

The background of the entire page is a light gray gradient with several realistic water droplets of various sizes scattered across it. The droplets have highlights and shadows, giving them a three-dimensional appearance.

A GUIDE TO THE EDWARDS AQUIFER

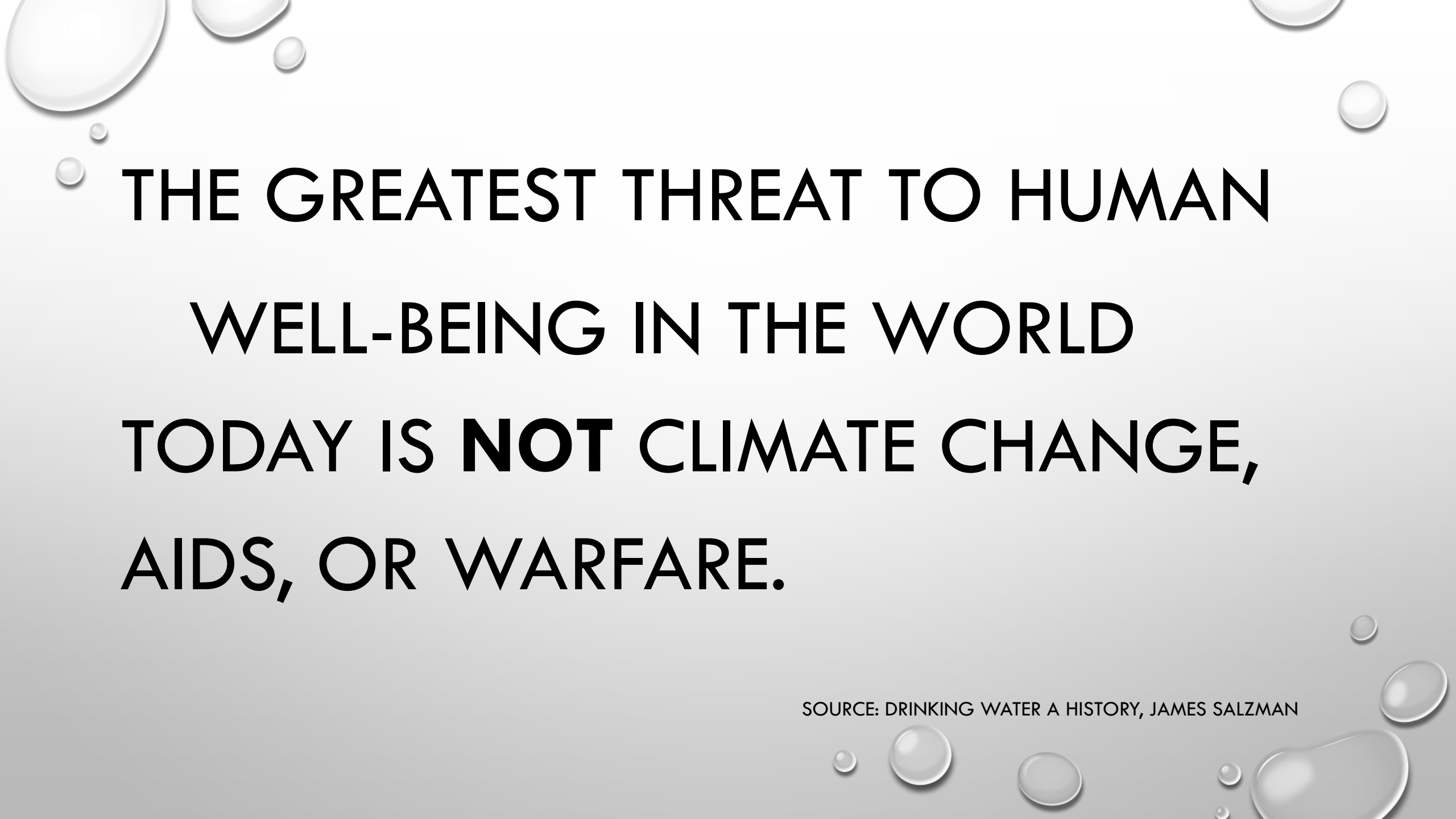
SAN ANTONIO'S PRIMARY WATER SUPPLY

J. DELUNA

GREATER EDWARDS AQUIFER ALLIANCE EDUCATION PROJECT MANAGER

OUR EARTH IS CALLED THE WATER PLANET
CURRENTLY IT IS THE ONLY PLANET THAT WE KNOW OF THAT SUPPORTS LIFE.
70% OF THE SURFACE IS COVERED WITH WATER





**THE GREATEST THREAT TO HUMAN
WELL-BEING IN THE WORLD
TODAY IS **NOT** CLIMATE CHANGE,
AIDS, OR WARFARE.**

SOURCE: DRINKING WATER A HISTORY, JAMES SALZMAN




IT IS...

UNSAFE DRINKING WATER

WHICH IS THE SINGLE LARGEST
KILLER IN THE WORLD.

UNSAFE DRINKING WATER IS THE SINGLE
LEADING SOURCE OF MORTALITY IN THE
DEVELOPING WORLD, EXACTING ITS GREATEST
TOLL ON CHILDREN.



DRINKING WATER HAS BECOME TOO VALUABLE TO TAKE FOR GRANTED.

- IN THE WORLD OF 2030, THE UNITED NATIONS ESTIMATES THAT MORE THAN HALF OF THE WORLD'S POPULATION WILL LIVE IN WATER SCARCE AREAS.
- THIS NUMBER COULD BE EVEN HIGHER, DEPENDING ON HOW CLIMATE CHANGE WORSENS DROUGHTS, REDUCING ALREADY SCARCE FRESHWATER SUPPLIES.

SOURCE: DRINKING WATER, A HISTORY JAMES SALZMAN

3.4 MILLION PEOPLE



DIE EACH YEAR FROM A WATER RELATED DISEASE.

THAT IS ALMOST THE ENTIRE CITY OF LOS ANGELES.



LOS ANGELES

780

MILLION PEOPLE LACK ACCESS TO CLEAN WATER



THAT'S MORE THAN 2½ TIMES THE UNITED STATES POPULATION



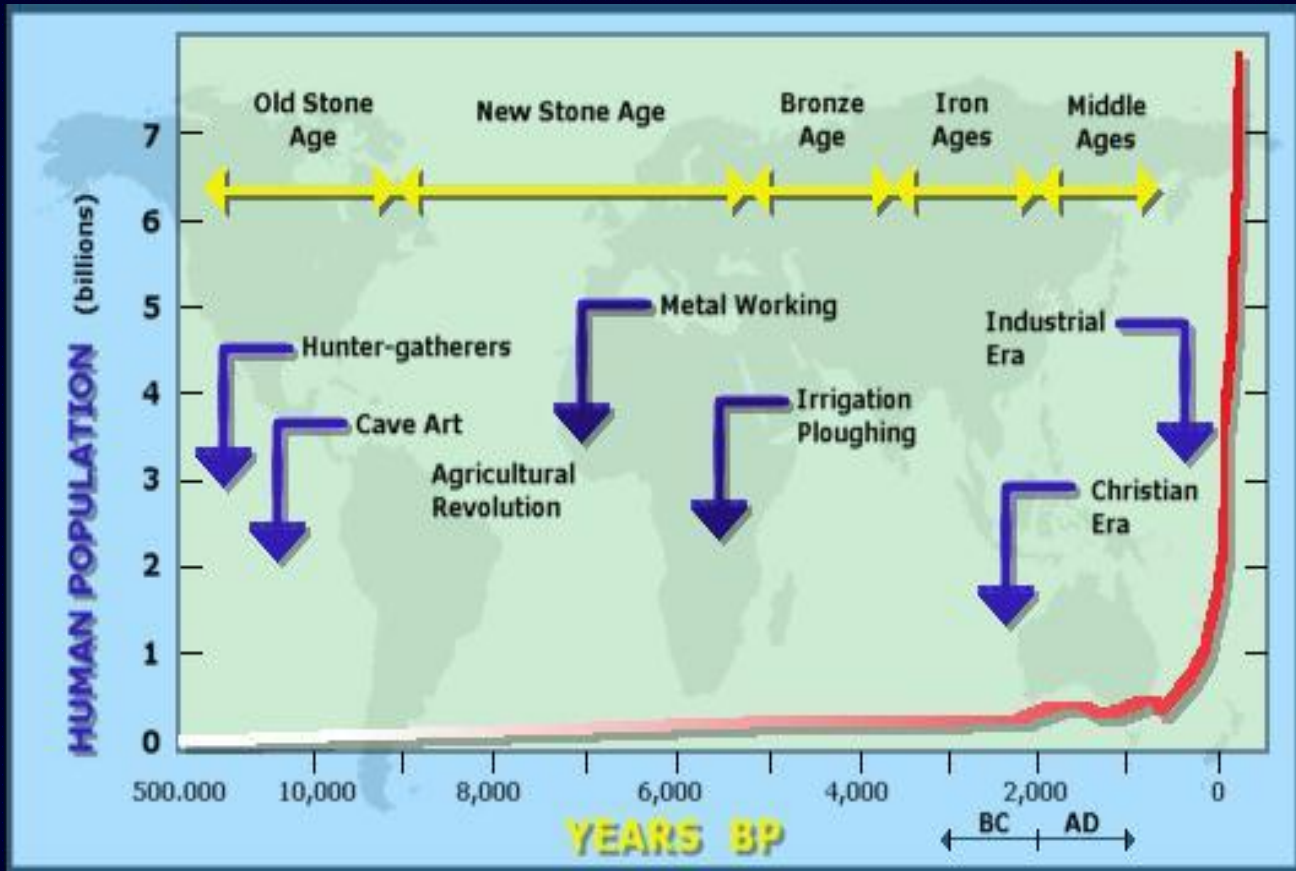
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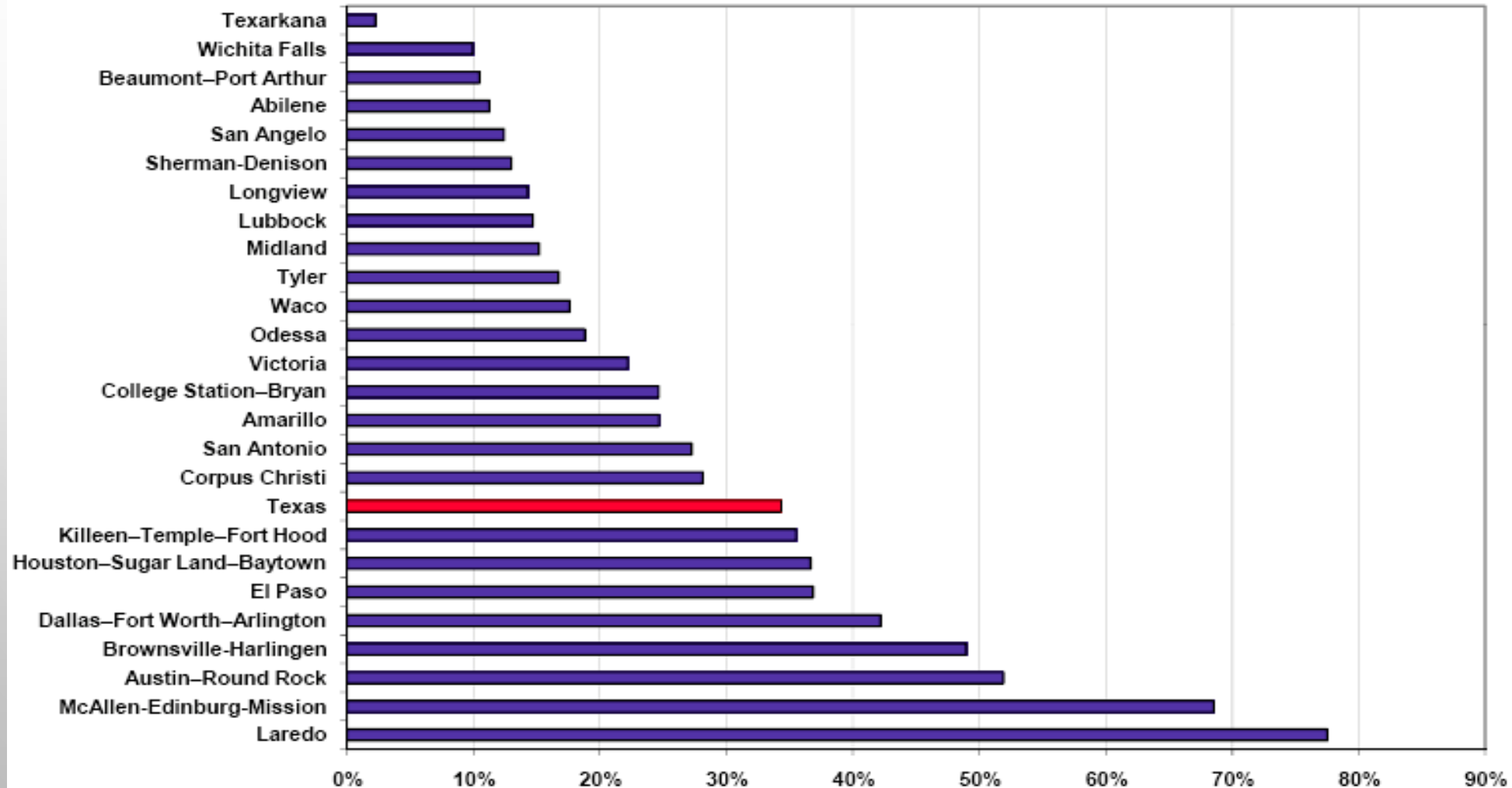


THE WORLD'S POPULATION IS INCREASING, BUT THE SUPPLY OF FRESH SAFE DRINKING WATER IS NOT. **DEMAND IS EXCEEDING SUPPLY**



TEXAS CITIES ARE EXPERIENCING A DRAMATIC POPULATION INCREASE

Texas Metropolitan Area
Population Growth Forecast, 2000–2020



Source: Texas State Data Center – Scenario 0.5 (2006 projection)

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

- THIS MEANS THAT **TWICE AS MANY PEOPLE** WILL NEED FRESH DRINKING WATER, FOOD, ENERGY, ROADS, HOSPITALS AND PLACES TO LIVE.
- HOWEVER THIS AREA IS CURRENTLY EXPERIENCING ONE OF THE WORST DROUGHTS SINCE THE 1950'S
- WATERING RESTRICTIONS IN THE SUMMER ARE NOW NECESSARY TO CONSERVE OUR WATER.



