

A GUIDE TO THE EDWARDS AQUIFER

SAN ANTONIO'S PRIMARY WATER SUPPLY

JOANN P. DELUNA

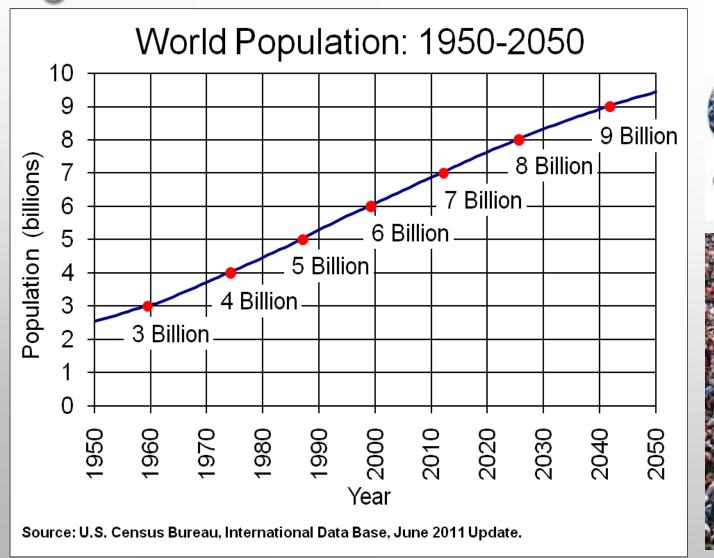
GREATER EDWARDS AQUIFER ALLIANCE EDUCATIONAL PROGRAMS DIRECTOR

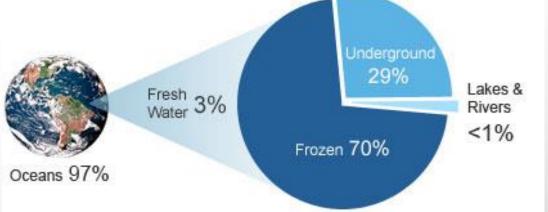


OBJECTIVES

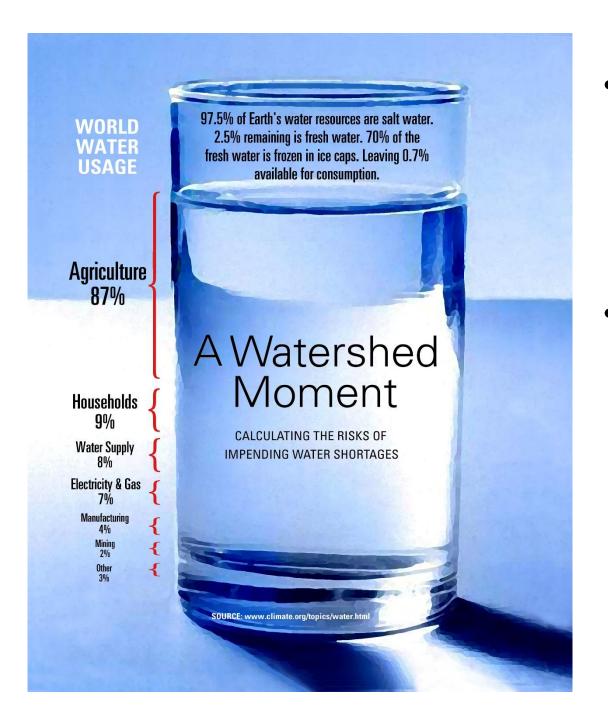
- BY THE END OF THIS PRESENTATION YOU SHOULD BE ABLE TO:
- EXPLAIN WHAT AN AQUIFER IS, AND HOW OURS WORKS.
- EXPLAIN HOW HUMANS AFFECT THE QUALITY OF SURFACE AND GROUNDWATER.
- EXPLAIN WHY WE NEED TO PROTECT THE RECHARGE ZONE OF THE EDWARDS AQUIFER.
- LIST 5 THINGS THAT YOU CAN DO TO PROTECT WATER QUALITY.

THE WORLD'S POPULATION IS **INCREASING**, BUT **THE SUPPLY OF FRESH SAFE DRINKING WATER IS NOT**. DEMAND IS EXCEEDING SUPPLY AND THIS IS CREATING GLOBAL WATER SHORTAGES.









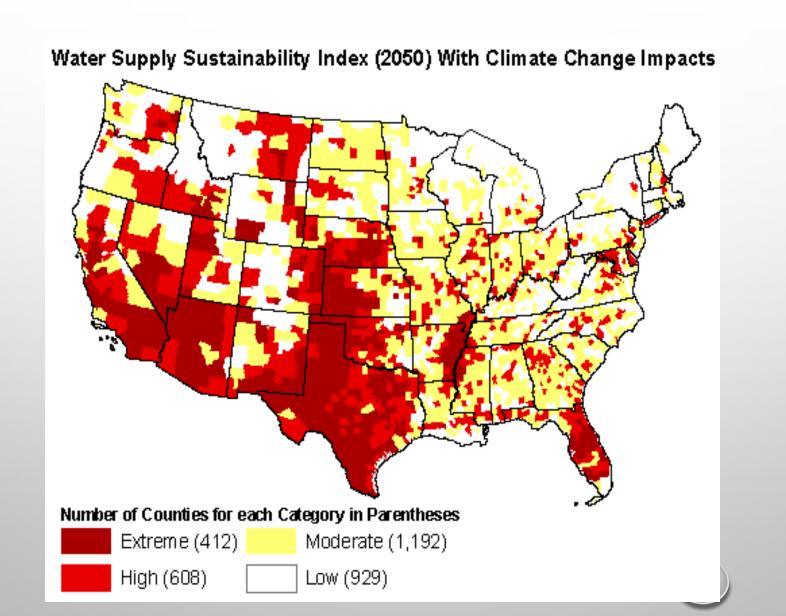
- AS MUCH AS ONE-FOURTH OF

 GLOBAL FRESHWATER USE MAY

 ALREADY BE EXCEEDING ACCESSIBLE,

 SUSTAINABLE SUPPLY.
- SOME 70 MAJOR RIVER SYSTEMS ARE ALMOST TOTALLY DRAINED,
 GROUNDWATER TABLES LEVELS ARE PLUNGING, AND MOUNTAIN GLACIERS VITAL TO RE-STOCKING FRESHWATER FLOWS ARE SHRINKING WORLDWIDE.

THE UNITED STATES IS ALREADY FACING WATER SHORTAGES.



SAN ANTONIO IS NOW THE SEVENTH LARGEST CITY IN THE UNITED STATES



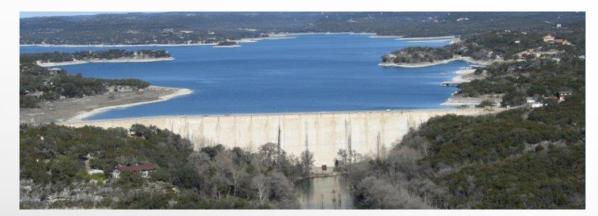


THE POPULATION OF SAN ANTONIO IS PROJECTED TO DOUBLE IN THE NEXT 28 YEARS.

- THIS MEANS THAT TWICE AS MANY PEOPLE WILL
 DEPEND ON THE EDWARDS
 AQUIFER FOR THEIR WATER.
- HOWEVER THIS AREA IS CURRENTLY EXPERIENCING ONE OF THE WORST DROUGHTS SINCE THE 1950'S.



MEDINA LAKE BEFORE AND DURING THE CURRENT DROUGHT











WILL WE ALWAYS BE ABLE TO GET ENOUGH <u>CLEAN WATER</u> FROM OUR AQUIFER TO MEET THE GROWING NEEDS OF OUR POPULATION, AGRICULTURE, BUSINESSES, AND INDUSTRIES?



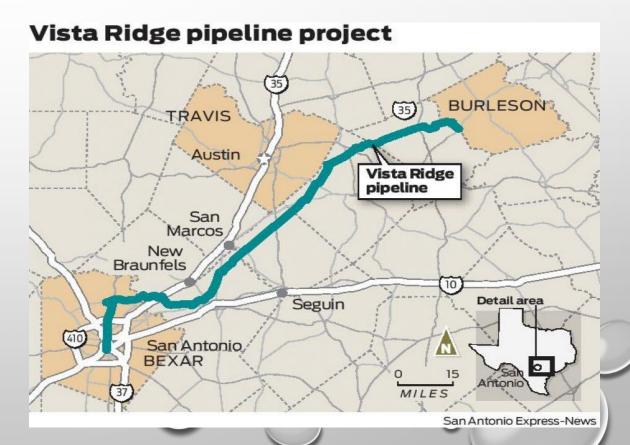


SAN ANTONIO IS CURRENTLY BUILDING AND PLANNING WATER PROJECTS TO MEET OUR NEEDS FOR THE FUTURE

WE ARE BUILDING A DESALINATION PLANT SOUTH OF TOWN THAT WILL CLEAN BRACKISH (SALTY) WATER FOR US TO USE.



THE VISTA RIDGE PIPELINE PROJECT WILL BRING WATER FROM THE BURLESON AREA TO MEET THE NEEDS OF THE INCREASING POPULATION GROWTH IN OUR CITY.



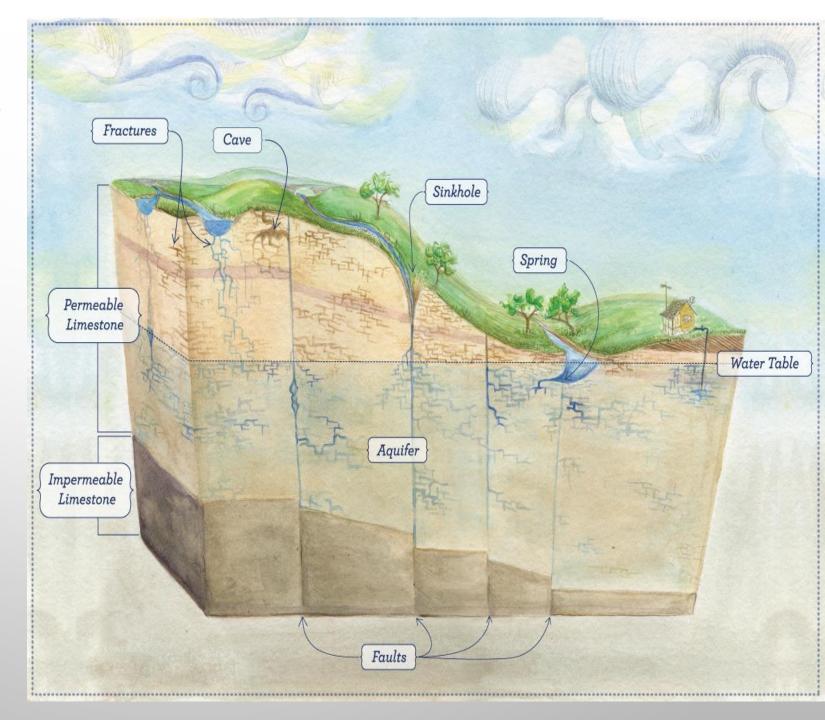
90% OF OUR CURRENT WATER SUPPLY COMES DIRECTLY FROM THE EDWARDS AQUIFER



SO WHAT IS AN AQUIFER?

 AN AQUIFER IS AN UNDERGROUND LAYER OF ROCK CAPABLE OF STORING AND TRANSMITTING WATER IN USABLE QUANTITIES.

 THIS WATER CAN BE BROUGHT TO THE SURFACE THROUGH NATURAL SPRINGS OR BY PUMPING.



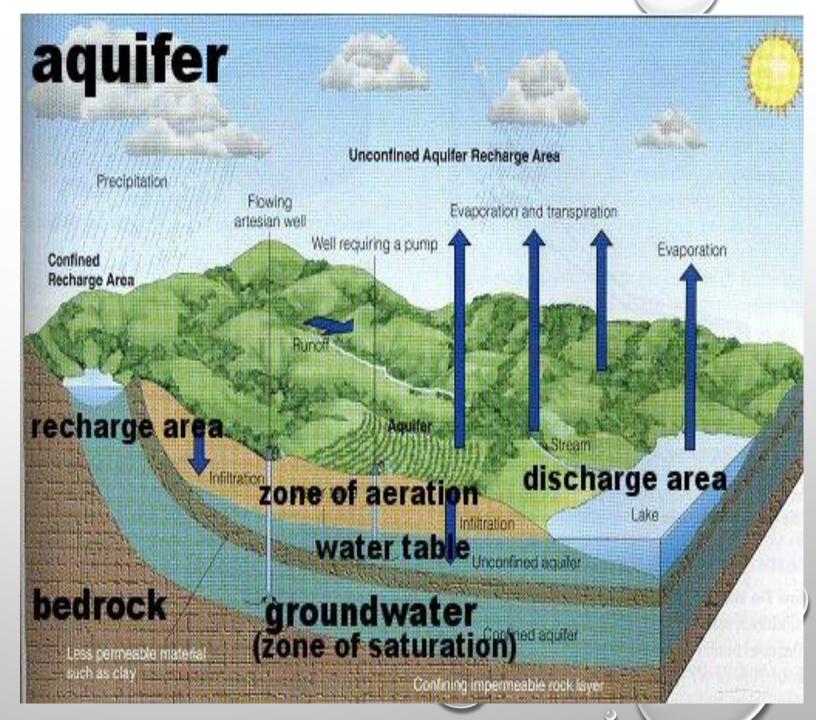
- THE GROUNDWATER

 CONTAINED IN AQUIFERS

 IS ONE OF THE MOST

 IMPORTANT SOURCES OF

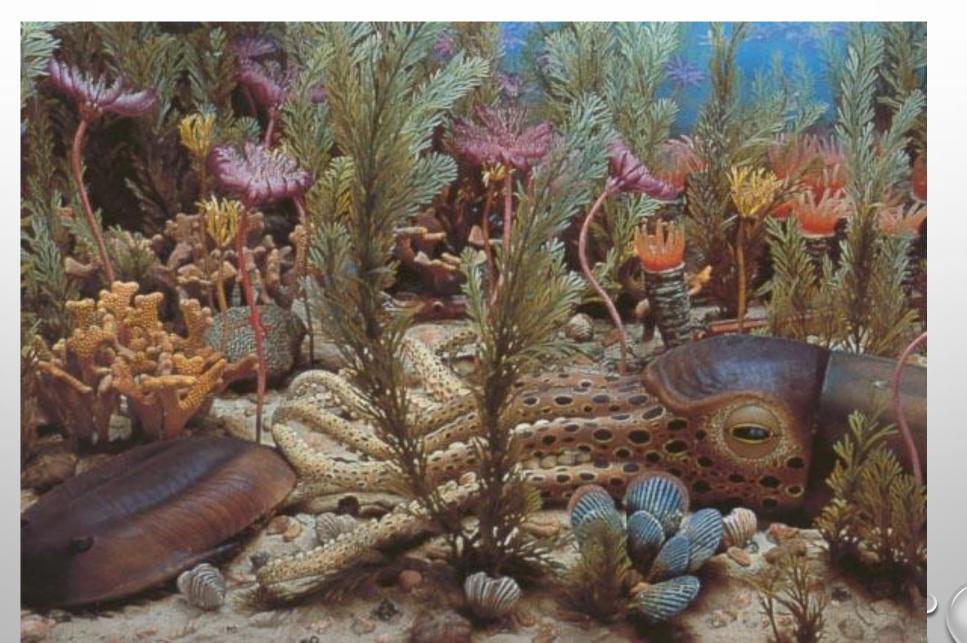
 WATER ON EARTH:
- · ABOUT 96 % OF OUR LIQUID FRESHWATER IS GROUNDWATER. THE REST IS FOUND AT THE SURFACE IN STREAMS, LAKES, RIVERS AND WETLANDS.

