Water Quality in the Leon Creek Watershed Recharge Zone as a Function of Urban Development, and Community Education of the Threats and Conservation of the Edwards Aquifer

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PROJECT OBJECTIVES

Objective 1

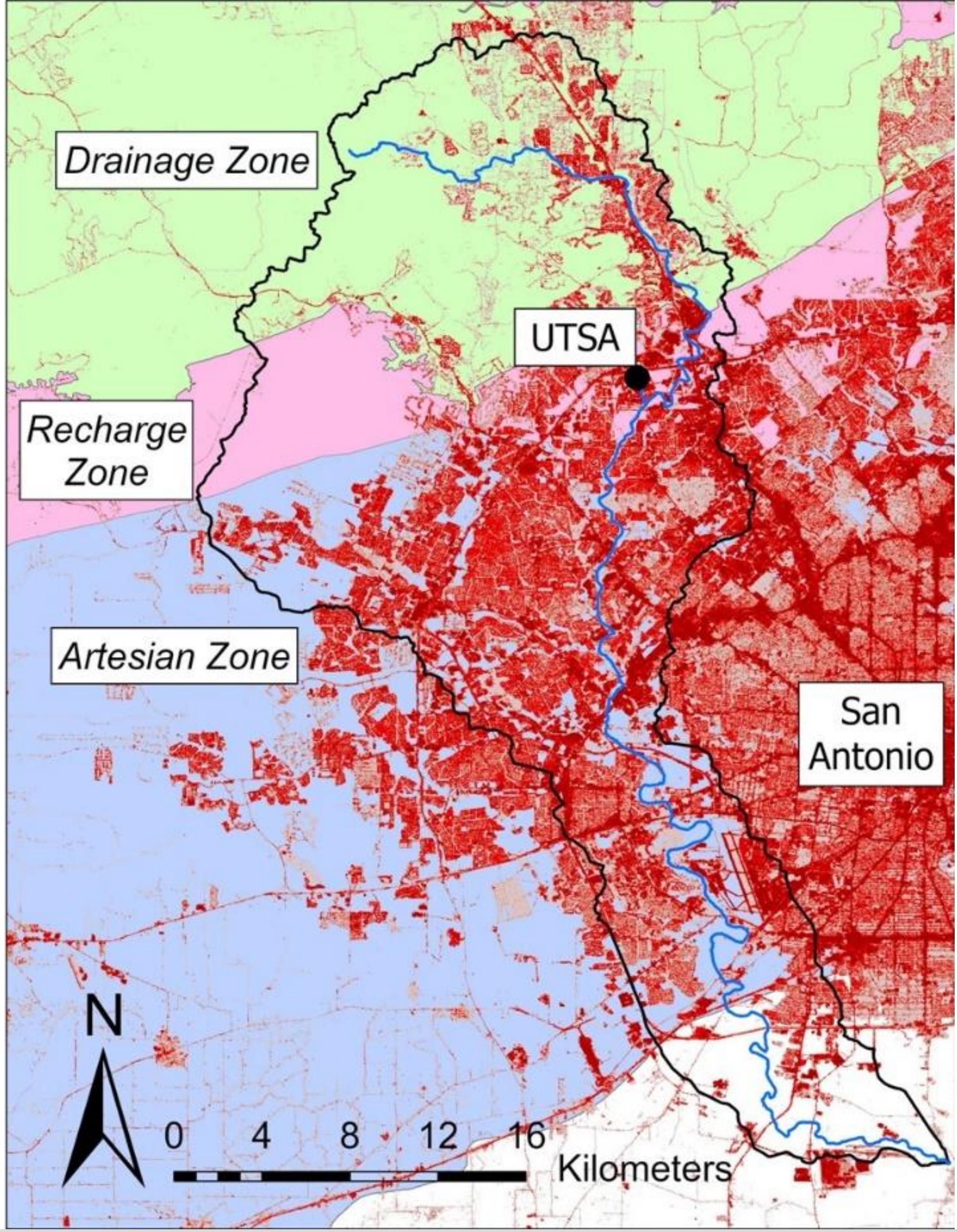
- Investigate impacts of urban land use on hydrology, riparian vegetation, and water quality in the upper Leon Creek watershed

Objective 2

- Change in water quality before and after construction
- Performance effectiveness of three bioretention basins on the UTSA campus

