

# **Measuring Impact: Evaluating the Economic, Social, and Ecological Services of the City of Ann Arbor Greenbelt Program**

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## **Executive Summary**

### Purpose of Study

This report details the findings of a Master's project group for the University of Michigan's School for Environment and Sustainability (SEAS). The project evaluated the Ann Arbor Greenbelt Program, a land preservation program that aims to protect farmland and open space around the city. The Greenbelt Program was created by the Open Space and Parkland Preservation Millage, which passed in 2003. As the Program approaches its 15th year, the Greenbelt Advisory Commission (GAC) requested an assessment of the ecological, social, and economic outcomes of the Program to date. This project focused solely on the portion of the millage funding that is used for the purchasing of development rights to properties outside the City of Ann Arbor limits.

### Ecological Impacts

Through this section of the project, we produced the first Program-wide, quantitative inventory of land use for Greenbelt properties, and then used these classifications to complete a comparative runoff analysis. The manual land use classification using aerial photography was completed for all land within the Greenbelt Program as of June, 2017. Lands were classified into 11 different land use / land cover classifications, which were then summarized into five higher level classifications. In the resulting summary, 66% of Greenbelt land is in agricultural use, while 24% of land is forested. This inventory will inform GAC's future property recommendations, by allowing the committee to target specific balances of agricultural land and natural spaces, according to Program objectives.

The land use classification was used to complete a comparative runoff analysis. A baseline scenario, representing current land use, was compared against two hypothetical alternative scenarios. The first scenario represented hypothetical conversion of forest and grassland within the greenbelt to agricultural use, while the second represented complete development of Greenbelt properties into residential and commercial uses. The Long Term Hydrologic Impact Analysis (L-THIA) runoff model was then used to compare the potential effects of these three land use scenarios on runoff and nonpoint source pollution. Compared with these alternative scenarios, the current land uses, which have been preserved in perpetuity through Greenbelt Program's purchase of development rights, provide significant benefits. Both alternative scenarios predict increases in volume of runoff into the Huron River. Each alternative scenario also predicts increases in pollutants posing risks to water quality and human health, including common fertilizing nutrients and heavy metals.

### Social Impacts

This portion of the project focused on the social impacts that the Program has had on the local farming community and seeks to answer the following questions: How has the Greenbelt Program affected the local farming community in the Greenbelt District? How do Ann Arbor residents value and perceive the Greenbelt Program? To answer this question, data were collected through in-person interviews with landowners participating in the Greenbelt Program and survey responses from Ann Arbor property owners. Using a qualitative approach, these data were reduced into three major themes and then analyzed to understand the social impact of the Greenbelt Program: (1) promoting resilience for the local food system and agriculture businesses, (2) preserving a farming legacy and highly desirable rural characteristics of the townships surrounding Ann Arbor, and (3)

bolstering regional agricultural economics. We use a case study of the Drake Family Dairy, located in Lodi Township, to display these themes.

### Economic Impacts

The final component of the project was directed at an economic benefits-costs evaluation of the program. Several approaches were considered to measure the benefits and costs of the Greenbelt Program. The approach of using a Contingent Valuation study to estimate the non-use, or existence, value of the Greenbelt was ultimately selected as the best approach. A survey with a Contingent Valuation question and questions regarding attitudes towards the Greenbelt was administered to 1,300 Ann Arbor households. There were 441 responses to the survey, a response rate of approximately 34%. An estimated median willingness to pay (WTP) per year for the Greenbelt Program's continued existence was found to be \$127.19 per household. This amount was generated using a parametric analysis on a double-bounded dichotomous choice Contingent Valuation question. Aggregating this amount and comparing it with the real costs of the Program (paid through property taxes), it was found that the WTP for the Program was greater than the Program's costs. This conclusion continued to hold through several sensitivity analyses of the statistical model and approaches.

### Conclusions

This project provided new insight into the ecological, social, and economic contributions of the Ann Arbor Greenbelt Program. We have demonstrated that the Greenbelt Program provides substantial benefits to both residents in Ann Arbor as well as residents in the neighboring townships. As the millage reaches its halfway point, the results from these studies can be used to guide future research and public outreach, strengthen regional funding partnerships, and bolster Program development.

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# **Chapter 1:**

## **The Background to the Greenbelt Master's Project**

### **Problem Statement**

During the 1990s and early 2000s, the communities surrounding Ann Arbor experienced substantial residential development pressure. Urban sprawl was resulting in a permanent loss of critical natural resources including rural landscapes for community residents (Open Space and Parkland Preservation Millage, 2004). Ann Arbor residents recognized the value of these remaining agricultural and open spaces around the city as an essential part of both the quality of life and character of the area. They also saw the need to protect the productive agricultural land that was facing strong development pressure from surrounding communities. As such, the Ann Arbor-based Ecology Center led a campaign to put a greenbelt millage on the ballot (Stanton, 2010). In 2003, the City of Ann Arbor voted to pass the Open Space and Parkland Preservation Ordinance, a 30 year one half mil tax. One third of these funds is designated to be used for parkland acquisition within the city limits and two thirds of the funds would be used to purchase the development rights to open space, natural land, and agricultural property outside the city's limits.

In May 2004, the Open Space and Parkland Preservation millage established the Ann Arbor Greenbelt Program. The purpose of the Ann Arbor Greenbelt program is to preserve and protect open space including agricultural land, natural habitats, and the City's source waters within the Greenbelt District. The Greenbelt District encompasses all the land outside the city limits to about a six-miles from the city center and includes adjoining townships. The 30-year Greenbelt millage is approaching its midpoint and the commission that oversees the implementation of the Greenbelt Program requested a SEAS Master project to evaluate the impacts and outcomes that the Program has had by using various economic, ecological, and social indicators.

### **Project Objectives and Project Scope**

The primary goal of this project was to determine the effects that the Ann Arbor Greenbelt millage has had on local ecosystems, the local economy, and the citizens of the community. Using runoff modeling, landowner interviews, and an economic valuation survey, we estimated three types of benefits of the Greenbelt Program to Program participants and to the Ann Arbor tax payers.

This project focused solely on the impacts of the two thirds of the Open Space and Parkland Preservation Millage that purchases the development rights to open space, natural landscapes, and agricultural land outside the city limits, not the on third designated for purchase of parkland within the city limits. The scope of this was also limited to properties where the City holds the primary

easement terms. More specifically, this means that GAC led in the acquisition and purchase of the property's development rights as well as holds and enforces the terms of the conservation easement.

## **Importance of Land Conservation**

Land conservation has become an increasingly important issue as expansion of humans beyond urban boundaries has resulted in conversion of natural land into agricultural and urban land use. Populations have grown and humans have placed more strain on our natural resources (Freilich, 1999; Wallace et al., 2008). To ensure our remaining natural resources are protected and preserved, federal, state and local governments, along with non-profits and other citizen groups have turned to land conservation programs. Two main categories of land conservation programs exist: (1) conservation programs designed to protect parks, recreation areas and other green and open spaces in already developed or urban areas and (2) conservation programs aimed at keeping agricultural land, wildlife habitat, or open spaces from being developed (Lapping & Daniels, 2016). This project specifically looked at the second type of land conservation in which rural open space, natural space, or agricultural land is protected from development through conservation easements and the purchase of development rights.

## **Mechanisms for the Preservation of Agricultural Land and Open Space**

There have been an entire suite of methods the government and other agencies have used to preserve and conserve natural or agricultural land including land donations, land trades, estate planning, conservation programs and conservation easements. Many of these approaches take advantage of the growing interest of private landowners to take part in land preservation and provide opportunities for landowners and municipalities to protect high quality agricultural land and natural landscapes in exchange for monetary or in kind benefits.

### Agricultural Conservation Programs

Many federal agencies have conservation programs in place to protect natural resources and wildlife (e.g. United States Fish and Wildlife Service and United States Forest Service). One of the major set of programs that protects agricultural land and natural landscapes is run by the Natural Resources Conservation Service (NRCS) and the Farm Service Agency (FSA), through the US Department of Agriculture (USDA). This agency group administers about twenty land conservation programs either directly through landowners or by working with municipal entities. These programs are available to all landowners, but most of the programs are aimed almost exclusively at agricultural land use.

As part of these land conservation programs, the USDA will offer technical assistance and monetary incentives in return for participating in these voluntary programs (Merenlender et al., 2004). For example, the Conservation Reserve Program (CRP) provides funding to farmers if they remove environmentally valuable land from their agricultural production. In this Program, the USDA gives priority to lands that reduce soil erosion or agricultural runoff (Charles, 2005). The USDA also implements the Grassland Reserve Program, which encourages farmers to keep their land in grazing or pasture instead of converting it to agricultural use (Stubbs, 2010).

### Conservation Easements and Purchase of Development Rights

Conservation easements are another mechanism used to preserve agricultural land and natural landscapes. A conservation easement is a legally binding restriction on the future development and/or division of a piece of property where a private landowner sells or donates the development rights to their property to a second party (usually a land trust or the government) (Brabec & Smith, 2002). The value of the development rights is the difference between the value of the land based on its development potential and the value of the land after easement. If the landowner chooses to sell (in contrast to donating) their rights, they will usually receive fair market value for the price of the development rights to the property. If they donate the land, the property owner may be able to receive tax benefits through a charitable donation based upon the fair market value of the easement.

Both processes result in a deed restriction (through a conservation easement) placed on the property. The deed restrictions on their property preventing development are permanent, meaning all current and future landowners are held to the restrictions laid out in the conservation easement (Bick & Haney, 2001). While the easement terms must place a heavy emphasis on conserving the land, the exact terms of the easement are usually flexible to meet the individual needs of the landowner and easement holder. For example, the conservation easement may allow the landowner to build an additional structure in a designated area of the easement or the land may continue to be used as source of income through farming or ranching (Wright, 1994; Wright & Skaggs, 2004).

One example of a conservation easement program is the Agricultural Conservation Easement Program (ACEP). The USDA administers the ACEP through the NRCS. In the ACEP, the NRCS partners with local governments or land trust organizations to fund the purchase of the development rights to a property. The landowner receives the fair market value for the development rights to the land. Technical assistance is also often provided to the landowner from the USDA or other land conservation entities as an added benefit of participating in the Program (US Department of Agriculture, 2014).

The approach of purchasing development rights in conjunction with conservation easements is also used by the Ann Arbor Greenbelt Program. By purchasing the development rights to land outside the city limits, the Greenbelt Program is able to protect some land around the city of Ann Arbor from further development pressure. Once a landowner is selected for inclusion in the Greenbelt Program, the Ann Arbor City Council purchases the development rights to the property and a conservation easement is placed in perpetuity on the property. The landowner can then use the cash from the sale of the development rights for reducing debt, retirement, improving or expanding farm operations, or buying/renting additional farmland.

### **Benefits of Land Preservation**

There are many positive impacts from the implementation of land conservation programs. This project sought to quantify and analyze the many benefits provided by the preservation of open space, natural landscapes, and agricultural land. More specifically, we evaluated the ecological, social, and economic benefits gained from the existence of the Ann Arbor Greenbelt Program.

### Ecological

Land conservation programs seek to address many of the ecological problems posed by urban sprawl and changing land use. Both open space and agricultural land provide ecological benefits, though there are differences in these benefits given the two different styles of land use. One of the many ecological benefits of maintaining a completely natural landscape through green or open space is improved water quality. Preserving open space and creating parks and greenways helps to buffer nearby waterways from harmful chemicals and serve as an area for groundwater recharge. Numerous studies have shown the ability of natural land and riparian buffers to greatly reduce the concentration of nitrogen, phosphorus, and other chemical compounds that leak into our waterways (Vought et al., 1995). Open space can also provide critical habitat for wildlife and improve overall biodiversity (Freemark, Boutin, & Keddy, 2002).

Keeping the land as agriculture instead of allowing development also has benefits. Development and urban sprawl usually leads to an increased amount of impervious surface. With increased impervious surfaces, the risk of flooding and pollutant loading into waterways also increases. The removal of natural land cover caused by development can also expose soil and result in soil loss. Through many agricultural practices, soil is retained in the buffer and not blown or washed into adjoining waterways (Nordstrom & Hotta, 2004).

The Ann Arbor Greenbelt has the potential to minimize the impacts of urban sprawl on the environment. By limiting urban sprawl and directing development toward the urban core, more natural areas and agricultural land will remain intact. When agricultural and natural landscapes are protected, communities reap the many benefits mentioned above. In the context of the Ann Arbor Greenbelt, we would expect the city's source waters to be of higher quality when adjacent to natural land versus urban and suburban development. We might also see lessened runoff in these areas by minimizing the amount of impervious surface beyond the urban core.

### Social

The benefits of land conservation often extend beyond the ecological realm. On the social side, open space has long been shown to improve physical and psychological health. People with access to parks and open space tend to exercise more. Increased exercise leads to an improvement in overall health and also reduces the risk of many fatal diseases (e.g., hypertension, cancer, diabetes) (De Vries et al., 2003). Green spaces, especially in urban areas, have also been shown to provide substantial community benefits. Particularly in low income areas, green spaces often serve as community gathering areas and spaces for youth recreation (Trust for Public Land, 2003).

The social impacts in the context of the Ann Arbor Greenbelt Program were less obvious and more difficult to define. Given the nature of the Ann Arbor Greenbelt and its emphasis on protecting open space and agricultural land, we first looked to quantify the benefits farm operators and other landowners receive from participating in the Program. From previous literature, we might expect this group to feel an increased sense of community by participating in a city wide program. Whereas rural landowners might feel disconnected from their urban neighbors, the Greenbelt would help to make connections between the two communities. This common goal might provide a social benefit of building community -- urban folks want to keep the development contained to maintain the character of the city and rural landowners want to keep the development contained



so they can continue to farm. On the other side, resident tax payers might gain a sense of resiliency by knowing they are protecting their community's long-term sustainability. As other communities face increased development pressure and uncoordinated growth, Ann Arbor tax payers know they have protected high quality lands from urban sprawl in perpetuity.

### Economic

Numerous studies have also shown that open spaces and parks provide economic benefits. For example, proximity to open spaces and parks increases the value of surrounding properties and influences decisions about peoples' choices of where to live (Correll, Lillydahl, & Singell, 1978; Gardner, 1977; Peiser & Schwann, 1993). Open space also provides recreational space, which can produce many economic benefits. When communities decide to protect the open spaces around them, usually through some type of conservation program, they are securing their revenue from recreation and tourism (United States – Bureau of the Census, 2011). Economic benefits also come in the form of local agriculture. Consumers increasingly value the availability of local products and are often willing to pay more for them. Protecting agricultural land in the vicinity of an urban area also ensures a viable local food network for the community (Lynch & Duke, 2007).

Economic benefits are especially important in the context of the Ann Arbor Greenbelt since taxpayers are paying directly into the Program via the millage. While most Ann Arbor citizens do not have direct interactions with the Greenbelt given its location outside the city limits, there are still indirect benefits to consider. For example, Ann Arbor citizens might value the Greenbelt because they can buy local produce at the farmer's market. Or one might value the Greenbelt because it helps to provide cleaner water to kayak on the Huron River. While we could not measure benefits to land preservation via changes in housing prices, we instead measured the existence value of the Greenbelt by surveying taxpayers' willingness to pay for the continuation of the Greenbelt Program.

## **Chapter 2:**

# **The Ann Arbor Greenbelt Program**

### **Greenbelt Programs**

The modern-day greenbelt concept is derived from Ebenezer Howard's introduction of garden cities to England around the turn of the century. Greenbelts have been defined as "undeveloped land that either surround[s] or runs adjacent to urban areas . . . to control urban sprawl and provide green space for recreational and agricultural uses" (Powers, 2010). Howard envisioned greenbelts as both an opportunity for urbanites to experience rural areas and as a means to control the expansion of cities (Morley, 2007). Greenbelts in the United States began as a part of the New Deal in post-depression America and are the product of the federal government experimenting with affordable and livable cities that promote community cohesion (MacKean, 2013), but only the town of Greenbelt, Maryland remains of the original New Deal greenbelt cities today. In 1967, and later again in 1989, the City of Boulder voted to tax itself to preserve the open spaces around the city. While several states and cities in the United States have greenbelts and urban growth boundaries, the interest in these types of programs is certainly growing.

### **Ann Arbor Greenbelt**

#### Background

During the 1990s and early 2000s, the greater Ann Arbor area was experiencing rapid development and growth. The subsequent urban sprawl was affecting the quality of life in Ann Arbor leading to fragmented open space, wildlife habitat, and forestland; loss of productive farmland; degradation of rural landscapes; decline in water quality and the loss of wetlands; increased automobile dependency, fuel consumption, traffic congestion and air pollution; relocation of jobs to peripheral areas; and additional public costs for roads and utility infrastructure. In addition, the conversion of farmland, open space, and wetlands to residential or other more industrial uses was resulting in a permanent loss of a critical natural resources to community residents (Open Space and Parkland Preservation Millage, 2003).

Ann Arbor residents recognized the value of these natural resources and open spaces in and around the city as an essential part of both the quality of life and character of the area. To protect these landscapes, the citizens campaigned to put a greenbelt millage up for a vote in November 2003.

### The Open Space and Parkland Preservation Millage and the Greenbelt Program

In 2003, the City of Ann Arbor voted to pass the Open Space and Parkland Preservation Ordinance. The voters of the City of Ann Arbor approved a charter amendment to authorize a one-half mill tax for thirty years. Two-thirds of the funding generated through the millage are used to purchase the development rights for open space and agricultural properties within the Greenbelt Program boundary. The remaining one-third of the millage funds are allocated to parkland acquisition within City limits.

In May 2004, the Open Space and Parkland Preservation millage established the Ann Arbor Greenbelt Program and the Greenbelt Advisory Commission. The purpose of the Ann Arbor Greenbelt Program is to preserve and protect open space including agricultural land, natural habitats, parkland and the City's source waters within the Greenbelt District.

#### *Greenbelt Advisory Commission*

As established by the Open Space and Parkland Preservation Ordinance, the Greenbelt Advisory Commission (GAC) advises the Ann Arbor City Council in the selection of Greenbelt District lands and boundaries. The Commission consists of nine members: two representatives of environmental and/or conservation groups; one member who is an agricultural landowner or operator of an agricultural business; one member who is a real estate development professional; one member who is a plant or animal biologist; three members from the public; and one member from the Ann Arbor City Council.

#### *Strategic Direction*

In 2006, the Ann Arbor Greenbelt Program developed a strategic plan that was established to provide the greatest impact from future property acquisitions. This first part of this plan stated GAC would seek to prioritize large (1000+ acres) blocks of conserved land (The Conservation Fund, 2013). Five areas, or Farmland Complexes, were defined in the strategic plan as areas of prioritization for the contiguous blocks (Figure 2.1). Over the past few decades, large areas of open and agricultural land around the city of Ann Arbor have faced increasing pressure from development. By preserving large land tracts to form a greenbelt, development is contained to the urban core and urban sprawl is limited. Preserving farmland also secures the economic benefits of local agriculture by ensuring farming can continue without pressure to develop the land.

The Greenbelt Strategic Plan also outlines the need to prioritize land along the Huron River and its watershed given the important ecological function the Huron River provides to Ann Arbor. The Huron River is the drinking water source for most of the city's residents and provides ample recreation opportunities for Ann Arbor and surrounding communities.

#### *Land Acquisition Process*

Any property owner within the Greenbelt District can apply to have their property considered for inclusion in the Greenbelt Program. The first step in the process is for the landowner to submit an application to the Greenbelt Program. After an application is submitted, Greenbelt Program staff scores the property using a set list of criteria developed by GAC. This scoring system helps GAC prioritize and select the best applicant properties to be included in the Greenbelt.

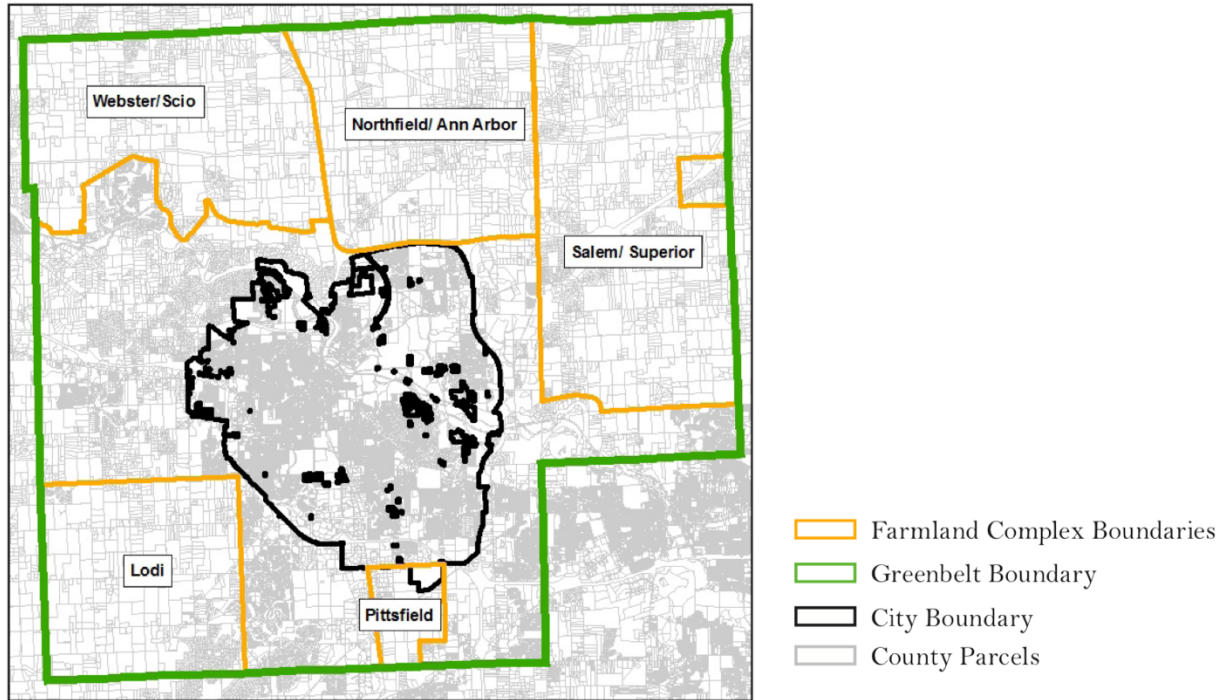


Figure 2.1: The Ann Arbor Greenbelt and the five Farmland Complexes outlines in the Strategic Plan

There are two separate scoring systems depending on the type of land being considered: agricultural and open space. Both types of land are scored on the same three criteria (characteristics of the land, context, and acquisition considerations), but the categories are weighted differently for the two land types. In the agricultural land scoring system, 44% of the points are awarded in the characteristics of the land section, 42% in the context section, and 14% in the acquisition consideration section. In contrast, the open space scoring system awards points at 34%, 42%, and 24%, respectively.

In the agricultural land scoring system examples of scoring criteria include: parcel size, landowner contribution, presence of natural features, and proximity to protected land. Examples of the scoring criteria for open space land include: recreational potential, historical or scenic value, distance to city limit, and presence of mature trees and/or rare species. Once the property is scored, the scoring and application are reviewed and a decision is made by GAC on whether to move the property forward in the land acquisition process.

The following is the process by which a property's development rights are purchased by the Ann Arbor City Council with advisory support by GAC:

1. Greenbelt application is submitted to Greenbelt Program;
2. Application is reviewed by Greenbelt staff and ranked according to Greenbelt scoring system;
3. GAC reviews application and scoring;
4. Appraisal and preliminary title work are completed;
5. GAC recommends acquisition to Ann Arbor City Council;
6. City Council approves acquisition;

7. Purchase agreement is signed by landowner and City;
8. Easement draft is provided to landowner;
9. Due diligence is completed by the City (survey, environmental site assessment, final title work);
10. Easement baseline report is prepared by City;
11. City and landowner approve all documents and agreements;
12. All land transaction documents signed and filed at closing.

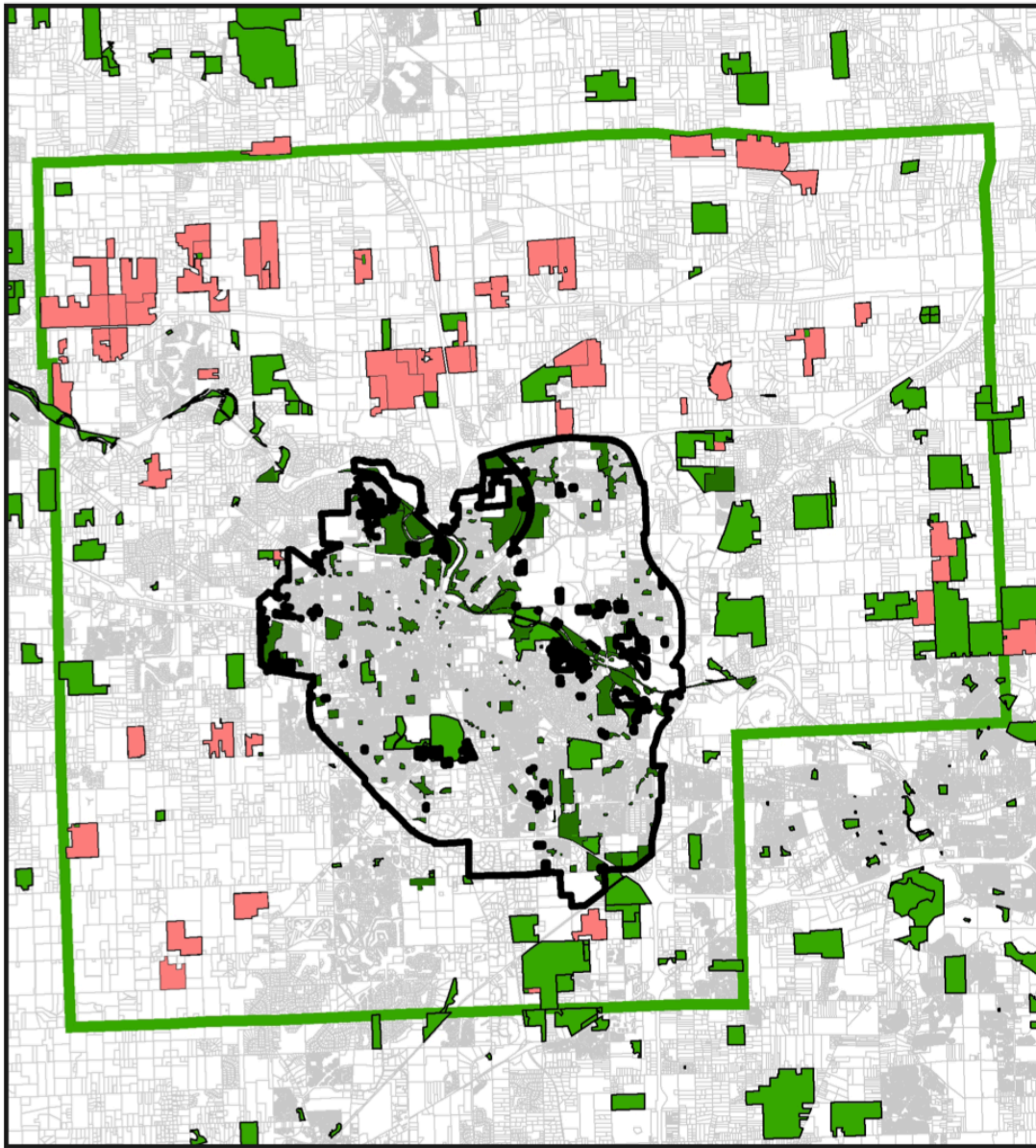
### *Partnerships and Leveraging of Funds*

The Greenbelt Program is committed to maximize citizens' tax dollars through grants from federal land conservation programs and partnerships with other conservation programs or landowner contributions. Prior to 2008, the Greenbelt focused on farms 40 acres or larger that were eligible for the U.S. Department of Agriculture Natural Resources Conservation Service's (USDA-NRCS) Farm and Ranch Land Protection Program (FRPP) grant funding. In 2014, this program was replaced by the aforementioned ACEP. Land eligible for agricultural easements includes cropland, rangeland, grassland, pastureland and nonindustrial private forest land. Under the Agricultural Land component, NRCS may contribute up to 50 percent of the fair market value of the agricultural land easement. Where NRCS determines that grasslands of special environmental significance will be protected, NRCS may contribute up to 75 percent of the fair market value of the agricultural land easement.

