



Subsidence Revisited – How and Why Is It Measured?

By: Barbara Payne

Over the years, there have been plenty of studies relating the withdrawal of groundwater to the occurrence of **subsidence**. As far back as the 1950s and '60s, experts had begun to link the increased frequency and severity of flooding in certain areas to the phenomena. The real wake-up call came back in 1961, when Hurricane Carla struck the area, and some of the worst fears about the potential impact of subsidence were realized. Fortunately, local governments got the message, and began to address the growing problem.

Subsidence – and all of its related problems and consequences – is not generally a topic for dinner table discussion. Perhaps three out of ten people might be able to accurately define it, and ten out of ten folks may have difficulty explaining why anyone should worry about it at all. That's not surprising; subsidence is one of those geological situations that go without notice because it happens gradually and without visual reference – unless it occurs in your neighborhood and there's enough rain to cause flooding.

Subsidence in the Houston area...

The Gulf Coast Aquifers, the source of our groundwater, consists of many layers of clays and sands. The sediments that have been left, over geologic time, slowly and naturally compacted. Sadly, some of our actions have sped up this natural process. By pumping increasing quantities of groundwater, for example, we de-pressure the aquifers and begin to pull our drinking water from the clay layers. The reduced pressure in the clays combined with the weight of the materials above, compacts the layers – triggering land-surface elevation loss, or what is called subsidence.

A period of rapid and sustained growth in the Houston area -- and the huge influx of new residents tied to the expansion of the petrochemical industry and allied businesses after World War II – adding six or more feet of subsidence in Harris and Galveston Counties along the Ship Channel by the mid-1970s. By 1979, up to 10 feet of subsidence was measured there, and over 3,000 square miles had 'sunk' by more than 1 foot.

One of the most dramatic incidences of subsidence took place in Brownwood, a subdivision in the City of Baytown that actually had to be abandoned. While regional land subsidence can be subtle and difficult to detect, there are locations in and near Houston in addition to Brownwood, where the effects are quite evident.

