

Processes Affecting Nitrogen Speciation in a Karst Aquifer

Barbara Mahler

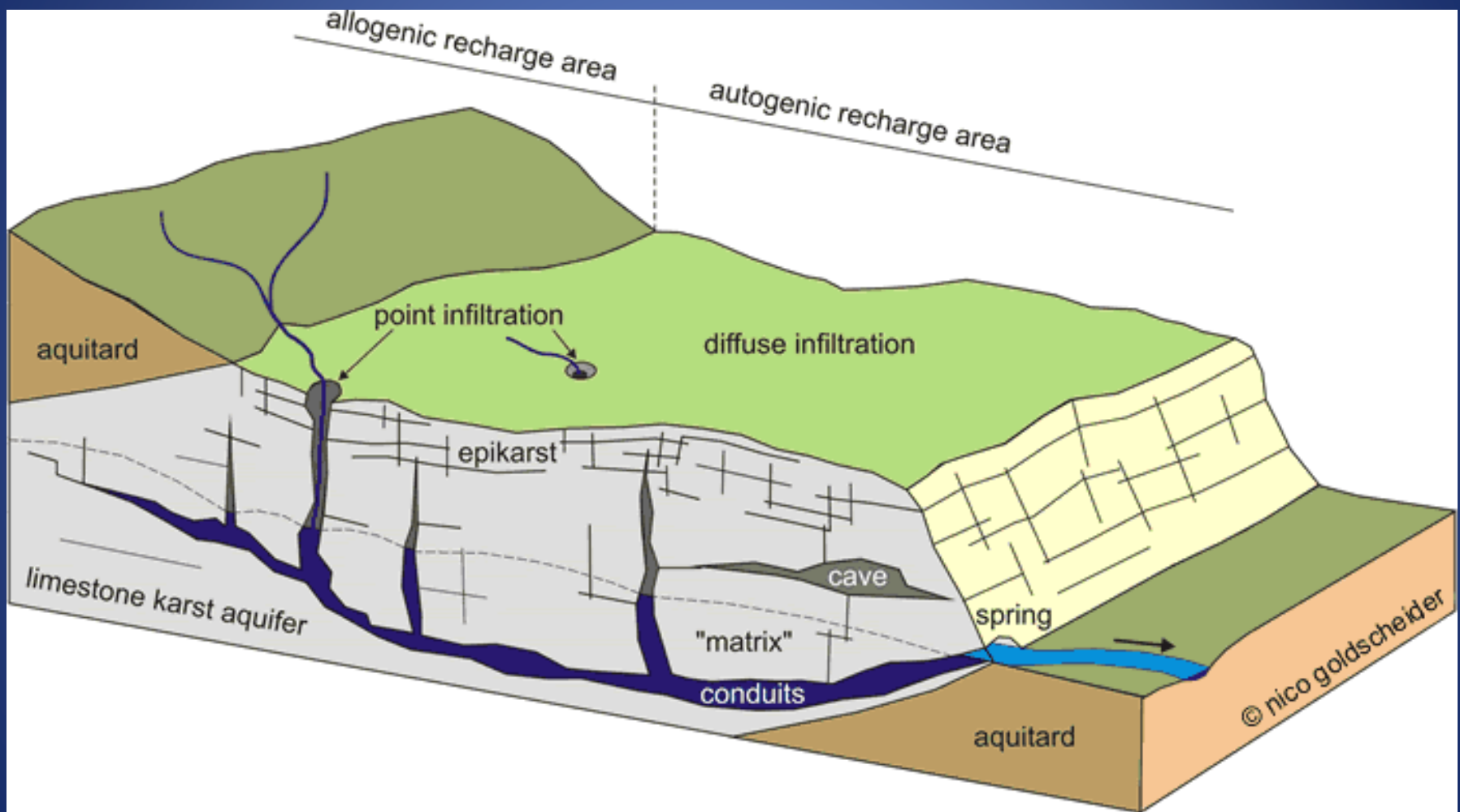
MaryLynn Musgrove

U.S. Geological Survey

Corinne Wong

University of Texas

