



THE PAST, PRESENT, AND FUTURE OF SUBSIDENCE IN THE HOUSTON REGION

Harris-Galveston Subsidence District

Michael J. Turco – General Manager

What is Subsidence?

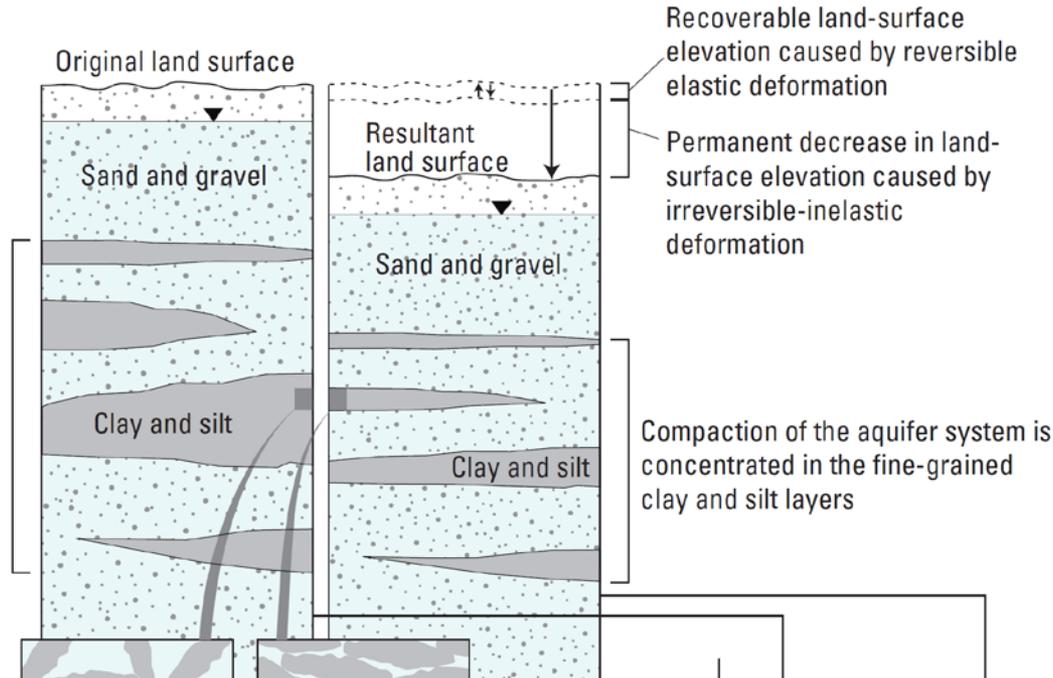
- Subsidence is the lowering of the elevation of land surface over time.
- Subsidence can have a wide range of consequences depending on the location of the occurrence and its proximity to surface drainage and coastal zones
- In this area, clay compaction resulting from groundwater withdrawal is the primary cause for subsidence



Mechanism for Subsidence in the Gulf Coast

When long-term withdrawals lower groundwater levels and raise pressure on the clay and silt layers beyond a threshold amount, the clay and silt layers compact, and the land-surface elevation decreases permanently

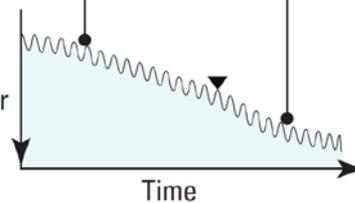
Initial aquifer sediment thickness before groundwater withdrawals began



Granular clay and silt skeleton defining fluid-filled interstitial-pore spaces that store groundwater

Rearranged and compacted granular clay and silt skeleton with reduced porosity and groundwater-storage capacity

