeable pavers allow water to go to the ground below, which prevents large amounts of water from going to the edges of large paved areas and flooding any plants there. Permeable pavers, as we discussed with facilities, have been put into a trial use near the IIT Research Institute tower. Facilities informed us that these pavers have two major problems associated with them that need to be solved before their more wide-spread use. First is that the pavers are often unstable, and have a habit of drifting up and down, creating an uneven surface. This feeds into the second problem, when these pavers are being plowed they tend to catch the plow blade. This damages the blades and can also forcibly remove the bricks from the ground.

One last issue we discussed was the use of external contractors for our landscaping. According to facilities, approximately 15 years ago all replanting and care was handled by a full time staff of IIT employees. By eliminating or reducing our use of external contractors, we may be able to both save money and use more specialized equipment for unique problems associated with our campus. Detailed cost analysis would be required to show that this method is financially sustainable before it is implemented.

RECOMMENDATIONS

FLOODING: In an effort to remediate the flooding concerns, we contacted and sought the recommendations of Bob Oja, a practicing soil scientist for 22 years (BLAH). We showed him the flooding photographs of the fraternity quad and explained the frequency of the floods. At his suggestion, we researched rain gardens and Bioswales as two possible solutions to this recurring problem.

Rain Gardens

Rain gardens are an effective solution to the flooding problem often experienced on IIT's fields, streets, sidewalks and parking lots. A rain garden is simply a collection of flowers and plants that can withstand heavy amounts of water, but not continuous standing water, to which water is funneled towards. The plants quickly absorb the water and then slowly release the moisture into the ground. This process has a number of benefits. When the water passes through the plants and soil, up to 30% of the pollution in the water is filtered out. Runoff into s ewer systems can be fun by 75-80% and in cases of new developments, it is 75% less expensive to build and maintain a rain garden than it is to create the necessary sewer infrastructure to manage the same rain load. Additionally, they make a great habitat for birds and insects[5].

Typically a rain garden is 5-10% of the size of the impervious surface that generates runoff for it. The soil mixture is 65% sand, 15% top soil and 20% compost. This mix is used to a depth of 4-8 inches. The grade in a rain garden should never exceed more than 10%. Beyond this, an owner should consider using a bioswale. There key difference between the two is that bioswales are used to carry water towards a destination while rain gardens do not. Bioswales often contain rain gardens along its path to clean and reduce the amount of water it carries along the way.

IIT could benefit from rain gardens in any number of locations. They could be placed around the perimeter of Siegel Field to reduce the flooding, or along sidewalks to collect ~~rain water~~rainwater and add plant diversity to the campus. Many other universities have them in their parking lots or collect water from the roofs of academic buildings and dormitories and drain the rain into the gardens to reduce the load on the sewer systems.

Bioswales

The flooding of the sidewalks is one of the major effects of the flooding on this campus. Though there are many solutions to this problem, there are certain areas that require specific solutions. There are many locations on campus where the water has no where to go, caused by vehicle damage, or there is just too much water. In these areas we propose the installation of a bioswale. This is the term generally given to any vegetated swale, ditch, or depression that conveys storm water. On this campus it would be used any place that needed water taken away from it and moved to a different location. There are a few key locations that could benefit greatly from this including, but not limited to, directly below the elevated green line tracks east of State Street Village, the strip of land north of the Galvin field, and also surrounding and inside of the all of the parking lots. Below is an example showing on one side, how the swale would meet the sidewalk and on the other side, how it would meet the parking lots.

Design: The design of the bioswale is very dependant on the location of the water. For most of the areas on campus we propose a trapezoidal shaped swale. The provides the best water filtration but also the water is allowed to travel slowly with virtually zero erosion. With this trapezoid shape, the sides are to be no more that a six percent slope to the swale's basin and also maximizing the area of the basin.

Soil: During the semester we have performed many soil test around the entire campus. The results came back to determine the causes of the obvious problems around campus. In most of these test sites the ph levels were extremely basic due to the flooding damage. One balanced, with a variety of organic fertilizers or composts, the soil of the swale will maintain this level through filtration of the water.

Vegetation: The main purpose of a swale's vegetation is to filter out any chemicals that could possibly clog or deteriorate or sewer lines. Depending on the area and the types of chemicals that are in the area determines the types of plants you put in your swale. For example, you would put salt tollerant plants near the roads or sidewalks.