The Greenbelt Program leverages its funds by collaborating with other local and regional land conservancy organizations. These partners have included Scio Township, Washtenaw County Natural Areas Preservation Program (NAPP), Webster Township, Ann Arbor Township, Lodi Township, Legacy Land Conservancy, and Southeast Michigan Land Conservancy. If partners are involved, the City completes a Participation Agreement that outlines the specific roles and responsibilities of each party, including defining the funding contribution of each party. In several Greenbelt transactions, the landowners themselves have contributed a portion of the purchase price by selling the development rights at less than the appraised value of the property.

### *Progress to Date*

As of June 2017, the Greenbelt has protected properties over 50 properties outside the city limits totaling over 4,800 acres of working farmland and open space. The Greenbelt Program has also funded the purchase of 98 acres of new parkland within the city limits (Figure 2.2). These parklands provide linkages between existing open spaces and protect high quality natural features remaining in the City. Many of the parklands purchased through the Program also provide recreational space for citizens to enjoy inside the City's limits.



- |               |                      |                 |
|---------------|----------------------|-----------------|
| City Boundary | Greenbelt Properties | Ann Arbor Parks |
| Tax Parcels   | Greenbelt Boundary   | Protected Lands |

*Figure 2.2: The Greenbelt District -- Properties protected by the Ann Arbor Greenbelt Program through June 30, 2017.*

## Chapter 3:

# Environmental Impact of the Greenbelt Program

### Relevant Appendices

- Appendix A: Examples of LULC Classification
- Appendix B: Baseline Scenario Land Use Mappings
- Appendix C: Township Master Plan Future Land Use Maps
- Appendix D: L-THIA Inputs Table

### Introduction

There are many potential ecological effects of land preservation programs like the Ann Arbor Greenbelt. As the footprint of urbanized Ann Arbor expands, the spatial distribution of properties under development restriction has interesting implications for connectivity, habitat suitability, and patchiness of habitat. These measures, however, vary greatly depending on the species of interest (Amos et al., 2014). Land use is also a leading determinant of carbon storage in soils and vegetation, an ecosystem function with global effects (Currie et al., 2016). Our project, however, investigated the effects on a more regional ecological resource: water quality.

The Ann Arbor Greenbelt Program Strategic Plan has a stated goal of protecting water quality and the Ann Arbor drinking water supply – the Huron River (The Conservation Fund, 2017). Runoff volume and nonpoint source pollutant loads are strongly affected by land use and land cover within a watershed (Brabec, Schulte, & Richards, 2002); changing percentages of impervious surface and natural areas within the Greenbelt District should be expected to have a significant impact on water quality of the Huron River. To assess the effects of the Ann Arbor Greenbelt Program on water quality, this project focused on the following questions:

1. **Characterization of Current Land Use:** Across all properties within the Greenbelt Program, what are the acreages of easement land in different land uses?
2. **Estimation of Effects on Runoff and Nonpoint Source Pollution:** In alternative scenarios where Greenbelt Program properties were instead developed for different uses, what is the expected effect on runoff and nonpoint source pollution from those properties?

## Methods

### Characterization of Current Land Use

Each property entering into the Greenbelt Program undergoes an in-depth evaluation, which is outlined in an easement baseline report. This document examines the site history, geology, soil types, natural features present, and explicitly describes current land uses and restrictions of future land uses of the property. However, there has not previously been a Program-wide assessment quantifying the areas under different land uses across all properties. Knowing current ratios of land uses within the Program would allow the Greenbelt Advisory Commission (GAC) to set Program-wide target ratios of agricultural land to natural spaces and inform GAC's future recommendations for applicant properties. This project provides a land cover / land use (LULC) classification of 49 different properties within the Greenbelt Program. This covers all Greenbelt properties as of June, 2017. More properties have since entered into the Greenbelt Program.

Two major national LULC datasets exist; the National Land Cover Database (Homer et al., 2015), and the Cropland Data Layer (USDA NASS, 2016). Both datasets are derived from computer algorithmic interpretation of satellite imagery at a 30-meter spatial resolution. While these products could be used to produce quantifications of land use on Greenbelt properties, the 30-meter spatial resolution of these datasets and the algorithmic classification methodologies used in their production make them suitable for analyzing land use and land use change over broader extents of land.

Since our interest was at a sub-parcel scale, a manual classification using interpretation of high resolution aerial photography was a more appropriate method for capturing the features of interest. These features include small (<10m) patches of remnant vegetation and fragments of forest, wetland, and shelterbelts, which have been shown to have significant positive effects on biodiversity, including insect-pollinated plants and reptiles (Guiller, Affre, Albert, Taton, & Dumas, 2016; Pulsford, Driscoll, Barton, & Lindenmayer, 2017).

Digital aerial photography was acquired for this classification from the National Agriculture Imagery Program (NAIP), administered by the USDA Farm Service Agency (USDA FSA, 2016). The imagery used was available as a mosaic, covering the entire Greenbelt District at a 0.6-meter spatial resolution, and was captured on August 4<sup>th</sup>, 2016, during the agricultural growing season, which allowed for identification of fields planted with row crops, as distinguished from fallow fields or other grassland.

A LULC classification protocol was adapted from a recent study of Great Plains state populations and environments (Parton, Gutmann, Hartman, Merchant, & Lutz, 2012). This protocol was selected because it focused on agricultural lands within the Midwest region, which encompasses the Greenbelt. All areas within the boundaries of Greenbelt Program easements were classified as one of 11 LULC classes, following the decision logic in Figure 3.1. Boundaries for Greenbelt Program easements were acquired from the City of Ann Arbor (City of Ann Arbor Data Catalogue, 2017). See Appendix A for descriptions of different LULC classes and examples.



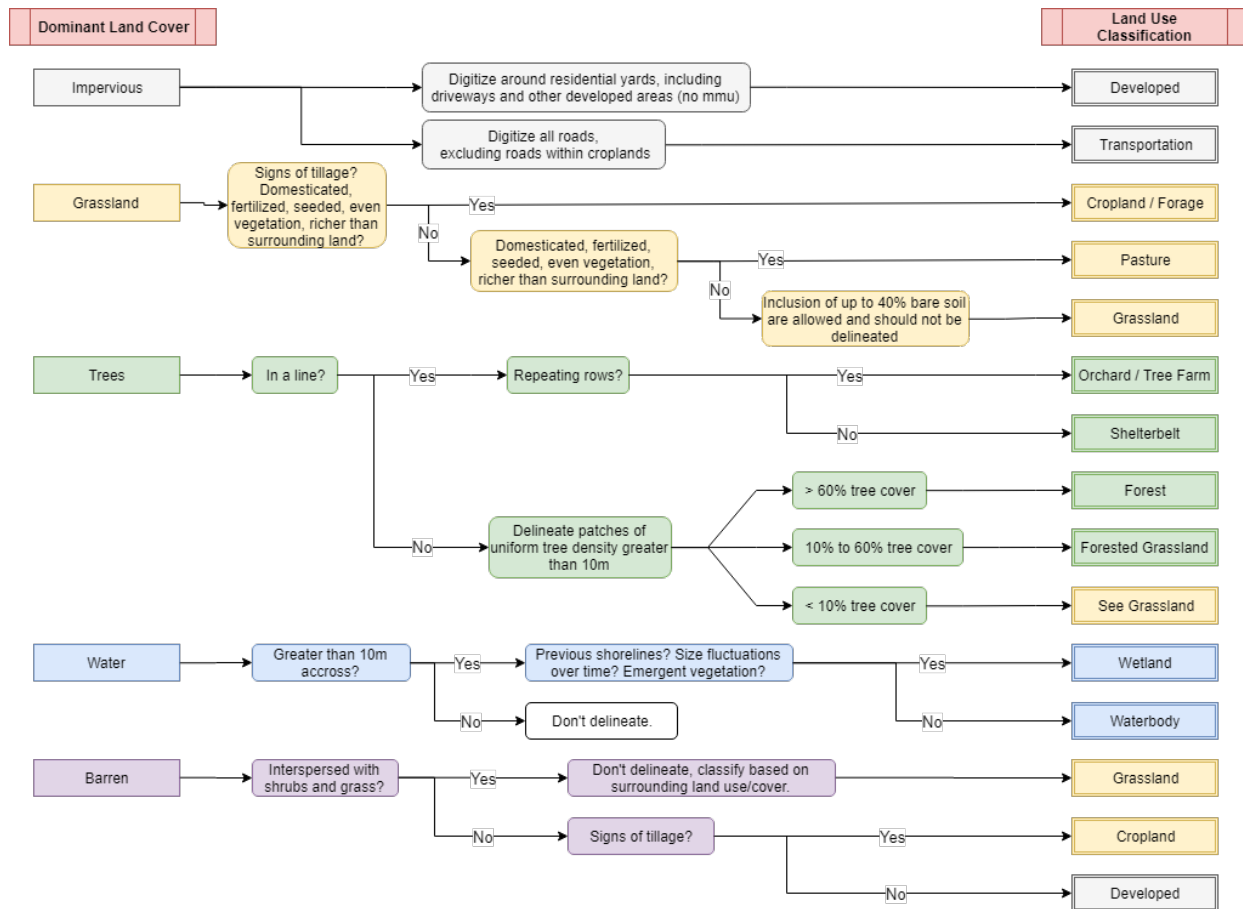


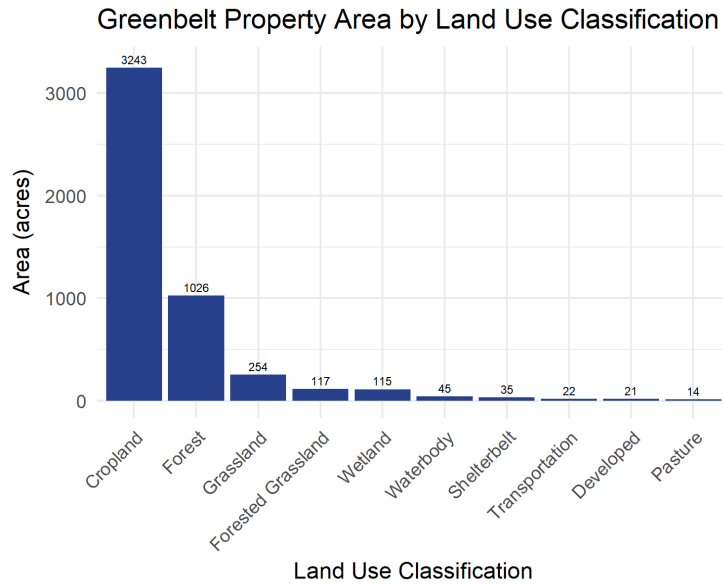
Figure 3.1: Land use classification decision tree for classification of Greenbelt Properties. Adapted from Parton, Gutmann, Hartman, Merchant, & Lutz (2012).

Classification was completed in ArcGIS Desktop with property boundaries overlaid on top of NAIP imagery. A layer of polygons representing known wetlands, developed by the Huron River Watershed Council Bioreserve Program (Olsson, 2017), was used as auxiliary data for identifying wetland areas with light canopy cover. All layers were projected into the Michigan State Plane projected coordinate system. Polygons of contiguous similar land use were drawn while maintaining a 1:4000 scale within ArcGIS. A minimum mapping unit of 10 meters was used for all classes except transportation and shelterbelts, which were delineated if present. That is, patches of contiguous land use were only delineated if they were 10 meters or greater across; small copses or single trees within a field were not delineated. Classifications of ambiguous land uses were reviewed by Shannon Brines, a local farmer, geospatial data analyst, and former member of GAC with knowledge of many of the Greenbelt Program properties.



*Figure 3.2: Example of NAIP imagery with Greenbelt parcel boundaries and classification polygons overlaid.*

No “Orchards / Tree Farms” were identified within the Greenbelt properties, so a total of ten land use classifications were used in practice. Furthermore, pastureland proved challenging to distinguish from other grassland, and was only readily identified with the existence of stable structures and permanent animal fencing. Land classified as pastureland likely underrepresents the actual Greenbelt land that is used for rotational or occasional grazing. Roughly two thirds of land within the Greenbelt Program is cropland, while close to another third of land is natural space of some form (Forest, Grassland, Forested Grassland, Wetland, or Waterbody).



Land Use Classification	Area (acres)	Percent of Total Area
Cropland	3242.7	66.3%
Forest	1026.0	21.0%
Grassland	254.4	5.2%
Forested Grassland	117.0	2.4%
Wetland	114.6	2.3%
Waterbody	45.4	0.9%
Shelterbelt	34.7	0.7%
Transportation	21.5	0.4%
Developed	20.9	0.4%
Pasture	13.9	0.3%
<b>Total</b>	<b>4891.1</b>	<b>100.0%</b>

Figure 3.3: Characterization of lands within Greenbelt properties.

#### Estimating effects on runoff and nonpoint source pollution

One of the stated goals of the Greenbelt Strategic Plan is to protect water quality and the Ann Arbor water supply (The Conservation Fund, 2017). Changes in land use can significantly impact the volume of storm water runoff and nonpoint source (NPS) pollution entering a waterway. In order to assess the effect of the Ann Arbor Greenbelt Program development restrictions on runoff and NPS pollution, a simple runoff model was used to generate a comparison between the baseline current land use and two other hypothetical land use scenarios.

#### *The L-THIA Model*

The Long Term Hydrologic Impact Analysis (L-THIA) model was developed as a simplified spreadsheet model available to land managers and planners and provides estimates of the effect of land use change on average annual runoff volumes and several NPS pollutants (Harbor, 1994). L-THIA is a hydrologic model with few required inputs; it is based on curve number, a quantity first described by the US Department of Agriculture (USDA NRCS, 1986), and derived from land cover, hydrologic soil group, and historical or projected precipitation. L-THIA's simplicity is limiting (see "Limitations" in the Discussion section below), but this simplicity allows it to be highly accessible for exploratory analyses.

In this study, we used an implementation of the L-THIA model which is hosted on the website of the Purdue University College of Engineering (Theller & Engle, 2016). This implementation includes 30 years of historical precipitation data at a Washtenaw County spatial aggregation. Thus, for this study, the only data requirements to assess runoff are land use and soil hydrologic group. Land use classes and curve numbers used in L-THIA were defined by the USDA NRCS (1986),

(see Table 3.1). Coefficients for estimating NPS pollution volumes used in the Purdue L-THIA implementation were defined by Baird & Jennings (1996).

### Soil Data

Soil hydrologic group data are available as shapefiles in the USDA Soil Survey Geographic Database (SSURGO) (USDA NRCS, 2017). Each watershed is available from SSURGO as a separate shapefile. The Greenbelt District has land within four different watersheds: the Huron River, the Rouge River (available as the “Detroit River” in SSURGO), the River Raisin, and the Ottawa-Stony watershed, each of which have some overlap. The four separate soil data layers were merged using ArcGIS, providing polygons of contiguous soil hydrologic groups covering the extent of the Greenbelt District. Polygons representing water features in SSURGO do not have a defined soil hydrologic group, since rainfall on bodies of water, by definition, does not contribute to runoff. Thus, these areas did not contribute to runoff totals in L-THIA outputs. See USDA NRCS (1986) for descriptions of the four soil hydrologic groups used (A, B, C, D) and their characteristics.

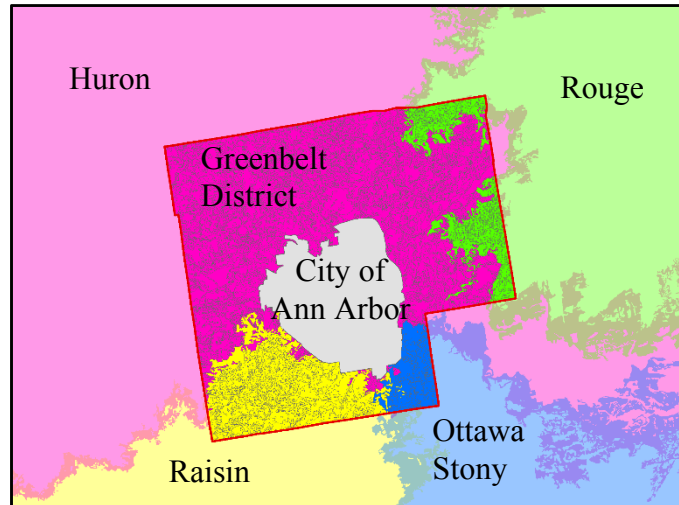


Figure 3.4: Four watersheds of SSURGO soil data overlap with the Greenbelt District.

### Alternative Scenarios

Standard practice for estimating the hydrologic effects of a particular land use profile is to compare outcomes with alternative, hypothetical land use scenarios, which represent different policy or growth assumptions (see Kepner, Semmens, Bassett, Mouat, & Goodrich 2004; Ray, Duckles, & Pijanowski, 2010; Olang, Kundu, Ouma, & Fürst, 2012). For the Ann Arbor Greenbelt properties, a baseline scenario was characterized using the manual land cover classification above. Two alternative scenarios were then developed, representing land use patterns that would be possible in the absence of Greenbelt easements. Each scenario is uniquely defined by a complete, spatially explicit, classification of land use of all 4,891 acres of Greenbelt Program land considered in this study. Land use classes used to define scenarios are required to match the classes used in our selected implementation of the L-THIA model, since each scenario is used to define a separate L-THIA model run.

L-THIA Land Use Class	Percent Impervious
Commercial	85%
Industrial	72%
High Density Residential (1/8 – 1/4 acre lots)	38 - 65%
Low Density Residential (1/2 - 2 acre lots)	12 - 25%
Water/Wetlands	0%
Grass/Pasture	0%
Agricultural	0%
Forest	0%

Table 3.1: Land use classes used in the L-THIA model. Impervious surface estimates and associated curve numbers were estimated by USDA NRCS (1986).

1. **Baseline Scenario:** The LULC classification completed using NAIP aerial imagery was used to define a baseline land use scenario. The LULC classes used in the manual classification do not match the land cover types used in the Purdue implementation of the L-THIA model (Table 3.1), so reclassification was required. This was completed using obvious logical mappings (see Appendix B). The baseline scenario used only five L-THIA land use classes, since no industrial, commercial, or high density residential lands exist within easement boundaries. Using L-THIA classifications, the properties within the Greenbelt Program are characterized by Figure 3.5. Roughly two thirds of land within the Greenbelt Program is under agricultural use, and roughly one quarter is forested.

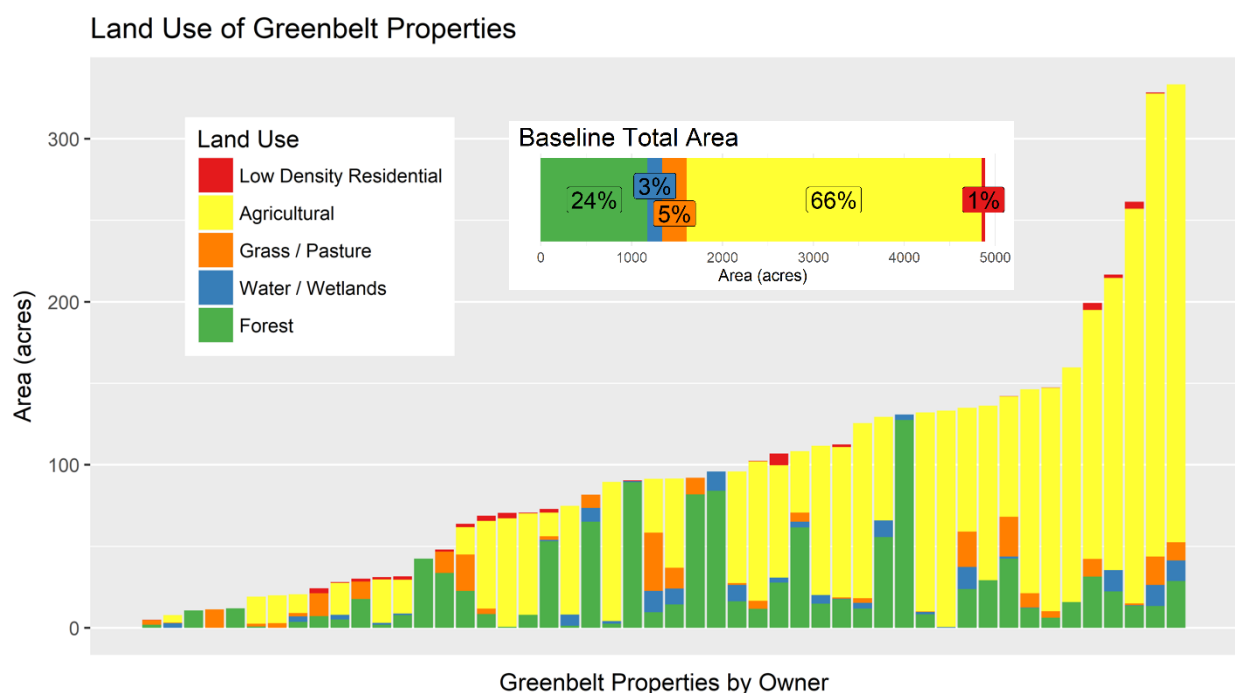


Figure 3.5: Baseline classification of current land use on Greenbelt properties using L-THIA land use classes.

2. **Agricultural Expansion Scenario:** The first alternative scenario was developed to represent a possible future expansion of agricultural use on land within the Greenbelt Program. Township master plans were used to identify natural spaces that may be more likely for conversion to agriculture in the absence of Greenbelt easements. The Greenbelt District lies within eight different townships, each of which develops and publishes a different master plan. Each of these plans contain maps or descriptions of planned future land use for all land within that township (see Appendix C for finding this information within these master plans). Referencing these future land use maps, each Greenbelt property was categorized into one of three planned future land use classes: “Agriculture”, “Open Space Preservation”, and “Low Density Residential”. Each township uses slightly different definitions for future land uses, but planned uses for areas in which Greenbelt properties lie clearly fall within one of these three categories. All township definitions

of “Low Density Residential” fall within the density range for L-THIA’s Low Density Residential LULC classification (1/2 – 2 acre lots).

Planned future land use classes of properties were used to define land use conversions for the agricultural expansion scenario. See Table 3.2 for specific defined conversions. In general, area planned as Low Density Residential was entirely converted to the Low Density Residential L-THIA class, area planned as Open Space Preservation was maintained in current uses and translated into L-THIA classes following the same mappings as in the baseline scenario (Appendix C) and area planned as Agricultural had conversion of forest and grassland to agricultural uses.

Master Planned Future Land Use	Current Land Use	Agricultural Expansion Scenario Land Use (L-THIA Classes)
Agricultural	Developed	Low Density Residential
Agricultural	Transportation	Low Density Residential
Agricultural	Cropland	Agricultural
Agricultural	Pasture	Grass / Pasture
Agricultural	Grassland	Agricultural
Agricultural	Orchard / Tree Farm	Agricultural
Agricultural	Shelterbelt	Forest
Agricultural	Forest	Agricultural
Agricultural	Forested Grassland	Agricultural
Agricultural	Wetland	Water / Wetlands
Agricultural	Waterbody	Water / Wetlands
Open Space Preservation	Developed	Low Density Residential
Open Space Preservation	Transportation	Low Density Residential
Open Space Preservation	Cropland	Agricultural
Open Space Preservation	Pasture	Grass / Pasture
Open Space Preservation	Grassland	Grass / Pasture
Open Space Preservation	Orchard / Tree Farm	Agricultural
Open Space Preservation	Shelterbelt	Forest
Open Space Preservation	Forest	Forest
Open Space Preservation	Forested Grassland	Forest
Open Space Preservation	Wetland	Water / Wetlands
Open Space Preservation	Waterbody	Water / Wetlands
Low Density Residential	[ALL CLASSES	Low Density Residential

*Table 3.2: Conversion mappings for Agricultural Expansion land use scenario.*



3. Residential and Commercial Development Scenario: A final scenario was developed to represent extreme sprawling development in the areas surrounding Ann Arbor. A simple strategy was used to define conversion of Greenbelt property lands to either Low Density Residential, High Density Residential, or Commercial uses. Buffers surrounding the boundary of the City of Ann Arbor were created in ArcGIS at distances of 2.5km and 3km. Portions of Greenbelt Properties within 2.5km of the boundary of the city of Ann Arbor were assigned to the Commercial land use class. Areas between 2.5km and 3km of the boundary of Ann Arbor were assigned to the High Density Residential land use class. Areas greater than 3km of the boundary of Ann Arbor were assigned to the Low Density Residential land use class.

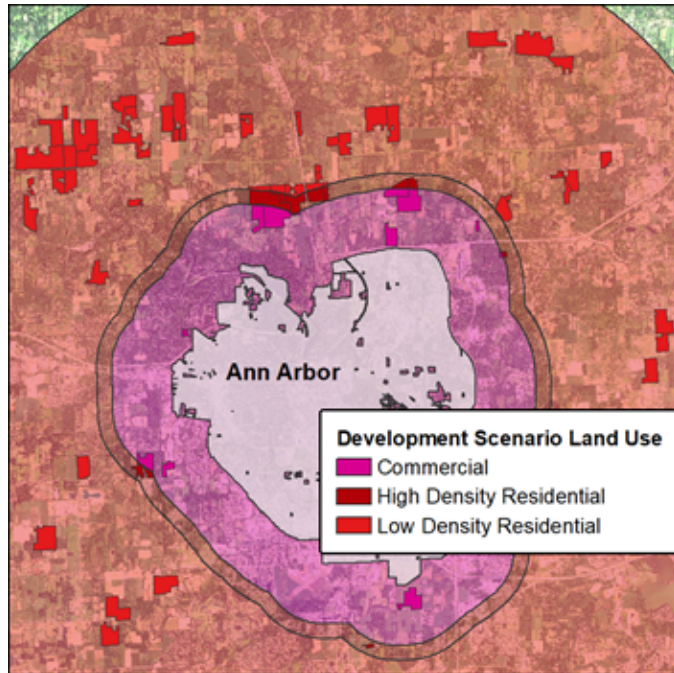


Figure 3.6: Development scenario buffers and classification.

The Residential and Commercial Development scenario classification may not align with what type of development pressure (i.e. residential vs. commercial) a property would actually face in the absence of a Greenbelt easement. A more sophisticated analysis of factors including city services and accessibility would be required to develop a more informed scenario. However, the buffer distance method provides a simple process for defining spatially explicit reassignments that match reasonable estimates of the ratios of residential and commercial development. The makeup of land uses in the three different scenarios is given in Figure 3.7.

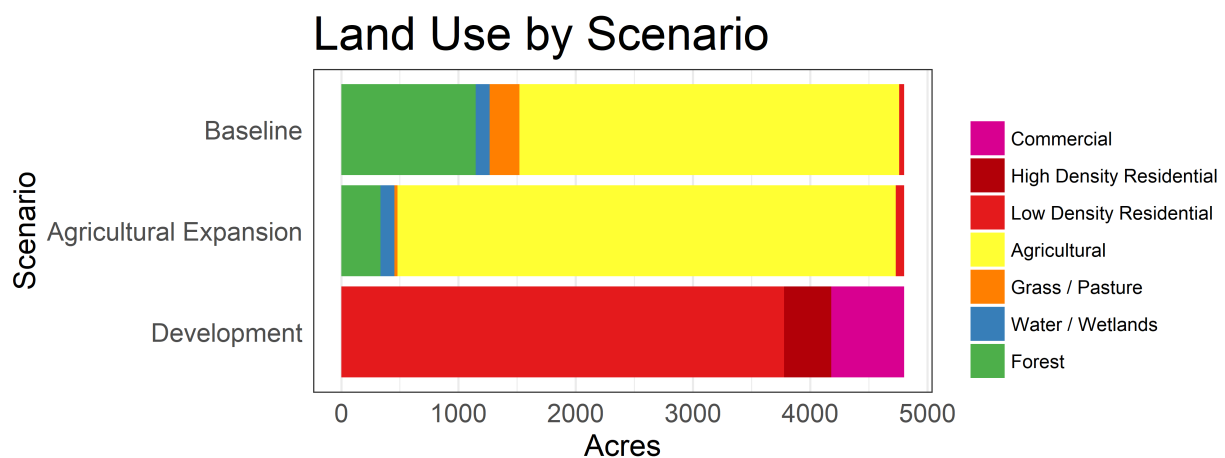


Figure 3.7: Comparison of LULC area totals across the three defined scenarios.

