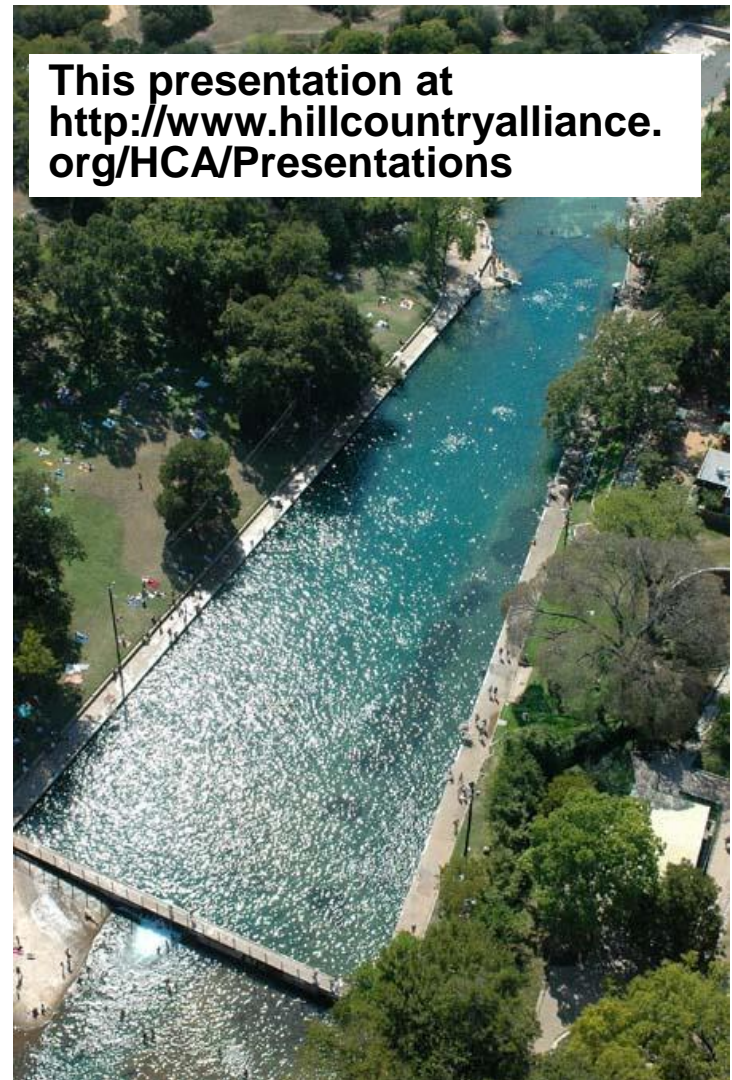
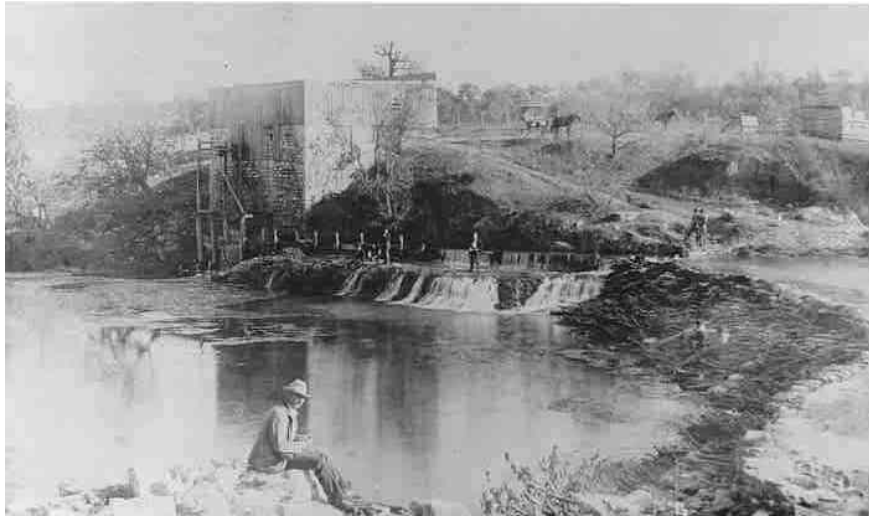


The Barton Springs Part of the Edwards Aquifer: Basic physical and hydrologic characteristics pertinent to permitted discharges

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Presentation organization

- **Summary comparison of size and water in Barton Springs and San Antonio parts of the Edwards aquifer**
- **Water quality limitations for effluent discharges**
- **Threat to Edwards aquifer and Barton Springs due to lack of appropriate protection from effluent discharges in upper Barton Creek**
- **Vulnerability of Edwards aquifer to nutrients**
- **Lack of attenuation of quantity or water quality for effluent discharges in Barton Springs contributing zone**
- **Rapid movement of water in the aquifer**
- **Summary of no flow and low flow characteristics for recharge zone**
- **Comparison of stream water quality and permitted discharge quality**
- **Summary**

San Antonio

Barton Springs

Barton Springs values as percent of San Antonio values

Comparison of Characteristics: San Antonio and Barton Springs parts of the Edwards aquifer

4400
1500
2100

264
90
60

- Contributing zone (sq mi)
- Recharge zone
- Transition/Artesian zone
- Artesian zone

