The EAA Abandoned Well Program
Presentation to EAA Board of Directors
August 8, 2017
San Antonio, TX

Advocating for enhanced groundwater protection by:

- identifying abandoned wells
- identifying risks to water quality based on well condition
- identifying risks to water quality based on well circumstances, i.e. proximity to contaminants…
- utilizing GIS tools for risk analysis and mapping

Mariah Bonham, Environmental Coordinator
Taylor Bruecher, Environmental Analyst – GIS
Roger Andrade, P.G. Groundwater Protection Manager

EDWARDS AQUIFER AUTHORITY

Outline

Roger:

- Basic water well configuration and specifications
- Abandoned well procedures and methodology – case studies

Mariah:

- Risk Criteria
- Ranking System

Taylor:

- GIS Analysis and Applications
- Mapping

How do we become aware of abandoned wells?

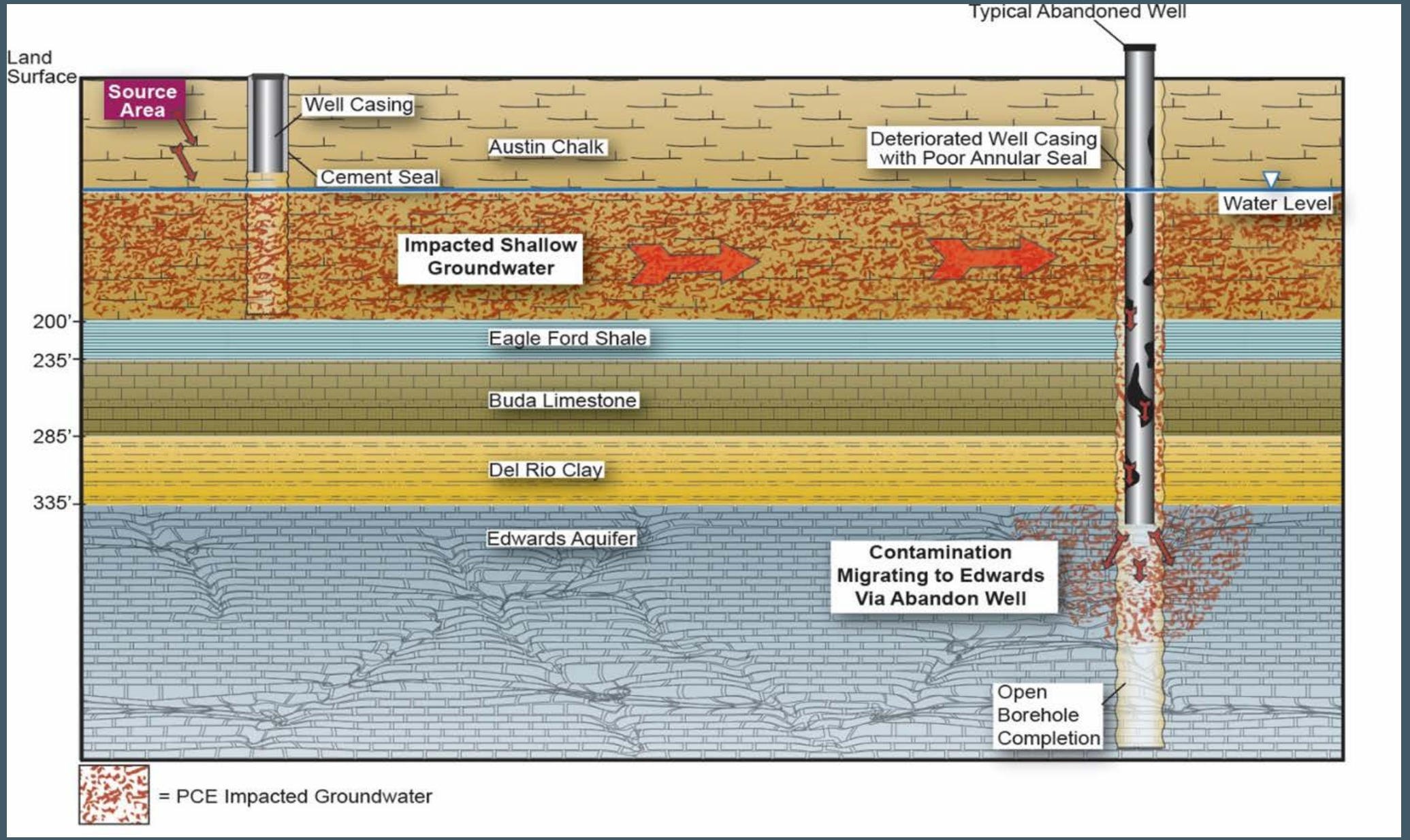
- Calls from Concerned Citizens
- Registration Efforts
- Other Agencies
- Water Pollution Abatement Plans (TCEQ)
- Drillers inquiring about specific wells
- Real Estate agents
- Consultants
- Others

Abandoned and Deteriorated Wells

- Pose threat to well water and public safety
- Serve as conduits or channels for contaminants to reach groundwater.
- Top of the list of potential groundwater contamination sources that *can be identified and eliminated.*

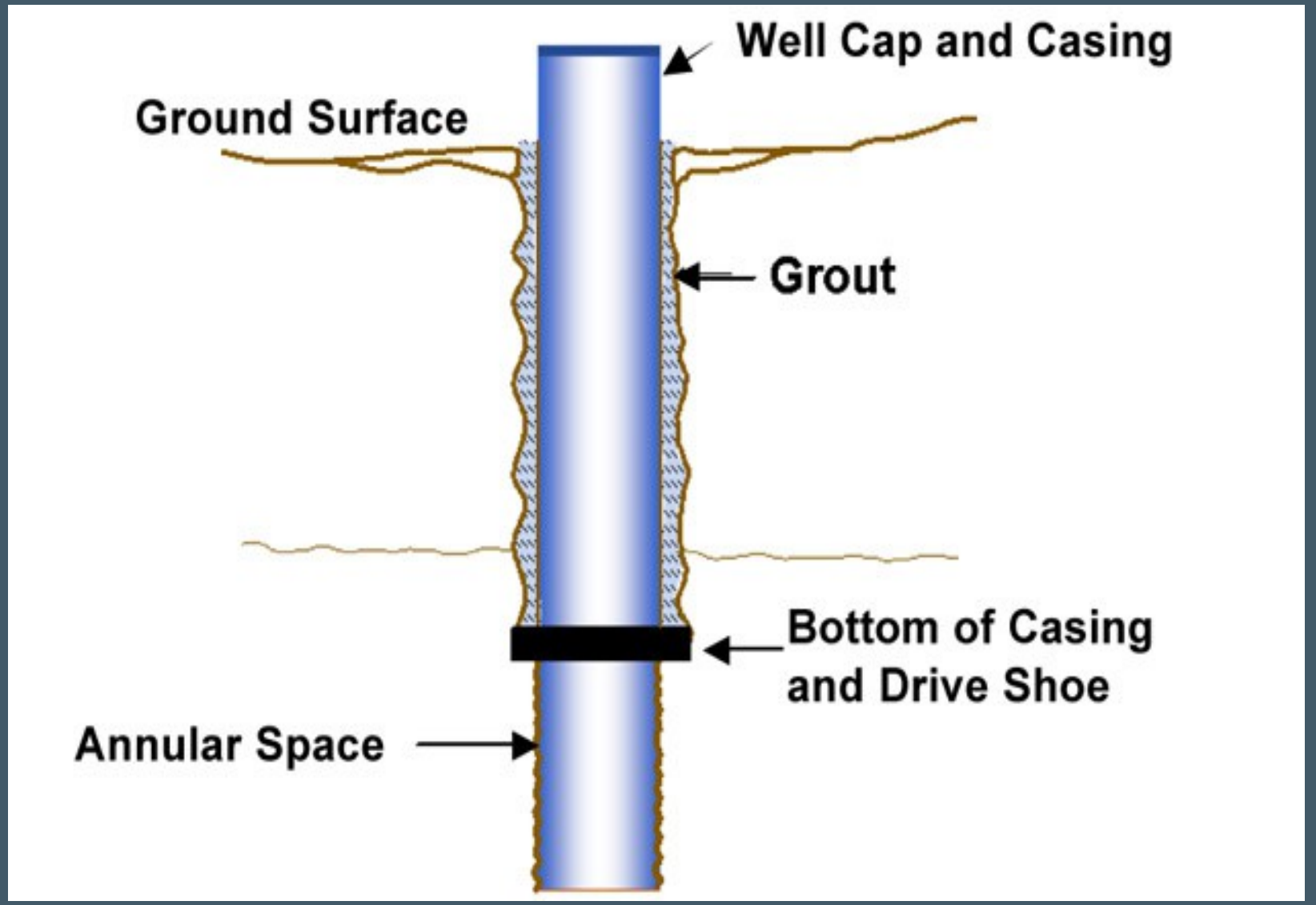
http://tgpc.state.tx.us/water-wells/#3

Mechanism for How Abandoned Wells can contribute to Groundwater Contamination



Grouting Factor

Grout protects the aquifer from contamination



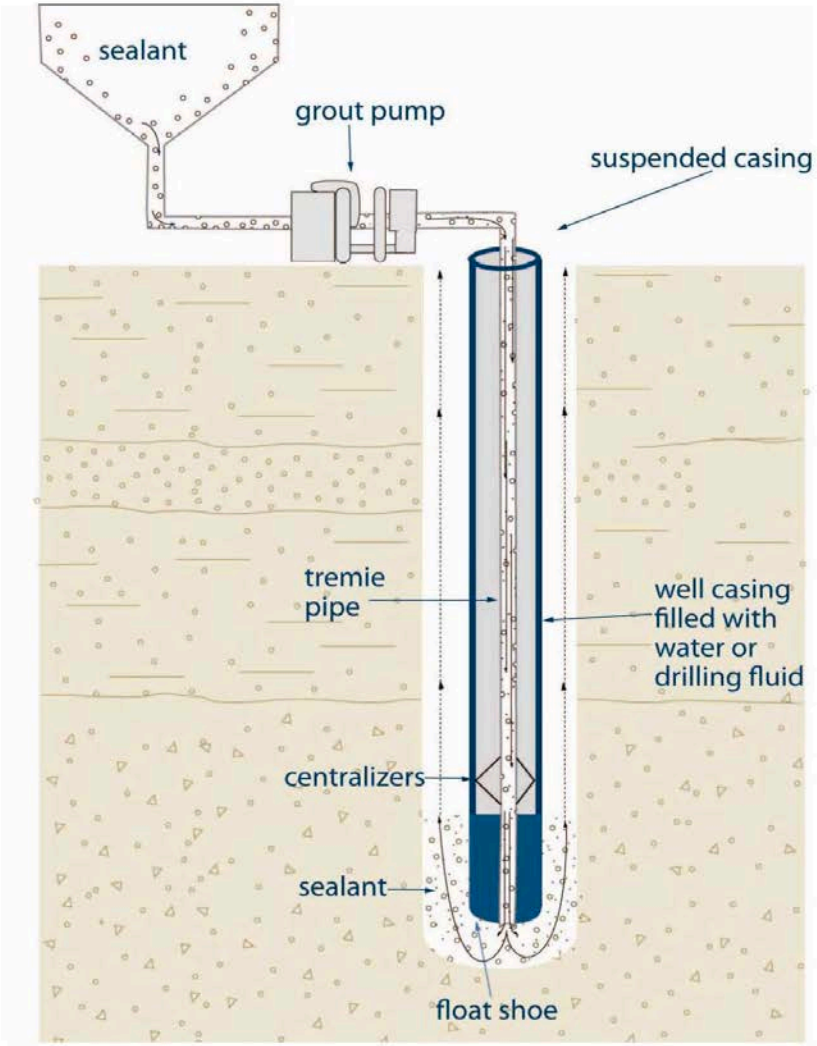
Grout is a sealant that is used to fill in the spaces around the outside of the well. It protects the well against the intrusion of contaminants. A grout mixture can be made of cement, bentonite, or concrete (each used separately).

http://www.groundwater.org/get-informed/basics/wells.html

http://extension.psu.edu/natural-resources/water/drinking-water/wells/protecting-wells-with-sanitary-well-caps-and-grouting Penn State Extension Service

Proper cement placement between the well casing and the formation is essential.

