Image Analysis – Measuring Landscape vegetation in 1.4 million Parcels for outdoor water budgets

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Overview

- Project Background
- Image Analysis Process and Data Products
- Technical Challenges
- Project Status
- Use ArcGIS Online
  Share Maps, Distribute Data

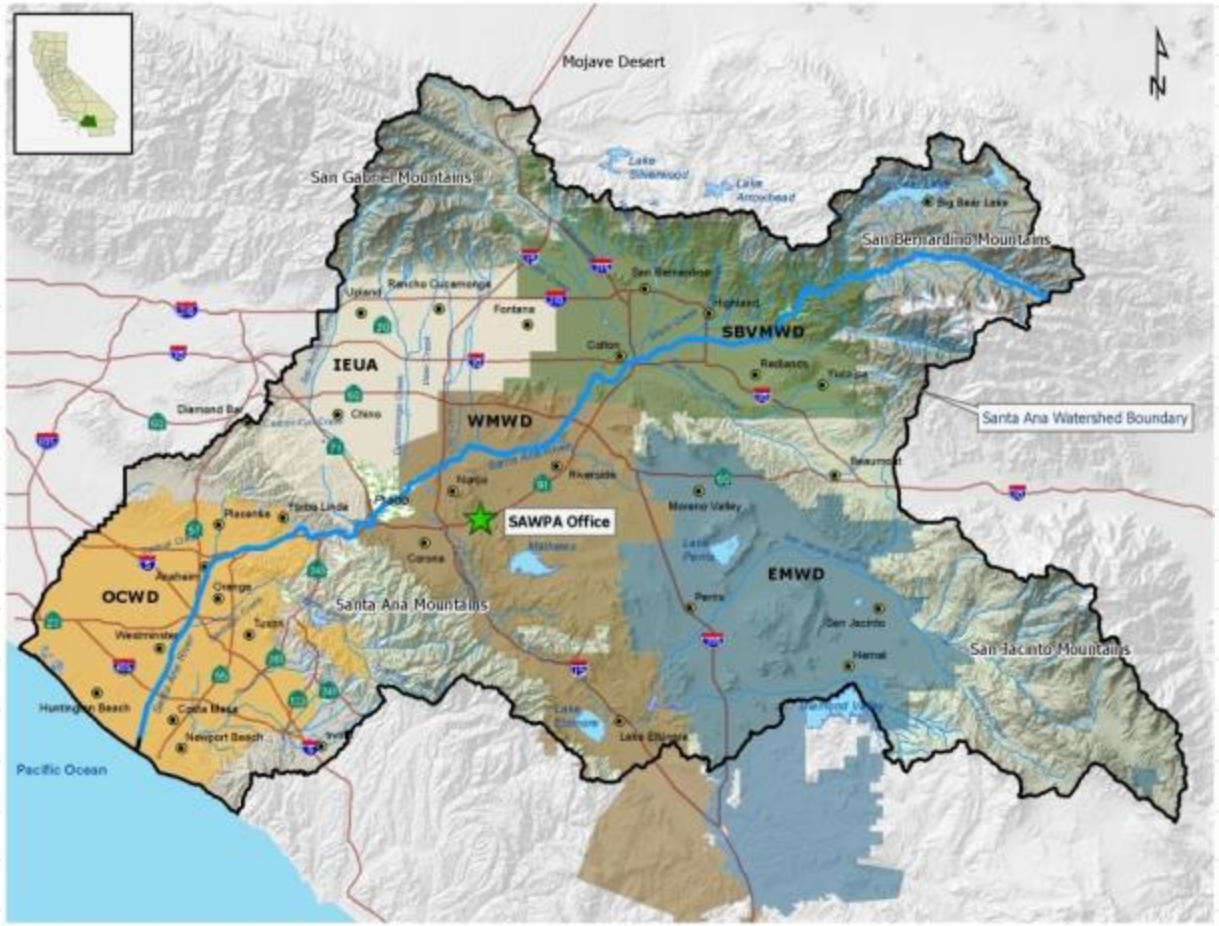
SAWPA Background

Regional Water Agency in Southern CA

5 Members

25 Employees

Santa Ana River Watershed



SAWPA Functions

Protect/Enhance Water Quality and Supply:

- Planning
  - Grants for Water Projects
    - Get Funding
    - Project Management
  - Collaboration to Solve Regional Issues

- Engineering
  - Brine Line/Industrial Sewer

Project Background

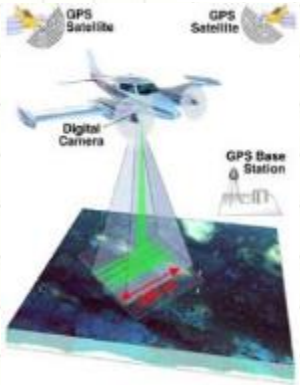
- Funded by grant from Prop 84 Emergency Drought Response

1) Rebate for Turf Removal

2) Web-Based Water Consumption Reporting

Topic

3) Image Analysis to Calculate Irrigated Areas (Outdoor Water Budgets)