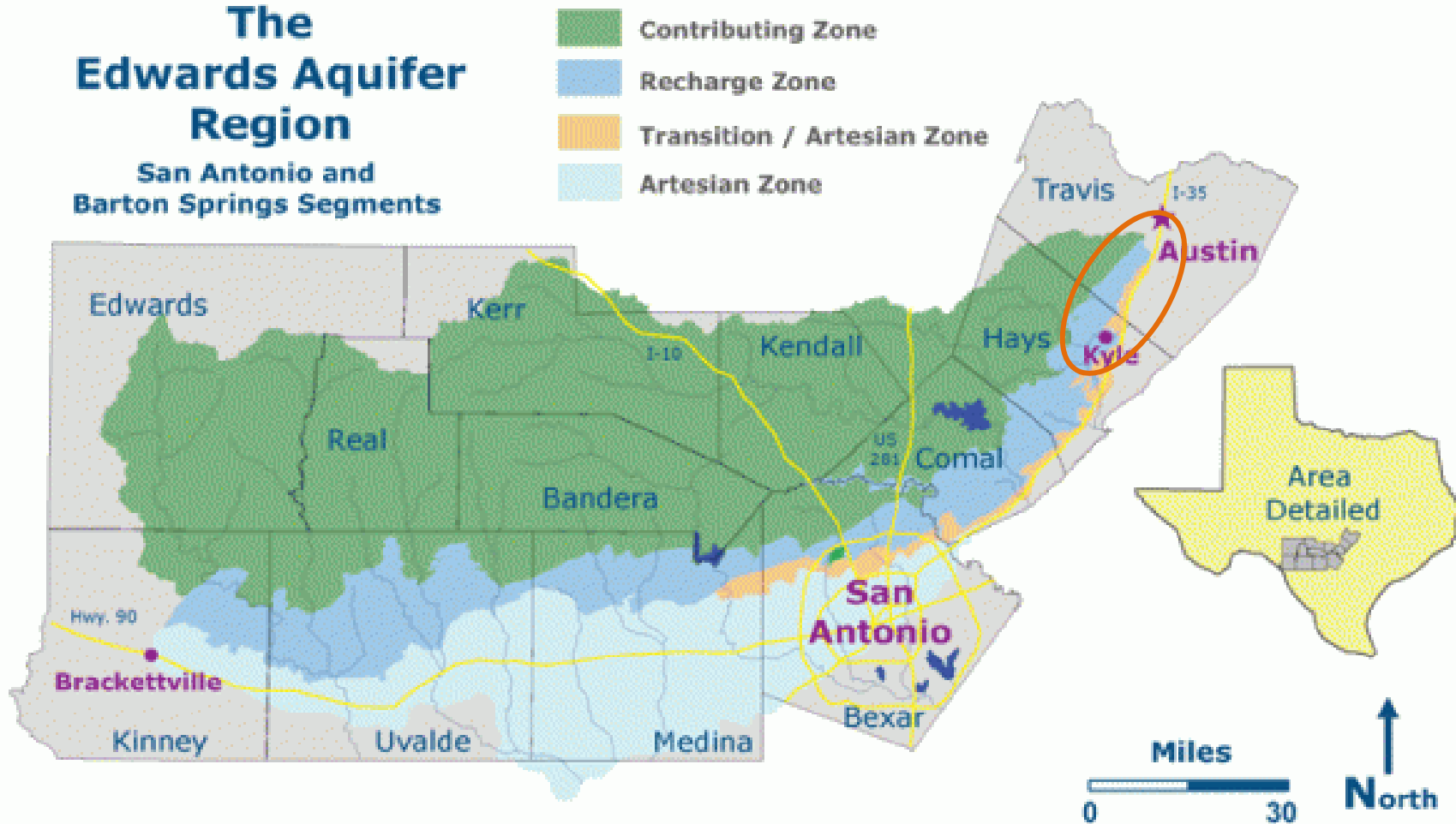
Anatomy of a karst aquifer



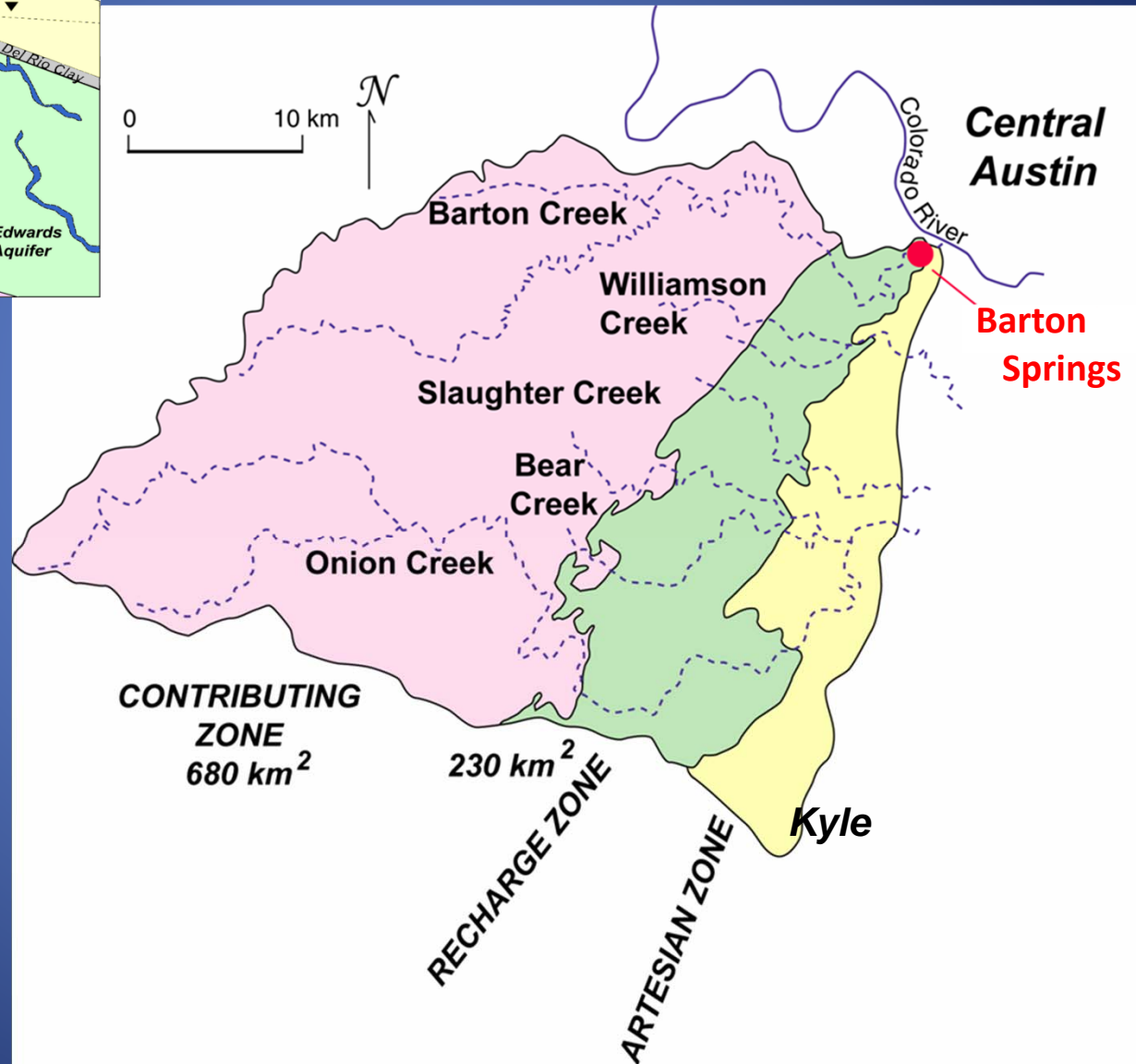
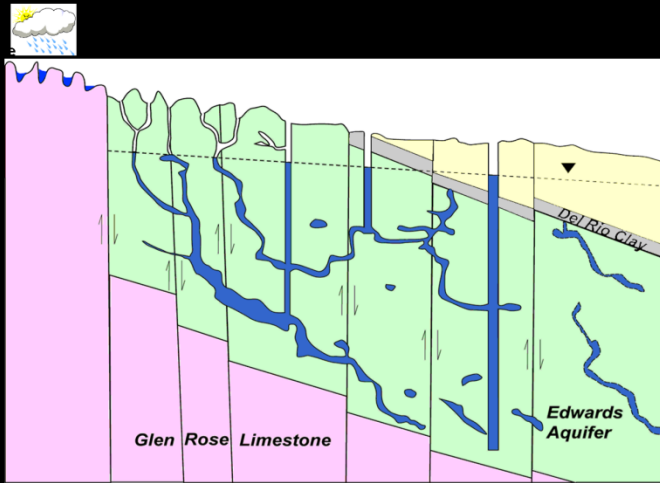
The Edwards Aquifer and the Barton Springs segment

