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Location Analysis for Outdoor Recycling Bin Placement

Prepared for:



The rising STAR of Texas

Prepared by: Dynamic Geo Solutions
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Introduction

Summary

According to the EPA, 26 percent of the municipal solid waste (MSW) generated in 2011 in the United States was recovered through recycling. The amount of MSW generated that is disposed of in landfills has decreased from 89 percent in 1980 to less than 54 percent in 2011 (EPA 2011). Recycling not only reduces greenhouse gas emissions and other pollutants, but also preserves natural resources, reduces the need for landfills, and produces economic benefit.

Texas State University in San Marcos enrolled over 35,000 students in 2013 and is still growing (Blaschke 2013). As an Emerging Research University it seeks to be cutting edge, not only in academics and research, but in infrastructure sustainability as well. A key part of this goal is an efficient, university-wide recycling program. Texas State currently has 44 outdoor recycling bins placed across campus, and 8 more bought with revenue from the university recycling program that have yet to be placed. The university utilizes single stream recycling, where all empty metal, glass, and plastic containers can be placed in a single receptacle. In cooperation with Texas State University and Recycling and Waste Management Supervisor Mario Garza, Dynamic Geo Solutions will determine the optimal positions for both the unplaced and existing recycling bins to maximize the amount of appropriate goods captured and recycled.

Purpose

This study will analyze the flow of foot traffic on campus to determine the most used paths, and with that information determine the optimal locations for outdoor recycling bins. The study will also take into consideration areas of high need, such as food court areas that produce a large amount of recyclable material, and currently underserved areas. Both university enrollment data and data collected in the field will be used to make recommendations for the placement of bins. In

addition, we will update the digital file containing the locations of the outdoor recycling bins to show the locations of the newly placed bins, and create a map showing the intensity of pedestrian traffic across the central campus area. We will create this map in such a manner that it will be easy to update with new enrollment figures.

Scope

This study will cover the central campus area of Texas State University. According to the specifications of Recycling and Waste Management Supervisor Mario Garza this will comprise the area east of Academy and west of University, and north of University and Lindsey and south of Sessom (Fig. 1). All processes and deliverables will be executed during the spring 2014 semester, February 2014 – May 2014, with the final recommendations being submitted no later than 2 May 2014.

Literature Review

After reviewing the existing literature, Dynamic Geo Solutions has been able to build upon recognized patterns to determine proper placement of recycling bins around the campus of Texas State University. Numerous studies relating to the recycling of reusable materials have been conducted both domestically and internationally. These studies are useful in developing methods to acquire maximum recyclable waste given available resources. One of the greatest factors in successful recyclable waste collection is the accessibility to corresponding receptacles. In this scenario, accessibility is characterized by both *location of* and *distance to* receptacles.

A study published in *Waste Management* by P. González and B. Adenso reviewed pedestrian travel tendencies concerning the disposal of waste. In this study, González and Adenso review survey findings that indicate that distance and ease of accessibility are the most important determinants in recycling behavior (Adenso-Días and González-Torre 2005).

Similarly, a guide provided by the Australian Department of Environment and Conservation provides basic suggestions for recycling bin placement. They suggest that bins should be placed in areas of high foot traffic, and near areas where people are likely to dispose of materials. Recycling bins should also always be placed next to a refuse bin in order to avoid contamination. Most importantly, they reference research that indicates individuals will walk up to 12 meters (approximately 40 feet) to dispose of refuse in a public place (Department of Environment and Conservation 2005).

In addition, in order to understand general population movement and modeling, we referenced a 2009 article by M. Batty of University College London, UK. Batty explained that urban models can be used to understand the distribution of an activity according to gravitational hypotheses. In other words, consider what factors cause the highest frequency of traffic flow (i.e. most populous building during specific time frames) and then determine their respective weight. In this simplified model, Texas State University

can be considered a small city. Additionally, it suggests that aggregation of individual students' route choices into simplified foot traffic paths is appropriate considering the scale and scope of the project (Batty 2009).

Proposal

Data

Data	Source
Campus Base Map – sidewalks, buildings, current outdoor recycling bins	Bob Stafford, Facilities Planning, Design, and Construction Department, Texas State University
Foot Traffic Network	To be created by Dynamic Geo Solutions Geography Department W Drive
Campus Building Populations	
Outdoor Recycle Containers Hardcopy Map – locations of new bins	Mario Garza, Recycling and Waste Management Department, Texas State University
GPS Data for New Outdoor Recycling Bins	To be created by Dynamic Geo Solutions

Software

ArcMap
Network Analyst Extension

Methodology

The goal of this study is to locate optimal sites for the placement of outdoor recycling bins. The proper placement of recycling bins relative to foot traffic is essential to maximizing the collection of recyclable material around campus. In order to accomplish this we will use GIS techniques and tools to identify high traffic areas that are in need of recycling bins.