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Outdoor Water Budget

- Component of water use on property

Used for **Water Budget Based Rates**

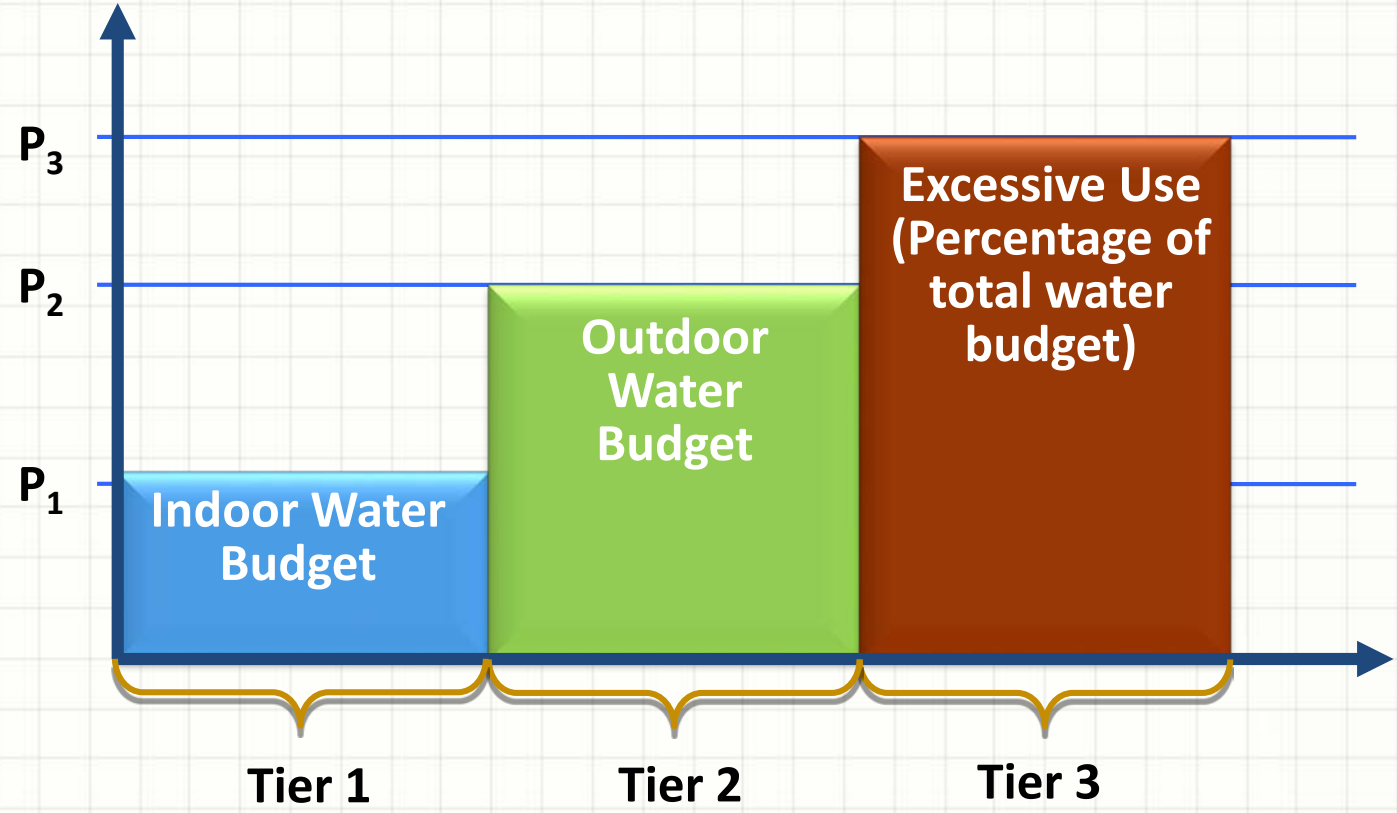


Image Analysis

- Software Analysis
  - 3” Resolution
  - 4 Band Aerial Imagery
  - Flown May - June 2015

- Image Analysis
- Vegetation Classification
- Calculate Irrigated Area

- Provide Results to Retailers
- Incorporate with billing

Project Team

Aerial Imagery

- **Geophex**
- Flight and geotiffs

Image Mosaic

- **Resource Strategies, Inc.**
- RFP and Image Mosaicking (ECWS, SIDs)

