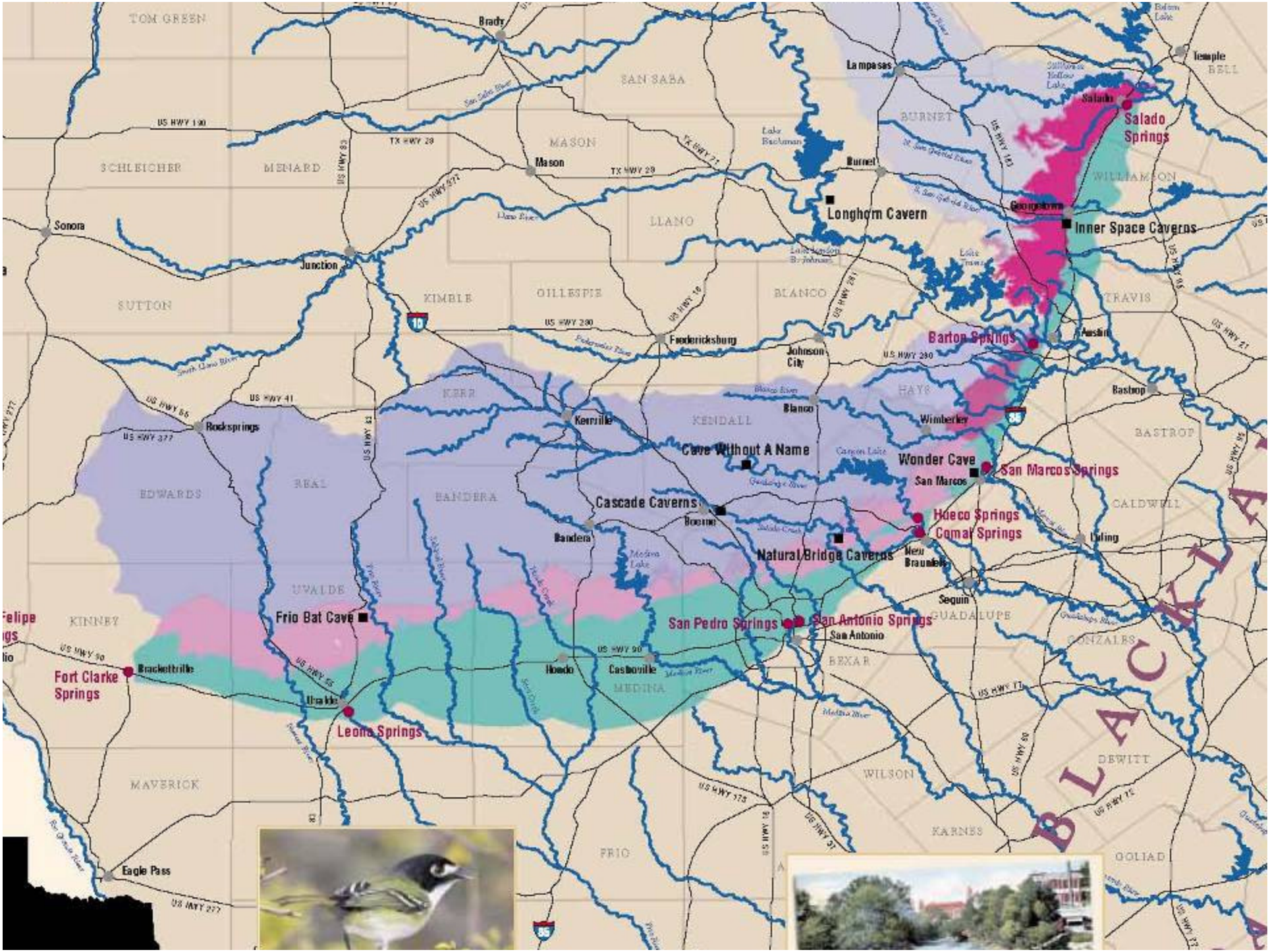
Low Impact Design: Managing Stormwater for the Edwards Aquifer

Annalisa Peace, Executive Director
Greater Edwards Aquifer Alliance

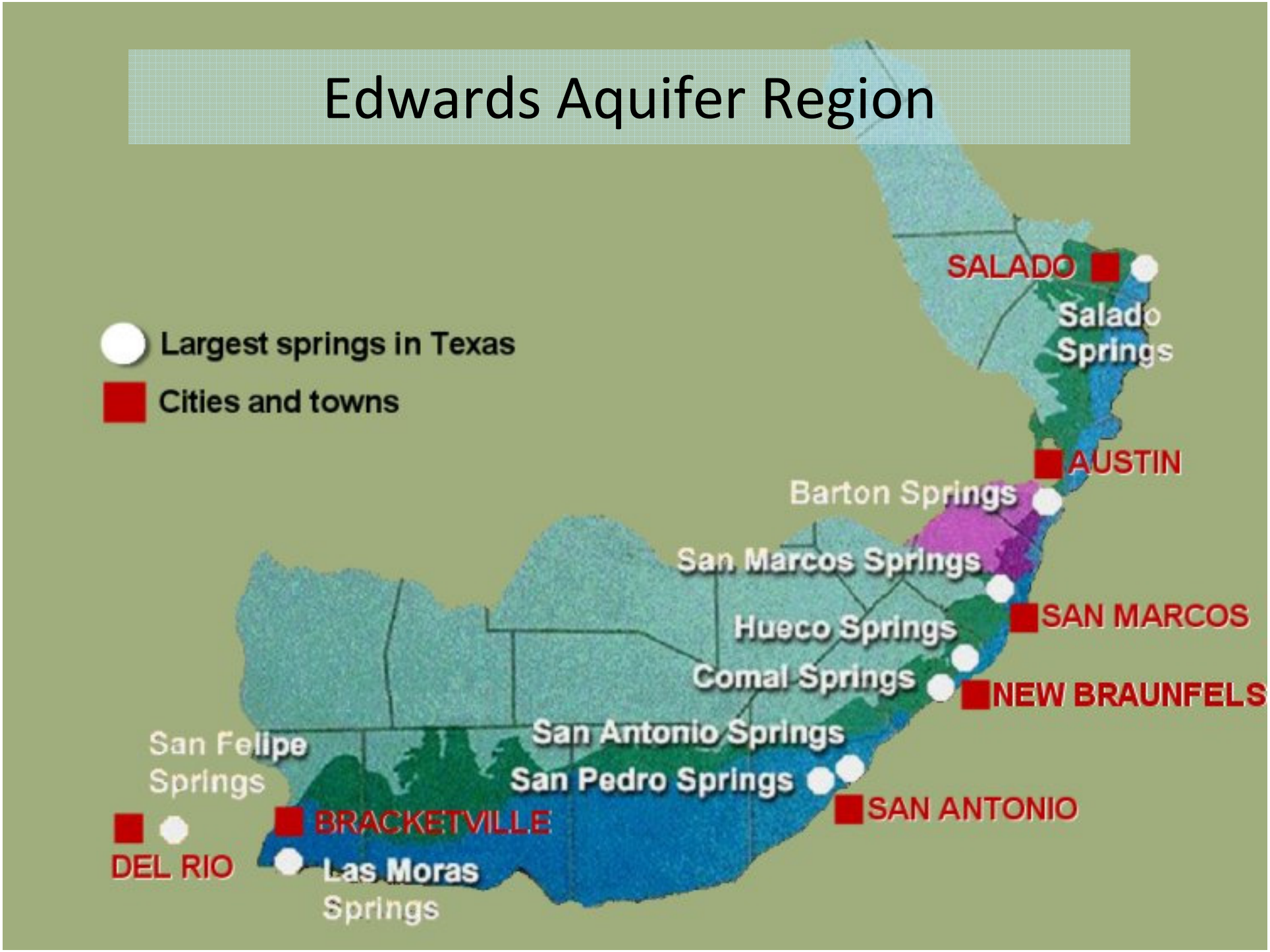
Marita Roos RLA LEED^{AP,} Principal UrbanBiology

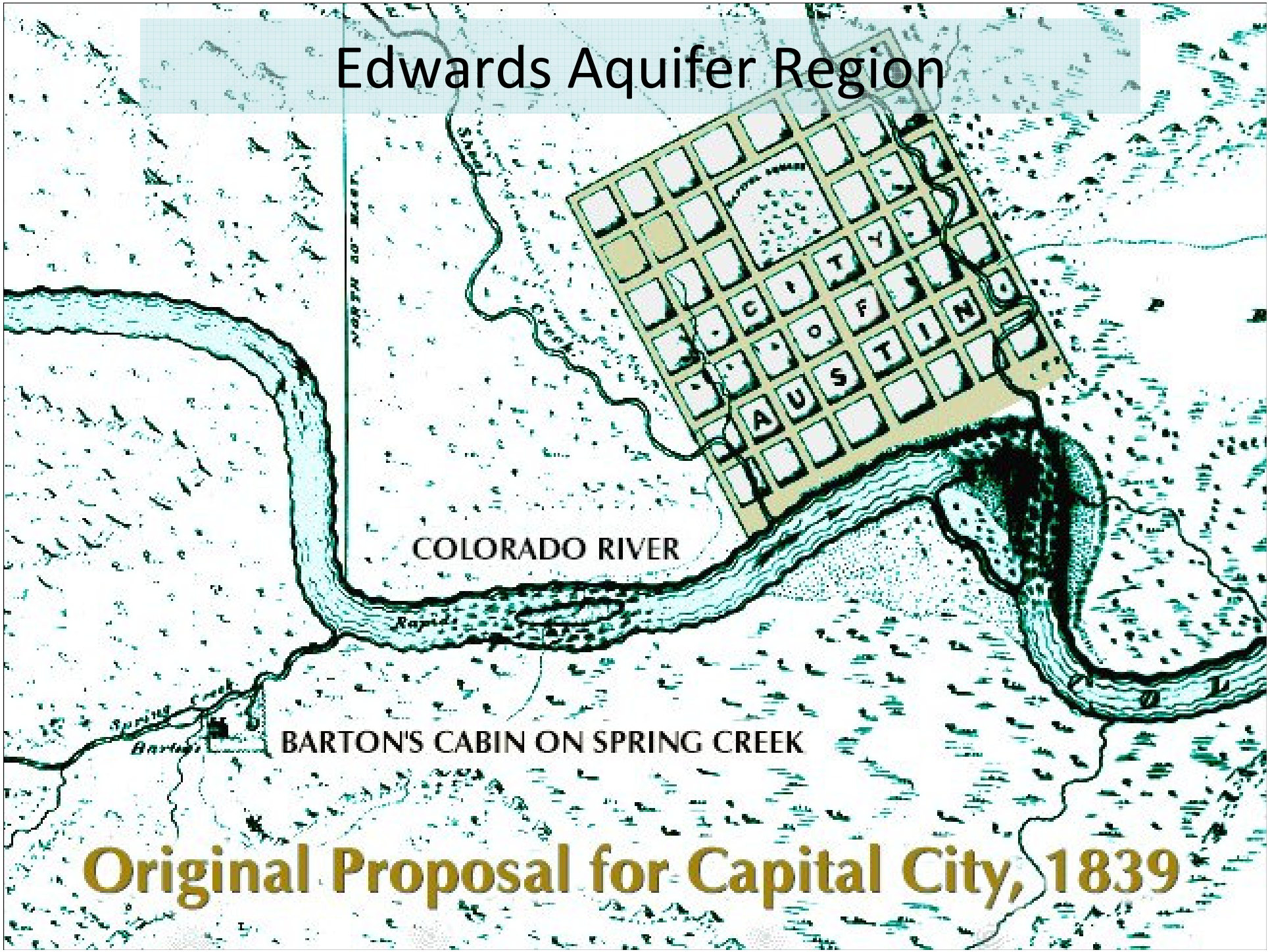
Texas Society of Architects Annual Meeting October 2010


The Edwards Aquifer Ecosystem
The Heart of Texas


TOM GREEN
Brady
SAN SABA
Lampasas
Temple
BELL
Salado
Salado Springs
US HWY 190
TX HWY 29
MASON
BURNET
SCHLEICHER
MENARD
Mason
Burnet
WILLIAMSON
Longhorn Cavern
Georgetown
Inner Space Caverns
Sonora
Junction
LLANO
KIMBLE
GILLESPIE
BLANCO
TRAVIS
SUTTON
US HWY 290
Fredericksburg
Johnson City
Barton Springs
Austin
Bastrop
KERR
HAYS
Blanco
Kerrville
Wimberley
Rocksprings
US HWY 377
US HWY 41
KENDALL
BASTROP
Cave Without A Name
Wonder Cave
San Marcos Springs
San Marcos
EDWARDS
REAL
BANDERA
Cascade Caverns
Boerne
CALDWELL
Hueco Springs
Comal Springs
Bandera
Natural Bridge Caverns
New Braunfels
Luling
UVALDE
Seguin
KINNEY
Frio Bat Cave
San Pedro Springs
San Antonio Springs
San Antonio
GUADALUPE
GONZALES
US HWY 90
Fort Clarke Springs
Brackettville
Hondo
Castroville
BEXAR
MEDINA
Uvalde
Leona Springs
DEWITT
MAVERICK
WILSON
KARNES
FRIO
Eagle Pass
GOLIAD
BLACKLAND

Edwards Aquifer Region




Edwards Aquifer Region
CITY OF AUSTIN
COLORADO RIVER
BARTON'S CABIN ON SPRING CREEK
Original Proposal for Capital City, 1839

Edwards Aquifer Ecosystem

Home to over 50 plant and animal species that live nowhere else in the world.

Black capped Vireo

Golden cheeked Warbler

Barton Springs salamander (*Eurycea sosorum*)

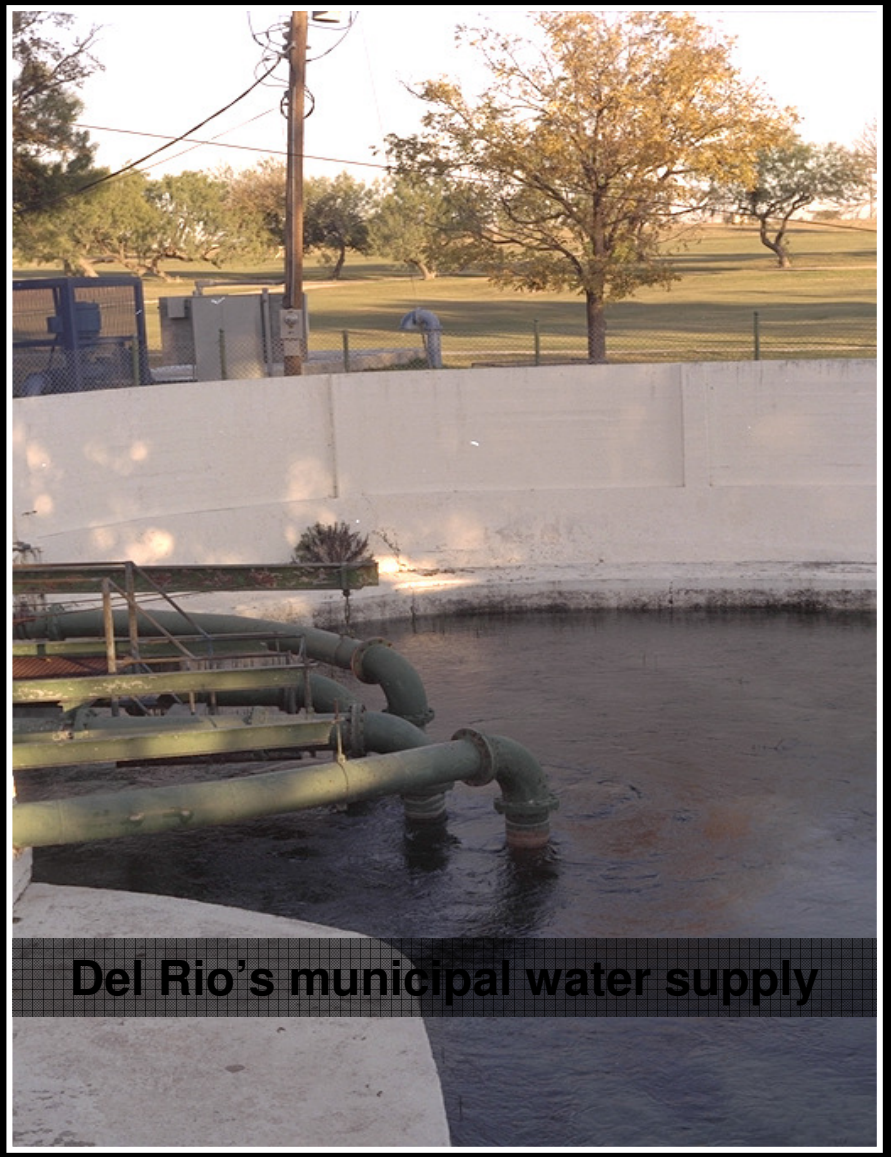
Texas Blind salamander (*Eurycea rathbuni*)

Texas wild rice

Fountain darters

Edwards Aquifer Ecosystem

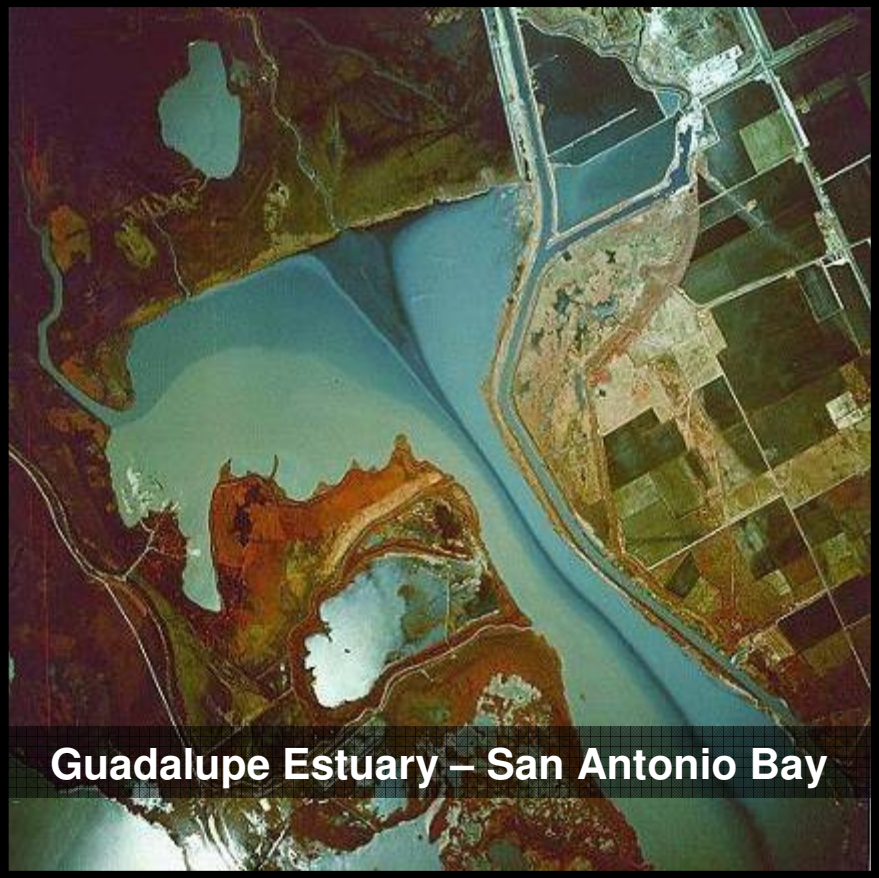
Providing the sole source of drinking water to more than 1.5 million citizens…



