

EA Project Summaries and Findings Report Project

Project 2 – Evaluation of Wastewater Disposal in the Recharge and Contributing Zones of the Edwards Aquifer Using a Coupled Surface-Water/Groundwater Model

Project Summary

Author: SWRI

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\$530,398

1 Summary

The *Comparative Evaluation of Wastewater Disposal Practices in the Contributing Zone of the Edwards Aquifer* study (SWRI WW Study) was performed to compare the relative impact that different methods of wastewater treatment and disposal would have on the quality of water recharged to the Edwards Aquifer. The SWRI WW Study included evaluation of three wastewater disposal alternatives that are relatively common in the state of Texas and include:

- On-site sewage facilities (OSSF), also commonly referred to as septic systems, where wastewater is contained and treated on site.
- Land application of treated effluent through a Texas Land Application Permit (TLAP), where treated wastewater from a wastewater treatment plant is used on-site or at a nearby location for irrigation or other beneficial uses.
- Discharge of treated wastewater through a Texas Pollutant Discharge Elimination Systems (TPDES) permit. This alternative includes the disposal of treated wastewater effluent from a wastewater treatment plant into surface waters. The study primarily relied on surface and groundwater modeling of total nitrogen loading to evaluate these impacts. There was also limited monitoring performed, but these data are not referenced much in the discussion of the study results and findings. The integrated surface- water / groundwater model developed for this study can be used to compare different wastewater system planning scenarios.

Stated objectives of the study – *This project will develop a coupled surface-water / groundwater model that accurately simulates solute transport from on-site sewage facilities (OSSF) or Texas Land Application Permit (TLAP) wastewater disposal in the Edwards Contributing Zone and that quantifies the impact of solute transport on recharge to the Edwards Aquifer, including the impact of residential land-use development on surface-water and groundwater quality.*

Justification for the study – *A critical but as yet unanswered question concerns what method of wastewater disposal imposes the greatest impact on the water recharging the Edwards Aquifer: wastewater disposal using individual OSSF or wastewater disposal by TLAP. Understanding the impact of wastewater disposal practices will provide a valuable tool when targeting areas within the Contributing and Recharge zones of the Edwards Aquifer that are most vulnerable to degradation from development.*

The most common current waste treatment and disposal method in this area is OSSF. This study compared OSSF to the two other types of disposal methods based on total nitrogen loading. The study results can be used to compare the current method to two other common methods in Texas to assess the potential impacts to receiving waters and the Edwards Aquifer.

1.1 Methods

The SWRI WW Study included the use of integrated numerical and analytical models to estimate the impacts of the three wastewater disposal methodologies by generating surface-water / groundwater regimes.

The study used total nitrogen as a conservative constituent to evaluate the impacts of the disposal methods on the trophic state of Helotes Creek and recharge into the Edwards Aquifer. Literature values were used for pollutant discharge concentrations and discharge volumes for the three disposal methodologies and input into the models to evaluate transport. Because the study treats total nitrogen as a conservative constituent, pollutant dynamics, uptake, retention in soils or other potential impacts to loading was not evaluated.

The model framework included an integrated surface-water / groundwater model using GSFLOW software, that links

- Watershed model PRMS-IV, and
- Groundwater model MODFLOW 2005.

Additional software programs were used for particle transport assessment (MODPATH) and to calculate water budgets for the MODFLOW model (ZONEBUDGET).

Nine scenarios were modeled. These were:

- Three scenarios that considered different future OSSF scenarios
 - The base scenario using the estimates for OSSFs currently in the study area.
 - Failing systems
 - Increases in numbers of OSSFs.
- Four scenarios with TLAP facilities. These included two scenarios using aerial dispersion and two scenarios that used injection.
- One TPDES disposal scenario.

