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May 8, 2020

Texas Commission on Environmental Quality
Office of the Chief Clerk
MC-105
P.O. Box 13087
Austin, Texas 78711-3087

Subject: Proposed Silesia Properties, L.P. Permit No. WQ0015835001
Dear Chief Clerk:

I am submitting these comments on behalf of the Greater Edwards Aquifer Alliance regarding the Texas Land Application Permit (WQ0015835001) proposed for Silesia Properties, LP. The proposed permit would authorize wastewater treatment and subsurface drip dispersal system disposal for 0.365 million gallons per day into the Honey Creek watershed upstream of the Honey Creek State Natural Area.

My comments are based on information provided by the applicant and on the draft wastewater permit as revised, February 3, 2020. My opinions are also founded upon my education, experience and engineering expertise in water resources, surface and groundwater hydrology, pollutant fate and transport, as demonstrated in my resume in Attachment 1.

I have been an engineer and resident of the Texas Hill Country for more than thirty years and have studied the natural character, flow, and channel conditions associated with Hill Country streams. I have also witnessed degradation of streams, pools, and springs from wastewater effluent and nutrient loads based on visual observation and on laboratory analysis of water samples I have collected.

The proposed draft permit terms and conditions fail to adequately protect downstream surface water, including Honey Creek and the Guadalupe River, the Honey Creek State Natural Area, the Trinity Aquifer and the Southern Segment of the Edwards Aquifer. Effluent limits, treatment, storage, and disposal area requirements in the proposed permit are inconsistent and will not achieve either the proposed permit standards or Clean Water Act standards to protect downstream water.

The following paragraphs describe the sensitive hydrologic setting of the proposed sewage effluent subsurface drip disposal as well as specific ways in which the draft permit terms fail to achieve adequate water quality protection:

- Proposed effluent limits are too high to protect downstream surface water and aquifer quality. They fail to include all wastewater effluent chemicals that would degrade downstream water and aquifers.
- The proposed effluent disposal area of 84 acres and the proposed storage volume of 3.36 acre-feet are both too small to prevent system overflows and irrigation during saturated soil conditions. Irrigation on saturated or frozen soils is prohibited in the permit.
- The proposed 84-acre disposal area is only large enough to accommodate about 150,000 gallons per day of effluent. Even with this smaller daily effluent volume, storage would need to be increased to 26 acre-feet to prevent irrigation on saturated soils.
- Proposed soil, seep, and spring monitoring provisions are inadequate to protect the Honey Creek tributary.
- Setbacks from karst features are too small to prevent water and undesirable chemicals from migrating into them.
- The proposed chlorine disinfection is inappropriate. It will destroy soil health and bacteria necessary to process land disposed effluent.
- The Class C operator requirement does not provide the treatment and disposal operation oversight necessary to protect water quality and the associated aquifers.
- The proposal to seed sewage effluent disposal areas with invasive Bermuda grass is inappropriate for this environmentally sensitive location.

- The applicant proposes to supplement sewage effluent disposal authorized by this permit with reuse under the requirements of Chapter 210. Chapter 210 requirements for treatment and disposal areas, however, will not adequately protect sensitive environmental resources in the vicinity of and downstream from the proposed Honey Creek Ranch development.
- The draft permit does not address or protect mapped wetland areas on Honey Creek Ranch, including three adjacent to, with, or downstream from proposed effluent disposal areas.
- Additional public oversight and expanded availability of information is necessary to assure permit compliance and environmental protection.

## Surface Water Setting

The proposed wastewater treatment and effluent disposal would occur within the watershed of a tributary to Honey Creek. The proposed location would be only slightly more than one-third mile upstream of the Honey Creek State Natural Area and Guadalupe River State Park, as shown on Figure 1.

The U.S. Geological Survey conducted a study of the impact of wastewater on these sensitive Hill Country streams including streams and rivers near the proposed sewage effluent treatment and disposal operations.[1] The results of the study demonstrated that Texas Hill Country streams and rivers not affected by sewage effluent naturally exhibit very low nutrient concentrations.

Streams with low nutrient concentrations like those observed in the Texas hill country are described as oligotrophic. Oligotrophic conditions create the remarkably

[1] Mabe, Jeffrey A., 2007, Nutrient and Biological Conditions of Selected Small Streams in the Edwards Plateau, Central Texas, 2005–06, and Implications for Development of Nutrient Criteria: Scientific Investigations Report 2007–5195: U.S. Geological Survey.

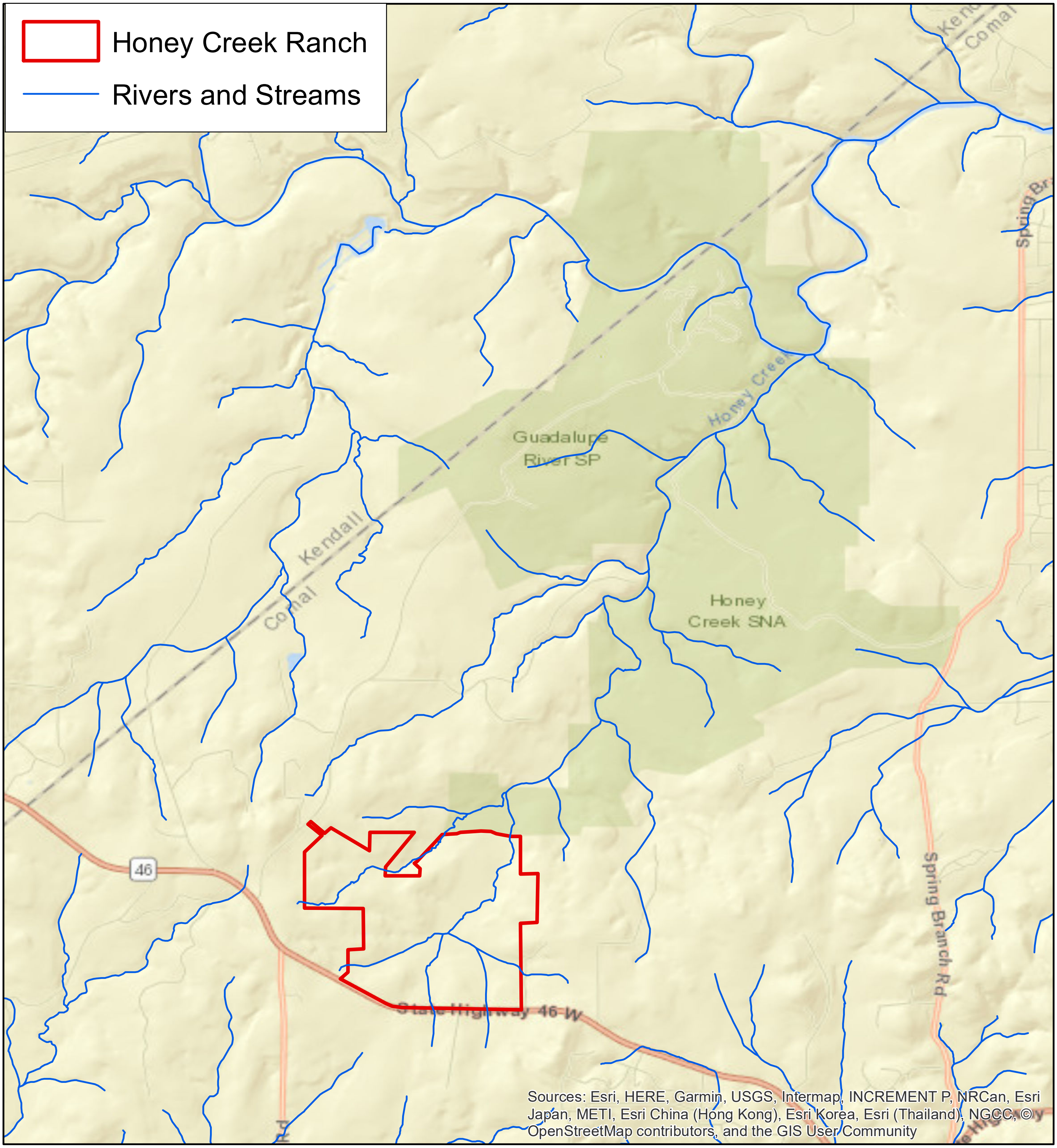


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Figure 1. Proposed Honey Creek Ranch

clear water and visible limestone bottoms present and valued throughout the Texas Hill Country. They also create habitat for endemic aquatic life found nowhere else.

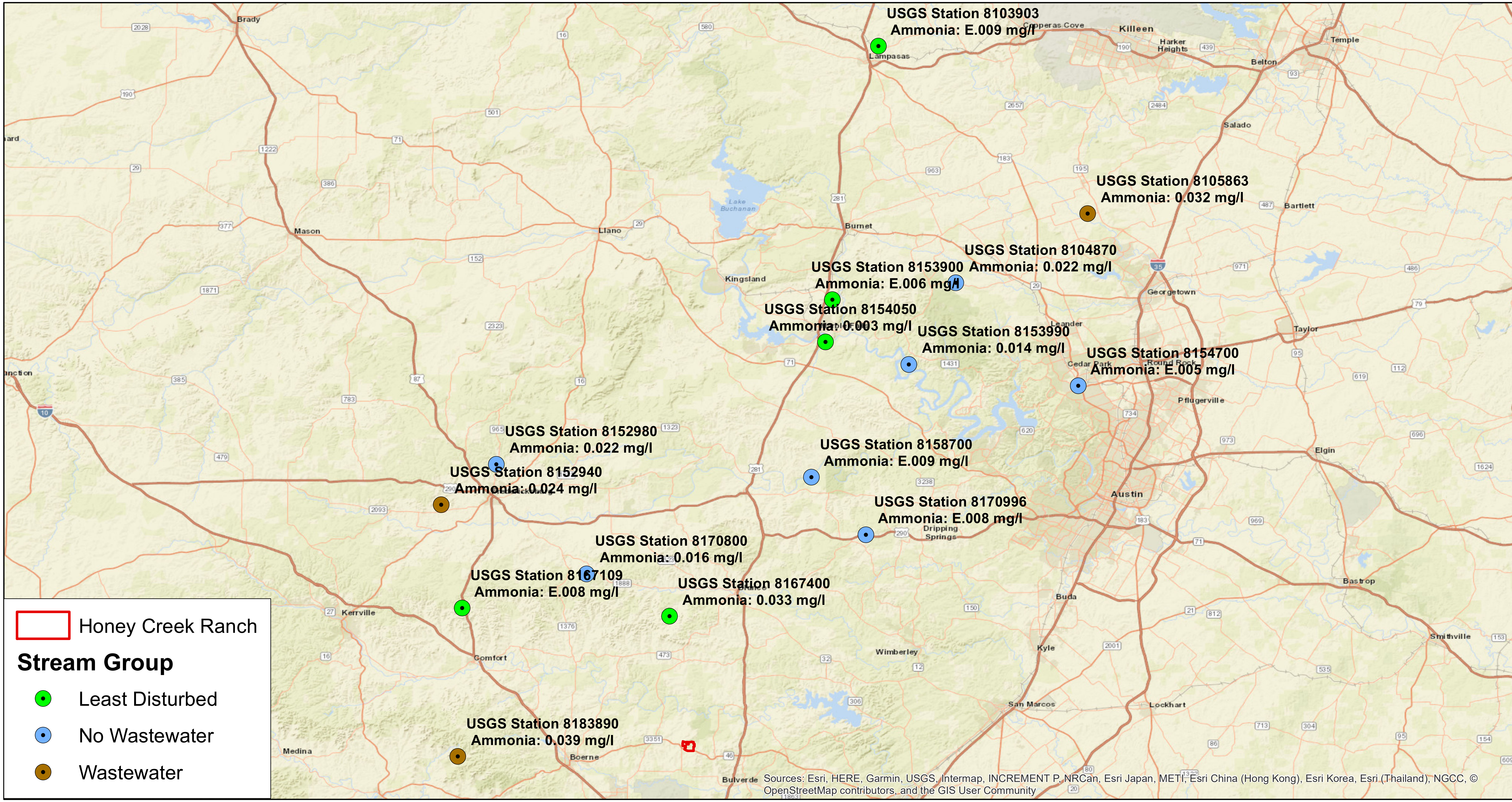
Streams in the U.S. Geological Survey study were characterized as belonging to one of three groups: least disturbed, not impacted by wastewater, or impacted by wastewater. Samples from each stream were collected and analyzed for several characteristics, including nutrient concentrations. The results of these analyses for samples collected in 2005 are mapped on Figure 2 (ammonia-nitrogen), Figure 3 (total nitrogen), and Figure 4 (total phosphorus). These nutrients, key to determining stream quality, are either much lower in natural streams than in the proposed permit (ammonia-nitrogen) or else the proposed draft permit proposes no effluent nutrient limit (total nitrogen and phosphorus).

## Groundwater Setting

Surficial geology at the proposed sewage treatment and disposal areas is mapped as the Lower Glen Rose Formation. See Figure 5. This Cretaceous period formation consists of limestone, dolomite, and marl as alternating resistant and recessive beds forming the widely expressed stairstep topography of Central Texas.

The Texas Water Development Board maps the location of Honey Creek Ranch and the proposed sewage disposal fields as the outcrop of the Trinity Aquifer. This outcrop area is a source of aquifer recharge.

In addition to the Trinity Aquifer, the proposed sewage treatment and subsurface drip disposal area also contributes recharge to the Southern Edwards Aquifer. It is mapped by the Texas Commission on Environmental Quality as within the Edwards Aquifer Contributing Zone. See Figure 6. Recharge would be transmitted from the site to the Edwards Aquifer through Honey Creek flows into the Guadalupe River as well as through subsurface Trinity Aquifer contributions.