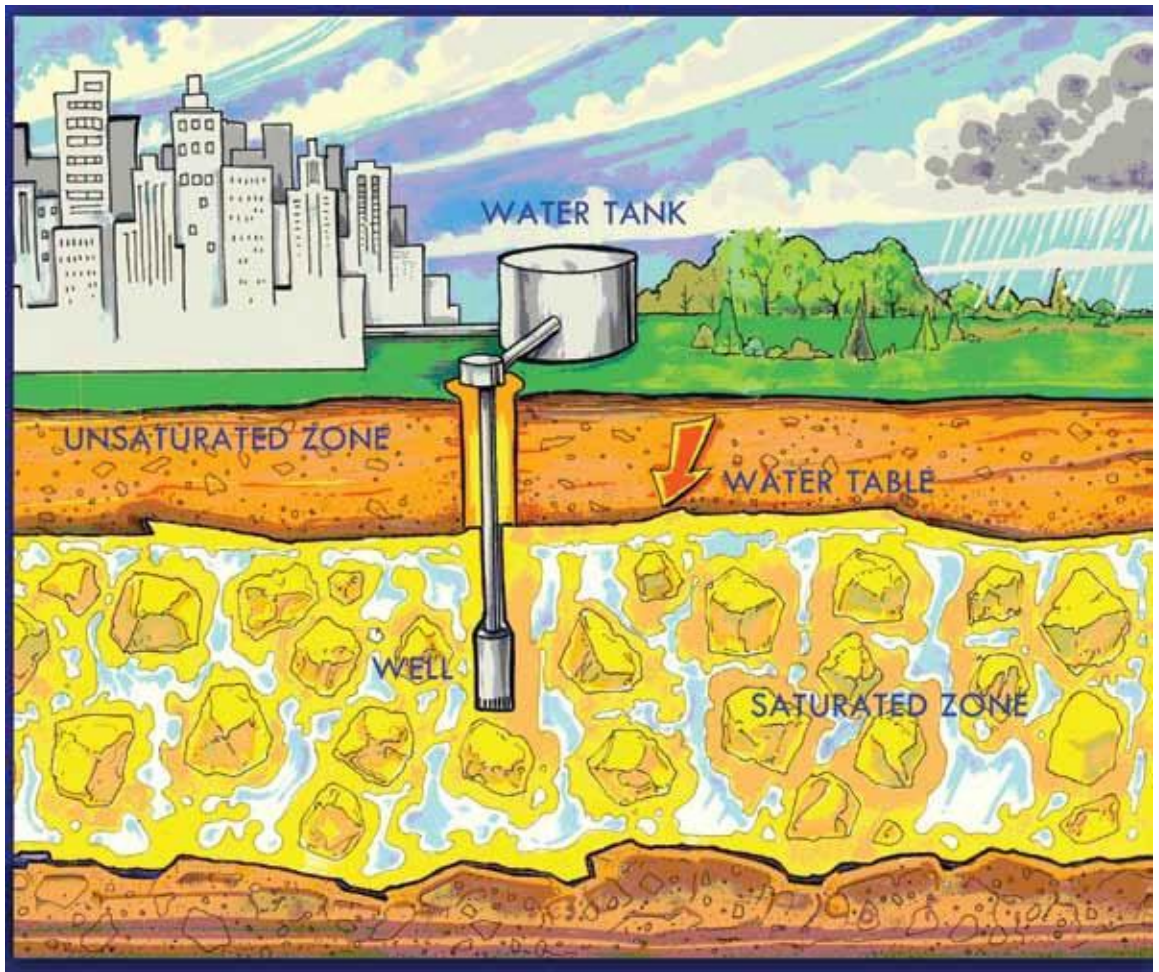


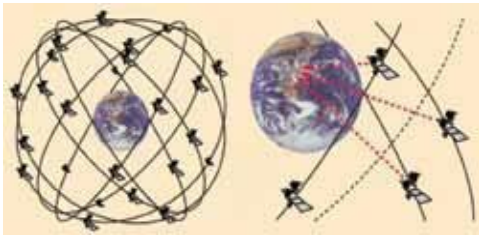
The Jersey Village subdivision in northwest Harris County experienced horrific flooding in June 2001 when a Tropical Storm Allison dumped about 35 inches of rain on the Houston area in a little over 24 hours.

As much as 10 feet of subsidence has shifted the coastline and changed the distribution of important wetlands. One of the most obvious impacts of subsidence has occurred at the San Jacinto Battleground State Historical Park, where Texas won its independence, which is now partly submerged with 100 acres of the park under water.

After the creation of the Harris-Galveston Subsidence District (HGSD) in 1974, the District concentrated on developing and implementing its first Groundwater Regulatory Plan. The good news is that after industries along the Houston Ship Channel were converted to surface water supplied from the newly completed Lake Livingston reservoir, subsidence in the Baytown-Pasadena area was arrested and dramatically improved. While subsidence was stabilizing in the coastal areas, however, groundwater levels in inland areas north and west of Houston were still rapidly declining. In just one area in the Evangeline aquifer, USGS measurements recorded a decline of more than 180 feet between 1977 and 2005.

The Lone Star Groundwater Conservation District (LSGCD) was created by the 77th legislature in 2001 to protect and manage the groundwater resources of Montgomery County. As with the other such Districts, Lone Star works to maintain a balance between protecting the rights of private landowners and their responsibility to protect groundwater. The District focuses on preventing waste, collecting data, educating the public about water conservation and





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preventing irreparable harm to the aquifer.

Montgomery County faces similar groundwater withdrawal problems. Quite simply, Lone Star has been warning that we're pumping groundwater faster than the aquifers can recharge. According to Kathy Turner Jones, general manager of LSGCD, "Virtually all of our current water supply is provided by groundwater. Over the years, there have been adequate supplies of groundwater to fuel and sustain significant economic growth and development in Montgomery County. In just the last decade," she continued, "the County's population had already experienced a staggering 52 percent increase, making it one of the fastest growing counties in the U. S. Obviously, more people means increasing demand for water...at least that has always been true in the past."