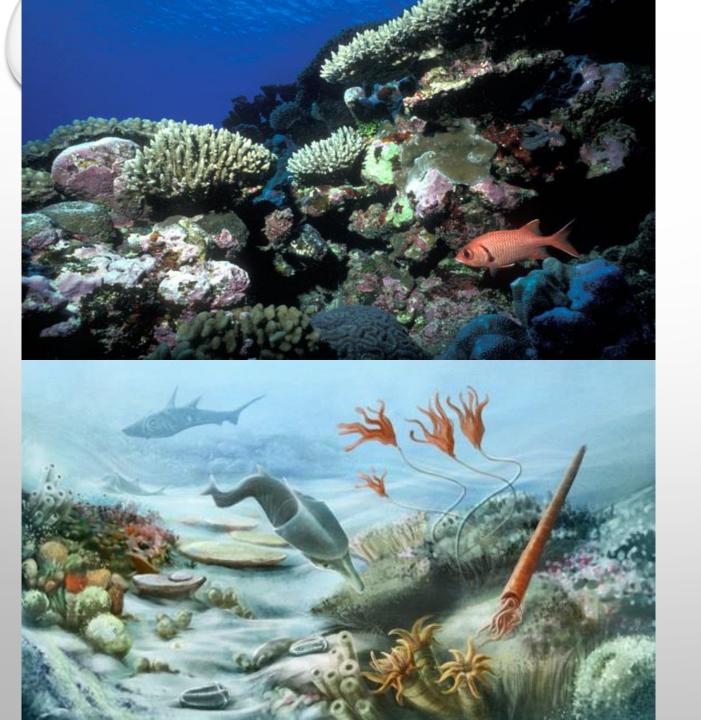


THE EDWARDS AQUIFER STARTED FORMING OVER 140 MILLION YEARS AGO WHEN WE WERE COVERED BY A SHALLOW OCEAN

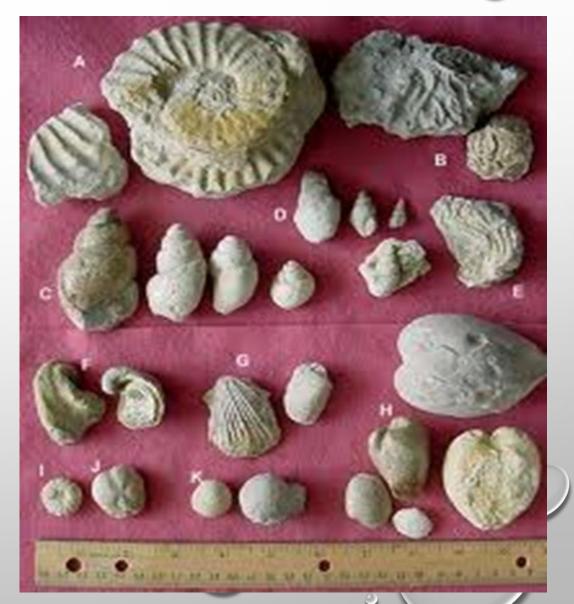


WHERE YOU ARE SITTING WOULD HAVE LOOKED LIKE THIS....





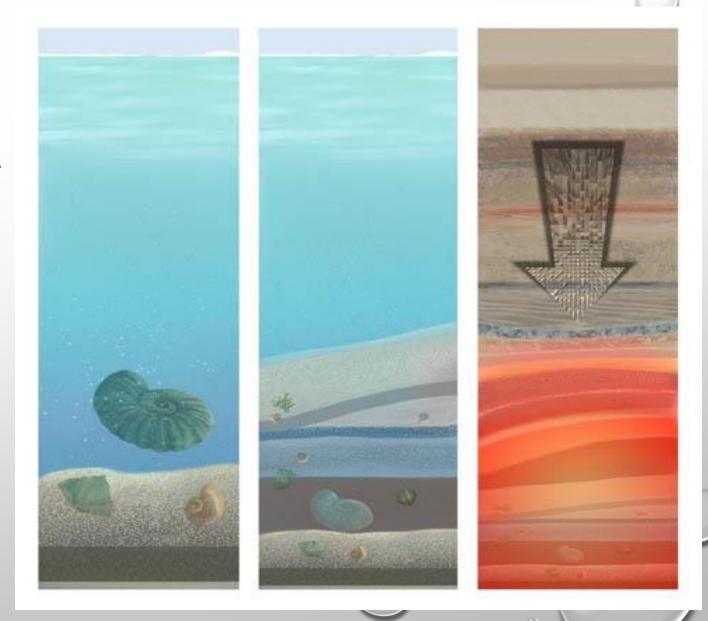
FOSSILS ARE PROOF THAT THIS WAS ONCE A SHALLOW OCEAN



HOW DOES LIMESTONE FORM?

 MOST LIMESTONES FORM IN SHALLOW, CALM, WARM MARINE WATERS WHERE OCEAN-DWELLING ORGANISMS LIKE OYSTERS, CLAMS, MUSSELS AND CORAL USE CALCIUM CARBONATE FOUND IN SEAWATER TO CREATE THEIR SHELLS.

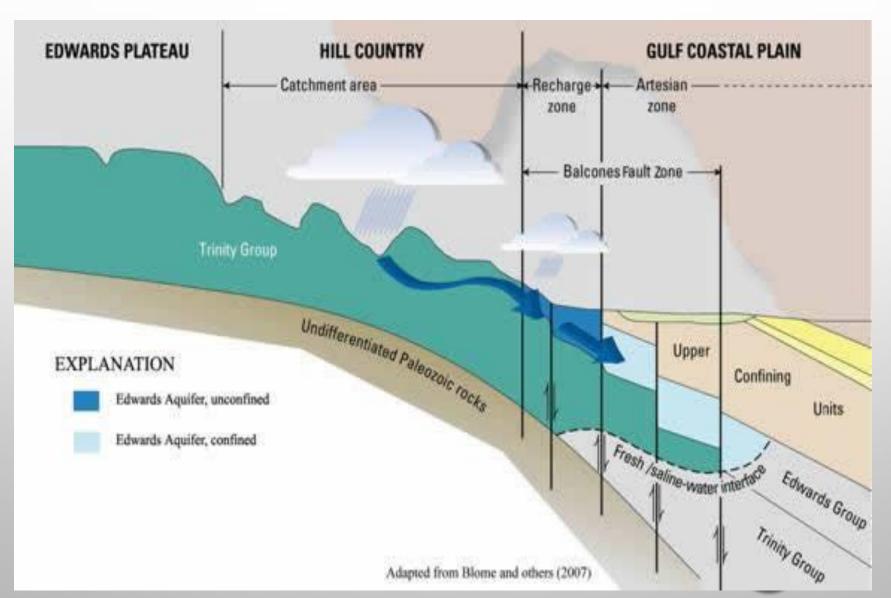
WHEN THESE ORGANISMS DIE, THEIR SHELLS SETTLE ON THE OCEAN FLOOR WHERE THEY ARE COMPACTED OVER MILLIONS OF YEARS. LIMESTONE IS CREATED WHEN THESE SEDIMENTS ARE PRESSURED BY THE WEIGHT OF OCEAN WATER AND THE LAYERS ON TOP PUSHING DOWN.



OVER MILLIONS OF YEARS LIMESTONE, A SEDIMENTARY ROCK, WAS DEPOSITED IN LAYERS ON THE OCEAN FLOOR.



ABOUT 25 MILLION YEARS AGO THESE LAYERS STARTED SLIPPING TOWARDS THE GULF OF MEXICO WHICH CREATED THE BALCONES FAULT ZONE.



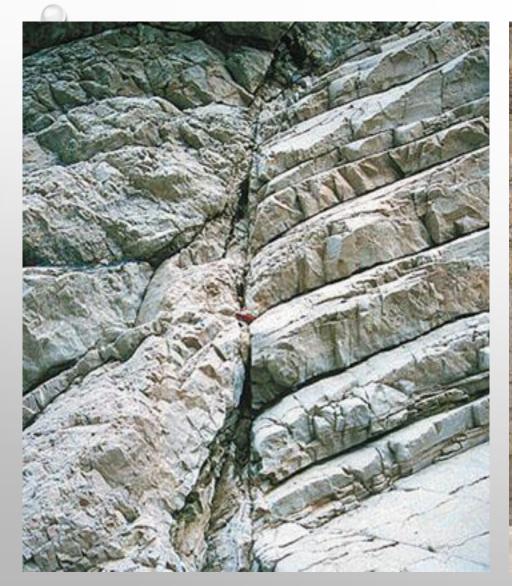
AS THE LAND UPLIFTED ABOVE THE OCEAN THE LIMESTONE WAS NOW EXPOSED TO WEATHERING

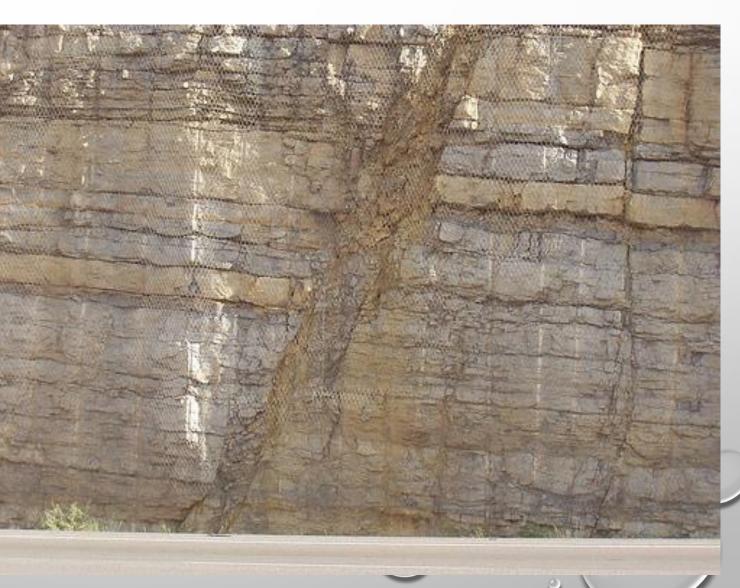


LIMESTONE BEFORE WEATHERING IS **IMPERMEABLE**MEANING WATER CANNOT FLOW THROUGH IT



WHEN THE LIMESTONE WAS FRACTURED AND FAULTED BY THE UPLIFT THIS CREATED CRACKS THAT RAIN COULD SEEP INTO.

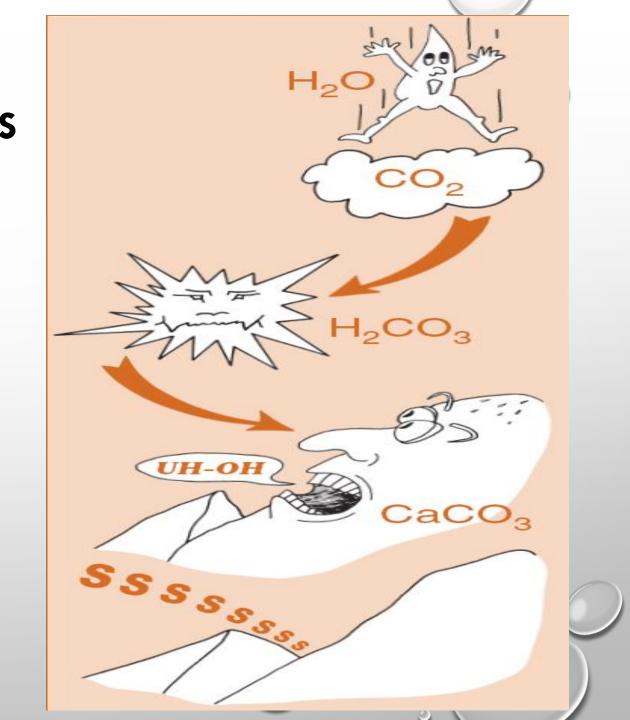






PERMEABLE IMPERMEABLE CHEMICAL WEATHERING DEMO

RAIN WATER WITH CARBON DIOXIDE IN IT FROM THE AIR SOAKS INTO THE UPPER LAYERS OF THE SOIL WHERE IT PASSES THROUGH A LAYER OF DECAYING PLANTS AND ANIMAL MATERIAL RICH IN CARBON DIOXIDE. THIS CARBON DIOXIDE COMBINES WITH THE WATER TO FORM A WEAK ACID CALLED CARBONIC ACID.



LIMESTONE AFTER CHEMICAL WEATHERING BY CARBONIC ACID. THE ROCK IS NOW PERMEABLE - MEANING THAT WATER CAN

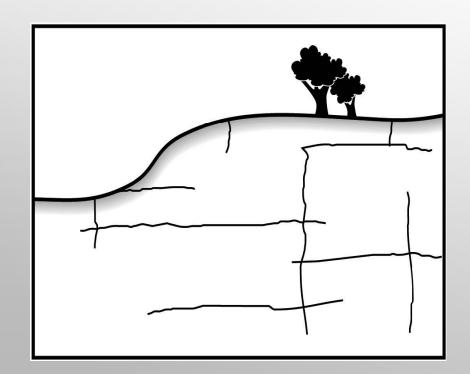
PASS THROUGH IT. THIS IS HOW WATER ENTERS OUR AQUIFER



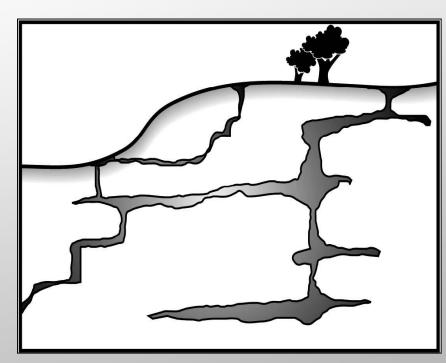


OVER TIME CAVES FORM IN THE LIMESTONE

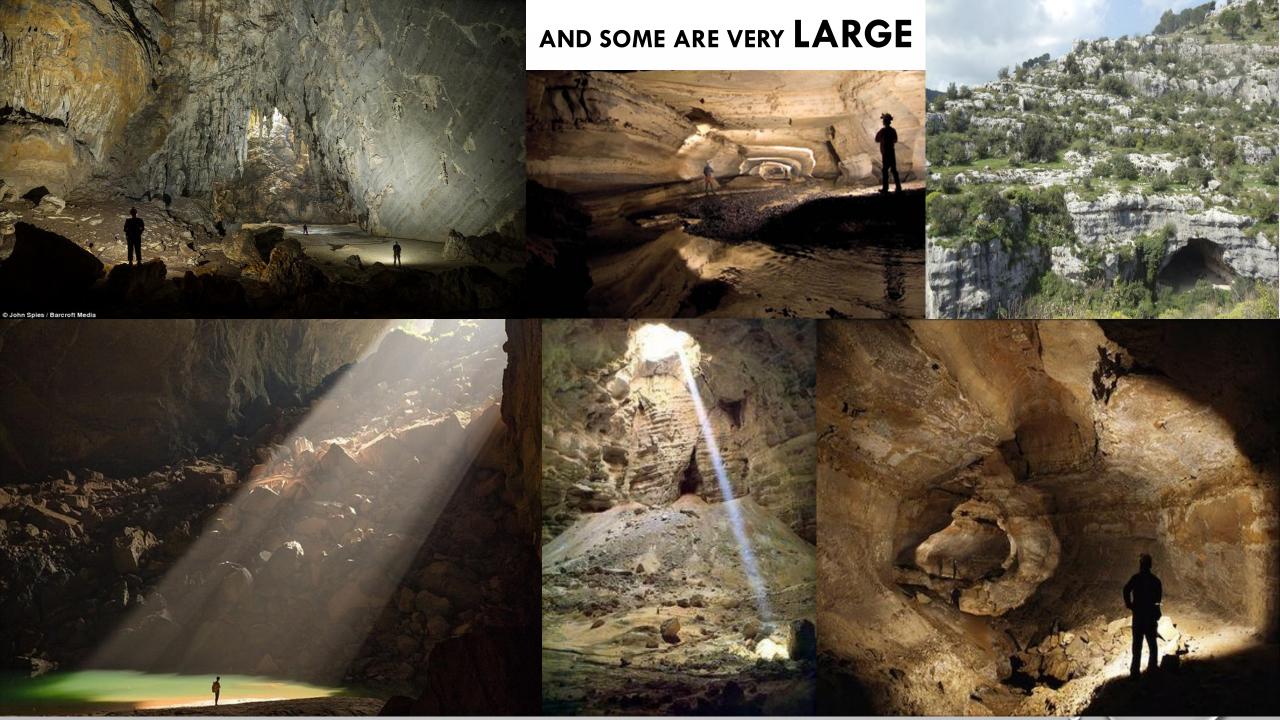
ACIDIC WATER (CONTAINING CARBONIC ACID) FLOWS DOWN THROUGH THE CRACKS IN THE LIMESTONE, DISSOLVING THE ROCK UNDERGROUND BY CHEMICAL WEATHERING. OVER MILLIONS OF YEARS THE OPENINGS GET LARGER AND LARGER AND CAVE SYSTEMS ARE CREATED.