Depth to water

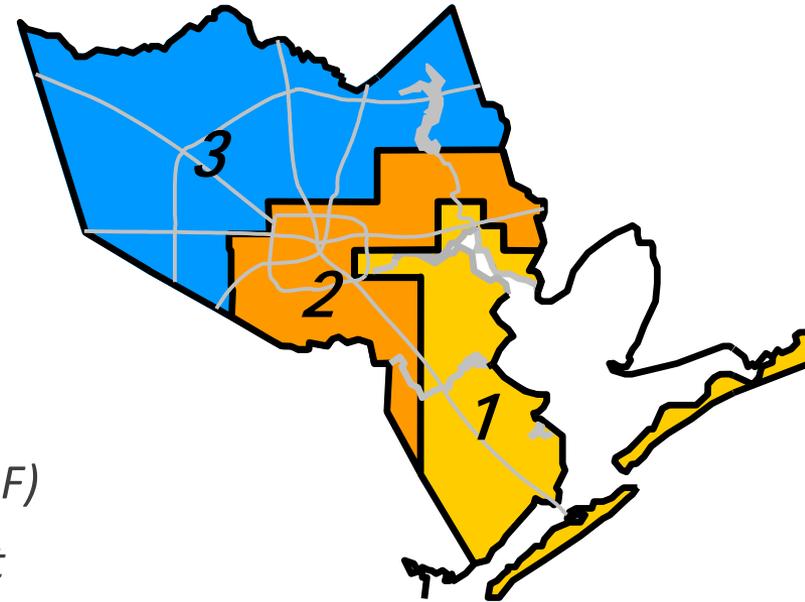


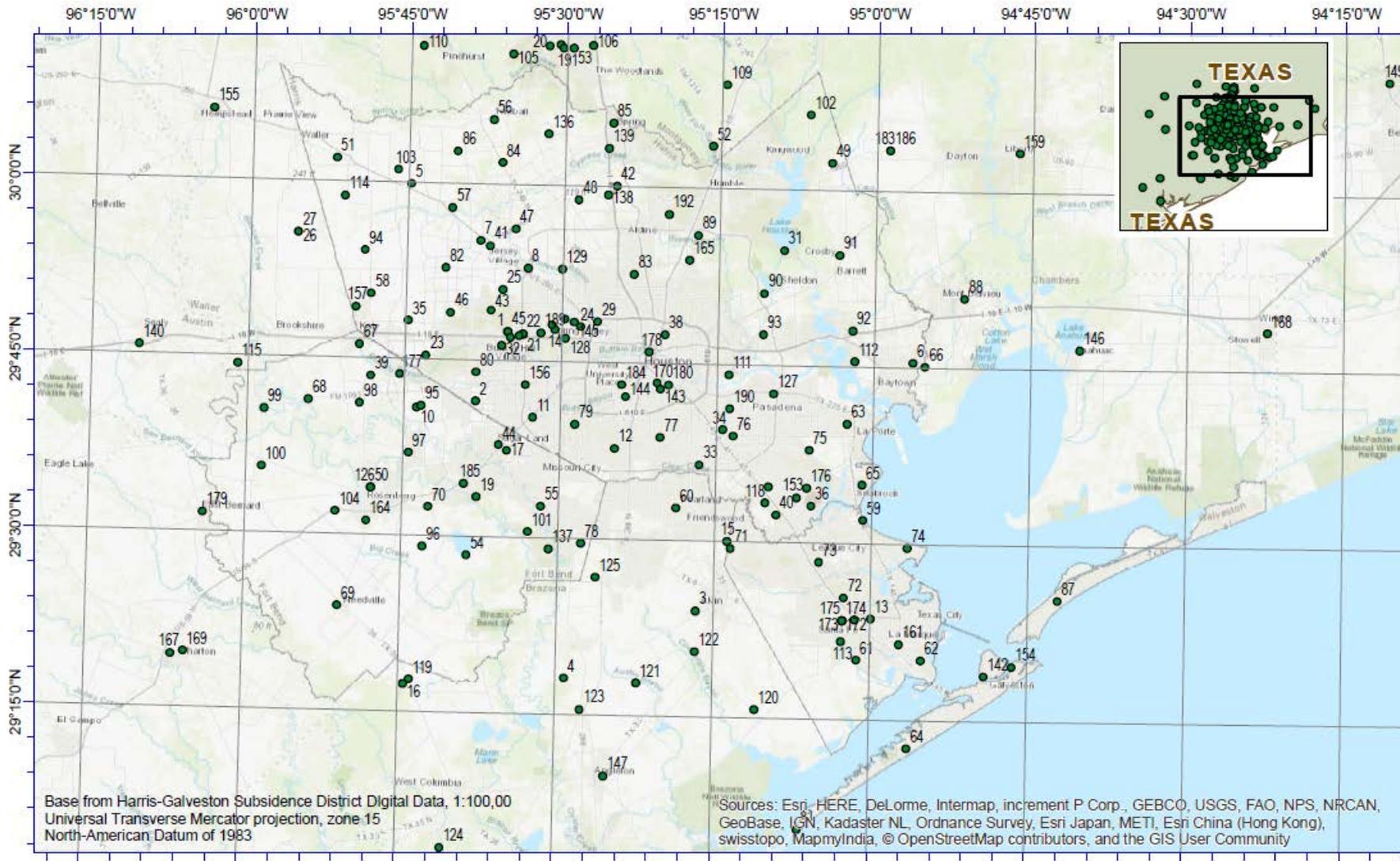
Long-term water-level decline modulated by the seasonal cycles of groundwater withdrawals