6.0 %
6.0 %
2.8 %

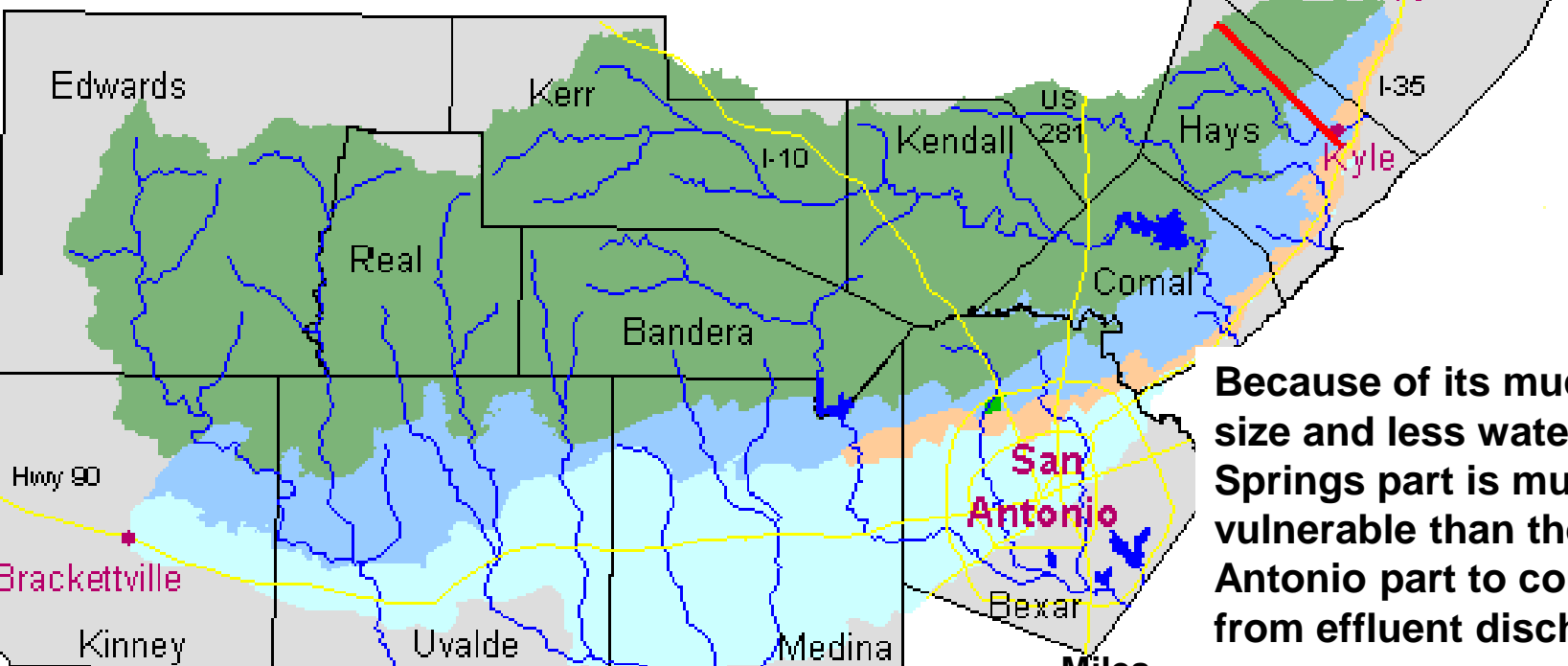
3600
45
731

150
0.31
36

- Aquifer Area
- Stored Water (million ac-ft)
- Mean Recharge (thousand ac-ft/yr)

4.2 %
0.7 %
4.9 %

**Barton Springs part NE of red boundary.
San Antonio part SW of red boundary**



Because of its much smaller size and less water, the Barton Springs part is much more vulnerable than the San Antonio part to contamination from effluent discharge

0 30 Miles

Water quality limitations for effluent discharges

§311.43 Effluent Requirements for All Tributaries of Segment 1428 of the Colorado River and Segment 1427, Onion Creek, and Its Tributaries, of the Colorado River Basin.

- 5 mg/L carbonaceous biochemical oxygen demand
- 5 mg/L total suspended solids
- 2 mg/L ammonia nitrogen
- 1 mg/L phosphorus

§ 213.6.c.1 Effluent requirements for permitted discharges in the contributing zone within 5 stream miles of the Edwards aquifer recharge zone (same levels as above)

§ 213.6.c.2 Effluent requirements for permitted discharges in the contributing zone within 5-10 stream miles of the Edwards aquifer recharge zone