Objective 3

- Community education
- Facility and programs
- Demonstration LID facilities

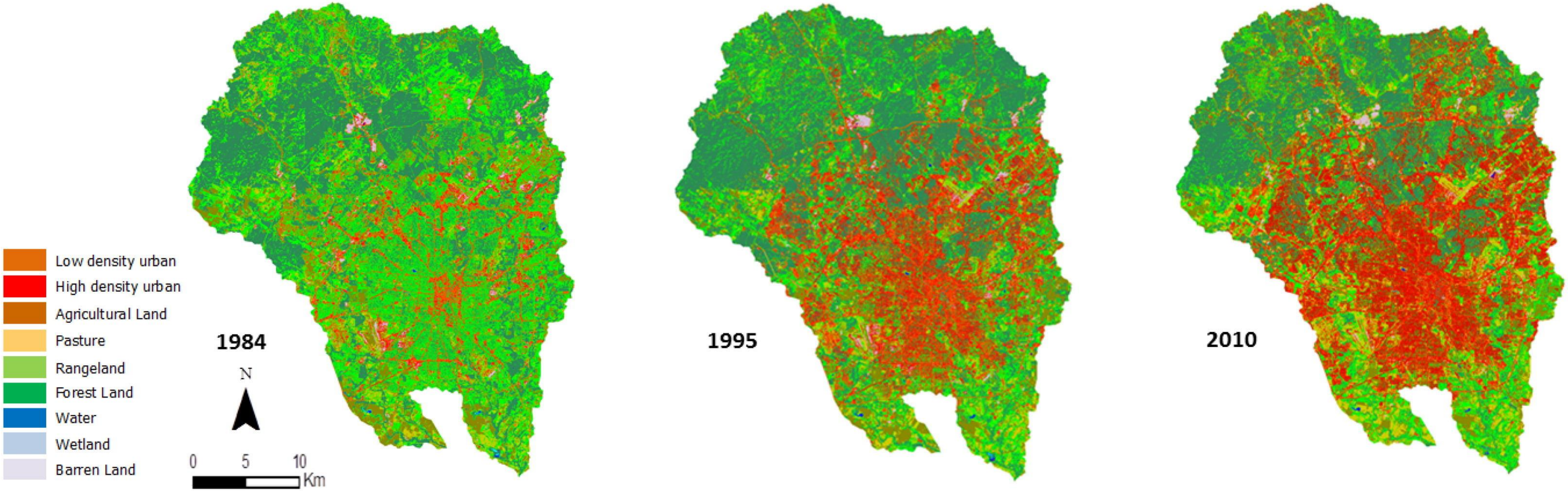


Project Budget

Living Lab Construction:	$ 1,400,000
Research, equipment, indirect costs:	$1,271,236
TOTAL PROJECT COST:	**$2,671,236**
Addendum for pesticide testing:	$ 12,000

OBJECTIVE 1

Evaluating change in water quality as a function of urbanization.

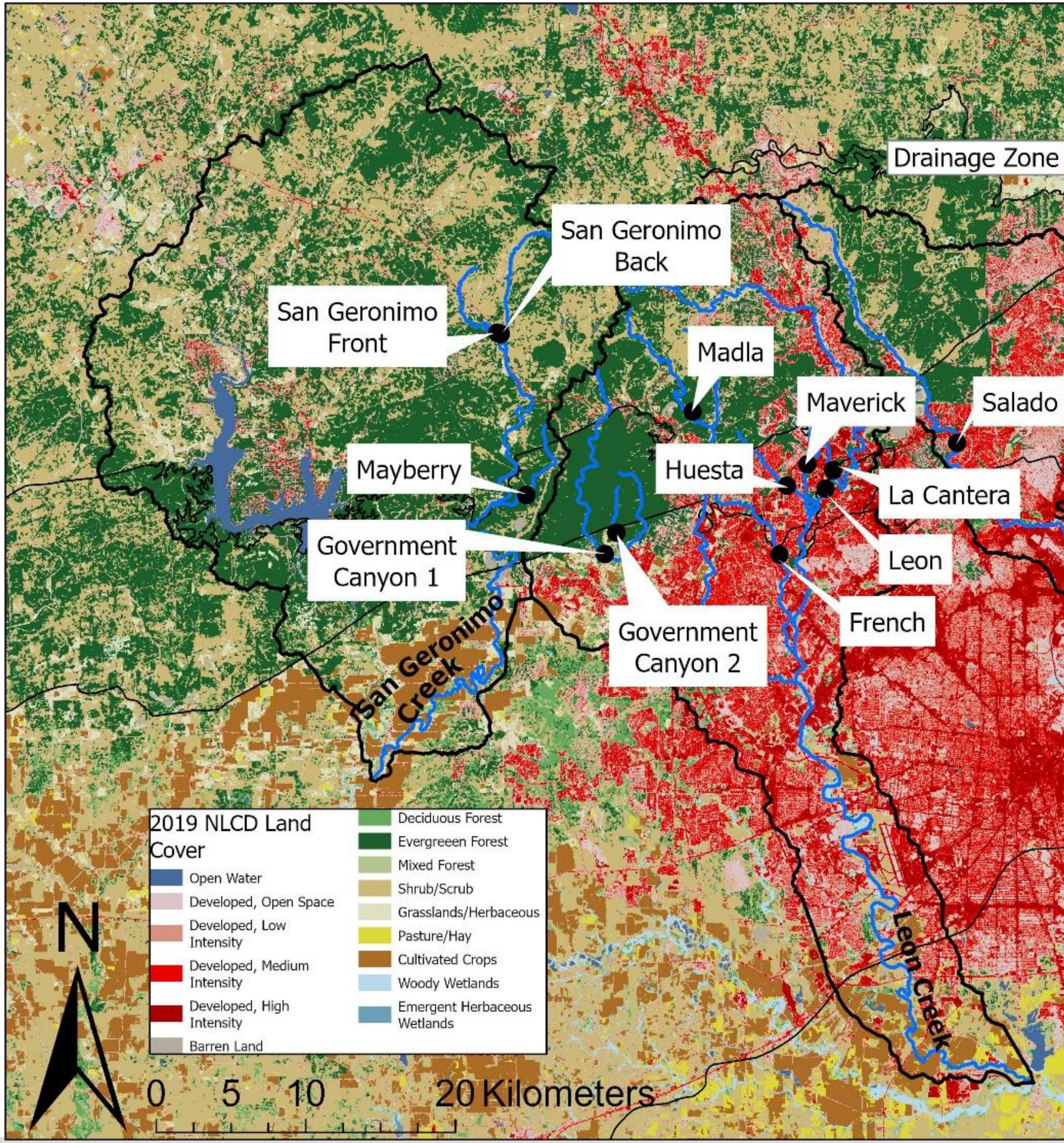


Yi et al. 2017. Impacts of Land Change on Ecosystem Services in the San Antonio River Basin, Texas, from 1984 to 2010. Ecological Economics, 135, 125–135. https://doi.org/10.1016/j.ecolecon.2016.11.019