For each scenario defined, L-THIA land class polygons were intersected with soil hydrologic group polygons. The result is a collection of smaller polygons, each with a defined land class and hydrologic group, which can be thought of as a pairing (for example (*Low Density Residential, Group C*)). Total area for each unique pairing was tabulated. A few soil polygons in the SSURGO dataset had split hydrologic groups (e.g. C/D). Area of split groups was reassigned evenly between the the two soil groups with the same land use class.

## Results

The table of area totals for each (*land class, hydrologic group*) pairing (Appendix D) was entered into the L-THIA model using the basic model tool hosted online by the Purdue University College of Engineering (Theller & Engle, 2016). L-THIA returns estimates on average annual runoff totals and volume estimates for 14 different NPS pollutants (Table 3.3).

Measure	Units	Baseline	Agricultural Expansion	Development
Average Annual Runoff Volume	acre-ft.	687.49	825.82	1249.13
Average Annual Runoff Depth	in.	1.71	2.06	3.12
Nitrogen	lbs.	7332.024	9712.663	5513.486
Phosphorus	lbs.	2118.335	2862.323	1583.4
Suspended Solids	lbs.	174658.301	235743.363	159951
Lead	lbs.	3.737	3.32	33.126
Copper	lbs.	4.904	3.48	35.127
Zinc	lbs.	27.702	35.276	409.493
Cadmium	lbs.	1.861	2.238	2.843
Chromium	lbs.	16.823	20.377	16.735
Nickel	lbs.	0.153	0.246	33.249
Biological Oxygen Demand (BOD)	lbs.	7002.185	9417.713	83262
Chemical Oxygen Demand (COD)	lbs.	762.342	1225.532	262098
Oil & Grease	lbs.	25.011	41.018	16058.454
Fecal Coliform	coliform (millions)	193568.645	261502.816	225561
Fecal Strep	coliform (millions)	3923	6308	623132

Table 3.3: L-THIA results from the three defined scenarios.

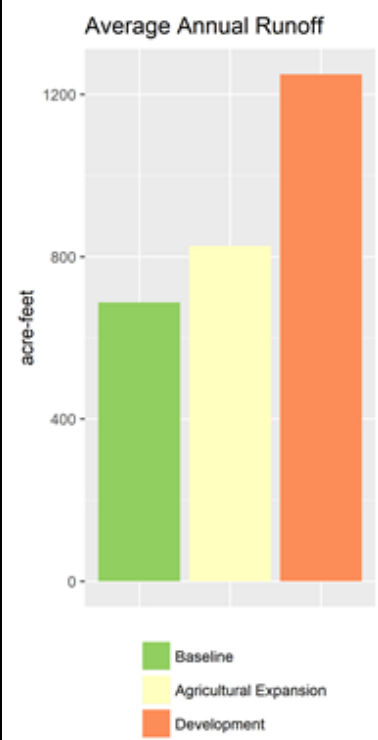


Figure 3.8: Average annual runoff for the three defined scenarios.



Both the agricultural expansion and development scenarios projected increases in average annual runoff volume when compared to the baseline scenario. For the agricultural expansion scenario, this increase is due to the conversion from forest and grassland to agricultural land use, which has higher runoff potential (US EPA, 2000). In the development scenario, the increase in runoff is driven by a large expansion in impervious surface cover on Greenbelt properties, primarily in the areas of high density residential and commercial land (see Table 3.1).

Unsurprisingly, runoff of agricultural inputs (nitrogen and phosphorus) increased in the agricultural expansion scenario, while actually decreasing in the development scenario when compared to the baseline. It is notable that conversion from agricultural to residential land use (baseline vs. development scenarios) only somewhat reduces nitrogen (24.8%) and phosphorus (25.2%). This reflects the significant impact residential lawn care can have on watershed nitrogen and phosphorus levels (Law, Band, & Grove, 2004). Suspended solid runoff, which is strongly influenced by erosion from tillage practices on agricultural lands, followed a similar pattern, with an increase in the agricultural expansion scenario and a slight decrease (8.4%) in the development scenario when compared to the baseline. Most other NPS pollutants had highest runoff volumes in the development scenario. This included lead, which poses a public health concern if present in the Ann Arbor water supply, and fecal coliform, which has been associated with pathogens which pose risks to human health, especially in waterways used for recreation such as the Huron River (Templar, Dila, Bootsma, Corsi, & Mclellan, 2016).

## **Discussion**

### Limitations

The simple methods used in this study have several significant limitations, but our exploratory analysis does suggest areas for refinement for a more robust study. The web implementation of the L-THIA model was selected for its simplicity of data requirements and accessibility, but future work could better calibrate the L-THIA methodology to local conditions.

Our results use average curve numbers and NPS runoff coefficients for different land uses and hydrological groups found in the literature (USDA NRCS, 1986; Baird & Jennings, 1996). Agricultural land, however, can have widely varying impacts on runoff and NPS volumes depending sustainable practices implemented (cover crops, contour tilling, etc.) and which crops are grown (Aryal et al., 2018). Many of the farms selected for inclusion in the Greenbelt Program use a variety of sustainable practices, which would suggest that the environmental runoff impacts estimated by our baseline scenario are overestimating the actual runoff from these properties. Accuracy of the baseline scenario could be improved by refining the “agriculture” land use class into several classes that reflect different farming practices, using suitable curve numbers and NPS coefficients in the literature (USDA NRCS, 1986).

The hypothetical alternative scenarios developed in this study were also coarsely defined and could be refined to account for expected threat of land conversion based on proximal factors. The Washtenaw County Parks and Recreation Commission has developed a scoring tool for agricultural lands that assess threat of development based on anthropogenic factors, including distance from roads and sewers. This tool could be used to develop alternative scenarios that more

closely reflect the development potential of Greenbelt properties, and therefore provide more realistic counterfactual comparisons to the baseline scenario.

Finally, the L-THIA methodology is a simplification of complex hydrologic processes, and does not account for many factors that could have serious impacts on runoff. L-THIA does not account for topographic variation, stream networks, temperature, or landscape patchiness, all of which may have significant effects on runoff dynamics (Moore, Grayson, & Ladson, 1991; Fiener, Auerswald, & Van Oost, 2011). L-THIA has the benefit of being accessible for land managers and decision makers without deep backgrounds in hydrology, but use of more complex hydrologic models would increase the robustness of these results. The BASINS model, for example, was developed by the US EPA (2015) and explicitly accounts for elevation and catchments.

### Conclusions

There is an apparent tension between different goals of the Greenbelt Program: maintaining working agricultural land near the City of Ann Arbor, and protecting the Huron River and water quality within its watershed. Farmland typically yields higher runoff volumes than forest and natural spaces, as can be seen in the effects of hypothetical land conversion in the agricultural expansion alternative scenario. When compared to commercial and dense residential development, however, maintaining current agricultural land uses are clearly beneficial. Understanding the current balance of agricultural and natural land within the Greenbelt provides insight into the level of support of each of these Program objectives, and should inform alignment of property selection with Program goals in the future. The dual goals, farm preservation and water quality improvement, can be further aligned by continuing to prioritize selection of farms which use conservation practices aimed at minimizing runoff.

## Chapter 4:

# Impact of the Greenbelt Program on the Local Farm Community

### Relevant Appendices

Appendix E: Greenbelt Landowner Participation Letter

Appendix F: Greenbelt Landowner Financial Impact Survey

Appendix G: Greenbelt Landowner Interview Guide

### Introduction

This section of the study provides a qualitative evaluation of the Greenbelt Program's impact on the local farming community. We decided to focus on the farming community because the Greenbelt Strategic Plan and opportunities for funding partnerships have successfully promoted the inclusion of agricultural lands into the Greenbelt. Since the inception of the program, the majority of landowner engagement and interest has originated from farm operators in the Greenbelt District (The Conservation Fund, 2017). Agricultural lands are also a high priority for the Greenbelt Advisory Commission and the City of Ann Arbor. The 2013 update to the Greenbelt Strategic Plan also contains an emphasis on Farm Complexes within the Greenbelt to support the long-term viability of food production activities in the region (The Conservation Fund, 2013). The focus on agricultural land allows the City to efficiently leverage funds and qualify for grants from various land preservation partnerships. Our social impact study explores the following questions:

1. **Farming Community Impacts:** How has the Greenbelt Program affected the local farming community in the Greenbelt District?
2. **Greenbelt Value:** How do Ann Arbor residents value and perceive the Greenbelt Program?

### Methodology

To investigate these questions, we took an interpretivist approach and collected data from two main sources: (1) on-site interviews with landowners and (2) written comments submitted by Ann Arbor property owners.

#### Interviews with Landowners

For the on-site interviews, we identified 24 of the Greenbelt properties that had conservation easement agreements where the Ann Arbor Greenbelt Program was the lead funding agency. Interview requests were sent in the form of physical letters to each of these 24 landowners (see Appendix E). Out of the 24, eight landowners showed interest in participating in our study, and

three were available for interviews. Interviewees for this study operated farms located in three different townships adjacent to Ann Arbor: Superior Township, Lodi Township, and Webster Township.

With the help of the Ann Arbor Greenbelt Program staff, an interview guide (see Appendix G) was constructed to focus on personal experience with the Greenbelt Program and ensure that participants would feel comfortable either answering or opting out of questions. Interviews were conducted in early 2018, inside the landowner's home or walking around the property, and lasted about an hour and a half to two hours each. At least three out of the four researchers were present for each interview.

Semi-structured interviews were the ideal mode for collecting empirical data about how farm operators and landowners view their role in society, through the specific context of the Greenbelt Program. Open-ended questions encouraged landowners to follow their own associations and provide details about their lives and determine what is important for understanding the Greenbelt and their role in the Greenbelt Program (Luker, 2008, pp. 169-189).

With permission, conversations were recorded and transcribed. For conversations that were not recorded by request, we compared field notes and agreed upon prominent issues.

#### Survey Comments from Ann Arbor Resident Property Owners

As part of or economic valuation of the Greenbelt Program, we sent surveys to a random sample of 1,300 Ann Arbor property owner. Although the primary purpose of the surveys was to conduct an economic valuation of the Greenbelt (see Chapter 5), we were also able to collect data from comments written in the open comment box at the end of the surveys. About 25.4% of all surveys returned included written comments. These comments provided insight into respondents' personal experiences with the Greenbelt Program and a suite of relevant issues including the 2003 millage, justifications for answers to auxiliary questions, clarifications for responses to auxiliary questions in the survey, as well as questions and concerns about the Greenbelt Program's impact and sustainability. The content and nature of these comments varied in detail and included both positive and negative feedback.

#### Coding and Analysis

Interviews were transcribed and manually coded using an open coding method (Luker, 2008; Weiss, 1994). We reduced and refined content into codes and categories of codes. Major themes were developed through an iterative process of reviewing literature based on search terms generated by interview content and repeatedly coding interviews manually (Fujii, 2017).

All hand-written responses included in the survey comment box or on any other pages of the survey document were compiled in a single document. These comments were then coded in a similar fashion to the interviews. Survey comments and interviews were coded separately to allow as many concepts and issues to emerge before analyzing them together.

These codes were then sorted into categories which informed the subsequent literature review. Understanding literature around the topics emerging from the data helped us further reduce codes from two major sets of data into a single set of themes around perceptions and experiences with

the Greenbelt Program (see Tables 4.1 and 4.2). This process of reviewing literature and data provided theoretical links between the data and our initial research question (Box-Steffensmeier et al., 2012; Luker, 2008).

### Financial Impact Survey

Initially, we also included a financial impact survey along with a request for on-site interviews with landowners. This financial survey included questions about number of employees, revenues, expenditures, loans, use of funds gained from selling property development rights, and financial outlook (see Appendix F). However, due to the lack of voluntary responses, we were unable to include data from these financial surveys in our study.

## **Results**

### On-site Interviews with Landowners (Farm Operators in the Greenbelt District)

We transcribed and manually coded each interview and produced five categories of codes (See Table 4.1):

- 1) Experience with the Greenbelt Program: This category includes personal experiences with the application process, positive/negative impacts of the program, positive/negative impacts on neighbors, positive/negative feedback from neighbors, and their personal motives for participating in the Greenbelt.
- 2) Changes to Farm Operations: This category of codes comprises all references to farm operations before/after the establishment of the Greenbelt Program, the Great Recession, and impact of residential development in the townships.
- 3) Challenges Facing Farms/Farming Industry: This category comprises more farm-specific challenges around weather, financial stability, and changes to their specific industry.
- 4) Developers and New Residential Builds Threatening Farms: All interviewees experienced changes to their neighborhoods, property values, property characteristics attributed to increased residential development in the townships around Ann Arbor.
- 5) Regional Agricultural Economics: This is the concept that geographic proximity to other farms, processors, and retailers is necessary for the success of an individual's farm operations. All interviewees often referred to neighbors as both friends and business partners.

### Survey Comments (Ann Arbor Resident Property Owners)

Survey documents were de-identified and manually coded to produce categories of codes (See Table 4.2):

- 1) Personal Finances: Respondents often use the comment box to refer to their own tax burdens and income levels as factors that influence their opinion of the Greenbelt.
- 2) Environmental Conditions/Health: Respondents also referred to concerns over environmental health (e.g. water quality, air quality, viewshed) as a reason for supporting the program. Others expressed disappointment in the Greenbelt's ability to limit residential development in neighboring townships.

- 3) Personal Preferences: Comment boxes were often used to express personal values and expectations for the Greenbelt Program and use of millage funds (e.g. increasing recreational opportunities, improving access to local food, increasing access to Greenbelt, maintaining quality of life in Ann Arbor)
- 4) Government Priorities: This was a particularly strong theme throughout all of the comments. Most respondents were living in Ann Arbor in 2003 when the Open Space and Parkland Preservation Millage passed (see Figure 5.6) and used this space to express their opinions on the city government's priorities such as road maintenance, "green" programs, and deer management.
- 5) Greenbelt Program and Survey Feedback: Respondents shared critiques and suggestions for improving our survey instrument, which revealed varying levels of understanding and interest in the Greenbelt Program. Overall it appears that our respondents understood our survey and had many suggestions for changes to the Greenbelt Program. However, a lot of responses also mentioned city parks, which suggests that many respondents associated the Greenbelt Program with city parks, even though the survey was explicitly about the Greenbelt and not city parks.

## **Analysis**

These codes provided search terms for further literature review in the fields of sociology, economics, urban agriculture, land use planning, and public policy. This literature review and coding process revealed three major themes underlying the major impacts that the Greenbelt Program has had on the local farm community.

### 1) Greenbelt Program promotes social resilience

This theme emerged from both discussions around how landowners decide to enter the Greenbelt and the way Ann Arbor residents refer to local food, farms, and amenities. According to Adelaja et al. (2012) and Condon et al. (2011), city planning for both population growth and preservation of agricultural land contributes significantly to the local economy and promotes sustainable land use. These policy actions, in turn, impact social welfare by promoting food security and food sovereignty. Promoting food production near urban centers often requires collaborative planning because urban growth planning does not usually consider the loss of local food production associated with expansion (del Mar Lopez et al., 2001). The Greenbelt Program promotes local food production through collaborations with neighboring townships, the county, and land conservancies.

Landowners were quick to mention that the Greenbelt Program allowed their farms and other neighboring farms to resist development pressures and rising taxes. When asked about how the conservation easement funds helped their farms, landowners often referred to them only as additional resources to their short-term operations. All landowners stressed that the long-term value came from knowing that other farmers in the region were acting to protect agricultural land. Landowners used words such as "secured" or "protected" to describe how their own farm's viability was dependent on their neighbors. Without protected land nearby, they felt "vulnerable" to the encroaching residential development that has been driving up taxes. The value of seeing a

future in living in the Ann Arbor area and continuing to operate their businesses was much more salient than the initial funds received from entering the Greenbelt Program.

Ann Arbor property owners recognized the value of proactively preserving agricultural land, but often included caveats for their support or reasons for their opposition to the millage. Typical positive responses include: “Strongly in favor of the Greenbelt! Better to be aggressive rather than rueful for lack of effort early on” and “I am proud that Ann Arborites chose to do this”. Typical negative comments include: “I totally oppose a city purchasing development rights on a permanent basis” and “I do not see a strategic value in this”. Residents often connected the existence of the Greenbelt with their long-term well-being, which was expressed in terms of financial sustainability, high taxes, and quality of life in general. Explanations for support or opposition to the Greenbelt Program usually included personal trade-off calculations. For example, a resident may have indicated that they valued the protection of natural resources and recreational opportunities but made it a point to mention that “affordable housing and diverse community is more important”. Or, a resident may have mentioned that while they wanted to increase property value, the Greenbelt Program is “a better use of tax dollars than a lot of government spending”.

Though both landowners and Ann Arbor residents recognized the trade-offs associated with funding the Greenbelt Program, many referred to their support or opposition for the program in terms of personal values and moral responsibility. Survey respondents used the comments section to clarify that they opposed the Greenbelt because of what they believe, such as minimal government intervention, letting market forces determine land use, and opposing the use of Ann Arbor property taxes for investments outside of the city. Voting for or against the millage is ultimately a political action that allows residents to express what they think is the best course of action for their community’s long-term welfare.

## 2) Greenbelt Program helps individuals preserve farming legacy

Whether this was conveyed as a community feature, personal value, or vision for the future, both landowners and Ann Arbor residents expressed the importance of preserving the region’s rural characteristics.

For farm operators, the preservation of prime agricultural land was empowering because they knew the land would be an available resource for future generations. With the threat of encroaching residential development, conservation easements provide a way for farmers to know that their farmland has a greater likelihood of remaining farmland. They were eager to see more neighbors preserve farmland so new farmers, children of farmers, and neighboring farmers could succeed and see a future for their businesses. According to Knight and Riggs (2010), urban sustainability planning for food production or soil conservation should ultimately include a broader approach and incorporate non-urban areas. Farmers in the Greenbelt recognize the value of collaborating with Ann Arbor to promote both economic and cultural vitality to the region.

For Ann Arbor residents, the rural characteristics of the area surrounding the city boundaries were a highly desirable amenity. Many residents mentioned a high preference for urban infill over sprawling developments as well as a strong desire to see improvements in public access to open spaces and natural areas. Both landowners and Ann Arbor residents were very proud of Ann Arbor’s mix of urban and rural features. City residents want future generations to have green

spaces, parks, and local food, and landowners value the sense of security they get from knowing they can continue living and conducting their business where they currently do.

### 3) Greenbelt Program bolsters regional agricultural economics

Lastly, a major theme that emerged from our data was the importance of the Greenbelt Program to regional agricultural economics. Creating the Greenbelt as a “District” and a contiguous ring around Ann Arbor is critical to protecting the local farming community’s ability to keep farming. This approach encourages actors in the local supply chain to remain in geographic proximity to one another, thereby making the local farm industry more robust. The Strategic Plan further supports clustering of preserved land by prioritizing contiguous blocks of land and land within the Farm Complexes (The Conservation Fund, 2013).

According to Anderson (1982), interdependence of all the actors in the food system is an important indicator of a healthy agricultural sector. Geographic proximity of farms and farmers promotes sharing and efficient use of resources. Landowners described cooperation with neighbors as long-term relationships that they have relied on throughout their careers to sustain their business through different seasons and generations of family members. They often rented or purchased land from one another, shared tools and equipment, and pooled labor. Farmers rely on agri-food networks to remain resilient to unpredictable changes to weather, commodities markets, or family structures, which could impact farms at any time (Wu et al., 2017). When one farm experiences hardship, another farm can help out by renting or buying parcels of land. According to Jarosz (2000), this is a common phenomenon that promotes sustainability in agriculture sectors. Efficient use of resources (e.g. land, labor, facilities, equipment, etc.) promotes vitality within the industry by helping operators reduce costs and reduce risks. When farms are successful, they also make the region more attractive to good farm operators and business owners (Colson, 2008). Creating a Greenbelt “District” with contiguous plots of land was an intentional part of the Greenbelt Program design, and landowners recognize this feature as a major benefit to their industry.



**Table 4.1: Analysis of Interviews with Landowners**

Categories of codes	Ideas associated with categories
Experiences with Greenbelt Program	<ul style="list-style-type: none"> <li>• Importance of keeping good quality farmland around Ann Arbor</li> <li>• Greenbelt Program participation contributing to the viability of farm operations (short-term and long-term financial benefit)</li> <li>• Ability to pass farm down to future generations of farmers</li> <li>• Application process (changing Greenbelt boundaries, etc.)</li> <li>• Great Recession (hurting land value, waning interest in selling property development rights, slowing residential development)</li> <li>• Greenbelt Program improving outlook on the future of farming in the region, sense of security from having agricultural lands preserved</li> <li>• Participation in other regional, county, and state land preservation programs</li> <li>• Land as a place of business and a home</li> <li>• Experience with the millage, divided support from farm community (other farmers wanting to increase land value and cash out)</li> <li>• Greenbelt Program helps farms co-exist with local residences</li> <li>• Purpose of Greenbelt is to keep land resource available for future farmers</li> <li>• Living in Ann Arbor as life-long residents (proximity to Ann Arbor amenities)</li> </ul>
Changes to Farm Operations	<ul style="list-style-type: none"> <li>• Ability to upgrade and change farm operations to remain competitive</li> <li>• Ability to maintain current operations and activities while in the Greenbelt (hunting, harvesting timber, farming, etc.)</li> <li>• Feeling in control of farm operations</li> <li>• Changing to accommodate new residential neighbors</li> <li>• Inability to expand due to loss of farmland</li> <li>• Greenbelt encourages farms to engage in long-term business planning</li> </ul>
Challenges Facing Farms/Farming Industry	<ul style="list-style-type: none"> <li>• Changes to farm industry threatening viability of farm and local farm community</li> <li>• Encroaching industrial farm businesses operating like prospectors that negatively impact quality of arable land and drive out farmers</li> <li>• Weather patterns</li> <li>• Small profit margins; farms less able to adapt to rising taxes, economic downturns</li> <li>• Sense of insecurity when neighboring farms are unable to continue operating</li> </ul>
Developers and New Residential Builds Threatening Farms	<ul style="list-style-type: none"> <li>• Skyrocketing taxes due to increasing property value</li> <li>• Interactions with “encroaching” residents (noise, pollution, and traffic from constructing new builds; complaints over smelly farms)</li> <li>• Proximity to Ann Arbor as a benefit and a cost</li> <li>• Turning productive farmland into subdivisions</li> <li>• Developers as “outsiders” of the community</li> <li>• Greenbelt has stopped frequent calls from developers offering to purchase their farms</li> <li>• Feeling “vulnerable” versus feeling “protected”</li> </ul>
Regional Agricultural Economics	<ul style="list-style-type: none"> <li>• Sharing/renting/working/selling/buying land as part of local network</li> <li>• Business/working relationships with neighbors to support them in times of need (aging farmers, farmers with children working “off the farm”)</li> <li>• Appreciation for local network of actors in farm industry (suppliers, processors, delivery services, distributors, markets, etc.)</li> <li>• Value of contiguous plots of farmland</li> <li>• Membership in cooperatives</li> <li>• Educational opportunities for local schools to learn about farms and farming</li> <li>• Hiring labor for farms</li> <li>• Proximity to business partners necessary for efficiently using outputs from land</li> </ul>

**Table 4.2: Analysis of Survey Comments by Ann Arbor Resident Property Owners**

Quotations (in italics) have been edited lightly for grammar and selected based on their representativeness of common patterns. Emphasis added in bold.

Categories of codes	Ideas associated with categories	Sample Comments
Personal Finances	<ul style="list-style-type: none"> <li>• Amount of taxes paid (paying too much, enough)</li> <li>• Affordability (for current residents/retirees/future residents)</li> <li>• Personal tradeoffs (cannot afford to pay more, limited budget)</li> </ul>	<p>“We are on a <b>fixed income</b> but feel the Greenbelt is a <b>better use of tax dollars</b> than a lot of government spending.”</p> <p>“I like farms, I like open space, <b>but cannot afford</b> any more taxes.”</p> <p>“The total local <b>tax burden</b> [...] increasingly drives middle-income residents to the townships.”</p>
Environmental Conditions/ Health	<ul style="list-style-type: none"> <li>• Pollution (water, air, soil)</li> <li>• Environmental degradation</li> </ul>	<p>“<b>Development</b> is just going along in a rushed, haphazard way. Auto <b>pollution</b> and idling cars, congestion, has been on the rise.”</p>
Personal Preferences	<ul style="list-style-type: none"> <li>• Impact on neighboring areas (development, gentrification, etc.)</li> <li>• Amount of green spaces</li> <li>• Recreation (swimming, hiking, biking, hunting, birdwatching7)</li> <li>• Increasing accessibility to green spaces</li> <li>• Sustainable farming, farmers markets, local food</li> <li>• Quality of life, diversity, economy of Ann Arbor</li> <li>• Property values (rising, falling)</li> </ul>	<p>“Protecting open spaces and farms is very <b>important</b> to us!”</p> <p>“I do not see a strategic value in this.”</p> <p>“The greenbelt properties are [...] not generally <b>accessible</b> to the public.”</p> <p>“Affordable housing and <b>diverse community is more important</b> to me.”</p> <p>“I want to improve <b>property value</b>.”</p> <p>“I feel this only benefits those <b>new developments</b> [in the Greenbelt].”</p>
Government Priorities	<ul style="list-style-type: none"> <li>• Government spending, taxes/funds</li> <li>• Budget and policy priorities</li> <li>• Competing city priorities: roads, snow/ice removal, library lot, ice rink, parks</li> <li>• City Council, Mayor</li> <li>• Deer cull/population/management</li> </ul>	<p>“Ann Arbor has great <b>open space</b> and <b>we love it!</b>”</p> <p>“What good are scenic views when you drive on crumbling <b>roads?</b>”</p> <p>“<b>More parks</b> would enhance Ann Arbor.”</p> <p>“You can’t have “Greenbelt” and NOT have <b>deer!</b> Quit killing them!”</p>
Greenbelt Program and Survey Feedback	<ul style="list-style-type: none"> <li>• Public outreach, education</li> <li>• Opinion on Greenbelt Program’s priorities, success, selection process, permanent restrictions</li> <li>• Opinion of CV Survey effectiveness and how it should be structured</li> <li>• Impact/concerns about infill/development</li> <li>• Experience with the vote</li> <li>• Other entities that are/should be engaged in preservation</li> <li>• Future outlook (sustainability of program for City, for resident taxpayers)</li> <li>• Population growth in Ann Arbor</li> </ul>	<p>“Greenbelt should be funded entirely by <b>voluntary</b> donations from those who believe in the program.”</p> <p>“I’m <b>proud</b> of our <b>forward-thinking</b> Greenbelt Program!”</p> <p>“Greenbelt money should be focused on <b>Huron River</b> areas”</p> <p>“I would personally prefer [preserved Greenbelt land] <b>close to the city boundary</b>.”</p> <p>“[...] we might as well try and save greenspace, as is <b>too late</b> to save the city from all the <b>hideous development</b>.”</p> <p>“Relying on <b>local property taxes</b> over and over is <b>not sustainable</b>.”</p> <p>“My concern is that <b>taxes continue to rise</b> and this could be a problem once I <b>retire</b>.”</p> <p>“I totally <b>oppose</b> a city purchasing development rights on a <b>permanent</b> basis”</p>

## **Challenges and Recommendations**

Considering our original research question, several themes have emerged in the research that give us insight on public understanding of the program as well as impacts on the farming community in the Greenbelt District.

