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Estimating and Integrating Irrigation Efficiency Potential into Implementation Strategies

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Overview

Study area and objectives

Data collection

Analytical methods and findings

Conclusions and next steps

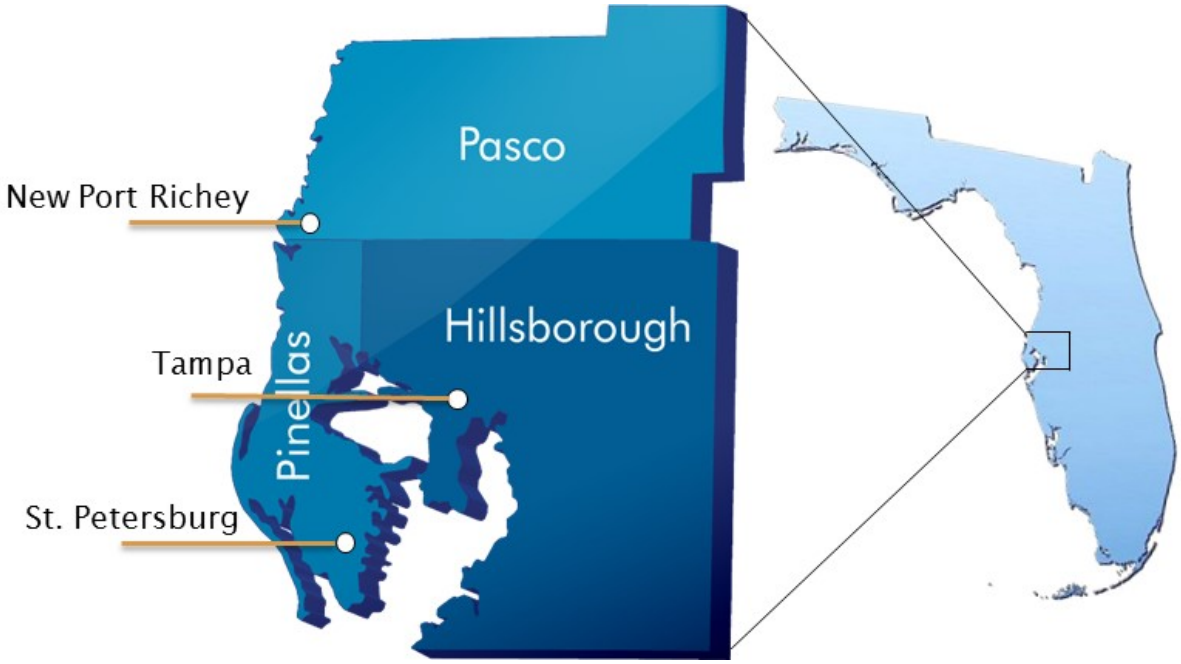
Tampa Bay Water

Regional water supply authority

2.5 million customers

6 member governments, across three counties

Experiencing growth, but susceptible to swings in economy



TAMPA BAY WATER
Supplying Water To The Region

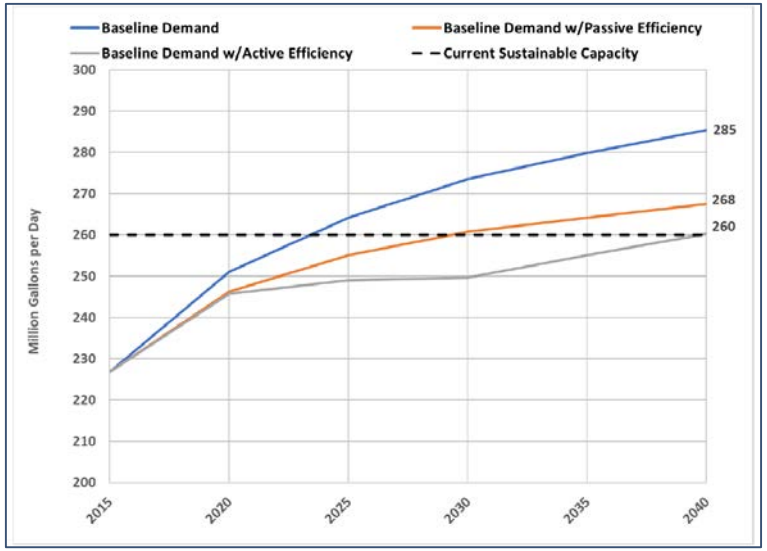
Tampa Bay Water's Demand Management Planning

Historical planning and coordination role

Tampa Bay Water's Demand Management Planning

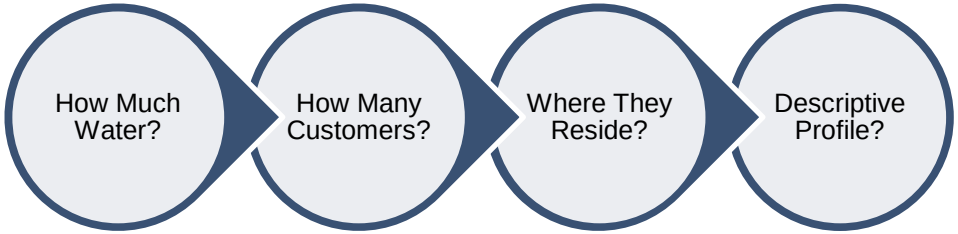
2018 DMP Update includes evaluation of program implementation strategies

- Potential to reduce capacity development needs
- First linkage between DMP and how it gets implemented
- Includes outdoor programs



Current objectives related to landscape irrigation

- Identify customers using excess amounts of water
  - Estimated irrigation use versus “requirements”
  - Potential numbers of customers and quantities of water
  - Relationship to customer attributes and small geographic areas (parcels, developments, neighborhoods)



Implementation Focus

Programmatic options and criteria selected in 2018 DMP

Program Option	Targets	Notes
Alternative Water Sources	“Surplus Irrigators” + Upper Quartile of “Deficit Irrigators”	Shallow wells
Florida Water Star	New Homes	New home certification program
Soil Moisture Sensors or ET Controllers	Existing Homes (with New Homes Option)	Watering technology

Information Needs

To estimate deficit/surplus irrigation

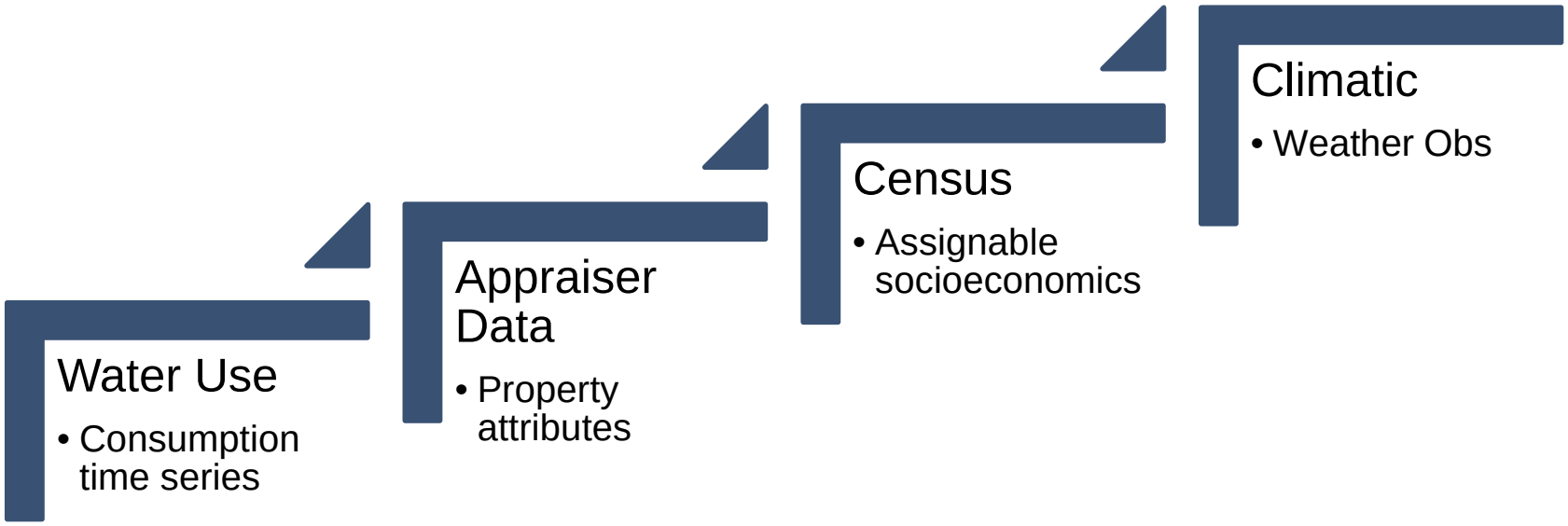
- ✓ Potable water consumption
- ✓ Irrigable area
- ✓ Theoretical irrigation requirements

To evaluate program targeting (and for analytics)