OBJECTIVE 1

Methodology

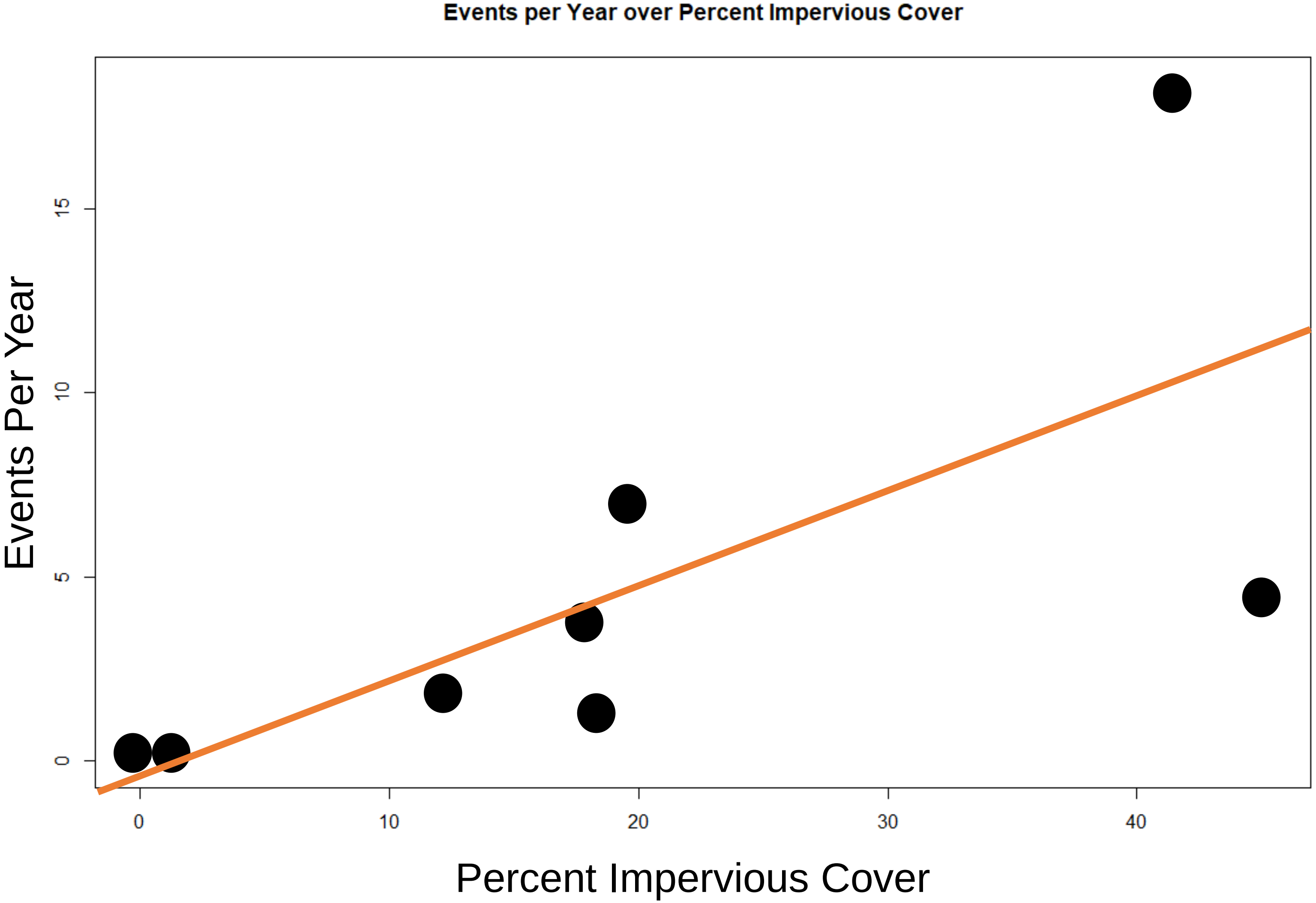
- Sampled urban and rural sites
- Continuous flow monitoring
- Riparian vegetation surveys
- Water quality during storm events
  - ✓ Total dissolved solids
  - ✓ Total suspended solids
  - ✓ E. coli
  - ✓ Nutrients
  - ✓ Metals