### Challenges to Studying Social Impact of Greenbelt Program

*Financial Impact Survey for Landowners.* We mailed interview requests to each of the 24 landowners along with a financial impact survey. Although we received interest in participating in the interview portion of our study, we did not receive any responses to the financial impact survey.

*Interviews and Positionality.* Throughout the interview process, we remained aware of our role as researchers and graduate students and the potential biases that may influence interviewee responses. Prior to scheduling our on-site interviews, we provided landowners with the purpose of our interview and goal of our overall study. Despite our efforts, our interviewees appeared to have different ideas about who we were as a research team and our relationship with GAC. Some viewed our team favorably as extensions of GAC, which was helpful for gaining access to the interviewee. Others thought the interview was intended to provide direct feedback to GAC, and therefore may have been concerned about only saying positive things about the program. However, we found it helpful to clarify at the beginning of our conversations that the intent of the interviews was to provide generalized information about the impact of the Greenbelt on farm operators, rather than send quotations or feedback to GAC. To combat potential bias or uncomfortable conversations, we kept interviews conversational and casual. We also used academic literature and documents such as news articles and conservation easement deeds to corroborate events and facts mentioned in the interviews. After each interview, the researchers compared field notes to discuss potential biases in the conversations based on our own identities (as researchers, people who do not understand agriculture, graduate students, extensions of GAC, etc.)

*Access to Landowners.* Ideally, we would have been able to interview all 24 landowners to draw broader social understandings of identity and experience with the Greenbelt. Out of the eight landowners who had shown initial interest, however, only three were able to commit to interviews. Although we had limited interview data, we found that similar issues and patterns emerged, which gave us a reasonable foundation for constant comparative analysis (Fujii, 2017).

In addition to interviewing more Greenbelt landowners, it would have been ideal to conduct interviews with current, previous, or potential applicants to the Greenbelt Program. All applications to the program are kept confidential by the Greenbelt Advisory Commission until an agreement is reached and voted upon. These other applicants who were in the process of applying, who failed to work out an agreement with Ann Arbor, or who ultimately declined to sell their development rights, were not accessible to us, but could have provided more information about perception and barriers to participation in the Greenbelt Program.

### Recommendations

We found many differences in how landowners residing in the Greenbelt District and property owners in Ann Arbor view and value the Greenbelt. For the purposes of creating a mutual understanding of the goals and outlook of the Program, we recommend that the City of Ann Arbor consider addressing lingering questions and concerns through public education. For example,

many survey respondents seemed to be aware of the program during the millage vote, but unsure about its current operations, progress, costs, and benefits.

Below are several recommendations for future research:

*Missing Data.* If possible, we would recommend further research on populations of landowners that were not accessible to our team for this study. Applicants who are unable to join the Greenbelt Program or applicants who rejected proposed deals (e.g. due to lower than expected land valuation, preference to sell land to developers, etc.) with the City of Ann Arbor could have other critical points of views that would give us a more holistic understanding of the diversity of farm operators in the region and dynamics of residents within the Greenbelt District.

*Local Food.* This study touched upon the dynamics between farmers and emphasized the need for a local network of suppliers, processors, retailers, distributors, farmers. According to survey results, Ann Arbor residents were very interested in learning more about what types of farms and food production occur on Greenbelt properties. We recommend further research into Greenbelt farms and their contribution to the local food system by examining the flow of crops and farm products as well as farming practices.

*Interaction with other Land Preservation Programs.* This study focused on conservation easements that were primarily funded by the City of Ann Arbor. However, the City collaborates with and works alongside the townships, Washtenaw County, Southeast Michigan Land Conservancy, Legacy Land Conservancy, and the State of Michigan Department of Agriculture to preserve land all around the Ann Arbor region. We recommend expanding this research and working with other open space and agricultural preservation programs to learn how policies interact and impact the communities throughout the region.

*Impact of Greenbelt on Surrounding Townships.* For this study we only targeted Ann Arbor residents to assess their valuation and opinions about the Greenbelt Program. However, residents in neighboring townships also interact with the Greenbelt Program and the decisions made by Ann Arbor voters. Some townships, such as Webster Township, have similar long-term millages in place to support this program, and others do not or have rejected local ballot measures for such millages. We recommend further research to determine how complementary, competing, or failed millages may impact Greenbelt progress.

*Other Residents of Ann Arbor.* For the purposes of our economic valuation study, we targeted Ann Arbor residents who were most likely to own the homes they lived in. The purpose of that was to send surveys to people who were most directly impacted by the millage (i.e. paid property taxes that contribute to the Greenbelt funds). However, there are other residents in Ann Arbor who do not own property but may have voted on the millage (and expressed their values though they may not directly pay property taxes). These other residents may negatively or positively view and value the Greenbelt but contribute to the millage indirectly through a lease or rental property. We recommend expanding the survey to other voters and residents who do not pay property taxes directly to capture a fuller value of the Greenbelt to voters in Ann Arbor.

*Document Analysis.* Future research could also include an in-depth document analysis of high quality, objective data such as conservation easement agreements (which contain detailed information about activities, permitted uses, and exchanges of services) and news articles (available through MLive, Michigan Radio, and similar news outlets). Document analysis is advantageous for verifying values and concerns expressed in interviews and survey comments, confirming findings that are relevant to the broader population of interest rather than solely the subsample of respondents, and providing background on public discourse and the political history of the Greenbelt Program.

## **Case Study: Preserving the Family Dairy for Future Generations**

### Summary

In 2011, the Greenbelt Advisory Commission expanded the borders of the Greenbelt District to include parts of Lodi Township and Salem Township. This expansion allowed Steve Drake and his family to apply for and enter the Greenbelt in January 2013. By preserving farmland and removing development rights off 130 acres of his land, the Drake family has been able to withstand pressure from developers and rising taxes. As Steve Drake's children continue to learn and work on the dairy, they hope to eventually expand the amount of protected agricultural land in their neighborhood and pass the dairy on to future generations.



*Figure 4.1: Steve Drake is a third generation dairy farmer in Lodi Township.*

### Introduction

Preservation of agricultural land has benefitted many small, family farm operations in the Greenbelt District. Steve Drake (Figure 4.1) is a third-generation dairy farmer in Lodi Township and credits the Greenbelt Program with saving his dairy. The Drake family currently operates a small dairy with forty dairy cows. They are part of the Michigan Milk Producers Association, a cooperative representing over 1700 farmers in Michigan, Indiana, Ohio, and Wisconsin. This cooperative markets and processes milk which is made into fresh bottled milk, cheese, powdered milk, and butter (MMPA, 2018).

### Impact of Development Pressures

Although Michigan Milk provides market power to small dairy producers, the Drakes were struggling in the early 2000's to sustain their operations. During the Great Recession, milk prices plummeted (NASS, 2008), forcing the dairy to reduce production. Extensive residential development in Lodi Township was also causing land values and taxes to rise. As developers began to purchase farmland to convert into subdivisions, the taxable value of the Drake property was increasing at an unsustainable rate. With limited options, the Drakes were unsure about their future as a dairy.

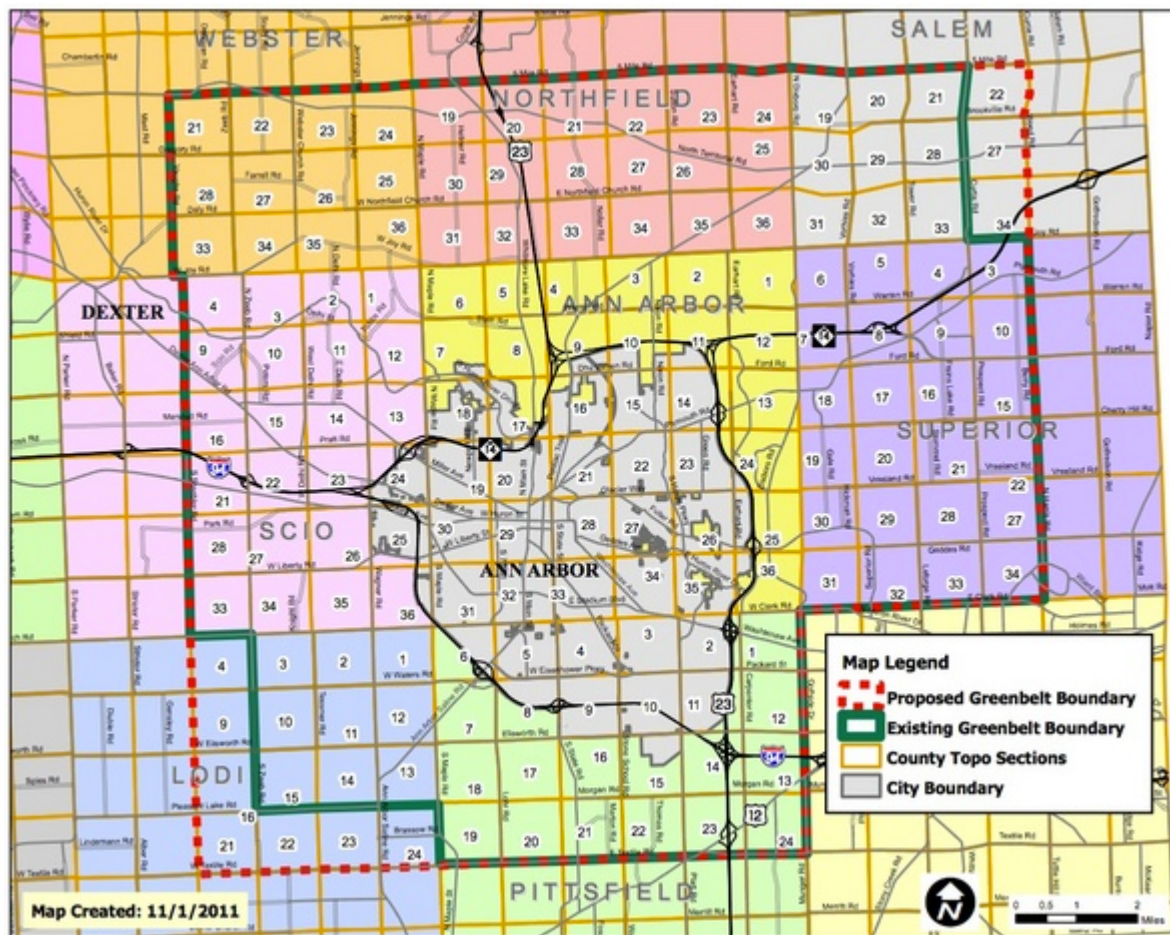


Figure 4. 2: Map of Greenbelt District and 2011 Expansion in Salem and Lodi (Stanton, 2011)



### Expansion of the Greenbelt District

The Drakes property was located just outside of the original Greenbelt District borders. After the Greenbelt lines were redrawn in 2011, Steve Drake applied to enter his land into the program. In 2013, the City of Ann Arbor purchased the development rights to 130 acres of open space and agricultural land for \$568,000. This conservation easement was funded with contributions from the City of Ann Arbor, Washtenaw County and Lodi Township (Conservation Easement Deed, filed February 7, 2013). The terms of the conservation easement have also opened the farm to the local community. Steve Drake is proud to open his farm to school field trips for children to learn about his farm. There is also limited public access on his woodlot for visitors to take walks, photograph, hunt, and extract timber from his woodlot.

The Drake Family Dairy is an excellent case of the three major themes found in our study.

#### **1) Promoting Resilience**

*“The Greenbelt is [preserving] a piece of ground so that I can keep farming.”*

Steve Drake recognizes that he would not have been able to sustain farming operations without the Greenbelt Program. As a small dairy farm, operations are sensitive to fluctuations in the milk market and land values, amongst other things such as soy bean prices. Permanently removing development rights from a large part of their land has helped them remain resilient and see a future for their farm. As the last family owned dairy in Washtenaw County, Drake sees his farm as a crucial part of local milk demand. His milk is transported throughout the region and processed into dehydrated milk, mozzarella cheese, and bottled milk. His cooperative has been able to meet demand for milk in Michigan, and often sells surplus to other states such as Pennsylvania and Ohio when they have milk deficits.

#### **2) Preserving Farming Legacy**

*“Passing it down from generation to generation [...] My goal is to be able to see my grandkids be able to do the same thing [dairy farming].”*

In addition to his individual farm’s survival, Drake also mentioned the importance of preserving the rural characteristics and farming community in the Ann Arbor area. Ann Arbor residents value the rural characteristics of the surrounding townships, and farmers in the townships enjoy the city amenities that Ann Arbor offers. Drake sees it as his responsibility to share the value of the local farm with others. This is why he is involved in education and shares his facilities with local youth raising livestock for activities such as the Saline Community Fair. Drake credits the Greenbelt Program with improving his outlook on the future of the dairy farm and his ability to continue the legacy of farming in Lodi.

#### **3) Regional Agricultural Economics**

*“[My grandparents] farmed in partnership for years. And that’s how community is supposed to be [...] we still work back and forth with the neighbor [...] help each other out.”*

The Drakes have also benefitted from the Greenbelt’s contribution to healthy regional agricultural economic activities. As dairy farmers, they rely on Michigan Milk to efficiently transport and distribute their milk to nearby processors and bottling plants. They rely on neighbors for sharing equipment and labor throughout the year. The Greenbelt Program’s strategy of focusing on farm clusters and prioritizing contiguous land helps provide a sense of stability for the individual farm. Multiple actors in the local farm network that have worked together for generations can make business decisions knowing their industry has chance to survive in the region. For the Drakes, who have been farming on their land for over eighty years, many of their neighbors are also friends and family.



*Figure 4. 3: Mr. Drake is proud to educate the public about the value of farms. He allows local youth to use his facilities to raise livestock for show at the Saline Community Fair.*



*Figure 4.4: Mr. Drake points to animals being raised by his son and daughter. His daughter is also involved in mentoring local youth and teaching them about dairy farming.*



## **Chapter 5:**

# **Economic Evaluation of the Greenbelt Program**

### **Relevant Appendices**

Appendix H: Contingent Valuation Survey

Appendix I: Non-disclosure Agreement

Appendix J: Contingent Valuation Survey Results

Appendix K: Contingent Valuation Analysis Results

### **Background on Economic Analysis**

Several approaches and methods were considered for the economic evaluation of the Greenbelt Program. Each one was scrutinized for its applicability to the Greenbelt Advisory Commission (GAC) and its feasibility for successful implementation. Feasibility was measured for each approach by considering data availability, the time needed for each approach, and the relevance of the scope of each approach to the project goals. The primary hurdle faced in selecting the proper technique was the unique structure of the Greenbelt Program. The program is supported via funds generated through tax revenues from the Open Space and Parkland Preservation millage, which is levied on the property owners of Ann Arbor (Ord. No. 17-04, 2004). However, the Greenbelt portion of the millage conserves open spaces and farmland outside of the City's limits. This created an issue regarding spatial disconnect – the economic evaluation needed to include taxpayers within City limits, but the land protected by the Program was outside the City boundaries. Many of the analytical approaches that are typically appropriate for valuing environmental amenities were thus unsuitable due to either spatial or economic divide. Given these conditions, a non-use value perspective was ultimately determined to be the best approach for the situation. The following section details the methods considered for an economic analysis and why they were ultimately not selected as a part of the study. The method that was eventually utilized, the Contingent Valuation Method, is introduced afterwards.

### **Methods Considered**

#### Greenbelt Farm Contributions to Local Food Markets

As mentioned in Chapter 4, our team initially considered conducting a study of the commodities grown on Greenbelt properties. The goal of this would have been to identify and assess the types and quantities of each good being sold locally in Ann Arbor. The results of such a study would have informed GAC about the linkages between millage taxes and the local goods generated from protected farms. In pursuing this approach, we sent a letter to Greenbelt farmers asking if they would be willing to share information regarding local sales with us. However, no responses were

returned to the group. Given the sensitive nature of financial information, we decided to not pursue this route further.

Identifying and quantifying local sales from Greenbelt farms could pose as an interesting endeavor for the Greenbelt Advisory Commission in the future. Members of the Commission who are more familiar with the various Greenbelt properties and their owners could identify and gather data from farmers that sell produce in local marketplaces. In addition to this, Ann Arbor market surveys and interviews could determine the sources of goods that are deemed “local”. This information could then be used to identify the proportion of local goods that come from Greenbelt farms.

### Hedonic Pricing Method

Hedonic price analyses have been conducted on other greenbelt programs, thus the initial interest for this study. This method was developed in the early 1960s to help recognize the impacts that certain indirect characteristics and features have on the prices of certain goods, such as a beautiful view affecting the price of a house (a feature that isn’t directly part of the house) (Nicholls and Crompton, 2005). This method was later adopted by environmental economists to understand the impact of certain environmental characteristics (e.g. distance to a greenbelt property) on the market value of a home. Essentially, the Hedonic Pricing Method relies on the Proximate Principle, which states that the value of residential properties is partially influenced by nearby amenities such as parks (Crompton, 2001b). In Austin, Texas researchers found that greenways (undeveloped recreational land) had significant positive impacts on proximate property values (Nicholls and Crompton, 2005). In Boulder, Colorado, a hedonic price analysis revealed that for every foot one moves away from a greenbelt property, the property value decreases \$10.20 (Correll et al., 1978).

For our study, we considered using the hedonic pricing method to evaluate impacts of protected Greenbelt properties on market values of nearby homes and neighborhoods. However, unlike the studies referenced above, the properties of the Ann Arbor Greenbelt that were of interest for this project (farms and open spaces outside the city) are not heavily utilized for recreational purposes and are also typically more isolated from residential housing. The hedonic method is more applicable when greenbelts/green spaces are adjacent to homes and/or are utilized for recreational purposes, such as parks and hiking trails. As mentioned before, this project focused solely on Greenbelt properties outside of city limits and typically within an agricultural area. Given this, any potential analysis on how these properties might impact home prices would only be applicable to homes outside of city limits. Such information would not be useful for directly connecting any economic impacts of the Greenbelt with the property owners of Ann Arbor, who fund the program via the millage tax.

### Cost of Community Services Method

This approach was developed by the American Farmland Trust (AFT) as a simple tool to establish community-specific data about land uses and costs (American Farmland Trust, 1993). Outputs from COCS studies are valuable for determining whether certain types of land uses are “paying for their own existence” through taxes or if they are creating a net imbalance for the local government to maintain and operate them. The outcome of a COCS study is a set of ratios that compare the tax revenues of specific land uses to the costs of government services to that same type of land (Kelsey, 1996). These ratios provide a straight-forward comparison of the costs and benefits of different land uses.

Unfortunately, due to the geographic distribution of the Greenbelt sites, the COCS approach would not have been able to provide useful results. The millage is being leveraged on Ann Arbor property owners to fund purchase of development rights on areas outside of city limits. The purchasing of development rights in these areas does conserve farmland, which typically is a beneficial type of land use under the COCS lens (farmland generates tax revenues with little to no public service dollars for operation and maintenance). However, this doesn't necessarily benefit the Ann Arbor taxpayers who are a focus for this evaluation. While some public services in Ann Arbor may be utilized by neighboring townships such as the Ann Arbor Township, as a whole there is not a clear or specific relationship between Ann Arbor taxes/public services and the areas where Greenbelt properties are located. Because of this, the COCS approach was not utilized for this project. A COCS would be a worthy pursuit for the GAC to pursue along with partner organizations in order to see how farmland impacts each of the townships and/or the county where the Greenbelt properties lie. A relevant study that may contain useful information or serve as a baseline for a Greenbelt COCS was produced approximately 10 years ago by the Huron River Watershed Council (Riggs, 2007).

While there was potential to pursue COCS and other methods for this study, ultimately a contingent valuation technique was chosen as the most effective approach for an economic evaluation of the Ann Arbor Greenbelt.

## **Overview of Contingent Valuation Method**

### Introduction

To perform an economic analysis of the Greenbelt that included the taxpayers of Ann Arbor, an approach utilizing the Contingent Valuation Method (CV or CVM) was selected as the most appropriate for the context of this study. Specifically, since tangible connections between the Greenbelt and Ann Arbor residents were unclear, it was determined that a non-use viewpoint was necessary to assess how the Greenbelt is valued. Simply put, CV asks what dollar amount people place on the continued existence of the Ann Arbor Greenbelt. Given that the millage is reaching its half-way point, the value that taxpayers now place on the program can be equated to benefits they receive from its existence. The results of such an analysis would be a cost-benefit comparison between the existence value of the Greenbelt (benefits) and what property owners pay in taxes (costs).

CV is one of the most common techniques utilized in what are broadly known as Stated Preference (SP) studies. SP studies are used to provide estimates of economic value via questions administered through surveys or interviews. This is typically done through a carefully designed hypothetical, yet realistic, scenario in which specific changes to the good of interest (such as environmental conservation) are proposed (Kling et al., 2012). SP studies generate unique data based on the responses to these scenarios and in doing so aim to capture the total value of a good that has no market. SP studies are the only known method for estimating the value of non-use goods, which are goods in which no market data exists (Johnston et al., 2017).

In the case of CV, hypothetical changes are proposed to an existing good and respondents are asked to state their Willingness to Pay (WTP) for these changes. For this study, the change being

valued was the continued existence of the Ann Arbor Greenbelt Program. This question was developed as a referendum vote posed to the public, as is common in CV. A WTP to keep the program in existence indicates that the program is valued and that individuals feel they benefit from having it. Determining the specific level of WTP will elicit a sense of how much the program is valued in an economic sense.

An early synthesis of this method describes three central components of a CV survey or interview, which still hold true to this day as CV best practices (Mitchell & Carson, 1989). They are:

- 1) A hypothetical situation described using specific and relevant details that create a realistic market for the good to be valued. This situation is to describe a baseline condition of the good, the method of payment for the good, and the potential alternatives to the good barring changes to the baseline;
- 2) A willingness to pay question related to the good being valued; and
- 3) Auxiliary questions regarding the individual responding to the survey or interview, including their opinions of the good being valued.

### *Use of CVs in Environmental Economics*

Valuing non-use goods through a specifically designed survey can be traced back to the 1940's (see Bowen, 1943 and Ciriacy-Wantrup, 1947 in Carson, 2012). CV studies, however, only appear sporadically in research until Krutilla noted the importance of the existence value of natural resources and how there might be a willingness to pay for the preservation of such goods in a landmark paper titled *Conservation Reconsidered* (Krutilla, 1967). Thereafter, CVs became more frequent in the environmental economics literature and eventually gained momentum in the 1980's. This was largely due to their use in estimating the value of damages to natural resources in governmental lawsuits – a power granted through the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (Portney, 1994).

CVs gained a more widespread popularity following the application of the method to value the damages caused by the Exxon-Valdez oil spill in Alaska's Prince William Sound (Carson et al., 1992). The results from the Carson et al. CV study on the willingness to pay to avoid another such spill concluded a total value of \$3 billion using a non-use value approach. A similar study evaluating the costs of direct economic losses from the spill resulted in just a \$4 million figure (Carson, 2012). This substantial difference between non-use valuation and direct valuation can be attributed to the high existence value that people placed on the Alaskan ecosystems that were impacted by the spill. There has been much debate over the appropriateness and validity of contingent valuation studies, and much work has been done over the past three decades to test varying hypotheses and methods (Kling et al., 2012, Hausman, 2012, Haab & McConnell, 2002). At the same time, CVs and other SP approaches are recognized as the only way to elicit any kind of estimate for the non-use or existence value of a good (Carson, 2012). To date, over 7,500 CV studies have been used to establish the non-use value of various environmental resources (Snowball, 2012). In addition to this, a Blue-Ribbon panel of economic experts was formed to study the applicability of CVs following controversies over the CV for the Exxon-Valdez oil spill. This panel found that if researchers are able to carefully design a survey under a specific set of guidance recommendations and also justify their methods and results, then CVs can be seen as meaningful approaches to estimate WTP (Arrow et al., 1993).

### *Applicability to Study*

As mentioned above, a CV approach was appropriate for the case of the Greenbelt Program because it provided information on the existence value of the program to Ann Arbor taxpayers (its non-use value). In a CV study, a hypothetical market is constructed where individuals make a decision that is hinged on their perceptions of the benefits (or lack thereof) of a non-use good. In this study, the continued existence of the Greenbelt Program was placed in a hypothetical scenario for survey respondents to consider. In doing so, we asked individuals to assess whether the existence of the Greenbelt Program is of economic value to them, and if so, how much. Responses to these questions can help to better understand the value that the taxpayers of Ann Arbor place on the Greenbelt. In addition to the benefits of valuing the Greenbelt, administering a survey was identified as being of considerable worth to the client of this project. Through the survey, we were able to ask supplementary questions regarding perceptions and knowledge of the Greenbelt and gained valuable feedback via open responses incorporated in the survey's open comment box.

A survey with a CV question provided the most efficient means of gathering relevant information given the time and resources provided for this study. The survey provided novel information on the Ann Arbor Greenbelt and thus advanced the understanding of how the Greenbelt is perceived and valued after 15 years of existence. In addition to this, results from the CV portion of the survey can be compared to the costs of the Greenbelt Program in a straightforward benefit-cost analysis. The following section details how the survey for this study was designed and administered.

## **Survey Design Methods**

### Survey Framework

Our survey instrument was comprised of three primary sections: Part A consists of auxiliary questions and serves as a warm-up to the CV section, Part B is the CV section which is preceded by an information briefing on the Greenbelt Program and followed by Greenbelt-related questions, and Part C consists of demographic questions. The following page contains a breakdown of the sections, the type of questions asked, and the actual questions themselves. A complete copy of the survey instrument is available in Appendix H. A breakdown of the questions is as follows:

Ann Arbor Greenbelt Survey				
Part	Number	Question	Sub-Question	Type
A	1	Please estimate the number of times in the last 12 months that you participated in each of the following activities.	Visited outdoor recreation areas for hiking, camping, or biking in Washtenaw County Swam, kayaked, canoed, or boated on the Huron River or its tributaries Fished, birdwatched, or hunted in Washtenaw County	Open-Ended
	2	Please answer the following questions by marking the box that best describes the degree to which you agree or disagree with each of the following statements.	Ann Arbor offers scenic views Being able to buy local produce is not important to me There are more open spaces in Ann Arbor than in other places I've lived Being able to buy organic food is not important to me Ann Arbor and the surrounding area offers extensive outdoor recreational activities	Likert
B	3	The Greenbelt Program is the only issue on the ballot and would cost your household \$X every year for 15 years.	Yes or No follow up questions based on response to this question	Contingent Valuation (Dichotomous Choice)
	4	Please mark the box that best describes the degree to which you agree or disagree with the following statements.	I value having farmers in my community Open space in the Greenbelt does not add value to Ann Arbor and the surrounding area Preserving open space in the Greenbelt is a valuable use of tax dollars Open space is not visually attractive I knew a lot about the Ann Arbor Greenbelt prior to this survey	Likert
	5	Please rank from 1 to 4 in order of importance to you, with 1 being most important. (Greenbelt goals)	Protect natural areas Establish more scenic views Preserve local farmland Contain development to urban areas Don't know	Ranking
C	1	How long have you lived in Ann Arbor?	0-4 years 5-9 years 10-14 years 15-19 years 20+ years	Closed-Ended
	2	Do you rent or own your current residence?	Rent Own	Dichotomous Choice
	3	What is your highest completed level of education?	Middle school or less Some high school High school graduate Vocational Some college Associate's Degree Bachelor's Degree Advanced/Graduate Degree	Closed-Ended
	4	How many people live in your household?	Adults (18+) Childred (<18)	Open-Ended
	5	What is your annual household income before taxes?	Less than \$9,999 \$10,000-\$24,999 \$25,000-\$49,999 \$50,000-\$74,999 \$75,000-\$99,999 \$100,000-\$124,999 \$125,000-\$149,999 \$150,000-\$174,999 \$175,000-\$199,999 \$200,000-\$249,999 \$250,000-\$299,999 Greater than \$300,000	Closed-Ended

Our survey design was informed from a highly relevant, detailed, and comprehensive guidance document for stated preference studies which contained a list of recommendations for best practices in CV survey design (Johnston et al., 2017). In general, the authors recommended that effective methods for survey design include a clear presentation of baseline conditions, how those conditions are proposed to be changed, and how these proposed changes would be valued. Next, we summarize the key recommendations from this paper (paraphrased for brevity and clarity) and how they relate to our study. Note that the references to SP studies are synonymous with the CV method.