Image Analysis

- **Statistical Research, Inc.**
- Vegetation Classification, Irrigated Areas

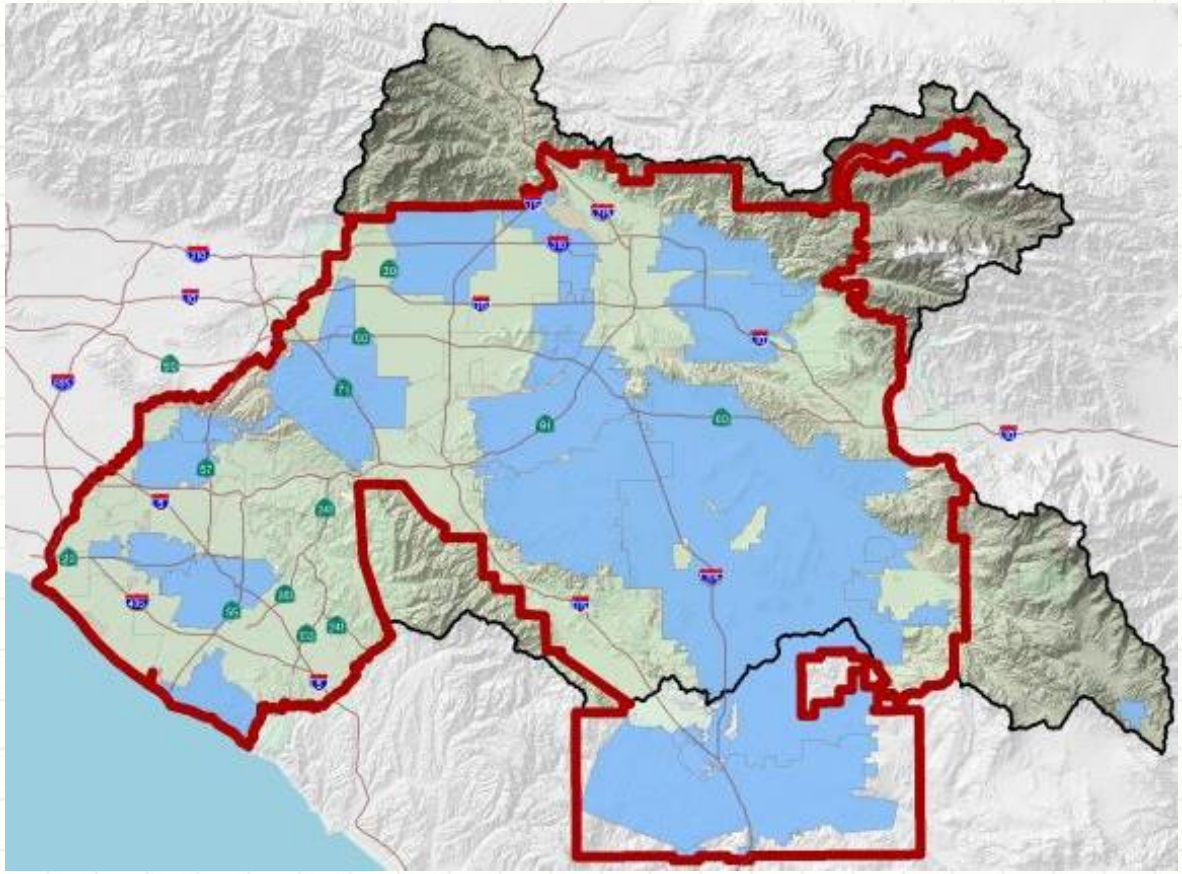
QC

- **SAWPA**
- Agency Coordination, QC, Data Delivery

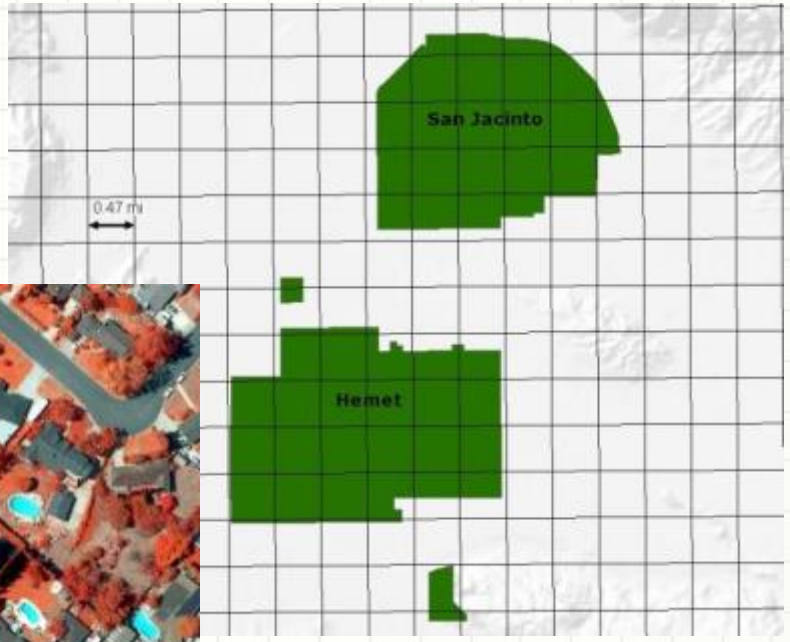
Area of Interest

Urban Areas within Santa Ana Watershed

- 2,500 mi2
- Data Size:
- 5 TB Geo Tiffs
- 3 TB Veg Analysis
- 22 Retailers
  (Imagery, Veg Analysis)
- 8 Other Agencies
  (Imagery Only)



