2020

Emergency Responder's Guide to Protecting the Edwards Aquifer: Instructional Enhancements

Rudolph A. Rosen
Texas A&M University-San Antonio

Marcus Gary
Edwards Aquifer Authority

Emergency Responder's Guide to Protecting the Edwards Aquifer: Instructional Enhancements

Photo: RUDOLPH ROSEN

In 2006 a fire near Helotes burned for three months in an eight-story high debris pile located over the Edwards Aquifer.

Photo: JOHN DAVENPORT, SAN ANTONIO EXPRESS-NEWS

Responders’ biggest concern ultimately centered on the threat of hazardous materials leaking into the aquifer with water runoff from fire fighting, threatening San Antonino's water supply.

Photo: JOHN DAVENPORT, SAN ANTONIO EXPRESS-NEWS

First responder concern over release of hazardous materials into the aquifer is valid throughout Bexar County and elsewhere across the aquifer's recharge and contributing zones.

Hazardous and polluting materials are present almost everywhere, not just at chemical manufacturing or storage locations. HAZMATs are in every hardware and garden store, grocery store, gas station, pharmacy, and in trucks and rail cars along every transportation route. Even backyard garden sheds and residential garages contain HAZMATs.

The aquifer drinking water supplies for San Antonio and Bexar County are particularly susceptible to contamination due to the unique vulnerability of the aquifer to contaminants from the surface and two other factors: 1) the presence of major military and medical facilities along with associated support businesses that typically use or store a wide range of HAZMATs, and 2) San Antonio is a transportation hub and corridor for high volumes of rail and truck traffic that contain undetermined HAZMATs coming from and going to Mexico through Laredo, the nation's largest inland port.

Photo: RUDOLPH ROSEN

The Edwards Aquifer supplies San Antonio and surrounding areas with an abundance of clean water. But our aquifer is vulnerable to contamination from the land's surface.

The aquifer is made up of rocks that have been chemically dissolved naturally by normal acidity in rainwater over millions of years. This has created thousands of cracks, sinkholes, caves, underground rivers, and other openings extending from the surface to the aquifer. These openings allow rapid infiltration of water from the surface into the aquifer's water we drink.

