Understanding the Impact of HOAs on Residential Water Use in Denver Metro Area

Sustaining Colorado Watersheds Conference

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THE Water Research FOUNDATION

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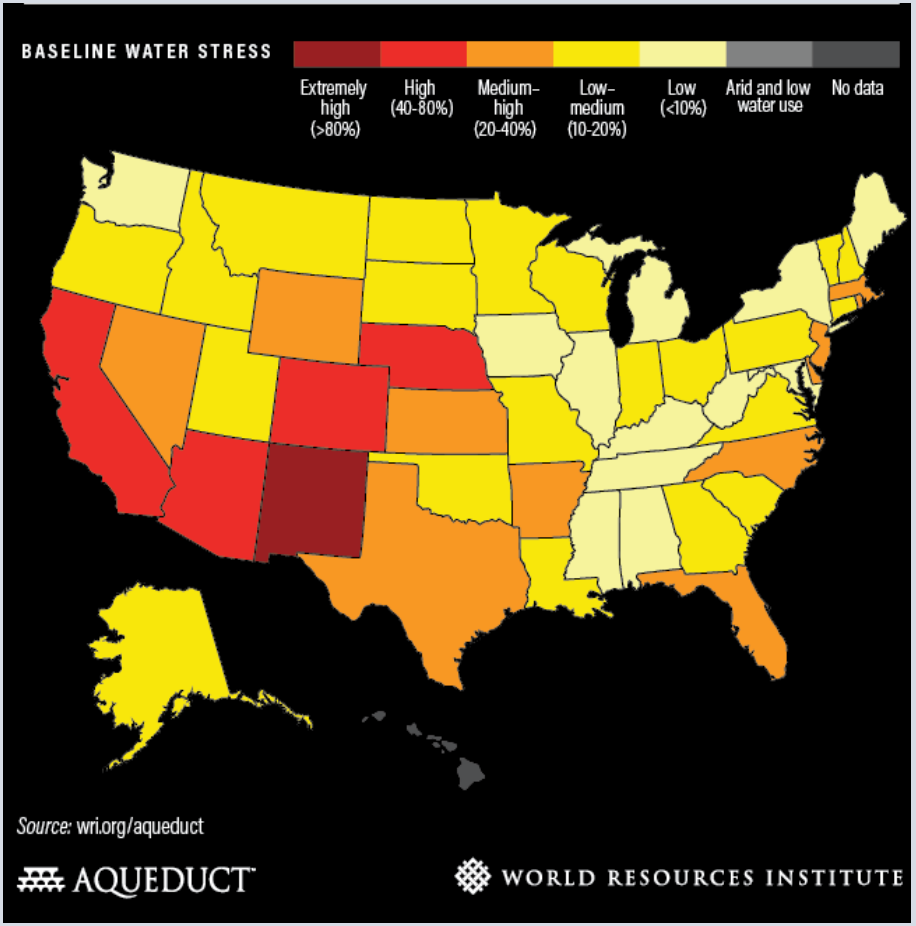
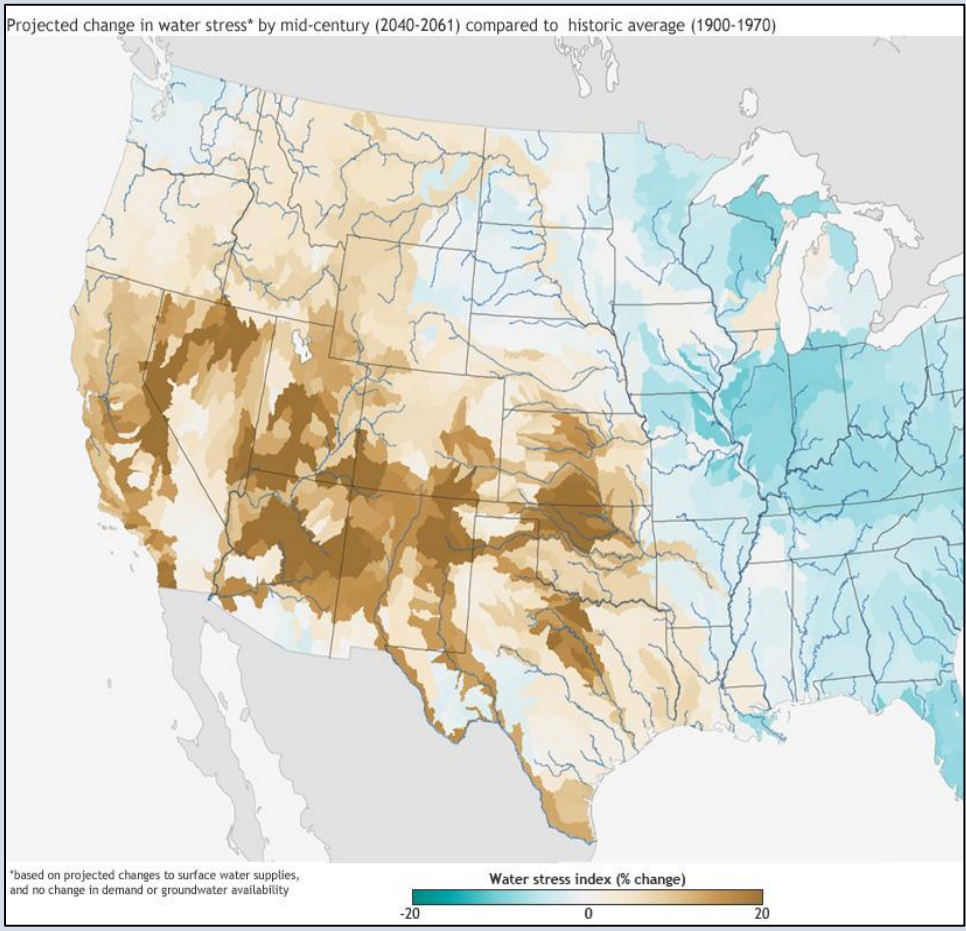
A Little Context on Water Demand Management & Focus on Outdoor Water Use

US Current Water Stress Rating 2019



Projected Water Stress 2040-2061



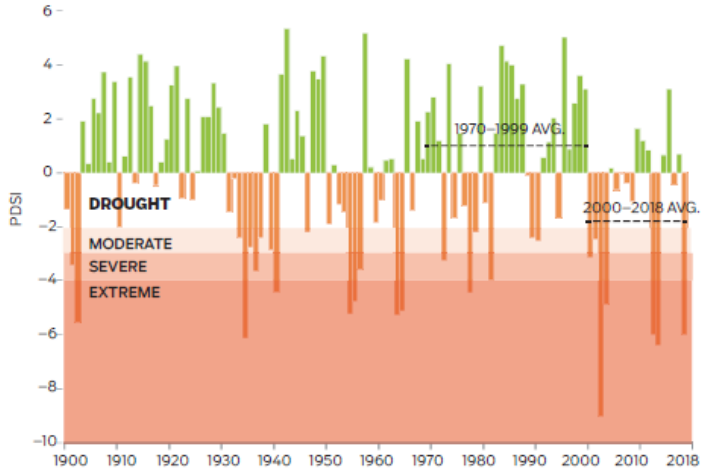
As the population continues to grow, it becomes increasingly important to consider the impacts of land use decisions on water and other natural resources

Colorado River's Over-Allocation Problems

- Over-allocation of Colorado River water due to 1922 Colorado River Compact negotiations based on wet period of early 1900s
- The result is that more water is promised on paper than flows annually in the river, by over one million acre-feet.

Colorado July Palmer Drought Severity Index (PDSI), 1900–2018

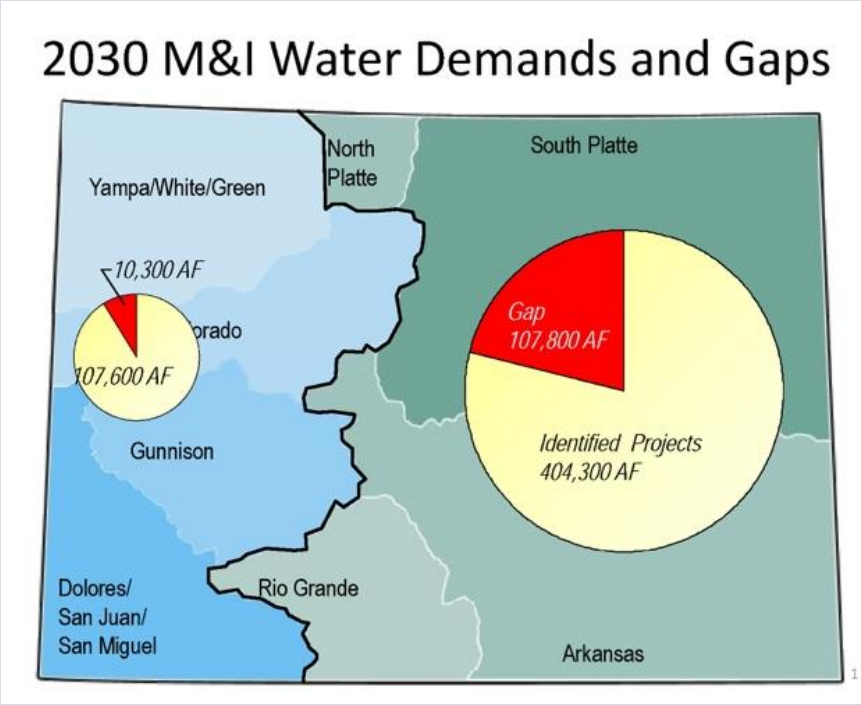
The Palmer Drought Severity Index uses temperature and precipitation data to estimate relative dryness and quantify long-term drought. The 1970–1999 average was +0.9, or wetter than normal, while the 2000-2018 average is –1.7, or drier than normal.

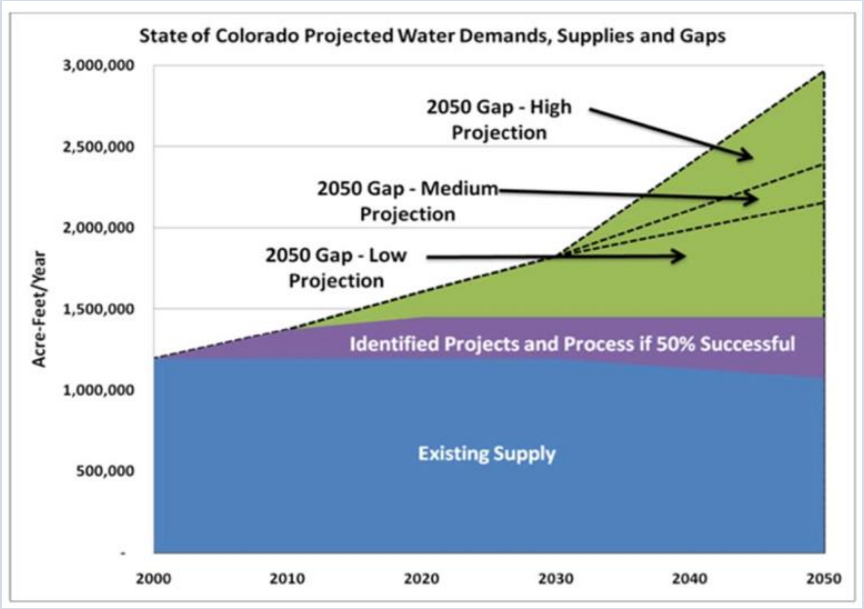


Source: Adapted and updated from Lukas et al., Climate Change in Colorado, 2014; Data: NOAA NCEI; http://www.ncdc.noaa.gov/cag/

Colorado April 1 Snow-Water Equivalent, 1968–2018

There is an apparent long-term declining trend in spring snowpack; in the 21 years from 1998 to 2018, 16 years were below the long-term median.