**Recommendation 1:** Stated Preference (SP) surveys should present the baseline condition, the mechanism of change, and the changes to be valued in a clear and acceptable format.

This recommendation aims at creating surveys that allow for respondents to accurately anticipate the potential effects that a change to the baseline condition may have on their welfare. The information presented in a survey should not only be clear and easy to understand for a diverse set of recipients but should also be something that they find credible. In the case of our survey, we utilized a vote for the continuation of the Open Space and Parkland Preservation Ordinance as a framework to base our CV question on. Our survey frames the hypothetical situation in the following format:

*“Suppose that an election is being held today with a ballot proposal to continue the Greenbelt Program for 15 additional years. The renewal of the Program is expected to preserve an additional 5,000 acres of farmland and natural areas within the current Greenbelt Program boundary. If the renewal were to fail, no additional land would be conserved under the Greenbelt Program.”*

The framing of the continuation of the ordinance was geared to add credibility to our question so that respondents gain the sense that this survey may be used to inform future policy decisions. In this same sense, the mechanism of change and changes to be valued are also clear. The program would continue through positive votes and an expected 5,000 additional acres of farmland and natural areas would be conserved as a result. Conversely, responding “no” to this question results in a termination in the program and no extra conserved land.

**Recommendation 2:** Pretest the survey for both qualitative and quantitative measures.

This recommendation serves two purposes: to establish a palatable and relevant distribution of bid prices and to determine if questions are understandable to a broad audience. Bid prices are defined as the assigned dollar value related to the valuation question. A bid price is given to survey recipients and they are asked to answer YES or NO to whether they would pay that price for the specific change of the good being valued. Quantitative pretesting is typically used to support hypothesis testing and to help determine bid intervals. Given that this survey was based on an existing and known distribution of millage values, we felt that our bid prices were justified, and a pretest was not needed. This decision also coincides with the short time frame and limited budget to administer the survey. The method for determining the bid prices for the survey used in this study is detailed in the *survey development section*.

Pretesting is also useful to determine if survey recipients are given the appropriate amount of information in surveys to make informed decisions and value questions accurately (Boyle, 2003).

This would have been of use for our survey, but the study team lacked the time and resources necessary to bring in a focus group or conduct one-on-one cognitive interviews. However, the content of the survey and framing of information that was presented was developed and reviewed with exceptional feedback from the client, two project advisors, and several members of the Greenbelt Advisory Commission.

**Recommendation 3:** Choosing between a Contingent Valuation and a Choice Experiment (CE) requires how three questions may be answered.

A CE study evaluates whether the change to be valued will affect specific characteristics of an item while a CV evaluates the changes to the item as a whole. Our CV approach is applicable because we sought to elicit the value for a fixed set of changes through the continuation of GB program for 15 years, with an estimated 5,000 extra acres of easements. If, for example, respondents were to be asked about adding more acres specifically for open space, or to select a preference for an allocation of the millage funds, then a CE study would be more appropriate.

**Recommendation 4:** CVs should be designed with unbiased and relevant estimates of preference parameters and should present how value estimates were generated.

Values in CV studies are typically generated from empirical research or from survey pretesting. Our study had the convenience of having existing millage values of our target population to base survey bid values on. Using the actual millage values makes the values we sent to survey recipients credible, easy to understand, and realistic.

**Recommendation 5:** Review boards (University or otherwise) should review surveys and any other relevant portions of the study, especially if focus groups and/or in-person interviews are a part of the study design.

Our survey was reviewed and approved by the University of Michigan's Institutional Review Board (IRB) on 11/14/2017. It was listed as Exempt under Exemption #2 of the 45 CFR 46.101.(b): *“Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.”*

Our data has been analyzed using non-identifying codes that only project researchers have access to. Following the completion of the study, these codes can be removed and the remaining data will be turned over to the project client or deleted completely, depending on their wishes. We did not utilize focus groups or have any in-person interactions as a part of this component of the project, so an IRB approval was not sought out for direct human subject interactions.

**Recommendation 6:** The most appropriate mode of survey instrument is applied and data collection is context specific, but the rationale for choice should be documented. Extent of market (survey recipients) should also be justified to be in accordance with the context of the study.



The mode of the survey was based on the existing Open Space and Parkland Preservation millage. The survey is framed as a re-vote to either continue or discontinue the millage, as if at the time of the survey the millage period was at an end. Basing the survey on the existing millage gave us a valid rationale for the data collection and framing of the choice posed to the survey recipients. The survey recipients were a subsample of the Ann Arbor population (the market extent) which was a straightforward decision given the nature of the millage and context of the study.

A mail survey was chosen over an interview approach, which is also utilized in CV studies. Given the limitations of time and budget, a mail survey was determined to be more effective at capturing a larger sample size than what was achievable through interviews. A mail survey also allowed for convenient comparisons between surveys and actual millage information of households through simple address matching.

**Recommendation 7:** WTP should not be a default, and WTA can be considered given the proper setting and survey instrument.

Willingness to Accept (WTA) is how much a household or individual would accept in compensation for something negative, such as pollution or damages to an amenity. Given that the specific payment vehicle for this study is a vote on a tax, and that the relevant valuation question relates to renewing the Greenbelt Program, the WTP approach was appropriate for our survey. WTP in the context of a stated preference study is the survey respondent's maximum willingness to pay for a specific change in a non-use good.

**Recommendation 8:** For CV response formats, the use of a single, binary choice is preferred (at least for a public good), but others may be considered.

A binary choice (also known as dichotomous choice) format was utilized in our survey. Other methods applied in CVs include open-ended CVs, bidding games, and payment cards. Open-ended CVs ask the respondent to provide a specific dollar amount indicating their WTP for the good in question. Bidding games are typically used during in-person interviews and involve asking a certain amount of WTP and sequentially raising/lowering this amount until a specific point of WTP is reached. Payment cards involve respondents choosing a point or a range of WTP values from a list of values that were determined appropriate for the survey by the researchers.

Binary choice is the most common approach in CV surveys and is preferred to these other methods due to its incentive compatibility (Haab & McConnell, 2002). Incentive compatibility means that survey respondents are provided the motivation to truthfully respond to questions in a survey, thus matching their real preferences (Cummings et al., 1997). Positive incentives for truthful responses result from a binary choice model because, generally speaking, respondents may view the restriction of two options as potential considerations for policy outcomes (Cummings et al., 1997). In addition to incentive compatibility, binary choices reduce the opportunity to skew results through unrealistic responses. This would be a concern with open-ended responses, where one respondent can skew results through unrealistically high or low WTP estimates.

Following recommendations from several studies, we chose to expand upon the single binary choice method by utilizing a double-bounded dichotomous choice (DBDC) approach. The DBDC

method involves asking one bid question that is followed up by a second bid question. The bid amount provided in the second question is dependent on the answer to the first. In the case of our survey, a “Yes” response to the first bid question resulted in a second bid that was twice the original bid price and a “No” response to the first bid resulted in a follow-up bid that was half the original bid price. The DBDC CV question appeared as follows in the surveys administered in this study:

<b>The Greenbelt Program is the only issue on the ballot and would cost your household \$ __[X]__ every year for 15 years.</b>			
<b>Question 1. Given this information, would you vote in favor of the Greenbelt Program?</b>			
<input type="checkbox"/> YES		<input type="checkbox"/> NO	
<b>If you answered YES to Question 1, please proceed to Questions 2a and 3a.</b>		<b>If you answered NO to Question 1, please proceed to Questions 2b and 3b.</b>	
<b>Question 2a. Would you be willing to pay [2X]?</b>		<b>Question 2b. Would you be willing to pay [0.5X]?</b>	
<input type="checkbox"/> YES	<input type="checkbox"/> NO	<input type="checkbox"/> YES	<input type="checkbox"/> NO

A double-bounded approach has been found to increase statistical efficiency when compared to a single-bounded method (Hanemann, Loomis, & Kanninen, 1991; Hanemann, 1995). The combinations of yes-no and no-yes responses help to determine clearer bounds for WTP estimates and allows for the models used in analysis to be fitted with more observations since the number of responses is increased (Haab & McConnell, 2002).

**Recommendation 9:** A no-answer option is not always necessary to include in a CV question.

We did not include a no-answer option (i.e., a protest response). Given that these were mail surveys, recipients are voluntarily returning their responses and in doing so can choose not to answer a question if they so wish. A no-answer option may have allowed for participants to forego the thought process that is intended to be associated with answering a CV question and just choose the quick response of no-answer. This would potentially negate the purpose of including the CV question.

**Recommendations 10 & 11:** A credible decision rule should be chosen for the CV question. Payment vehicle should be realistic, credible, familiar, and binding for respondents. Payments should be clear and noted as being fixed as well.

The bid question in this survey was based on a previously voted on issue. Our hypothetical vote thus mimics this real-world example and can be considered as a credible, realistic, familiar, and binding decision. The payment method was clearly noted as being a millage tax per year.

**Recommendation 12:** Auxiliary questions should be included with the survey to evaluate validity of responses. These questions should have a specific and relevant purpose to complement the CV question and should be pretested along with the CV question.

Outside of the DBDC CV questions, 17 auxiliary questions were asked as part of the survey. Questions ranged from demographic information (income, years lived in Ann Arbor, etc.) to perceptions on farming and viewsheds. These questions can be found in the survey instrument in Appendix H. Four of these questions were asked in a “reversed” manner that allowed for an evaluation of the validity of survey responses. As mentioned previously, survey questions were not pretested on a focus group, but were vetted through several channels.

**Recommendation 13:** Truthful responses should be encouraged through clear consequences to choices.

Consequences to choices were related to tax payments that support the program. Given that these same payments are already made by the survey population, the consequences of the hypothetical vote are straightforward and relevant. In addition to this, information provided within the survey helps to build on these consequences in terms of program outcomes and time and duration of payments.

### Survey Development

As previously mentioned, this survey focused solely on Ann Arbor residents. Specifically, our population of concern was residents who pay property taxes in Ann Arbor and thus are subject to the millage tax from the Parkland Preservation and Open Space Millage. The following section generally describes how a targeted population and sample were selected, how bid prices were determined, and how the survey was administered.

#### *Population Target*

The source data for this project was collected from the City of Ann Arbor and was obtained through special permission granted to the project group through a Non-Disclosure Agreement (NDA) (See Appendix I). The data consisted of an Excel file which contained descriptive data on City parcels and a GIS shapefile containing spatial information of Ann Arbor properties.

The initial step in selecting a target population of Ann Arbor property owners involved a spatial selection of parcels located only in Ann Arbor. The database contained information that included neighboring townships and unincorporated areas, hence the need for this step. In addition to selecting for Ann Arbor parcels, the data were also filtered at this stage to only include residential properties owned by residents of Ann Arbor (as opposed to an out-of-state homeowner, who may be leasing the home). Following these steps, a total of 23,855 properties were selected. The resulting spatial data of these properties were then converted to an Excel document, which was then appended to the City parcels data.

The new file contained the relevant information regarding Ann Arbor homeowner’s taxable values, addresses, and the listed owner names. The taxable value of a property is what is used in Michigan to calculate property taxes such as the millage, hence the relevance to this study. Upon examining the data on taxable values in our dataset, it was noted that there were abnormal values ranging from \$0-\$10,000 which were deemed too low to be considered reliable data. These values (102 properties total) were removed from the dataset. Following this, the top and bottom 2% of taxable values were removed in an effort to discard any more extreme values, a normal practice in survey design. The resulting data, our target population, contained 22,683 properties. The distribution of taxable values and descriptive statistics can be found in Table 5.1, which also shows the same information for millage values. The associated millages with the taxable values of our target population were calculated using the following formula, which was found on the Ann Arbor city website:

$$(Mill\ Rate/1,000) * Taxable\ Value = Mill$$

According to the Open Space and Parkland Preservation Millage, the mill levied on Ann Arbor residents for the Greenbelt Program is 0.5, or one-half mill (Ord. No. 17-04, 2004). Calculating the millages for our target population resulted in an average mill value of \$62.01.

Taxable Values						
Population	N	Mean	Max	Min	Median	SD
Target Population	22,683	\$124,012.20	\$361,994.00	\$32,412.00	\$109,539.00	\$60,978.38
Millage Values						
Population	N	Mean	Max	Min	Median	SD
Target Population	22,683	\$62.01	\$181.00	\$16.21	\$54.77	\$30.49

*Table 5.1: Descriptive Statistics of Taxable Values and Millage Values of Ann Arbor Target Population*

### Sample Selection

Following the process above, the cleaned Ann Arbor data were further refined in preparation for selecting a sample. The first step was to filter for properties where the listed owner address was the same as the listed property address. The reasoning for this was to capture a sample that consisted solely of home owners. Home owners were targeted because they are responsible for paying their own property taxes and are thus the appropriate population to be capturing in a vote regarding millage rates. While it is recognized that other taxpayers in Ann Arbor can vote on millage propositions, there was concern that there would be too much ambiguity with how the payment vehicle of a new millage would affect renters and other residents in economic terms.

Following this data selection, a sample size of 1,366 was chosen at random from the target population. A sample size of 1,300 surveys was the maximum amount that this study was able to administer given budget constraints. We oversampled to 1,366 in case any of the selected participants had missing data or if property owners were listed as rental companies or trusts. The names of property owners were then manually organized into a first name/last name format for convenience in printing labels for mailing purposes. The sample was then randomly trimmed down to the desired sample size of 1,300.

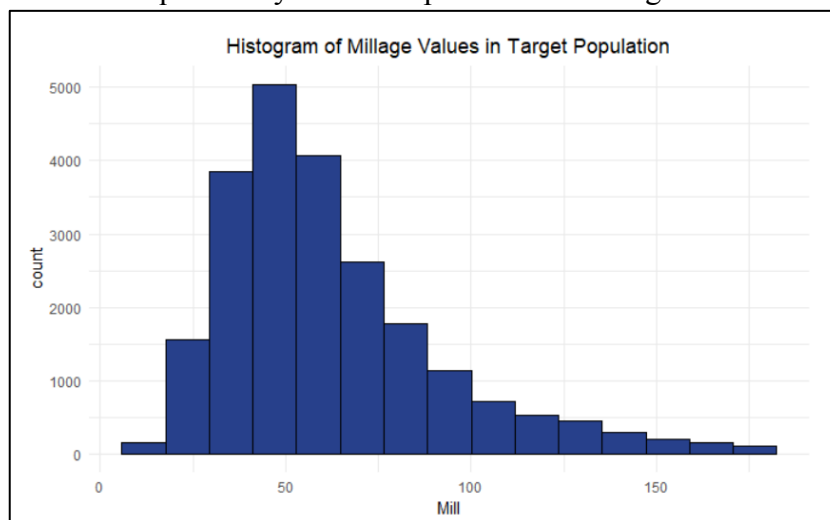
The final sample had a mean Taxable Value of \$125,610.30 and an average mill for the Greenbelt millage (0.5 mill rate) of \$62.82. The sample had a Taxable Value range of \$33,481-\$361,932 and a mill range of \$17-\$181. These values closely resembled the original population to a level that was representative of what was needed for this study. Table 5.2 shows this comparison:

Taxable Values						
Population	N	Mean	Max	Min	Median	SD
Target Population	22,683	\$124,012.20	\$361,994.00	\$32,412.00	\$109,539.00	\$60,978.38
Sample	1500	\$125,610.30	\$361,932.00	\$33,481.00	\$111,484.00	\$60,728.72
Millage Values						
Population	N	Mean	Max	Min	Median	SD
Target Population	22,683	\$62.01	\$181.00	\$16.21	\$54.77	\$30.49
Sample	1500	\$62.82	\$181.00	\$17.00	\$56.00	\$30.36

*Table 5.2: Comparison of Targeted Population and Sample: Taxable Values and Millage Values Assigning Mill Values*

After the sample (n=1,300) was determined, mill values were randomly assigned to each individual household. These values were generated to match the proportion and distribution of millage values in both our sample and the target population. Once randomly assigned, they would then become the bid prices presented to survey recipients in their CV question (for example, in the sentence “Would you be willing to pay \$X for a certain good? “X” would be the bid price). The general process for assigning these bid prices is outlined in the following section.

Fifteen separate bid values were chosen based on bins from a histogram of mills from our targeted population, as is represented in Figure 5.1. Each bar in this histogram represents the number of properties that pay a millage between a certain range. The 15 bid values were calculated based on the average of each range in the 15 bars of the histograms. A level of 15 different bins was determined appropriate through discussions with the study group and the project investigators. These bins represent 15 unique surveys with bid prices listed in Figure 5.2.



*Figure 5.1: Histogram of Targeted Population Millages*

This study was using the current payment of millage values as a proxy for an estimated willingness to pay that may otherwise be determined through survey pretesting and focus groups (see

Recommendation 2 in the *Survey Design* section). Given this approach, we wanted to conserve both the distribution and the proportion of mill values from the target population in our sample. Since the sample had a similar distribution of millage values as the target population, the proportions of millage values in the two groups were also comparable, as is illustrated in Figure 5.2.

Population					Sample			
Bid	Bid Price	Number of Individuals	Percentage of Total		Bid	Bid Price	Number of Individuals	Percentage of Total
1	\$ 20	1303	5.7%		1	\$ 20	75	5.8%
2	\$ 35	3041	13.4%		2	\$ 35	174	13.4%
3	\$ 45	4669	20.6%		3	\$ 45	266	20.5%
4	\$ 55	4287	18.9%		4	\$ 55	246	18.9%
5	\$ 65	2889	12.7%		5	\$ 65	166	12.8%
6	\$ 80	2002	8.8%		6	\$ 80	115	8.8%
7	\$ 90	1430	6.3%		7	\$ 90	82	6.3%
8	\$ 100	867	3.8%		8	\$ 100	50	3.8%
9	\$ 110	594	2.6%		9	\$ 110	34	2.6%
10	\$ 120	473	2.1%		10	\$ 120	27	2.1%
11	\$ 130	396	1.7%		11	\$ 130	23	1.8%
12	\$ 145	272	1.2%		12	\$ 145	16	1.2%
13	\$ 155	183	0.8%		13	\$ 155	10	0.8%
14	\$ 165	153	0.7%		14	\$ 165	9	0.7%
15	\$ 175	124	0.5%		15	\$ 175	7	0.5%
	<b>Total:</b>	<b>22,683</b>	<b>100.0%</b>		<b>Total:</b>	<b>1,300</b>	<b>100.0%</b>	

Figure 5.2: Comparison of The Proportions of Individuals and Surveys in Each Bid Level

After the distribution and proportions of mill values were confirmed to match the target population, the sample was randomly sorted and bid values were assigned sequentially to this new random list. For example, the first 75 households in this random list received a bid price of \$20, the next 174 households received a bid price of \$35, and so on. Each observation was then assigned a specific survey identification number for later matching of response surveys to relevant data.

#### *Creating and Sending the Surveys*

The sample list with the newly generated bid prices was used to print the surveys. To print, 15 surveys (all identical with the exception of the 15 unique bid prices) were taken to a printing service. They were copied according to the “Number of Surveys” column listed in Figure 5.2. Names and addresses of the sample households were printed using an automated label printer. These labels were attached to individually stamped envelopes which contained the survey and a return envelope that was pre-addressed and stamped for convenience. All 1,300 surveys were sent out via USPS in early 2018.

# Results

## Survey Results

Of the 1,300 surveys that were sent out, 441 were completed and returned to the study group. 20 additional surveys were sent back as “return to senders”, indicating an invalid household address. This reduced our sample size to 1280 and resulted in a final response rate of 34.45%. The following sections detail the main results of survey questions. Many figures and tables associated with the survey can be found in Appendix J. The CV question is covered in a separate section titled *Contingent Valuation Results*, which follows the reported survey results below.

### Survey Part A

Part A of the survey consisted of auxiliary questions with a general environmental theme. It was comprised of a question with three open-ended components and a question with five statements asking survey respondents to rank their level of agreement with each statement. This system utilized the Likert scale that is typically utilized in questionnaires. It asks respondents to select whether they “Strongly Disagree”, “Disagree”, are “Neutral”, “Agree”, “Strongly Agree”, or “Don’t Know” with the associated statement.

Question 1 of Part A is open-ended and asks how many times people have participated in three different outdoor activities. Table 5.3 in Appendix J shows the average responses, the maximum amount reported, and the sum of total counts of self-reported outdoor activities.

Question 2 of Part A consists of five opinion-based statements with corresponding rankings based on a Likert scale. These statements were related to opinions of Ann Arbor, open spaces, and attitudes towards organic food. Results of this section are visualized in Figure 5.3.

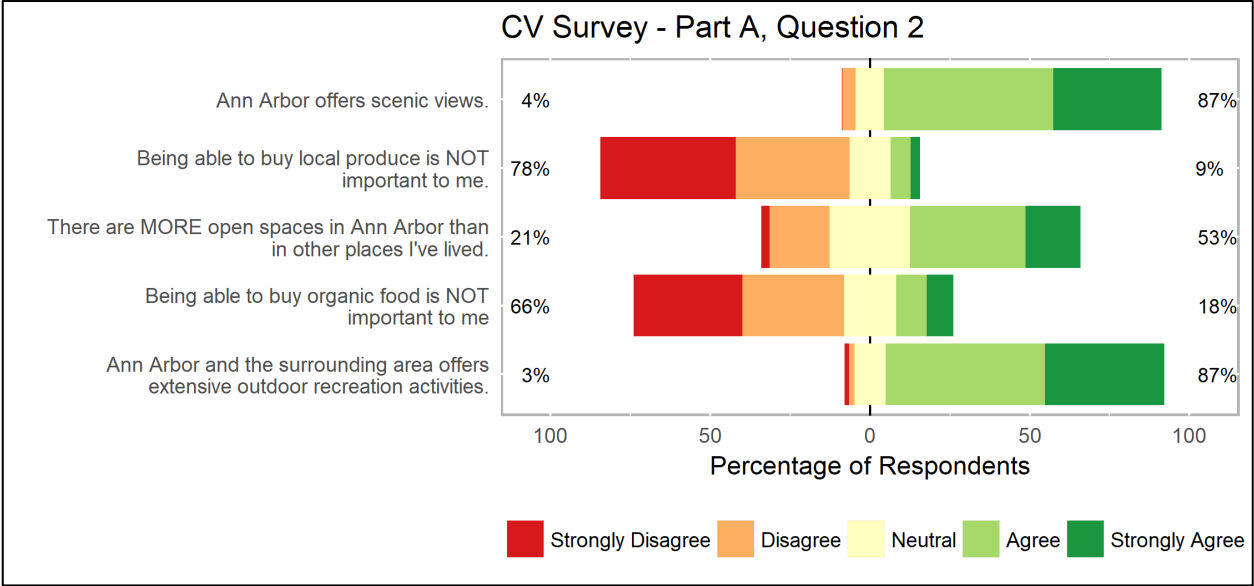


Figure 5.3: Responses to questions from Part A Question 2

### Survey Part B

Part B continued with five opinion-based statements with corresponding rankings based on a Likert scale in a manner consistent with Part A. These questions were focused primarily on attitudes towards the Greenbelt. Results of this section are displayed in Figure 5.4.

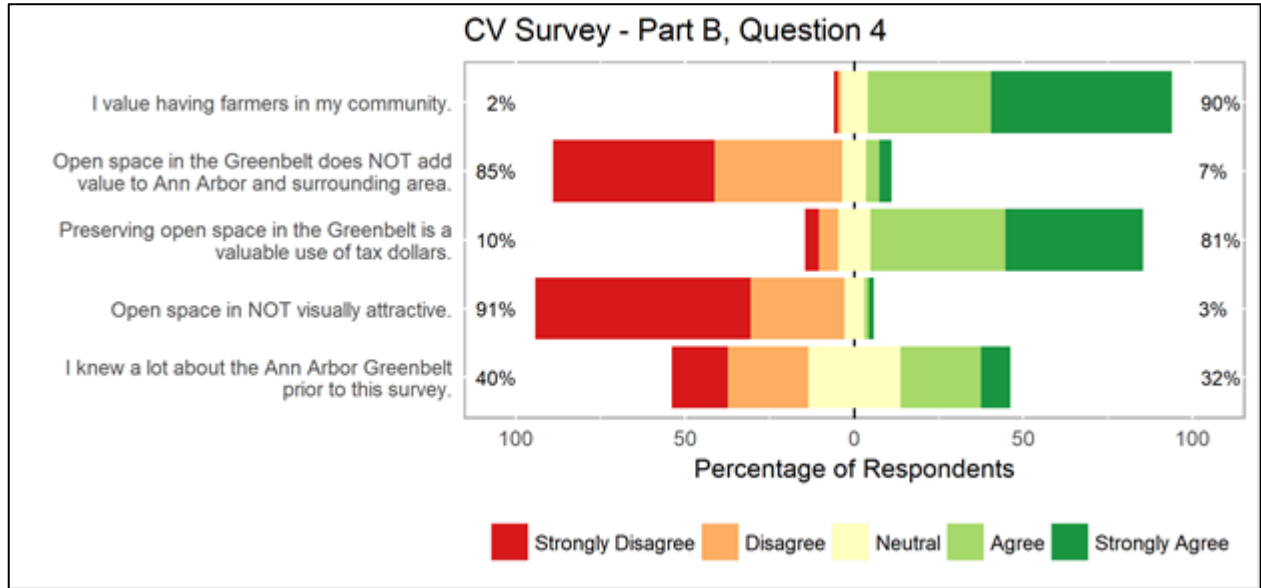


Figure 5.4: Responses to Part B Question 4

Part B also asked respondents to rank the importance they place on each of the general Greenbelt goals. The responses to these rankings can be found in Figure 5.5 in Appendix J.

### Survey Part C

Part C of the survey was composed of basic demographic questions. The demographic composition of our survey respondents can be found in Figures 5.6-5.8 in Appendix J.

### Contingent Valuation Results

Table 5.4 shows the breakdown of response rates for each bid. A histogram of the millage values presented to respondents and a comparison of this distribution to the millage values presented to the total sample can be found in Appendix K Figures 5.9 and 5.10.



<b>Bid</b>	<b># Sent</b>	<b># Returned</b>	<b>Response Rate</b>
\$ 20	75	27	36%
\$ 35	174	64	37%
\$ 45	266	82	31%
\$ 55	246	91	37%
\$ 65	166	61	37%
\$ 80	115	33	29%
\$ 90	82	27	33%
\$ 100	50	13	26%
\$ 110	34	12	35%
\$ 120	27	10	37%
\$ 130	23	8	35%
\$ 145	16	4	25%
\$ 155	10	6	60%
\$ 165	9	3	33%
\$ 175	7	0	0%
<b>Totals:</b>	<b>1300</b>	<b>441</b>	<b>34%</b>

*Table 5.4: Survey Response Rate*

Of the 441 respondents to the survey, 428 responded to both the original bid question and the follow-up question from the second bid. Approximately 83% of respondents indicated a “yes” response to the first bid question. In all, over half of the 428 respondents responded with two “yes” responses to the bid questions. The responses to the bid amounts provided can be seen in Table 5.5 and visualized in Figures 5.11 and 5.12.