"Since the early 1990's however, some parts of the state have learned that by aggressively taking some common-sense measures to use water more efficiently, they were actually able to keep the level of demand relatively constant even though the

population continued to increase. And that is our goal, as well," she explained. "In order to evaluate the impact of our regulations, we will need good, historical elevation data, and to continue to incorporate new and exciting technologies into our monitoring network."

So, how do you measure subsidence?

The Harris-Galveston Subsidence District has been measuring subsidence since the mid-1970s. Fortunately, Lone Star has been able to share this data that has been collected in Montgomery County over the years. The current measurement methods combine the latest technology – some of which is collected from orbiting satellites – with knowledge gained from more traditional methods, to deliver highly accurate measurements of change in land elevation due to subsidence. Included in their data acquisition arsenal is Global Positioning Satellite (GPS) technology, in use since 1987.

There are permanent stations known as GPS Continuously Operating Reference Stations, or **CORS**. In the mid-1990s, HGSD and the National Geodetic Survey (NGS) began utilizing portable units, as well, called **PAMS** – an acronym that originally stood for **Port-A-Measure** because they were moved from location to location on a trailer. Today, the acronym is for **Periodically Active Monitor** -- thanks to improvements in technology and cost decreases, the units can be permanently placed at a site where ongoing measurements are needed.



PAM Units

Basically – very basically – subsidence is measured by a number of highly technical, interactive devices that monitor, collect, and exchange information that is of critical importance in determining the relationship between groundwater withdrawals, water-level declines, and subsidence.

■ **PAM units** – very unobtrusive sites that

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include a 4'x4' concrete pad, an 8' antennae pole, and a 5' tall equipment pole on which is mounted a small solar panel and battery box. GPS data at the PAM sites is collected by a transportable monitor shared and moved among several PAM sites. It collects data every 30 seconds for a period of 7 days. At the end of that time, the information on the monitor is downloaded to a laptop, and the monitor is moved to the next site in rotation. This same process is followed until all the PAMs' data has been collected, and then the data-collection cycle begins once again.

n CORS reference – these permanent stations continuously output data, and provide a basis from which change comparisons can be made and analyzed. The PAM GPS data is compared to CORS stable points – deep, anchored borehole extensometers, drilled with a pipe inserted to a stable subsurface, below the level of the aquifers from which the groundwater is being withdrawn.

Measuring the Future...

Recently, the Lone Star Board of Directors approved assuming the responsibility for two of HGSD's monitors located in Montgomery County, as well as the installation of six additional PAM monitoring stations throughout the county.

"These units will be instrumental in detecting any subsidence occurring in our area," Jones explained. "The information these instruments will provide will help us establish appropriate, meaningful, and specific rules and regulations to halt subsidence and allow the aquifers to recharge in the years ahead. The goal, obviously, is to make sure that we avoid situations like those in Brownwood and Jersey Village neighborhoods. Access to good data will help allow that to happen."

For additional information about the role of LSGCD in halting subsidence and in promoting water conservation, please visit online: www.lonestargcd.org. **u**

Think PPP when you think Hurricane Safety.

A moment to plan hurricane safety can give you peace of mind and keep your family and home safe. If you want to be hurricane-safe, just follow the three Ps:

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It's always important for a family to have a plan for emergencies, whether it be a fire, earthquake or hurricane. Every family member must know what to do to stay safe.

PREPARE

Your home should have a survival kit prepared for any emergency. To ensure your home is prepared, cover up windows and doors using hurricane shutters. Serious hurricane damage can occur when wind and debris get into your house through a broken door or window.

PROTECT

If you decide to ride out the hurricane, protect yourself. If you don't need to evacuate the area, stay indoors away from windows or glass doors. If you need to leave the area, make sure you go directly to the shelter with your survival kit.

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