

HARRIS-GALVESTON



SUBSIDENCE  
DISTRICT

# SUBSIDENCE IN THE HOUSTON REGION

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Presented by:

**Michael Turco**

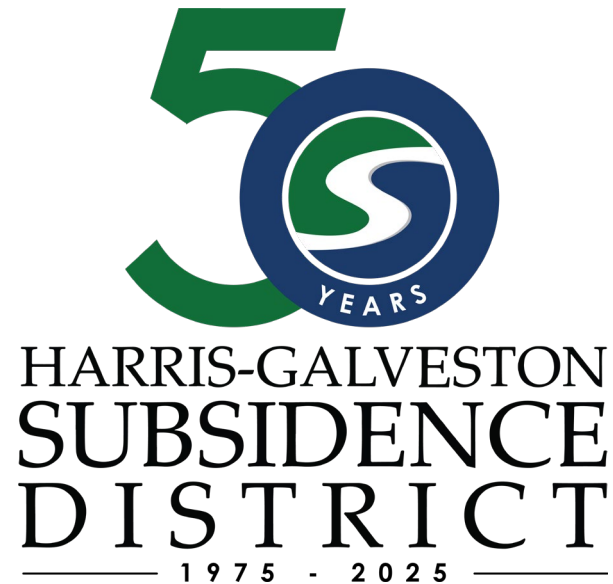
General Manager

Harris-Galveston Subsidence District



# Harris-Galveston Subsidence District

The Harris-Galveston Subsidence District (HGSD) is a special-purpose district created by the Texas Legislature in 1975 to prevent further land subsidence in Harris and Galveston counties.



## GROUNDWATER REGULATION

- Collaborating with local groundwater conservation districts, regional water providers, and other water agencies to manage groundwater use through water planning and well permitting.

## SCIENCE & RESEARCH

- Utilizing the highest quality data and research to monitor groundwater usage, aquifer characteristics, and land surface changes as well as analyzing the best-available predictive models.

## WATER CONSERVATION

- Equipping permittees, residents, businesses, and educators with water conservation tools and resources to reduce water usage and empower the community to value water.

# Collaboration



## Local Agencies

- Water providers (cities, MUDs, regional water authorities)
- Groundwater Conservation Districts
- Harris County Flood Control District

## State Agencies

- Texas Department of Transportation
- Texas Water Development Board

## Federal Agencies

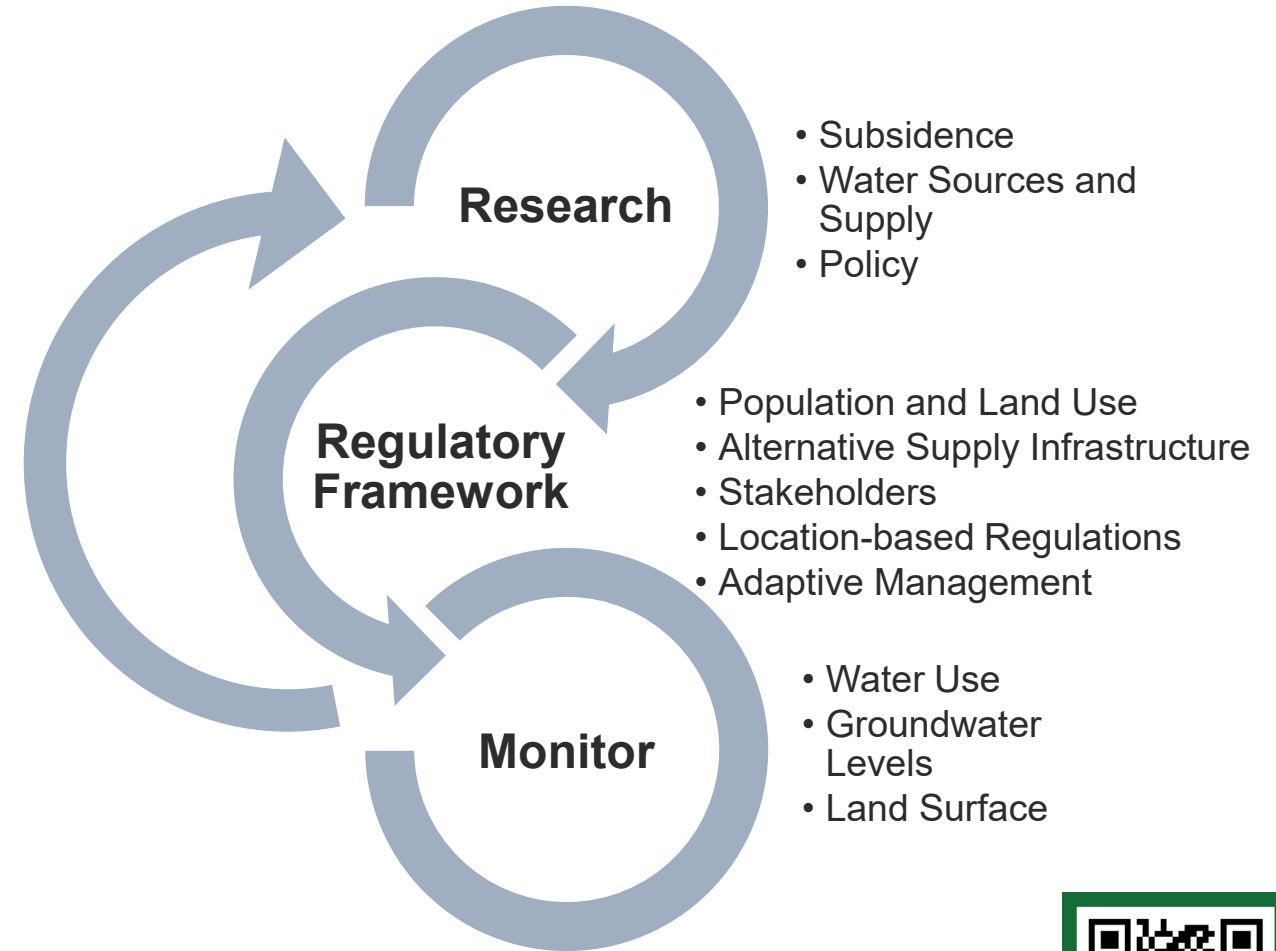
- United States Geological Survey
- National Geodetic Survey

## Universities

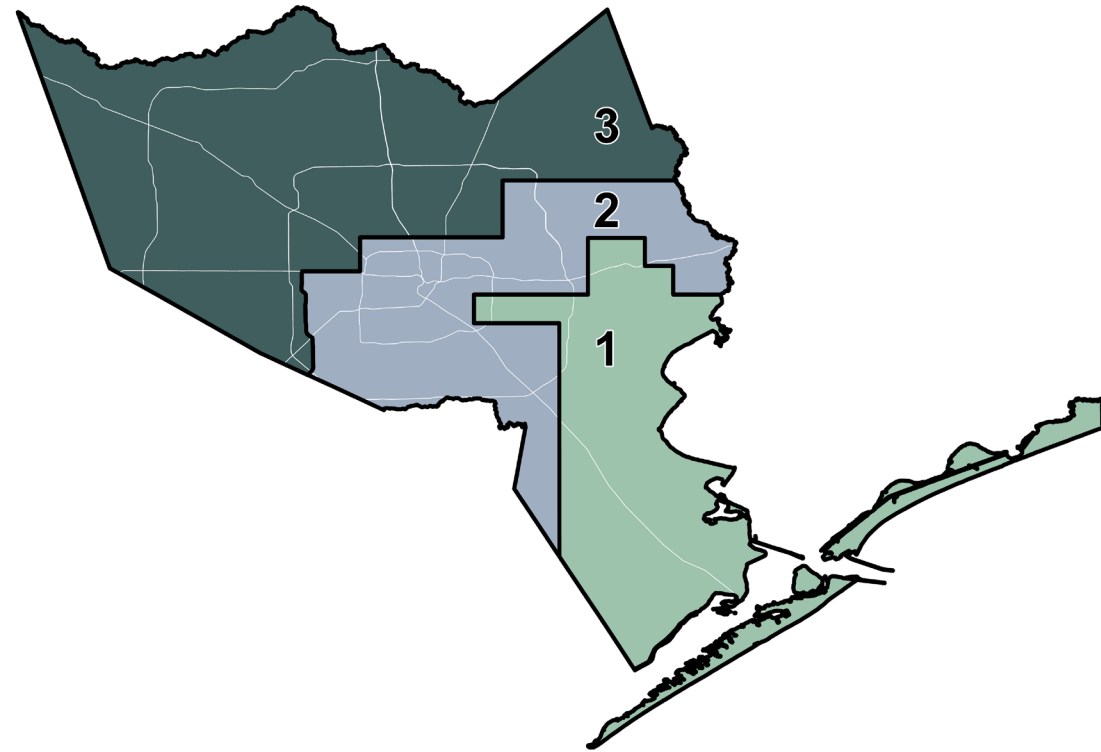
- University of Houston
- Southern Methodist University
- Conrad Blucher Institute – Texas A&M Corpus Christi