Aerial Imagery Products



- 3” Resolution
  4 Band
  Tiled Geotiffs

- 3” ECW File

- Increasing Accuracy over time (NAIP)

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Aerial Image Accuracy Analysis -

Orange County

- Measure image to Parcel Layer Edge
- Record Vector Shifts
- Measured at curves, cul-de-sacs

- NAIP 2005
  - Sum: 604.45
  - Count: 59
  - **Mean: 10.24**
  - **Maximum: 41.22**
  - **Minimum: 1.41**
  - Range: 39.80
- NAIP 2009
  - Sum: 170.62
  - Count: 58
  - **Mean: 2.94**
  - **Maximum: 10.32**
  - **Minimum: 0.47**
  - Range: 9.84
- 3” 2015
  - Sum: 32.20
  - Count: 60
  - **Mean: 0.53**
  - **Maximum: 1.52**
  - **Minimum: 0.09**
  - Range: 1.43

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Image Analysis – Veg Classification

ERDAS Software

- Image Analysis

Plant Types:

- USDA Natural Resources Conservation Service

ESRI Software

- Calculate Irrigated Area

PLANTS Description	PLANTS Definition	Notes
	TURF	
Forb/herb	Vascular plant without significant woody tissue above or at the ground. Forbs and herbs may be annual, biennial, or perennial but always lack significant thickening by secondary woody growth and have perennating buds borne at or below the ground surface. In PLANTS, graminoids are excluded but ferns, horsetails, lycopods, and whisk-ferns are included.	Applies to vascular plants only. Federal Geographic Data Committee (FGDC) definition includes graminoids, forbs, and ferns.
Graminoid	Grass or grass-like plant, including grasses (Poaceae), sedges (Cyperaceae), rushes (Juncaceae), arrow-grasses (Juncaginaceae), and quillworts (Isoetes).	Applies to vascular plants only. An herb in the FGDC classification.
	TREES/SHRUBS	
Shrub	Perennial, multi-stemmed woody plant that is usually less than 4 to 5 meters (13 to 16 feet) in height. Shrubs typically have several stems arising from or near the ground, but may be taller than 5 meters or single-stemmed under certain environmental conditions.	Applies to vascular plants only.
Subshrub	Low-growing shrub usually under 0.5 m (1.5 feet) tall, never exceeding 1 meter (3 feet) tall at maturity.	Applies to vascular plants only. A dwarf-shrub in the FGDC classification.
Tree	Perennial, woody plant with a single stem (trunk), normally greater than 4 to 5 meters (13 to 16 feet) in height; under certain environmental conditions, some tree species may develop a multi-stemmed or short growth form (less than 4 meters or 13 feet in height).	Applies to vascular plants only.
Vine	Twining/climbing plant with relatively long stems, can be woody or herbaceous.	Applies to vascular plants only. FGDC classification considers woody vines to be shrubs and herbaceous vines to be herbs.
	OTHER VEGETATION	
Lichenous	Organism generally recognized as a single "plant" that consists of a fungus and an alga or cyanobacterium living in symbiotic association. Often attached to solid objects such as rocks or living or dead wood rather than soil.	Applies to lichens only, which are not true plants.
Nonvascular	Nonvascular, terrestrial green plant, including mosses, hornworts, and liverworts. Always herbaceous, often attached to solid objects such as rocks or living or dead wood rather than soil.	Applies to non-vascular plants only; in PLANTS system this is groups HN (Hornworts), LV (Liverworts), and MS (Mosses).

Image Analysis – Veg Classification

Unsupervised/NDVI/Supervised

50-80+ classes per flight

For each class identify percent:

Turf
Trees/Shrubs
Pools

→ Irrigated Area

Other Veg – mostly aquatic

Dead Veg → Potential Irrigated Area

Non-Veg

Shadow - Uncertainty

Mapping/display category

RASTER

Table

f_3c_sig_classed.img

OID	Value	Count	Red	Green	Blue	Opacity	Class_Name	VegPC	TURPC	TSHPC	POLPC	OTHPC	DEDPC	NONPC	SHAPC
0	0	28898185514	0	0	0	0	Unclassified	0	0	0	0	0	0	0	0
1	1	1510075758	0.457408	0.501234	0.500622	1	Class 01 water 20 / shadow nonveg 40 / shadow veg 40	40	20	20	0	20	0	40	80
2	2	578004220	0.577258	0.533583	0.550817	1	Class 02 shadow veg 20 / shadow nonveg 40 / nonveg 40	20	10	10	0	0	0	80	60
3	3	381365486	0.717602	0.467967	0.509235	1	Class 03 nrg tree shrub 100	100	0	100	0	0	0	0	0

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Image Analysis – Veg Classification

Calculating Irrigated Areas

Modify Parcels → Meter Service Area

Sum Veg classes by MSA → Irrigated Area

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Meter Service Area Attributes