1.2 Findings

The authors of the SWRI WW Study suggest that based on the modeling results, the transition from OSSFs to disposal through either a TLAP or a wastewater treatment plant would increase the loads of total nitrogen to the Edwards Aquifer. The relative amounts of total nitrogen discharged to the Edwards Aquifer are shown in Figure 1 (Figure 5-3 of the SWRI report). The graph shows results based on relative total nitrogen mass to the base scenario. As shown in the graph, the results of the scenarios are all within about 25% of each other.

The study also claims that based on the transport simulations, if either a TLAP or TPDES facility were installed in the Helotes Creek watershed and the amount of wastewater disposed was “substantially” increased, the trophic state of Helotes Creek would be further degraded.

Numbers used for the TPDES scenario are based on concentrations for package wastewater treatment systems that are often higher in total nitrogen than traditional engineered systems.

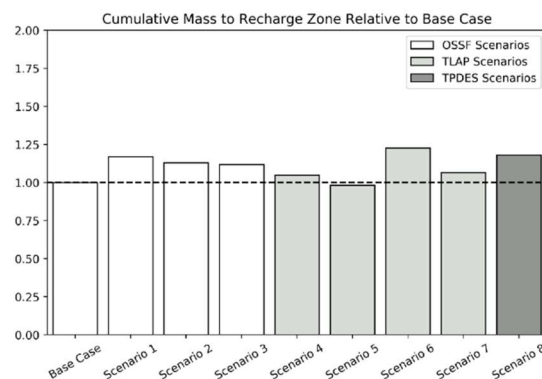


Figure 1 – Relative Total Nitrogen mass to EARZ

1.3 Challenges and Limitations

In addition to the scenarios that were run during this study, there are many potential upgrades to the model that could enable users to better understand the impact of planning strategies. Updating the model framework to evaluate the impacts of loading of total nitrogen to concentrations in the Edwards Aquifer or Helotes Creek could provide a better understanding of impacts from the different systems.

Literature on septic systems and other sources includes large ranges and variability for the parameters modeled, and the results of the model depend highly on the values used. Therefore, it would be beneficial to perform model runs under multiple different scenarios to better understand potential variability in the results. The modeled scenarios included in such an effort should consider local studies, such as that by Barrett and Charbeneau who estimated the average total nitrogen recharged to the aquifer (Barrett and Charbeneau, 1996b).

The concentration of total nitrogen for failing systems is assumed to be twice that of performing systems. Additional studies can be used to verify or adjust this number.

In addition, future efforts should consider validation of the model results. The base case scenario assumes that there are no non-permitted systems and no failing systems. Comparing TPDES and TLAP scenarios to a base case with no non-permitted or failing systems may underestimate the loading from the current condition. Validation of the model could be used to help verify this and potentially update the model.

Another future effort could be updates to the model for the evaluation of travel time. In addition, it would be interesting to evaluate the future growth condition impacts for TLAP and wastewater treatment plants.

2 Benefits

This study provides multiple benefits to understand the impacts of wastewater management alternatives on Edwards Aquifer water quality, including septic systems, TLAP systems, and wastewater treatment plant discharge. The model can also be expanded in the future to help understand other potential management scenarios.

The benefits of the study include:

- The authors developed an integrated surface-water / groundwater model. The model framework can be used to make predictions about pollutant loading to the Edwards Aquifer and Helotes Creek for different wastewater management scenarios and to help guide policy.
- The authors expanded the local dataset for groundwater pollutant data. This can help support our understanding of the system and future modeling efforts.
- The study provides new insights into surface-water / groundwater connectivity.

Project Deliverables:

Flores, M. E., Green, R.T., Nicholaides, K., Southard, P., Nunu, R., Ferrill, D., Watler, G., Stothoff, S., Martin, M. (2020). Comparative evaluation of wastewater disposal practices in the contributing zone of the Edwards aquifer. Southwest Research Institute.

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Benefits

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Project Graphic

**Project 2 - Evaluation of Wastewater Disposal in the
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Study to evaluate the relative loading of pollutants from
wastewater disposal practices