# Science-based Groundwater Regulation

- **Conduct research**
- **Identify where subsidence is occurring**
- **Communicate with stakeholders**
- **Establish a regulatory framework**
- **Implement a monitoring program**
- **Continue research and outreach**



# HGSD's Regulatory Areas



- **Area 1:** No more than 10% of Total Water Demand (TWD) may be sourced from groundwater.
- **Area 2:** No more than 20% of TWD may be sourced from groundwater.
  - Groundwater Reduction Plan (GRP) may be approved with conditions.
- **Area 3:** No more than 20% of TWD may be sourced from groundwater.
  - Permittees operating within an approved GRP have the following requirements:
    - 2010 – reduce groundwater use to no more than 70% of TWD
    - 2025 – reduce groundwater use to no more than 40% of TWD
    - 2035 – reduce groundwater use to no more than 20% of TWD

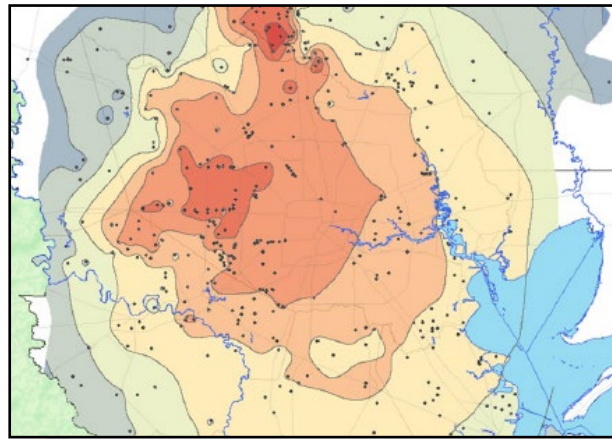
# Subsidence Monitoring

Monitoring the occurrence of subsidence and the impact of groundwater withdrawal requires consistent collection of water use data, aquifer data, and land surface data. Together, these data improve our understanding of the groundwater system and our ability to predict subsidence in the future.



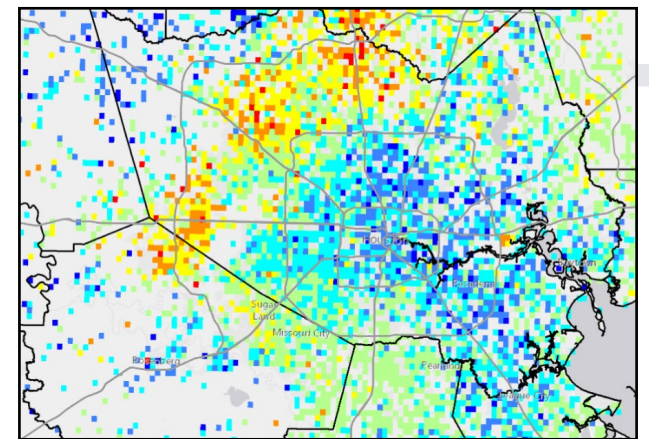
## Water Use Data

- Groundwater Pumpage
- Alternative Water Usage



## Aquifer Data

- Water Levels
- Lithology
- Extensometers

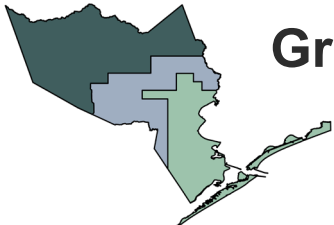


## Land Surface Data

- Benchmark Surveys
- GPS Stations
- InSAR



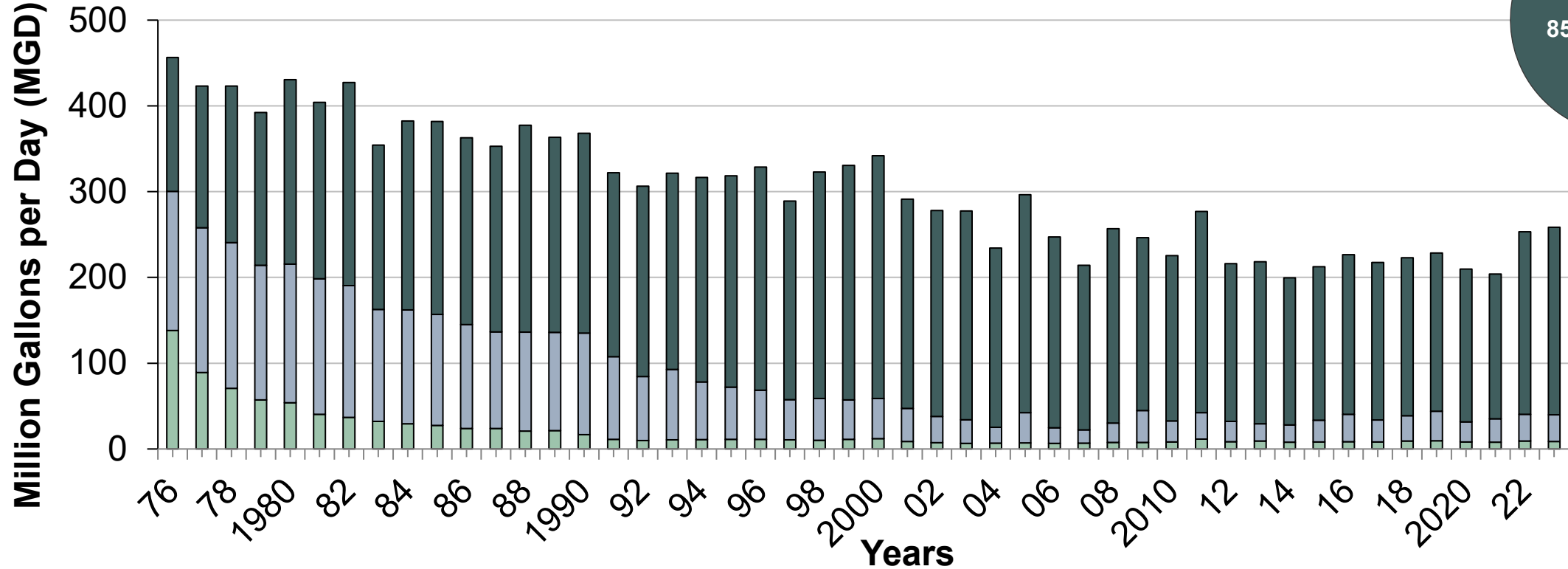
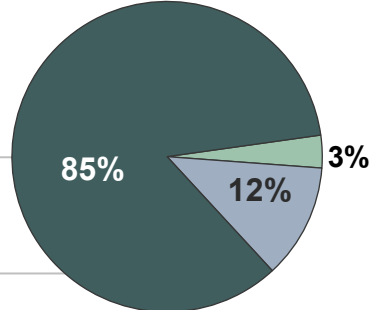
# Water Use Data