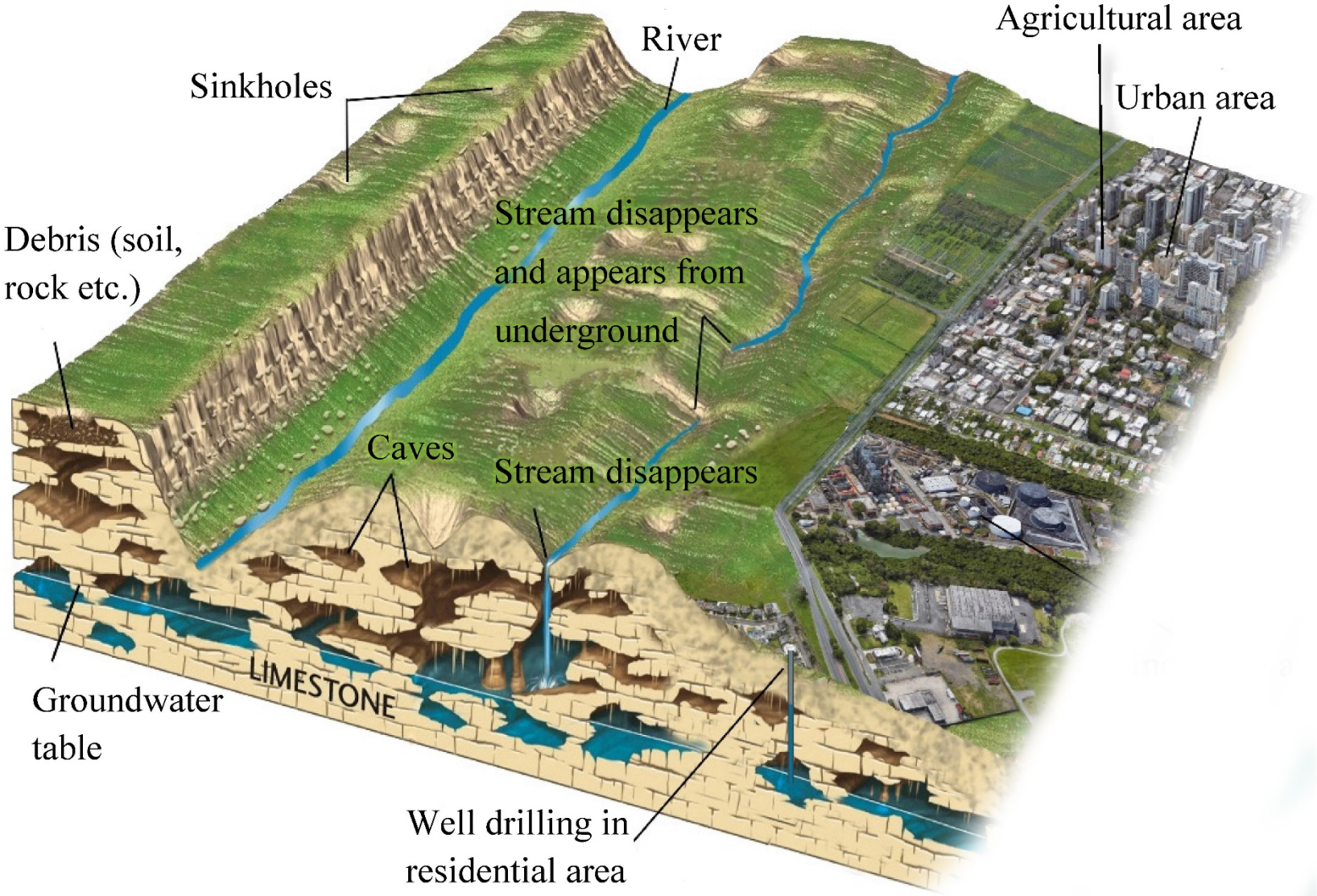


Illustration from: Kalhor, K. 2017. Assessment and Modeling of Groundwater Flow and Nitrate Contamination within Coastal Karst Aquifer of Puerto Rico. Northeastern University, Boston.

Because openings from the surface into the aquifer can be large, there is little to hold back or filter contaminants that may be carried from the surface into the aquifer with water from fire fighting.

Once water enters the aquifer, it can move and disperse through the aquifer quickly, moving thousands of feet or even miles per day. This spreads contaminants across the aquifer. It can imperil the health and safety of citizens.