Colorado's Projected Water Supply & Demand Gaps

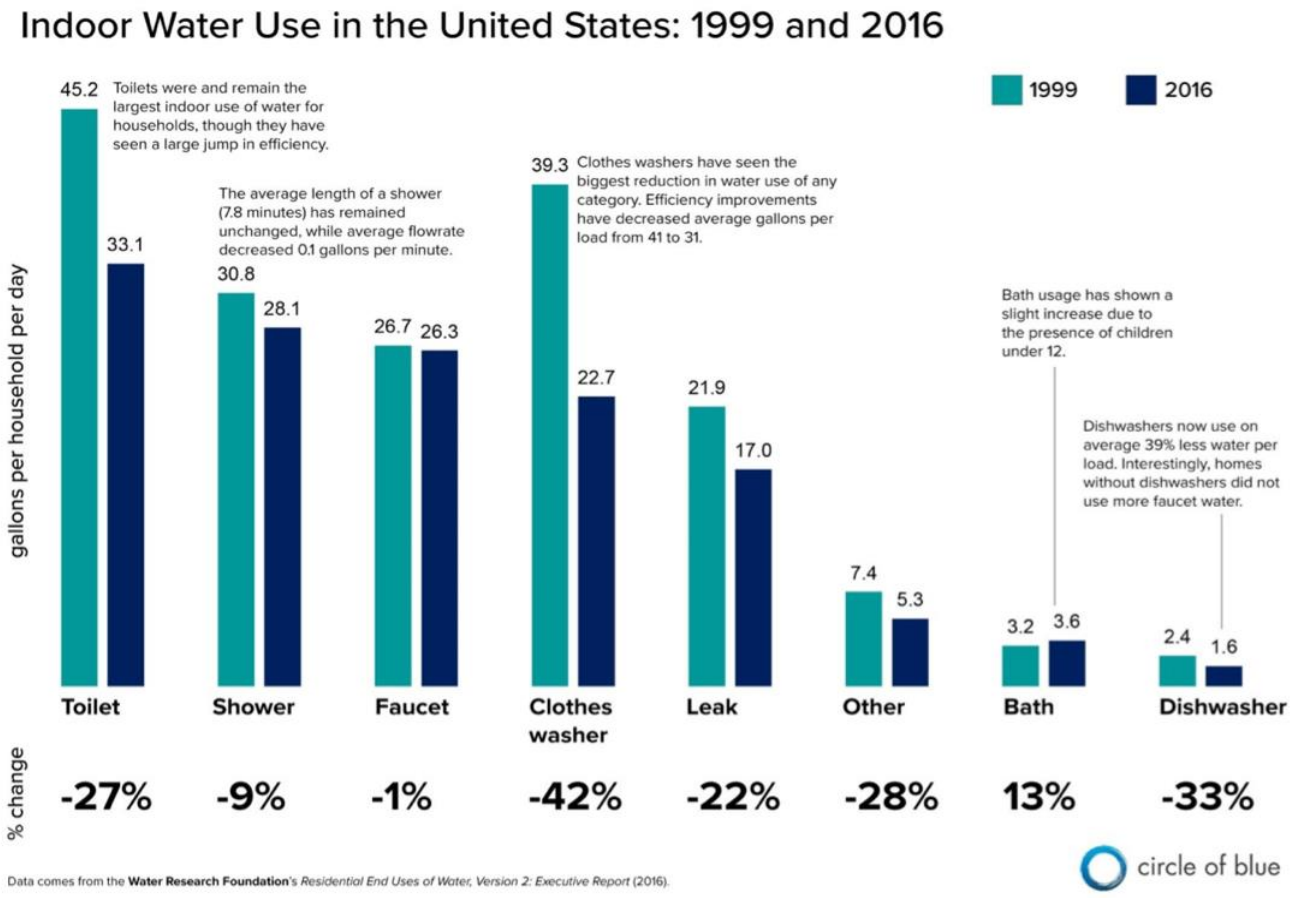
CLOSING	PLANNING	INTEGRATING	SUSTAINING	PROTECTING	IMPROVING
CLOSING THE GAP: Getting to Zero by 2030	PLANNING FOR STORAGE: Along side Conservation	INTEGRATING WATER SAVING ACTIONS: Land Use Planning	SUSTAINING OUR AG ECONOMY: Alongside Growth	PROTECTING OUR WATERSHEDS: For Our Way of Life and Economy	IMPROVING PUBLIC AWARENESS: Engagement on Water Issues

Meeting State Water Plan Goals

Benefits of Demand Management

Improve	Reduce	Improve	Assist in	Reduce	Manage
Improve water use productivity and efficiency	Reduce capital investments in large-scale infrastructure projects	Improve the equity of water allocation and charges	Assist in the provision of the basic water needs for all sectors	Reduce conflict	Manage water more sustainably

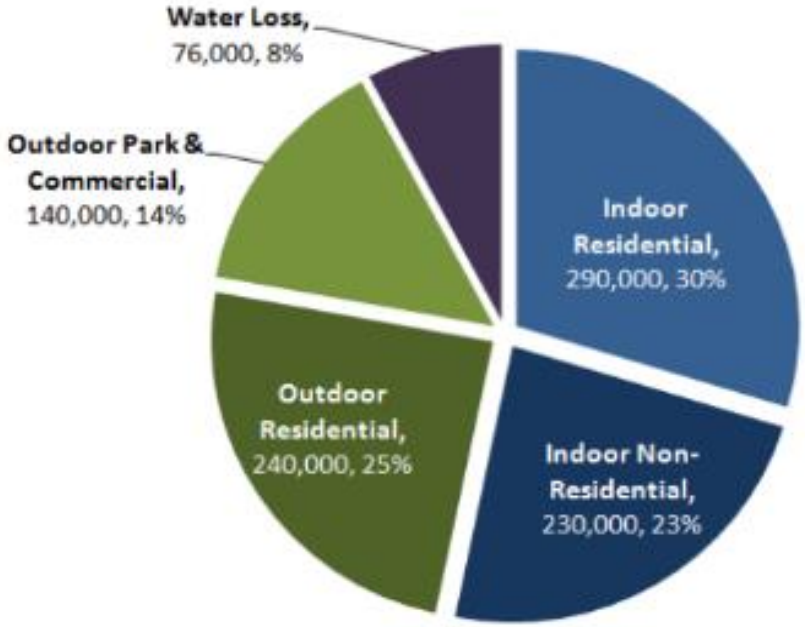
INDOOR WATER USE IS INCREASINGLY EFFICIENT DUE TO FIXTURES & APPLICANCES



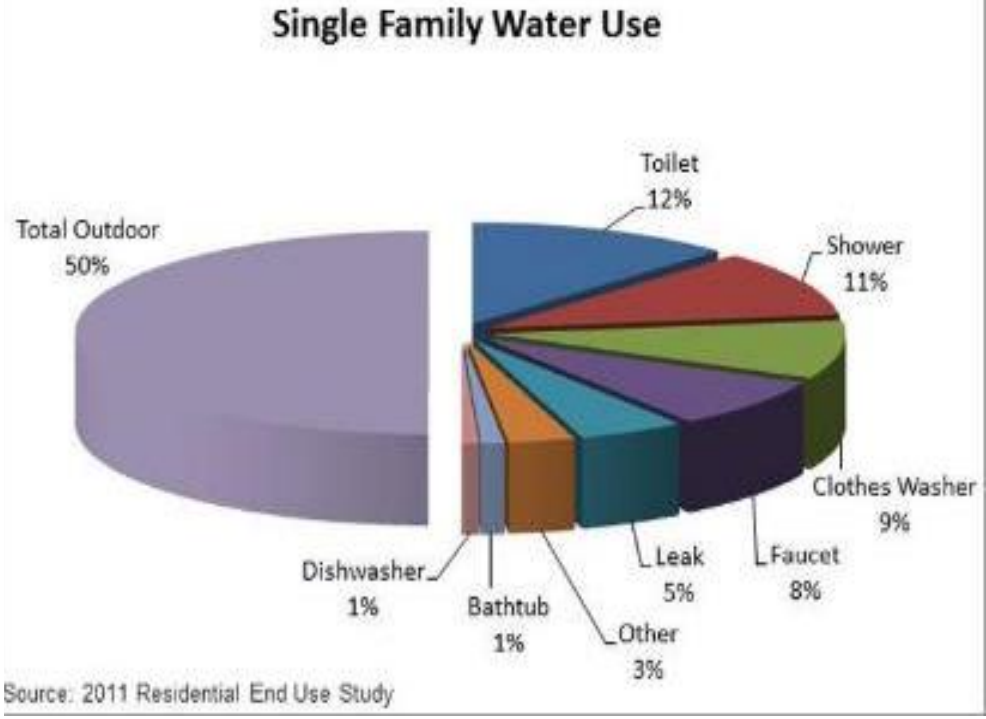
….Which Leads Us to The Importance of Outdoor Water Use

Importance of Outdoor Irrigation

Image source: Eric Sonstroem (https://www.flickr.com/photos/sonstroem/), Data: Denver Water and CO state water plan