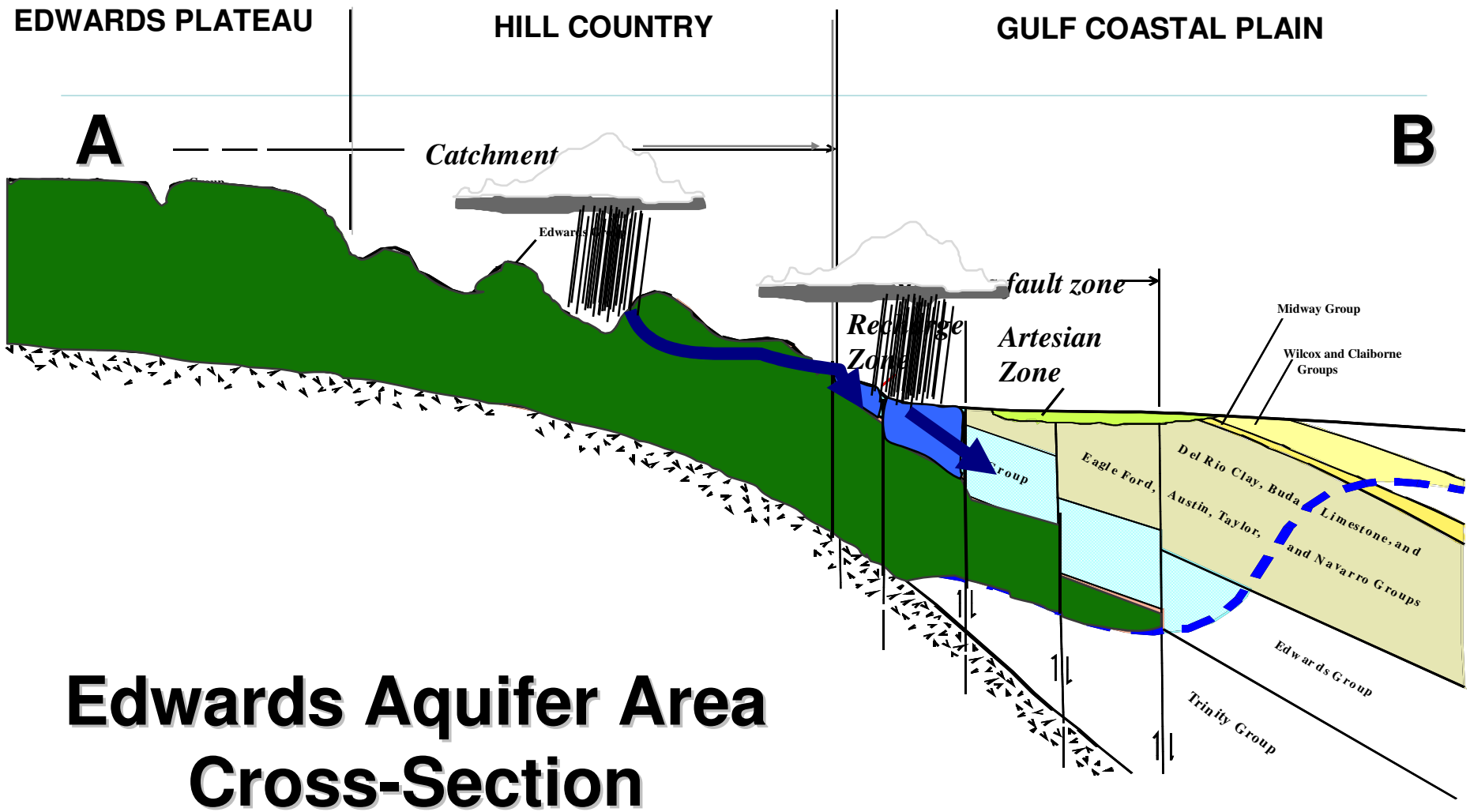
Del Rio's municipal water supply

Edwards Aquifer Ecosystem

…and sustaining essential freshwater flows to bays and estuaries during times of drought



Guadalupe Estuary – San Antonio Bay



Edwards Aquifer Area Cross-Section

Edwards Aquifer Ecosystem

Thin to non-existent Hill Country soils . . .

. . . rapid, groundwater recharge. . .

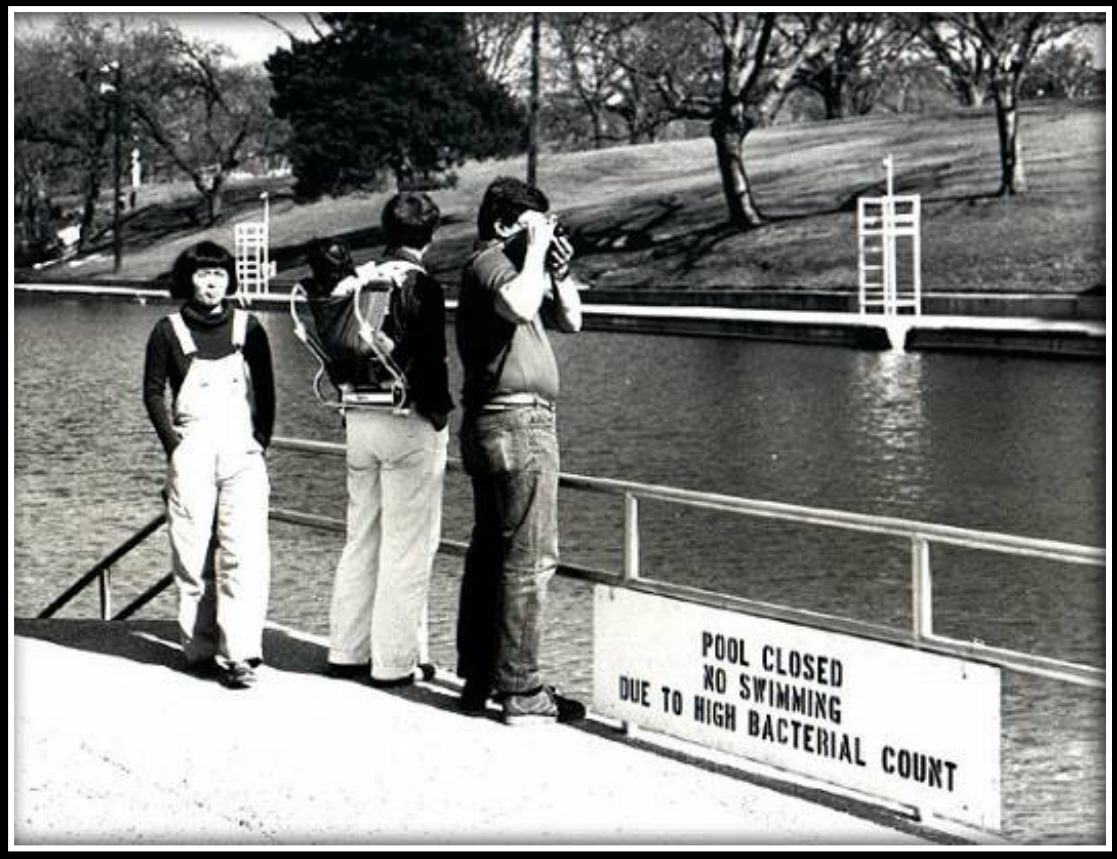
. . . rapid open channel flow . . .

. . . provides minimal filtration of pollutants that enter the aquifer…

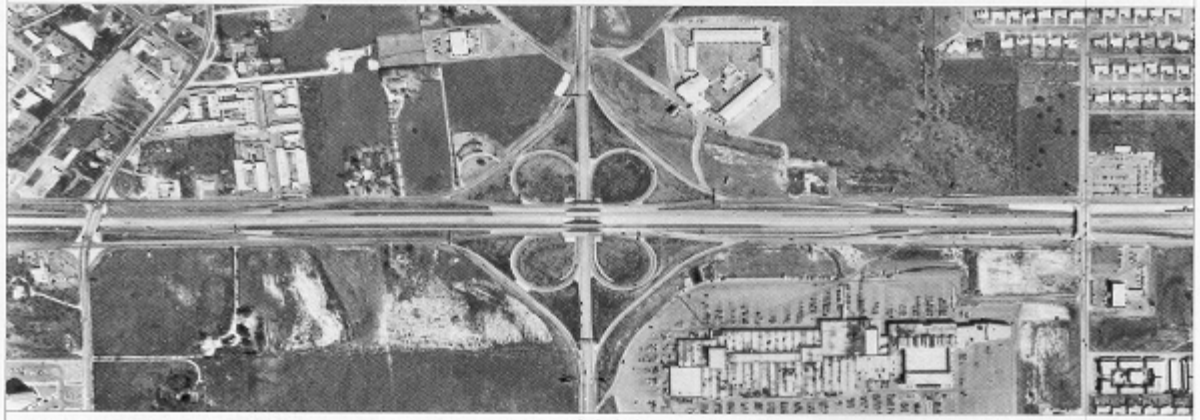
. . . combine to make the Edwards Aquifer more vulnerable to pollution than any other major aquifer in Texas.

Edwards Aquifer Ecosystem

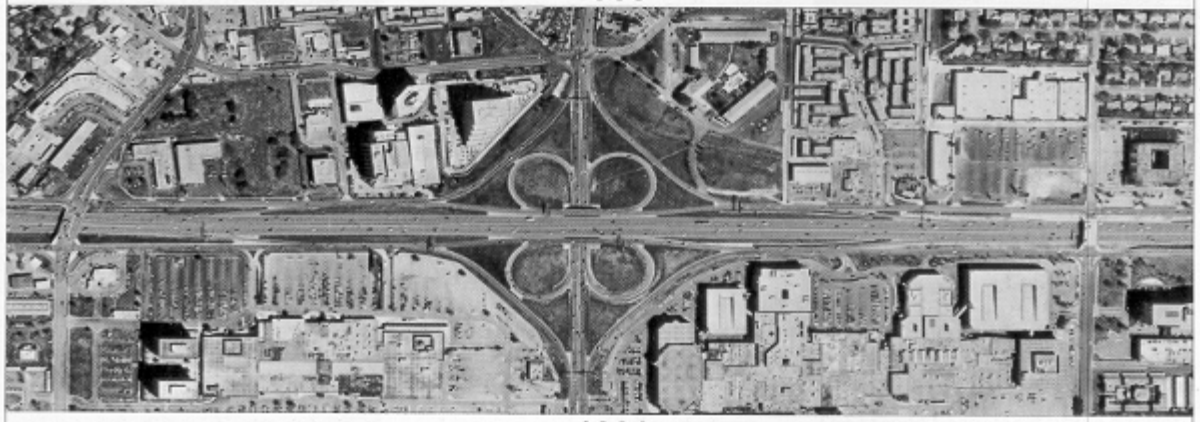
Rapid, unsustainable urbanization threatens pollution of the Great Springs of Texas.