Harris-Galveston Subsidence District Regulatory Plan

- *Updated in 2013*
- **Areas 1 and 2 – Fully Converted**
 - *Area 1 GW Reduced to 10% or less of TWD*
 - *Area 2 GW Reduced to 20% or less of TWD*
- **Area 3**
 - *Reduce Groundwater usage by 30% by 2010*
 - *Reduce Groundwater usage by 60% by 2025*
 - *Reduce Groundwater usage by 80% by 2035*
- *Exemptions: Agricultural Irrigation*
- *Non compliance subject to DISINCENTIVE FEE (DF)*
- *DF is indexed to 200% of the Maximum Contract Water Rate of the City of Houston*
- *2018 DF is \$8.75 per thousand gallons*

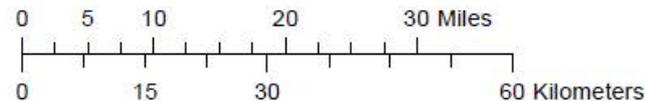




Legend

- Subsidence Monitoring Station and Map ID

1:820,000



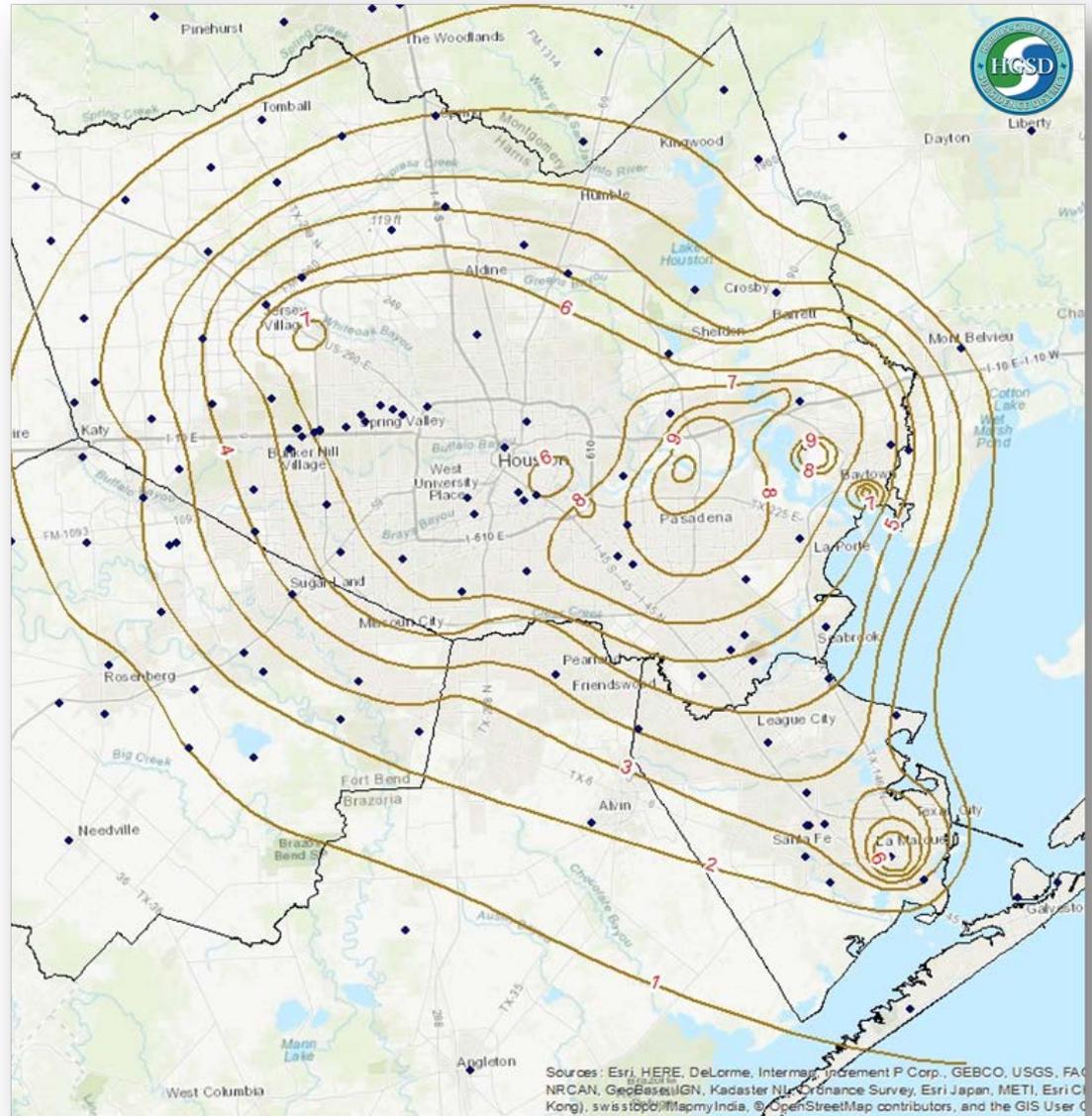
Estimated Subsidence 1906-2000

Developed through the comparison of historical topographic information and level surveys conducted by the District in 2000.