First, we will use existing campus maps to create a network of walking routes in a GIS. We will then use GPS to plot the locations of the recently placed recycling bins that are missing from the data set. This will allow us to have a full understanding of the current coverage provided by the existing bins. Next, we will calculate the change of population for each building according to the distribution of student population across six different time segments, 7-10, 10-1, 1-3, 3-6, and 6-9. We will plot these buildings as points of origin and destination for students throughout the day and using network analyst tools, identify which routes are most commonly used by students. Once we have our most commonly used routes highlighted, we will assign weights based on how frequently the routes are used. This will allow us to see which routes have higher foot traffic and we can then relate those results to the location of current recycling bins.

Lastly, we will use basic GIS tools to identify areas that have high foot traffic but lack enough, or any, recycling bins. Once our areas of interest are identified, we will verify our results by going into the field and observing these areas to make sure they are indeed areas of high traffic. Based on this combination of GIS and field methods we will make recommendations to Texas State Recycling and Waste Management for the optimal placement of outdoor recycling bins, thereby allowing them to increase the collection of recyclable material.

Implications

The final results of our analysis will aid Texas State Recycling and Waste Management by identifying potential locations for outdoor recycling bins in order to maximize the collection of recyclable materials. Included in the process will be a statistical analysis to determine percentages of students gained and lost from each building in order to identify which paths have the highest flow of traffic. The resulting map of campus foot traffic will be useful not just for the scope of this project, but for the placement of other bins into the future.

Budget

Data Collection		
Manager:	(5 hours/week * 4 weeks)	20 hrs.
Assistant Manager:	(7 hours/week * 4 weeks)	28 hrs.
GIS Analysts:	(10 hours/week * 4 weeks) * 2 consultants)	80 hrs.
Total Hours		128 hrs.
Hourly Pay		\$24.50
Subtotal		\$3,136.00
Pre-Processing Data and Manipulation		
Manager:	(5 hours/week * 4 weeks)	20 hrs.
Assistant Manager:	(7 hours/week * 4 weeks)	28 hrs.
GIS Analysts:	(10 hours/week * 4 weeks) * 2 consultants)	80 hrs.
Total Hours		128 hrs.
Hourly Pay		\$24.50
Subtotal		\$3,136.00
Data Analysis and Interpretation		
Manager:	(5 hours/week * 6 weeks)	30 hrs.
Assistant Manager:	(7 hours/week * 6 weeks)	42 hrs.
GIS Analysts:	(10 hours/week * 6 weeks) * 2 consultants)	120 hrs.
Total Hours		172 hrs.
Hourly Pay		\$24.50
Subtotal		\$4,214.00
System Management		
Manager:	(4 hours/week * 14 weeks)	56 hrs.
Assistant Manager:	(3 hours/week * 14 weeks)	42 hrs.
Total Hours		98 hrs.
Hourly Pay		\$28.25
Subtotal		\$2,768.50
Website Development		
Webmaster:	(8 hours/week * 3 weeks)	24 hrs.
Hourly Pay		\$25.00
Subtotal		\$600
Software Licensing		
		8 weeks
		\$1500
Total Cost of Project		\$15,354.50

Timetable

January 2014						
S	M	T	W	Th	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

February 2014						
S	M	T	W	Th	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	

March 2014						
S	M	T	W	Th	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

April 2014						
S	M	T	W	Th	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

May 2014						
S	M	T	W	Th	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

Data Collection	Weeks 1-4
Pre-Processing of Data	Weeks 5-8
Data Analysis	Weeks 9-12
Data Interpretation	Weeks 13-14
Dates of Importance:	
February 12 th – Proposal Presentation	
March 24 th – Progress Report Presentation	
May 2 nd – Final Presentation	

Final Deliverables

- Final Report
- Professional Poster
 - Map of foot traffic and recycling bins
 - Map of potential areas for future bins
- Website
- CD containing:
 - Metadata
 - Final Report
 - Poster
 - PowerPoint Presentation
- Map of high foot traffic routes
- Map of most suitable locations for future bins

The final deliverables will include a map highlighting routes that have high foot traffic as well as a map that details which areas on campus are in most need of recycling bins.

There will also be a map included that displays the recommend placement of future recycling bins that Texas State Recycling and Waste Management can utilize for the next university master plan.