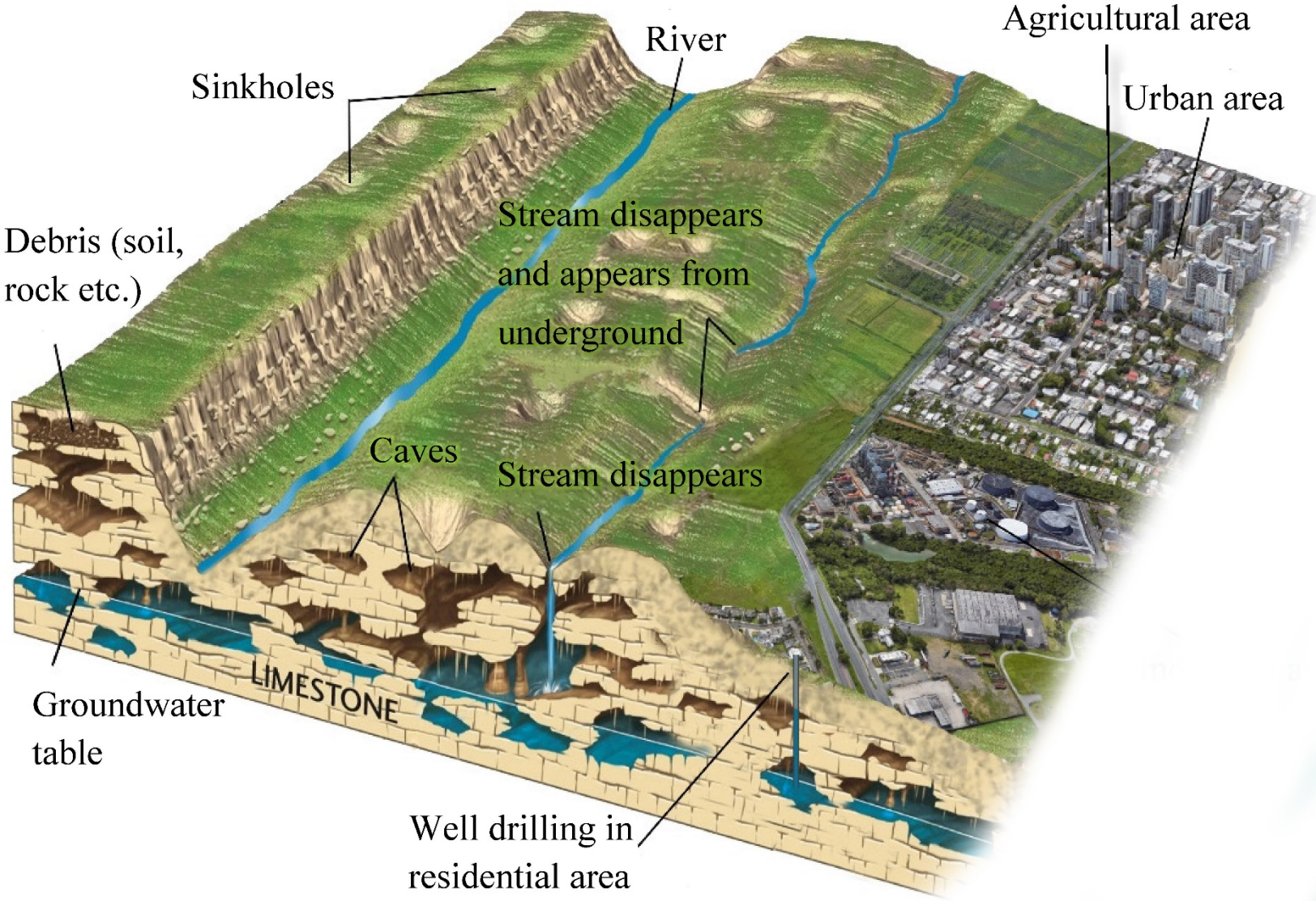


Illustration from: Kalhor, K. 2017. Assessment and Modeling of Groundwater Flow and Nitrate Contamination within Coastal Karst Aquifer of Puerto Rico. Northeastern University, Boston.

Here's what the Edwards Aquifer looks like deep underground.