Shows broad area of about 6 feet of subsidence encompassing most of the City of Houston and Harris County.

In comparison the amount and breadth of subsidence in the northern and western parts of Harris County just showing the beginning signs of Subsidence.

This data was developed by Bob Gabrysch and pushed at the fifth international symposium on subsidence

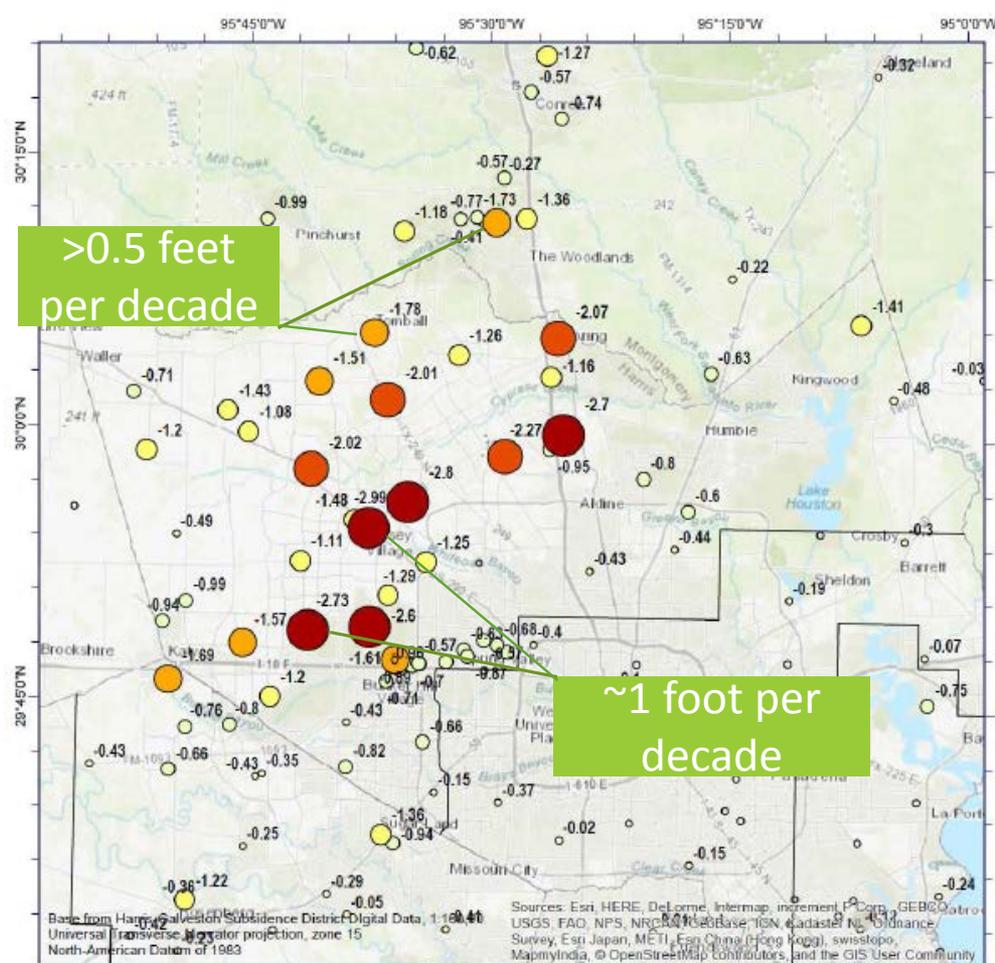


Annual Subsidence Rate 2013-2017

The highest subsidence rates observed today in the region are located in Southern Montgomery County, Northern and Western Harris County, North-eastern Fort Bend County.

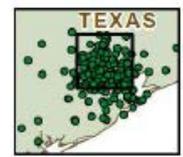
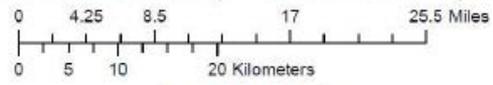
The City of Houston in cooperation with the Regional Water Authorities are currently undertaking the largest water infrastructure project in the US to supply alternative water to these areas.

Subsidence has generally ceased in areas where conversion has been completed and groundwater use has been reduced.



EXPLANATION

- Subsidence Rate (2013-2017) cm/year**
- greater than 2.5
 - 2.4 - 2.0
 - 1.9 - 1.5
 - 1.4 - 1.0
 - 0.9 - 0.5
 - Subsidence Rate less than 0.5 cm/year or period of record less than 2 years



Annual estimated subsidence rate from GPS data measured from 2013-2017 at monitoring locations with more than two years of data.