- ✓ Geographic locations
- ✓ Socioeconomic and property attributes

LTDFS Database

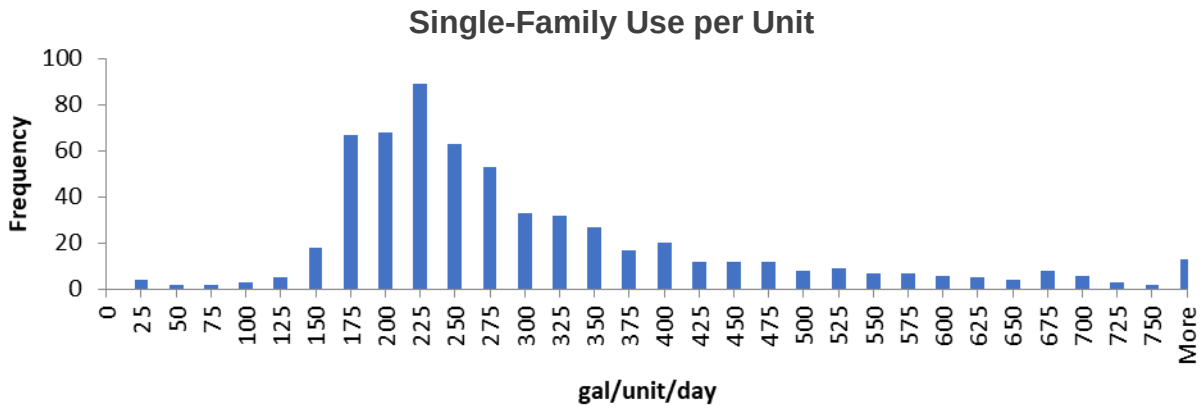
Long Term Demand Forecasting System database assembled and maintained for modeling



Water Use Metrics Analyzed

Multi-year averages for each Single-Family location:

- Annual water use
- “Minimum month” use → Annual seasonal use
- High season average (April, May, June)



Theoretical Requirements

$$LWR = RTM \times \left[(ET_o \times K_L) - (R_{CT}\, x\, R_{pe})\right] \times A * C_u$$

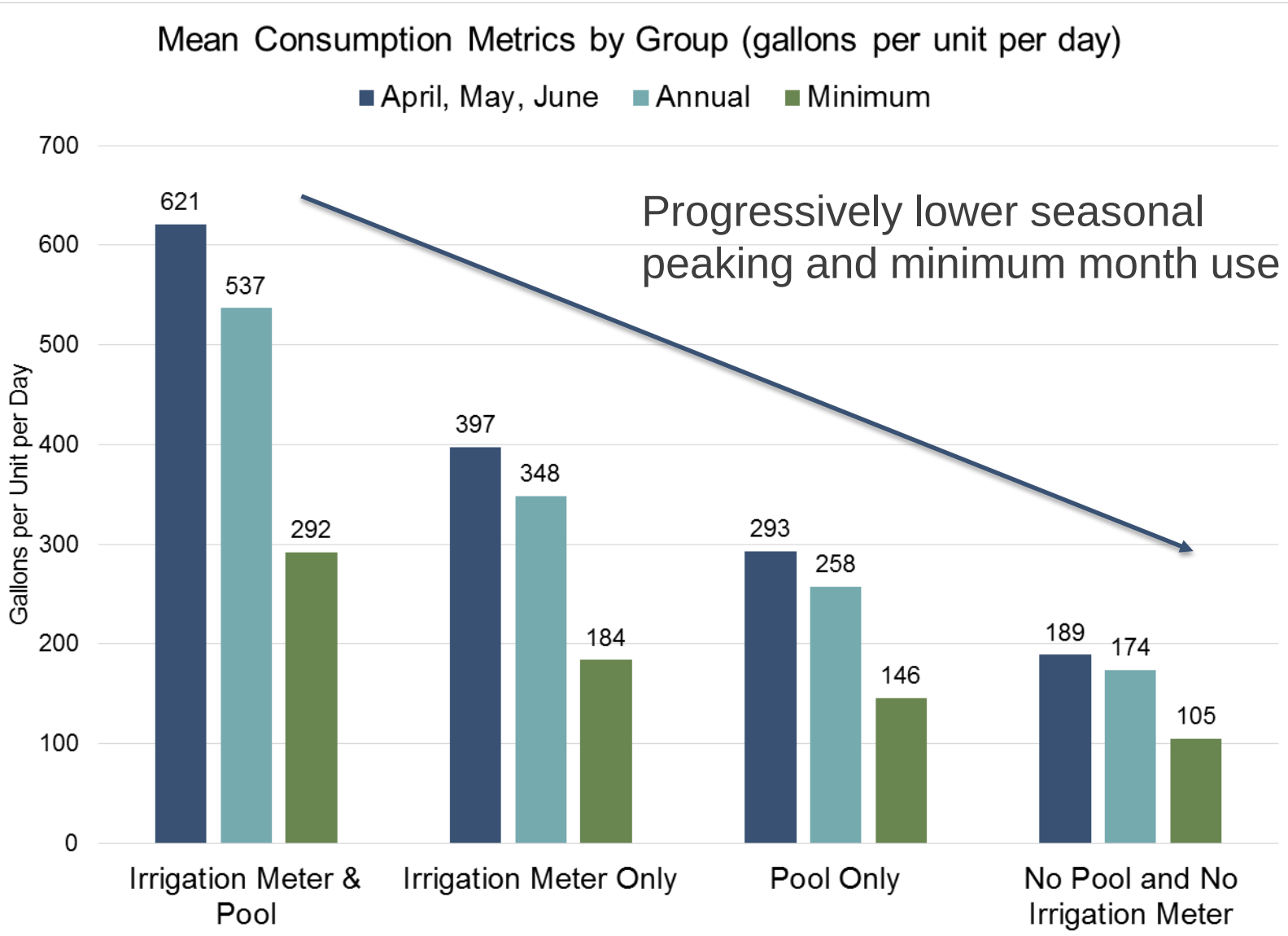
Where

LWR	=	Landscape water requirement (gpy)
RTM	=	Run-time multiplier (inverse of irrigation efficiency)
ET_o	=	Reference evapotranspiration in inches per year
K_L	=	Landscape coefficient for the dominant plant type
R_{CT}	=	Census Tract precipitation in inches per year
R_{pe}	=	Percent effective precipitation
A	=	Greenspace estimate in square feet
C_u	=	Conversion factor to express LWR in gpy

- Major assumptions taken from University of Florida research on turf-grass
- Precipitation estimates assigned by parcel according to Census Tract weather contour

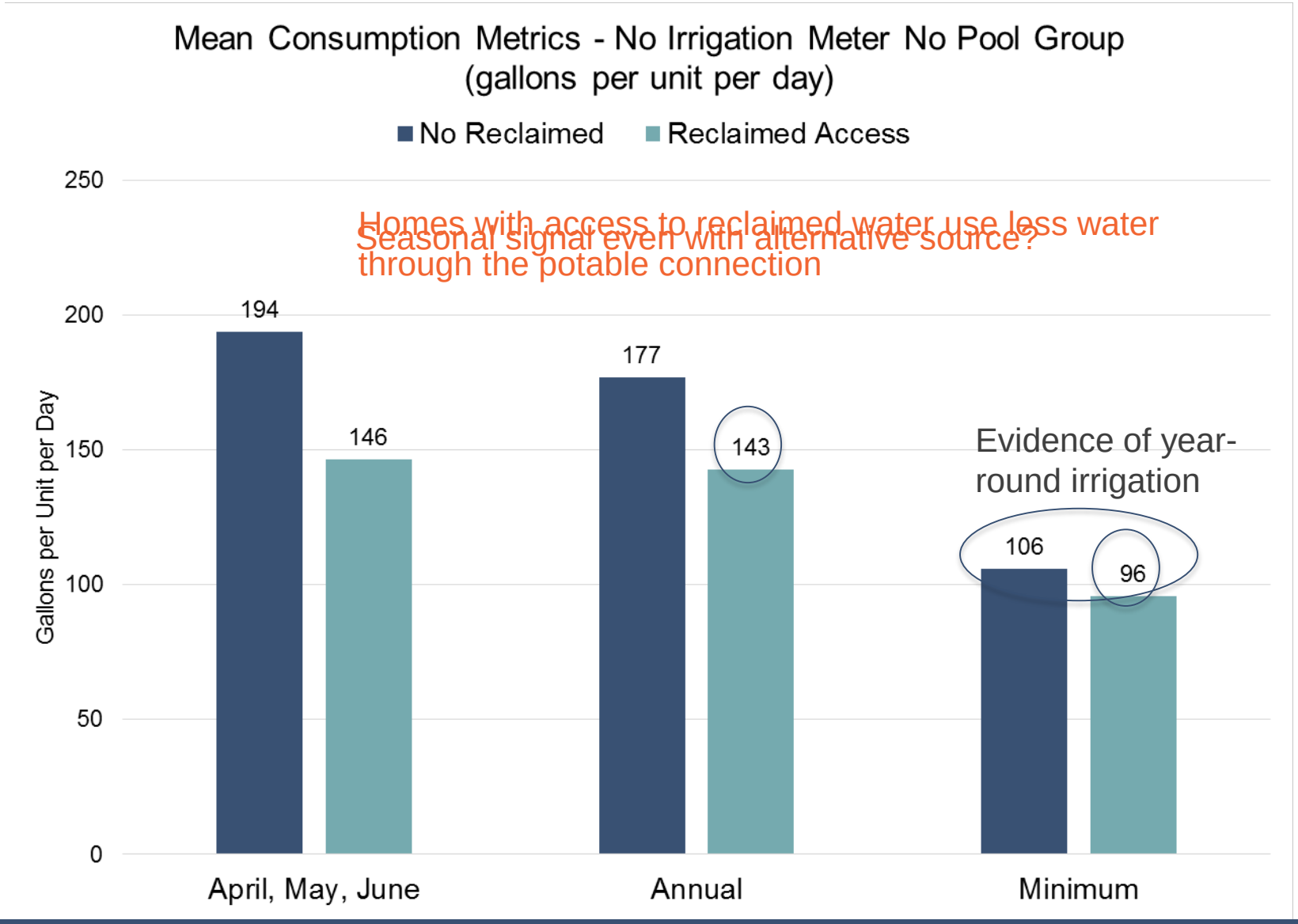
Socioeconomic and property attributes for each location