SNOW REMOVAL PROCESS:

~~We recommend that IIT begin to reduce the amount of rock salt used on campus by gradually introducing more eco-friendly options. These can include:~~

Salt Recommendations

As reported by facilities, IIT uses an average of 100-150 tons of rock salt on campus during each winter season. In addition to this, Calcium Chloride is also used. These salts can be a major pollutant due to runoff and can cause high sodium and chloride concentrations in ponds, lakes, and rivers. This can cause undesirable fish kills and changes to water chemistry.

Additionally, these salts have been shown to harm plants. They interfere with the osmotic balance of cells, making it impossible for cells, and ultimately entire plants, to properly regulate the absorption of water. Plants exposed to excessive salt show symptoms of dehydration. Their uptake of water and nutrients is inhibited, growth slows, and leaves and grasses turn brown, sometimes known as "salt burn." When the soil becomes salty, the germination of seeds slows or stops entirely. If salt is continuously introduced into the soil, the soil structure changes; it becomes poorly aerated and alkaline and becomes much less hospitable to many plant species. Perhaps just as important, Chloride ions destroy beneficial soil organisms such as bacteria, fungi, protozoa and nematodes that are the essential link between plant roots and macro- and micro-nutrients in the rhizosphere.

As a result of these findings, one of the major considerations of the IPRO 326 team became reducing the amount of rock salt (Sodium Chloride) and Calcium Chloride used as deicers on campus. In the winter of the 2009-2010 academic year, facilities began its own trial by initiating the use of Magnesium Chloride as a replacement for rock salt/Calcium Chloride near the entrances of buildings. As reported by facilities, this magnesium salt is very effective at melting ice, doesn't harm the lawn as much, and is also much easier on the health of the facilities workers tasked with applying the salt (facilities workers reported less irritation to skin and lungs as a result of working with the magnesium salt as compared with the rock salt and Calcium Chloride). However, the magnesium salt is not available in bulk and costs an average of $400-500 per ton (as compared with a cost of $63.42 per ton for the 110 tons of rock salt used on campus during the 2009-2010 winter season-information provided by John Sebby of facilities). Thus, magnesium chloride is hardly an economical replacement for rock salt in terms of a campus-wide deicer.

In addition to this, Facilities has also tried placing salt spray barriers along State Street to prevent damage to the lawn caused by salts applied to the road by the city (since it is likely that the city will continue to use rock salt on the roadways). As facilities has seen less damage with the employment of this practice, we recommend continuing the experiment in future winters, as well as thorough documentation of the results.

Based on this research IPRO 326 has looked into various solutions to help provide traction on pavements and de-ice sidewalks and parking areas.

http://ecotraction.com/productinfo.html
One solution to the IIT salting problem would be to look at other options to de-ice that are not salt. For example, there is one mixture called Ecotraction®. Ecotraction® is a mixture of hydrothermal volcanic minerals that imbed themselves into the snow to provide an excellent amount of traction while walking on ice. After the snow melts the mixture will release nutrients back into the plants and

grass and help to remove any noxious fumes from that air that may result from car pollution or sewer problems (Earth Innovations Inc. 2008.)

http://www.ktechcoatings.com/geomelt

Another alternative that IIT could implement to solve the salt damage crisis is to start replacing some of the salt spread with beet juice spread instead. Beet juice is an all natural solution that is not only sustainable because it reuses waste that would normally be dumped down a drain, but is also not harmful to the environment like salt is because of its natural agricultural properties. Combining beet juice and salt will help reduce the amount of salt required and help to enhance the effectiveness of the de-icing properties of the salt by up to 30% (K-tech 2009.) It will bond the salt to the ground for up to 2 days after snowfall, ultimately requiring fewer applications of de-icing, and it can operate at temperatures as low as 30 below zero (K-tech 2009.) Furthermore, beet juice does not require any special mixture solutions or equipment to use. These elements work together to help form a sustainable solution that will help lower maintenance applications.

Overall, in keeping with our view that solving underlying causes prevents the continual occurrence of problems such as the death of grass along sidewalks due to salting, IPRO 326 recommends that facilities move to procedure of proactive application of salts prior to a winter storm. This way, the salt can begin to do its job immediately when the storm begins, and the task of snow cleanup and removal will be easier and less invasive.

Development of a de-icing vs. anti-icing program on campus.

Taken from the website facilitiesnet.com, this program is summarized as follows: "Historically, departments have removed snow and ice with overuse of chemicals as a complement to the use of shovels, plows, and related equipment. In recent years, granular materials have become a popular and effective method for maintaining safe conditions during and after a storm. Understanding the difference between anti-icing and deicing can give managers insights into the different approaches that can help them deal with ice efficiently. Deicing is the reactive application of ice-control products to melt existing snow and ice on driving or walking surfaces. Deicing after snow removal operations can melt any remaining snow and ice. Anti-icing refers to the proactive application of ice- and snow-melting products to driving or walking surfaces before a storm. This tactic helps prevent snow and ice from bonding to the pavement, and workers can clear them away more easily. Used effectively, anti-icing can create some of the safest conditions in the winter and can be a cost-effective alternative to deicing."