**Groundwater Withdrawals Grouped by Regulatory Area**

Area 1 Area 2 Area 3

2023: 258.6 MGD





# Aquifer Data

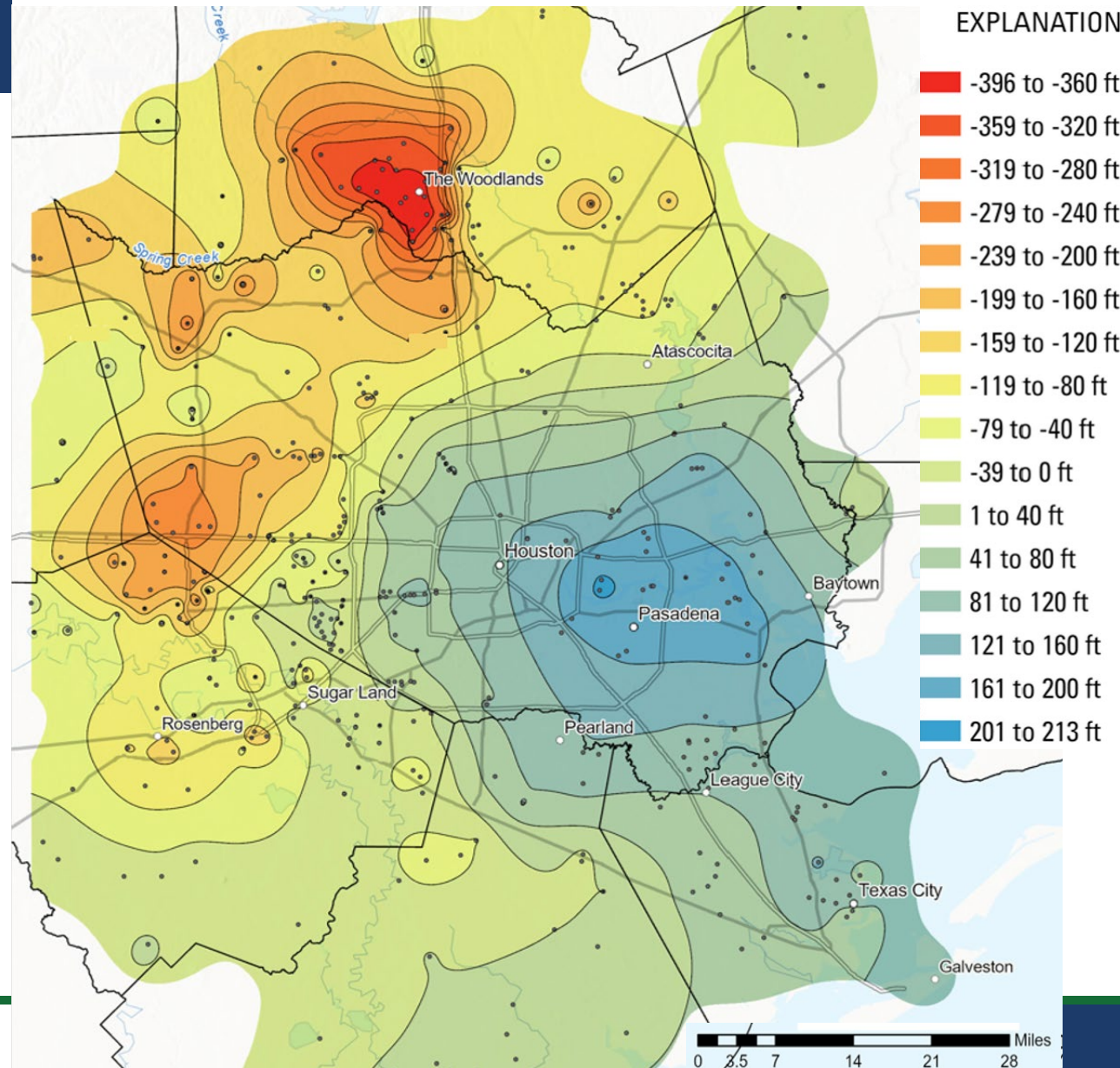
The United States Geological Survey monitors over 550 public supply, irrigation, industrial, and observation wells spread across 11 counties in the Houston-Galveston Region.

- A multi-agency effort with Harris-Galveston Subsidence District, Fort Bend Subsidence District, City of Houston, Bluebonnet Groundwater Conservation District, and Lonestar Groundwater Conservation District.

## Map of Chicot and Evangeline (undiff.) Water-Level Change Since 1977

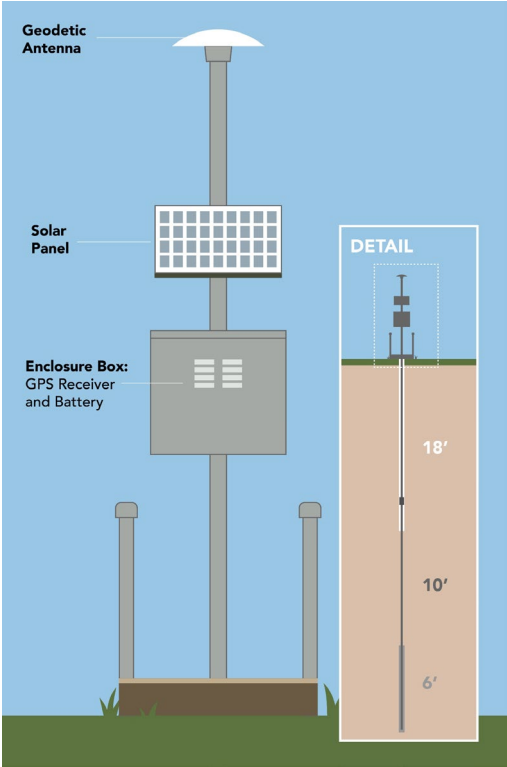
- Highest areas of decline exist in northern and western Harris County, and the south-central portion of Montgomery County.
- Large area of rise in central and eastern Harris County and Galveston County indicative of a shift in water supply from groundwater to alternatives.

Chicot and Evangeline (undiff.) Water-Level Change from 1977 to 2024



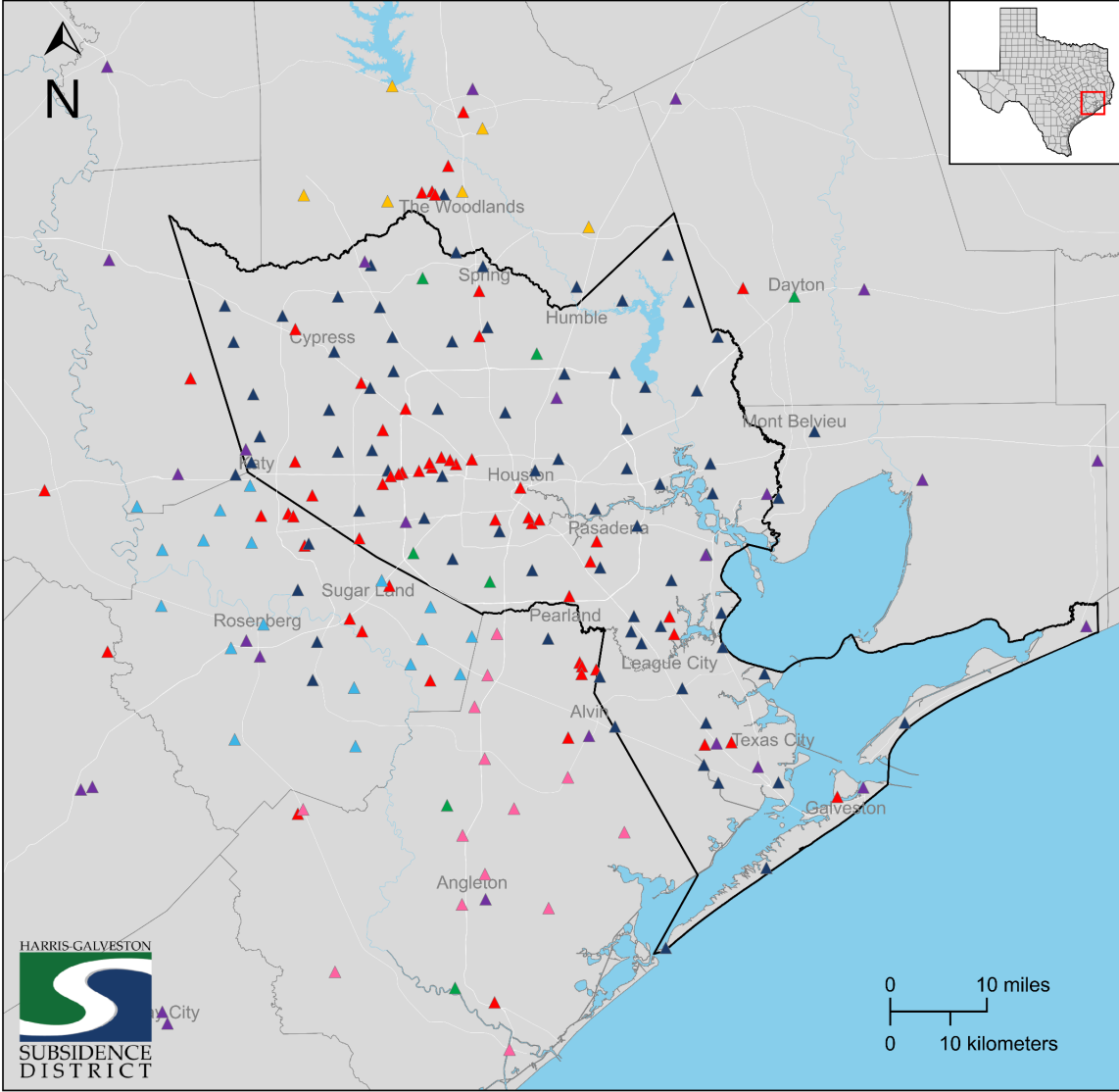
# Land Surface Data

Our subsidence monitoring network utilizes over 100 Global Positioning System (GPS) stations constructed in the Port-a-Measure (PAM) design that collect GPS data to track changes in the land surface.