- Total versus pervious area
- Home size (heated area)
- Assessed value (property, land, building)
- Year built and effective age
- Median income (block group assignment)
- Presence of pools
- Presence of devoted irrigation meters
- Access to reclaimed water source

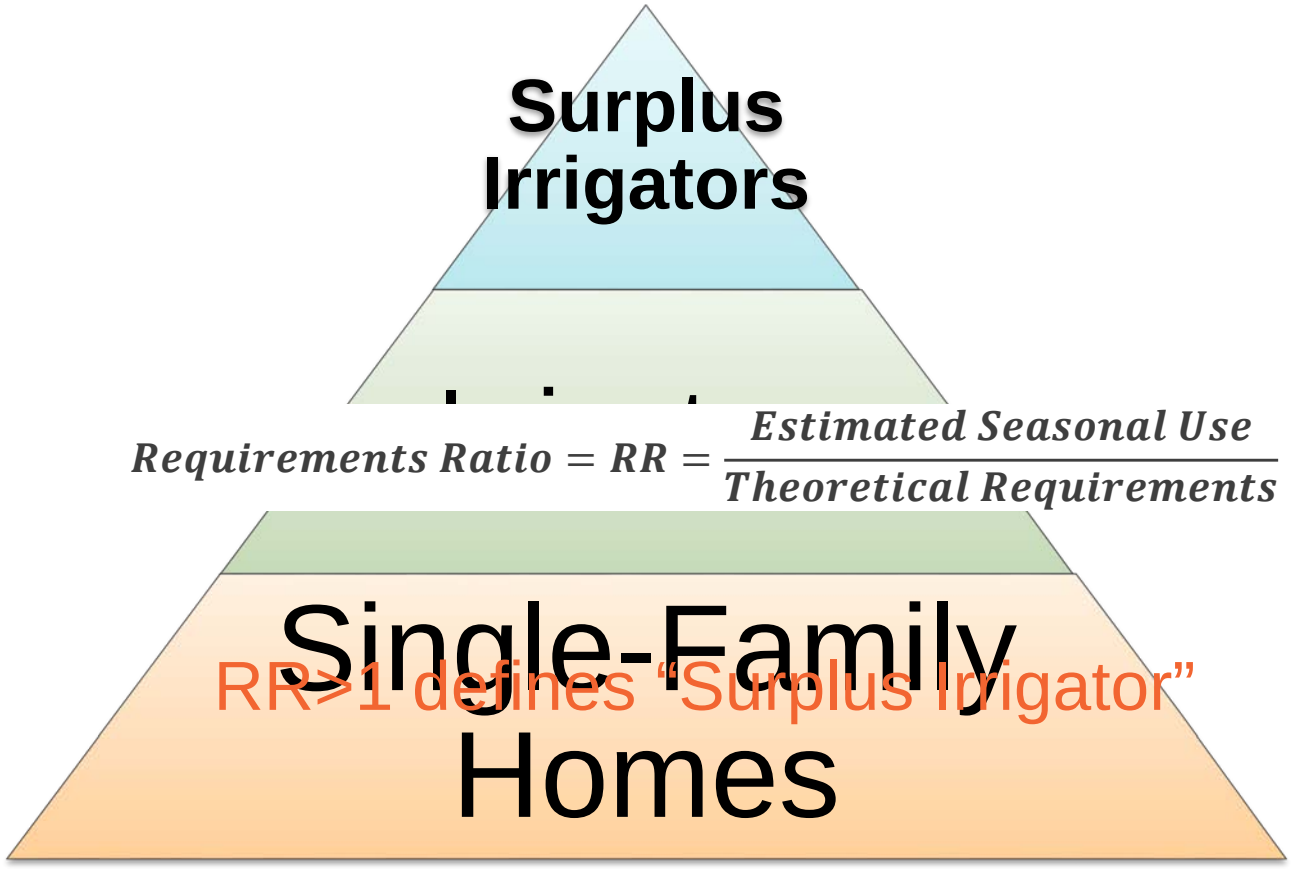


"Seasonal" Use	245 gpud	164 gpud	112 gpud	69 gpud

Effect of Reclaimed Water Access

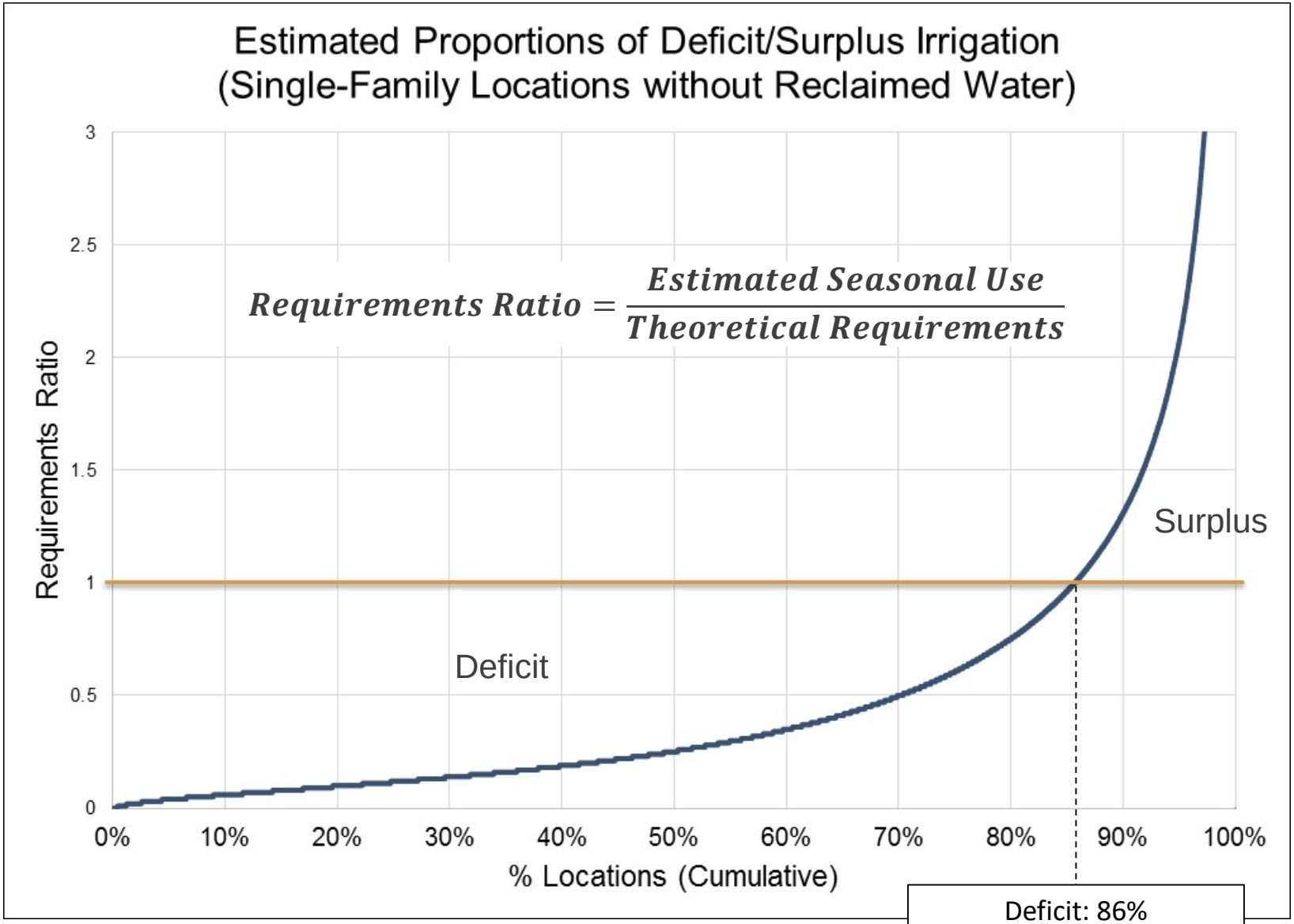


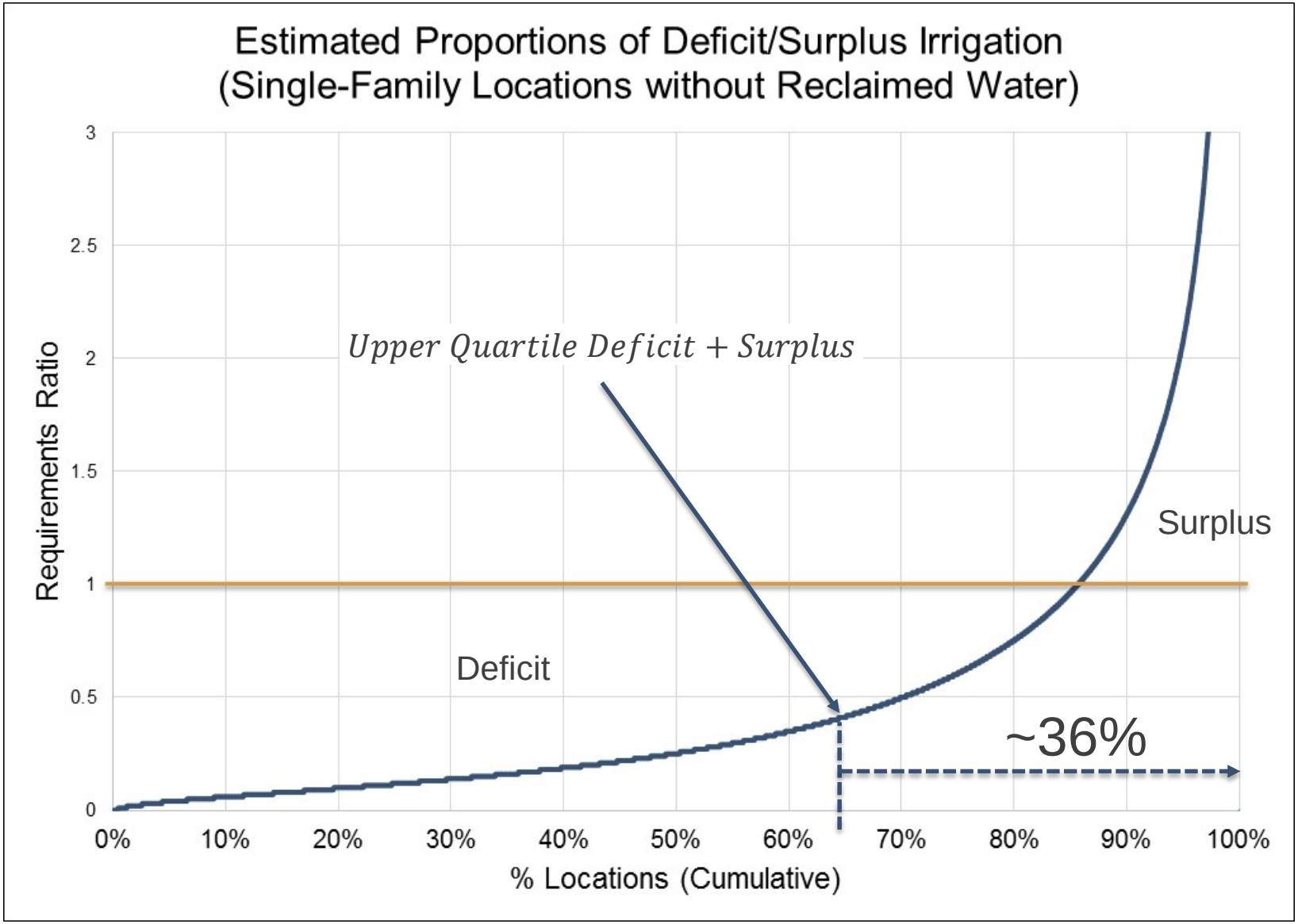
Generalized Process for Evaluating Surplus Irrigation