Parcel APN
Owner
Address

→ Meter → Water Bill

Meter Service Area Square Feet
Parcel Square Feet
Building Square Feet – Assessor
Pool Square Feet
Slope Correction Factor
Vegetation Square Feet – All Veg (Tree/Shrub, Turf, other)
→ **Irrigated Square Feet – (Tree/Shrub, Turf + Pools)**

SHAPE FILE

Table

TustinCity_MSAVEGCLASS

FID	Shape *	MSA_APNX	TURPC_SF	TSHPC_SF	OTHPC_SF	DEDPC_SF	MSA_SF	PAR_SF	BLD_SF	POOL_SF	VEG_SF	IRRIG_SF
0	Polygon ZM		2606.84375	7463.80625	3138.6625	24867.16875	145392.500731	288.661402	0	0	13209.3125	10070.65
1	Polygon ZM	094-082-13	3532.59375	7537.790625	89.115625	729.865625	20090.203118	15999.655162	1703	0	11159.5	11070.384375
2	Polygon ZM	094-082-14	3108.525	6218.434375	113.640625	730.659375	25915.939483	15912.504487	1396	547	9440.6	9873.959375
3	Polygon ZM	094-082-15	1487.60625	3451.6375	20.815625	542.328125	19586.198676	15991.156399	3112	547	4960.059375	5486.24375

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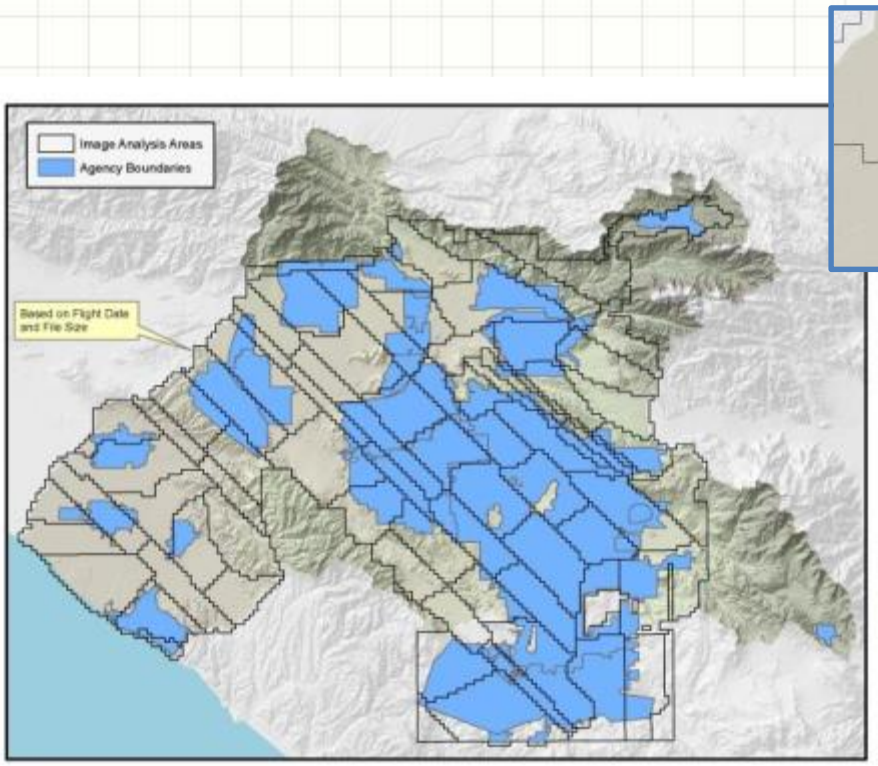
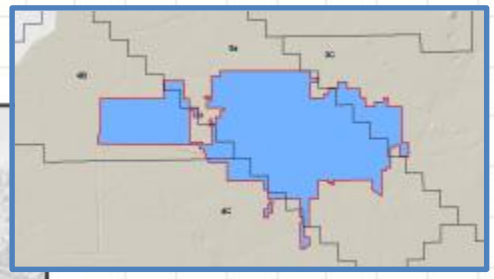
Technical Challenges – Image Analysis

- Analyze by Flight Date
  - Sensitive to weather and light
  - File size target 10–25 GB

