Dashboard
Stormwater Net Increase (Delta) from developed Areas

Alcely Lau & Eleonora Demaria

March 15th, 2023

Pima County Regional Flood Control District

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Study Objectives

1. Estimate stormwater net increase (Delta) volume from urban watersheds.
2. Identify potential locations for recharge basins.
3. Attempt to cost out basins for groundwater recharge as well as for storage.

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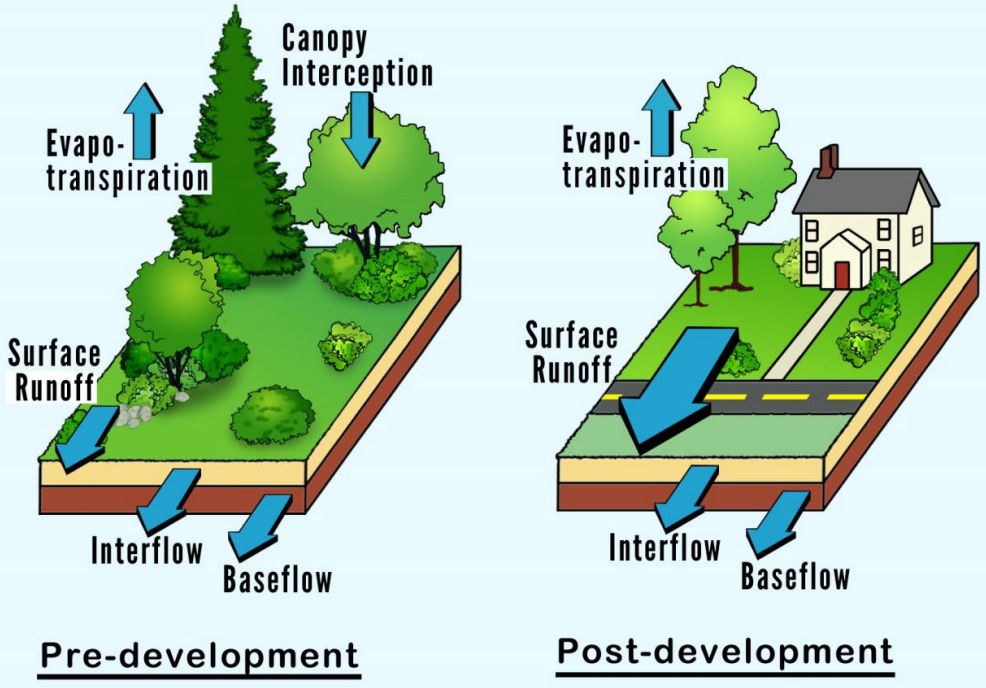
DELTA: Stormwater runoff net increases due to development

$$Delta\ volume = Runoff_{post} - Runoff_{pre}$$

Figure 1.1 Water Balance at a Developed and Underdeveloped Site
(Source: Schueler, 1987)



Surface runoff is minimal in an undeveloped site, but dominates the water balance at a highly impervious site.

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Delta volume equation

$$Delta = Runoff_{post} - Runoff_{pre} \quad (1)$$

Where, the **runoff pre-development** is,

$$Runoff_{pre} = (Rain) \times (\%RO_{Soil}) \times (Total\ Area) \quad (2)$$

The **runoff post-development** is expressed as,

$$Runoff_{post} = (Rain) \times \left[\left(\%RO_{imp}\right) \times \left(Area_{imp}\right) + (\%RO_{Soil}) \times \left(Area_{per}\right)\right] \quad (3)$$

Replacing equations (2) and (3) into (1), **delta** is expressed as:

$$Delta = (Rain) \times \left(Area_{imp}\right) \times \left(\%RO_{imp} - \%RO_{Soil}\right) \quad (4)$$

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Percentage of rainfall that produces runoff (%RO)

$$Delta = (Rain) \times (Area_{imp}) \times (\%RO_{imp} - \%\boldsymbol{RO_{Soil}})$$

Post- development %RO imp

- Percentage of rainfall that produces runoff post-development, %RO imp = 75% for all impervious surfaces.

Pre-development %RO soil

- For B soils, %RO soil = 3.9%
- For D soils, %RO soil = 15.8%
- For A or C soil groups or mixed, %RO soil = 10%

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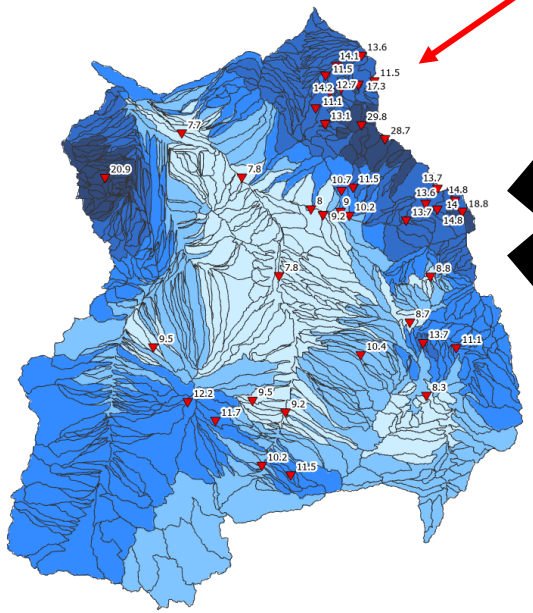
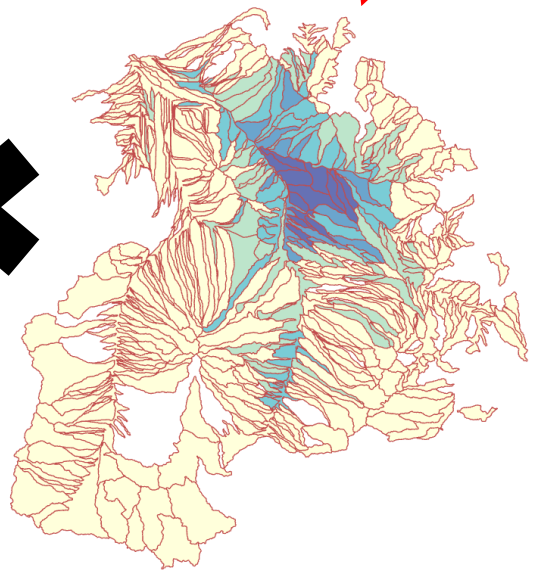
Estimating annual Delta volume