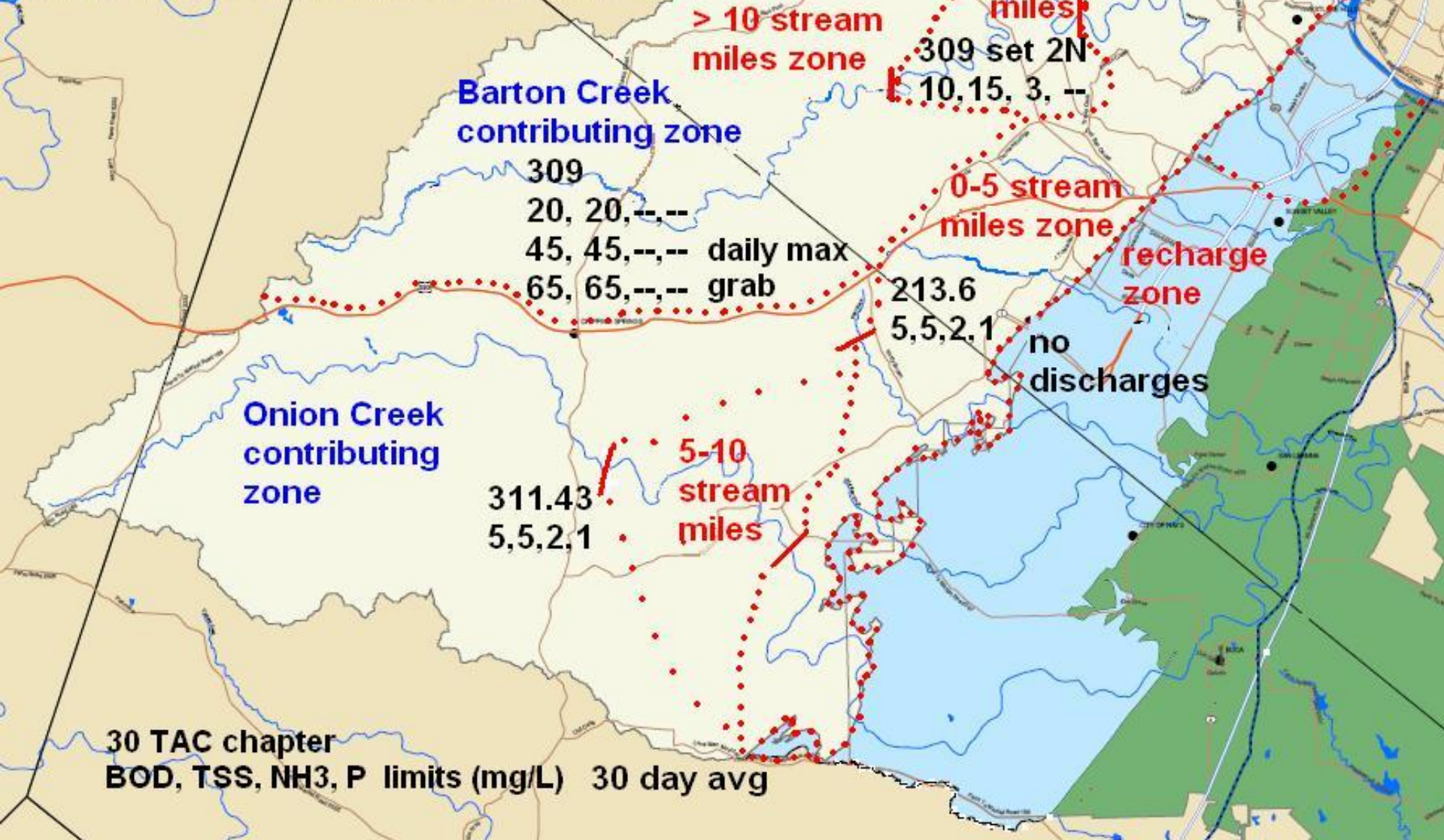
- 10 mg/L carbonaceous biochemical oxygen demand
- 15 mg/L total suspended solids
- 3 mg/L ammonia nitrogen

However, neither of the above rules apply to the contributing zone of Barton Creek at least 10 miles upstream from the recharge zone

§ 309 Applies to Barton creek >10 miles from recharge zone

- 20 mg/L carbonaceous biochemical oxygen demand
- 20 mg/L total suspended solids

Discharge water quality limits for areas within the Barton Springs Edwards Aquifer contributing zone



Relation of Barton Creek to Barton Springs

- **The recharge zone for Barton Creek is adjacent to Barton Springs part**
- **Samples from Barton Springs during many storm events document that recharge from Barton Creek provide immediate discharge from Barton Springs.**

“The quality of water at the springs responds rapidly to changes in quality of recharge contributed by Barton Creek. Ground water originating from Barton Creek remains in the aquifer for only a short period before discharging at Barton Springs; thus processes such as absorption, adsorption, and chemical precipitation have relatively little time to decrease concentrations of water-quality constituents of that water. Because of the amount and proximity of recharge contributed by Barton Creek, this creek has a greater impact upon the quality of Barton Springs than any other recharge source.”

-- Slade, R.M., Jr., Dorsey, M.E., and Stewart, S.L., 1986, Hydrology and water quality of Barton Springs and associated Edwards aquifer in the Austin area, Texas: U.S. Geological Survey Water-Resources Investigations Report 86-4036, 117 p.

Vulnerability of Edwards aquifer to nutrients

Phosphorus

Phosphorus levels as low as **0.05 mg/l** have produced as much as one-half of the average algal biomass in Texas streams studies and phosphorus concentrations as low as **0.20 mg/l** cause full maximum algae production in streams. (Kiesling and others, 2001, p. 35-37).

The Edwards aquifer contributing zone permitted discharge value for phosphorus (1.0 mg/l) is **20 times** larger than the first value above and **5 times** larger than the second value

Kiesling, R.L., McFarland, A.M.S., and Hauck, L.M., 2001, Nutrient Targets for Lake Waco and North Bosque River: Developing Ecosystem Restoration Criteria: Texas Institute for Applied Environmental Research Report TR0107. 52 p.

Vulnerability of Edwards aquifer to nutrients (cont.)

U.S Environmental Protection Agency recommendations for nutrient criteria for Region IV (which includes the Barton springs area) are **0.56 mg/l** for total nitrogen and **.023 mg/l** for total phosphorus. (U.S Environmental Protection Agency, 2002).

The permitted discharge value for the Edwards aquifer contributing zone for ammonia nitrogen (2 mg/l) is **3.6 times** larger than the recommended nitrogen value and the permitted discharge value for phosphorus is **43 times** larger than the recommended phosphorus value.

