

Appendix A – Exhibits Presented at Public Hearing held on May 28, 2020

Harris-Galveston Subsidence District Presentation




2019 ANNUAL GROUNDWATER REPORT

Public Hearing - May 28, 2020


PROVISIONAL – SUBJECT TO CHANGE

Subsidence District Mission







- The Subsidence District was created in 1976 to prevent land subsidence in Harris and Galveston counties through the management of groundwater.
- Land subsidence contributes to flooding, threatening the economic health of the area
- Efforts to prevent subsidence by the District and the regulated community have required significant investment in order to create a more resilient infrastructure to mitigate flooding while securing reliable water sources for future needs
- Annual groundwater hearing required by enabling act to receive testimony regarding the effects of groundwater withdrawals on subsidence


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Agenda





-  Climate
-  Groundwater Use
-  Groundwater Levels
-  Subsidence Data

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Agenda

-  Climate
-  Groundwater Use
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-  Subsidence Data

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Weather Service Climate Stations

Location of weather service climate stations that were used for rainfall data.

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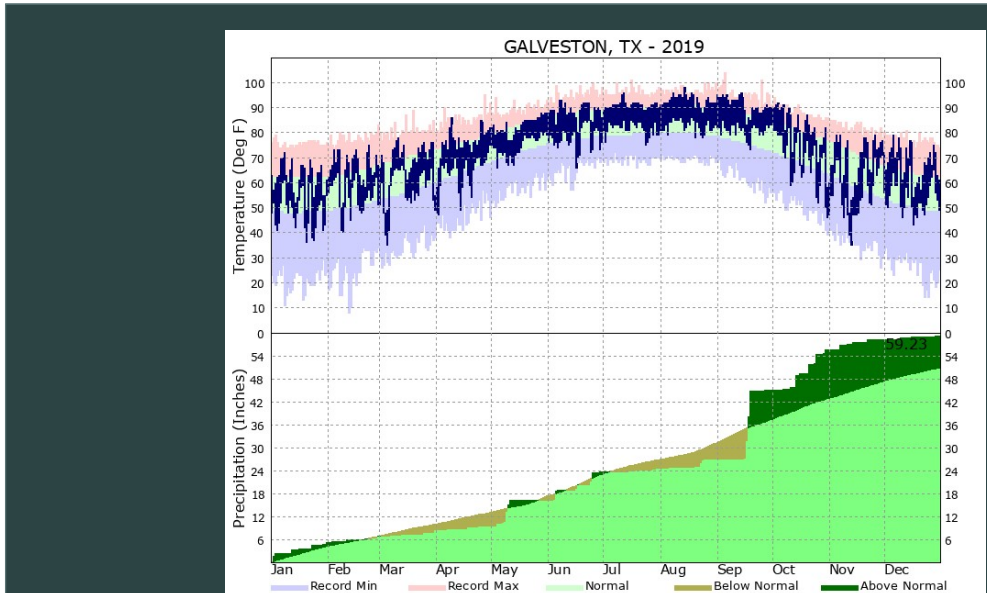
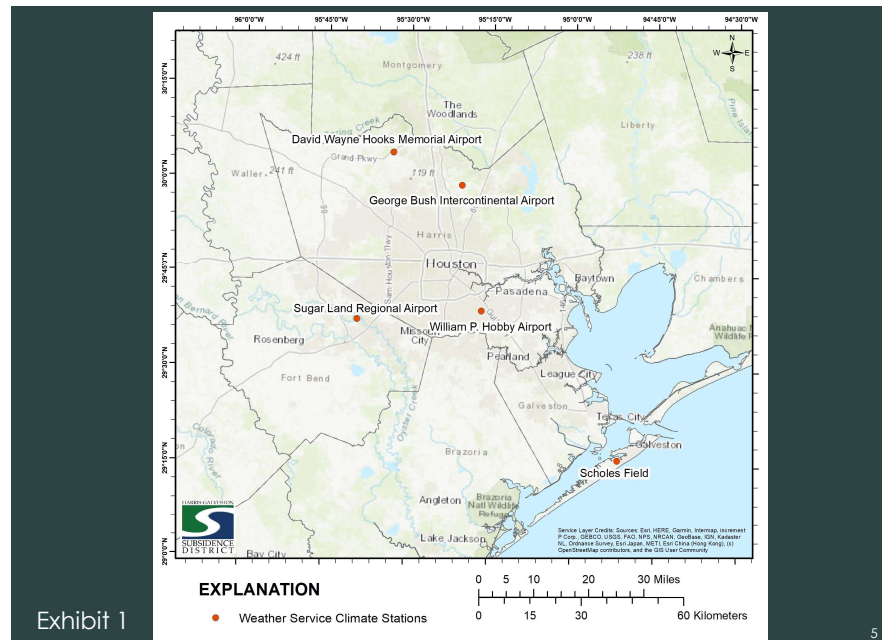
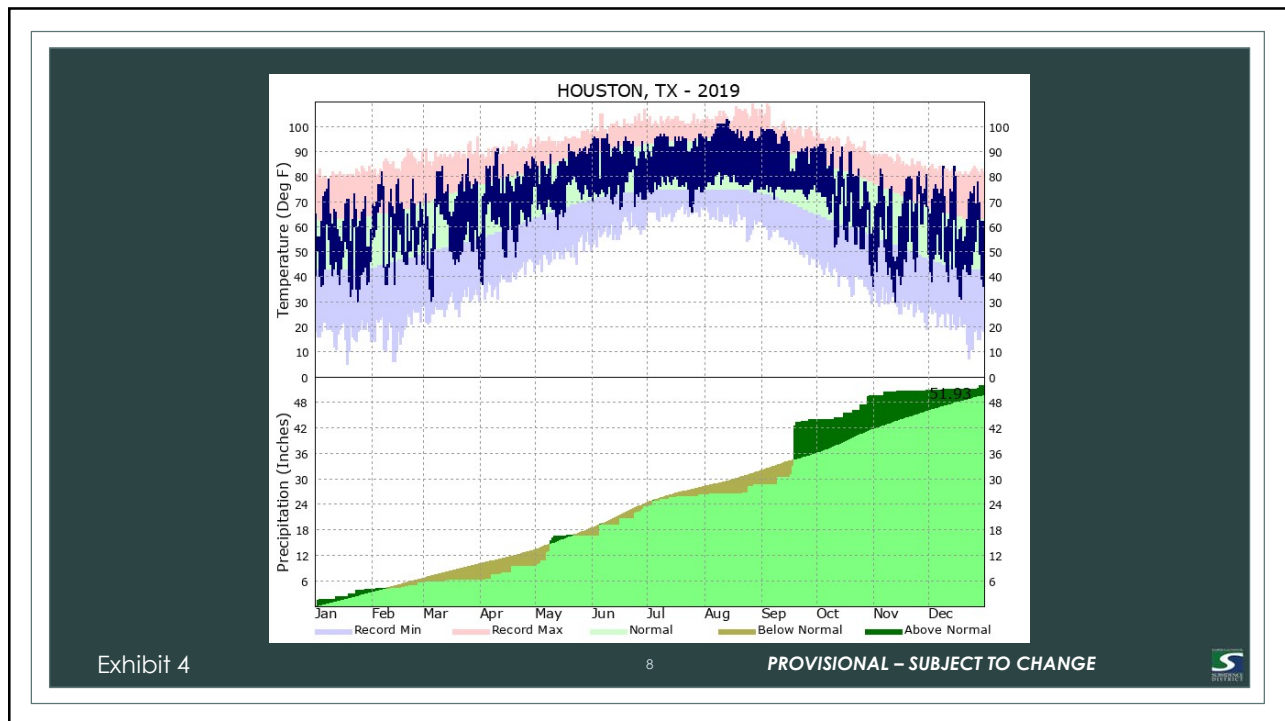
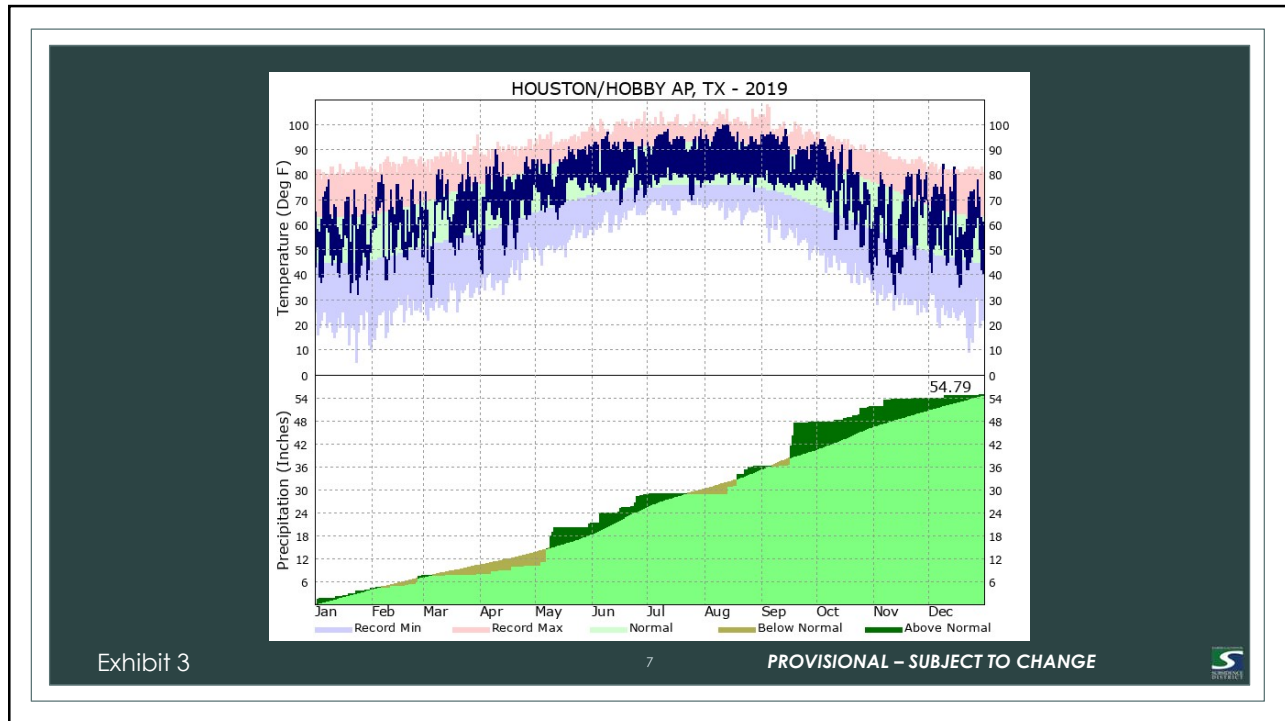


Exhibit 2





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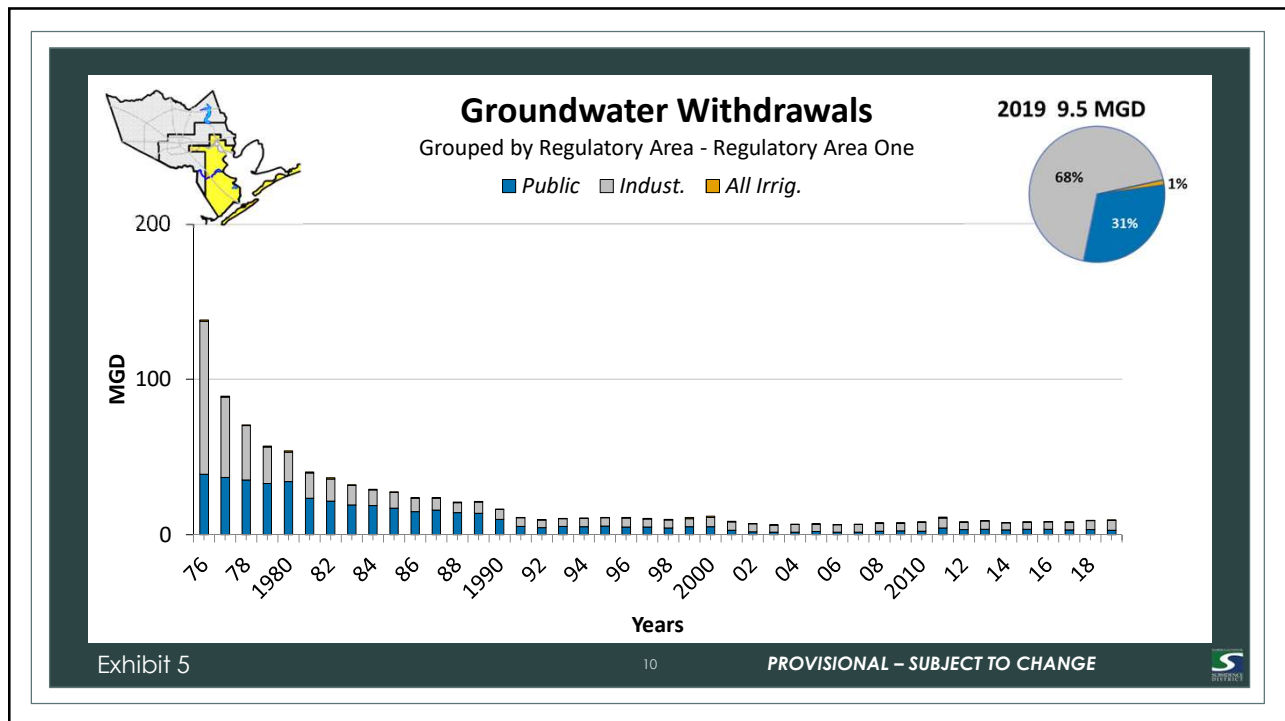


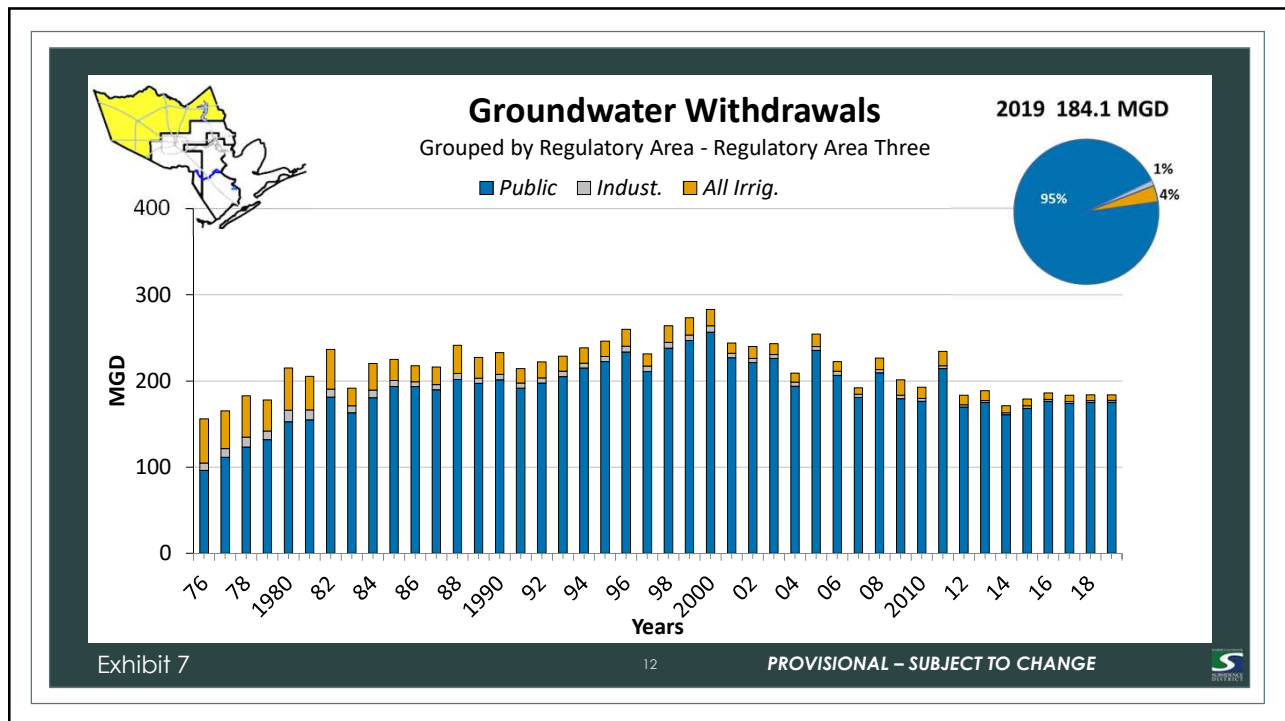
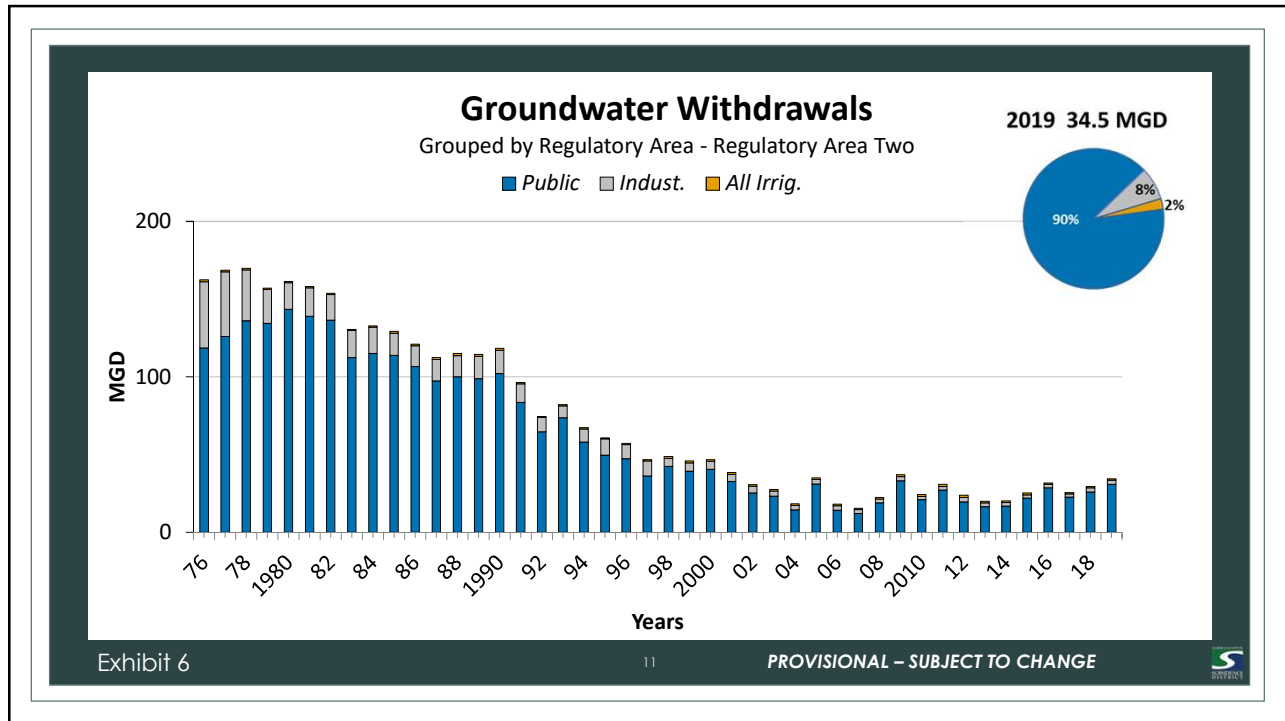