Over time the fractures in the limestone are enlarged by chemical weathering creating cave passage.



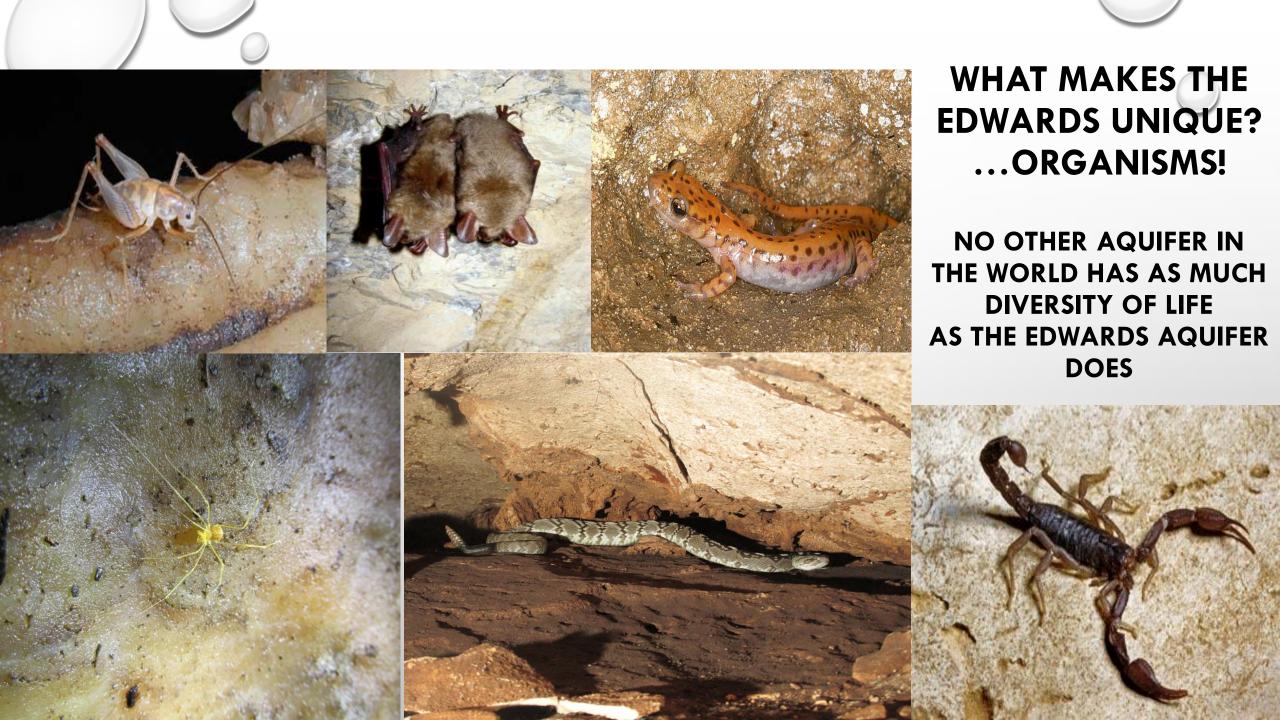






KARST IS WEATHERED LIMESTONE THE EDWARDS AQUIFER IS A KARST AQUIFER





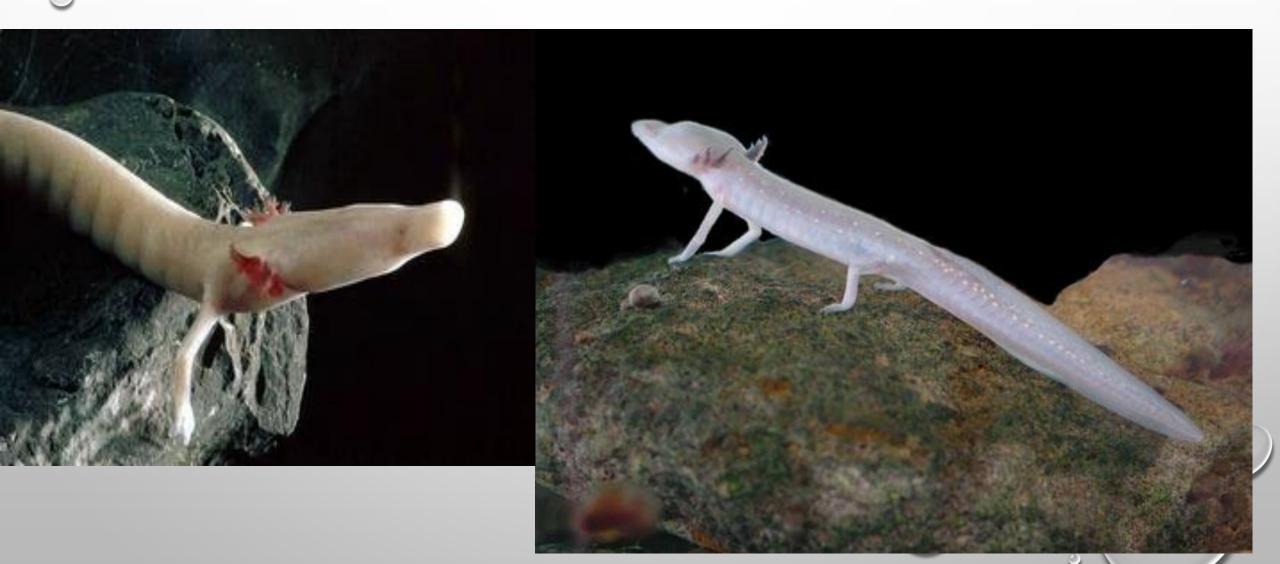
CAVES ARE UNIQUE AND FRAGILE ECOSYSTEMS THAT ARE EXTREMELY SENSITIVE TO POLLUTANTS.



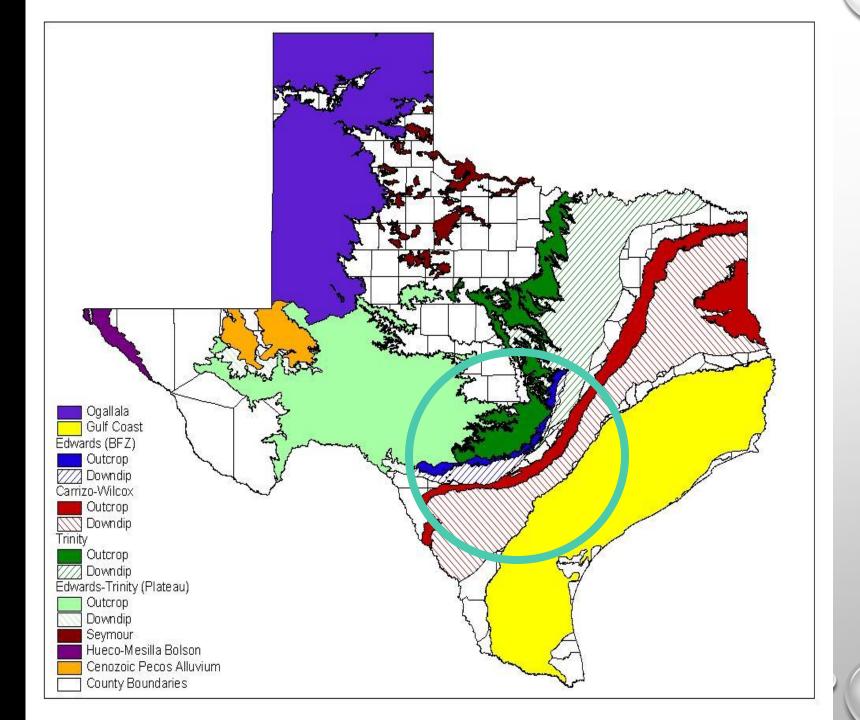
TROGLOBITES ARE ORGANISMS THAT HAVE ADAPTED TO LIVING IN THE DARKNESS OF CAVES.

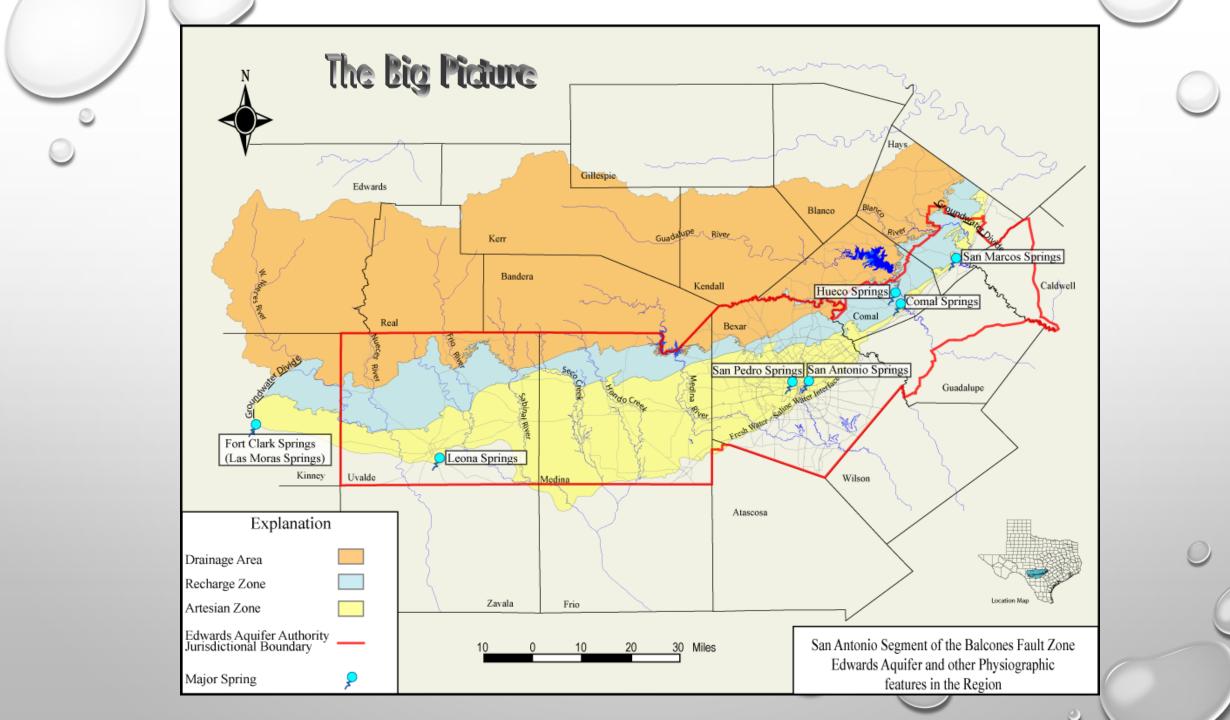


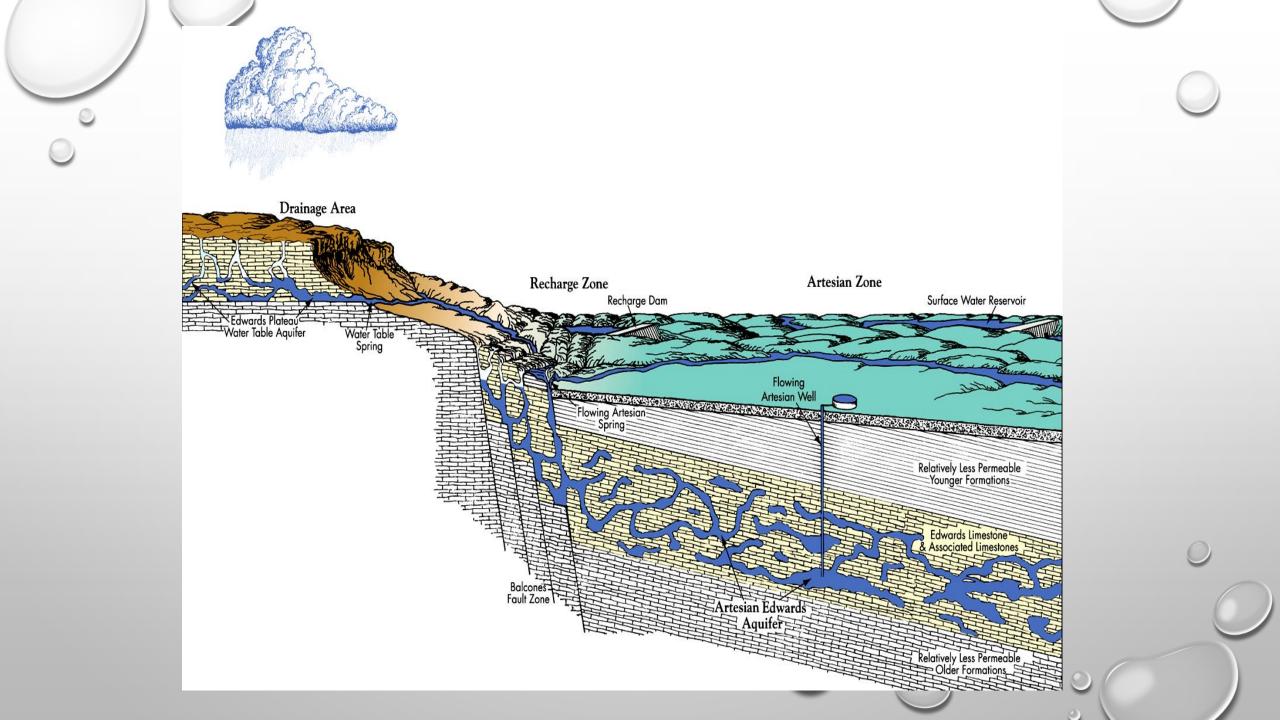
TEXAS BLIND SALAMANDERS ARE NOW AN ENDANGERED SPECIES. THEY ARE AN INDICATOR SPECIES THAT SHOW US THAT WE ARE AFFECTING THE QUALITY OF THE GROUNDWATER.



