“Irrigation-Free” Residential Landscapes in Florida’s Springs Region: Making the Case

FINAL RESEARCH REPORT — 15 DECEMBER 2021

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I. Executive Summary

Context & Study Motivation

The goal of this study was to better understand the incentives, benefits, and tradeoffs associated with the adoption and installation of non-traditional "irrigation-free" landscapes—i.e., those that do not use automatic, in-ground systems for regularly irrigating trees, shrubs, lawns or turfgrass, landscape beds and ornamentals beyond the initial landscape establishment period. The new housing market in Florida is characterized by inertia and incentive structures that perpetuate a certain residential landscape look, feel, and maintenance regime, one that is failing to protect the freshwater and ecological resources upon which all residents depend. We investigate this issue/challenge and opportunity for improvement through the lens of several different stakeholder groups in Florida's residential housing market: land developers, new home residents (homeowners and tenants), and others with vested interest in reducing the adverse impacts of Florida land development and protecting, enhancing, and restoring our imperiled freshwater resources. Our team's long-term goal is to identify policy strategies and interventions—or leverage points—for shifting the traditional market paradigm for new residential land development from high water-use/freshwater supply depleting and nutrient input/water quality degrading toward more sustainable landscapes with documented and significant (i.e., measurably lower) water use and water quality footprints.

Research Questions

1) ***Do alternative "irrigation-free" landscapes in new residential developments demonstrate measurably lower water use*** than "conventional" subdivisions constructed with landscape irrigation standard?
2) ***Do these alternative landscape developments and homes retain market values*** comparable to and competitive with conventional subdivisions where automatic in-ground irrigation typically comes standard?
3) ***Do surveys of residents living in 'test'/irrigation-free and 'control'/conventional subdivisions reveal differences*** in home and landscape priorities, management and maintenance behaviors, and expenditures to maintain yards across groups?

Methods

This study combines a georeferenced UF/IFAS Extension program tool, H_2OSAV (Water Savings, Analytics, and Verification) and the rich sets of metered water use data directly integrated with the tool with additional quantitative and qualitative data collected from residents of new 'irrigation-free' and comparable 'reference' developments to investigate our research questions. A unique aspect of the research is that it deliberately focuses on a study population that is routinely excluded from landscape maintenance and irrigation behavior surveys or questionnaires. We have a wealth of knowledge on the preferences, costs, and benefits associated with the status quo of irrigated landscapes and efficiency interventions. Conversely, our depth of knowledge about those pursuing the "path less taken" is quite limited.

We use a natural experiment case study framework and mixed-method paired comparisons of "Irrigation-Free" ('Test') with comparable conventional ('Control') new subdivisions and homes to assess and evaluate the incentives, benefits, and tradeoffs associated with "irrigation-free" vs. irrigated Florida landscapes. This approach recognizes the complexity of interactions among social, technical, and scientific factors that drive systems-level change and willingness to pay or accept alternatives to the status quo – from both the supply (developer) and demand (homeowner/renter) sides of the Florida residential landscape and housing market equation.

Key Findings

Water Use Patterns: Irrigation-free case study subdivisions used significantly less water than comparable subdivisions with automatic irrigation systems installed. Average monthly use of test groups ranged from 97 gallons per day (gpd) to 146 gpd relative to a range of 209-287 gpd on average for the reference groups. *The four test groups used an average of 49% (141 gpd) to 61% (162 gpd) less water than their reference subdivision counterparts.*

Property Market Values: The 2021 *assessed values of irrigation-free (test' group) properties are nominally lower (by 2-10%) than their counterpart 'reference' group properties*, with average values ranging from $247 to $261 thousand for test properties compared to a range of $265 to $273 thousand for reference properties. These *differences in property value, however, are not statistically significant*, and this finding applies across all four test-to-reference analysis sub-groups.

Resident Surveys: We received 166 complete resident surveys, which were segmented by test vs. reference group for the analysis. Responses revealed:

- *significant differences in yard composition* (reference groups with much more of their yard in lawns), *landscape irrigation systems, and intensity of irrigation events* (consistent with the water use analyses)
- *divergence in rankings for most 'important' yard features* (with presence of native plants and attraction of pollinators ranked significantly higher by the test group respondents and aesthetic beauty and low maintenance costs ranked significantly higher by the reference group)
- *significantly more 'Do-it-yourself' maintenance activities by the test group and higher-input practices by the reference group*
- *significant differences in reported yard maintenance expenses* (reference group reporting spending over three times more in a typical year than test group respondents.)

In terms of the benefits provided and respondent satisfaction with their yards:

- the *reference group reported significantly higher agreement that their yards 'provide functional space for outdoor activities' and that they 'feel pressure to maintain their yard in a certain way'*
- *the test group reported significantly higher agreement that they 'often see wildlife in their yard'*
- *Test group respondents' overall satisfaction with their yards was nominally higher than that of the reference group*, but these differences were not statistically significant.

Takeaway Conclusions

- ***Learning from Living Laboratories:*** Examples of "irrigation-free" landscapes in new Florida residential subdivisions are few and far between, but they do exist, and we can take advantage of and learn from them as real-world living laboratories.
- ***Making the Case with Real-World Data:*** Quantitative and qualitative real-world data from "irrigation-free" homes and landscapes are critical for understanding and making the case for a new, more sustainable urban landscape paradigm in Florida.
- ***Lightening the Water Footprint of Residential Landscapes:*** Irrigation-free 'test' subdivisions and homes use substantially less water than comparable, conventional homes and landscapes in Alachua County and Gainesville, and these differences are highly statistically significant.
- ***Retaining Competitive Market Value:*** 'Test' subdivision and homes' market values and sales pace are comparable and competitive with those of 'reference' subdivision and homes. While the 'reference' property value averages are nominally higher than those of the 'test' groups, the data reveal no statistically significant differences in market value between the "test" and "reference" groups of homes.
- ***Reducing Landscape Costs to Homeowners and the Environment:*** A key finding of this study's resident survey is that homeowners and renters living in test 'irrigation-free' subdivisions reported spending significantly less money for hired landscape maintenance services and materials needed to care for their lawns. Together, study results offer evidence that lower maintenance costs, resident satisfaction with landscapes, and adoption of behaviors that protect the environment are not mutually exclusive goals – they can and may be synergistic outcomes.
- ***Case Study Postscript:*** The developer and builder of the 88th Street Cottages project has since started his own company and in November 2021 completed his first development, "Cottages on the Avenue", which is very similar to the 88th Street Cottages project. Next up in 2022, he will be starting a new "Cottages" project with 173 detached units and plans to follow the same landscaping practices. From the developer's perspective, the aesthetics and economics of irrigation-free landscaping are working well.
- ***Future Research Needs:*** Continuing to track these projects while using the analysis results from this study to engage other local builders/developers should be a priority.
- ***Accessing Untapped Demand for "Irrigation-Free", Low-Impact Landscapes:*** The untapped demand for low-impact landscapes represents a potential "win-win-win" situation for homeowners and renters, developers, and our freshwater resources. Our team of scientists, researchers, and educators from UF, The Nature Conservancy Florida, and more are ramping up our work promoting irrigation-free landscapes and other holistic sustainability and resource-efficiency strategies with several large (30- to 50-year build out) master-planned community developments in Central Florida.

II. Study Context

The Fish and Wildlife Foundation of Florida (FWFF) Springs Tag Grant is supporting TNC Florida's freshwater resources research partnership with the UF/IFAS Center for Land Use Efficiency (CLUE), Program for Resource Efficient Communities (PREC), and Sustainable Floridians Benchmarking & Monitoring Program (SF-BMP). For this project, "Irrigation-Free Residential Landscapes in Florida's Springs Region: Making the Case", the near-term applied research goal is to better understand the incentives, benefits, and tradeoffs associated with Florida developers' adoption and installation of non-traditional "irrigation-free" landscapes—i.e., those that do not use automatic, in-ground systems for irrigating trees, shrubs, lawns or turfgrass, landscape beds and ornamentals, beyond the initial landscape establishment period. The project's long-term goal is to identify policy strategies and interventions or leverage points to shift Florida's traditional market paradigm for new residential homes and landscapes from high water-use/freshwater supply depleting and nutrient input/water quality degrading toward more sustainable landscapes with documented and significant (i.e., measurably lower) water use and water quality footprints.

Ultimately, we hope the study reveals tangible leverage points for and measurable benefits of providing a diversity of sustainable urban landscape models to the new housing market, particularly within Florida's springshed regions and sensitive groundwater areas. A first, critical step in this direction is to identify developers who have already brought alternative landscapes to market in new residential subdivisions, thereby creating "natural experiment" conditions ripe for study. This study provides documented evidence from real Florida case studies where developers have taken a non-conventional path and installed varying degrees of "irrigation-free" landscapes that have the potential to protect and preserve rather than deplete and degrade our valuable freshwater resources. *This final report describes the research approach and methodology, findings, and market implications of an alternative landscape performance study, including a social science survey of residents living in case study subdivisions,* conducted to collect and evaluate developer and resident perspectives of alternative "irrigation-free" landscape viability, costs, benefits, and tradeoffs. All four "irrigation-free" subdivision case studies are within Alachua County and the Gainesville Regional Utilities (GRU) service territory.

III. Problem Statement

If you have ever been on the market for a new home in Florida, chances are that most homes available for you to choose from—regardless of price point—came standard with two key landscape features: pre-established, tidy, turf-dominant yards and pre-installed, automatic irrigation systems. These "typical" contemporary residential landscapes may provide a range of direct and indirect benefits for people (i.e., goods or utility) and the environment (i.e., ecosystem services). Yet they can also generate a stream of economic and ecological costs that are often less apparent, can be difficult to quantify with precision, and/or are externalized to society, meaning the damages and responsibility for mitigation ultimately falls to the public rather than the individual decision makers who received the upstream, privatized landscape benefits. Groundwater supply depletion and water quality degradation/impairment are among the most consequential of the externalized costs associated with Florida's prevailing urban landscape paradigm. These issues of public interest and concern are the impetus for this study. Given that the majority of Florida's freshwater supply is for public use and that among most new residential subdivisions and homes, landscape irrigation typically accounts for half to two-thirds of this water use footprint, the focus of this study is on new, master-planned community developments and the decision-makers (developers and landowners) whose choices determine the supply of landscaping options available to prospective homeowners and renters.

The new housing market in Florida is characterized by inertia and incentive structures that perpetuate a certain residential landscape look, feel, and maintenance regime. Most new communities offer relatively homogeneous, "cookie-cutter" landscape designs with little diversity of groundcover, trees, shrubs, and ornamental plant materials. By defaulting to yards with extensive turf that can only survive with supplemental water supply (i.e., beyond rainfall), automatic, in-ground irrigation systems become standard practice, which creates and anchors the magnitude of an embedded demand for irrigation water. Similarly, conventional earthwork processes of clearing existing site vegetation, cutting the soil profile, importing fill, and leveling/contouring to grade fundamentally alters the soil physical properties and degrades the functional services provided by healthy soils in native ecosystem landscapes.

Post-development soils tend to have low organic matter content, which reduces soil moisture and nutrient retention capacity, thus constraining the availability of water and food needed to support plant life. They are typically highly compacted, with limited water infiltration and storage capacity, promoting stormwater runoff from the site. They also support few insects and microorganisms whose biological activity and decomposition can mitigate soil compaction (restore porosity, percolation, and infiltration rates) and replenish soil fertility. Without healthy soils to establish deep-rooted, healthy urban landscapes, the literal foundations of each new development project are driving baseline demand and growing use of supplemental fertilizers, pesticides, herbicides, *and* irrigation water from limited freshwater supplies. Ultimately, pollutants introduced to the environment through our landscaping behaviors can leach into groundwater and/or be carried by stormwater runoff to downstream water bodies, thereby degrading our shared freshwater resources.

IV. Study Objectives & Research Questions

Overarching goals of this study are to: 1) fill gaps in our current knowledge and understanding of the demonstrated performance, costs, benefits, consequences, and tradeoffs associated with Florida's urban landscape paradigm relative to "irrigation-free" landscape alternatives, and 2) identify practical and scalable policy strategies and market incentives/mechanisms to promote the adoption of more sustainable landscape alternatives that reduce embedded resource demands and protect Florida's freshwater supply and water quality.

Investigating applied case studies of new, "irrigation-free" residential subdivisions in Alachua County/GRU territory, *three study objectives and parallel research questions* guide the mixed methods approach described here:

> <u>Performance Objective & *Research Question* 1:</u> Assess post-installation water use patterns of alternative "irrigation-free" test landscapes [**herein referred to as the "irrigation-free test group(s) or test groups"**] relative to those of conventional landscapes in comparable residential subdivisions [**herein referred to as the "conventional reference group(s) or reference groups"**]. *Following initial establishment and homeowner/tenant occupancy, do alternative (test) landscapes demonstrate statistically significant differences in water use compared to conventional (reference) landscapes?*
>
> <u>Performance Objective & *Research Question* 2:</u> Assess and document appraised property values of the irrigation-free 'test' groups relative to the conventional reference group homes and subdivisions. *From the property appraiser and market data available, do alternative (test) landscape homes and subdivisions demonstrate statistically significant differences in market value compared to conventional (reference) homes and subdivisions?*
>
> <u>Survey Objective & *Research Question* 3:</u> Identify resident (homeowner/tenant) priorities and preferences when making their home purchase or rental decision and assess landscape management inputs and patterns for the irrigation-free test group and the conventional reference group. *Do resident surveys reveal statistically significant differences in home purchase or rental priorities and landscape input management behaviors across alternative (test) and conventional (reference) homes and subdivisions?*

V. Methods

i. Methodological Framework

We use a **natural experiment case study framework and mixed-method paired comparisons** to assess and evaluate the incentives, benefits, and tradeoffs associated with the irrigation-free test group and the conventional reference group. This approach recognizes the complexity of interactions among social, technical, and scientific factors that drive systems-level change and willingness to pay or accept alternatives to the status quo – from both the supply (developer) and demand (homeowner/renter) sides of the Florida residential landscape and housing market equation. It aligns with several conceptual frameworks for evaluating behavioral norms and change, with *Sociotechnical Transitions or Domestication Theory* among the most suitable to guide our methods and analysis. A *Sociotechnical Transitions* construct considers three inter-related levels or scales of influence in driving change: niche, regime, and landscape. In our study, the irrigation-free test group reflects a contemporary niche nested and operating within the residential market status quo of turf-dominant, irrigated landscapes (the regime level), which is further nested within the context of state, regional, and/or national institutions and systems (i.e., the exogenous landscape exerting pressure on and being shaped over time by regime and niche forces). *Domestication Theory* considers the factors and phases that a technology goes through as it is introduced, adopted, objectified, and internalized by end users.[1]

While it is useful to consider how this study and our research objectives align with different theoretical constructs, at the end of the day our goal is to leverage and learn from the 'natural experiments' occurring right here in Alachua County providing some alternatives to the conventional Florida residential landscape status quo, document measurable performance outcomes, and use what we learn to identify incremental and comprehensive strategies (policy, adaptive management, communications, and technologies) for promoting the adoption of alternatives that work (protect water resources) while maximizing net benefits along the housing supply chain. The methodological approach includes two distinct analyses:

- **Quantitative, data-driven analysis** of actual water use patterns and property values (sales and appraisal data) at the household and subdivision level using UF's in-house H_2OSAV (Water Savings, Analytics, and Verification) database and online mapping tool (described further on in this document).
- **Qualitative, survey-based assessment** of developer and residents' preferences for, satisfaction with, and tradeoffs associated with "irrigation-free" landscapes as an alternative to the Florida residential landscape status quo.

[1] Sovacool and Hess (2017) provide a comprehensive review of theoretical frameworks or constructs for evaluating socio-technical change and discuss their defining characteristics and suitability for application within different research contexts.

ii. Study Population

This study generated information of interest to Florida's land and natural resource managers, local government officials and staff, water utilities and service providers, and citizens alike—prospective and existing homeowners and renters—who wish to make informed landscape choices and management strategies that are viable in the marketplace while also protecting Florida's essential and valuable freshwater resources. To explore our research objectives and address gaps in information about provision of alternative residential landscape options designed to conserve and protect water resources, we have two distinct populations: 1) irrigation-free case study ('test') subdivisions (**referred to herein as the irrigation-free test group or test groups**) and 2) conventional landscapes in comparable residential subdivisions (**herein referred to as the "conventional reference group(s) or reference groups"**).

a. "Irrigation-Free" Case Studies ('Test' Group)

Described in further detail in Appendix A - Irrigation-Free Test Group, our study population includes four housing segments and resident audiences as represented by each irrigation-free test group subdivision as described below. They provide insight to **four different housing segments and resident audiences**. While the four case studies are all located in Gainesville, Alachua County and GRU service territory, the lessons learned are potentially transferable and scalable for application statewide. We expect that results will be applicable to growth management and land use planning in counties, municipalities, water management districts, and utilities in most if not all of Florida's springs and sensitive groundwater regions.

1) **88th Street Cottages,** a small (3.8-acre) outparcel subdivision developed by Robinshore Homes, Inc., and *tenants/renters* of 27 "cottage" apartment units completed in 2020. Common "greens", lawns and landscapes were installed without permanent in-ground irrigation systems and common greens soils were amended with organic compost prior to planting with landscape trees and *Bahia grass* turf. The 88th Street Cottages community website is at https://www.88thstreetcottages.com/.
2) **Hidden Lake Phase II**, a 17-lot residential subdivision on ~2 acres at the North Central edge of the city, also developed by Robinshore Homes, Inc. All Hidden Lake Phase II landscapes were established with no permanent in-ground landscape irrigation. Homes in the community were built from 2017-2019 and are occupied by *homeowner residents*. Current sales listings at http://www.robinshoreinc.com/.
3) **Gainesville Cohousing**, a "green" shared living subdivision of 24 residential lots, 17 of which are currently occupied, on 4.75 acres of land in Northwest Gainesville. This "intentional sustainable living" community was founded and designed by members to include a common house owned by all members, solar PV on private homes and common area structures, water-conserving landscape designs and practices, and Florida-Friendly Landscaping (FFL). There are no permanent in-ground irrigation systems in private yards and common areas other than one irrigation service line to supply the community vegetable garden and irrigation requirements for street trees in the city right-of-way. The Gainesville Cohousing community website is at http://www.gainesvillecohousing.org/.
4) **Madera** subdivision, one of Florida's first low-impact development (LID) communities, with 89 total lots on 44-acres and 13 Phase I lots and SFD homes (average year built 2008). Throughout the

community, Madera integrates green stormwater infrastructure, Energy Star™ certified single-family detached homes, FFL landscapes with no permanent in-ground irrigation systems, and extensive preservation of existing tree canopy and vegetation. This WUFT 'Project Blue Ether' article, "*A gentler water footprint and a good life*" by Chloe Bennett gives a concise introduction to Madera's unique sustainability and resilience features: https://www.wuft.org/specials/water/gainesvilles-madera-is-one-model-how-floridians-can-live-better/.

Table 1 summarizes key features and statistics for each case study subdivision: 88th Street Cottages rental/tenant-occupied homes, Hidden Lake Phase II owner-occupied homes, Gainesville Cohousing owner/community-member occupied homes, and Madera owner-occupied homes. All irrigation-free test group developments are in West Gainesville, Alachua County (Figure 1) and within the Orange Creek watershed, which drains to four lakes that are impaired for nutrients (Nitrogen and Phosphorous), are under the jurisdiction of the St Johns River Water Management District (SJRWMD) and are being restored through the Orange Creek Basin Management Action Plan (BMAP)[2]. Figure 2 shows the boundaries of the Orange Creek Basin, Gainesville city limits, and locations of impaired waterbodies within the basin.

Table 1: Case Study summary statistics

'Irrigation-Free' Case Study Subdivision	Resident Type	# of Units	Avg Lot Size (Acres)	Avg Sq Ft	Avg Yr Built	Avg Sales Price
1) 88th Street Cottages	Tenant/Renter	27	0.05	1,242	2020	$1,550/mo (Rental)
2) Hidden Lake Phase II	Homeowner	17	0.125	1,554	2018	$203,886
3) Gainesville Cohousing	Homeowner/ Member	17	0.08	1,451	2019	$236,584*
4) Madera Phase I	Homeowner	13	0.25	2,379	2008	$249,568

*Property appraiser sales data for these units include lot-level land purchases only; average sales price here is from Zillow estimates (2021) for lots with completed and occupied homes.