1939

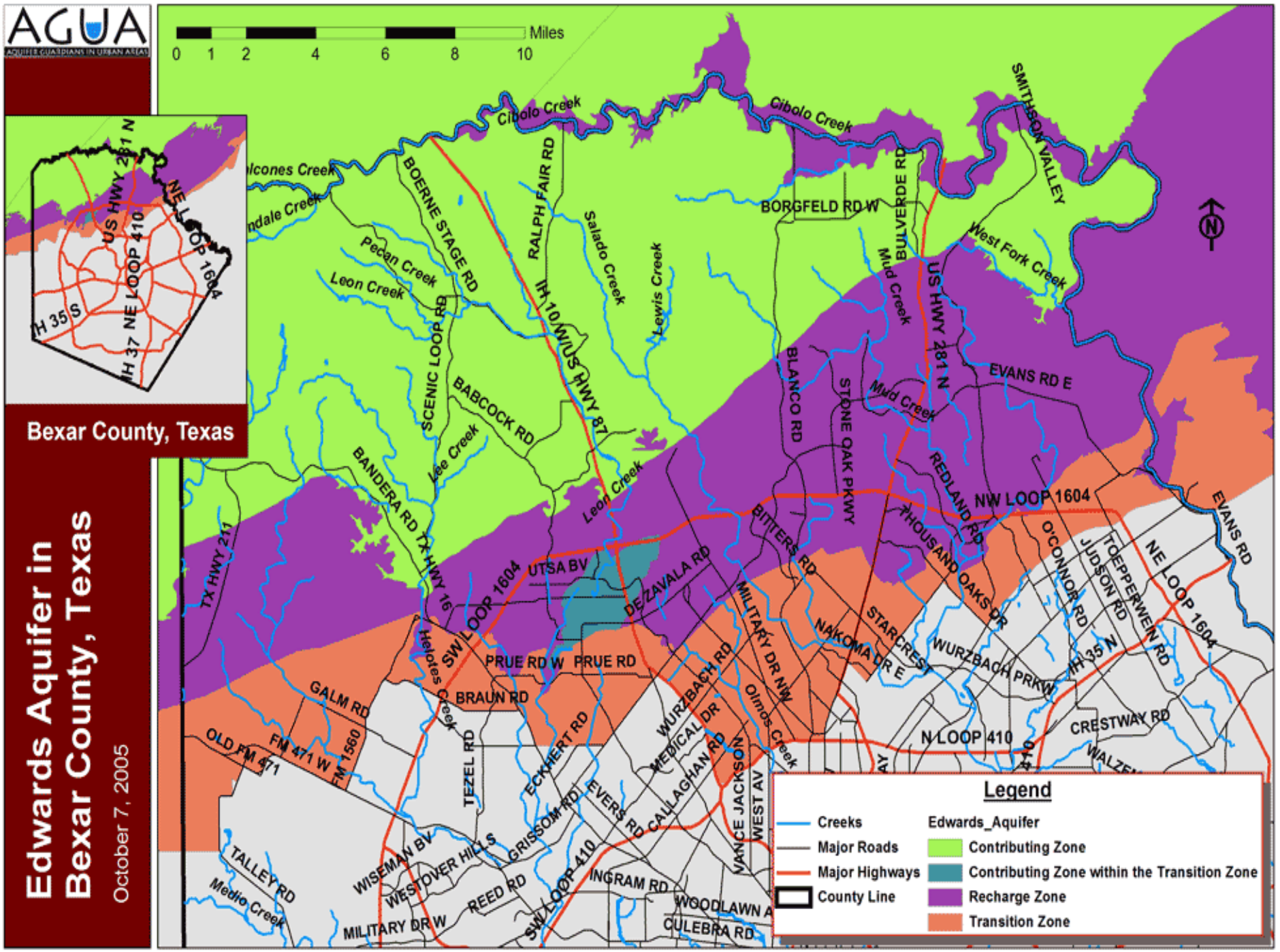


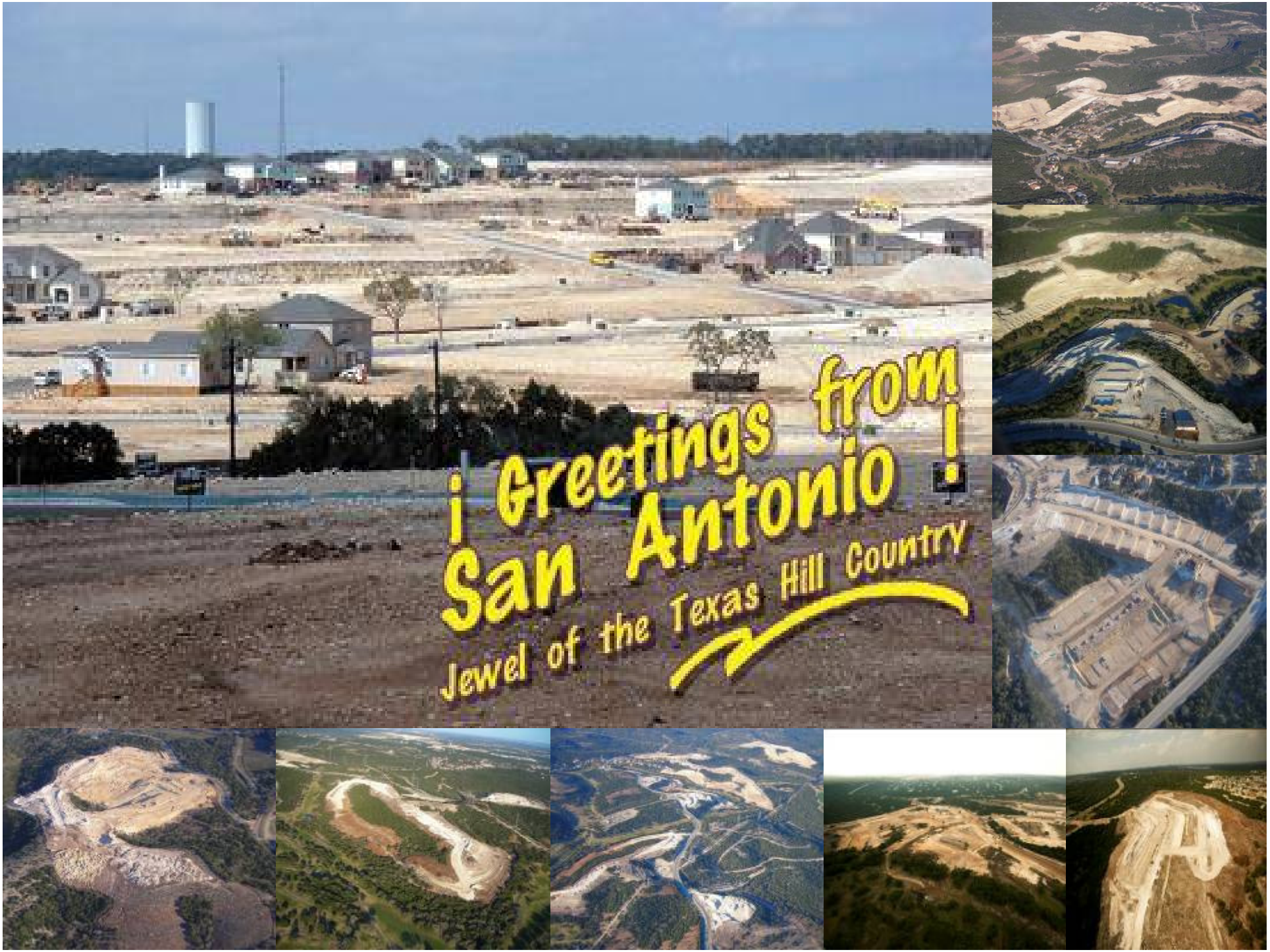
1966

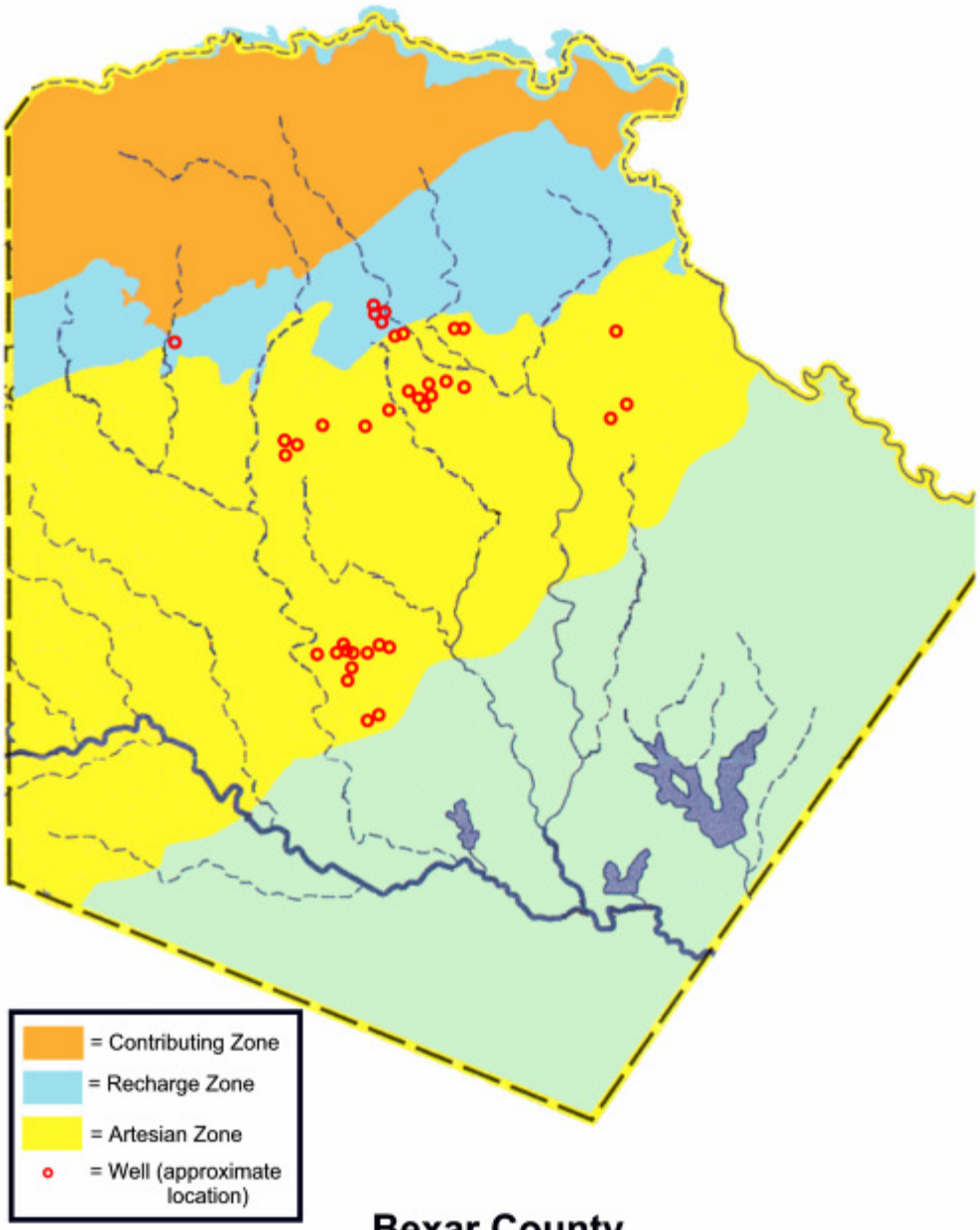


1991

Intersection of Interstate Highway 410 and San Pedro Avenue, San Antonio, Texas illustrates population growth in Bexar County

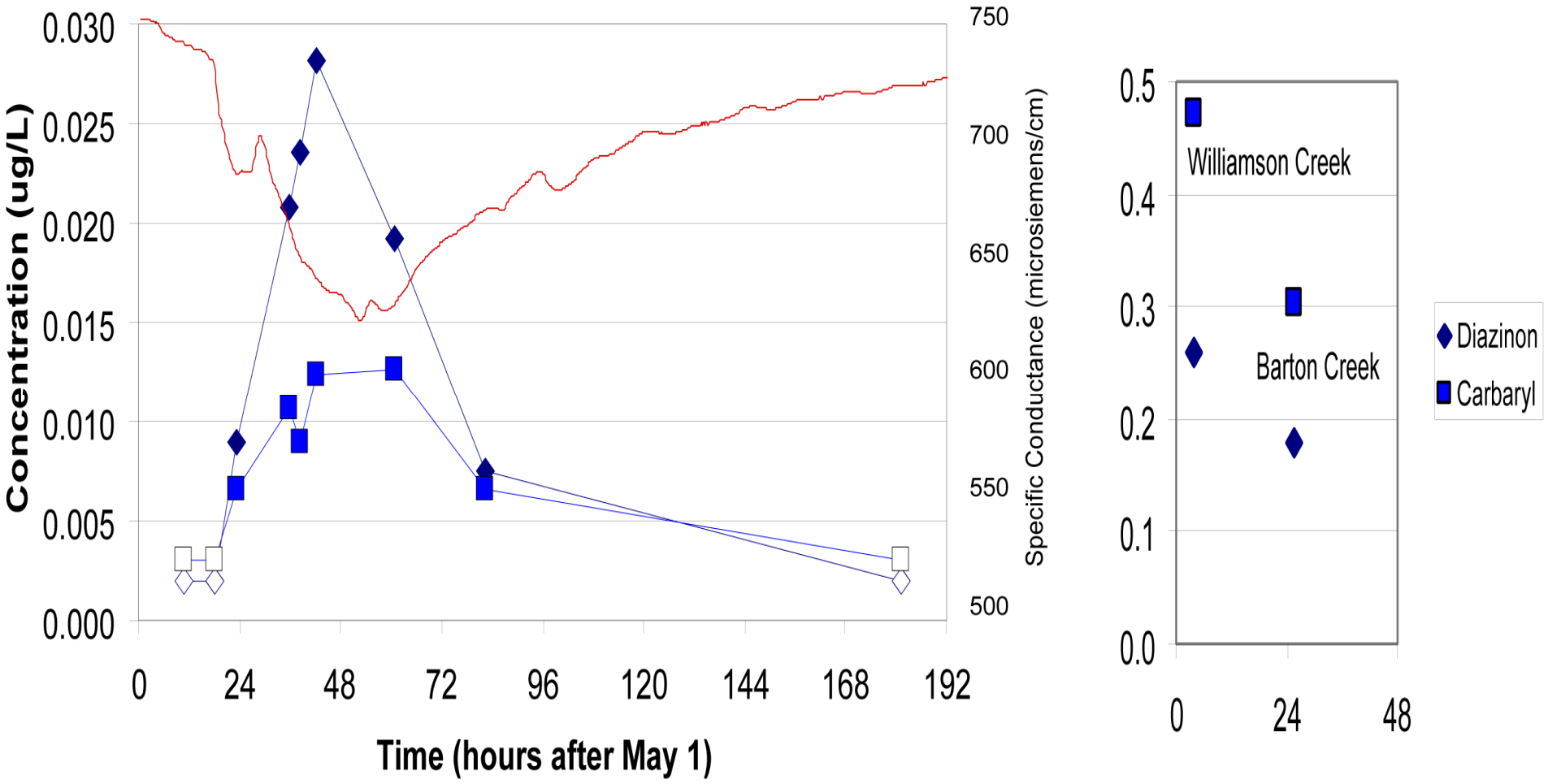

AGUA
AQUIFER GUARDIANS IN URBAN AREAS
Edwards Aquifer in Bexar County, Texas
October 7, 2005
Bexar County, Texas
Miles
0 1 2 4 6 8 10
Cibolo Creek
Salado Creek
Lewis Creek
Pecan Creek
Leon Creek
Mud Creek
West Fork Creek
Lee Creek
Helotes Creek
Olmos Creek
Medio Creek
BOERNE STAGE RD
RALPH FAIR RD
IH 10 W/US HWY 87
SCENIC LOOP RD
BABCOCK RD
BANDERA RD TX HWY 16
TX HWY 211
BORGFELD RD W
BULVERDE RD
SMITHSON VALLEY
US HWY 281 N
EVANS RD E
BLANCO RD
STONE OAK PKWY
REDLAND RD
THOUSAND OAKS DR
NW LOOP 1604
EVANS RD
NE LOOP 1604
O'CONNOR RD
JUDSON RD
TOEPPERWEIN RD
IH 35 N
WURZBACH PRKWY
STARCREST
NAKOMA DR E
BITTERS RD
DE ZAVALA RD
UTSA BV
SW LOOP 1604
PRUE RD W
PRUE RD
BRAUN RD
GALM RD
OLD FM 471
FM 471 W
FM 1560
TEZEL RD
ECKHERT RD
WURZBACH RD
MEDICAL DR
CALLAGHAN RD
MILITARY DR NW
VANCE JACKSON
WEST AV
N LOOP 410
CRESTWAY RD
WALZEM
GRISSOM RD
EVERS RD
WISEMAN BV
WESTOVER HILLS
TALLEY RD
REED RD
MILITARY DR W
SW LOOP 410
INGRAM RD
WOODLAWN A
CULEBRA RD
Legend
Creeks
Major Roads
Major Highways
County Line
Edwards_Aquifer
Contributing Zone
Contributing Zone within the Transition Zone
Recharge Zone
Transition Zone


¡ Greetings from
San Antonio !
Jewel of the Texas Hill Country



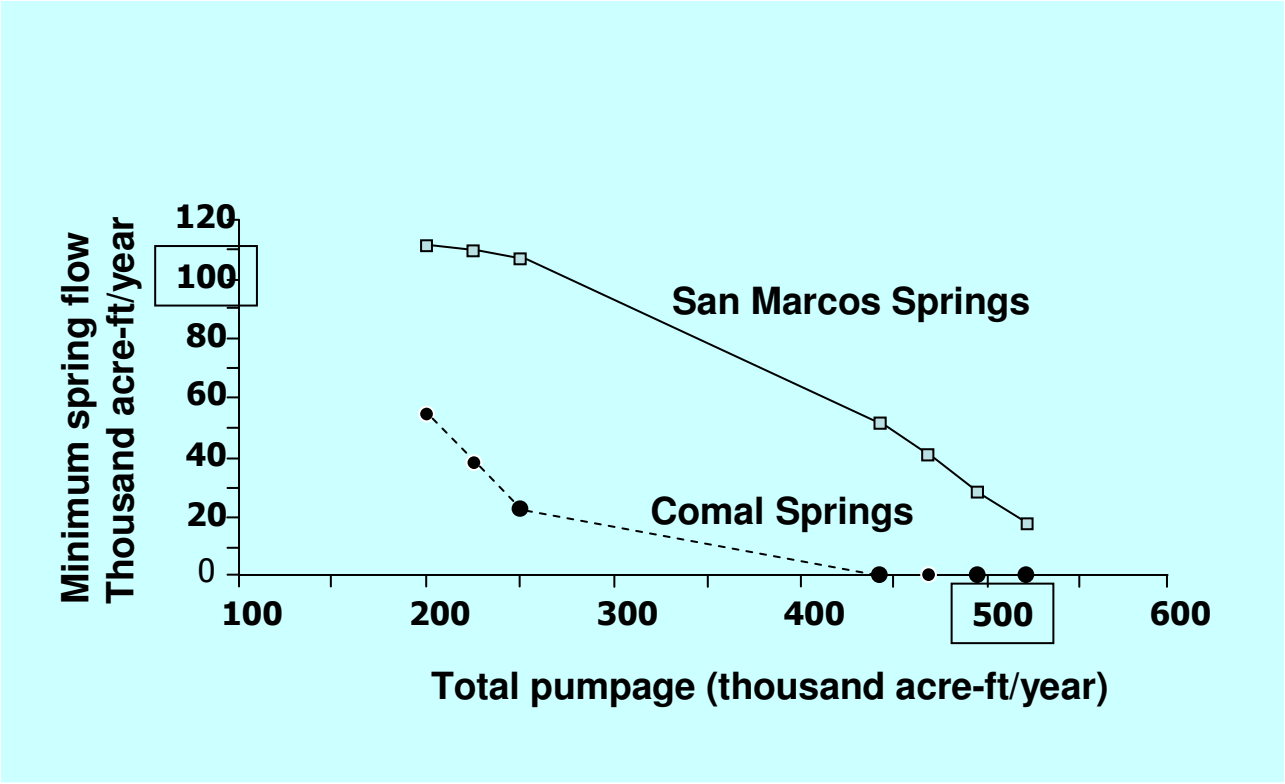
Bexar County
Public Supply Wells Found to Contain Chlorinated Solvents

Carbaryl and Diazinon in Barton Springs



Edwards Aquifer Ecosystem
a treasure at risk

Overpumping of the aquifer also threatens the economic and ecological health of the central Texas coast



Edwards Aquifer Ecosystem
A Treasure at Risk

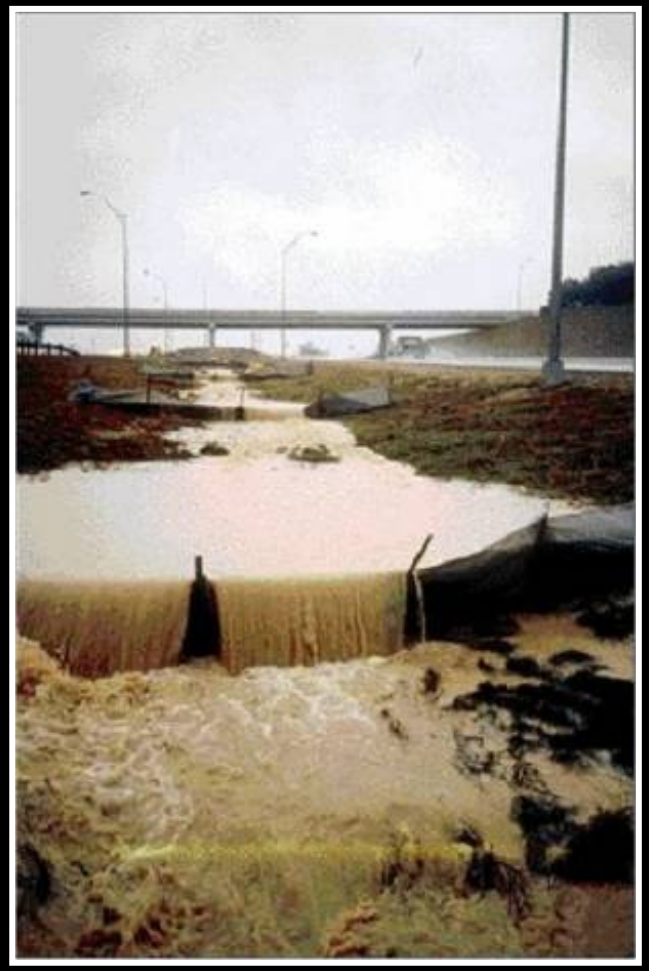
Rapid, unsustainable urbanization is pushing aquatic species to the brink of extinction

Barton Springs salamander with gas bubble disease

Edwards Aquifer Sustainability Initiative
A Need for Action

Current measures are inadequate.

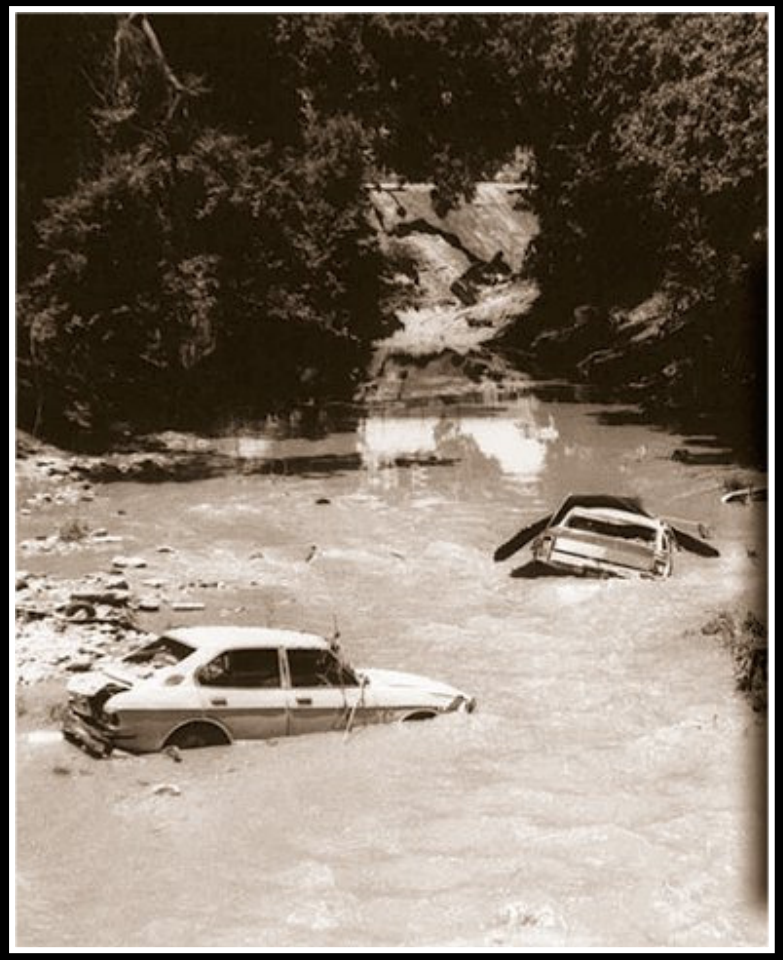
Structural controls often fail to prevent pollution.