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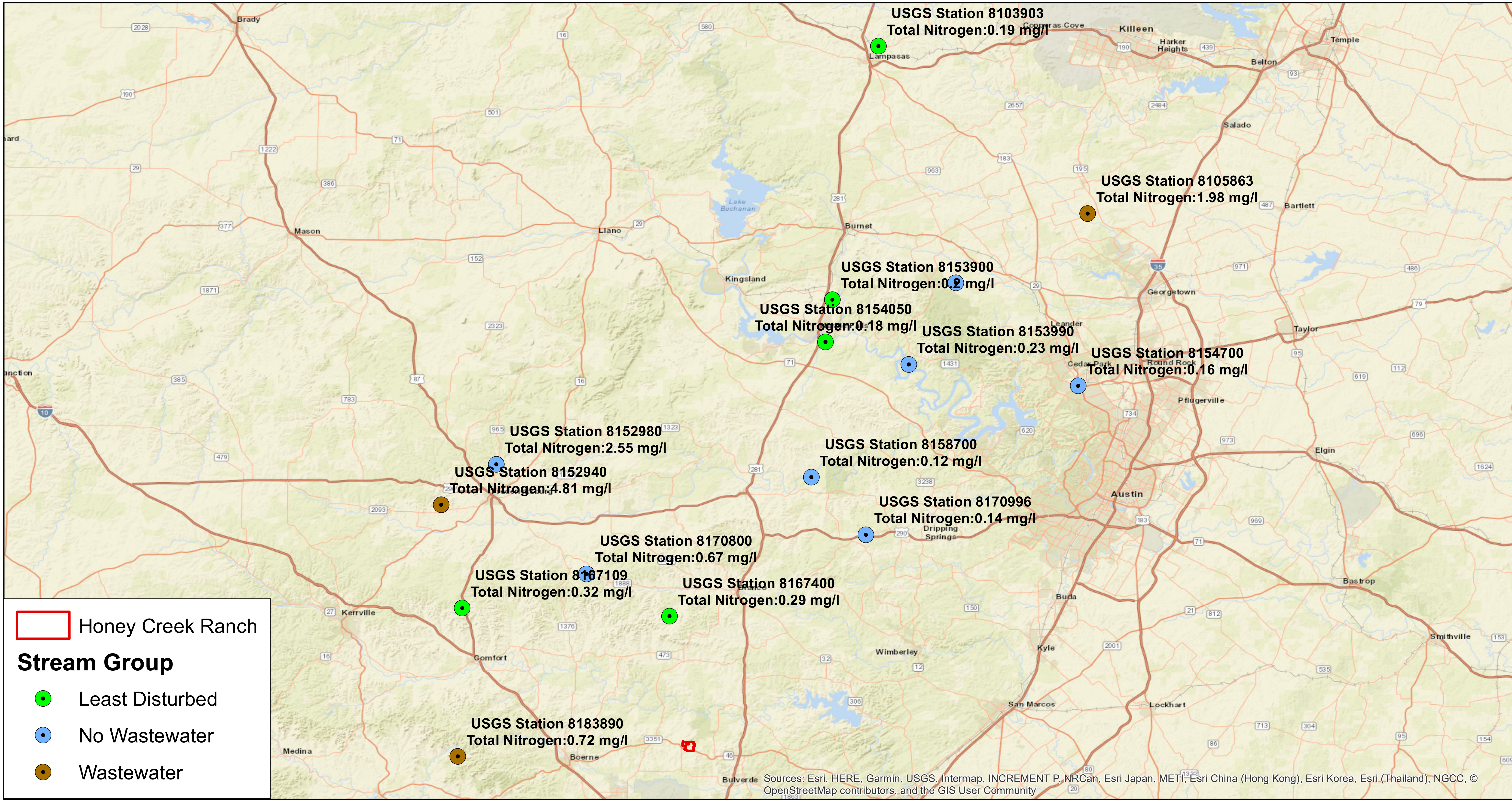
Ammonia concentrations in 2005 from USGS report by Mabe (2007), Table 3.
"E" values are estimated.

0 10 20 40 Miles

Figure 2. Ammonia Concentrations in Texas Hill Country Streams

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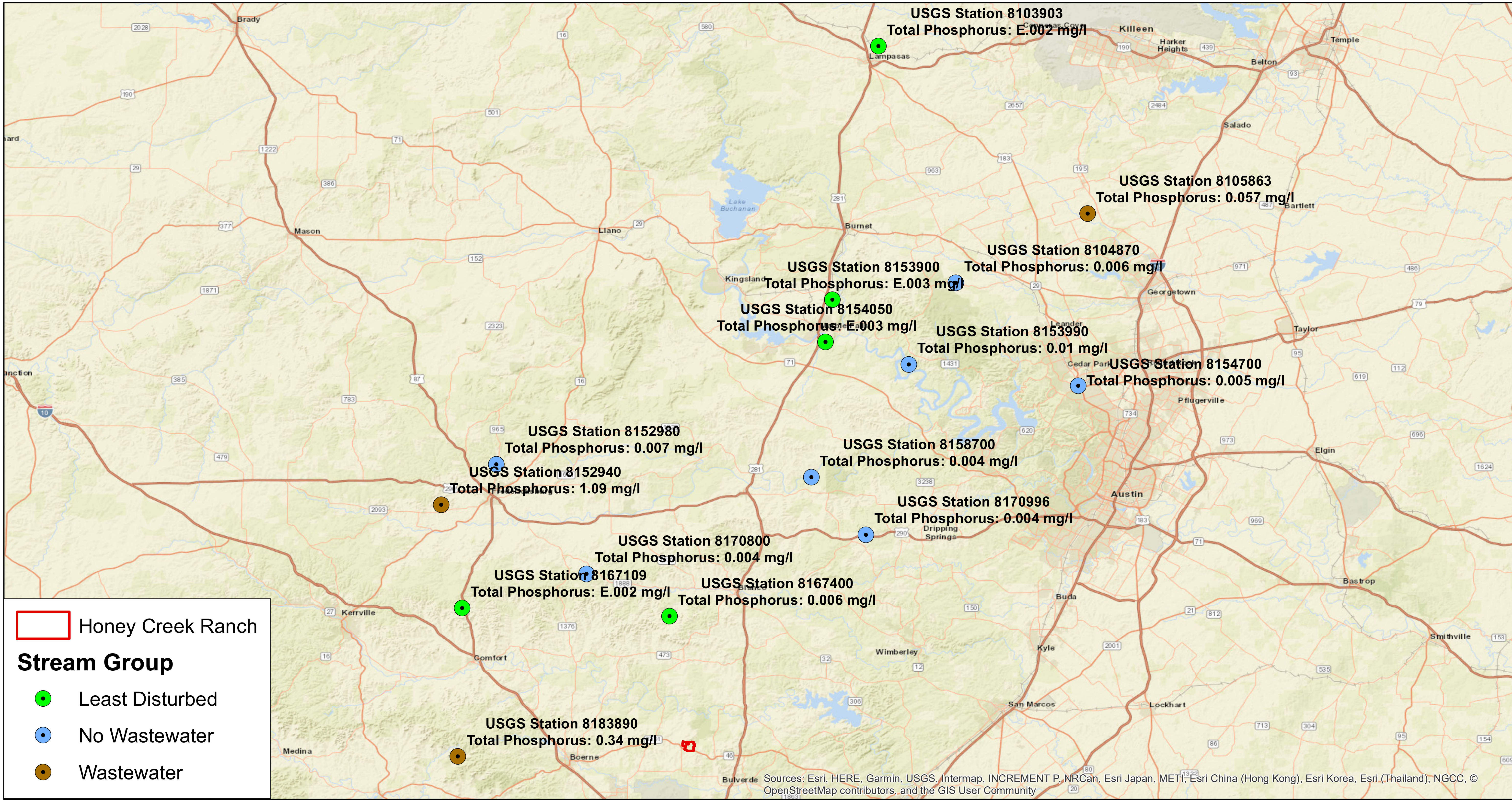
Total nitrogen concentrations in 2005 from USGS report by Mabe (2007), Table 3.

Figure 3. Total Nitrogen Concentrations in Texas Hill Country Streams

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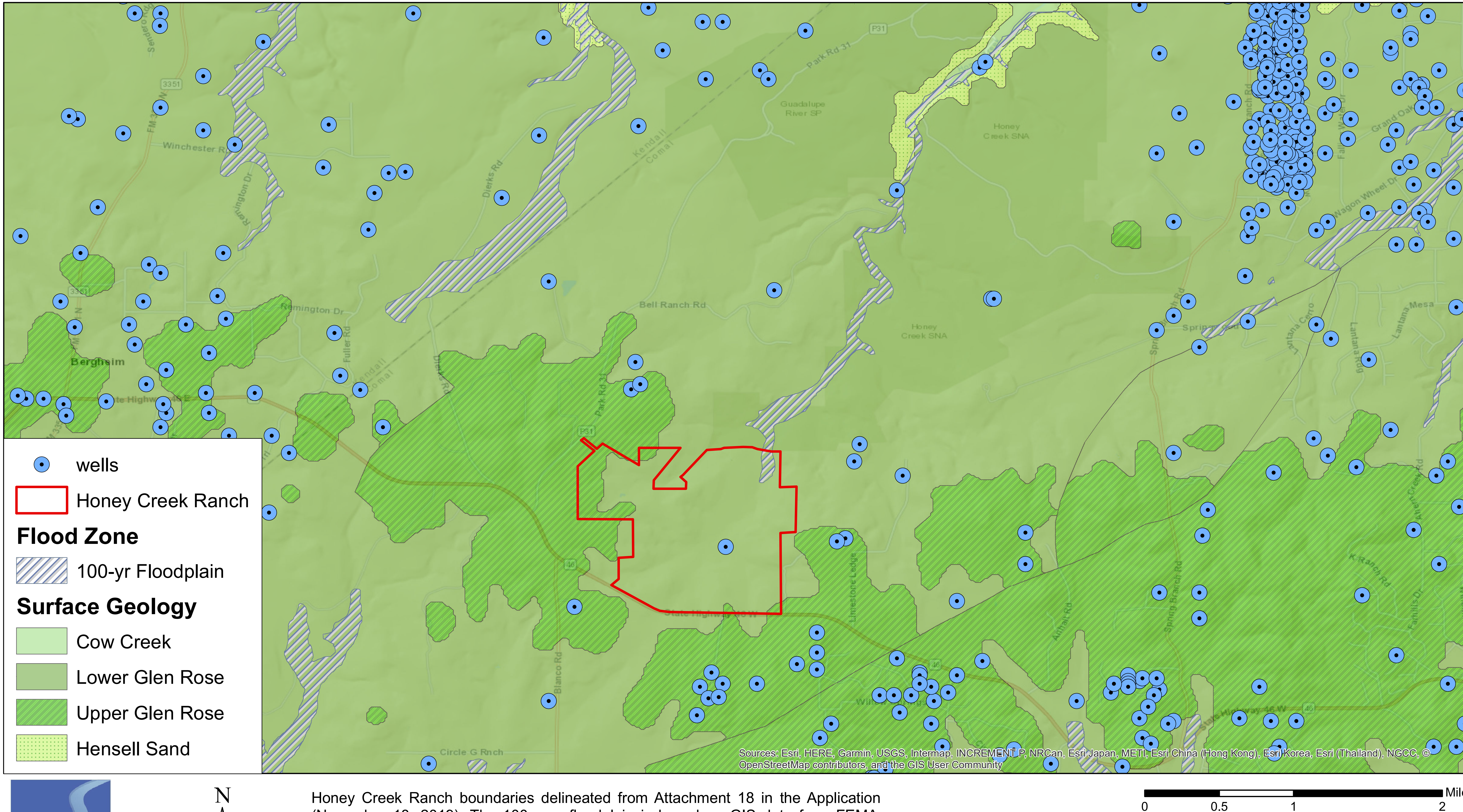
Total phosphorus concentrations in 2005 from USGS report by Mabe (2007), Table 3. "E" values are estimated.

Figure 4. Total Phosphorus Concentrations in Texas Hill Country Streams

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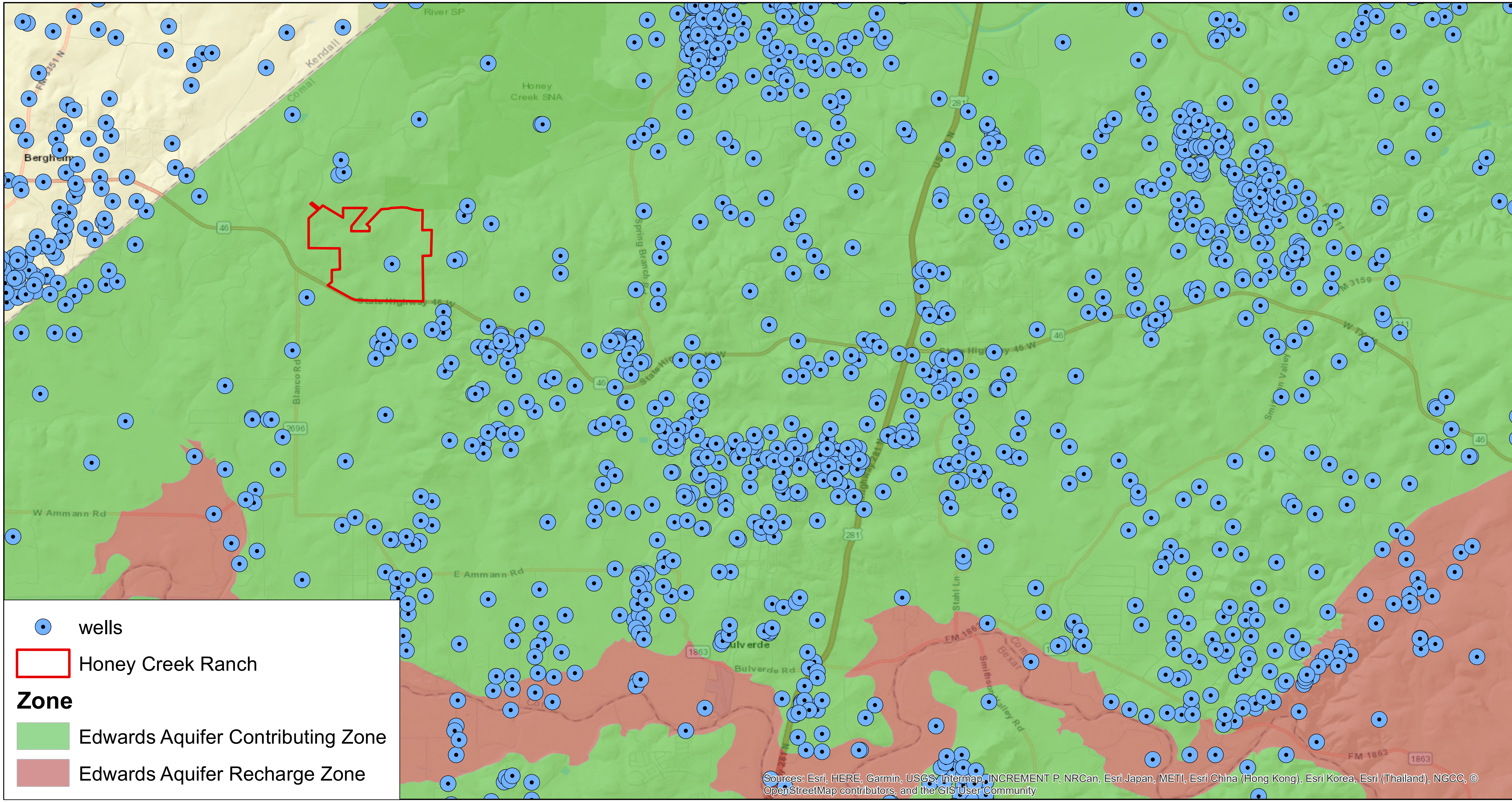
Honey Creek Ranch boundaries delineated from Attachment 18 in the Application (November 18, 2019). The 100-year floodplain is based on GIS data from FEMA. Geology is from the US Geological Survey Geologic Database of Texas, 20007. Wells based on the Texas Water Development Board Submitted Drillers Reports and Groundwater Databases.

Figure 5. Surface Geology and Wells

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Honey Creek Ranch delineated from Attachment 18 in the Application (November 18, 2019). Well locations are based on the water production wells in theTexas Water Development Board Submitted Drillers Reports and Groundwater Databases.The Edwards Aquifer Contributing and Recharge Zones are based on GIS mapping by the Texas Commission on Environmental Quality.

0 0.5 1 2 Miles

Figure 6. Edwards Aquifer Recharge and Contributing Zones

The Lower Glen Rose Formation forms part of the Trinity Aquifer and locally provides water supply to numerous public and private wells. Wells near the proposed wastewater system are also shown on Figure 5.

Wells in the vicinity of the proposed sewage treatment and disposal are completed in the Trinity Aquifer. There is no laterally extensive confining bed or aquaclude within the Trinity Aquifer to impede the downward migration of effluent. Wastewater effluent would percolate to deeper groundwater zones, potentially migrating into the underlying aquifer and contaminating water wells.