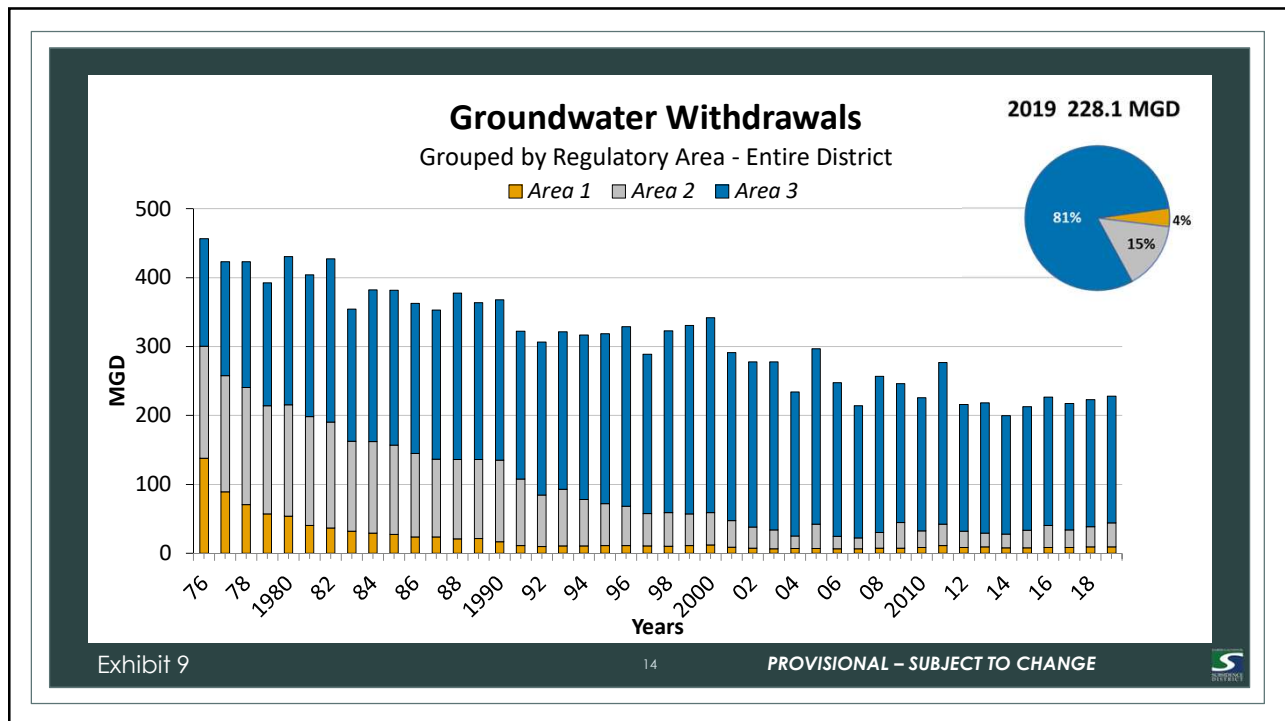
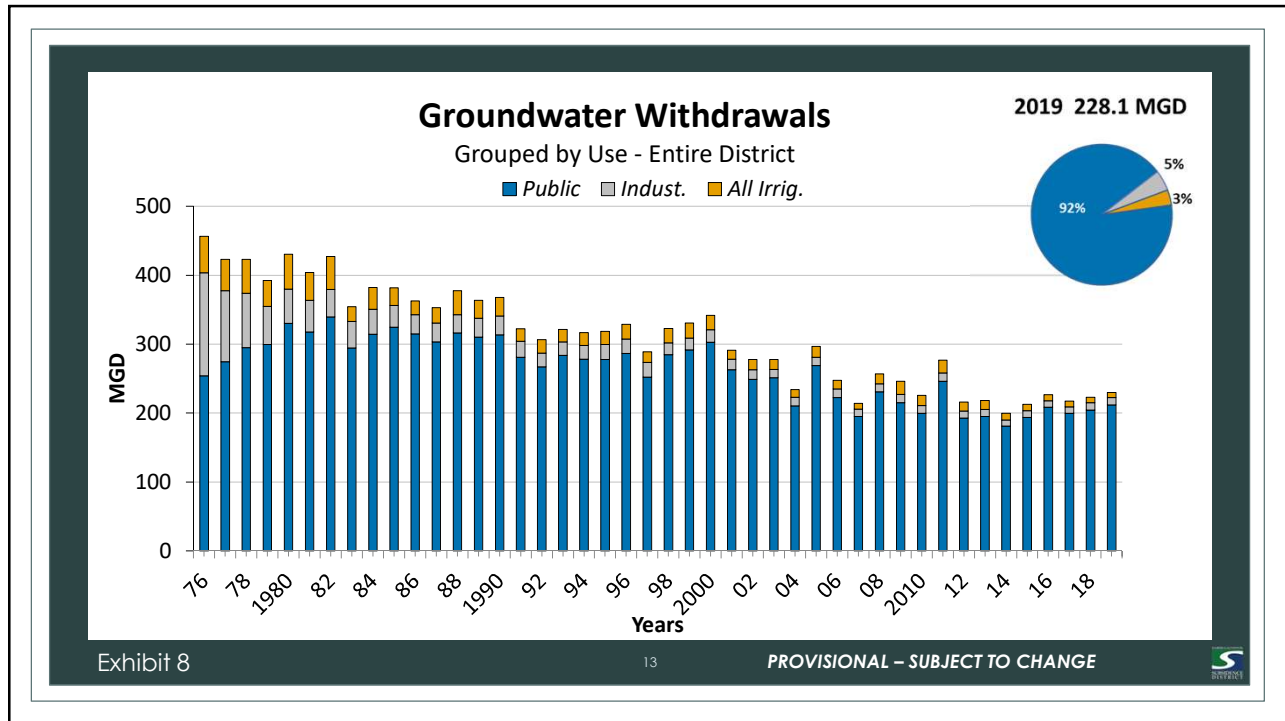
Agenda

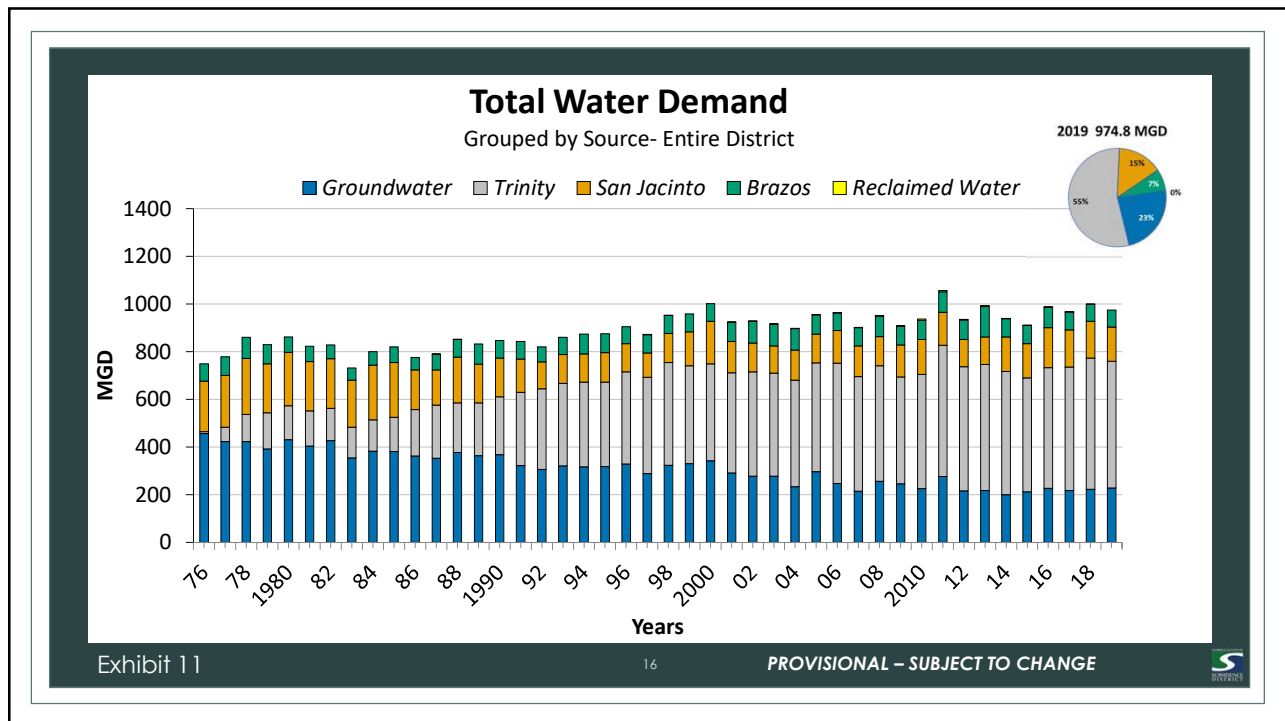
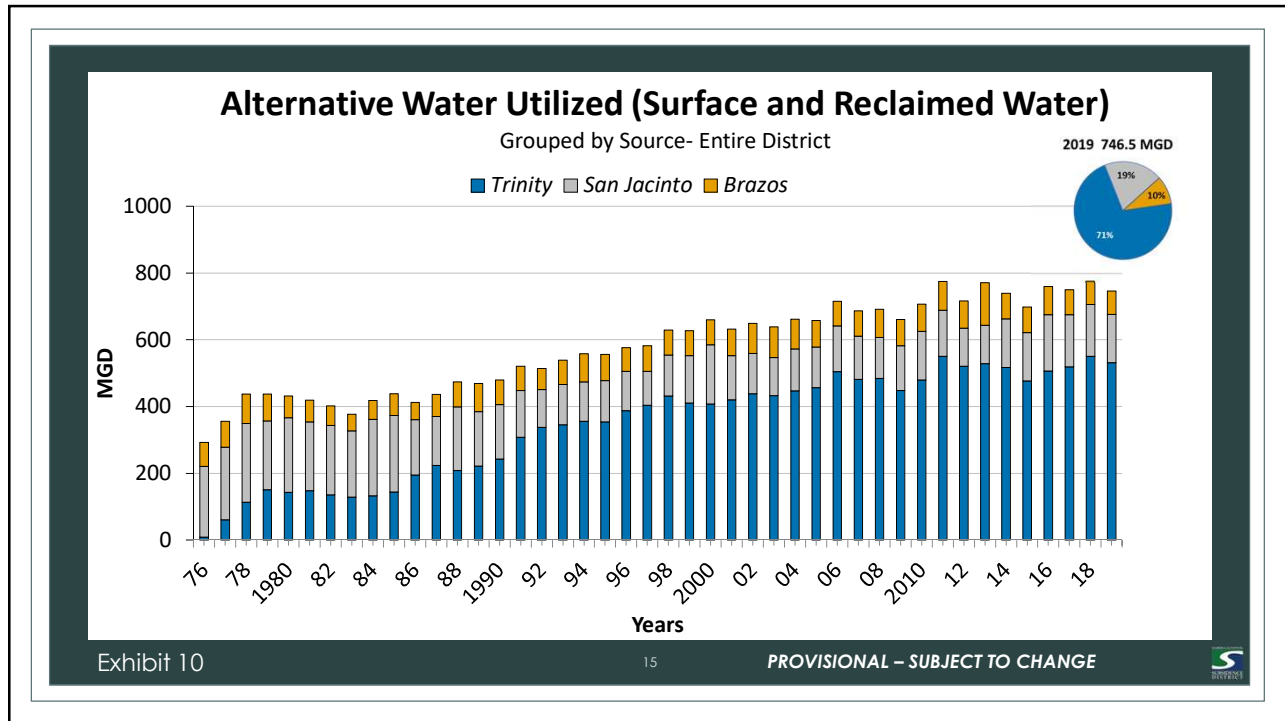
-  Climate
-  **Groundwater Use**
-  Groundwater Levels
-  Subsidence Data

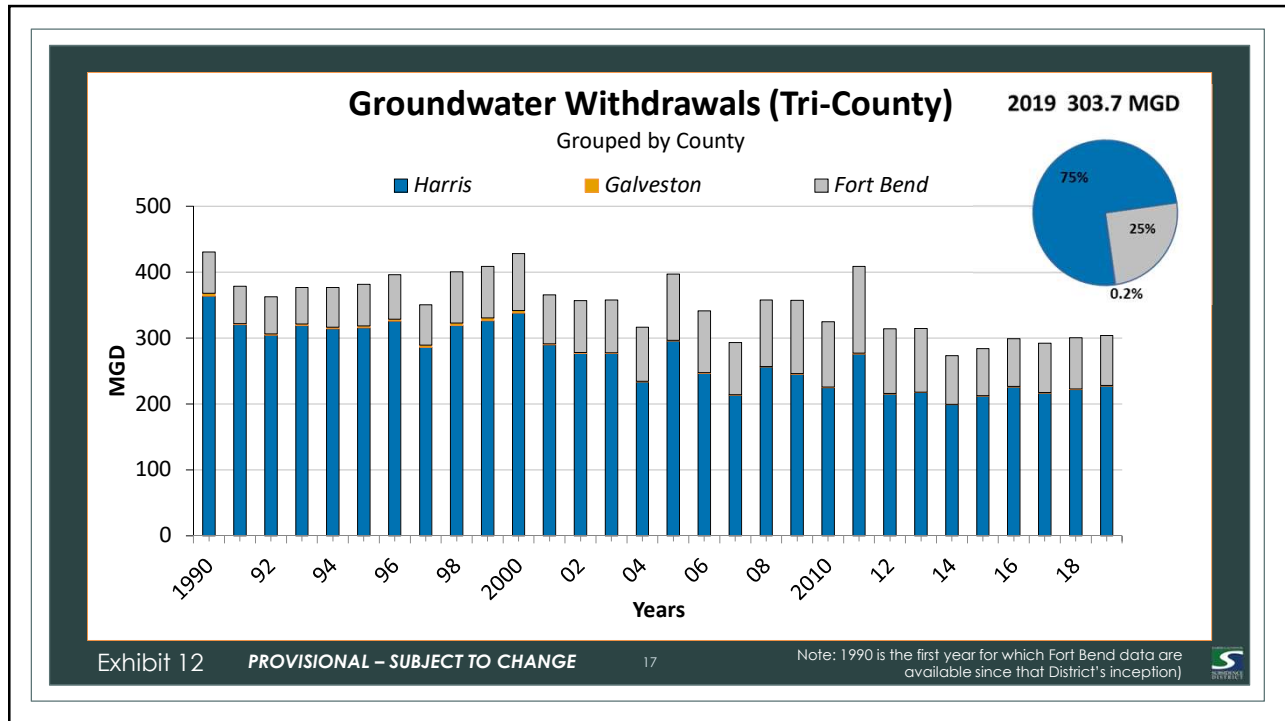
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Agenda

- Climate
- Groundwater Use
- Groundwater Levels
- Subsidence Data

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

USGS Presentation

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Agenda

-  Climate
-  Groundwater Use
-  Groundwater Levels
-  Subsidence Data

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GPS Monitoring Network

Location and Map Identification of GPS Monitoring Sites that record periodic or continuous GPS data within Harris and Surrounding Counties, Texas, 2019.

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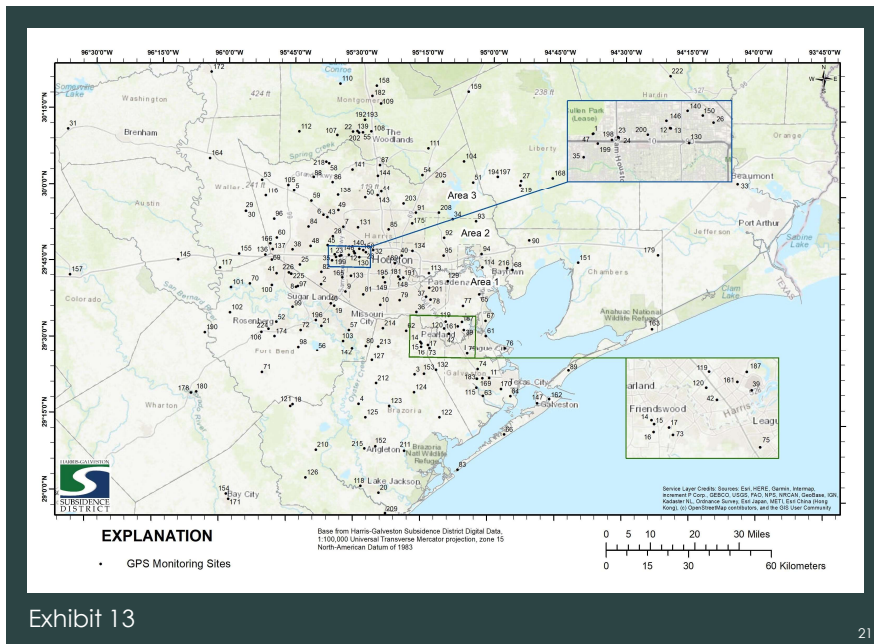


Exhibit 13

Annual Subsidence Rate

Annual subsidence rate, in centimeters per year (cm/yr), estimated from three or more years of periodic or continuous GPS data measured at GPS monitoring sites in Harris and Surrounding Counties, Texas, 2015-2019.

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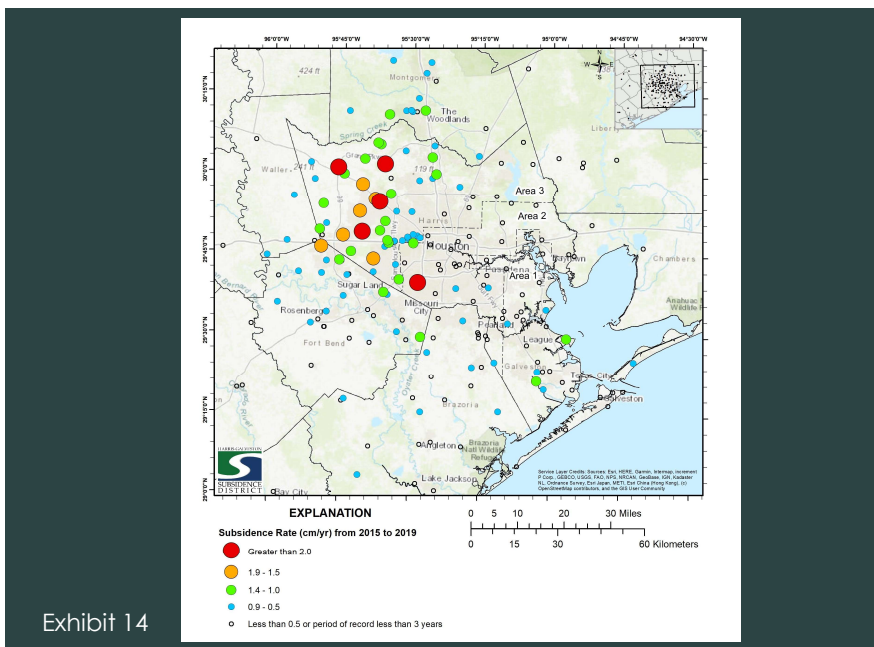


Exhibit 14

Regulatory Area Three

Annual subsidence rate (cm/yr) estimated from three or more years of periodic or continuous GPS data measured at GPS monitoring sites in Harris County, Texas, 2015-2019.

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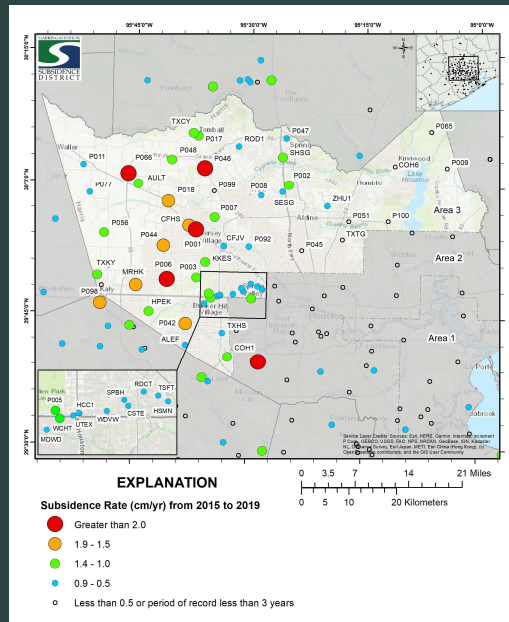


Exhibit 15 ²³

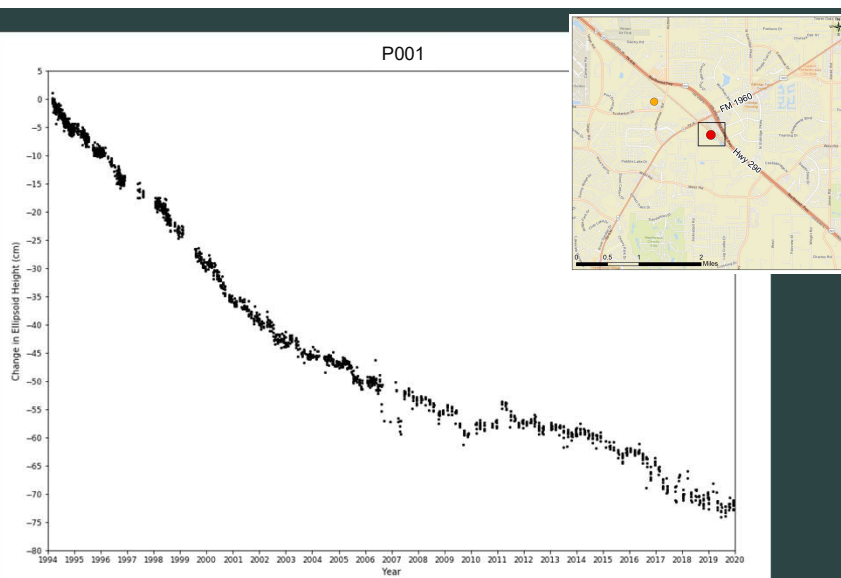


Exhibit 16

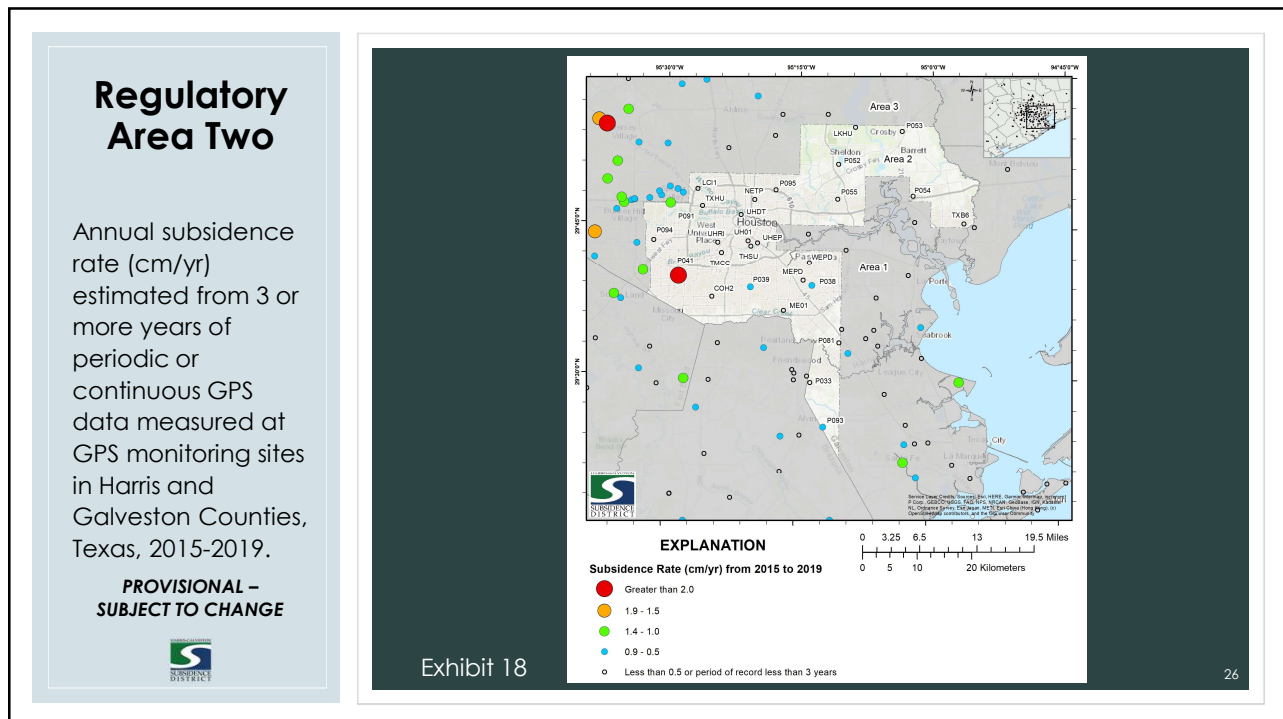
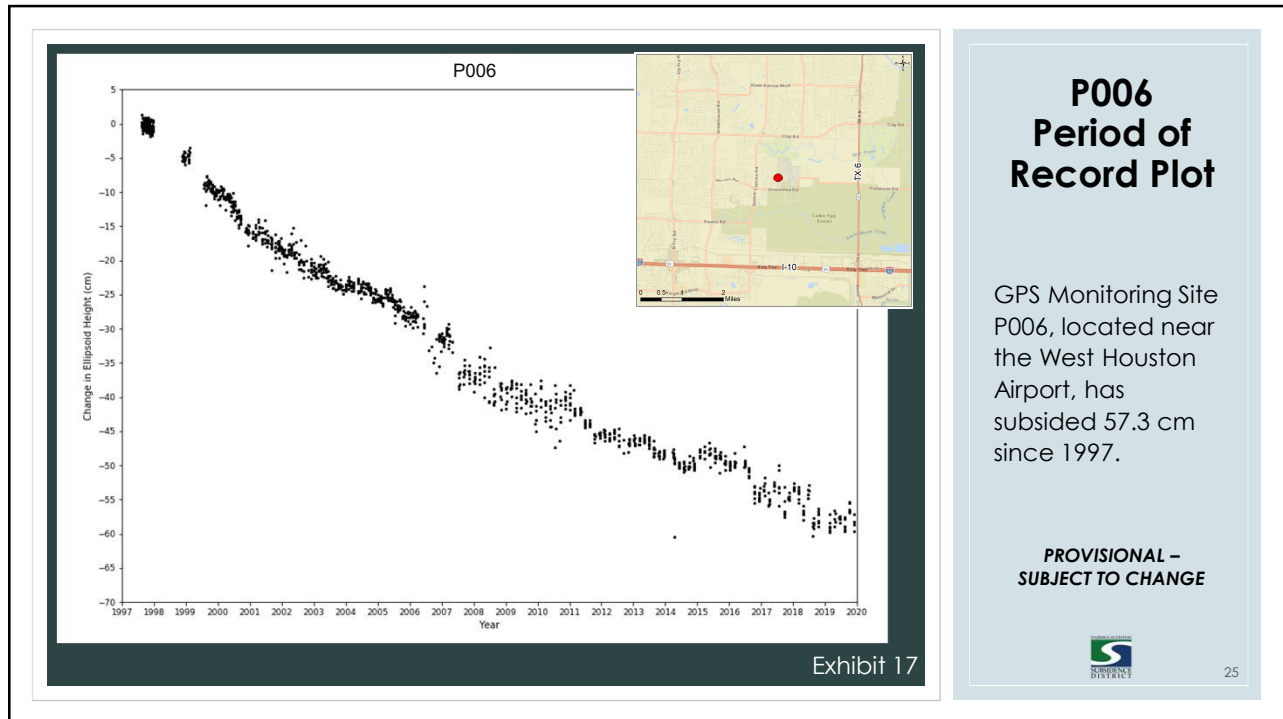
P001 Period of Record Plot