Edwards Aquifer Sustainability Initiative
A Need for Action

Current measures are inadequate.

Increased impervious cover increases stormwater flows, erosion, and flooding.



Pollutants found in Barton Springs or Contributing Stream Sediments Above Levels which are Toxic to Aquatic Life

Heavy Metals

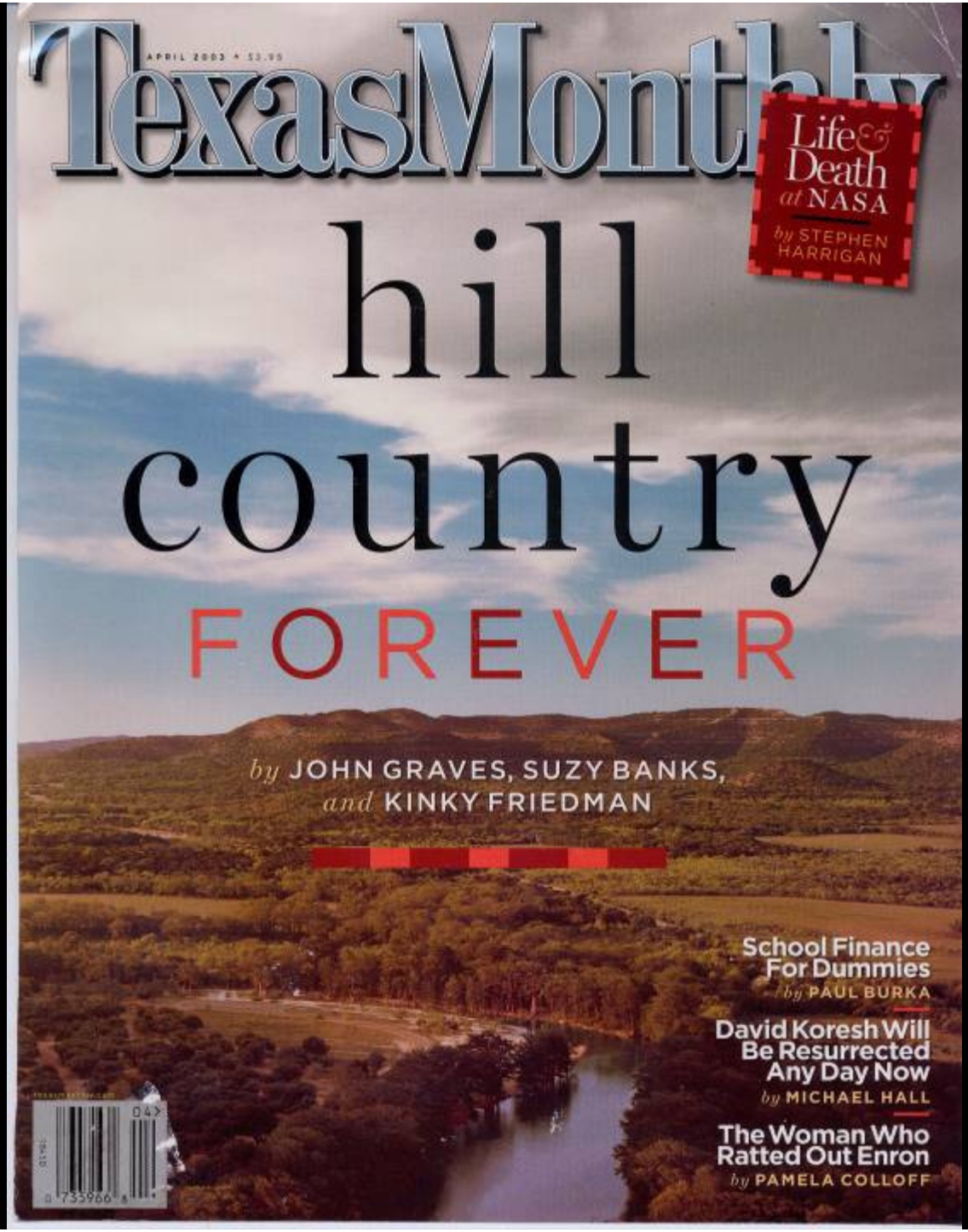
- Arsenic
- Cadmium
- Copper
- Lead
- Mercury
- Silver

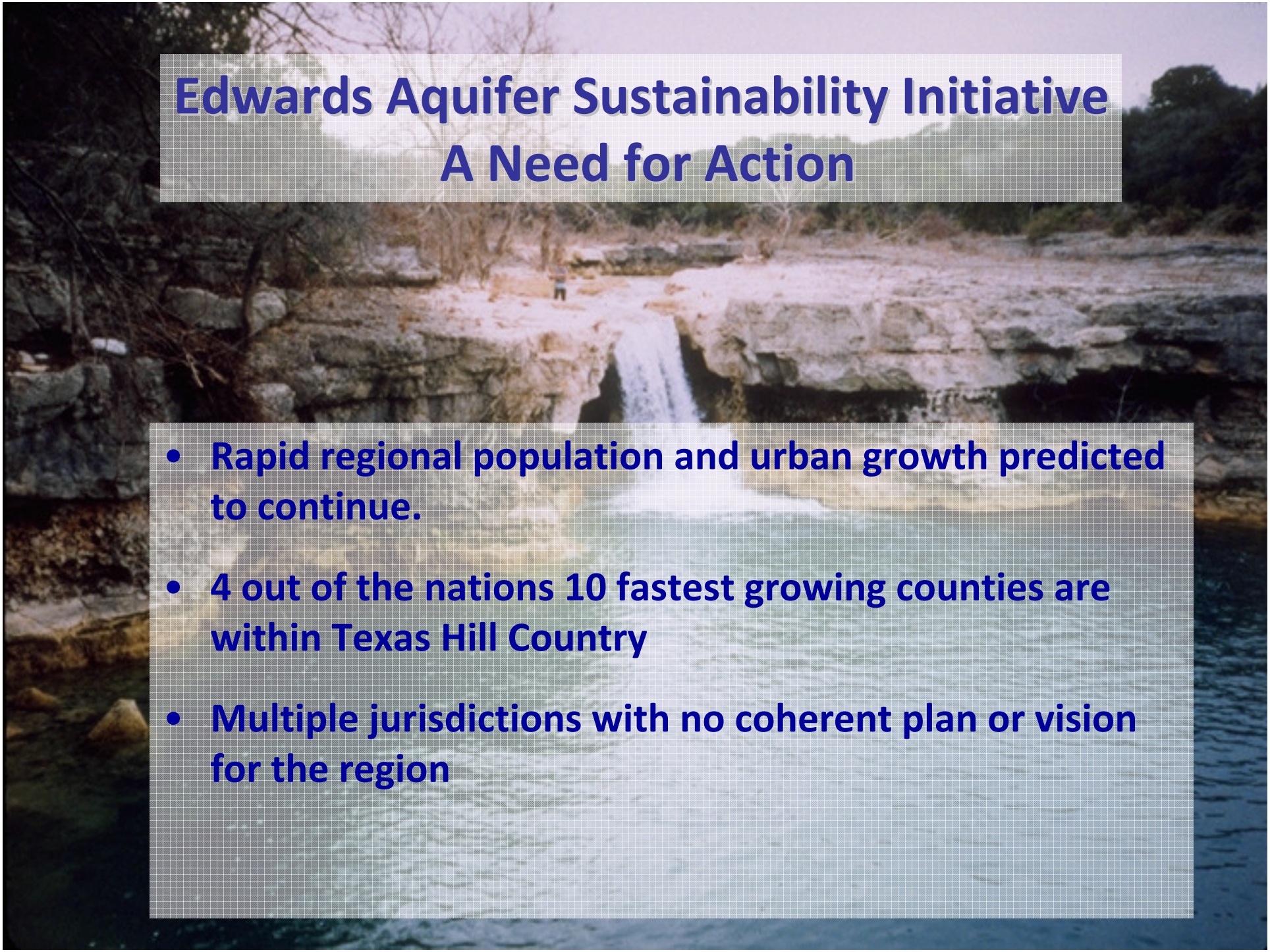
Pesticides

- P-P'-DDD
- P-P'-DDE
- P-P'-DDT
- Aldrin
- Endrin
- Heptachlor Epoxide
- Beta-BHC
- Delta-BHC
- Gamma-BHC (lindane)
- PCD

Polyaromatic hydrocarbons

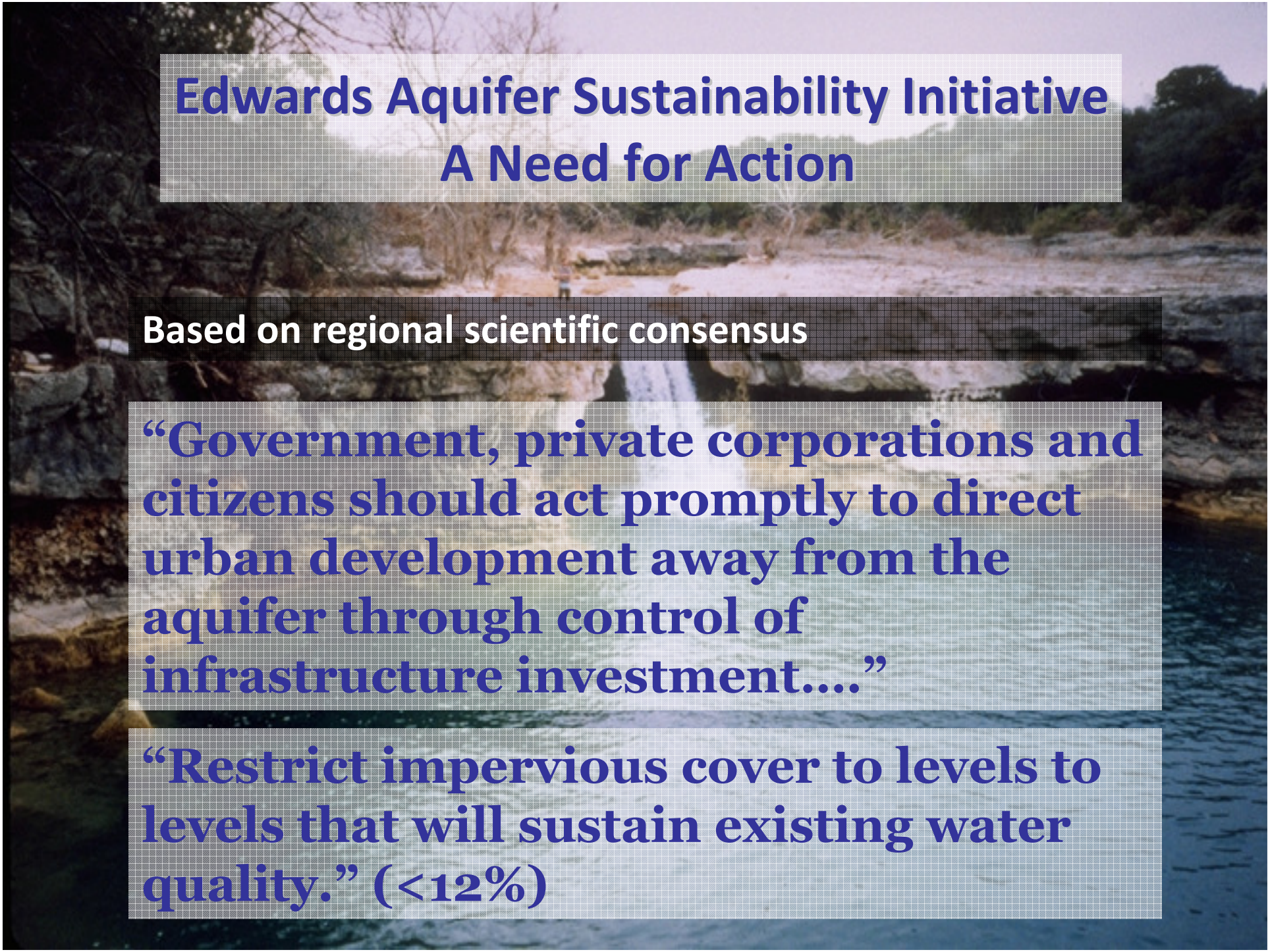
- Benzo(A)anthrocene
- Benzo(B)fluoranthene
- Benzo(K)fluoranthene
- Benzo(A)pyrene
- Chrysene
- Dibenz(AH)anthracene
- Fluoranthene
- Phenanthrene
- Pyrene


APRIL 2003 • $3.95
Texas Monthly
Life & Death at NASA
by STEPHEN HARRIGAN
hill country
FOREVER
by JOHN GRAVES, SUZY BANKS, and KINKY FRIEDMAN
School Finance For Dummies
by PAUL BURKA
David Koresh Will Be Resurrected Any Day Now
by MICHAEL HALL
The Woman Who Ratted Out Enron
by PAMELA COLLOFF



Edwards Aquifer Sustainability Initiative
A Need for Action

- Rapid regional population and urban growth predicted to continue.
- 4 out of the nations 10 fastest growing counties are within Texas Hill Country
- Multiple jurisdictions with no coherent plan or vision for the region



Edwards Aquifer Sustainability Initiative
A Need for Action

Based on regional scientific consensus

"Government, private corporations and citizens should act promptly to direct urban development away from the aquifer through control of infrastructure investment…."

"Restrict impervious cover to levels to levels that will sustain existing water quality." (<12%)

Edwards Aquifer Sustainability Initiative
A Need for Action

Based on regional economic consensus

Chamber of Commerce's "New Century Economic Report" confirms that a high quality environment is necessary for a healthy economy


Save It, Don’t Pave It

For more information about GEAA
and our member groups visit
www.AquiferAlliance.org

You may contact me:
Annalisa Peace
210-320-6294
annalisa@aquiferalliance.org


Sustainable Stormwater Management
for the Edwards Aquifer
ENTERING
EDWARDS
AQUIFER
RECHARGE ZONE
… not there yet

Some issues with the current regulations

- Development may fail to follow the natural system of drainage & recharge
- Stormwater management must be established AND stabilized before construction
- Leak inspections conducted every 5 years; leaks fixed *within 1 year*
- Improper installation and lack of maintenance are typical causes of BMP failures
- Site planning does not always lead development process

Building to regulation – isolated, single purpose, spatially dead BMP structures – and they may not work anyway

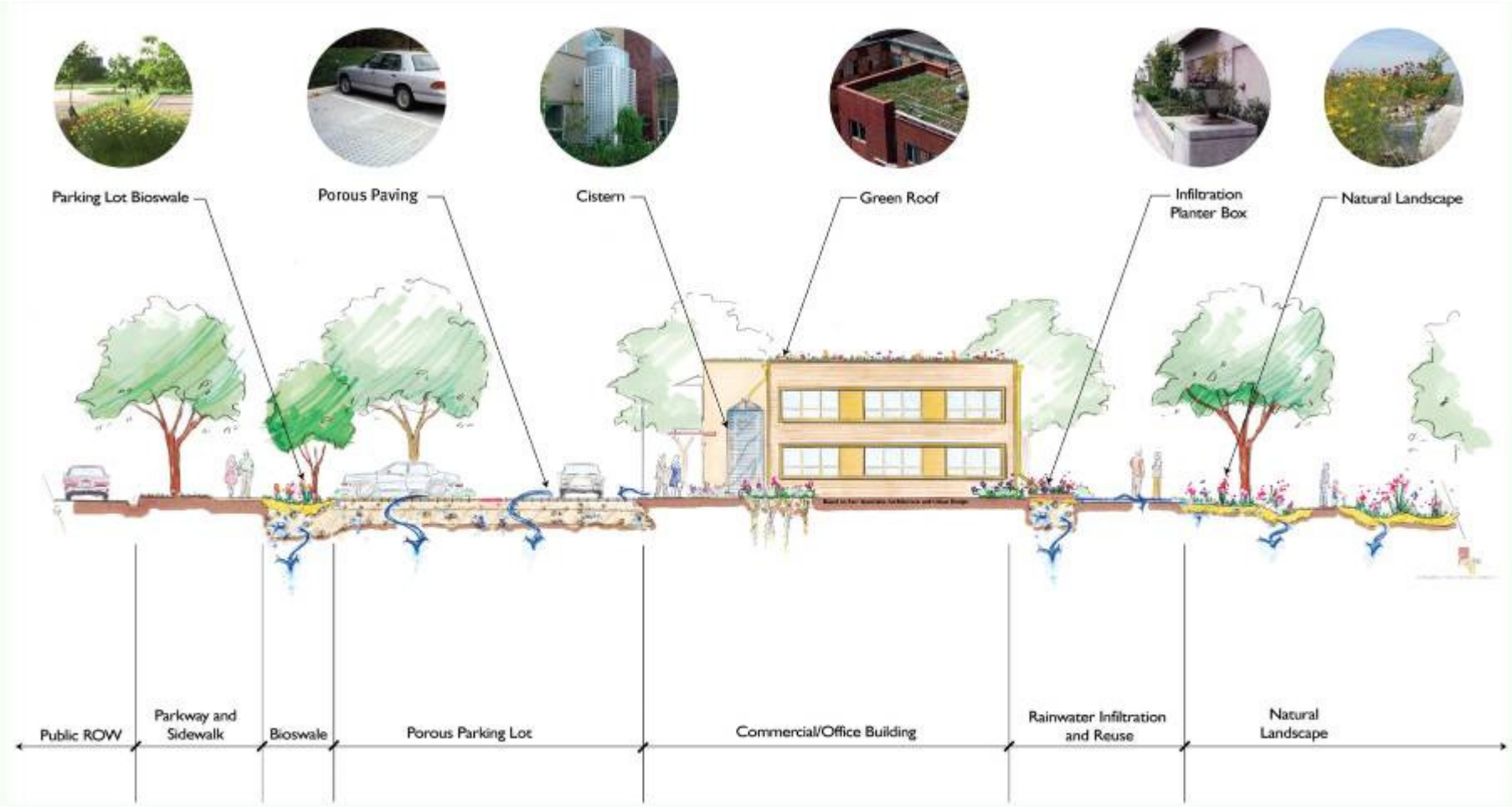
- Sand filters are primary BMP, require regular cleaning after storm events, fencing
- 10-15% of 3,000 BMPs are non-compliant

Communities across US, internationally are implementing LID as part of improved regulatory environment

Villanova University traffic island
Portland OR streetscape swale

- Biofiltration may capture up to 100% rainfall
- Filters out 95% pollutants in plant + soil layer
- Special soil mix applied in areas of thin soils
- Applications: parking lot islands, filter strips, pre-treatment swales, rain gardens