Wastewater effluent, along with mobile chemicals within it, may also move laterally and be expressed in shallow seeps and springs along Honey Creek tributaries. From these seeps and springs, effluent would move into Honey Creek, through the Honey Creek State Natural Area and into the Guadalupe River. This effluent, carrying its mobile constituents, would recharge into the Trinity and Southern Edwards Aquifers.

## Inadequate Effluent Limits

Effluent limits proposed for the sewage treatment and disposal facility are: 5 milligrams per liter 5-day biochemical oxygen demand; 5 milligrams per liter total suspended solids; 2 milligrams per liter ammonia nitrogen; and pH not less than 6.0 nor greater than 9.0 standard units. The permit requires a residual chlorine concentration and a maximum *E. coli* count of 126 colony forming units or most probable number per 100 milliliters.

Figures 2, 3 and 4 show the low natural nutrient concentrations in unimpacted streams northwest, north, and northeast of the proposed discharge. Effluent nutrient concentrations that could be legally discharged under the proposed draft terms are significantly higher than these natural concentrations.

Proposed effluent limits are compared to the range of reported concentrations by the U.S. Geological Survey for least disturbed and unimpacted streams for 2005 (the year for which data is more complete) in Table 1. This table also includes expected total nitrogen and phosphorus concentrations, for effluent generated by the proposed membrane bioreactor (MBR) treatment technology,

The proposed wastewater permit would allow effluent with nutrient concentrations as much as several hundred to a thousand times higher than those measured in unimpacted Texas hill country streams. Even using land effluent disposal and stream dilution, the proposed permit terms would not control degradation from significant increases in stream nutrient concentrations. As demonstrated in the paragraphs below, stream degradation from escalating nutrient loads into Texas hill country streams have been observed and documented for other land disposal[2] wastewater systems. See my report in Attachment 2.

**Table 1. Effluent Limits and Natural Stream Nutrient Concentrations**

| Nutrient | Minimum in Least Disturbed and Unimpacted Streams | Maximum in Least Disturbed and Unimpacted Streams | Proposed Effluent Limit | Typical Concentration for Proposed MBR Treatment[3] |
|---|---|---|---|---|
| **Ammonia (mg/l)** | 0.003 | 0.033 | 2 | 0.7 to 3.0 |
| **Total Nitrogen (mg/l)** | 0.12 | 2.55* | unlimited | 3 to 10 |
| **Total Phosphorus (mg/l)** | 0.002[4] | 0.01 | unlimited | 0.5 to 2.0 |

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[2] "Land disposal" refers to both subsurface drip disposal and surface irrigation disposal systems.

[3] Metcalf & Eddy|AECOM et al., 2014, *Wastewater Engineering: Treatment and Resource Recovery*, 5th edition: McGraw Hill Education, Table 4-5, page 282.

[4] Estimated.

- Anomalously high. This stream was measured at 0.44 milligrams per liter in the same study in 2006.

Proposed effluent limit standards in the draft permit are also inadequate because they address parameters that are largely irrelevant for sewage effluent subsurface drip disposal but fail to provide effluent limits for either total nitrogen or phosphorus. Neither biochemical oxygen demand nor total suspended solids, for example, have environmental consequences in a properly designed, constructed, and managed sewage treatment and disposal system where all of the effluent disposal occurs through soil irrigation and infiltration. These effluent constituents are readily filtered by the soil and/or degraded by soil microbial activity.

Meanwhile neither nitrate nor total nitrogen is limited in the proposed permit. The U.S. Geological Survey, however, found the following:

> *Neither OSSFs nor TLAPS involve intentional discharge to surface water, yet even without any intentional discharges the concentration of nitrate in the streams crossing the contributing zone increased relative to similar flow conditions by a factor of 3 (Barton Creek, medium-flow conditions) to 11 (Onion Creek, medium-flow conditions).*[5]

Nutrient pollution is one of the leading causes of water quality impairment in the United States. Impacts from nutrient pollution include:

- Human health affected by methemoglobinemia ("blue baby syndrome");

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[5] Mahler, Barbara, MaryLynn Musgrove, Chris Herrington, and Thomas Sample, *Recent (2008-10) Concentrations of Isotopic Compositions of Nitrate and Concentrations of Wastewater Compound in the Barton Springs Zone, South-Central Texas, and their Potential Relation to Urban Development in the Contributing Zone,* U.S. Geological survey, Scientific Investigations Report 2001-5018, 2011, p. 33.

- Human health affected by neurotoxic, paralytic, and diarrheic toxic algal blooms;
- Increased costs to treat water to potable standards;
- Reduced aesthetics, impaired recreation and tourism;
- Impaired navigation; and
- Hypoxic and anoxic dissolved oxygen levels.

Nitrogen and phosphorus pollution stimulates excessive algal blooms, depresses dissolved oxygen concentrations, kills fish, clouds water, and impairs desirable plant and animal habitat. Increased algae and turbidity lead to higher chlorination requirements for safe drinking water, which increases treatment costs and produces higher concentrations of disinfection by-products that increase cancer risks.

Harmful algal blooms, stimulated by excessive nutrients, affect tourism, commercial fisheries, property values, and human health. Associated costs for these outcomes have been documented in Texas, Ohio, and Florida. The presence of additional algae in in Honey Creek and the Guadalupe River would impair uses, including swimming, contact and non-contact recreation, and species habitat.

I have observed algae impacts similar to those described above in Texas hill country streams downstream from treated sewage effluent land disposal. Photographs 1 through 3 illustrate such increases in stream algae in Lick Creek, a tributary to the Pedernales River.

By Lauren Ross, Ph.D., P.E.

**Photograph 1. East Lick Creek Unaffected by Wastewater Effluent**


By Lauren Ross, Ph.D., P.E.

**Photograph 2. West Lick Creek below Wastewater Treatment and Effluent Land Application**

Other effluent constituents of concern that are known components of wastewater effluent (including compounds like caffeine)[6] have been detected in water downstream from sewage effluent disposal or discharge. The proposed wastewater permit has no terms, requirements, or standards to address these chemicals.

By Lauren Ross, Ph.D., P.E.

**Photograph 3. Cladophora Algae in West Lick Creek**

## Inadequate Effluent Disposal Area and Effluent Storage Volume

Preventing wastewater migration through the soil and into the Honey Creek tributary and the Trinity Aquifer requires an adequate land area for disposal. It also requires adequate storage to retain effluent and eliminate irrigation during saturated soil conditions. The proposed 3.36 acre-feet of storage, however, is much less than the

[6] Mahler, Barbara, MaryLynn Musgrove, Chris Herrington, and Thomas Sample, *Recent (2008-10) Concentrations of Isotopic Compositions of Nitrate and Concentrations of Wastewater Compound in the Barton Springs Zone, South-Central Texas, and their Potential Relation to Urban Development in the Contributing Zone,* U.S. Geological survey, Scientific Investigations Report 2001-5018, 2011.

volume required to retain effluent during extended rain events when soils are saturated.

I have performed a preliminary water balance for 365,00 gallons per day of effluent disposed onto 84 acres. In conducting this water balance, I used site-specific soil properties published by the Natural Resources Conservation Service for the proposed effluent disposal areas. The water balance uses daily precipitation and evapotranspiration from January 1, 1954 through December 31, 2014 to determine the daily volume of effluent that can be accommodated up to the point of saturated soils. Volumes in excess of the soil's saturated capacity cannot, under the terms of the permit, be irrigated. The model calculates these excess effluent volumes.

While the proposed draft permit prohibits irrigation on saturated or frozen soil, there are no enforcement mechanisms to prevent it. Given the trouble and expense of hauling excess wastewater, the simple solution is to send excess effluent to the irrigation field even when soils are saturated.

My comparison of irrigation volumes and rainfall records for other effluent land disposal operations, conversations with neighbors adjacent to disposal fields, and downstream stream degraded water quality all support the presumption that effluent irrigation occurs onto saturated soils. Wastewater irrigated onto saturated soil runs off toward adjacent property and waterways. It migrates below the plant root zone to contaminate groundwater, perched groundwater, springs, and the downstream water into which they flow.

My preliminary calculations indicate that effluent ranging from about 10 percent to 30 percent of the proposed effluent volume, on an annual basis, would not be accommodated within the proposed storage volume and disposal area without over-saturating soils. Based on my preliminary modeling, wastewater effluent would exceed the proposed system capacity by at least 69 day and up to 157 days in each of the 61 years from 1954 to 2014.

The total volume of excess effluent over this 61-year period would be 1.8 ***billion*** gallons. Twenty-two percent of the proposed effluent volume proposed in the permit would be either irrigated onto saturated soils or else pumped and hauled to another treatment facility.

The proposed 84-acre effluent disposal area would be sufficient to dispose of 150,000 gallons per day of effluent, without over-saturating soils, if effluent storage was increased to 8.5 million gallons.

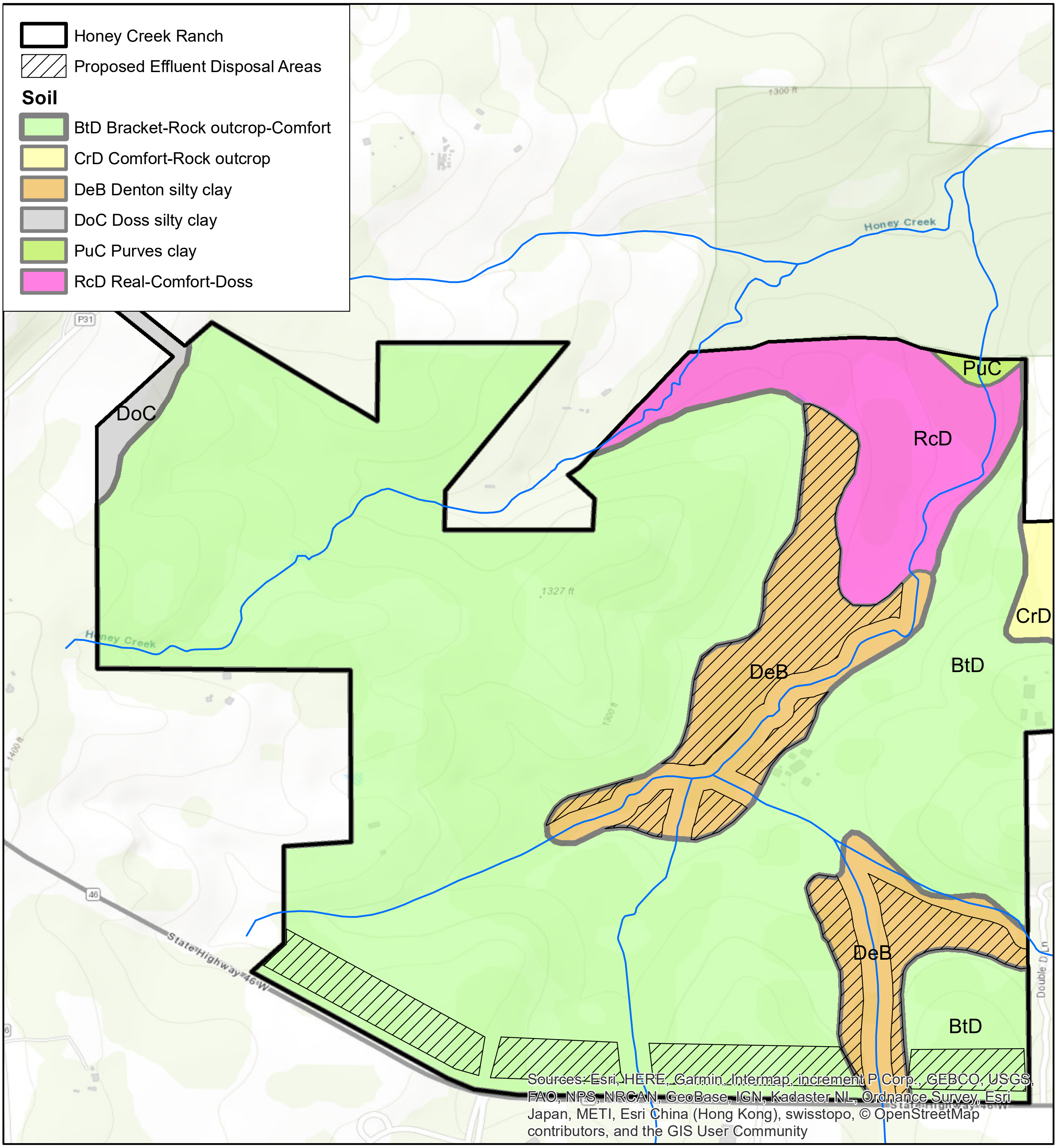
## Inadequate Soil Depth and Necessary Soil Importation Standards

Soils proposed for sewage effluent disposal under the draft permit are mapped by the Natural Resources Conservation Survey as Brackett-Rock outcrop-Comfort complex with 1 to 8 percent slopes (BtD) and Denton silty clay, 1 to 3 percent slopes (DeB). as shown on Figure 7. These soils are identified as Hydrologic Soil Group D. They consist chiefly of clays with very slow infiltration rates and high runoff potential.

Soils on Honey Creek Ranch proposed for irrigation are also described by the Natural Resources Conservation Service as shallow, with soil depths of less than 20 inches. Because of these shallow depths, the Natural Resource Conservation Services has described all of the proposed disposal area soils as either very limited or somewhat limited for subsurface drip irrigation, as shown on Figure 8. Some of the area proposed for effluent disposal includes rock outcrop over which soil depths would be essentially zero.

All of the 46.3 acres within Honey Creek Ranch that are not ***very limited*** for sewage effluent drip irrigation have been proposed for sewage effluent disposal. An additional 37.7 acres must be on soil identified by the U.S. Natural Resources Conservation Service as "very limited" for that purpose.