Of relevance for springs protection efforts, portions of western Alachua County fall within springsheds[3] of the Santa Fe River Basin (Figure 3), which is under the jurisdiction of the Suwannee River Water Management District (SRWMD). Three Outstanding Florida Springs within the Santa Fe River Basin are classified as impaired for nutrients (specifically, nitrate or NO_3), and water quality restoration strategies and stakeholder responsibilities are identified in the Santa Fe River BMAP[4]. While the four developments in our study are located within Santa Fe River springsheds, they do not fall within the geographic boundaries/contributing areas of the Santa Fe River BMAP (Figure 4). Still, they are new Florida developments offering alternatives to the urban landscape status quo—representing a small and unique slice of the new housing market—and they provide a practical basis for collecting real-world

[2] The complete 2019 Orange Creek Basin Management Action Plan (BMAP) Amendment and Story Map are available at this FDEP site: https://floridadep.gov/dear/water-quality-restoration/content/basin-management-action-plans-bmaps.
[3] The Gainesville Clean Water Partnership defines springshed as "…an area within a ground or surface water basin that contributes to the spring flow. The boundaries of springsheds are dynamic – they change based on the level of the aquifer (otherwise known as its potentiometric surface). This means that springsheds may cover different areas at different times, depending on whether water levels are high or low." Source: http://www.gainesvillecreeks.org/springshed.html.
[4] The complete June 2018 Santa Fe River Basin Management Action Plan is available at this FDEP website: https://floridadep.gov/sites/default/files/Santa%20Fe%20Final%202018.pdf.

performance data (on water use for irrigation, landscape maintenance practices, market viability) that can inform freshwater protection and management initiatives statewide.

b. Comparable Conventional Subdivisions ('Reference' Groups)

For each case study subdivision of 'test' homes, we identified and sampled a statistically valid set of conventional reference group subdivisions and homes with conventional landscapes and automatic in-ground irrigation systems. The 'reference' group subdivisions and homes were selected from among the full population of GRU residential customers living in SFD homes (~40,000 customer accounts) by matching them with 'test' homes using Alachua County Property Appraiser data that are already housed and merged with GRU utility data through the UF/IFAS PREC H_2OSAV platform[5]. Primary selection (screening) parameters included: resident/housing type; lot and home size; subdivision location/neighborhood (a proxy for market value), number of homes, and age (year built); and presence of an irrigation system. We evaluated reference groups with the performance metrics for Research Questions 1 and 2 and an online resident survey instrument/questionnaire (Research Question 4) to evaluate 'test' and 'reference' groups' resident perspectives. To ensure sufficient statistical power for quantitative analysis, we selected comparison groups with sample sizes orders of magnitude larger than the test sample sizes, yielding an initial, pre-screened sample size of over 3,000 homes.

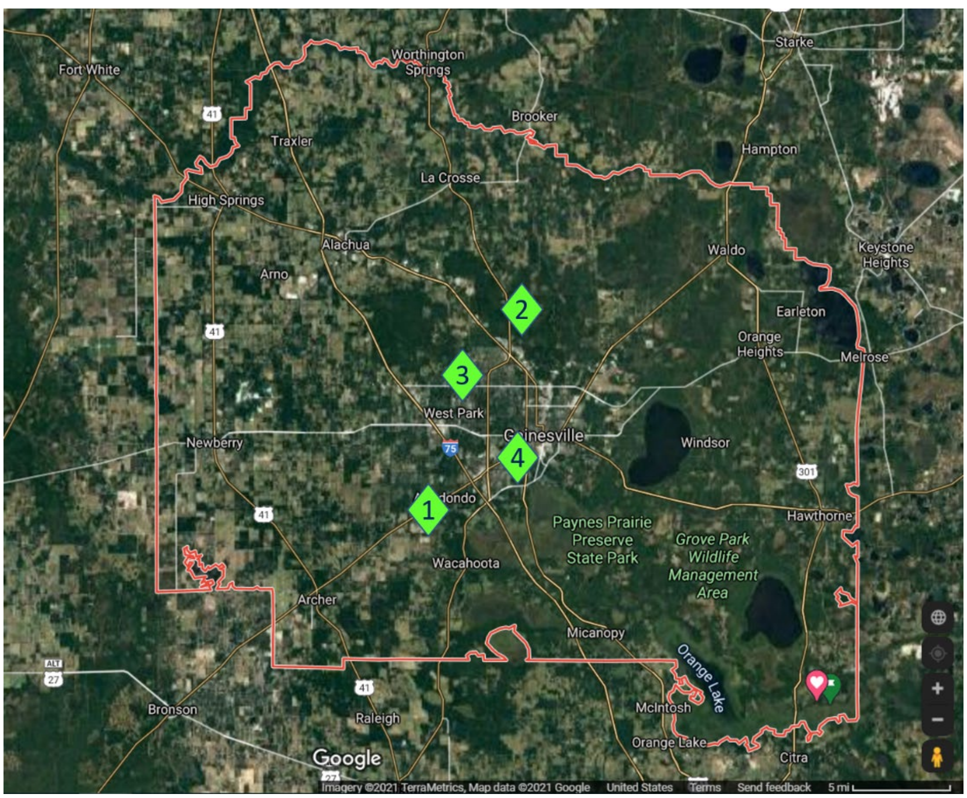


Figure 1: Case Study locations in Alachua County (Google Maps)

[5] This web platform and Extension program (at https://h2osav.buildgreen.org/) are described in further detail in Section 5: Landscape & Water Use Performance Methods.

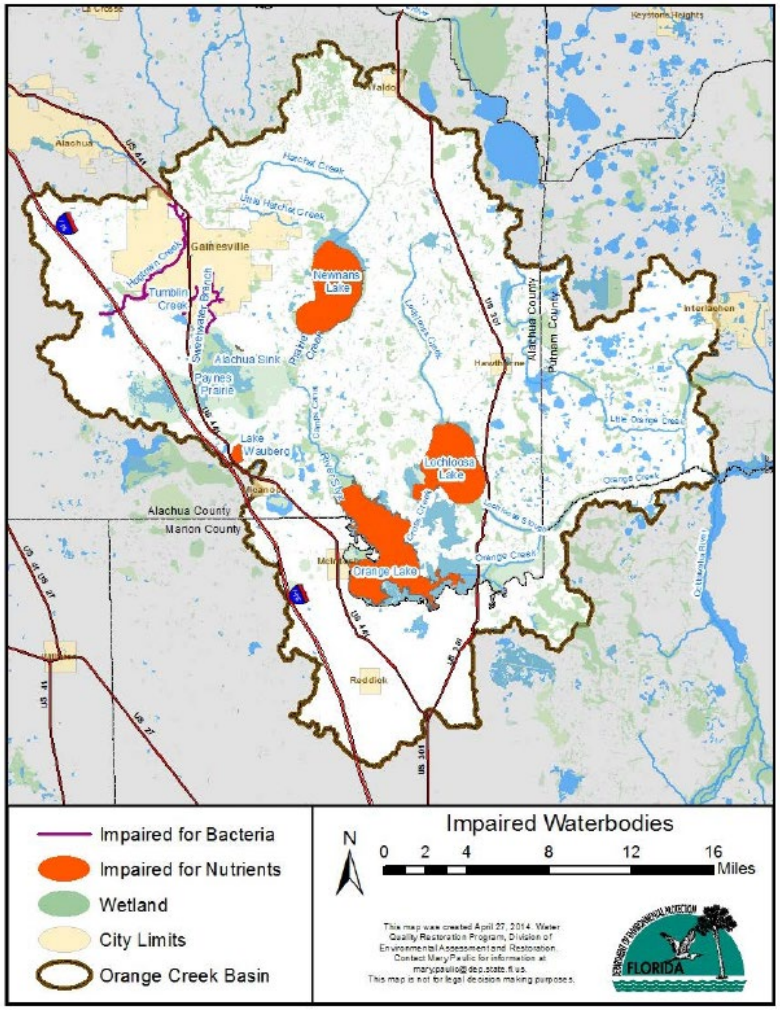


Figure 2: Orange Creek Basin Boundary and Impaired Waters (FDEP 2019, p.10)

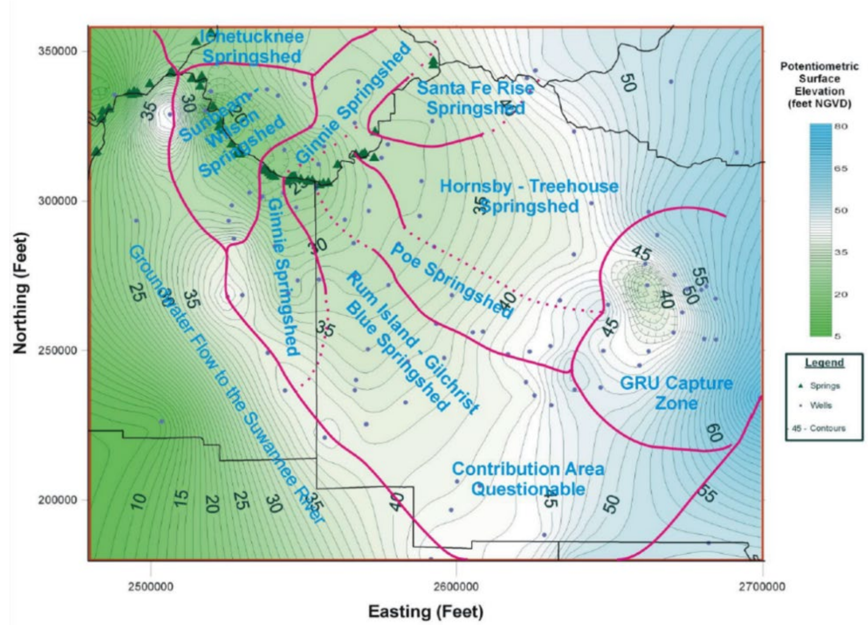
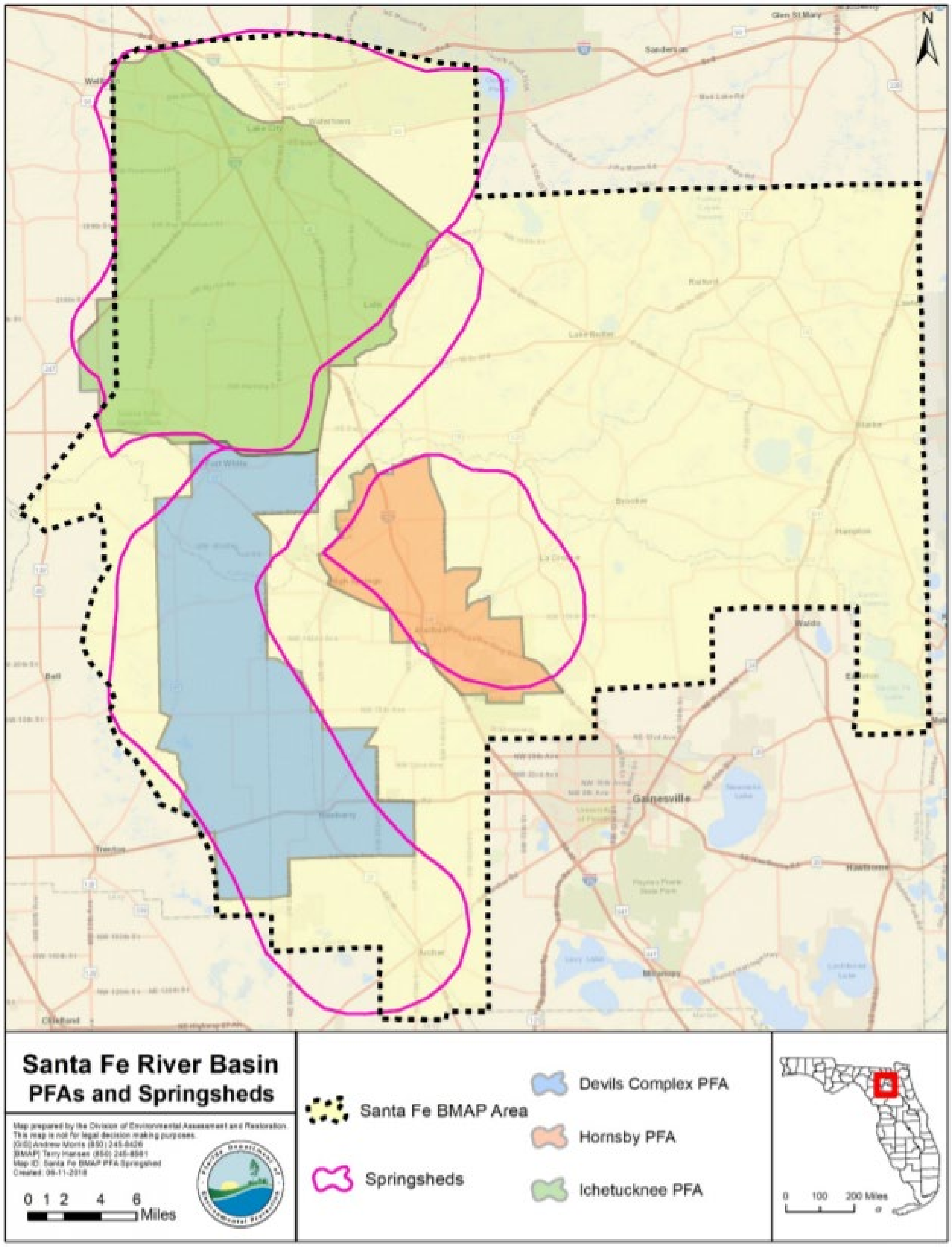


Figure 3: Springsheds of the Santa Fe River Basin (Upchurch Et Al. 2008)


Santa Fe River Basin
PFAs and Springsheds
Santa Fe BMAP Area
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Devils Complex PFA
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iii. Water Use & Landscape Performance Monitoring Methods (Research Objective #1)

Our first study objective was to assess the post-installation water use patterns and performance of the test group landscapes relative to those of the reference group landscapes. To address this objective, we ask the research question: *Following initial establishment and homeowner/tenant occupancy, do the test group landscapes demonstrate statistically significant differences in water use compared to the reference group landscapes?*

The data necessary to answer this research question are available in-house through the UF/IFAS PREC H_2OSAV platform that houses multi-year, premise-level, monthly metered water use records from 15 Florida water utilities (including GRU) integrated with property appraiser and utility conservation program data.[6] The power of H_2OSAV comes with its embedded tools and algorithms that enable rapid and geo-visualized comparisons of water use across premises (individual homes and customer accounts), neighborhoods and subdivisions, and utility service areas.

The standard unit for water use is gallons per household per day (gpd) and the data are disaggregated in cases where homes have dual meters—one for potable water servicing indoor needs and one for reclaimed water providing landscape irrigation and other outdoor water needs. Figure 5 shows a screenshot of the GRU service territory with water use segmented and color-coded by quartile; the darkest red parcels are in the top quartile of consumption, with the largest water footprints (i.e., the 'High Users') while the lightest orange/yellow are in the bottom quartile with the lowest water footprints (i.e., the 'Low Users').[7] As a reference point, locations of the four case study sites are marked with the green diamonds. Note that they are all in West Gainesville, where most new residential growth is occurring in the county, and they are distributed across a north-to-south transect of the city and GRU service area.

The GRU data already analyzed and published through this platform and prior research (e.g., "Envision Alachua Water Consumption Baselines"[8] provide a robust baseline for expected water use among 'typical' new residential communities where turfgrass (sod) lawns and in-ground irrigation systems are standard in the landscape. Across all residential customers, water use averages 190 gpd while use among the 'High Users' group/quartile averages more than twice this at 401gpd. Taylor et al. (2020) note that these 'High Users' consume more water collectively than the other 75% of customers *combined*. They also estimate from these data that a typical home on an 0.25-acre lot uses ~2,000 gallons of water each time they irrigate their lawns. That is roughly the amount of water used indoors by the lowest use GRU customers *in a typical month.*

The H_2OSAV platform will also serve as the tool for selecting comparison groups, estimating relevant water use benchmarks, measuring actual use, and characterizing water use patterns for 'test' vs. 'reference' subdivisions. To the extent possible, 'reference' baseline sampling was matched with 'test' sample characteristics to generate the most valid comparison points for the analysis. Specific, ordered steps in assessing the performance of study homes and subdivisions from a landscape water use perspective and using H_2OSAV included:

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[6] The public-facing site for this web platform and Extension program is online at https://h2osav.buildgreen.org/.
[7] From Taylor et al. (2020). Florida H_2OSAV Insights: Home Water use in the Gainesville Regional Utilities (GRU) Service Territory. A UF/IFAS educational fact sheet accessible online at https://edis.ifas.ufl.edu/pdffiles/AE/AE54400.pdf.
[8] PREC (2014) http://buildgreen.ufl.edu/Analysis/2014-4-29_EnvisionAlachua_WaterConsumptionBaselines_FinalReport.pdf

- Screening and verifying the physical and market features of the case study parcels, lots, units, hardscapes, landscapes.
- Measuring/estimating in both absolute (total square feet) and relative (percentage of entire lot) the pervious and irrigable area per unit of case study lots, distinguishing between lawns/turf and landscape bed areas to the extent feasible.
- Matching case study features and irrigable area metrics to identify and select a valid sample of comparison lots and homes from adjacent subdivisions.
- Querying and compiling in a master database the actual monthly water use (metered from GRU and on-site well at 88th Street Cottages) for case study and comparison homes.[9]
- Evaluating water use data and patterns to document patterns at the household and subdivision levels over time.
- Statistically comparing test group vs. representative group sample landscape features and water use patterns (using SAS Enterprise and JMP software) and applying the algorithmic Annual Community Baselines or ACB model to measure water use of 'test' / "irrigation-free" homes and 'reference'/baseline units and subdivisions to assess relative performance.

[9] If necessary, to provide higher resolution data for the well water use at 88th Street Cottages than that which can be collected manually through periodic (monthly or bi-weekly) site visits, we will request permission from Robinshore and 88th Street Cottages property management to install and access software to remotely monitor and log data from the well meter.

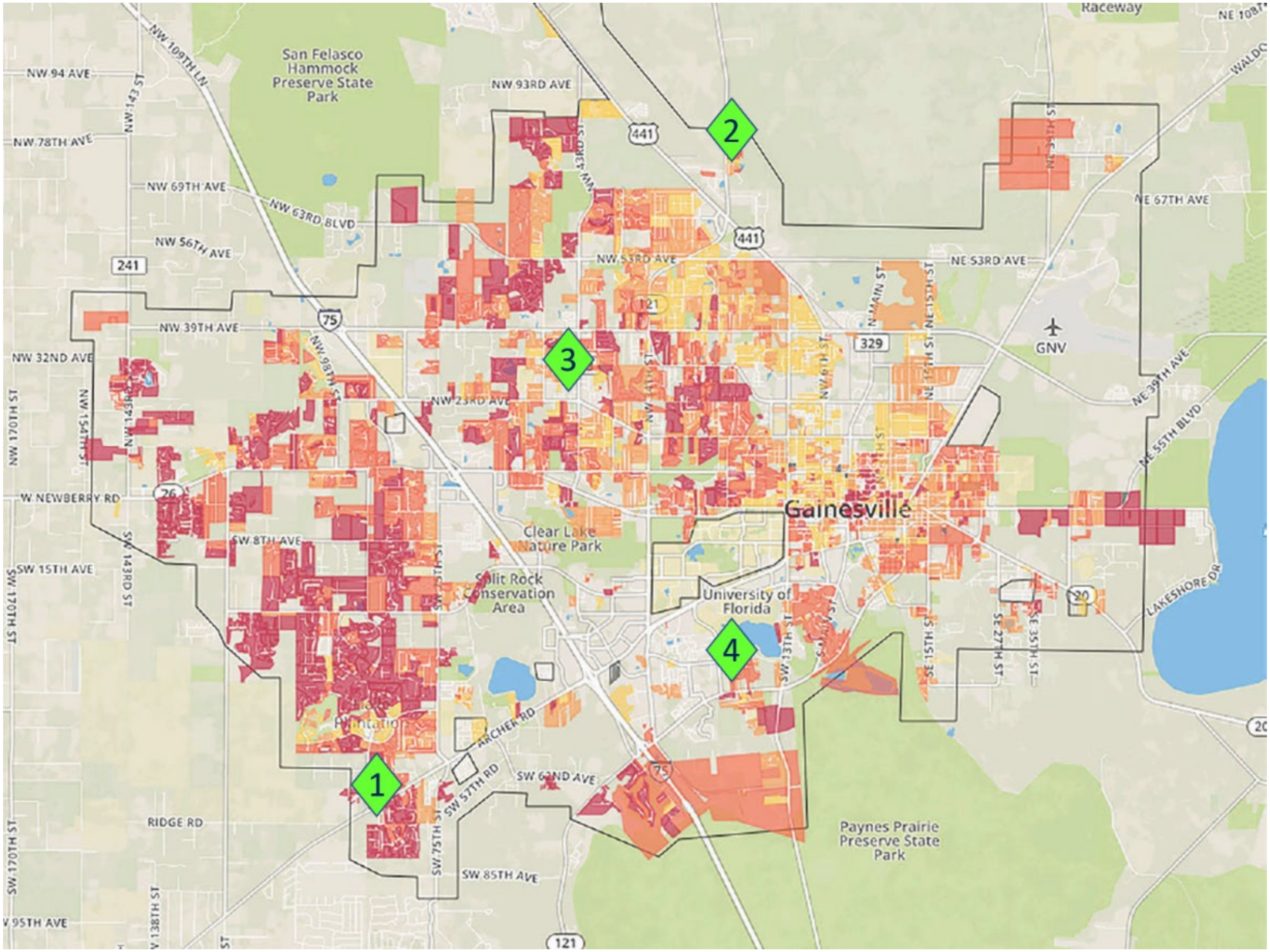


Figure 5: Case Study locations in the UF/IFAS PREC H_2OSAV platform (residential subdivisions color-coded by water use)

iv. Housing Market Value Performance Monitoring Methods (Research Objective #2)