Estimated Subsidence 1906-2016

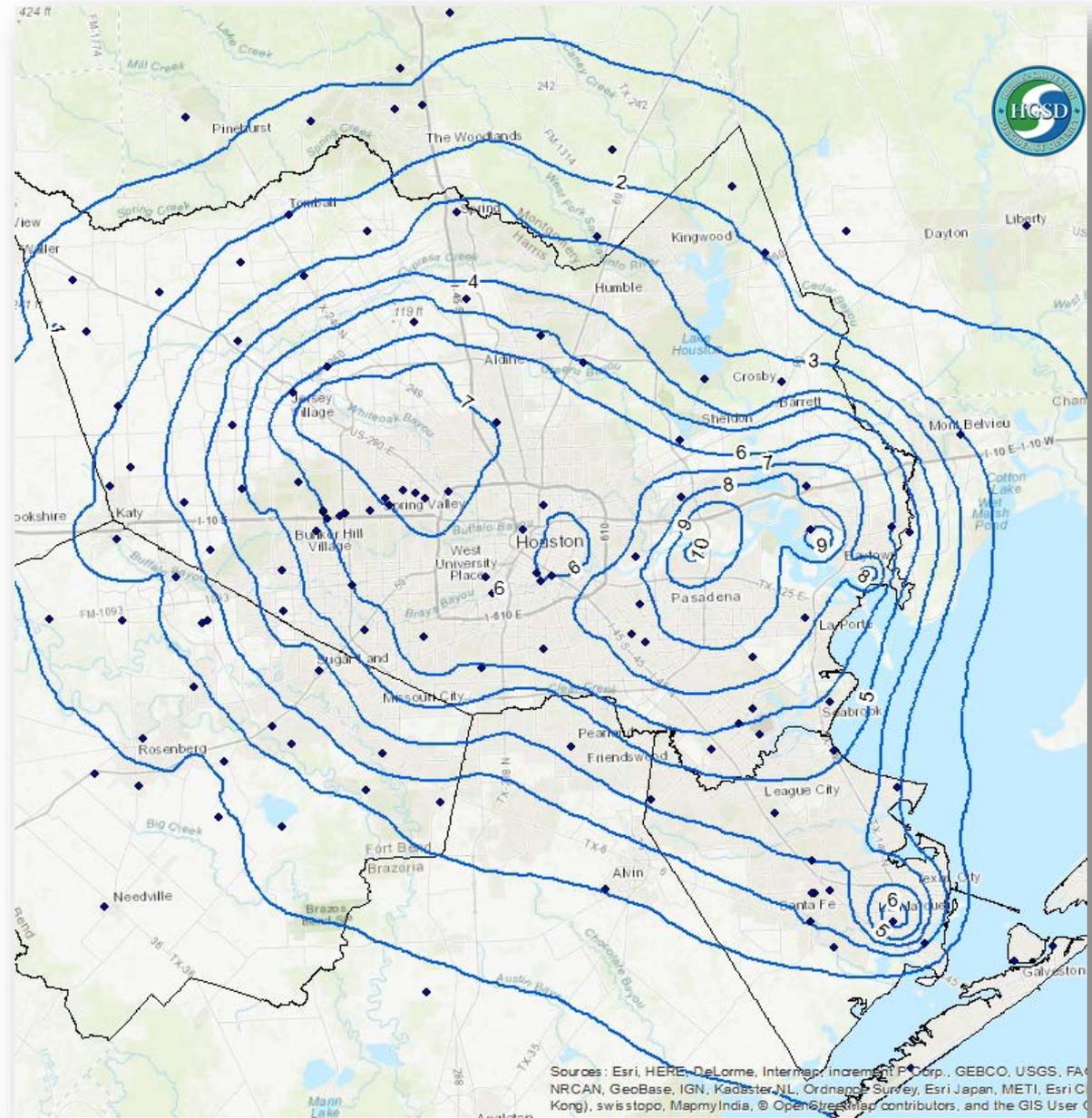
Developed through the assumption that subsidence rates (2011-2016) remained constant from 2000-2016. Estimated total subsidence was then added to the 1906-2000 surface.