LID methods ideally used in sequence for water quality

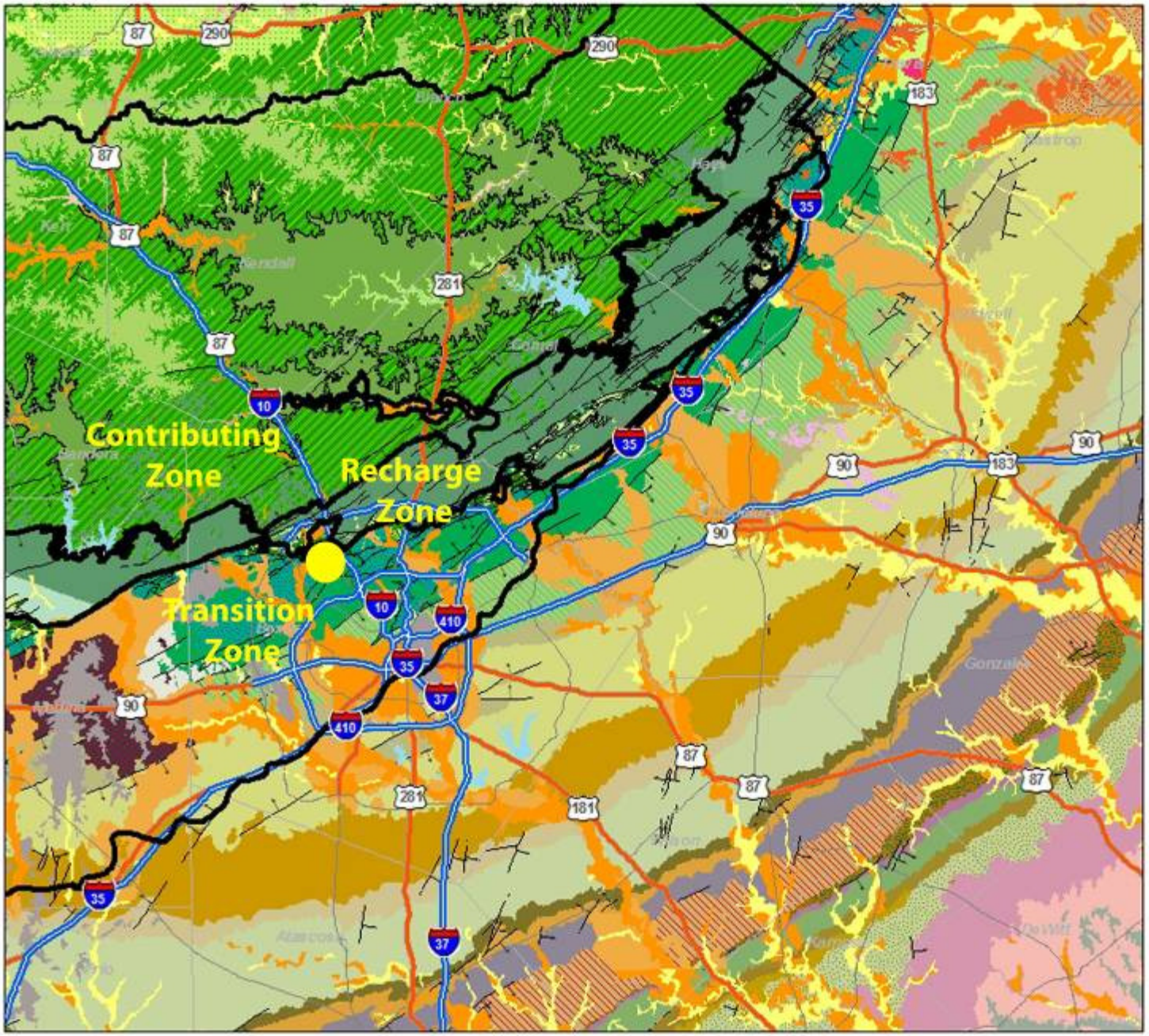


"stormwater treatment train" or recharge sequence

LID principles for the Edwards Aquifer

- **Respect the context** of the Edwards Plateau and nearby Texas Hill Country
- Balance growth with **preservation of the natural drainage** and infiltration system
- Take a systems approach to development, integrating **water planning** from the onset
- Use every **building project as an opportunity** to improve groundwater collection, quality and monitoring
- Integrate aquifer management into site programs through **LID multiple use** projects

Respect the context of the land



Geology Map with Major Aquifer Zones

source: Texas Geology Map 1999

Karst regions have special issues for LID

- Stormwater runoff carries pollutants from impervious roadways and parking lots, which enter aquifer quickly through porous karst.
- Stormwater in urbanizing karst regions tends to concentrate water, eroding and destabilizing limestone bedrock.
- Investigation of subsurface geology and avoidance of known sinkhole areas important if considering use of infiltration

Balance growth with preservation of the natural drainage and infiltration system

75% of aquifer recharge infiltration occurs in streambeds

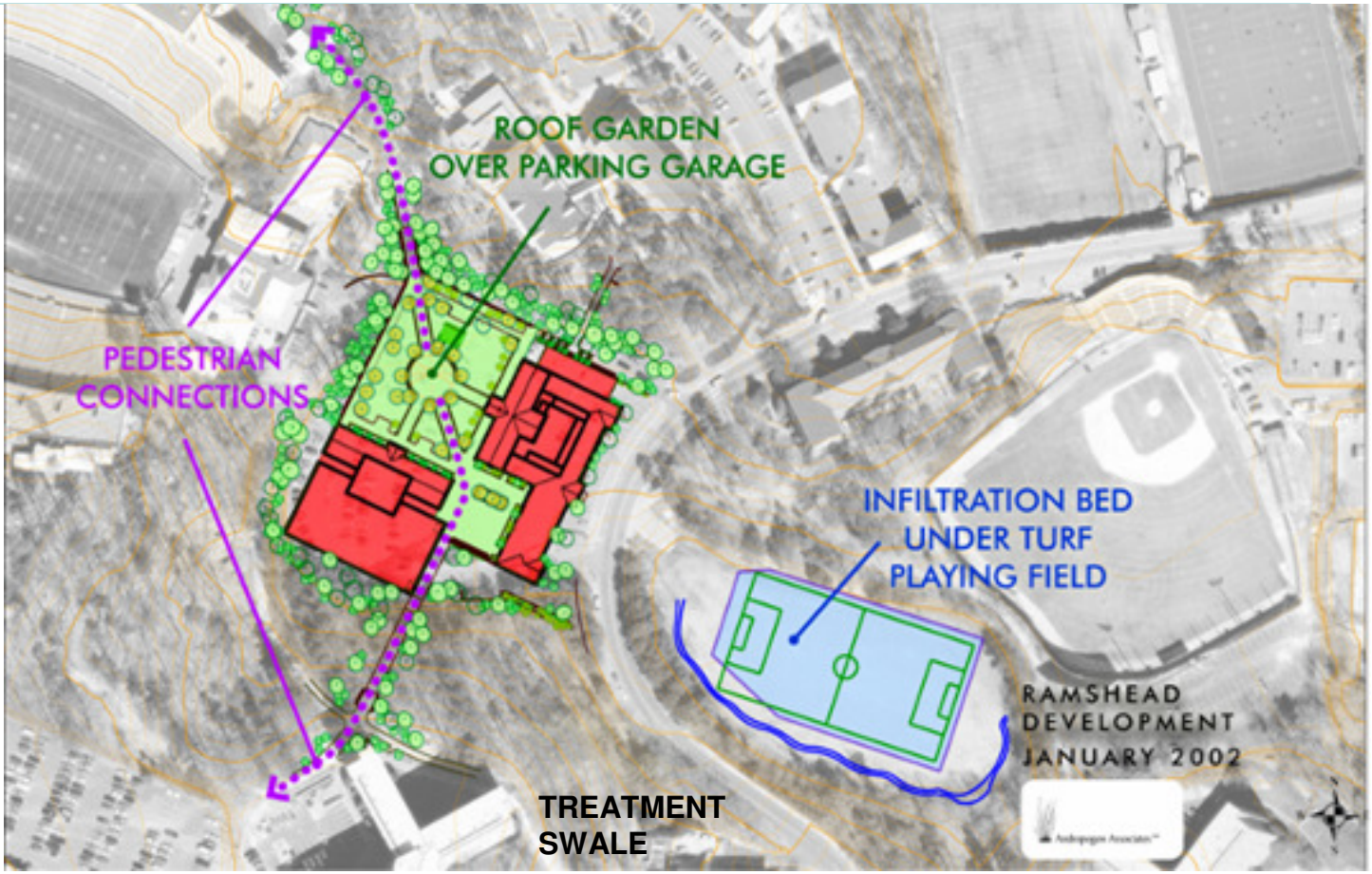
Case study:
UNC Stormwater Master Plan 2004

Taking a systems approach to water protection from the onset of new development

Figure 1-7 EIGHT-YEAR DEVELOPMENT PLAN SHOWING NEW BUILDINGS, TOPOGRAPHY AND IMPERVIOUS SURFACE *(July 2003)*

LID practices meet & beat federal, state regulations for controlling runoff, improving water quality

UNC
Stormwater Plan
Implementation



- Rainwater harvested from roofs **reduces detention** requirements
- Floodplain functions restored to channelized stream

Reduce detention, practice multiple use

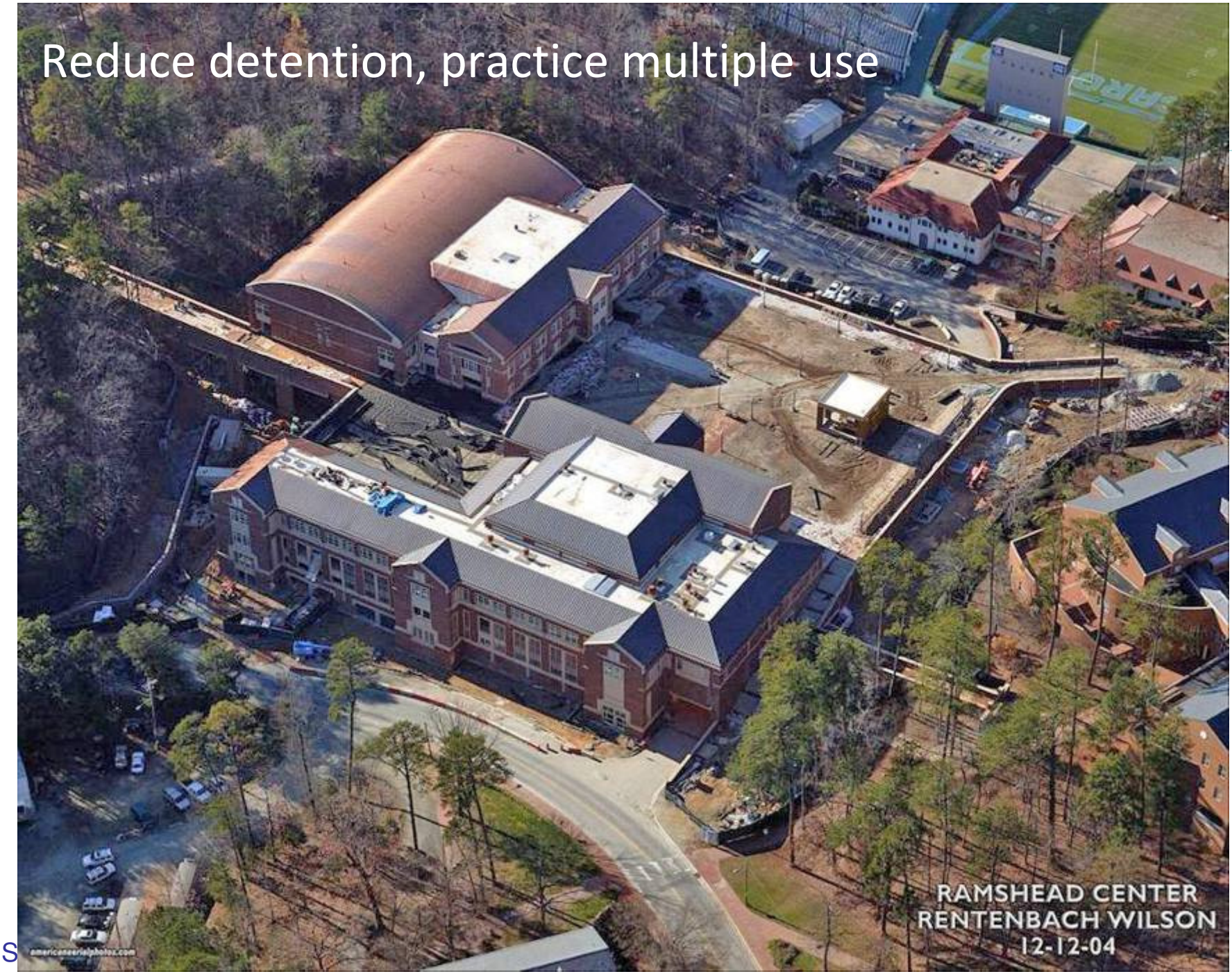


Figure 5-22
SECTION THROUGH PLAZA SHOWING GREEN ROOF AND RECEIVING SWALE IN LANDSCAPE FOR STORMWATER OVERFLOW

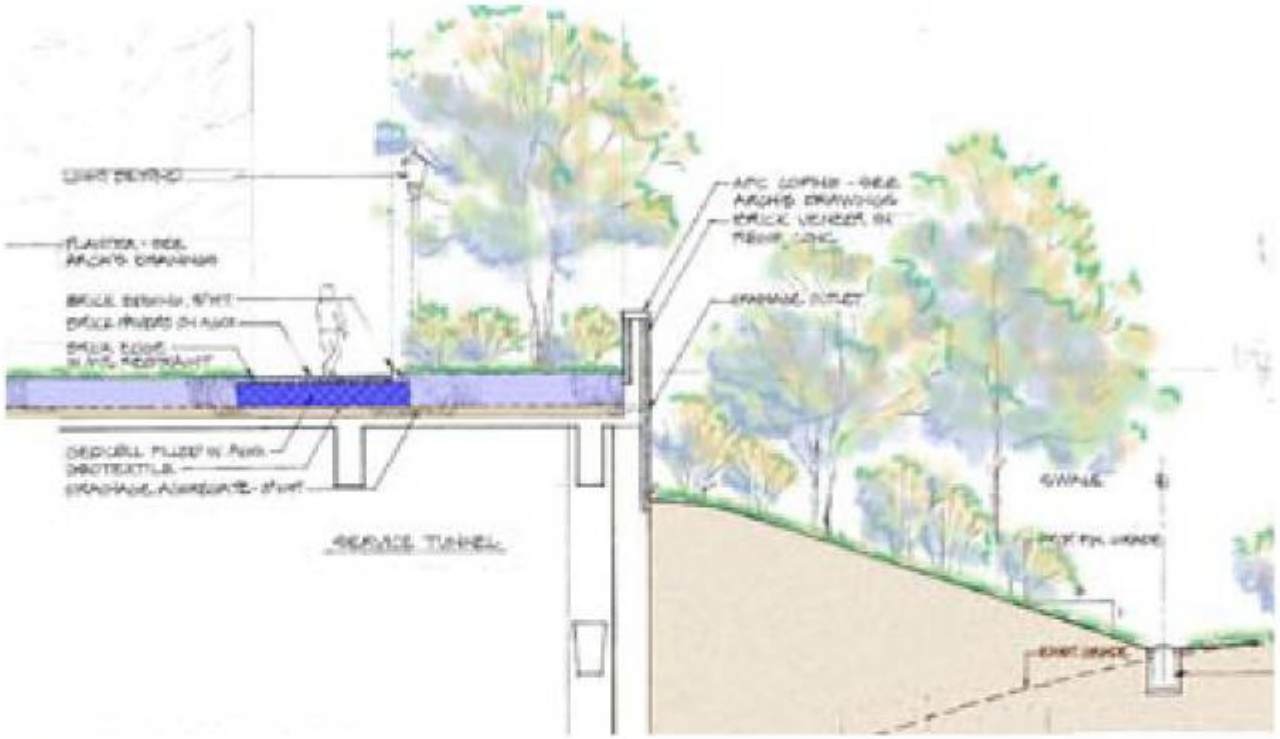
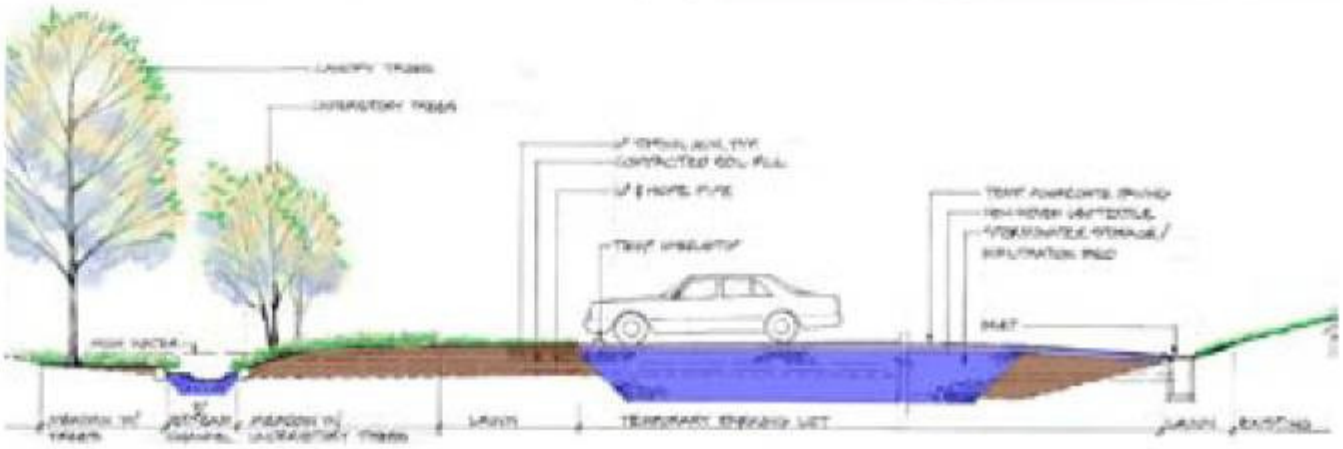


Figure 5-23
CONCEPTUAL SECTION THROUGH EHRINGHAUS FIELD SHOWING STORMWATER STORAGE/ INFILTRATION SYSTEM CONSTRUCTED UNDER TEMPORARY PARKING