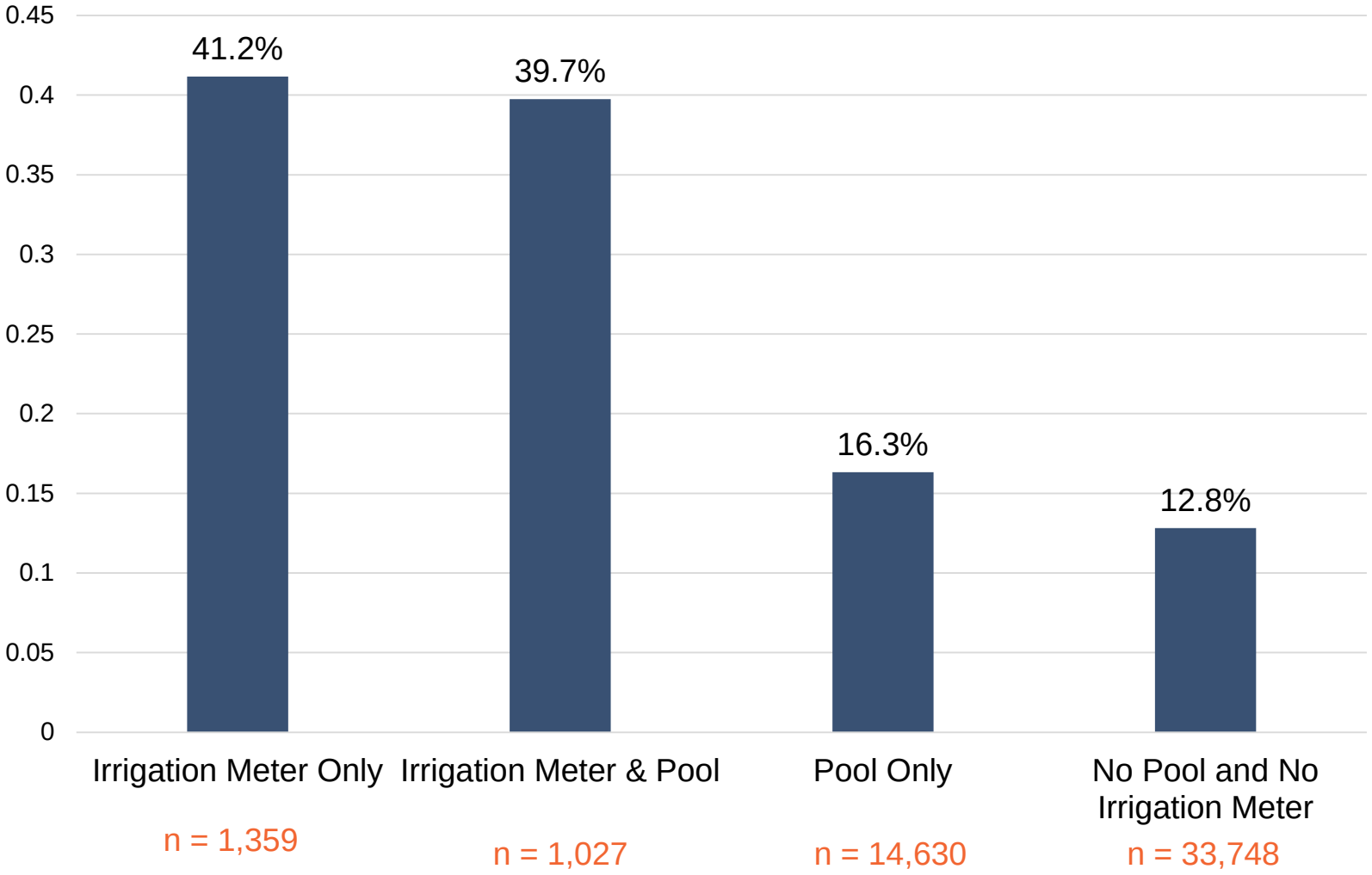
Criteria for Identifying Irrigators

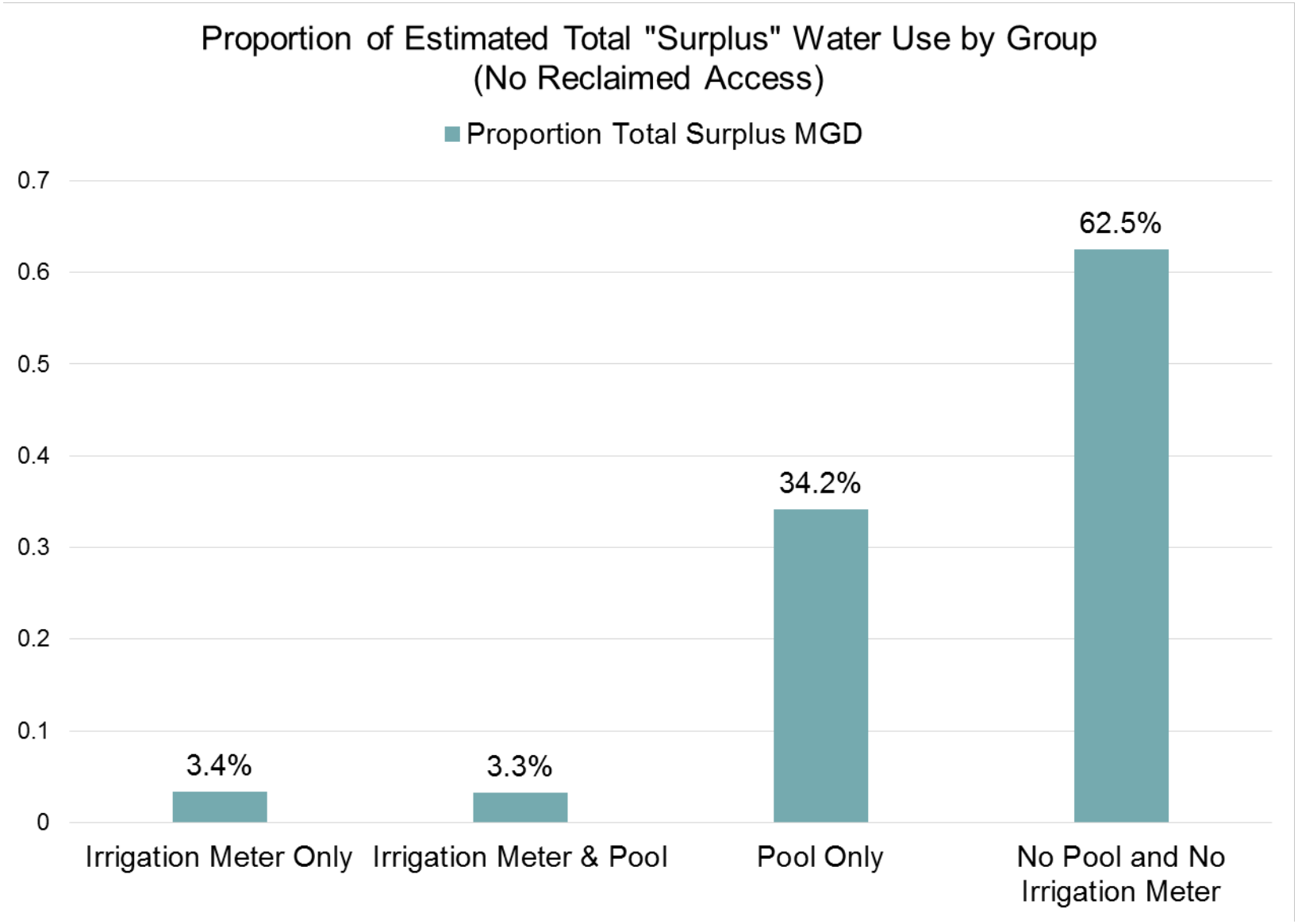
Effort	Definition of "Irrigators"	Implications
Previous DMP	Locations using > 177 gpud annually	Covers high water users Misses substantial number of small households
2018 DMP	Locations with high season use > 1.1 times annual average use	Captures more households on low use spectrum Misses consistently high year-round users
Latest option (2018 DMP supplement)	No "irrigator" criteria used to screen	More inclusive by design