Total Municipal Water Diversions = 970,000 AF



Yard irrigation is variable

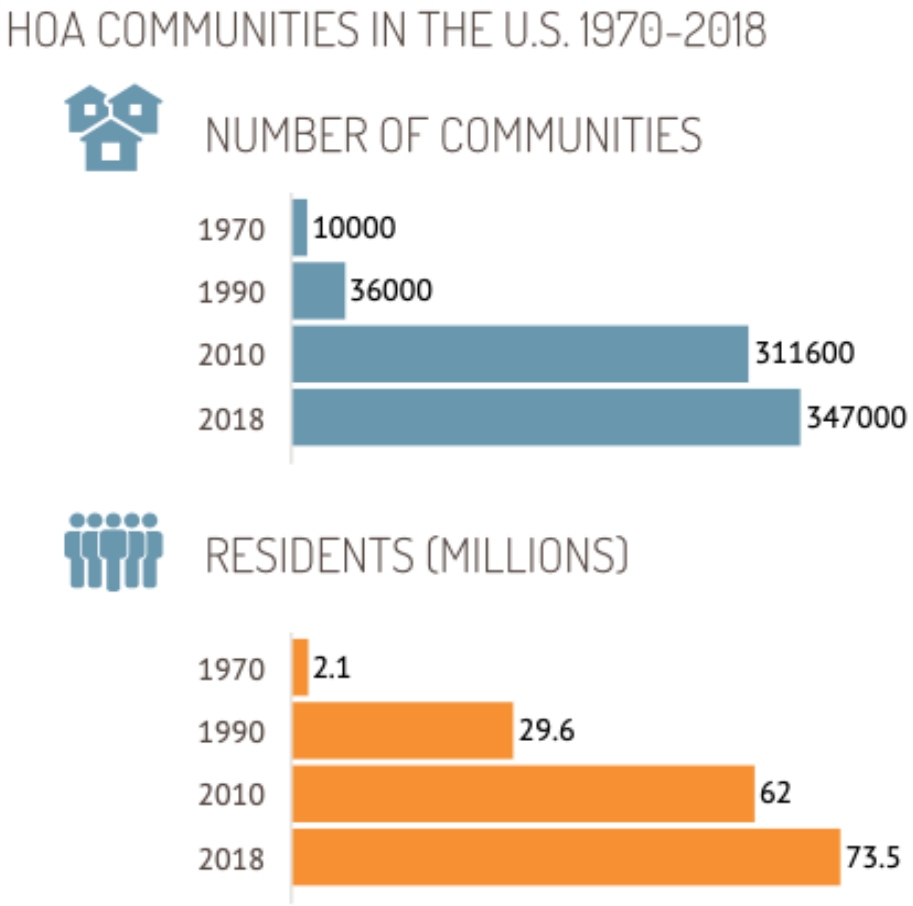
Table ES.10 Summary of annual and outdoor water use for landscape group (n=838)

Site	Sample Size (n)	Average Annual Use (kgal)	Average Outdoor Use (kgal)	% Outdoor
Clayton County	103	62	19.2	31%
Denver Water	95	125	77.0	62%
Ft. Collins	88	111	55.9	50%
Peel	69	87	24.1	28%
San Antonio	98	112	62.0	55%
Scottsdale	111	186	120.4	65%
Tacoma Water	107	73	27.0	37%
Toho	95	93	33.1	36%
Waterloo	72	58	13.0	22%
Total (9 sites)	838	100.8	50.5	50 %

Source: Water Research Foundation 2016

Factors of Irrigation Variation

- Climate
- Yard sizes
- Technology
- Yard Composition & Irrigation Behavior driven by:
  - Economics/pricing
  - Social norms, expectations, legacy effects, informal rules
  - “lifestyle” : type of housing, home ownership rates, size and age of household members, and residence duration
  - Identity expression
  - Historical legacy effects (housing age)
  - Regulation, CCRs, informal rules



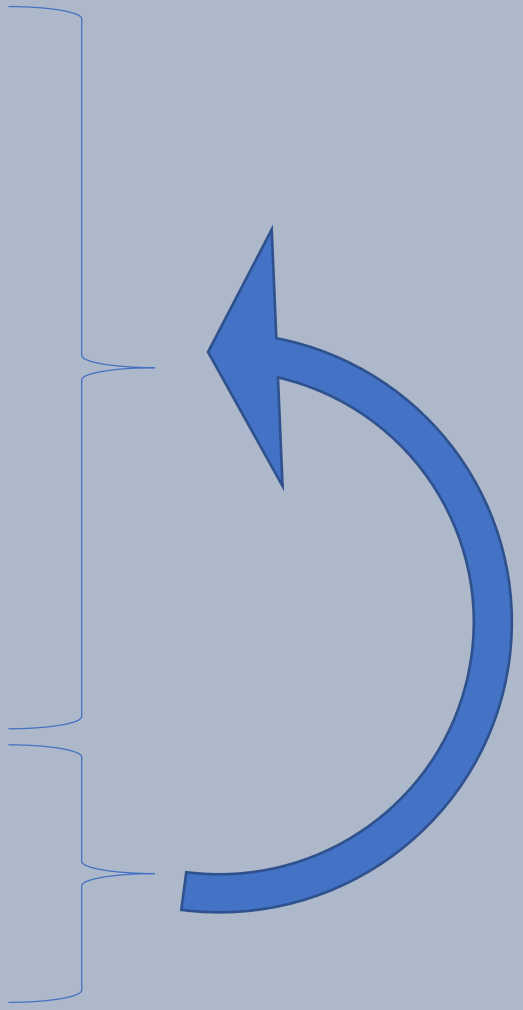
Why HOAs and CC&Rs Are Important Factors in Water Demand Management……

- In US, HOAs are in 347,000 communities comprised of 26.6 million housing units with 73.5 million residents living in HOA housing, which equates to 24% of the US population.
- Most NEW housing development is in HOAs
- HOAs increasingly set standards for yard composition.
- Sometimes provide recommended species/plant list, to enforce vegetative standards
- *However, they often go against water conservation statutes, e.g. CA HOAs threatened to fine homeowners for not maintaining lawns during state water crisis despite state statute (Wentz et al 2016)*

Yard Characteristics that May Predict Variability

1. Grass area and greenness
2. Tree canopy area
3. Tree size/age
4. Tree and building shade on growing space
5. Species grown

- **HOA CRRs**
- **Housing/subdivision age**



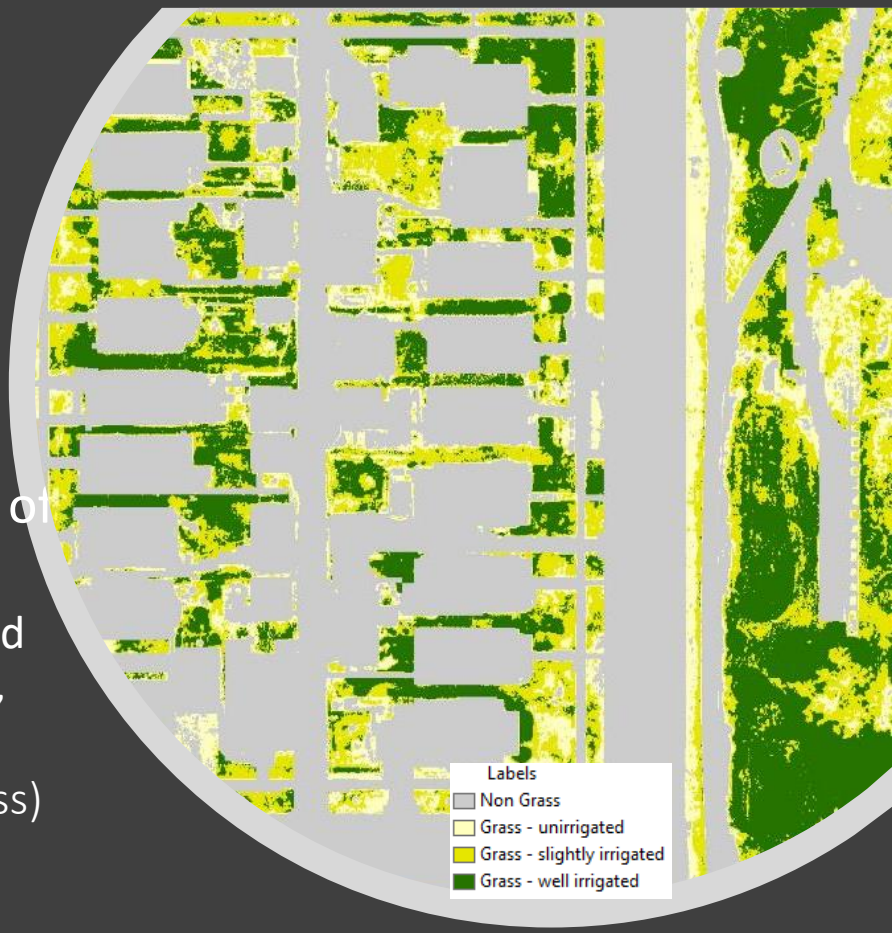
Building Upon An Initial Denver Water Study of 425 yards

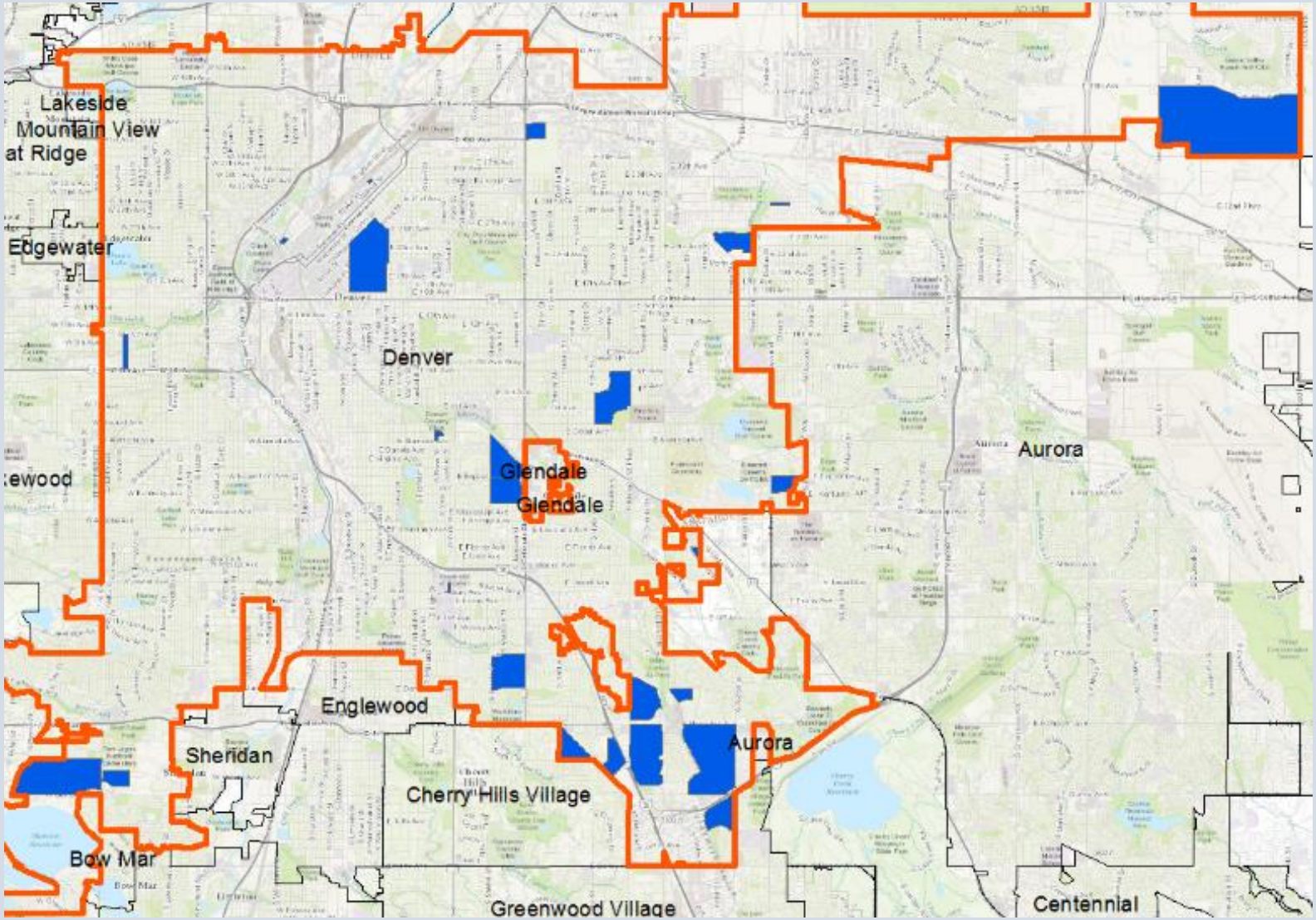
- 53% of pervious area – bluegrass turf – 18 GPSF
- 29% of pervious area – alternative landscape types (xeriscape, native, low-use) – 9 GPSF
- 18% of pervious area – no irrigation (walkways, rock, mulch etc.)