### EXPLANATION

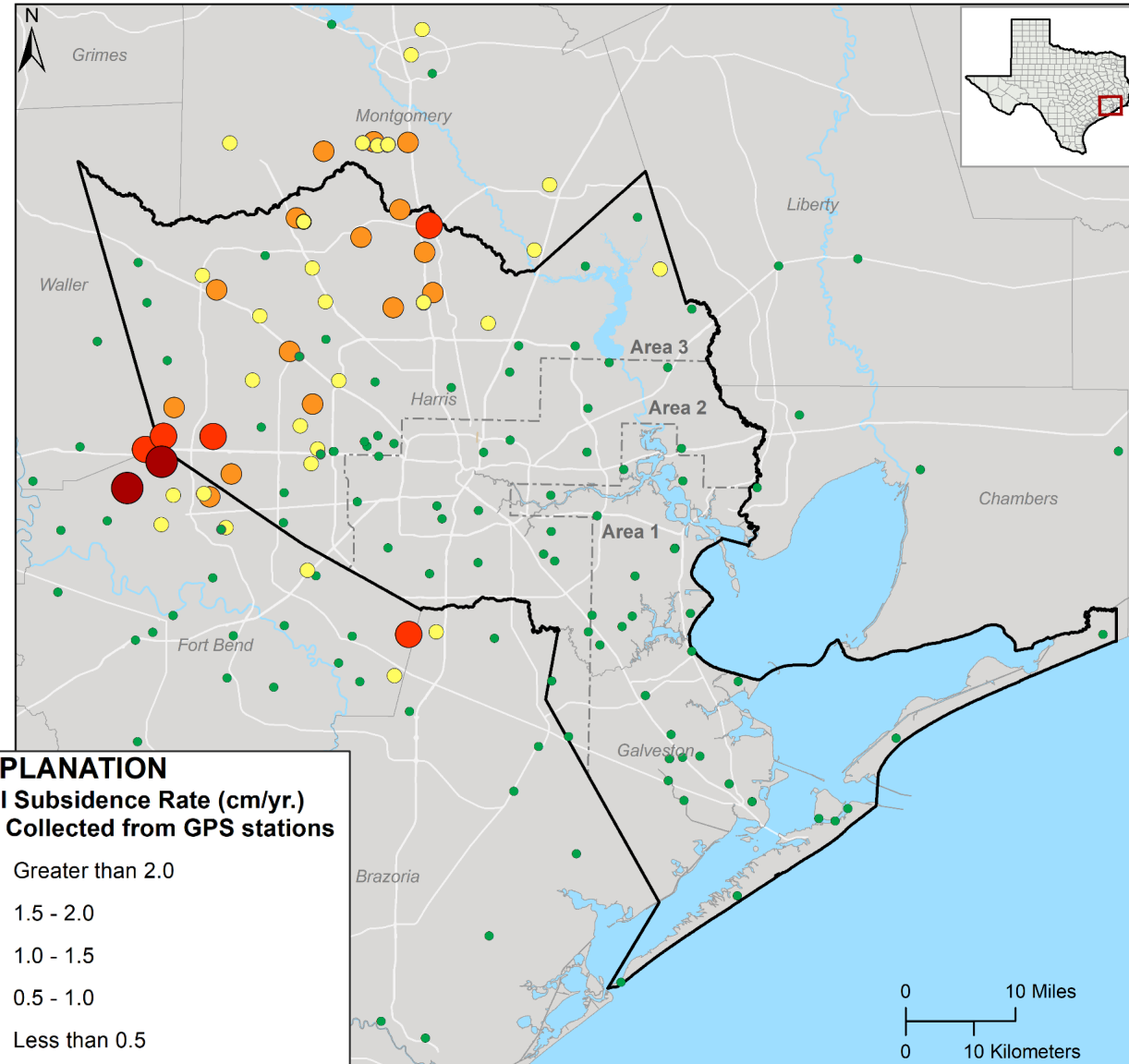
- HGSD Jurisdiction
- Harris-Galveston Subsidence District
- Fort Bend Subsidence District
- University of Houston
- Texas Department of Transportation
- Brazoria County Groundwater Conservation District
- Lone Star Groundwater Conservation District
- Other Operators



# Subsidence Rates from GPS Monitoring Stations

## Average Annual Subsidence Rate from 2019 to 2023 Collected from GPS Stations

- Fully converted Areas 1 and 2 show the impact that groundwater regulation has had on stabilizing subsidence rates.
- Decreased subsidence rates were achieved by the reduced reliance on groundwater through a collaborative effort to develop infrastructure amongst regional water authorities and the City of Houston.



# Subsidence Rates from Benchmark Surveys

## HGSD 2022 GNSS Survey

This map shows benchmarks observed in the Harris-Galveston Subsidence District's 2022 GNSS Survey and validated by the National Geodetic Survey (NGS).

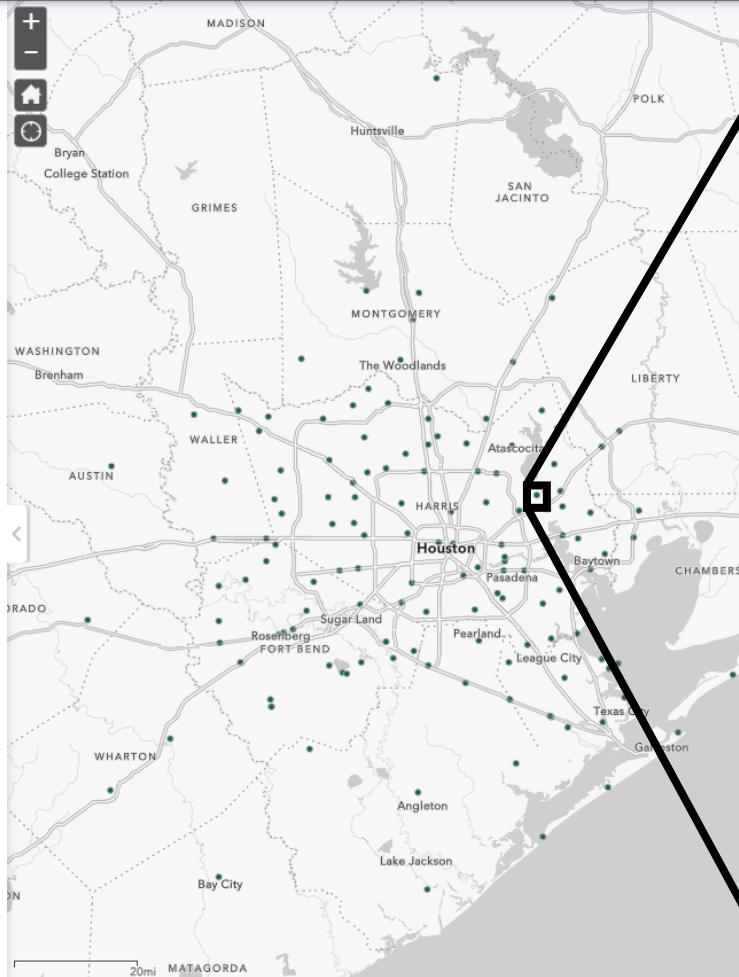
The circles represent a benchmark that was observed using GNSS equipment and processed in NGS's OPUS Projects.

### INSTRUCTIONS:

- Click on the circle to open a pop-up that contains basic geodetic information, HGSD and NGS datasheets, and photos of the selected benchmark.
- To download the datasheets, scroll to the bottom of the pop-up and click the link.
- To view photos of the benchmark, scroll to the bottom of the pop-up under "Attachments" and click the photo link.
  - For a close-up view, select the photo ending in 10.jpg.
  - For a general location view, select the photo ending in 11.jpg.

### Additional Map Tools:

- Select the icons in the upper right panel for the following options from left to right:
  - Legend - description of map icons.
  - Measurement - use to measure distances.
  - Basemap - use to change the background map.
  - Search - enter address to view location on map.



### Benchmark Designation: W 1019

PID	AW1973
4-CHAR ID	W019
MARK DESIGNATION	W 1019
GENERAL LOCATION	Houston
COUNTY	Harris
LATITUDE [DMS]	29°53'00.76967"(N)
LATITUDE [DD]	29.883547
LONGITUDE [DMS]	095°07'43.06037"(W)
LONGITUDE [DD]	-95.128628
ELLIPSOID HEIGHT [USft]	-60.65
HORIZONTAL DATUM	NAD83 (2011) Epoch 2010.0
GEOID HEIGHT [USft]	-89.68
ORTHOMETRIC HEIGHT [USft]	29.00
ORTHOMETRIC HEIGHT SOURCE	GPS OBS
VERTICAL DATUM	NAVD88
GEOID MODEL	Geoid 18
NORTHING [USft]	13889111.44
EASTING [USft]	3195096.32
SPCS	TXSC 4204
COMBINED SCALE FACTOR	0.99991185
NGS DATASHEET	<a href="#">More info</a>
HGSD DATASHEET	<a href="#">More info</a>

Attachments:  
[W019\\_10.jpg](#)  
[W019\\_11.jpg](#)