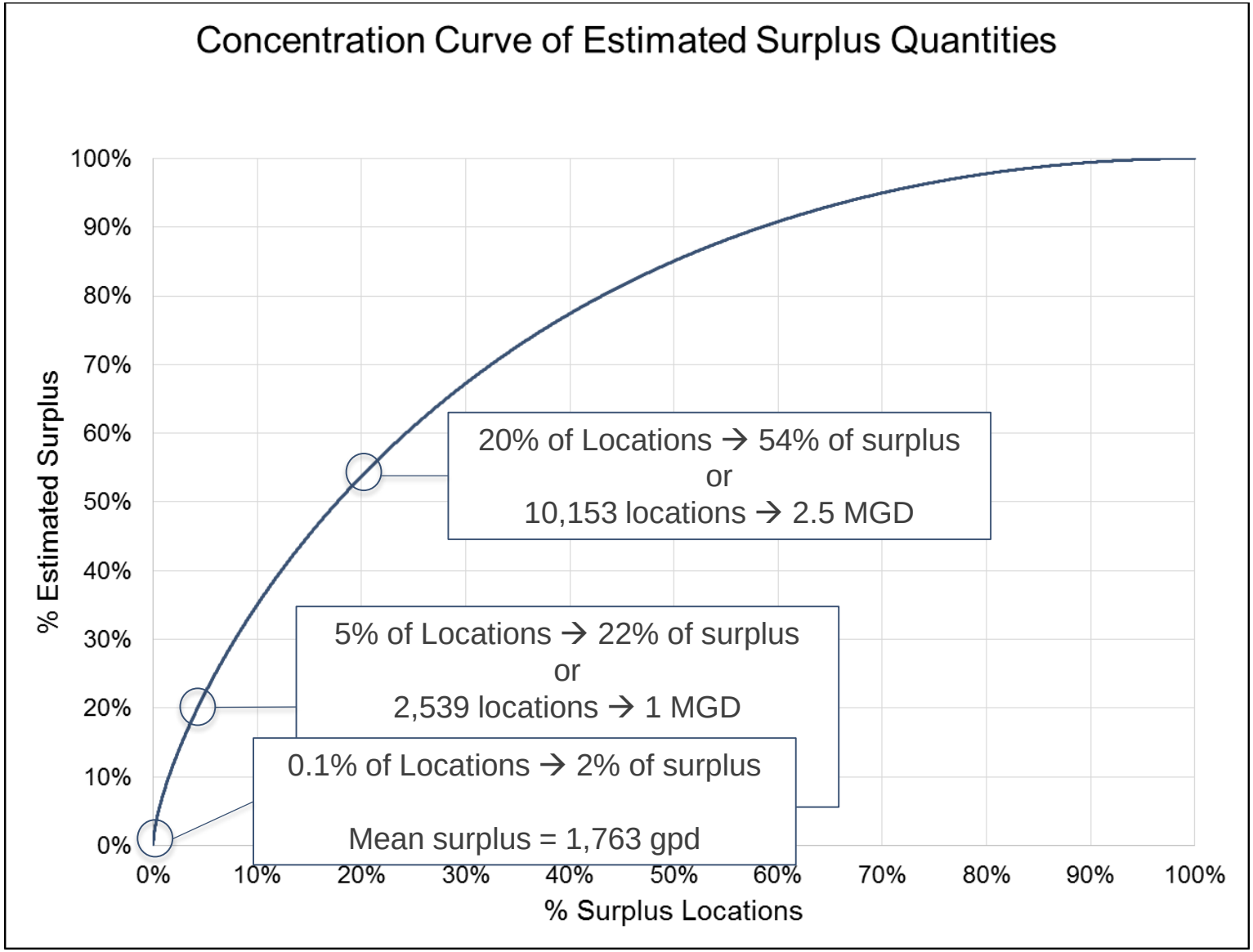

Estimated Proportions of Deficit/Surplus Irrigation
(Single-Family Locations without Reclaimed Water)
$$Requirements\ Ratio = \frac{Estimated\ Seasonal\ Use}{Theoretical\ Requirements}$$
Requirements Ratio
3
2.5
2
1.5
1
0.5
0
Surplus
Deficit
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Locations (Cumulative)
Deficit: 86%
Surplus: 14%


Estimated Proportions of Deficit/Surplus Irrigation
(Single-Family Locations without Reclaimed Water)
Requirements Ratio
3
2.5
2
1.5
1
0.5
0
Upper Quartile Deficit + Surplus
Surplus
Deficit
~36%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Locations (Cumulative)

Proportion of Sample Groups Exceeding Estimated Watering Requirements (Single Family without Reclaimed Access)




Proportion of Estimated Total "Surplus" Water Use by Group
(No Reclaimed Access)
Proportion Total Surplus MGD
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
3.4%
3.3%
34.2%
62.5%
Irrigation Meter Only
Irrigation Meter & Pool
Pool Only
No Pool and No Irrigation Meter

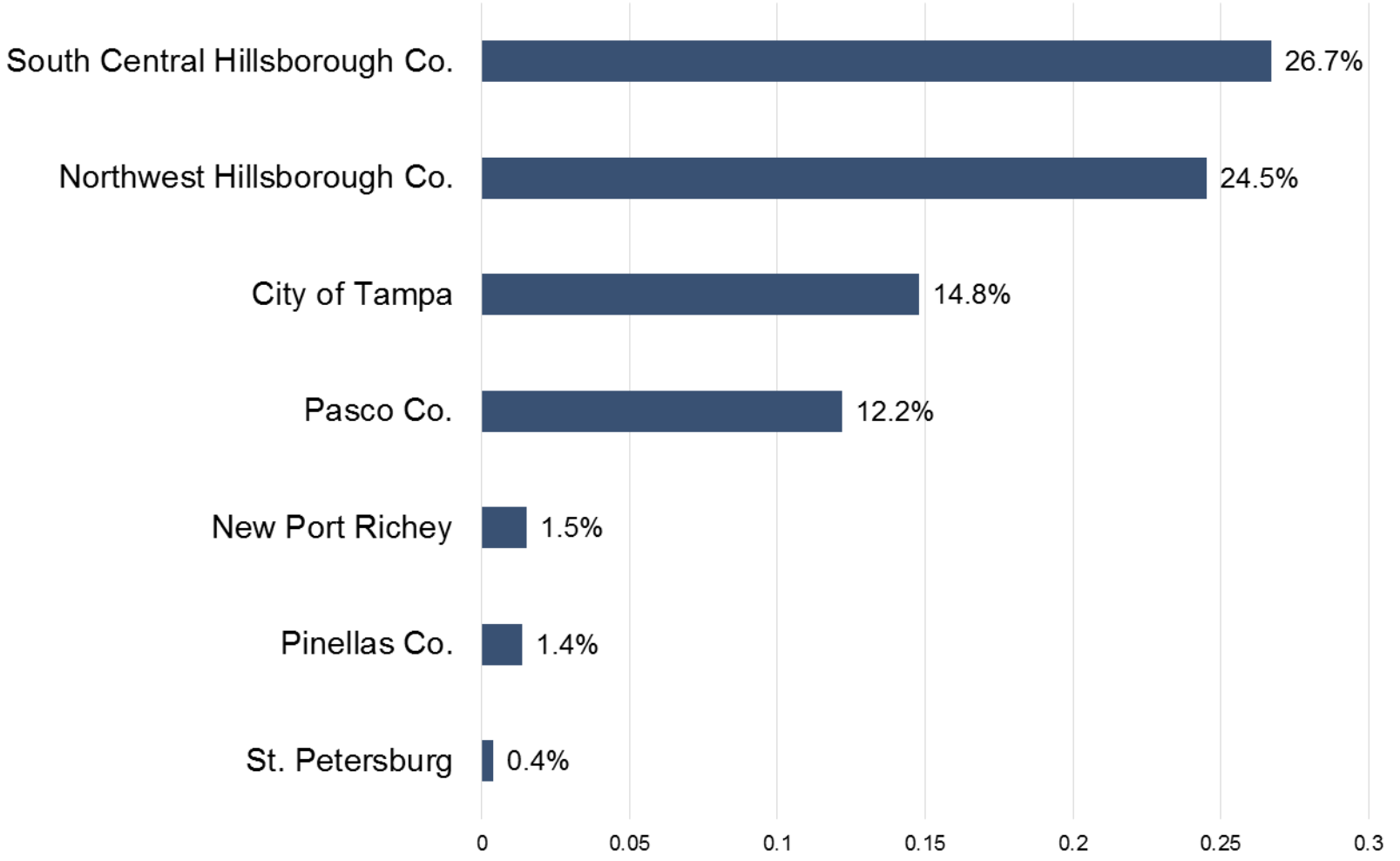

Concentration Curve of Estimated Surplus Quantities
% Estimated Surplus
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% Surplus Locations
20% of Locations → 54% of surplus
or
10,153 locations → 2.5 MGD
5% of Locations → 22% of surplus
or
2,539 locations → 1 MGD
0.1% of Locations → 2% of surplus
Mean surplus = 1,763 gpd