WE HAVE GONE FROM THIS...



TO THIS



SAN ANTONIO'S PRIMARY SOURCE OF WATER IS THE EDWARDS
AQUIFER WHICH STARTED FORMING OVER 100 MILLION YEARS AGO
WHEN WE WERE COVERED BY A SHALLOW OCEAN



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



LIMESTONE, A SEDIMENTARY ROCK, FORMS ON OCEAN FLOORS IN LAYERS. THESE LAYERS REPRESENT MILLIONS OF YEARS OF DEPOSITION FROM WHEN WE WERE UNDER A SHALLOW OCEAN.



DURING THE MESOZOIC DINOSAURS ROAMED THIS AREA
THERE ARE DINOSAUR FOOTPRINTS AT GOVERNMENT CANYON.



Allosaurus on the prowl, Jurassic period
Artwork by Chris Butler/Photo Researchers, Inc.

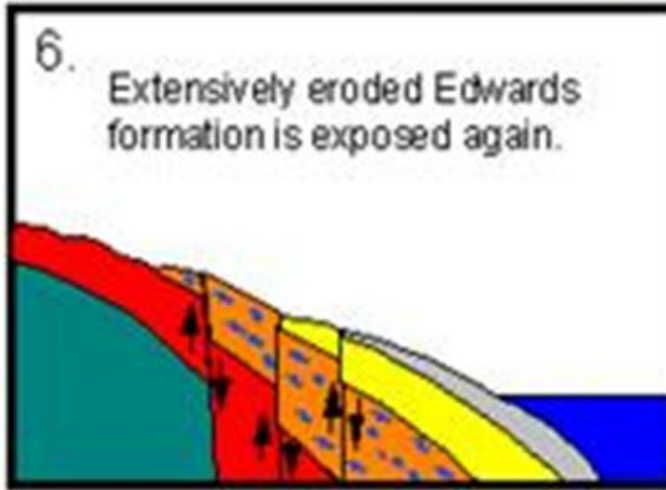
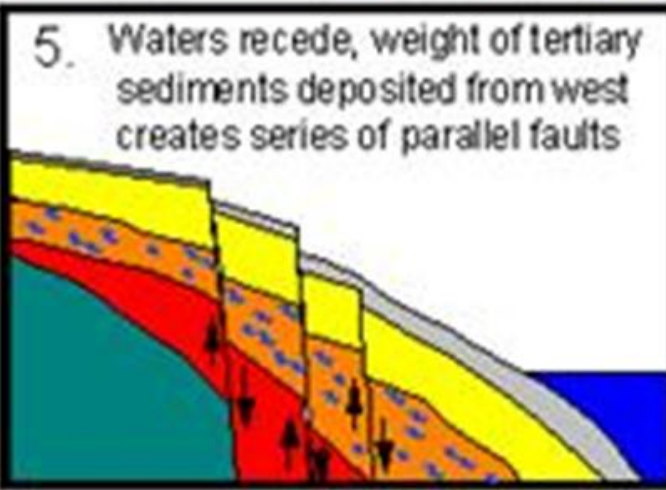
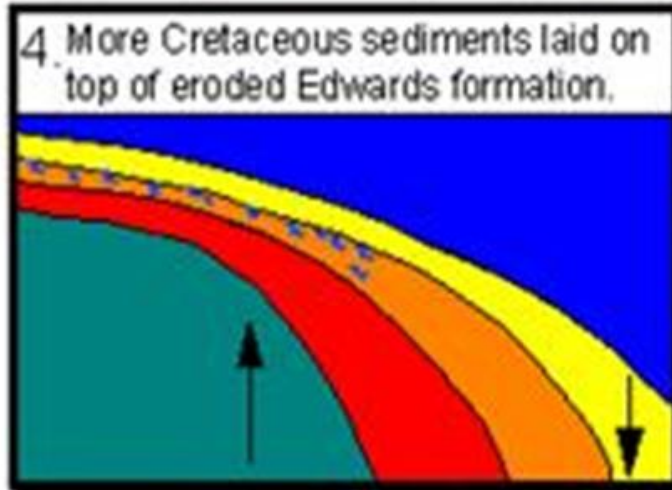
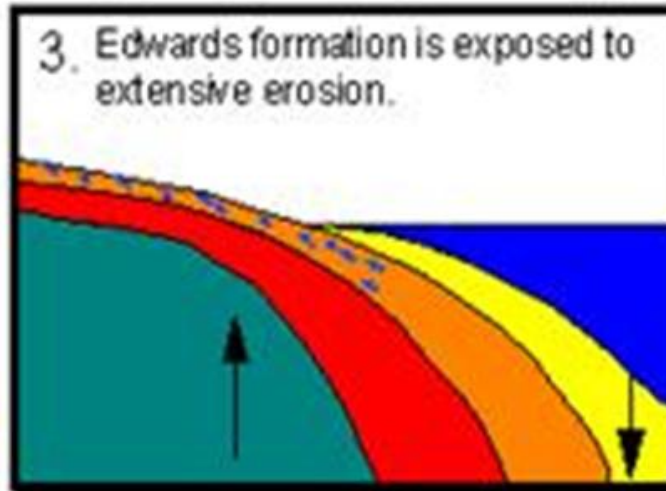
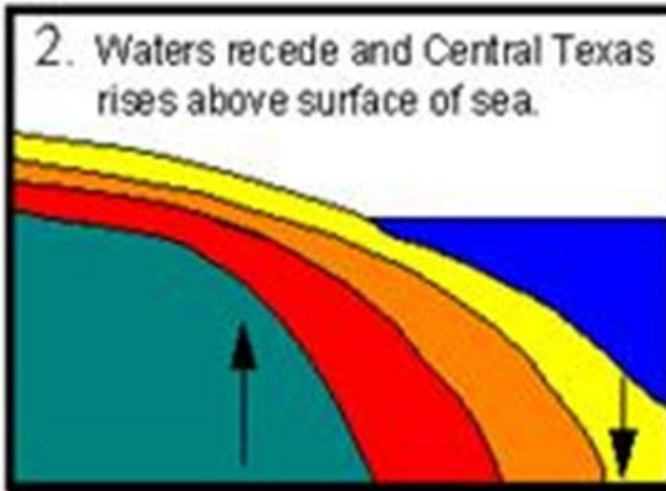
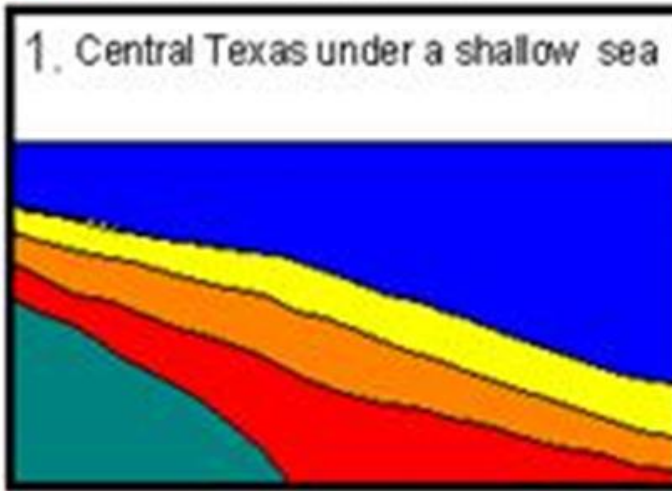


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Formation of the Edwards Aquifer

- Ancestral Gulf of Mexico
- Tertiary sediments
- Cretaceous sediments younger than Edwards
- Edwards formation
- Cretaceous sediments older than Edwards
- Precambrian Basement



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



**BUT WHEN THE LIMESTONE WAS UPLIFTED IT FRACTURED
AND FAULTED CREATING CRACKS FOR RAIN TO ENTER**

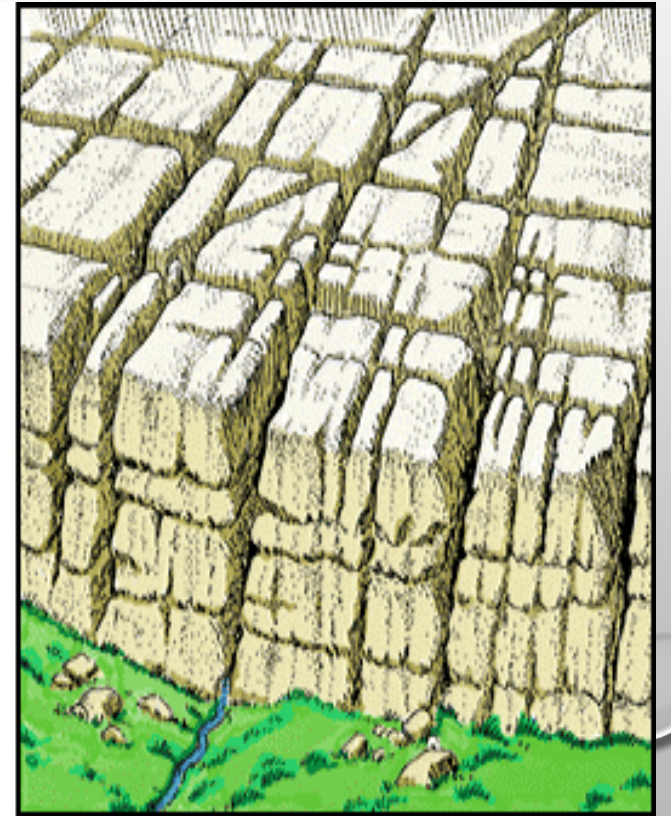
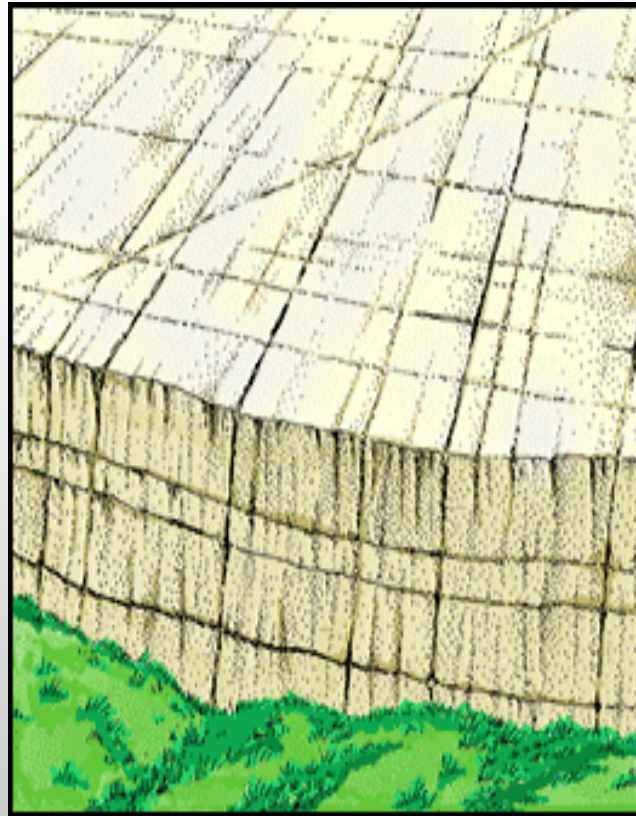