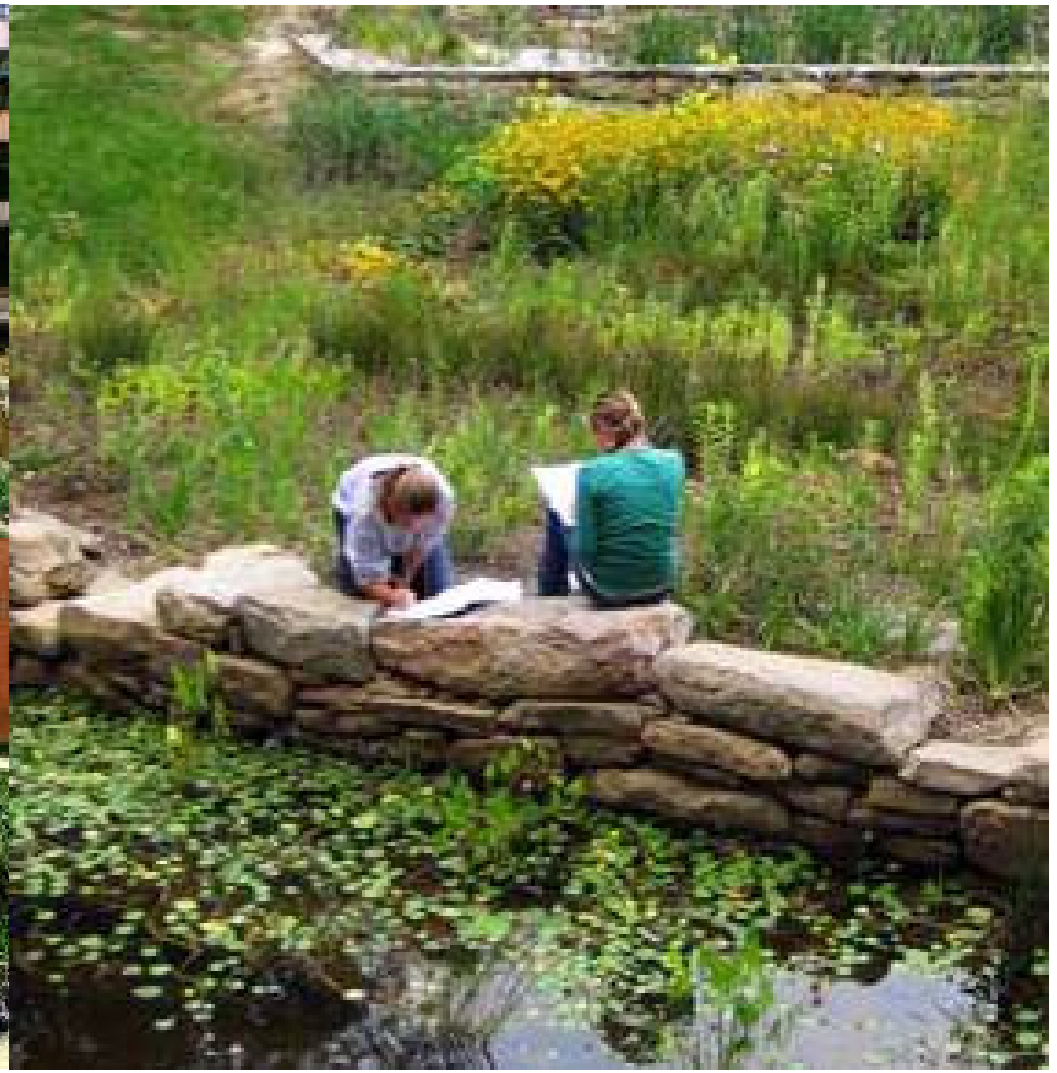


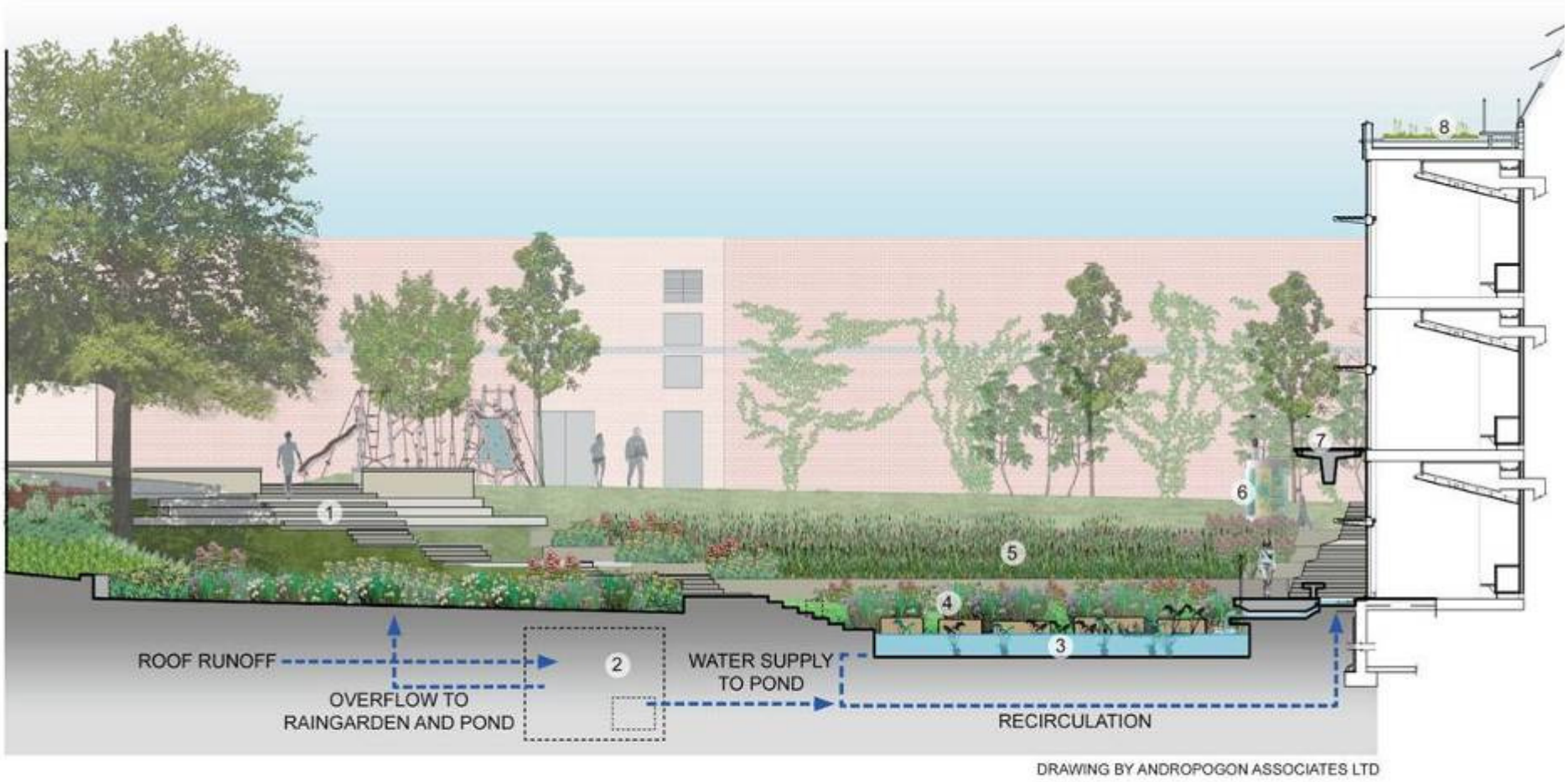
Multipurpose campus space protects stream valley, saves water & enriches community life

Use every building as an opportunity – capture LEED credits, save energy, integrate landscape

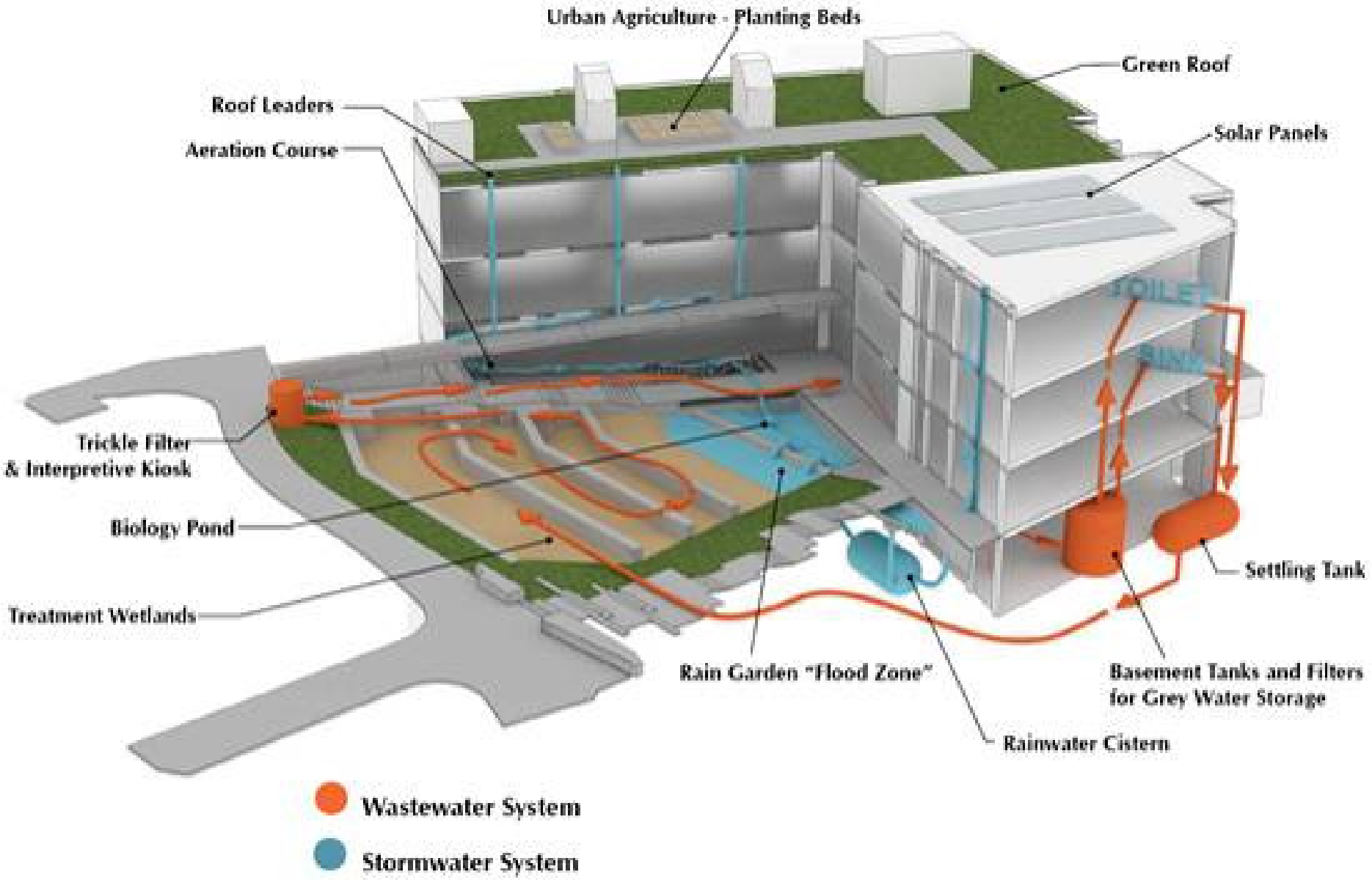
Water treatment integrated with green building – Sidwell Friends Middle School, NW Washington DC

Water treatment as part of curriculum
Opportunity for LEED ID credit + grant funding



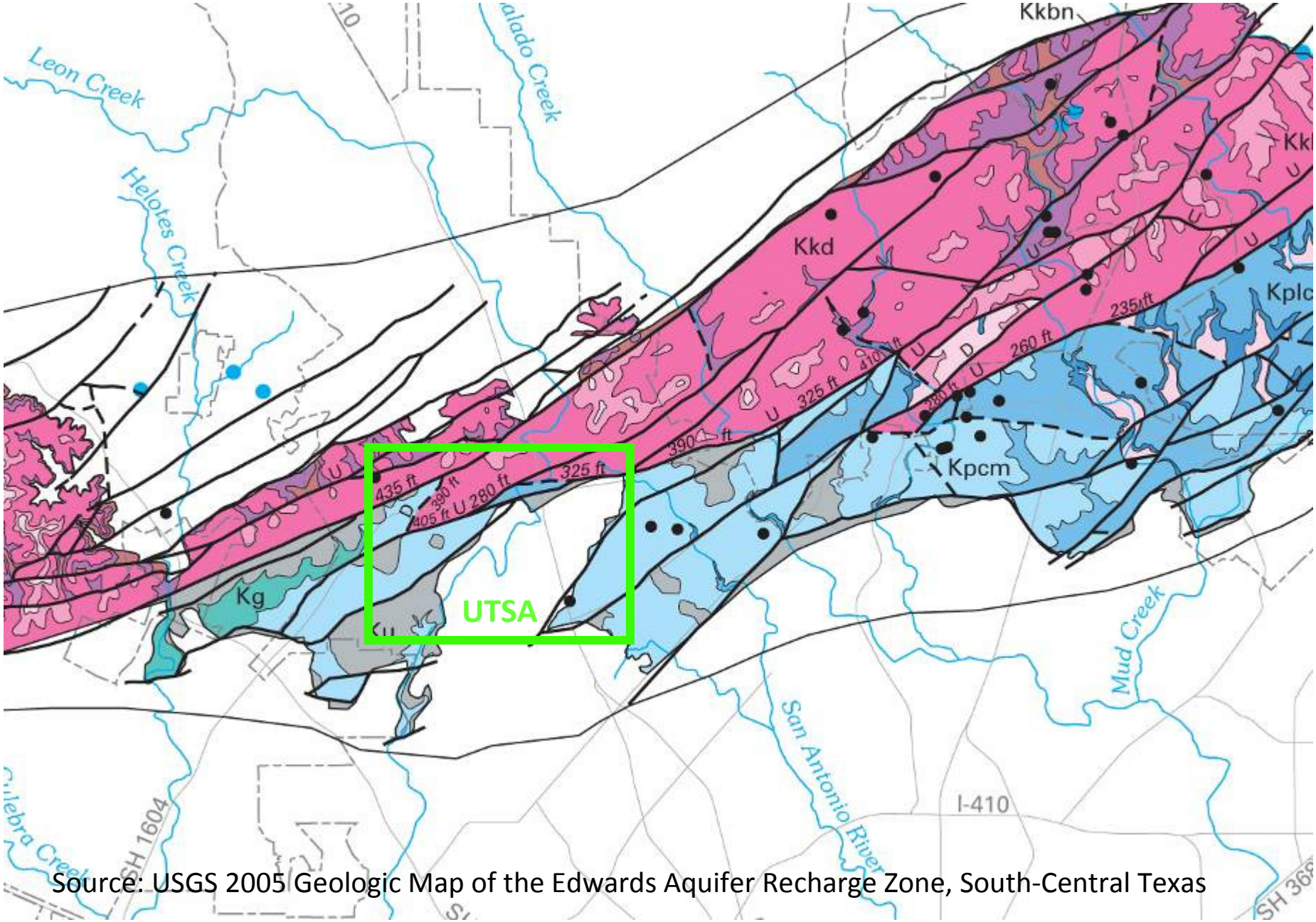


1. OUTDOOR CLASSROOM
2. CISTERN
3. POND
4. RAIN GARDEN
5. WETLANDS FOR WASTEWATER TREATMENT
6. TRICKLE FILTER WITH INTERPRETIVE DISPLAY
7. RAMP TO SECOND FLOOR ENTRY
8. GREEN ROOF

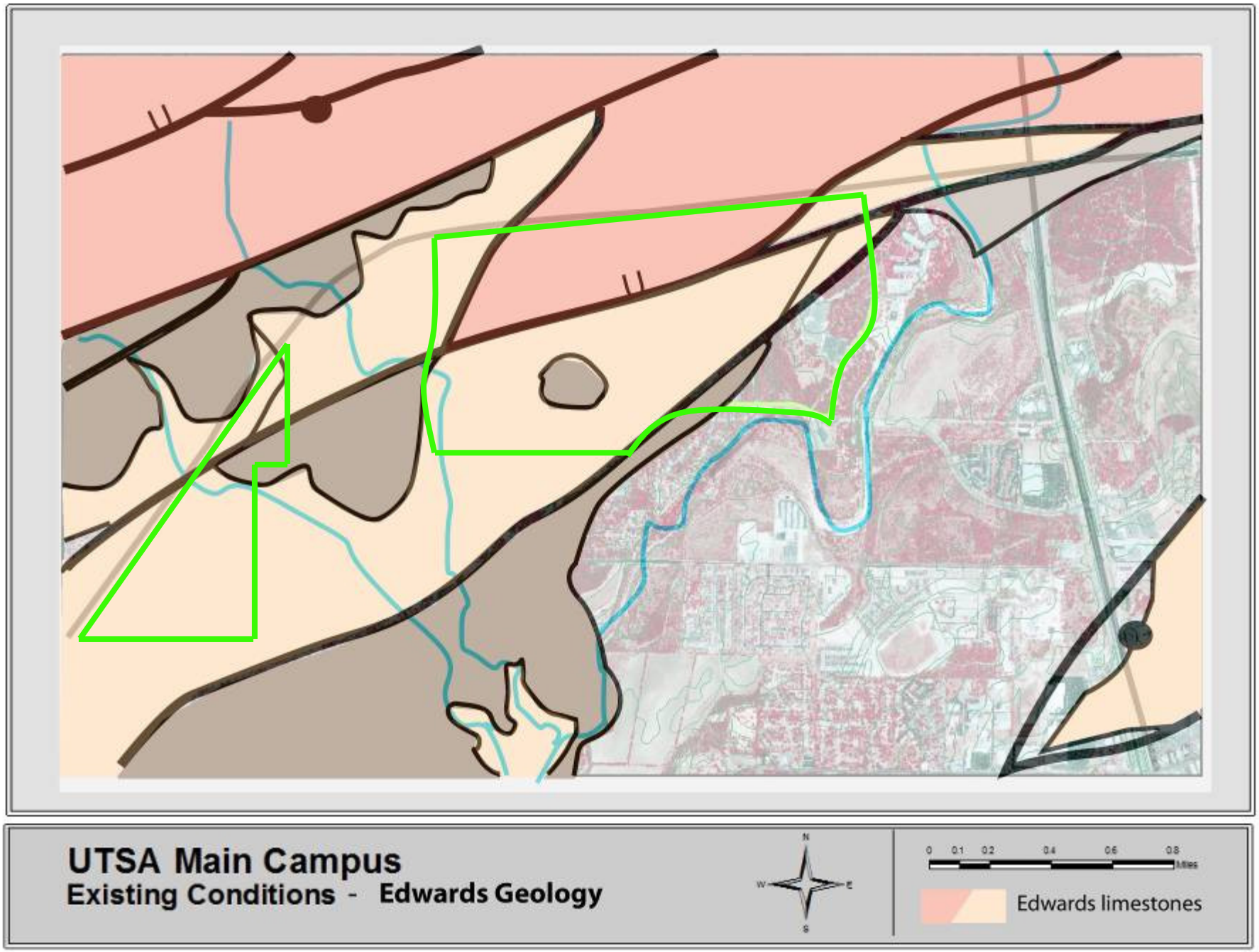

Urban Agriculture - Planting Beds
Green Roof
Roof Leaders
Aeration Course
Solar Panels
Trickle Filter
& Interpretive Kiosk
Biology Pond
Treatment Wetlands
Settling Tank
Rain Garden "Flood Zone"
Basement Tanks and Filters
for Grey Water Storage
Rainwater Cistern
Wastewater System
Stormwater System