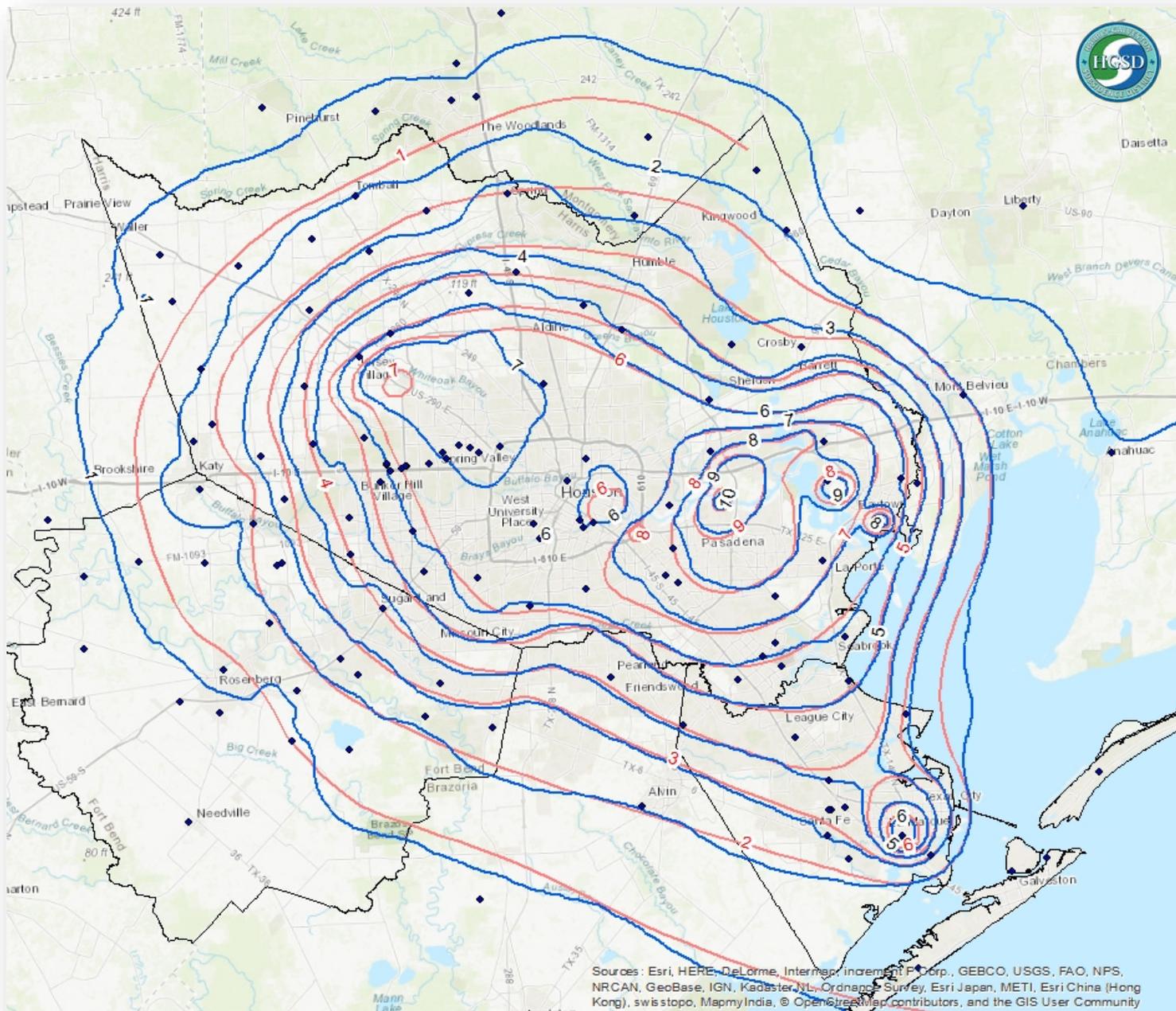
Little change is noted in the areas to the east of downtown Houston, where full conversion has completed.

The area of subsidence expands to include Montgomery and Waller counties. Western Harris County, Northern Fort Bend County, Northern Harris county show change from the 1906-2000 comparison.

This data was developed by the Subsidence District

This map is preliminary and subject to revision.





