

EA Project Summaries and Findings Report Project

Project 1 – Characterizing the Stormwater Runoff to Ground Water Quality Connection in the Recharge Zone of the Edwards Aquifer, Bexar, County, TX

Author: USGS

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Funding Amount

\$432,000

1 Summary

This study was performed to improve our understanding of the relationship between contaminants in surface water runoff and groundwater quality in the San Antonio Segment of the Edwards Aquifer recharge and contributing zones. A better understanding of this connection can clarify the impacts of urbanization on our watersheds, highlight the importance of protecting surface waters in these zones, and ultimately can help improve watershed management efforts.

The study collected water level and quality data from two pairs of hydrologically connected surface and groundwater sites to see how surface water impacts groundwater especially after large rainfall events (see Figure 1 with site pair 1&3 in Salado Creek and site pair 2&4 in West Elm Creek).

Stated objectives of the study – Develop a better understanding of the connection between contaminants in stormwater runoff (surface water) and the water quality in the Edwards Aquifer. This scientific study will improve our conceptual model of how the aquifer system works. In addition, the study will provide new data that will be important for calibrating potential future computer models that are used to simulate “what if” scenarios.

Justification for the study – Historically, studies on the Edwards Aquifer have collected data on either groundwater or stormwater runoff, but not both within the same study. A water quality network connecting stormwater runoff and groundwater quality provides the specific data needed to understand how development on the recharge zone in Bexar County is influencing water quality in the Edwards Aquifer.

1.1 Methods

The project team identified two sites where samples could be collected from creeks and nearby groundwater wells expected to be influenced by conditions in the creeks. The Salado Creek site pair is located within a less developed watershed of the contributing zone of the Edwards Aquifer. The West Elm Creek site pair is located in a watershed with a higher rate of development within the recharge zone of the Edwards Aquifer.

The project team collected water quality samples from both the creeks and wells, with an aim to capture water samples immediately after large storm events. The samples were analyzed for up to 20 different water quality components such as nutrients and for the presence of up to 226 different pesticides or pesticide-related compounds. The project team also installed long-term monitors at the groundwater well sites that collected some water conditions continuously.

The results of the water quality and water level sampling were then analyzed to determine if the concentrations within the aquifer changed as conditions in the creek changed, especially after large storm events. The project team also analyzed the nutrient results, specifically for nitrate, to assess potential sources of nitrate including human and animal waste, fertilizer, soil nitrogen, or rainfall.

1.2 Findings

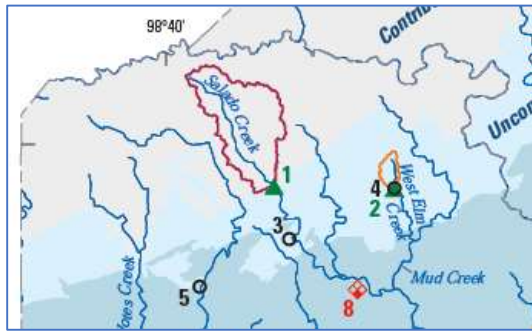


Figure 1 – Relative locations of surface water-groundwater site pairs within the contributing zone (grey) and recharge zone (light blue). See report for additional detail and figure legend.

Figure 1 of the report shows the timing of sample collection compared to rainfall and water levels in each site pair. The continuous sampling provided some of the most compelling insight into the hydrologic connectivity between the creeks and groundwater site pairs which can be seen in Figure 5 of the report. The West Elm Creek site pair showed a direct response of elevated groundwater level and nitrate (a commonly measured nutrient) concentration in the well after a rainfall event and elevated surface concentrations. This shows how quickly changes that happen at the surface within the recharge zone can directly impact conditions in the Edwards Aquifer. By contrast, conditions in the

groundwater well at the Salado Creek site pair (in the contributing zone) also changed after the rain event, but the effect was not as immediate or pronounced.

The analysis suggests that the sources of nitrogen are most likely from soil with a small component from wastewater sources. An overview of potential sources and land uses within the drainage area for each watershed would be a valuable next step in understanding the impact of urban development on local conditions. None of the nutrient-related concentrations were above any regulatory standard or screening level for nutrients.