Implement greener alternatives to salt.

New products are currently out on the market, and have been shown to safely and effectively treat icy conditions. A few of these are:

- **ecoTRACTION®. (from ecotraction.com)**

  - Just one cup of ecoTRACTION® can cover one whole parking space (144 square feet)
  - Safe to touch or accidentally ingest by children, pets and wildlife
  - Will not burn or damage grass or plants
  - Will not corrode or damage brick, stone or uncured concrete
  - Will not rust vehicles or metal landscaping elements
  - Will not stain clothing or carpets
  - Does not contain any carcinogenic silica dust like sand
  - Contains no salt, chlorides, chemicals, or dyes

Naturally Benefits Our Environment

- Aerates soil through its porous 'honeycomb' structure
- Releases nutrients and minerals back to plants slowly

• Retains water in the soil medium longer reducing watering requirements
• Reduces lawn damage from dog urine as it neutralizes the ammonia before it burns the grass
• Absorbs and removes heavy metals from lakes, rivers and sewage
• Filters the air from noxious fumes and absorbs nuisance odors
• Even absorbs the residual white sodium staining caused by salt and ice smelters

• Simply sweep ecoTRACTION® onto your lawn and garden in the spring, or collect for re-use the following winter

Guidelines for use:

- Dry, Powdery Snow

Start by removing the snow and if walking conditions are still slippery, spread a thin layer of ecoTRACTION® so that the walking area is visibly covered.

- Sleet, Freezing Rain

As soon as ice begins to build up, apply ecoTRACTION® to ensure safe walking conditions. Its absorbent quality will provide incredible traction instantly.

Repeated applications might be necessary as EcoTraction gets covered by additional ice layers. However, ecoTRACTION® does have the ability to stay on top of ice even after some melting.

- Wet, Heavy Snow

Remove snow with a shovel and then lightly apply ecoTRACTION®. When more than two inches accumulate, shovel excess snow and reapply if necessary.

Note that much of the ecoTRACTION® should remain embedded into the bottom ice layer and stay there in spite of shoveling.

- Accumulations of Hardened Snow and Ice

ecoTRACTION® is the perfect product for areas where snow and ice have been left naturally, packed down, and there is no intention to remove it.

Simply sprinkle ecoTRACTION® directly on top of the hard-packed snow and reapply lightly if necessary after subsequent snow and ice storms.

As slippery conditions are created in the spring from melting during the day to freezing at night, ecoTRACTION® will provide constant traction as each layer of snow that melts exposes the previous application.

0.**Beet Juice-derived anti-icing and de-icing products such as GEOMELT®**

[from http://www.ktechcoatings.com/geomelt]

GEOMELT®, the patented sugar beet by-product, is combined with salt or any liquid brines to create a more effective natural anti-icing or de-icing option. GEOMELT products are all-natural agricultural liquid products, made from a waste product that used to be dumped down the drain. GEOMELT works by lowering the freezing temperature of any standard de-icing product. It enhances the attributes of any natural de-icing product, including rock salt, salt/sand mixtures, or any of the standard brine mixtures, and is an excellent salt pile treatment.

BENEFITS OF ADDING GEOMELT to any anti-icing or deicing program include:

MINIMIZES YOUR WINTER MAINTENANCE BUDGET:

0.The application rate for any anti-icing or deicing product decreases approximately 25%-30%with

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GEOMELT added to that product.

0.When GEOMELT is blended with rock salt, the bounce scatter of the salt is reduced. More salt stays on the surface that you actually want to de-ice.

0.Your anti-icing or deicing product will last longer when combined with GEOMELT.

0.GEOMELT products bond more effectively to the surfaces, keeping walkways and pavements clear.

0.Fewer applications + more effectiveness + anti-bonding reduces all winter operations costs.

GEOMELT products work faster and in a greater range of temperatures.

0.GEOMELT products do not need sunlight to activate.

0.GEOMELT products melts ice in lower temperatures – up to 30° below zero.

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GEOMELT products reduce damage associated with anti and de-icing products.

0.The anti-corrosive nature of GEOMELT also increases equipment life.

0.GEOMELT reduces the tracking problems inherent with other products. With GEOMELT, there is less tracking into buildings . . . a clear benefit for carpets, rugs and floors.