Regression of Annual Water Consumption

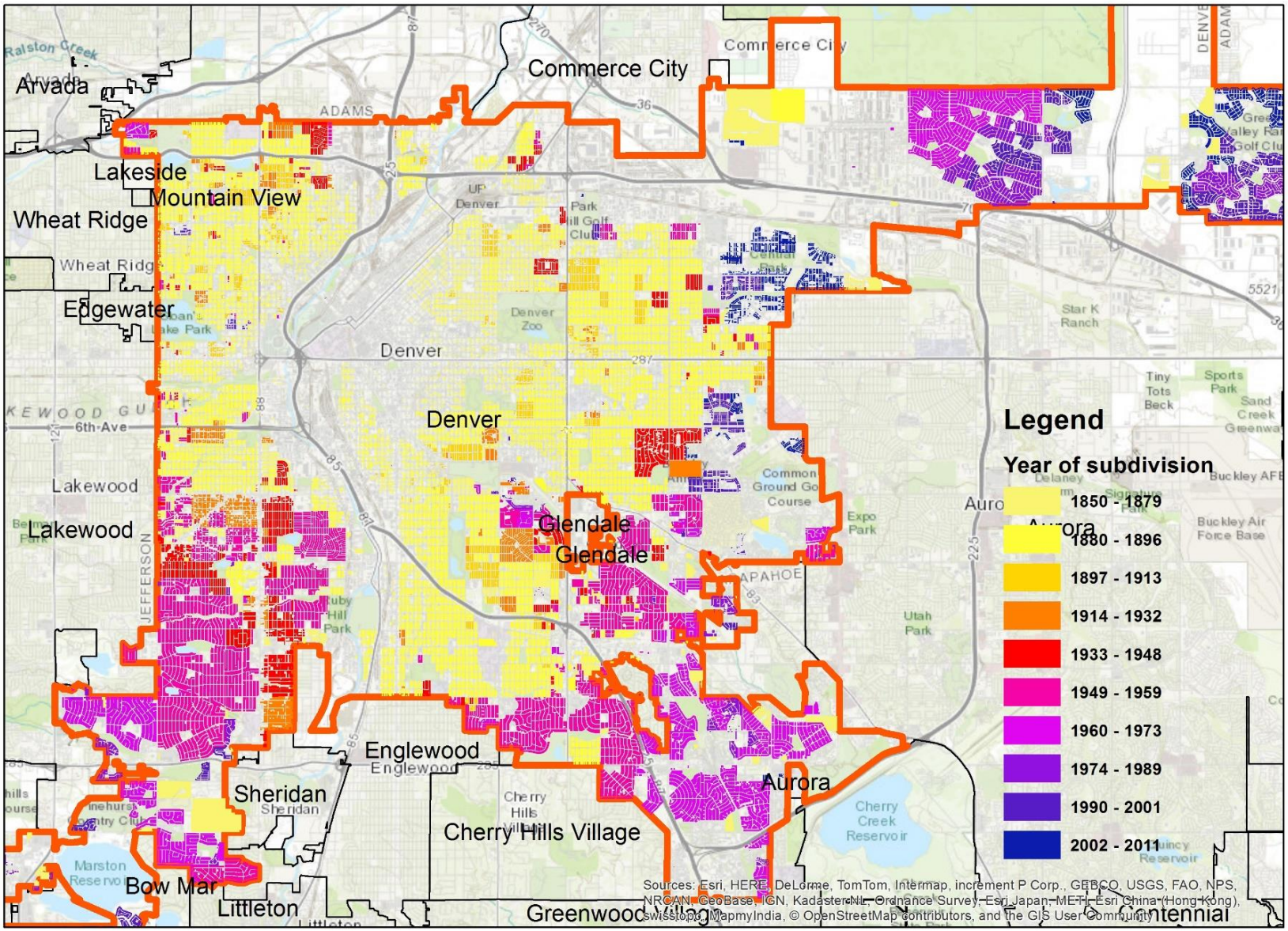
- Regress <u>water consumption</u> (**Dependent Variable**) by parcel for Denver, (& Aurora next) against:
  - **Independent Variables**: Determinants of water demand =
    - **Lot characteristics** average household and demographics (i.e., income, race, lot size, home age)
    - **Irrigated area** (NDVI-high to low greenness)
    - **Time of Construction** from **post-1950** subdivision
    - **Property is part of HOA**

***Denver Water 2014-2016 consumption records filtered for private Single Family Homes with lot coverage< 30%, July water use> 0, grass area >0= 53,852 observations*



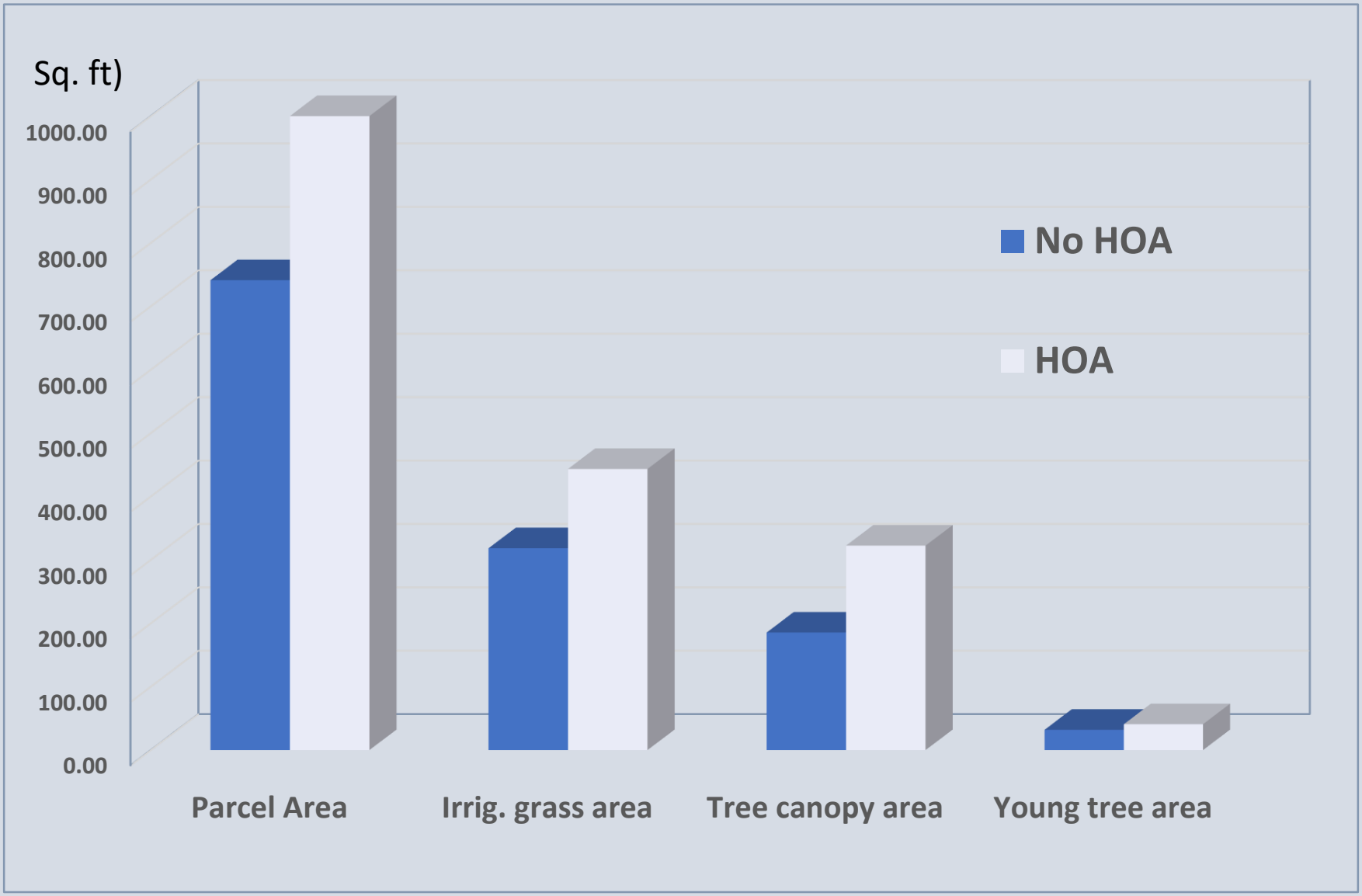


Denver Home Owner Associations (HOAs)