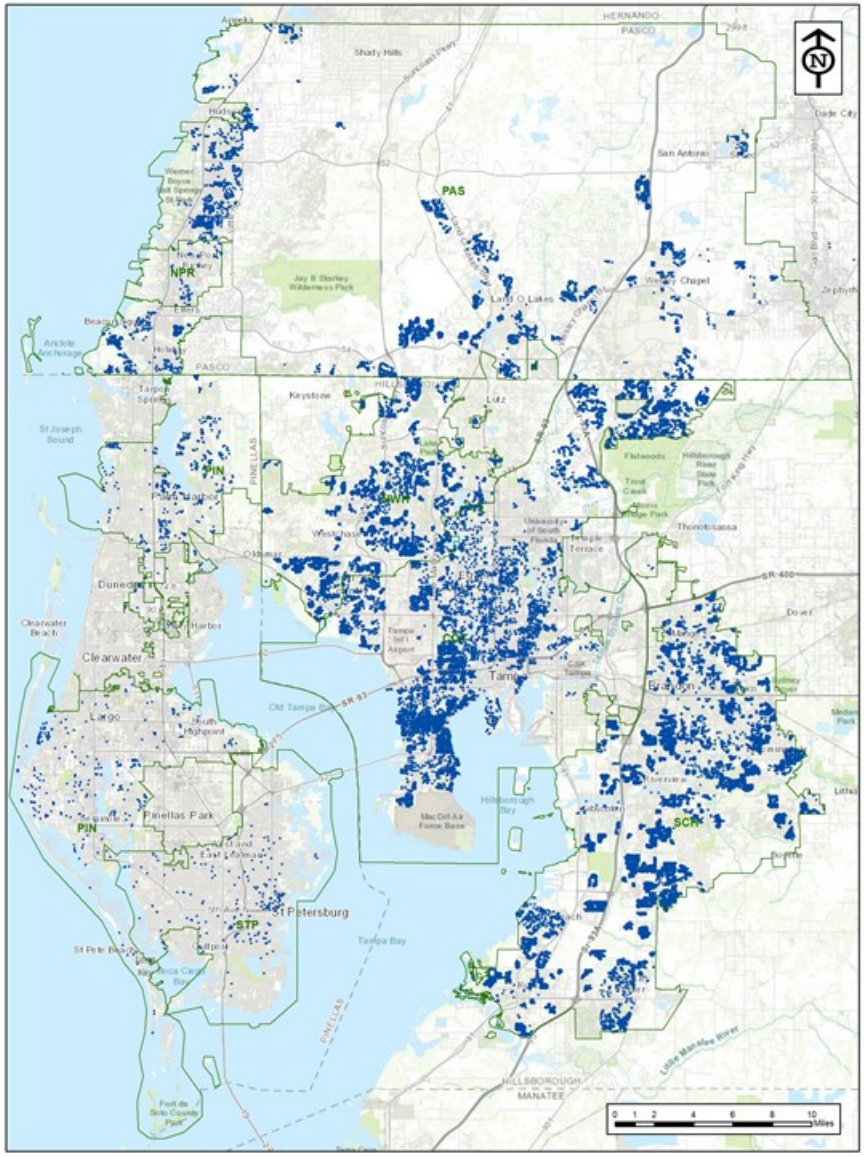
Estimated Surplus by Range of Requirements Ratio

Requirements Ratio	Number of Locations	Cumulative Surplus (MGD)	Marginal Surplus (MGD)	Estimated Surplus (gpud)
0 to 1.25	12,903	0.2	0.2	19
1.26 to 1.50	8,651	0.7	0.5	53
1.51 to 2.00	10,375	1.6	0.9	88
2.01 to 3.00	9,062	2.8	1.2	132
3.01 to 4.00	3,585	3.4	0.6	160
4.01 to 5.00	1,900	3.7	0.3	179
5.01 to 6.00	1,075	3.9	0.2	192
6.01 to 7.00	647	4.1	0.1	192
7.01 to 8.00	438	4.2	0.1	188
8.01 to 9.00	365	4.2	0.1	205
9.01 to 10.00	253	4.3	0.1	227
>10.00	1,510	4.6	0.3	220

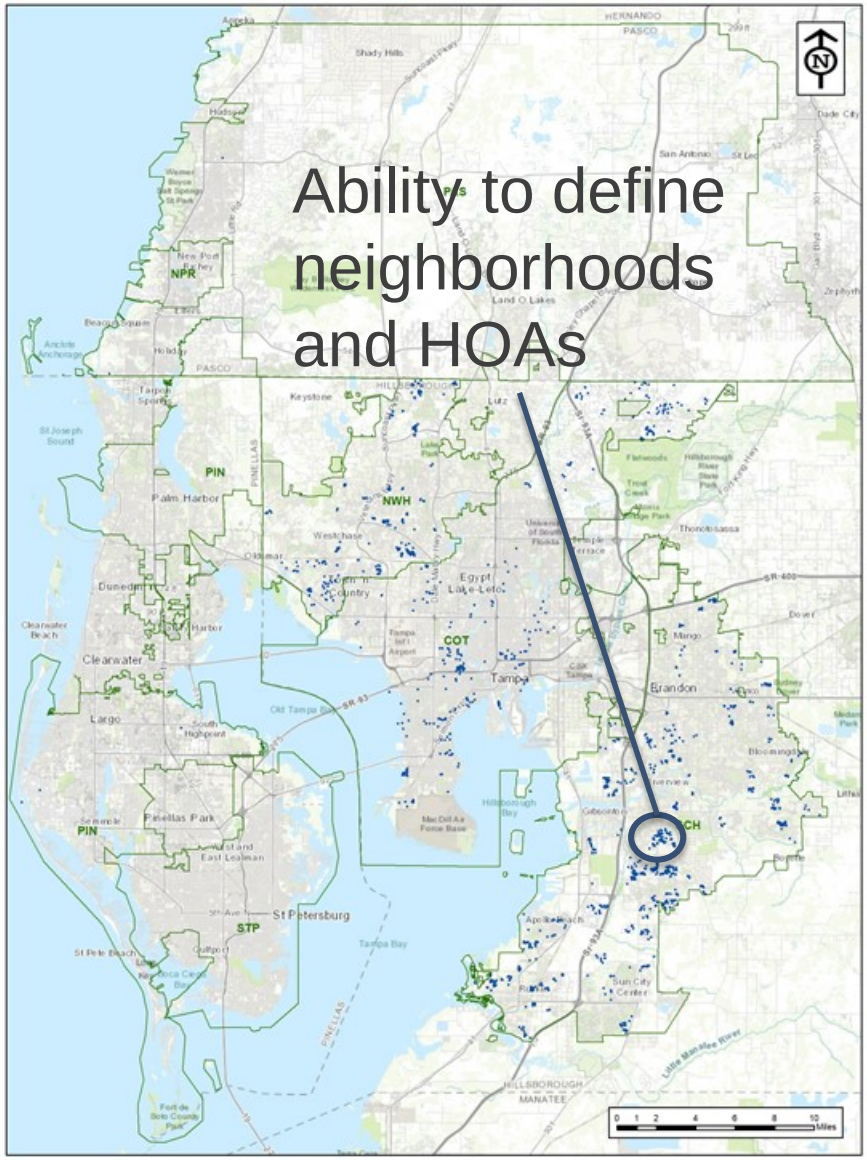
Possibility to target majority of surplus, while reducing risk of imprecision in estimates

Proportion Exceeding Estimated Watering Requirements by Water Demand Planning Area (No Reclaimed Access)