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GEOMELT is ecologically friendly.

0.GEOMELT is a natural, agriculturally safe product. It is a carbohydrate that is a derivative of the sugar beet.

0.GEOMELT, being a natural agricultural product, poses minimal harm to grass, trees and shrubs.

0.GEOMELT is water soluble.

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GEOMELT is versatile and stable.

0.GEOMELT will not ferment. It will not spoil and it will add stability to your salt and other deicing products.

0.GEOMELT is stable. Rock salt treated with GEOMELT will retain the benefits provided by GEOMELT – GEOMELT will not bleed off.

0.GEOMELT acts as an anti-caking agent on your rock salt stockpiles and helps solve storage problems.

0.GEOMELT does not require advanced mixing operations or special equipment.

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0.**Continue implementation of silt barriers along major campus streets (i.e. State Street) to lessen the amount of damage done by salt spray.**

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0.**If chemicals for deicing are necessary, consider these alternatives. They are listed with advantages and disadvantages and their relative cost compared to rock salt.**

[from Mother Earth News. Issue #201, December/January 2004]

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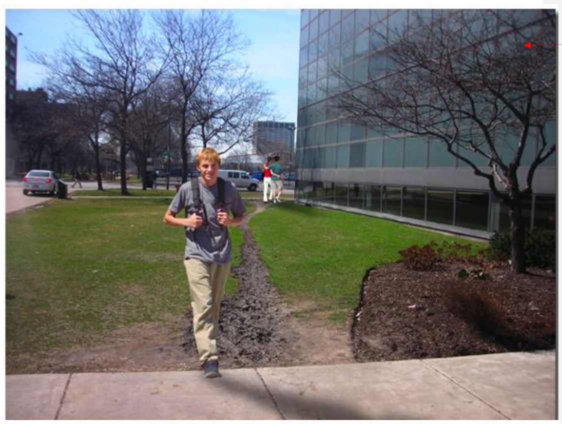
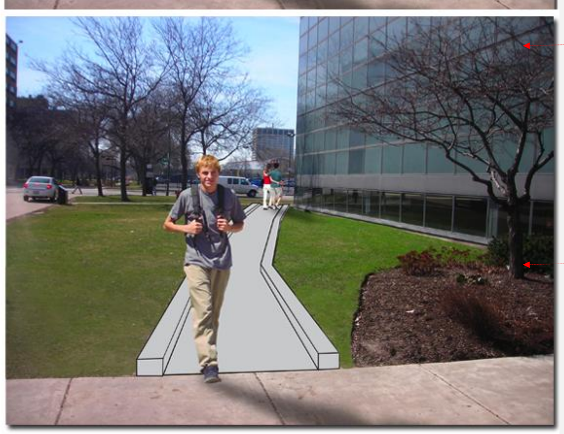




FIGURES 10-11: FORMALIZE DIRT FOOT PATHS TO AESETHIC AND PRACTICAL APPEAL

~~Sidewalk plow-guiding pavers - Skinner~~

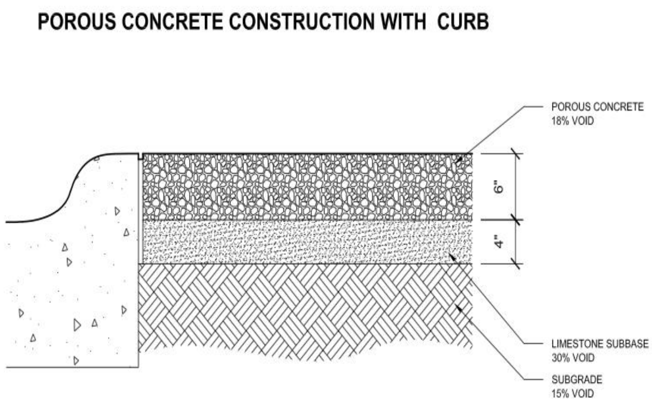
HIGH TRAFFIC AREAS:

Our recommendation to the foot path problem is to place pavement wherever these strong desire lines occur, which IIT has already done in the past. IIT has connected the HUB to E1 and MSV to MTCC Commons. IPRO 326, and many campus users, believes that IIT should continue with placing pavement on those desire lines for not only the aesthetic appeal, but also for the campus users' comfort. Not only to students and faculty want this, but the original 1999 campus maser plan calls for this (appendix B).