$$Delta = (Rain) \times (Area_{imp}) \times (\%RO_{imp} - \%RO_{Soil})$$

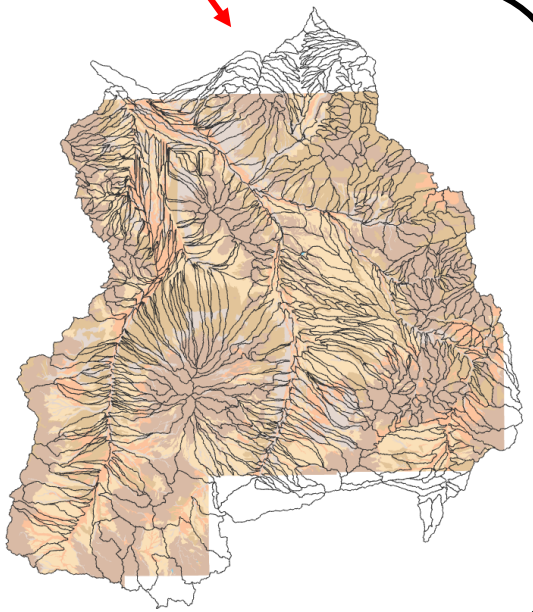


Annual Total Rain (inches)
- 8.3 - 9.9
- 10 - 10.7
- 10.8 - 12.4
- 12.5 - 16.5
- 16.6 - 26.1



Impervious & Buildings Area Percentage (%)
- 0.0% - 2.7%
- 2.8% - 8.6%
- 8.7% - 18.8%
- 18.9% - 35.1%
- 35.2% - 50.1%

75%



Soil group & %RO
- A , 10%
- B, 3.9%
- C, 10%
- D, 15.8%
- Mixed
- Water

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Annual Delta volume from urban watersheds

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Stormwater Net Increase (Delta) from Developed Areas

How to get started?
click this icon in the map
& select layers

1. Select the desired layers in the map.
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Legend

Major Washes

Delta: Stormwater Net increase estimation

Annual Delta Volume

Delta Volume (acre-ft)

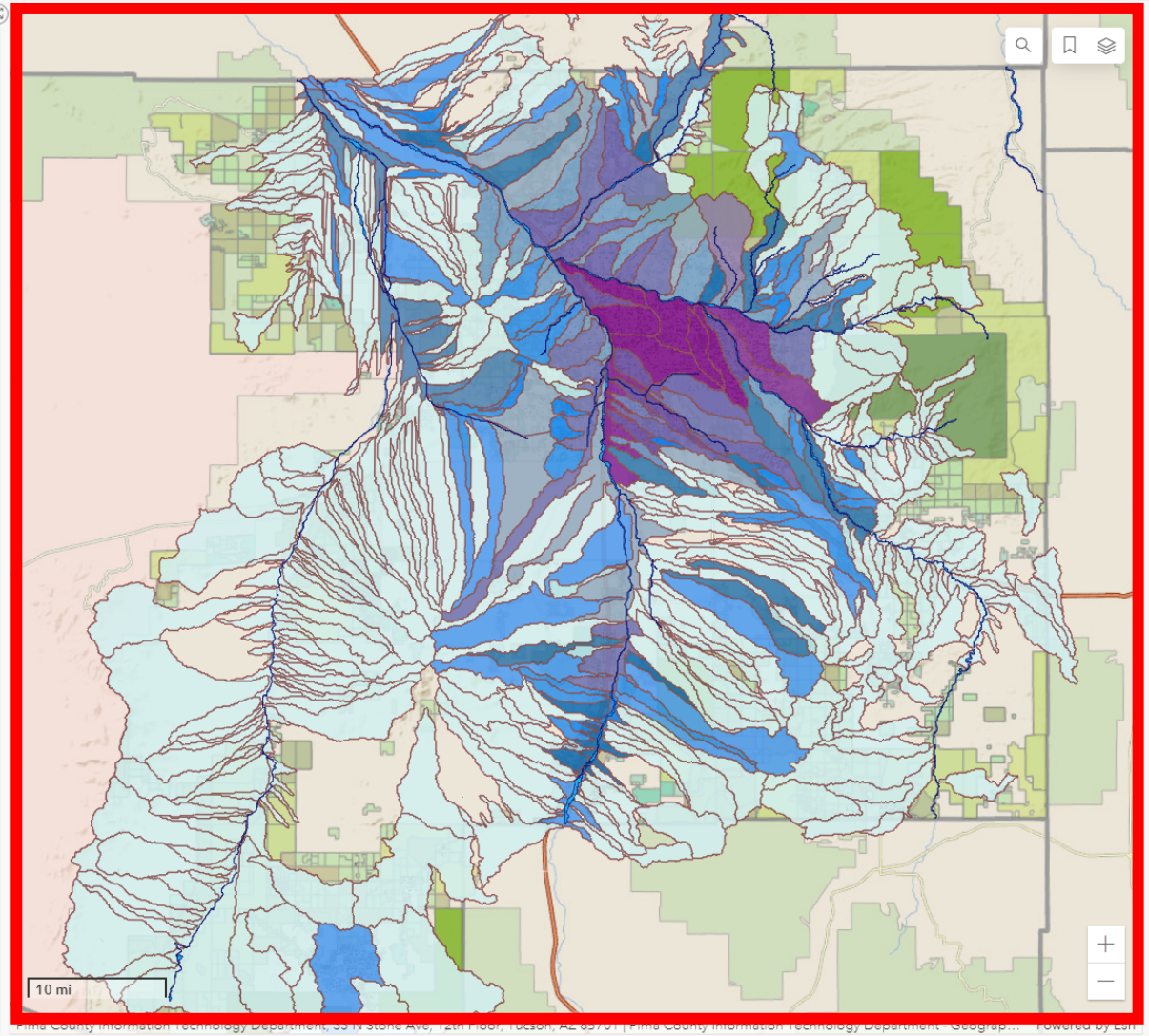
- 800.01 - 1701.05
- 400.01 - 800.00
- 200.01 - 400.00
- 100.01 - 200.00
- 35.01 - 100.00
- 0.00 - 35.00

Impervious Area Layers

Total Impervious Area

Impervious & Buildings Area Percentage (%)