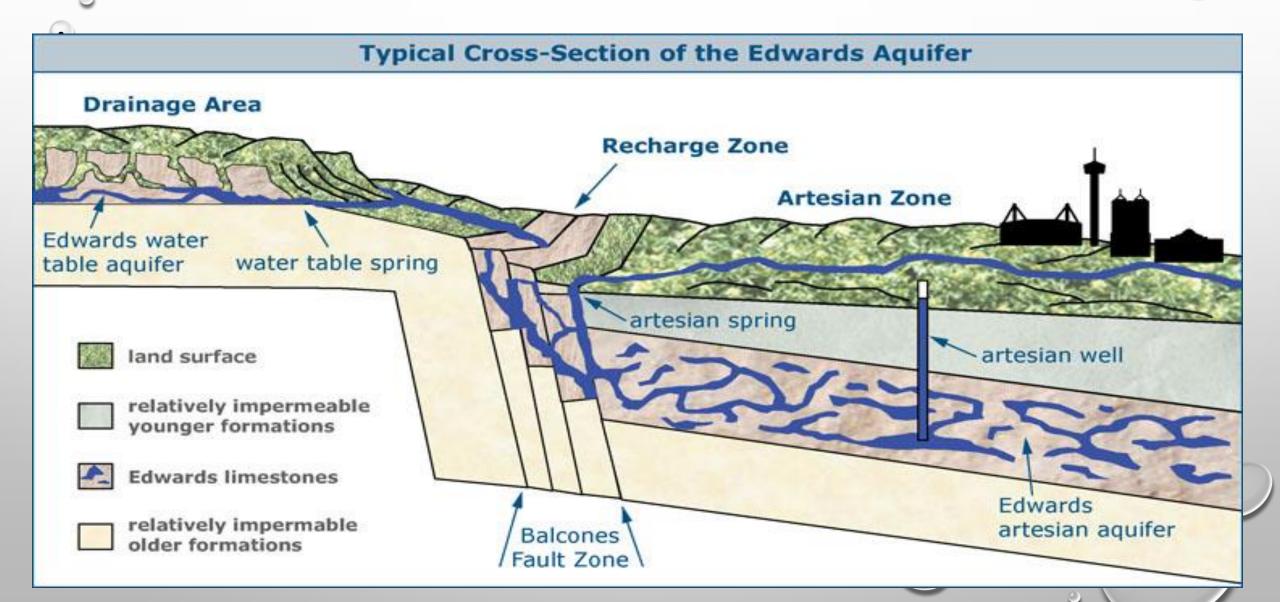
IN TEX MAJOR AQUIFERS



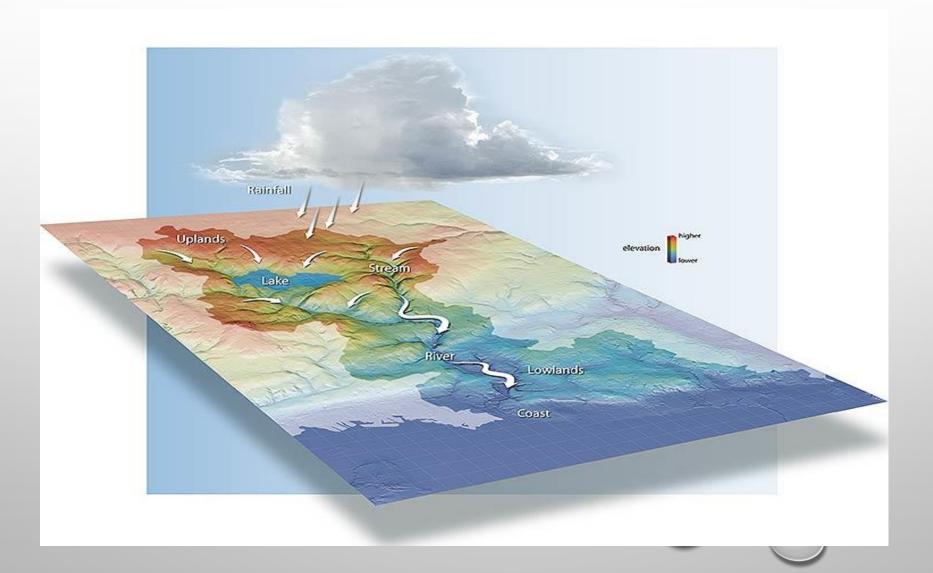




THE FIRST ZONE IS THE CONTRIBUTING ZONE, OR THE DRAINAGE AREA. THIS IS LOCATED IN THE HILL COUNTRY. THIS IS PART OF THE WATERSHED.



WATERSHEDS ARE ELEVATED AREAS WHERE RAINWATER DRAINS OFF OF THE LAND, GOING FROM HIGH TO LOW, AND FORMS RIVERS AND STREAMS WHICH FLOW INTO THE OCEAN.

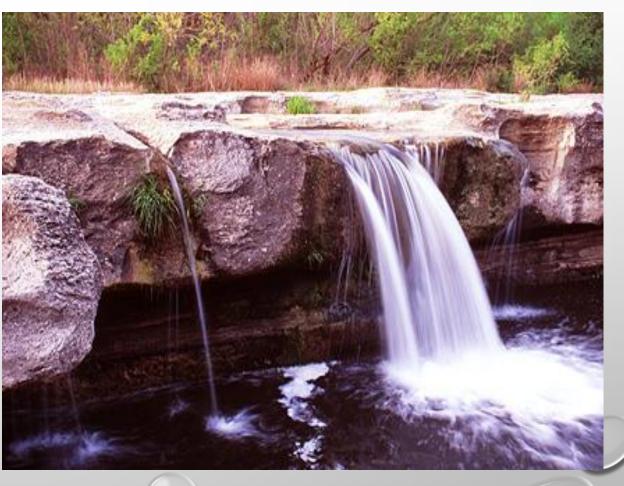


WATERSHEDS DRAIN THE CONTRIBUTING ZONE. WATER RUNNING OFF OF THIS LAND WILL ENTER THE EDWARDS AQUIFER IN OUR RECHARGE ZONE



RUNOFF IS WHEN WATER DRAINS FROM ELEVATED AREAS TO LOWER ONES.





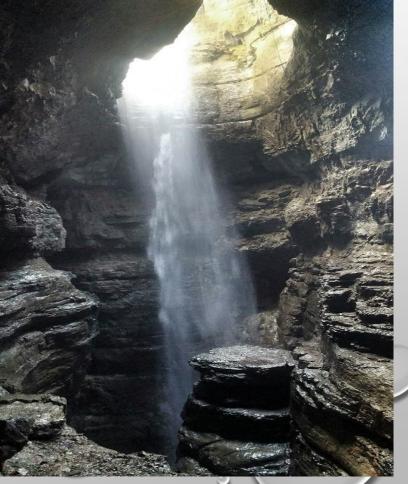
THE NEXT ZONE IS THE RECHARGE ZONE.

THIS IS WHERE WATER THAT RUNS OFF OF THE DRAINAGE AREA GOES UNDERGROUND INTO THE AQUIFER BY ENTERING THROUGH A SERIES OF FAULTS, CAVES, AND SINKHOLES.









GOVERNMENT CANYON STATE NATURAL AREA IS PART OF THE UPPER LEON CREEK WATERSHED AND ON OUR RECHARGE ZONE. IT WAS PURCHASED BY THE CITY OF SAN ANTONIO TO PROTECT THE QUALITY OF THE WATER RECHARGING OUR AQUIFER.

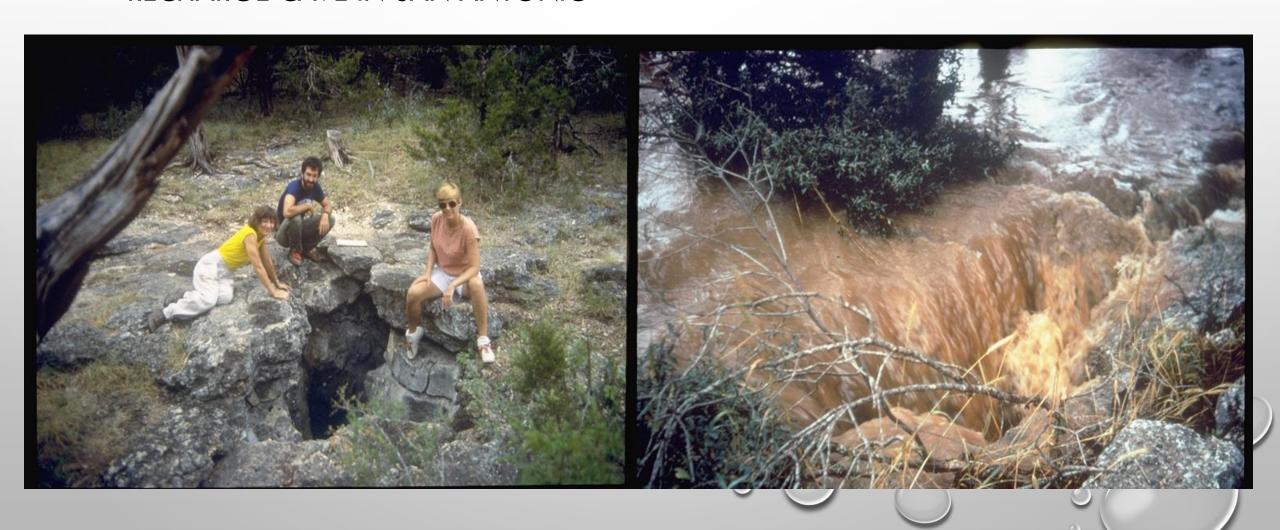




SINKHOLES ARE A MAJOR RECHARGE FEATURE

RECHARGE CAVE IN SAN ANTONIO

SAME CAVE AFTER STORM



VALDINA FARMS (SECO CREEK) RECHARGE PROJECT

WATER IS COLLECTED AND CHANNELED INTO THE SINKHOLE TO INCREASE AQUIFER RECHARGE. SINKHOLES CAN QUICKLY RECEIVE LARGE VOLUMES OF RECHARGE DURING RAINSTORMS AND TRANSMIT THE RECHARGE DIRECTLY INTO THE AQUIFER



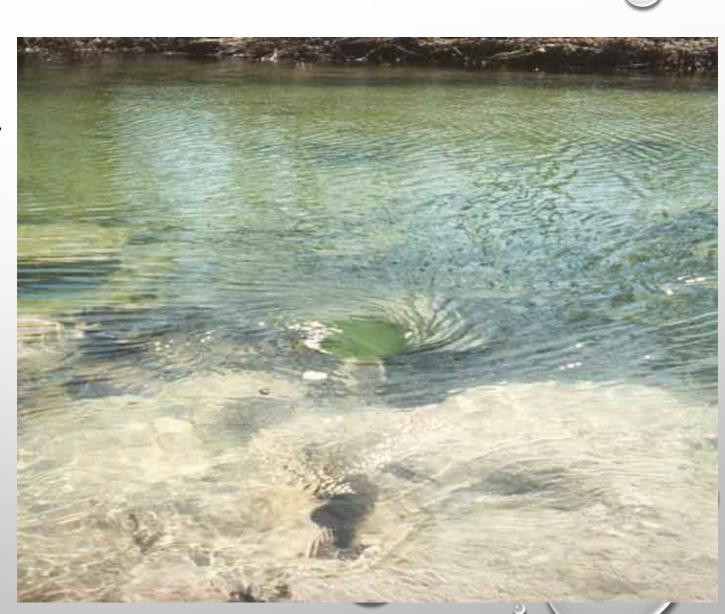




THE RECHARGE ZONE IS AN AREA OF CRITICAL IMPORTANCE! THIS IS THE AREA THAT IS MOST SENSITIVE TO POLLUTION.

 ABOUT 75% OF RECHARGE OCCURS WHEN STREAMS AND RIVERS CROSS THIS PERMEABLE AREA AND GO UNDERGROUND. MOST OF THIS IS LOCATED OVER RURAL (UNDEVELOPED) AREAS.

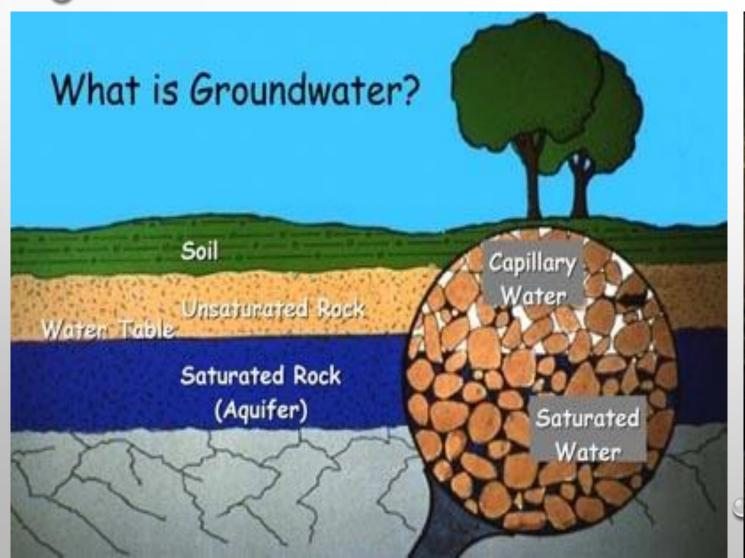


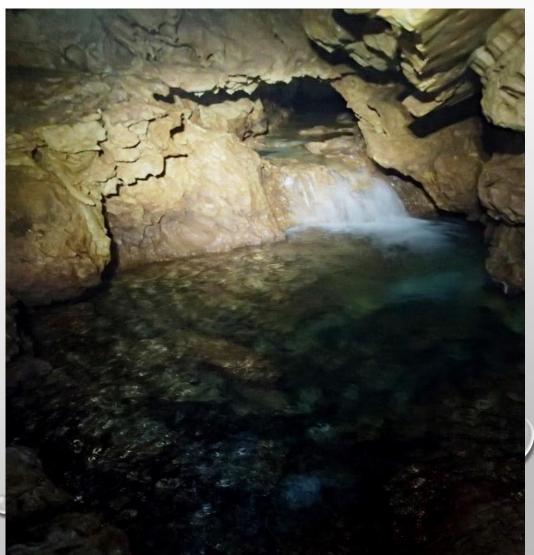




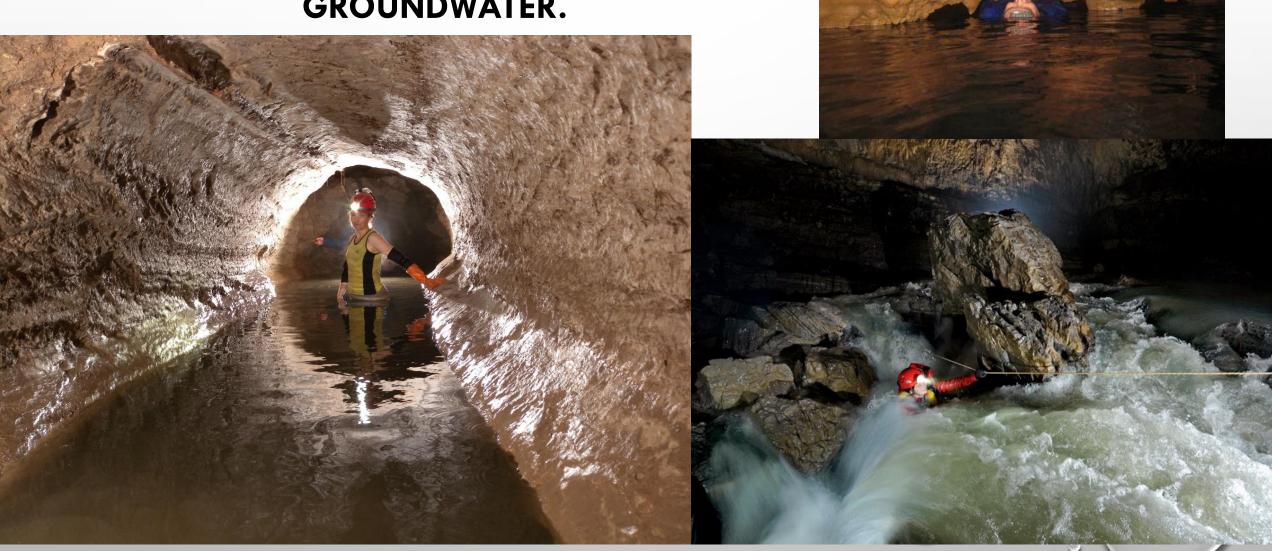
THE WATER IN AQUIFERS IS CALLED

GROUNDWATER





SURFACE WATER CAN SINK UNDERGROUND THROUGH FRACTURES AND FAULTS IN THE RECHARGE ZONE INTO CAVES AND BECOMES GROUNDWATER.