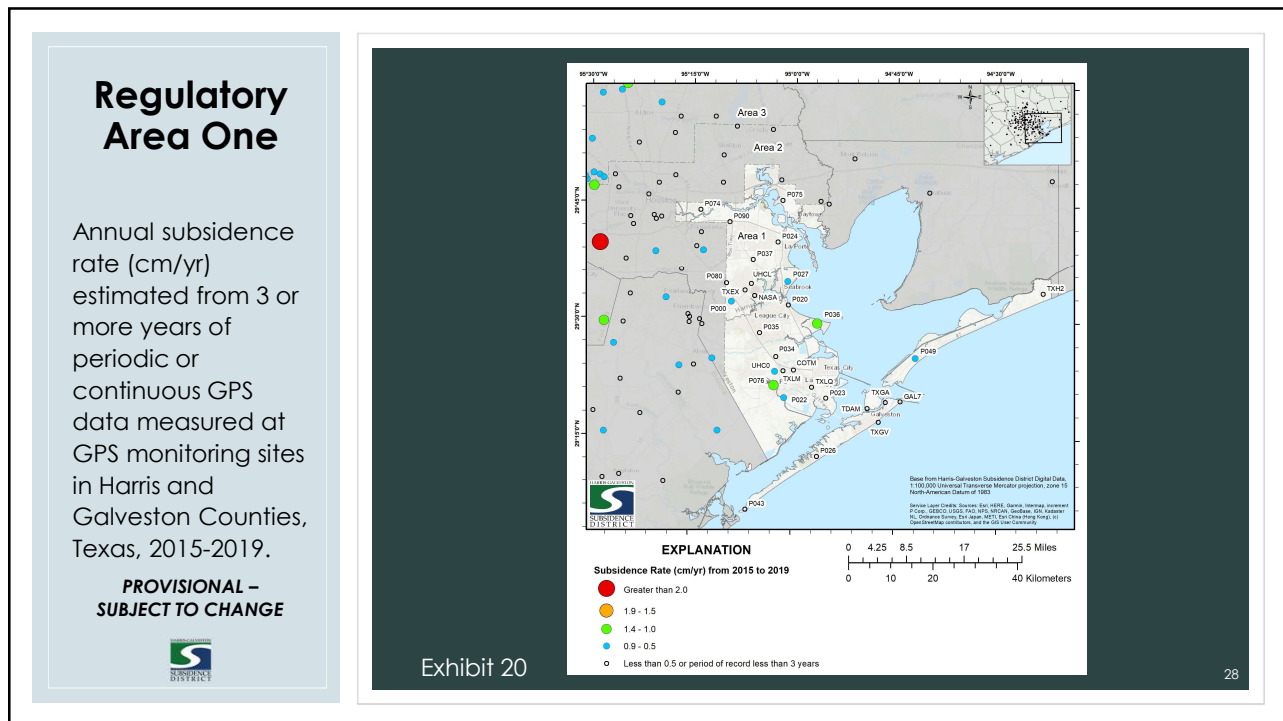
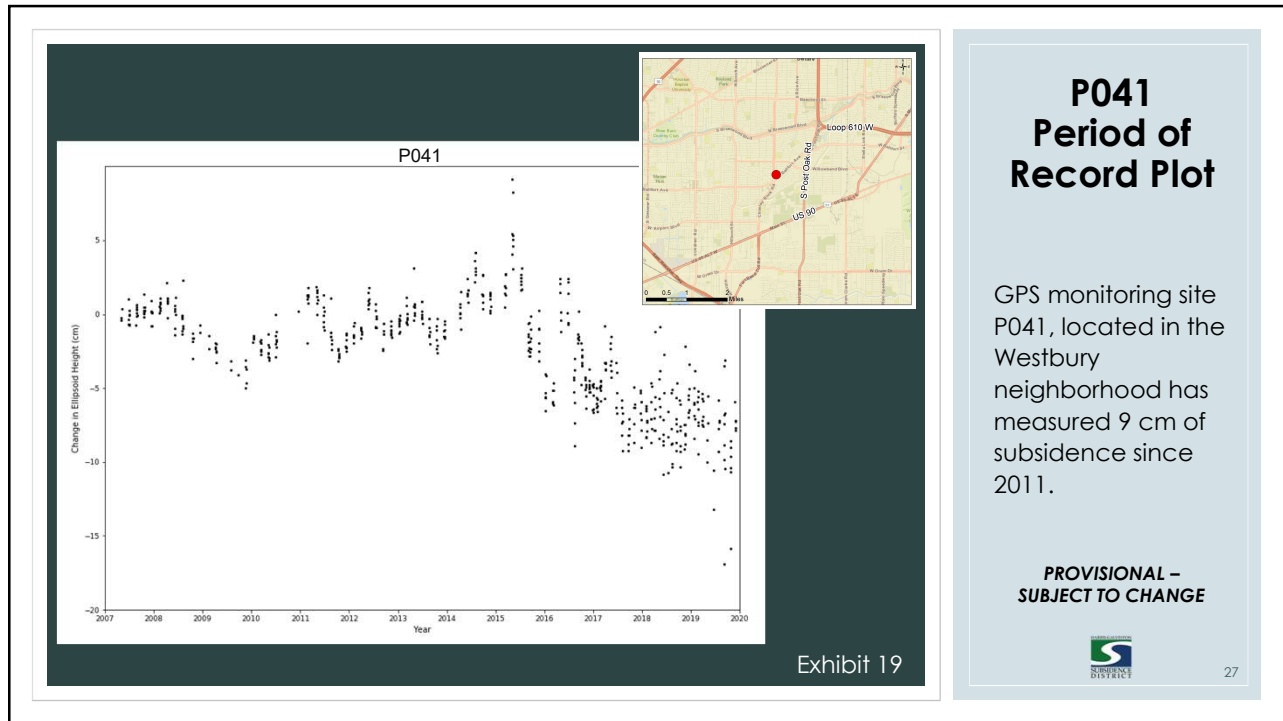
GPS monitoring site P001, located in Jersey Village, has the greatest subsidence measuring at 71.8 cm since 1994.

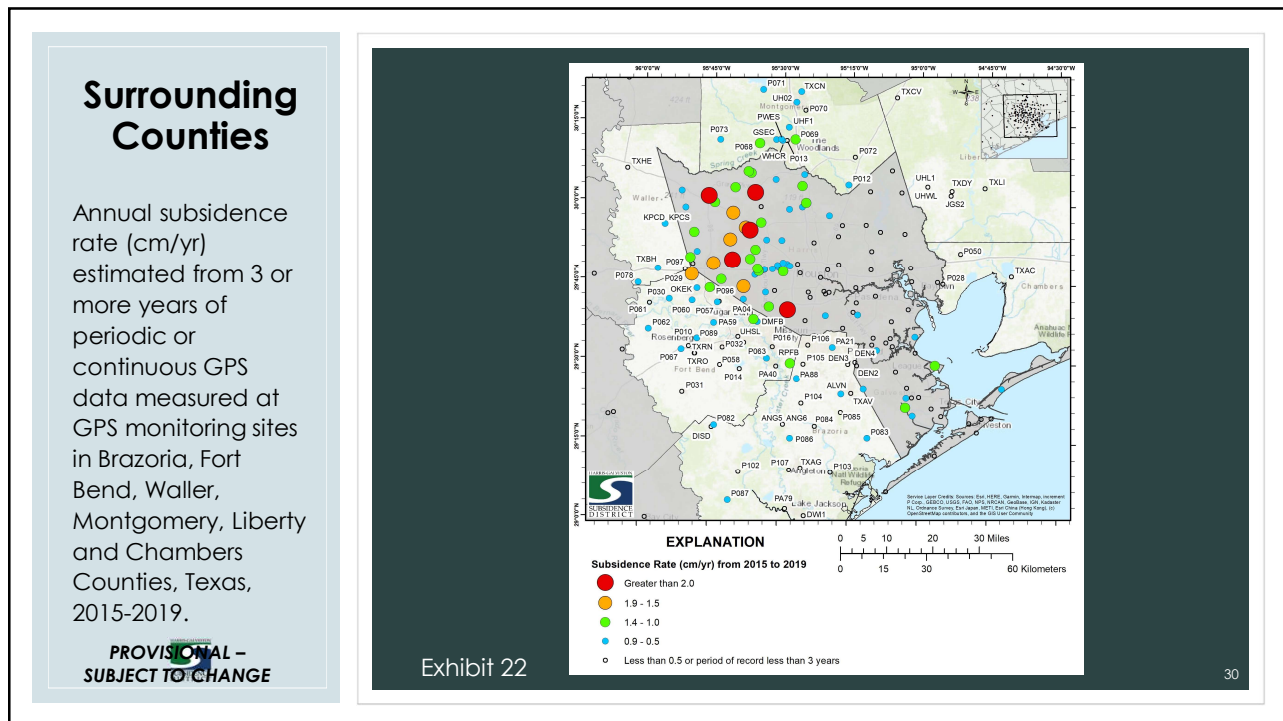
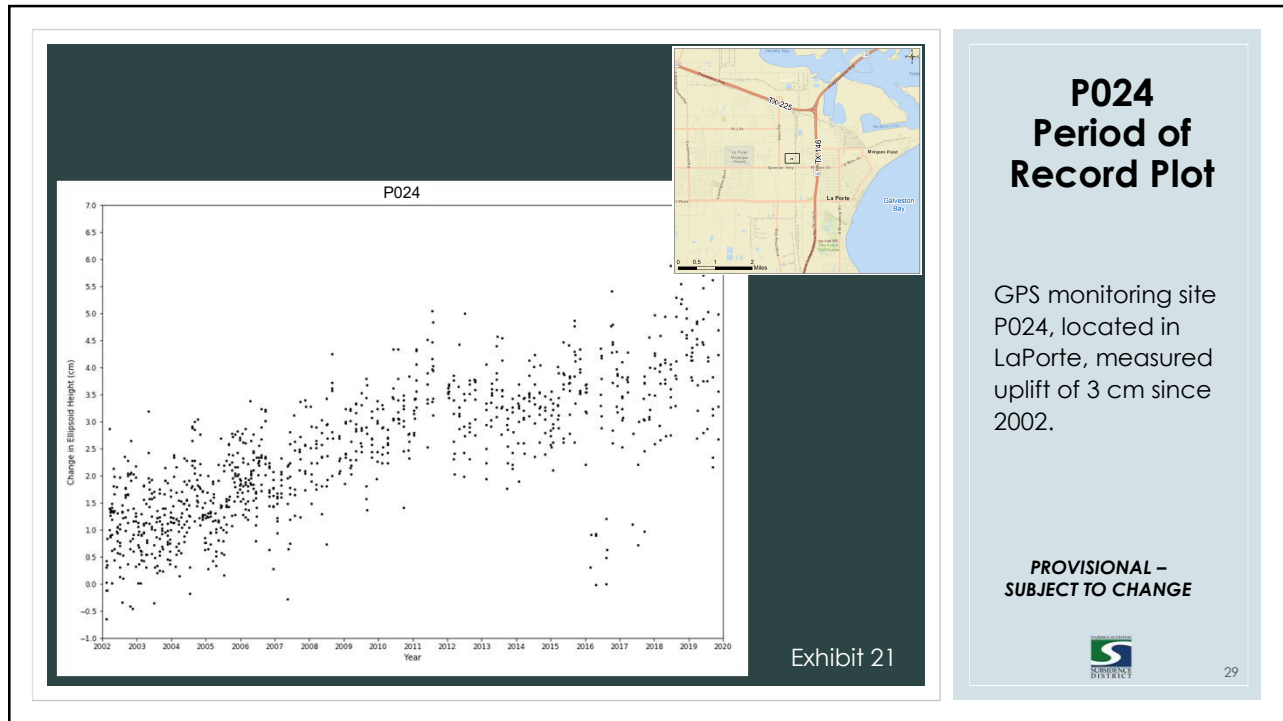
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Fort Bend County

Annual subsidence rate (cm/yr) estimated from 3 or more years of periodic or continuous GPS data measured at GPS monitoring sites in Fort Bend County, Texas, 2015-2019.

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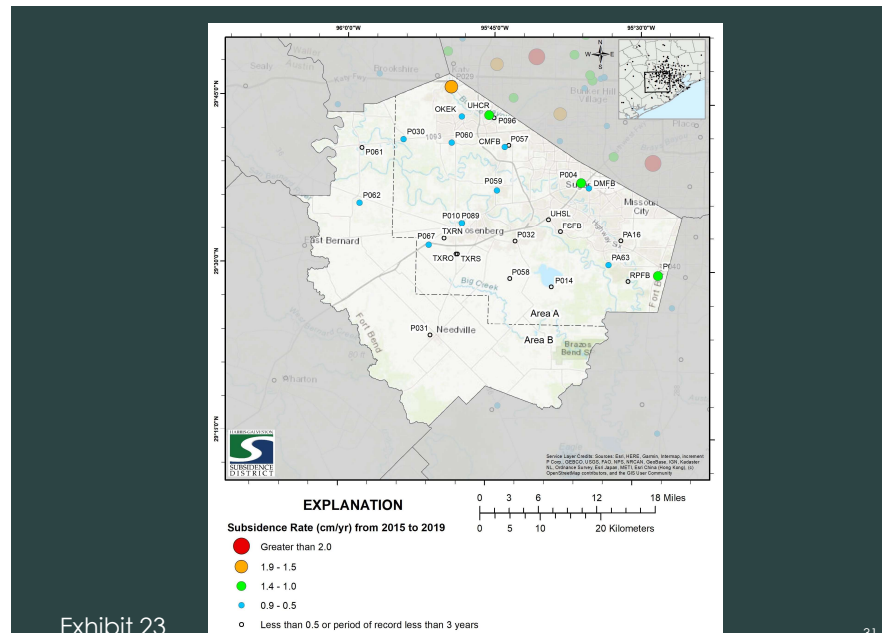


Exhibit 23

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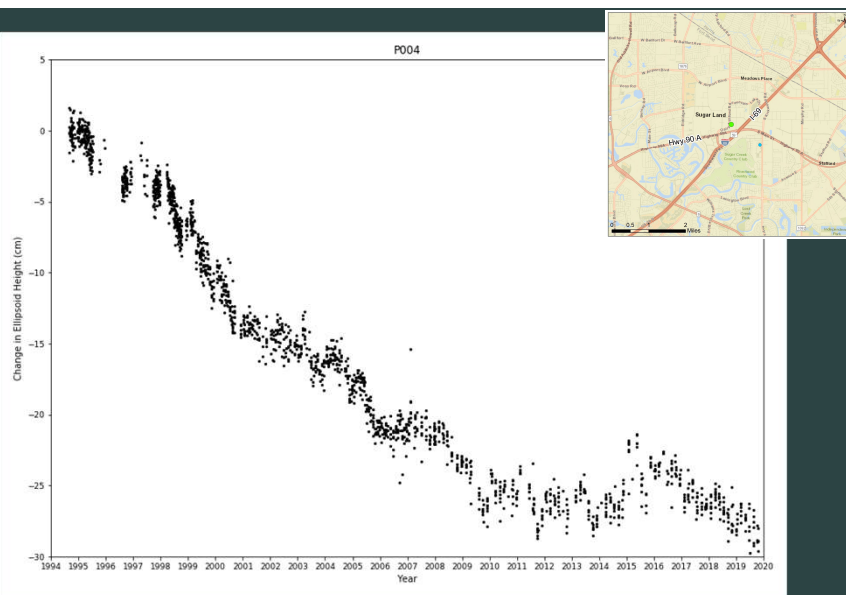


Exhibit 24

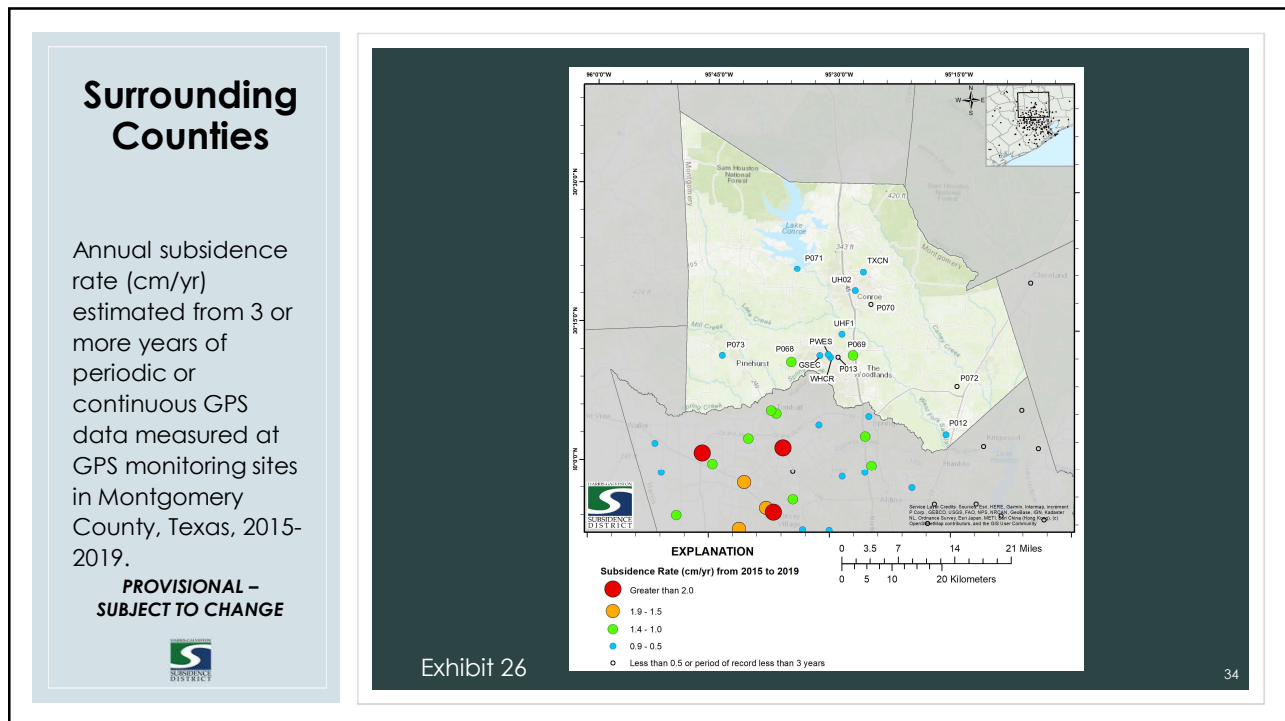
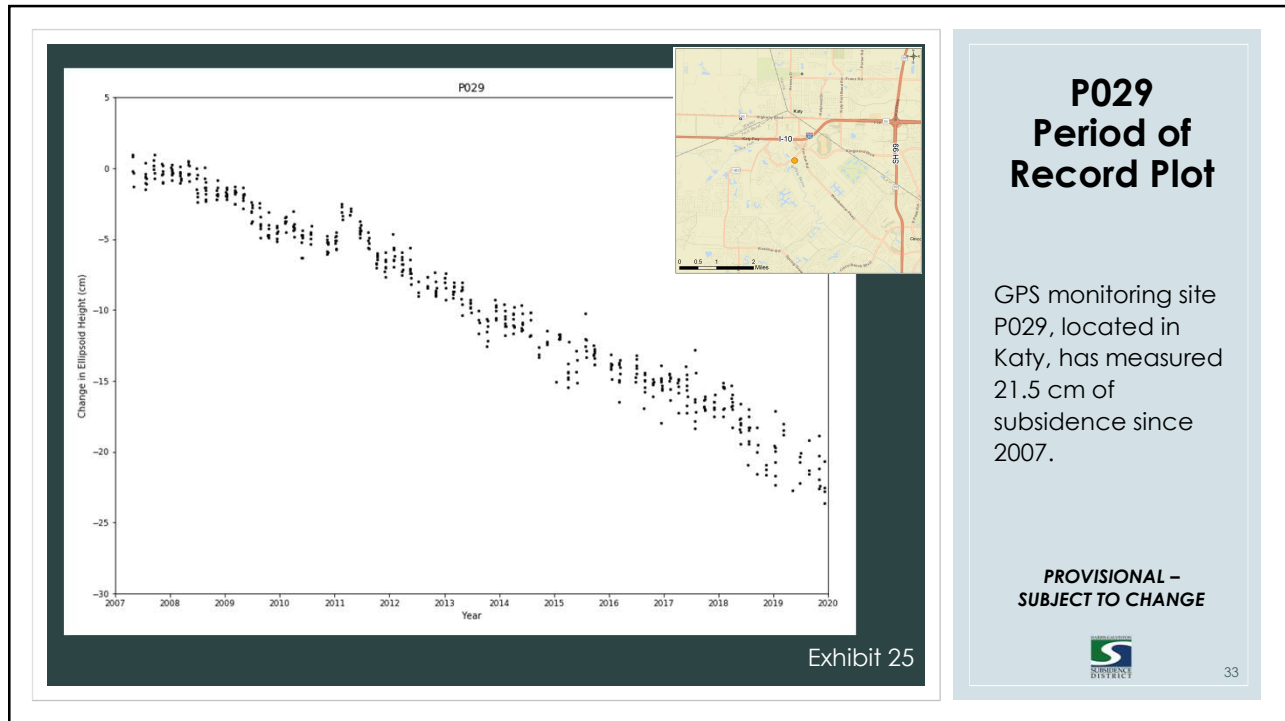
P004 Period of Record Plot