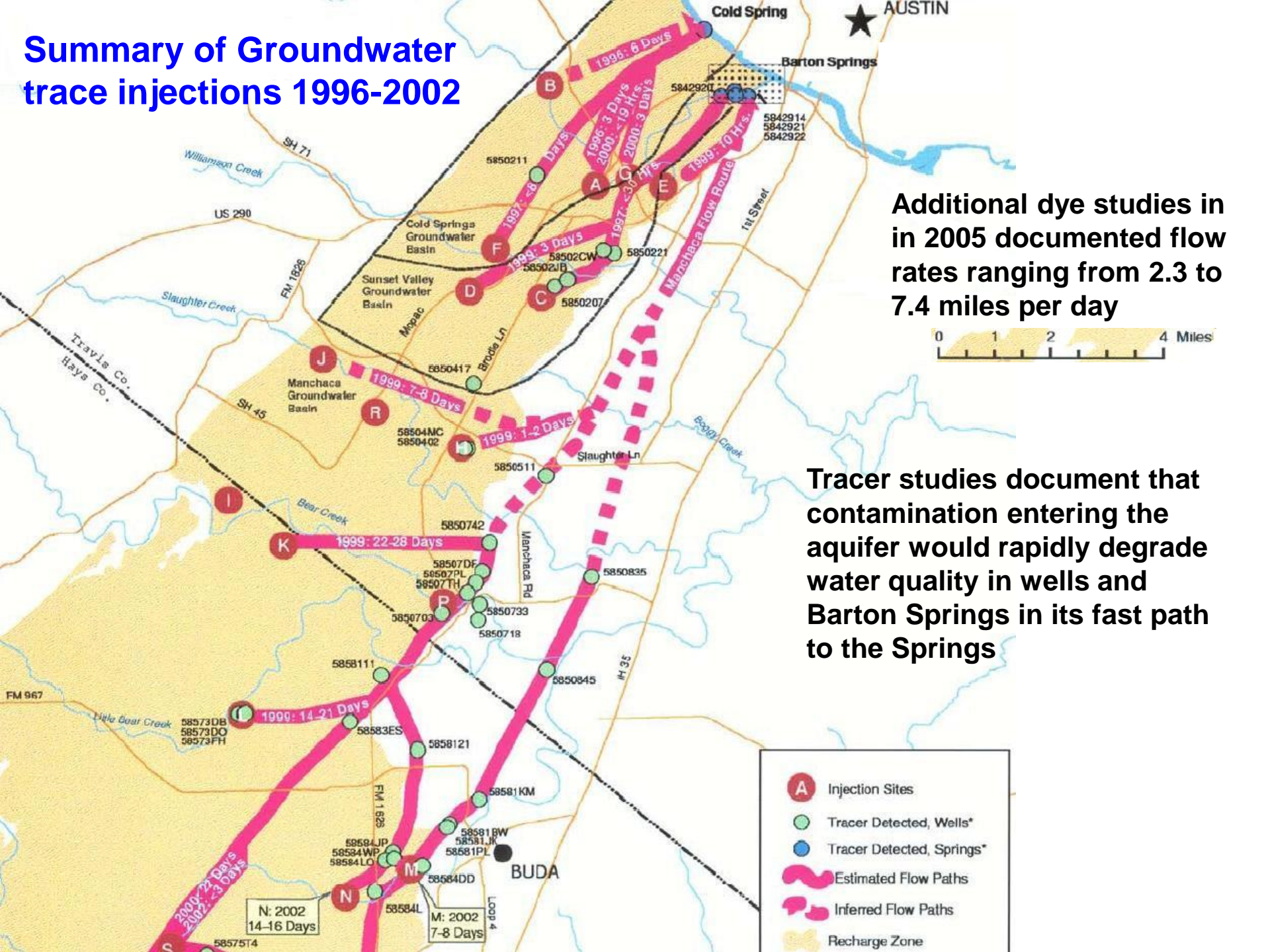
U.S. Environmental Protection Agency, 2002, Summary Data for the Nutrient Criteria Documents: Ambient Water Quality Criteria Recommendations—Rivers and Streams in Nutrient Ecoregions.

Lack of attenuation of quantity or water quality for effluent in Barton Springs contributing zone

Three USGS streamflow gain loss studies on Barton Creek and two for Onion Creek document that streamflow gains rather than losses occur almost throughout the Barton Springs Edwards aquifer contributing zone. Therefore, it is likely that most if not all permitted discharges on the Trinity aquifer in this area will be lost as recharge to the Edwards aquifer rather than the Trinity aquifer.

Additionally, the low flow channels for these streams are generally composed of rock and contain minimal vegetation. Therefore, only minimal reduction of wastewater nutrients would occur due to uptake by vegetation in the channels.