Our second study objective is to assess residential market performance by evaluating initial home sale price points and subsequent market value dynamics of alternative “irrigation-free” landscape homes and subdivisions relative to those of comparable landscape homes and subdivisions. To address this objective, we ask the research question: *At point of initial sale/signing of rental agreement and over time following occupancy of homes and rental units, do the test group landscape homes and subdivisions demonstrate statistically significant differences in market value compared to the reference group homes and subdivisions?*

Consistent with the approach used to assess water use performance, we relied primarily on mining and analyzing housing market data already captured in-house via H_2OSAV to answer this research question. Specific steps in the process included:

- Screening and verifying the property appraiser sales and valuation data for the case study and comparison group parcels, lots, units, hardscapes, landscapes.
- Normalizing market and property value data over time by adjusting for inflation and net present value of homes.
- Querying and appending to the master database the actual real estate data for case study and comparison homes.
- Documenting unit-level market value descriptive statistics, including initial and subsequent sales since construction was completed.
- Applying an OLS regression model to estimate statistical relationships among landscape features, water use patterns, and property values (the dependent variable of interest). We will use SAS Enterprise and JMP software for this analysis and apply a modified version of the Annual Community Baselines© or ACB model developed by PREC faculty to normalize property value estimates over time and space and measure deviations between actual and expected property values.
- Using paired t-tests to measure for differences and statistical significance of differences across ‘test’ vs. ‘reference’ group property values at a subdivision level. This final step will test the null hypothesis that there are no statistically significant differences in market value between our paired samples of ‘test’ case study homes and ‘reference’ homes.

v. Resident Social Science Survey Methods (Research Objective #3)

Our third study objective was to identify resident (homeowner/tenant) priorities and preferences when making their home purchase or rental decision and assess landscape management inputs and patterns among test group subdivisions relative to resident priorities and preferences among reference group landscapes, units, and subdivisions. To address this objective, we asked the research question: *Do resident surveys reveal statistically significant differences in home and yard priorities and landscape input management behaviors across the test and reference homes and subdivisions?*

a. Survey Structure & Sampling Protocol

To collect feedback on the value (perceived benefits, costs, tradeoffs) of irrigation-free landscapes vs. conventional Florida residential landscapes, we surveyed case and reference group residents with a purposive (non-random), balanced (representative), and statistically valid sample of 'test' and 'reference' homeowners and renters living in new (built since 2005) subdivision homes in Gainesville and Alachua County. The resident survey instrument was formatted as a structured online questionnaire including a mix of closed- and open-ended questions as well as quantitative and qualitative lines of inquiry. It was administered through Qualtrics and designed to take no more than 15 minutes of respondents' time to complete. Drafts of the survey instrument and data collection approach were reviewed by University of Florida and The Nature Conservancy colleagues, and the final questionnaire and survey protocols were approved by the University of Florida Institutional Review Board (IRB #202101992) prior to sampling.

The survey sample and contact information (name and physical mailing addresses) for each prospective respondent were generated using publicly available property appraiser and tax roll data, which were already captured in the H_2OSAV platform. Final sample sizes for the four test and reference groups, included 74 test and 3,272 reference group residents, for a total (prospective) respondent sample size of 3,346.

Participants were recruited through two series of postcard mailings asking them to 'help us by sharing your experiences with and opinions about your Gainesville/Alachua County yard" (see Appendix B). The first postcard notified them about the study and its purpose and provided details about how to participate, including a shortened URL (https://bit.ly/MyFloridaYard) to access the survey and a QR code that could be scanned with a smartphone to do the same. We gave prospective respondents an incentive to respond by providing a $50 Amazon Gift Card to every 25th person who completed the survey; this approach ensured that everyone recruited to participate had an equal likelihood of receiving the incentive. Recruitment postcards also included contact information for the research team lead so that they could reach us with any questions about participation or to discuss the larger study.

Survey invitation postcards were printed with unique respondent ID codes included in the address line, and these codes were included in the first question of the survey to provide a mechanism for verifying that we are matching their responses with the correct property location. The first round of postcard invitations was sent to the full sample by regular US Postal Service mail on September 21, 2021. Three weeks later, on October 13, the second round of follow-up postcards was sent to remind prospective participants about the study and to encourage them to respond.

b. Online Questionnaire Topics of Inquiry

Primary objectives of the resident survey were to understand which landscape attributes (aesthetics, function, ecosystem services, recreation, etc.) residents value most, how they maintain their landscapes (including irrigation and fertilization practices), how much they spend on landscape expenses, and how satisfied they are with the services provided by their yards and outdoor spaces.

In concert with parallel UF/IFAS Program for Resource Efficient Communities (PREC) applied research studies (e.g., the concurrent SEED-IT project[10] being led by Dr. Basil Iannone, "How Much Does Your Landscape Cost to Maintain? Increasing Consumer Awareness and Developer Incentive to Promote Early Adoption of Sustainable Landscaping"), our team also solicited information via the online survey about yard composition, mowing frequency, use and frequency of fertilizer and pesticide applications, and landscape maintenance activities and expenses. This information was used collectively to assess performance of and resident satisfaction with non-irrigated (test) landscapes relative to conventional (reference) landscapes.

The primary topics of inquiry covered by the online questionnaire included:

a. overall composition of respondents' yards and outdoor spaces
b. respondents' preferences for different yard features and perceived utility (function, benefits) of different yard and landscape attributes
c. landscape irrigation characteristics and behaviors (including types, frequency, and duration of different irrigation events)
d. typical landscape maintenance behaviors (mowing, fertilization, application of compost, pesticides, herbicides, etc.) including tasks done by the residents themselves ("DIY") or those done by someone else
e. typical expenses for landscape maintenance (hired services and materials)
f. respondents' satisfaction with the benefits/values currently provided by their yards and outdoor spaces (specific features and overall)

We also included a question to gauge respondents' environmental attitudes using an index of statements about Florida's natural resources and environment (including springs). The full questionnaire is provided in Appendix C.

[10] Complete list of Support for Emerging Enterprise Development Integration Teams (SEED-IT) projects awarded in 2020 is at https://research.ifas.ufl.edu/research-areas/funding-old/seedit-funding-announcement/.

VI. Results

vi. Water Use Patterns (Research Objective #1)

a. Screening

To generate the final water use and property value analysis dataset, we first screened the full sample of conventional 'reference' groups to identify the subdivisions where automatic in-ground irrigation systems were installed as a standard feature of new home landscapes. For each of the potentially comparable reference subdivisions, Figure 6 plots the share (percentage) of all homes in the sample that have 'sprinkler systems' installed (according to property appraiser data from H_2OSAV) vs. those that do not. Based on these data, we selected for the 'reference' groups only subdivisions where 80% or more of the homes are identified as having sprinkler systems (denoted with an asterisk before the subdivision names in Figure 6). This screen removed from the final analysis dataset 20 prospective 'reference' group subdivisions (and 1,038 properties altogether). Note also that 32% (11) of the homes in the Madera 'test' group were identified as having sprinkler systems. These homes were also removed from the final analysis dataset to ensure that only irrigation-free homes were included in the four 'test' groups, which are outlined in dark yellow in Figure 6.

b. Quantifying Water Use

From unit-level records in the final analysis dataset, we calculated average monthly water use for each group of homes (subdivisions) within the four irrigation-free 'test' and corresponding 'reference' groups. Figure 7 summarizes these results, showing the average water use (measured in gallons per household per day, or gpd) of irrigation-free 'test' groups in dark yellow, the average of corresponding conventional 'reference' groups in dark blue, and the averages for each subdivision within 'reference' groups in royal blue. Over the one-year period from July 2020-June 2021, water use of the 'test' group households averaged 97 gpd for 88th Street Cottages, 109 gpd for Hidden Lake, 102 gpd for Gainesville Cohousing, and 146 gpd for Madera. Note that with only one exception—Millhopper Forest in the Madera 'reference' group—all conventional subdivisions' water use exceeds that of the irrigation-free 'test' subdivisions. Average water use across 'conventional' reference groups ranges from 209 gpd for the 88th Street Cottages reference group to 287 gpd for the Madera reference group. These measured differences in water use equate to average *savings by test vs. reference groups of 49% for Madera (141 gpd less), 54% for 88th Street Cottages (112 gpd less), 59% for Hidden Lake (158 gpd less), and 61% for Gainesville Cohousing (162 gpd less).*

c. Measuring Differences in Water Use Patterns

Next, we tested whether the differences in average water use between 'test' and 'reference' groups are statistically significant. Figure 8 shows the distribution of individual households' water use values within each subgroup using a box plot. For each 'test' and 'reference' group, each individual unit's average water use (gpd) is plotted vertically and shown as small blue circles, and outliers (a small subset of extreme high water users) are excluded. The blue boxes show the inner-quartile range, which includes homes with use values between the 25th and 75th percentile of each group's overall distribution. The horizontal line inside of each box represents the groups' median water use and the 'x' marker represents the groups' average (mean) water use. Homes with use beyond the 75th percentile are plotted above the boxes and those with use below the 25th percentile are plotted below the boxes. *Two-tailed t-tests comparing these water-use distributions across 'test' and 'reference' groups (assuming unequal variances) all reject the null hypothesis that water use is equivalent at a 95% confidence level or higher. In other words, the water use of irrigation-free 'test' groups is statistically significantly lower than that of conventional 'reference' groups for all four groups.*

Figures 9-12 segment the 'reference' water-use data further, plotting the distributions of use for each subdivision within each of the four 'reference' groups and comparing each of these to the water-use distribution of the irrigation-free 'test' subdivision. For example, Figure 9 shows seven 'box and whisker' plots. The first (from left to right along the horizontal axis) represents the distribution of water use values for 88th Street Cottages units. The other box plots show water use distributions for each of the six 'reference' subdivisions that make up the larger 88th Street Cottages reference group (Walnut Creek, Cottage Grove, etc.) The median water use value for 88th Street Cottages is ~80 gpd relative to ~110 gpd for the lowest water-use reference subdivision in this group (Walnut Creek) and ~265 gpd for the highest-use reference subdivision (Ellis Park). *Again, t-tests on these means and distributions consistently reveal statistically significant differences between 'test' and 'reference' subdivision water use.*

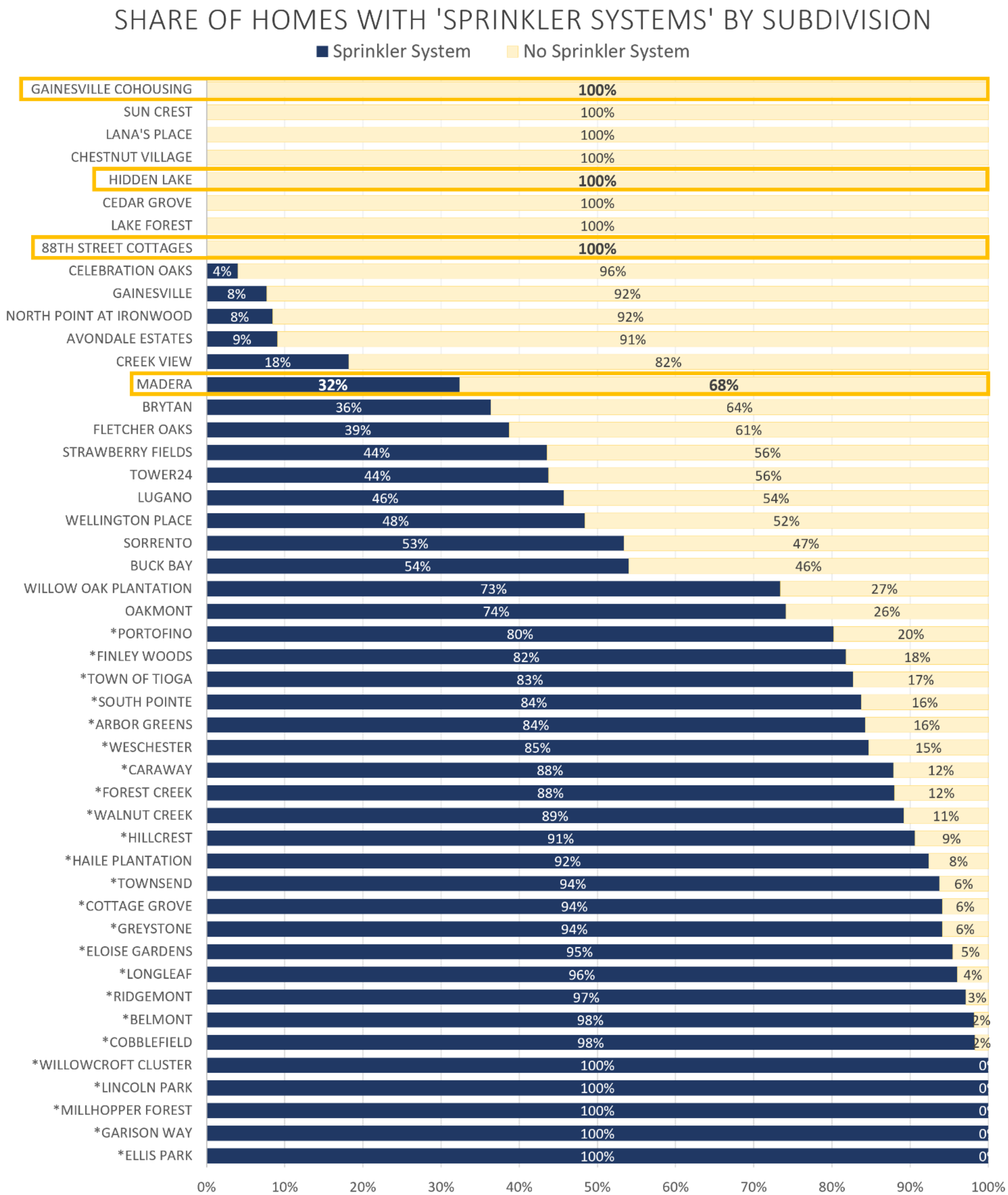


Figure 6: 'Test' and 'Reference' subdivisions from initial H_2OSAV sample - shown by portion of homes with and without 'Sprinkler Systems' with four Irrigation-Free 'Test' groups outlined in dark yellow. *Indicates subdivisions where 80% or more homes have sprinkler systems and are included as conventional 'Reference' groups for water use and property value analyses.

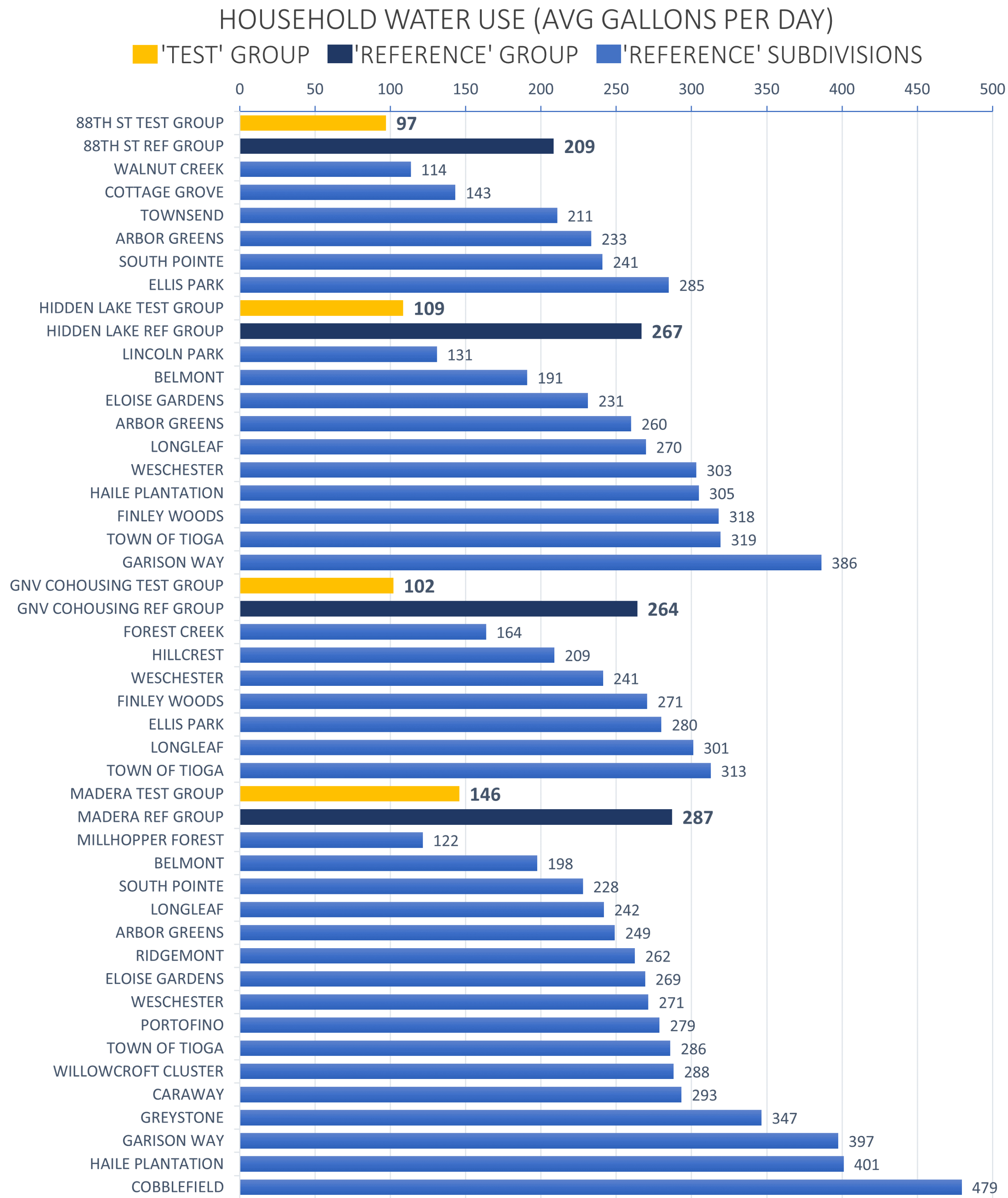


Figure 7: Average household water use (gallons per day) of four irrigation-free 'Test' groups, four conventional 'Reference' groups, and individual 'Reference' subdivisions

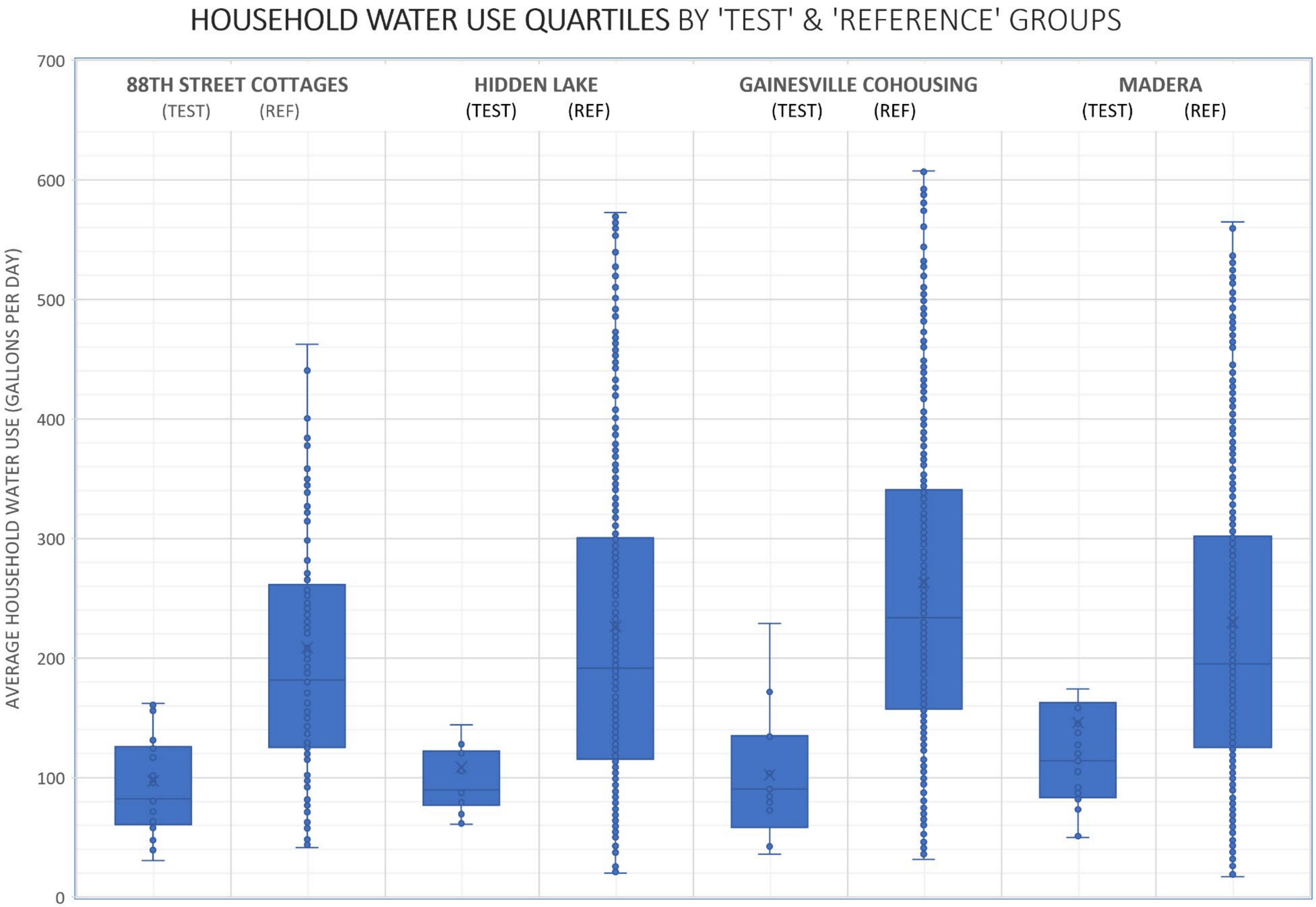


Figure 8: Household water use distribution across all four irrigation-free 'Test' & conventional 'Reference' groups and subdivisions