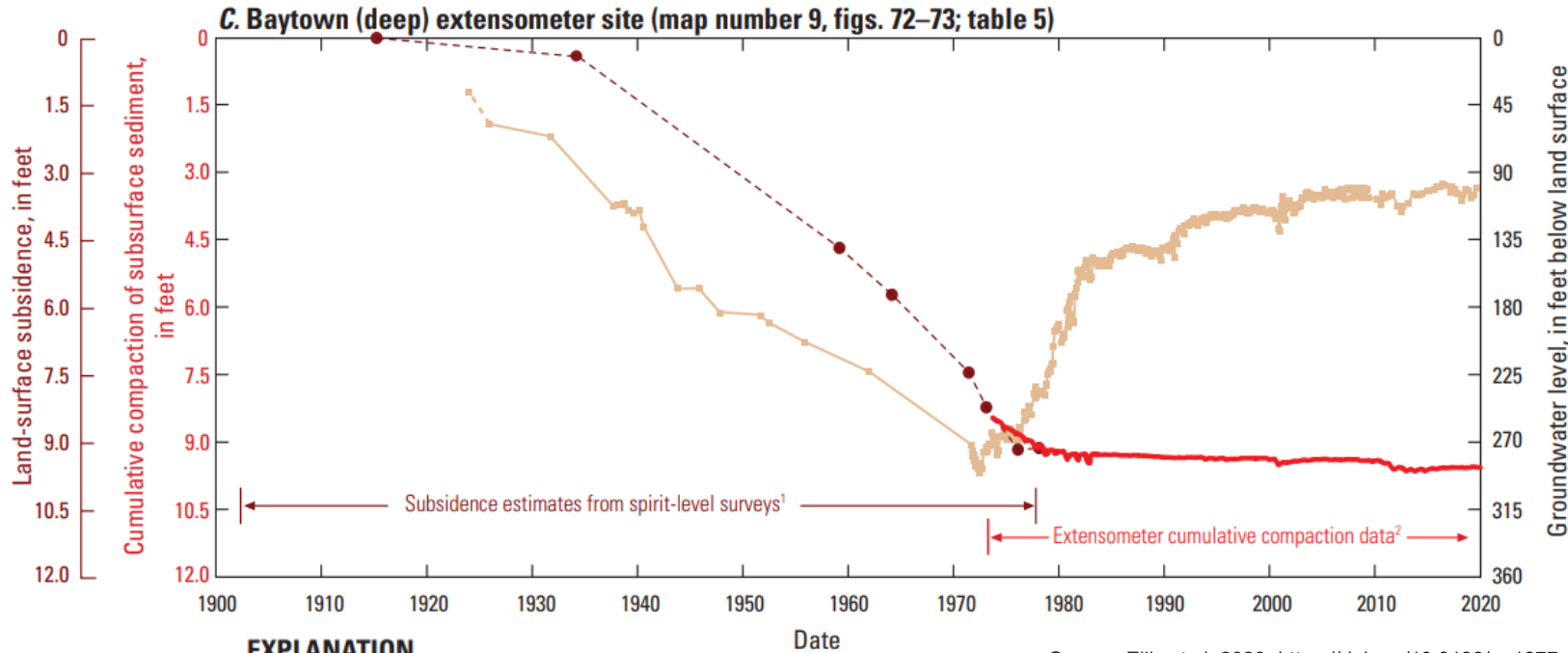


Scan to access survey data. →



# Measured Subsidence and Aquifer Compaction – Brownwood Subdivision – Baytown, TX

## Land-surface measurements obtained from benchmark PTS 185



Source: Ellis et al. 2023. <https://doi.org/10.3133/pp1877>

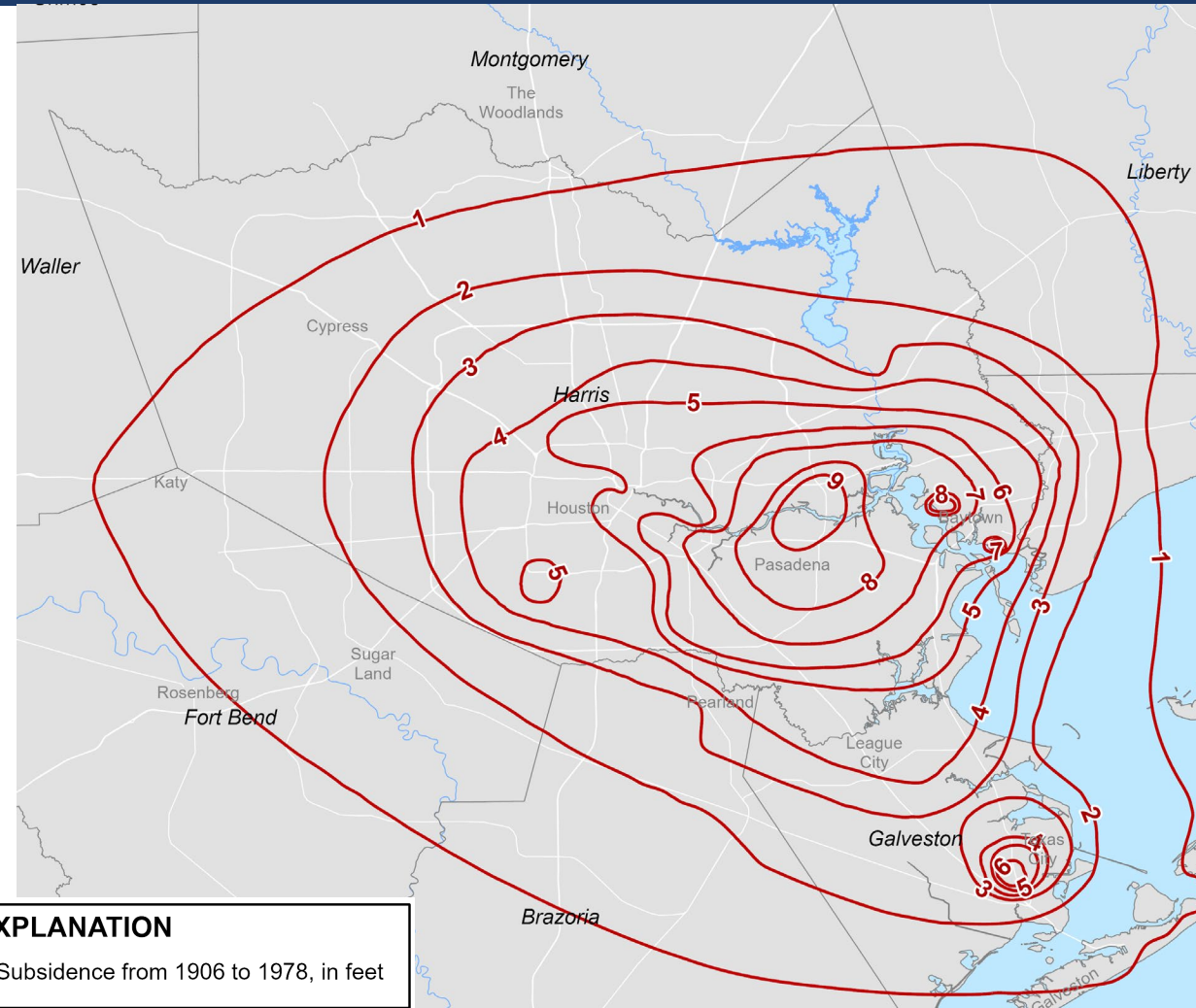


Scan for access to the full report. →



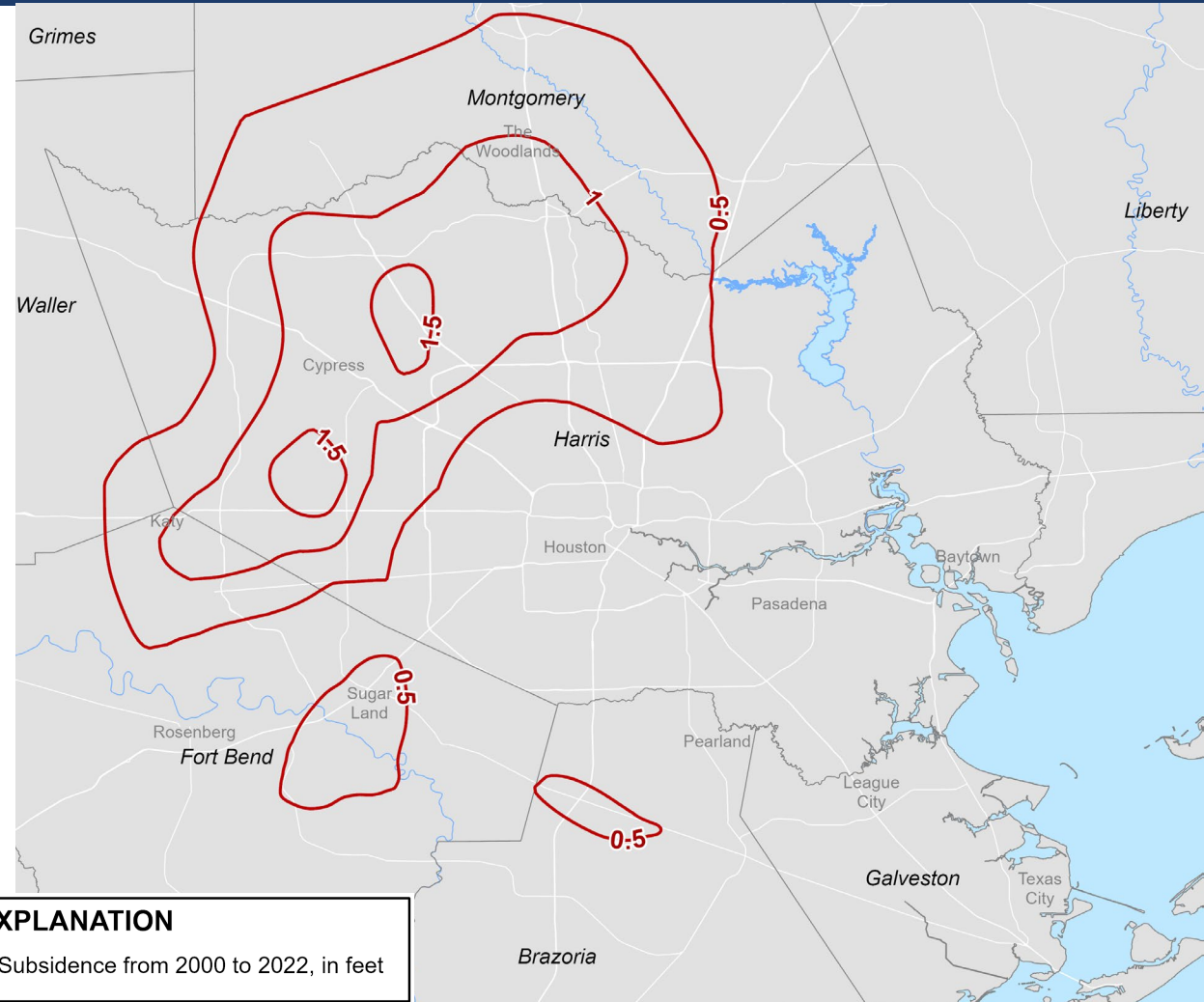
# Subsidence from 1906 to 1978

- Cumulative subsidence from 1906 to 1978 measured from spirit and first order leveling surveys in the greater Houston region.
- Representation of subsidence **prior** to the formation of HSGD.



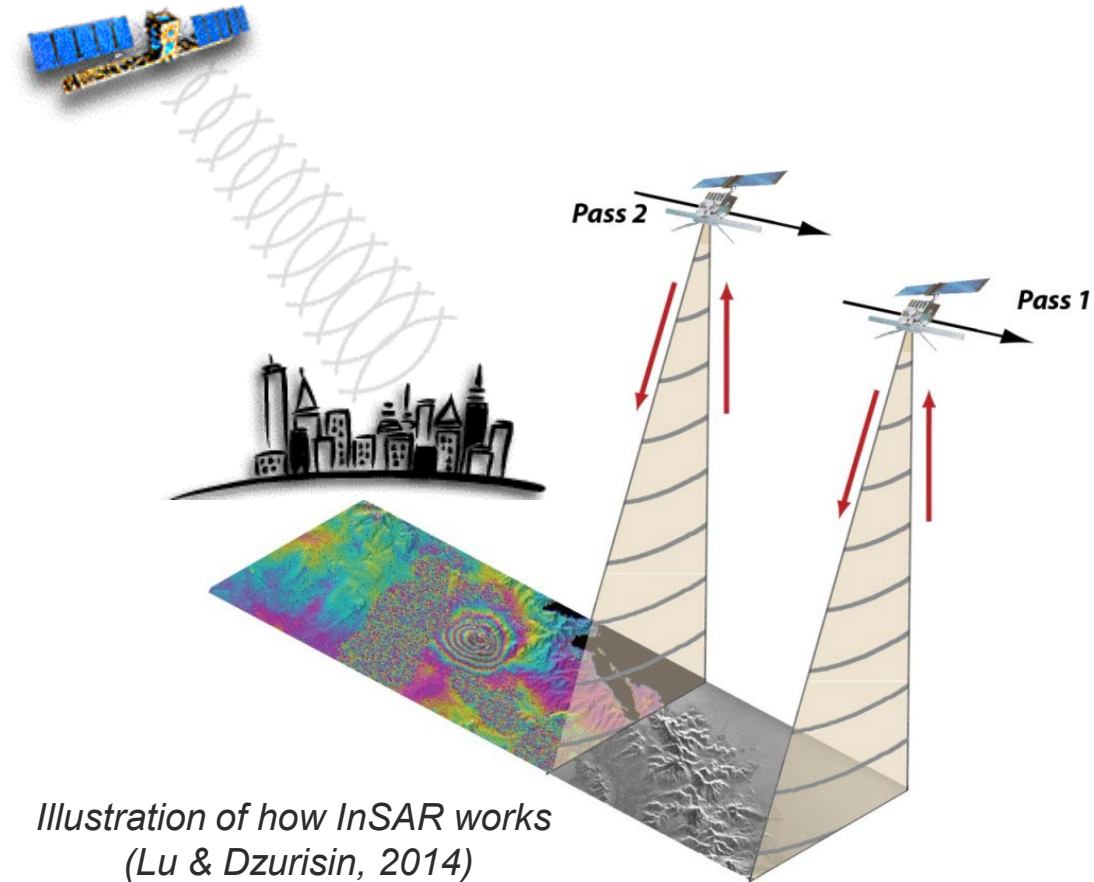
# Subsidence from 2000 to 2022

- Cumulative subsidence from 2000 to 2022 measured from GNSS surveys in the greater Houston region.