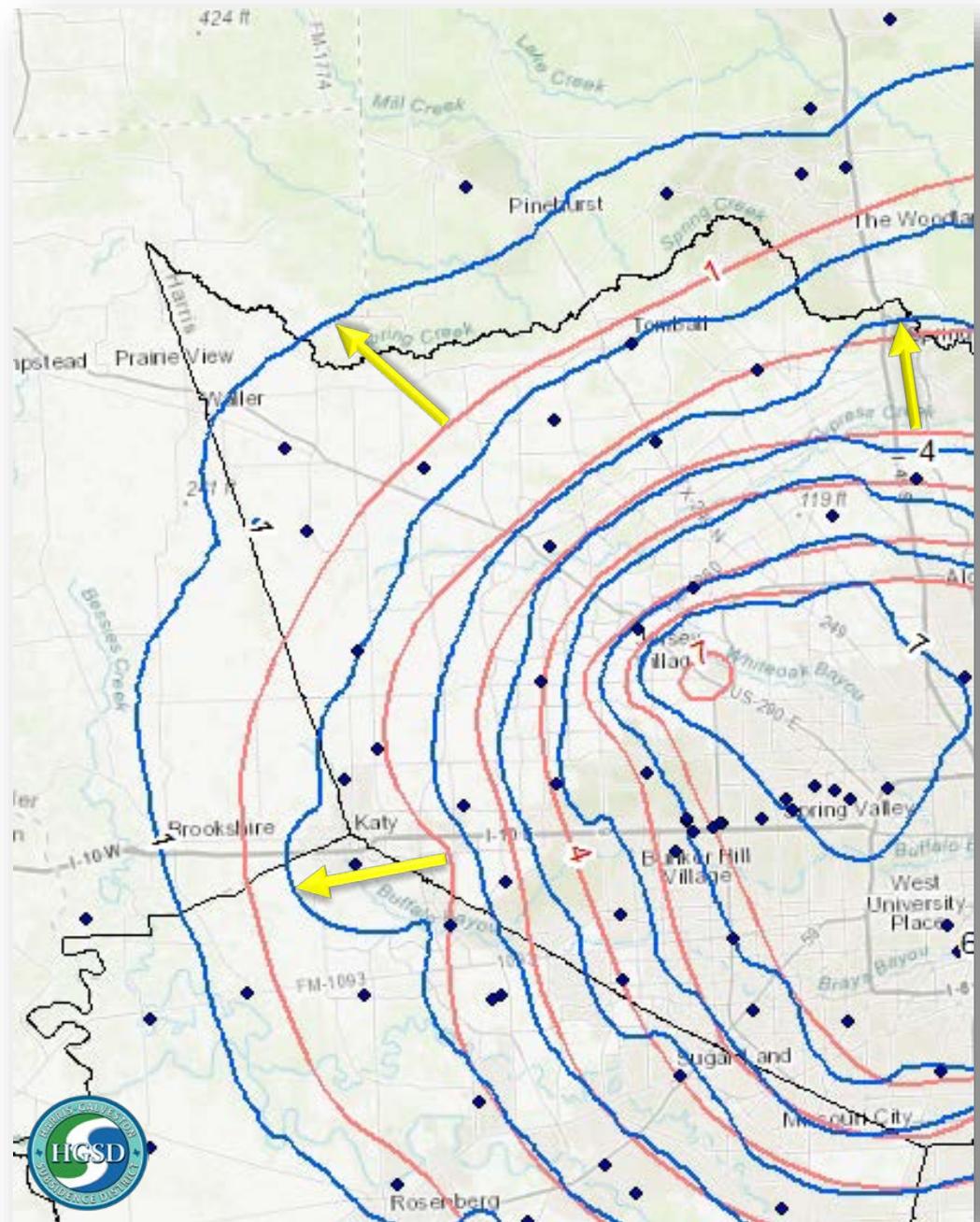
Subsidence 1906-2000 vs. 1906-2016

Subsidence 1906-2000 vs. 1906-2016

Areas to the west and north of downtown Houston show the largest amounts of change

1-foot contour extends well into Montgomery and Waller Counties.

Smaller 7-foot feature in the 1906-2000 surface expands considerably.



Investigation of Brackish Resources in the Gulf Coast Aquifer and Determination of the Potential Subsidence Risk From Resource Development

A Presentation to the
Woodlands Township Drainage Task Force



Presented By:



August 21, 2018

ANY QUESTIONS?



**Original land-surface
elevation of slab when
well was installed**

**Decrease in land-
surface elevation**

**Elevation of land
surface in 2004**

**Protruding well casing
above land surface**



Crystal Bay

Brownwood

Crow Rd

Katherine

Cabaniss Ave

Bayshore Dr

Mapleton Ave

Borse Ave
Harvey Blvd
Brownwood Dr

Image NASA
Image Texas General Land Office

Google earth

LONE STAR GROUNDWATER CONSERVATION DISTRICT



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LONE STAR GROUNDWATER CONSERVATION DISTRICT

Study Motivation & Products

- The Districts' Science and Research Plan calls for the determination of the occurrence and hydrogeologic characteristics of the brackish resources within the District and surrounding areas
- Two Primary Work Products
 - Report and data delineating brackish groundwater resources with the Harris-Galveston and Fort Bend Subsidence Districts
 - Risk Analysis for Subsidence from Development of the Brackish Jasper Aquifer
- This study: (1) provides foundational information to inform future subsidence studies; (2) provides an improved understanding of the historically undeveloped brackish resources; and informs potential regulation of brackish resources