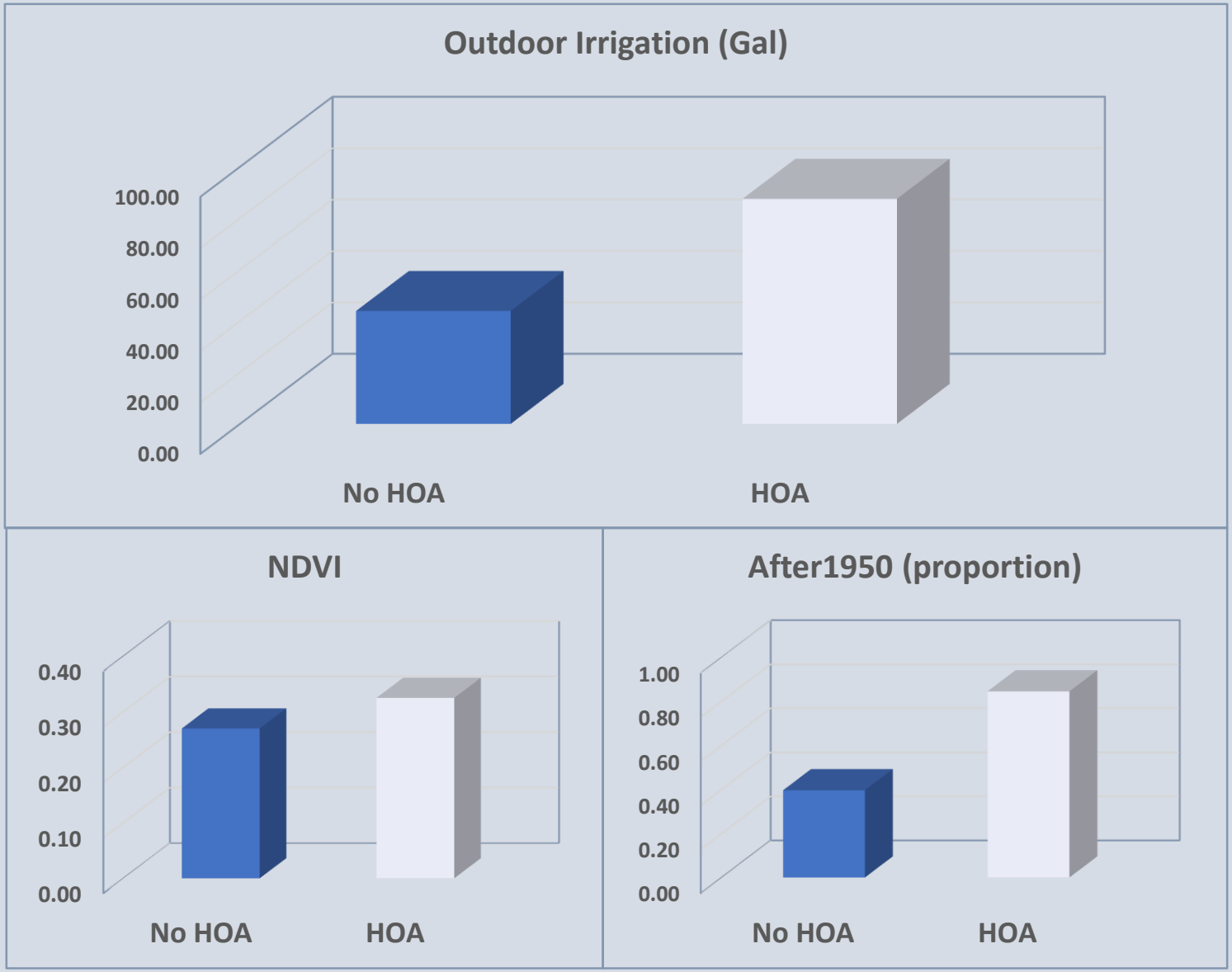


Year of subdivision

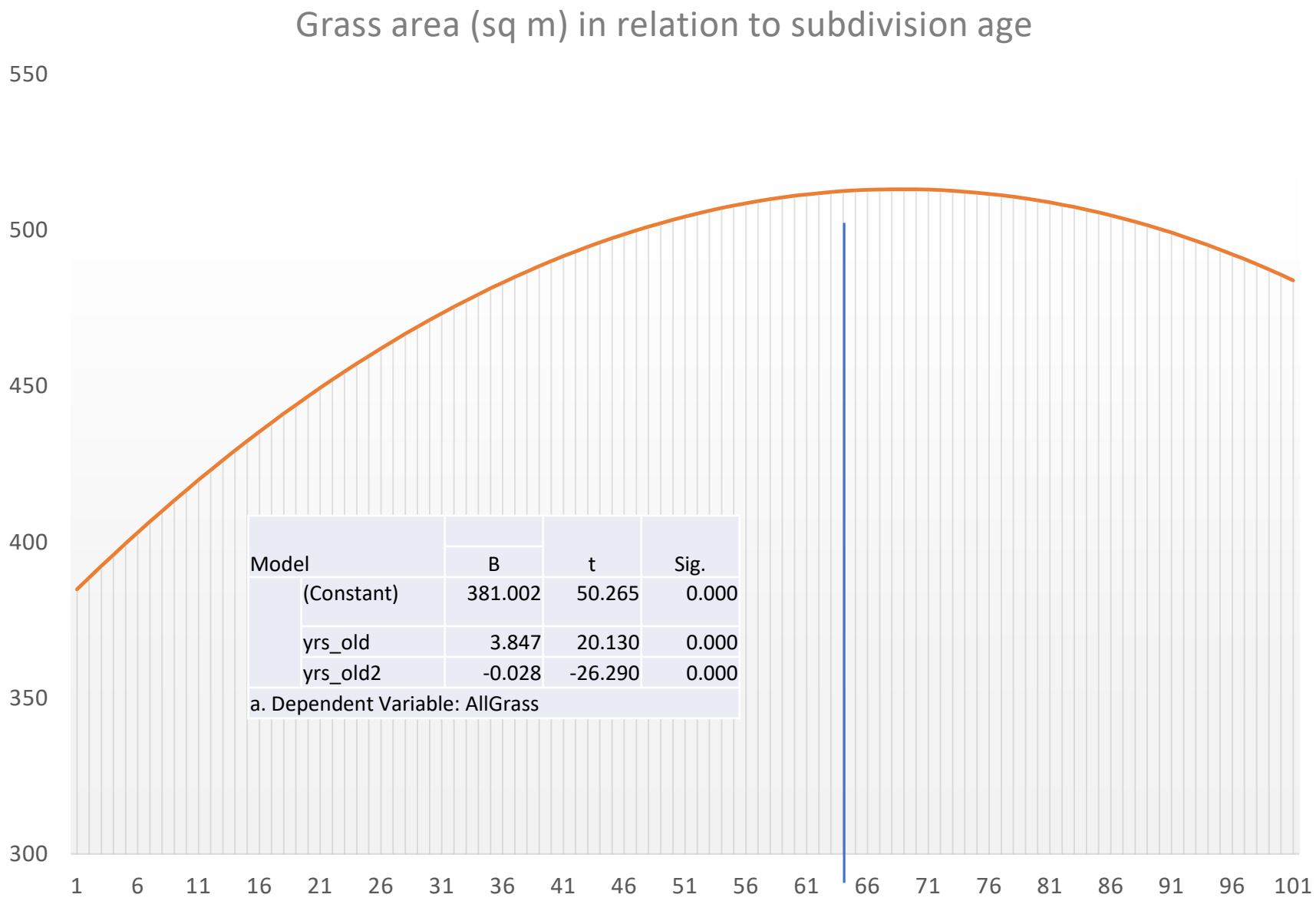
HOA Differences in Denver



HOA Differences in Denver

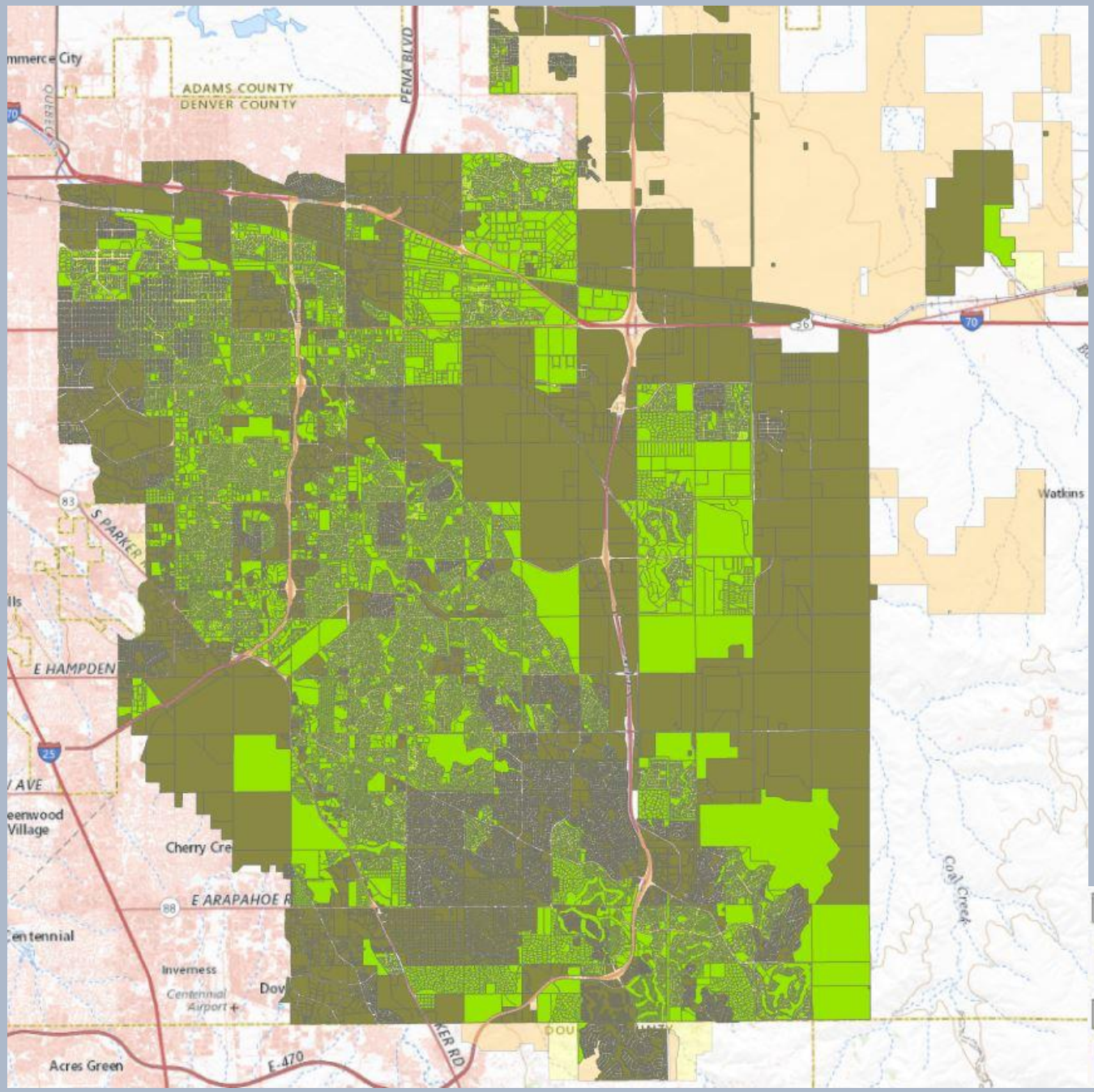


Subdivision age also drives grass area



Model		B	t	Sig.
	(Constant)	381.002	50.265	0.000
	yrs_old	3.847	20.130	0.000
	yrs_old2	-0.028	-26.290	0.000