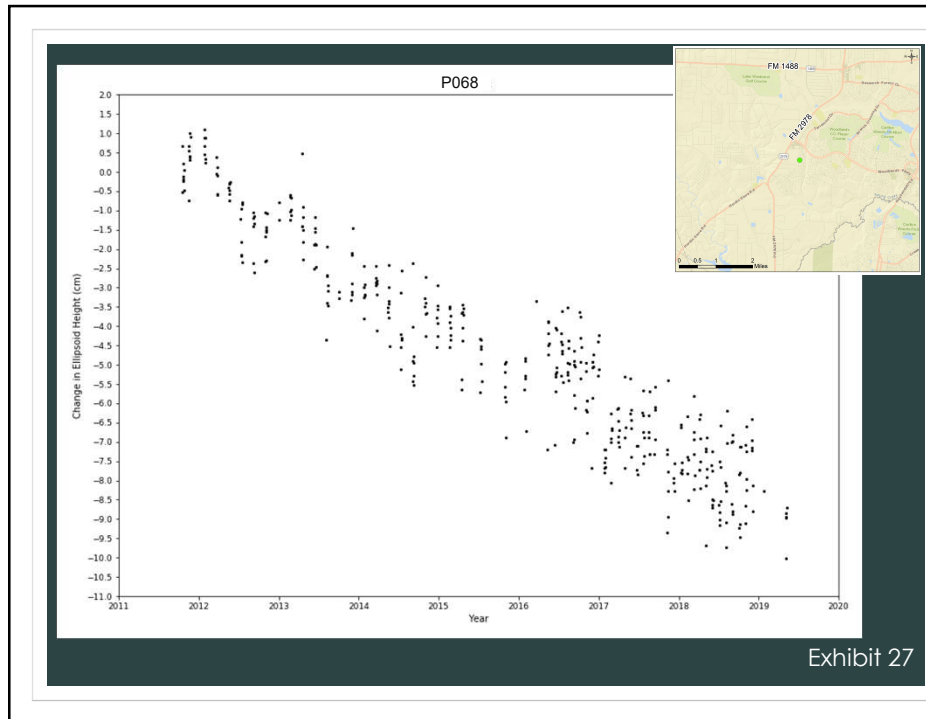
GPS monitoring site P004, located in Sugar Land, has measured 28.4 cm of subsidence since 1994.

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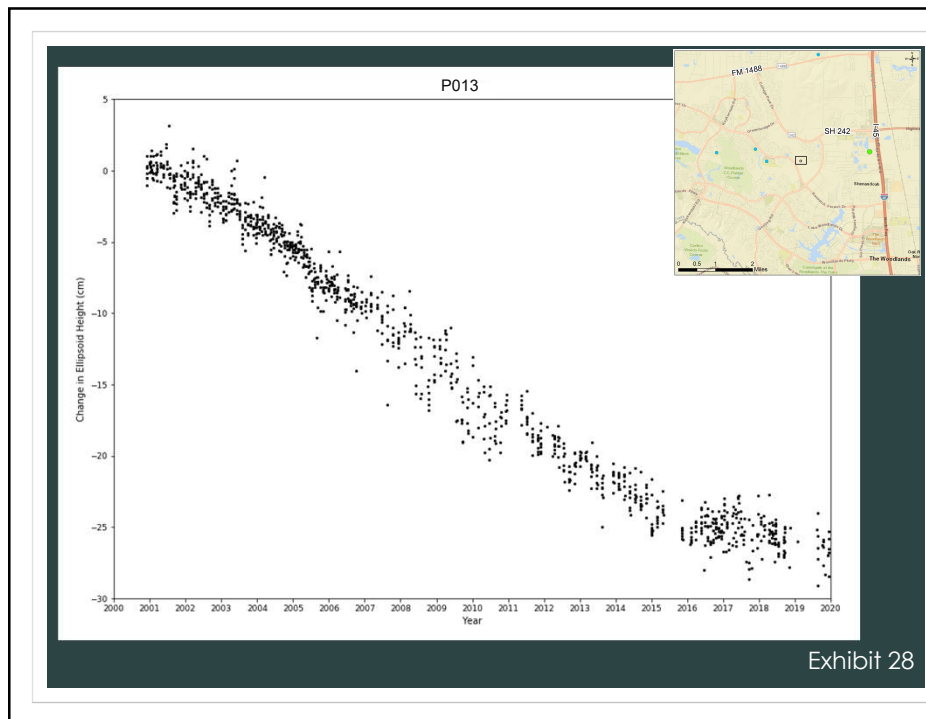
P068 Period of Record Plot

GPS monitoring site P068, located in The Woodlands, has measured 8.2 cm of subsidence since 2011.

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P013 Period of Record Plot

GPS monitoring site P013, located in The Woodlands, has measured 26.7 cm of subsidence since 2000.

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Surrounding Counties

Annual subsidence rate (cm/yr) estimated from 3 or more years of periodic or continuous GPS data measured at GPS monitoring sites in Brazoria County, Texas, 2015-2019.

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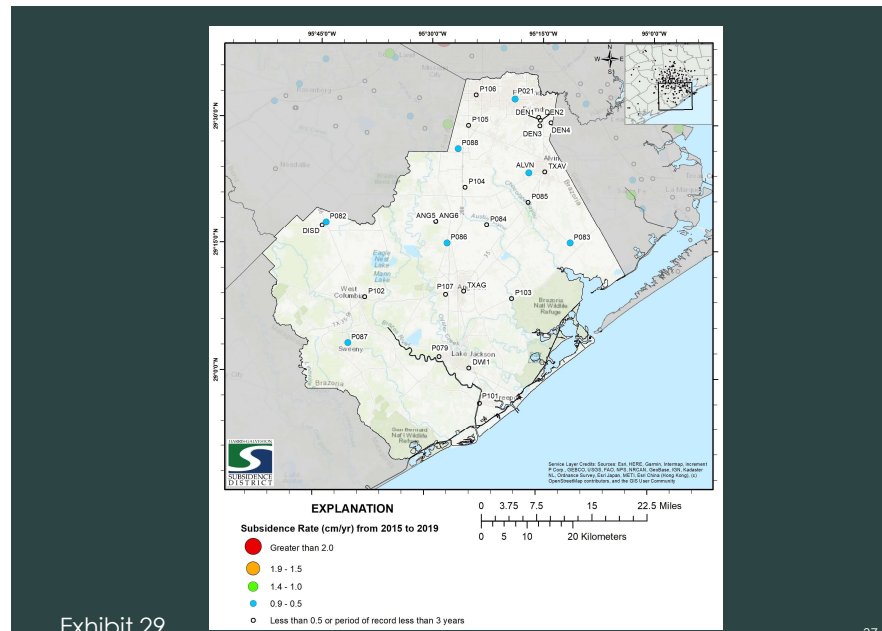


Exhibit 29

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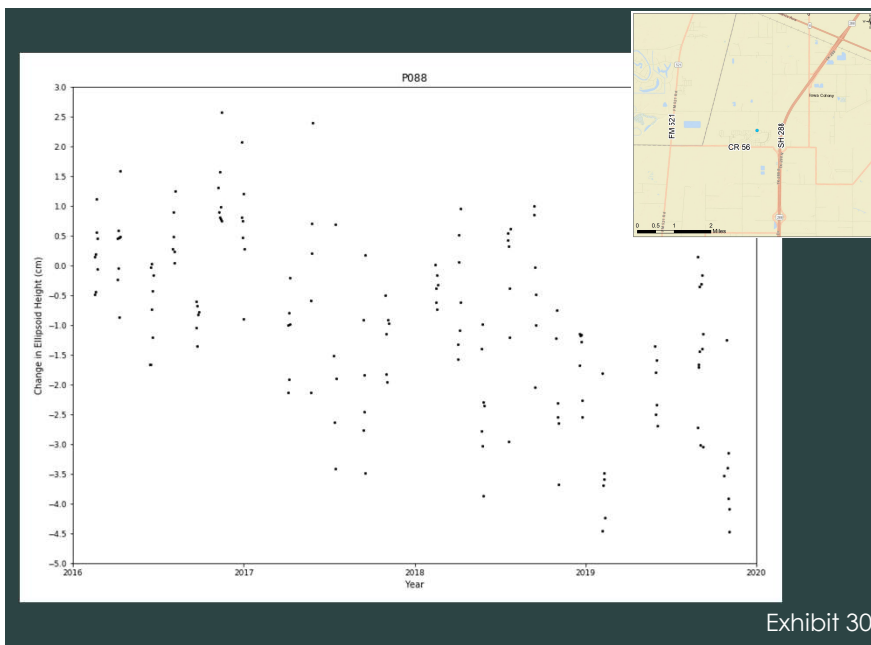


Exhibit 30

P088 Period of Record Plot

GPS monitoring site P088, located in Rosharon, has measured 2.7 cm of subsidence since 2016.

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United States Geological Survey Presentation



Groundwater-level altitudes and changes in the Chicot, Evangeline, and Jasper Aquifers (2020) and compaction in the Chicot and Evangeline Aquifers (1973-2019)

For the Houston-Galveston Region, Texas



Pumping well turbine, Montgomery County, Texas

U.S. Department of the Interior
U.S. Geological Survey

Jason Ramage | jkramage@usgs.gov
USGS Oklahoma–Texas Water Science Center

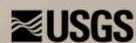
Chris Braun | clbraun@usgs.gov
USGS Oklahoma–Texas Water Science Center

*USGS Texas Water Science Center
Houston Branch*

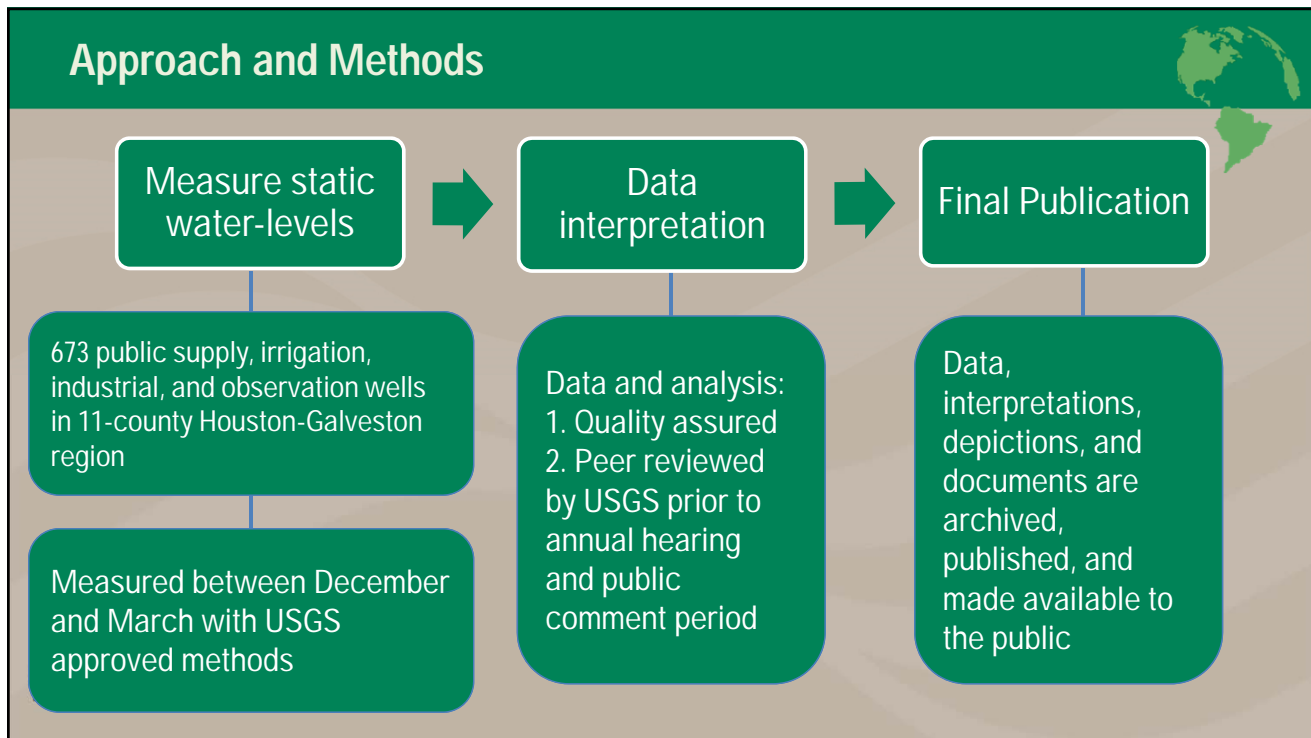


Overview

- Approach and Methods
- Gulf Coast Aquifer System
- Groundwater Monitoring Network
- Groundwater-Level Maps by Aquifer
 - Current water-level altitudes
 - 1-year and 5-year water-level change
 - Long term water-level altitude change
- Cumulative Compaction