One major issue with the campus landscape occurs during winter. When the sidewalks are covered in snow, finding out where to plow them can be an issue. Often the plow will run off the side of the sidewalk and scrap and tear up the sides of the landscape. By adding elements to the sidewalk, this problem can easily be remedied. One way is to add a low riding fence along the walk so that it will help guide the snow plows. Another would be to add a curb to the walks. Also a simple gravel bed would suffice to help cushion the plow from the grass.

PERMEABLE PAVEMENT CROSS-SECTIONS

Permeable pavements reduce or eliminate storm water problems at the source by changing the way urban structures are built and the way they operate[6]. They restore the landscape's natural water retaining function by bringing water back into contact with the underling soil or by filtration through pavement surface. By combining pavement storm water control functions, it may be possible to reduce costs and deter some of the flooding. One possible option, porous concrete, is Portland concrete made with single sized aggregate. The durability of porous concrete in cold climates can be enhanced by polymer fiber reinforcement.

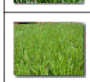


HARDY PLANTS DATABASE:

We found a twenty seven page list of plants that the Chicago Department of Transportation has tested over several years and confirmed to be effective in areas with high salt and moisture content, particularly for use along curbs and sidewalks. Many of these plants are perennials and native Illinois

TABLE 3: EXAMPLE OF PLANT DATABASE ENTRY (APPENDIX A)

GROUNDCOVER

	BOTANICAL NAME	COMMON NAME	CDOT RATING	H x W	BLOOM TIME	COLOR	SOIL MOISTURE	CONCERNS	PH RANGE	LIGHT REQUIRE-MENT	SALT TOLERANCE
	Poa Pratensis	Kentucky Blue Grass	Good Survival Rate	H: 3-4 in.	Spring & Early Summer	Dark Green	Moderate	Low to Moderate Wear Resistance	6 - 7	Full	Moderate
	Lolium perenne L.	Perennial Ryegrass	Good Survival Rate	H: 2-6 in.	Spring & Early Summer	Dark Green	Low to High	Low Reproduction Rate	5.5 - 7.5	Partial	Moderate

plants. We converted that list into an Excel spreadsheet and added some of our own criteria we think is important for the IIT landscape, including pH range and salt tolerance. Added to the list are some of the plants employed in the Millennium park prairie garden that have also demonstrated stamina in urban conditions. We recommend future plantings to be chosen from this list, particularly along curbs and other salt-prone, flood-prone areas.

SECTION 5: PERMANENT IMPLICATIONS/FUTURE SUGGESTIONS

To aid the university in their landscaping projects, Ipro 326 has created a manual for the facilities workers to solve landscaping issues. Our Ipro has collected data from soil samples taken around campus to determine which plants best respond to the different types of soil conditions found around our campus. These findings will be presented with a table that will also include lighting requirements for different plant species. Additionally, many of the plants are well suited for areas that receive a heavy amount of water so they can live successfully in areas of the campus where drainage is an issue. By presenting this research in an easy to understand manual, facilities workers will be able to quickly and accurately determine which types of plants can be successfully grown in different types of areas.

In addition to this manual, member of Ipro 326 have created a number of test plots around campus to demonstrate the various solutions we feel are appropriate to this campus. These small test plots serve as prototypes of systems that can be implemented at a larger scale around campus to solve IIT's landscaping problems. Each of them encourages the use of native plants that respond well to the specific conditions of the site. By using a variety of plants we help encourage a more diverse ecosystem around campus, save the university money by being self sustaining, reduce the amount of storm water that ruins into Chicago's strained sewer system, and reduce the redundant and plain feel of IIT's landscaping around campus. These test plots can also be used to gather feedback from students and staff as to which systems they would like IIT to focus on as landscaping improvements continue in the future.

South of Galvin Library is an open field where a greenhouse is proposed. In addition to plant studies that can be performed here, IIT use this space to grow flowers during the winter to be planted in the spring. Using flowers grown on campus is one more investment that IPRO 326 is looking to save IIT money.

In addition to the mentioned solutions and strategies to be implemented immediately, other long term strategies that are time consuming and/or expensive are suggested to be pursued in the future. Ipro 326 suggests the reduction of the amount of salt used on campus by (a) possibly introducing beet juice as a replacement, (b) installation of radiant heating to illuminate the need for salt and vehicular snow plowing, and (c) reconsider the type of salt used according to the needs of different soils as found in the plot tests.

While pursuing certain documents and information, it seemed that there is a need to keep track of test results and maps that were conducted over the years. Previous soil tests conducted for the 1999 master plan would have been useful and time saving, if there was a record organization system that gathered information for easier future accessibility. Combined with information provided by Ipro 326's gathered information and results, an organized record keeping system would be very beneficial to future and long term efforts of implementation.

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