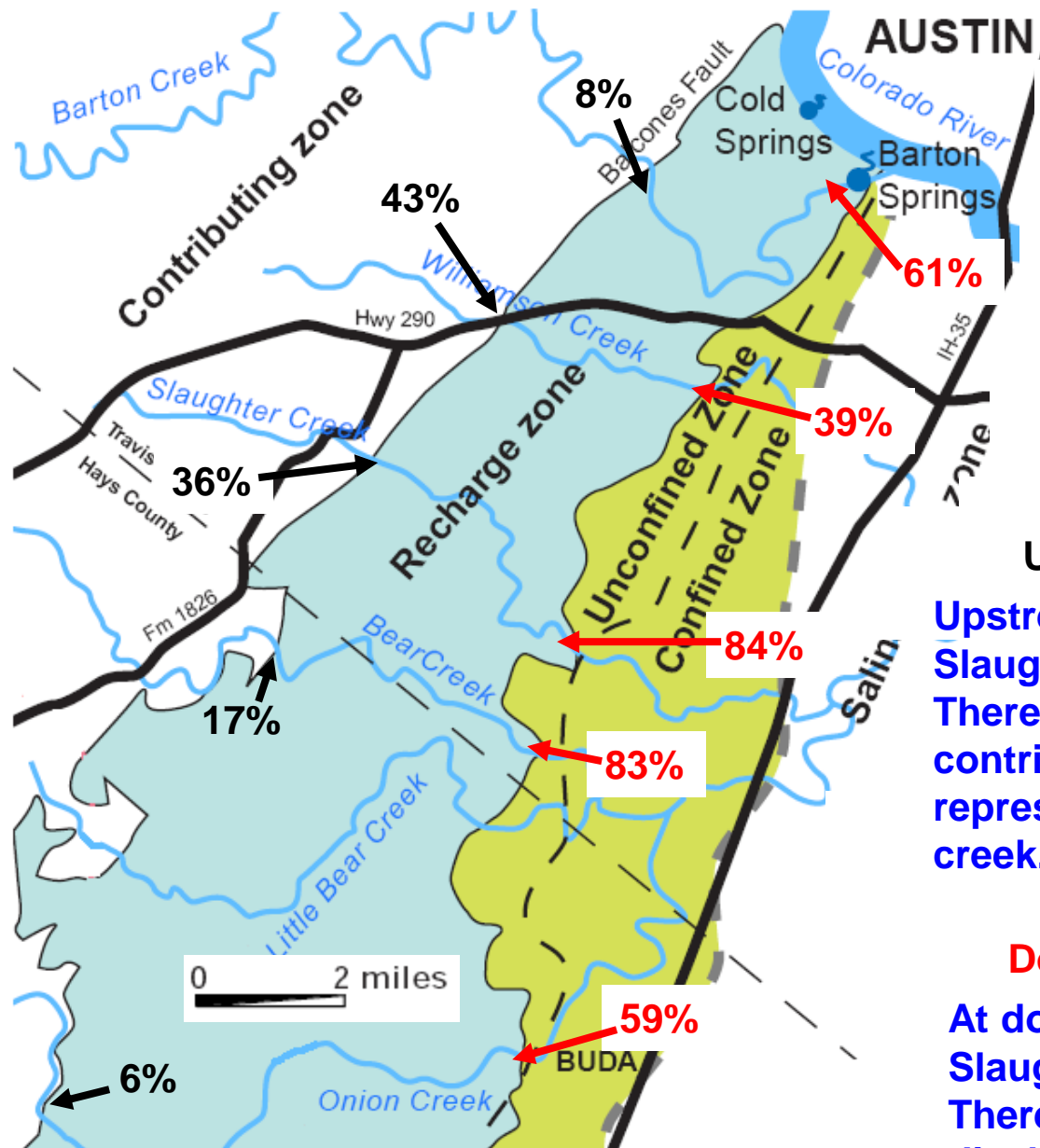
Summary of Groundwater trace injections 1996-2002



Additional dye studies in 2005 documented flow rates ranging from 2.3 to 7.4 miles per day

Tracer studies document that contamination entering the aquifer would rapidly degrade water quality in wells and Barton Springs in its fast path to the Springs

- A Injection Sites
- Tracer Detected, Wells*
- Tracer Detected, Springs*
- Estimated Flow Paths
- - - Inferred Flow Paths
- Recharge Zone



Percent of time for no flow at upstream and downstream ends of streams crossing recharge zone

(Data from USGS)