FIGURE 6-15: INNER STRING METHOD OF GROUT PLACEMENT



The diagram above is not to scale and is for illustrative purposes for this chapter only.

All figures and diagrams are for illustrative purposes only and do not necessarily represent full compliance with other requirements found in the **Wells Regulation.**

Grout Deterioration Over Time

View from below surface pad

Surface view

- Cement deteriorates over time
- Leaks occur when cement shrinks, develops cracks or channels

Corrosion

Steel is thermodynamically unstable under normal atmospheric conditions and will release energy and revert back to its natural state—iron oxide, or rust. This process is called corrosion.

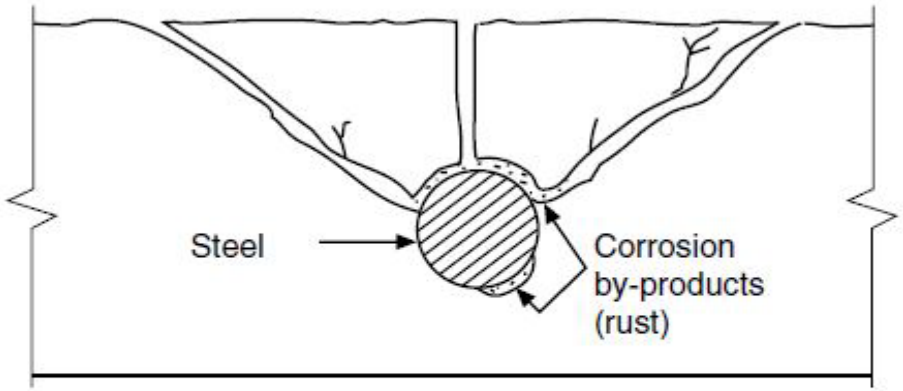


Fig. 2. The expansion of corroding steel creates tensile stresses in the concrete, which can cause cracking, delamination, and spalling.

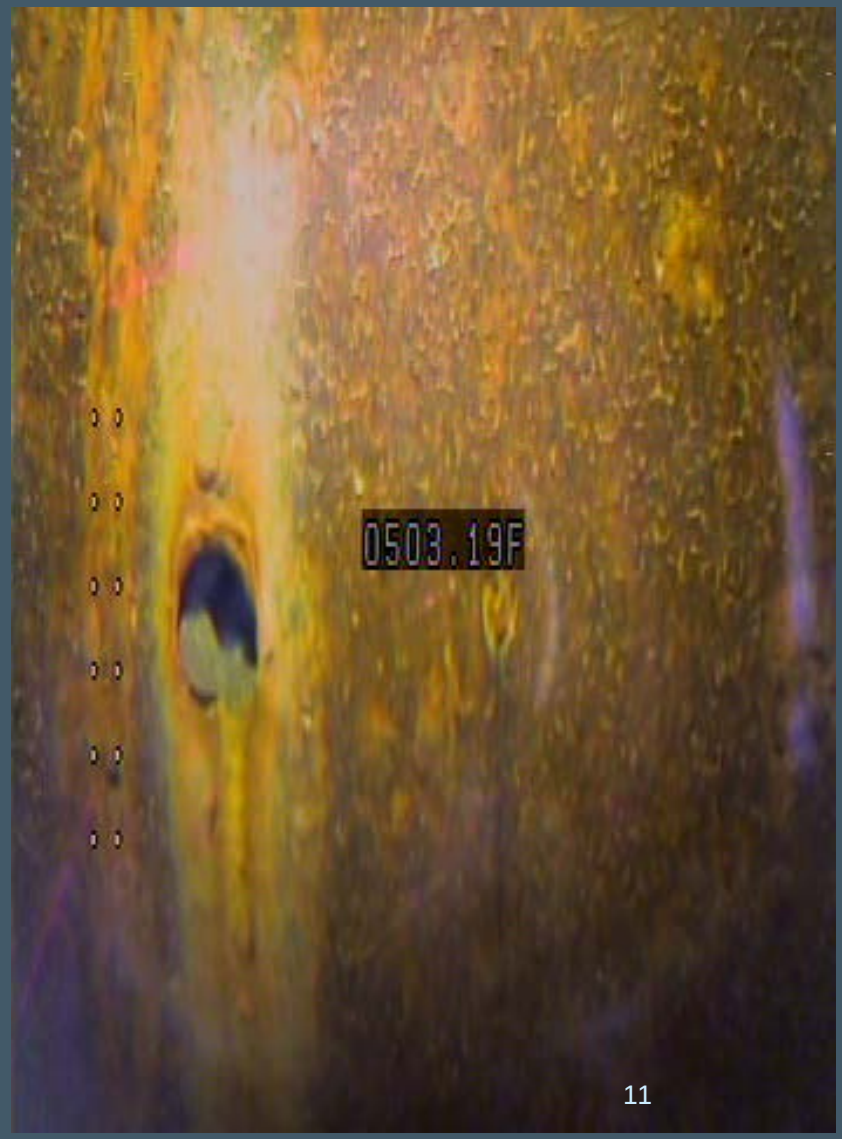
http://www.cement.org/docs/default-source/fc_concrete_technology/durability/is536-types-and-causes-of-concrete-deterioration.pdf?sfvrsn=4

Casing Deterioration Over Time

Casing Subject to:

- Oxidation (rust)
- Corrosion process
- Structural Collapse
  - Rupture
  - Stress
- Inflow of low quality water

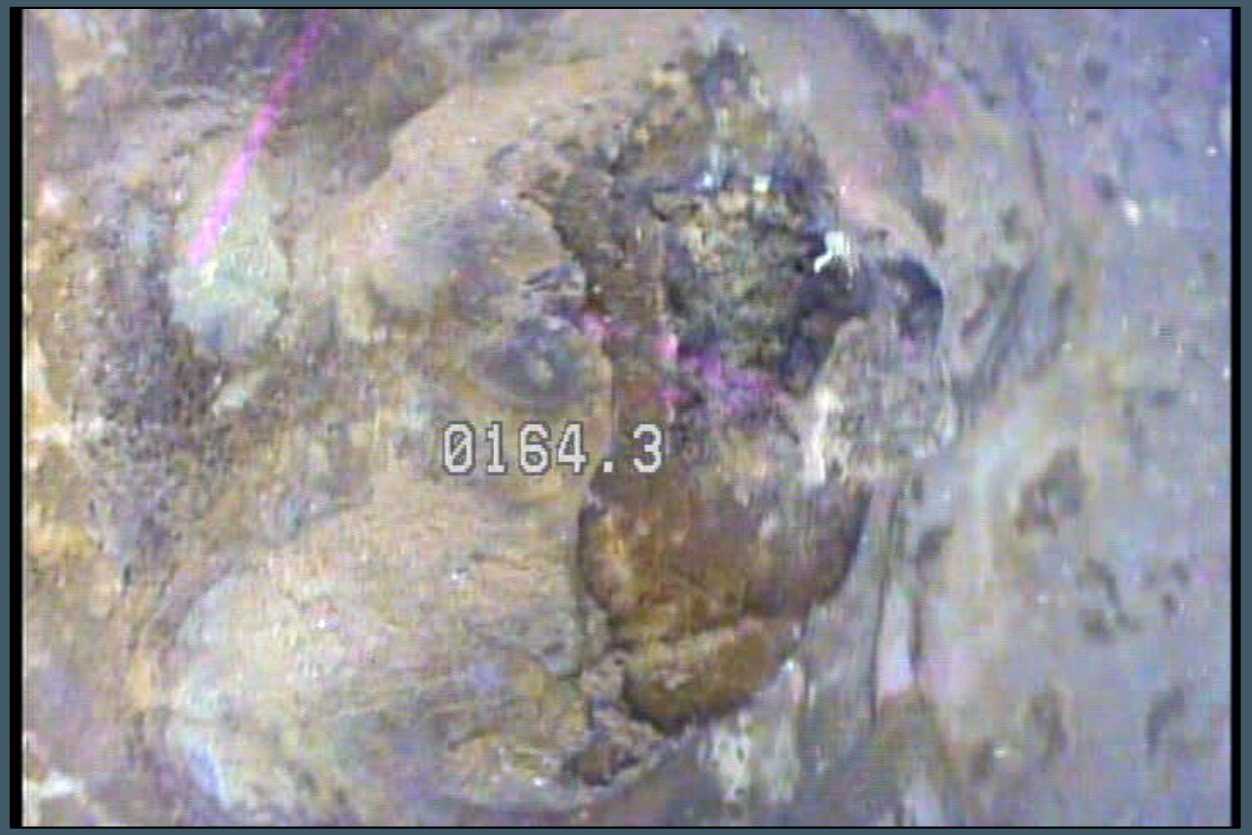
Deteriorated Casing:
Split casing and holes in casing



Abandoned wells are subject to increased scrutiny due to well age

Old Wells

- Turbine Pumps are likely to leak lubricating oils over time.
- Casings are likely to have undergone corrosion process.
- Environmental forces have been stressing well casing and cement grout.
- Even 30-40 year old modern casings are subject to corrosion and perforation.