ONLY 20% OF THE RECHARGE ZONE IN BEXAR COUNTY AND ONLY 6% OF THE ENTIRE EDWARDS AQUIFER RECHARGE ZONE IS CURRENTLY UNDER PROTECTION.





DOES THE EDWARDS AQUIFER FILTER AND CLEAN THE WATER THAT RECHARGES IT? DEMO

AS WE COVER THE RECHARGE ZONE WITH IMPERMEABLE/IMPERVIOUS SURFACES POLLUTED WATER CAN RUN OFF AND ENTER RECHARGE FEATURES OVER THE AQUIFER.

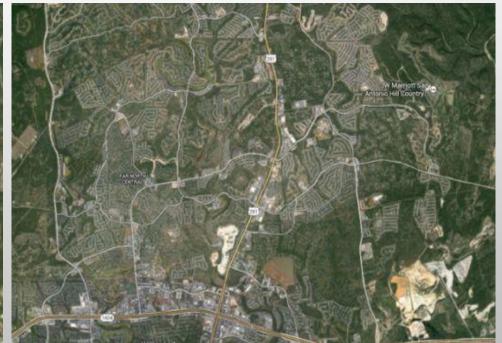












HOUSING
DEVELOPMENT
OVER THE
RECHARGE
ZONE IN
STONE OAK
1996-2015

AS PEOPLE BUILD OVER THE RECHARGE ZONE SEWAGE PIPES CAN BREAK WHEN THE SOIL SHIFTS. SEWAGE CAN SEEP DIRECTLY INTO THE AQUIFER. SOME PEOPLE INCORRECTLY BELIEVE THAT THE AQUIFER WILL FILTER OUT POLLUTANTS.

THE QUALITY OF THE SURFACE WATER WILL DETERMINE THE QUALITY OF THE GROUNDWATER





IF SURFACE WATER IS POLLUTED AND FLOWS INTO THE AQUIFER THROUGH THE RECHARGE ZONE THEN THE GROUNDWATER WILL BE POLLUTED.



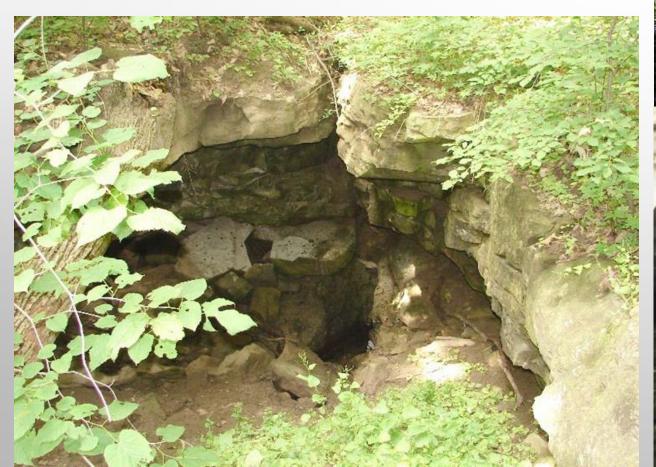


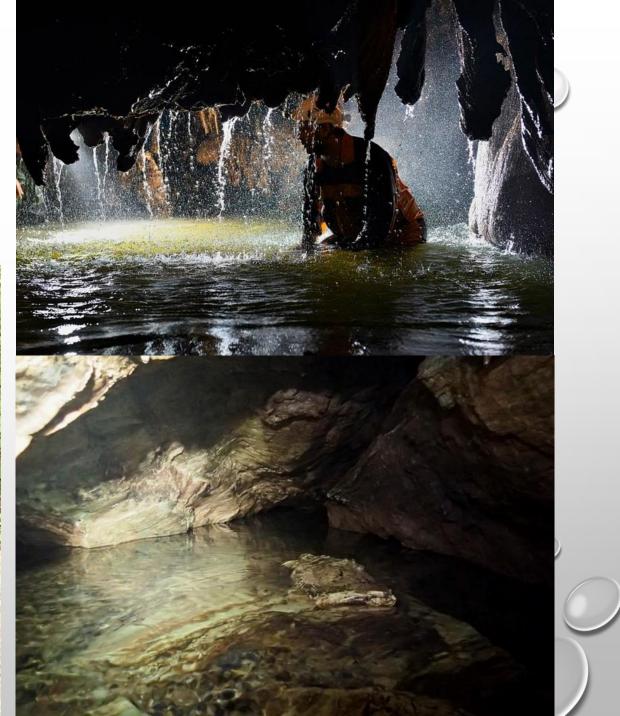
THE EDWARDS AQUIFER DOES **NOT** FILTER MOST SUBSTANCES OUT OF THE WATER THAT RECHARGES IT.



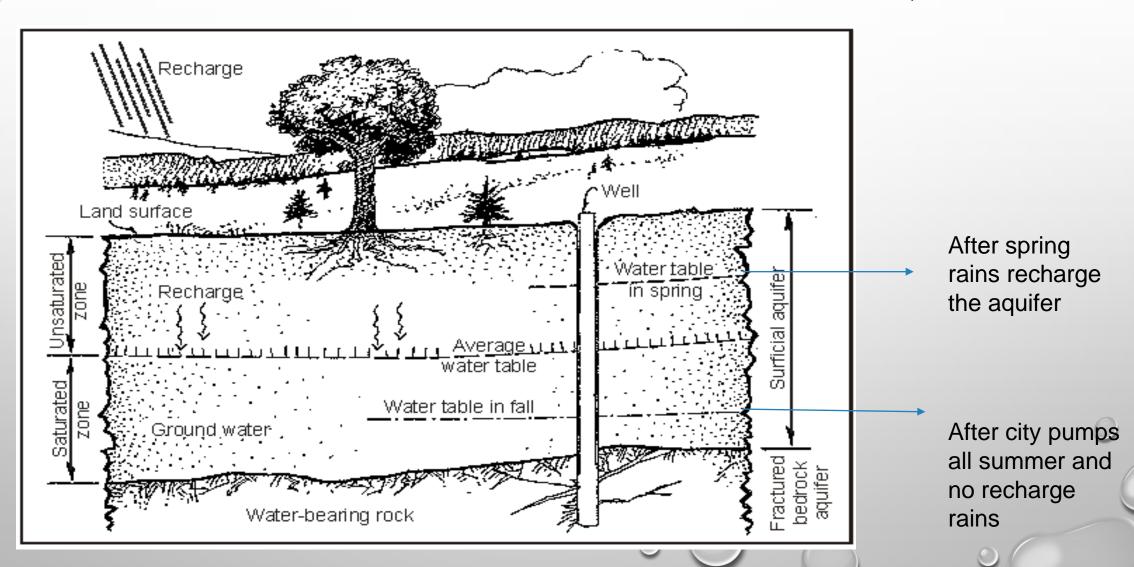
WE NEED TO PROTECT OUR RECHARGE ZONE!

THIS IS THE <u>ONLY</u> AREA WHERE WATER CAN ENTER OUR EDWARDS AQUIFER.

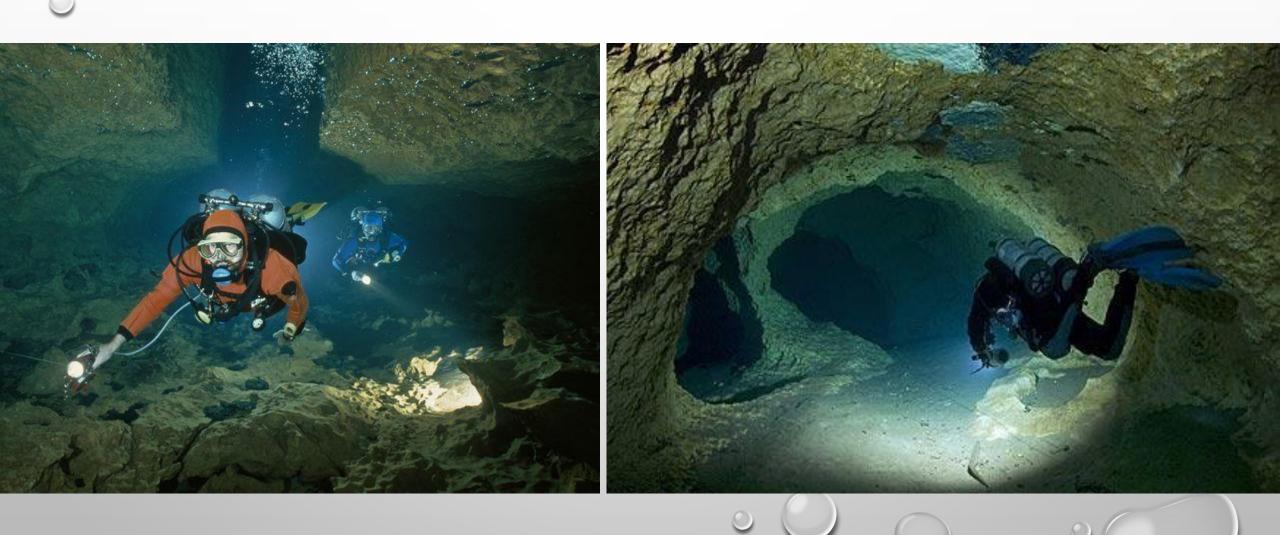




THE WATER TABLE IS THE TOP LEVEL OF THE GROUNDWATER. IT RISES AND FALLS DEPENDING ON THE AMOUNT OFF RAINFALL, AND HOW MUCH WATER IS BEING PUMPED FROM THE AQUIFER



WHEN IT RAINS THE AQUIFER RECHARGES AND THE WATER TABLE IS HIGH. CAVES FILL WITH WATER THAT WE PUMP OUT AND USE.

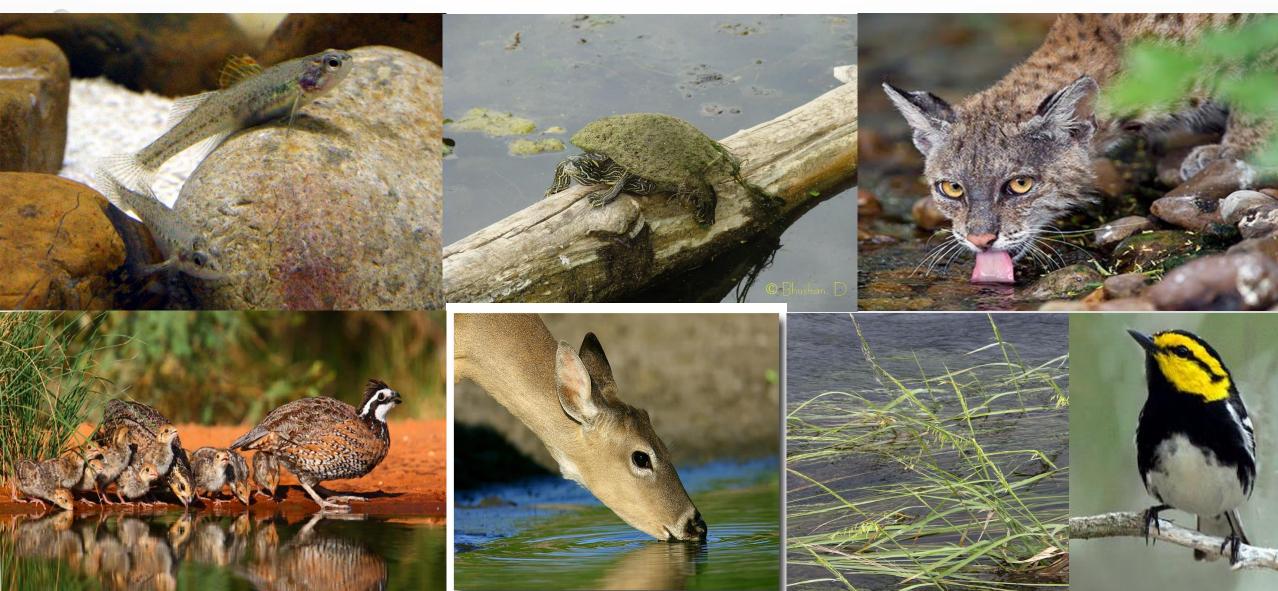


WHEN WE ARE IN A DROUGHT THE WATER TABLE LOWERS BECAUSE THE AQUIFER IS <u>NOT</u> RECHARGED AND CAVES LOOK LIKE THIS.

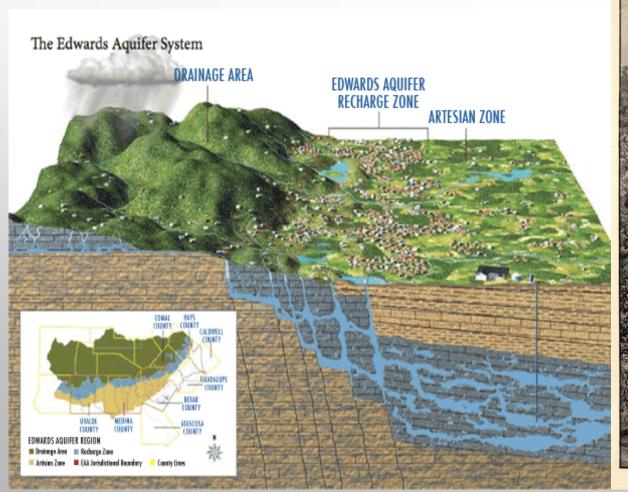




MANY ANIMALS AND PLANTS DEPEND ON WATER FROM SPRINGS TO STAY ALIVE.