Conclusion

With the increase in student enrollment at Texas State University, there has been a corresponding growth in the production of recyclable waste on campus. By using a combination of statistics, network analysis, and field research, DynamicGeo Solutions will provide Texas State Recycling and Waste Management with the tools they need to not only maximize their collection efficiency, but to also create and maintain a green and sustainable infrastructure on campus.

Participation

Analyst	Position	Duties
Cameron King	GIS Analyst	Methodology, Processing
Enrique Delgado	GIS Analyst	Literature Review, Processing
Elizabeth Wesley	Project Manager, GIS Analyst	Introduction, Graphic Design, Processing, Editing
Jennifer Lopez	Assistant Project Manager, GIS Analyst	Timeline, Budget, Processing, Editing

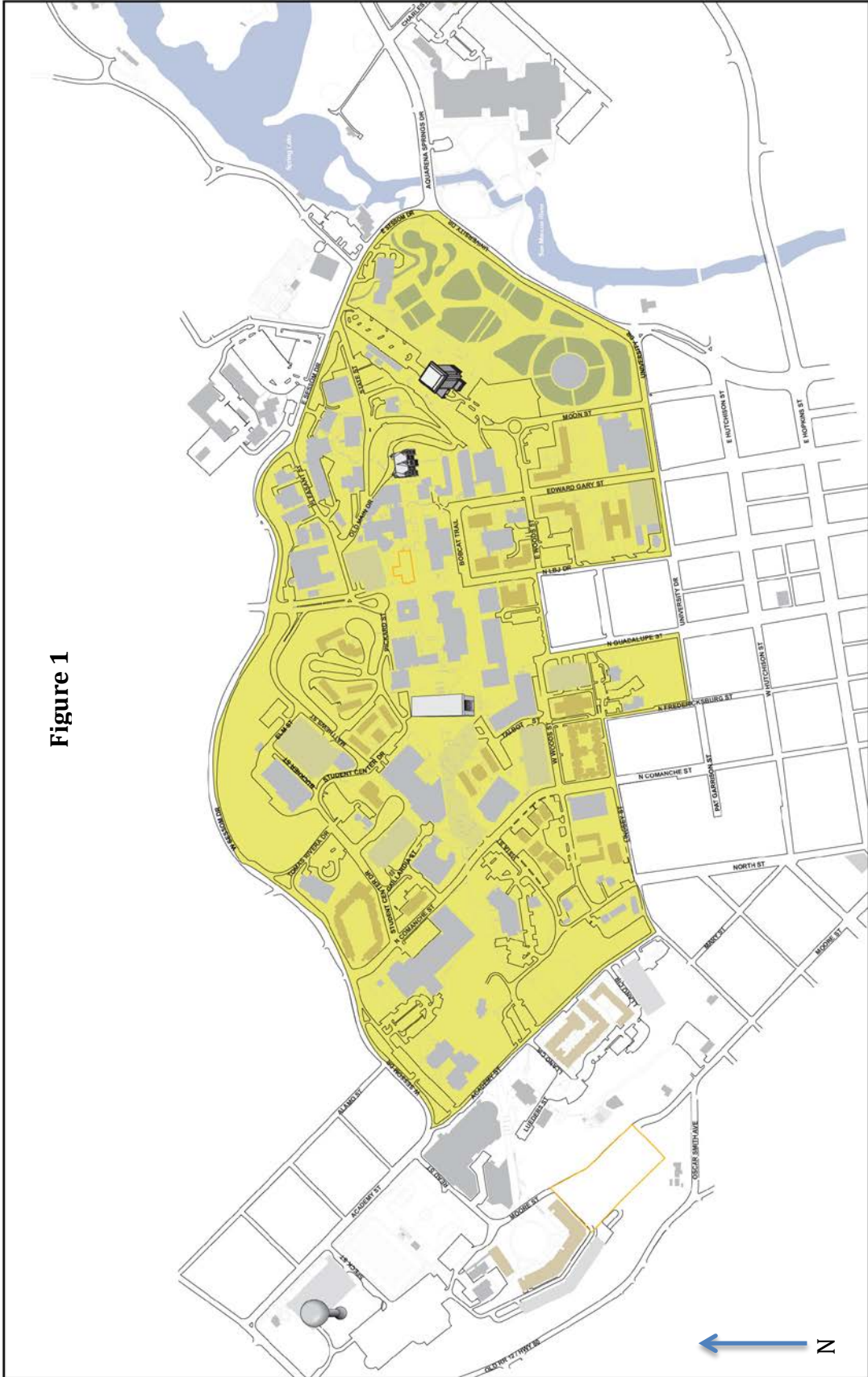


Figure 1

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