- 35.2% - 50.1%
- 18.9% - 35.1%
- 8.7% - 18.8%
- 2.8% - 8.6%
- 0.0% - 2.7%



1 of 466

Annual Delta
1.7k acre-ft
WID478 Arroyo Chico / Tucson Arroyo

1 of 466

Monsoon Delta
919.77 acre-ft
WID478 Arroyo Chico / Tucson Arroyo

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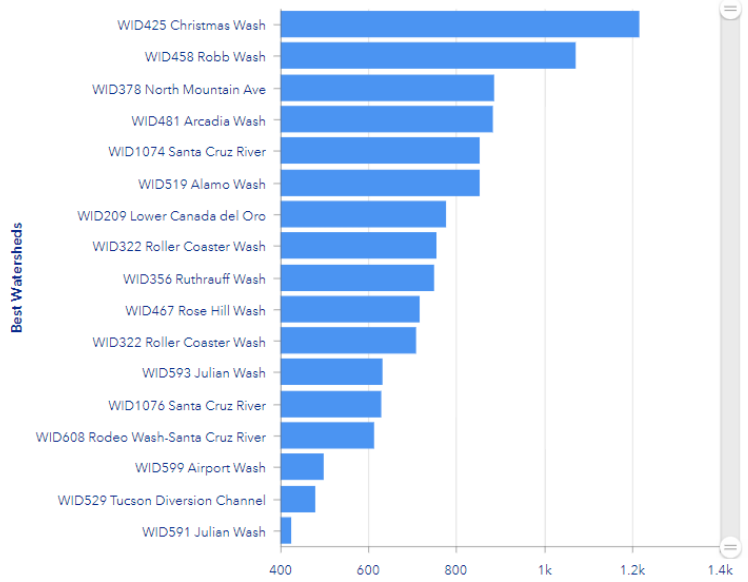
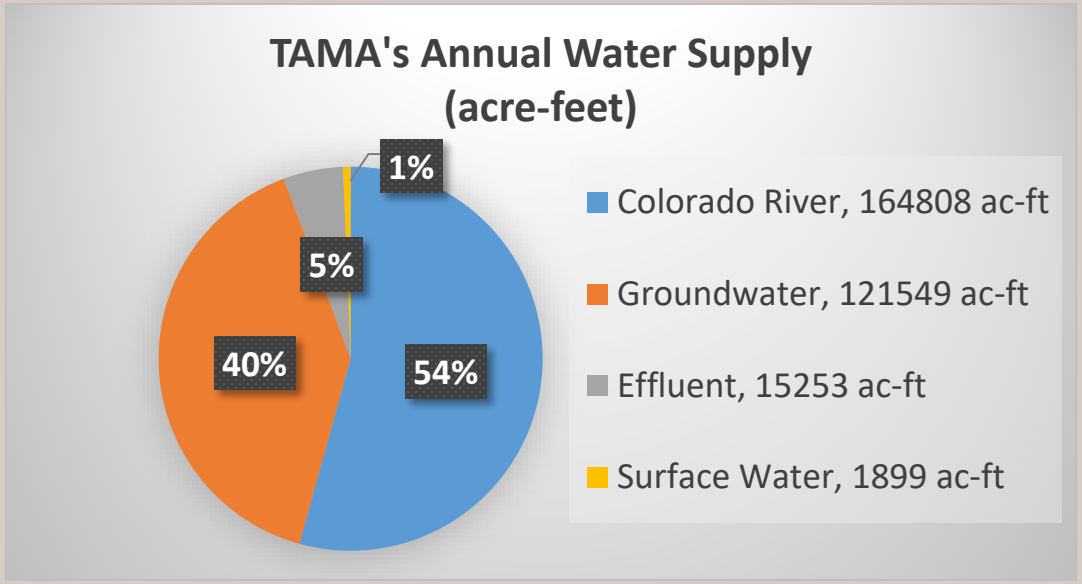
Non-Monsoon Delta
791.4 acre-ft
WID478 Arroyo Chico / Tucson Arroyo

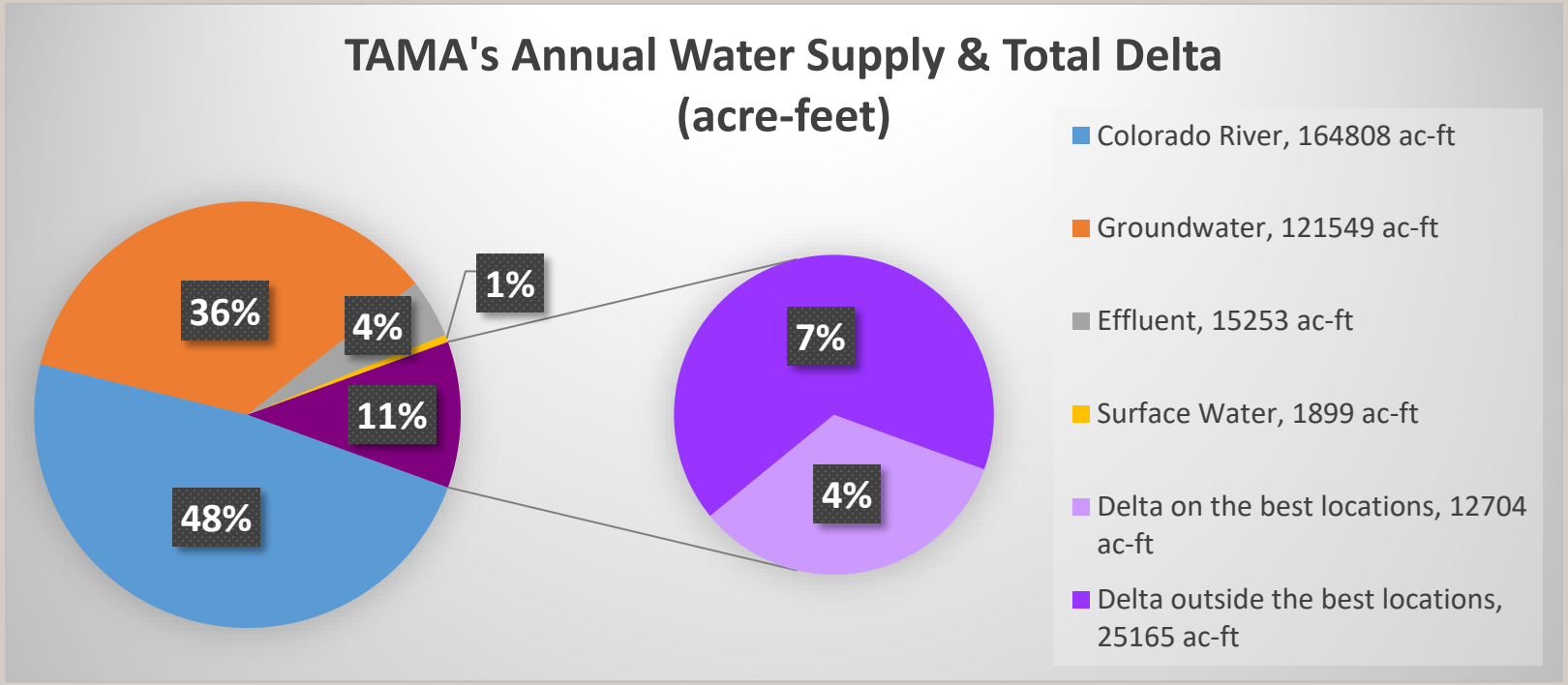


** Activate the Annual Delta Volume layer in the map view.*

Annual Delta Volume

Current water supply -vs- Capturing Delta volume





TAMA'S Annual water supply: https://new.azwater.gov/ama/ama-data

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Where open spaces to build retention basins are located?