OBJECTIVE 1

Results of continuous flow monitoring

Urban sites had more frequent flow events

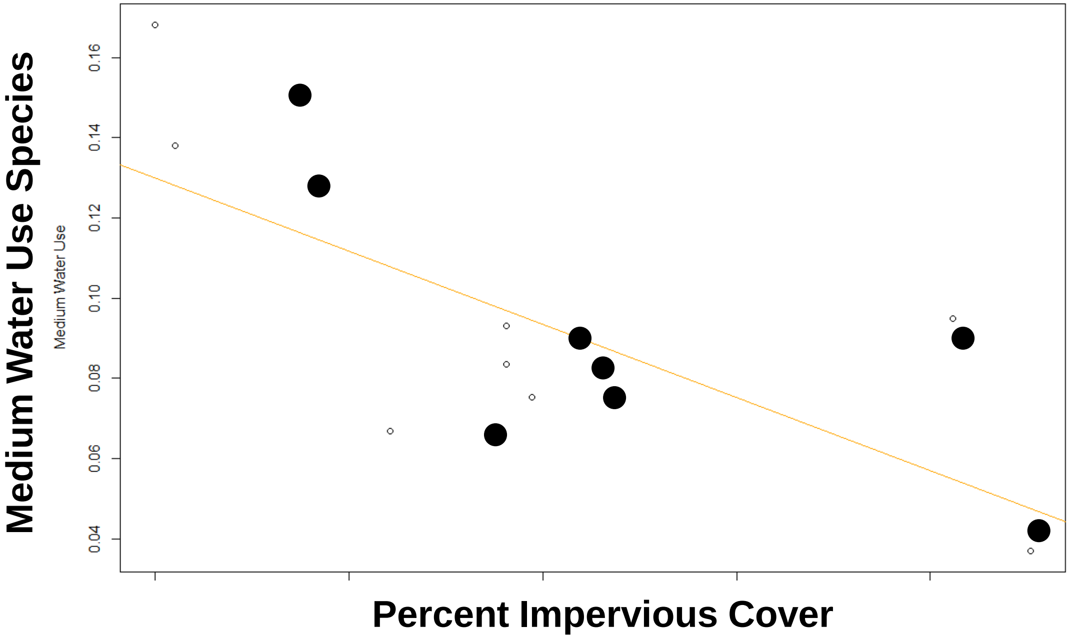


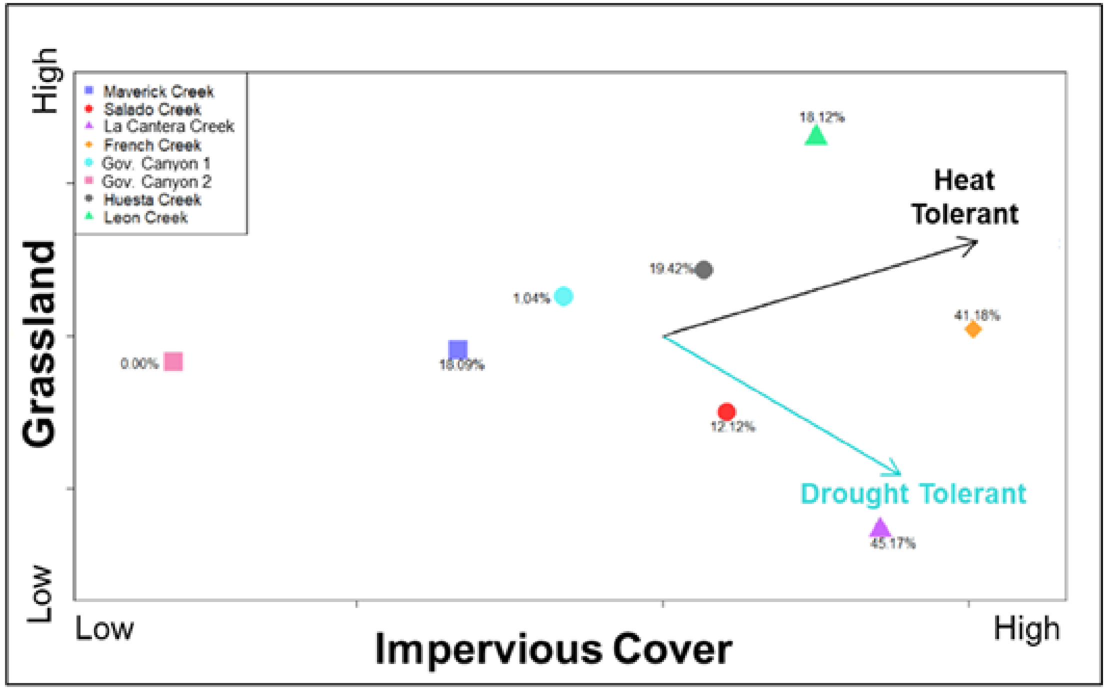
OBJECTIVE 1

Results

- Urban sites had different communities
- Other land cover factors important
- Urban sites had greater abundance of heat and drought tolerant species

Medium Water Use Basal over Precent Impervious Cover





OBJECTIVE 1 WATER QUALITY AS A FUNCTION OF LAND USE

Results

Six water quality parameters showed significant differences between Urban and Rural sites.