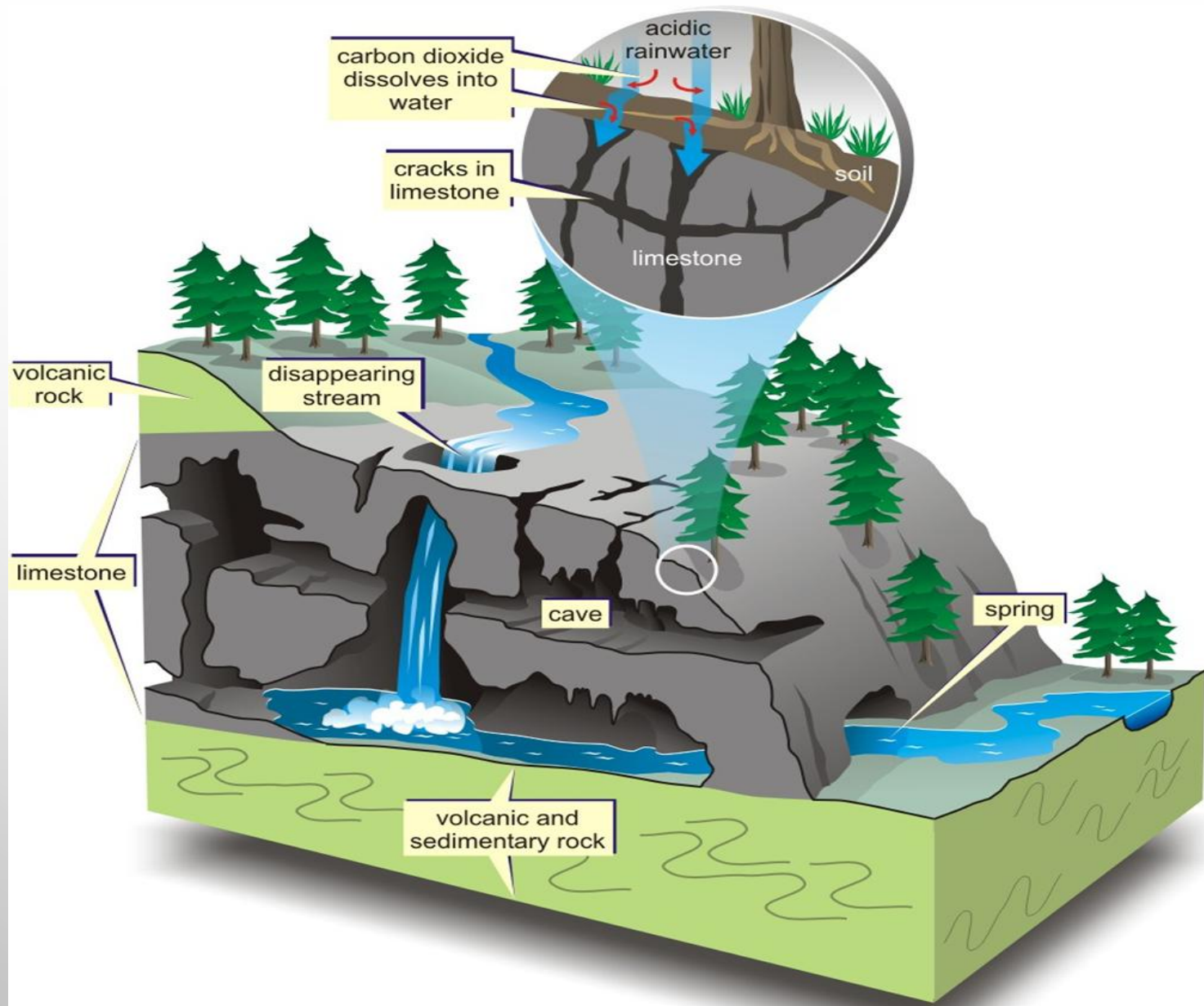
CHEMICAL WEATHERING CREATED OUR AQUIFER

LIMESTONE WILL DISSOLVE WHEN RAINWATER COMBINES WITH
CARBON DIOXIDE IN THE AIR TO FORM **CARBONIC ACID**



CARBONIC ACID THEN SEEPS INTO
FRACTURES IN THE LIMESTONE
DISSOLVING THE ROCK AND
CREATING AREAS UNDERGROUND
THAT CAN STORE WATER
(AN AQUIFER)





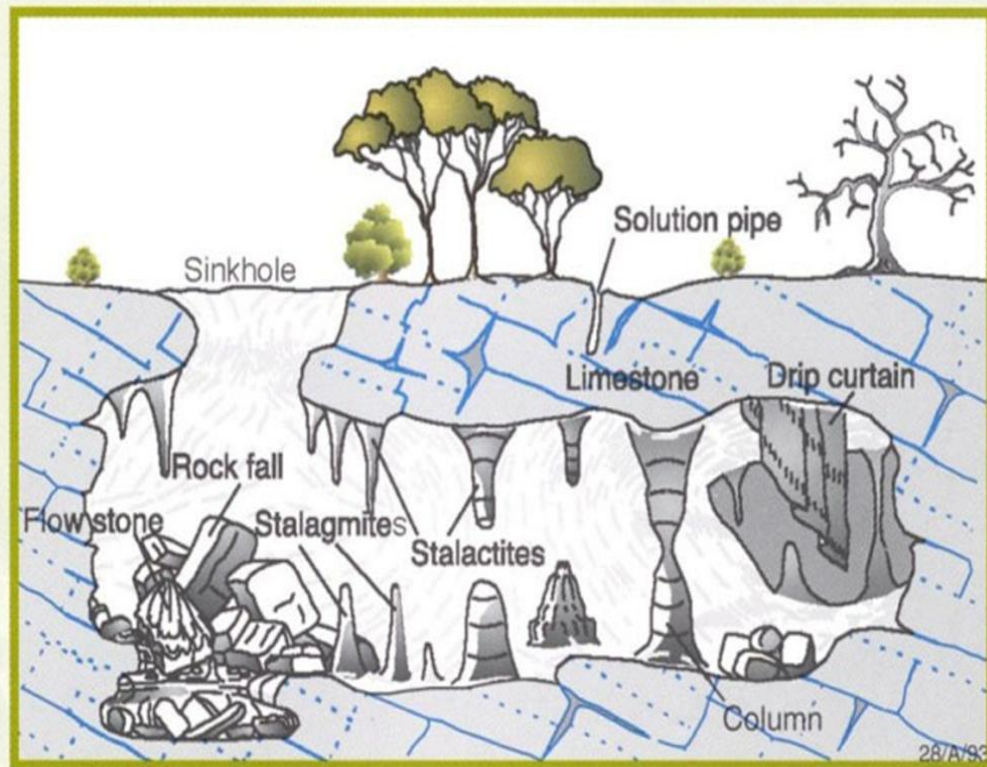
LIMESTONE AFTER WEATHERING BY CARBONIC ACID.
THE ROCK IS NOW **PERMEABLE** MEANING THAT WATER
CAN PASS THROUGH IT.



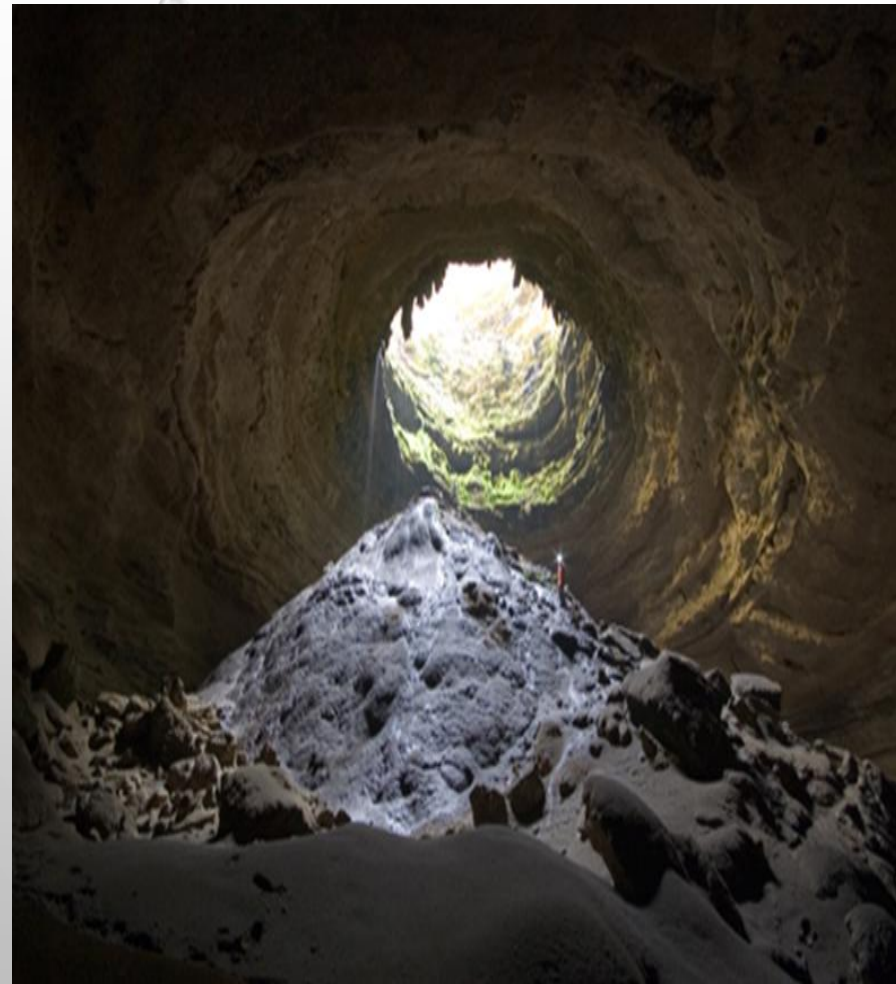
THIS WEATHERED LIMESTONE IS CALLED **KARST**.
THE EDWARDS AQUIFER IS A KARST AQUIFER