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Stormwater Net Increase (Delta) from Developed Areas

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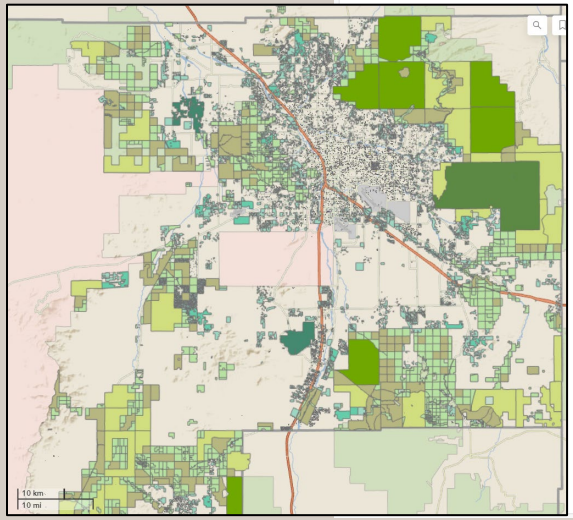
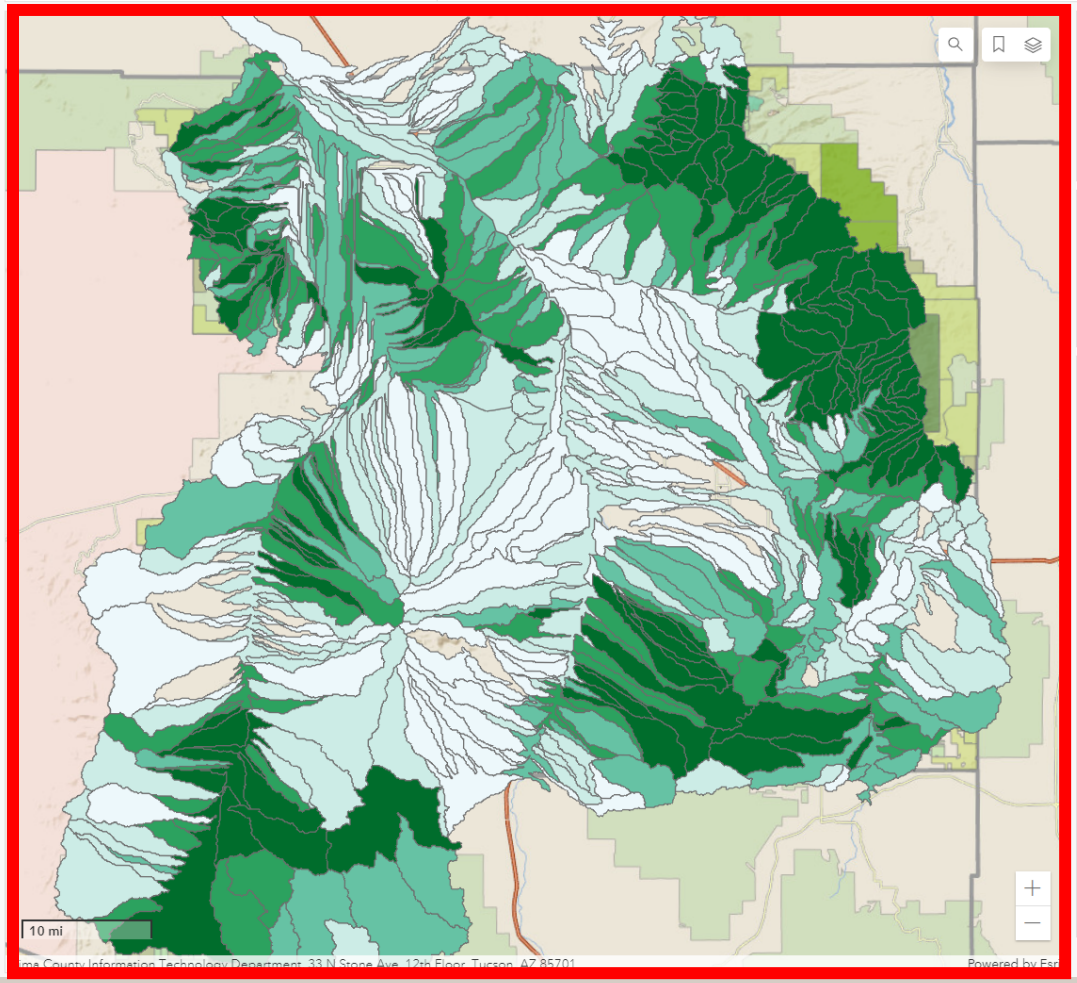
Legend

Preserve and vacant land percentage

Total Open Space Percentage (%)

- 80.01 - 100.00
- 50.01 - 80.00
- 30.01 - 50.00
- 10.01 - 30.00
- 0.00 - 10.00





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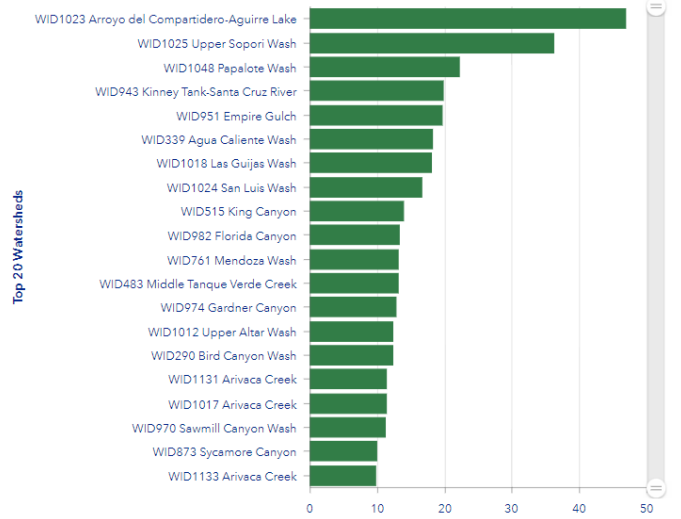

Active Preserve & Vacant Lands layer in the map view.