Bid	# Returned	Responses to Bid							
		YY	YY %	YN	YN %	NN	NN %	NY	NY %
\$ 20	27	18	67%	3	11%	5	19%	0	NA
\$ 35	64	36	56%	19	30%	6	9%	2	3%
\$ 45	82	46	56%	27	33%	6	7%	1	1%
\$ 55	91	45	49%	29	32%	10	11%	5	5%
\$ 65	61	32	52%	18	30%	6	10%	2	3%
\$ 80	33	17	52%	9	27%	5	15%	2	6%
\$ 90	27	11	41%	10	37%	4	15%	2	7%
\$ 100	13	2	15%	2	15%	3	23%	4	31%
\$ 110	12	3	25%	5	42%	3	25%	1	8%
\$ 120	10	4	40%	4	40%	1	10%	1	10%
\$ 130	8	4	50%	2	25%	0	NA	1	13%
\$ 145	4	2	50%	2	50%	0	NA	0	NA
\$ 155	6	1	17%	3	50%	0	NA	1	17%
\$ 165	3	1	33%	1	33%	1	33%	0	NA
\$ 175	0	0	NA	0	NA	0	NA	0	NA
<b>Totals</b>	<b>441</b>	<b>222</b>	<b>52%</b>	<b>134</b>	<b>31%</b>	<b>50</b>	<b>12%</b>	<b>22</b>	<b>5%</b>

Table 5.5: Breakdown of Yes-Yes, Yes-No, No-No, and No-Yes Responses from the double-bounded contingent valuation question

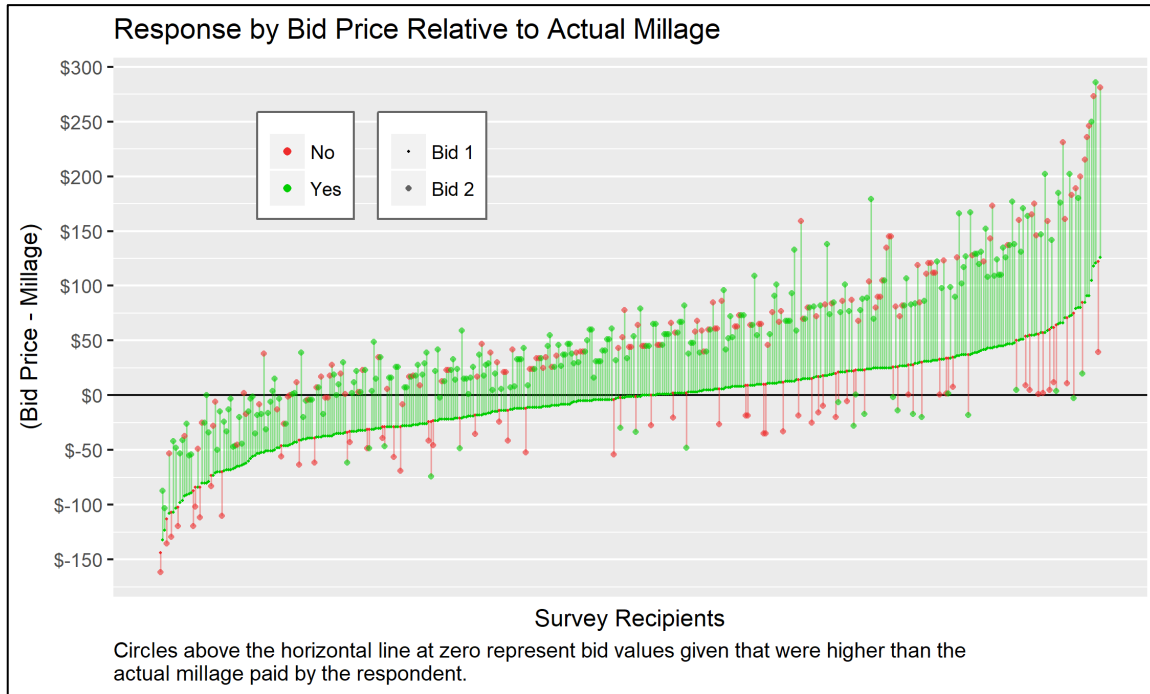


Figure 5.11: Comparison of bid price received to what survey respondents actually pay for the Greenbelt Millage. This figure also shows how they responded to the initial bid price, which is symbolized by a green (“yes” response) or red (“no” response) dot along the continuous “s-shaped” line. A “yes” response to the first bid is represented by a positive vertical green line ending in a dot indicating their response to the follow up bid price. A “no” response to the first

*bid is represented by a negative vertical red line ending in a dot that also symbolizes what their follow up bid price was and color-coded by how they responded.*



*Figure 5.12: The levels of bid values and their corresponding responses. The dots represent the bid amount provided and the colors of the dots represent the response. Green vertical lines indicate a “yes” response to the original bid price and red vertical lines indicate a “no” to the original bid price.*

### WTP Results

Consistent with previous reports utilizing the double-bounded dichotomous choice (DBDC) method, WTP was analyzed through both nonparametric and parametric analyses (Carson et al., 2003, Carson, Wilks, & Imber, 1994). Both analyses were carried out with the use of the DCchoice package in the statistical software program R (Aizaki, Nakatani, & Sato, 2014).

#### *Nonparametric Analysis*

Nonparametric analysis allows for the complete relaxation of assumptions made on the distribution of WTP and is considered the most “straightforward” and least-restrictive analysis of WTP in DBDC studies (Abdullah & Jeanty, 2011, Haab & McConnell, 2002). Instead of relying on assumptions, a nonparametric analysis empirically estimates the survival function that gives the probability of observing a specific value of WTP (Aizaki, Nakatani, & Sato, 2014). While the calculations to obtain WTP are simple, nonparametric analyses are limited in the amount of economic information that they provide given their lack of covariates.

Nonparametric estimates of WTP were generated using the Turnbull distribution-free estimator, also known as the Kaplan-Meir-Turnbull estimator (Aizaki, Nakatani, & Sato, 2014). Figure 5.13 shows the survival function of respondent’s WTP using the Turnbull estimator. A WTP “survives”

a bid level when a respondent indicates they are willing to pay that bid amount. A full table of bid levels and survival probabilities can be found in Appendix K. The Turnbull estimator resulted in a confidence interval for a median WTP of \$155-\$160 with a 95% confidence level. The mean WTP was estimated at \$155.92 under the Kaplan-Meier approach, which cuts off estimations at the maximum bid level for which there is data (\$330 in our results).

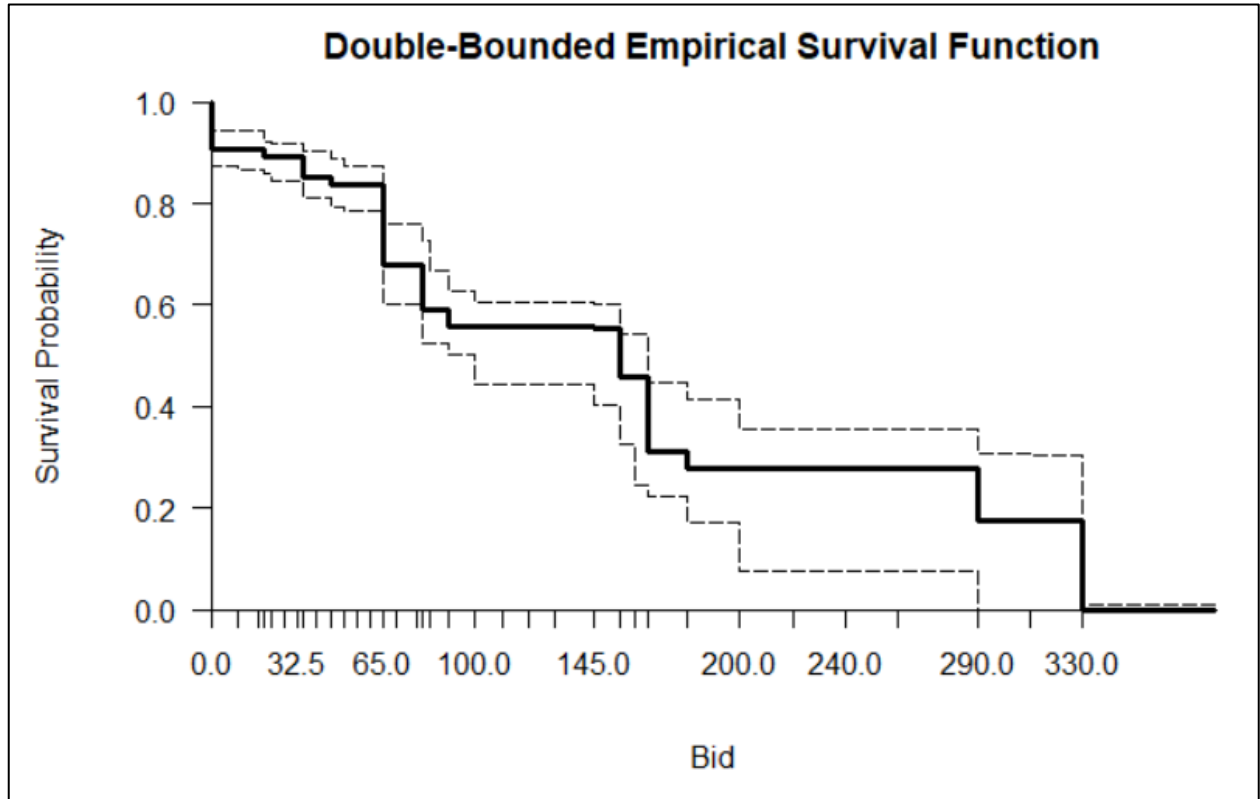


Figure 5.13: Survival function of the nonparametric WTP with confidence intervals at the 95% level. Mean WTP is the area under the line (up until a bid value of \$330) and the Median WTP corresponds to the value(s) at 0.5 survival probability.

#### Parametric Analysis

Parametric analyses provided by the DCchoice package utilize the utility difference approach when estimating WTP (Aizaki, Nakatani, & Sato, 2014). This approach maximizes the log-likelihood function based on assumptions of the distribution of the function. The log-likelihood function is as follows:

$$\ln L = \sum_{n=1}^N [d_n^{yy} \ln \{P^{yy}(t_n, t_n^U)\} + d_n^{nn} \ln \{P^{nn}(t_n, t_n^L)\} + d_n^{yn} \ln \{P^{yn}(t_n, t_n^U)\} + d_n^{ny} \ln \{P^{ny}(t_n, t_n^L)\}]$$

First, a parametric “null model” was administered to serve as a benchmark for subsequent models. A null model only includes the bid values and no other covariates. The results of the null model are as follows:

*Null Model Results:*

Null Model					
Coefficients:					
	Estimate	Std. Error	z-value	Pr(> z )	
(Intercept)	7.0706	0.4645	15.22	<2.2e-16	***
log(bid)	-1.4482	0.1005	-14.42	<2.2e-16	***
Observations	428				
Log-likelihood	-500.17				
AIC	1004.34				
***p<0.001					
WTP Estimates:					
Mean	346.47				
Mean	161.93	(truncated at the maximum bid)			
Mean	204.86	(truncated at the maximum bid-adjusted)			
Median	131.95				

*\*The first mean reported is based on an unmodified error distribution, while the second and third means operate with the error distribution truncated at the maximum bid level in the data (Aizaki, Nakatani, & Sato, 2014). The adjusted mean utilizes a method developed by well-known CV practioners (Boyle et al., 1988).*

Following the null model, education level, income level, and two variables, titled “Value1” and “Visual1”, were added to the model to generate WTP estimates. Education and income are typical characteristics that affect economic decisions and were thus included in all models of analysis. Value1 and Visual1 were chosen from a set of questions from the survey that were relevant to the Greenbelt and were also suspected as being correlated with responses to the CV question.

The Visual1 variable was from Part B Question 4 and asks for the respondent’s opinion on the statement “Open space is NOT visually attractive”. This question was coded numerically on a 1-5 scale with a “Strongly Agree” response being a 1 and a “Strongly Disagree” response being a 5. Value1 was taken from the same part of the survey and asks for respondent’s opinion on the statement “Open space in the Greenbelt does NOT add value to Ann Arbor or the Surrounding Area”. This response was also coded on a 1-5 scale using the same approach for the Visual1 variable. The combination of these variables in the parametric double-bounded model resulted in the following output:

Model 1 Results:

Model 1				
Coefficients:				
	Estimate	Std. Error	z-value	Pr(> z )
(Intercept)	-2.7829	1.9541	-1.424	0.1544
Edu1	0.2811	0.1300	2.162	0.03061 *
log.income	0.3680	0.1589	2.316	0.02054 *
Value1	1.2658	0.1481	8.548	<2.e-16 ***
Visual1	0.3276	0.1489	2.2	0.02781 *
log(bid)	-2.0428	0.1471	-13.885	<2.e-16 ***
Observations	372			
Log-likelihood	-354.86			
AIC	721.71			
***p<0.001 **p<0.01 *p<0.05				
WTP Estimates:				
Mean	195.7			
Mean	152.58 (truncated at the maximum bid)			
Mean	174.34 (truncated at the maximum bid-adjusted)			
Median	127.19			

*\*The first mean reported is based on an unmodified error distribution, while the second and third means operate with the error distribution truncated at the maximum bid level in the data (Aizaki, Nakatani, & Sato, 2014). The adjusted mean utilizes a method developed by well-known CV practioners (Boyle et al., 1988).*

Education level (Edu1), income (log.income), and the variable “Visual1” were all statistically significant at a 95% confidence level. The variable “Value1” was statistically significant at a 99.9% confidence level. Each of these significant variables resulted in positive estimated coefficients, as would be expected. This implies that households were more likely to respond yes to the CV question as the variables increased in value. These results are consistent with economic theory: as income and education levels increased, and as support for the value and visual aspects of the Greenbelt increased, so did the likelihood of the WTP for the continuation of the Greenbelt Program. The estimated coefficient on the bid presented to survey respondents was also statistically significant at the 99.9% confidence level with a negative sign. This implies that as bid values increased, the likelihood of the WTP of respondents decreased – a finding that is both expected and consistent with literature (Aizaki, Nakatani, & Sato, 2014).

Benefit-Cost Comparison:

The values of estimated WTP were then aggregated with the goal of computing the economic benefits that Ann Arbor homeowners accrue from the existence of the Greenbelt. From these benefits, we compared the total costs of what homeowners actually pay for the Greenbelt Program in a straightforward benefit-cost analysis.

Consistent with previous CV studies, benefits were summed based on the Median WTP value from Model 1. More information on this decision can be found in the *Discussion* section under *WTP & CV Discussion*. Additional comparisons using the estimates from the mean WTP values, the Null

Model and the Nonparametric Model can be found in Appendix K Tables 5.6-5.8. Costs were found using existing data on the millage tax payments of homes. Comparisons are made at four levels: responding households, sampled households, targeted Ann Arbor homeowners, and for the City of Ann Arbor as a whole.

Benefits	Costs
Estimated Median WTP x # Households	Sum of Millage Tax Payments



	# Households	Benefits	Costs	Difference
<b>Responding Households</b>	441	\$ 56,090.79	\$ 28,699.00	\$ 27,391.79
<b>Sample Households</b>	1,300	\$ 165,347.00	\$ 81,665.00	\$ 83,682.00
<b>Targeted AA Homeowners</b>	22,683	\$ 2,885,050.77	\$ 1,406,484.00	\$ 1,478,566.77
<b>City of Ann Arbor*</b>	NA	\$ 2,885,050.77	\$ 2,383,653.00	\$ 501,397.77

\*City of Ann Arbor comparisons made with actual aggregate tax payments to the program for 2017 (costs) and the WTP estimates we calculated from our targeted homeowners

Table 5.9: Benefits and costs compared using Median WTP of \$127.19 generated from Model 1 multiplied by number of households to calculate benefits

## Discussion

### Survey Discussion

#### *Survey Part A, Question 1*

The open-ended questions asking respondents to indicate their frequency of certain outdoor activities over the past year generated ambiguous results. Respondents varied in their interpretation of the question and the listed activities, which was made clear in both the distribution of responses and through comments that individuals wrote directly on their survey. For example, one respondent indicated that they “Visited outdoor recreation areas for hiking, camping, or biking in Washtenaw County” 365 times in the past year. Next to their response, they wrote a comment indicating that they walk their dog in a nearby park every day. This question was meant to capture levels of interaction with intentional outdoor recreational activities such as hiking, camping, or biking. However, due to the various degree of interpretations that were apparent in the results and comments, this question was disregarded in our analyses.

#### *Survey Part A, Question 2*

Question 2 of Part A had two statements that received overwhelming support through positive indications of “agree” or “strongly agree”. These two questions were “Ann Arbor offers scenic views” and “Ann Arbor and the surrounding area offers extensive outdoor recreation activities”. Approximately 87% of respondents answered positively to both statements (see Figure 5.3). This indicates strong support for Ann Arbor being a scenic area with broad outdoor opportunities.

Statements asking about local food and organic food also received support indicating that respondents in general felt that these types of food were important to have available. Both statements were reversed to test for respondent’s attention to survey questions. Given the

distribution towards “disagree” and “strongly disagree” responses, and the consistency with these responses to other questions, we feel that respondents in all were accurate in their interpretation of this section’s questions.

#### *Survey Part B, Question 4*

Three statements in Question 4 of Part B received over 85% of responses on one end of the Likert scale (either “agree” or “strongly agree”, or “disagree” or “strongly disagree”), and one question received 81% support (“agree” or “strongly agree”). The three statements with the most one-sidedness were: “I value having farmers in my community”, “Open space in the Greenbelt does NOT add value to Ann Arbor and surrounding areas”, and “Open space is NOT visually attractive”. The first statement received positive responses and the latter two received negative responses, which was expected given their reversed nature. The fourth statement with 81% supporting the statement was “Preserving open space in the Greenbelt is a valuable use of tax dollars”. These responses express a high amount of support for the Greenbelt and its associated goals, an important takeaway from the survey.

The most evenly distributed responses on the Likert scale came from the statement “I knew a lot about the Ann Arbor Greenbelt prior to this survey”. This is a very telling response and is also useful information to our client. Approximately 40% of respondents selected a “disagree” or “strongly disagree” response to this statement, signifying that they did not know very much about the program prior to the survey. This could be related to the timeline of the program – after 15 years of operation the Greenbelt may have lost some of its momentum in the public’s eye. The identified lack of awareness of the program can help drive future outreach and educational opportunities going forward.

#### *Survey Part B, Question 5*

Question 5 in Part B asked respondents to rank the four general goals of greenbelts according to what they deemed as the most important to least important. 68.5% of respondents selected “Protect natural areas” as the top goal in terms of importance. This preference corresponds to support for conservation measures, which is a goal of the Greenbelt program.

### WTP & CV Discussion

#### *Benefits Outweighing Costs*

As demonstrated in Table 5.9, all WTP estimates place the value of the existence of the Greenbelt as being greater than the total costs that households pay for the program through millage tax payments. In the final row of the table, the benefits estimated from the targeted 22,683 households were compared to the total costs to all property taxpayers in Ann Arbor from 2017. These costs include many more households than were targeted for the estimated benefits, but even so the benefits still outweighed the costs by approximately \$500,000. This difference amounts to what is known as Consumer’s Surplus, which is the net benefit of the Greenbelt Program (benefits minus costs). The positive Consumer’s Surplus found in our benefit-costs analysis indicates that households are willing to pay more for the program than what they actually pay. This support for the program is further exemplified by the significant amount of “yes” and “yes-yes” responses shown in Table 5.5, Figure 5.11, and Figure 5.12. This finding is also consistent with other comparisons that use different estimations of WTP, which can be found in Appendix K.



### *A Conservative Comparison*

Model 1 represents WTP estimates that are on the conservative end (lower dollar values of WTP estimates) compared to other models that were not included in this study. Comparisons using less conservative estimates from the Null Model and Nonparametric Model can be found in Appendix K Tables 5.6-5.8. The estimated WTP values from these models are displayed in comparison with the Median WTP from Model1 in Table 5.10 below. Using a more conservative approach is consistent with popular CV studies and is appropriate given uncertainties in survey biases and model design (Carson et al., 2003).

The median willingness-to-pay value from Model1 was applied deliberately to the main benefit-cost analysis (Table 5.9) to construct a conservative estimate of the benefits. Other WTP estimates, such as those listed in Table 5.10, were all greater than the \$127.19 estimate and would thus lead to even larger net benefit values.

Source	WTP Estimate	CBA
<b>Model1</b>		
Median	\$ 127.19	Table 4.9
Mean	\$ 195.70	--
Mean (Truncated)	\$ 152.58	Table 4.6
<b>Null Model</b>		
Median	\$ 131.95	Table 4.7
Mean	\$ 346.70	--
Mean (Truncated)	\$ 161.93	--
<b>Nonparametric</b>		
Mean	\$ 155.92	--
Median (low)	\$ 155.00	Table 4.8
Median (high)	\$ 160.00	--

*Table 5.10: WTP Estimates and Related Sources*

Using a conservative figure to generate estimates of the benefits is consistent with much of the academic literature (Carson et al., 2003). Furthermore, the comparison of benefits and costs at the city level, which is displayed in the final row of Table 5.9, is also conservative. This comparison includes costs from many households that are not included in our benefits calculations due to uncertainties over the number of households that are subject to the millage. Even in this case, the estimated benefits outweighed the costs. The only comparison that led to negative net benefit values (benefits < costs) was a comparison that divided the estimated benefits in half (Table 5.11). Using this arbitrary approach still only resulted in two of the four comparisons having negative net benefits, one of which being at the city level, an uneven comparison. Given that the benefits exceeded the costs in these conservative analyses, it is with confidence that the Ann Arbor Greenbelt Program passes the benefit-cost test and is economically a favorable program for Ann Arbor homeowners.

### *Uncertainties and Limitations*

In terms of uncertainties and limitations regarding the survey results, we cite concerns over the credibility of responses (hypothetical bias), response bias, the potential misunderstandings of the Greenbelt Program, and the benefits/costs considered.

### Hypothetical Bias

As noted in recommendations 10 and 11 in the *survey framework* section, the payment mechanism for the CV question must be credible and binding to be taken seriously by respondents. In the context of our survey, the credibility is valid considering it is based on an existing vote, but it is unclear how binding respondents found our valuation question to be. The CV question we presented was based on a hypothetical voting scenario which in reality does not have the potential to impact the Program in the near future. The Program and its associated millages will run for another 15 years under the current policy. Because of this, responses to this survey cannot be used to influence any changes in the near-term.

While influencing policy was not a goal of this survey, it is still important to note this point from the standpoint of survey respondents. If survey respondents were aware that their responses had low, or no, consequences, then it is possible that responses may be different from what actual WTP amounts may be. This relates to the phenomenon of hypothetical bias, which is a common concern with CV studies. Hypothetical bias occurs when responses to hypothetical scenarios differ from real-world behaviors (Hausman, 2012). This typically results in inflated WTP estimates when compared to actual behaviors. In the context of our study, hypothetical bias would lead to responses of WTP that are higher than what would be reflected in a real-world voting scenario. To compensate for hypothetical bias, it has been recommended to divide WTP estimates in half to determine more realistic estimations (Hausman, 2012). Table 5.11 shows the median WTP estimates from Model1 divided in half and compared to the costs of the program. With this approach, the benefits only outweigh the costs for the Sample Households (n=1,300) and the Targeted Ann Arbor Homeowners (n=22,683). Once again, the comparison to the costs at the City of Ann Arbor level should be taken lightly, as the costs factor in a larger number of households than what was used for the benefits calculations.

	# Households	Benefits	Benefits/2	Costs	Difference
<b>Responding Households</b>	441	\$ 56,090.79	\$ 28,045.40	\$ 28,699.00	\$ (653.61)
<b>Sample Households</b>	1,300	\$ 165,347.00	\$ 82,673.50	\$ 81,665.00	\$ 1,008.50
<b>Targeted AA Homeowners</b>	22,683	\$ 2,885,050.77	\$ 1,442,525.39	\$ 1,406,484.00	\$ 36,041.39
<b>City of Ann Arbor*</b>	NA	\$ 2,885,050.77	\$ 1,442,525.39	\$ 2,383,653.00	\$ (941,127.62)

\*City of Ann Arbor comparisons made with actual revenue of program for 2017 (costs) and the WTP estimates we calculated from our targeted homeowners

*Table 5.11: Using median WTP of \$63.60 (approximately half of estimated \$127.19 WTP)*

### Response Bias

In addition to hypothetical bias, we also recognize that responses to our survey may be biased based solely on who responded. No special incentives or protocols were deployed in order to promote responses to surveys. Because of this, it is possible that those who responded feel strongly (either negatively or positively) about the Greenbelt Program, Ann Arbor policies, or other related topics. This concern is reflected in the Likert responses in Part A and Part B of the survey, which tended to be skewed one way. This concern is known as self-selection bias and adds a general uncertainty to generalizing the WTP estimates to the city as a whole. If those who responded were also those who feel strongly one way or the other, then our study lacks the data from those who are more indifferent to the program or to local policies.

To expand on this, U.S. census data indicate that the Median household income for Ann Arbor is \$57,697 (U.S. Census Bureau QuickFacts: Ann Arbor city, Michigan). The Median self-reported household income for our survey respondents was \$100,000. Census data also indicate that 73% of Ann Arbor residents (ages 25+) have a Bachelor’s Degree or higher. Approximately 88% of our survey respondents indicated they had attained a Bachelor’s Degree or higher. In both cases, our survey respondents were found to be well above the typical values for Ann Arbor, indicating a potential issue with generalizing this data to the rest of the taxpayers and residents of Ann Arbor.

Misunderstanding the Greenbelt Program and/or Survey

Some respondents elected to write in open-ended responses on the back of their surveys, an option encouraged in the survey design. It was noted that in these responses people commonly referenced parks as being part of the Greenbelt Program. While the survey was crafted to try to divert attention away from the park component of the millage, it seems that this still may have been factored into responses. In addition to this, the responses to Question 5 in Part B also led to concerns -- 69% of respondents selected “Protect natural areas” as their most important goal of greenbelt programs. This may indicate an impression that the Ann Arbor Greenbelt is primarily geared towards conservation of natural areas instead of farmland *and* natural areas. Given these two factors and the lack of prior Greenbelt knowledge among many respondents, misunderstandings of the Greenbelt program may be present in our survey respondents. These misunderstandings may lead to inflated WTP estimates if respondents are operating under the assumption that the program matches with their own personal preferences, which may not be the case.

Scope

A final limitation of our analysis, and a potential route for future studies, is the scope for the benefits-costs comparison. The benefits considered in this comparison only include those that survey respondents place on the existence value of the Greenbelt Program. The costs considered only include the property taxes that homeowners pay through the millage. Other benefits and costs that could potentially be considered for the program as a whole include but are not limited to:

Benefit Categories:	Cost Categories:
-Homeowners outside of AA but in Greenbelt District	-Program expenses (IT, administrative, etc.)
-Direct benefits to landowners participating in the program	
-Benefits from reduced runoff OR benefits from avoiding increases in runoff	

**Conclusion**

Several different approaches were considered for the economic evaluation of the Ann Arbor Greenbelt. This project focused on a non-use valuation approach and utilized a contingent valuation method to generate results. This was appropriate given the limited uses and interactions with the Greenbelt by residents of Ann Arbor, who fund the program through property taxes (a millage) via the Open Space and Parkland Preservation Millage.