a. Dependent Variable: AllGrass

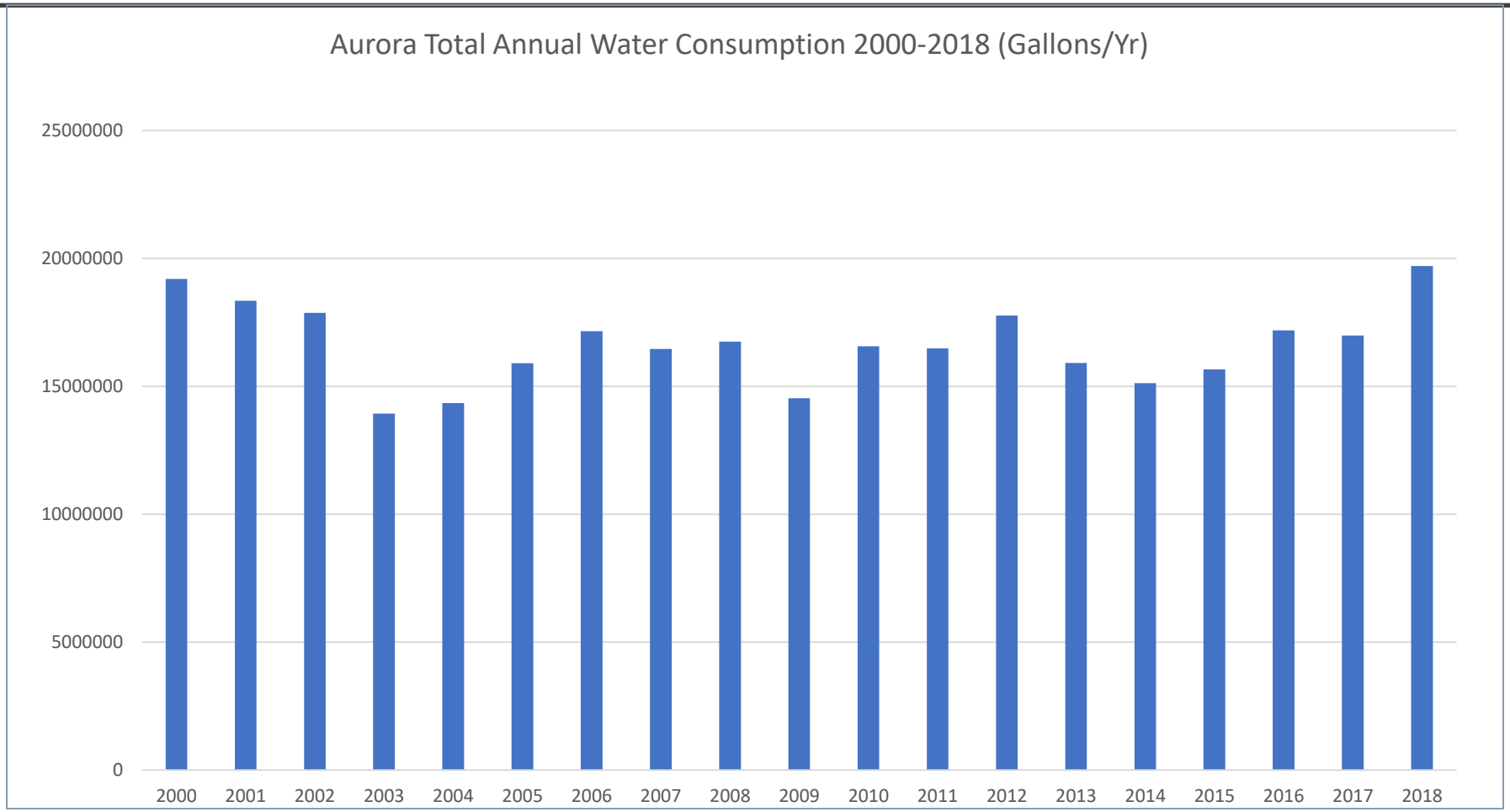


Aurora Parcels

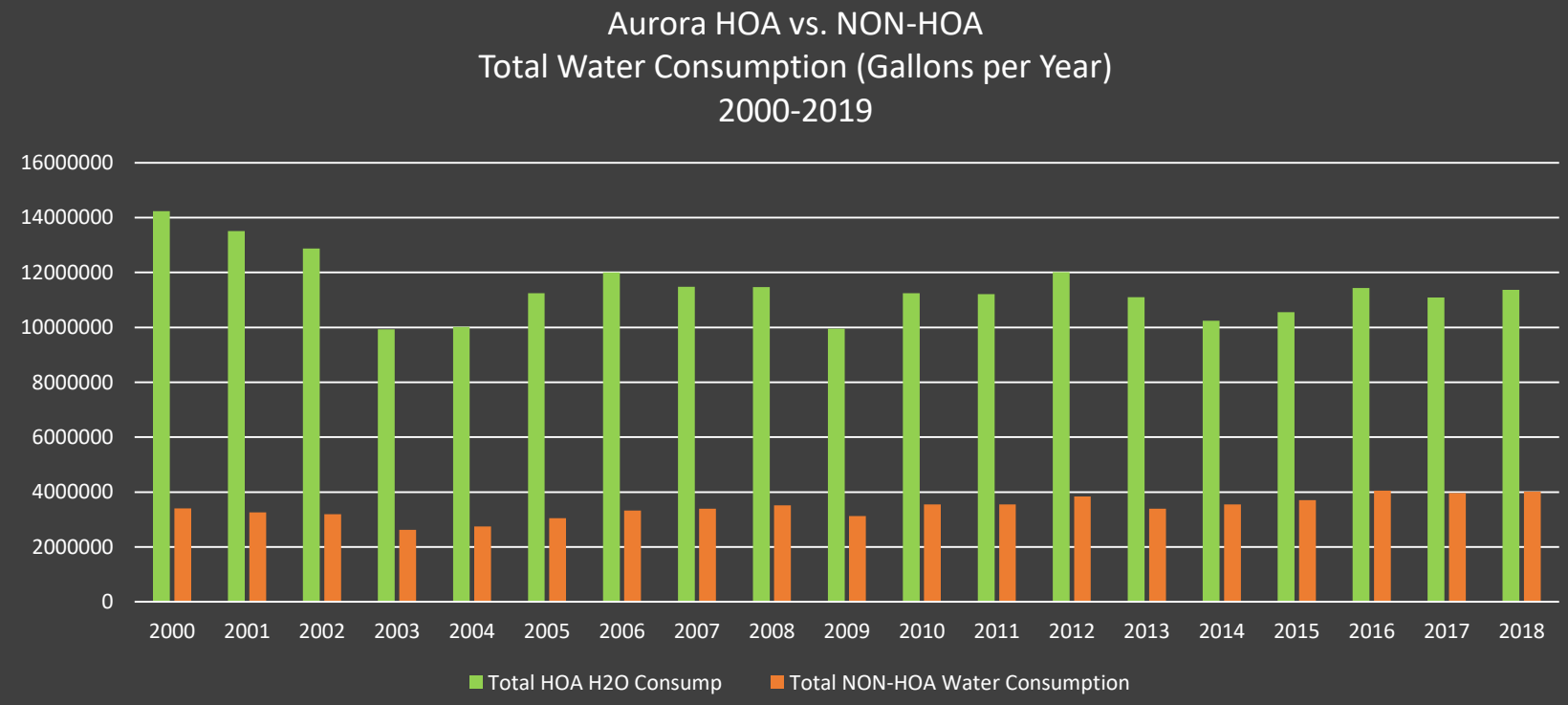
70% in HOAs

30% Non-HOA

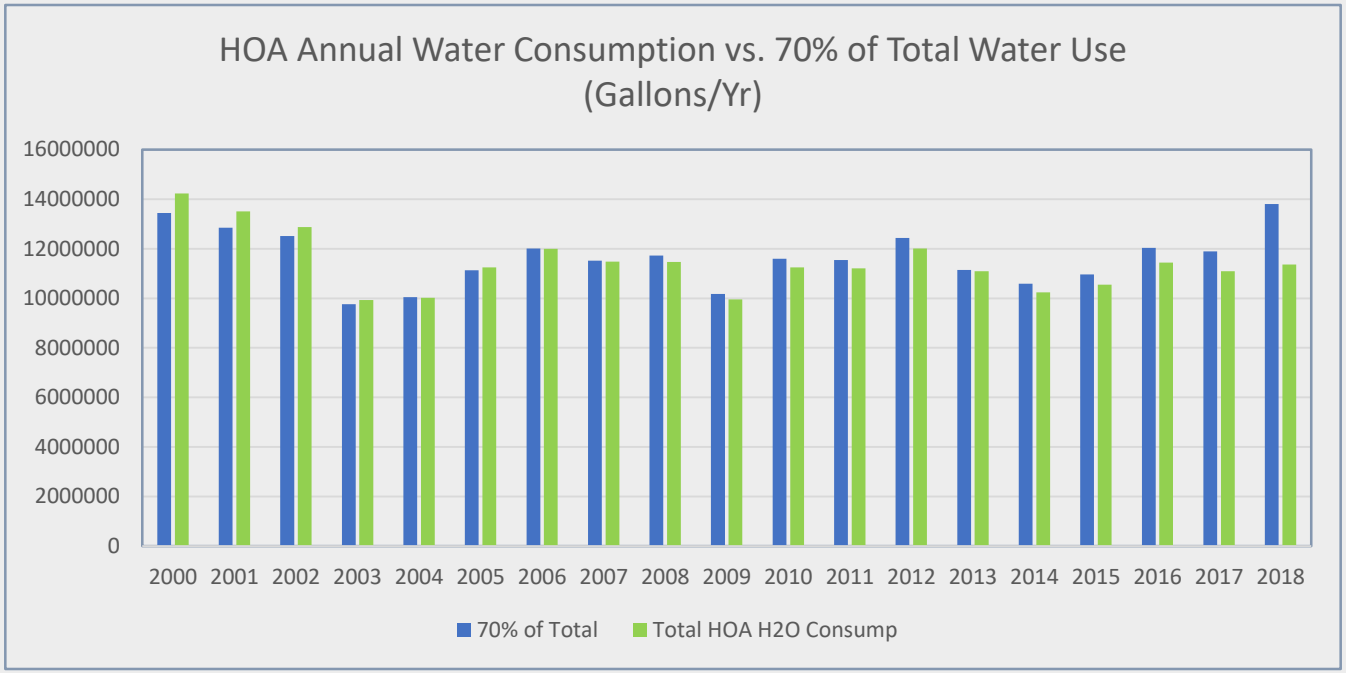
Aurora Water Consumption – 2000-2018
Population Yr2000 = 276k Yr2018= 374k