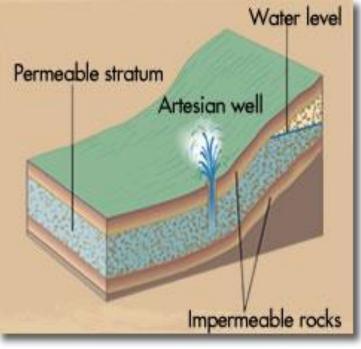


THE ARTESIAN ZONE IS WHERE GROUNDWATER IS TRAPPED BETWEEN 2 IMPERMEABLE SURFACES AND WILL RISE TO THE SURFACE WHEN A WELL IS DRILLED. MOST OF SAN ANTONIO IS LOCATED OVER THE ARTESIAN ZONE.



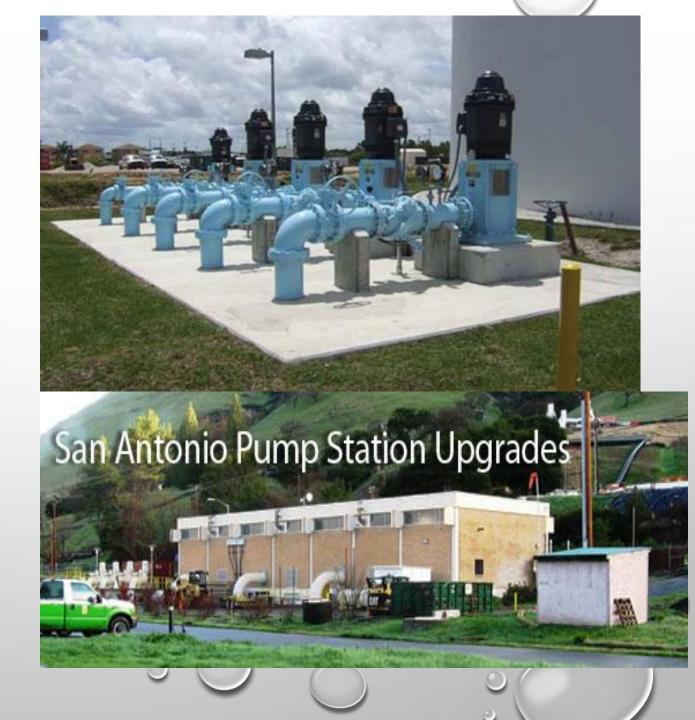






WE PUMP WATER OUT OF THE AQUIFER THROUGH WELLS. WE FILTER IT, ADD CHLORINE, AND IT IS READY TO DRINK.



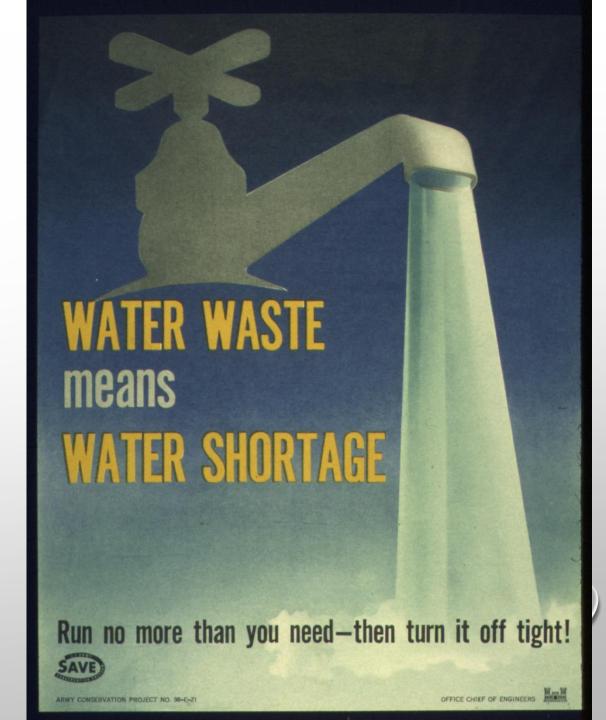


THE 2 BIGGEST DANGERS TO OUR EDWARDS AQUIFER THAT ARE CAUSED BY HUMANS ARE:

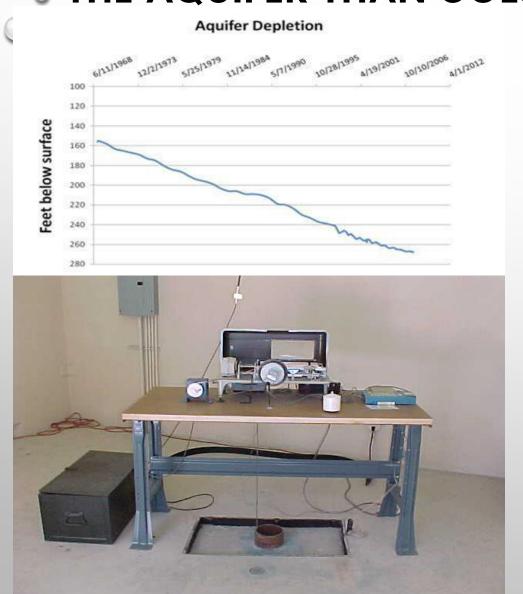
- 1. <u>DEPLETION</u> OF THE AQUIFER BECAUSE WE USE TOO MUCH WATER.
- 2. <u>POLLUTING</u> THE WATER THAT RECHARGES OUR AQUIFER BY NOT PROTECTING OUR RECHARGE ZONE.

DEPLETION BY USING TOO MUCH WATER: THIS OCCURS WHEN WE DO NOT USE WATER WISELY. IF WE OVER PUMP SPRINGS WILL STOP FLOWING, THE WATER TABLE DROPS, AND WELLS WILL GO DRY. THIS HAS A DEVASTATING EFFECT.





OVER PUMPING IS WHEN WE TAKE MORE WATER OUT OF THE AQUIFER THAN GOES BACK IN THROUGH RECHARGE.



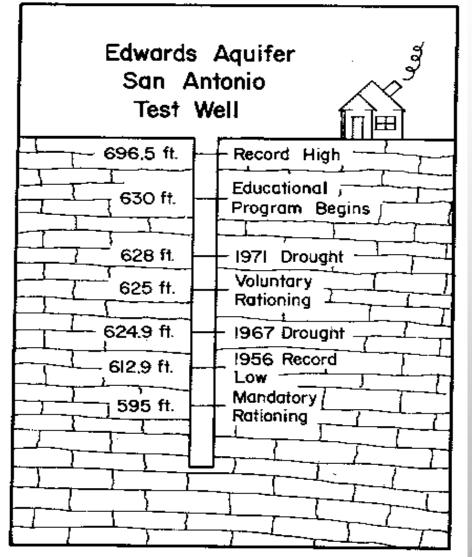
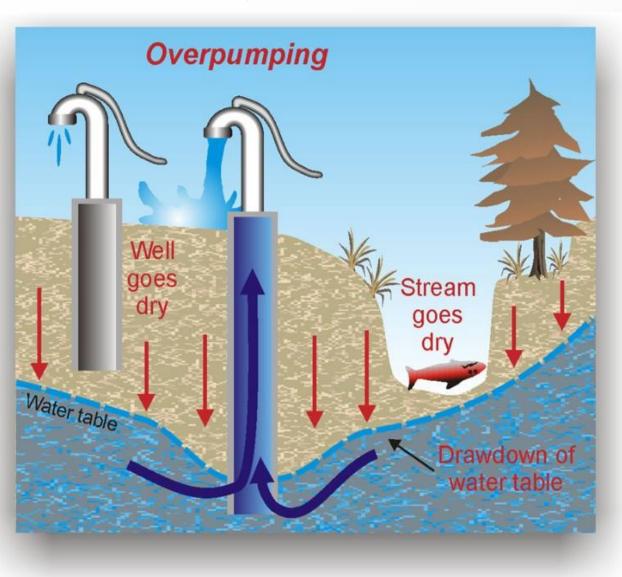


Figure 22. San Antonio reference well.

"WHEN THE WELL IS DRY, WE LEARN THE WORTH OF WATER."

— BENJAMIN FRANKLIN, POOR RICHARD'S ALMANAC 1733

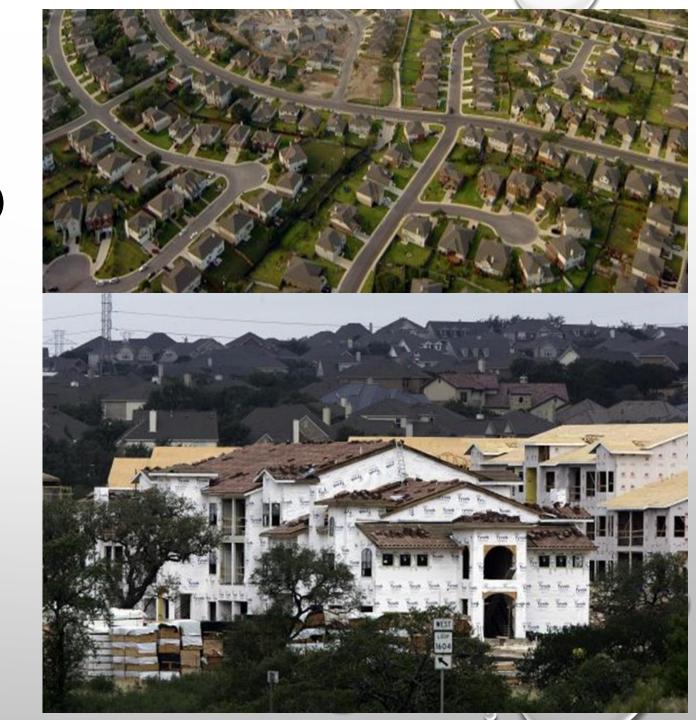




WATER POLLUTION: WHEN
DANGEROUS SUBSTANCES
(ESPECIALLY SOLUBLE MATERIALS)
ENTER THE AQUIFER.

THIS PRIMARILY OCCURS OVER
THE RECHARGE ZONE.

MOST DEVELOPMENT IN SAN
ANTONIO IS CURRENTLY
TAKING PLACE OVER OUR
RECHARGE ZONE.



Nonpoint Source Pollutants

NPS pollution is the leading remaining cause of water quality problems today. For more info visit www.wishthefish.com



Leaking cars and improper fueling practices can leave oil, grease, heavy metals and hydrocarbons to be washed away during the next storm event.



Grass clippings and leaves not swept up after lawn maintenance can clog stormdrains and carry excess nutrients to our waterways. Yard waste can also contain fertilizers and herbicides.



Storm drain dumping is illegal and can lead to massive stormwater pollution. Remember, "Only Rain in the Drain!"



Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks can harm aquatic habitats, clog stormdrain infrastructure and negatively affect water quality.



Not picking up after your pet can cause harmful amounts of bacteria to enter our water ways through stormwater pollution.



COMPARISON OF RECHARGE FROM DEVELOPED AND UNDEVELOPED LAND **DEMO**

SO WHAT CAN YOU DO TO HELP OUT? YOU CAN MAKE A DIFFERENCE!

- CONSERVE WATER USE IT WISELY!
- DO NOT EVER FLUSH MEDICINE OR TOXIC SUBSTANCES INTO THE TOILET.
- IF YOU CHANGE THE OIL IN YOUR CAR DO NOT POUR IT INTO THE STREET OR DOWN STORM DRAINS.
- DO NOT USE PESTICIDES, HERBICIDES, OR FERTILIZER ON YOUR LAWN.
- PICK UP AFTER YOUR PETS.
- DON'T LITTER! PICK UP YOUR TRASH.
- SHARE THIS INFORMATION WITH OTHERS.

OBJECTIVES

- BY THE END OF THIS PRESENTATION YOU SHOULD BE ABLE TO:
- EXPLAIN WHAT AN AQUIFER IS, AND HOW OURS WORKS.
- EXPLAIN HOW HUMANS AFFECT THE QUALITY OF SURFACE AND GROUNDWATER.
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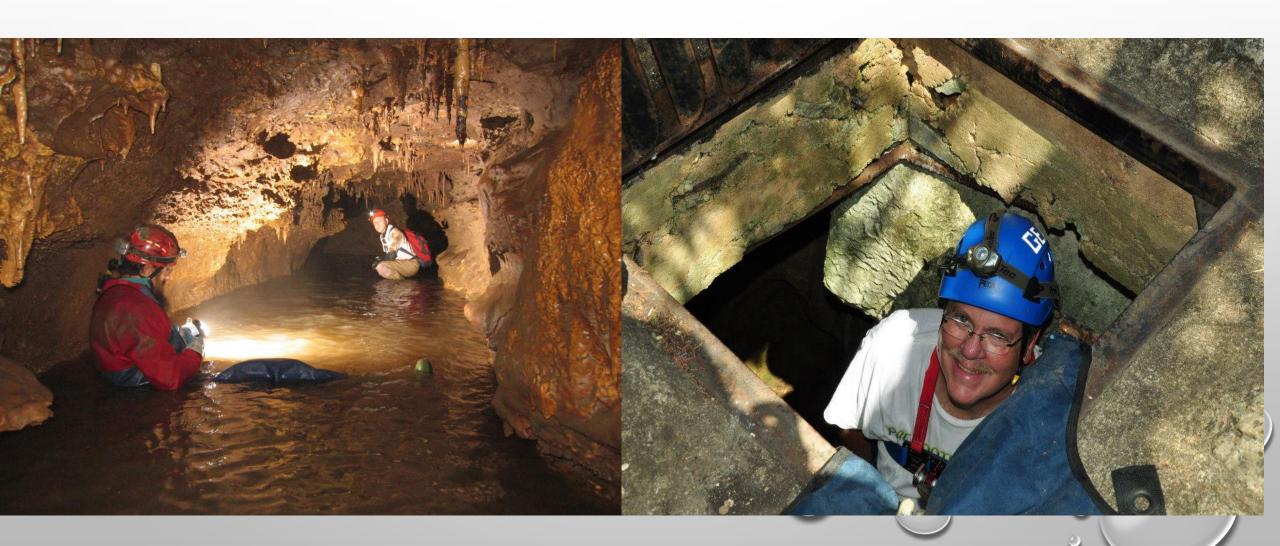


 THIS PRESENTATION WAS MADE POSSIBLE BY GENEROUS SUPPORT FROM <u>RACKSPACE</u> AND THE <u>GREATER</u>
 EDWARDS AQUIFER ALLIANCE

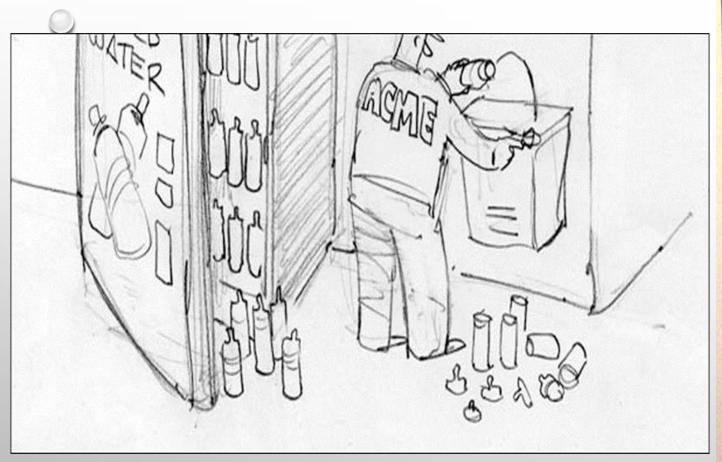
A NONPROFIT ORGANIZATION DEDICATED TO PROTECTING THE MAJOR SOURCE OF OUR DRINKING WATER... THE EDWARDS AQUIFER

SPECIAL THANKS TO:

MARVIN MILLER AND GEARY SCHINDEL FOR PERMISSION TO USE SOME OF THEIR PHOTOS IN THIS PRESENTATION.