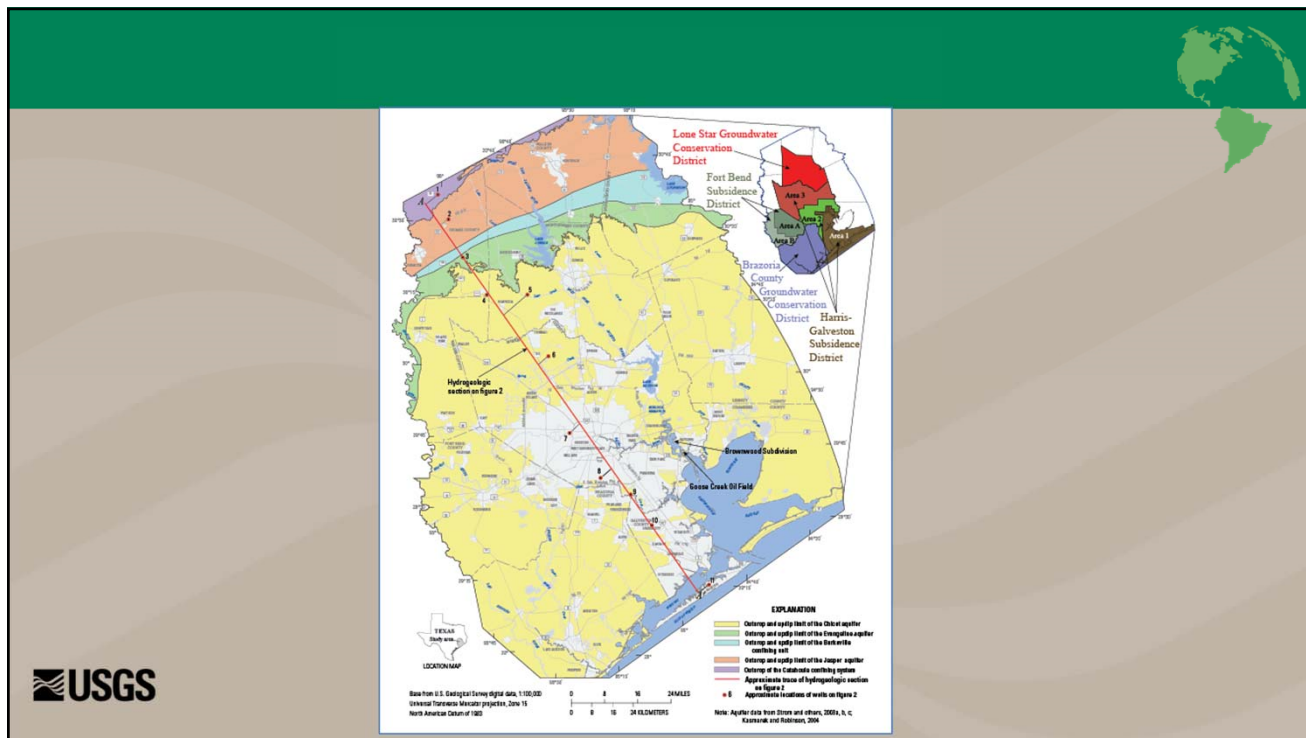


Approach and Methods

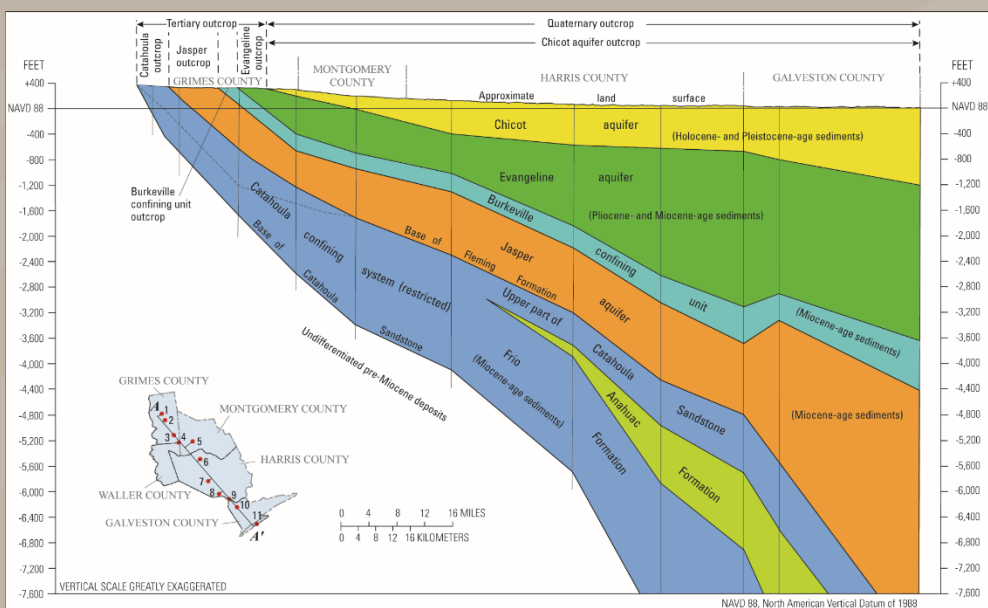


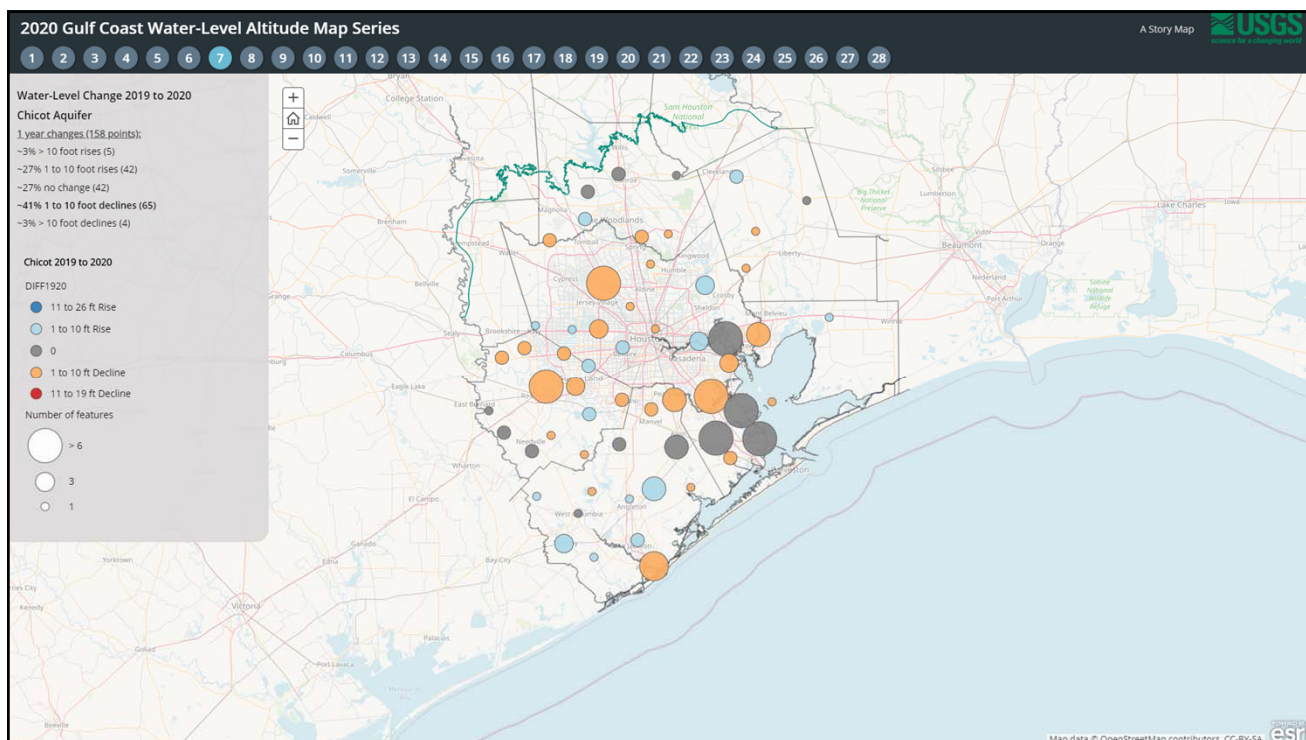
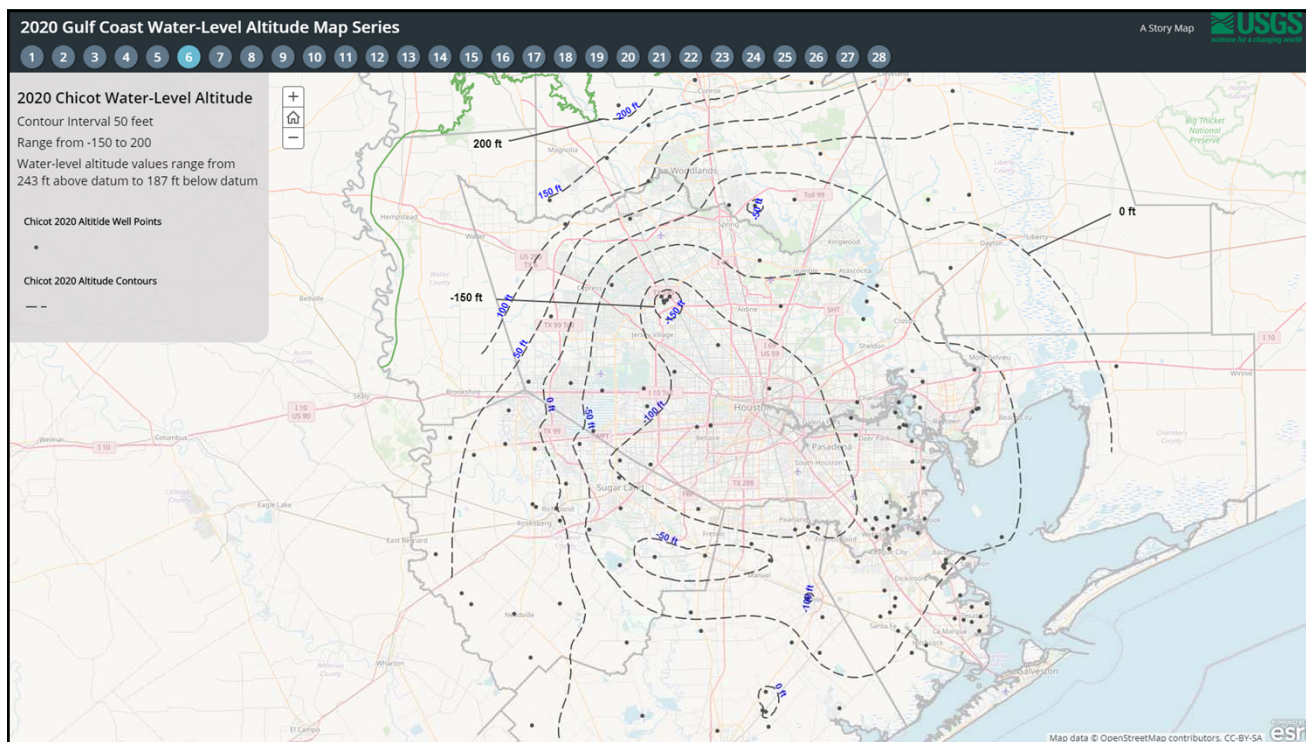
Groundwater Network

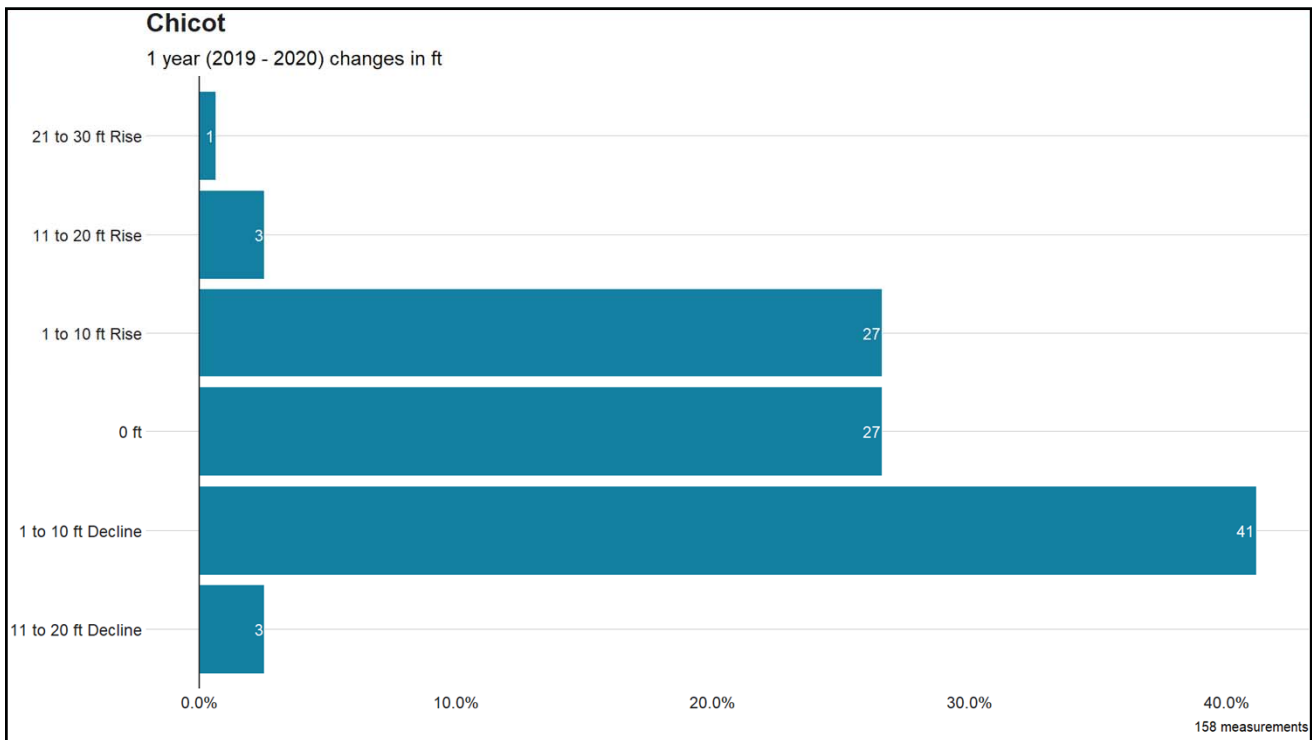
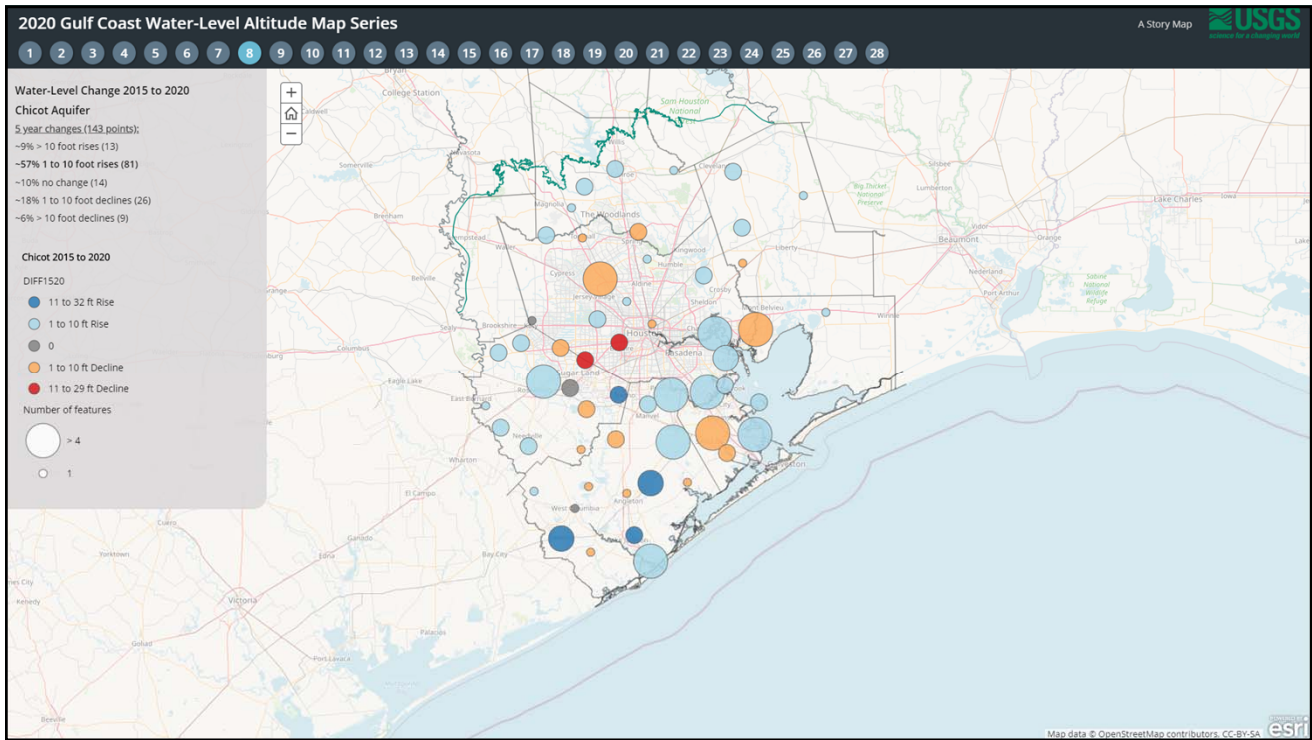
- Strong collaboration with local well owners, municipalities, MUDs, PUDs, SUDs
- Chicot and Evangeline aquifers are hydraulically connected: withdrawals from one aquifer can affect heads in the other
- Number of wells used to construct 2020 contours:
 - Chicot (173)
 - Evangeline (326)
 - Jasper (112)

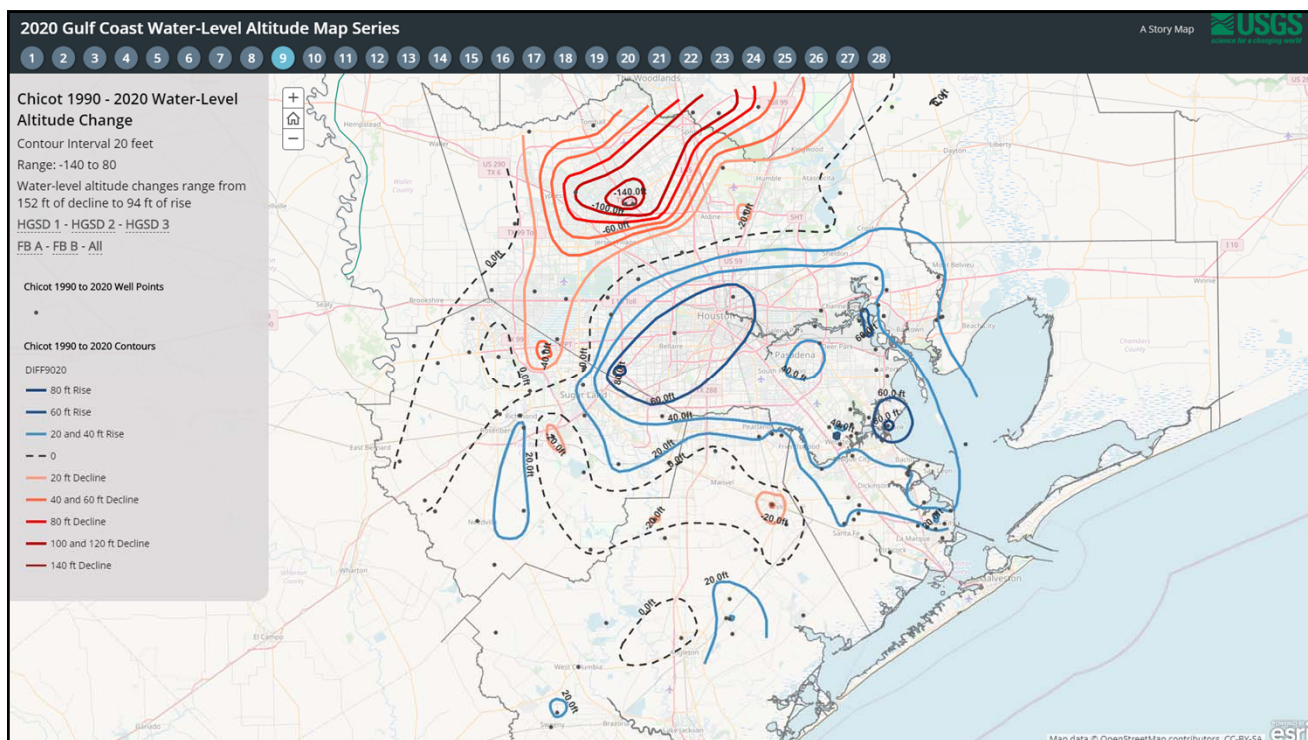
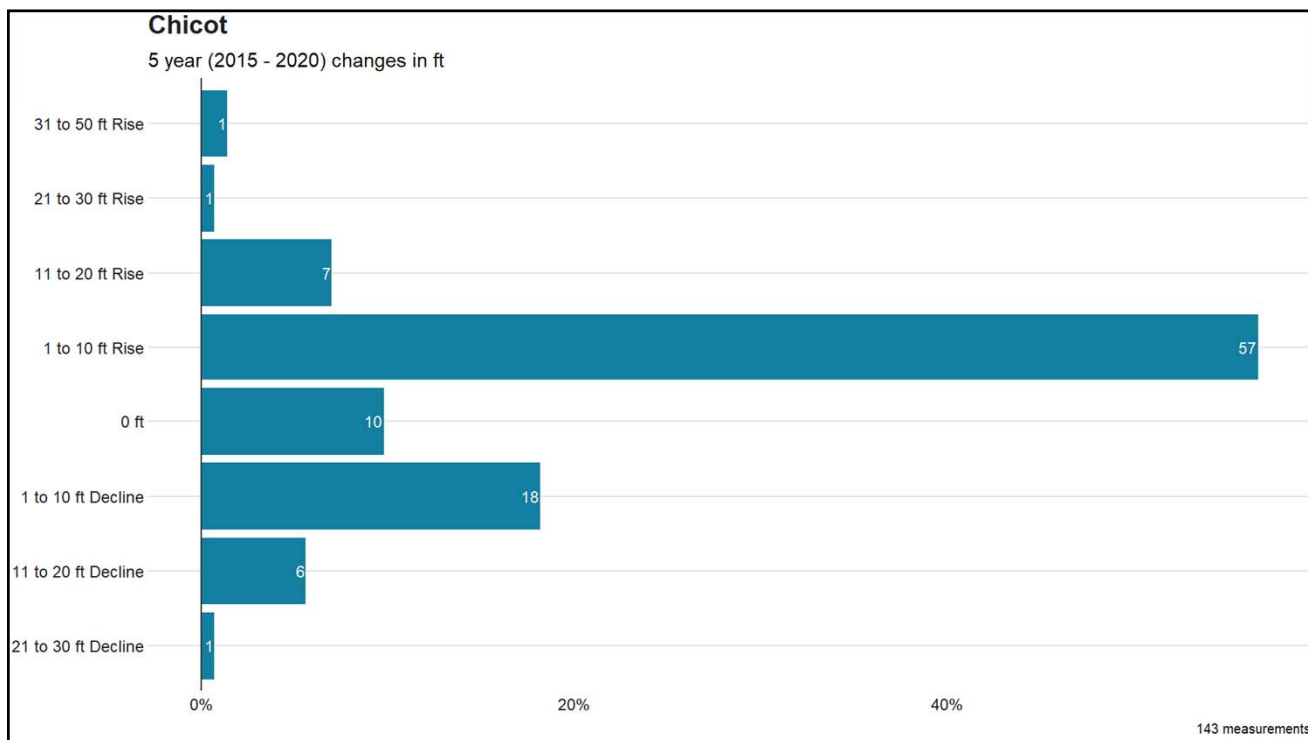


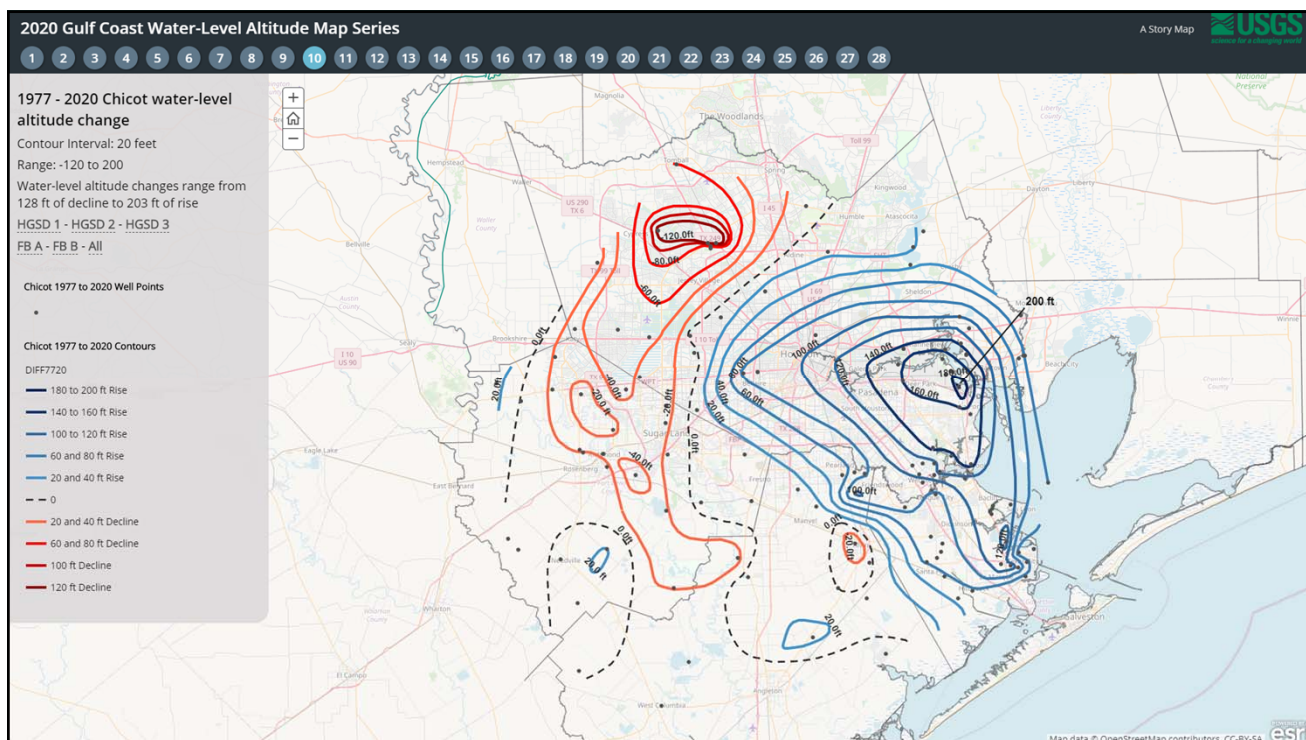
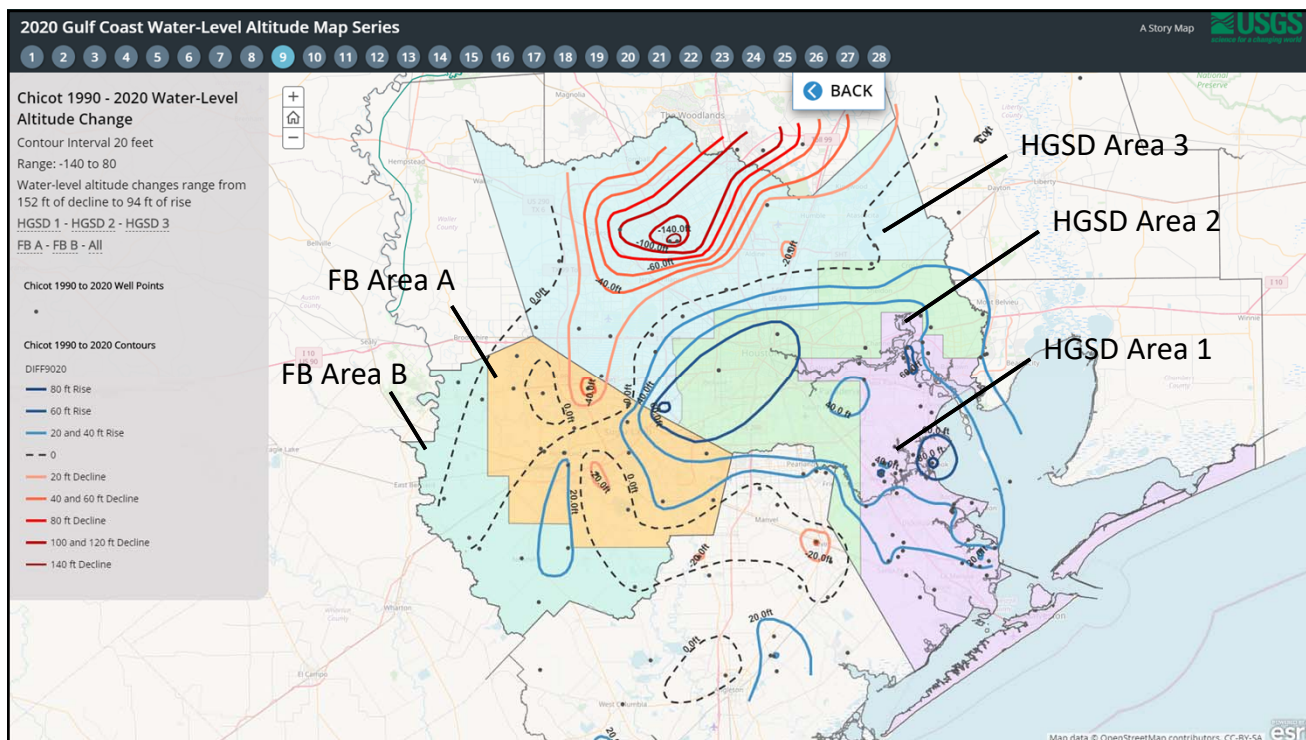
Hydrologic section of the Gulf Coast aquifer system