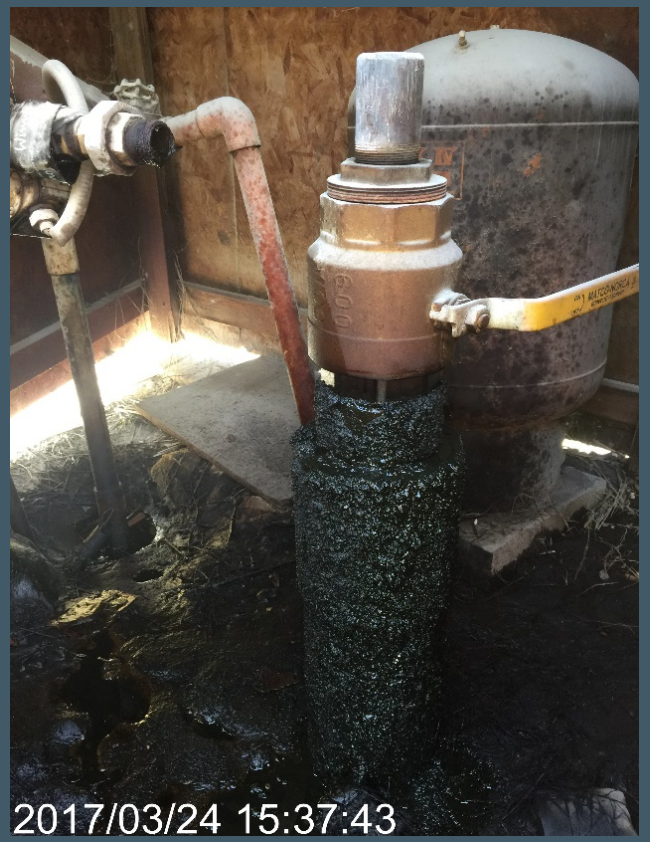


http://extension.missouri.edu/p/EQM103F

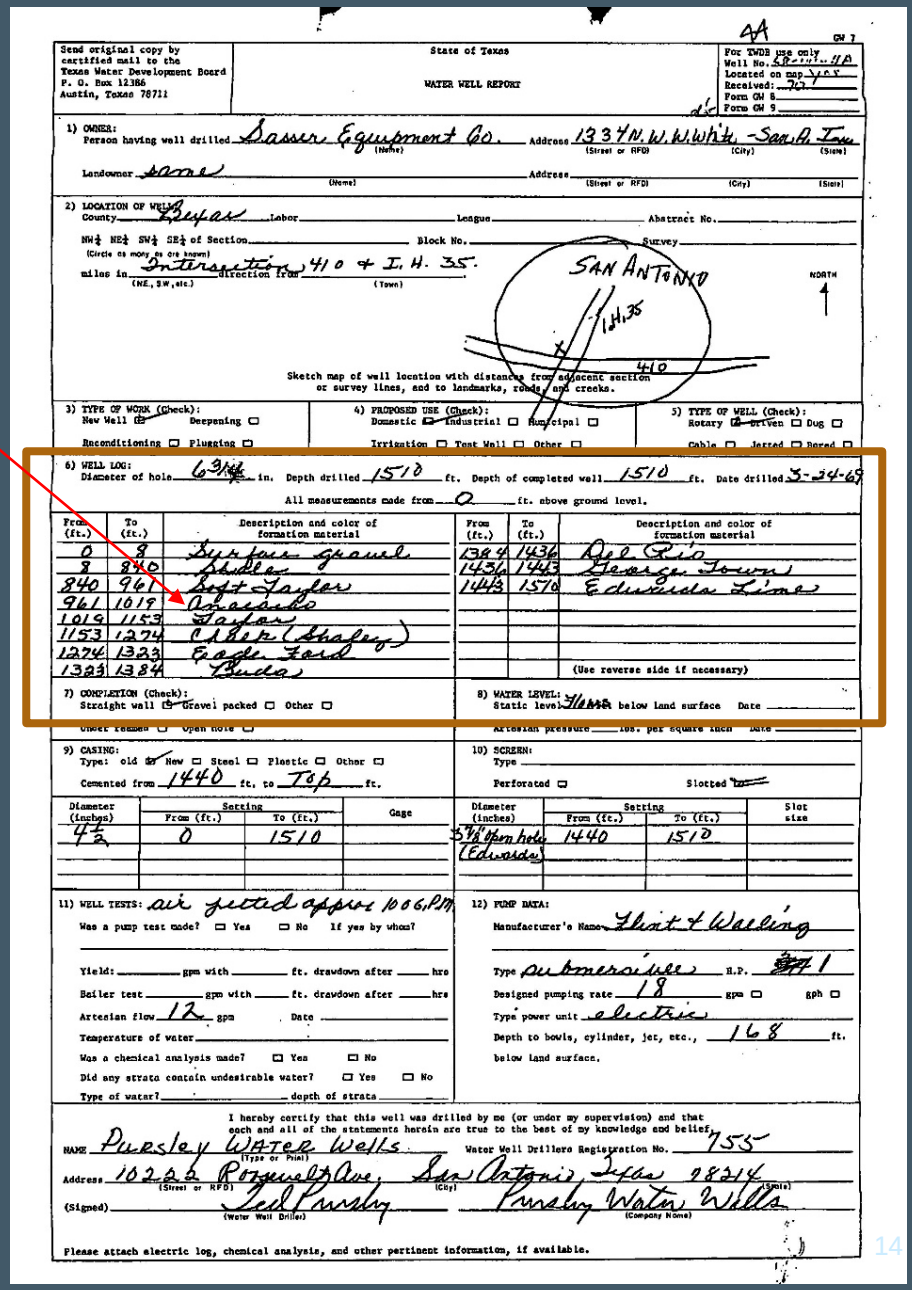
Turbine pump column with pump bowls removed from a recently plugged water well

Lubricating oil leaked from turbine pump

Deteriorated Wells: Water Quality Issue



Suspected oil source



4A GW 1

Send original copy by certified mail to the Texas Water Development Board P. O. Box 12386 Austin, Texas 78711

State of Texas

WATER WELL REPORT

For TWDB use only
Well No. Bexar-11A
Located on map Yes
Received: 7-2
Form GW 8
Form GW 9

1) OWNER:
Person having well drilled Sasser Equipment Co. (Name) Address 1334 N. W. W. White (Street or RFD) San A. Tex (City) (State)
Landowner same (Name) Address (Street or RFD) (City) (State)

2) LOCATION OF WELL:
County Bexar Labor League Abstract No.
NW¼ NE¼ SW¼ SE¼ of Section Block No. Survey
(Circle as many as are known)
miles in Intersection 410 & I. H. 35. direction from (Town)
(NE, SW, etc.)

Sketch map of well location with distances from adjacent section or survey lines, and to landmarks, roads, and creeks.

SAN ANTONIO
I.H. 35
410
NORTH

3) TYPE OF WORK (Check): New Well ☒ Deepening ☐ Reconditioning ☐ Plugging ☐

4) PROPOSED USE (Check): Domestic ☐ Industrial ☒ Municipal ☐ Irrigation ☐ Test Well ☐ Other ☐

5) TYPE OF WELL (Check): Rotary ☒ Driven ☐ Dug ☐ Cable ☐ Jetted ☐ Bored ☐

6) WELL LOG:
Diameter of hole 6 3/4 in. Depth drilled 1510 ft. Depth of completed well 1510 ft. Date drilled 3-24-69
All measurements made from 0 ft. above ground level.

From (ft.)	To (ft.)	Description and color of formation material
0	8	Surface gravel
8	840	Shales
840	961	Soft Taylor
961	1019	Glauconite
1019	1153	Taylor
1153	1274	Creek (Shales)
1274	1323	Eagle Ford
1323	1384	Buda
1384	1436	Del Rio
1436	1443	Georgetown
1443	1510	Edwards Lime

(Use reverse side if necessary)

7) COMPLETION (Check): Straight wall ☒ Gravel packed ☐ Other ☐ Under reamed ☐ Open hole ☐

8) WATER LEVEL: Static level Flows below Land surface Date
Artesian pressure lbs. per square inch Date

9) CASING: Type: old ☐ New ☐ Steel ☐ Plastic ☐ Other ☐
Cemented from 1440 ft. to Top ft.

Diameter (inches)	Setting From (ft.)	Setting To (ft.)	Gage
4½	0	1510	

10) SCREEN: Type
Perforated ☐ Slotted ☐

Diameter (inches)	Setting From (ft.)	Setting To (ft.)	Slot size
3⅞ Open hole (Edwards)	1440	1510	

11) WELL TESTS: air jetted approx 1006 PM
Was a pump test made? ☐ Yes ☐ No If yes by whom?
Yield: gpm with ft. drawdown after hrs
Bailer test gpm with ft. drawdown after hrs
Artesian flow 12 gpm Date
Temperature of water
Was a chemical analysis made? ☐ Yes ☐ No
Did any strata contain undesirable water? ☐ Yes ☐ No
Type of water? depth of strata

12) PUMP DATA:
Manufacturer's Name Flint & Walling
Type submersible H.P. 7½
Designed pumping rate 18 gpm ☐ gph ☐
Type power unit electric
Depth to bowls, cylinder, jet, etc., 168 ft. below land surface.

I hereby certify that this well was drilled by me (or under my supervision) and that each and all of the statements herein are true to the best of my knowledge and belief.

NAME Pursley Water Wells (Type or Print) Water Well Drillers Registration No. 755
Address 10205 Roosevelt Ave. (Street or RFD) San Antonio (City) Texas 78214 (State)
(Signed) Ted Pursley (Water Well Driller) Pursley Water Wells (Company Name)

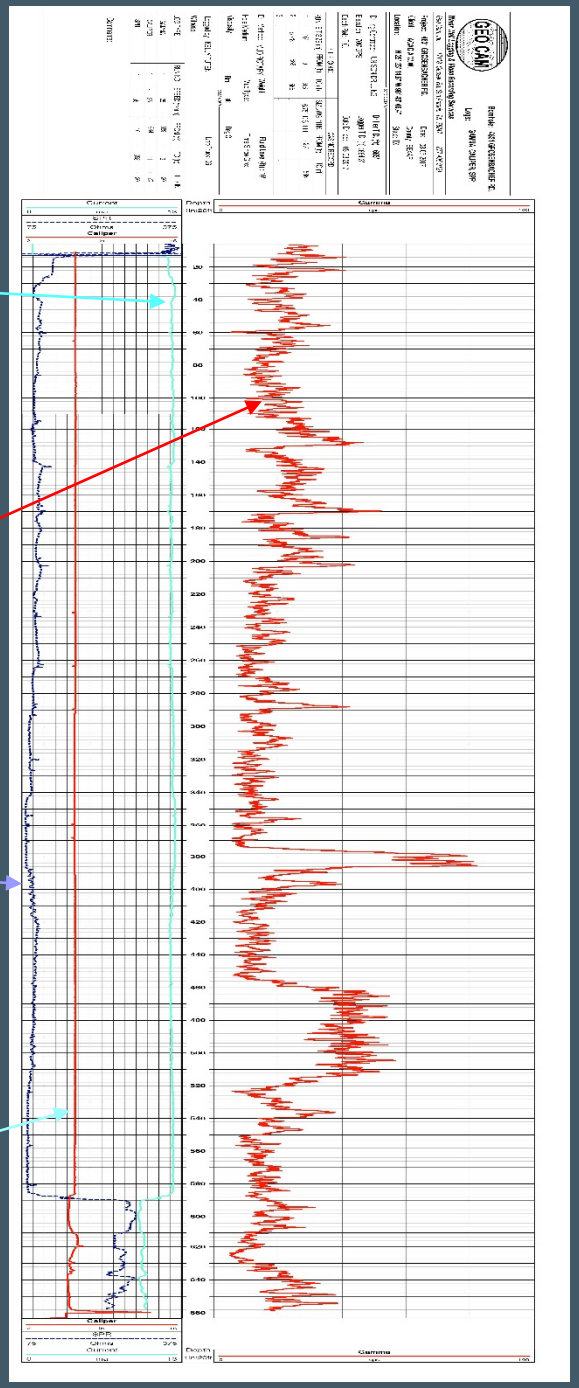
Please attach electric log, chemical analysis, and other pertinent information, if available.