Total Preserve & Vacant Land Area

Best locations to capture & recharge/store Delta volume

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Stormwater Net Increase (Delta) from Developed Areas

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Legend

Major Washes

Best locations for stormwater capture and recharge

Tritium Sites

Tritium Measure

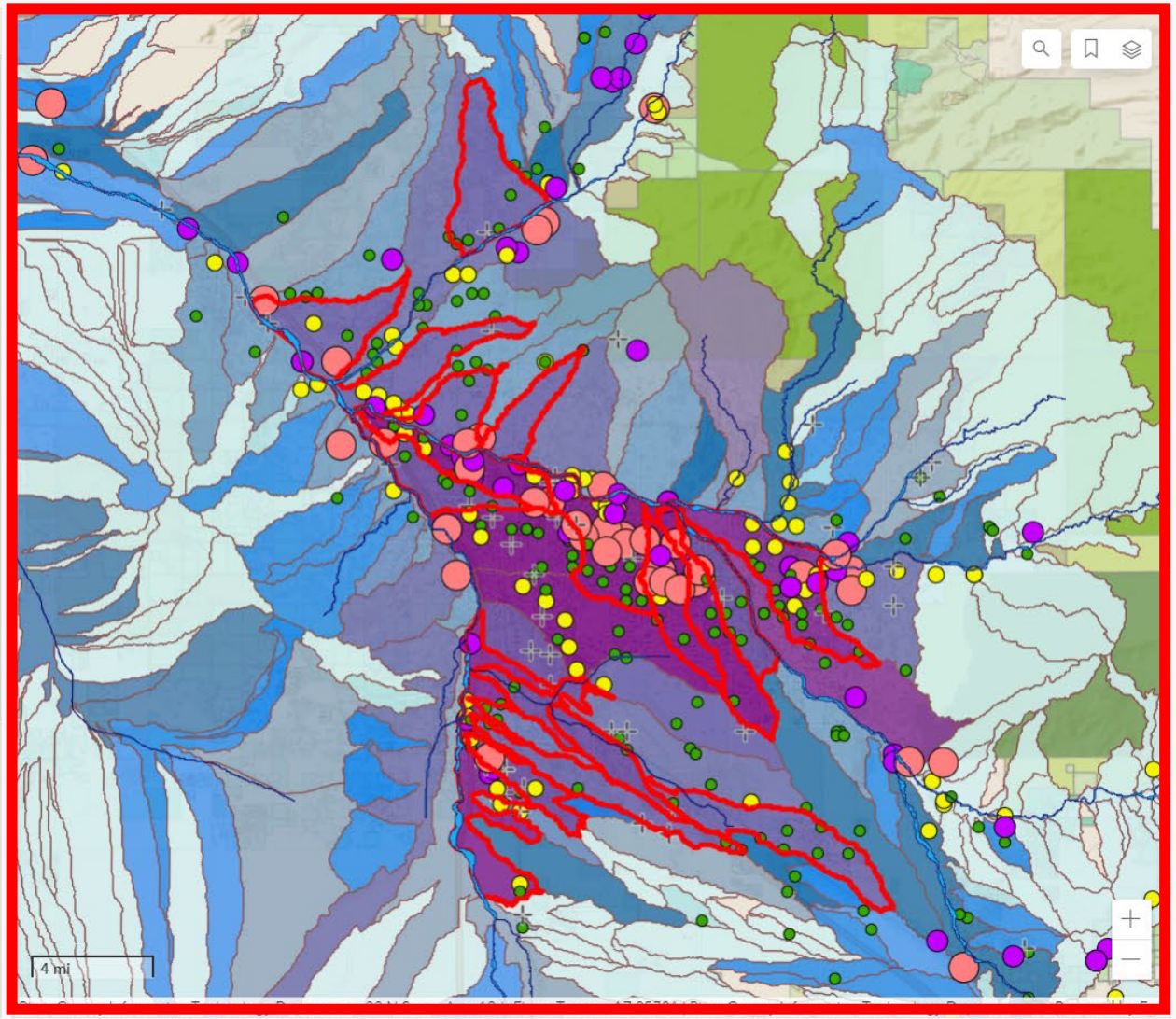
- >10
- 5.1-10
- 1.7 - 5
- <1.7
- No Detected/Measured

Delta: Stormwater Net increase estimation

Annual Delta Volume

Delta Volume (acre-ft)

- 800.01 - 1701.05
- 400.01 - 800.00
- 200.01 - 400.00
- 100.01 - 200.00
- 35.01 - 100.00
- 0.00 - 35.00



The selection criteria were:

- Delta volume greater than 400 acre-ft.
- Six feet depth retention volume greater than its delta volume.
- Percentage of impervious area greater than 20%
- Some level of Tritium was detected within the watershed.

** Activate the Annual Delta Volume layer in the map view.*

Annual Delta Volume

Which of the open spaces could store the Delta generated from a 1-inch rainfall event more than once in a year?

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Estimate Delta volume that a 1-inch rainfall event could produce in each watershed,

$$1inch\ Delta\ =\ (1\ inch) \times \left(Area_{imp}\right) \times \left(\%RO_{imp} - \%RO_{Soil}\right)$$

Estimate retention volume if the entire open land area is used for the basin,

$$retention\ volume = 6\ feet\ \times\ open\ land\ area$$

Criteria to select the best open lands to build retention basins,

1 $$1inch\ Delta > median = 28\ ac - ft$$

2 $$retention\ volume > 1inch\ Delta$$

3 $$Times\ \text{basin is full} = \frac{Annual\ Delta}{retention\ volume} > 1$$

Which of the open spaces could retain the delta from a 1-inch rainfall event more than once in a year?