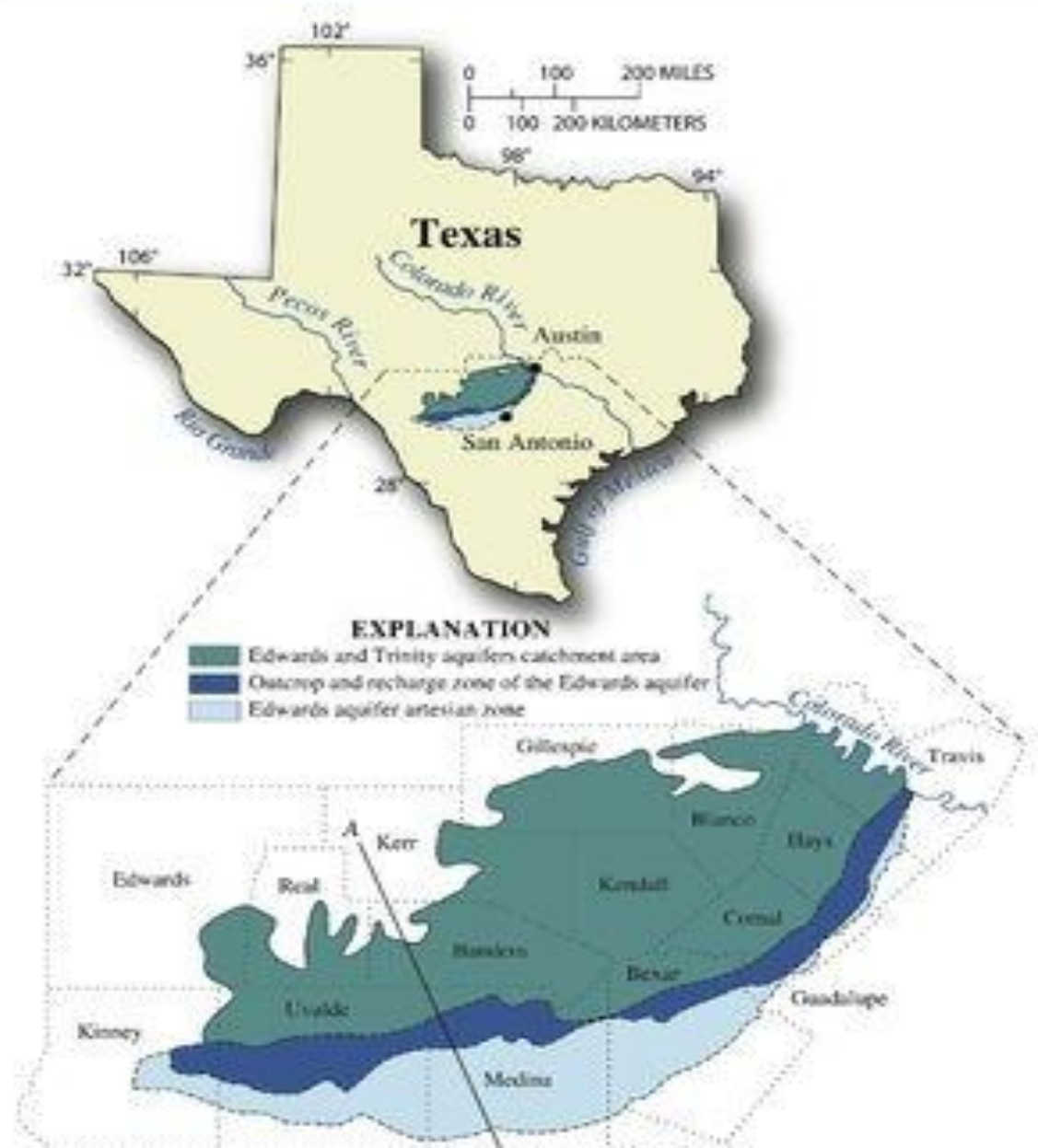
CAVES FORM IN THE WEATHERED LIMESTONE LOCATED OVER AN IMPERMEABLE ROCK LAYER



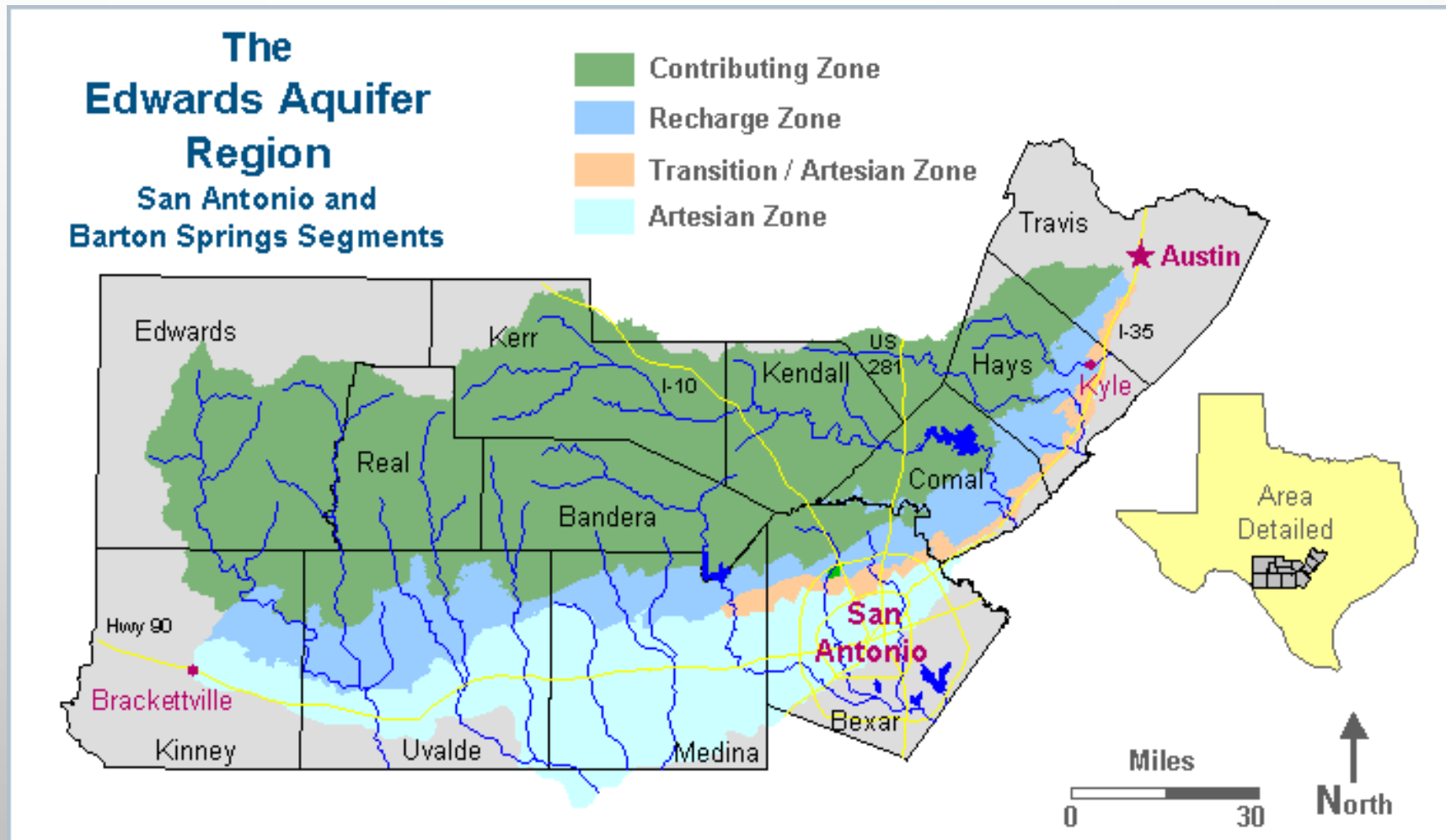
SINKHOLES ARE CREATED WHEN GROUNDWATER CARRYING CARBONIC ACID DISSOLVES LIMESTONE AND THE SURFACE COLLAPSES DOWNWARDS.
SINKHOLES ARE MAJOR RECHARGE FEATURES



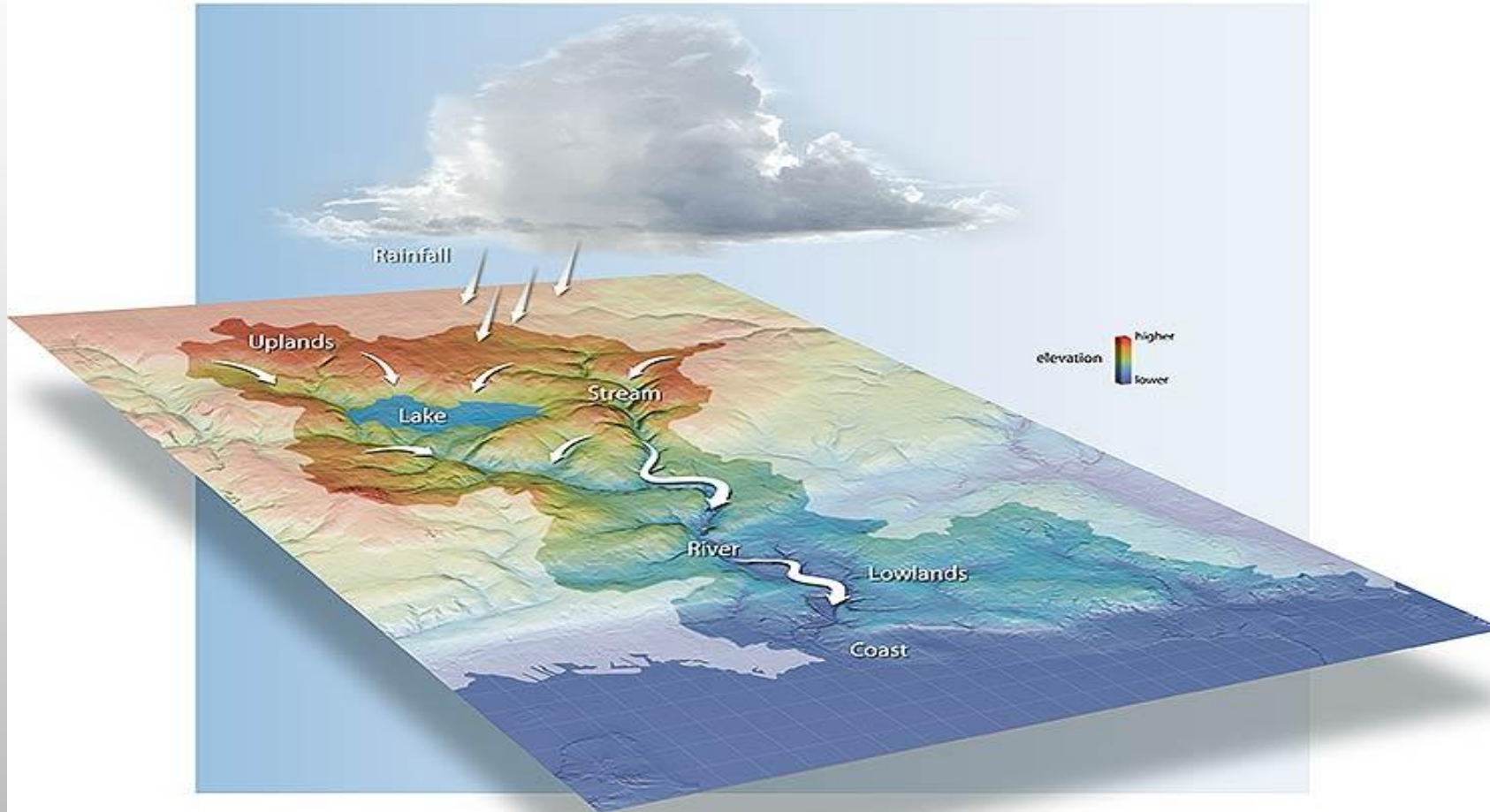
THE EDWARDS AQUIFER HAS 3 MAJOR ZONES



THE CATCHMENT ZONE IS THE WATERSHED. IT IS ALSO CALLED THE CONTRIBUTING ZONE OR DRAINAGE AREA. GOVERNMENT CANYON S.N.A. IS A LOCAL WATERSHED



WATERSHEDS ARE ELEVATED IMPERMEABLE ROCKS WHERE RAINWATER FLOWS DOWNWARDS TOWARDS THE OCEAN.