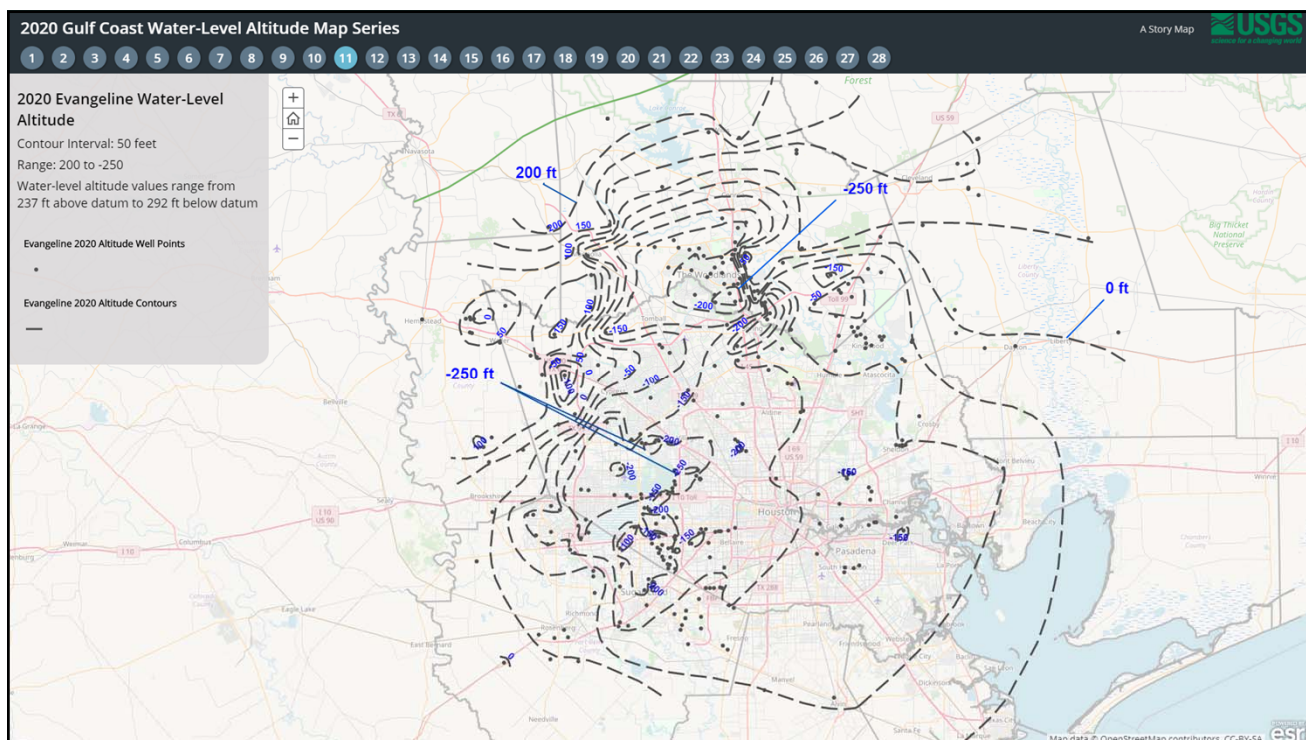
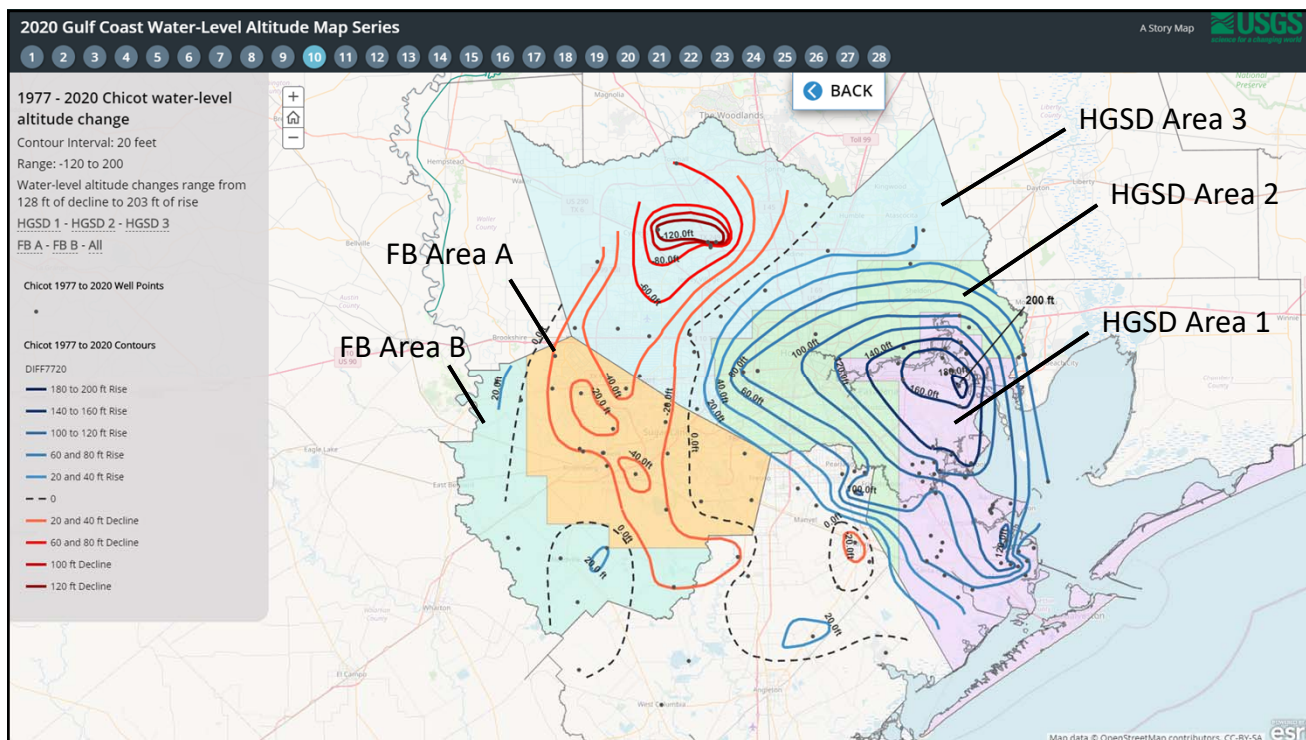


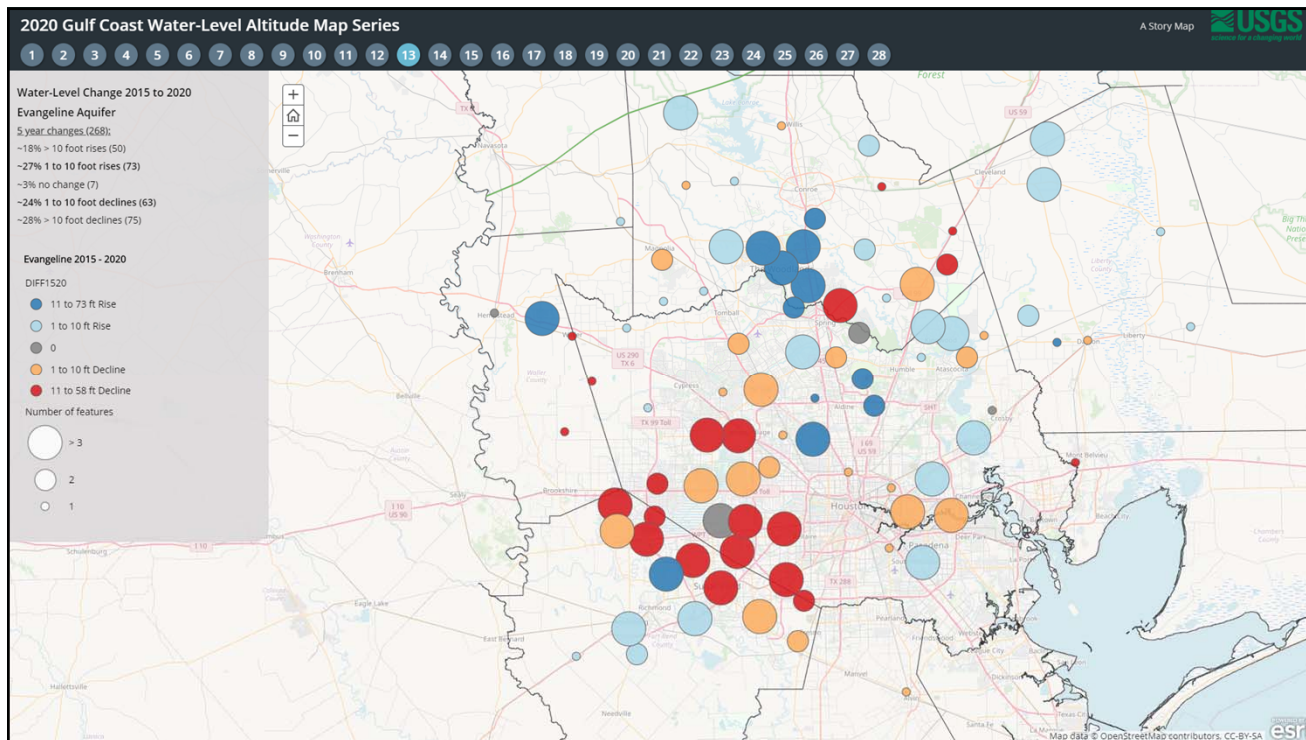
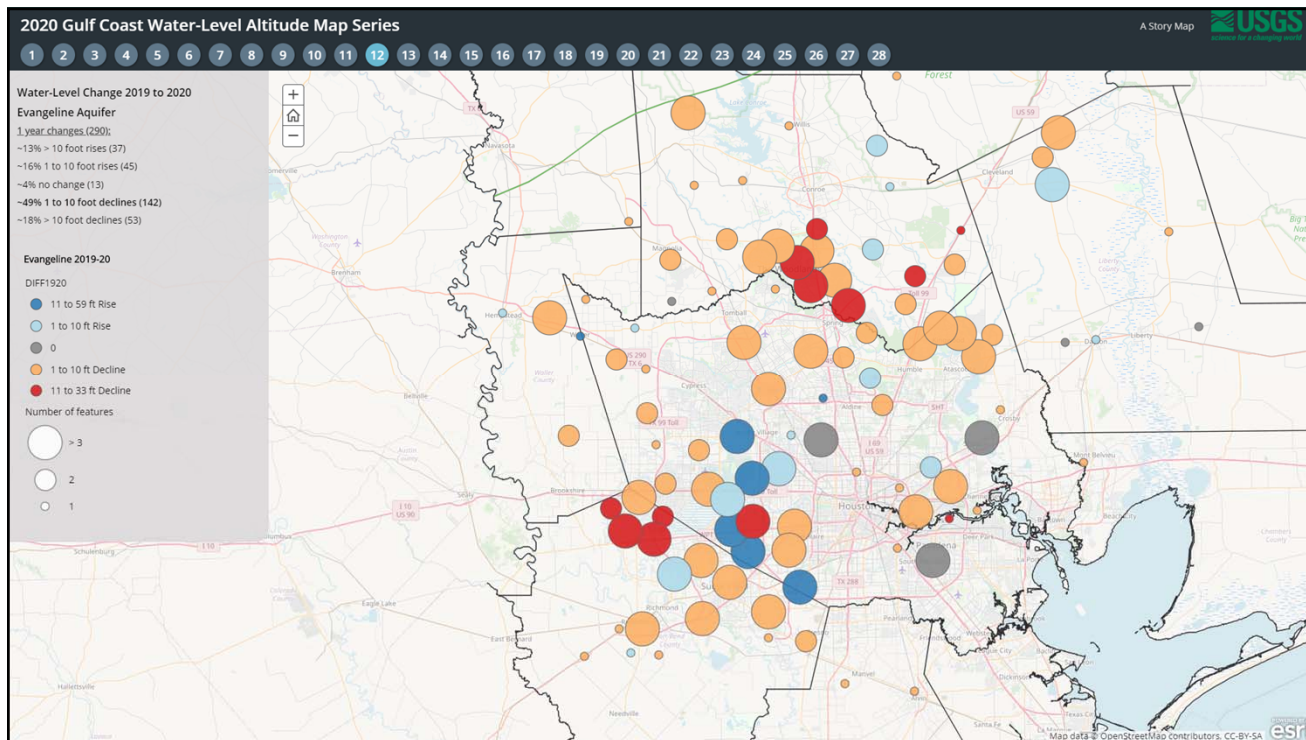


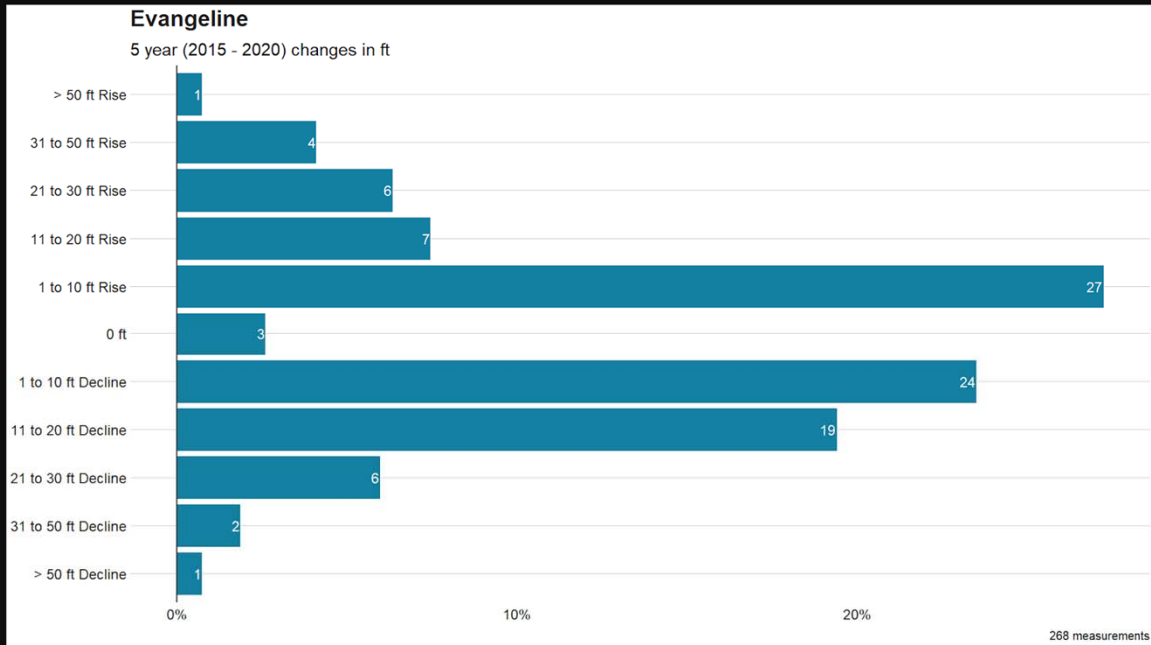
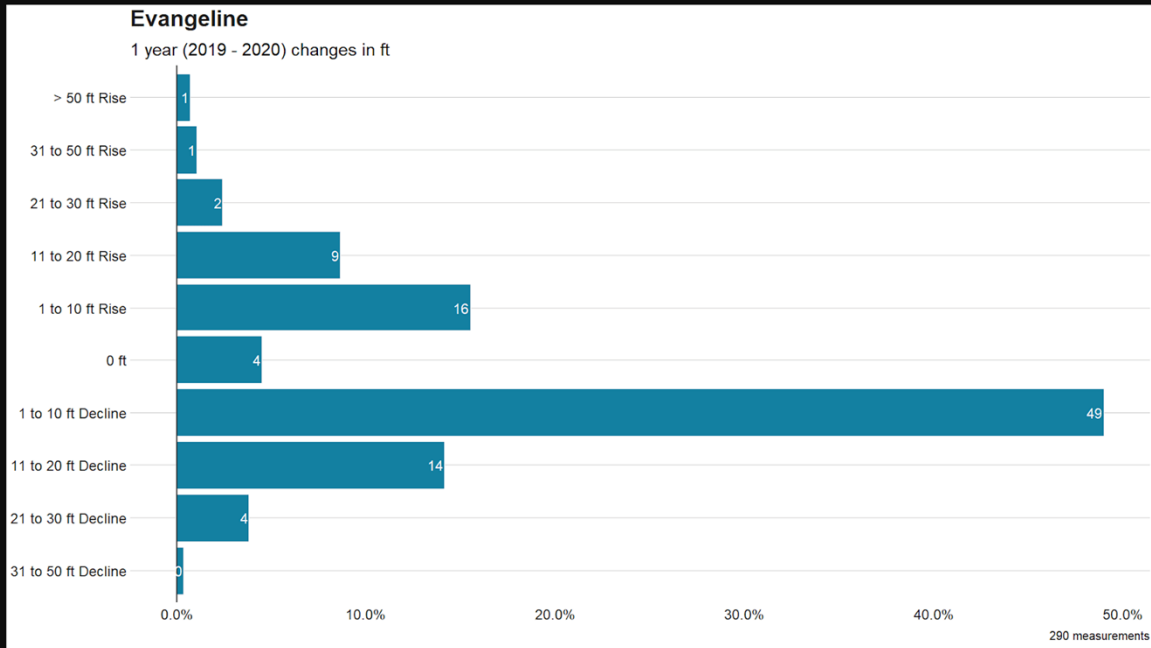


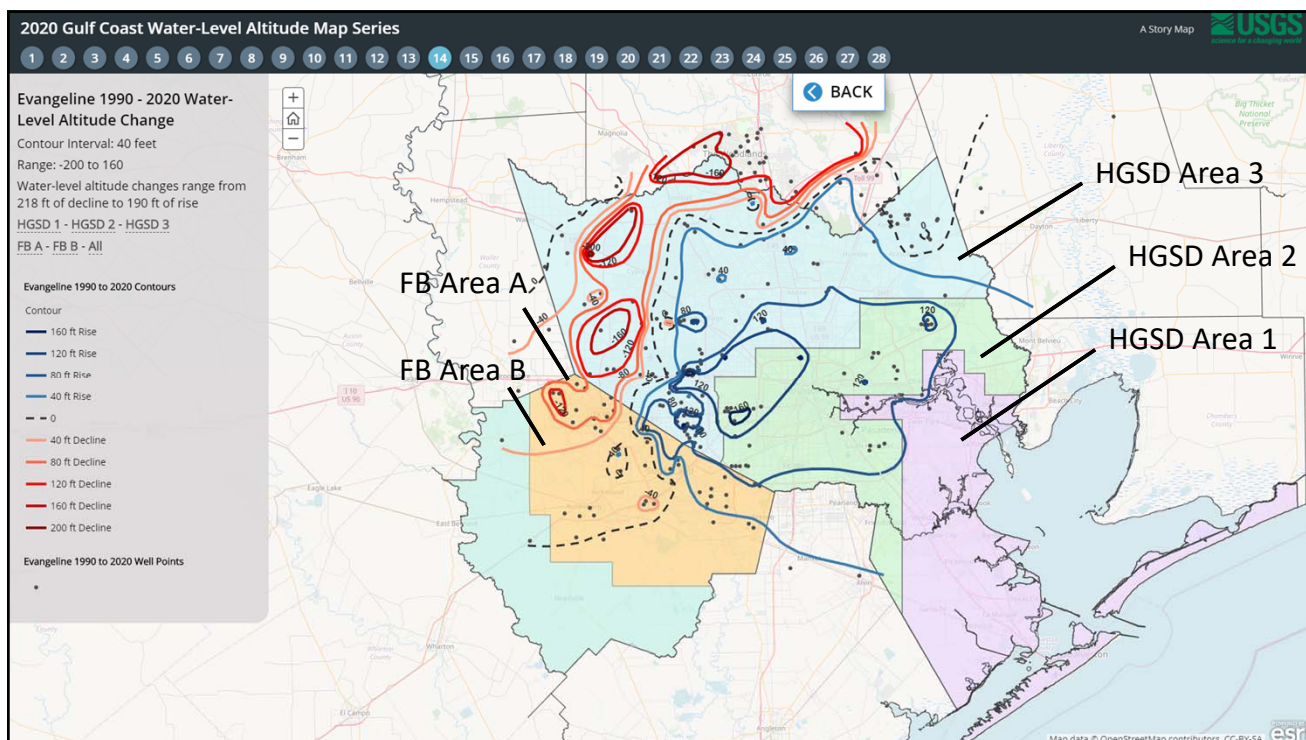
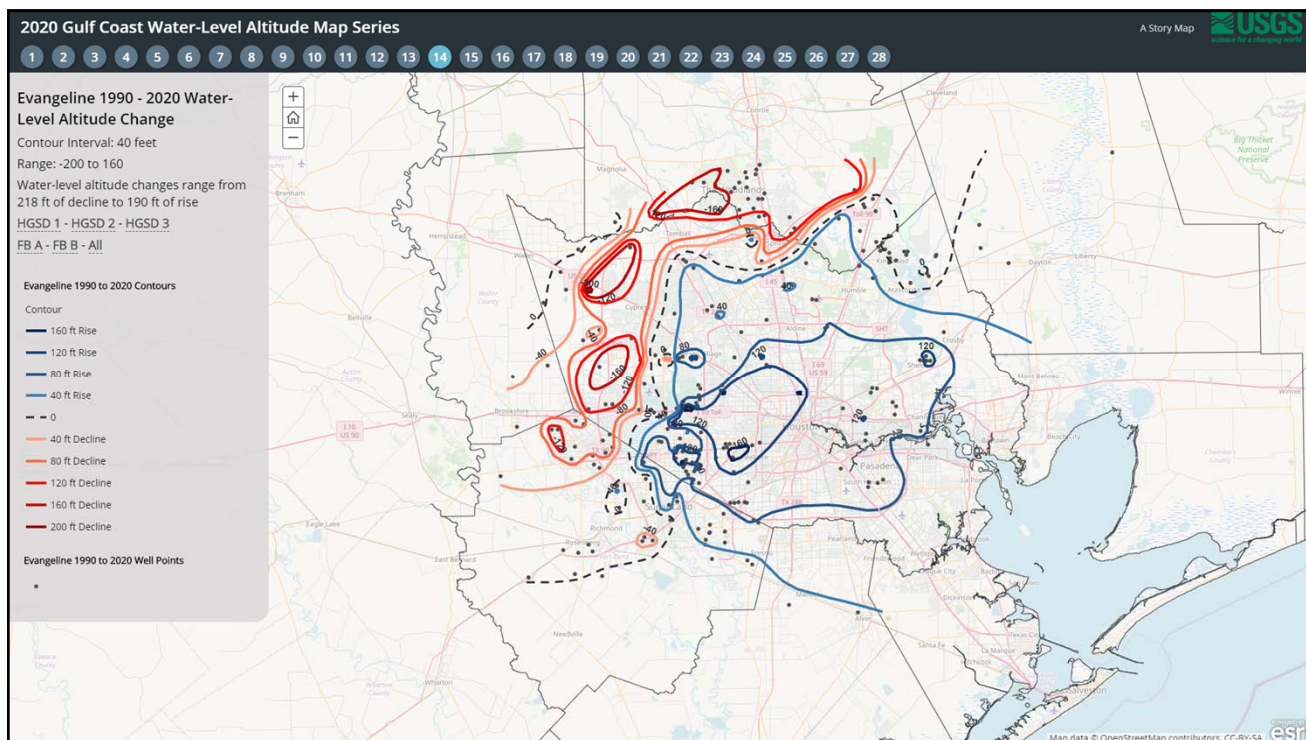