In addition to shallow depths, published saturated hydraulic conductivity of the proposed disposal site soils is severely limited. For some of the proposed sewage

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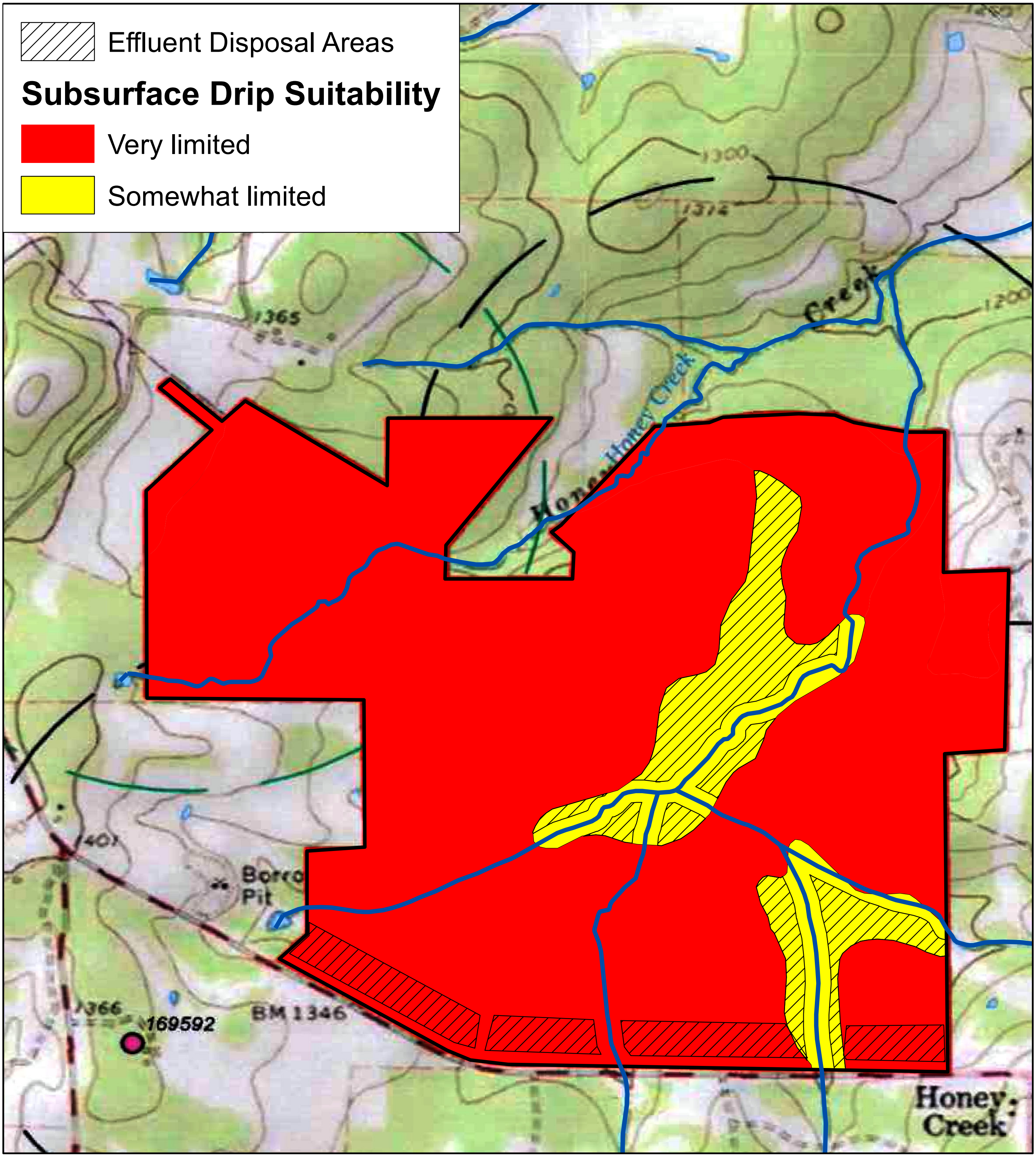
Base map is Attachment 18 of application.
Soil data from the Natural Resources Conservation Service Soil Web Survey.



Figure 7.
Soils and Proposed Irrigation Areas

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Base map is Attachment 18. Soil suitability data from the Natural Resources Conservation Service Soil Web Survey.

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Figure 8. Soil Suitability for Subsurface Drip Irrgation

effluent disposal areas, published saturated hydraulic conductivity is as low as 0.06 inches per hour. The consequence of low conductivity soils is an inability to absorb applied sewage effluent and consequently earlier ponding and runoff. Neither the proposed effluent storage volume nor the 84-acre disposal area in the proposed permit account for low-conductivity soils.

While the permit allows for soil importation to supplement inadequate soil depth, there are no permit terms to assure shallow soil areas will be identified and supplemented with suitably permeable soils.

## Inadequate Soil, Seep and Spring Monitoring Permit Provisions

Draft permit Special Provision 21.a. proposes quarterly field checks at the drip irrigation fields and down-gradient of the fields to identify emerging springs or seeps. This proposed quarterly monitoring is too infrequent. Seeps and springs would be expected only during wet conditions. The seeps and springs might last only a few days, while the consequential algae would be much more persistent in the stream.

Quarterly monitoring is likely to miss temporary springs and seeps, leading to the erroneous conclusion that there is no effluent migration from the field. Monitoring should be required within 2 days of rain events of more than one-half inch, with a quarterly monitoring requirement as a minimum.

The proposed list of seep and spring monitoring parameters fails to include metals or biochemically active compounds, even though these compounds have been detected in wastewater effluent and in springs and seeps downstream from sewage effluent disposal areas. The permit should require springs and seep samples to be tested for these additional parameters: sodium, chloride, fluoride, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, zinc and organic and biochemically active compounds.

The permit requires corrective measures if seeps or springs develop after sewage effluent disposal begins. There is, however, no mechanism for determining whether a seep or spring was present before sewage effluent disposal.

Furthermore, after the subdivision is developed options to increase the disposal area to prevent seeps and springs would be eliminated by the occupation of available land by homes and yards. Volume reductions are also difficult to achieve after homes are built. Families are unlikely to stop flushing toilets, taking showers, or washing dishes.

## Inadequate Setbacks from Karst Features

The proposed setback of 50 feet from karst feature's surface expression is a minimally protective standard. Each feature should be evaluated in terms of its potential lateral subsurface extent and sewage effluent disposal prohibited above or within 50 feet of a feature's surface or subsurface lateral extent. Because of the potential for sewage effluent runoff from the low-permeability soils proposed for disposal, an upgradient buffer should be at least 300 feet.

## Alternative Disinfection

Of numerous ways to achieve effluent disinfection, the draft permit proposes chlorine. Chlorination, however, has several unique disadvantages compared to alternative processes:[7]

- Chlorine is highly corrosive and toxic. Storage, shipping, and handling pose safety risks.
- Chlorine is toxic to aquatic life at low concentrations.

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[7] U.S. Environmental Protection Agency. *Wastewater Technology Fact Sheet: Chlorine Disinfection.* EPA 832-F-99-062. (September 1999).

- Chlorine oxidizes wastewater organic matter, creating hazardous compounds like trihalomethanes that can be toxic and/or carcinogenic and harmful to human health and aquatic life.
- Long-term effects of disposing chlorinated water and/or chlorinated compounds into soil are unknown, but likely deleterious.

There are alternatives to chlorine disinfection that could be employed at the proposed wastewater treatment facility that would eliminate these disadvantages. One such option is disinfection using ultraviolet light.

## Operator Class

The importance of well-controlled treatment facility operation to achieve significant nutrient reductions in wastewater effluent is well-documented: [8]

> *"Achieving significant reductions in both nitrogen and phosphorus requires careful design, analysis,* ***and process control*** *to optimize the environment of nutrient removing organisms. (emphasis added)"* [9]

The proposed draft permit requires the plant operator to hold a Wastewater Class C operator license. Qualifying requirements for such a license are a high school diploma or equivalent, two years of work experience, and training courses. Neither core nor elective courses for the Wastewater Class C operator license, however, require training on nutrient reduction processes or the type of tertiary treatment system proposed in the draft permit. These Class C operator license requirements are insufficient to assure adequate operation of the treatment and sewage effluent disposal system and/or timely and accurate response to monitoring data.

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[8] https://www.tceq.texas.gov/licensing/licenses/wwlic/#WWacceptC.
[9] Water Environment Federation. *Nutrient Roadmap Version 1.0.* (September 2014): 6.

## Proposed Invasive Grass for Irrigation Area Vegetation

The draft permit requires maintenance of Bermuda grass and Ryegrass on the sewage effluent disposal areas. Bermuda grass is identified as invasive and its use is incompatible with the proposed disposal area location upstream from sensitive Honey Creek State Natural Area.

## Additional Requirements Necessary for Beneficial Reuse

As discussed above, there are natural limitations to the suitability of land within the proposed development for sewage effluent disposal. These natural site suitability limitations include thin soils, sensitive and transmissive karst limestone, and the presence of sensitive, low-nutrient creeks.

The proposed permit includes standards for designated effluent disposal areas to address sensitive area characteristics: limited sewage effluent application rates; disposal prohibitions on frozen or saturated soils; requirements to import and supplement thin soils; requirements to provide well, stream and karst feature buffer setbacks; and soil, seep and spring monitoring requirements.

None of these standards, however, apply to disposal of sewage effluent under Chapter 210 Use of Reclaimed Water. Chapter 210 requires effluent limits stricter than those in the proposed permit ***only*** for fecal coliform and *Enterococci*.[10] Chapter 210 effluent standards fail to address nutrient and biochemical effluent constituents that would cause public health concerns and environmental degradation.

[10] 30 TAC §210.33(1).

## Wetlands Protection

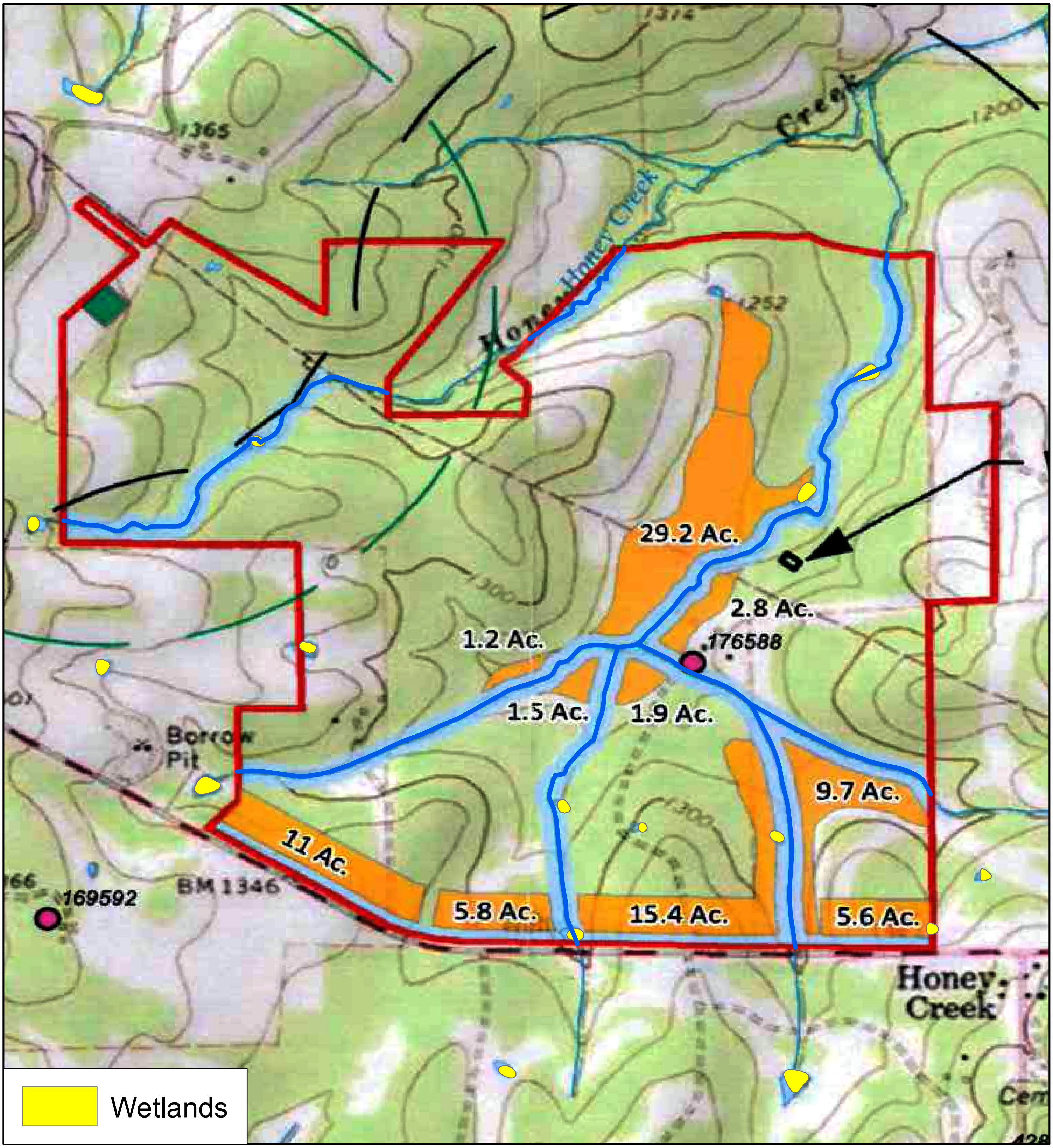
The database of Texas wetland areas includes eight freshwater ponds and one freshwater emergent wetland within Honey Creek Ranch, as shown on Figure 9.[11] Three of these features are within, adjacent to, or downstream from proposed wastewater effluent disposal areas. The proposed permit fails to protect these sensitive wetland features.

## Inadequate Public Oversight

Because of the sensitivity of the Honey Creek State Natural Area and other local and public downstream sensitive resources, the community should be granted reasonable access to information regarding wastewater treatment and disposal operations. This public information access should include, at a minimum, records of daily sewage effluent disposal rates, volume of effluent applied, monitoring data, soil sensor data and vegetation management: planting, over-seeding, mowing, fertilizing, and harvesting, pond leakage and/or liner maintenance, daily effluent storage volumes, plant or disposal system leaks and spills, and any pump-and-haul incidences.

The permit requires the operator to maintain all of this information and make it available to the Texas Commission on Environmental Quality. The additional burden to make the information publicly available is reasonably offset by the public interests potentially diminished by the proposed treatment and disposal operations.

[11] U.S. Fish & Wildlife Service national Wetland Inventory accessed and downloaded on July 12, 2016.






Base map is Attachment 18 of application. Wetlands were delineated by the U.S. Fish and Wildlife Service: https://www.fws.gov/wetlands/data/data-download.html.

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Figure 9. Wetlands

## Reservation for Additional Comments

On behalf of the Greater Edwards Aquifer Alliance, I reserve the right to supplement or amend these comments based on new or additional or corrected information on or before June 9th. the date to when the hearing has been rescheduled.

Sincerely,

Lauren Ross, Ph. D., P. E.
President
Glenrose Engineering, Inc.

Sealed on May 8, 2020

# D. Lauren Ross, Ph. D., P. E. – Principal Engineer

Dr. Lauren Ross is an environmental engineer and owner of Glenrose Engineering, Inc. in Austin, Texas since 1987.

## Education

Ph. D. Civil Engineering, University of Texas at Austin; 1993.
M. S. Civil Engineering, Colorado State University, Fort Collins, Colorado; 1982.
B. S. Civil Engineering, University of Texas at Austin; 1977, *summa cum laude*

## Registration and Certification

Registered Professional Engineer: State of Texas, 1984
OSHA 40-hour Hazardous Waste Health and Safety Training, 1993
Certified Professional in Erosion and Sediment Control, 2009.

## Experience

**Wastewater Engineering and Permitting**

- Design of a constructed wetland system to treat high biochemical oxygen demand and concentrated nutrient wastewater from a tofu production facility.
- Soil, spring, and groundwater monitoring system recommendations for Texas land application systems: Barton Creek West Water Supply Corporation, Rocky Creek Wastewater Utility, Austin Highway 290 (Headwaters), City of Dripping Springs, Travis County Municipal Utility District No. 4, Scenic Greens, Hays County Water Control and Improvement District No. 1, Prentiss Properties Acquisition Limited Partnership
- Water balance modeling for septic systems in the Barton Springs Edwards Aquifer Recharge and Contributing Zones
- Water balance modeling for Three Rivers Refinery wastewater effluent irrigation
- Environmental sampling and/or data analysis associated with wastewater effluent irrigation at Barton Creek West WSC, Hays County Water Control and Improvement District No. 1 (Belterra), Hays County Municipal Utility District No. 5 (Highpointe) Three Rivers Refinery, and West Cypress Hills wastewater effluent irrigation

**Ground Water**

- Pollution concentration predictions in Barton Springs from a pipeline leak using a numerical model based on field dye trace data
- Evaluation of environmental data to determine coal combustion waste disposal impacts in the Four Corners region
- Groundwater contamination study, waste evaluation, sampling, and analysis for petroleum refinery.
- Closed landfill study: field investigation, compiled and reviewed historical records, assessed potential environmental consequences, installed, sampled, and evaluated data from monitoring wells.
- Conducted geologic assessment, designed and installed groundwater monitoring well system for municipal landfills.