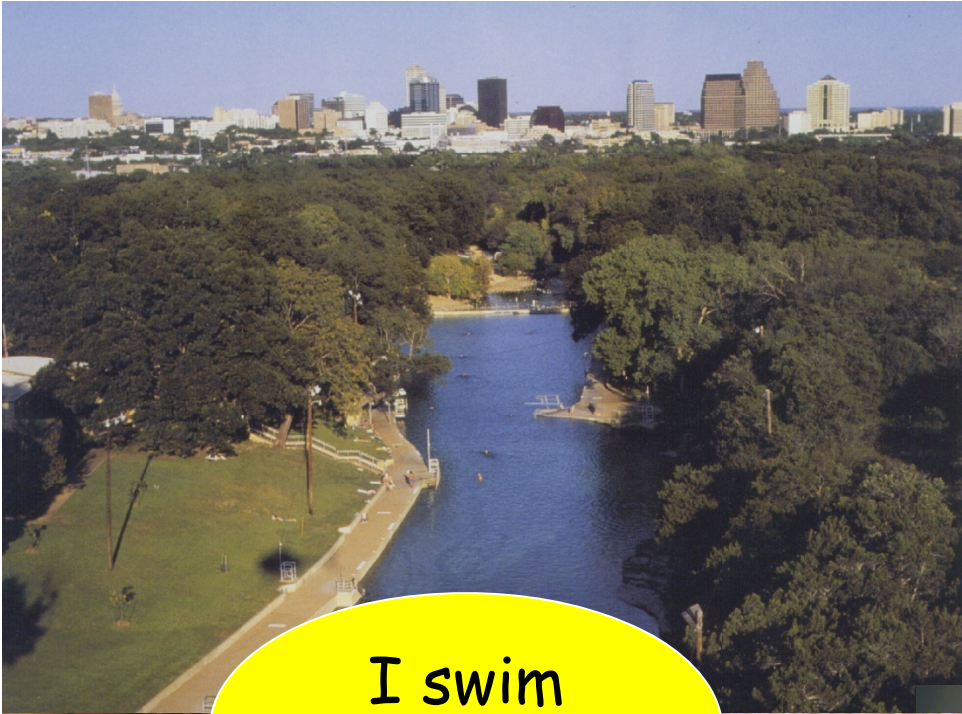
The Edwards Aquifer Region

San Antonio and Barton Springs Segments



The Barton Springs segment

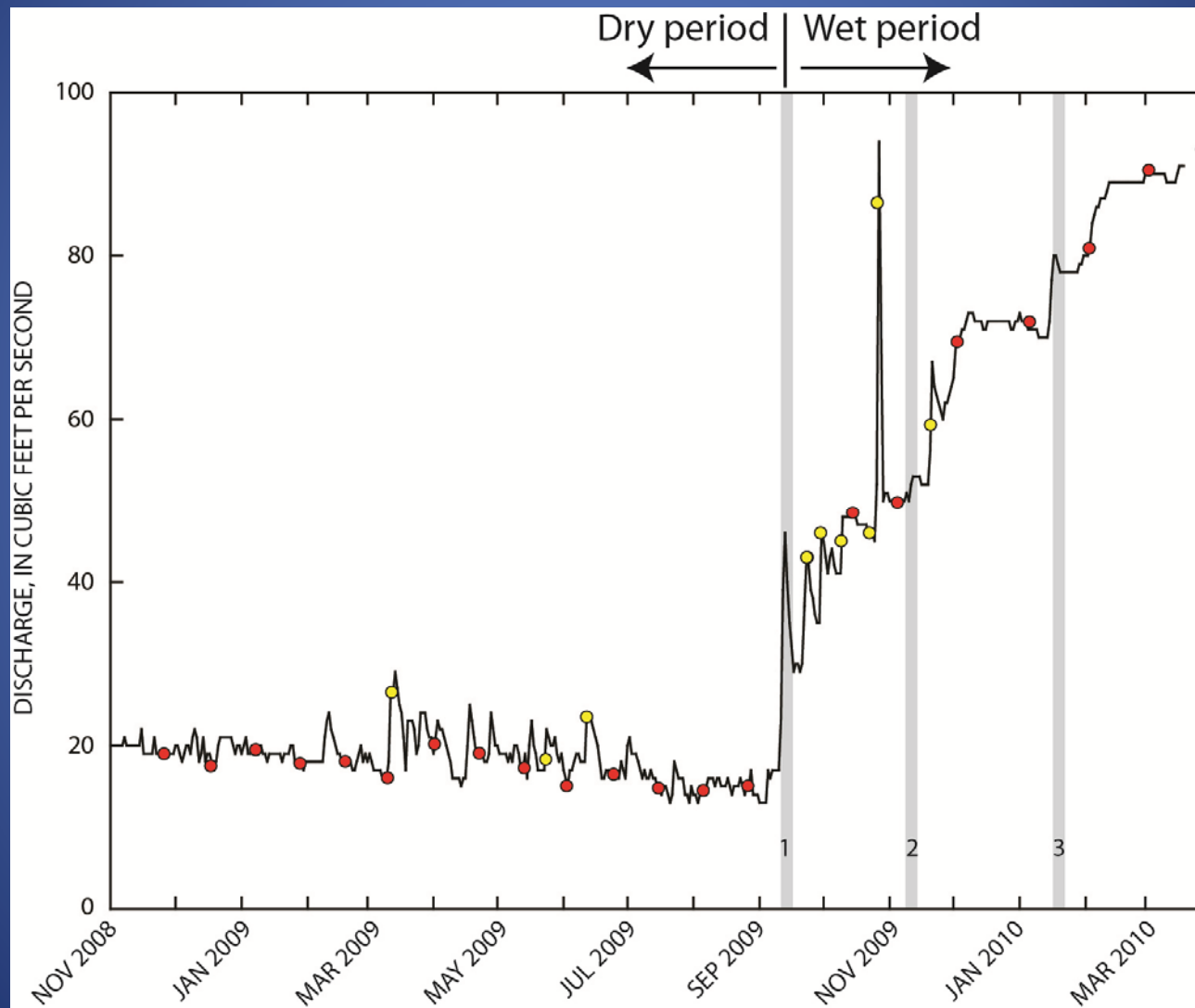