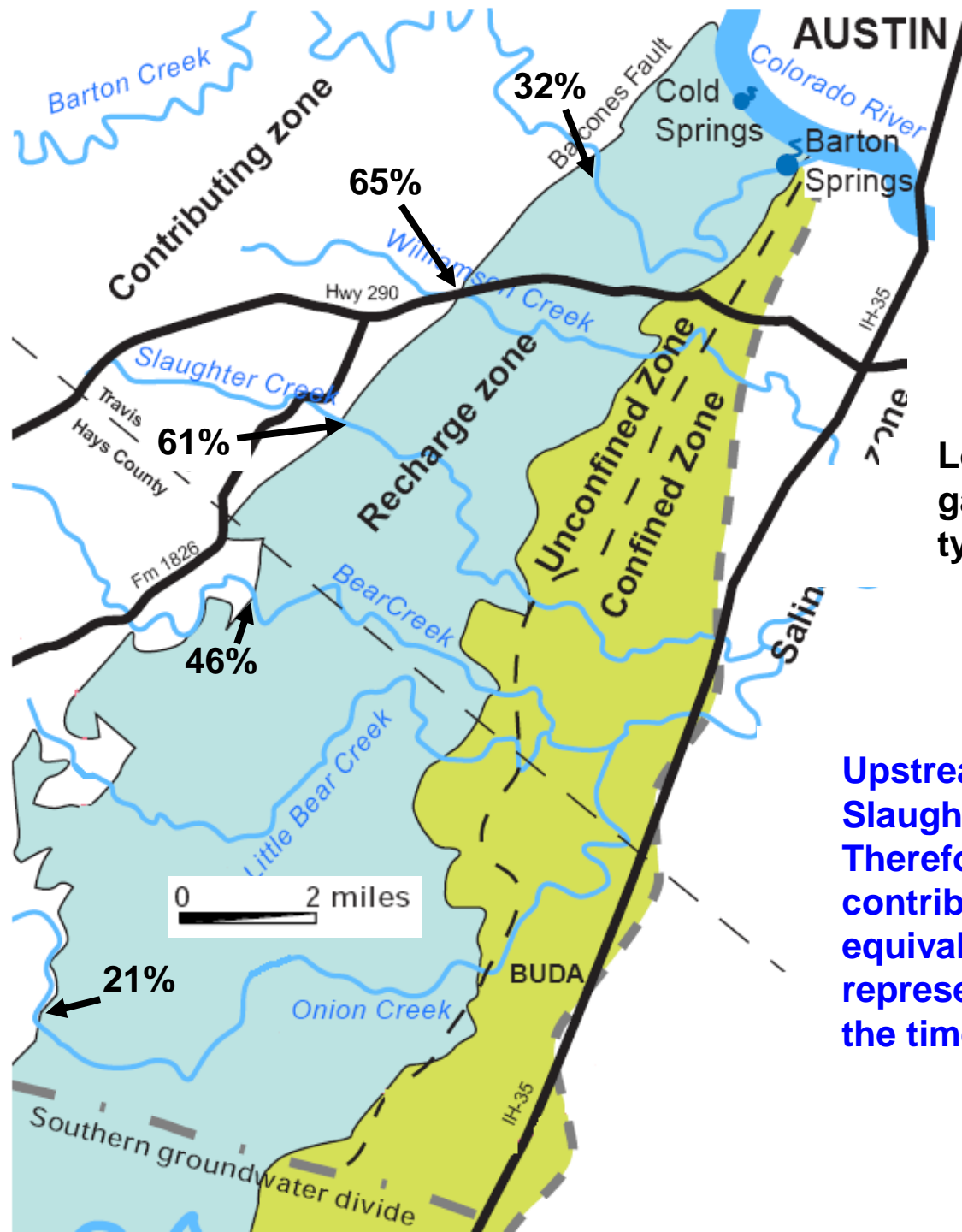
Upstream end of recharge zone

Upstream end of recharge zone for Slaughter Creek is no flow 36% of time. Therefore, wastewater discharged into the contributing zone for this basin would represent all recharge 36% of time for this creek.

Downstream end of recharge zone

At downstream end of recharge zone Slaughter Creek is no flow 84% of time. Therefore, 84% of time all wastewater discharged into basin would recharge to the Edwards aquifer rather than flow downstream

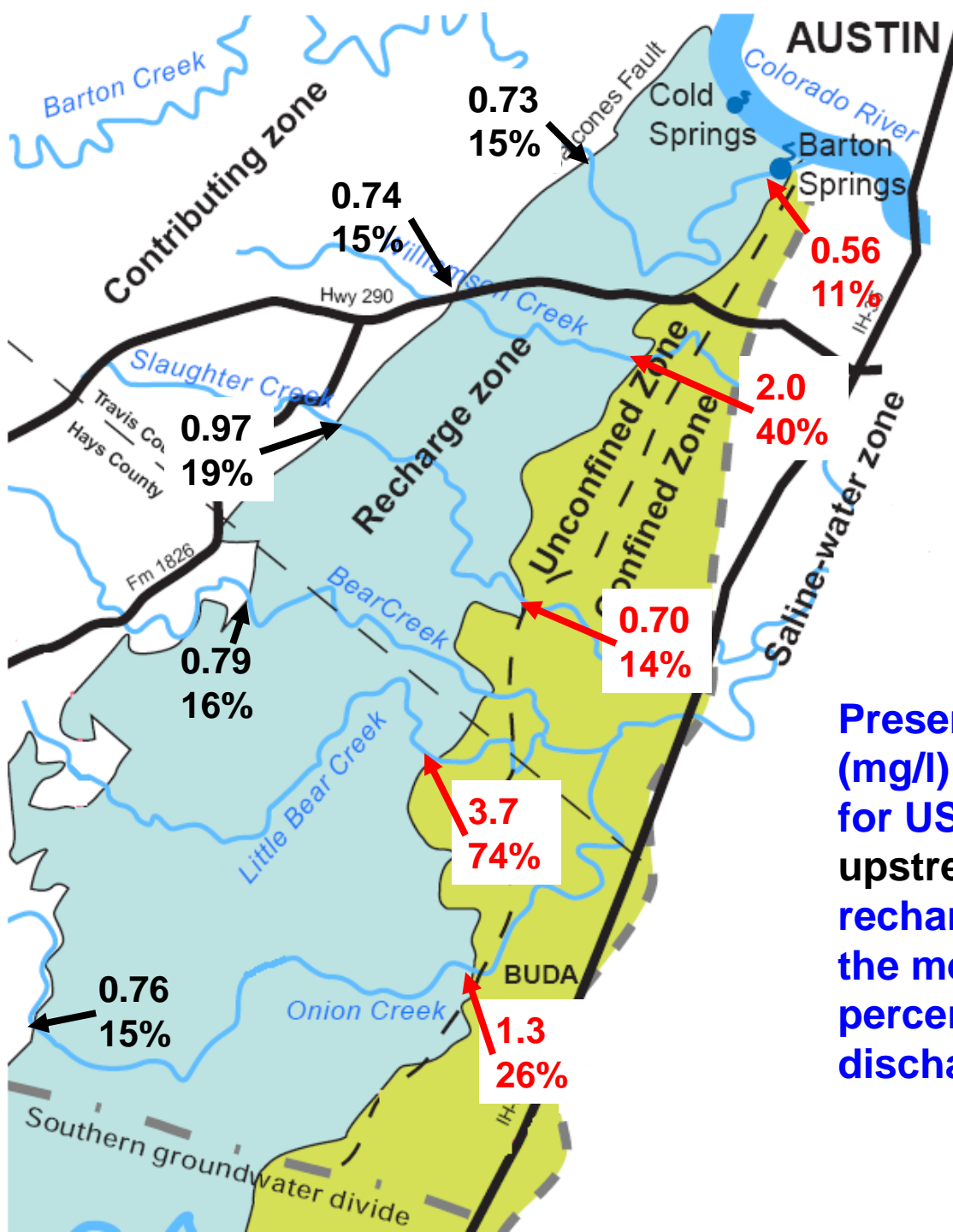
Note: Due to streamflow capture by recent increased groundwater pumping in Hays County, Onion Creek at upstream end of recharge zone was no flow only 1% of time prior to Nov 2005 but no flow 52% of the time since.