- Designed a system to limit methane and leached organic chemical migration from a closed municipal landfill into a karst limestone sole-source drinking water aquifer.
- Developed groundwater management alternatives to limit withdrawal and related land subsidence.

**Environmental Assessment**

- Baseline and impact assessment for wastewater line remediation project including evaluation of soils, geology, topography, and flow regimes.
- Environmental Assessment evaluation for a proposed project to convert an inactive crude oil pipeline, largely constructed in 1950, into active service as a high-pressure fuel transmission line. Work included: evaluating historical spill records; calculating statistical failure probabilities for different pipeline reaches and spill sizes; predicting time and concentrations of toxic and carcinogenic constituent migration through and discharge from a karst limestone aquifer; and evaluating the Operational Reliability Assessment performed for the pipeline.

**Solid Waste**

- Investigated waste metal migration in soil for petroleum land treatment unit.
- Investigated geologic setting and groundwater contamination and designed recovery well system for groundwater remediation at a commercial RCRA waste storage impoundment.
- Designed petroleum waste land treatment units: baseline soil and groundwater characterization; monitor well system design and installation; lysimeter systems; and land treatment demonstrations to determine maximum waste capacity and loading rates.
- Developed sampling procedures and in-place treatment for RCRA waste at electrical generation power plants.
- Managed and prepared technical phases of Industrial Solid Waste Permit Applications under RCRA and Texas Natural Resource Conservation Commission regulations for waste management facilities: land treatment units, surface impoundments, container storage areas.
- Designed closure plans for RCRA waste impoundments to store, treat and dispose of inorganic acids, spent pickle liquor, and organic chemicals.
- Review of proposed municipal solid waste landfill applications.

**Water Quality and Engineering Design**

- Gravity-flow retention and irrigation water pollution control system for a large hospital complex within the contributing watershed of the karst Barton Springs Aquifer.
- Design of an innovative bioretention water quality control system for a municipal complex located on the Barton Springs Edwards Aquifer Recharge Zone and permitting under Texas Commission on Environmental Quality Edwards Aquifer protection rules.
- Design of an innovative pervious pavement storm runoff detention and treatment system for a proposed parking lot to be located on the Northern Edwards Aquifer Recharge Zone and permitting under stringent City of Austin and Texas Commission on Environmental Quality water quality protection rules.
- Wet pond design and detention basin retrofit to treat stormwater from existing residential and commercial development in the Oak Springs neighborhood in East Austin.

- Combined wet pond and bioretention design for commercial storm runoff.
- Combined wet pond and retention/irrigation design for an existing 162-acre residential development over the sensitive Barton Springs recharge zone in the City of Austin, Texas.
- Municipal engineer responsible for all water quality design, review, inspection, rules, and ordinances for the City of Sunset Valley, Texas since 1994.
- Analyzed nonpoint pollution sources and structural and non-structural retrofit controls for recharge and contributing zone of a sensitive karst aquifer.
- Analyzed nonpoint pollution sources and structural and non-structural retrofit controls as water quality engineer for the City of Sunset Valley, Texas.
- Technical consultant to the City of Austin on implementation of the 1991 Comprehensive Watersheds Ordinance and associated water quality monitoring system.
- Analyzed stormwater conveyance and flooding potential, designed regional detention basin to protect natural ecological systems for Armand Bayou Master Drainage Study.
- Estimated long-term groundwater yields based on rainfall rates, soil type, and river losses for Chisumbanje region of Zimbabwe, Africa.
- Evaluated land use, soils, agricultural and silvicultural practices to assess non-point pollution potential in the San Jacinto River Basin.
- Designed storm water drainage for subdivisions and regional water detention facilities.

**Teaching and Presentations**

- Semester Course in Statistics for Environmental Monitoring; University of Texas at Austin; Fall 1995.
- Semester Course in Water Resources, University of Texas at Austin.
- Land Development Seminar; Travis County Bar Association, 12 July 1996.
- Water Quality Protection Programs to Reduce Nonpoint Source Pollution, a presentation to the Barton Springs/Edwards Aquifer Conservation District's Watershed Management: Challenges and Innovations--A Nonpoint Source Pollution Conference, 25 July 1996.
- Presenter at Emerging Issues in Groundwater Regulation panel discussion, Key Environmental Issues in U.S. EPA Region VI conference, hosted by U.S. EPA and the American Bar Association, May 12-13, 1997.
- Short Courses in Statistics for Environmental Monitoring; University of Texas Continuing Engineering Studies Program: Spring 1995, Fall 1995, Spring 1996, Spring 1997, Spring 1998.
- Short Courses in Statistics for Environmental Monitoring; Louisiana Department of Environmental Quality. Focus on surface water sampling considerations, trend analysis and methods to assess the achievement of data quality objectives.

**Statistics**

- Evaluated surface and groundwater measurements for normality, differences in mean, spatial variability, and time series analysis. Techniques used include Student's t-test, Wilcoxon test, parametric and non-parametric ANOVA, Fourier series decomposition, Shapiro-Wilkes test, and Chi-squared tests.
- Geostatistical analysis and kriging of groundwater transmissivity data.

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- Statistically-based sampling design including optimum sample number, stratified random sampling, and assessment of monitoring parameters to achieve efficient sampling designs.

**Field/ Laboratory Experience**

- Field supervision of auger drilling, rotary-bit drilling, well installation, Shelby-tube core and split-spoon sampling, and soil type identification using the Unified Soils Classification System.
- Surface, groundwater and hazardous waste sampling for a variety of constituents, including volatile organic constituents, dioxins, nutrients, metals, anions, cations, and other collection-sensitive parameters.
- Laboratory experiments to measure unsaturated hydraulic conductivity, water content versus soil water pressure, and other geophysical soil properties.

**Reports and Publications**

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- *City of Houston Sanitary Sewer Overflow Data Summary: Preliminary Report,* Eric Allmon, attorney, June 2018.
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- *Prefiled Testimony on Application of 130 Environmental Park, LLC for Proposed TCEQ Municipal Solid Waste Permit No. 2383,* attorney Marisa Perales, June 2016.
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- *Preliminary Engineering Design of Storm Runoff Treatment System,* Parkside Montessori Community School, February 2015.
- *Declaration regarding Wetlands Development in Galveston Baykeeper, Inc. vs. Trendmaker Homes, Inc.,* Galveston Baykeeper, Inc., November 2014.
- *Prefiled Testimony on Application of DHJB Development, LLC for a Major Amendment to TPDES Permit No. WQ 0014975001,* attorney Mary Conner, October 2014.
- *Potential Improvements to the Join Task Force Municipal Separate Storm Sewer MS4 Permit,* Houston Parks Board, Galveston Bay Foundation, Buffalo Bayou Partnership and Bayou Preservation Association, March 2014.
- *Circle Acres Environmental Sampling Report*, Ecology Action, January 2014.

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- *Potential Improvements to the Harris County Municipal Separate Storm Sewer MS4 Permit*, Houston Parks Board, Galveston Bay Foundation, Buffalo Bayou Partnership, and Bayou Preservation Association, January 2014.
- *Circle Acres Preliminary Engineering Biofilter Design*, Ecology Action, August 2013.
- *Circle Acres Storm Water Management Concept Plan*, Ecology Action, May 2013.
- C*omments on Draft Environmental Assessment of the Proposed Longhorn Pipeline Reversal*, City of Austin, September 2012.
- *Water for Coal-Fired Power Generation in Texas: Current and Future Demands,* for Sierra Club, February 2012.
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- *Surface Water and Sediment Sample Results Associated with the Walsh Cresson Ranch and Walsh West Ranch,* submitted to Mary Sahs, attorney, May 2007.
- *Biofiltration Water Quality Control Design Standards,* submitted to the City of Sunset Valley, Texas, 2007.
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# *Land-Applied Wastewater Effluent Impacts on the Edwards Aquifer*

***Prepared for:***
**Greater Edwards Aquifer Alliance**
**and**
**Save Our Springs Alliance**

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# Tables



# Figures

# Acknowledgements

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# *Executive Summary*

This report examines existing evidence that wastewater effluent discharged in the Barton Springs and San Antonio Edwards Aquifer contributing zones under Texas Land Application Permits (TLAPs), issued by the Texas Commission on Environmental Quality, have failed to protect springs, creeks, rivers, and groundwater. Significant findings of the study include:

- The total TLAP-permitted daily flow in the Barton Springs Edwards Aquifer contributing zone is 5.75 million gallons per day, compared with only 3.18 million gallons per day in the San Antonio Edwards contributing zone. On a per acre basis, the permitted effluent in the Barton Springs Edwards Aquifer contributing zone is 24 times the amount in the San Antonio Edwards Aquifer contributing zone.
- Across the Barton Springs and San Antonio Edwards Aquifer recharge zones from Austin to Brackettville, there are currently no TLAPs. A recently proposed TLAP system over the Barton Springs Edwards Aquifer recharge zone presents a significant new threat to aquifer water quality.
- TLAPs are wildly inconsistent in terms of requirements for wastewater treatment, offline effluent storage volume, irrigation area size, or downgradient monitoring. The result of these inconsistencies is widely different levels of protection for downgradient springs, streams, rivers, and wells.
- Sparsely available monitoring data from streams and/or springs downstream from TLAPs indicate significant degradation of the high quality water that would naturally occur at those locations.
- Regulations governing TLAPs should be overhauled to provide a consistent and high level of water quality protection across the Edwards Aquifer.

In the context of the thin soils, numerous springs, and delicately sensitive Texas Hill Country streams, rivers, and aquifers, any wastewater effluent system represents the threat of permanent and significant degradation. Only by soundly based and strictly enforced regulations can we balance provision of wastewater infrastructure to suburban residences with protection of the natural streams and springs that draw people to these areas.

# *Introduction*

In the drought-prone, arid area of the Texas Hill Country, springs, creeks, rivers, and groundwater are valued for their clarity and purity. These pristine water characteristics arise out of a unique natural setting of geology, soils, and vegetation. Partly ***because*** of their limited water supply, watersheds that sustain Texas Hill Country streams and aquifers have remained primarily rural ranch land.

With the combined pressures of increasing population and water importation, however, rural ranch land is rapidly being converted to suburban development. Along with more people and more water comes more wastewater. Because of their unique sensitivity to pollution, the Texas Commission on Environmental Quality (TCEQ) and its predecessor agencies have traditionally refused to grant wastewater effluent discharge permits within the San Antonio Edwards and Barton Springs recharge and contributing zones. An alternative permit, the Texas Land Application Permit (TLAP), has been granted instead. A TLAP requires that all wastewater effluent be irrigated onto fields or wooded areas, rather than being piped directly into a river or stream.

Until recently the number of TLAPs within the Texas Hill Country watersheds has been small. In 2003, for example, the volume of effluent disposal through TLAP permitted systems for the Barton Springs contributing zone was 1.7 million gallons per day.[1] As more people choose to live outside of the central urban areas, however, the volume of wastewater effluent being disposed of through TLAPs is burgeoning. By 2010, 7.2 million gallons per day of effluent irrigation had been permitted in the Barton Springs Edwards Aquifer contributing zone.

This report examines available evidence that current TLAP standards have failed to protect springs, creeks, rivers, and groundwater. It identifies significant permit inconsistencies; and short-comings of the current regulations governing TLAP permits terms. It recommends necessary regulatory changes to protect the character and quality of pristine Texas Hill Country streams and springs against an onslaught of expanding development and larger wastewater effluent volumes that come with increased human habitation.

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[1] Herrington, Chris, Matthew Menchaca and Matthew Westbrook, *Wastewater Disposal Practices and Change in Development in the Barton Springs Edwards Aquifer Recharge Zone,* City of Austin Watershed Protection Department, 2010, and personal communication.

# Setting

This study addresses effects of wastewater effluent disposal in the San Antonio and Barton Springs Edwards Aquifer contributing zones shown in Figure 1. This study region was selected because of its uniquely beautiful landscape; the importance of springs and stream flow in an otherwise water-short setting; and because the characteristics of these springs and streams make them naturally vulnerable to degradation from wastewater effluent. The following sections provide additional information on the streams and aquifers in the study region.

**Natural Stream Conditions**

There are ten major streams or rivers that originate in the contributing or recharge zones and carry water across the recharging limestone to sustain flow in the Edwards Aquifer. From west to east, these are the West Nueces, the Nueces, the Frio, the Sabinal, Hondo Creek, the Medina, the Guadalupe, the Blanco Rivers, Onion Creek and Barton Creek. In addition to these major rivers and creeks, there are numerous smaller creeks with unique biological habitat and beauty that contribute flow to the aquifer and springs. The pristine conditions of these creeks are also shared by other creeks and rivers near to, but outside of the Edwards Aquifer area, like the Pedernales River and its tributary Lick Creek.

**Photograph 1. East Lick Creek in Travis County, Prior to Effluent Irrigation Impacts**

Flow in these streams and rivers are characterized by two distinct regimes: a high flow regime shortly following storm rainfall; and a long duration low or baseflow regime. The long duration of the low-flow baseflow regime provides little to no dilution of any pollutants from wastewater effluent.