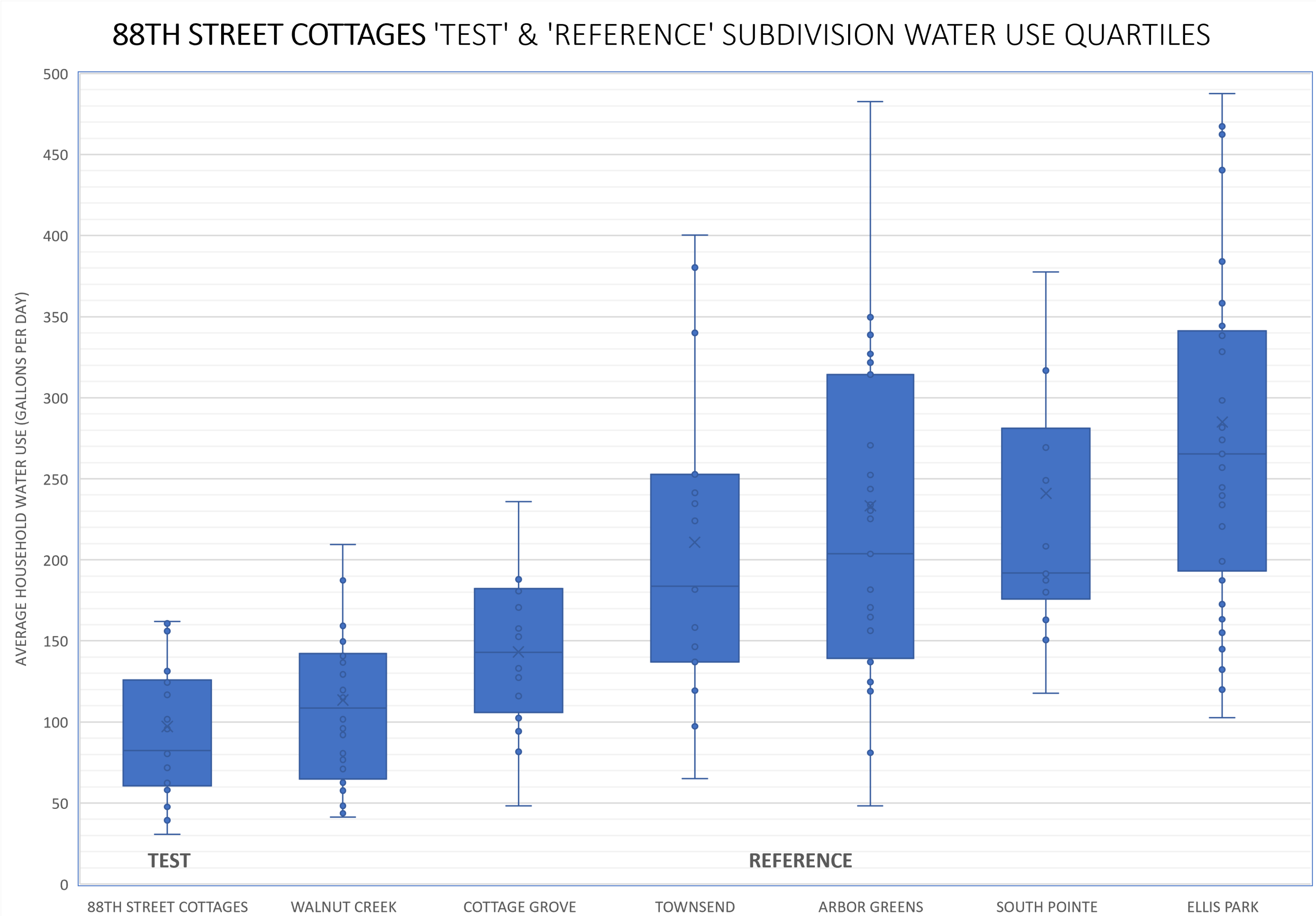


Figure 9: Household water use distribution of 88th Street Cottages 'Test 1' & six 'Reference' subdivisions

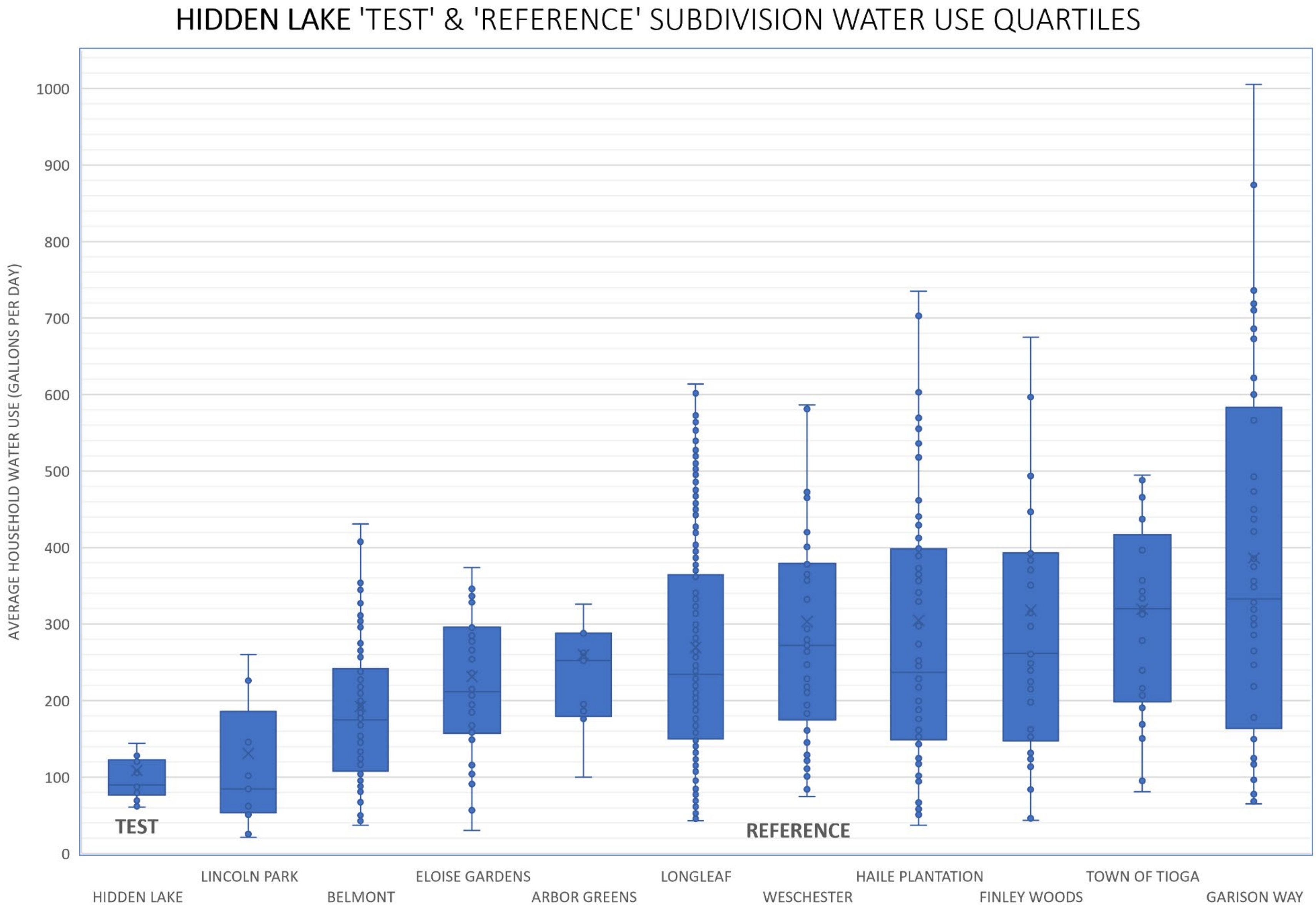


Figure 10: Household water use distribution of Hidden Lake 'Test 2' & ten 'Reference' subdivisions

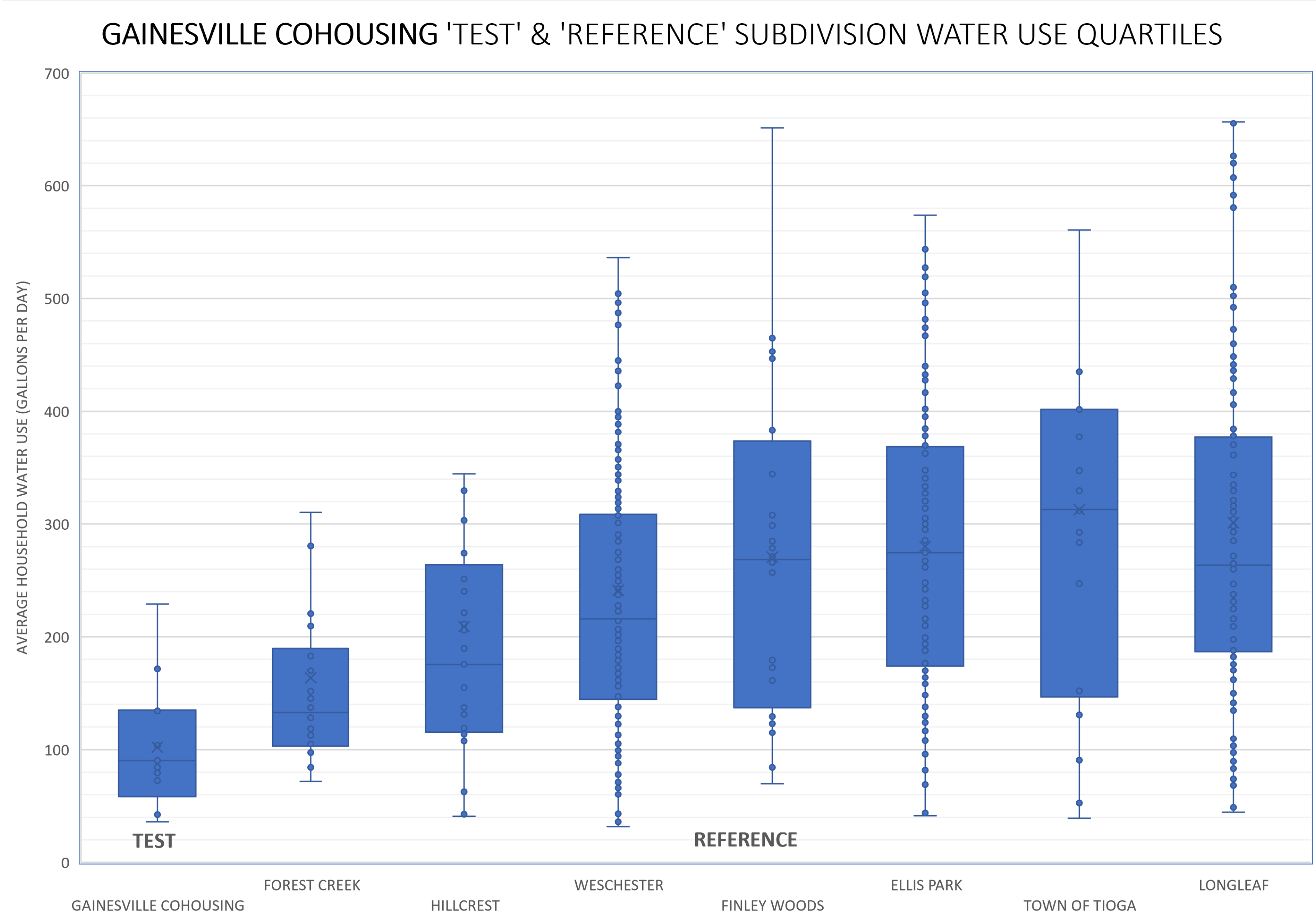


Figure 11: Household water use distribution of Gainesville Cohousing 'Test 3' & seven 'Reference' subdivisions

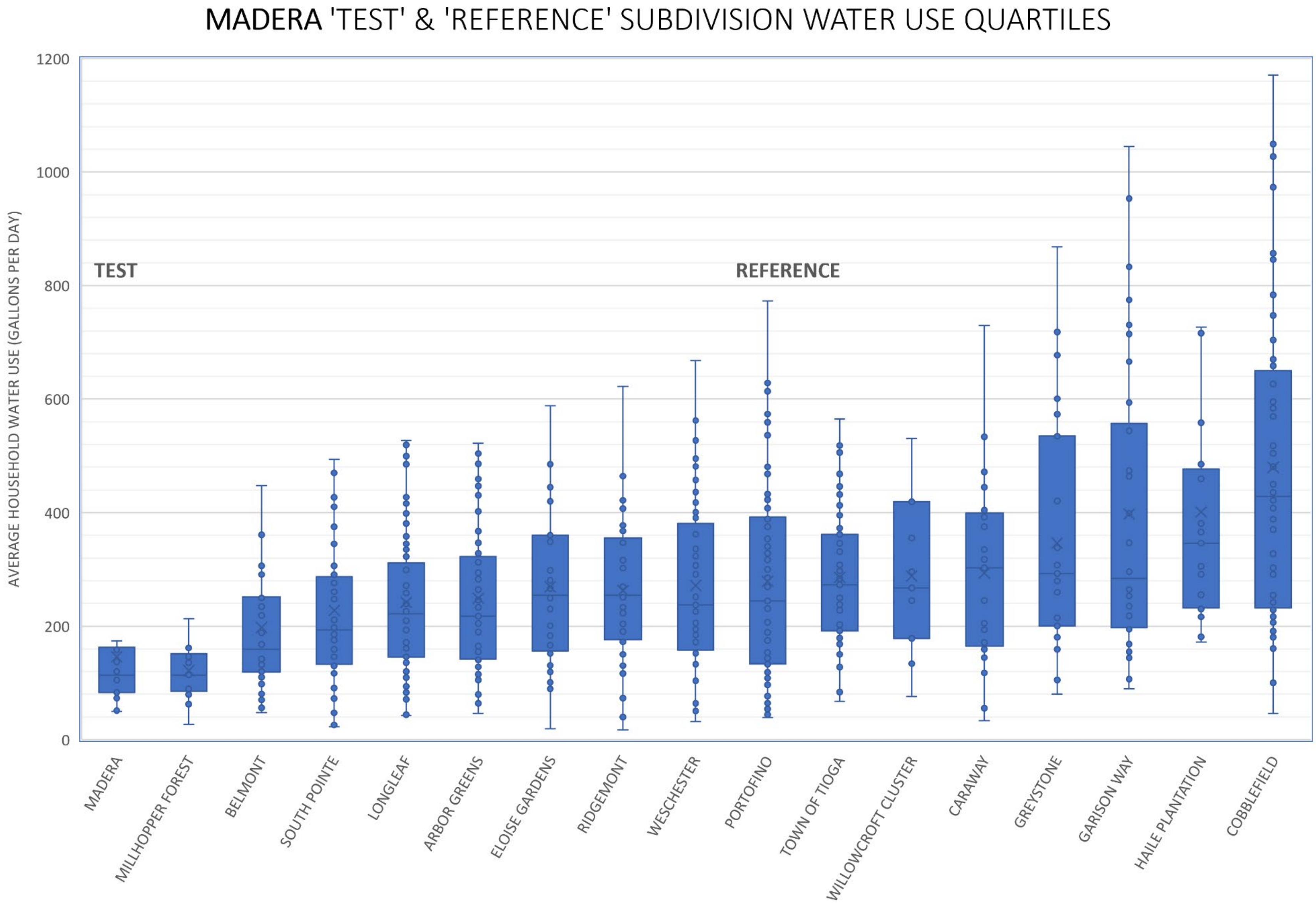


Figure 12: Household water use distribution of Madera 'Test 4' & sixteen 'Reference' subdivisions

vii. Market Value Results (Research Objective #2)

a. Screening

For assessing market value of 'test' and 'reference' groups (subdivisions and homes), we used the same sample of unit-level data used for the analysis of water use patterns (i.e., no new records were added, and no additional records were removed.) Thus, the data in this section are analyzed and summarized in the same fashion as the water use data but evaluating the metric of current property appraisal value. Property values are directly from the Alachua County Property Appraiser 2021 data, which are housed in and were queried from H_2OSAV.

b. Quantifying Property Values

From unit-level data, we calculated average 2021 appraised property values for each group of homes (subdivisions) within the four irrigation-free 'test' and corresponding 'reference' groups. Figure 13 summarizes these results, showing the average appraised property value (measured in units of $1,000s in year 2021) of 'test' groups in dark yellow, the average of corresponding conventional 'reference' groups' property values in dark green, and the averages for each subdivision within 'reference' groups in bright green. In 2021, appraised market values of the 'test' group properties averaged $259K for 88th Street Cottages, $258K for Hidden Lake, $261K for Gainesville Cohousing, and $247K for Madera. 'Reference' subdivisions' average property values vary relative to those of the 'test' properties, and their average values within reference groups are nominally higher (~$14K more) than that of the 'test' groups. *Average appraised value across each reference group ranges from $265K for the 88th Street Cottages reference group to $273K for the Gainesville Cohousing reference group and exceeds that of test groups by only 2% (relative to 88th Street Cottages), 4% (relative to Hidden Lake), 5% (relative to Gainesville Cohousing), and 10% (relative to Madera).*

c. Measuring Differences in Property Values

Next, we tested whether the differences in average property value between 'test' and 'reference' groups are statistically significant. Like Figure 8 for the water use values, Figure 14 shows the distribution of individual households' 2021 appraised property values within each subgroup using a box plot. For each 'test' and 'reference' group, each individual unit's value ($1,000s) is plotted vertically and shown as small green circles, and outliers (a small subset of extreme high values) are excluded. The green boxes show the inner-quartile range of these distributions, with properties where appraised value falls between the 25th and 75th percentile of each group's overall distribution. The horizontal line inside of each box represents the groups' median property value and the 'x' marker represents the groups' average (mean) property value. Property values higher than the 75th percentile are plotted above the boxes and values lower than the 25th percentile are plotted below the boxes. *Two-tailed t-tests comparing these property value distributions across 'test' and 'reference' groups (assuming unequal variances) all fail to reject the null hypothesis that property values are equivalent at a 95% confidence level or higher. In other words, the assessed value of irrigation-free 'test' group properties is not statistically different (lower or higher) than that of 'reference' group properties, and this applies across all four analysis sub-groups.*

Figures 15-18 segment the 'reference' appraised property value data further, plotting the distributions for each subdivision within each of the four 'reference' groups and comparing each of these to the distribution of the corresponding irrigation-free 'test' subdivision's values. For example, Figure 16 shows eleven 'box and whisker' plots. The first (from left to right along the horizontal axis) represents the distribution of appraised property values for Hidden Lake homes. The other ten show property value distributions for each 'reference' subdivision included in the larger Hidden Lakes reference group (Lincoln Park, Belmont, Eloise Gardens, etc.) The median property value for Hidden Lake is $244K relative to $240K median for the lowest (average) value reference subdivision in this group (Weschester) and ~$284K for the highest (average) value reference subdivision (Finley Woods). *Again, t-tests on these means and distributions consistently reveal no statistically significant differences between 'test' and 'reference' subdivision property values; we fail to reject the null hypothesis that property values are equivalent.*