Brackish Resources Delineation Report

- Study Area - the Harris-Galveston and Fort Bend Subsidence Districts and surrounding counties
- Study builds on the analysis begun by the TWDB HB-30 work increasing the resolution of the analysis
- Performed a detailed assessment of aquifer structure, lithology and salinity in Gulf Coast Aquifer System
- Fully digital dataset of aquifer lithology (sand/clay) and salinity
 - 299 geophysical logs – Salinity
 - 294 geophysical logs – Lithology
 - 209 geophysical logs - Stratigraphy

FINAL REPORT ON THE DELINEATION OF FRESH, BRACKISH AND SALINE GROUNDWATER RESOURCES BASED ON INTERPRETATION OF GEOPHYSICAL LOGS

Prepared for:



Harris-Galveston Subsidence District



Fort Bend Subsidence District

Prepared by:



INTERA Incorporated



LBG-Guyton & Associates



Bureau of Economic Geology

December 2017

Characterization of Subsidence Risk in the Jasper Aquifer

- Performed a Risk Assessment for groundwater development from the Jasper Aquifer
 - Study area focused on brackish portions of the Jasper Aquifer (generally $> 2,000$ feet)
 - Developed a conceptual model and base-case parameters for assessment of compaction in the Jasper Aquifer
 - Normalized Risk Methodology based upon three performance metrics:
 - Compaction in the Jasper Aquifer
 - Land subsidence from Jasper compaction
 - Consequence from subsidence (flood plain)

SUBSIDENCE RISK ASSESSMENT AND REGULATORY CONSIDERATIONS FOR THE BRACKISH JASPER AQUIFER

Harris-Galveston and Fort Bend Subsidence Districts

Final Report

Prepared for:



Harris-Galveston Subsidence District



Fort Bend Subsidence District

Prepared by:

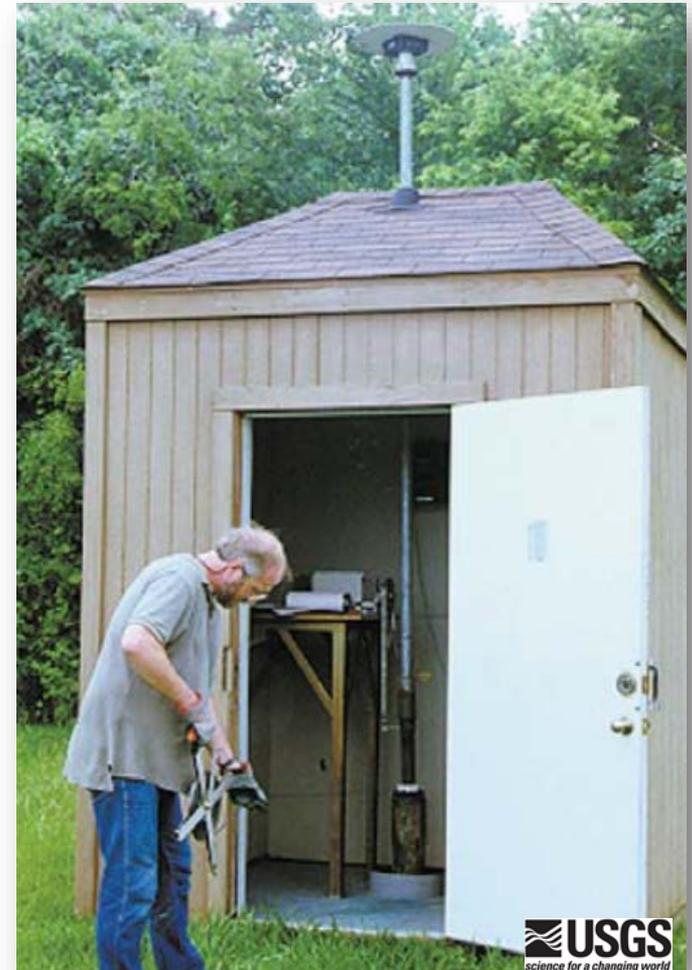


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May 2018

Measurement of clay-compaction and subsidence

- The District has a long history of working with multiple agencies and private firms to understand the mechanism and occurrence of subsidence in the region
 - **U.S. Geological Survey:** Determined much of the mechanics and works through a cooperative agreement with each district to monitor water-level, develop groundwater models, and provide technical assistance.
 - **National Geodetic Survey:** Developed the GPS monitoring network and provides technical assistance.
 - **University of Houston:** Cooperation in data collection, processing, and dissemination
 - **Private Consultants**



Regulatory Planning



Utilized data from the 2010 Census, Annual Water-Level and Subsidence Data collected by the USGS and the Subsidence District

Brought together a group of consultants to help develop the plan:

- Conducted population projections and migration prediction
- Updated multiple local scale analytical subsidence models in the Houston Region
- Updated the regional groundwater flow model
- Developed the predictive model data sets