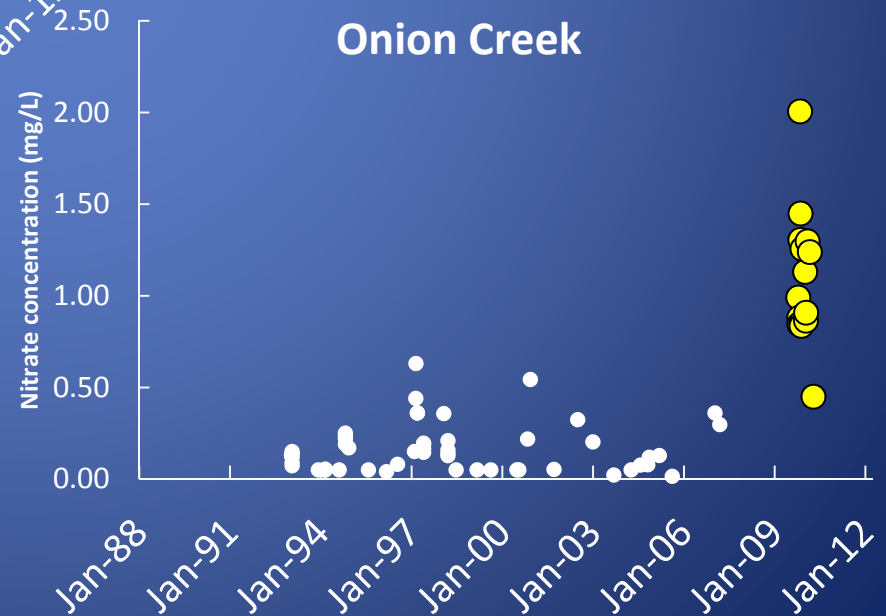
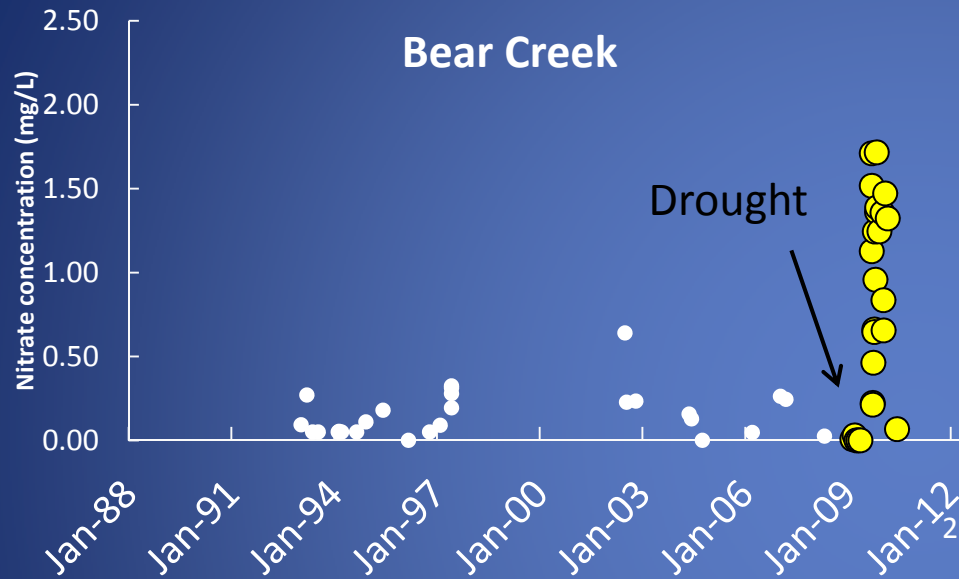
I swim here too!



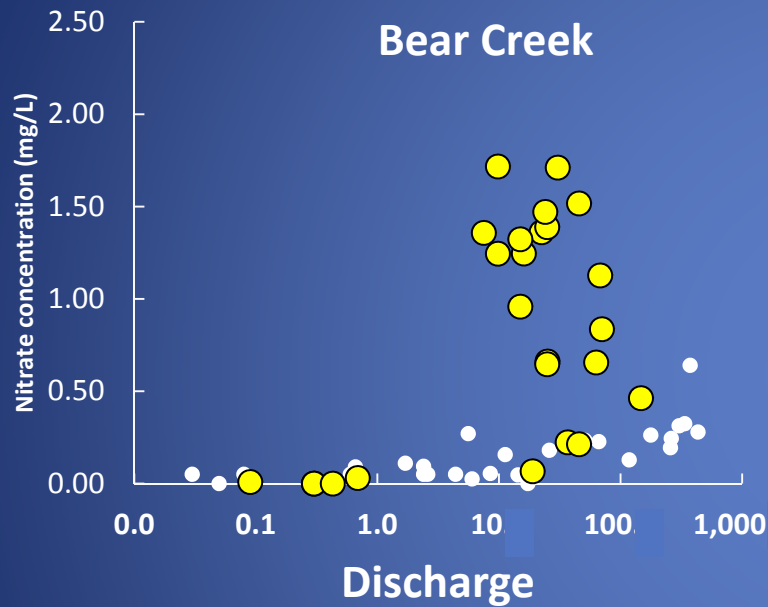
Hydrologic conditions: transition from drought to post-drought