Current: milli-amperes

Gamma: Counts per Second

Spontaneous Potential
Resistivity: Ohms

Caliper: inches



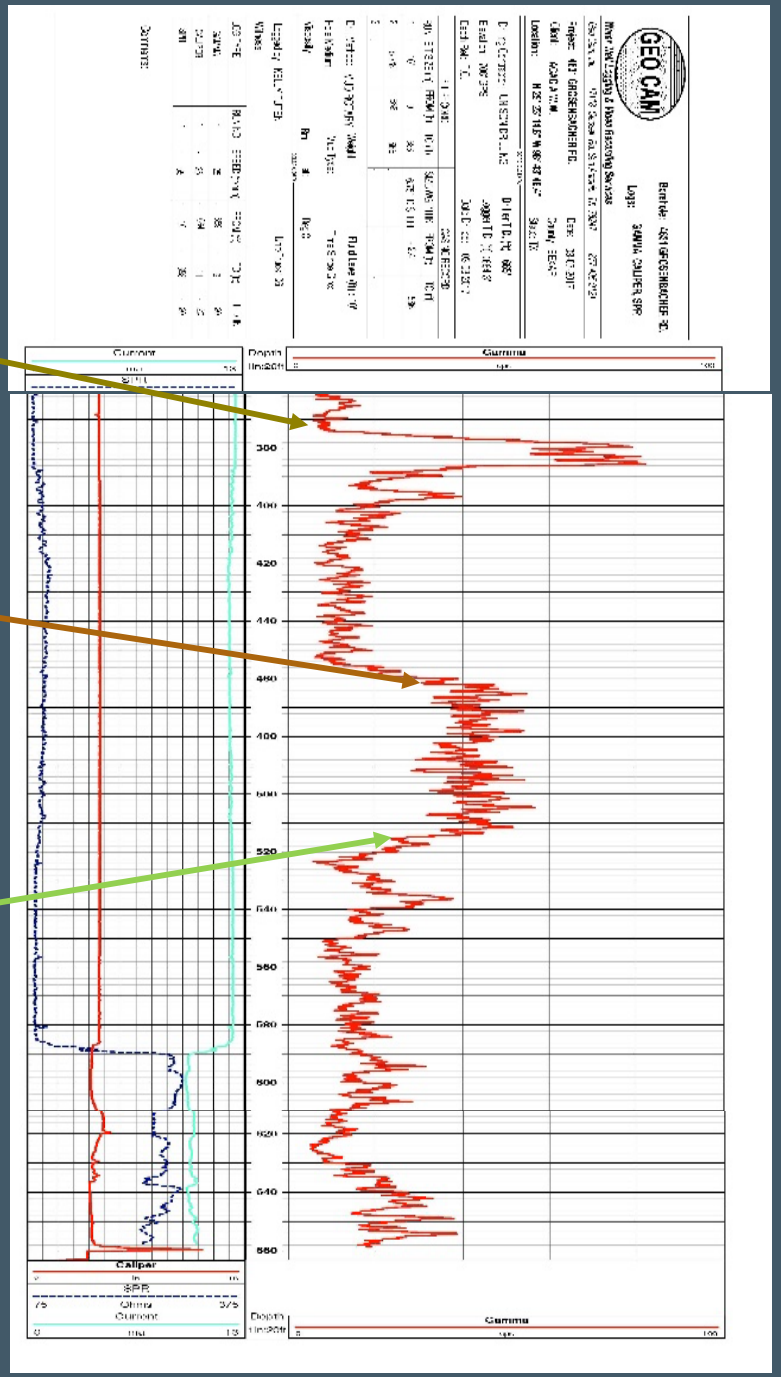
Geophysical Log Facts:

- The gamma tool measures the natural-gamma radiation (photons) emitted by all rocks and soils.
- Clays and Shales are high emitters compared to sandstone, limestone, and dolomite.
- Gamma tools can be run in cased or uncased wellbores, in or out of water.
- Caliper tool measures diameter of well as is ascends through the borehole and casing.
- Current
- Resistivity

Top of Eagle Ford Shale

Top of Del Rio Clay

Top of Kg: Georgetown Formation (Edwards)



Geophysical Log Uses:

- Standardized methodology to categorize well lithology
- Supplements well driller’s notes
- Fills in missing data
- Gamma signal highly distinct through confining units above Edwards

Destroyed Well Case Study

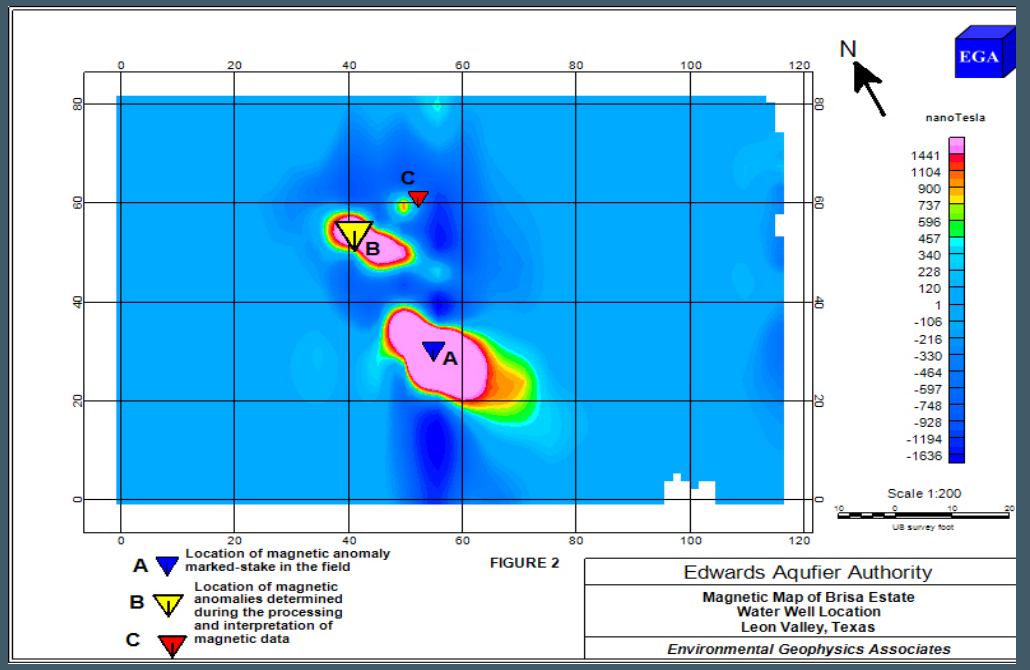
Research and Uncover in Leon Valley

- Concerned citizen reports well
- Phase I Environmental Site Assessment – no well mentioned
- Neighbors provided signed affidavit of their knowledge of a well at site

PHASE I ENVIRONMENTAL SITE ASSESSMENT
5.03-ACRE TRACT OF LAND
WATERCRESS AT BLACKBERRY DRIVE
LEON VALLEY, TEXAS

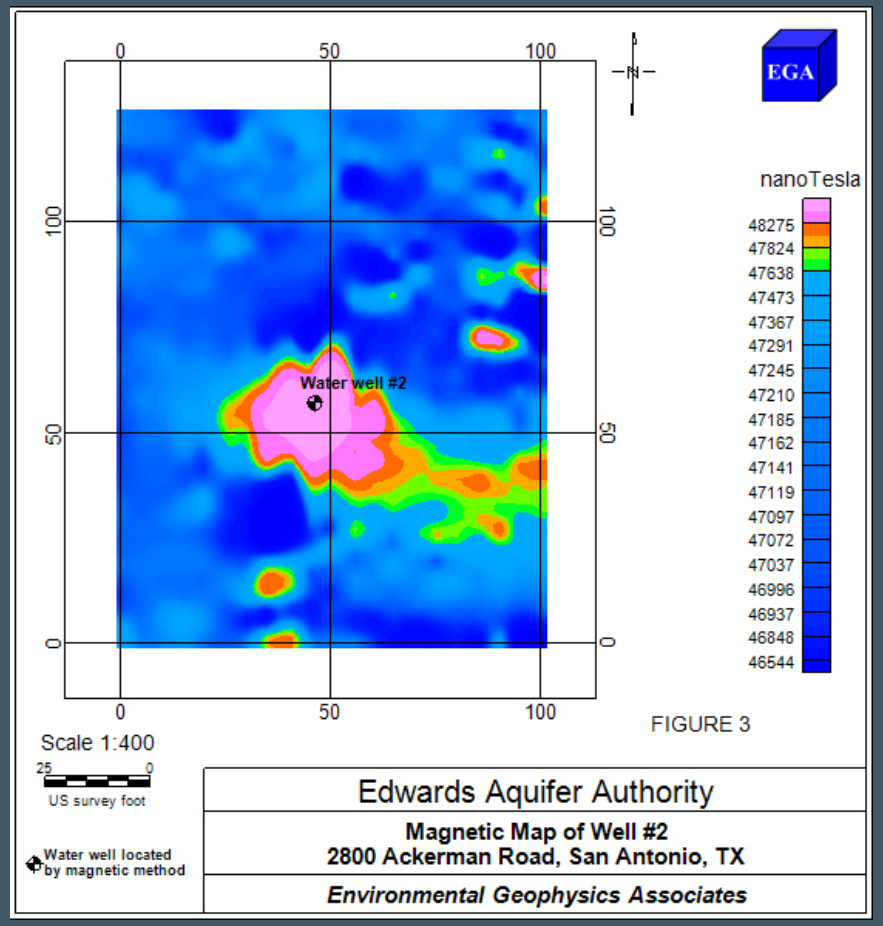
- Well reported June 2010
- Geophysics May 2011
- Excavated June 2011
- Plugged 2015

Leon Valley Well Site GPR and Magnetometer Survey Results



Case Study
Ackermann Rd Well Site: Landis Wilson Water Supply System

- Reported seepage at site
- TWDB indicates two wells
- Owner excavating in search of well
- Magnetometer and GPR Survey



Ackermann Rd Well Site: Landis Wilson Water Supply System

Ackermann Rd Well Site: Landis Wilson Water Supply System

Case study MRP Site: Picture of Mr. Braunig during well completion of the MRP well. Apparently largest well in the USA prior to the Catfish farm.

MEMORANDUM FOR THE RECORD

6 March 1974

I met with Mr. Charles McGee, City Public Service Board, and Mr. Hugh Whorton, Halliburton Company, to discuss means of determining which of the four wells at 202 Mission Road could be leaking and causing their seepage problem.