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Legend

Major Washes

Preserve & Vacant Lands for retention basins
- Best
- Second Best

Best locations for stormwater capture and recharge

Delta: Stormwater Net increase estimation

Annual Delta Volume

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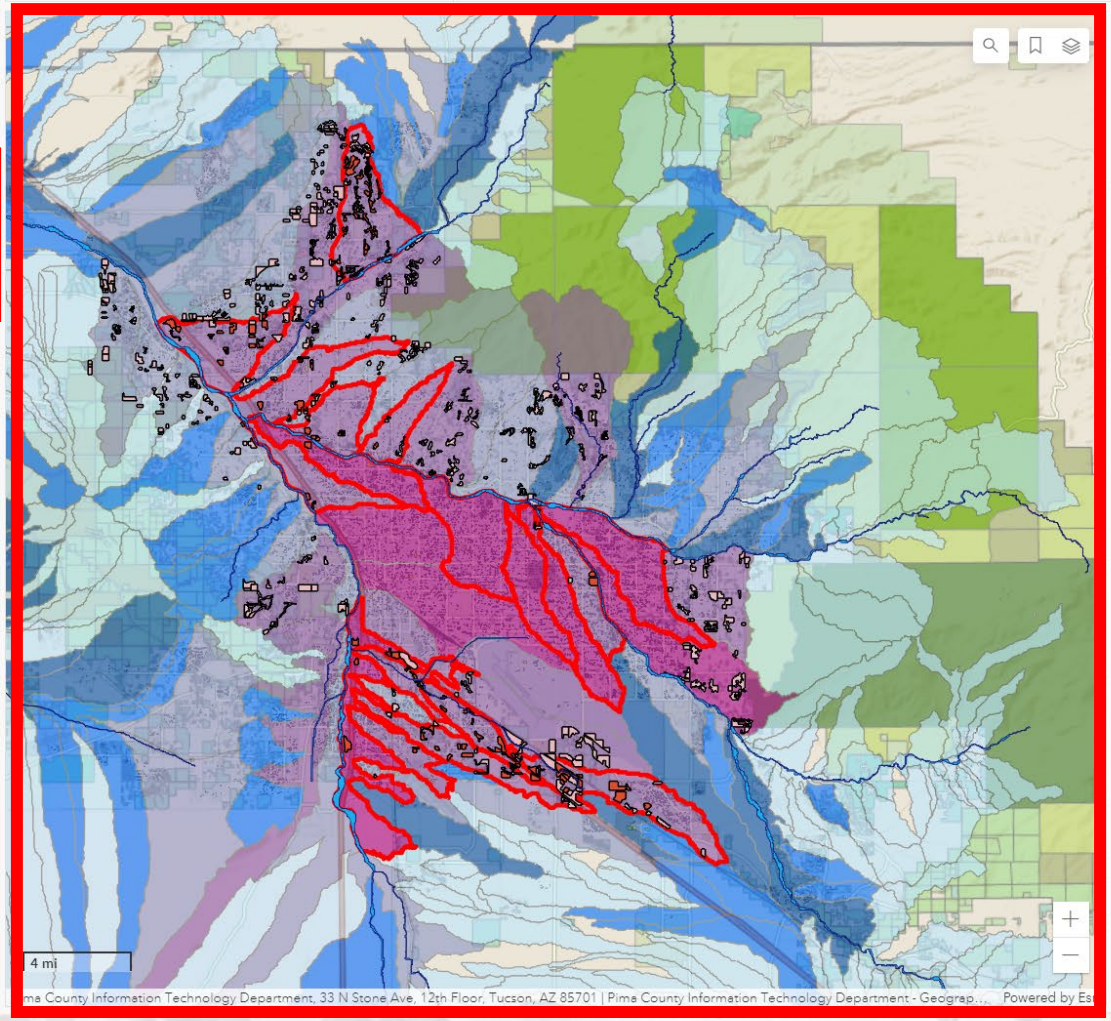

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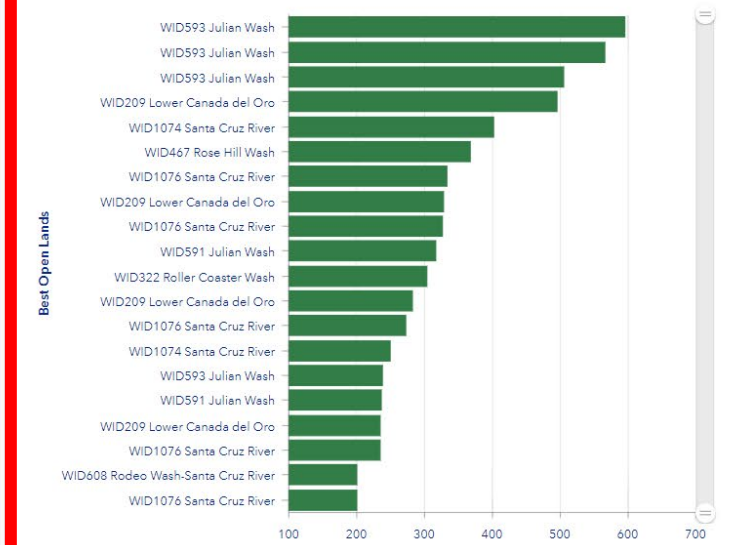

**Active Preserve & Vacant Lands for retention basins layer in the map view.*

Retention Volume in Preserve and Vacant Spaces

Main Assumptions

Rain

- Mean of annual total rain from 1985 to 2021.
- Spatial interpolation over areas without ALERT gages.
- Uniform distribution over each watershed.

%RO

- Constant values for impervious surface and each group soils.
- Arithmetic average over each watershed.
- Pre-development conditions = Natural conditions

Losses

- No losses (evapotranspiration, interception, other uses, etc.) were considered for the Delta or storage volume.

Storage

- 1-inch storm event uniformly distributed over each watershed.
- Times the basin is full based on capturing all Delta volume without losses.
- Basin volume using the entire open space area by 6 feet deep.