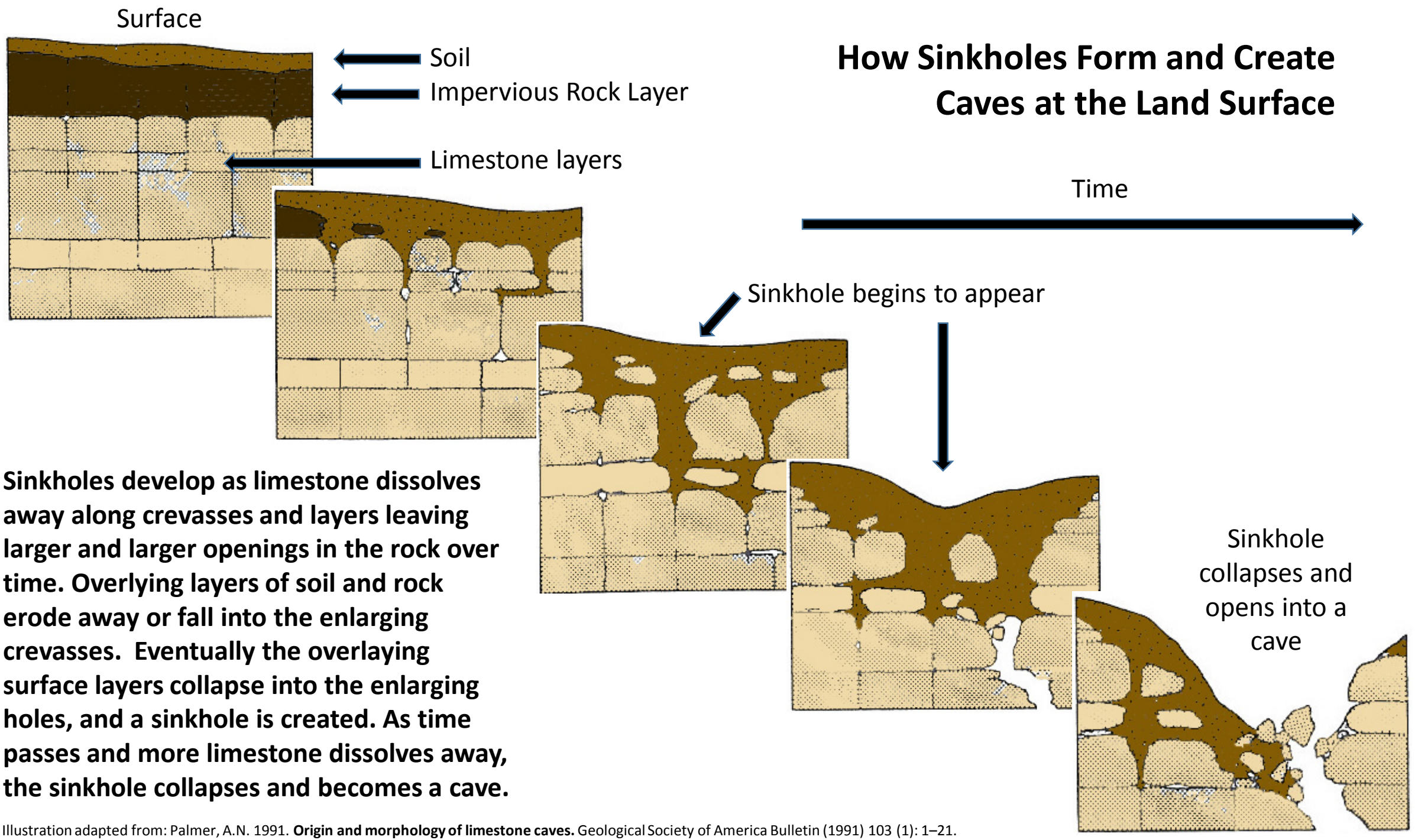
It's a place of wide open tunnels, underground rivers, and caves all connected to the surface by thousands of cracks and openings.

Photo: FROM TEXASAQUATICSCIENCE.ORG – THE UNDERWATER DESIGNER

Photo: FROM TEXASAQUATICSCIENCE.ORG – THE UNDERWATER DESIGNER

Photo: FROM TEXASAQUATICSCIENCE.ORG – THE UNDERWATER DESIGNER

How Sinkholes Form and Create Caves at the Land Surface



Sinkholes develop as limestone dissolves away along crevasses and layers leaving larger and larger openings in the rock over time. Overlying layers of soil and rock erode away or fall into the enlarging crevasses. Eventually the overlaying surface layers collapse into the enlarging holes, and a sinkhole is created. As time passes and more limestone dissolves away, the sinkhole collapses and becomes a cave.

Illustration adapted from: Palmer, A.N. 1991. **Origin and morphology of limestone caves.** Geological Society of America Bulletin (1991) 103 (1): 1–21.

Sink holes and depressions in the land surface are typical signs of openings to the aquifer.

Openings can be at or just below the surface.

Photo: RUDOLPH ROSEN


Photo: RUDOLPH ROSEN

Photo: RUDOLPH/ROSEN


Photo: RUDOLPH ROSEN

Photo: RUDOLPH ROSEN

Photo: RUDOLPH ROSEN

Sink holes and depressions in the land surface are typical signs of openings to the aquifer at or just below the surface.

Sink holes and depressions in the land surface are typical signs of openings to the aquifer at or just below the surface.