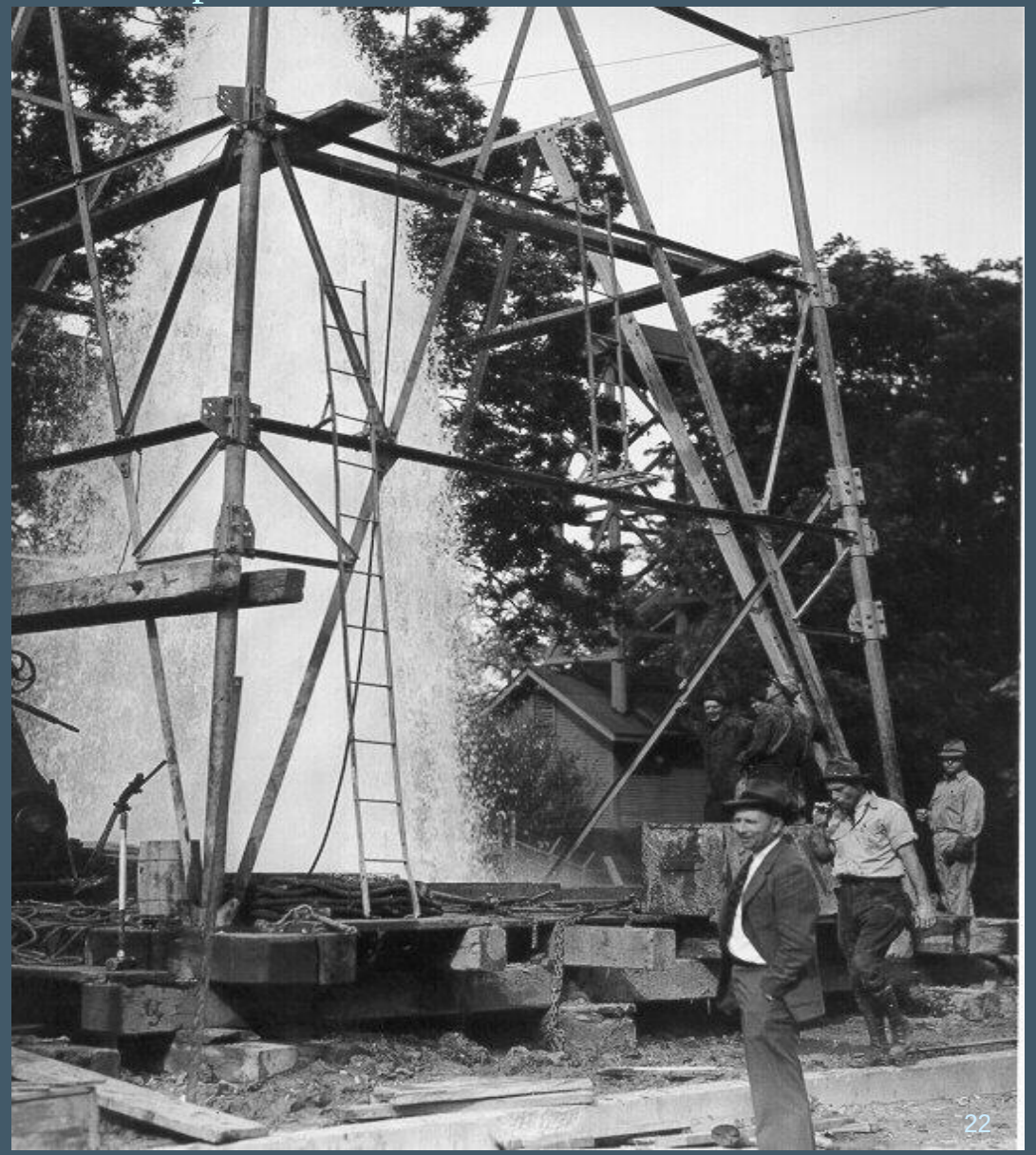
Methods discussed which could be used to determine the source of the water were:

1. Run complete chemical analysis from all wells and from seepage.
2. Pump fluorescent dye, as recommended by USGS, into one well at a time and check seepage for trace of dye.
3. Use an air compressor to pump down water to determine possible hole in casing. This should be done with great caution.

Some mention was made that the CPSB plans to plug Well No. 1 which produces very little water and Well No. 2 which produces a strong sulphur odor. I informed both Mr. McGee and Mr. Whorton that a permit was required for any repair or plugging with a waiver on the fees. They were requested to notify us any time work is done.

Oliver Grobe

Oliver Grobe, Jr.
Water Quality Inspector



Station B artesian well with Braunig ca 1947

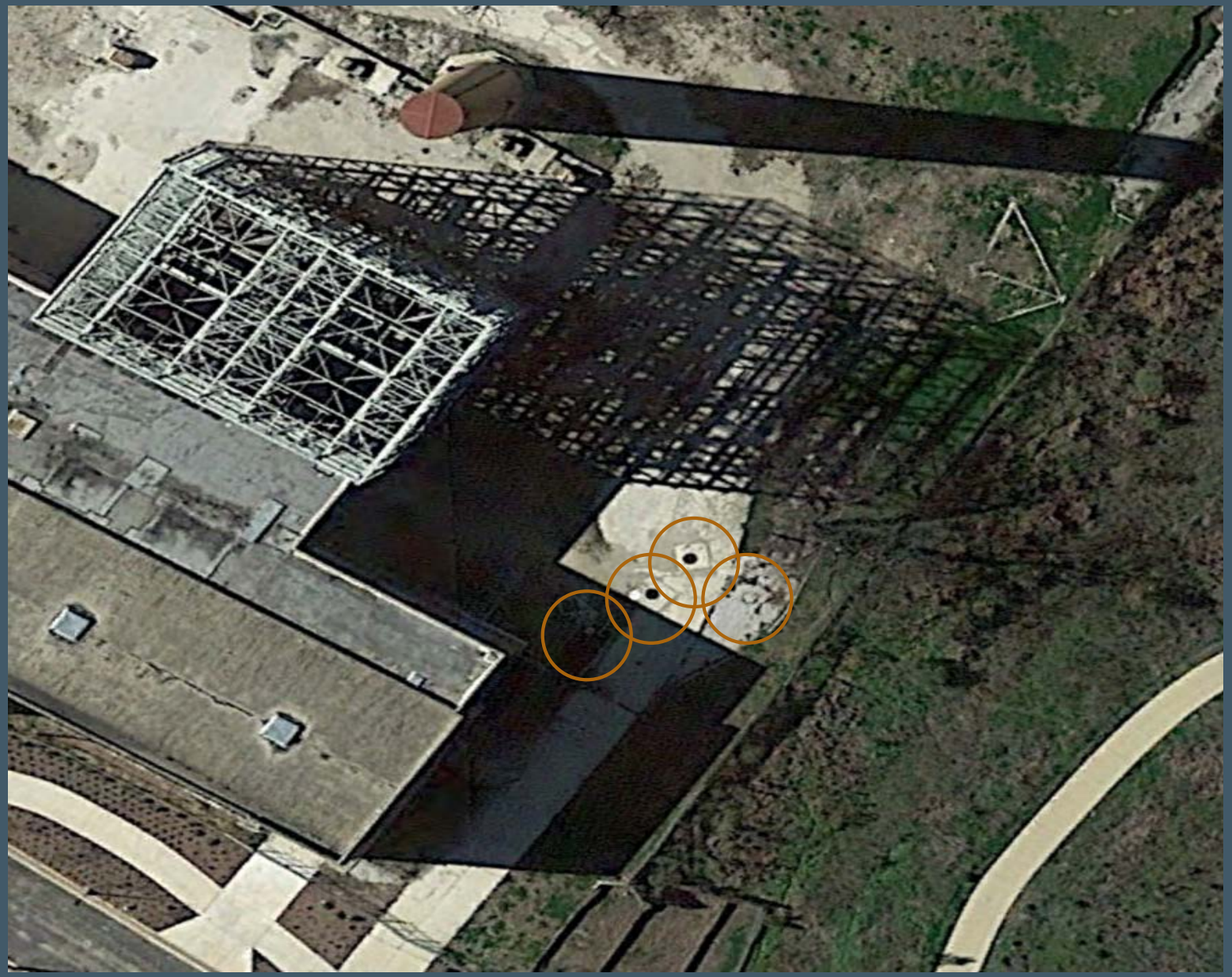
MRP Site south of downtown S.A. on east side of San Antonio River

Only well visible at ground surface.

MRP Site

MRP Site

MRP Site



Case Study: Bexar County Abandoned Flowing Artesian Well

Significant ecosystem has developed over many years from an abandoned flowing artesian well.
Suggestion to plug well met significant resistance from community entities.

Flowing Artesian Well

Costly to plug:

- Build platform around well
- Deep Well
- Stop artesian flow

Case Study: Downtown San Antonio Well Site

Downtown San Antonio Well Site

Recent high aquifer levels to start flowing above standpipe height, requiring additional PVC section.

Downtown San Antonio Well Site

Abandoned Wells

Abandoned Wells

Casing Repair

Repair process involved installing 2-foot stainless steel, 10 gauge patch overlaid with a 4-foot stainless steel, 10 gauge patch over the casing separation located approximately 70 feet below land surface

Swage tool that applies 1,500 PSI to both patches to seal the separation.

Well Plugging

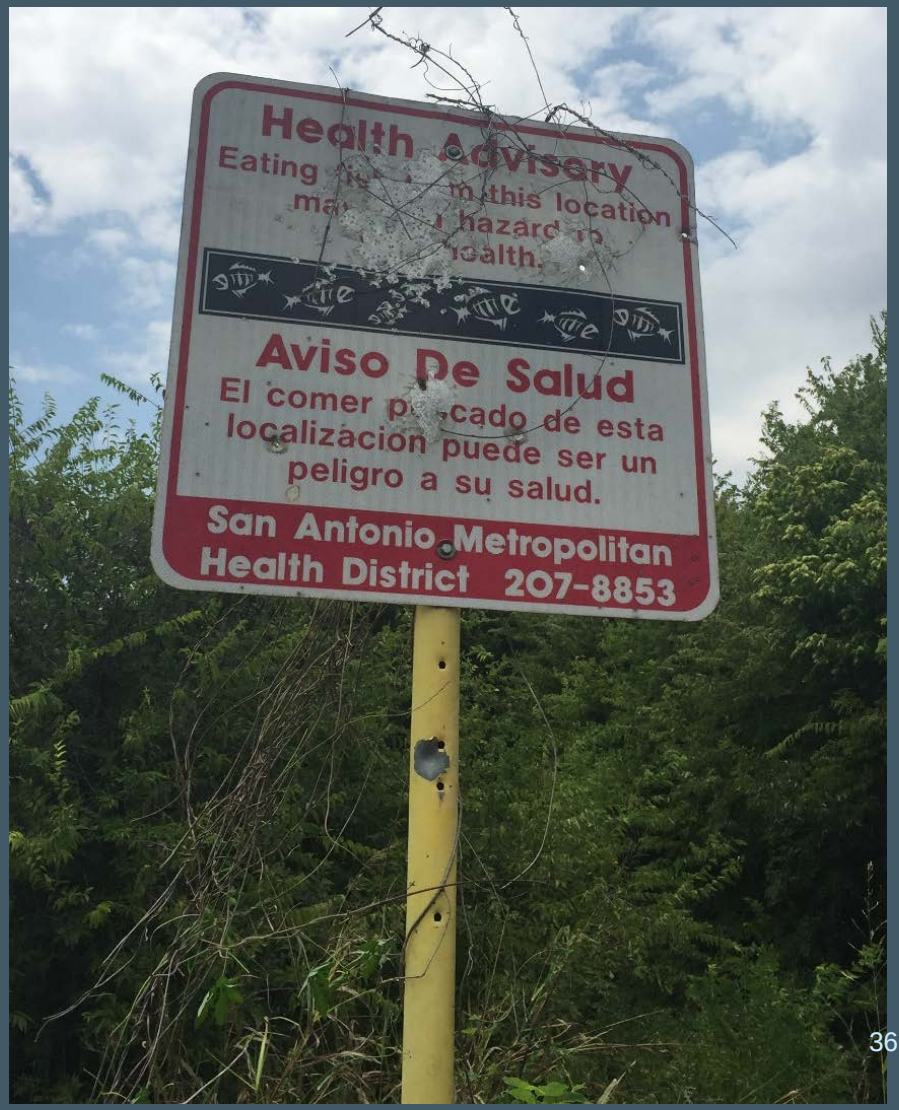
Plugging an abandoned well:

