1. Title. Environmental Impacts and Runoff Dynamics Associated with Urban Landscape Conversions

2. Project Type. Research

3. Focus Categories. Ecology, Surface water

4. Research Category. Water Quality

5. Keywords. Residential landscape, Runoff, Turfgrass

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9. Congressional District. 17th Congressional District of Texas

10. Abstract.
As rapid population growth continues to occur in urban areas throughout Texas, water conservation has become a key priority for many municipalities. It has been estimated that approximately 30-50% of potable municipal water is used for residential landscape irrigation (Heavenrich and Hall, 2016). While traditionally homeowners have installed landscapes comprised predominantly of turfgrass, many municipalities have recently offered rebate programs in which incentivize removal of turfgrass areas and conversion to alternative landscapes. The goal of these incentives is to reduce outdoor water use. In some arid and semiarid areas, water conserving landscape designs and planting materials have been proposed for use in such landscapes (Spinti et al., 2004; St. Hilaire et al., 2010). However, water losses and their concomitant chemistry through runoff also need to be considered before conducting this kind of landscape conversion. In this project, we converted several existing St. Augustinegrass turfgrass plots to four other commonly used water-efficient residential landscapes. Thus, 5 landscapes are used in this study including St. Augustine lawn, xeriscaping (decomposed granite with native plants), mulch, artificial turf, and sand-capped lawn. In this way, the effects of

different residential landscapes on runoff volumes, runoff chemistry, and soil physical and biological properties can be evaluated.

11. <u>Statement of regional or State water problem</u>.
In some big cities like Austin, water conserving landscape designs and planting materials have been proposed for reducing potable water use. In addition, a Water Wise landscape residential rebate program has been developed by Austin Water to help residents converting turfgrass to native plant beds. However, the change of land cover may have several environmental impacts including altering runoff dynamics and soil chemistry dynamics. This information would be of interest to municipalities and water management districts in understanding the full implications of such conversions. Communities could also refer to this information when enacting rebate programs that incentivize removal of turfgrass and conversion to alternative landscapes, with the goal of reducing outdoor water use.

12. <u>Statement of results or benefits</u>.
Based on the preliminary results, St. Augustine lawn resulted in the least total runoff on all rainfall events, and the highest water loss through runoff was found from mulch landscape (Figure 1). Artificial Turf and Xeriscaping showed similar patterns of runoff which mirrored precipitation patterns, suggesting a limited capacity to capture rainfall and mitigate runoff during rainfall events. Mulch and Sand-Capped grass plots had lower initial peak flow rates compared to other treatments but generated continual runoff flow over an extended period following the rainfall event, which contributed to higher overall runoff volumes (data not shown). We expect that the runoff dynamics of all landscapes might be varied during the entire year.

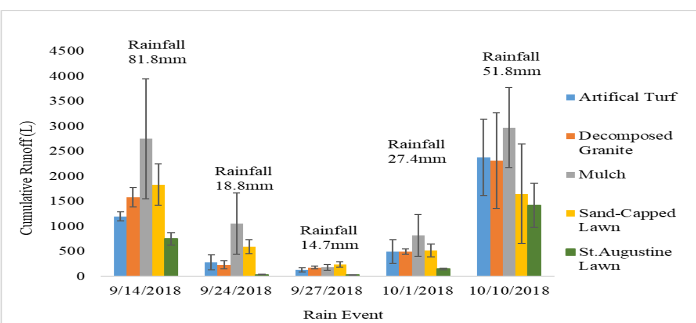


**Figure 1.** Cumulative runoff volumes occurring from various landscape types tested over five precipitation events during the study period.

13. <u>Nature, scope, and objectives of the project, including a timeline of activities</u>.
The objective of this research is to examine runoff flow, cumulative runoff volume, and runoff chemistry as well as runoff sediment associated with urban landscape conversions including artificial turf, water efficient landscapes composed of either decomposed granite or mulch, and sand-capped lawns in relation to established St. Augustine lawn. The project will also seek to document differences in maintenance requirements and overall landscape performance over the course of the study.

14. <u>Methods, procedures, and facilities</u>.
This study is being conducted at the Urban Landscape Runoff Facility located at the Texas A&M University Soil and Crop Sciences Field Research Laboratory, College Station, TX. The facility

is used to consists of 24 individually irrigated 13' x 27' plots established with 6-yr old 'Raleigh' St. Augustinegrass. More information on this facility can be found at the following link: https://www.jove.com/video/51540/design-and-construction-of-an-urban-runoff-research-facility. Each plot has its own irrigation control and runoff collection system composed of an ISCO flow meter and auto-sampler. This provides full documentation of the runoff dynamics including flow patterns and runoff water volumes from irrigation and rainfall events, and also collects samples from these events for subsequent chemical analysis.
Landscape conversions were made during August 2018, with treatments consisting of:

1. **St. Augustine Lawn** – 6 years old St. Augustinegrass (*Stenotaphrum secundatum*) established atop of native fine sandy-loam soil and irrigated 2x weekly at 60% x reference evapotranspiration levels.
2. **Xeriscaping** - Native, water conserving drip-irrigated plants (50% of total plot area) including Red Yucca (*Hesperaloe parviflora*), Texas sage (*Leucophyllum frutescens*), Muhly grass (*Muhlenbergia capillaris*), and Dwarf yaupon holly (*Ilex vomitoria*) established in 7.6 cm of compacted decomposed granite. Plants are irrigated twice a week at a total of 1.6 L per week to achieve a recommended rate of 0.23 L per day (Smith, 2003).
3. **Water Efficient Landscape- Mulch** - Native, water conserving drip-irrigated plants (50% of total plot area) including Red Yucca (*Hesperaloe parviflora*), Texas sage (*Leucophyllum frutescens*), Muhly grass (*Muhlenbergia capillaris*), and Dwarf yaupon holly (*Ilex vomitoria*) grown in native fine sandy-loam soil and mulched with 5 cm of dark hardwood mulch. Plants are irrigated twice a week at a total of 1.6 L per week to achieve a recommended rate of 0.23 L per day (Smith, 2003).
4. **Artificial Turf** - Premium II (EPS Turf) unirrigated synthetic turf was installed atop of 5 cm of compacted decomposed granite. Grit silica sand infill was incorporated into the base of the turf at a rate of 9.76 kg $m^{-2}$. These Plots received no irrigation.
5. **Sand-Capped Lawn-** Washed St. Augustinegrass sod laid atop of 10 cm of sand (medium-coarse concrete sand) plated over native fine-sandy loam soil. Irrigated 2x weekly at 60% x reference evapotranspiration levels.

Peak Flow and Volumes: Runoff characteristics will be evaluated for all naturally occurring rainfall event from throughout the study. Peak flow rates as well as total runoff volumes from each landscape type will be compared to determine influence of landscapes on runoff characteristics. Hydrograph data and total runoff volume data will be analyzed for all rain events. Additionally, runoff water samples will be collected and analyzed for pH, electrical conductivity (EC), Suspended Sediment (> 0.7 um), Nitrogen (Total N, $NO_3$-N, $NH_4$-N, organic N) and orthophosphate-P concentrations.

Moisture content in plots will also be measured for the 0-6" depth using handheld TDR (time domain reflectometer) at multiple locations per plot for at least twice a month (one will be measured before rainfall and one will be measured two days after rainfall). At the end of the study, total liters or millimeters of water used for irrigating each plot will be determined as well as inputs from rain events.

15. Related research.

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16. Training potential.

The principal investigator, Baoxin Chang, and several undergraduate student workers (approximately 2) who are working for the turf lab will receive training in the project.

19. Investigator's qualifications.