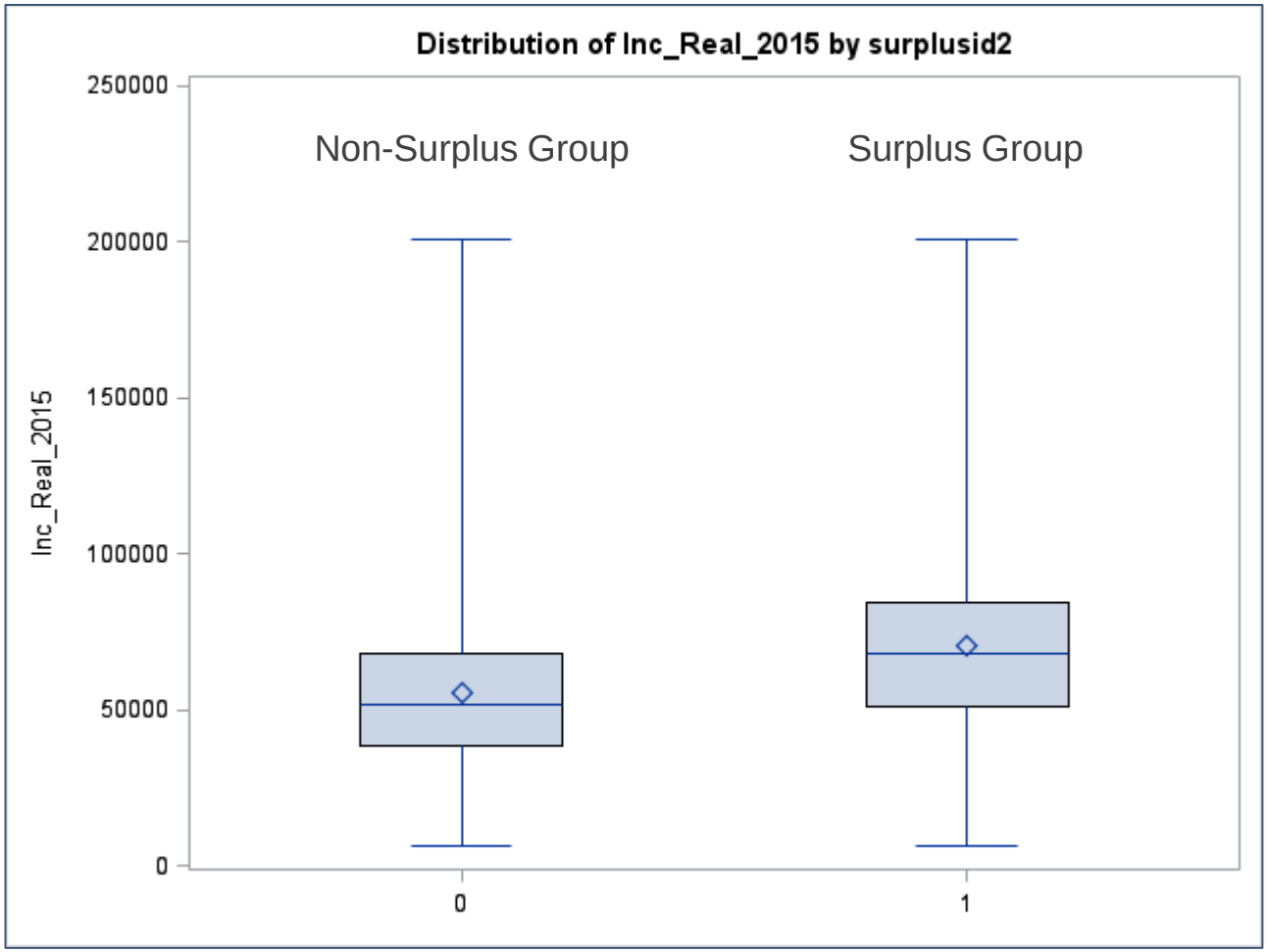


All Identified as Surplus



>10x Theoretical Requirements

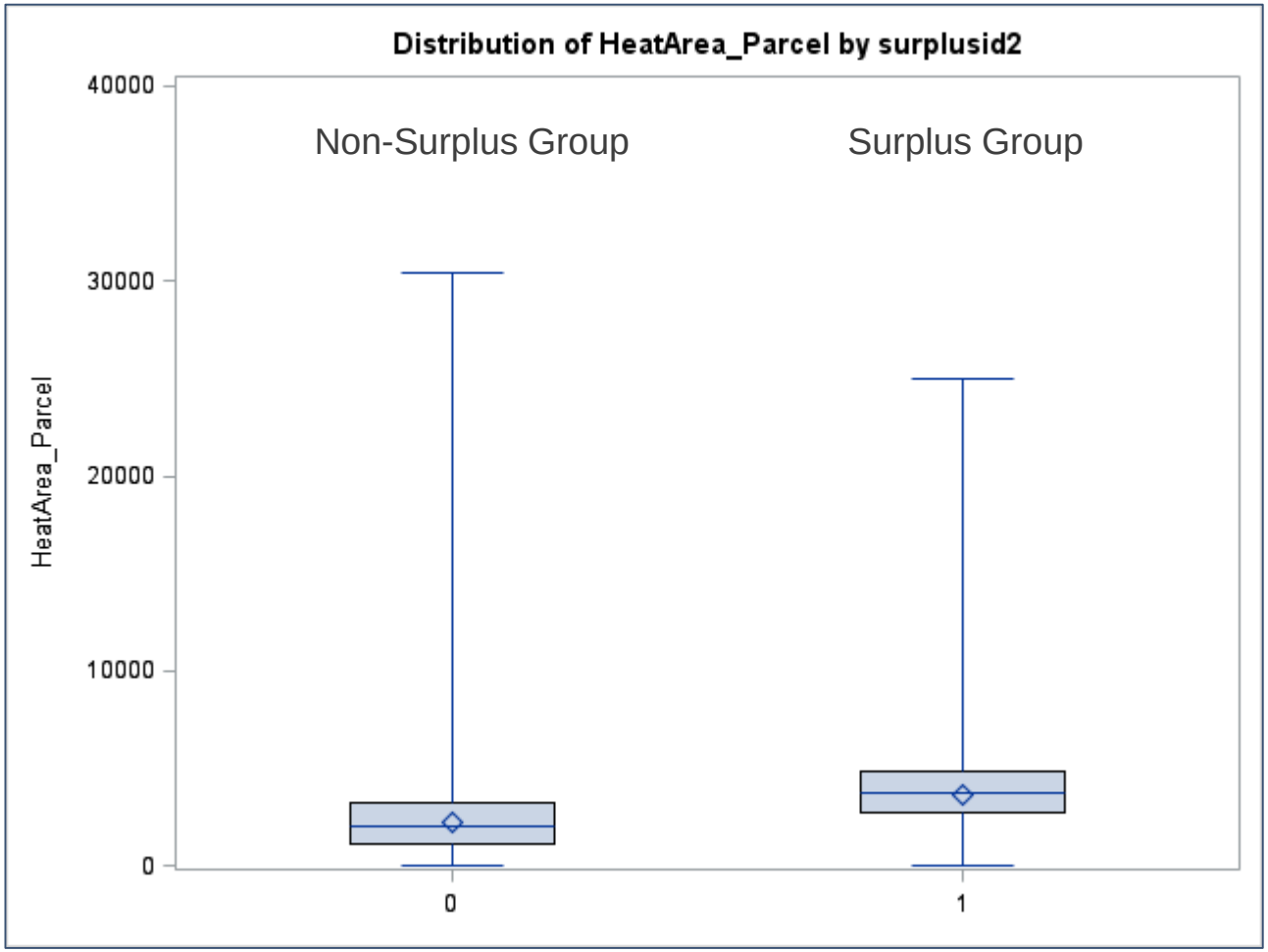
Explanatory Factors: Median Income



Surplus Irrigators tend to live in higher income areas

Analysis Variable : Median Income (Block Group 2015$)			
Surplus_ID	N Obs	Mean	Median
0	308,039	55,559	51,524
1	50,764	70,778	68,083