# Subsidence Monitoring using Interferometric Synthetic Aperture Radar (InSAR)

- Synthetic aperture radar (SAR) data are generated by transmitting electromagnetic radiation and observing the return signal during all weather conditions.
- Interferometric SAR (InSAR) uses two SAR images of the same area to find the phase difference between them.
- By precisely measuring the phase shift in an InSAR image, the change in distance from satellite to ground can be calculated to an accuracy of centimeters.
- State-of-the-art multi-temporal InSAR (MTI) techniques can be used to suppress the artifacts that plague conventional InSAR methods to achieve an accuracy of millimeters (Qu et al. 2015, 2019).



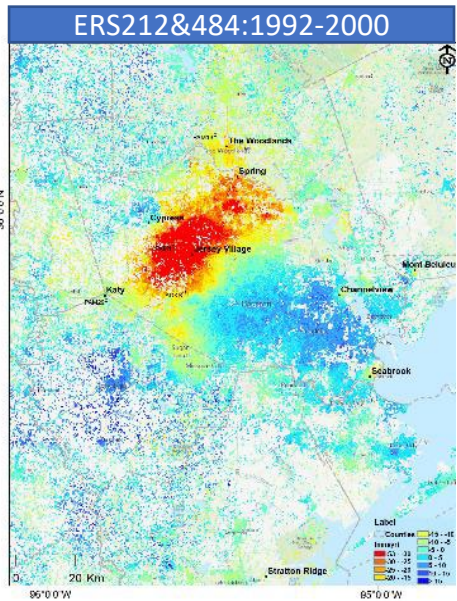
Scan for access to the full report. →



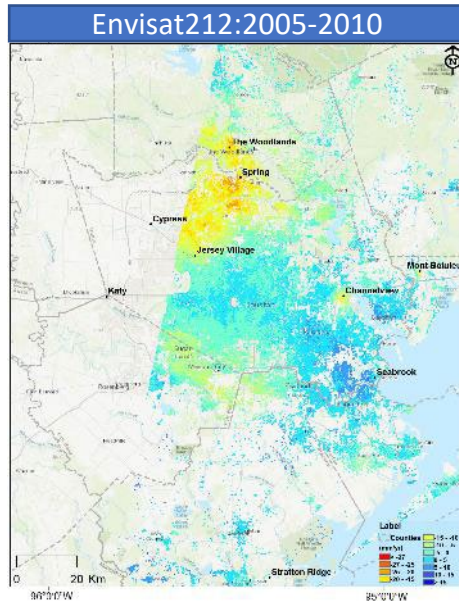


# Subsidence Monitoring Using InSAR

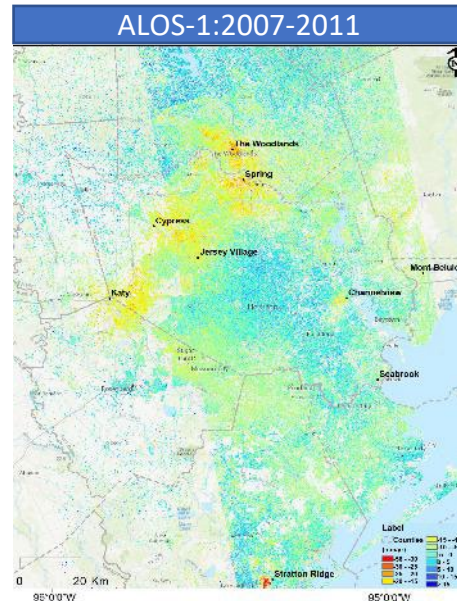
## InSAR-derived land surface deformation evolution across the Houston-Galveston Region