Percent of time for low flow at upstream end of streams crossing recharge zone
 (Data from USGS)

Low flow defined as one-half million gallons per day—equivalent to typical wastewater discharge

Upstream end of recharge zone for Slaughter Creek is low flow 61% of time. Therefore, **wastewater** discharged into the contributing zone for this basin would be equivalent to existing flow and thus represent $\frac{1}{2}$ or more of all recharge 61% of the time for this creek.



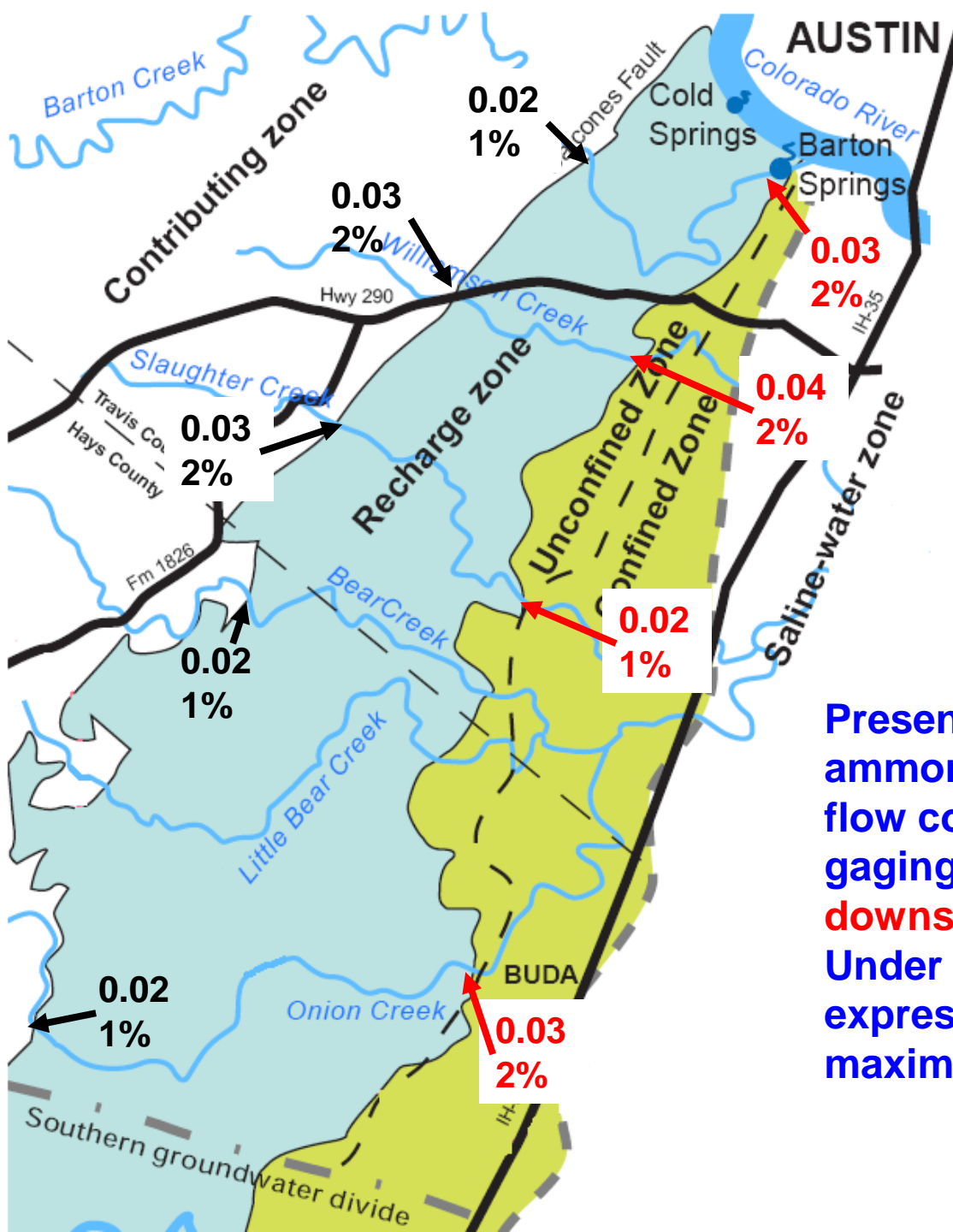
Comparison of existing stream water quality and permitted discharge quality

(Data from USGS)

CBOD

Maximum permitted discharge value
5.0 mg/l

Presented are mean values for BOD (mg/l) during low flow conditions for USGS stream gaging stations at upstream and downstream ends of recharge zone. Under that value is the mean value expressed as a percent of the maximum permitted discharge value.