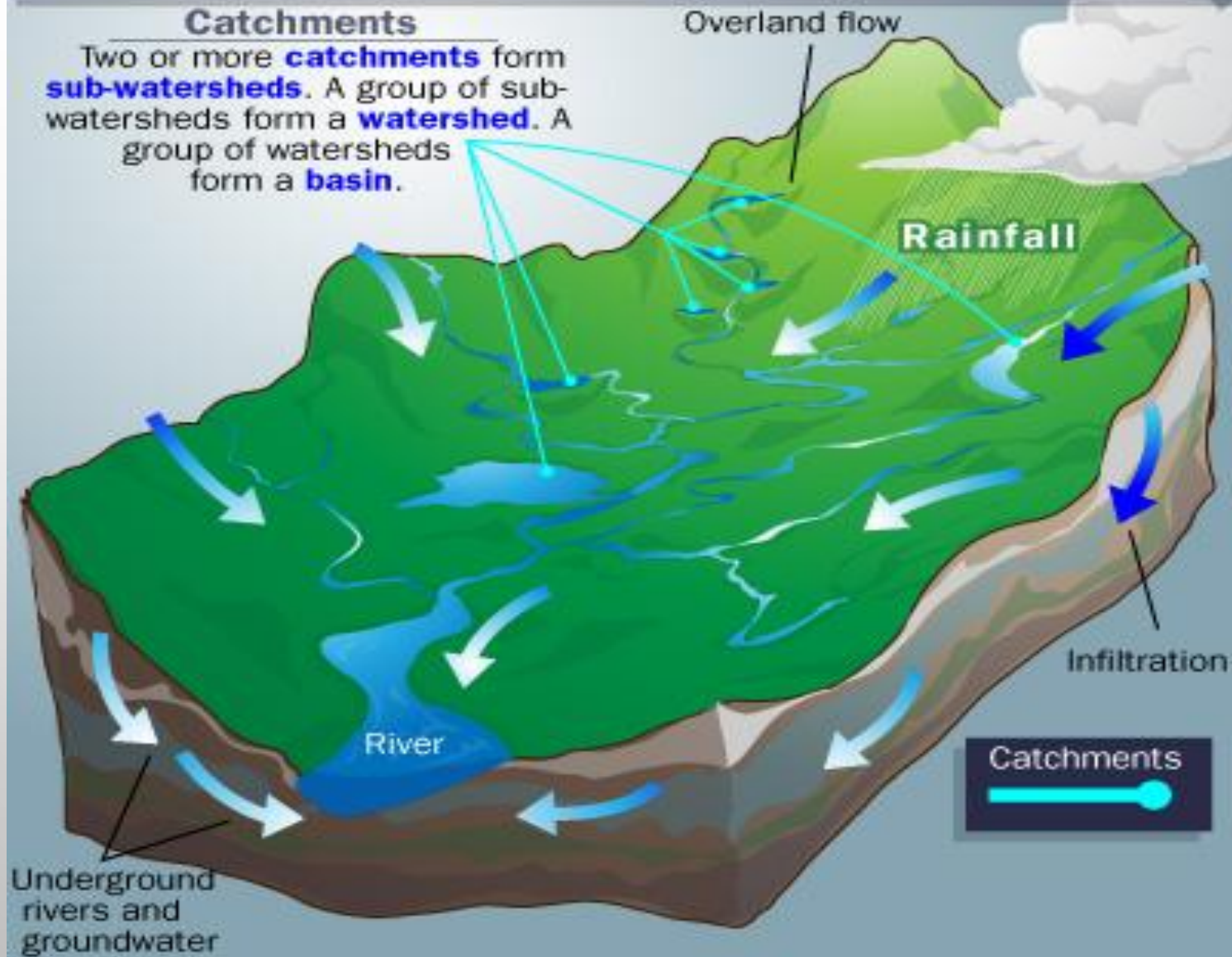


How Watersheds Work

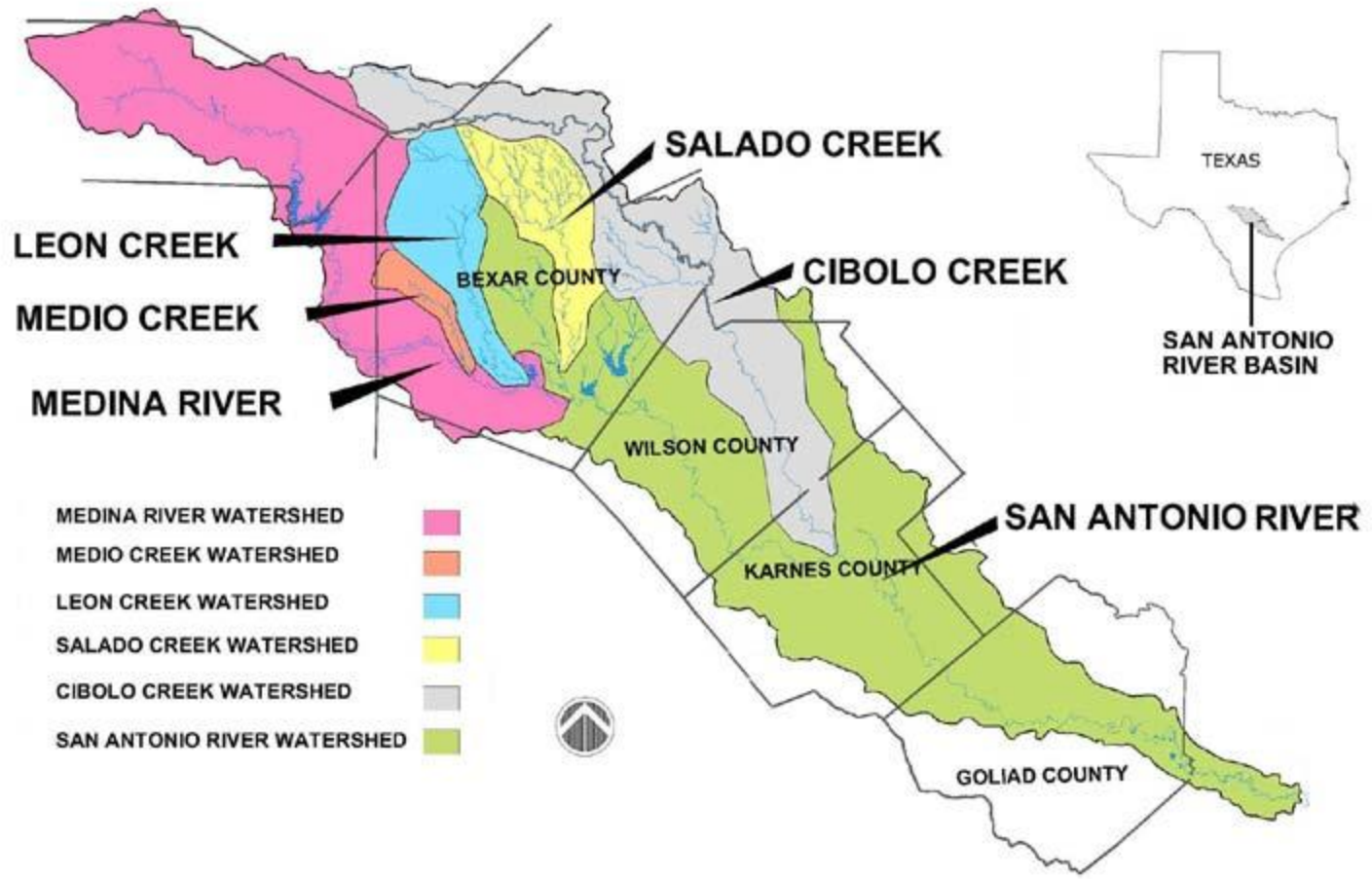
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Catchments

Two or more **catchments** form **sub-watersheds**. A group of sub-watersheds form a **watershed**. A group of watersheds form a **basin**.



SAN ANTONIO RIVER BASIN WATERSHEDS



LEON CREEK

MEDIO CREEK

MEDINA RIVER

SALADO CREEK

CIBOLO CREEK

SAN ANTONIO RIVER

- MEDINA RIVER WATERSHED
- MEDIO CREEK WATERSHED
- LEON CREEK WATERSHED
- SALADO CREEK WATERSHED
- CIBOLO CREEK WATERSHED
- SAN ANTONIO RIVER WATERSHED

BEXAR COUNTY

WILSON COUNTY

KARNES COUNTY

GOLIAD COUNTY



GOVERNMENT CANYON STATE NATURAL AREA



THIS WATERSHED WAS PURCHASED BY THE CITY OF SAN ANTONIO TO PROTECT THE QUALITY OF THE RECHARGE WATER THAT ENTERS OUR AQUIFER





12861 GALM RD
SAN ANTONIO, TX 78254
LATITUDE: 29.571323
LONGITUDE: -98.753246

- GOVERNMENT CANYON STATE NATURAL AREA (GCSNA) PRESERVES 12,047 ACRES OF RUGGED HILLS AND CANYONS TYPICAL OF THE TEXAS HILL COUNTRY. IT IS DESIGNATED A NATURAL AREA, RATHER THAN A STATE PARK, AND THEREFORE THE PRIMARY FOCUS IS MAINTENANCE AND PROTECTION OF THE PROPERTY'S NATURAL STATE.
- THE RESERVE IS LOCATED IN THE EXTREME NW CORNER OF BEXAR COUNTY, AND PROTECTS A LARGE, RELATIVELY PRISTINE TRACT OF HILL COUNTRY TERRAIN, NUMEROUS AND DIVERSE SPECIES OF PLANTS & WILDLIFE, PART OF THE UPPER LEON CREEK WATERSHED, AND A CRITICAL AQUIFER RECHARGE ZONE FOR THE CITY OF SAN ANTONIO WATER SYSTEM. IT INCLUDES NESTING HABITATS OF THE GOLDEN-CHEEKED WARBLER AND THE BLACK-CAPPED VIREO, BOTH OF WHICH ARE CLASSIFIED AS ENDANGERED.

GOVERNMENT CANYON TRIP INFO

- BRING:
- CLOSED TOE WALKING SHOES STURDY ENOUGH FOR HIKING OVER ROUGH TERRAIN
- (NO SANDALS, CHANCLAS, SLIDES, FLIPFLOPS, HEELS, OR WIMPY SHOES)
- DRESS COMFORTABLY AS YOU WILL BE HIKING
- A HAT
- BRING LOTS OF DRINKING WATER, SNACKS, STUFF FOR LUNCH
- A CAMERA (OPTIONAL)
- SUNSCREEN IF YOU BURN EASILY
- A PENCIL FOR THE LAB ACTIVITY

WE WILL BE DOING THE LAB AND EATING LUNCH AT THE PAVILION



YES, THERE ARE RESTROOMS AND WATER FOUNTAINS



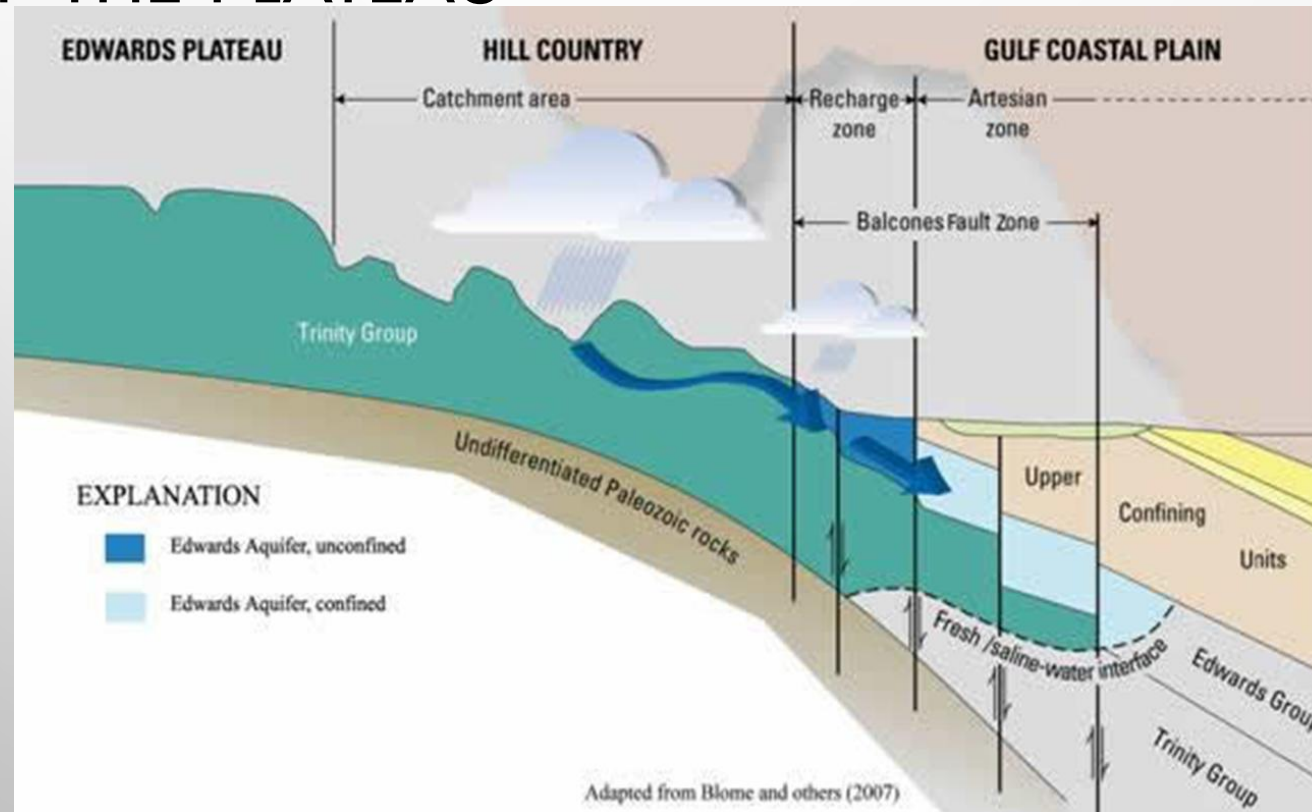
WEAR COMFORTABLE STURDY SHOES
FOR HIKING



IT'S IMPORTANT TO STAY ON THE TRAIL AND LISTEN TO THE PARK RANGER



THE DRAINAGE AREA OR CATCHMENT AREA COVERS AN AREA OF ABOUT 5,400 SQUARE MILES LAND SURFACE "CATCHES" RAINFALL AND WATER RUNS OFF INTO STREAMS OR INFILTRATES INTO THE WATER TABLE AQUIFER OF THE PLATEAU



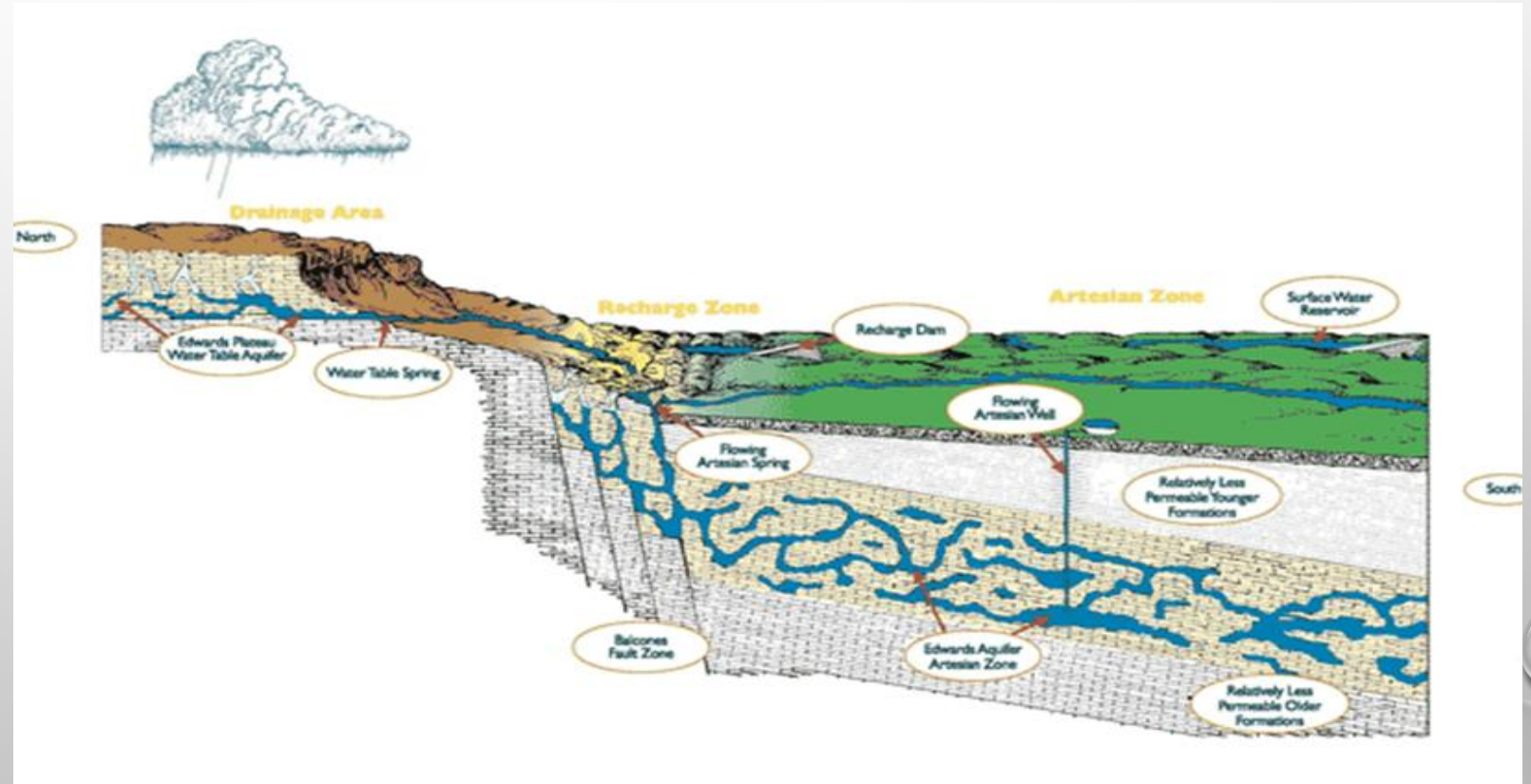
THE RECHARGE ZONE IS AN AREA OF CRITICAL IMPORTANCE

- OUR RECHARGE ZONE EXTENDS OVER 1,250 SQUARE MILES AND CONSISTS OF HIGHLY FRACTURED AND FAULTED EDWARDS LIMESTONE OUTCROPS AT THE SURFACE.
- 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.
- ABOUT 25% OF RECHARGE OCCURS WHEN PRECIPITATION FALLS DIRECTLY ONTO THE RECHARGE AREA.