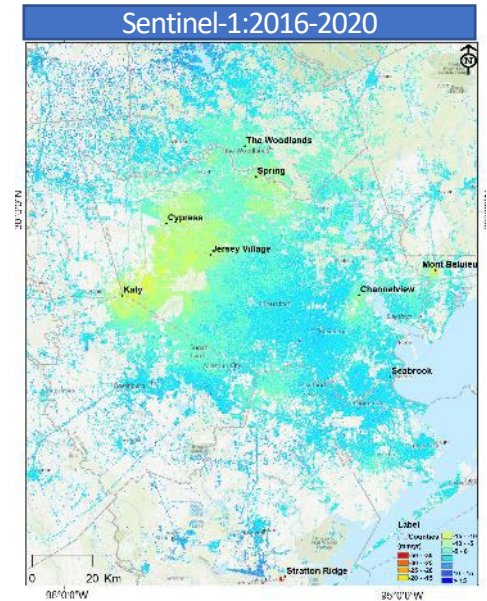
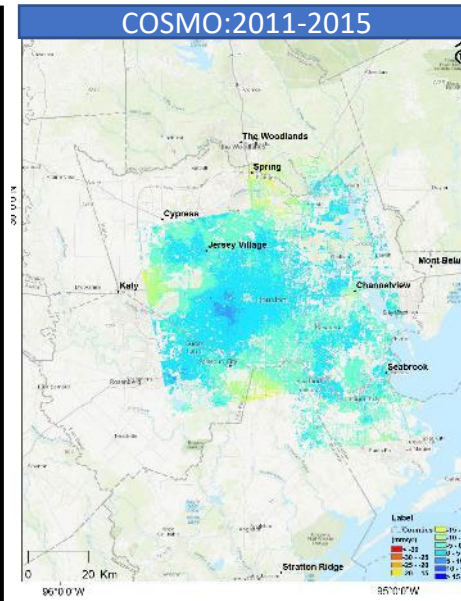
1992-2000  
Jersey Village  
5 cm/yr.



2000-2011  
Spring and The Woodlands  
2-3 cm/yr.



2012-2020  
Katy and Cypress  
2 cm/yr.



Scan for access to the full report. →



# Annual Groundwater Reports

Each year, the District publishes an annual groundwater report and holds a public hearing to take testimony concerning the effects of groundwater withdrawals on the subsidence of land within the District during the preceding year. It includes information on:



- Precipitation data from weather stations
- Water use from groundwater and alternative sources
- Groundwater levels in Chicot/Evangeline and Jasper aquifers
- Compaction measurements from extensometers
- Land surface deformation from GPS stations



# Joint Regulatory Plan Review

1

## Develop Population and Demand Projections

Develop projections of population and water demand over a ten-county area through the year 2100.



2

## Conduct Alternative Water Supply Assessment

Review alternative water supplies for the capability of reducing future groundwater demand.



3

## Develop the Gulf Coast Land Subsidence and Groundwater Flow Model

Development of the GULF-2023 model for simulating regional groundwater flow and subsidence in the Gulf Coast Aquifer.



4

## Evaluate Regulatory Scenarios

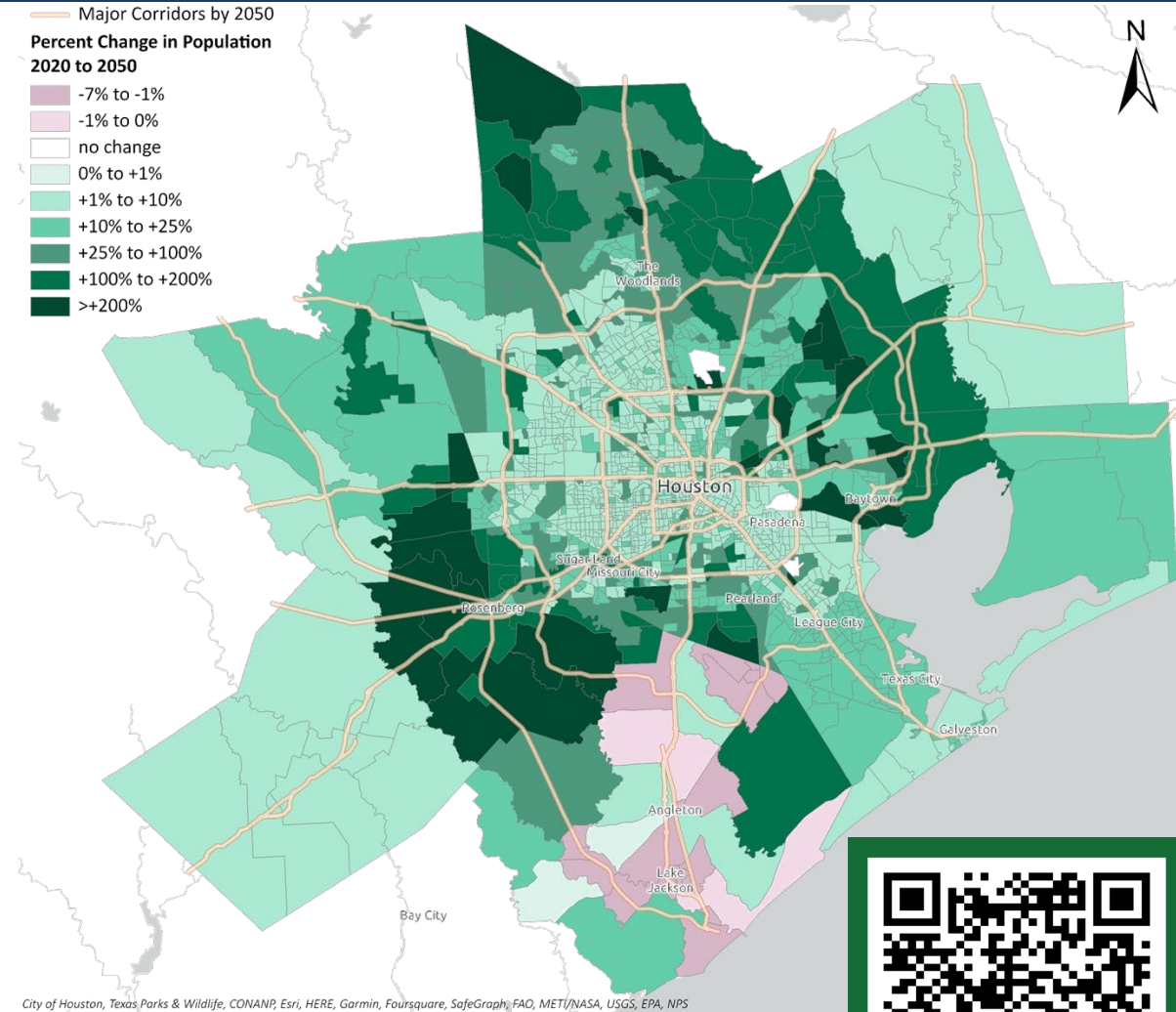
Evaluate the performance of the HGSD and FBSD regulatory plans and consider refinements to the regulatory plan framework to accommodate future growth, alternative water supplies, and the most recent aquifer science.



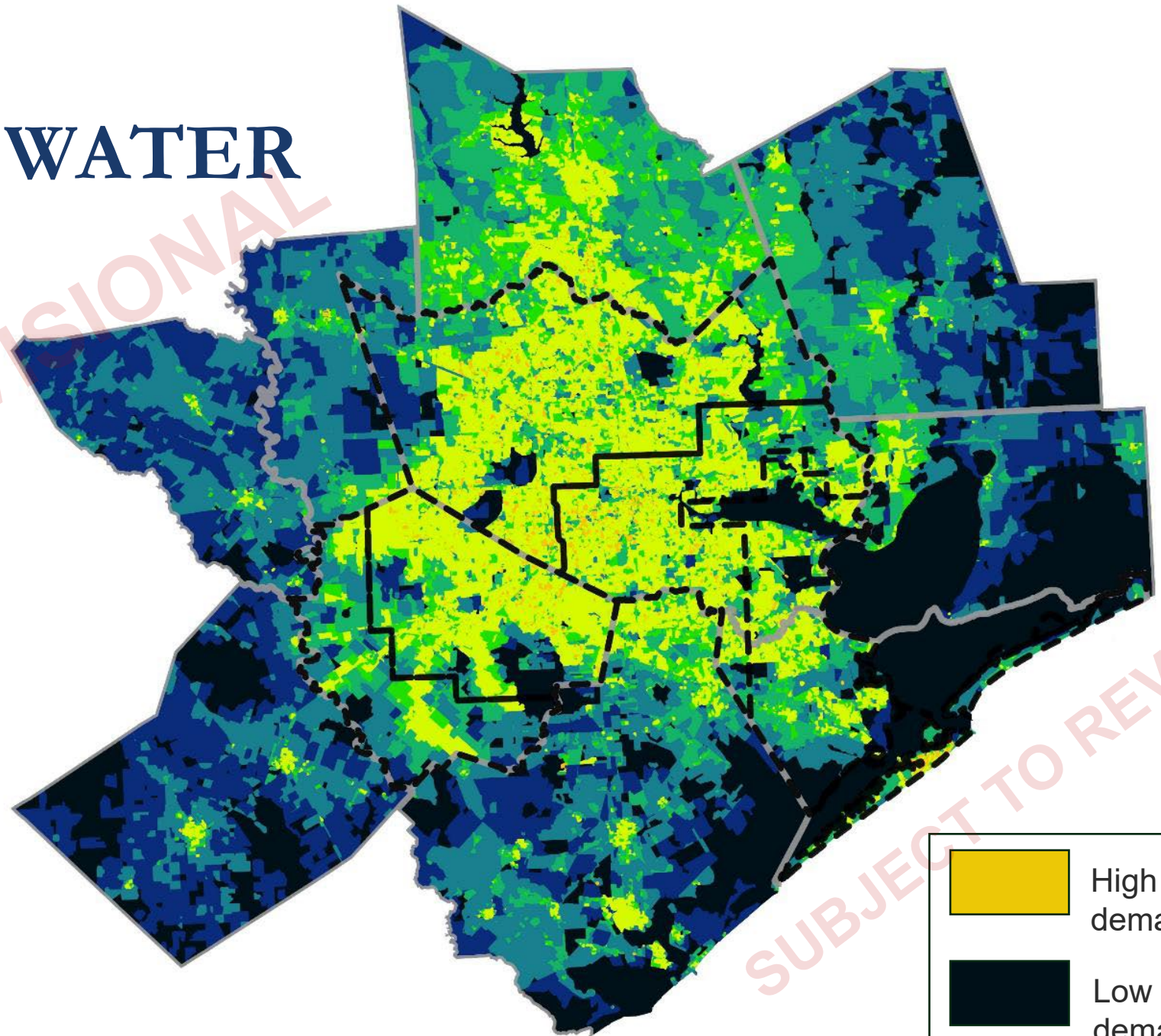
# Population Growth Forecast 2020 to 2050