Higher Mean

Means Significant Results	Urban	Rural
Salinity	0.211	0.074
E. coli	1258.653	344.761
Nitrate as N	1.113	0.360
Specfic Conductance	149.161	436.633
Total Dissolved Solids	103.38	275.02
Barium	0.016	0.037

Linear Mixed Effects Model Urban Higher Than Rural

Sample	FIXED EFFECT	CL 2.5%	CL 97.5%
NitrateasN	1.301		
Urban	3.467	0.226437	6.537117
E.Coli	349.2		
Urban	902.8	285.2111	1520.7726

Linear Mixed Effects Model Urban Lower Than Rural

Sample	FIXED EFFECT	CL 2.5%	CL 97.5%
Barium	0.03659		-0.008839
Urban	-0.01766	-0.02654841	-0.02654841
Total Dissolved Solids	265.1		
Urban	-152.8	-185.74677	-120.26586
Specific Conductance	431.4		
Urban	-277.9	-338.287050	-217.698900
SALINITY g/kg	0.2006		
Urban	-0.1204	-0.14551612	-0.09550411

Discussion

1. Urbanization impacting streams
   - Urban sites had more frequent flow events
   - Urban sites had greater abundance of heat and drought tolerant species
   - Nitrate and E.coli were significantly higher in Urban sites. Also likely higher downstream exports
2. Water quality protections i.e. green infrastructure, policies to limit impervious cover, storm water fees, are justified especially in areas of expanding development, to reduce effect of urbanization.

Means Significant Results	Urban	Rural
Salinity	0.211	0.074
E. coli	1258.653	344.761
Nitrate as N	1.113	0.360
Specfic Conductance	149.161	436.633
Total Dissolved Solids	103.384	10.300
Barium	0.016	0.037

Objective 2

Hydrologic and water quality performance of bioretention basins

OBJECTIVE 2

Methodology

- **Continuous hydrologic monitoring of one basin**

- **First flush comparison for basin efficiency**

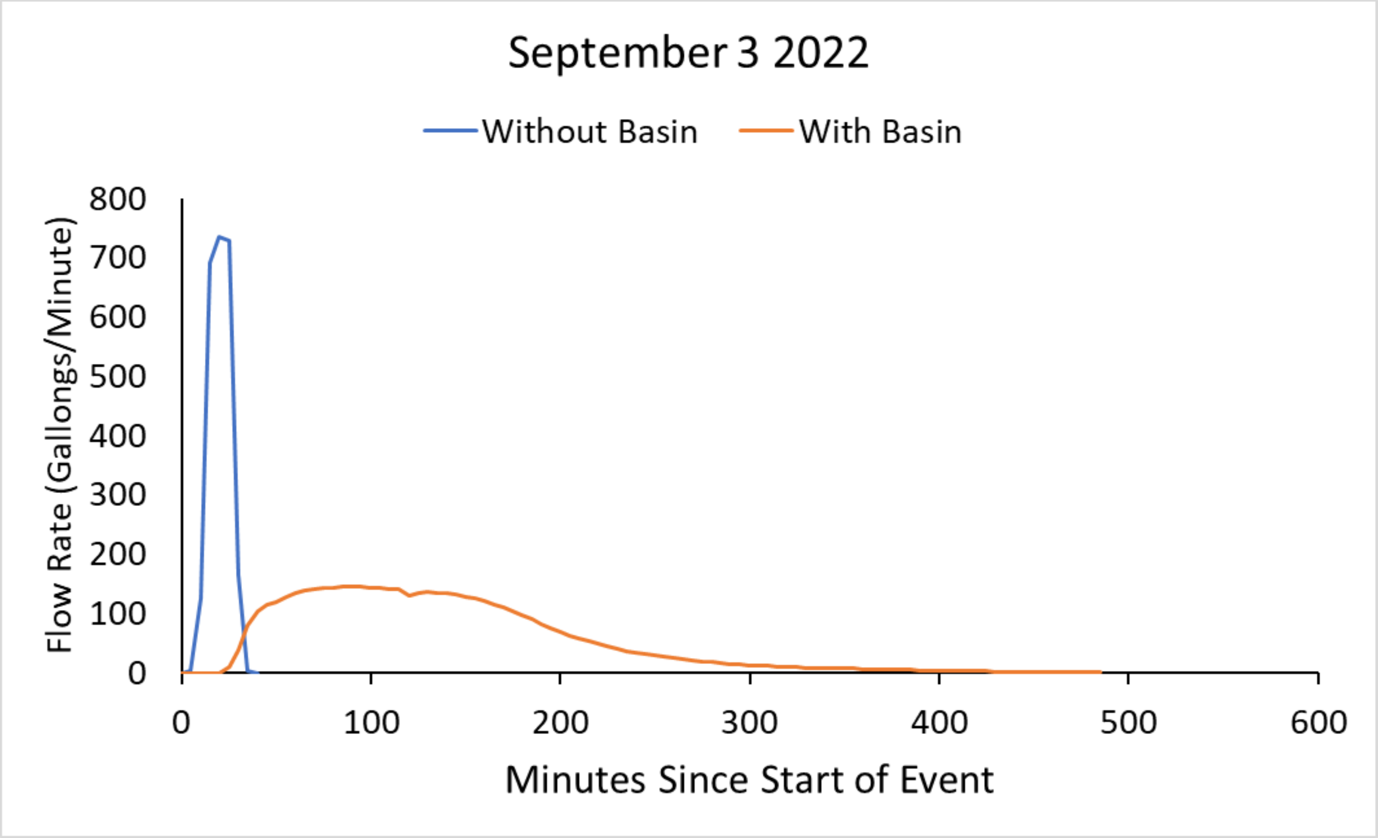
  1. Comparison of inlet results to outlet results