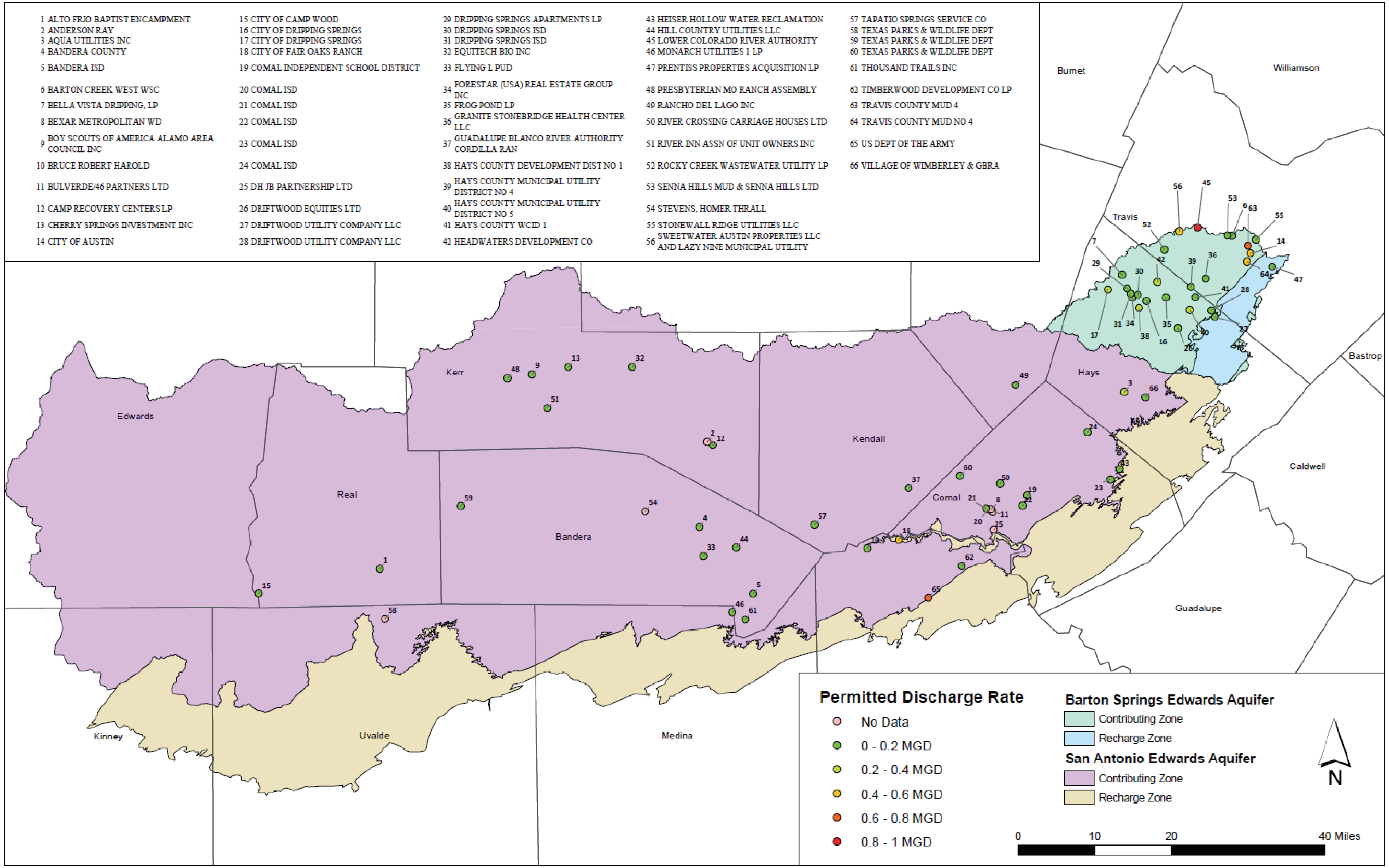


**Figure 1. TLAPs Permitted within the San Antonio and Barton Springs Recharge and Contributing Zones**

These Hill Country streams are also characterized by very low nutrient concentrations. Typical total phosphorous concentrations during baseflow conditions in a pristine Hill Country stream range from about 0.003 to 0.010 milligrams per liter and total nitrogen ranges from about 0.1 to 0.7 milligrams per liter.[2] Streams with these nutrient concentrations are classified as "oligotrophic." Oligotrophic waters are clear, with little algae. They have consistently high dissolved oxygen levels that support fish and other aquatic life.

**Edwards Aquifer**

Both the San Antonio and the Barton Springs Edwards Aquifers are karst systems. Groundwater flows through voids dissolved from the limestone. These voids range in size from pencil-width or smaller, to "big enough to drive a truck through." Water can move through a karst aquifer from recharge to discharge points in a matter of hours. The large passageways and rapid movement offer little opportunity for filtration or natural attenuation. Pollution that enters this aquifer shows up quickly in springs or wells. Karst aquifers are uniquely vulnerable to damage from pollution, including wastewater effluent.

**Photograph 2. Underground Flow of Water in Blowing Sink Cave, Travis County, Texas**

Pollution enters the Edwards Aquifer with the flow of recharging water. Understanding the source of water into the Edwards, both under natural conditions and in the presence of effluent irrigation conditions, is important to protecting the aquifer from pollution. Water can enter the Edwards Aquifer from four sources:

1. from upstream watersheds through recharge

[2] Herrington, Chris, *Impacts of the Proposed HCWCID 1 Wastewater Discharge to Bear Creek on Nutrient and DO Concentrations at Barton Springs,* City of Austin Watershed Protection Department, 2008; and Mabe, J.A., "Nutrient and biological conditions of selected small streams in the Edwards Plateau, Central Texas, 2005–06, and implications for development of nutrient criteria." *U.S. Geological Survey Scientific Investigations Report 2007–5195*, 2007.

features in creek channels;

2. through soil and fractured rock;
3. through internal drainage into sinkholes; and
4. from overlying or adjacent aquifers.

A recent study by Hauwert[3] estimated that 27% to 36% of the Barton Springs discharge might be sourced from upland areas rather than from stream bottoms. That study also determined that the proportion of rainfall recharging through soil-covered areas increased from 3% of rainfall during average rainfall conditions to 26% of rainfall during wet conditions.

This experimental finding is significant in two ways for understanding the potential effect of TLAPs on Edwards Aquifer water quality. First, the findings indicate direct connection between upland areas, where effluent irrigation occurs, and the underlying aquifer. There is no requirement that effluent first migrate to a channel bottom for aquifer degradation to occur. Second, aquifer recharge through soils regularly irrigated with effluent will be significantly higher than through soils saturated only by rainfall.

Wastewater treatment plants built for Shady Hollow and Travis Country residential developments in the 1980s irrigated wastewater effluent onto the recharge zone. Both plants were closed in the early 1990s to protect the Barton Springs Edwards Aquifer water quality. Currently there are no TLAPs for either the San Antonio or Barton Springs Edwards Aquifer recharge zones. There is, however, currently a permit application before the Texas Commission on Environmental Quality for such a system.[4]

A significant portion of the Edwards groundwater enters the aquifer through openings in the bottom of streams. Water to these stream bottoms is provided from their entire watersheds, which may stretch as far as 50 miles beyond the recharge zone boundary. These relatively large contributing watersheds gather rainfall runoff and then funnel it across stream bottom recharge features where the Edwards Limestone crops out. Wastewater effluent disposal within both the recharge and contributing areas would potentially affect the aquifer water quality.

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[3] Hauwert, Nico. *Groundwater Flow and Recharge within the Barton Springs Segment of the Edwards Aquifer, Southern Travis and Northern Hays Counties, Texas.* Dissertation, University of Texas at Austin, 2009, page 213.
[4] Jeremiah Venture, L.P., February 1, 2007.

# Wastewater Effluent

Of the wastewater generated and disposed of within the study area, the majority is municipal or domestic wastewater. Domestic wastewater is a mix of human urine and feces, soaps, detergents, cleaning products, body care products, and pharmaceuticals. The Federal Clean Water Act, originally passed in 1972 and subsequently amended, requires communities to treat wastewater before releasing it into streams or rivers.

Wastewater treatment however, usually addresses only a couple of wastewater characteristics. Oxygen demand is treated by inoculating wastewater with a concentrated liquor of biological microorganisms; and then supporting their growth by bubbling air into the mixture. After a certain amount of time, this mixture is transferred to a clarifying basin where suspended solids settle to the bottom of the basin. The clearer water flows over the top edge of the basin into the next basin. Chlorine is added to sterilize pathogens, and the wastewater effluent is then discharged to streams or rivers.

Wastewater effluent permits do ***not*** require treatment to remove metals, pharmaceutical chemicals, or the wide range of chemicals found in body care products, soaps, detergents, pesticides, or other cleaning products. These chemicals remaining in treated effluent are undesirable additions to pristine streams or aquifers. They reduce oxygen levels, kill fish, and stimulate algae blooms. These chemicals contribute to the occurrence of cancer, birth defects and impaired health. Even at very low concentrations, nutrients, toxic metals, pesticides, and pharmaceuticals disrupt aquatic life. Some of these chemicals may accumulate in fatty tissue, impair ability to reproduce, escape predation, maintain proper metabolism, and/or lead to premature death.

Municipal wastewater typically contains 20 to 85 milligrams per liter of total nitrogen. Approximately 60% of the nitrogen will be in the form of ammonia; and 40% bound up in plant and animal tissue. Activated sludge and similar treatment processes typically reduce effluent total nitrogen concentrations to 15 to 35 milligrams per liter. Advanced biological nitrification/denitrification processes can achieve total nitrogen concentrations of 2 to 10 milligrams per liter.[5]

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[5] Solomon, Clement, et al. *Trickling Filters: Achieving Nitrification*. National Small Flows Clearinghouse. http://www.nesc.wvu.edu/pdf/WW/publications/eti/TF_tech.pdf, September 25, 2011.

Elevated nutrients in drinking water can also significantly affect human health. Elevated nitrate concentrations have been linked to methemoglobinemia (blue baby syndrome), bladder and ovarian cancers in older women, and brain cancer in children of women using private well water during pregnancy. When combined with factors like low vitamin C or high meat intake, more than 10 years of exposure to water with more than 5 milligrams per liter of nitrate has been associated with a significant increase in the risk of colon cancer. Studies have also found positive associations between higher levels of nitrate intake during pregnancy and infant neural tube and congenital heart defects.[6]

Although nutrients are essential for a healthy ecosystem, natural ecosystems are precisely tuned to historical nutrient timing and concentrations. Nutrients higher than historical levels disrupt habitat. Increased plant growth pulls more oxygen out of the water when the dead plant matter decomposes. Excessive plant material also reduces stream velocities and increases sediment bottom deposition.

# Current Texas Land Application Permits (TLAPs) in the Barton Springs and San Antonio Edwards Contributing Zones

Texas has historically recognized the sensitivity of the Edwards Aquifer by refusing to permit wastewater effluent discharges directly into creek and rivers within the San Antonio and Barton Springs Edwards Aquifer recharge and contributing zones. Wastewater treatment systems within these areas have been required to obtain a Texas Land Application Permit (TLAP), rather than a Texas Pollution Discharge Elimination System (TPDES) permits. In February 2009 TCEQ granted a direct discharge permit to Hays County Municipal Utility District No.1 (Belterra Subdivision), overturning decades of precedent requiring a more protective permit standard. To date there have been no TLAPs issued for either the San Antonio or Barton Spring Edwards Aquifer recharge zones.

[6] Mary H. Ward, Division of Cancer Epidemiology and Genetics, National Cancer Institute, National Institutes of Health, Department of Health and Human Services, Bethesda, MD, Jean D. Brender, Department of Epidemiology and Biostatistics, Texas A&M Health Science Center, School of Rural Public Health, College Station, TX, Nitrate in Drinking Water: Potential Health Effects in Dubrovsky, N.M., Burow, K.R., Clark, G.M., Gronberg, J.M., Hamilton P.A., Hitt, K.J., Mueller, D.K., Munn, M.D., Nolan, B.T., Puckett, L.J., Rupert, M.G., Short, T.M., Spahr, N.E., Sprague, L.A., and Wilber, W.G., 2010, The quality of our Nation's waters—Nutrients in the Nation's streams and groundwater, 1992–2004: U.S. Geological Survey Circular 1350, 174 p. http://water.usgs.gov/nawqa/nutrients/pubs/circ1350.

Effluent disposal under TLAP is generally more protective of creeks, rivers, springs, and the aquifer, compared with a TPDES disposal permit. Effluent receives additional treatment within plant roots and soil in several ways. Water is removed by plant roots and evapotranspiration, reducing the hydraulic pressure to carry contaminants beyond the disposal field. Soil organisms and plants convert nutrients into living cells. Toxic chemicals are transformed into safer substances. Chemicals are bound to organic matter and clay. Metals precipitate and are bound into the soil by iron and clay.

Whether or not these processes work effectively, however, depend on several aspects of the TLAP system:

- the chemical quality of treated effluent;
- the effluent application rate;
- soil depth;
- offline effluent storage capacity, used when the soil is saturated or frozen;
- excess vegetation removal; and
- monitoring and adjusting effluent irrigation in response to weather and rain.

Permit copies were obtained for this report from the TCEQ for 64 out of a total of 70 TLAPs issued for systems operating within the contributing zones of the San Antonio and Barton Springs Edwards Aquifer. Basic characteristics regarding the permitted flow, effluent quality, application rates, and storage volume were extracted from the TLAPs and are presented in Appendix A.[7]

The degree to which TLAPs degrade rivers, streams, and springs depends partly on the volume of wastewater that is treated and disposed of within a given area. Figure 1 illustrates the high density of TLAP systems in the Barton Springs Edwards Aquifer contributing zone compared with the San Antonio Edwards Aquifer contributing zone. An analysis of the data supports the visual impression. Table 1 compares TLAPs in the San Antonio and Barton Springs Edwards contributing zones. The permitted effluent volume in the Barton Springs Edwards Aquifer contributing zone is almost twice the volume permitted in the San Antonio contributing zones, even though the San Antonio contributing area is 17 times larger. On a per-area basis, there is 24 times as much wastewater effluent permitted for

[7] Permits for six systems in the San Antonio Edwards contributing zone were not located. These permits are listed in Appendix B.

irrigation in the Barton Springs Edwards Aquifer contributing zone compared with the San Antonio Edwards.

**Table 1. Permitted TLAP Effluent in the Barton Springs Edwards Aquifer Contributing Zone Compared with the San Antonio Edwards**

| Aquifer | Total Flow (MGD) | Total Irrigated Area (acres) | Zone Area (acres) | GPD per Acre |
|---|---|---|---|---|
| Barton Springs | 5.75 | 2,063 | 238,557 | 24 |
| San Antonio Edwards | 3.18 | 1,461 | 4,177,172 | 1 |

River, stream, well and spring degradation also depends on the degree of effluent treatment before it is irrigated onto the soil. There is a wide variety of effluent treatment methods, effluent quality standards, effluent storage capacity, and irrigation area size requirements in TLAPs issued within the study area. Table 2 lists the different types of treatment technologies and the number of permits associated with each. Of the 64 TLAPS, 44 use the activated sludge treatment method described above. Twelve of the TLAPs either fail to specify any required treatment method, or specify a treatment method less effective than activated sludge.

**Table 2. Treatment Technologies for TLAPs in the Study Area**

| Treatment Methods | |
|---|---|
| **Treatment Method** | **Number of TLAPs** |
| activated sludge | 44 |
| septic tank | 6 |
| single stage nitrification | 2 |
| not specified | 2 |
| membrane bioreactor | 2 |
| septic and textile filter | 1 |
| S&L Fast K 1086 T | 1 |
| facultative lagoon | 1 |
| disk filtration | 1 |
| Cycle-let | 1 |
| aerobic treatment | 1 |
| aeration basin | 1 |

Out of the 64 TLAPs, only 10 specify limits on nutrient discharges. Of these 10 that specify nutrient limits, eight limit only ammonia nitrogen. An ammonia limitation does ***not***, however, reduce available nitrogen in the discharge. In the activated sludge system used in each of these eight systems ammonia nitrogen is converted to nitrate nitrogen.[8] Nutrient nitrogen is not removed; it is simply converted to a different form.

In addition to differences in treatment methods and nutrient standards, TLAPs in the San Antonio Edwards and Barton Springs contributing zones differ widely in terms of the allowed application rates and the required effluent storage volume. An examination of the information in Appendix A indicates that the permit-allowed application rates range from 0.08 to 12.20 acre-feet per acre per year. The most common application rate is 4.88 acre-feet per acre per year, equivalent to the subsurface drip irrigation rate of 0.1 gallons per day per square foot. Twenty seven of the 64 current permits specify this application rate. Note, however, that the next section describes three systems with this application rate that exhibit indications of downstream degradation.

Out of 64 TLAPs, only 43 specify an effluent storage volume requirement. Twenty-one TLAPs have no effluent storage requirements. All permit-required volumes have been converted to “days of storage.” See Appendix A. This measure is the number of days for which the entire permitted flow could be contained in the storage volume. Since the value of effluent storage is the ability to postpone irrigation during saturated or frozen soil conditions, this measure in days is comparable between facilities across the range of permitted flows.