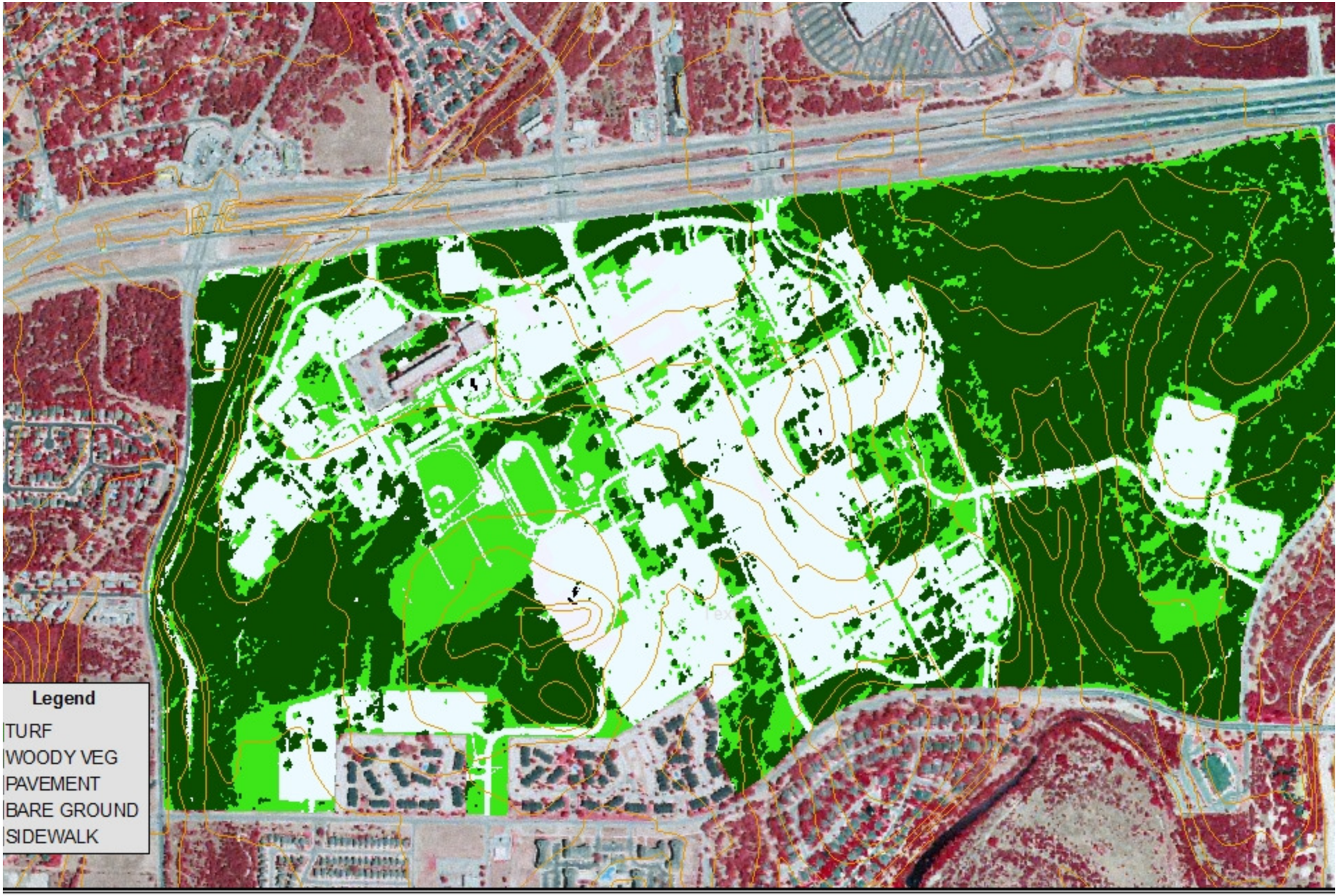
LID principles for the Edwards Aquifer

- Respect the context of the Edwards Plateau and nearby Texas Hill Country
- Balance growth with preservation of the natural drainage and infiltration system
- Take a systems approach to development, integrating water planning from the onset
- Use every building project as an opportunity to improve groundwater collection, quality and monitoring
- **Integrate aquifer management into site programs through LID multiple use projects**



Source: USGS 2005 Geologic Map of the Edwards Aquifer Recharge Zone, South-Central Texas


UTSA Main Campus
Existing Conditions - Edwards Geology
N
W
E
S
0 0.1 0.2 0.4 0.6 0.8
Edwards limestones



UTSA Main Campus

Existing Conditions Land Cover

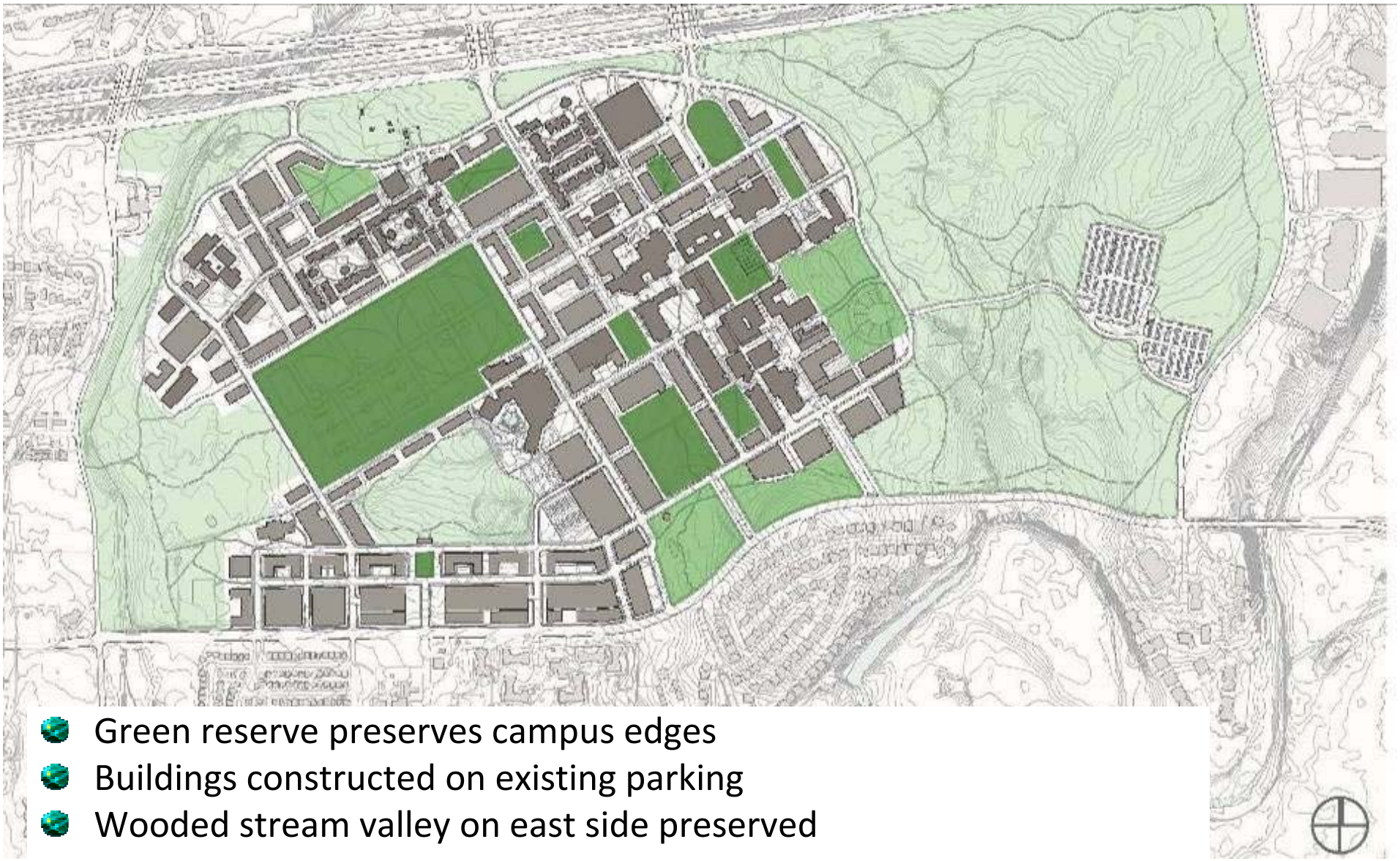
N
W E

0 0.1 0.2 0.4 Mil

UTSA Main Campus – campus core has large hardscape areas

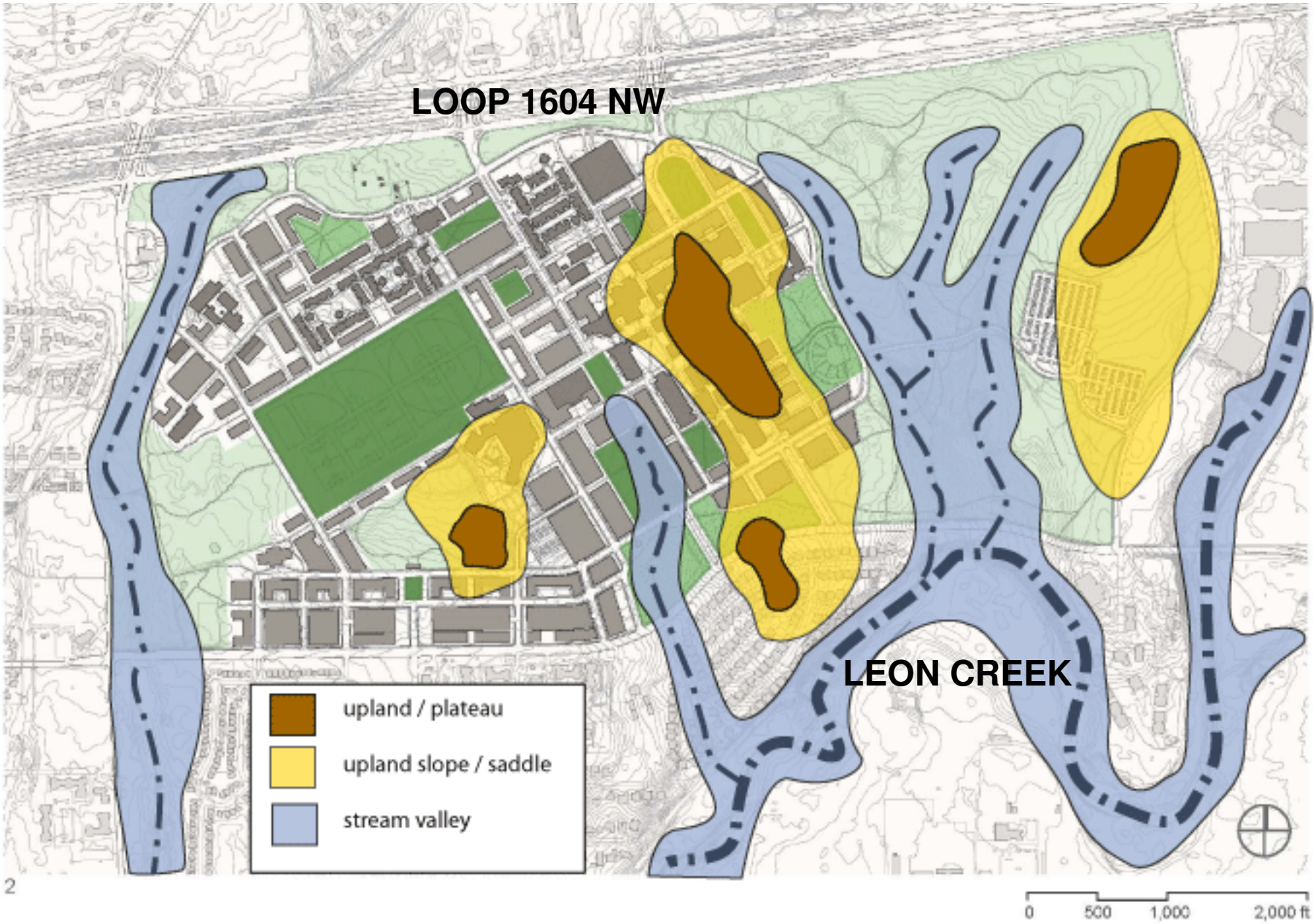
UTSA Main Campus – native landscape, maintained landscape

UTSA 2009 Master Plan – dense building grid predominates

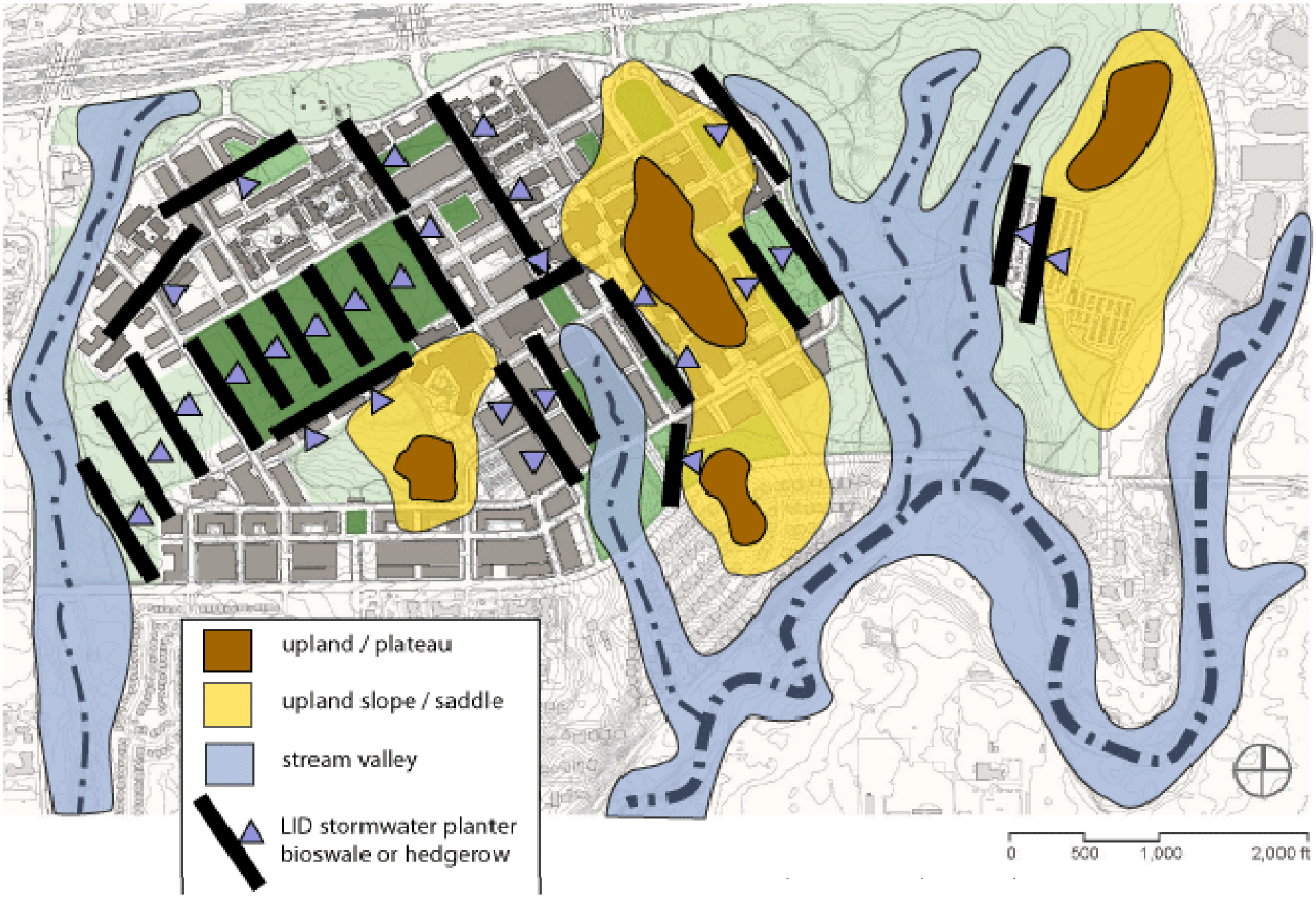


- Green reserve preserves campus edges
- Buildings constructed on existing parking
- Wooded stream valley on east side preserved