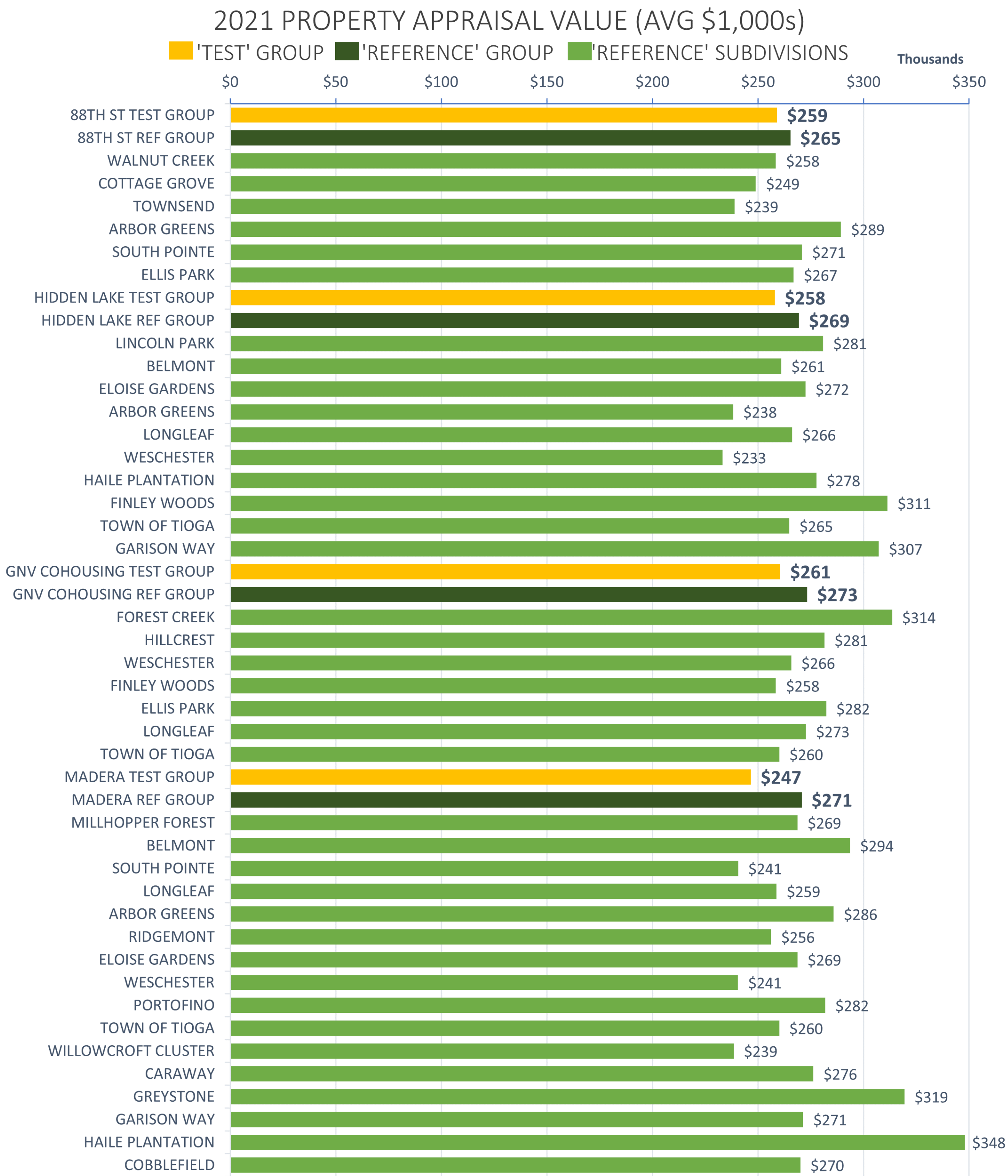


Figure 13: Average 2021 property appraisal value ($1,000s) of all four irrigation-free 'Test' & conventional 'Reference' groups and subdivisions

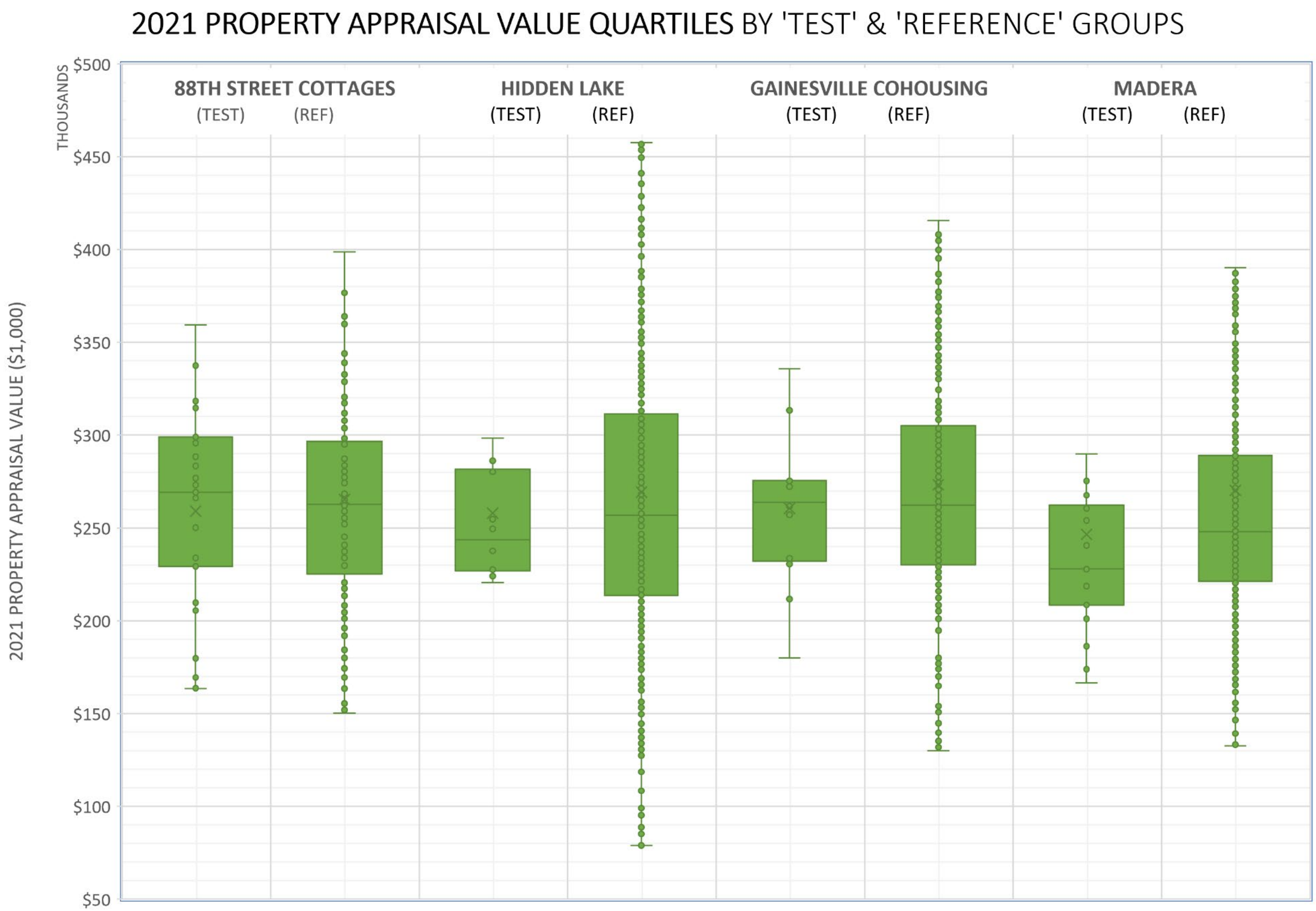


Figure 14: 2021 property appraisal values ($1,000s) across all four irrigation-free 'Test' & conventional 'Reference' groups and subdivisions

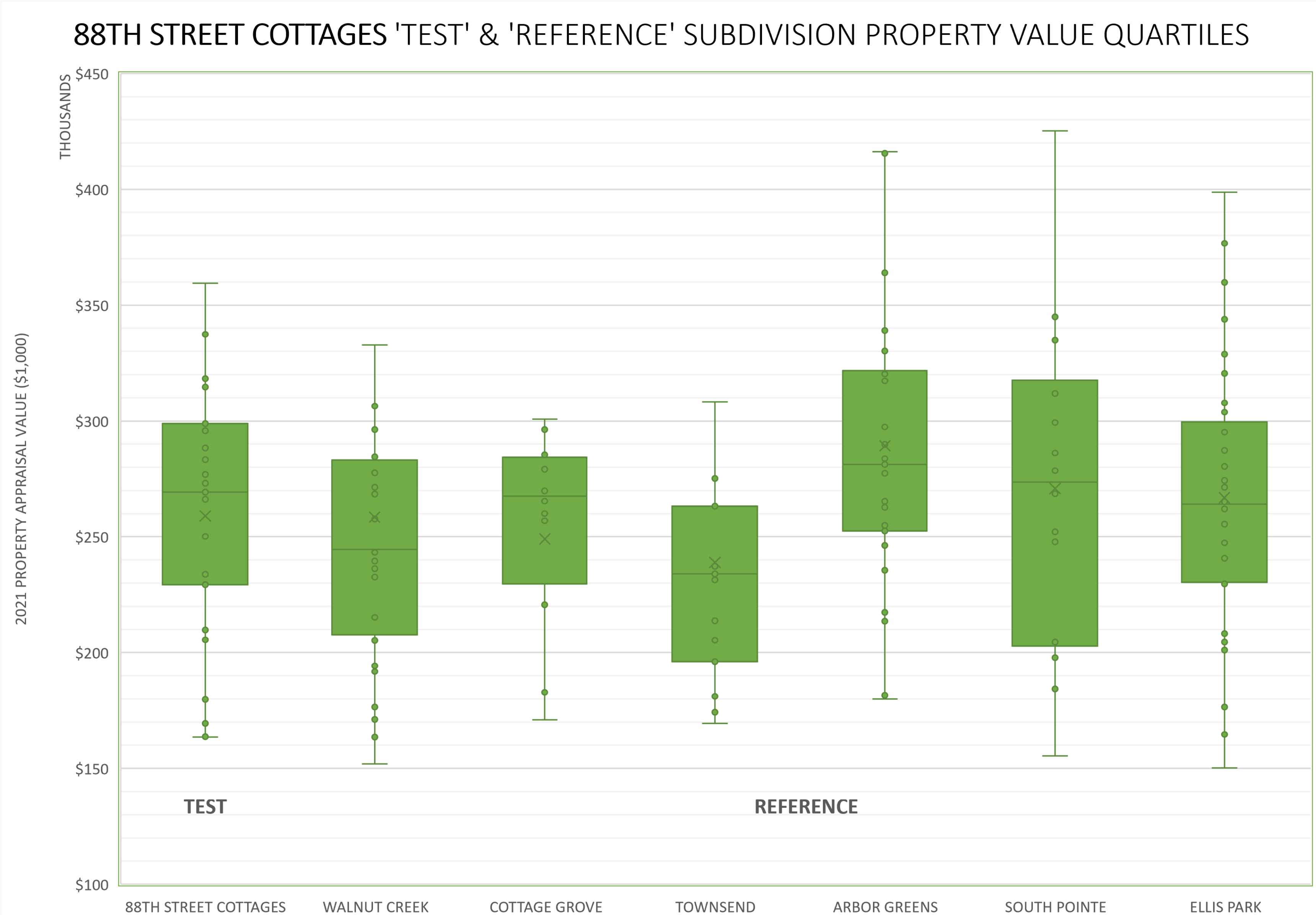


Figure 15: Appraised property value distribution of 88th Street Cottages 'Test 1' & six 'Reference' subdivisions

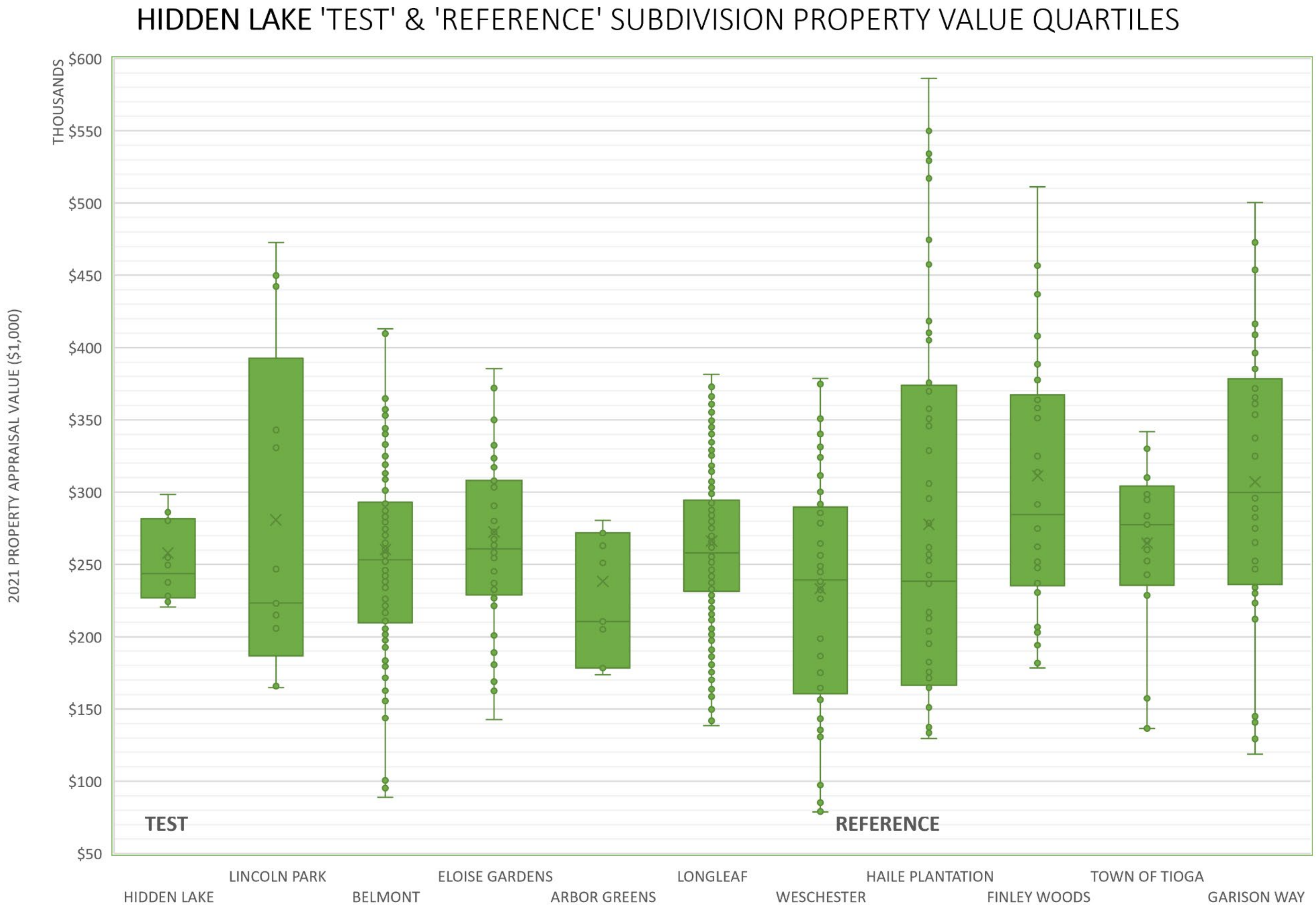


Figure 16: Appraised property value distribution of Hidden Lake 'Test 2' & ten 'Reference' subdivisions

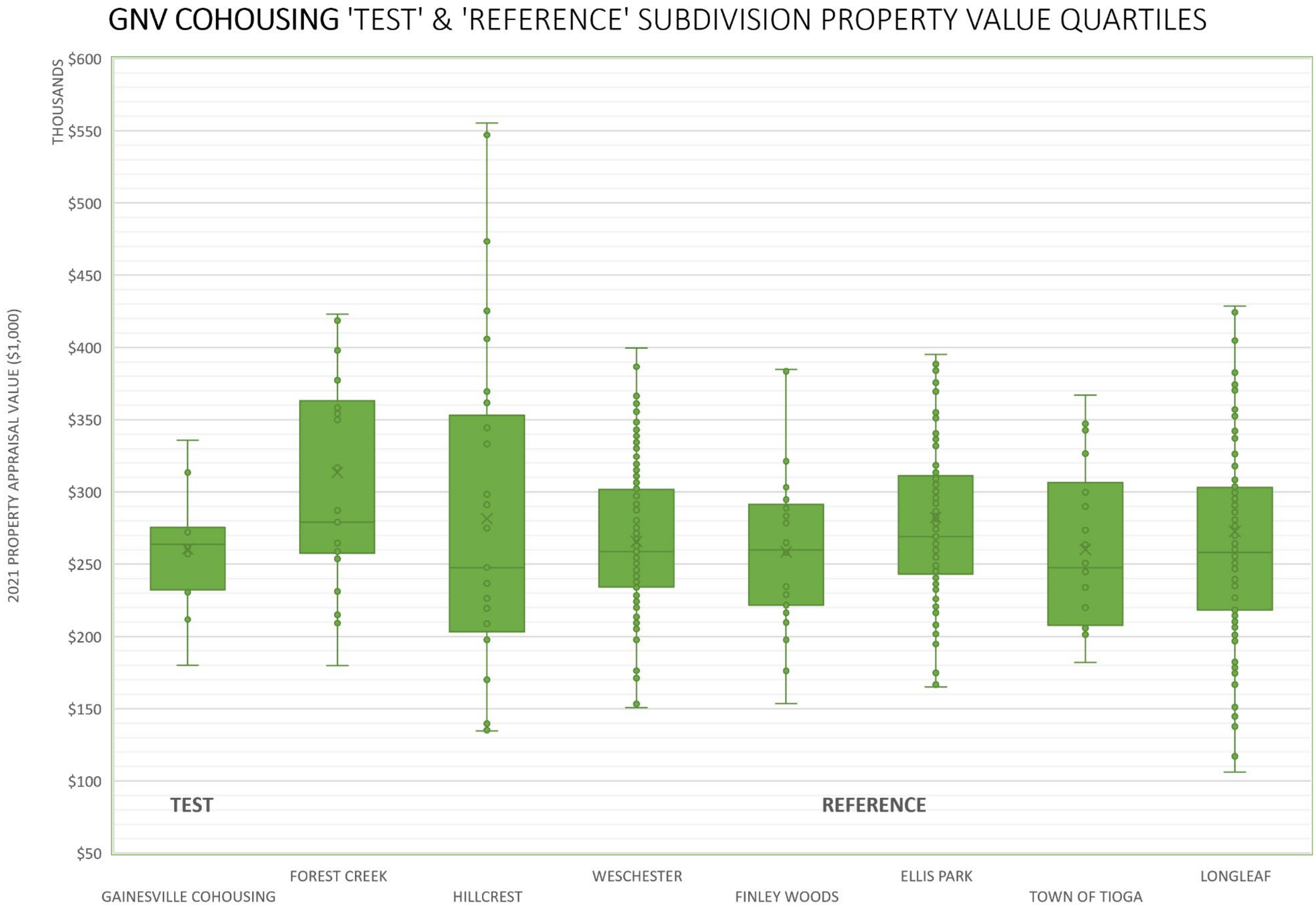


Figure 17: Appraised property value distribution of Gainesville Cohousing 'Test 3' & seven 'Reference' subdivisions

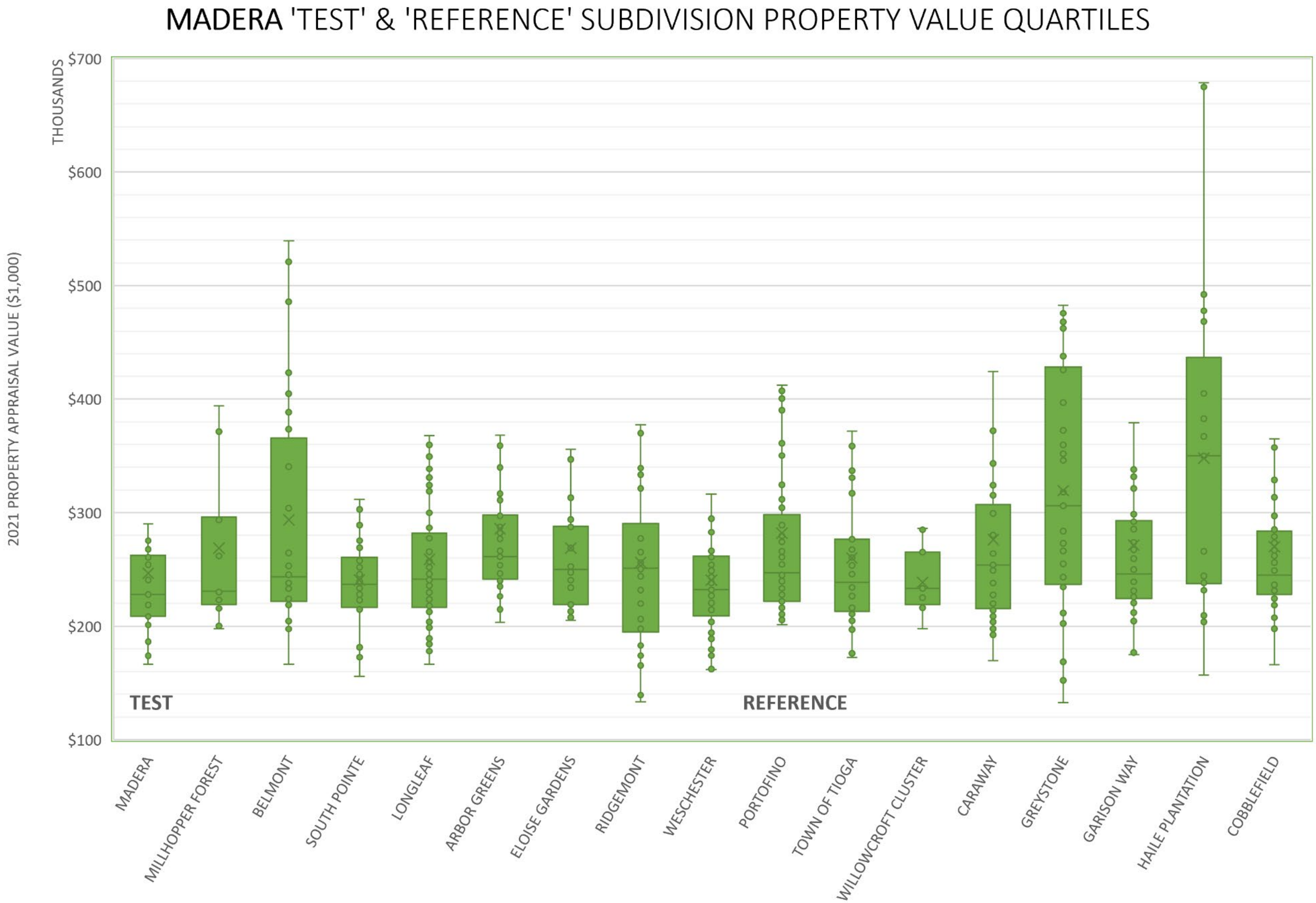


Figure 18: Appraised property value distribution of Madera 'Test 4' & sixteen 'Reference' subdivisions

viii. Resident Online Survey Results (Research Objective #3)

Over the 6-week data collection period in September and October 2021, 185 total questionnaire responses were received, 166 of which (90%) were complete and usable for the survey analysis. The completed survey sample included resident respondents from all 4 test subdivisions (13 test respondents) and from 36 reference subdivisions (153 reference respondents). Itemized responses to the resident survey questionnaire are detailed in Appendix D while the results for the central lines of survey inquiry and corresponding statistical analyses are presented here.