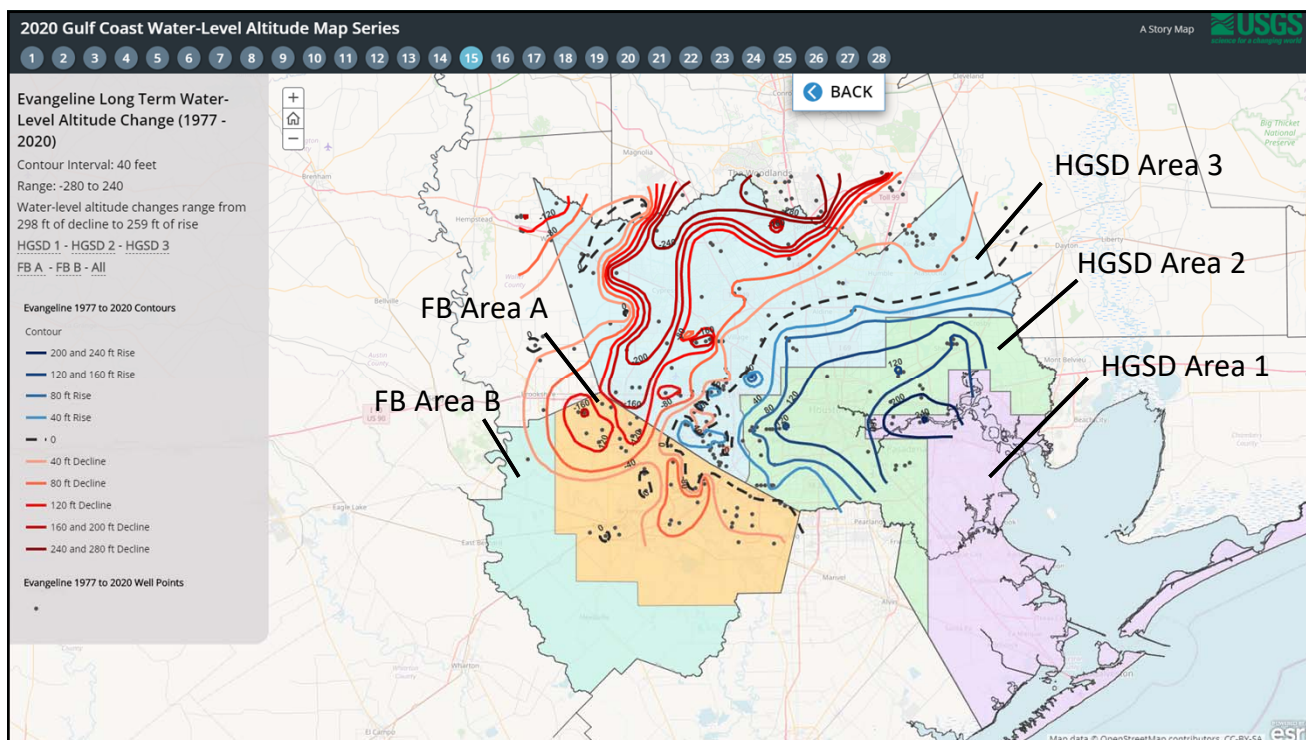
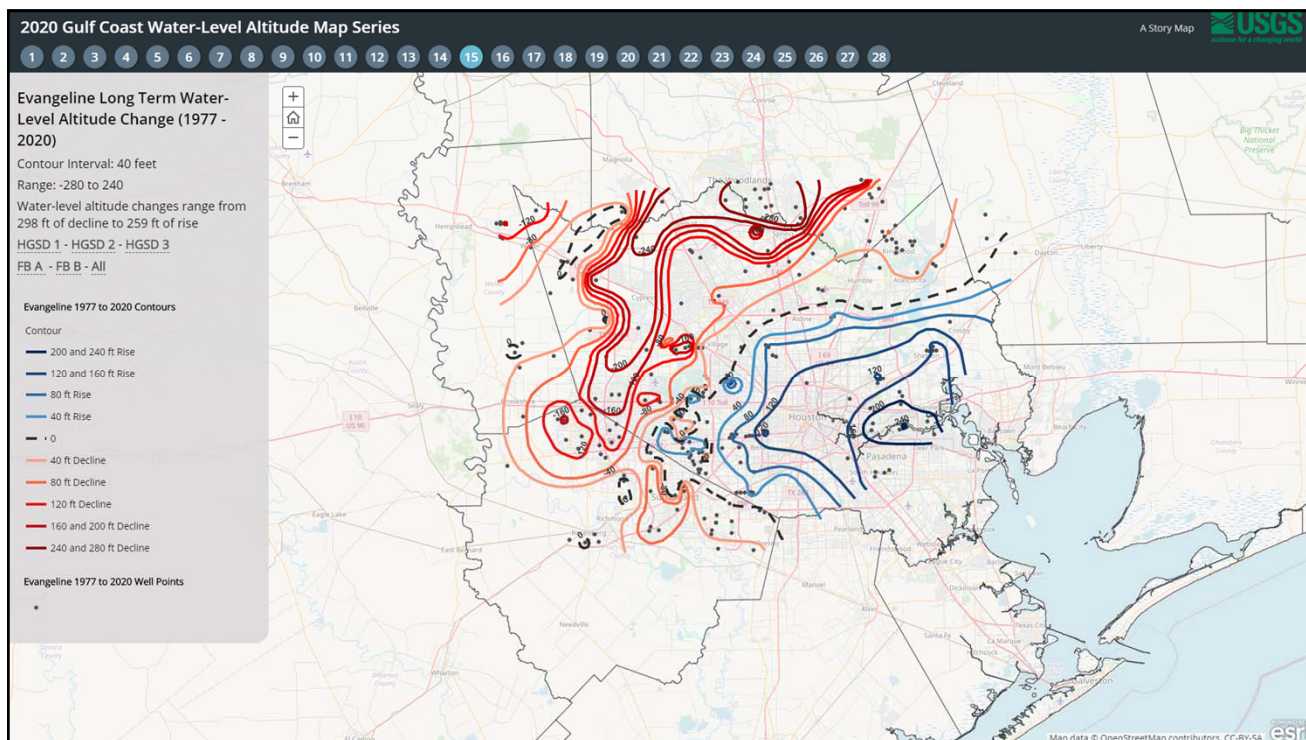


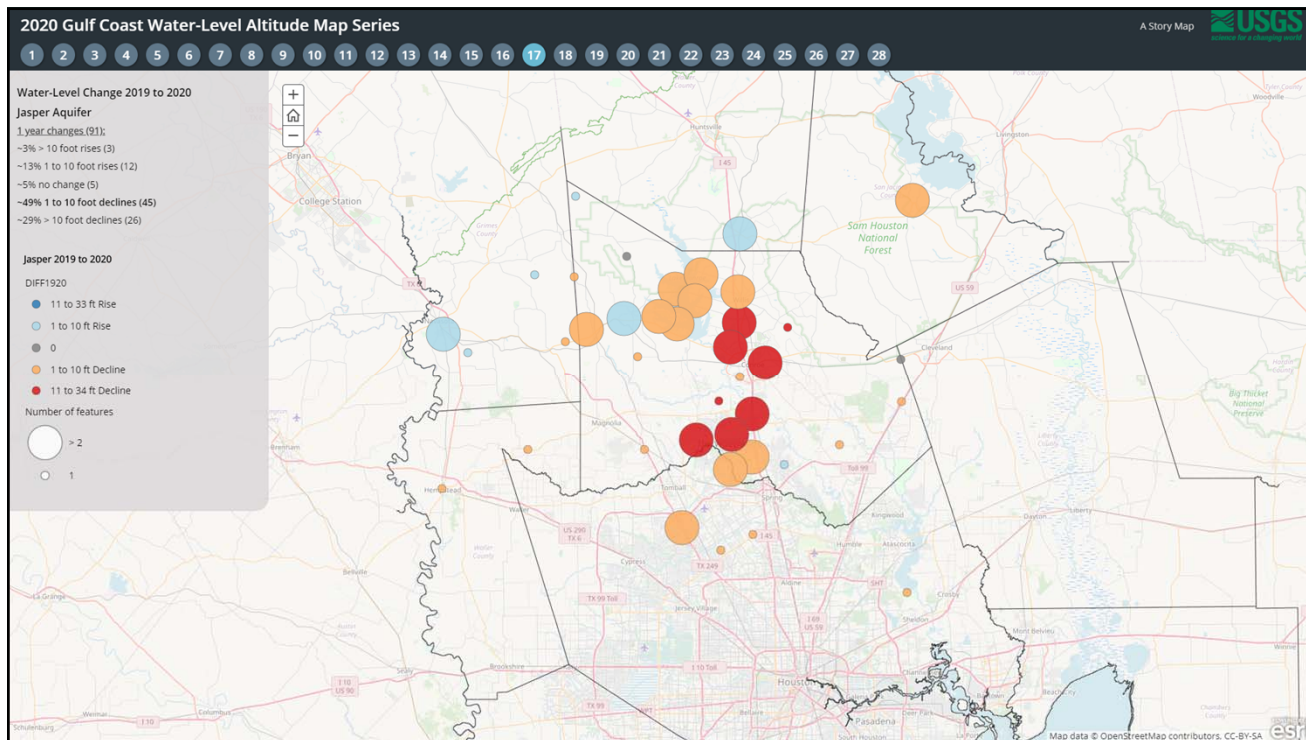
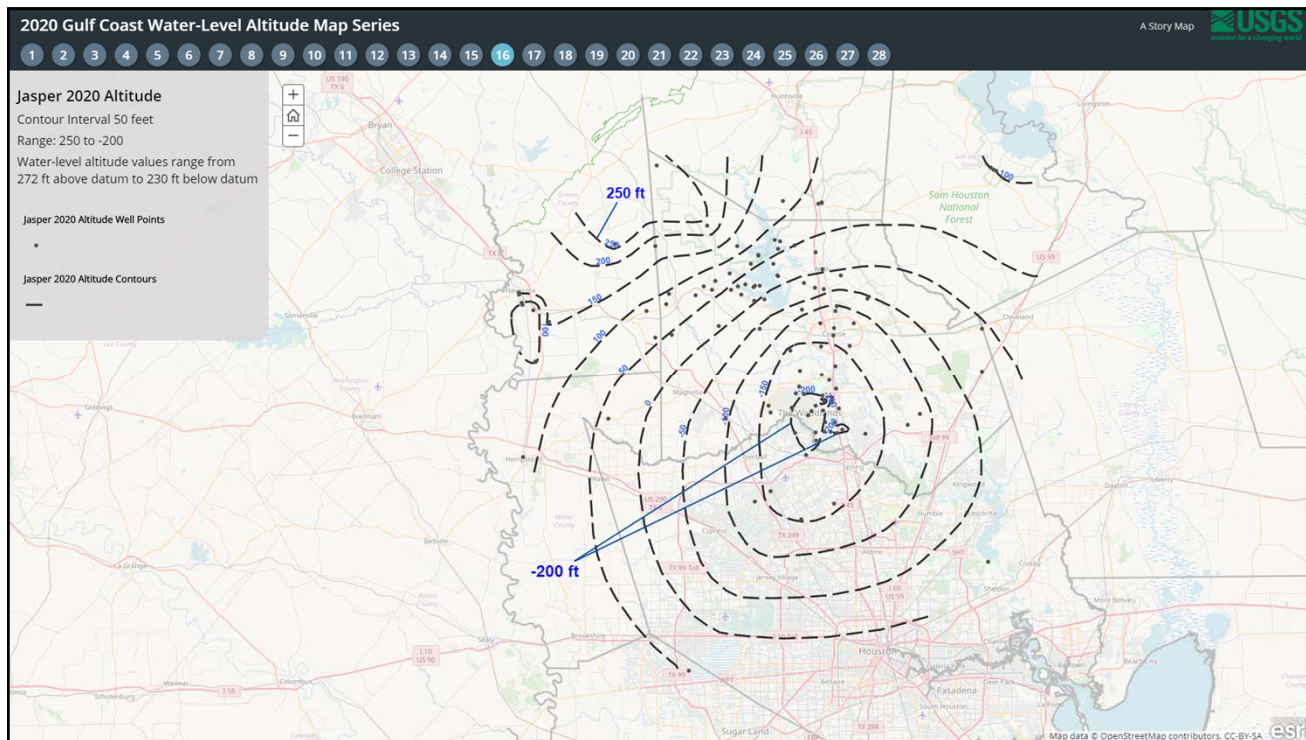


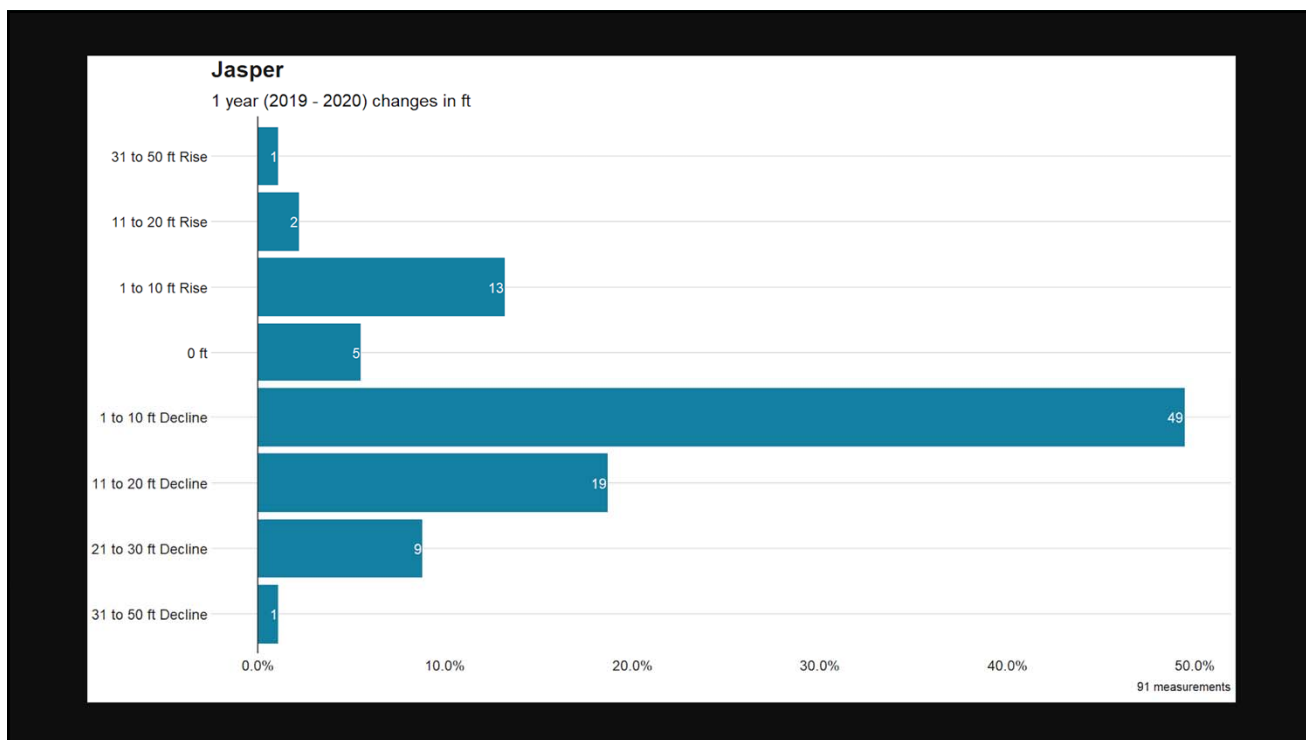
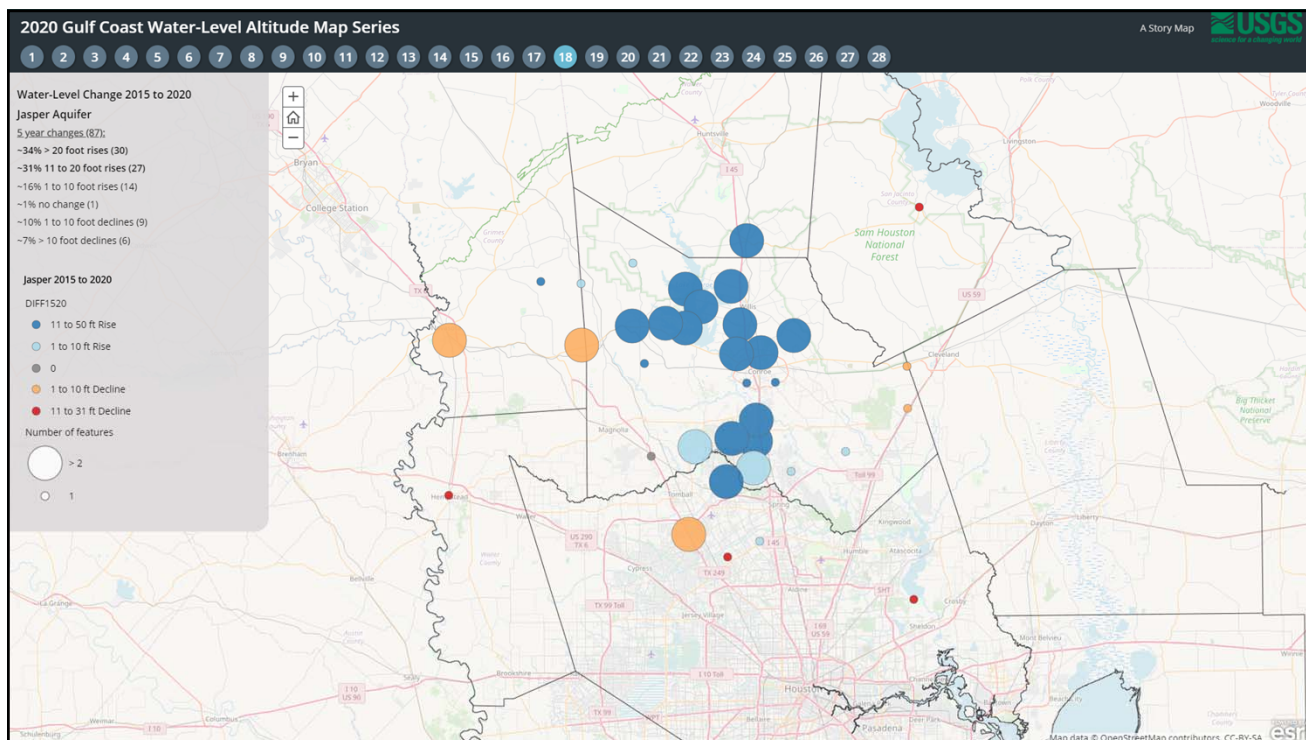