- Long and challenging process
- A well may need to be cleaned out
- Access to the well has to be established
- Can be costly
- Each abandoned well has unique circumstances

Risk Based Assessment:
Categorizing and Prioritizing Abandoned Wells and Identifying Areas of Concern

- Identify Abandoned Well Risk Criteria
  - 1) ***Threat to the Aquifer***
    - Abandoned Well Condition
    - Proximity of Well to Contaminants
  - 2) Feasibility of Plugging Wells
    - Cost
    - Time-Sensitivity

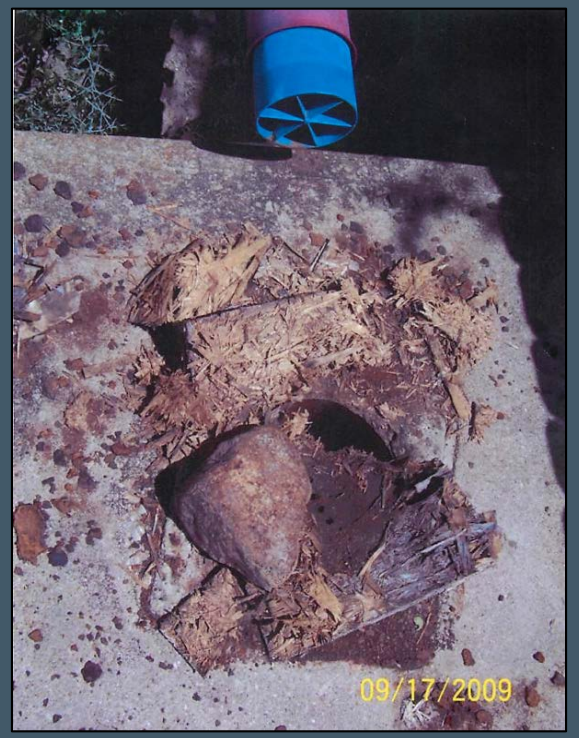
- Introduce GIS tool
  - 1) Cumulation of risk criteria
  - 2) Rank abandoned wells



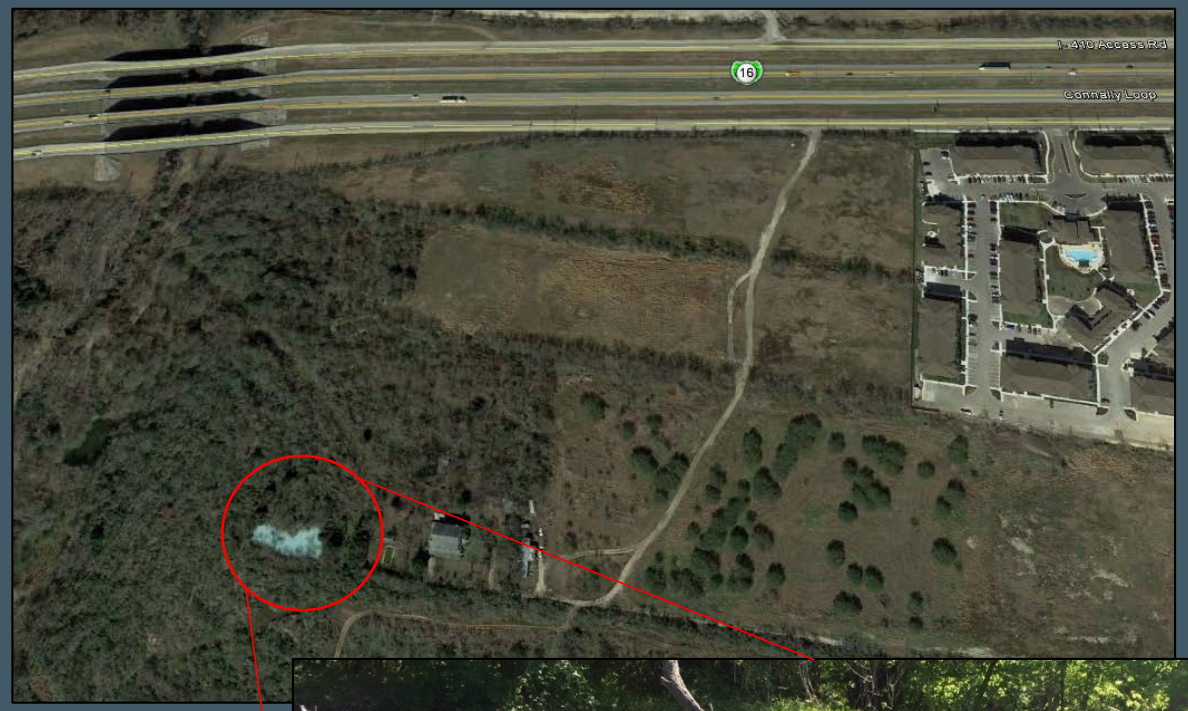
Risk Criteria—Threat to the Aquifer
Abandoned Well Condition: Deteriorated Casing

Risk Criteria—Threat to the Aquifer
Abandoned Well Condition: Casing Location

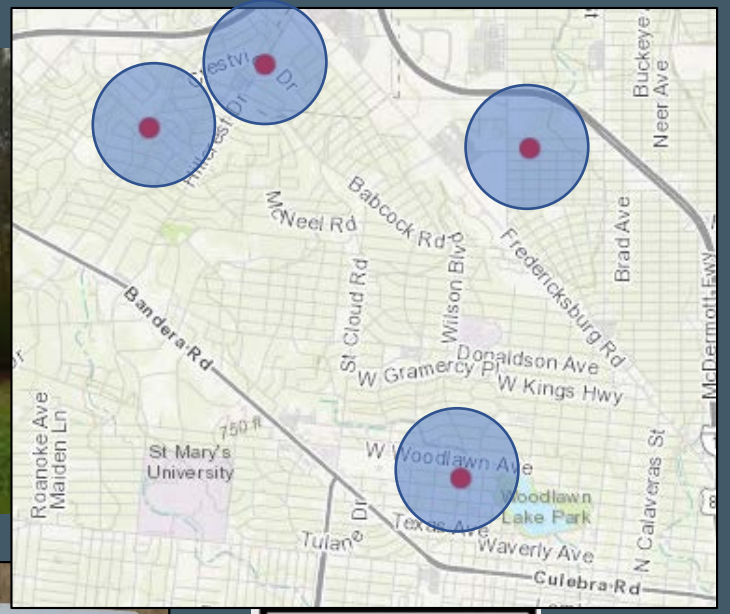
Risk Criteria—Threat to the Aquifer
Abandoned Well Condition: Casing Seal

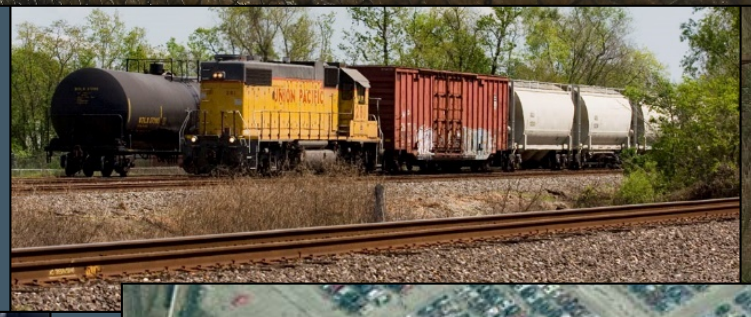


Risk Criteria—Threat to the Aquifer
Abandoned Well Condition: Communication with poor quality waters or Petroleum-Bearing Formations



Risk Criteria—Threat to the Aquifer
Abandoned Well Proximity to Contaminants and Potential Contaminants