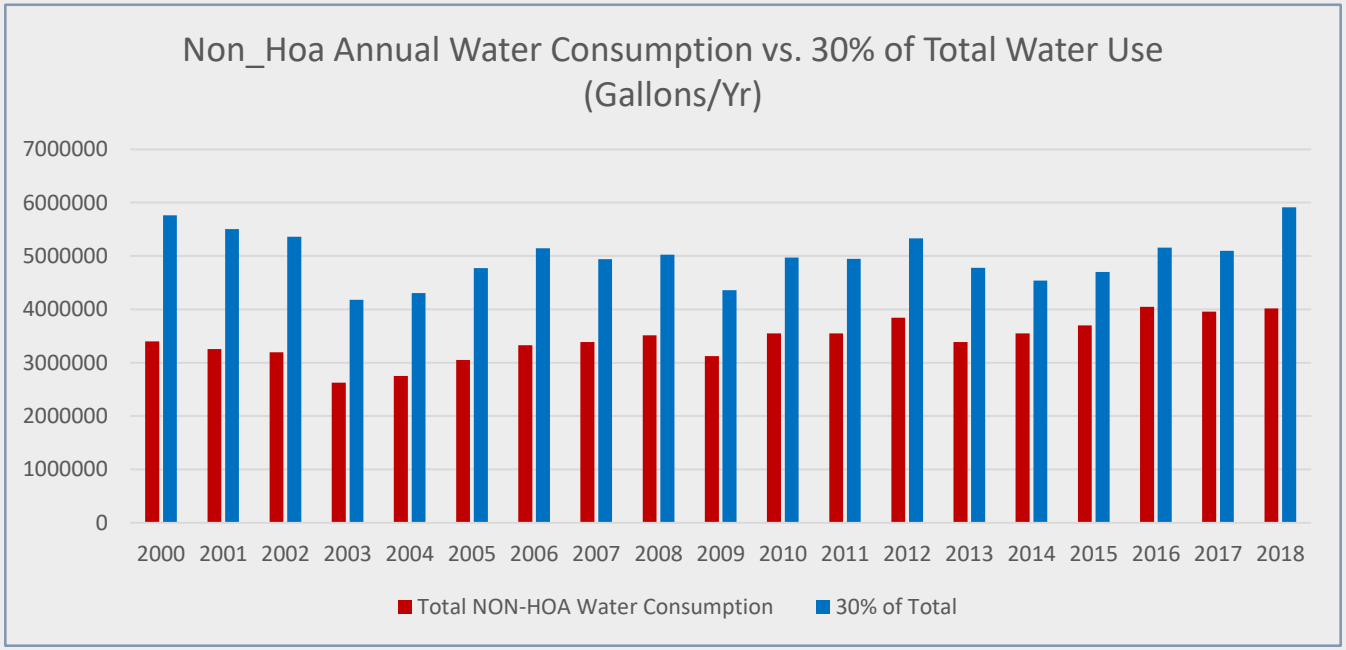


Aurora Total HOA vs. Non-HOA Water Use

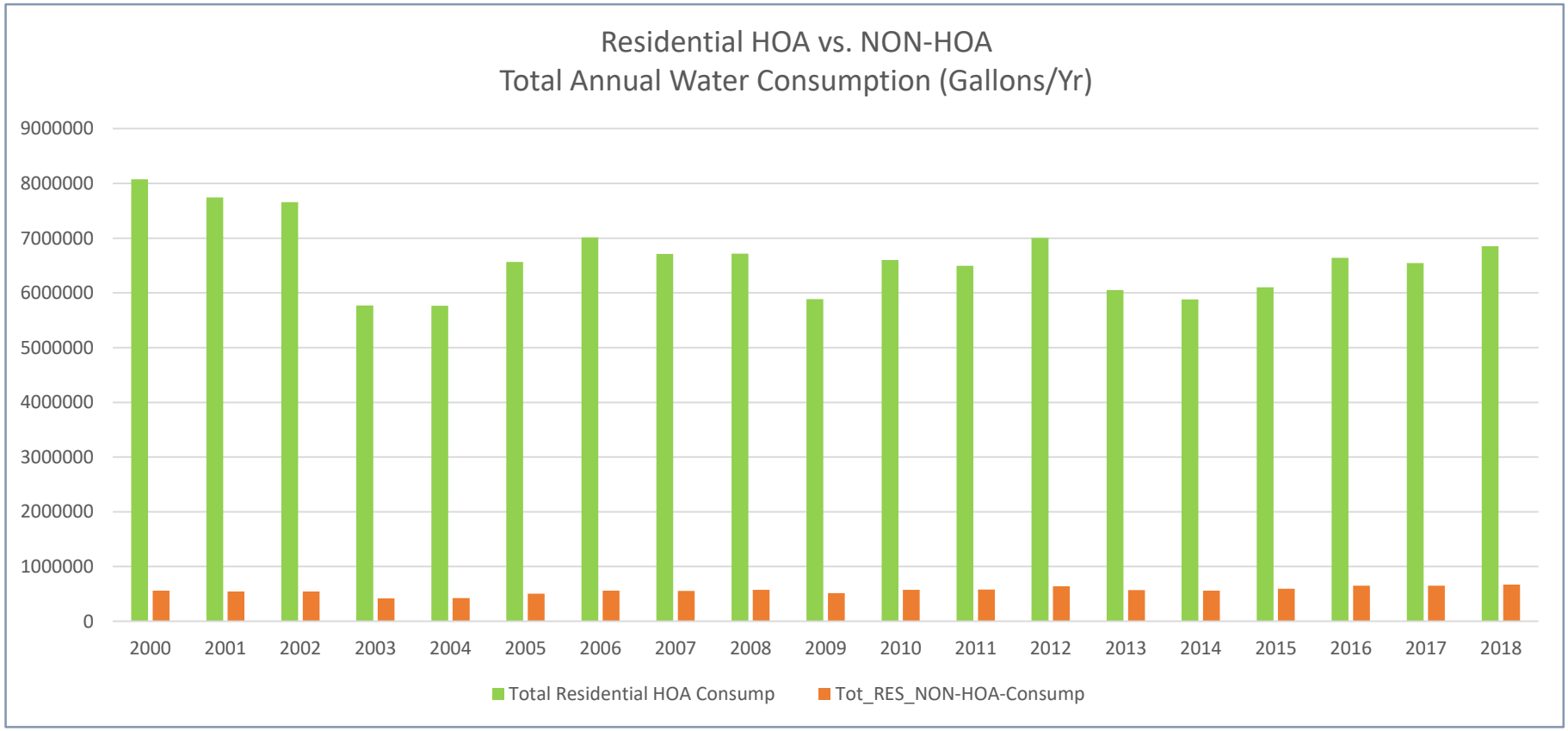


Remembering that 70% of Aurora Parcels are in HOAs……

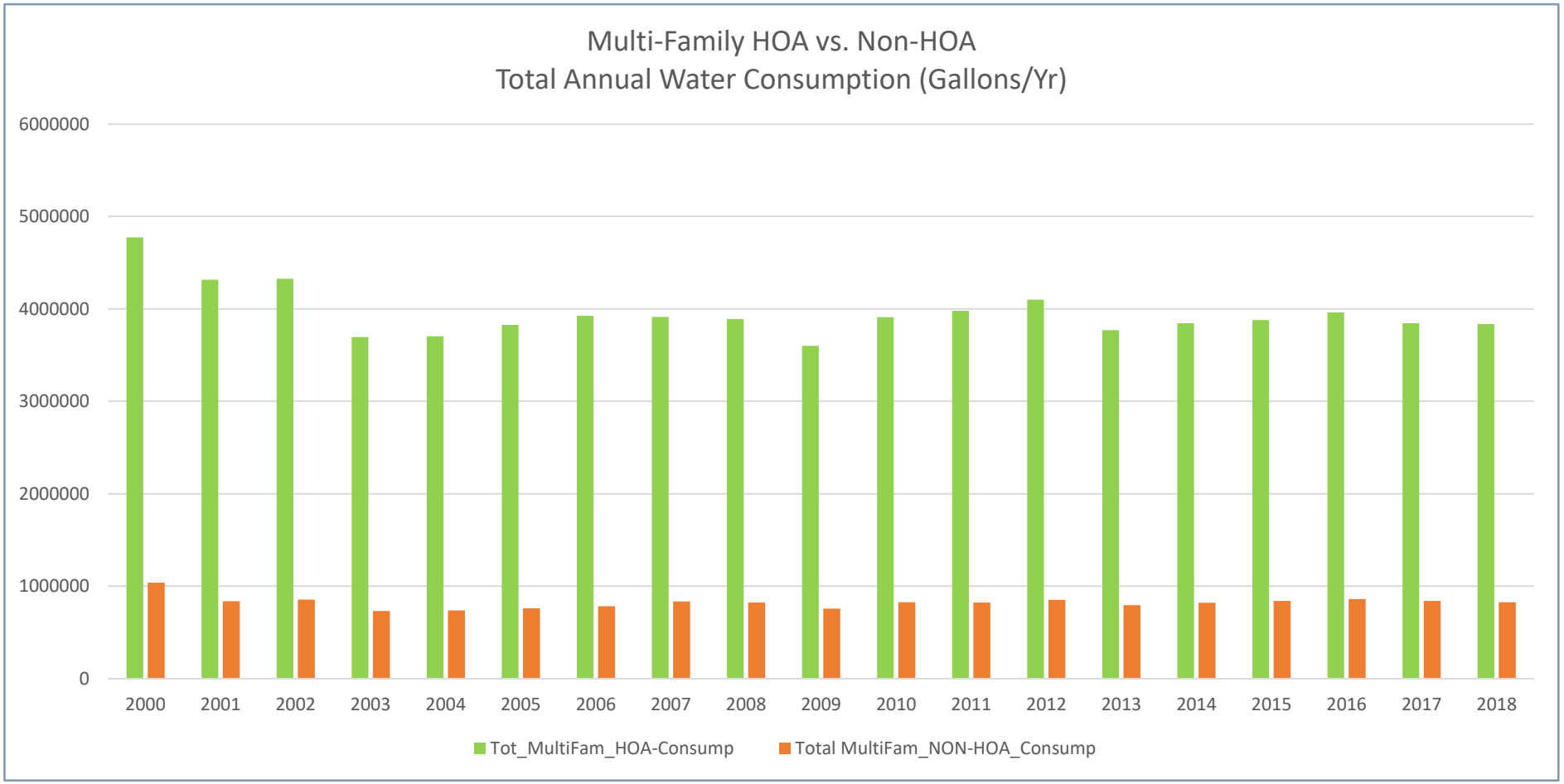


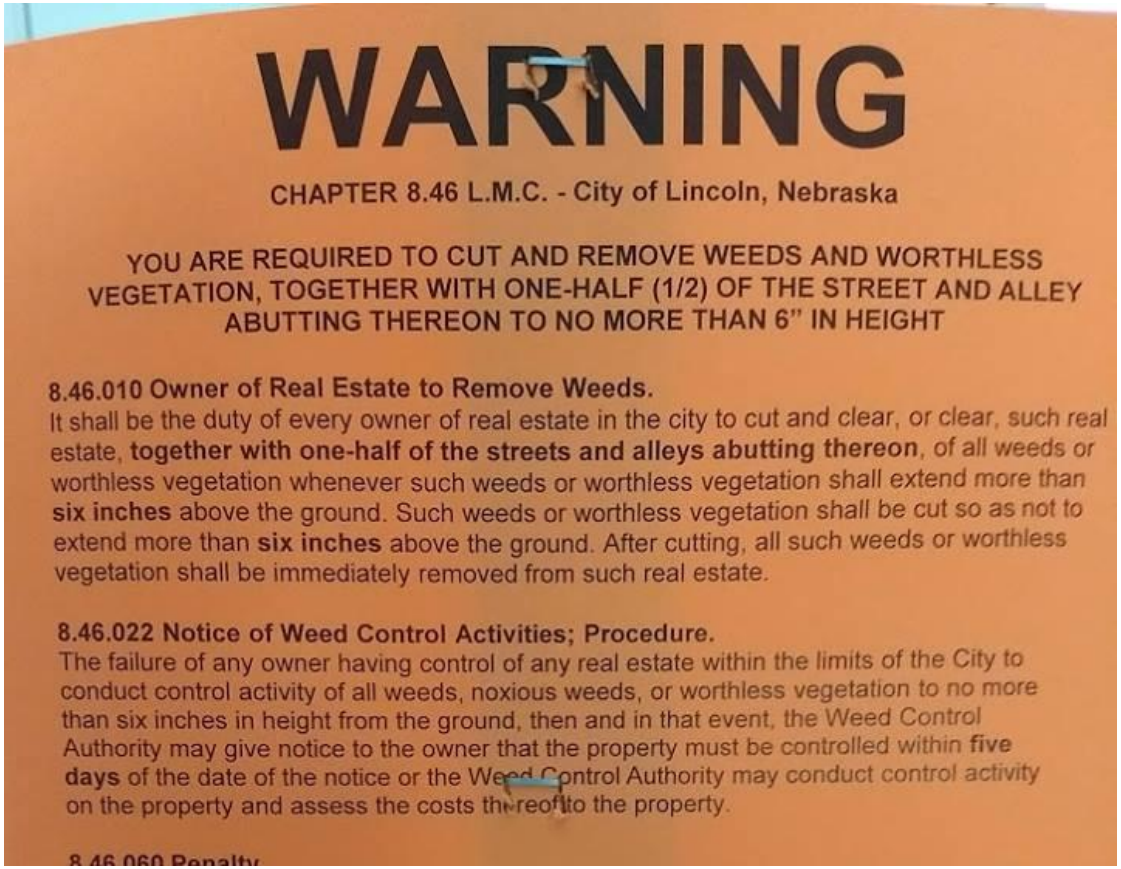


Looking at Residential HOAs vs. Non-HOAs



Multi-Family HOAs vs. Non-HOAs





But…..HOAs and CC&Rs ……could go either way

- HOAs could also be a mechanism for urban water reduction strategies (Schwarz and Megdal, 2008;Gachango et al., 2015)
- HOA landscape rules commonly take the form of turf covered yards.
- However, landscape rules could support low water use landscaping guidelines.
- Landscape Ordinances in communities can work to change status-quo HOA landscaped design.

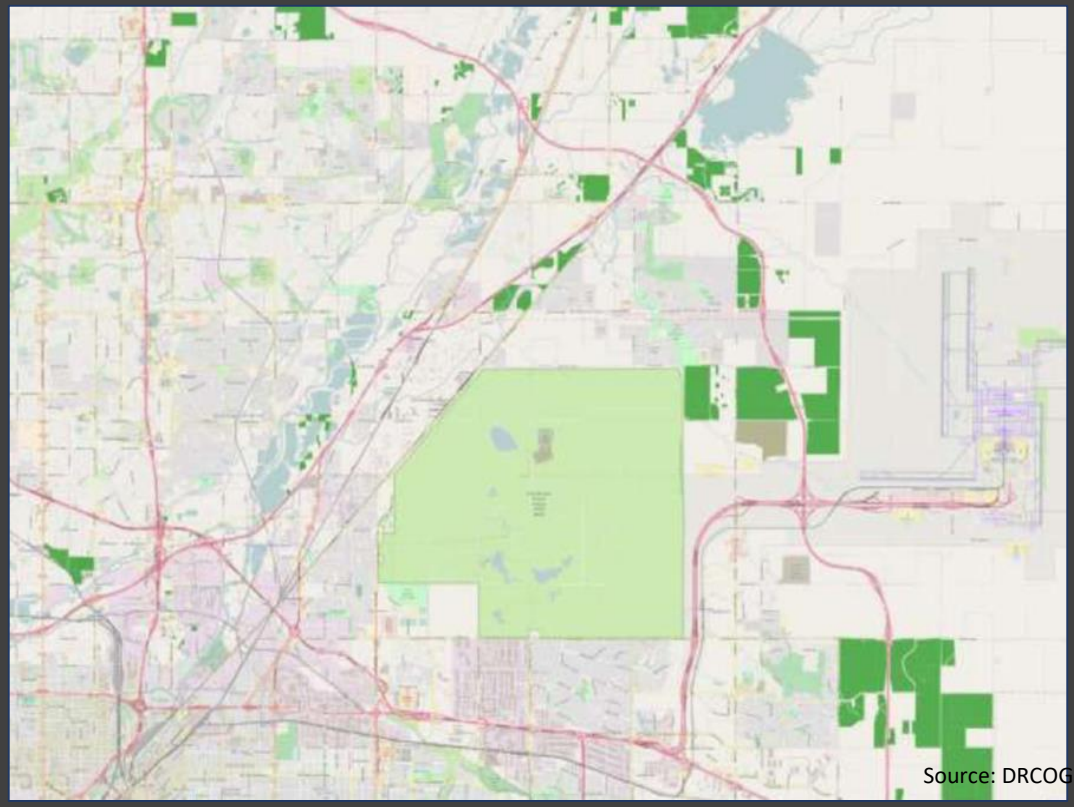
Initial results opposite of those from Phoenix, AZ

- Areas with HOAs tend to be newer, have a greater portion of desert-like 'xeric' landscaping compared to areas without HOA rules (Larsen and Harlan 2006; Martin et al. 2003).
- Properties in HOAs have greater bird and plant diversity (Lerman et al 2012)
- HOA properties used less water, averaged about 35 m^2 less vegetation coverage for the entire yard area, maybe due to very low landscape requirements (Wentz et al 2016)

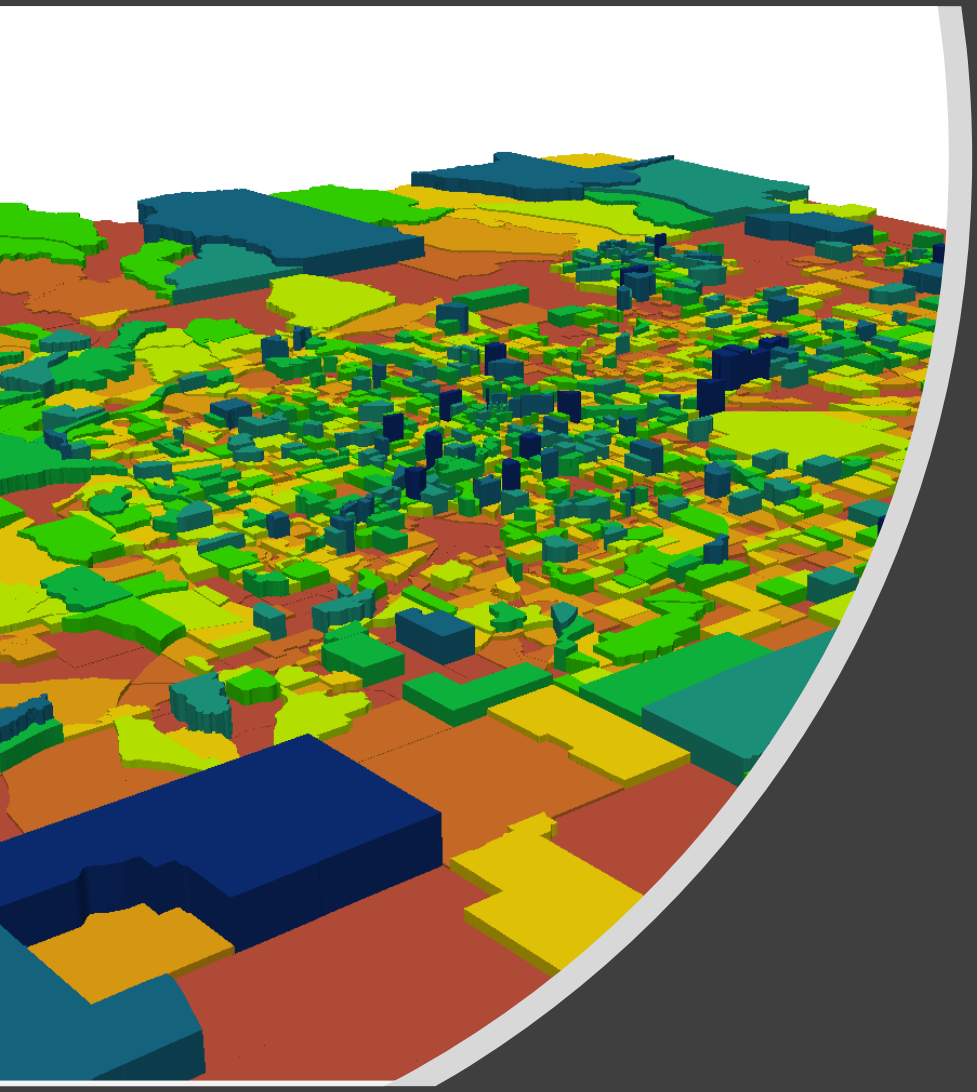
DRCOG UrbanSim Model

- Simulation system for planning & analysis of urban development,
- Incorporates interactions between land use, transportation, the economy, & the environment.
- Includes constraints such as open space and current zoning.
- Current comp plans/zoning codes
- Future scheduled development

By 2040, 13.5% of housing in Adams County will be in what are currently Greenfields.