First, we look at the water use and property value data for survey respondents vs. nonrespondents. A comparison of the average water use segmented by test and reference group indicates that the respondent samples' water use is statistically equivalent to that of nonrespondents for both groups (Figure 19). Similarly, survey respondents' property values are equivalent to those of nonrespondents for both test and reference groups (Figure 20). In other words, respondents' water use and property value data verify that the final survey sample is statistically representative of the full population surveyed.

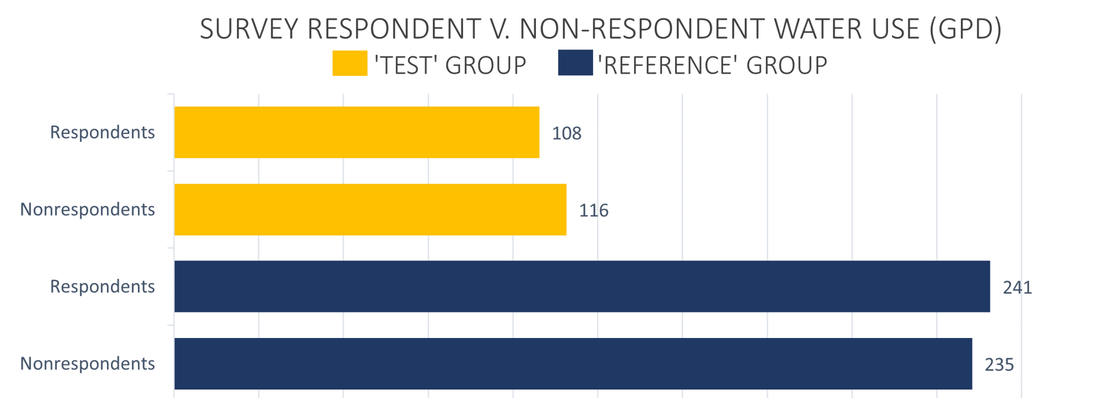


Figure 19: Survey Response Groups' Water Use (Average Gallons per Day)

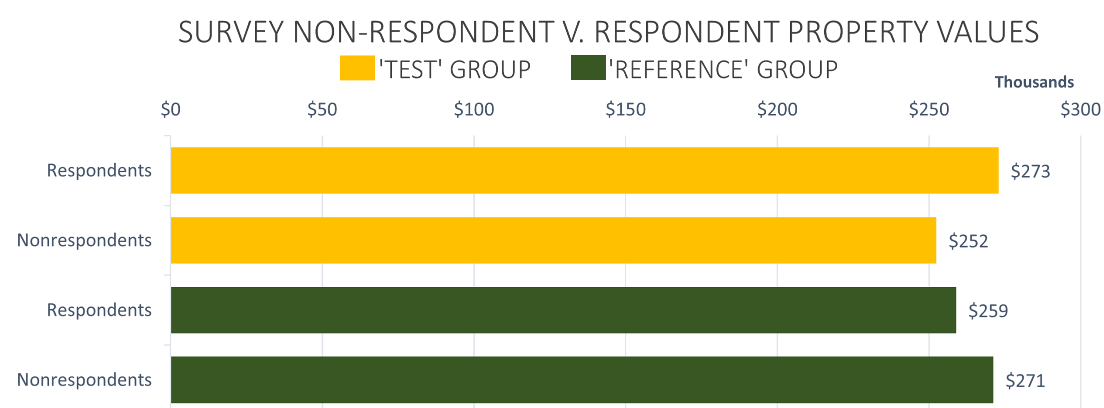


Figure 20: Survey Response Groups' Property Values (2021 Appraisal Data)

a. Resident & Property Characteristics

The majority (92%) of both test and reference respondents own their homes and said the homes were their primary residence. Most reported living at their current residence for five years or less (85% of test and 64% of reference respondents, respectively) and most plan on remaining in the home for at least another five years (76% of test and 68% of reference respondents, respectively). Figure 21 summarizes these respondent residency characteristics.

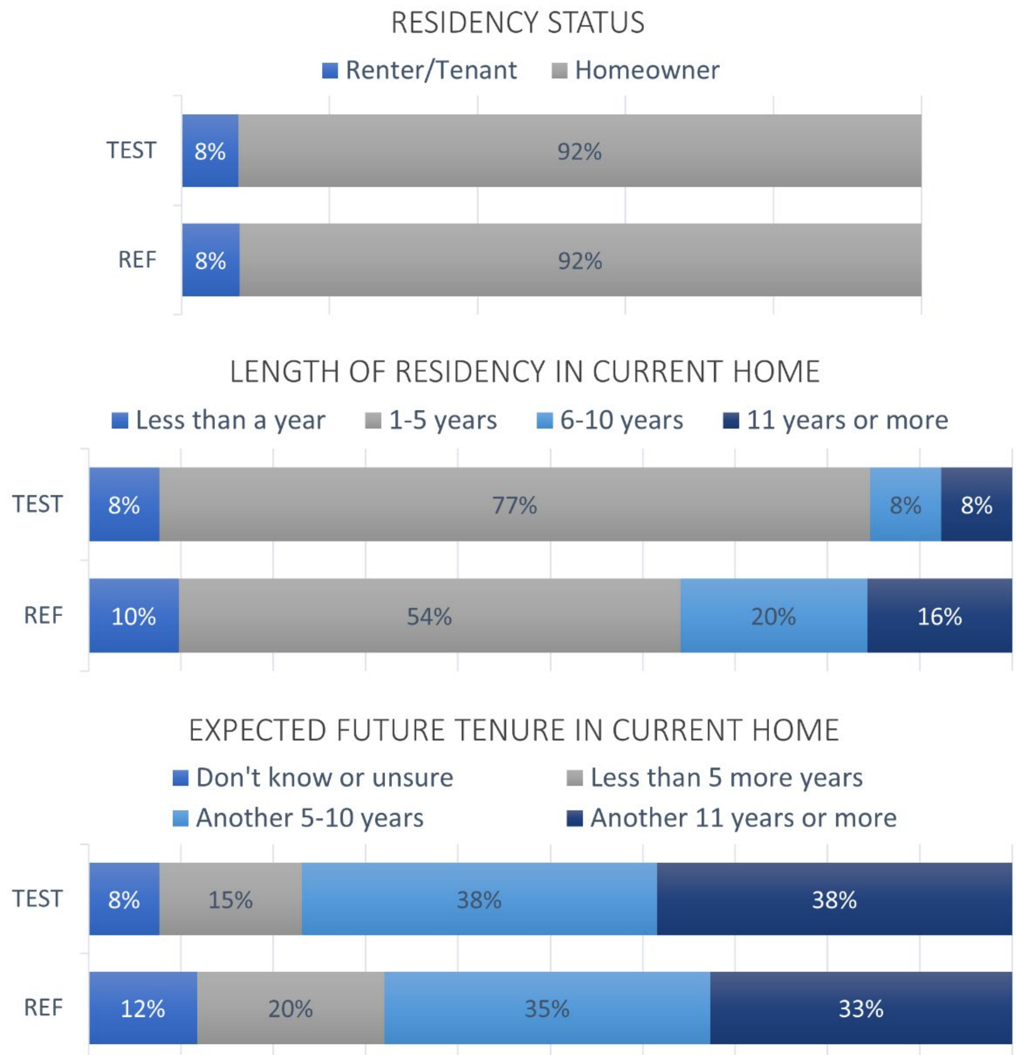


Figure 21: Survey respondent residency characteristics (rent or own; length of time and expected tenure in current home)

The structure of yards and landscape features differs across 'test' and 'reference' group properties. A higher percentage of test respondents (85% vs. 69%) reported that their yards are mostly (~3/4) softscaped. Test homes were also reported to have less lawn/turfgrass as a portion of the overall softscaped outdoor spaces (average of 22% lawn compared to 64% for reference group landscapes). Consistent with this finding, test respondent landscapes also have less irrigable area than reference landscapes, although these differences are nominal in magnitude and are not statistically significant. Test respondents' property appraiser data (subset of the larger sample of H_2OSAV analysis dataset) show that their lots have ~90% of the irrigable area, on average (4,054 ft^2), relative to that of lots and landscapes in the survey respondents' reference group (4,385 ft^2). Figure 22 summarizes these characteristics of survey respondents' properties and yards.

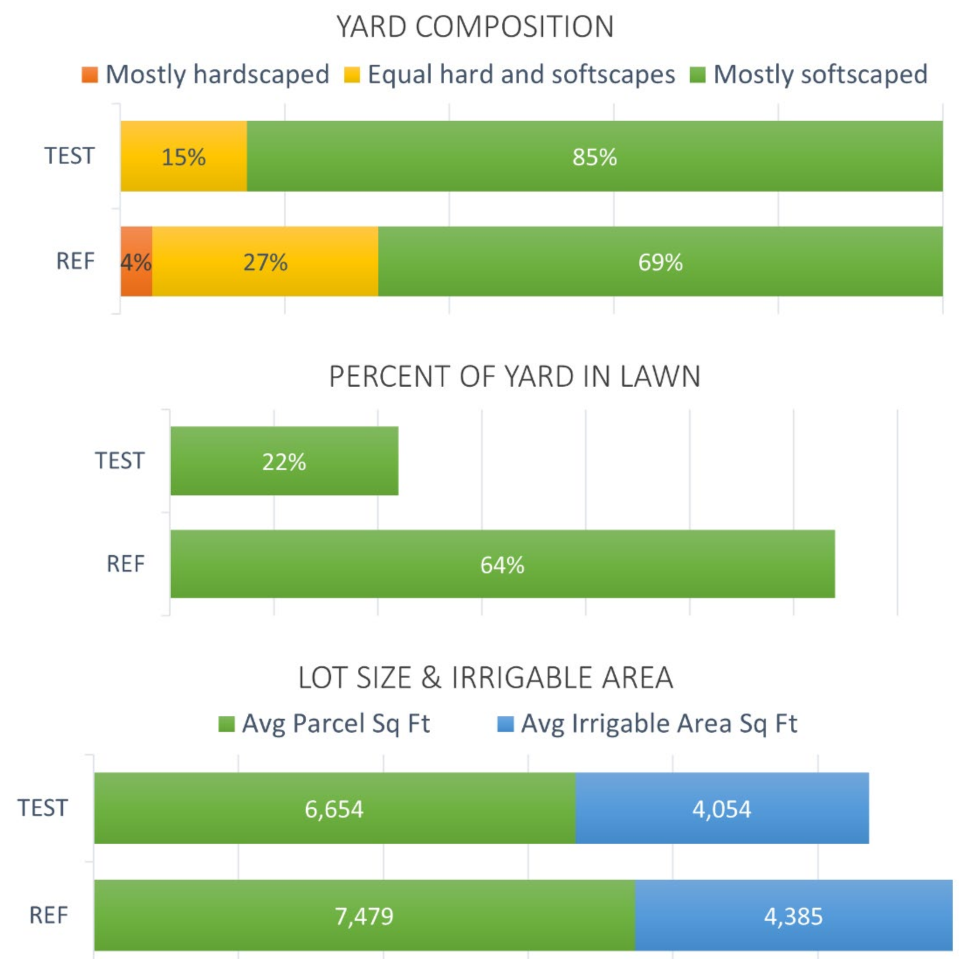


Figure 22: Survey respondent yard characteristics: hard vs. softscape, portion of yards that are lawn/turfgrass, lot sizes and irrigable areas

b. Yard & Outdoor Space Preferences

After providing information about their homes and yards, survey respondents were asked to rank a series of nine items—different features that residents commonly consider as adding value to their yards—by order of importance to them personally. The item ranked at the top of a respondent's priority list was given a score of '1', the next most important was given a score of '2', and so on. When looking at average scores for each of the nine features, a lower average score indicates higher order of priority or importance. If a feature's average score is 1.0 across the full sample, this would mean that all survey respondents chose that feature as their most important among the nine features presented to them; likewise, if a feature's average score is 9.0, this means it was selected as the least important by all respondents. Figure 23 below shows the average rank of each feature for the full sample of survey respondents: collectively, residents ranked 'aesthetic beauty', 'low maintenance costs', and 'providing a comfortable environment for outdoor activities' as the top three *most important* yard features. Conversely, they collectively ranked 'produces food or other useful plants', 'creates habitat for wildlife', and 'has native plants' as the bottom three *least important* features.

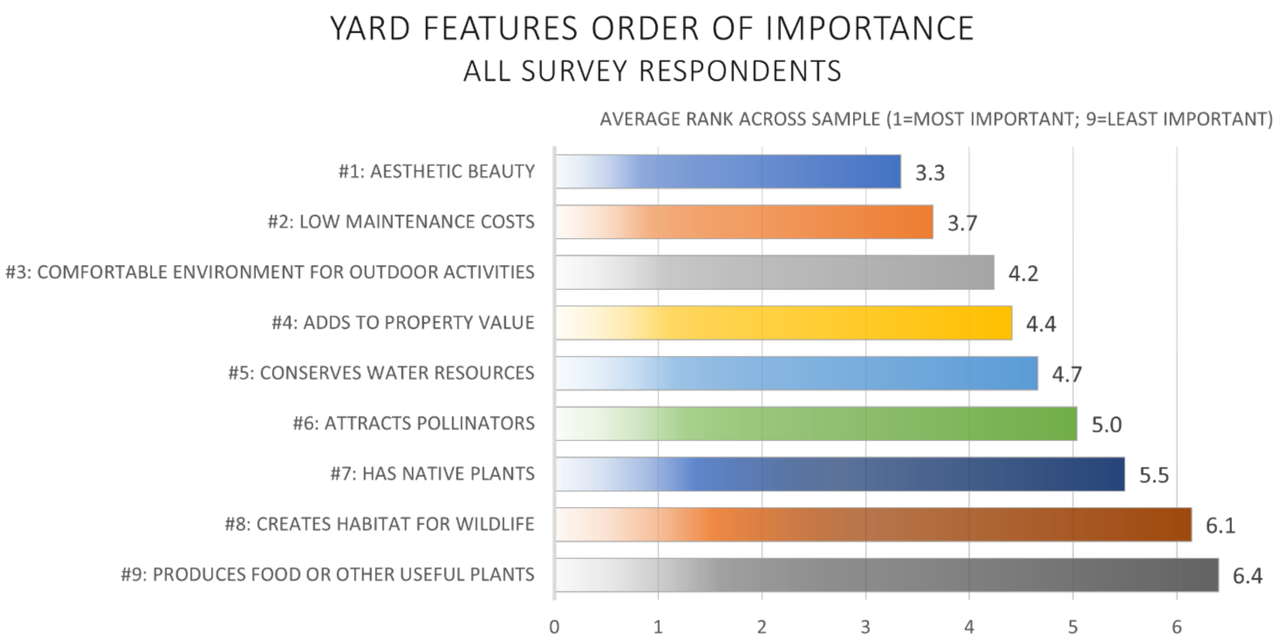
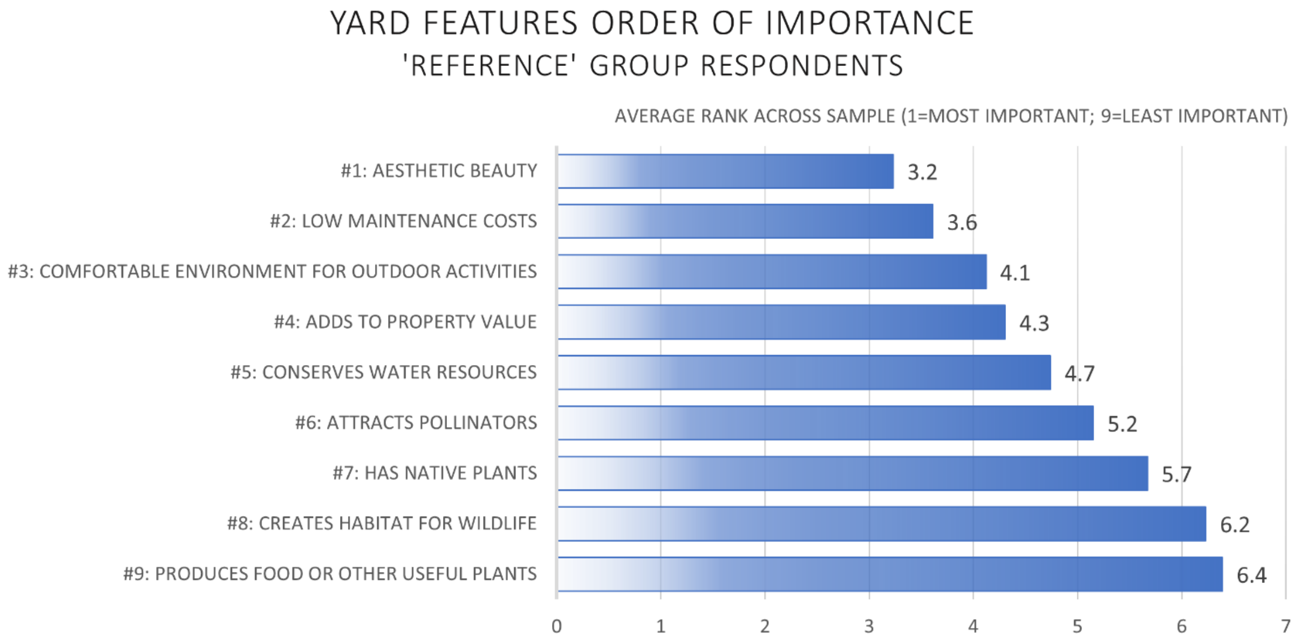


Figure 23: Order of landscape priorities for all survey respondents (n=166); lower average rank scores reflect higher priority/importance

When segmented by test (irrigation-free) and reference (conventional) groups of survey respondents, however, these yard feature rankings diverge, revealing that residents of test subdivisions prioritize a different set of landscape features than do residents of reference subdivisions. For the reference group of respondents, ordered rankings of yard features matched the order of rankings for all respondents (see the top graph in Figure 24). For the test group of respondents, the top three most important yard features, as revealed by relative rankings, were that they 'have native plants', 'attract pollinators', and 'conserve water resources' (see the bottom graph in Figure 24).