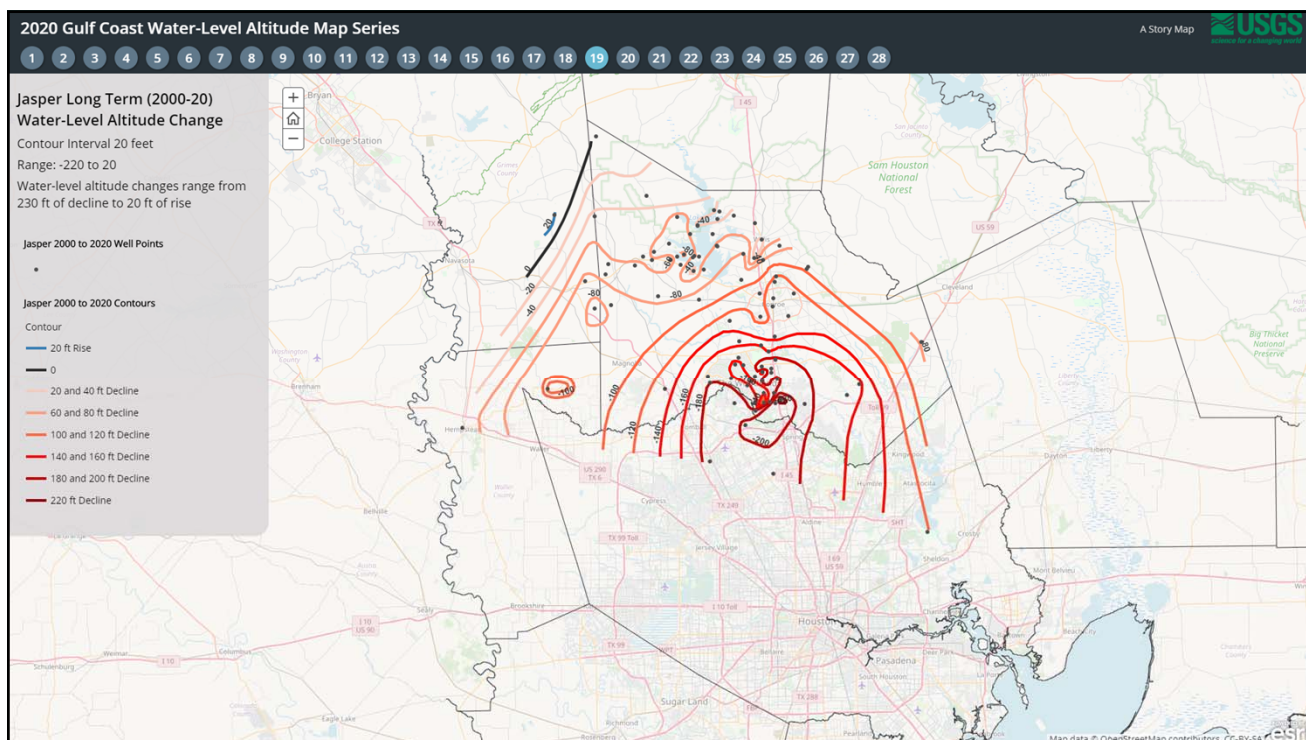
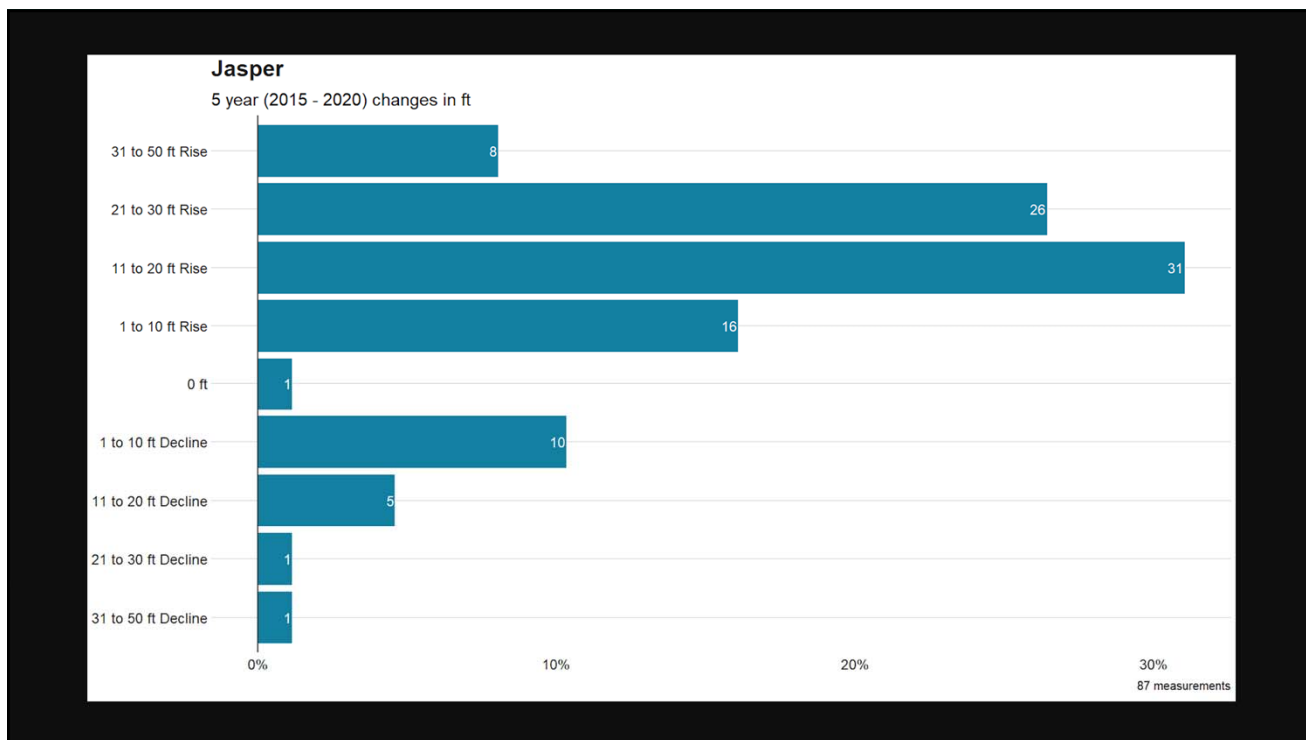












Summary: Groundwater levels



1 year changes (2019 to 2020)

- *Chicot*: about 41% **declines** in the 1 to 10 ft range
- *Evangeline*: about 49% **declines** in the 1 to 10 ft range
- *Jasper*: about 49% **declines** in the 1 to 10 ft range

5 year changes (2015 to 2020)

- *Chicot*: about 57% **rises** in the 1 to 10 ft range
- *Evangeline*: about 27% **rises** in the 1 to 10 ft range and about 24% **declines** in the 1 to 10 ft range
- *Jasper*: about 65% greater than 10 feet of **rise**



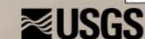
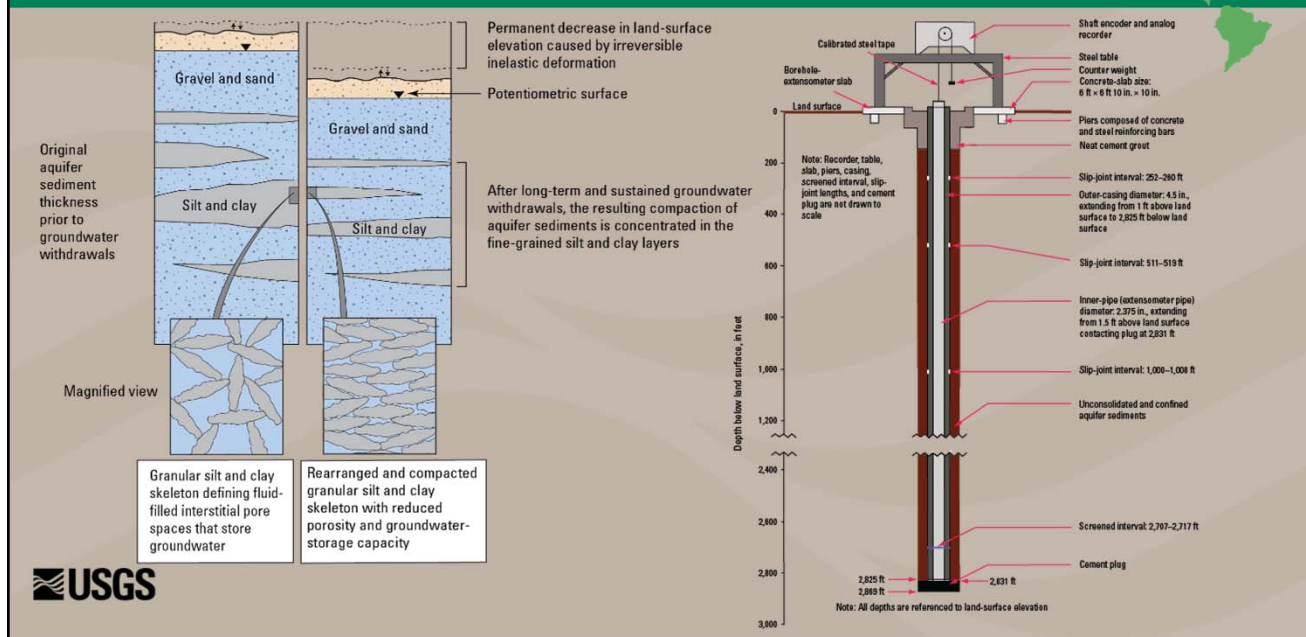
Summary: Groundwater levels (cont.)



- Chicot water-level altitudes since 1990 and 1977 show mostly **rises** (~64% and ~64%)
- Evangeline water-level altitudes since 1990 indicate mostly **rises** – (~62%)
- Evangeline water-level altitudes since 1977 indicate mostly (~66%) **declines**
- Over the period of 2000 to 2020, about 99% of water-level altitudes in the Jasper aquifer have **declined**.



Mechanism of Compaction and Method of Measurement



2020 Gulf Coast Water-Level Altitude Map Series

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A Story Map

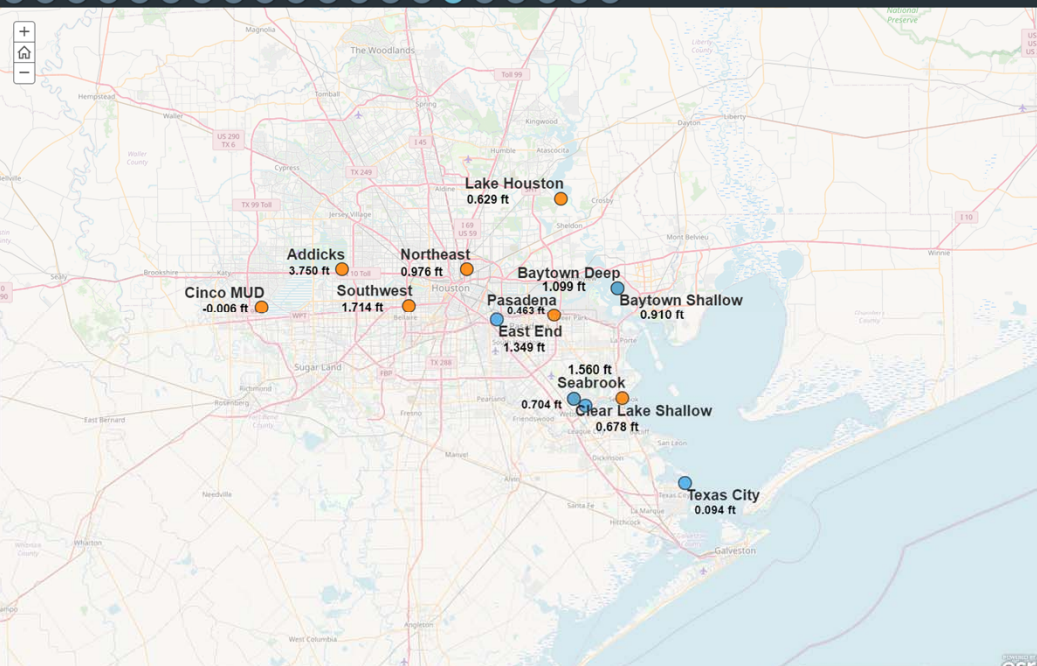
Cumulative compaction values in feet

- Addicks - 3.750
- Baytown Deep - 1.100
- Baytown Shallow - 0.910
- Clear Lake Deep - 0.704
- Clear Lake Shallow - 0.678
- East End - 1.350
- Johnson SC - 2.570
- Lake Houston - 0.629
- Northeast - 0.976
- Pasadena - 0.463
- Seabrook - 1.560
- Southwest - 1.710
- Texas City - 0.094
- Cinco MUD - -0.006

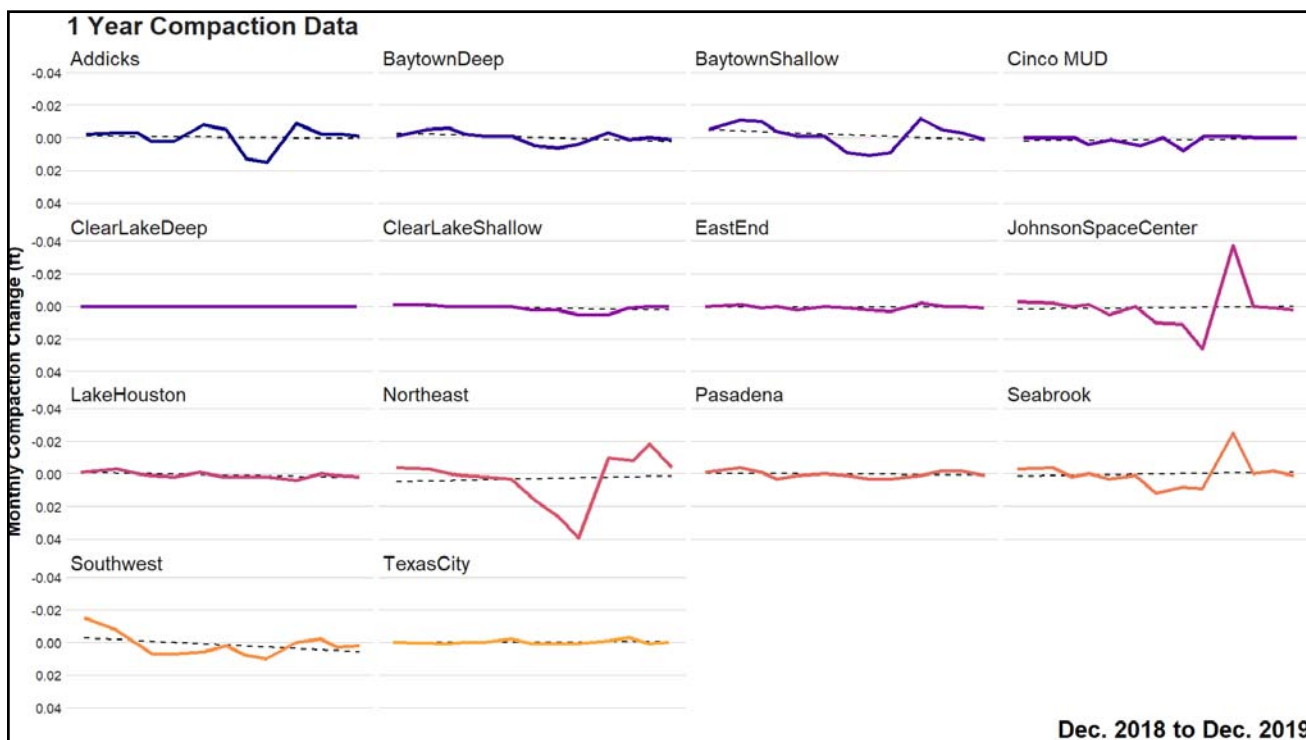
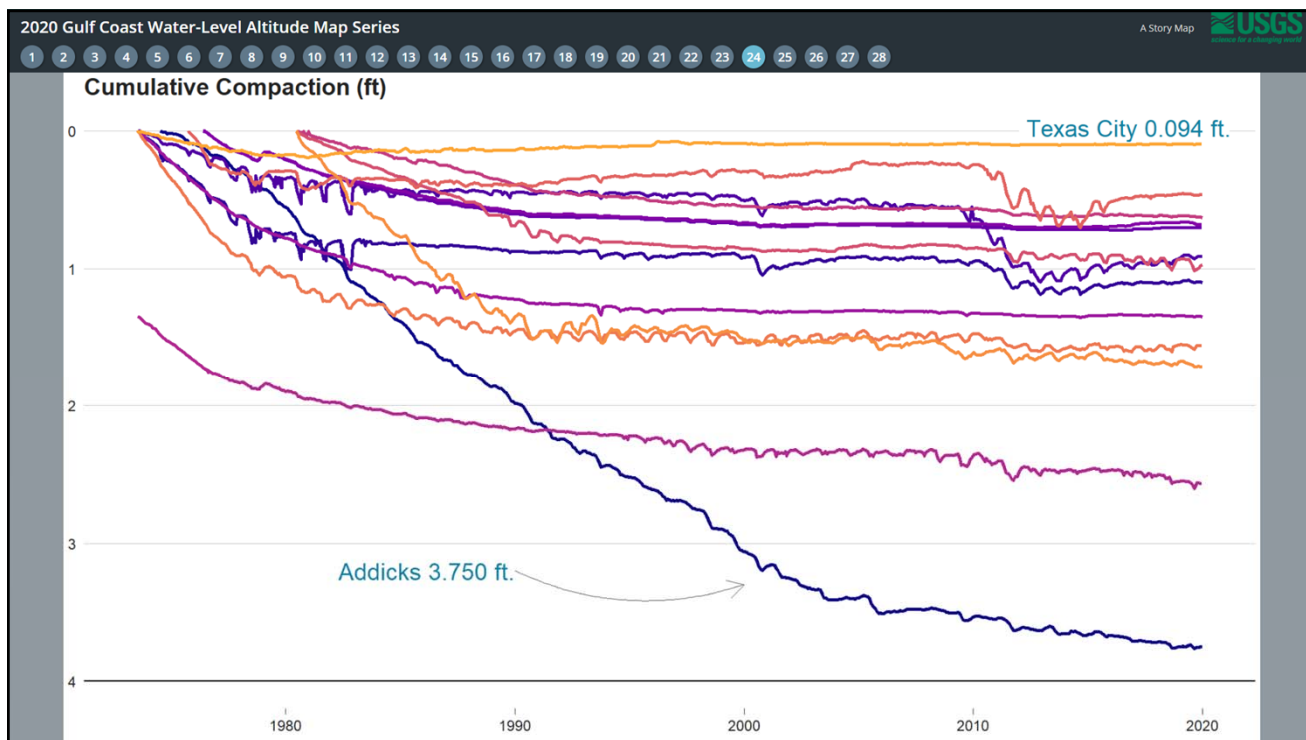
Chicot Compaction Monitors

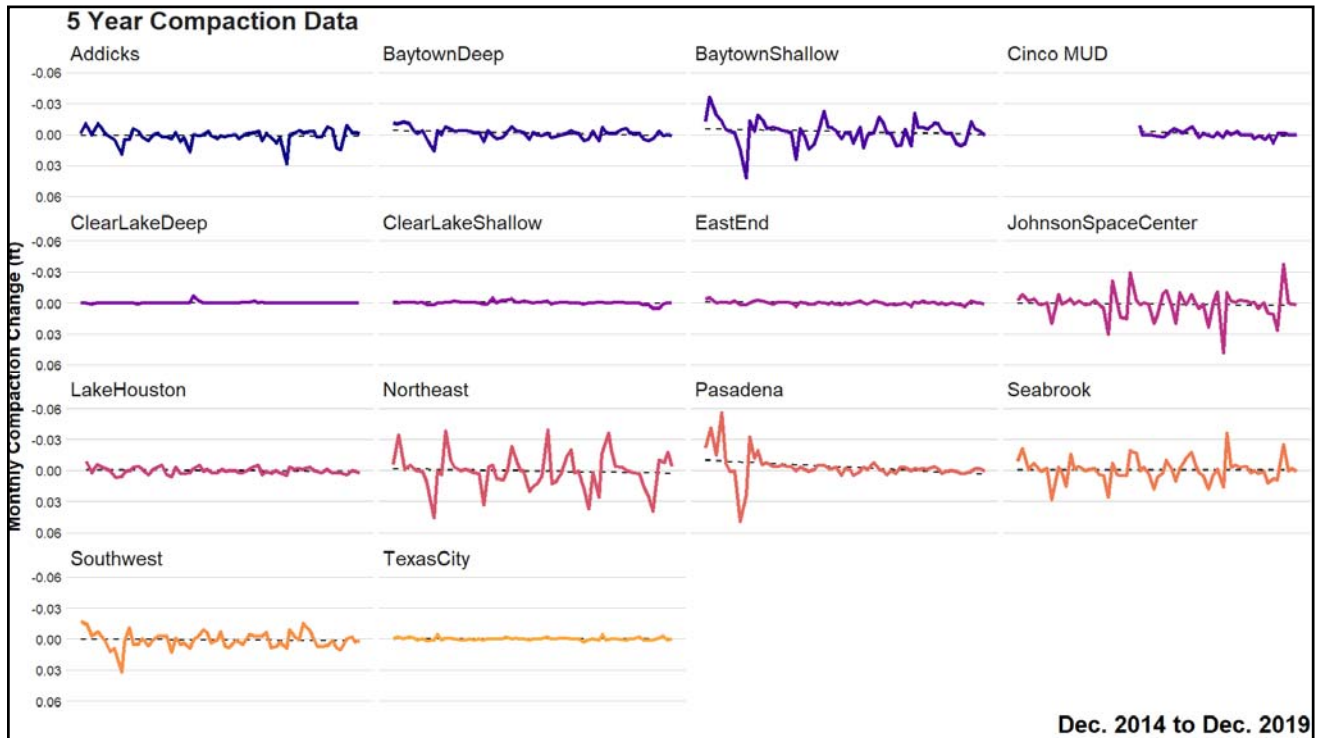


Chicot and Evangeline Compaction Monitors



Map data © OpenStreetMap contributors, CC-BY-SA





Summary: Compaction

For the Period December 2018 through December 2019

- Four (4) sites recorded uplift ranging from 0.001 ft to 0.017 ft.
- Nine (9) sites recorded compaction ranging from 0.004 ft to 0.044 ft.
- One (1) compaction site recorded no change



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