Source: DRCOG



Coefficients from model will inform housing typology for UrbanSim-based predictive water consumption model

Thank you

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Results: Water consumption

Variable	Coefficient	T stat
Constant	-.096	-.075
MeanShadeHours*	-1.576[a]	-4.044*
TreeArea *	.022	9.389*
Grass-unirrigated	.000	-.068
Grass—semi-irrigated	-.005	-2.838*
Grass—irrigated	.069	26.713*
BuiltArea*	.316	60.804*
STORIES*	28.359	45.072*
PShortTree*	7.275	4.291*
After1950*	3.769	7.569*
HOA*	10.493	10.435*

Dependent Variable: TOTAL_QTY
R-squared= 0.267
*= significant at the 99% confidence level.
a. MeanShadeHours=-1.136 when only tree shade modeled

Interpretation of results

- Each additional 100 m ^{2} of **irrigated grass** (Grass3) is associated with 6000 additional gal of irrigation per year
- **Trees** use irrigation, but less than grass.
- Each additional 100 m ^{2}of **tree canopy** is associated with 2,200 more gallons or irrigation.
- For each 10% increase in the proportion of **trees that are short**, there is a 726 gal increase in water use. i.e. old, mature trees use less proportionally. Consistent with Bijoor et al (2012)

Interpretation of results

- **Shade** cast by trees and buildings on lawns serves to at least partially offset the water use of trees: for each additional hour of average shade across all grass pixels, 1,576 fewer gallons of water are used (1,136 with only tree shade). Consistent with Litvak et al (2013)
- **Shade** also increases **NDVI**
- If it were possible for a yard with 100 m^2 of tall trees to achieve a mean shading hours of **1.4** for lawn pixels , **water savings from the shade would outweigh water use of trees**