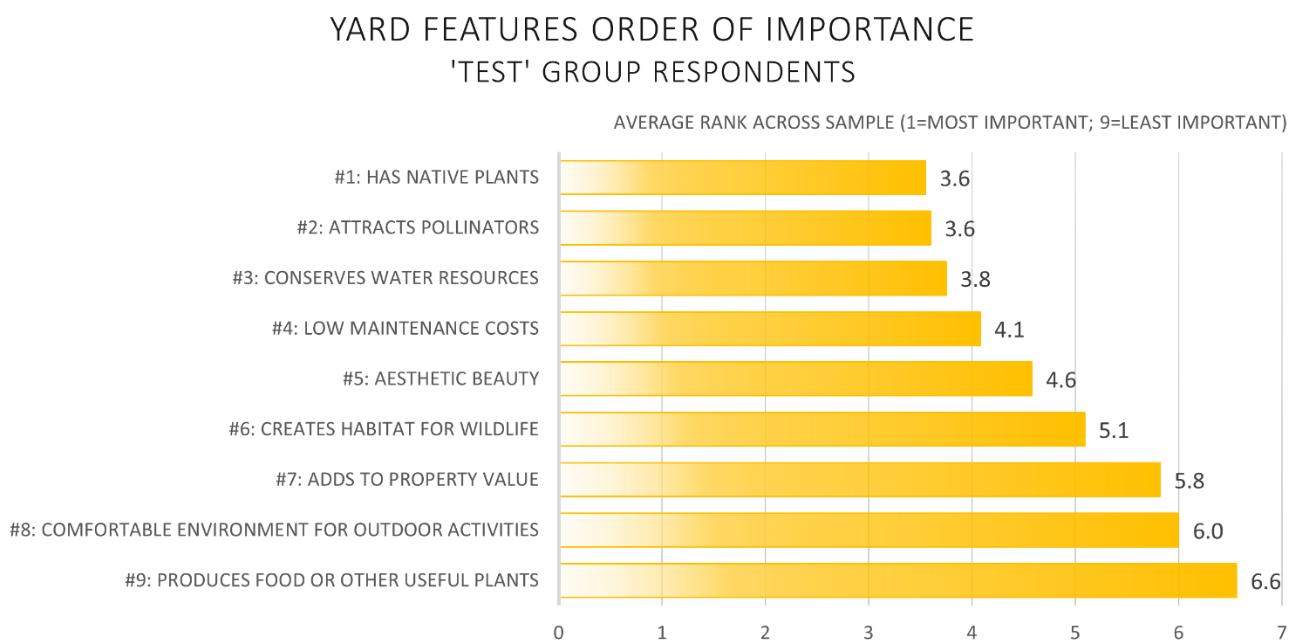
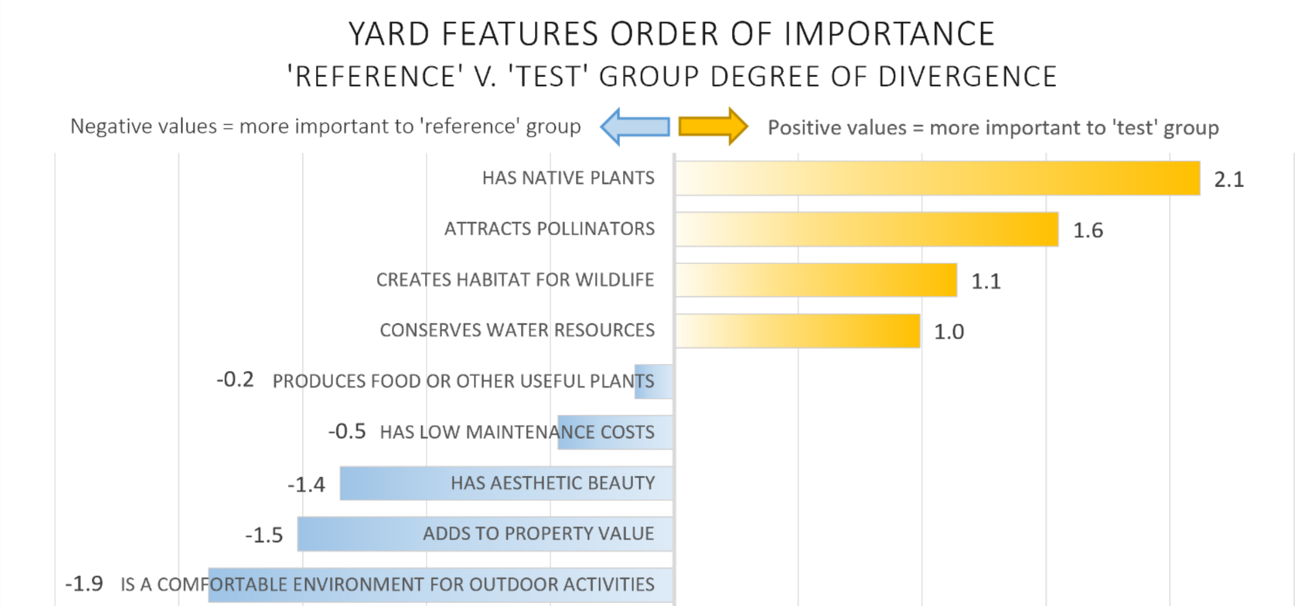


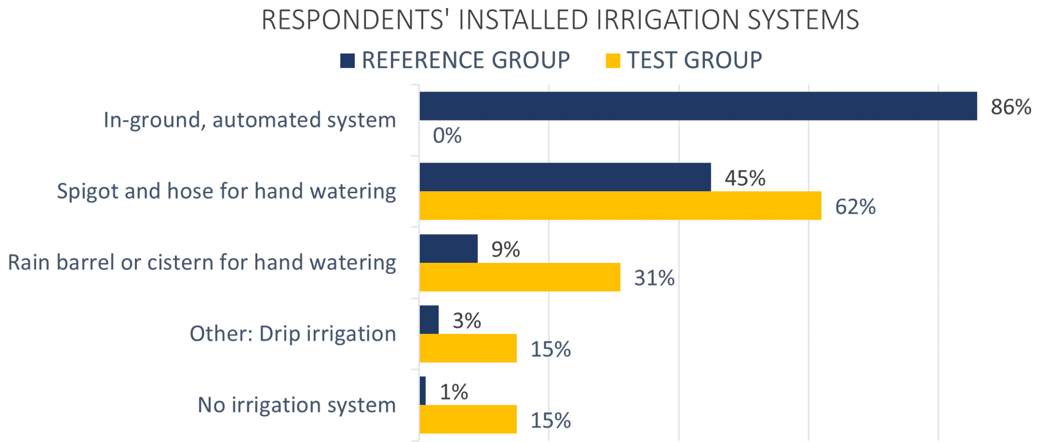
Figure 24: Order of landscape priorities for reference (top, blue) and test (bottom, yellow) survey respondent groups

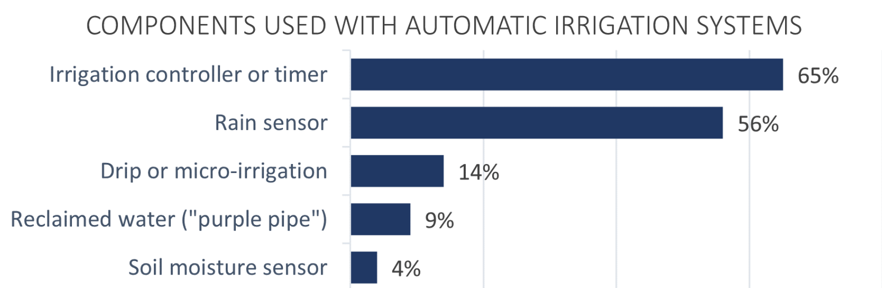
To get a clearer picture of how significantly these priority rankings diverge across test and reference groups, Figure 25 plots differences in average rank score. Measured for each feature as the reference groups' average score minus the test groups' average score, higher (positive) values indicate features that are more important to the test group respondents (in yellow) and lower (negative) values indicate features that are more important to the reference group respondents. When comparing groups' relative rankings of yard features in this normalized fashion, we can infer that the greatest divergence based on order of importance is for 'having native plants' (2.1, more important to test group), 'providing a comfortable environment for outdoor activities' (-1.9, more important to reference group), 'attracts pollinators' (1.6, more important to test group), and 'adds to property value (-1.5, more important to reference group). The bottom line is that these responses provide evidence to suggest that there is a segment of the new home (buyer or renter) market in Gainesville and Alachua County that values a set of attributes distinct from those typically marketed to 'conventional' new homebuyers or renters.

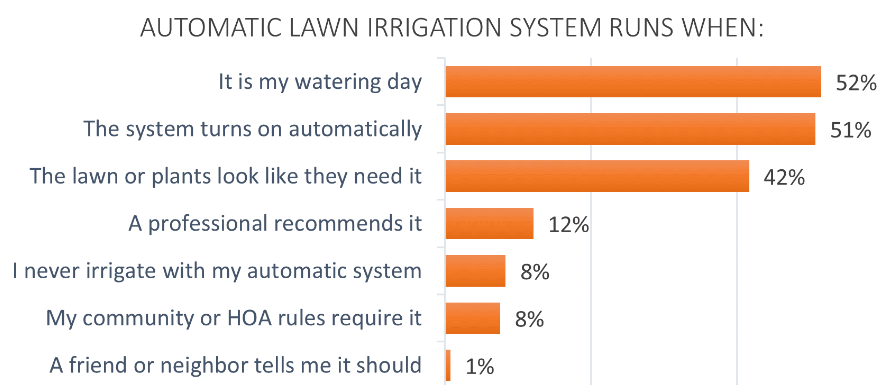


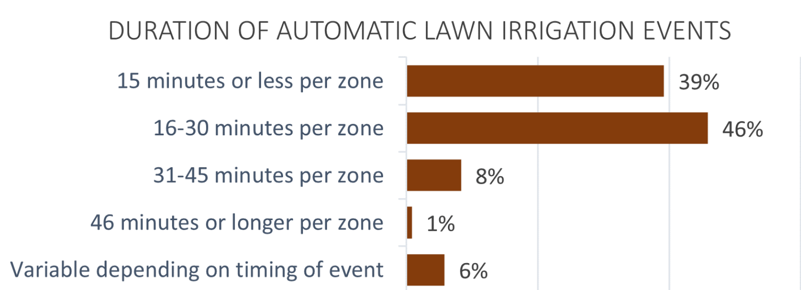
c. Landscape Irrigation Characteristics & Behaviors

Before evaluating the irrigation characteristics and behaviors of survey respondents, data from H_2OSAV were analyzed for the test subset of respondents versus the reference subset (Figure 19 above). This analysis showed that that test (irrigation-free) respondents use 108 gallons per day on average, less than half (45%) that of reference group survey respondents (241 gallons per day). Survey responses offer insight to the irrigation system characteristics and behaviors across test and reference groups: 86% of reference respondents reported that they have automatic in-ground irrigation systems installed compared to none (0%) of the test respondents (Figure 26). Of these most reported using an irrigation sensor (65%) and/or rain sensor (56%) with their automatic systems while a small portion (4%) also reported using a soil moisture sensor (Figure 27). Most automatic irrigation system users said they run their systems when it is their watering day or the system turns on automatically, and most reported that their systems run for 16-30 minutes (46%) or 15 minutes or less (39%) during each lawn irrigation event (Figure 28).


RESPONDENTS' INSTALLED IRRIGATION SYSTEMS
REFERENCE GROUP
TEST GROUP
In-ground, automated system
86%
0%
Spigot and hose for hand watering
45%
62%
Rain barrel or cistern for hand watering
9%
31%
Other: Drip irrigation
3%
15%
No irrigation system
1%
15%

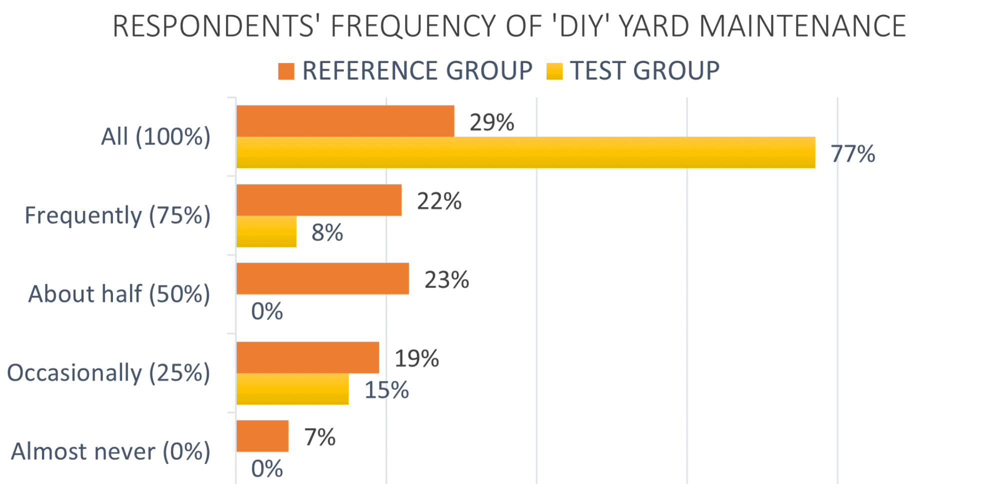

COMPONENTS USED WITH AUTOMATIC IRRIGATION SYSTEMS
Irrigation controller or timer
65%
Rain sensor
56%
Drip or micro-irrigation
14%
Reclaimed water ("purple pipe")
9%
Soil moisture sensor
4%

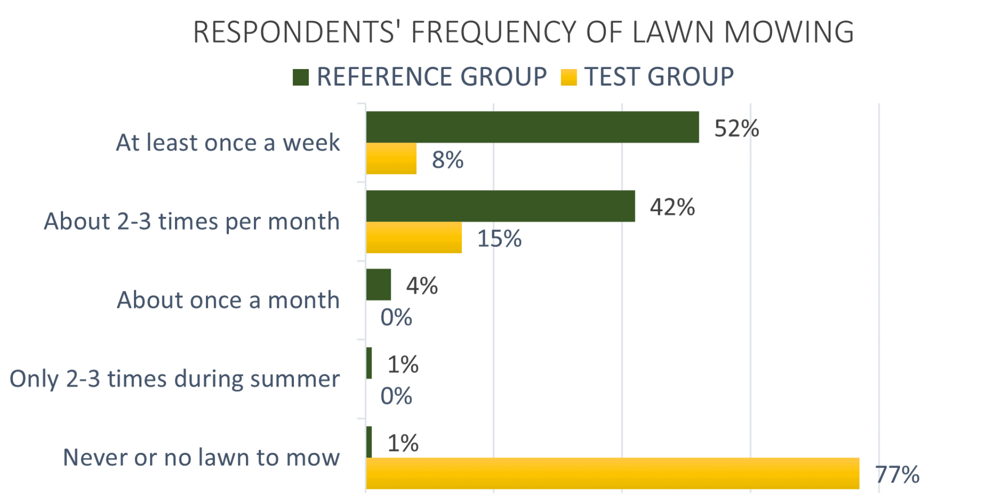

AUTOMATIC LAWN IRRIGATION SYSTEM RUNS WHEN:
It is my watering day
52%
The system turns on automatically
51%
The lawn or plants look like they need it
42%
A professional recommends it
12%
I never irrigate with my automatic system
8%
My community or HOA rules require it
8%
A friend or neighbor tells me it should
1%


DURATION OF AUTOMATIC LAWN IRRIGATION EVENTS
15 minutes or less per zone
39%
16-30 minutes per zone
46%
31-45 minutes per zone
8%
46 minutes or longer per zone
1%
Variable depending on timing of event
6%

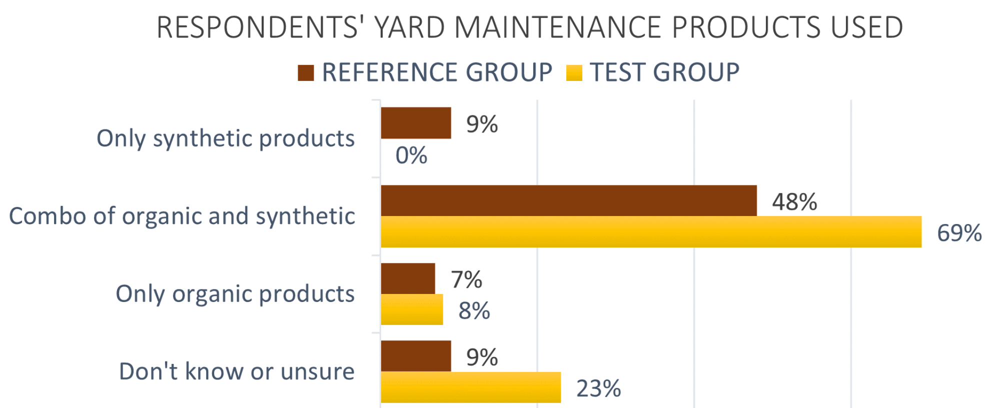
d. Landscape Maintenance Behaviors & Expenses

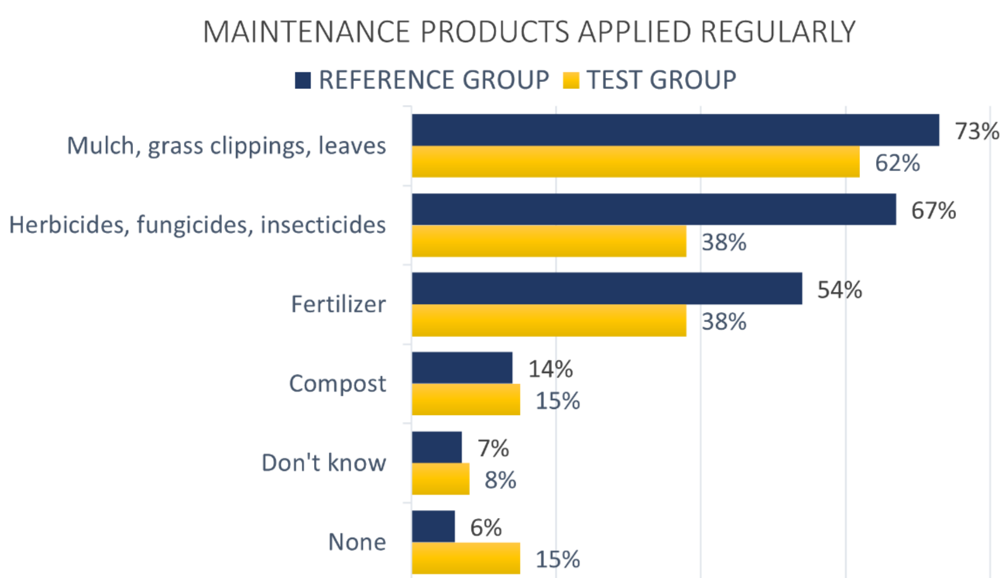
Test survey respondents (with 'irrigation-free' landscapes) report engaging more frequently in Do-It-Yourself ('DIY') yard maintenance activities than do reference group survey respondents: over twice the portion of test respondents (77% vs. 29%) said that 100% of their yard maintenance is typically done by themselves or someone else in their household and none of the test respondents said that they 'almost never' engage in 'DIY' yard maintenance activities (Figure 29). Test respondents also engage in lower intensities of yard maintenance activities. Notably, the same portion (77%) of test respondents who reported 100% 'DIY' maintenance also said that they never mow their lawns during summer months or that they have no lawn to mow. In contrast, a substantial 97% of reference group respondents reported mowing their lawns weekly or bi-weekly during the summer months (Figure 30).



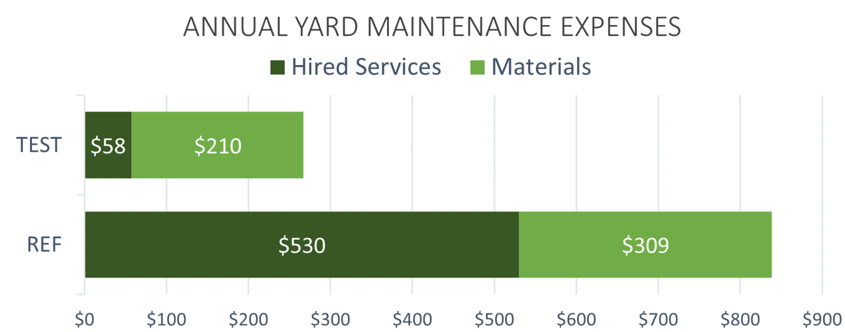


In terms of the types of maintenance products used regularly, test group respondents reported using 'only organic' or 'a combination of organic and synthetic' maintenance products whereas 9% of reference group respondents reported using 'only synthetic products' (Figure 31). Similarly, reference group respondents revealed higher-input landscape maintenance behaviors than did test group respondents: 67% of reference group respondents reported that they regularly apply 'herbicides, fungicides, and/or insecticides' compared to 38% of test respondents, and 54% of reference respondents said they regularly apply fertilizer compared to 38% of test respondents (Figure 32).