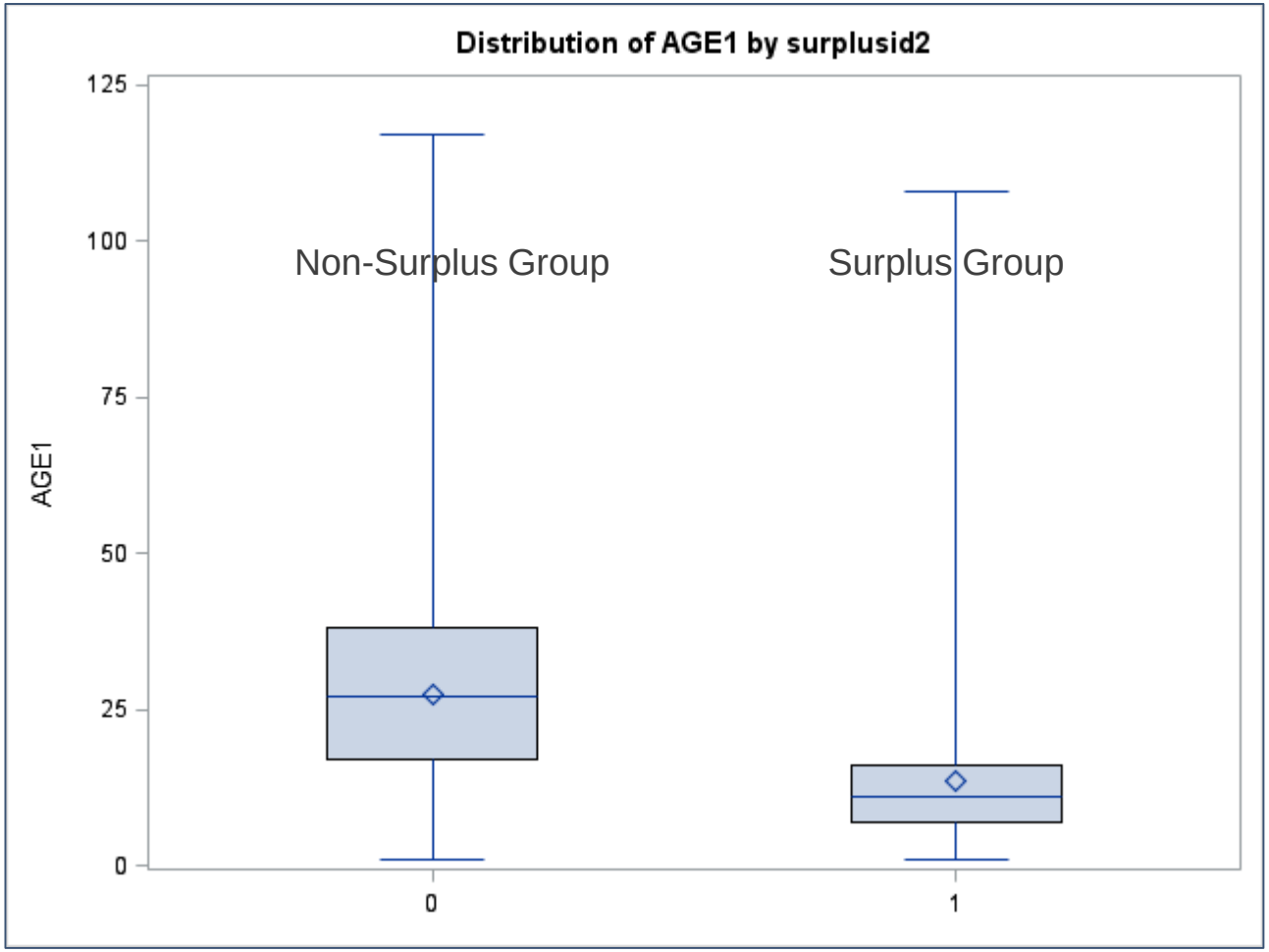
Explanatory Factors: Heated Area



Surplus Irrigators tend to live in larger homes

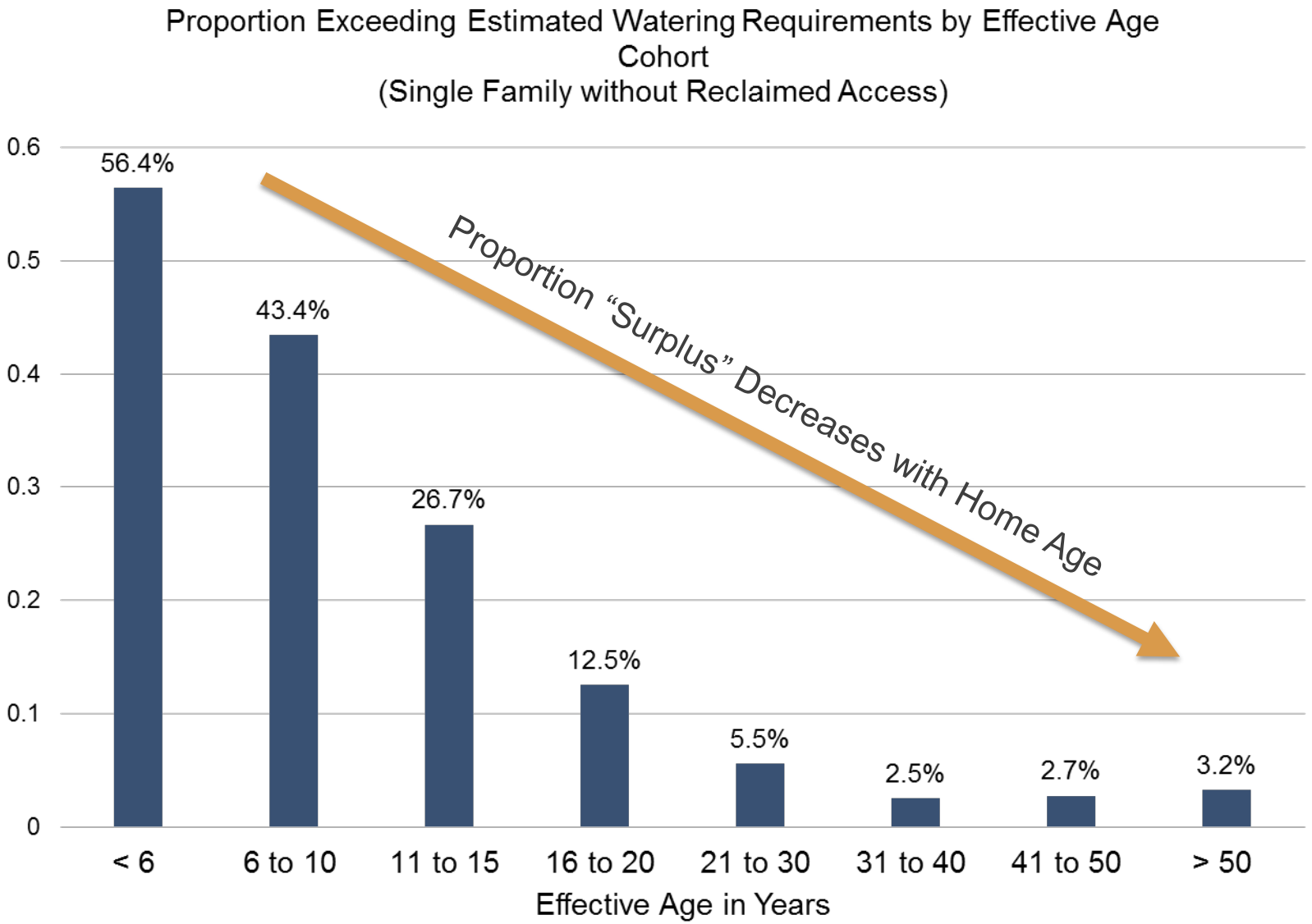
Analysis Variable : Heated Area			
Surplus_ID	N Obs	Mean	Median
0	308,039	2,257	2,045
1	50,764	3,679	3,724

Explanatory Factors: Effective Age of SF Home



Analysis Variable : Effective Age (years)			
Surplus_ID	N Obs	Mean	Median
0	308,039	27.26	27.00
1	50,764	13.54	11.00

Surplus Irrigators tend to live in newer homes

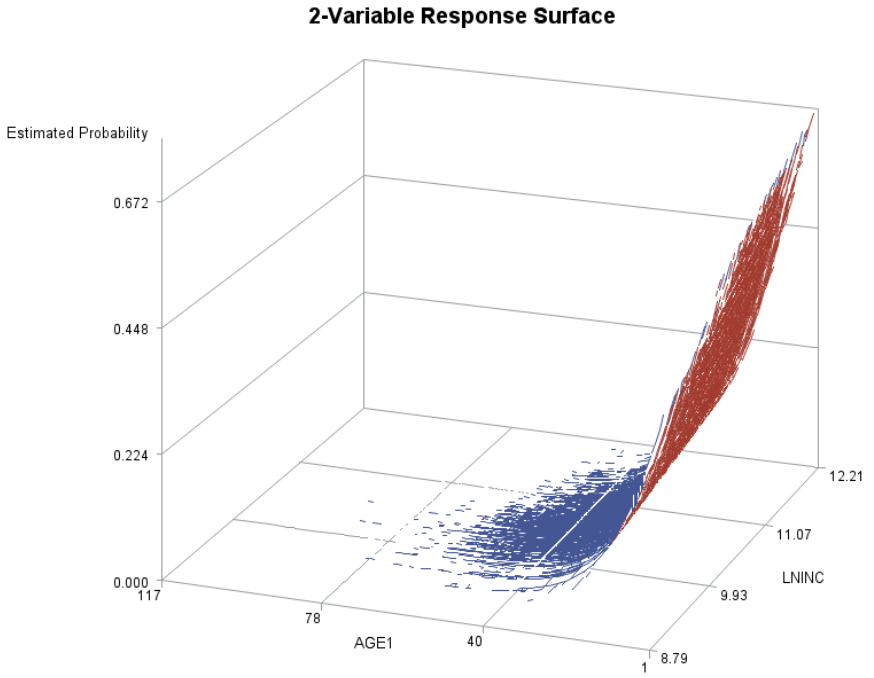

Proportion Exceeding Estimated Watering Requirements by Effective Age Cohort
(Single Family without Reclaimed Access)
0.6
0.5
0.4
0.3
0.2
0.1
0
56.4%
43.4%
26.7%
12.5%
5.5%
2.5%
2.7%
3.2%
Proportion "Surplus" Decreases with Home Age
< 6
6 to 10
11 to 15
16 to 20
21 to 30
31 to 40
41 to 50
> 50
Effective Age in Years

Predictive Analytics Framework

Statistical model that predicts likelihood of being a surplus irrigator

Statistical controls:

- ✓ Pervious area (-)
- ✓ Median income (+)
- ✓ Heated area (+)
- ✓ Effective age (-)
- ✓ Presence of pool (+)
- ✓ Presence of irrigation meter (+)



Example of predicted probabilities of being a Surplus Irrigator

Attribute	Hypothetical Property		
	A	B	C
Effective age	2	10	40
Median income	200,000	100,000	60,000
Heated area	3000	2000	1500
Pervious area	1000	2000	2500
Pool (0/1)	1	1	0
Irrigation meter (0/1)	1	1	0
Prob(Surplus)	0.96	0.57	0.03

Conclusions

- About half of Agency's demand management goal could be met by eliminating surplus irrigation
  - Program participation rates likely to reduce savings below estimated potential
- Savings potential identifiable geographically and by quantity thresholds
  - Objective is to refine targets to maximize B/C ratio
  - Focus on more extreme cases to address uncertainties in calculations

Conclusions

- Generalized attributes of program targets provides program focus
  - Relatively new, larger homes, on relatively smaller lots in higher income areas
  - Accounting for influence of other factors, surplus use may decrease with time without changing sources or technologies

Next Steps - Implementation

Design implementation plan(s) focused on:

1. New Homes - offer Florida Water Star funds to facilitate paradigm shift in the new home market
2. Existing homes - provide Alternative Source incentives to surplus irrigators and the upper quartile of deficit irrigators
3. Existing homes – promote Soil Moisture Sensors and ET Controller installation where Alternative Sources (shallow wells) are precluded

Next Steps - Analytics

- Continue data updates and model refinements
  - Extend data to capture more historical time periods up to current data
  - Update and integrate predictive model within GIS
  - Once programs are implemented, incorporate and model attributes of program participants
  - Perform a pilot application of the model to assess tangible benefits for optimizing costs/value of implementation

Thank you!

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