Of those that require effluent storage, required volumes range across five orders of magnitude, from 0.08 to 308 days. Effluent storage required for subsurface irrigation systems ranges from 0.08 to 70 days; and the average is 5.8 days. For surface irrigation systems the range is 12 to 308 days and the average is 70 days. The wide difference in average storage reflects differences in TCEQ regulations for subsurface and surface irrigation TLAPs. This wide difference in average storage requirements does not, however, reflect any difference in the sorptive capacity of the soils. In general, systems with less storage will be less protective of rivers, streams, wells, and springs than those with more storage. For

[8] Solomon, Clement, et al., *Trickling Filters: Achieving Nitrification*; National Small Flows Clearinghouse, http://www.nesc.wvu.edu/pdf/WW/publications/eti/TF_tech.pdf, September 25, 2011.

this and other reasons, subsurface irrigation systems represent a greater risk of degradation compared to surface irrigation.

# *Evidence of Degradation from TLAP Wastewater Systems*

Monitoring to determine whether TLAPs have damaged streams, creeks, springs, and wells is not required by Texas environmental regulations; nor is it a requirement of most permits. Nevertheless, water monitoring programs by other agencies indicate stream and aquifer degradation in streams and springs associated with TLAPs. This section summarizes some of the available water quality measurements indicating TLAP systems have resulted in degraded water quality.

## Hays County Water Control Improvement District No. 1

Hays County Water Control Improvement District No. 1, for the Belterra Subdivision, holds a subsurface irrigation permit for 150,000 gallons per day. The irrigation area is 35 acres in the Bear Creek watershed, tributary to Onion Creek, and located about seven stream miles upstream of the Barton Springs Edwards Aquifer recharge zone. The authorized application rate for this drip irrigation system is 4.88 acre-feet per acre per year. The system has 2.2 days of effluent storage, and the treatment limits, on a daily average, are 20 milligrams per liter biochemical oxygen demand and 20 milligrams per liter total suspended solids. There are no nitrogen or phosphorous effluent limits.

The City of Austin collected water quality samples from Bear Creek at seven locations to determine whether wastewater effluent irrigation associated with the Belterra Subdivision may have caused creek degradation.[9] The City's program includes monitoring from a spring at Aspen Drive upstream of possible TLAP irrigation field influences, downstream to a riffle at Bear Creek Pass. The City has also monitored four tributary locations to assess the impact of their inflows on Bear Creek water quality.

[9] Turner, Martha, *Bear Creek Receiving Water Assessment – January 2009 – March 2010,* City of Austin Watershed Protection Department, SR-10-10, September 2010.

The City's monitoring and data analysis found higher nitrate concentrations at sites immediately below the Belterra TLAP irrigation fields compared with nitrate in the spring above the irrigation fields.[10] The average nitrate concentration increased from 0.47 milligrams per liter upstream, to 1.31 milligrams per liter downstream of the TLAP irrigation area. See Figure 2. This nitrogen concentration increase shifts Bear Creek across the classification boundary between an oligotrophic and a mesotrophic stream at 0.7 milligrams per liter.

Chlorophyll-a concentrations, a measure of algae, were also higher in the Davis Pond immediately downstream from the irrigation fields, compared with the pond at Bear Creek Pass. Similarly, there are significantly higher occurrences of plants and algae above the Davis Pond, compared with the sampling site at Bear Creek Pass.[11]

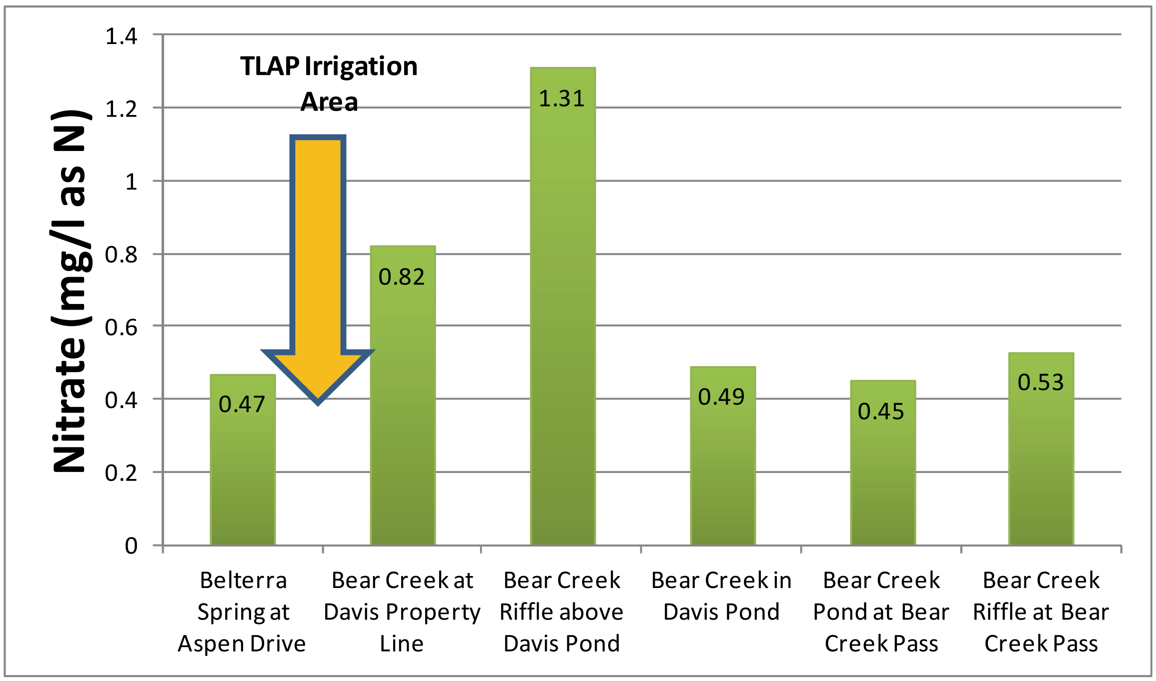


**Figure 2. Increased Average Nitrate Concentration Downstream from Belterra TLAP Irrigation Area**

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[10] Turner, Martha, *Bear Creek Receiving Water Assessment – January 2009 – March 2010,* City of Austin Watershed Protection Department, SR-10-10, September 2010, page 10.

[11] Turner, Martha, *Bear Creek Receiving Water Assessment – January 2009 – March 2010,* City of Austin Watershed Protection Department, SR-10-10, September 2010.

Sources other than effluent irrigation could produce higher nitrate concentrations and algae indicators downstream from the TLAP irrigation fields. These sources include subdivision fertilization, cattle ranching, and suburban stormwater runoff. There are several factors, however, that suggest that the observed water quality degradation is associated with the TLAP system, rather than any of these alternative sources:

- Nitrate concentrations are similar in Bear Creek at the Davis property line and in the Davis Pond. The property line site is above the influence of any cattle on the Davis property.
- Nitrate concentrations are highest during low flow situations. If the source were storm runoff, high concentrations would be observed during high flow, storm runoff conditions.
- Nitrate concentrations are highest during winter months. This pattern is consistent with TLAP effluent application when plant uptake is reduced.
- Algae occurrence increased during baseflow following heavy rains, suggesting that nutrients in the irrigation field may be flushed during these events.

In addition to sampling in the main stem of Bear Creek, the City of Austin also sampled two tributaries. One tributary north of the pond has relatively better quality than Bear Creek. Contributions from this tributary dilute nutrients and improve Bear Creek water quality.

Measurements on samples collected by the City of Austin from the western tributary to Bear Creek are similar to those of the main stem below the Belterra irrigation fields. This western tributary is downstream from the Highpointe subdivision, which is located on its headwaters. Like Belterra, Highpointe is served by a TLAP effluent irrigation system. This system is permitted for 300,000 gallons per day, subsurface irrigated on 68.87 acres. The application rate, 4.88 acre-feet per acre per year, is the same as Belterra's. Effluent treatment standards for Highpointe are the same as for Belterra.

Similarly to the situation in Bear Creek above and below the Belterra effluent irrigation fields, nitrates were relatively low (less than 0.004 milligrams per liter) in the western tributary above the Highpointe TLAP fields; and increase below the TLAPS irrigation fields to about 0.64 milligrams per liter.[12]

[12] Turner, Martha, *Bear Creek Receiving Water Assessment – January 2009 – March 2010,* City of Austin Watershed Protection Department, SR-10-10. September 2010, Figure 11.

## Barton Creek West

Barton Creek West is a residential subdivision in the Barton Creek watershed. The subdivision is located about 8 miles west of downtown Austin on Bee Caves Road. The Barton Creek West Homeowners Association, Inc. was registered in April 1985; and the subdivision currently consists of 398 homes.[13] The TLAP authorizes treatment and surface irrigation of 126,000 gallons of effluent per day on 53.3 acres of native grass. The allowed application rate is 2.7 acre-feet per acre per year. The system includes 62.7 acre-feet of storage to store 162 days of effluent. Treatment limits, on a daily average, are 10 milligrams per liter biochemical oxygen demand and 15 milligrams per liter total suspended solids. The permit does not restrict nitrogen or phosphorous in the treated effluent.

The City of Austin has monitored water quality in Scenic Bluff Spring, downstream of the irrigation fields since 1997. Average nitrate concentrations in this pool are 1.3 milligrams per liter[14]; and the maximum observed concentration is 5.9 milligrams per liter. Nitrate concentrations in uncontaminated wells and springs from the Glen Rose formation, from which this spring emerges, are about 10 to 50 times lower than these concentrations; on the order of 0.1 milligrams per liter.

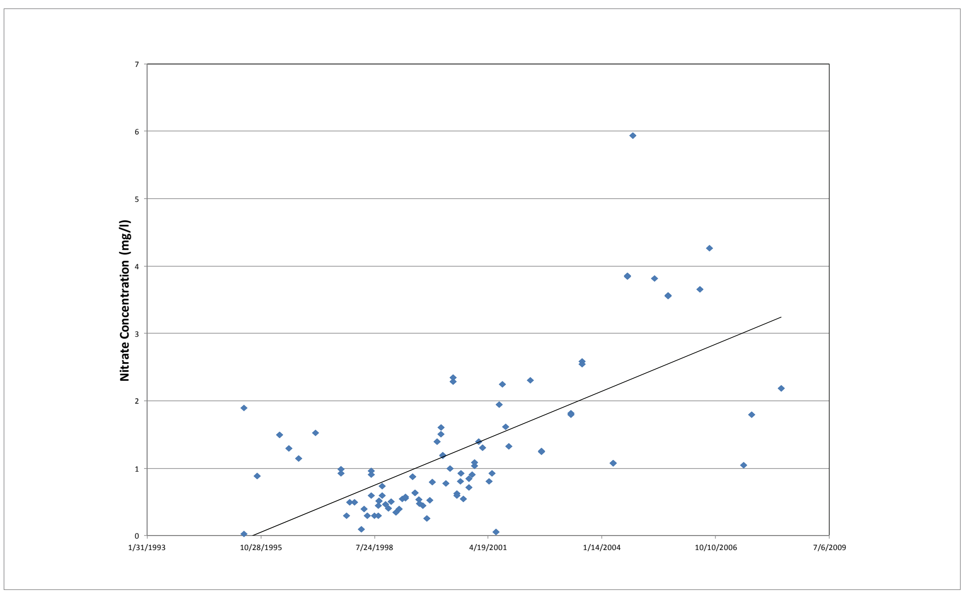


**Figure 3. Increasing Nitrate Concentrations in Scenic Bluff Springs Over Time**

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[13] Barton Creek West HOA. https://community.associawebsites.com/sites/BartonCreekWestHOA/Pages/AcwDefault.aspx, September 25, 2011.
[14] Nitrate concentration as nitrogen.

Figure 3 is a graph of nitrate concentrations in Scenic Bluff Spring as a function of time. The graph shows a clear trend of increasing concentrations. Grotto Spring, also apparently downgradient from the irrigation fields shows a similar trend of increasing nitrate concentrations with time.

Hebbingston Hollow, downstream from Bluff Springs, has been dammed to form a small pond. The presence of a thick algae layer across the entire surface of the pool on June 11, 2009 demonstrates the consequences of the high nitrate concentrations measured in the spring.

**Photograph 3. Algae-Covered Pool Downstream from Barton Creek West Irrigation Fields**

Residential lawn fertilization may be another source for the observed nitrate concentration increases over time in the two springs downstream from the Barton Creek West effluent irrigation fields. Monitoring by the City of Austin, however, suggests that stream nitrogen concentrations downstream from suburban residential areas on septic systems are relatively low compared with similar areas irrigated with effluent. See Figure 4. This difference suggests that irrigated effluent is at least partly the source of the elevated nitrate concentrations observed in Bluff Springs.

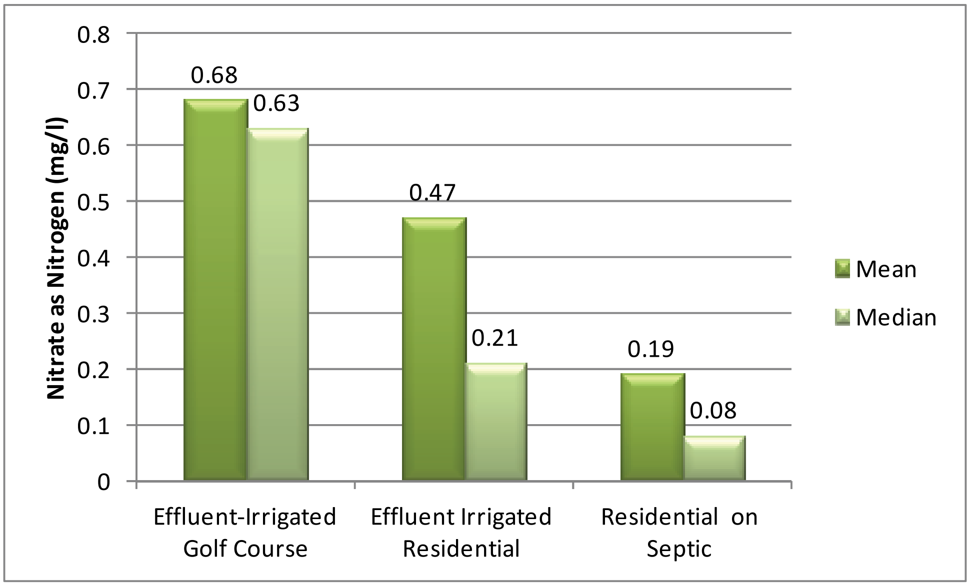


**Figure 4. Nitrate Concentration in Barton Creek Canyons Baseflow**

## West Cypress Hills

West Cypress Hills is a residential subdivision located about 16 miles west of central Austin. Although the system is located just outside of the contributing zone to the Barton Springs Edwards Aquifer, it is included here because soils, geology, climate, and regulatory requirements for wastewater effluent are similar to many of the systems within the subject area of this study. This is another TLAP system for which water quality measurements in East Lick Creek above and below the TLAP irrigation fields are available. There is also another branch of Lick Creek, West Lick Creek without wastewater effluent irrigation, for which water quality measurements provide a comparable reference.