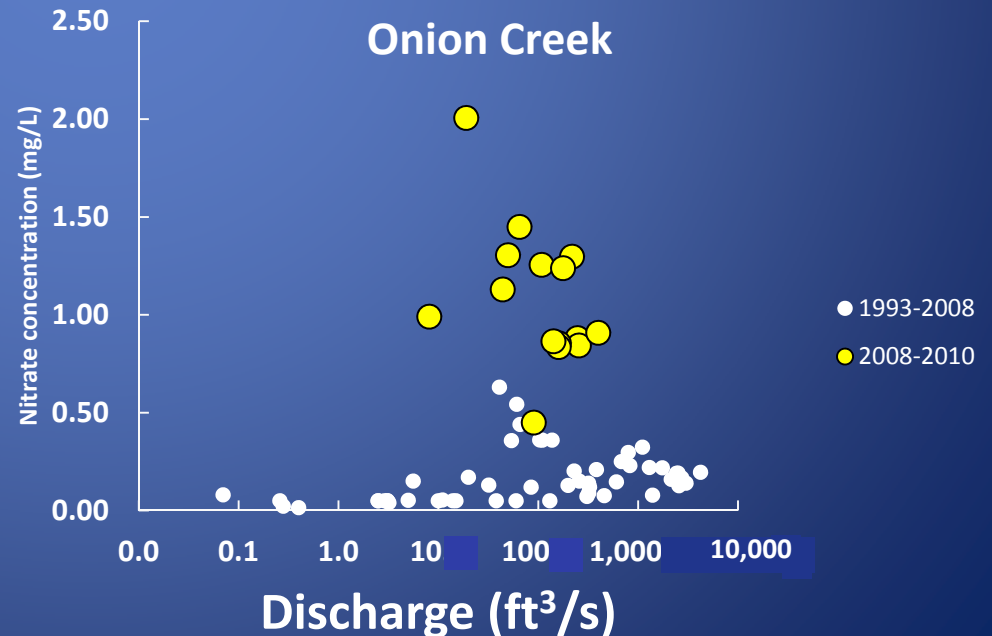
Unprecedentedly high nitrate concentrations



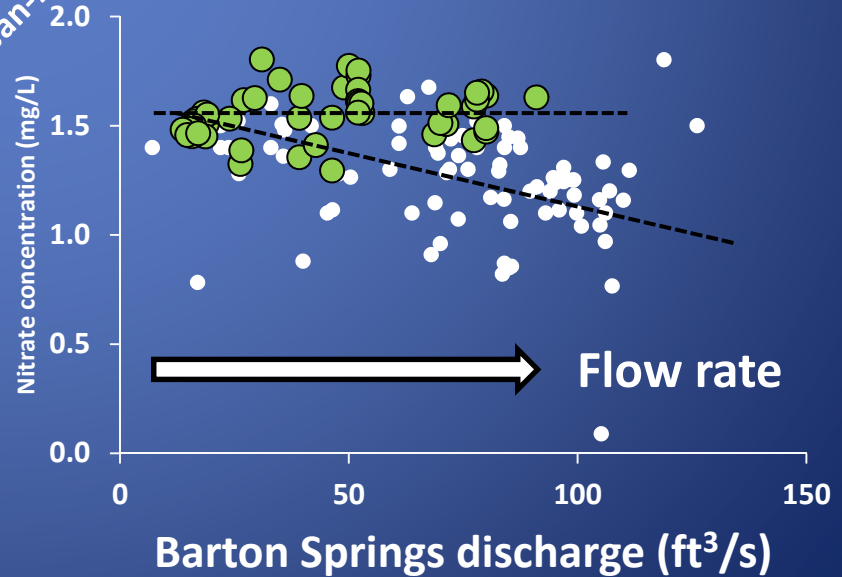
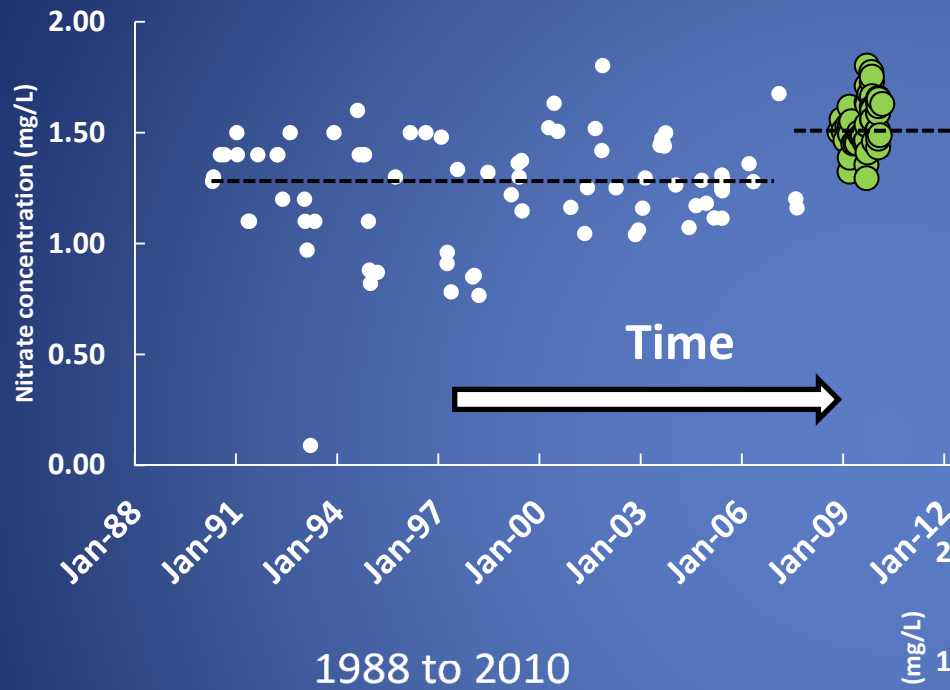
Nitrate high relative to discharge