Analysis areas by flight date and file size





All Areas Complete before delivery

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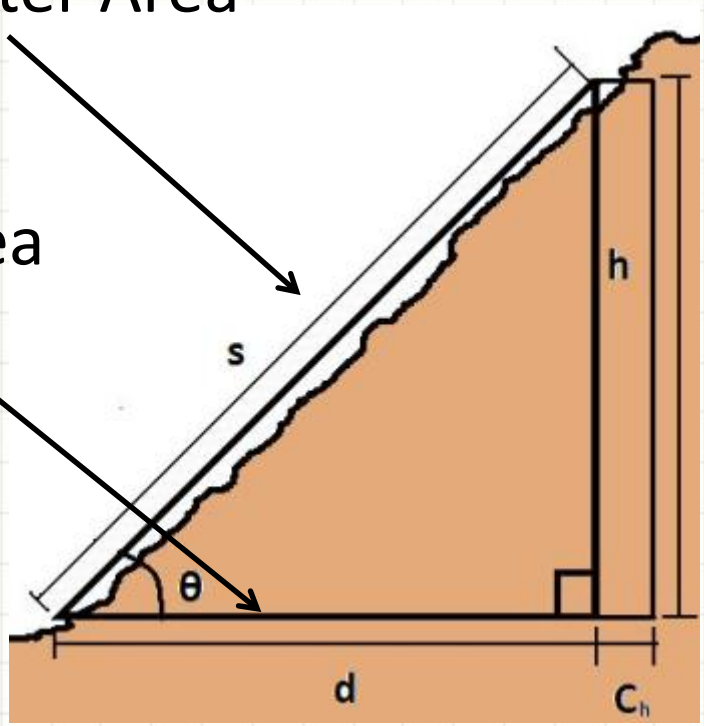
Technical Challenges -Slopes

Irrigated Areas underestimated in areas of slope if slope not accounted for

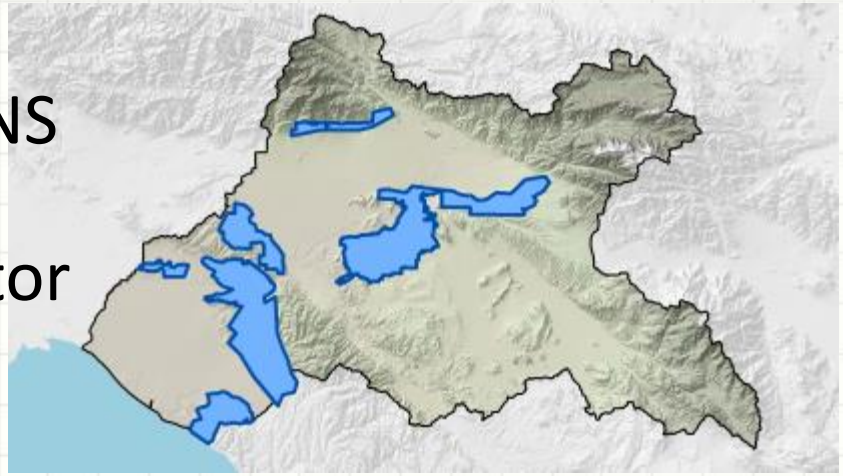
Actual Water Area

2D Water Area



Technical Challenges -Slopes

- Identify Areas of 2:1 slope with 30 meter DEM
- Elevation Mass Points and Hard Breaklines from aerial photography
- Build TINS from Points and Breaklines
- Calculate Slope from TINS
- Develop Correction Factor to make adjustments



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Deliver 1 foot contours and points

Technical Challenges – Parcel Lines

- Inaccurate Lines impact irrigated area calculation
- Accuracies improving
- Can be addressed in future work as needed on by Agency Basis

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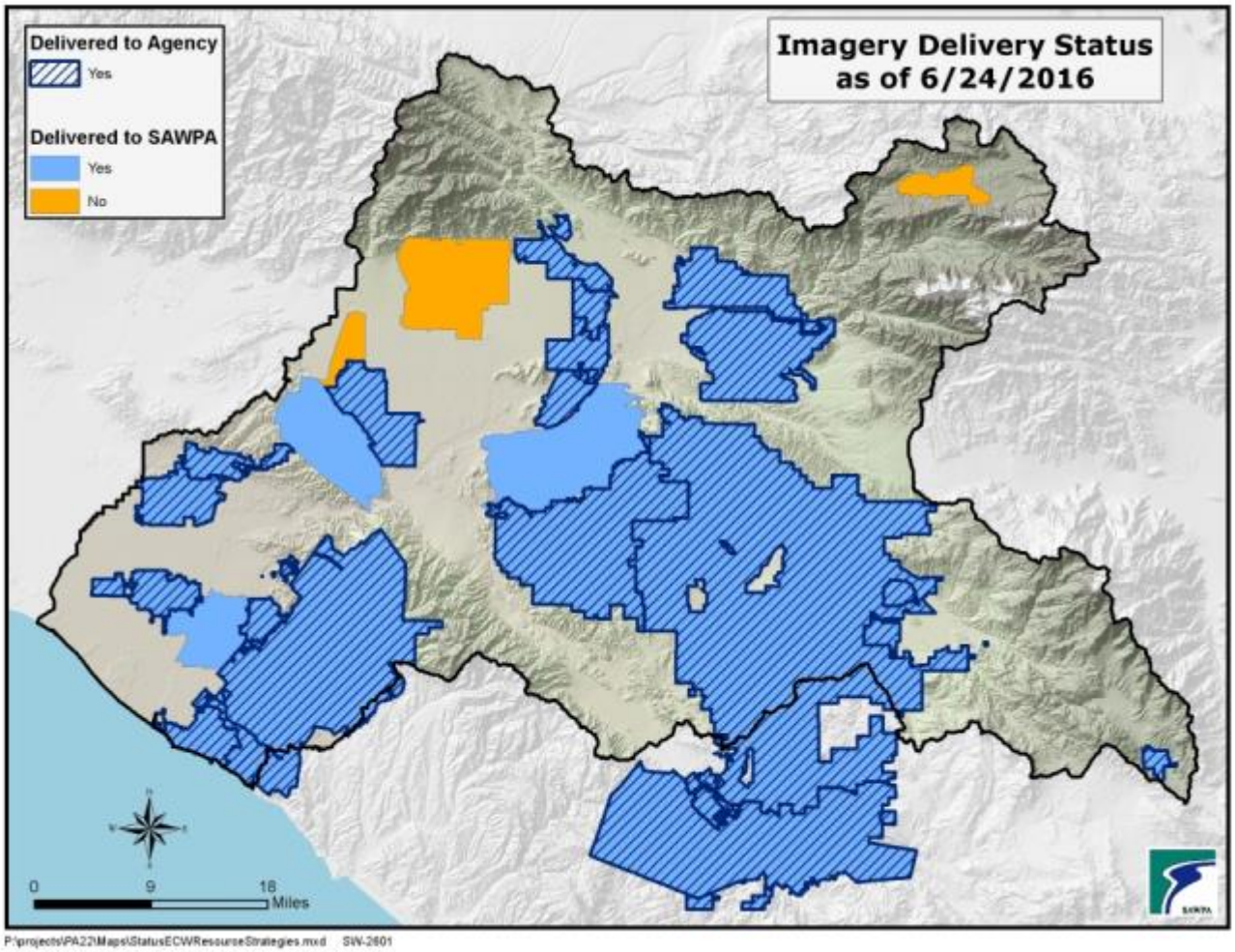
Delivery Status - Imagery