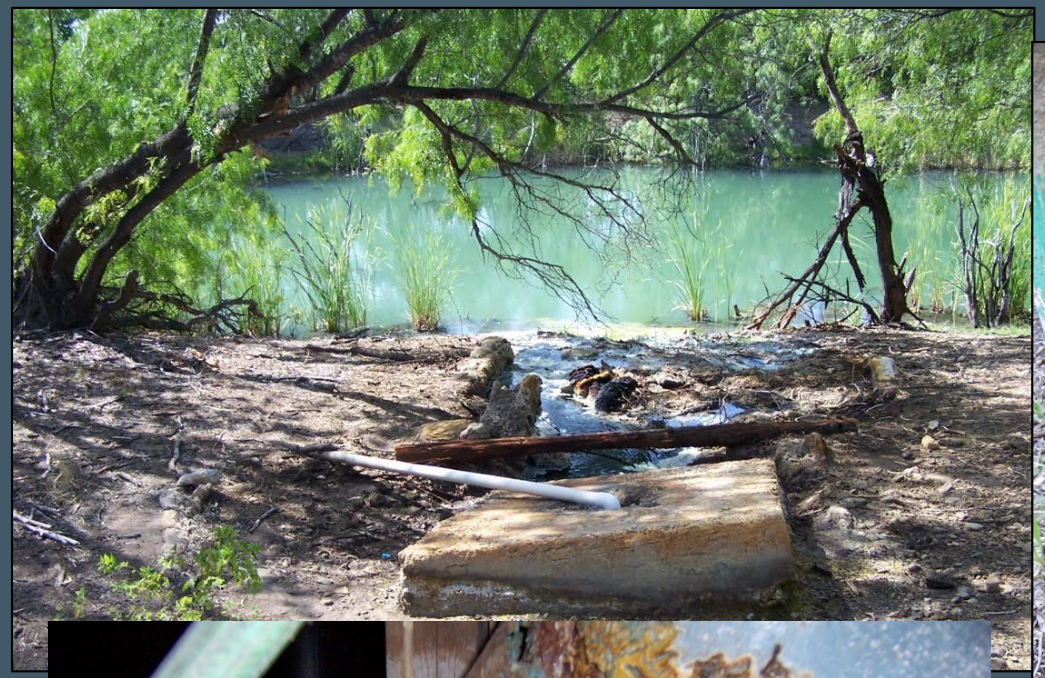




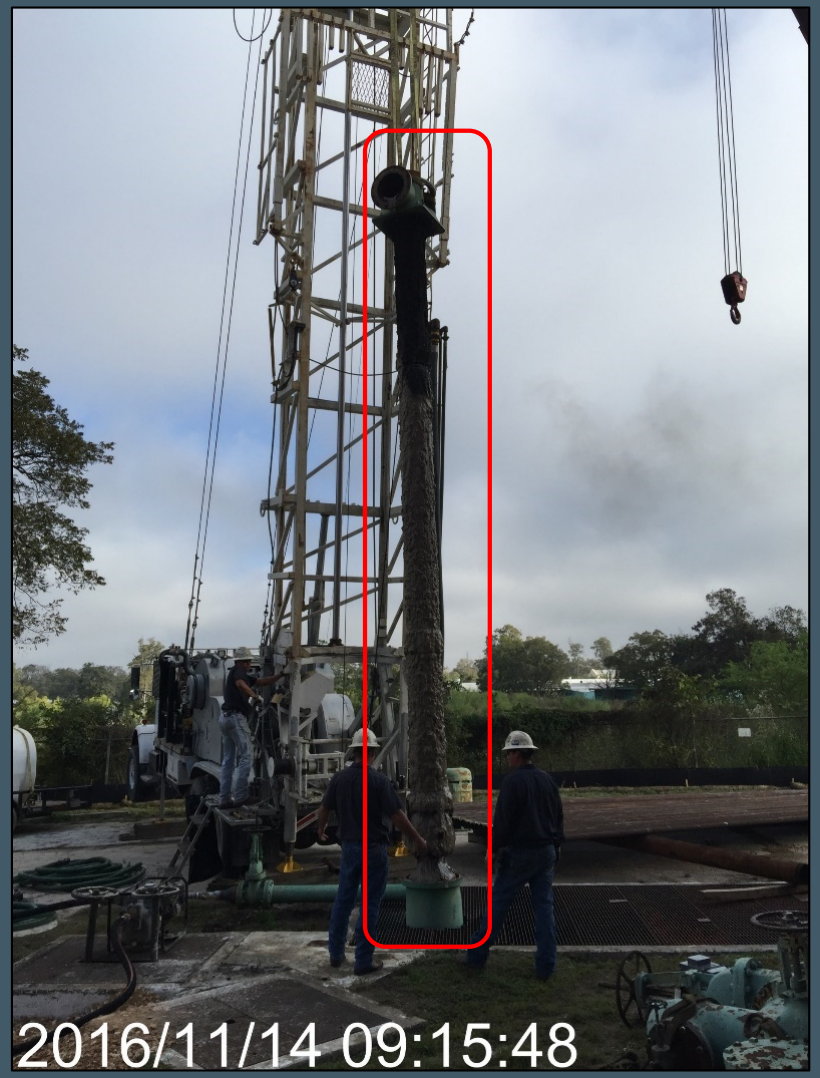
Risk Criteria—Threat to the Aquifer
Land Use & Population Density at Abandoned Well Sites

Criteria: Plugging Abandoned Wells – Accessing Wells

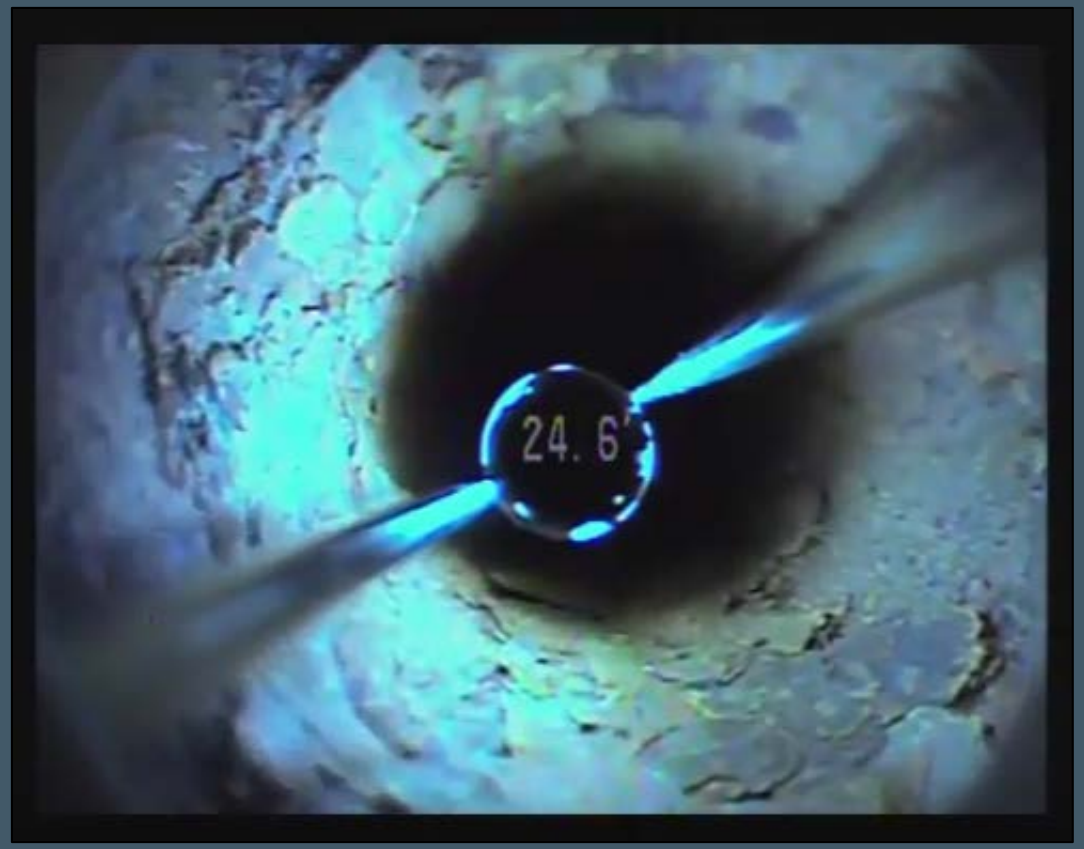
Criteria: Plugging Abandoned Wells – Flowing Artesian Wells

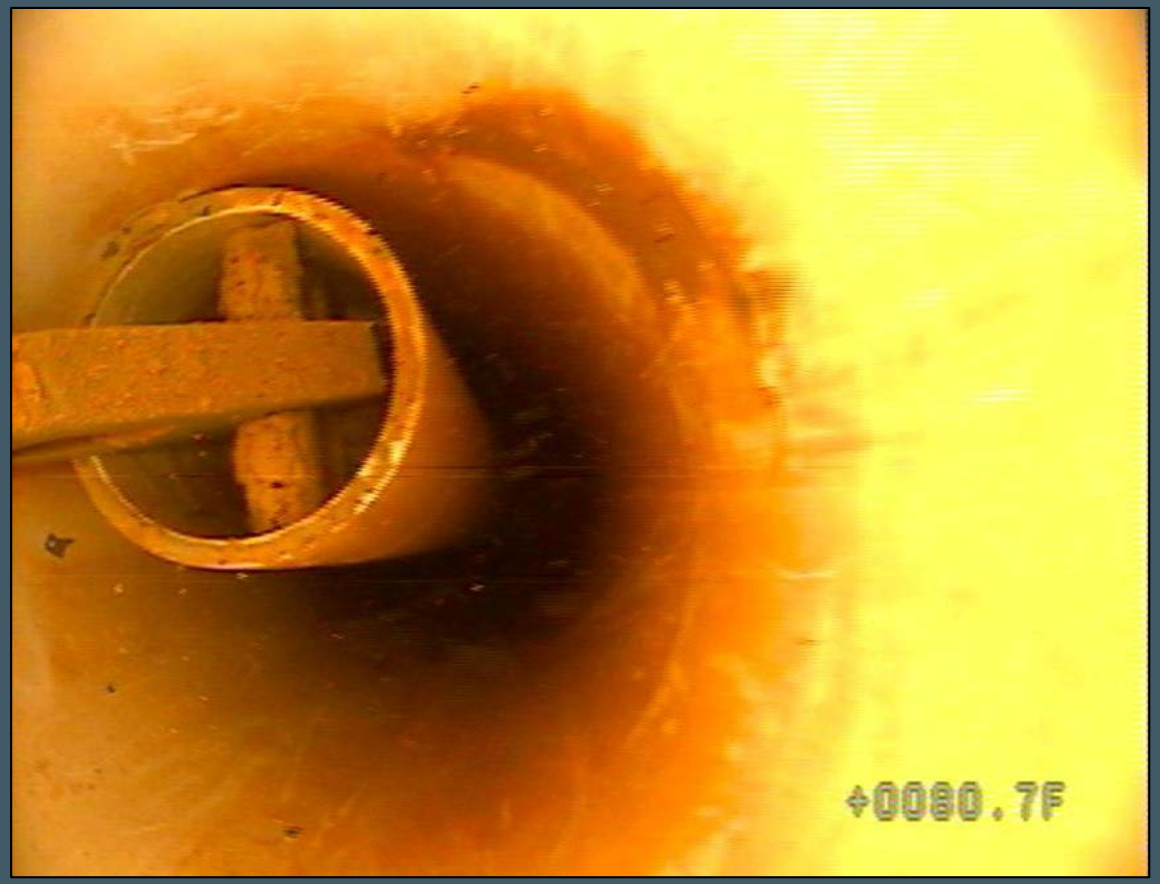


Criteria: Plugging Abandoned Wells – Large Diameter, Deep Wells



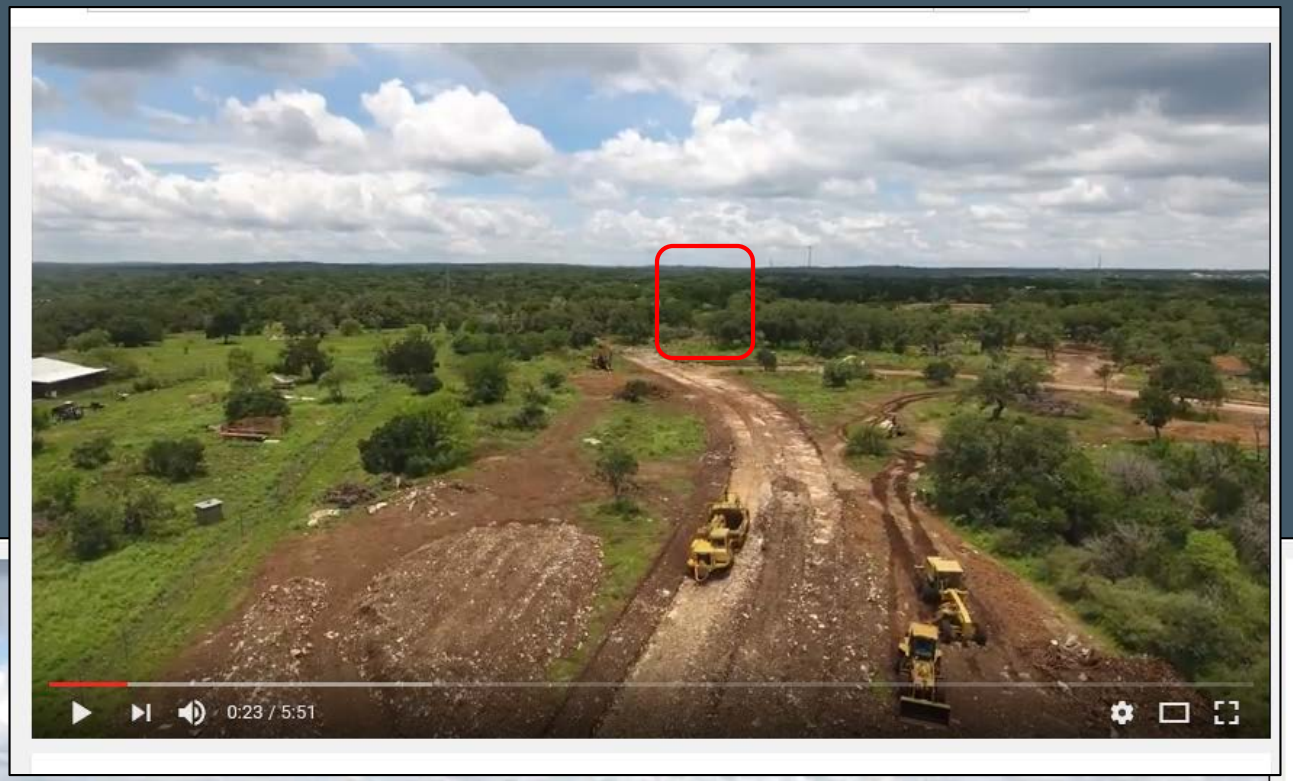
Criteria: Plugging Abandoned Wells – Clearing out wells