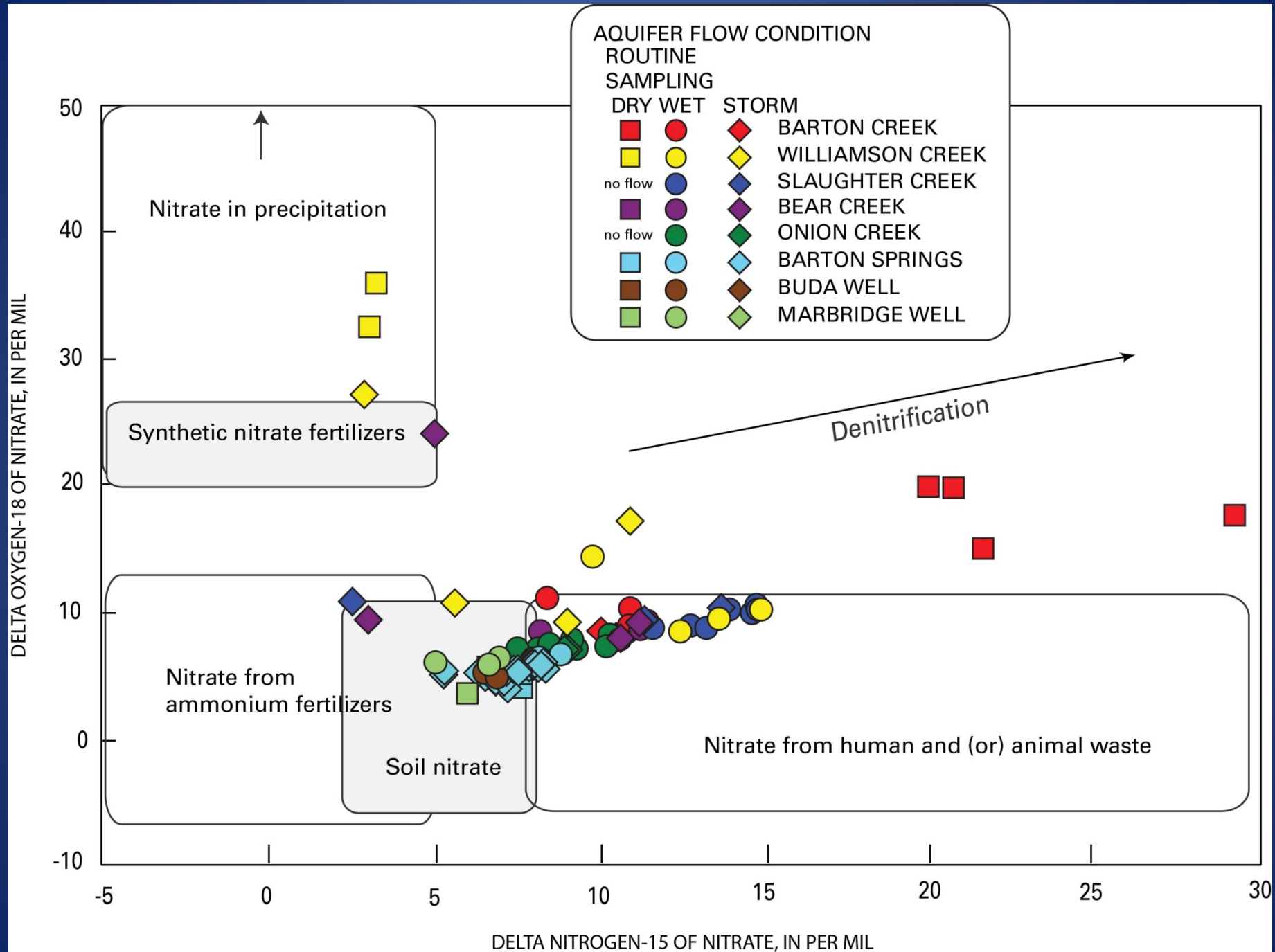


Flow rate



What's happening in Barton Springs?