{ Bottled Water vs. Tap Water }

Did You Know?

On average, bottled water consumes around

2,000

times more energy than tap water.

30,000,000



bottles per day end up in landfills or the ocean. Only 5% of plastic water bottles are recycled in the U.S.



Tap water is tested more often and held to higher safety standards than bottled water in the U.S.

liter of bottled water requires

3 liters of water to produce.

Bottled water costs

10,000

times more than tap water in the U.S., more by volume than gasoline or soda.



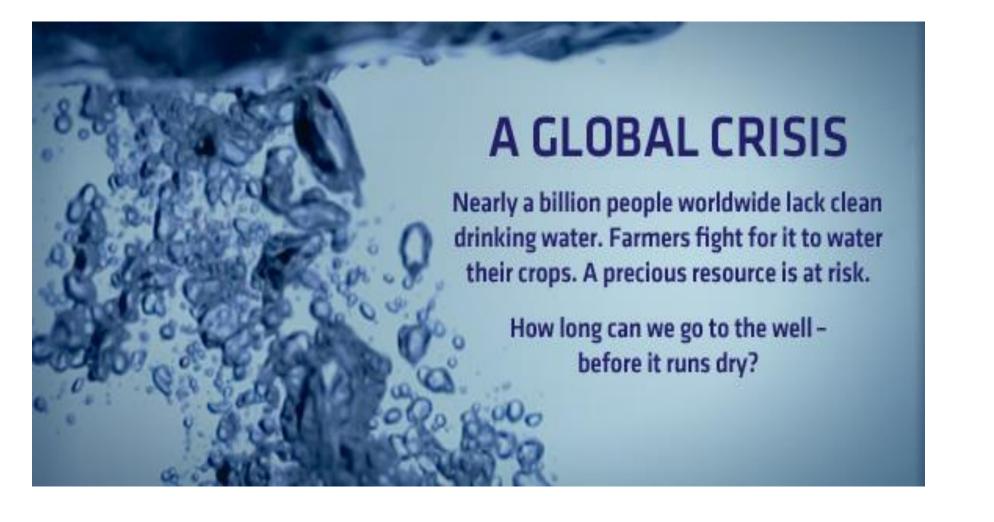




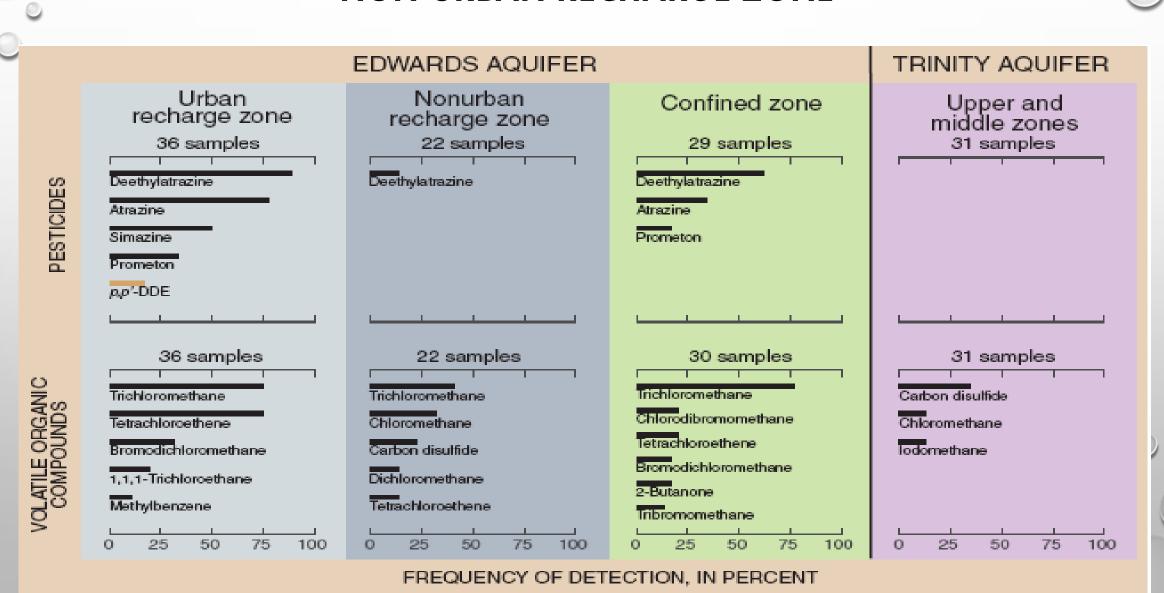


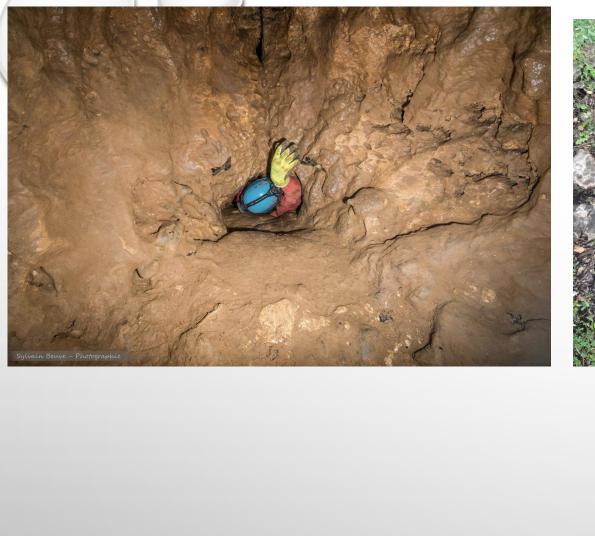






COMPARISON OF POLLUTANTS IN URBAN AND NON-URBAN RECHARGE ZONE











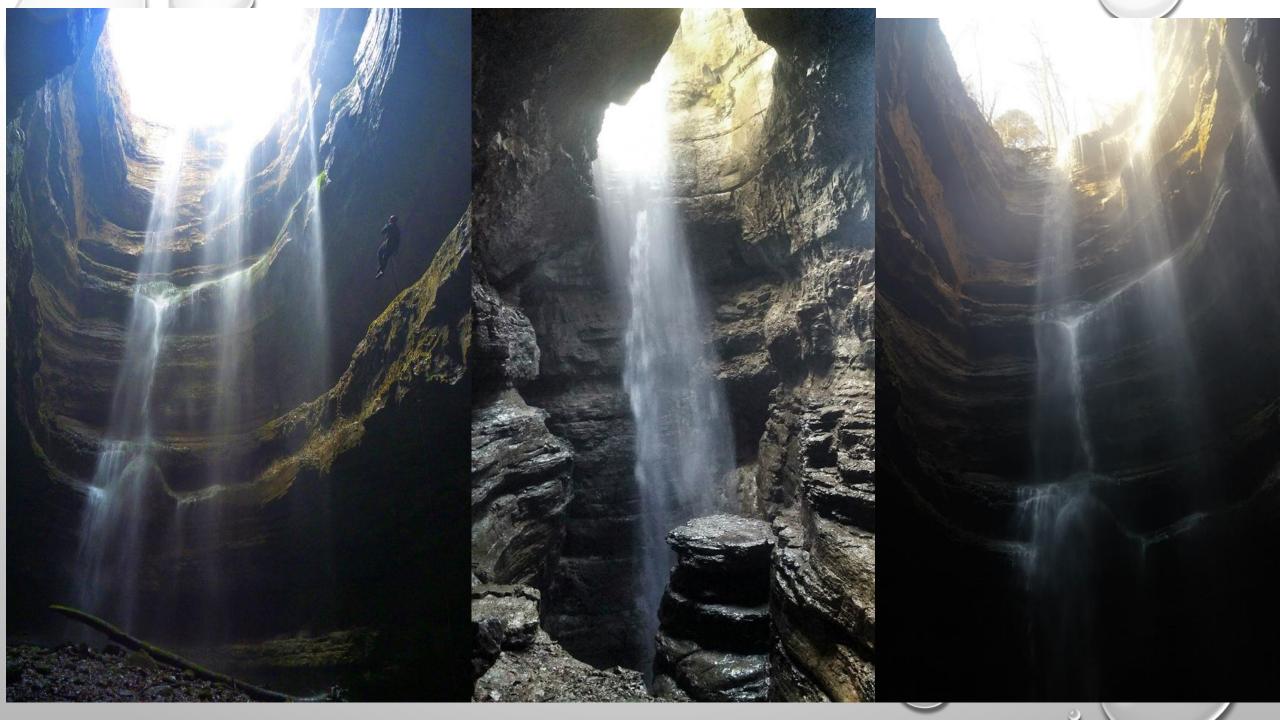








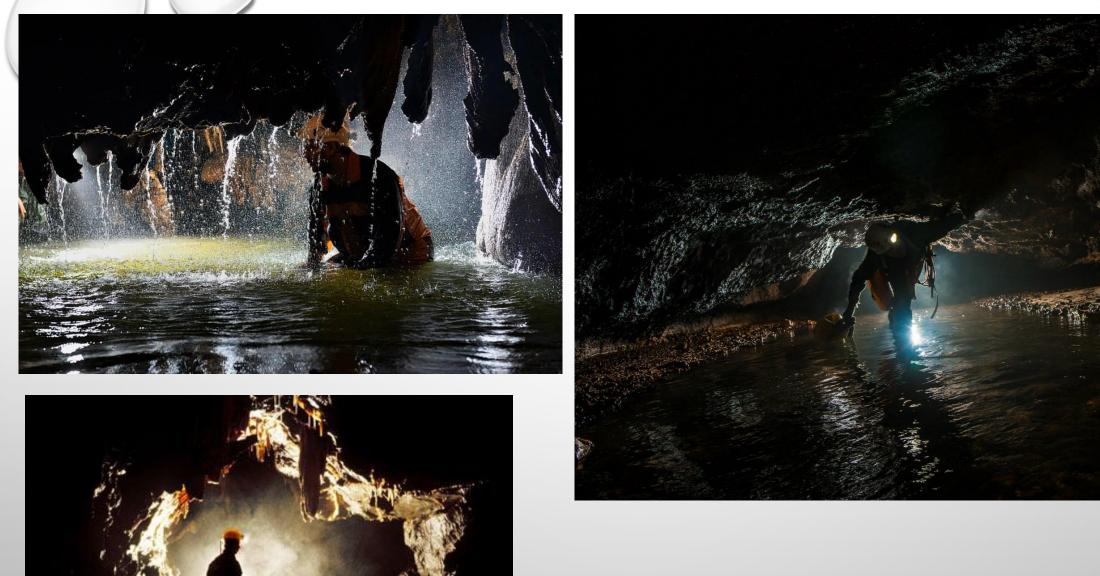






VALDINA FARM SINKHOLE (Seco Creek Sinkhole)

Photo by Dave Bunnell





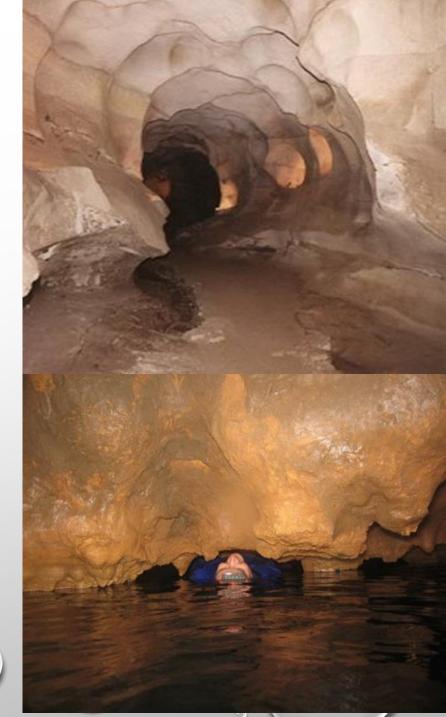






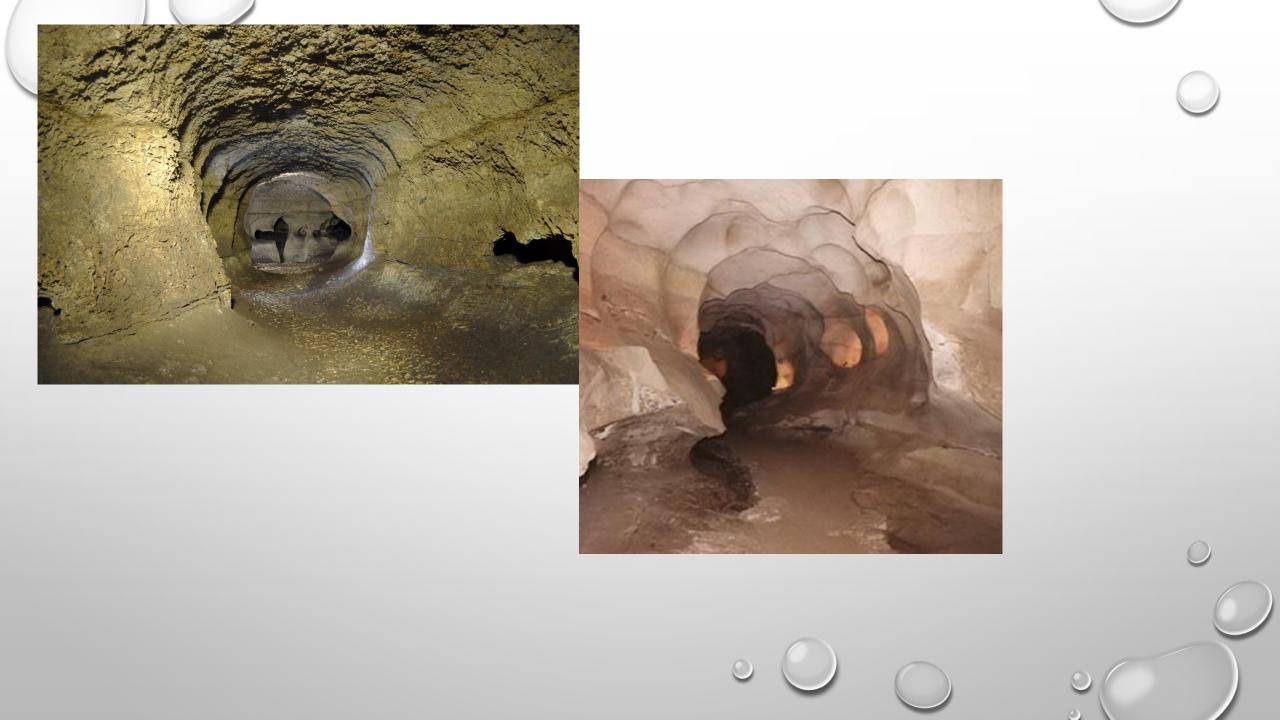


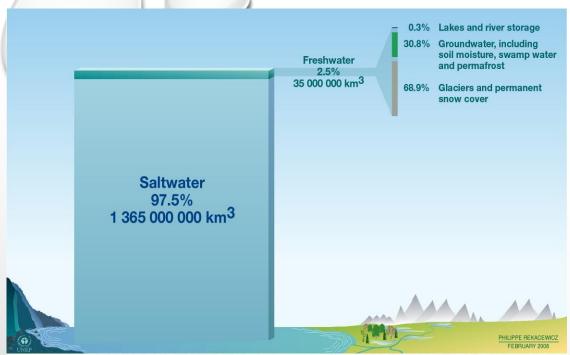




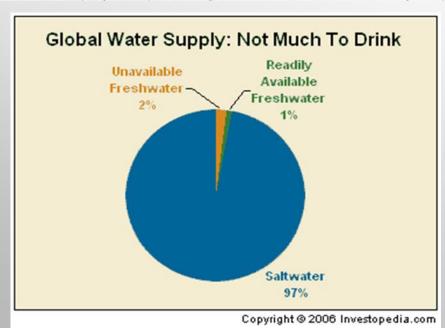


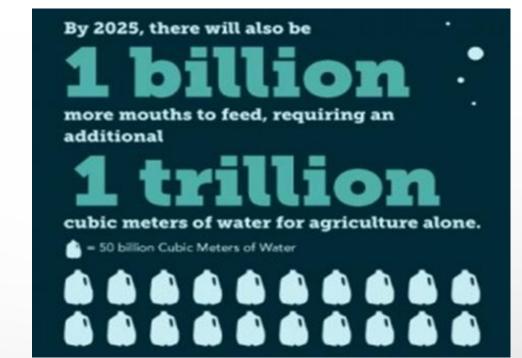


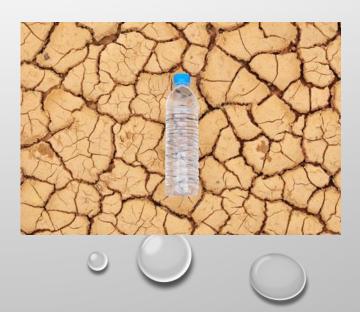




Source: Igor A. Shiklomanov, State Hydrological Institute (SHI, St. Petersburg) and United Nations Educational, Scientific and Cultural Organisation (UNESCO, Paris), 1999.