THE RECHARGE ZONE.

THIS IS WHERE WATER THAT RUNS OFF OF THE DRAINAGE AREA GOES UNDERGROUND INTO THE AQUIFER BY SINKING THROUGH A SERIES OF FAULTS.



**HELOTES CREEK IN RECHARGE ZONE
LARGE PLATES OF FRACTURED LIMESTONE IN THE CREEK
BOTTOM, WHICH ALLOW RECHARGE WATER TO GO INTO
THE AQUIFER**

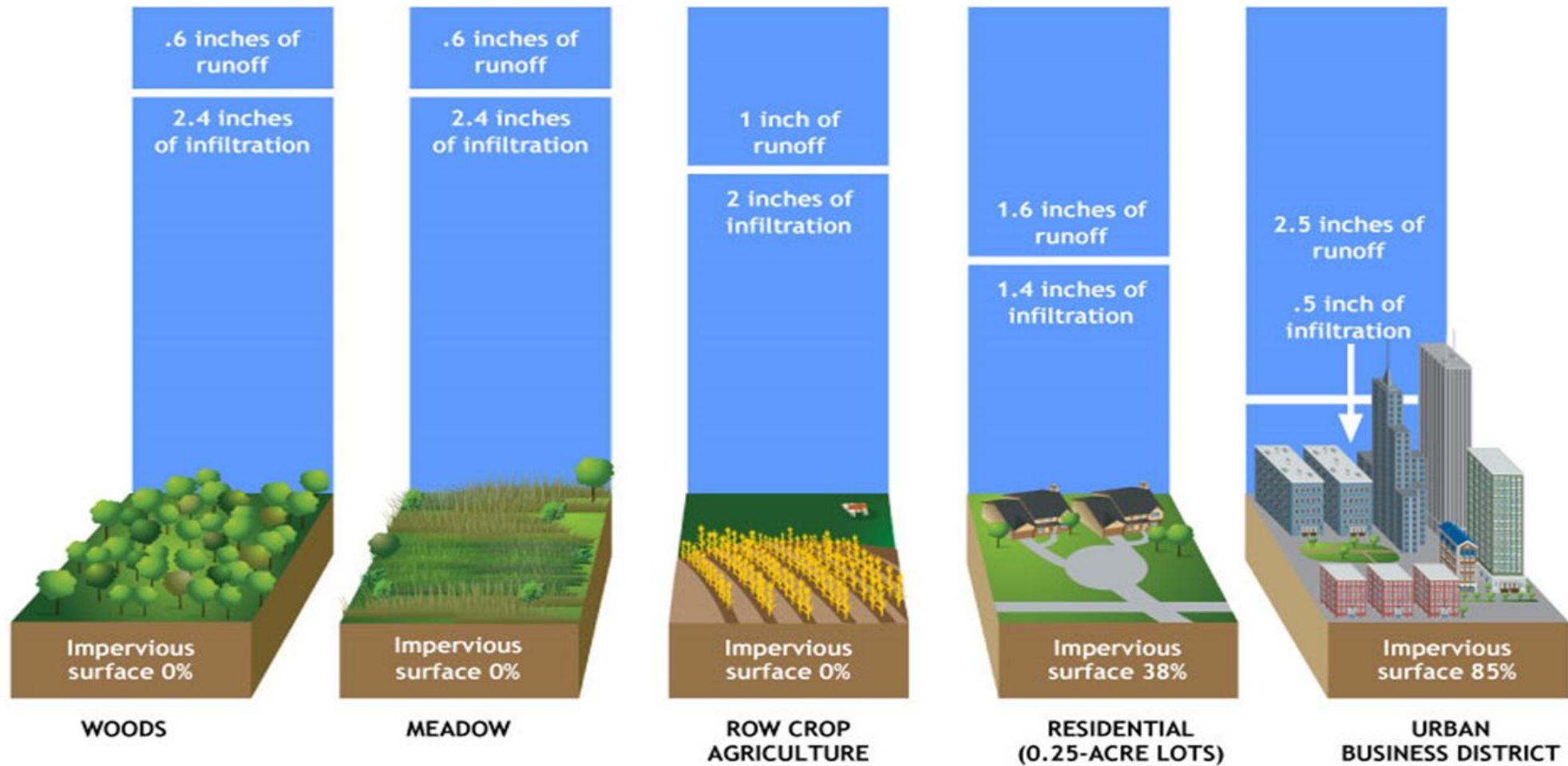


SECO CREEK RECHARGE PROJECT

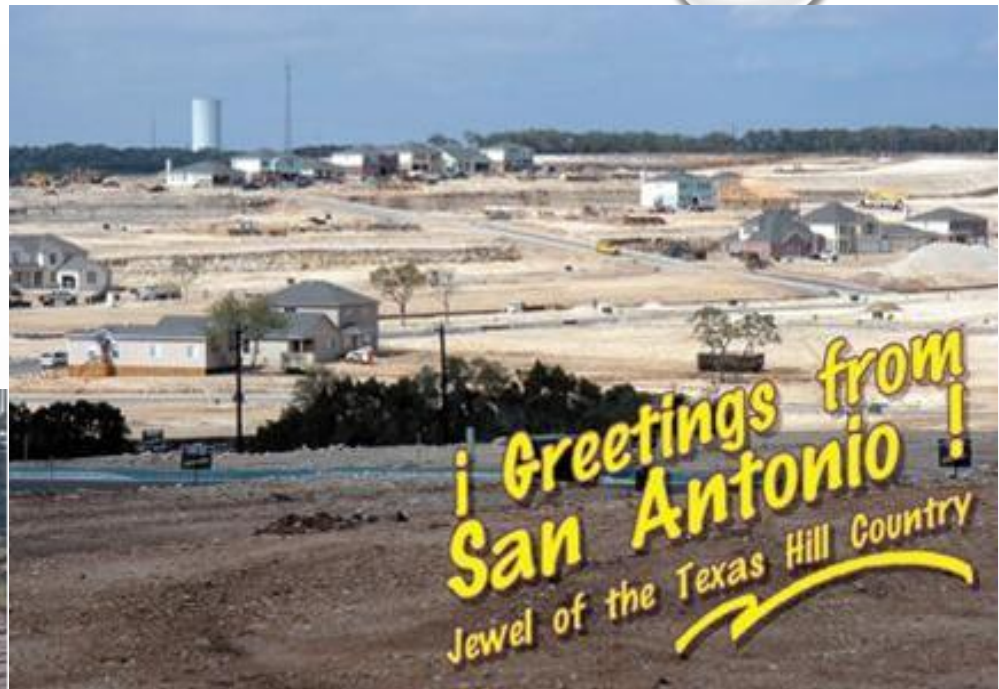
- WATER IS PURPOSEFULLY COLLECTED AND DIVERTED INTO THE SINKHOLE TO INCREASE AQUIFER RECHARGE
- SINKHOLES CAN QUICKLY RECEIVE LARGE VOLUMES OF RECHARGE DURING RAINSTORMS AND TRANSMIT THE RECHARGE DIRECTLY INTO THE AQUIFER



FACTORS AFFECTING RECHARGE



AS WE COVER THE RECHARGE ZONE WITH IMPERMEABLE/IMPERVIOUS SURFACES IT'S HARDER FOR CLEAN WATER TO ENTER THE AQUIFER.



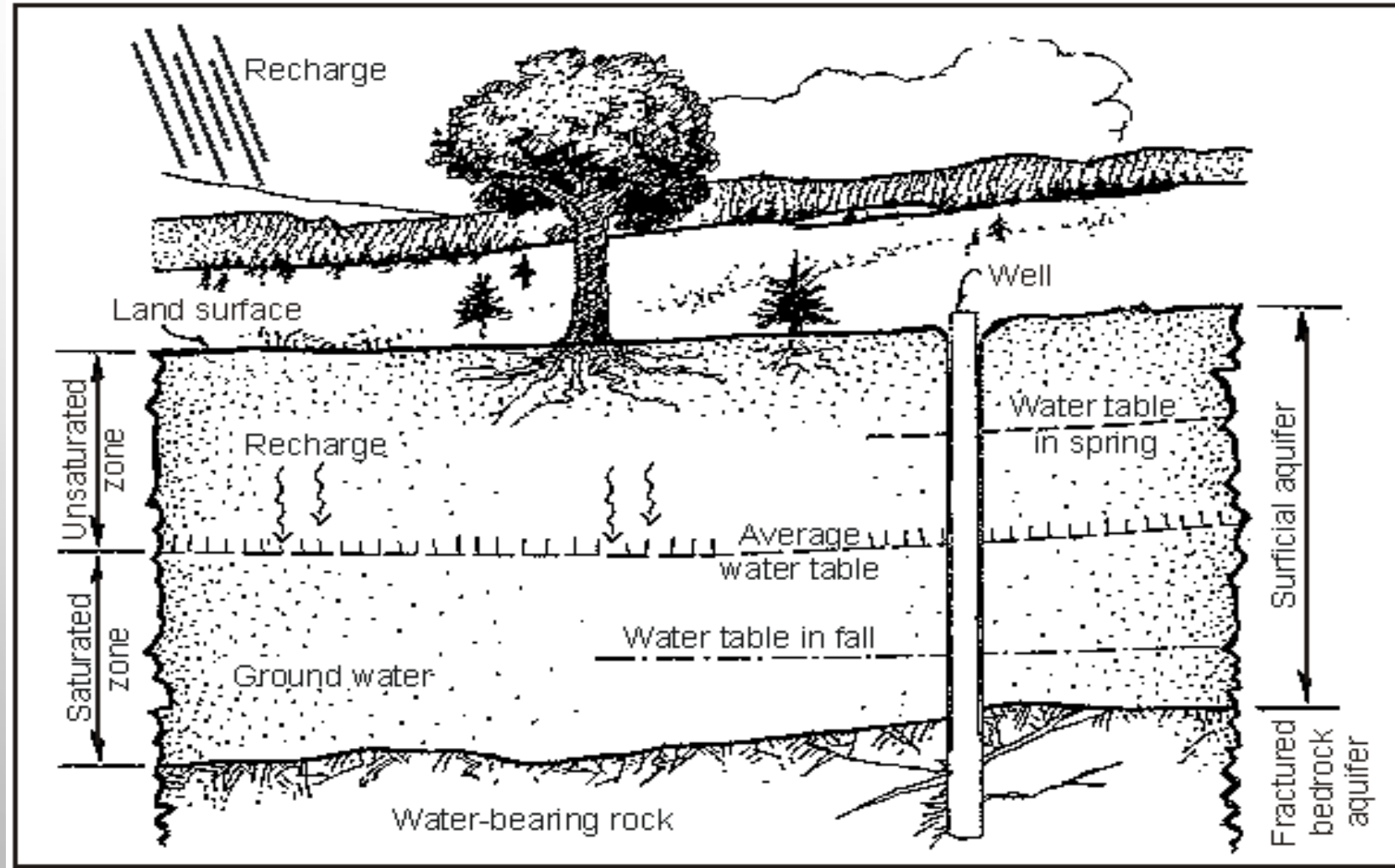
AS PEOPLE BUILD OVER THE RECHARGE ZONE. SEWAGE PIPES CAN
BREAK WHEN THE SOIL SHIFTS. THE BIG QUESTION IS-
DOES THE AQUIFER FILTER OUT POLLUTANTS?



THE WATER FLOWS THROUGH FAULTS AND FRACTURES IN
THE LIMESTONE AND COLLECTS IN CAVES



THE WATER TABLE IS THE TOP LEVEL OF THE GROUNDWATER. IT CHANGES DEPENDING ON THE AMOUNT OF 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.