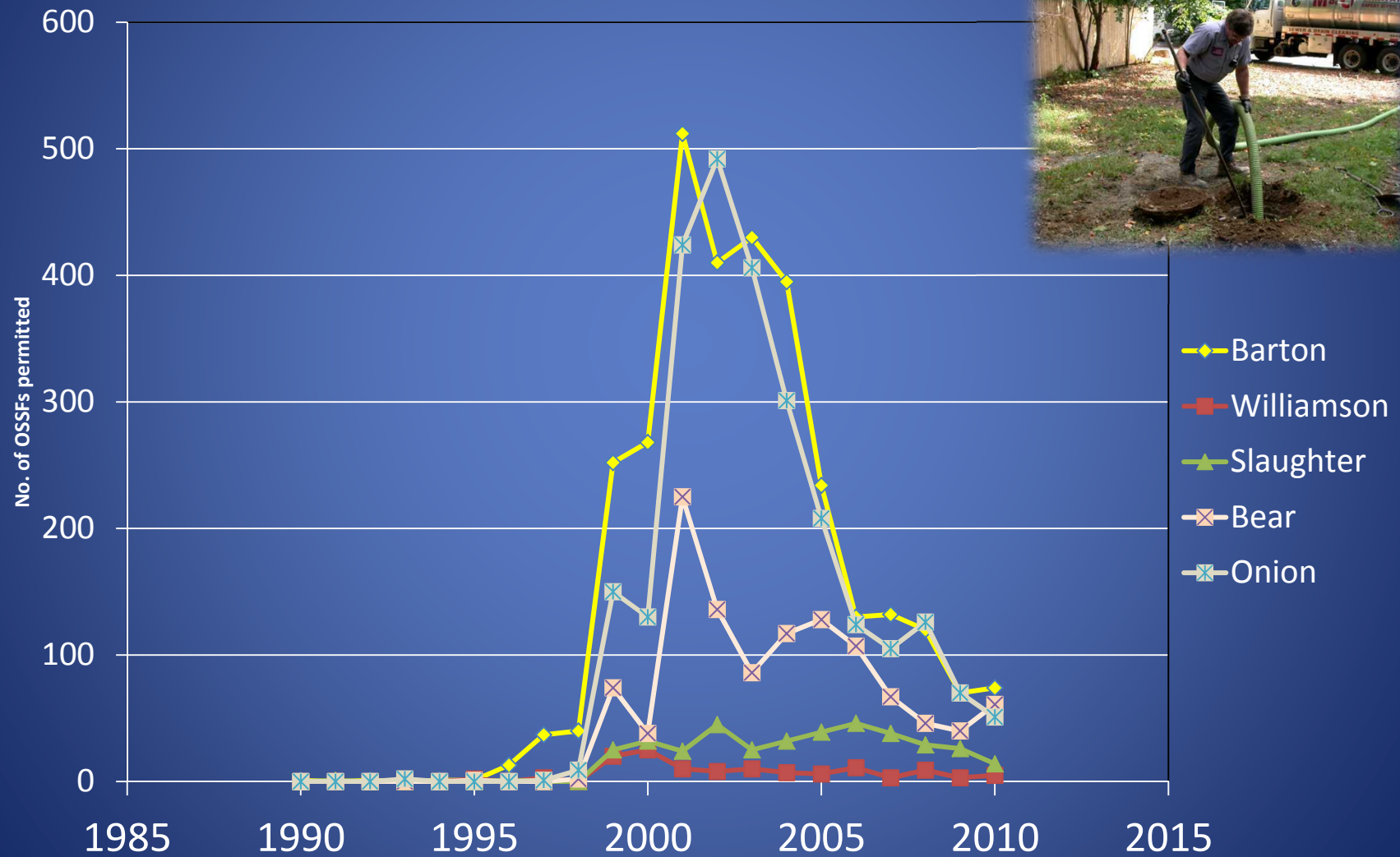




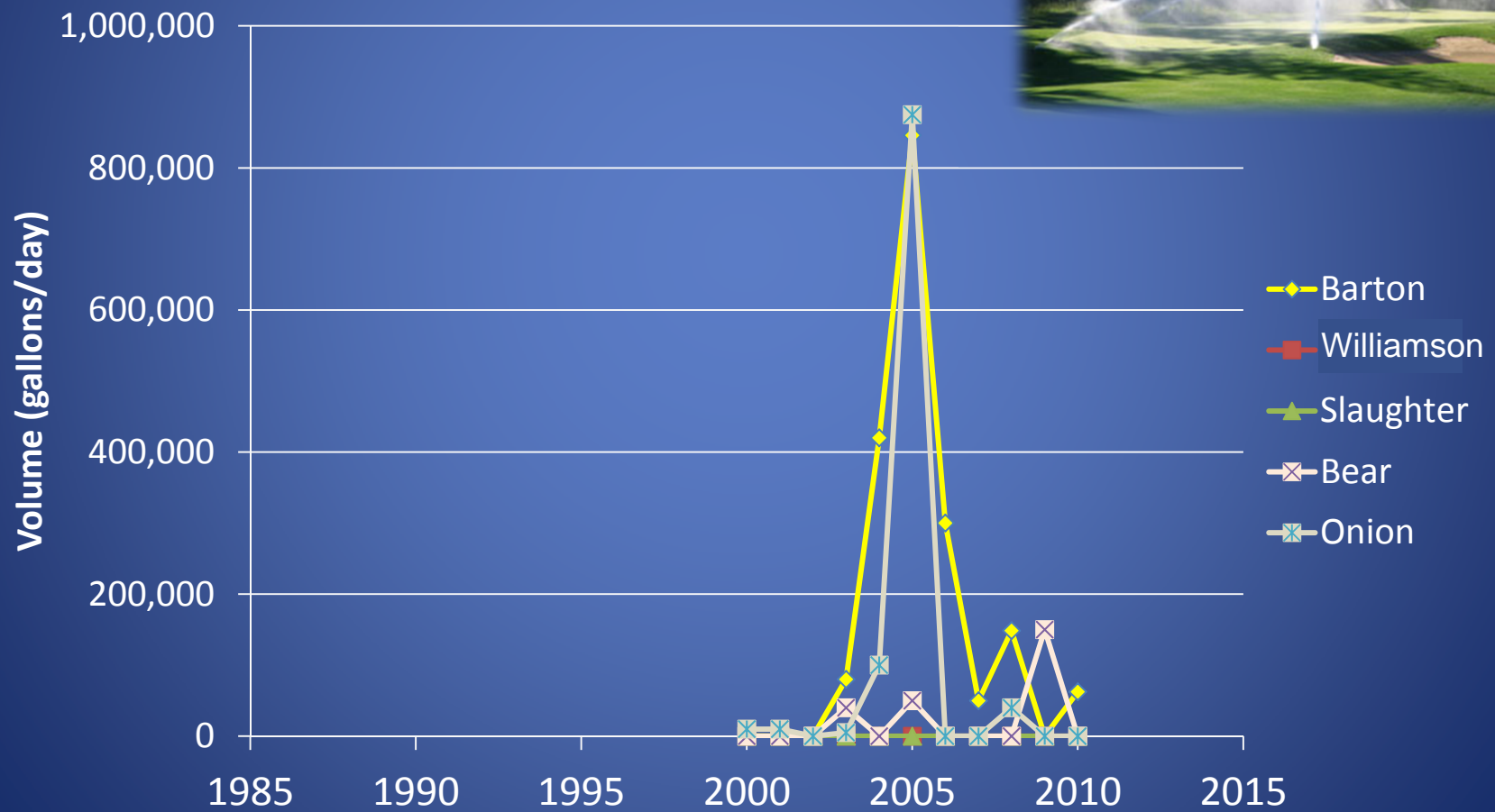
What's changed?



Septic systems permitted by year



Irrigation volume permitted by year



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USGS Water Resources Applications Software: LOADEST

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Load Estimator (LOADEST): A Program for Estimating Constituent Loads in Streams and Rivers

Welcome to the U.S. Geological Survey (USGS) Web page for the LOADEST software package. This page provides access to the LOADEST software and documentation. These items and additional features may be accessed using the navigational tabs at the top of the page.

LOAD ESTimator (LOADEST) is a FORTRAN program for estimating constituent loads in streams and rivers. Given a time series of streamflow, additional data variables, and constituent concentration, LOADEST assists the user in developing a regression model for the estimation of constituent load (calibration). Explanatory variables within the regression model include various functions of streamflow, decimal time, and additional user-specified data variables. The formulated regression model then is used to estimate loads over a user-specified time interval (estimation). Mean load estimates, standard errors, and 95 percent confidence intervals are developed on a monthly and(or) seasonal basis.

The calibration and estimation procedures within LOADEST are based on three statistical estimation methods. The first two methods, Adjusted Maximum Likelihood Estimation (AMLE) and Maximum Likelihood Estimation (MLE), are appropriate when the calibration model errors (residuals) are normally distributed. Of the two, AMLE is the method of choice when the calibration data set (time series of streamflow, additional data variables, and concentration) contains censored data. The third method, Least Absolute Deviation (LAD), is an alternative to maximum likelihood estimation when the residuals are not normally distributed. LOADEST output includes diagnostic tests and warnings to assist the user in determining the appropriate estimation method and in interpreting the estimated loads.