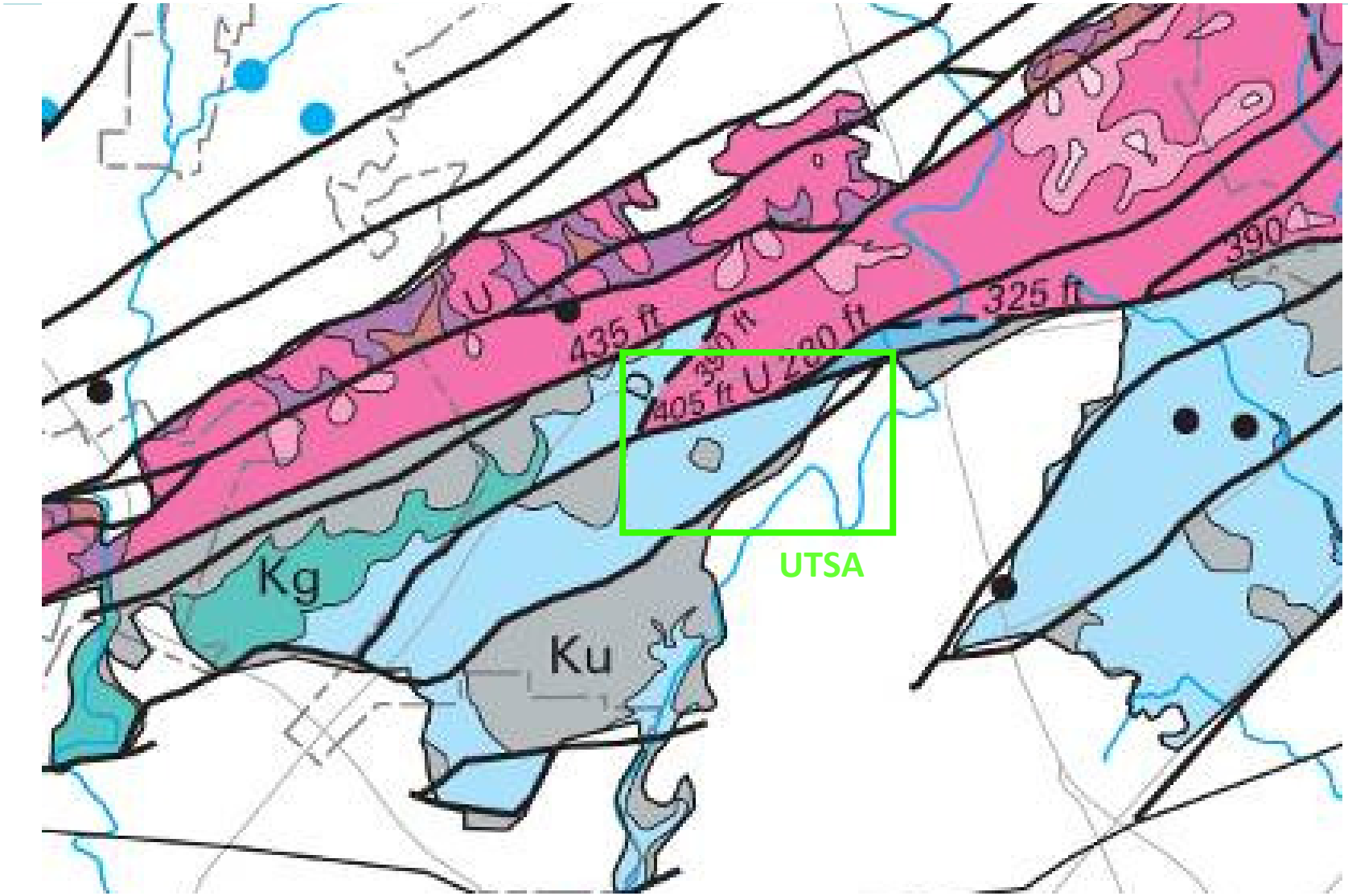
First goal of aquifer management: protect stream recharge



Location of linear LID features can protect aquifer recharge

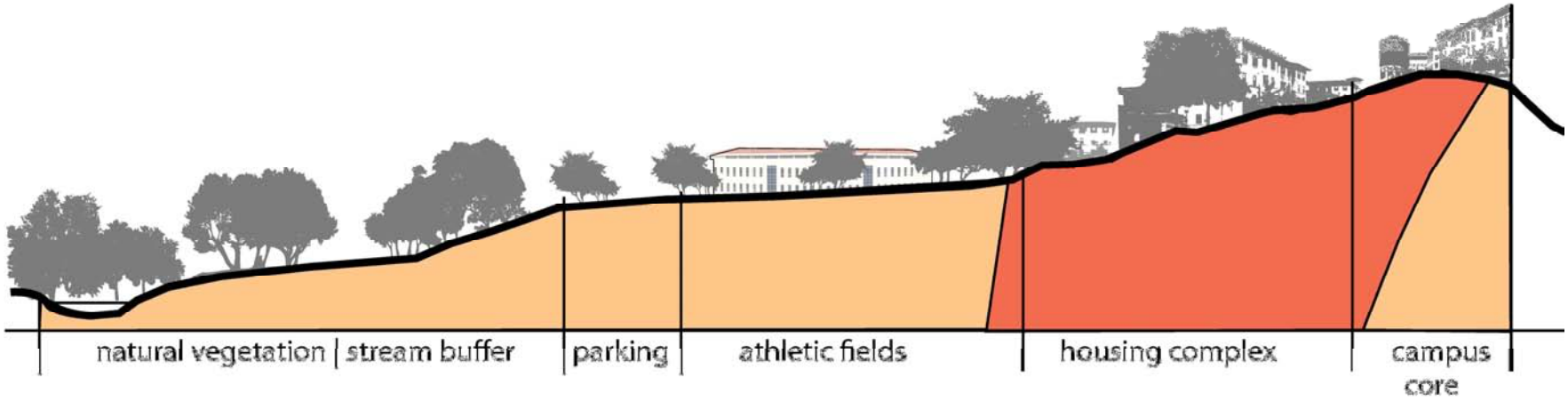


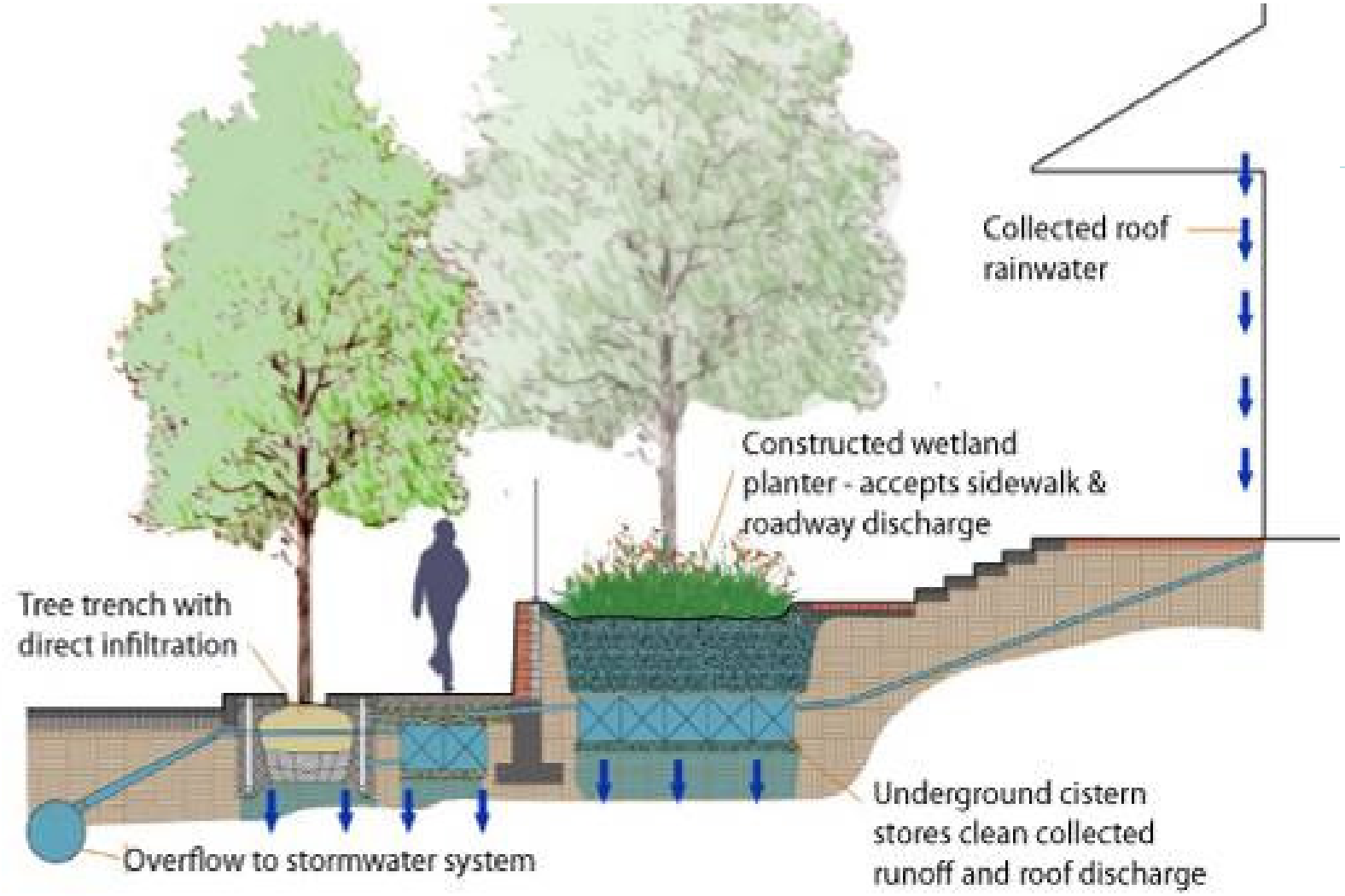
Geologic features influence patterns of campus development and inform the type of LID implementation



Campus core and planned housing are over the permeable Edwards limestone

- Clean water captured at source can be directly infiltrated
- Parking and vehicle use areas should be minimized

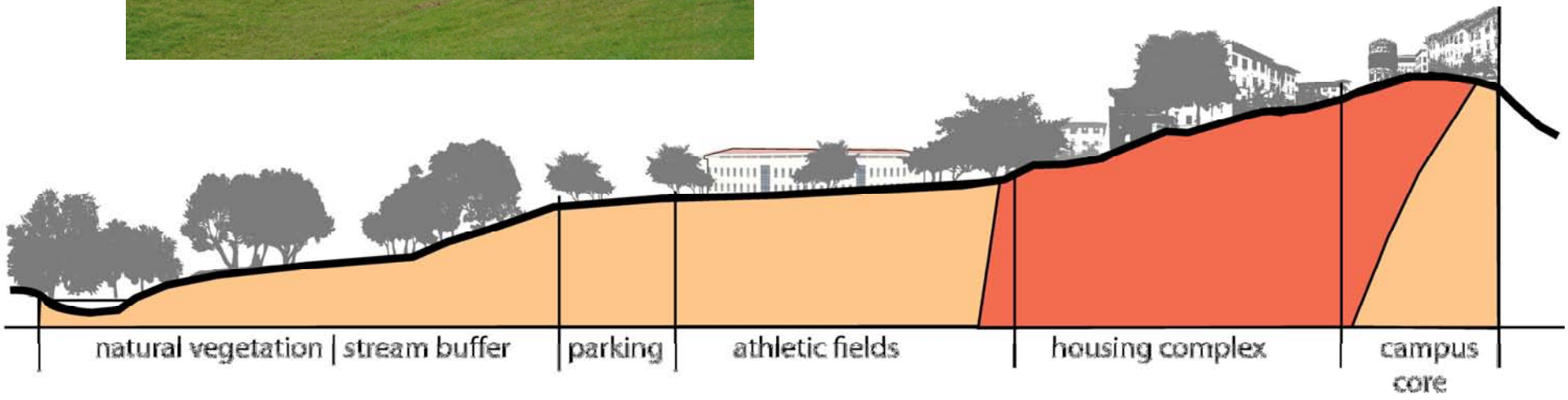




- Rainwater from roofs is stored separately in cisterns for reuse
- Stormwater from sidewalks, paved surfaces must be treated with bioretention prior to recharge

Proposed campus expansion, athletic fields and most parking is located in less permeable limestones

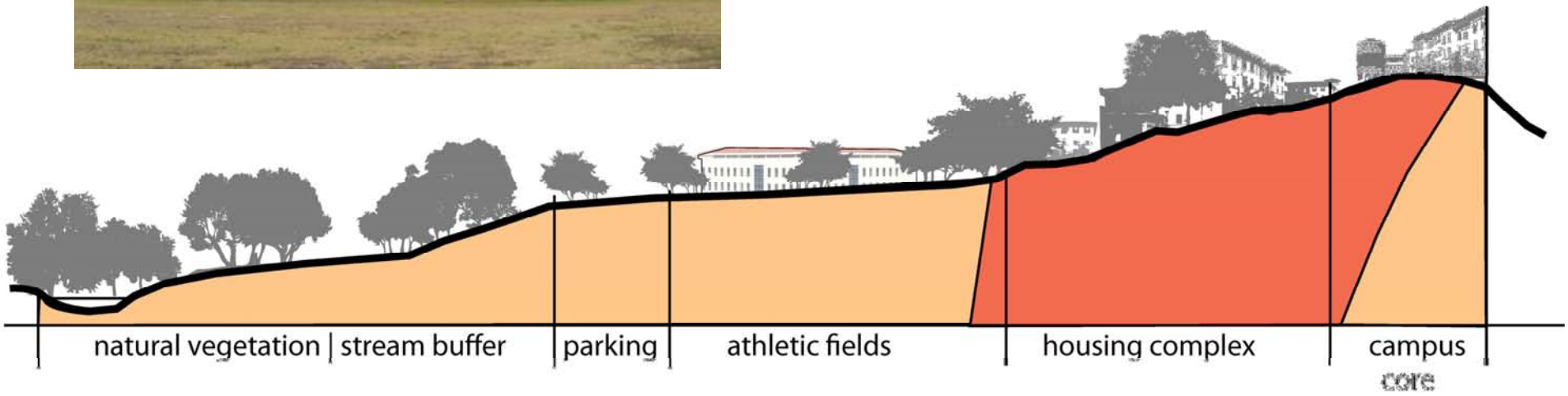
- Water simply drains to pipes with no treatment



Treatment swales with amended soils for infiltration

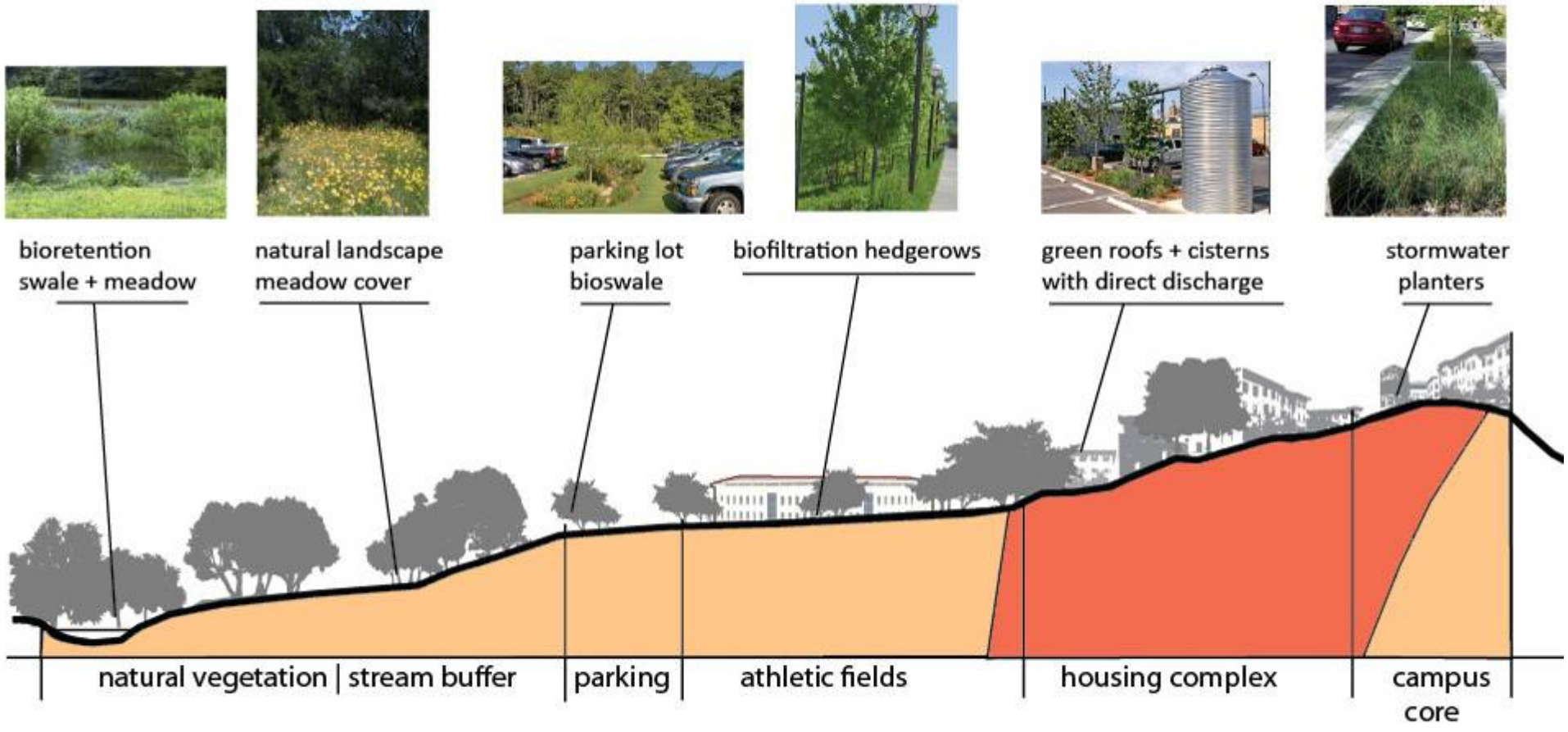
Proposed campus expansion, athletic fields and most parking is located in less permeable limestones

- Runoff from sports fields receives minimal treatment in grass swales



Hedgerow swales combine treatment with shade, habitat

Using LID as “treatment train” will improve recharge amount, improve water quality and integrate landscape + buildings

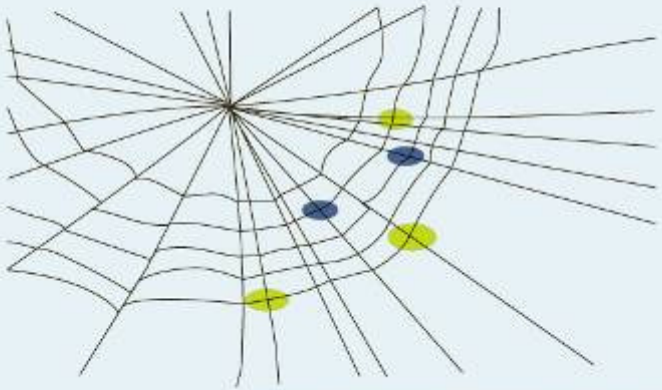


Swales, bioretention & tree trenches used in combination


Tree trenches
Meadow strips
Hedgerow swales
Green roof
Bioretention swales
FIGURE 1
Plan of the proposed Central Campus, Phase 1, representing approximately 4.5 million total gsf
Existing UTSA Buildings, approximately 3.7 million gsf
Future UTSA Buildings, Phase 1, approximately 850,000 gsf

UrbanBiology

design + planning for a living world



www.urbanbiology.net

Marita Roos RLA AICP LEED^{AP}

maritaroos@urbanbiology.net


I DON'T BELIEVE IN
GLOBAL WARMING