The contingent valuation method was applied as part of a survey sent to Ann Arbor homeowners. Survey recipients were selected at random and all responses were voluntary. Results of the contingent valuation question generated an estimated median willingness-to-pay for the continued existence of the Greenbelt of \$127.19 – a value that when aggregated significantly outweighed the real costs of the program. This value was chosen from several other estimates of WTP due to its conservative nature. Other estimates resulted in even greater values placed on the existence of the Greenbelt, leading to even greater net benefits (benefits minus costs). While biases and limitations such as hypothetical bias, response bias, and a narrowed scope of focus exist in our project, this all-around conservative approach to estimating WTP leads to more confidence in our cost-benefit analysis. Based on the findings of this study, the Greenbelt Program is estimated as at least breaking even in terms of costs paid versus the value that is placed on the program.

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## Appendix A: Examples of LULC Classification

**Developed:** Includes any buildings on Greenbelt properties, as well as maintained lawn surrounding those buildings.



**Transportation:** All roads and driveways, excluding minor roads within cropland.



**Cropland / Forage:** Cropland is indicated by signs of tillage, or extremely uniform dark green. Row crops appear in various stages of harvest in this imagery.



**Pasture:** Signs of pasture included worn animal tracks and stables / animal buildings. Confirmation of pasture was sought by Shannon Brines.



**Grassland:** Uneven shades of green, with small shrubs and trees, and no signs of tillage.





**Shelterbelt:** Narrow (<10m) tree lines between or next to agricultural fields.



**Forest:** Any area with greater than 60% tree cover. Boundaries between Forest and Forested Grassland were not always obvious.



**Forested Grassland:** Between 10% and 60% tree cover. Boundaries between grassland and forested grassland were not always obvious.



**Wetland:** Often indicated as the shoreline of a waterbody. An older wetland shape layer from the Huron River Watershed Council was used as ancillary data. Wetlands within forests were only delineated if obvious thinning of trees was accompanied by ancillary indication of wetlands.

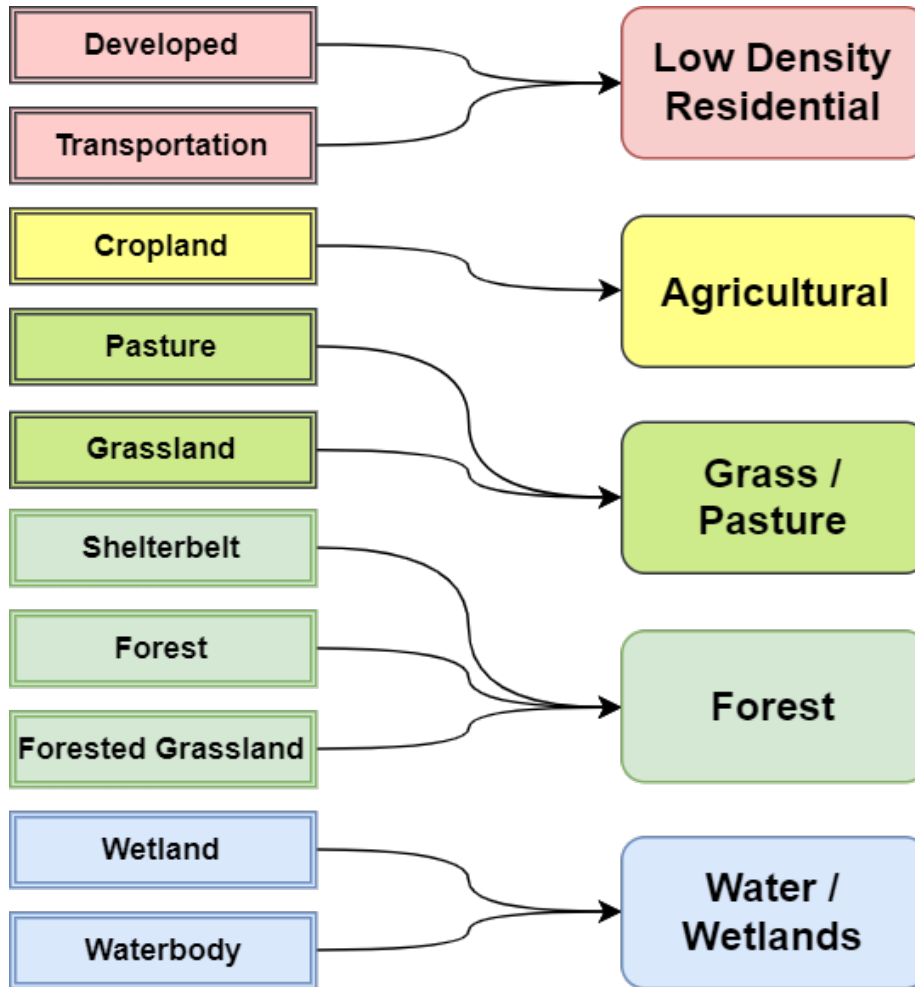


**Water:** Open water bodies, greater than 10m in diameter.



## Appendix B: Baseline Scenario Land Use Mappings

Mappings used to dissolve manual LULC classes into classes used by the L-THIA model.



## Appendix C: Township Master Plan Future Land Use Maps

Greenbelt properties fall within 8 townships, each of which has a different master plan. Future land use maps in township master plans were used to develop an alternative “Agricultural Expansion” land use scenario. Thanks to Rosie Pahl Donaldson of the Washtenaw County Parks and Recreation Commission for research assistance.

Township	Master Plan	Future Land Use
Ann Arbor Township	<a href="http://aatwp.org/wp-content/uploads/2013/10/Master-Plan-APPROVED-March-2015.pdf">http://aatwp.org/wp-content/uploads/2013/10/Master-Plan-APPROVED-March-2015.pdf</a> (Ann Arbor Township Planning Commission, 2015)	p.86
Scio	<a href="http://sciotownship.org/wp-content/uploads/2016/08/2015-Scio-Township-MP-Final.pdf">http://sciotownship.org/wp-content/uploads/2016/08/2015-Scio-Township-MP-Final.pdf</a> (Scio Township Planning Commission, 2015)	p.19
Northfield	<a href="http://www.twp-northfield.org/FINAL_w_MU_amendment_RED_8_5_14.pdf">http://www.twp-northfield.org/FINAL_w_MU_amendment_RED_8_5_14.pdf</a> (Northfield Township Planning Commission, 2014)	p.41
Webster	<a href="http://www.twp.webster.mi.us/Webster%20Township%20Master%20Plan%202015%20Revisions%20Final%20Draft%20for%20Comment.pdf">http://www.twp.webster.mi.us/Webster%20Township%20Master%20Plan%202015%20Revisions%20Final%20Draft%20for%20Comment.pdf</a> (Webster Township Planning Commission, 2015)	p.60
Superior	<a href="http://superiortownship.org/wp-content/uploads/2016/10/chap_6_final.pdf">http://superiortownship.org/wp-content/uploads/2016/10/chap_6_final.pdf</a> (Webster Township Planning Commission, 2016)	p.20
Salem	<a href="http://www.salem-mi.org/masterplan/Master_Plan_Part_3_Basic_Concepts_of_the_Master_Plan.pdf">http://www.salem-mi.org/masterplan/Master_Plan_Part_3_Basic_Concepts_of_the_Master_Plan.pdf</a> (Salem Township Planning Commission, 2009)	p.6
Lodi	<a href="http://twp-lodi.org/boards/bd_planning/Master%20Plan.pdf">http://twp-lodi.org/boards/bd_planning/Master%20Plan.pdf</a> (Lodi Township Planning Commission, 2016)	p.108
Pittsfield	<a href="http://en.calameo.com/read/0026597862fe714f5c9f1">http://en.calameo.com/read/0026597862fe714f5c9f1</a> (Pittsfield Township, 2017)	p.40-41



## Appendix D: L-THIA Inputs Table

L-THIA Class	Soil Hydrologic Group	Area (acres)		
		Baseline Scenario	Agricultural Expansion Scenario	Development Scenario
Agricultural	A	41.41	81.65	0
Agricultural	B	1880.82	2318.94	0
Agricultural	C	889.32	1162.23	0
Agricultural	D	428.72	686.85	0
Forest	A	44.11	7.81	0
Forest	B	643.96	268.42	0
Forest	C	236.09	30.59	0
Forest	D	222.87	27.7	0
Grass / Pasture	A	4.04	0	0
Grass / Pasture	B	109.26	23.41	0
Grass / Pasture	C	77.37	2.4	0
Grass / Pasture	D	63.73	0.38	0
Low Density Residential	A	0.18	0.28	108.35
Low Density Residential	B	23.73	47.29	1951.66
Low Density Residential	C	15.75	23.33	1092.1
Low Density Residential	D	2.02	2.41	624.67
Water / Wetlands	A	19.83	19.83	0
Water / Wetlands	B	24.23	23.93	0
Water / Wetlands	C	26.83	26.83	0
Water / Wetlands	D	48.58	48.58	0
Commercial	A	0	0	0.56
Commercial	B	0	0	394.75
Commercial	C	0	0	118.16
Commercial	D	0	0	109.08
High Density Residential	A	0	0	0.66
High Density Residential	B	0	0	335.59
High Density Residential	C	0	0	35.11
High Density Residential	D	0	0	32.16

## Appendix E: Greenbelt Landowner Participation Letter



### Greenbelt Program Landowners Needed for University of Michigan Project

Hello! We are Master's students at the University of Michigan School of Natural Resources and Environment (SNRE) working with the City of Ann Arbor and The Conservation Fund on a thesis project assessing the impacts of the Ann Arbor Greenbelt Program. We are seeking to "tell the story" of the Program.

#### About this study:

The goal of this project is to determine the effects of the Ann Arbor Greenbelt Program on local ecosystems, economy, and community. Enclosed is a sample of the type of reports we are hoping to produce for the City's Greenbelt Program.

To accomplish this, *we would like to hear from you!* Here are several ways you can participate:

- **Interview** (1 hour): The interview will take about one hour and can be completed in person or by phone. You are free to share as little or as much as you like. Information presented in our reports will not include any personal identifying information.
- **Anonymous Survey** (10 minutes): An economic survey will be used to estimate how involvement in the greenbelt has impacted your property from a business perspective. The survey is completely anonymous. No names, addresses, or identifying features will be included in our reports. The information generated will be aggregated and presented in tables and figures. A survey and return envelope will be mailed to interested participants.
- **Landowner Profiles:** If you are interested in telling a more in-depth story about your experience with the Greenbelt Program, you can also participate in our case study. This involves site visits by the Greenbelt Master's Project students, an interview with the landowner and/or active manager of the farm operations, and taking photos/videos. We are expecting these visits to take at least a couple of hours of your time. This case study will include identifying information, but you will be in complete control of which aspects of your story you wish to be presented. Enclosed is a profile similar to what we hope to produce for each case study property.

#### How do I participate?

If you are interested in helping us with our project, please call **734-794-6000 ext. 42797**, return the included postcard, or email [GreenbeltMP@umich.edu](mailto:GreenbeltMP@umich.edu) and we will gladly coordinate to schedule a time that works best for you. Please feel free to reach out with any other questions or comments!

We plan to conduct interviews and collect survey responses from **June-September 2017**. Thank you very much for your help. We hope to speak with you soon!

Sincerely,

Dan Tanner, Devin Kinney, Patrick Bradley, Sharon Hu  
Greenbelt Master's Project Team  
University of Michigan, School of Natural Resources and Environment  
**Email:** [GreenbeltMP@umich.edu](mailto:GreenbeltMP@umich.edu)

Cria Kay  
Intern, City of Ann Arbor Greenbelt Advisory Commission  
**Phone:** 734-794-6000 ext. 42797

## Appendix F: Greenbelt Landowner Financial Impact Survey



### Economic Impacts of the Greenbelt Program

We are looking for landowner feedback on the Greenbelt's economic impact. Your response would be immensely helpful for improving the program. **Your answers will be completely anonymous, and will only be used in a collective assessment.** If you do not wish to answer any of these questions, feel free to leave them blank.

1. How many employees work on your farm?  
 Permanent  Part-time/Seasonal
2. Generally, what are your annual farm revenues?  
 < \$1,000  
 \$1,000 - \$9,999  
 \$10,000 - \$49,999  
 \$50,000 - \$99,999  
 \$100,000 - \$499,999  
 > \$500,000
3. Where do you sell most of your products? Please rank:  
 Ann Arbor Area  Midwest  Entire United States  Internationally
4. Please provide a general summary of how your expenditures are allocated:  
\_\_\_\_\_  
\_\_\_\_\_
5. Have farm revenues changed since becoming part of the Greenbelt?  
 Yes  No
6. If yes, would you attribute any of these changes to your participation with the Greenbelt?  
\_\_\_\_\_  
\_\_\_\_\_
7. Would you associate any of these changes to the establishment of Greenbelt more generally?  
\_\_\_\_\_  
\_\_\_\_\_

See Back for Additional Questions



8. Has your business expanded since entering into an easement?

Yes       No

9. Did you use your conservation easement funds to (check all that apply):

- Repay loans or debt
- Purchase farm equipment
- Hire new employees
- Expand conservation practices
- Repair equipment and agricultural buildings
- Take care of personal or household needs
- Purchase new land
- Other: \_\_\_\_\_

10. Do you see future economic opportunities for people to start farming, and if so, where are they?

\_\_\_\_\_  
\_\_\_\_\_

11. How might the Greenbelt play a role in these opportunities?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

12. Do you feel that joining the Greenbelt has made your property more or less valuable? If so, how?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

13. Do you feel that land conservation in rural areas around Ann Arbor helps the local economy as a whole? If so, how?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Thank you for your time; your response is valuable to the quality of our analysis.**

Please mail back in the provided return envelope.

See Back for Additional Questions



# Appendix G: Greenbelt Landowner Interview Guide

## Interview Guide for Landowners in the Greenbelt

*Note: Do not cut interviewees off, even if they are going on a tangent, since this can produce valuable information. Once they finish their line of thought, then move on to the next question.*

### Introduction

**Background:** My name is \_\_\_\_ and I am Master's Student at University of Michigan's School of Natural Resources and Environment studying \_\_\_\_\_. Thank you so much for agreeing to participate in this interview, I am looking forward to getting your insights into the Greenbelt Program. Our project will evaluate the economic, social, and ecological impacts of the Greenbelt on landowners, local communities, neighbors, and Ann Arbor taxpayers. Do you have any questions about the project before we get started?

**Roadmap:** I will start by asking some questions about your experience with the Greenbelt program, transition into the Greenbelt's impact on your land and wrap up with your conservation beliefs broadly.

**Consent:** Give them consent form to sign, explain what they are agreeing to, and state that they can decide to no longer participate at any time. **State the following:** "The University of Michigan Health Sciences and Behavioral Sciences Institutional Review Board has determined that this research is exempt from IRB oversight." Ask "is it okay if I record our conversation so that no valuable information is lost during the interview? **It is completely fine if you are not comfortable being recorded. Also, please do not feel obligated to answer any questions.**" and "do you have any questions about the nature of this interview or what information will be used in the project?", *keep the signed copy of the consent form and give them a copy of the form for reference (mention that we can email them their signed copy if they would prefer).*

### Background

*I want to start off by hearing a little bit about the day-to-day activities on your farm and/or land.*

1. Walk me through a typical day on your farm during this season.
2. What do you enjoy most about the property you own?

### Greenbelt Involvement

*Now I am going to move into your involvement with the Greenbelt Program.*

3. How did you first hear about the Greenbelt?
  - a. What were your initial impressions of the program?
4. Can you walk me through your thought process when deciding to enter into an easement agreement?
  - a. What were your reservations?

5. When you were deciding to apply for the Greenbelt, how did think it would benefit you?
6. Has being part of the Greenbelt changed how you use and conserve your land in any way?
  - a. *If yes:* How so?
7. What challenges did you face when selling the development rights to your property?
  - a. If you could make any changes to the process, what would you do?
8. Has the Conservation Plan benefited your farm?
  - a. *If yes:* In what way?
  - b. Would regular updates to the plan benefit you?
    - i. What about suggestions for additional conservation practices that might improve your water and soil quality?
    - ii. If you could make any changes to the Conservation Plan, what would you choose to do?
9. Can you describe your experience working with Natural Resources Conservation Service biologists?
  - a. Have you received timely responses to questions you had?
10. Do you interact with other landowners who participate in the Greenbelt?
  - a. *If yes:* How often?
    - i. Do you feel there is a network of landowners to receive input/ help from within the Greenbelt? How is this helpful?
11. Do you receive consistent updates on the Greenbelt?
  - a. *If Yes:* How do you receive information and updates about the Greenbelt?
    - i. If it were up to you, how would you choose to receive information about the Greenbelt?
    - ii. What type of information would you like to receive?
    - iii. What type of information would you prefer to not receive?

#### **Farm Changes Under the Conservation Easement**

12. Since becoming part of the Greenbelt, have you noticed any changes in public interest in your property (i.e. visits, requesting information)?
  - a. *If Yes, follow up with:* Why do you think these changes occurred? Were these welcomed changes?
  - b. *If No, follow up with: \*Only ask if interviewee seems interested in more publicity for their farm\** Would you benefit from increased public interest? How do you think public interest in your property could increase because of your association with the Greenbelt?
13. What types of environmental changes have you noticed because of the Greenbelt's existence more generally, if any? (i.e. changes resulting from neighboring properties entering into an easement agreement)

14. How do you think being involved in the Greenbelt will allow you to improve the quality of your land?
  - a. What about the amount of wildlife and vegetation on the property?
  - b. What about the soil and water quality?

*\*\* The following two questions are particularly important, if the interviewee responds with a vague answer, follow up to clarify (for example: "That is really interesting, can you expand a bit?" "When you said \_\_\_\_ I was really intrigued, could you tell me more about that?") \*\**

15. What products did you produce prior to entering into a Greenbelt easement?
  - a. Have the products you sell changed since entering into the easement? *If yes: How so?*
16. Where do you typically sell your products?
  - a. *If they do not give specific locations:* Which local venues do you sell your products at?
  - b. *If they do not give information on region:* What region of the country do your products ship to? Are any of your products exported outside of the country?
  - c. Has this changed since entering the Greenbelt?

#### **Economic Impact**

17. Have farm revenues changed as a result of becoming part of the Greenbelt?
18. Has your business changed as a result of entering into an easement agreement? (i.e. number of employees, new enterprises, greater acreage)
  - a. *If they did not address whether or not they used easement funds to make improvements to their property ask: Did the conservation easement funds allow you to make improvements/purchases for your farm?*

#### **Conservation Ethos**

*I am going to shift gears a bit now and ask you some questions about your opinions and beliefs on environmental conservation, if that's alright.*

19. What are some of your fundamental beliefs about how humans should interact with the land?
20. Can you tell me about a foundational experience where you first felt a connection with the land you live on?
  - a. How did this shape your approach to conservation?
21. What land conservation, hunting, fishing or environmental groups do you follow beyond the Greenbelt, if any?

#### **Conclusion**

22. Finally, are there any questions I did not ask that you think should be addressed? Do you have any final thoughts that you would like to share?

*Thank you for your time, your responses have been immensely helpful.*



## Appendix H: Contingent Valuation Survey



### **The Ann Arbor Greenbelt**

#### *A Survey of Ann Arbor Residents*

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### **Let us know what you think about the Ann Arbor Greenbelt Program**

We are a group of researchers from the University of Michigan's School for Environment and Sustainability. We are studying the Ann Arbor Greenbelt Program, which protects farmland and open space outside of the city limits, an area known as the Greenbelt District. The Greenbelt Program is funded through the Open Space and Parkland Preservation Millage, which also funds the acquisition of parkland within the City limits. **Please note that this survey is only about protecting open space in the Greenbelt District, and NOT the parklands within city limits.**

You and other residents of the City have been randomly selected to receive this survey. Please take a few moments to read more about the program and answer the questions on the next few pages.

- The survey will take approximately 10 minutes to complete.
- All responses will be kept confidential. No identifying information will be used in the reports generated from this project.
- Given our limited resources, every survey response is vital to the project! Your feedback is much appreciated.
- Once you have finished, please enclose the survey in the pre-stamped and addressed return envelope and mail it back by February 21, 2018.

*Any questions can be directed to [GreenbeltMP@umich.edu](mailto:GreenbeltMP@umich.edu) or (810) 882-1775.*

**PART A**

**Question 1. Please estimate the number of times in the last 12 months that you participated in each of the following activities.**

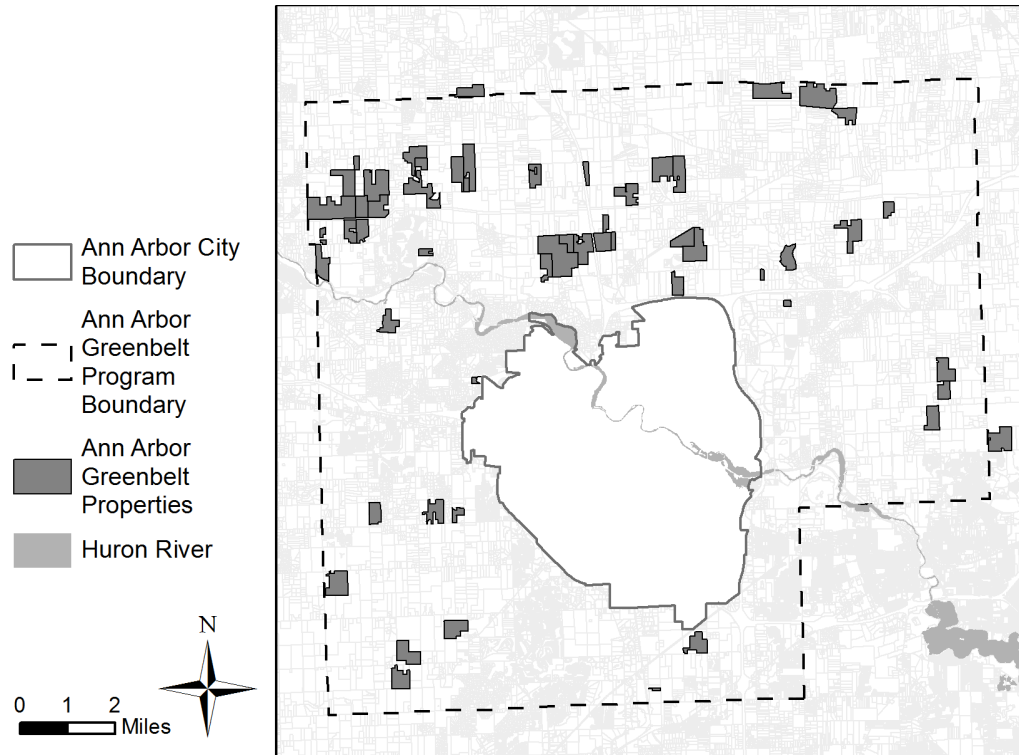
Visited outdoor recreation areas for hiking, camping, or biking in Washtenaw County. \_\_\_\_\_ times

Swam, kayaked, canoed, or boated on the Huron River or its tributaries. \_\_\_\_\_ times

Fished, birdwatched, or hunted in Washtenaw County. \_\_\_\_\_ times

**Question 2. Please answer the following questions by marking the box that best describes the degree to which you agree or disagree with each of the following statements.**

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't Know
Ann Arbor offers scenic views.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Being able to buy local produce is <u>not</u> important to me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There are <u>more</u> open spaces in Ann Arbor than in other places I've lived.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Being able to buy organic food is <u>not</u> important to me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ann Arbor and the surrounding area offers extensive outdoor recreational activities.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



**Map of the properties protected with Ann Arbor Greenbelt Program funding (as of May 30, 2017)**

## **PART B**

### **Greenbelt Programs**

The term “greenbelt” refers to any area of undeveloped natural land that has been set aside near urban or developed land to provide open space, offer light recreational opportunities, preserve agricultural lands, or contain development to urban areas. The plants, natural habitats, and wetlands in greenbelts serve as organic sponges for different forms of pollution and as storehouses of carbon dioxide. Preserved farmland also helps to maintain an active local farming community.

### **Ann Arbor Greenbelt Program**

In 2003, residents of Ann Arbor voted to pass the Open Space and Parkland Preservation Millage. This millage established the Greenbelt Program. The City of Ann Arbor City Council appointed a Greenbelt Advisory Commission to help prioritize applicant properties being considered for the program. For example, properties with prime agricultural soils, unique habitats, or that include streams flowing into the Huron River are given priority for inclusion.

If a property is selected, the city will purchase the development rights from the landowner for that property. Landowners may continue to farm their property, but are restricted from further construction or subdivision. These restrictions are permanent, and apply even if the land is sold in the future.

### **Goals and Purpose**

The purpose of the Ann Arbor Greenbelt Program is to protect working farmland, natural areas, and publicly accessible open space within a limited program boundary (see map). The priorities of the Greenbelt Program are to preserve large blocks of farmland (1,000 acres or greater) within five focal areas, preserve land along the Huron River and major tributaries, and leverage tax dollars whenever possible through landowner donations, grant funds and local partners. Other goals include supporting local food and specialty crop production.

### **Funding**

The Greenbelt Program is funded through the Open Space and Parkland Preservation Millage, which levies a unique property tax on Ann Arbor properties and runs through 2034. Two-thirds of the funding generated through the millage are used to purchase development rights for properties within the Greenbelt program boundary, as well as other open spaces. The remaining one-third of the millage funds are allocated to parkland acquisition within City limits. *Please note that this survey is only about the purchase of development rights in the Greenbelt District, and NOT parks.*

### **Progress**

To date, over 5,100 acres of working farmland and open space within and surrounding the City of Ann Arbor have been permanently protected from development using Greenbelt Program funds (see map on preceding page).

**Your Valuation of the Ann Arbor Greenbelt**

*Please answer the following questions regarding a hypothetical scenario.*

Suppose that an election is being held today with a ballot proposal to continue the Greenbelt Program for 15 additional years. The renewal of the Program is expected to preserve an additional 5,000 acres of farmland and natural areas within the current Greenbelt Program boundary. If the renewal were to fail, no additional land would be conserved under the Greenbelt Program.

**The Greenbelt Program is the only issue on the ballot and would cost your household \$ [X] every year for 15 years.**

<b>Question 1. Given this information, would you vote in favor of the Greenbelt Program?</b>	
<input type="checkbox"/> YES	<input type="checkbox"/> NO



**If you answered YES to Question 1, please proceed to Questions 2a and 3a.**

<b>Question 2a.</b> Would you be willing to pay \$2[X] per year for 15 years?
<input type="checkbox"/> YES <input type="checkbox"/> NO
<b>Question 3a.</b> Please check one or more boxes for the reasons that best describe why you voted in <u>favor</u> of the Greenbelt Program in <b>Question 1</b> .
<input type="checkbox"/> The Greenbelt Program is important to me. <input type="checkbox"/> I think it is our responsibility to protect natural areas. <input type="checkbox"/> I think it is our responsibility to protect farmlands. <input type="checkbox"/> I think it is our responsibility to limit urban sprawl.



**If you answered NO to Question 1, please proceed to Questions 2b and 3b.**

<b>Question 2b.</b> Would you be willing to pay \$0.5[X] per year for 15 years?
<input type="checkbox"/> YES <input type="checkbox"/> NO
<b>Question 3b.</b> Please check one or more boxes for the reasons that best describe why you voted <u>against</u> the Greenbelt Program in <b>Question 1</b> .
<input type="checkbox"/> The Greenbelt Program is not worth anything to me. <input type="checkbox"/> I am on a limited budget and the Greenbelt Program is not a priority. <input type="checkbox"/> I do not think the Greenbelt Program is effective. <input type="checkbox"/> I do not think it is fair to expect me to contribute to this program. <input type="checkbox"/> I do not support any new government programs.