  ✓ Total dissolved solids
  ✓ Total suspended solids
  ✓ E. coli
  ✓ Nutrients
  ✓ Metals

- **Basin Constructability and Operations**

Continuous hydrologic monitoring of one basin

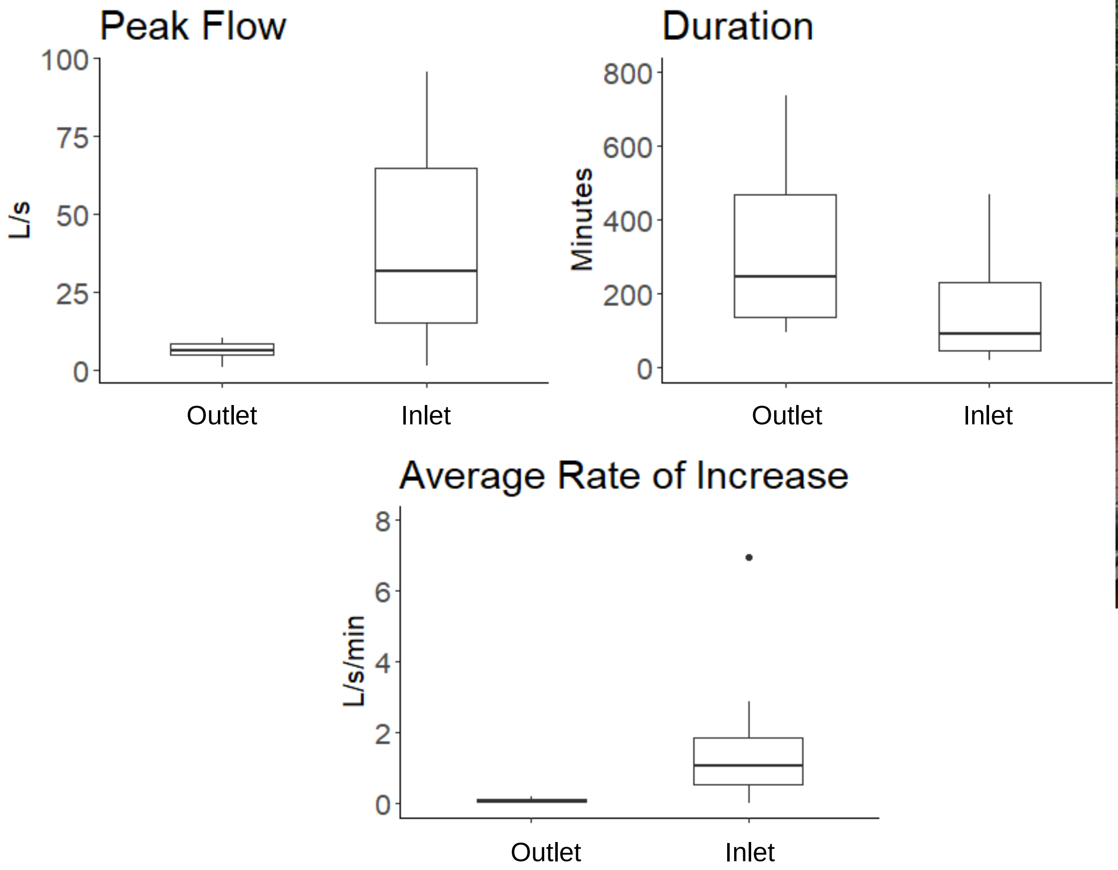
Living lab basin attenuated flow peaks and reduced flashiness



OBJECTIVE 2

Results Flow Comparisons

- Living lab basin attenuated flow peaks and reduced flashiness



OBJECTIVE 2

First flush comparison for basin efficiency

EC 1 INLET to EC1 OUTLET (F1)	DF	p-Value	EC 2 INLET to EC 2 OUTLET (F1)	DF	p-Value	LL 1 INLET to LL1 OUTLET (F1)	DF	p-Value
Arsenic	6	0.1788	Arsenic	3	0.02344	Arsenic	7	0.4363
Barium	13	0.243	Barium	7	0.009276	Barium	15	0.5561
Cadmium	13	0.2524	Cadmium	7	0.9638	Cadmium	15	0.3624
Chromium	13	0.2458	Chromium	7	0.7746	Chromium	15	0.9269
Copper	13	0.3891	Copper	7	0.9559	Copper	15	0.1318
Lead	13	0.8426	Lead	7	0.7697	Lead	15	0.3815
Zinc	13	0.3865	Zinc	7	0.3856	Zinc	15	0.2251
Total Kjeldahl Nitrogen	11	0.8989	Total Kjeldahl Nitrogen	2	0.156	NO DATA		
Phoshorus	5	0.1895	Phoshorus	2	0.4392			
1-Chloroctane	2	0.2911	1-Chloroctane	2	0.6164			
TPH 1005 1-Chlorooctadec	5	0.436	TPH 1005 1-Chlorooctadec	5	0.9542			
Total Nitrogen	11	0.2777	Total Nitrogen	5	0.535			
Nitrate as N	11	0.1076	Nitrate as N	4	0.4862			
Nitrite as N	11	0.08409	Nitrite as N	4	0.4862			
Total Organic Content	6	0.6183	Total Organic Content	5	0.68			
Salinity mg/L	8	0.02	Salinity mg/L	72	0.012	Salinity mg/L	49	0.04962
pH	8	0.402	pH	70	0.104	pH	49	0.6192
Specific Conductance	8	0.018	Specific Conductance	69	0	Specific Conductance	44	0.5432
Total Dissolved Solids mg/L	8	0.017	Total Dissolved Solids mg/L	69	0	Total Dissolved Solids mg/L	48	0.02443
Ecoli MPNadjusted	8	0.347	Ecoli MPNadjusted	45	0.655	Ecoli MPNadjusted	30	0.9774
TSS g/mg	341	0.9195	TSS mg/L	85	0.001926	TSS	61	0.07585