Formation of the Edwards Aquifer

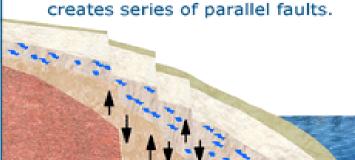
- Ancestral Gulf of Mexico
- Tertiary sediments
- Cretaceous sediments younger than Edwards
- Edwards formation
- Cretaceous sediments older than Edwards
- Precambrian Basement
- Central Texas under a shallow sea.



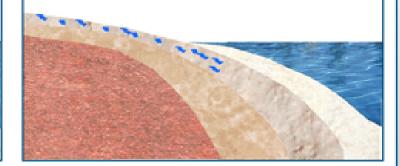
 Waters recede and Central Texas rises above surface of sea.



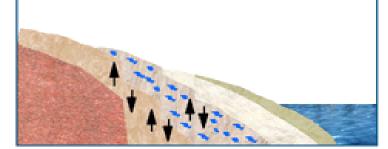
Waters recede, weight of tertiary sedments deposited from west creates series of parallel faults.

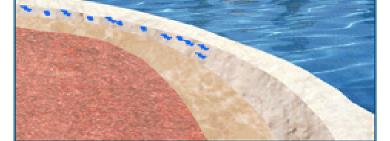


3. Edwards formation is exposed to extensive erosion.



Extensively eroded Edwards formation is exposed again.





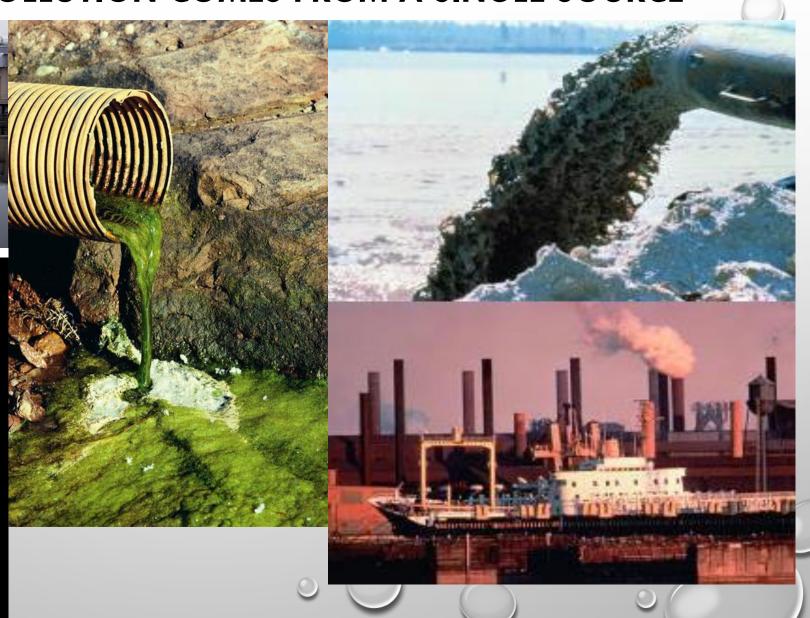
 More Cretaceous sediments laid on top of eroded Edwards formation.

POINT SOURCE POLLUTION COMES FROM A SINGLE SOURCE



What is a point source?

A point source is a stationary location or fixed facility such as an industry or municipality that discharges pollutants into air or surface water through pipes, ditches, lagoons, wells, or stacks, or a single identifiable source such as a ship or a mine.









NON POINT SOURCE POLLUTION CAN COME FROM A VARIETY OF SOURCES – ESPECIALLY THESE <u>SOLUBLE</u> SUBSTANCES. PEOPLE WHO LIVE OVER THE RECHARGE ZONE SHOULD <u>NOT</u> USE THESE SUBSTANCES ON THEIR LAWNS!



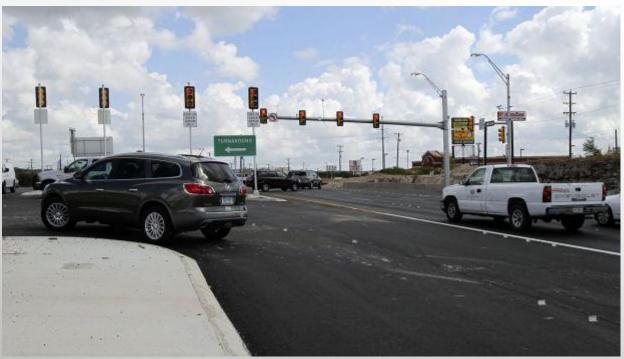


WEED KILLER





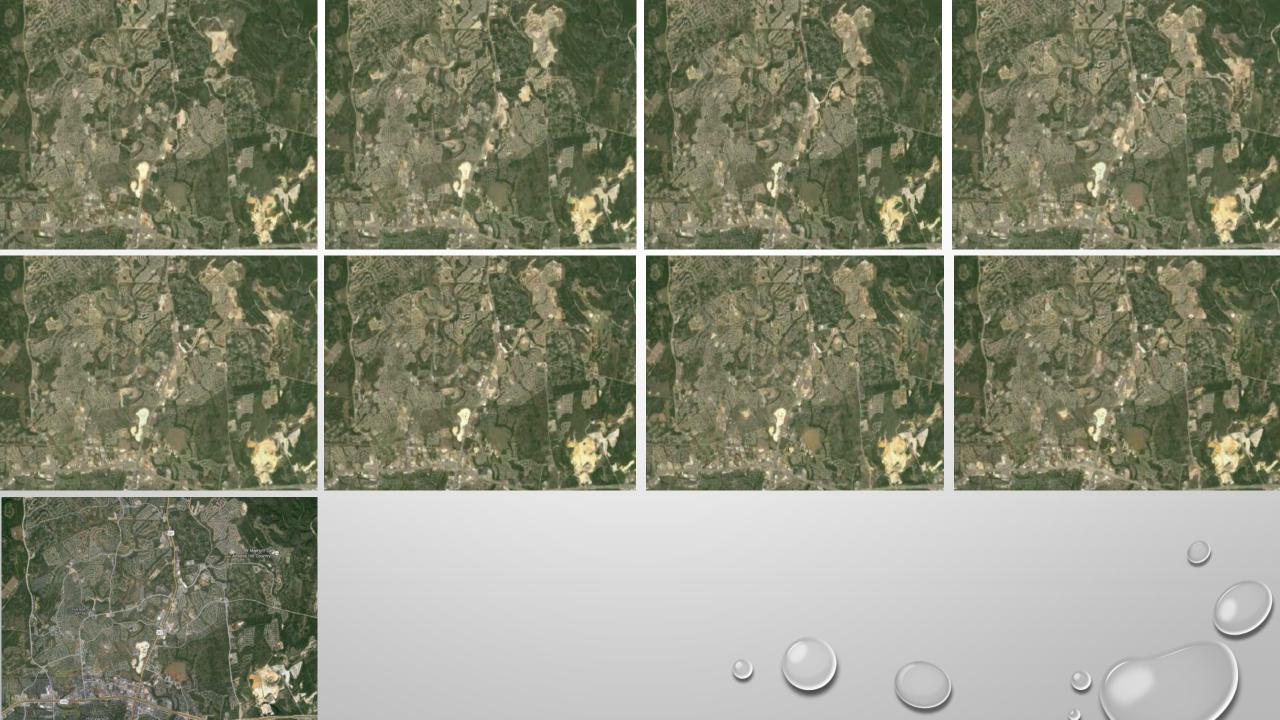


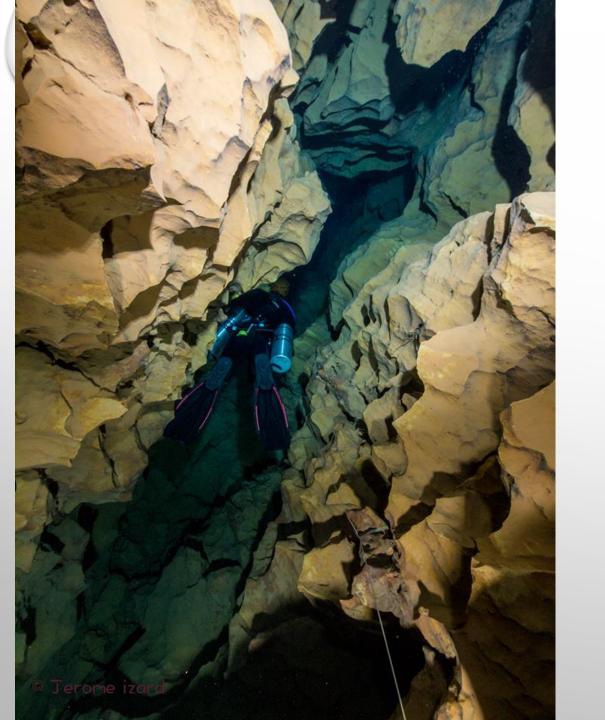


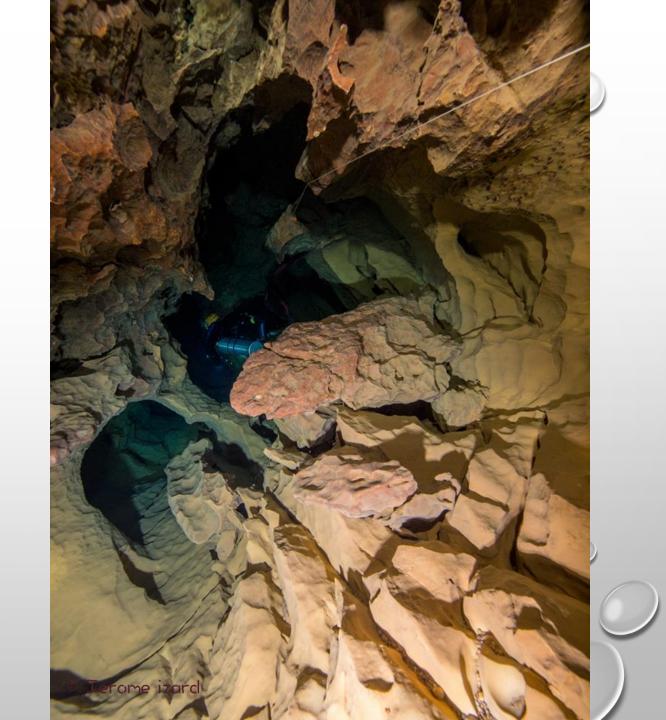








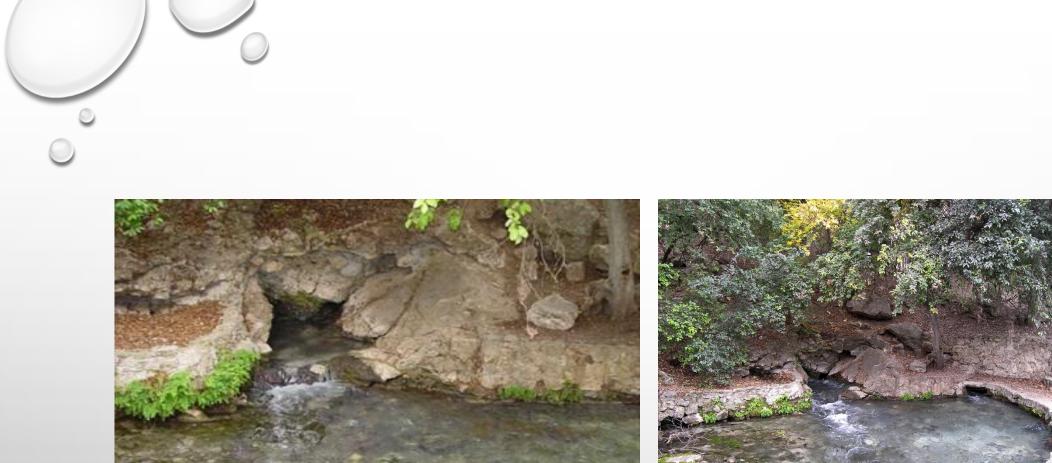














J-17 WELL WATER LEVEL MONITORING EQUIPMENT



MAJOR AQUIFER ISSUES

- WATER QUALITY
 - IF WATER GOES IN SO CAN OTHER STUFF
 - POINT SOURCE POLLUTANTS
 - LEAKING UNDERGROUND STORAGE TANKS
 - HAZARDOUS MATERIALS SPILLS
 - LEACHATE FROM FIRES (HELOTES)
 - NON-POINT SOURCE POLLUTANTS (URBANIZATION)
 - PARKING LOTS METALS AND OIL AND GREASE
 - SEPTIC TANKS PATHOGENS AND PPCPS
 - SEWER LINES PATHOGENS AND PPCPS
 - ANIMAL WASTE PATHOGENS



THE HYDROGEOLOGY OF THE EDWARDS AQUIFER

•THE AQUIFER IS MADE UP OF THE EDWARDS AND ASSOCIATED LIMESTONES OF CRETACEOUS AGE.



- IN THE GEOLOGIC TIME SCALE,
 THE CRETACEOUS PERIOD
 OCCURRED BETWEEN 65 TO
 140 MILLION YEARS AGO.
- AQUIFER MATERIAL IS LIMESTONE, CALCIUM CARBONATE (CACO₃)



STRATIGRAPHIC COLUMN

Austin Chalk

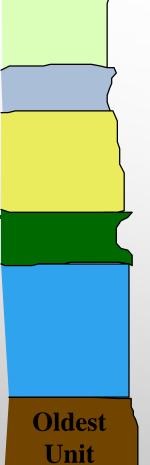
Eagle Ford Shale

Buda Limestone

Del Rio Clay

Edwards and Associated Limestones

Upper Glen Rose Limestone



Youngest

Unit