Along with the divergence in landscape input intensity, survey respondents also differed significantly in their reported yard maintenance expenses across test and reference groups. Reference respondents reported spending an average of $530 per year on 'hired landscaping services', nine times more than the $58 per year average reported by test group respondents. This difference is consistent with and not particularly surprising given the differences in reported frequency of 'DIY' yard maintenance (77% of test vs. 29% of reference reporting 100% 'DIY' maintenance – Figure 29). Reference respondents also reported higher annual expenses for materials needed to maintain their yards ('e.g., plants, mulch, fertilizer and other amendments, pesticides, lawn mower fuel, tools and equipment'): $309 vs. $210 on average reported by the test group (Figure 33). Combined, survey respondents' landscape maintenance expenses averaged $839 annually for the reference group, over three times more than those reported by the test group ($268).



e. <u>Landscape Benefits & Resident Satisfaction</u>

Two sections of survey questions were focused on the different benefits residents derive from their landscapes (yards and outdoor spaces) and residents' level of satisfaction (or dissatisfaction) with their landscapes. The first section was posed early in the questionnaire, after respondents completed the exercise ranking the importance of different landscape features (described in section viii-b. above) and asked them to indicate the extent to which they agree or disagree with a series of statements about different benefits or amenities their yards and outdoor spaces might provide (including direct or 'use' value benefits and indirect or 'non-use' value benefits). These questions helped engage respondents early on by asking them to share their personal experiences and perspectives on specific attributes of their yards and helped prime them to answer the following sections about their irrigation and maintenance behaviors. The second section of questions about landscape benefits and satisfaction was posed close to the end of the questionnaire and asked them to reflect on their overall satisfaction with their yards and outdoor spaces.

Figure 34 summarizes results of the first set of questions, *"Thinking about the different benefits your yard and outdoor spaces might provide, please <u>indicate the extent to which you agree (or disagree) with each of the statements listed below</u>."* Reference group responses are shown in orange and test group responses are shown in yellow. Each response was assigned a numeric code ranging from 2 (for 'strongly agree') to -2 (for strongly disagree) and each groups' responses were averaged to calculate the scores shown next to the horizontal bars. Average scores indicated that both groups generally agree (overall) that their yards and outdoor spaces provide all benefits listed except for *"providing them with food or useful 'natural' products"*.

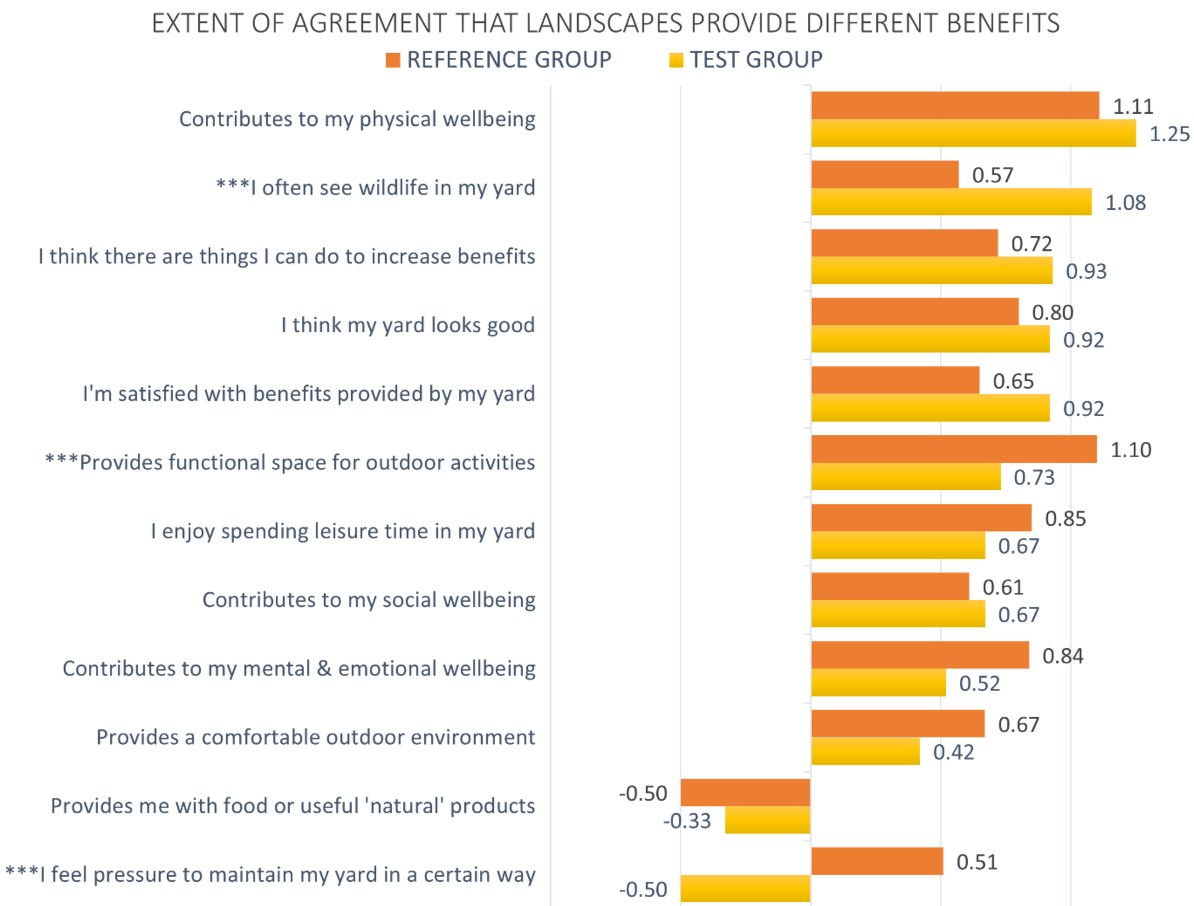


Figure 34: Range of possible benefits provided by respondents' yards - level of agreement (reference vs. test groups)

The respondent groups did differ significantly in their level of agreement with three of the statements, which are preceded with '***' in the Figure 34 axis labels, meaning that the differences are statistically significant at a 99% confidence level or higher. Test (irrigation-free landscape) respondents reported significantly stronger agreement that they ***"often see wildlife** in"* their yards than did reference respondents while the reference group reported significantly stronger agreement that their yards ***"provide a functional space for outdoor activities** (e.g., recreation, entertaining, relaxation, hobbies, work)"*. The third statement where the two groups diverged significantly not only in magnitude but also in direction of their agreement was *"I **feel pressure to maintain my yard in a certain way** so that it meets others' standards for acceptability."* Collectively, the reference group agrees somewhat with this statement whereas the test group disagrees somewhat, suggesting that test group respondents' landscaping behaviors and preferences are less influenced (or reference respondents are more influenced) by social norms.

After completing the sections about their homes, yards, and landscape input and maintenance behaviors, survey participants were asked the closed-end question, "Overall, are you satisfied with your home's yard and outdoor spaces?", with response choice options of 'Yes', 'No', and 'Maybe/it depends'. This question was then followed by a series of open-ended questions designed to gain insight to the reasons for their reported levels of satisfaction (or dissatisfaction):

1) *"In just a few words, what do you particularly like about your home's yard and outdoor spaces?"*
2) *"In just a few words, what do you particularly dislike about your home's yard and outdoor spaces?"*
3) *"What would you like to do, if anything, to improve your yard and outdoor spaces?"*

Those who replied 'Yes' to the closed-end question were only shown the first and third open-ended questions above while those who replied 'No' were shown only the second and third, and those who replied 'Maybe/it depends' were shown all three. All 166 respondents answered the closed-end question about overall satisfaction with their yards, with 54% selecting 'Yes', 13% selecting 'No', and 33% selecting 'Maybe/it depends'. When segmented by test vs. reference groups, we see that a larger share of those in the 'irrigation-free' landscapes group reported that 'Yes', they are 'satisfied, overall' with their home's yard and outdoor spaces than their 'reference' (conventional) landscape counterparts: 69% vs. 52% (Figure 35).

Taking into account the sizeable shares of respondents in both groups who selected 'Maybe/it depends' and to better interpret these segmented data, we assigned numerical scores of +1.0 to 'Yes' responses, 0.0 to 'Maybe/it depends' responses, and -1.0 to 'No' responses and used these to calculate an average overall 'Satisfaction Score' for each group. Positive average scores indicate overall satisfaction, negative scores indicate overall dissatisfaction, and a perfect score of 1.0 (100%) would reflect the case where all respondents answered 'Yes'. The bottom pair of horizontal bars in Figure 35 shows the results of these segmented and scored responses: the reference group's average 'Satisfaction Score' is 39% compared to 54% for the test group.

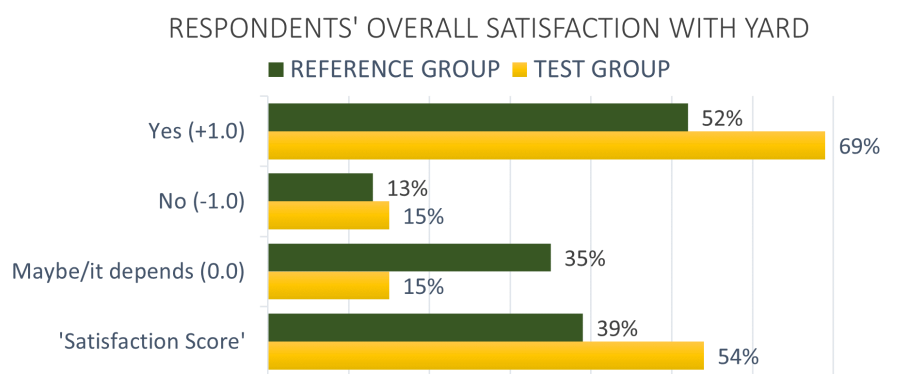


Figure 35: Overall satisfaction with yard and outdoor spaces (reference vs. test groups)

Segmented responses to the open-ended questions provide insight to the reasons for respondents' stated levels of satisfaction. We provide some examples here and include a complete list of responses in Appendix E. Test group respondents said they like the natural features, native plants, low maintenance needs, reduced environmental impacts, supporting pollinators and wildlife, and beauty of their yards and outdoor spaces, including:

- *Enough space to experiment with plants, not so much that I am overwhelmed. Recreational space not needed because that is provided in neighborhood.*
- *Many native plants in unstructured setting.*
- *Birds and butterflies, naturalness.*
- *Beautiful and low maintenance.*
- *Low water consumption, ease of maintenance, low cost of maintenance, natural feel.*
- *Low maintenance and looks good.*
- *Natural beauty, low maintenance, low impact on environment.*
- *Native plants feed wildlife.*

Test group respondents said they <u>would like to improve</u> the functionality of their yards and outdoor spaces (for recreation, socializing, gardening) and would like to incorporate more mulch, native species, and pollinator-attracting plants.

While certainly not homogeneous in their preferences, many reference group respondents highlighted as things they particularly <u>*like*</u> about their yards and landscapes: the aesthetics and beauty (flowers, color, neatness), functional and expansive spaces, ease of maintenance (several noted that others maintain their yards and they don't need to worry about it), privacy, peacefulness, and shade. Specific examples of responses from those who said they <u>like</u> their yards overall included:

- *I love seeing all the beautiful flowers and trees planted.*
- *I like that I have a reasonable amount of backyard space to play with my dog, that there is a decent amount of shade to escape the heat, and that I can mostly avoid maintenance aside from mowing.*
- *Flowers, birds, yard for my dogs, space for me to enjoy being outside.*
- *It is pretty, shady, and well designed by a student of landscaping.*
- *It's functional and easy (thanks to our landscapers).*
- *It's a lovely sanctuary to spend time in.*
- *My yard is small and easy to take care of. I do have a person that fertilizes and controls weeds and bugs for me.*
- *Shade tree in the back yard, patio, and grass area.*
- *Privacy and appearance.*
- *It's mine.*

Some reference group respondents who indicated they are <u>not satisfied overall</u> with their yards and outdoor spaces said they <u>dislike</u> the quality of the grassed/lawn areas (e.g., having to replace dying grass), high maintenance needs or poor maintenance, too many weeds and/or pests, and waste of resources (not sustainable). Some of the things they shared that they <u>would like to improve</u> about their yards include: adding native plants, getting rid of weeds and replace dying grass or plants, adding plants to attract pollinators, and incorporating more low-maintenance plants.

f. <u>Residents' Environmental Perspectives</u>

Toward the end of the survey, respondents were asked to state their level of agreement (from 'Strongly Agree' to 'Strongly Disagree') with a series of statements about Florida's environment and management of water and natural resources. Responses to five of these questions were recoded and combined to create an overall 'environmental perspective' score that could range from -2.0 to 2.0, where a perfect 2.0 score indicates the strongest 'pro-environment' perspective, meaning the respondent selected 'Strongly Agree' for two 'pro-environment' statements and 'Strongly Disagree' for three 'anti-environment' statements. Conversely, an overall score of -2.0 reflects the strongest possible "anti-environment' perspectives.

Figure 36 summarizes the results of this analysis of environmental perspectives, with the reference group scores shown in maroon and the test group's shown in dark yellow. All of the average scores were positive (for both groups) and the test group scores were higher across the board, reflecting stronger "pro-environment" preferences. These differences are statistically significant at the 99% or higher level (***) for the overall score and two individual statements: that *"Florida's freshwater resources are extremely valuable and must be protected"* and that *"The health of Florida's economy should be prioritized over the health of the environment"*. Note that for the latter statement, a 'strongly agree' response was coded as a -2.0 and a 'strongly disagree' response was coded as a +2.0. Differences were statistically significant at a 95% level (**) for the statement that *"Florida's water quality is declining, and we need to do more to protect it."*

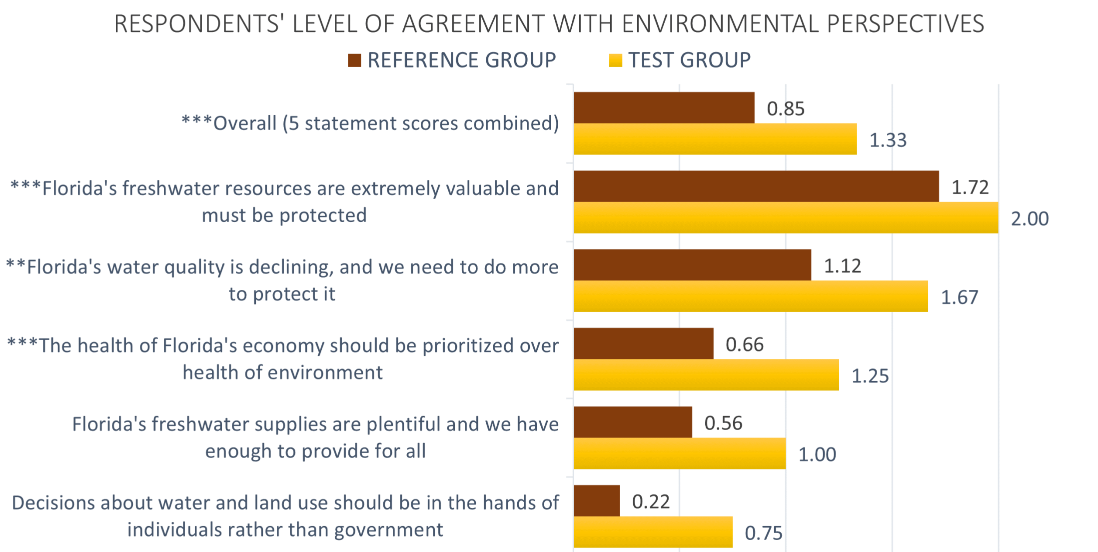


Figure 36: Level of agreement with different environmental perspectives (reference vs. test groups)

VII. Conclusions & Next Steps

Considered together, this study's quantitative and qualitative findings provide evidence to support the following takeaway conclusions, next steps, and future research needs:

- **Learning from Living Laboratories:** While accounting for a relatively small portion of all new subdivisions built since 2005, there are examples of real-world master-planned community developments in Florida where the developers, builders, and/or homeowners have deliberately opted to install "irrigation-free" landscapes—those without permanent in-ground yard "sprinkler" systems, designed to survive and thrive on rainfall following the initial establishment period, and supplemented only periodically with irrigation for watering to ensure plant survival (e.g., during extended dry or drought periods). *Examples of "irrigation-free" landscapes in new Florida residential subdivisions are few and far between, but they do exist, and we can take advantage of and learn from them as real-world living laboratories.*

- **Making the Case with Real-World Data:** These real-world "irrigation-free" landscape case studies represent unique and valuable opportunities to understand the market and non-market incentives that can be leveraged to shift Florida's residential development status quo from high-input (embedded water and fertilizer demands), natural resource-degrading (water supply, water quality, soil health and fertility), and costly (expensive, high maintenance, diminished ecosystem services) to low- or no-input, natural resource enhancing, and economically and ecologically beneficial. *Case study data (quantitative and qualitative) from real-world "irrigation-free" homes and landscapes are critical for understanding and making the case for a new, more sustainable urban landscape paradigm in Florida.*

- **Lightening the Water Footprint of Residential Landscapes:** As measured and validated with lot/household-level metered water use data from the UF/IFAS H_2OSAV Extension program database and analysis platform, irrigation-free 'test' subdivisions and homes use substantially less water than comparable, conventional homes and landscapes in Alachua County and Gainesville. For all four 'test' and 'reference' groups, these differences in water use are statistically significant at a 99% confidence level (P-values <0.01). The average monthly water use of 'test' subdivision homes ranged from 97 to 146 gallons per day (gpd) per household compared to 209 to 287 gpd for 'reference' subdivision homes. *Across the four groups, this equates to "irrigation-free" test homes and landscapes using an average of: 49% (141 gpd) less water by Madera; 54% (112 gpd) less by 88th Street Cottages; 59% (158 gpd) less by Hidden Lake; and 61% (162 gpd) less by Gainesville Cohousing.*

- **Retaining Competitive Market Value:** Also measured and validated by unit/household-level property appraiser data from the Alachua County Property Appraiser and queried from H_2OSAV, 'test' subdivision and homes' market values and sales pace are comparable and competitive with those of 'reference' subdivision and homes. The average assessed property values of the four 'test' subdivisions ranges from \$247K to \$261K compared to a range of \$265K to \$273K for the 'reference' groups. Percent difference in property values ranged from 2% less (for 88th Street Cottages) to 10% less (for Madera homes). *While the 'reference' property* *value averages are nominally higher than those of the 'test' groups, the data reveal no statistically significant differences in market value between the "test" and "reference" groups of homes.*

- **Reducing Landscape Costs to Homeowners and the Environment:** A key finding of this study's resident survey is that homeowners and renters living in test 'irrigation-free' subdivisions reported spending significantly less money for hired landscape maintenance services and materials needed to care for their lawns. At the same time, they are using significantly less water and reported lower frequency and intensity of fertilizer, herbicide, fungicide, and insecticide applications *and* they report higher overall satisfaction with their yards and outdoor spaces than their conventional 'reference' landscape counterparts (although these differences in satisfaction were not statistically significant). Together, these *results offer evidence that lower maintenance costs, resident satisfaction with landscapes, and adoption of behaviors that protect the environment are not mutually exclusive goals – they can and may be synergistic outcomes.*

- **Case Study Postscript:** Adam Bolton worked for Robinshore Inc. when he developed and built the 88th Street Cottages project. When that project was completed in the spring of 2020, he started his own company, Bolton Construction Services. The company's first development is "Cottages on the Avenue" and is very similar to the 88th Street Cottages project. It is in Alachua County and has thirteen detached rental units on very small lots. The landscape installation was completed on November 30, 2021. The bahiagrass turf strip in front of the cottages is irrigated with well water and managed by the property owner. However, the landscapes around the individual rental cottages have no installed automatic irrigation systems. As this project is wrapped up, Bolton Construction Services is starting a new "Cottages" project with 173 detached units and plans to follow the same landscaping practices. *From the developer's perspective, the aesthetics and economics of irrigation-free landscaping are working well.*

- **Future Research Needs:** As the numbers of units and project locations adopting this alternative landscape model increase, the opportunity to verify the longer-term efficacy of irrigation-free landscapes improves. The current "Cottages" projects are all rental units and could be considered a niche market, however, the units are all single family detached and are comparable to several affordable housing and in-fill projects in Alachua County. *Continuing to track these projects while using the analysis results from this study to engage other local builders/developers should be a priority.*

- **Accessing Untapped Demand for Low-Impact Landscapes:** Study findings suggest that there may be a sizeable share of consumers in Florida's new homebuyer market who seek alternatives to the typical water-thirsty landscapes that dominate the supply side of the market. This *untapped demand for low-impact landscapes represents a potential "win-win-win" situation for homeowners and renters, developers, and our freshwater resources.* The public-private partnerships already in place and advancing through the Sustainable Floridians Benchmarking and Monitoring Program (SF-BMP) aim to move the needle further and faster on tangible freshwater conservation, protection, and resource efficiency in the months and years to come. *Our team of scientists, researchers, and educators from UF, The Nature Conservancy Florida, and more are ramping up our work promoting irrigation-free landscapes and other holistic sustainability and resource-efficiency strategies* with several large (30- to 50-year build out) master-planned community developments in Central

Florida. For example, Dr. Basil Iannone is leading a collaborative research project with the University of Central Florida, Cherrylake Inc., Life Soils, and others to install, monitor, and evaluate the performance of alternative, ecologically diverse, low-input landscape plantings in the first and future phases of the Sunbridge (Tavistock) project in Osceola County.

VIII. Appendices

ix. Appendix A: Irrigation-Free Subdivisions – Test Site Case Studies

x. Appendix B: Resident Survey Postcards

xi. Appendix C: Resident Survey Instrument

xii. Appendix D: Resident Survey Itemized Responses

xiii. Appendix E: Resident Survey Q7 Open-Ended Responses