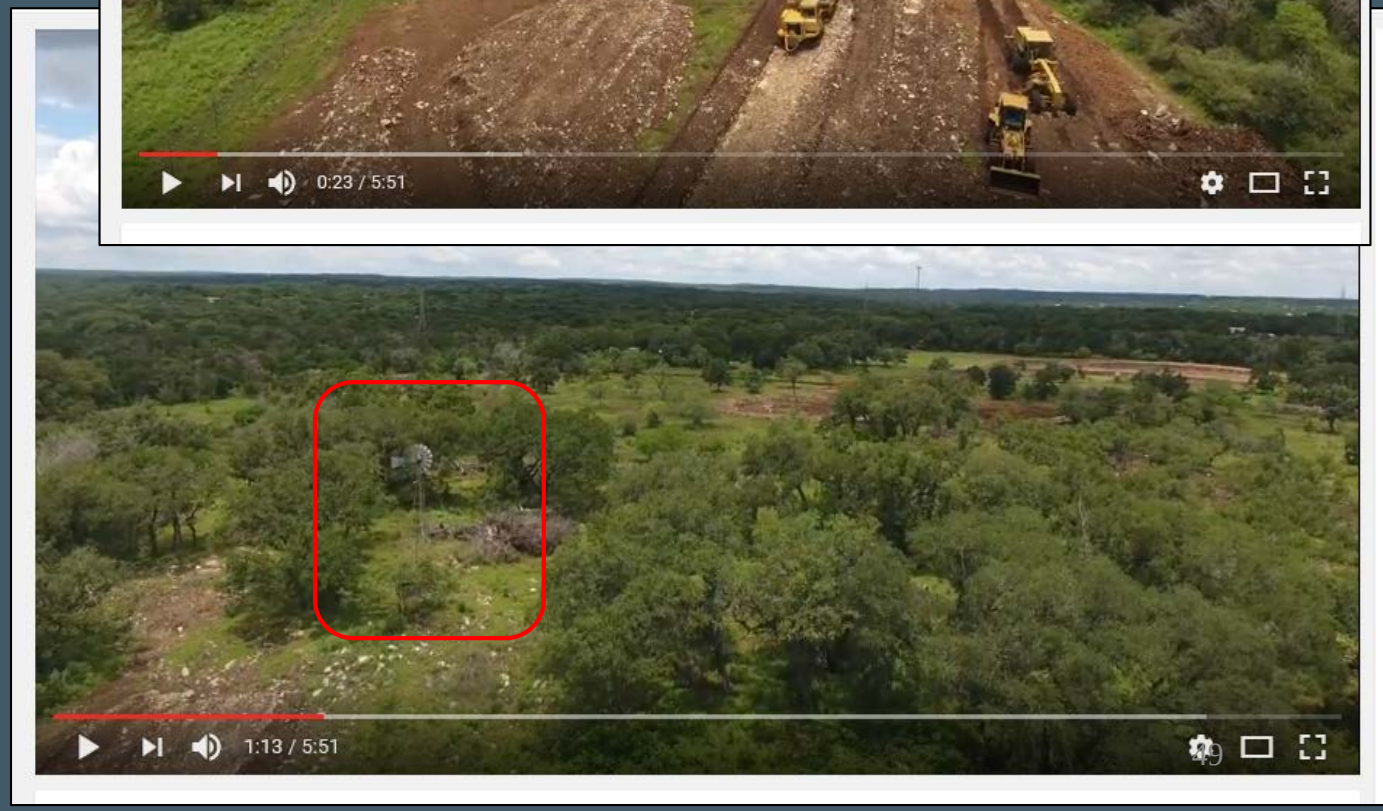




Criteria: Time-Sensitivity – Security of Abandoned Well Site

Criteria: Time-Sensitivity – Planned or Active Development





CREATING A GIS TOOL FROM RISK CRITERIA

Collaborative Effort

Feedback

Dynamic Process

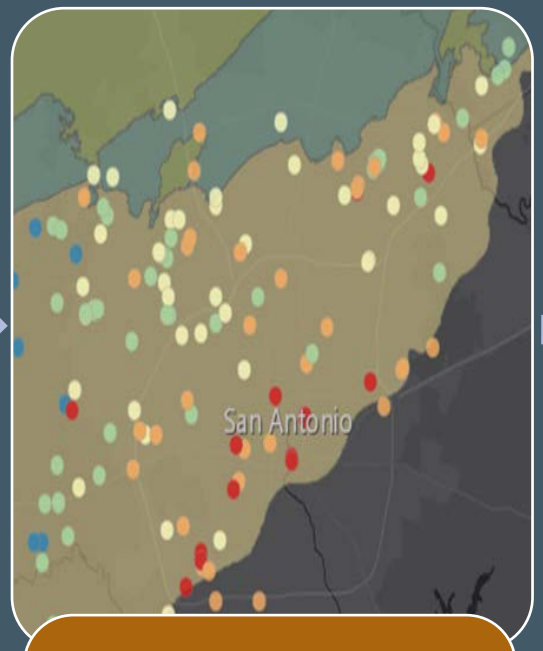
272 Abandoned Edwards Aquifer Wells

Question 1:

Which wells pose the greatest threat to the Aquifer?

Criteria:

- Abandoned Well Conditions
- Abandoned Well Proximity to Contaminants



Ranking of wells that pose the greatest threat to the Aquifer

(Highest-ranking 20)

Question 2:

Which wells can then most effectively be plugged?

Criteria:

- Cost
- Time-Sensitivity

Prioritized list of Abandoned Wells for Plugging

GIS TOOL

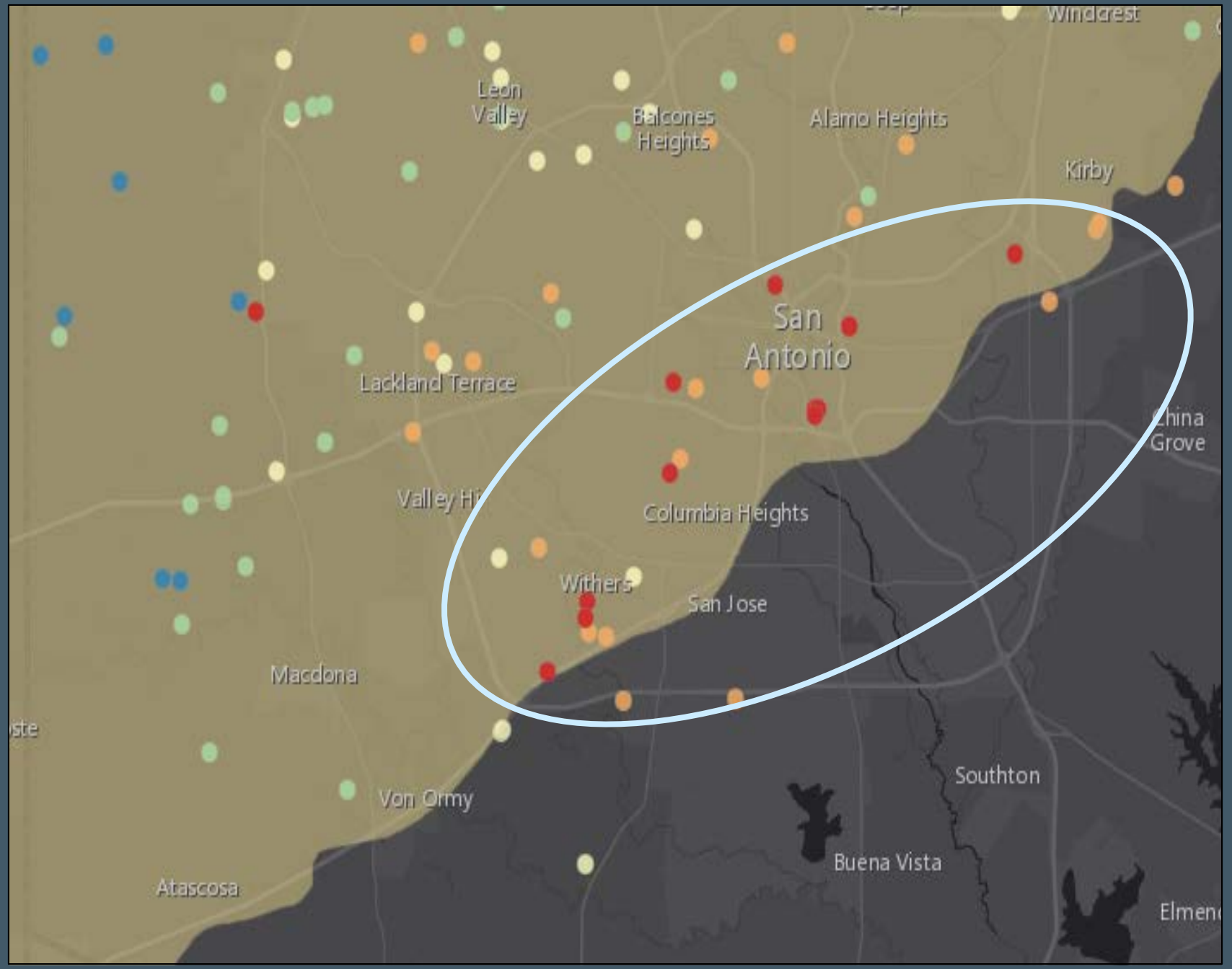
http://arcg.is/2ffDODk

Areas of Concern

Abandoned Wells

Rank

- High
- Moderate - High
- Moderate
- Moderate - Low
- Low



Other qualitative considerations

To fulfil our mission to

Manage, Enhance, & Protect the Edwards Aquifer many wells should be additionally prioritized for plugging to:

- **Prevent instances of waste or neglect**
- **Prevent potential litigation**
- **Demonstrate “Proactive” rather than “Reactive” environmental stewardship**

References and Acknowledgments:

- http://tgpc.state.tx.us/water-wells/#3 Texas Groundwater Protection Committee Publications
- Texas Commission on Environmental Quality
- Environmental Geophysics Associates (Mustafa Saribudak, Alf Hawkins.
- http://www.globalsecurity.org/military/library/policy/army/fm/5-484/Ch6.htm Global Security Org (field manuals)
- http://extension.psu.edu/natural-resources/water/drinking-water/wells/protecting-wells-with-sanitary-well-caps-and-grouting Penn State Extension Service
- https://pa.water.usgs.gov/reports/fs218-95.pdf USGS
- https://newsroom.cpsenergy.com/cps-energy-partners-commit-15m-for-epicenter/ CPS Energy
- https://ia800404.us.archive.org/2/items/std01078656.ome/std01078656.pdf Ontario Ministry of the Environment (MOE), Ontario Water Resources Act
- Corrosion of Water Wells, Chapter 5, Robert G. McLaughlan
- https://www.thebalance.com/types-of-corrosion-2340005
- http://www.cement.org/docs/default-source/fc_concrete_technology/durability/is536-types-and-causes-of-concrete-deterioration.pdf?sfvrsn=4