At least one pesticide was detected at each surface water and groundwater site. Overall, 33 different pesticides were detected at the surface water sites and 13 different pesticides were detected at the groundwater sites. Of these, there were four samples above the benchmark (non-regulatory) for invertebrates: three at West Elm Creek, and one at the groundwater site pair for Salado Creek.

For the surface water sites, seven different pesticides were detected at Salado Creek and 25 were detected at West Elm Creek which is the more developed site. Additionally, the total number of pesticide detections and the average number of detections per sample were five times higher at the more developed West Elm Creek site versus the Salado Creek site. In the wells, pesticides were detected at the West Elm Creek groundwater site pair almost twice as often as the Salado Creek groundwater site pair.

In the more developed West Elm Creek site pair, the number of pesticide detections increased directly after groundwater levels rose due to a large storm event, but this relationship is not as clear in the Salado Creek site pair. For additional information, Figure 10 in the report shows a plot over time of the number of pesticide detections in each sample.

The authors note that changes in water quality at each groundwater well site indicate mixing from multiple sources such as ambient groundwater, recent surface-derived recharge, and possibly inflow from other aquifers rather than the direct hydrologic connectivity of the surface water and groundwater pair.

1.3 Challenges and Limitations

Understanding the connection between urbanization and groundwater quality is a complex challenge. This cannot be inferred from the input of stormwater runoff alone as changes related to local and regional hydrologic conditions also need to be considered.

Only four surface water samples were collected in part due to the challenges of surface water sampling and the limited amount of rainfall during the sampling period. Additional data collection at site pairs would be needed to identify significant trends or correlations.

Long term monitoring sites can offer tremendous value in providing continuous data but have associated challenges such as keeping the equipment safe and free from theft or vandalism, time, cost, and maintaining the equipment.

2 Benefits

The study provides multiple benefits for our understanding of the connection of surface water and groundwater. The overall contributions of the study are the following:

- The authors expanded the library of monitoring data for surface and groundwater sites. This project is the first to install continuous nitrate monitors in wells. At least one of the sites will continue to collect continuous data. The study also adds to the available dataset for groundwater-surface water model development and calibration.
- The study provides additional information on the connectivity of surface and groundwater sites within the Edwards Aquifer, including the speed of the impact during rainfall events.
- The project offers additional insight into the potential sources of nutrients. The analysis suggests that the sources of nitrogen are most likely from soil with a small component from wastewater sources.
- The study provides additional information about the levels of pesticides in surface and groundwater. The pesticide detections show that the aquifer condition is not currently critical but may be worsening as development increases. In addition, the rate of detection of pesticides in the more developed watershed were twice as high as those in the undeveloped watershed.

Project Deliverables:

Opsahl, S.P., Musgrove, M., and Mecum, K.E. (2020). Temporal and spatial variability of water quality in the San Antonio segment of the Edwards aquifer recharge zone, Texas, with an emphasis on periods of groundwater recharge, September 2017 – July 2019. U.S. Geological Survey Scientific Investigations Report 2020-5033. <https://doi.org/10.3133/sir20205033>.

Opsahl, S.P., Musgrove, M., and Mecum, K.E. (2020). Effects of urbanization on water quality in the Edwards aquifer, San Antonio and Bexar County, Texas. U.S. Geological Survey Fact Sheet 2020-3028. <https://doi.org/10.3133/fs20203028>.

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Fact Sheet

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Benefits

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- The study provides additional information on the connectivity of surface and groundwater sites within the Edwards Aquifer, including the speed of the impact during rainfall events.
- The project offers additional insight into the potential sources of nutrients. The analysis suggests that the sources of nitrogen are most likely from soil with a small component from wastewater sources.
- The study provides additional information about the levels of pesticides in surface and groundwater. The pesticide detections show that the aquifer condition is not currently critical but may be worsening as development increases. In addition, the rate of detection of pesticides in the more developed watershed were twice as high as those in the undeveloped watershed.

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Project Graphic

**Project 1 - Characterizing the Stormwater Runoff to Ground
Water Quality Connection in the Recharge Zone of the
Edwards Aquifer, Bexar, County, TX**
Study to evaluate the connection between
stormwater and groundwater