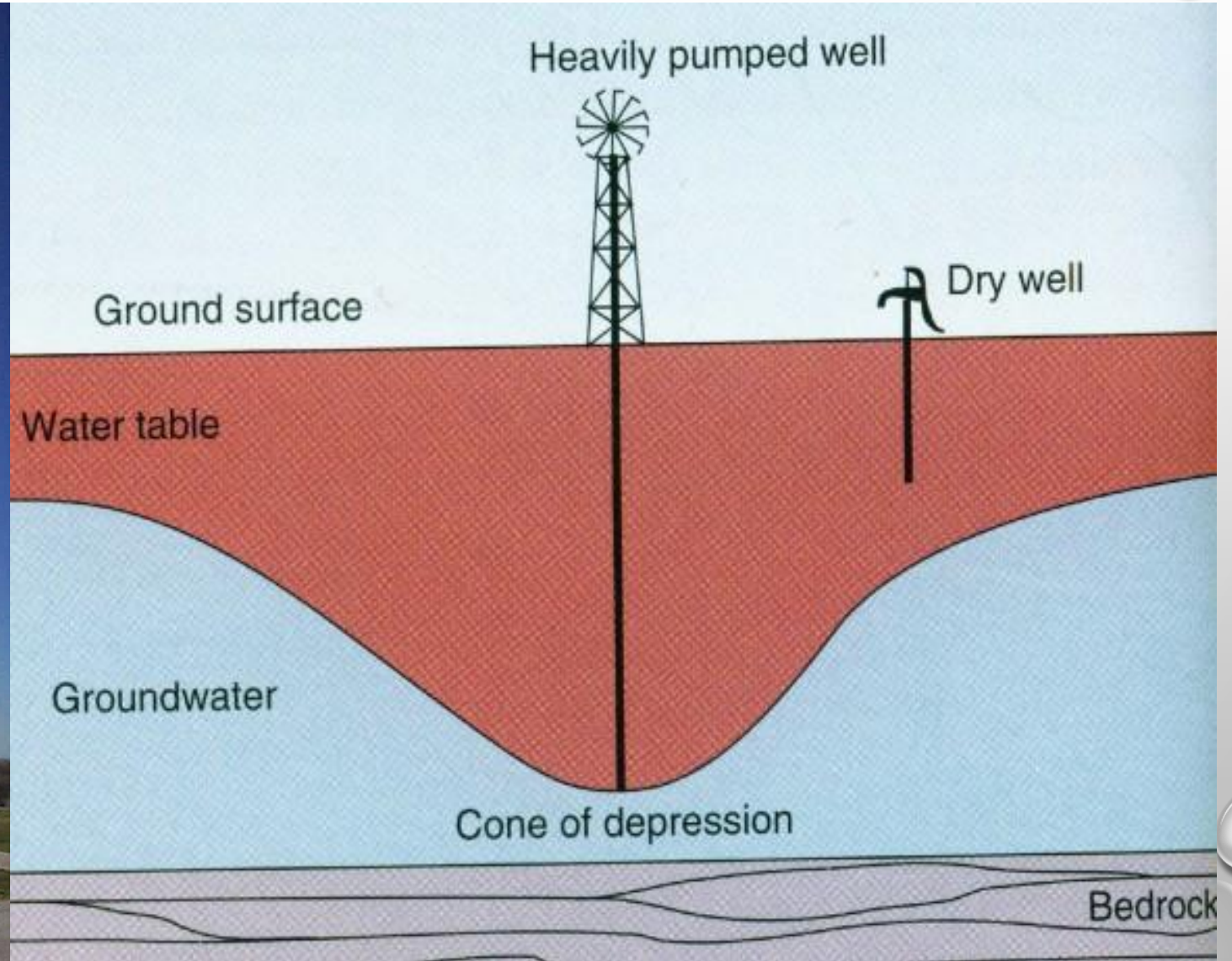


WHEN WE ARE IN A DROUGHT THE WATER TABLE DROPS
DOWN AND CAVES LOOK LIKE THIS

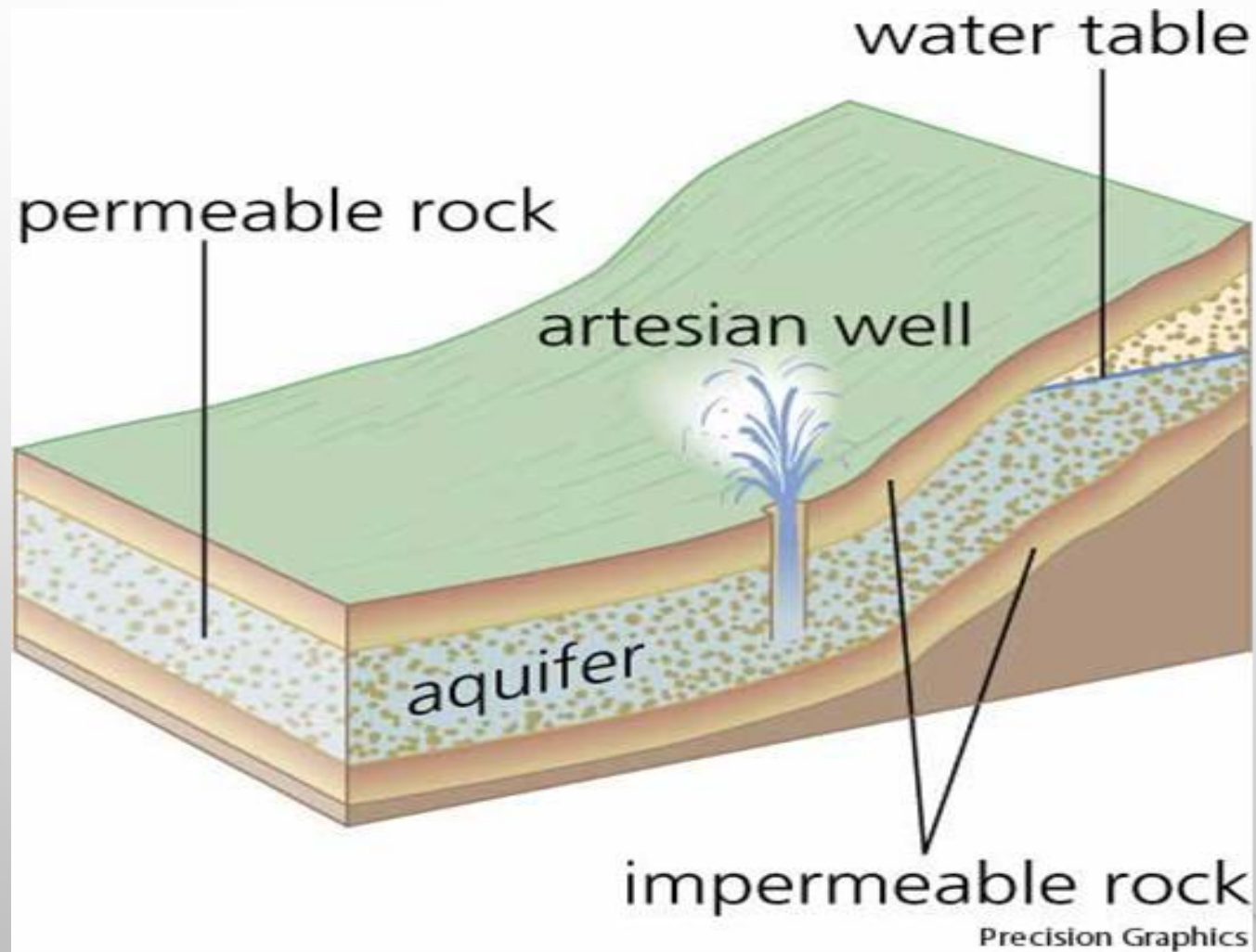


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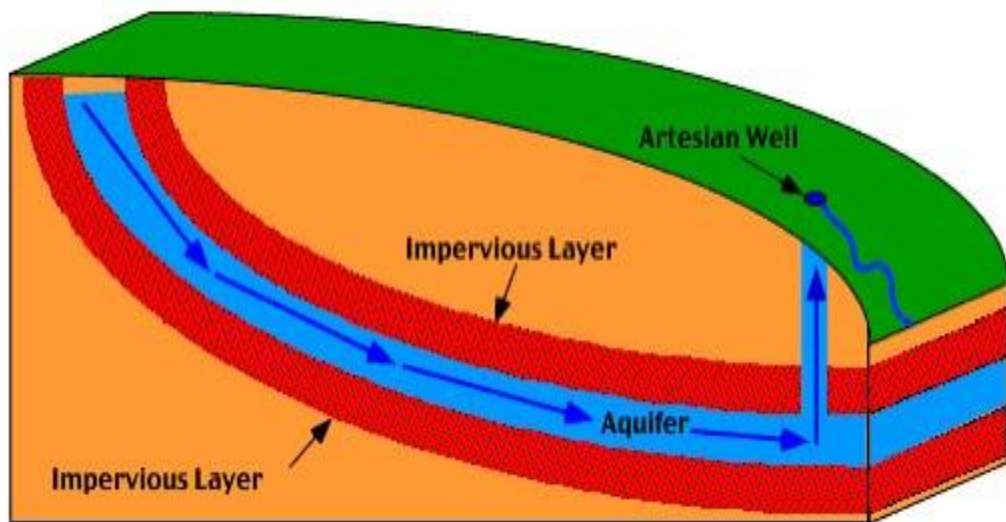
WE PUMP WATER FROM THE AQUIFER THROUGH WELLS.



THE LAST ZONE IS THE ARTESIAN ZONE WHICH IS SOUTH OF THE CITY. IN THIS AREA WATER IS TRAPPED BETWEEN 2 IMPERMEABLE LAYERS AND RISES TO THE SURFACE WHEN A WELL IS DRILLED.



WATER IS CONFINED BETWEEN TWO IMPERMEABLE FORMATIONS – THE GLEN ROSE FORMATION BELOW AND THE DEL RIO CLAY ON TOP. ARTESIAN WELLS AND SPRINGS EXIST WHERE HYDRAULIC PRESSURE IS SUFFICIENT TO FORCE WATER UP THROUGH WELLS AND FAULTS TO THE SURFACE. THE LARGEST ARTESIAN WELL IN THE WORLD WAS IN THE EDWARDS DISCHARGE ZONE SOUTH OF TOWN. THE WELL HAS SINCE BEEN CAPPED.

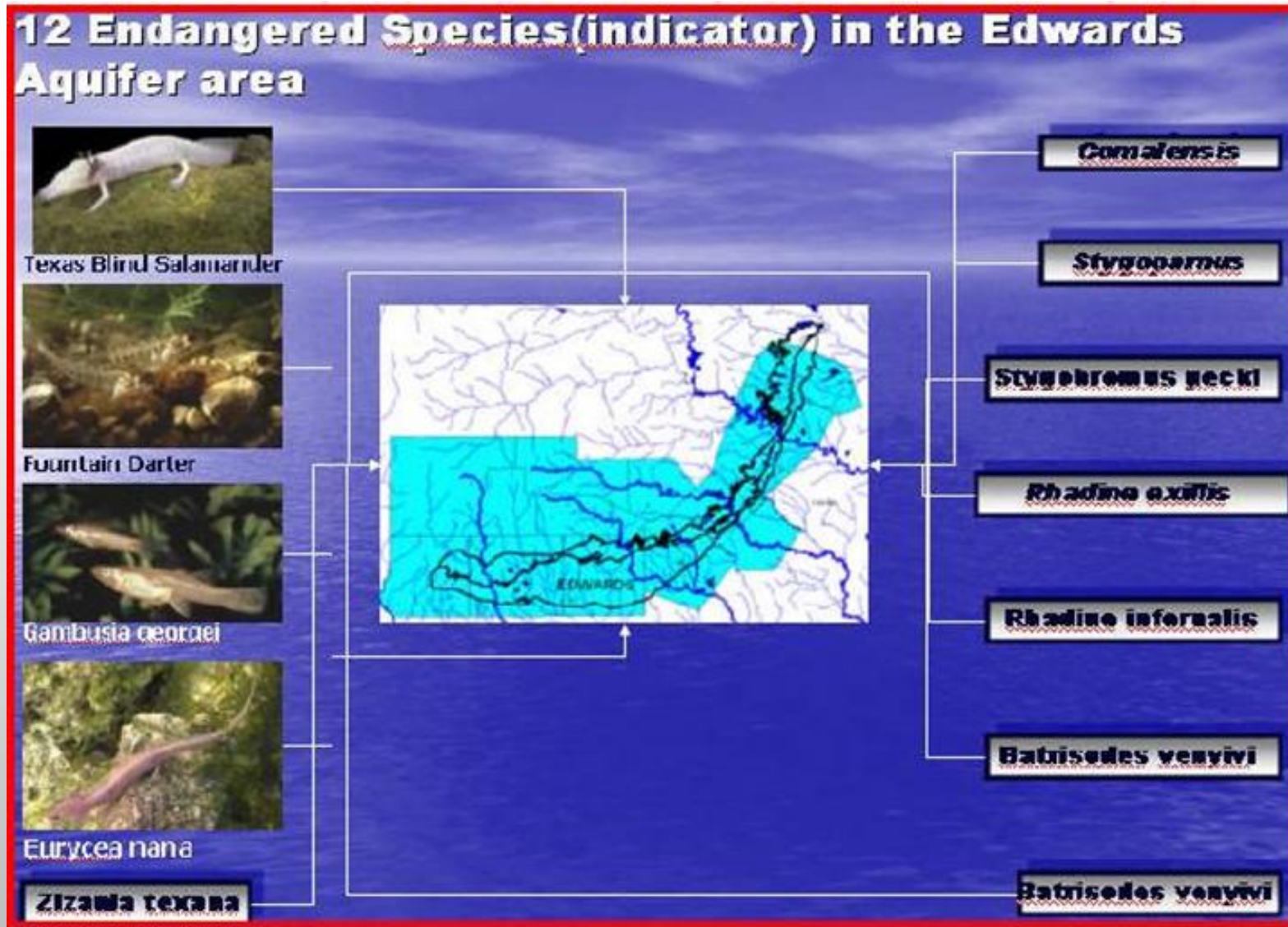


ARTESIAN WELLS IN SAN ANTONIO

- SAN ANTONIO BEGAN TO RELY ON ARTESIAN WELLS FOR ITS WATER SUPPLY IN 1891
- THE EFFECT OF RELEASING ALL THIS PRESSURE THROUGH WELLS WAS THAT SPRINGFLOWS BEGAN TO DECLINE IMMEDIATELY AND SIGNIFICANTLY