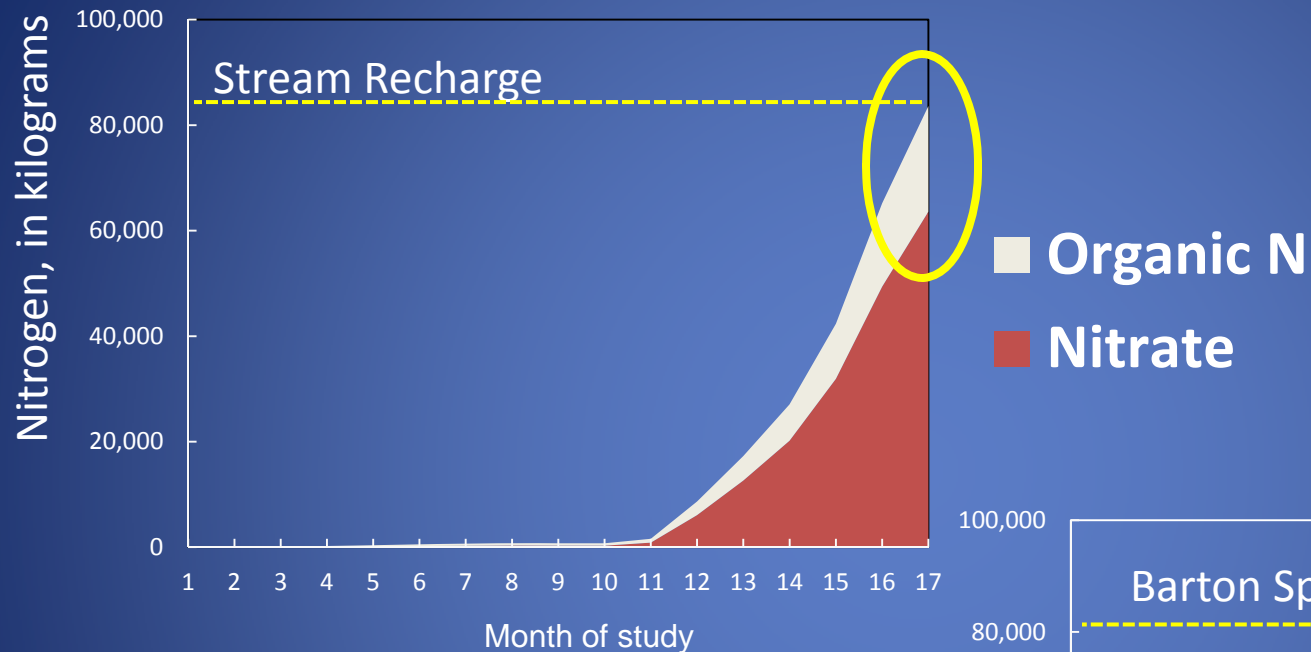
The LOADEST software and related materials (data and documentation) are made available by the U.S. Geological Survey (USGS) to be used in the public interest and the advancement of science. You may, without any fee or cost, use, copy, modify, or distribute this software, and any derivative works thereof, and its supporting documentation, subject to the USGS software [User's Rights Notice](#).

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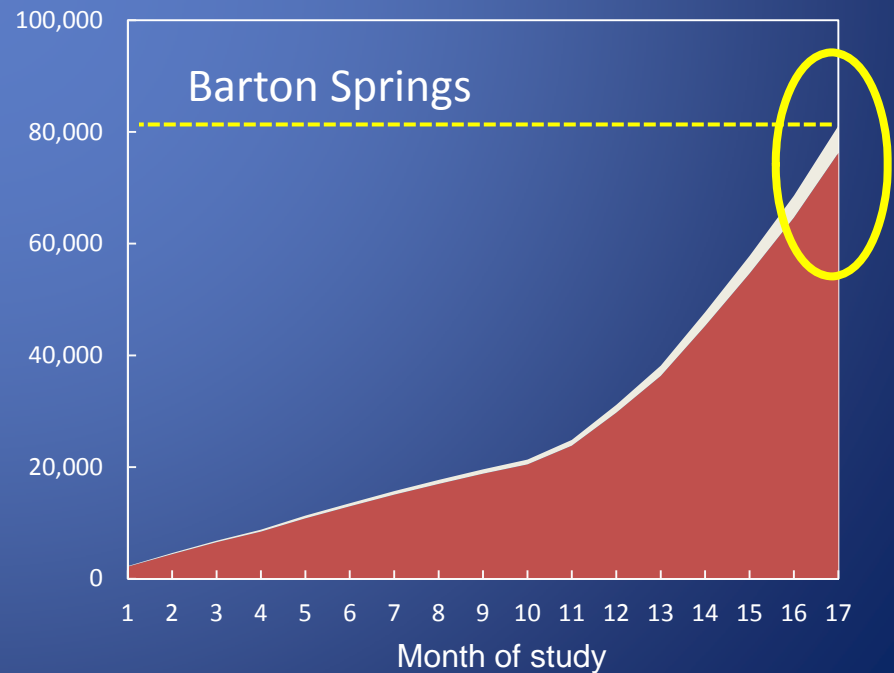
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Cumulative N loading



- Total N is being stored in the aquifer
- Organic N is being converted to nitrate in the aquifer



Implications of nitrification

- Organic nitrogen \rightarrow NH_4^+ (ammonification)
- $\text{NH}_4^+ + 1.5 \text{ O}_2 \rightarrow 2\text{H}^+ + 2\text{H}_2\text{O} + \text{NO}_2^-$
- $\text{NO}_2^- + 0.5 \text{ O}_2 \rightarrow \text{NO}_3^-$
- For every mg of ammonia oxidized to nitrate, 4.18 mg of oxygen are consumed
- Nitrification lowers the pH



Infiltration and discharge to surface water



Partial ammonification and nitrification; recharge to groundwater



Continued ammonification and nitrification of organic nitrogen



In cooperation with:

- Texas Commission on Environmental Quality
- City of Austin
- City of Dripping Springs
- Hays County
- Lower Colorado River Authority
- Barton Springs/Edwards Aquifer Conservation District

Additional information

- Real-time physical properties at Barton Springs (site 08155500): <http://tx.usgs.gov/>
- USGS Fact Sheet: <http://pubs.usgs.gov/fs/2011/3035/>
- USGS Scientific Investigations Report: <http://pubs.usgs.gov/sir/2011/5018/>