ANALYTE	EC1 IN MEAN	EC1 OUT MEAN	EC2 IN MEAN	EC2 OUT MEAN	LL IN MEAN	LL OUT MEAN
ARSENIC	0.000	0.002	0.001	0.031	0.002	0.002
BARIUM	0.014	0.016	0.037	0.251	0.010	0.051
SALINITY mg/L	0.054	0.181	0.110	0.251	0.090	0.174
SPECIFIC CONDUCTANCE uS/cm	107.960	325.534	88.126	396.542	155.636	305.183
TOTAL DISSOLVED SOLIDS mg/L	75.636	234.253	68.510	266.315	119.603	247.792
TSS g/mg	0.097	0.005	0.005	0.007	0.018	0.010

OBJECTIVE 2

Construction Lessons Learned

- EC2 construction issues
  - Basin was excavated and lined but heavy rain delayed further progress
  - During delay, liner slipped and lost integrity and silt from surrounding disturbed area accumulated in basin, possibly in underpiping
  - Basin was filled anyway but infiltration was slow
  - Basin was re-excavated and refilled with new biomedia but original, unwashed gravel
  - Basin infiltration still slow
  - Basin was re-excavated and filled a third time
  - Performance is better but infiltration still slow compared to others

OBJECTIVE 2

Construction Lessons Learned

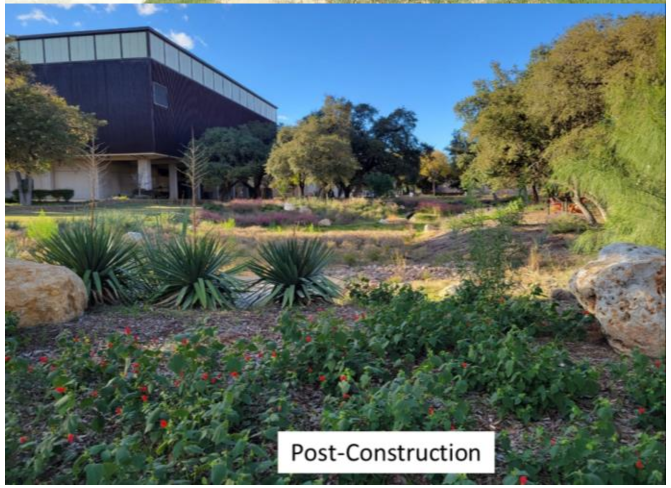
- Select experienced contractors
- Oversight and pre-construction review
- Minimize on-site storage of basin materials
- Minimize time between excavation and fill
- Site stabilization and BMPs for sediment control
- Confirm delivered material meets specifications
- Establish contingency plans for any delays
- Ensure adequate post-project vegetation planting

Activity	Cost
Soils testing for disposal	$600-$1,000
Hauling and replacement of media	$50,000
Reconstruction	$260,000

OBJECTIVE 2

Maintenance Activities and Cost

- Activities and cost similar to or lower than maintained lawn or other landscaping
  - Irrigation
  - Vegetation trimming
  - Herbicides
- Grass lawn at UTSA mowed on average once a week
  - Basin vegetation trimmed less frequently
- Additional activities
  - Periodic clearing of inlets and overflows
  - Erosion control early after construction
  - Some trash pick-up