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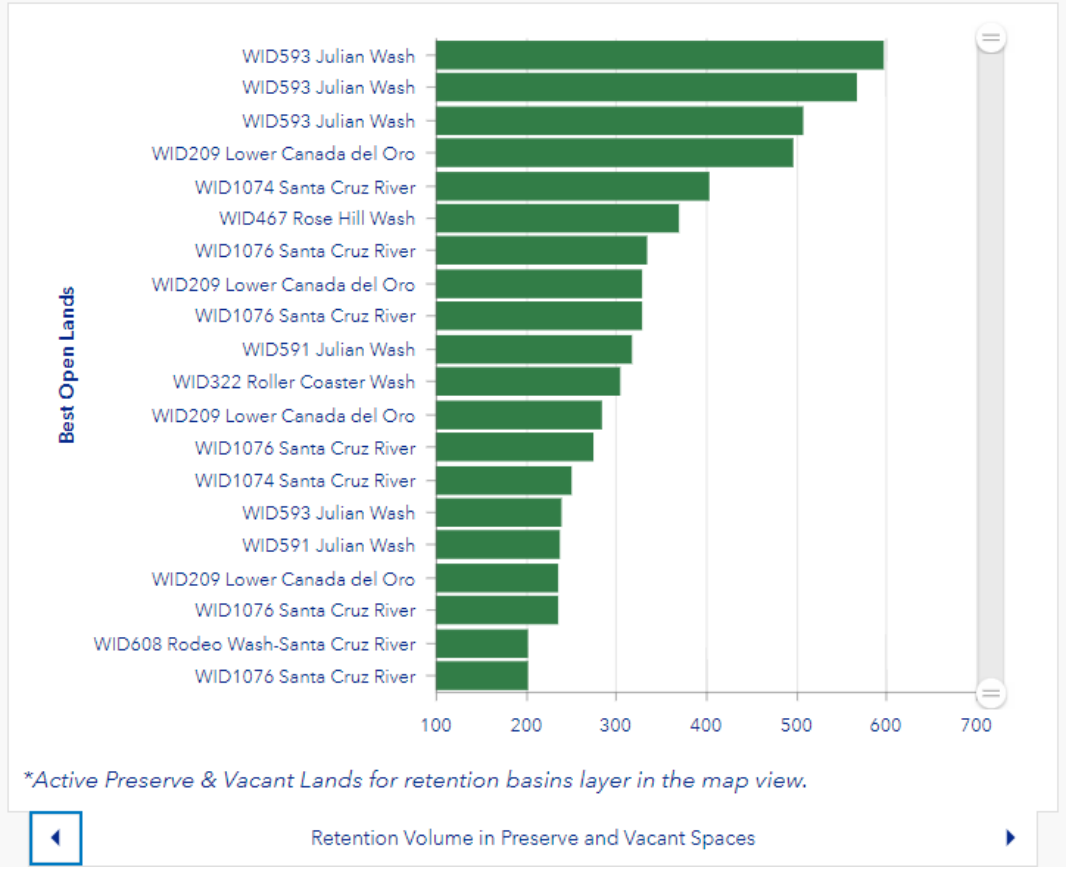
In perspective: Massingale & KERP

	KERP	Massingale basin
Basin storage (ac-ft)	1,880	76



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Hypothetical Case: Cost of building a 40 ac-ft retention basin

Estimate For Dashboard Hypothetical Basin

Date: 02/15/23

Item No	Description	Unit	Quantity	Unit Cost	Total cost
1	Mobilization	LS	1	$ 30,000.00	$ 30,000.00
2	Percolation Test	LS	2	$ 1,500.00	$ 3,000.00
3	Construction survey and layout	LS	1	$ 5,500.00	$ 5,500.00
4	Clearing and grubbing	AC	7	$ 7,000.00	$ 49,000.00
5	Excavate Basin and Haul Off[1]	CY	64,520	$ 40.00	$ 2,580,800.00
6	Inlet Grouted RipRap (6" w/ welded wire mesh)[2]	SY	120	$ 775.00	$ 93,000.00
7	Concrete inlet structure with apron[2]	SY	28	$ 2,500.00	$ 70,000.00
8	Permitter Post and Cable fence	LF	2252	$ 35.00	$ 78,820.00
9	Access cable with looped end	EA	2	$ 1,350.00	$ 2,700.00
10	Handrail (std detail 105)[2]	LF	152	$ 75.00	$ 11,400.00
11	Sidewalk scupper (type 2)[2]	LF	320	$ 625.00	$ 200,000.00
12	Hydroseeding	AC	7	$ 3,800.00	$ 26,600.00
13	Incidental items allowance	FA	1	$ 10,000.00	$ 10,000.00

Total = $ 3,160,820.00

$3.2 million

[1] Assumes that all material generated will need to be hauled off. Part of that assumption is the distance and location that the material would be hauled to which for the purpose of the estimate is a 5 mile haul to Sunset Pit. Creation of berms between basin cells and raising adjacent areas could reduce or eliminate this line item.

[2] Assumes 4 inlet structures would be needed for the 40 ac-ft basin.

Please note that depending on the intended use of the basins, whether its infiltration or storage for reuse, additional constructed elements will be required that are not captured in the hypothetical basin cost estimate above. Elements could include multiple dry wells for infiltration or lining, pump and piping for storage and reuse.

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Hypothetical Case: Installation of injection wells (dry wells) in a 40 ac-ft retention basin

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- supplement and replenish groundwater reserves
- dry wells can go 150-200 feet into the soil until reach a permeable layer
- Estimated cost $25,000 per unit
- injection wells have reported recovery rates of 0.1 cfs elsewhere in Arizona.
- **assuming this recovery rate and the installation of 18 dry wells within the 40 ac-ft retention basin it could take 11 days to drain a full basin.**