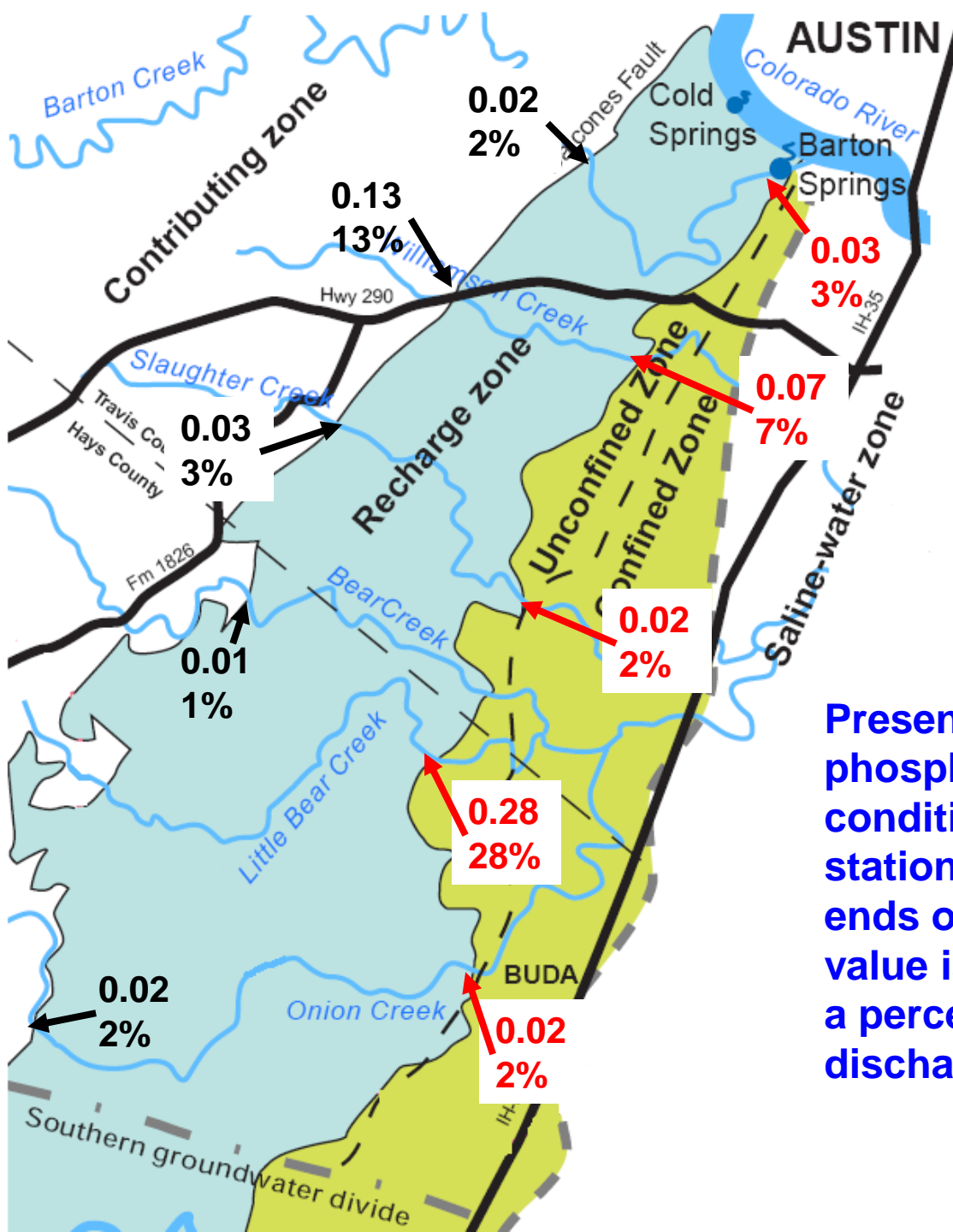
Comparison of existing stream water quality and permitted discharge quality

(Data from USGS)

Ammonia Nitrogen

Maximum permitted discharge value
2.0 mg/l

Presented are mean values for ammonia nitrogen (mg/l) during low flow conditions for USGS stream gaging stations at upstream and downstream ends of recharge zone. Under that value is the mean value expressed as a percent of the maximum permitted discharge value



Comparison of existing stream water quality and permitted discharge quality

(Data from USGS)

Phosphorus

Maximum permitted discharge value
1.0 mg/l

Presented are mean values for phosphorus (mg/l) during low flow conditions for USGS stream gaging stations at **upstream** and **downstream** ends of recharge zone. Under that value is the mean value expressed as a percent of the maximum permitted discharge value.

Summary

- The Barton Springs Edwards part is much smaller and has much less water than the San Antonio part thus likely is much more susceptible to contamination from effluent discharges than the San Antonio part
- **Due to lack of protection for Upper Barton Creek, the creek, aquifer and Barton Springs are vulnerable to contamination from effluent discharges**
- The Barton Springs contributing zone creeks likely would provide minimal attenuation for the quantity and water quality of effluent discharges
- **The rapid movement of water through the aquifer likely would cause water-quality degradation of wells and Barton Springs**
- The 6 major streams at the upstream end of the Edwards aquifer recharge zone are no flow or low flow most of the time thus effluent discharges would dominate recharge most of the time
- **The major streams are no flow most of the time at the downstream end of the recharge zone thus most effluent discharges would recharge the aquifer rather than flow downstream**
- The existing water quality for streams, the aquifer, and Barton Springs is much better than that of effluent discharges thus such discharges likely would cause water quality degradation