## Percent Change in Population by Census Tract

County	2020	2050	% Change
Austin	30,167	33,366	+11%
Brazoria	372,031	451,031	+21%
Chambers	46,571	102,555	+120%
Fort Bend	822,779	1,431,122	+74%
Galveston	350,682	401,517	+14%
Harris	4,731,145	5,547,593	+17%
Liberty	91,628	176,682	+93%
Montgomery	620,443	1,063,722	+71%
Waller	56,794	101,637	+79%
Wharton	41,570	42,335	+2%

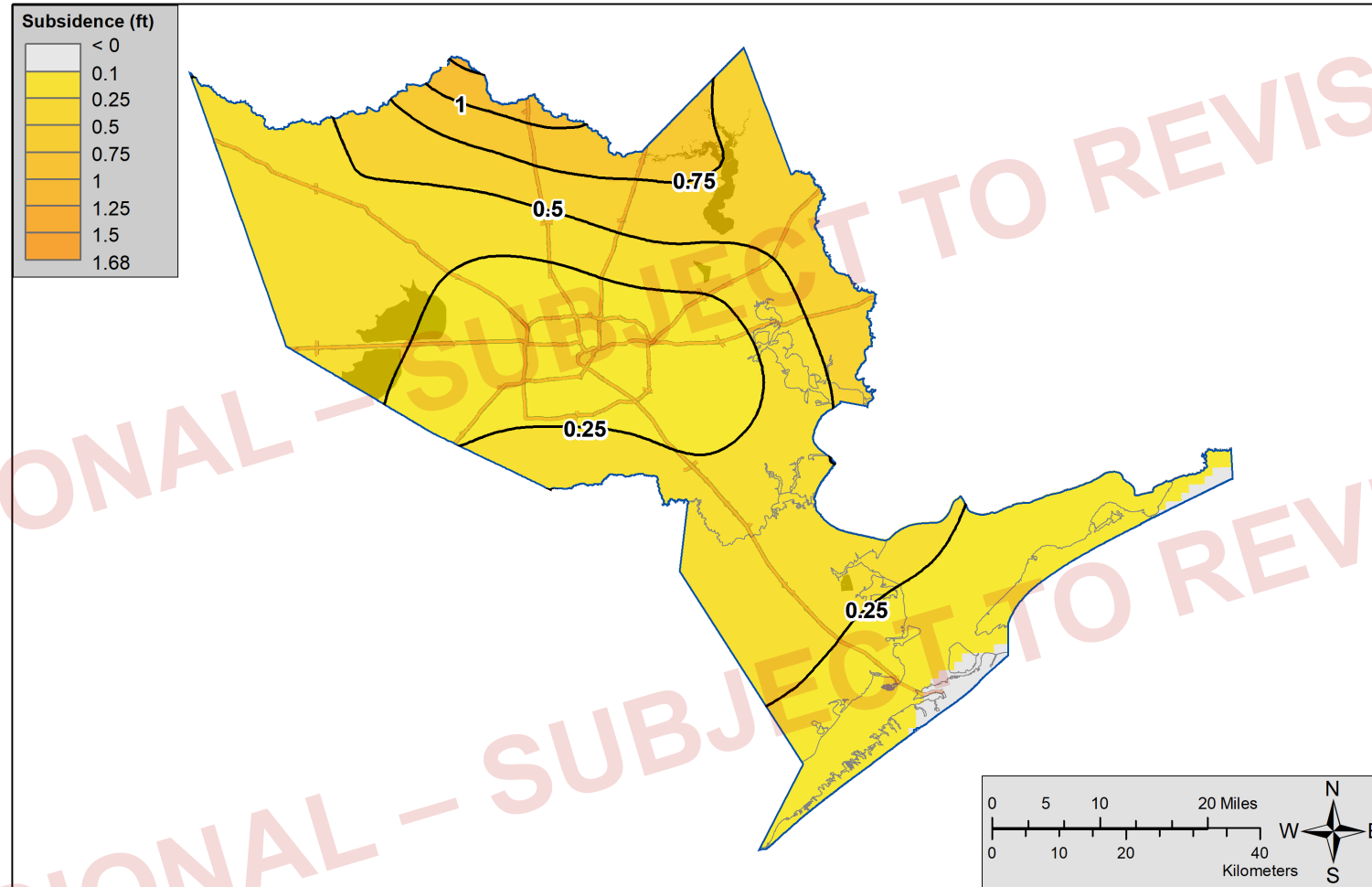


# PROJECTED MUNICIPAL WATER DEMAND (2050)

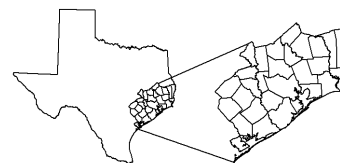


# BASELINE SCENARIO RESULT

B6 Baseline: Total Subsidence (2025 - 2050)



Major Roads  
Counties



HGSD Joint Regulatory Plan Review Workshop  
Presented on 09/11/2024

# Water Conservation Tools for Our Region

## Water Conservation School Program



H2O LAB! provides locally-based water education to 3rd through 6th-grade classrooms in Fort Bend, Galveston, and Harris counties. It provides tools and resources to help families practice water-saving habits, as well as raise awareness about subsidence and ways to prevent it. This program is made available through sponsorships from local water providers and businesses.

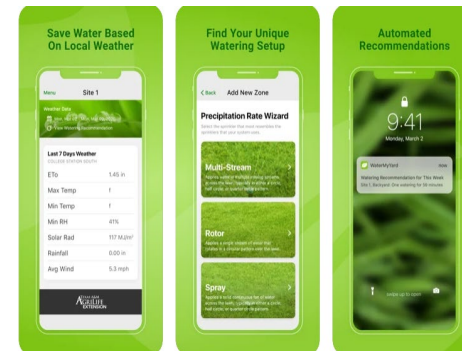
## Smarter About Water



Visit [SmarterAboutWater.org](https://www.SmarterAboutWater.org) and follow us on social media for water conservation resources that help homeowners, teachers, students, and businesses in the Gulf Coast Region.



## Water My Yard



The **Water My Yard** program helps homeowners and businesses save water and money through specifically designed recommendations for lawn irrigation that are customized per user.

Sign up for FREE watering recommendations by downloading the app on your smartphone or subscribing online at [watermyyard.org](https://www.watermyyard.org).

## Water Conservation Grant Program



The District provides grants for projects that can achieve quantifiable water reduction through water loss control measures, water efficiencies, or research.






# Gulf Coast Water Conservation Symposium

## 2025 GULF COAST WATER CONSERVATION *Symposium*

This symposium brings together local water utility and resource managers, engineers, architects, educators, communicators, and community members to learn about water resource management and water conservation. The one-day program will provide information on implementing successful water conservation programs, funding opportunities for water conservation projects, engaging customers, and planning for the future.



## #GCWCS25

-  May 21, 2025
-  Marriott at George Bush Intercontinental Airport
-  [www.eventcreate.com/e/gcwcs25](http://www.eventcreate.com/e/gcwcs25)







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General Manager

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Connect with us!



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