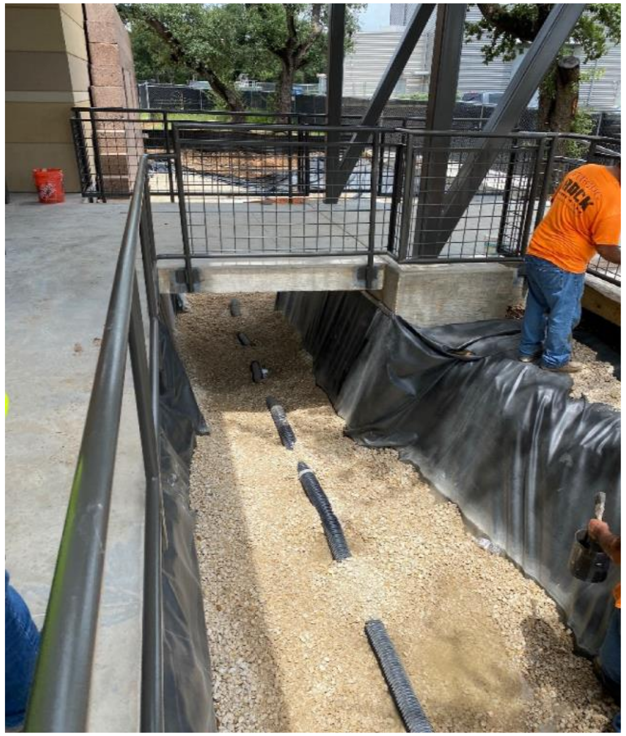


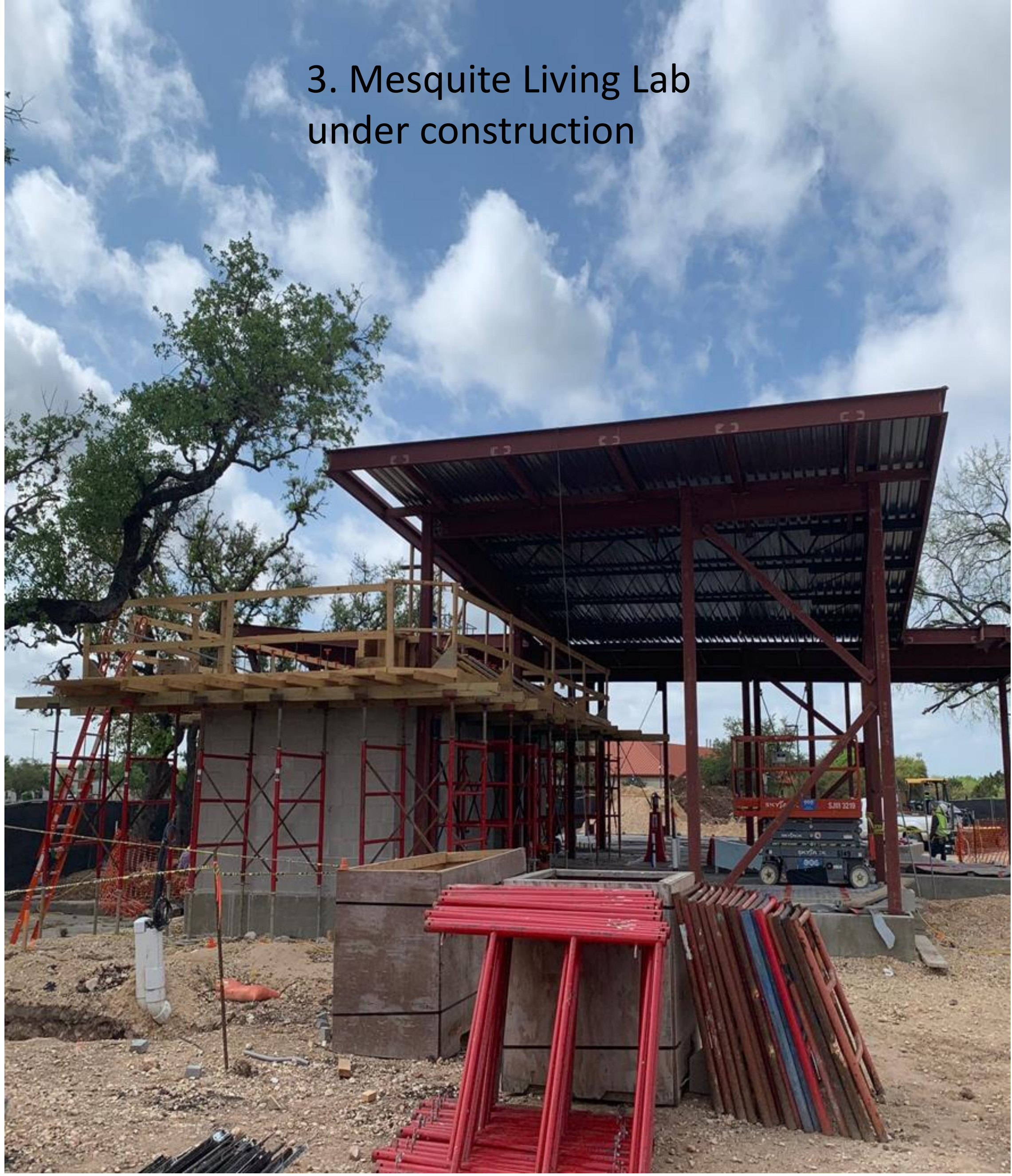
OBJECTIVE 2

Basin Constructability

1. Basin EC2 overtopping

2. ASTM #57 silted





3. Mesquite Living Lab under construction

Discussion

1. Bioretention basins help mitigate urban runoff
   - Reduced peakflows and flashiness
   - No significant reductions in pollutant concentrations
     - Relatively clean runoff water investigated
     - Loads may still be lower
2. Proper construction important to reduce cost
3. Maintenance no more costly than other landscaped/lawn areas

Objective 3

Community education

OBJECTIVE 3

Mesquite Living Laboratory

- Building dedicated to education and outreach about Edwards Aquifer and other environmental issues
- 2,000 square feet
- Open air classroom
- Outdoor amphitheater

OBJECTIVE 3

Mesquite Living Laboratory

- Demonstration LID facilities
  - Bioretention basin
  - Cistern
  - Green roof

OBJECTIVE 3

Mesquite Living Laboratory

- Hosted summer camps
- Hosted visits from San Antonio chapter of Environmental & Water Resources Institute (EWRI)
- Hosted visits from U.S. Fish and Wildlife Service
- Several undergraduate student projects
- Further outreach activities planned such as maintenance certification courses

OBJECTIVE 3

Education can provide awareness and interest

- Informally, summer camp students expressed greater interest in water management issues

- Some students express greater desire to pursue science-related careers

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