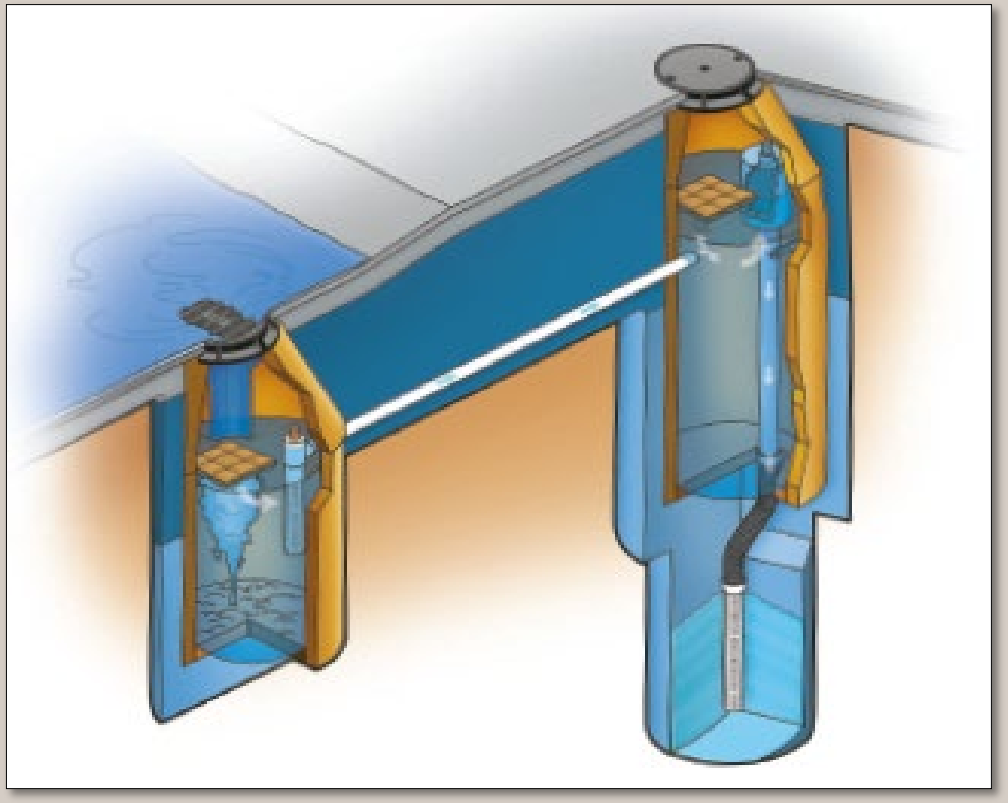
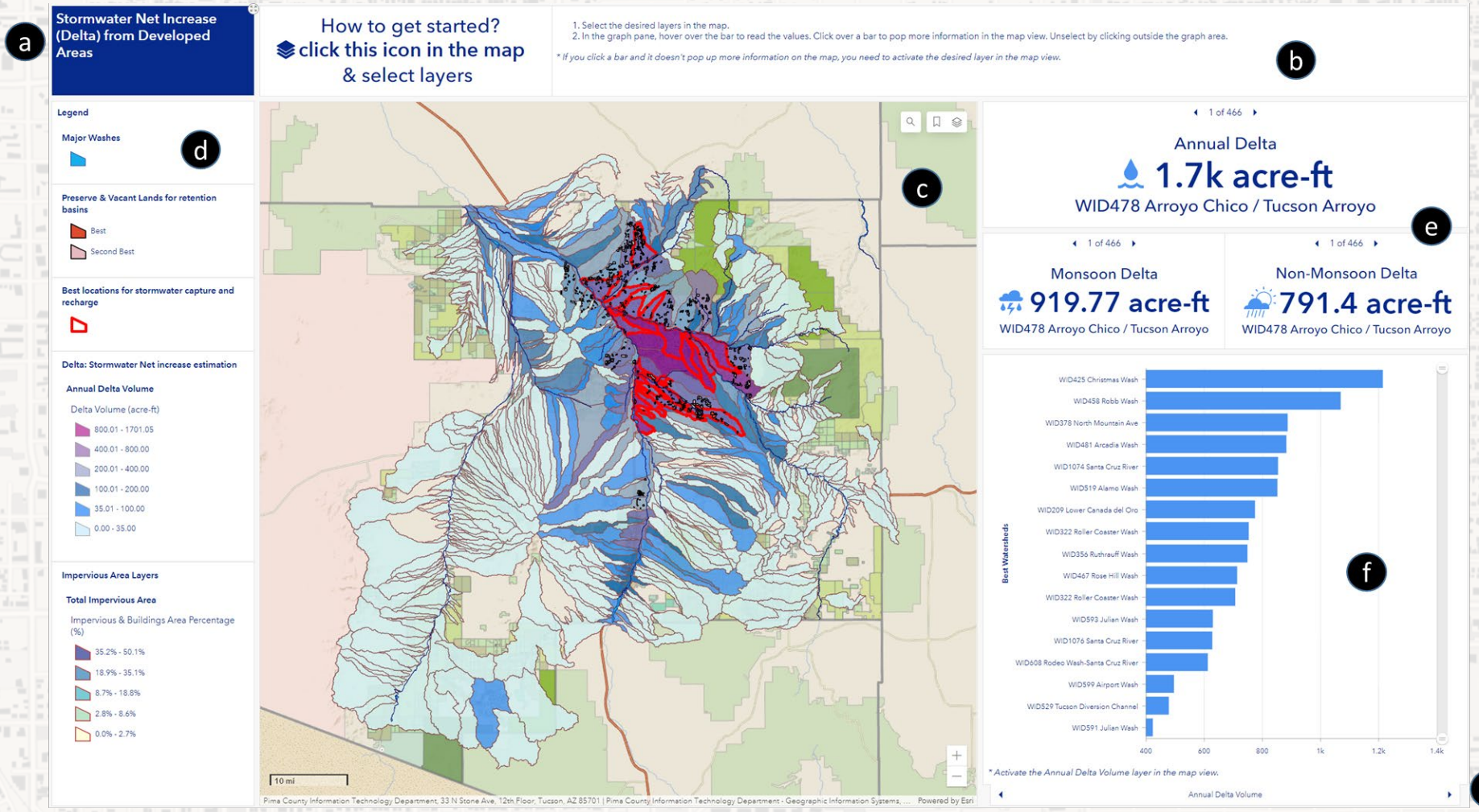
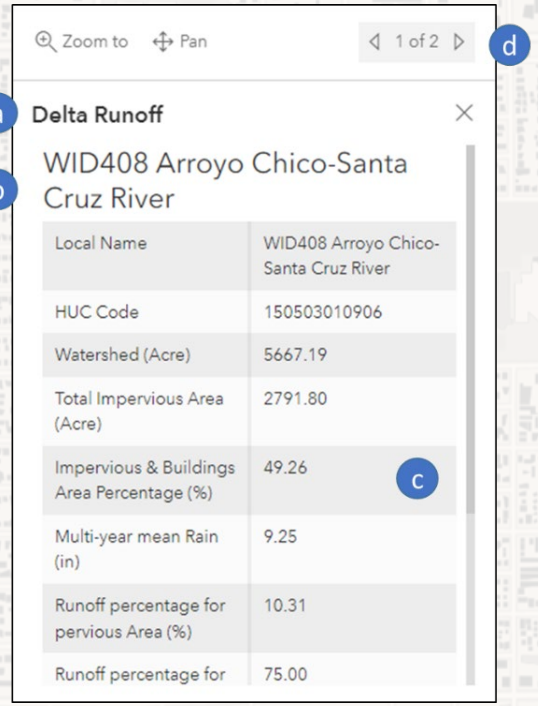


Figure 6. Schematic representation of the MaxWell Plus Torrent Resources drainage system

The Dashboard

https://pimamaps.maps.arcgis.com/apps/dashboards/e431d23fbbf040a58627c933c8e5a220





Thoughts?

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