**Your Opinions on Greenbelt-related Topics**

**Question 4. Please mark the box that best describes the degree to which you agree or disagree with the following statements.** *For these statements, we define “open space” as farmland and natural areas.*

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Don't Know
I value having farmers in my community.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Open space in the Greenbelt does <u>not</u> add value to Ann Arbor and the surrounding area.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Preserving open space in the Greenbelt is a valuable use of tax dollars.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Open space is <u>not</u> visually attractive.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I knew a lot about the Ann Arbor Greenbelt <u>prior</u> to this survey.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**Question 5. Greenbelt programs often list the following outcomes as primary goals. Please rank them from 1 to 4 in order of importance to you, with 1 being most important. Check “Don’t know” if you have no preference.**

- \_\_\_\_\_ Protect natural areas
- \_\_\_\_\_ Establish more scenic views
- \_\_\_\_\_ Preserve local farmland
- \_\_\_\_\_ Contain development to urban areas
- \_\_\_\_\_ Don't know (no preference)

**Part C - Household Information**

*This information is for statistical purposes only and is completely confidential.*

**Question 1. How long have you lived in Ann Arbor?**

- |                                      |                                      |
|--------------------------------------|--------------------------------------|
| <input type="checkbox"/> 0-4 years   | <input type="checkbox"/> 15-19 years |
| <input type="checkbox"/> 5-9 years   | <input type="checkbox"/> 20+ years   |
| <input type="checkbox"/> 10-14 years |                                      |

**Question 2. Do you rent or own your current residence?**

- |                               |                              |
|-------------------------------|------------------------------|
| <input type="checkbox"/> Rent | <input type="checkbox"/> Own |
|-------------------------------|------------------------------|

**Question 3. What is your highest completed level of education?**

- |  |   |
|--|---|
| <input type="checkbox"/> Middle school or less         | <input type="checkbox"/> Some college             |
| <input type="checkbox"/> Some high school              | <input type="checkbox"/> Associate's Degree       |
| <input type="checkbox"/> High school graduate          | <input type="checkbox"/> Bachelor's Degree        |
| <input type="checkbox"/> Vocational/technical training | <input type="checkbox"/> Advanced/Graduate Degree |

**Question 4. How many people live in your household?**

\_\_\_\_\_ Adults (18 + yrs.)                      \_\_\_\_\_ Children (< 18 yrs.)

**Question 5. What is your annual household income before taxes?**

- |  |   |
|--|---|
| <input type="checkbox"/> Less than \$9,999   | <input type="checkbox"/> \$125,000-\$149,999    |
| <input type="checkbox"/> \$10,000-\$24,999   | <input type="checkbox"/> \$150,000-\$174,999    |
| <input type="checkbox"/> \$25,000-\$49,999   | <input type="checkbox"/> \$175,000-\$199,999    |
| <input type="checkbox"/> \$50,000-\$74,999   | <input type="checkbox"/> \$200,000-\$249,999    |
| <input type="checkbox"/> \$75,000-\$99,999   | <input type="checkbox"/> \$250,000-\$299,999    |
| <input type="checkbox"/> \$100,000-\$124,999 | <input type="checkbox"/> Greater than \$300,000 |

**Thank you for taking the time to complete this survey! Please use the space provided below for any questions or comments:**

**Please return your completed survey in the provided pre-stamped and addressed envelope. The address is also listed below for your convenience.**

**Please direct any questions to [GreenbeltMP@umich.edu](mailto:GreenbeltMP@umich.edu) or (810) 882-1775.**



University of Michigan  
School for Environment and Sustainability  
Greenbelt Master's Project  
440 Church Street  
Dana Building  
Ann Arbor, MI 48109-1041



## Appendix I: Non-disclosure Agreement

### NON-DISCLOSURE AGREEMENT

This Agreement is effective as of May 25, 2017 (the "Effective Date"), between Patrick Bradley, Devin Kinney, Dan Tanner, and Sharon Hu\_\_\_\_, a natural resources and environment student at the University of Michigan School of Natural Resources and Environment ("Student") and the City of Ann Arbor, a Michigan municipal corporation, located at 301 E Huron St., Ann Arbor, Michigan, 48104 ("City").

### BACKGROUND

- A. Student is a student in the Master's Project Program at the University of Michigan School of Natural Resources and Environment ("Program"). As part of the Program, Student has elected to participate in a particular environmental research project sponsored by City ("Project").
- B. During the term ("Term") of the Program, Student will be required to prepare written documentation of his/her 12-18 months of Project work in a form reflecting academic procedures ("Academic Analysis") which will be posted as a final written product in a University archiving system. In addition to that requirement, Student will typically prepare other writings, including (i) work product for City, (ii) documentation related to University requirements, and (iii) other appropriate learning tools. In accomplishing the Project, Student will also discuss confidential information with appropriate University advisors (all within the context of the Project).
- C. City possesses, and considers to be proprietary and confidential, certain information, drawings, data, software, documentation, business plans and know-how relating to the City of Ann Arbor Greenbelt Program, (all such information and materials hereinafter referred to as "Confidential Information"). City and Student are both interested in having Student receive access to Confidential Information for the sole purpose of having Student work on Project during the Program ("Purpose").
- D. The parties understand that disclosure of information in connection with the Student's Program work and standard University academic procedures as described in this Agreement will not be a violation of the spirit or terms of this Confidentiality Agreement.

Consistent and subordinate to the above, City and Student hereby agree as follows:

### CONFIDENTIALITY

1. This Agreement does not obligate City to provide to Student any Confidential Information; and City may at its sole discretion determine which of its Confidential Information it will provide to Student.
2. All Confidential Information provided in tangible form will be marked as such. If City provides Confidential Information by verbal communications, it shall provide Student a written notice within thirty (30) days after each such communication that identifies what was considered Confidential Information in the communication.
3. Student will treat as confidential all Confidential Information which is or has been made available, directly or indirectly, to Student. From the date received, except as otherwise allowed under the terms of this Agreement, Student will not disclose Confidential Information to others for a period of three (3) years computed from the above date.
4. Student will use Confidential Information only to the extent necessary for the Purpose. Except as otherwise specifically provided in this Agreement, Student will limit access to such Confidential Information to personnel reasonably requiring access for the Purpose and who are obligated to treat Confidential Information as confidential and with the same degree of care as provided herein.

5. The confidentiality obligations of Student under this Agreement do not apply to Confidential Information which: (a) at the time of the disclosure is generally available to the public or thereafter becomes generally available to the public through no act or omission of Student; (b) Student can show by written records to have been in Student's possession prior to the time of the disclosure and was not acquired, directly or indirectly, from City; or (c) Student can show by written records to have been independently made available as a matter of right to the Student by others, provided such others did not acquire the Confidential Information directly or indirectly from City; or (d) is required to be disclosed by law or court order.

6. Within thirty (30) days of the completion of the Program, Student will, at City's option, either return to City or destroy all materials, drawings, data, memoranda, and written information in his/her possession relating to such Confidential Information, including copies thereof.

7. Nothing in this Agreement shall be construed to grant to Student any rights in respect of such Confidential Information other than for the Purpose.

8. Nothing in this Agreement precludes Student from seeking or obtaining employment or discussing the Project (but not Confidential Information) with any potential employer.

9. This Agreement applies only to Confidential Information received by Student during the term of Program.

10. Student acknowledges that monetary damages may not be adequate to compensate City for any breach of the confidentiality obligations in this Agreement. Accordingly, any breach or threatened breach of this Agreement may cause irreparable injury to City, and City may be entitled to injunctive relief against such breach or threatened breach.

11. This Agreement is binding upon and for the benefit of the undersigned parties, their successors and assigns, provided Student's right to access Confidential Information may not be assigned without prior written consent of City.

In witness whereof, the parties hereto have made, entered into, and executed this Agreement made effective as of the date above.

STUDENT

By 

Typed Name Patrick Bradley

Title SNRE Student

Date 4/28/17

FOR CITY

By 

Typed Name: Howard Lazarus

Title: City Administrator

Date \_\_\_\_\_

STUDENT

By 

Typed Name Sharon Hu

Title SNRE Student

Date \_\_\_\_\_

**STUDENT**

By 

Typed Name Dan Tanner

Title SNRE Student

Date 4/28/2017

**STUDENT**

By 

Typed Name Devin Kinney

Title SNRE Student

Date 5/9/2017

## Appendix J: Contingent Valuation Survey Results

How many times in the past year have you:	Responses (>0)	Average Value	Max Value	Sum of All Values
Visited outdoor recreation areas for hiking, camping, or biking in Washtenaw County	338	24	365	9588
Swam, kayaked, canoed, or boated on the Huron River or its tributaries	199	2	100	1002
Fished, birdwatched, or hunted in Washtenaw County	113	5	300	2143

Table 5.3 – Responses to Self-Reported Outdoor Activities (only included if >0)

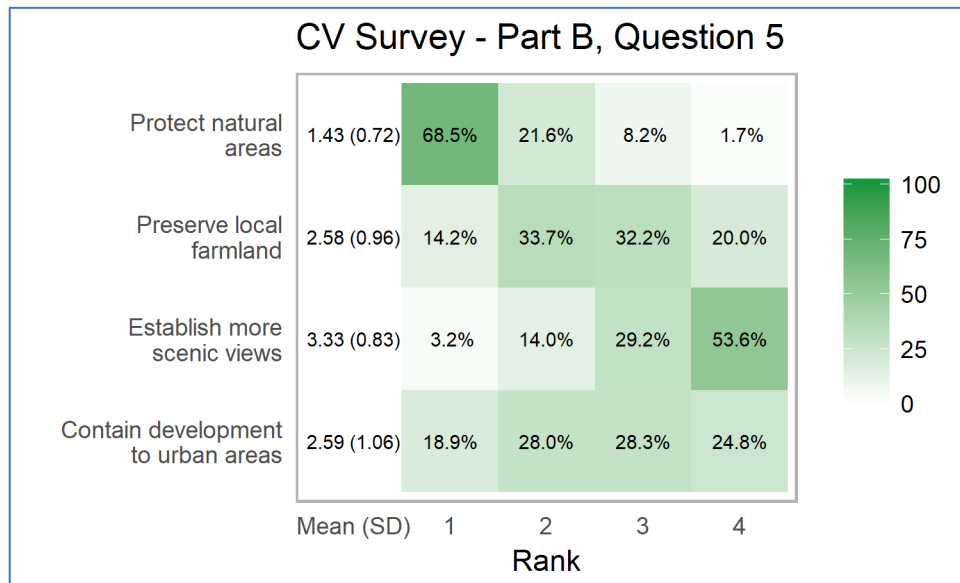


Figure 5.5 – Heat map indicating the ranked preferences of Greenbelt program objectives

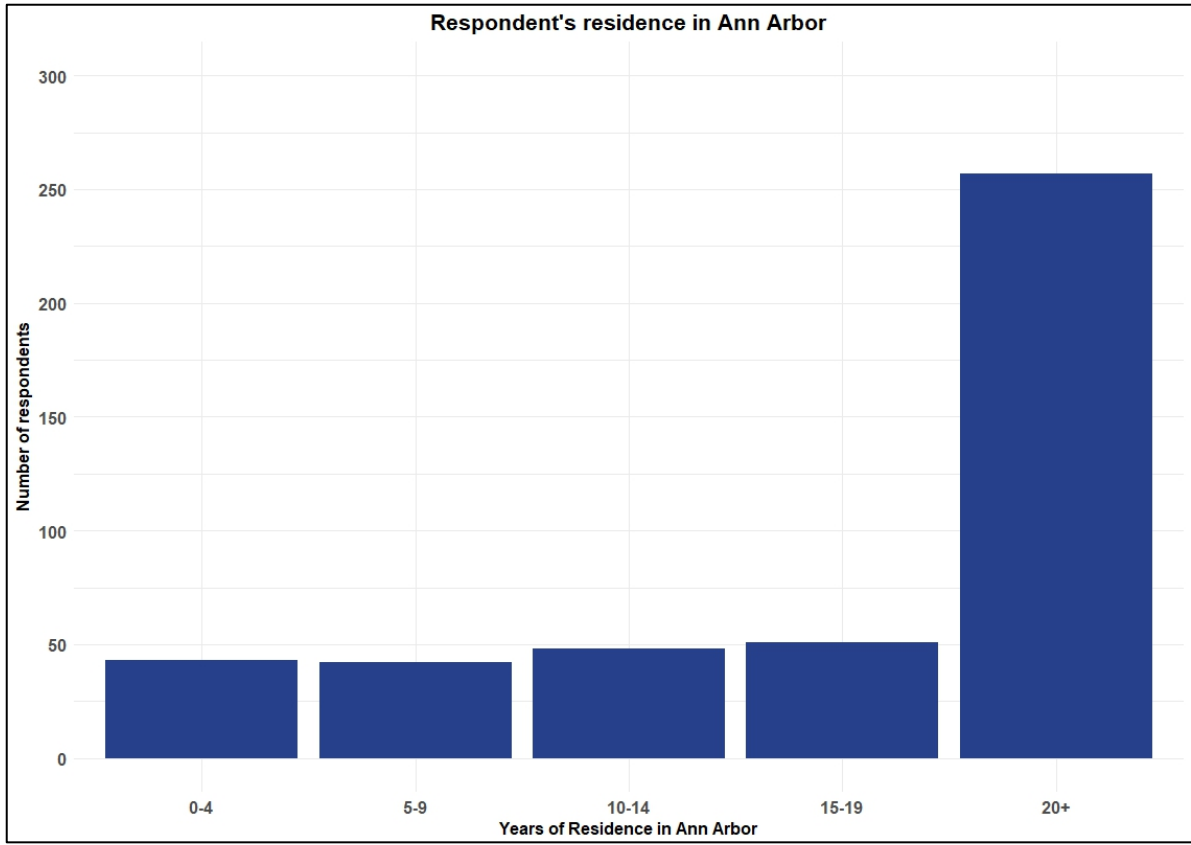


Figure 5.6 – Number of years survey respondents have lived in Ann Arbor

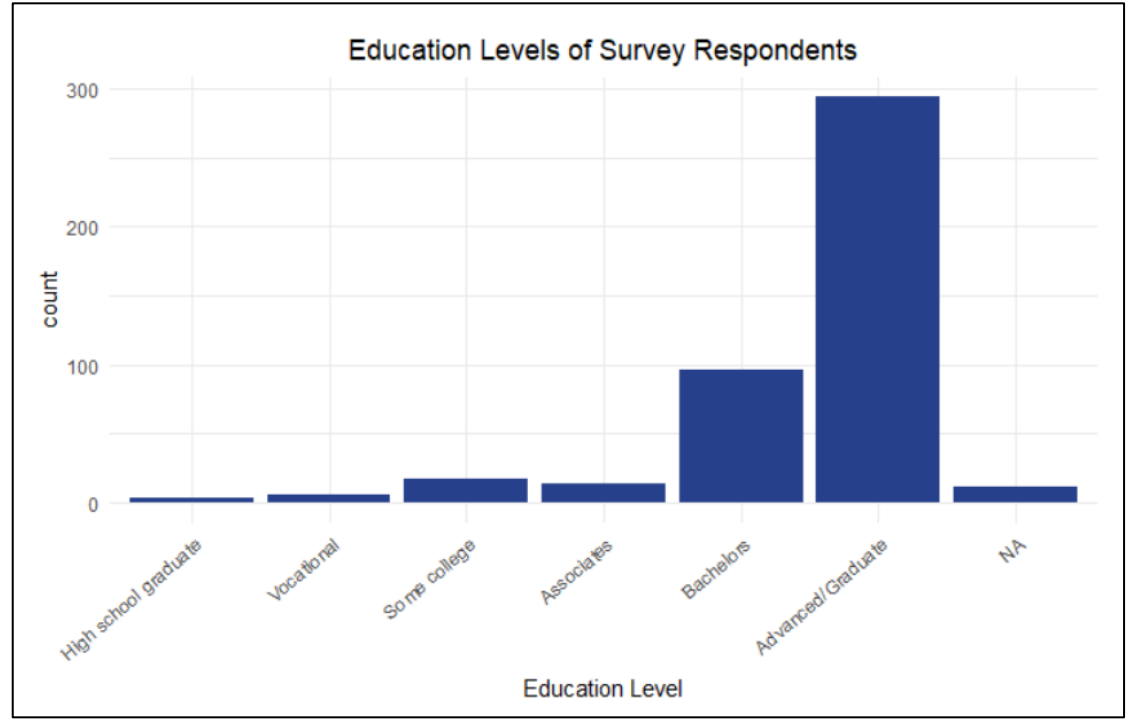


Figure 5.7 – Education level of survey respondents

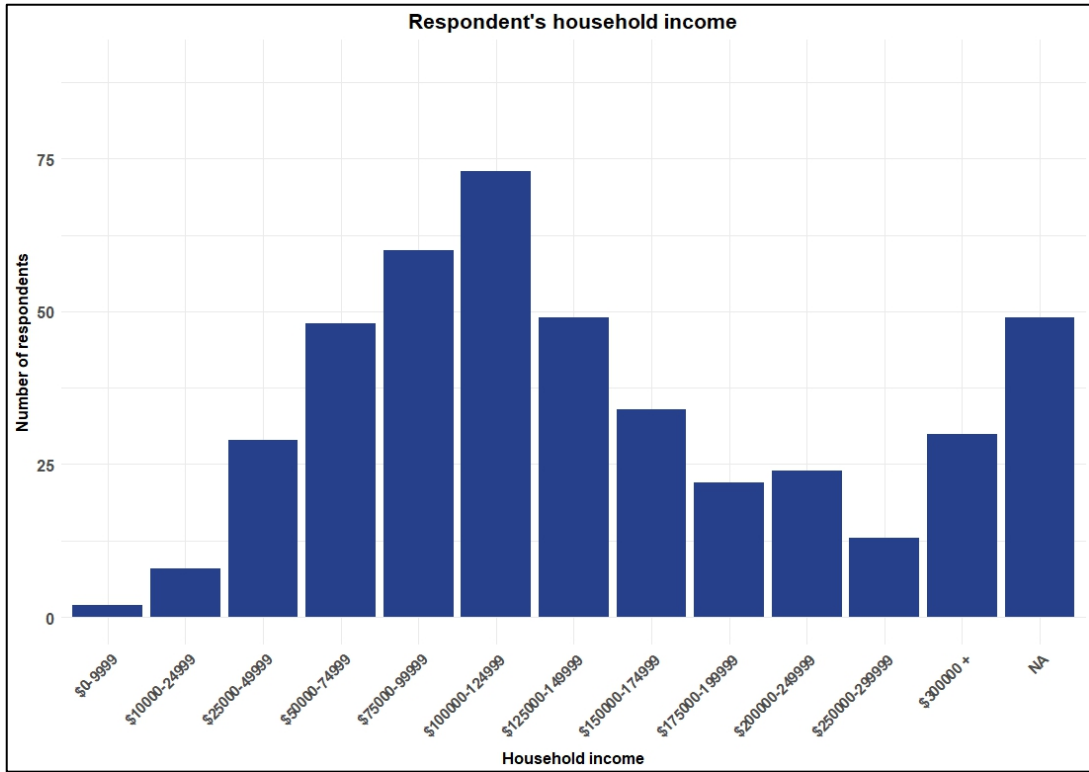


Figure 5.8 – Household income of survey respondents

## Appendix K: Contingent Valuation Analysis Results

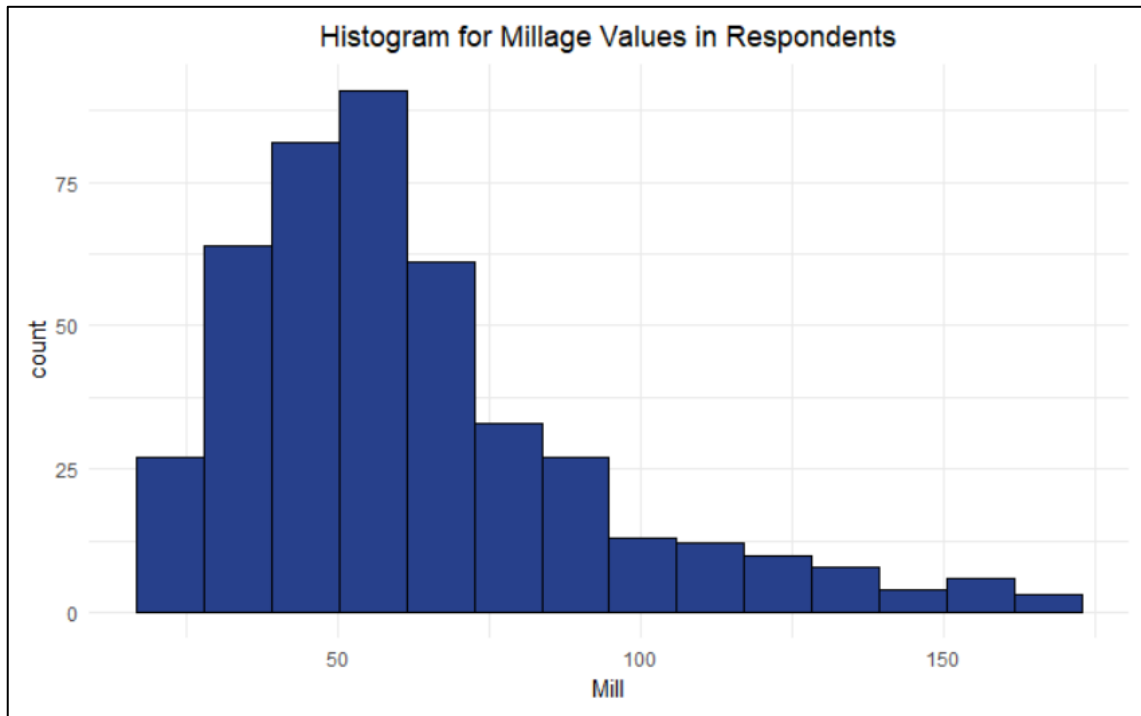


Figure 5.9: Histogram of millage values for respondents

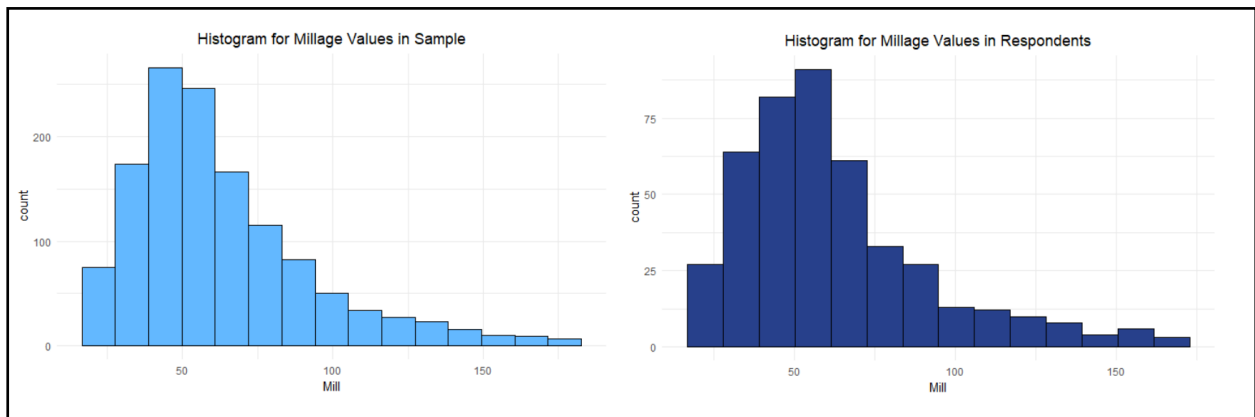


Figure 5.10: Comparison of millage values sent out to the sample (left) and millage values for respondents (right).

Full Turnbull Estimator Results

Survival probability:

	Upper	Prob.
1	0.0	1.0000
2	10.0	0.9072
3	17.5	0.9072
4	20.0	0.9072
5	22.5	0.8913
6	27.5	0.8913
7	32.5	0.8913
8	35.0	0.8913
9	40.0	0.8534
10	45.0	0.8534
11	50.0	0.8377
12	55.0	0.8377
13	60.0	0.8377
14	65.0	0.8377
15	70.0	0.6800
16	77.5	0.6800
17	80.0	0.6800
18	82.5	0.5916
19	90.0	0.5916
20	100.0	0.5567
21	110.0	0.5567
22	120.0	0.5567
23	130.0	0.5567
24	145.0	0.5567
25	155.0	0.5537
26	160.0	0.4584
27	165.0	0.4584
28	180.0	0.3099
29	200.0	0.2784
30	220.0	0.2784
31	240.0	0.2784
32	260.0	0.2784
33	290.0	0.2784
34	310.0	0.1748
35	330.0	0.1748
36	Inf	0.0000

WTP estimates:

Mean: 155.919207 (Kaplan-Meier)  
Mean: 159.934589 (Spearman-Kärber)  
Median in: [ 155 , 160 ]



Additional Benefit-Cost Comparisons:

These tables represent additional benefit-cost analyses using different estimates of WTP. Table 5.6 utilizes the Truncated Mean WTP estimate from Model1, the same model used in Table 5.9 for the benefit-cost comparison selected for the report. The Truncated Mean WTP was calculated with the error distribution cut off at the maximum bid level, which for our study was \$330. The Truncated Mean WTP resulted in an estimate of \$152.58, which was approximately \$25 greater than the value used in Table 5.9 of the report. This was also the second lowest value generated from Model1 behind the Median WTP estimate of \$127.19.

Table 5.7 is based off of the Median WTP estimate from the Null Model. This was the lowest estimated value in this model, and was chosen for a benefit-cost comparison because of this. This is the same type of estimate used in Model1 and Table 5.9, however the Median value from the Null Model was \$4 greater. In Table 5.8, the lowest estimated value was also chosen for the benefit-cost comparison. This was the lower bound of the confidence interval generated for Median WTP. This value, an estimated \$155, is approximately \$28 greater than the Median WTP from Model1.

	# Households	Benefits	Costs	Difference
<b>Responding Households</b>	441	\$ 67,287.78	\$ 28,699.00	\$ 38,588.78
<b>Sample Households</b>	1,300	\$ 198,354.00	\$ 81,665.00	\$ 116,689.00
<b>Targeted AA Homeowners</b>	22,683	\$3,460,972.14	\$1,406,484.00	\$2,054,488.14
<b>City of Ann Arbor*</b>	NA	\$3,460,972.14	\$2,383,653.00	\$1,077,319.14

\*City of Ann Arbor comparisons made with actual aggregate tax payments to the program for 2017 (costs) and the WTP estimates we calculated from our targeted homeowners

*Table 5.6: Benefits and costs compared using the Truncated Mean WTP of \$152.58 generated from Model 1 to calculate benefits*

	# Households	Benefits	Costs	Difference
<b>Responding Households</b>	441	\$ 58,189.95	\$ 28,699.00	\$ 29,490.95
<b>Sample Households</b>	1,300	\$ 171,535.00	\$ 81,665.00	\$ 89,870.00
<b>Targeted AA Homeowners</b>	22,683	\$2,993,021.85	\$1,406,484.00	\$1,586,537.85
<b>City of Ann Arbor*</b>	NA	\$2,993,021.85	\$2,383,653.00	\$ 609,368.85

\*City of Ann Arbor comparisons made with actual aggregate tax payments to the program for 2017 (costs) and the WTP estimates we calculated from our targeted homeowners

*Table 5.7: Benefits and costs compared using the Median WTP of \$131.95 from the Null Model to calculate benefits*

	<b># Households</b>	<b>Benefits</b>	<b>Costs</b>	<b>Difference</b>
<b>Responding Households</b>	441	\$ 68,355.00	\$ 28,699.00	\$ 39,656.00
<b>Sample Households</b>	1,300	\$ 201,500.00	\$ 81,665.00	\$ 119,835.00
<b>Targeted AA Homeowners</b>	22,683	\$ 3,515,865.00	\$ 1,406,484.00	\$ 2,109,381.00
<b>City of Ann Arbor*</b>	NA	\$ 3,515,865.00	\$ 2,383,653.00	\$ 1,132,212.00

\*City of Ann Arbor comparisons made with actual aggregate tax payments to the program for 2017 (costs) and the WTP estimates we calculated from our targeted homeowners

*Table 5.8: Benefits and costs compared using the Median WTP of \$155 from the lower bound of the Confidence Interval generated through nonparametric analysis to calculate benefits*