Delivered to 19 Agencies

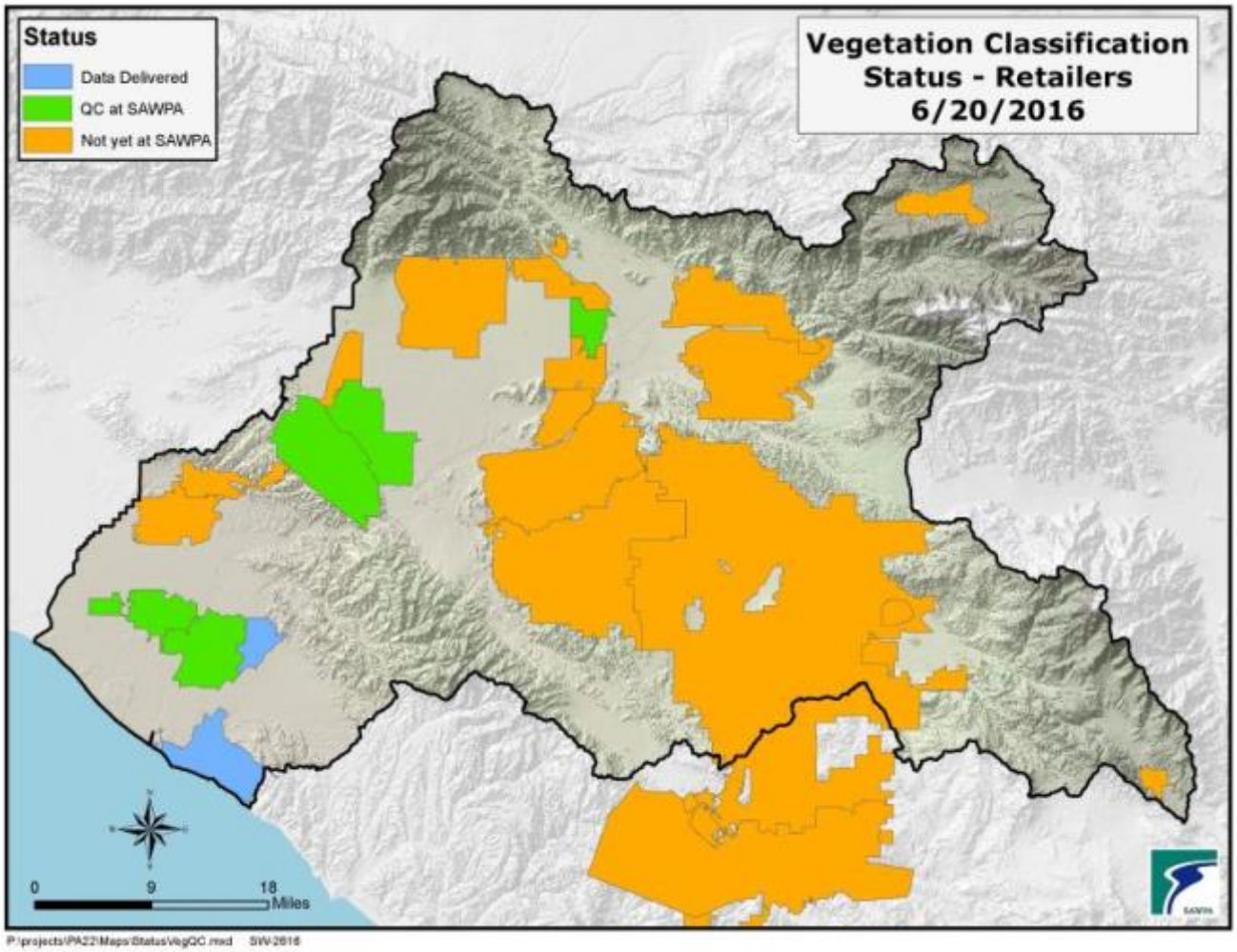
Complete August 2016



Delivery Status – Veg Classification

Delivered to 2 Agencies

Complete Dec 2016



ArcGIS Online - Maps

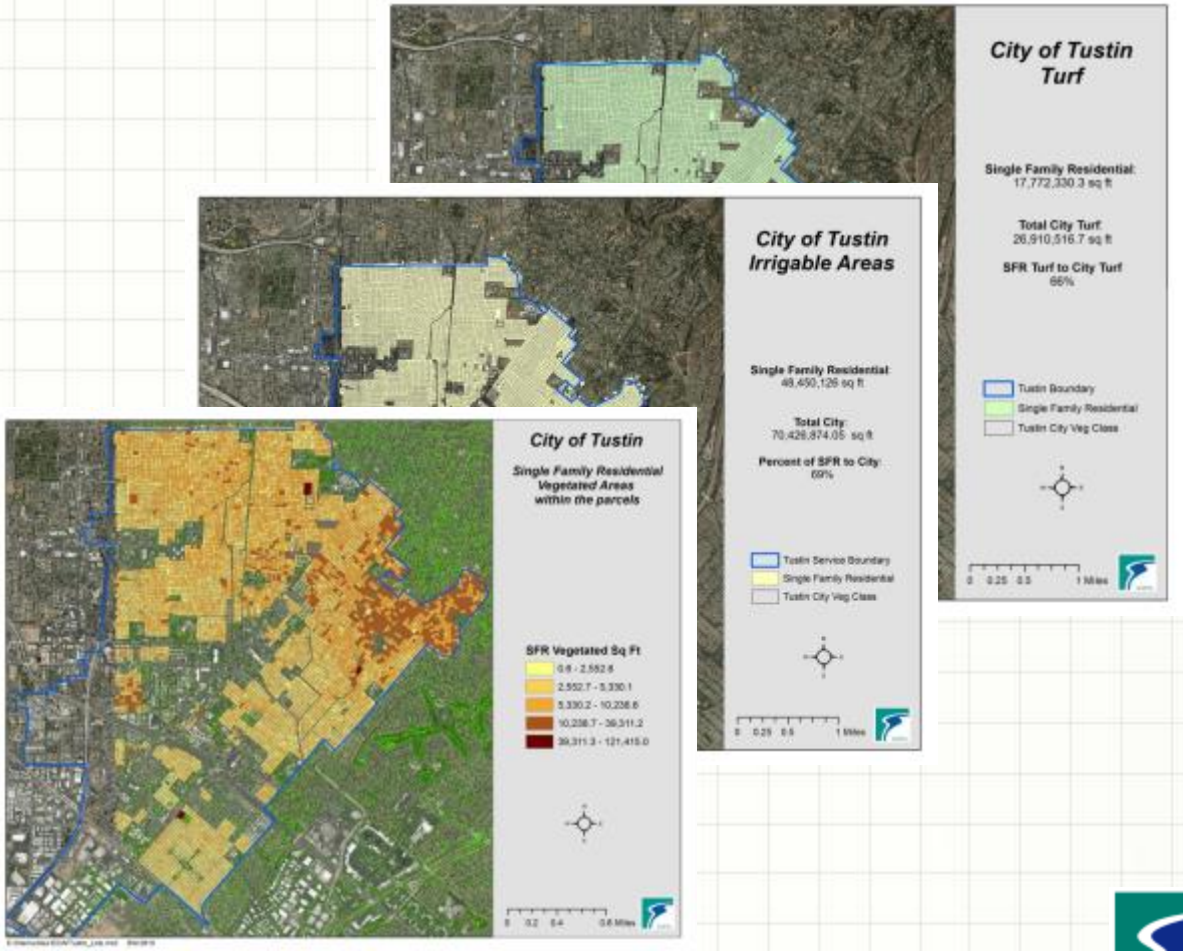
Share General Interest Watershed wide Maps

Irrigated Areas

Turf Areas

Land Uses
Most Turf

Large Land owners
schools HOA



ArcGIS Online - Services

- Share Imagery via Web Service

  Save USB Drives

  Weeks of copy time

- Share MSA Layers (Irrigated Areas)

Table

TustinCity_MSAVEGCLASS

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Next Steps

- Continue Data Delivery
- Receive Agency feedback
- Updates if funding available
  - New Development

Questions

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