Photo: RUDOLPH ROSEN


Photo: RUDOLPH ROSEN

Photo: RUDOLPH ROSEN

Photo: RUDOLPH ROSEN

Photo: RUDOLPH ROSEN

Photo: RUDOLPH ROSEN

Photo: RUDOLPH ROSEN

Sink holes and depressions come in many shapes, sizes and places.

Each may be a point of entry for runoff to reach the aquifer and our drinking water supply.

Photo: RUDOLPH ROSEN

This sinkhole measures 9 ft in diameter and 12 ft in depth. It receives flow from approximately 10 square meters off a hilltop.

This cavity is an enlarged fracture measuring 12 ft long by 3 ft wide by 1.6 ft deep. It receives flow off approximately 20 square meters of hillside.

Photos: MARCUS GARY

This cavity is an enlarged bedding plane measuring 5 x 1.5 ft and 1 ft deep. This feature has breakdown, silt, exposed bedrock, and vegetation present within. This feature is set high enough in the that it would not receive runoff from a roadway or ditch.

This enlarged fracture measures 1 x 4 ft and is 2 ft high. The feature contains exposed bedrock and broken rock fragments. It is located in a roadcut of Loop 1604.

Photos: MARCUS GARY

This sinkhole measures 3 ft in diameter and 1 ft in depth. The bottom is plugged with soft fill. The drainage area for this feature is very small at 21 square feet.

This sinkhole measures 4 x 3 ft and 4 ft deep. The feature contains loose rocks and silty soil. It is formed in a manmade drainage between the highway lanes of 1604 and the frontage road. The nature of this feature suggests that it is collapsing down into a natural opening below grade.

Photos: MARCUS GARY

This sinkhole measures 4.6 ft in diameter and 3 ft in depth. It appears to have a drain continuing further underground out of sight and out of reach

This cavity measures 1.5 x 1.5 ft and is 0.3 ft high The feature contains breakdown rocks, soil, and reddish brown clay.

Photos: MARCUS GARY

This sinkhole measures approximately 98 ft in diameter and 7 ft in depth. It receives drainage from the east, and the deepest part of the depression abuts a paved parking lot and a concrete drainage structure.

Photo: MARCUS GARY

This cavity measures 2.6 ft wide, 8.2 ft long, and 2.6 ft in vertical extent. It contains dry flowstone and exposed bedrock.

Hubcap Cave is located at the base of a road cut and slopes downward, with a vertical extent of 6.5 ft. The entrance is 6.6 ft wide, and this feature is at least 13.1 ft long.

Photos: MARCUS GARY

This cavity measures 4.5 x 3 ft and is 7 ft high. The feature contains silty clay, small breakdown, and exposed bedrock. This feature is formed at the base of a road cut, and slopes downward to a rubble fill.

This cavity is an enlarged bedding plane measuring 10 x 4.5 ft and is 1 ft high. The feature contains silt, breakdown, and exposed bedrock.

Photos: MARCUS GARY

This cavity measures 0.7 x 2.7 ft and is 0.5 ft high. The feature contains silt, pebbles, and exposed bedrock.

This cavity consists of an upper and lower void joined together by a shaft measuring 2 ft wide, extending 1.5 ft into a roadcut face, and 3.3 ft in total height.

Photos: MARCUS GARY

1. Look around.
2. Be aware.
3. Divert around or impound.

Thank you!

CREDITS

Production of the “Emergency Responder’s Guide to Protecting the Edwards Aquifer: Instructional Enhancements” was supported by funding from the City of San Antonio, through the voter-approved Proposition 1 Edwards Aquifer Protection Venue Project and the Edwards Aquifer Authority.

Production, design, and photographs by Rudolph Rosen, Ph.D., Institute for Water Resources Science and Technology, Texas A&M University-San Antonio and by Marcus Gary, Ph.D., Edwards Aquifer Authority.

Dr. Gary’s photographs were published previously in “Geologic Assessment – Loop 1604 Environmental Impact Study, Bexar County,” a report prepared for Michael J. Baker Jr., Inc., November 19, 2010.