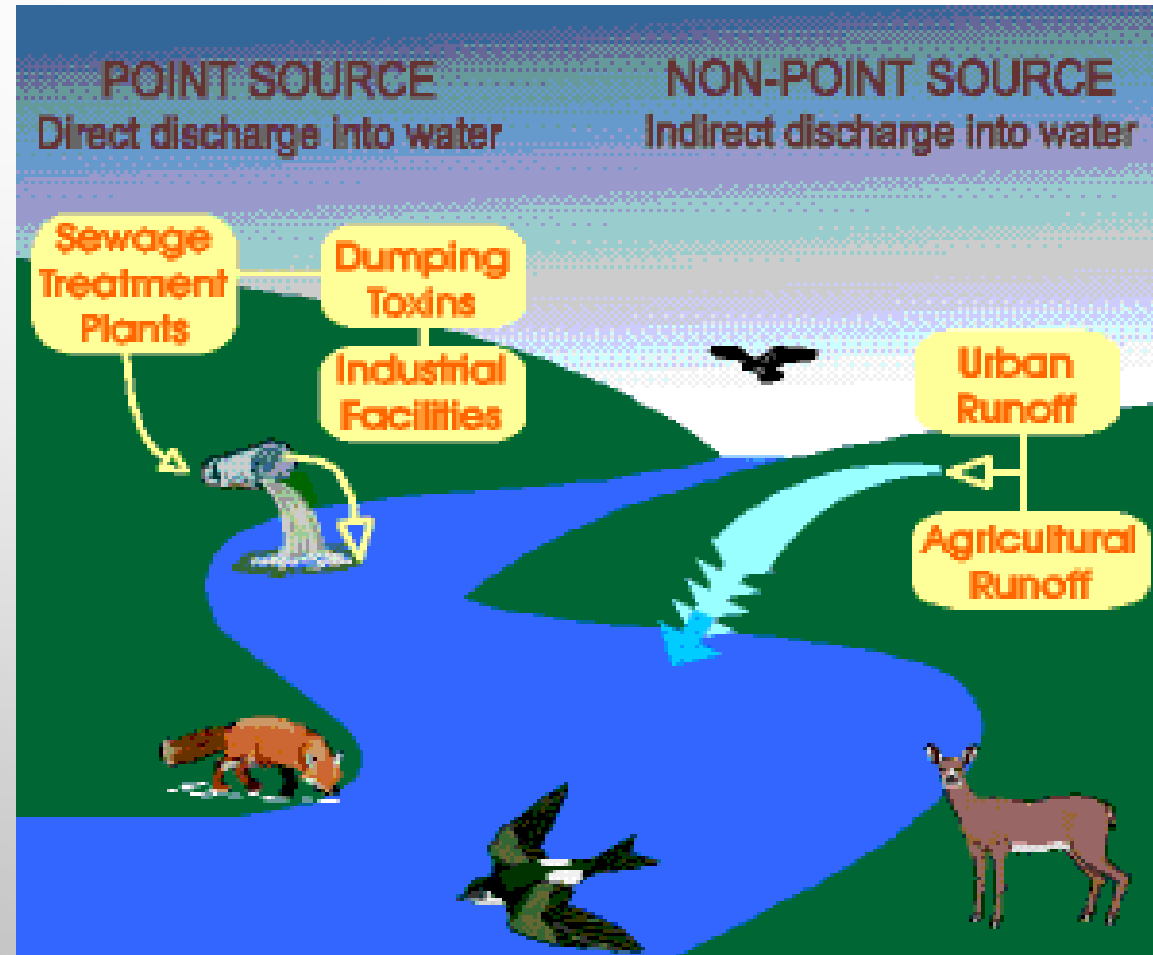
DEVELOPMENT OVER SAN ANTONIO'S RECHARGE ZONE IS CAUSING PROBLEMS FOR CREATURES THAT DEPEND ON THE AQUIFER....



TEXAS BLIND SALAMANDERS ARE IN DECLINE. THEY ARE AN INDICATOR SPECIES THAT SHOW US THE QUALITY OF OUR GROUNDWATER. (CANARY IN A COAL MINE)



THERE ARE TWO TYPES OF POLLUTION THAT CAN AFFECT OUR GROUNDWATER



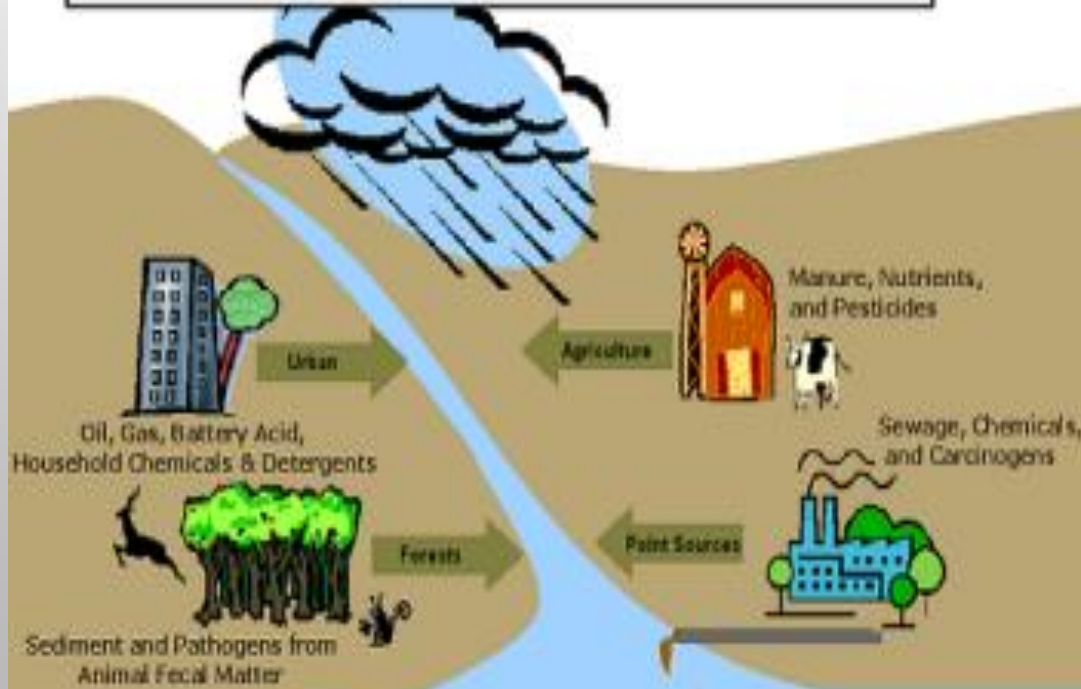
Nonpoint Source Pollution

Water pollution generated over a wide area from uncontrolled sources that cannot be traced back to a single outlet

Nonpoint Source Pollutants

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

MAJOR NPS POLLUTION SOURCES



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.

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



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

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



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



POINT SOURCE POLLUTION COMES FROM A SINGLE SOURCE

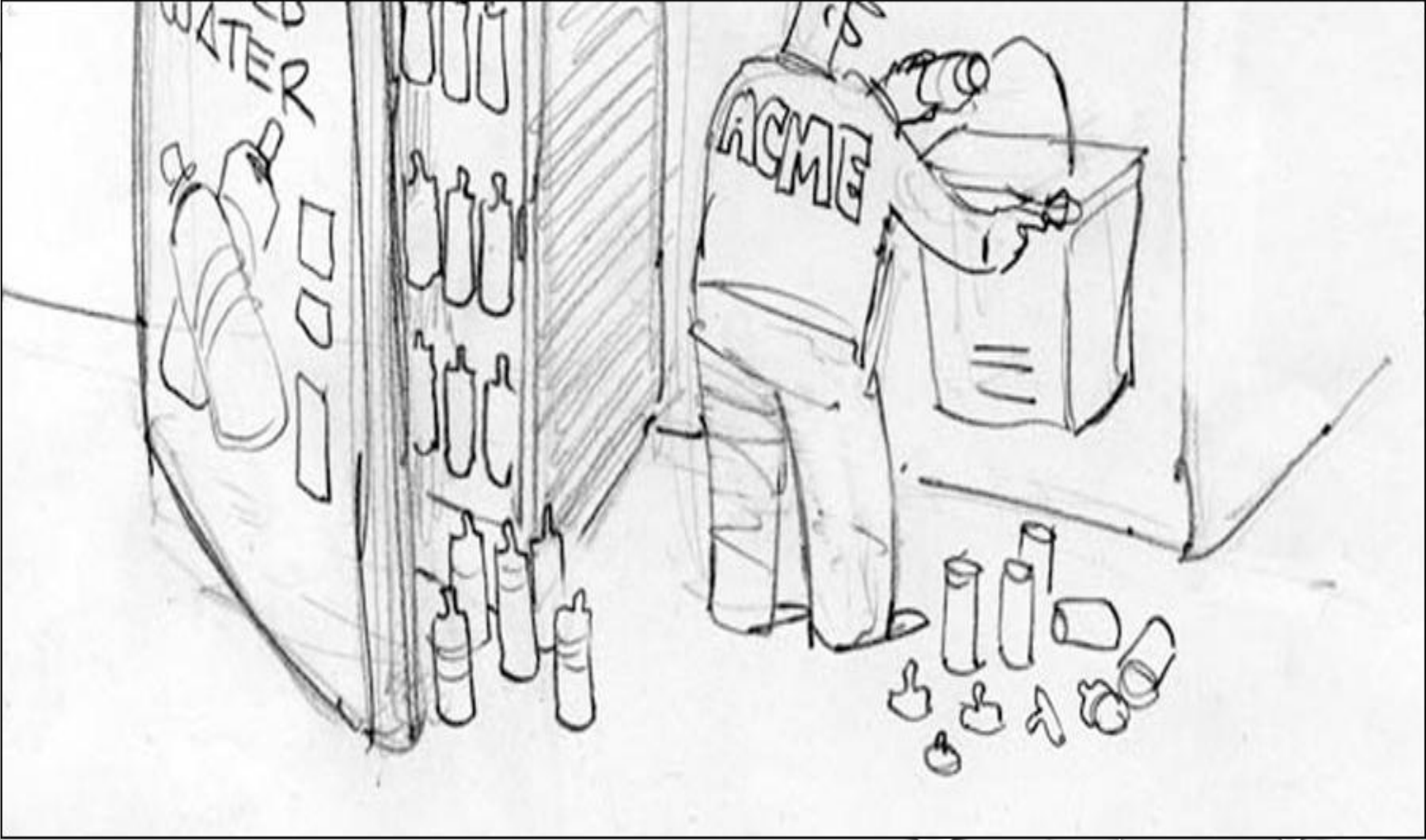


What is a point source?
A point source is a stationary location or fixed facility such as an industry or municipality that discharges pollutants into air or surface water through pipes, ditches, lagoons, wells, or stacks, or a single identifiable source such as a ship or a mine.



WE NEED TO PROTECT OUR EDWARDS AQUIFER IF WE WANT TO CONTINUE TO HAVE CLEAN WATER.







- WORKS CITED

- [HTTP://TEXASWATER.TAMU.EDU/GROUNDWATER.AQUIFER.HTM](http://TEXASWATER.TAMU.EDU/GROUNDWATER.AQUIFER.HTM)
- [HTTP://WWW.BIZJOURNALS.COM/AUSTIN/STORIES/2010/10/11/DAILY39.HTML](http://WWW.BIZJOURNALS.COM/AUSTIN/STORIES/2010/10/11/DAILY39.HTML)
- [HTTP://WWW.EDWARDSAQUIFER.NET/CHARTS.HTML](http://WWW.EDWARDSAQUIFER.NET/CHARTS.HTML)
- [HTTP://WWW.EDWARDSAQUIFER.NET/GEOLOGY.HTML](http://WWW.EDWARDSAQUIFER.NET/GEOLOGY.HTML)
- [HTTP://WWW.EDWARDSAQUIFER.NET/GEOLOGY.HTML#FLOWMAP](http://WWW.EDWARDSAQUIFER.NET/GEOLOGY.HTML#FLOWMAP)
- [HTTP://WWW.EDWARDSAQUIFER.NET/IMAGES/RECHARGE_ZONE_CONSTRUCTION.JPG](http://WWW.EDWARDSAQUIFER.NET/IMAGES/RECHARGE_ZONE_CONSTRUCTION.JPG)
- [HTTP://WWW.EDWARDSAQUIFER.NET/INTRO.HTML](http://WWW.EDWARDSAQUIFER.NET/INTRO.HTML)