West Cypress Hills is proposed to be constructed in three phases. The first phase, begun in 2003, encompassed construction of 88 residences.[15] The second and third phases of the development contemplate construction of an additional 244 and 895 residences, respectively. The final phase of this permit would allow 31,000 gallons per day to be applied through a subsurface drip irrigation system to 72.08 acres. Allowed application rates are 4.88 acre-feet per acre per year. At least three days of effluent storage are required. Effluent permit limits are 20 milligrams per liter biochemical oxygen

[15] The Moore Group, *Cypress Ranch Phase One*, Section One. Engineer's Report. April 6, 2003.

demand and 20 milligrams per liter total suspended solids, on a daily average basis. There are no nutrient limit requirements.

The owner's representative collected water quality samples from springs and streams upstream and downstream from the West Cypress Hills TLAP irrigation area in June and September 2007. Nitrate concentrations in these data, presented in Figure 5 show a pattern similar to the one observed downstream from the TLAP irrigation areas for Belterra and Barton Creek West.


**Photograph 4. West Lick Creek Downstream from Pedernales Canyon Trail**

Nitrate concentrations are low upstream from the irrigation fields. These concentrations rise sharply just downstream from the irrigation fields. Further downstream concentrations are once again lower. More extensive algae coverage of the creek, and the presence of algae types like *Cladophora,* however, indicate that the trophic state of the stream has been altered even where nutrient measurements in the water column are relatively low. Photograph 4 and Photograph 5 depict the difference in algae coverage in East Lick Creek downstream for the currently irrigated areas, compared with clear flow in West Lick Creek, where there are currently no effluent-irrigated fields in the watershed.


**Photograph 5. Algae in East Lick Creek Downstream from Pedernales Canyon Trail**

As with any suburban development, there are other potential nutrient sources. The West Cypress Hills developer originally believed that the source of the nitrogen might be a commercial plant nursery, a horse barn, or storm runoff from Highway 71. Nitrate concentrations from stream locations downgradient from these sites, however, are lower than at sites below the effluent irrigation areas.

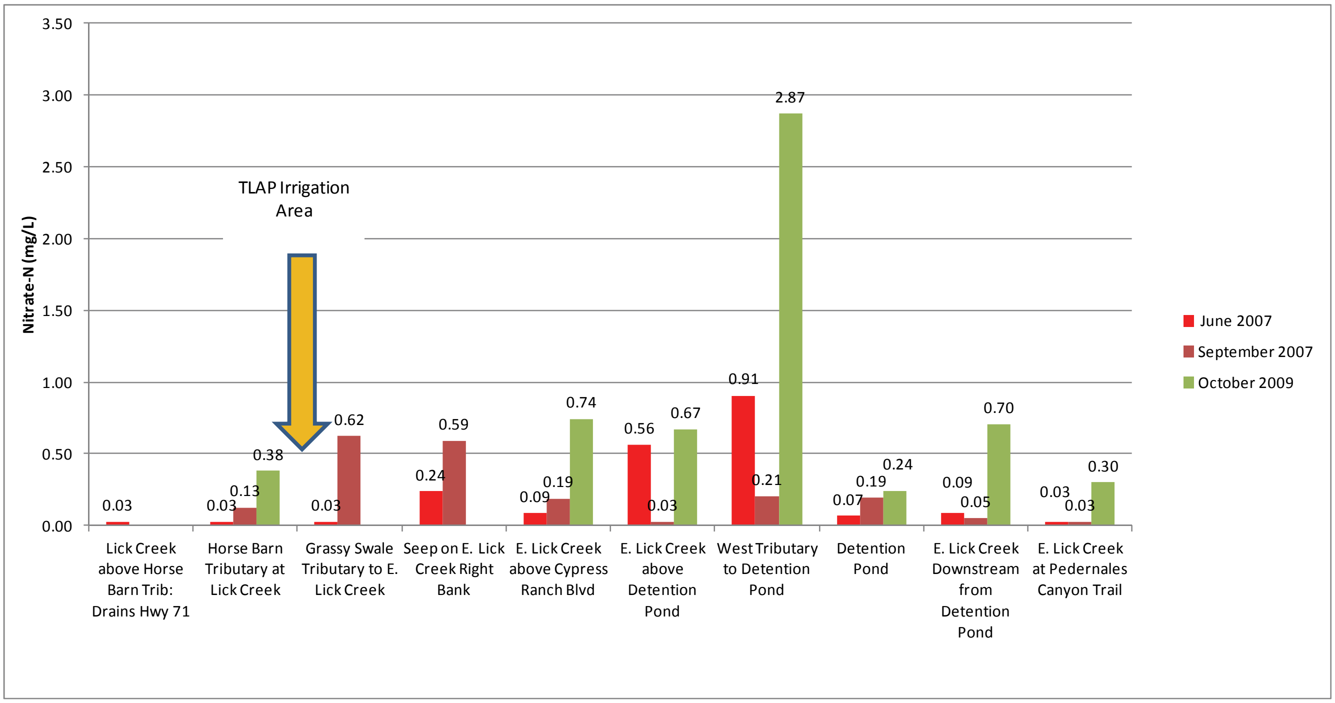


**Figure 5. Nitrate Concentrations Above and Below West Cypress Hills TLAP Irrigation Fields**

Other possible sources are residential lawn fertilization and compost used to revegetate the construction site.

## Effluent Land Application in Other Areas

The soils, climate, and geology of the Edwards Aquifer are unique. There is evidence from other locations, however, that corroborate groundwater degradation from the land application of effluent in similar systems. A study of well and spring water quality in the karstic Wakulla Spring in northern Florida found nitrate-nitrogen concentrations increased from about 0.2 to 1.1 milligrams per liter downstream from a 17 million gallon per day wastewater spray field farming operation on 313 acres. The largest contribution to the nitrogen load, 55%, was attributed to municipal wastewater. Nitrate isotope signatures ($\delta^{15}N$ and $\delta^{18}O$) in groundwater match those of the effluent.

Boron and chloride concentrations were elevated. One pharmaceutical compound, carbamazepine (an anti-convulsant drug) was also detected in the groundwater. Spring-fed streams in Florida have experienced a proliferation of nuisance aquatic vegetation and algal growth.[16]

# TLAP Noncompliance with Regulation Requirements

The following section discusses recommended improvements to current TLAP regulatory requirements. Before recommending regulatory improvements, however, it seems important to identify inadequate implementation of existing regulations.

## Required Soil Monitoring

TCEQ regulations do not require stream, river, well, or spring monitoring downstream from effluent irrigation areas. 30 TAC §309.20 (b)(4) does, however, require pre-operational and annual soil testing of pH, total nitrogen, potassium, phosphorus, and conductivity. This requirement is included as part of each TLAP in Special Provision 10: "*The permittee shall submit the results of the soil sample analyses to the TCEQ Regional Office and Water Quality Compliance Monitoring Team of the Enforcement Division during September of each year.*"

A search of TCEQ records, however, indicates reported soil monitoring results for only two of the 64 TLAPs within the study area. Even for these limited reported data, only 2 out of the 18 include the required nitrogen measurements. Given indications of nutrient migration from the effluent irrigation fields resulting in significant water degradation, the failure by TCEQ to regulate and enforce what is clearly intended to be an early warning system on nutrient accumulation in the soil disposal zone is troubling.

## Failure to Properly Review TLAP Applications

Numerous parties, including the City of Austin, Barton Springs Edwards Conservation District, the Lower Colorado River Authority, Hays County, and Save Our Springs Alliance are currently contesting a TLAP for Jeremiah Venture to treat and irrigate 330,000 gallons per day of wastewater effluent over

[16] Katz, Brian, Dale Griffin, J. Hal Davis, "Groundwater quality impacts from the land application of treated municipal wastewater in a large karstic spring basin: chemical and microbiological indicators." *Science of the Total Environment,* 407, 2872-2886, 2009.

the recharge area of the Barton Springs Edwards Aquifer. There are currently no surface or subsurface TLAP systems permitted within the San Antonio or Barton Springs Edwards Aquifer recharge zones.

Given the potential significance of this precedent-setting permit, and using the legal authority and resources of the contested hearing process, the City of Austin, Save Our Springs Alliance and Save Barton Creek Association undertook an in-depth review of the Jeremiah Venture TLAP application. The results of the review indicated that the TLAP application failed to represent the potential for significant degradation in the following ways:

- Effluent irrigation was proposed for areas where the soils were determined to be unsuitable for effluent irrigation because they were too rocky, thin, and clayey, and/or had more than 50% bedrock outcrop. Other irrigation areas were determined to be unsuitable because they were on gradients approaching 15% and soil water holding capacities were less than 2 inches.[17]
- The applicant's assessment identified four sinkholes, no caves, four solution cavities, and 14 closed non-karstic depressions. By comparison, a geologic assessment by the City of Austin,[18] conducted over eight days, identified nine cave features, 35 sinkholes, 27 karst depressions, 24 non-karst closed depressions, 23 solution enlarged fractures, 39 solution cavities, and 3 swallow holes. The applicant's assessment failed to characterize the potential for wastewater effluent migration through a sensitive karst region into the underlying Barton Springs Edwards Aquifer.
- Irrigation field sizing is based on a water balance of effluent irrigation, rainfall, runoff, evapotranspiration, and deep percolation. This water balance is particularly sensitive to the evapotranspiration estimates. The applicant's water balance was based on estimated evapotranspiration rates for dryer conditions west of the proposed Hays County location. The significance of this difference was that the applicant overestimated the volume of water that could be applied to the proposed irrigation area by 29%; and underestimated the required effluent storage volume by almost half.[19]

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[17] SOAH Docket No. 582-09-1617; TCEQ Docket No. 2008-1858-MWD. *Application of Jeremiah Venture, L.P. for a New TLAP, Permit No. WQ0014785001*, Direct Testimony of Dr. Lawrence (Larry) P. Wilding. July 31, 2009, pages 50-51.
[18] Hauwert, Nico, *Preliminary Phase I Assessment of the Jeremiah Ventures Site,* for the City of Austin, September 25, 2009.
[19] Ross, Lauren, *Engineering Analysis of Jeremiah Ventures L.P. Proposed Wastewater Irrigation Areas; Draft,* December 2009.

- As required by TCEQ regulations, the applicant provided a water balance for the wettest year of record: 2004. The wettest year of record does not, however, necessarily capture critical rainfall and evapotranspiration conditions. Weather conditions during 2007, a year with a lower rainfall total than 2004, are more restrictive in terms of both effluent irrigation area and storage volume. Nevertheless, the applicant was allowed to size these facilities based on a model using 2004 data.

The applicant proposed to provide wastewater service to 1450 residences. The number of residences that could be served using a water balance based on the appropriate evapotranspiration rates and providing buffers to the City of Austin-identified recharge features is 800. This significant financial incentive to the applicant to misrepresent actual site conditions can only be addressed by consistent and careful review by the authorizing agency, the Texas Commission on Environmental Quality.

# Recommendations

Given the number of currently permitted TLAP systems, particularly in the Barton Springs Edwards Aquifer contributing zone, and existing evidence of degraded streams and springs, several changes to TLAP regulations are warranted. These changes include:

- Given that karst features beneath irrigation areas cannot be completely identified, mapped or defined, spray effluent irrigation, as well as subsurface effluent irrigation, over recharge areas should be prohibited.
- Consistent effluent standards to limit concentrations of total nitrogen and phosphorous should be established. Any limitation based upon ammonia nitrogen alone provides no additional protection. Advanced wastewater treatment methods can consistently reduce total phosphorous concentrations to near or below 0.01 milligrams per liter.[20] Combined total nitrogen and total

[20] EPA Region 10, *Advanced Treatment to Achieve Low Concentration of Phosphorus,* April 2007, http://yosemite.epa.gov/r10/water.nsf/Water+Quality+Standards/AWT-Phosphorus/$FILE/AWT+Report.pdf, September 26, 2011.

phosphorous removal systems can achieve annual average concentrations less than 3 milligrams per liter and 0.1 milligrams per liter, respectively.[21]

- Subsurface effluent application does not increase soil storage or treatment capacity. In fact, because the potential evapotranspiration from the surface of tree and plant leaves is lost, the effluent storage and treatment capacity for subsurface effluent application is actually less than for surface applications. Furthermore, subsurface application bypasses the surface soil barrier to chemical and microbial migration.[22] Current rules should be changed to require the same effluent storage capacity for subsurface as for surface application systems.
- The same engineering basis should be used to determine effluent application rates and storage volume requirements for both surface and subsurface systems. That basis should be a daily time-step water balance using historic rainfall rates and evapotranspiration rates from representative weather stations within 25 miles of the proposed facility. The water balance modeling period should be the period of record.
- The leaching allowance in the current TLAP regulations is, essentially, an amount of effluent allowed to deep percolate into underlying aquifers. The leaching allowance should be eliminated.
- TLAPs should require downgradient monitoring, including nitrate, boron, chloride concentrations, nitrogen and oxygen isotope signatures and measures of the occurrence of algae, to identify any wastewater effluent contamination of springs, streams, and wells.[23]
- In addition to the current general prohibition, TLAPs should require soil monitoring to measure saturated or frozen conditions and prevent effluent application.
- Existing regulations requiring regular soil monitoring should be expanded to include a process for identifying soil monitoring results that would trigger a re-examination of the permit terms to prevent wastewater effluent chemical migration to streams, springs, and wells.

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[21] Kang, Shin, Kevin Olmstead, Krista Takacs, James Collins, *Municipal Nutrient Removal Technologies Reference Document,* EPA 832-R-08-006, September 2008, http://water.epa.gov/scitech/wastetech/upload/mnrt-volume1.pdf, September 26, 2011.
[22] Katz, Brian, Dale Griffin, J. Hal Davis, "Groundwater quality impacts from the land application of treated municipal wastewater in a large karstic spring basin: chemical and microbiological indicators." *Science of the Total Environment,* 407, page 2884, 2009.
[23] Katz, Brian, Dale Griffin, J. Hal Davis, "Groundwater quality impacts from the land application of treated municipal wastewater in a large karstic spring basin: chemical and microbiological indicators." *Science of the Total Environment,* 407, 2872-2886, 2009.

In the context of the thin soils, numerous springs, and delicately sensitive Texas Hill Country streams, rivers, and aquifers, any wastewater effluent system represents the threat of permanent and significant degradation. Only with soundly based and strictly enforced regulations can we balance provision of wastewater infrastructure to suburban residences with protection of the natural streams and springs that draw people to these areas.

# *Appendix A. TLAPs in the San Antonio and Barton Springs Edwards Contributing Zones*

# TLAP Permits in the San Antonio and Barton Springs Edwards Contributing Zones

| Aquifer | Permit | Permittee | River Segment | Flow (MGD) | Irrig Area (acres) | Appli-cation Rate (ac-ft/ac/yr) | Effluent Storage (days) | Treatment Method | BOD Grab (mg/L) | Daily Average BOD (mg/L) | Daily Average TSS (mg/L) | Daily Average NH3 (mg/L) | Daily Average P (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Barton Springs** | | | | | | | | | | | | | |
| | 11319-001 | CITY OF AUSTIN, LOST CREEK | Barton Creek | 0.52 | 308.42 | 1.89 | 43.36 | activated sludge | 35 | 10 | 15 | -1 | -1 |
| | 12786-001 | BARTON CREEK WEST WSC | Barton Creek | 0.13 | 53.30 | 2.65 | 162.15 | activated sludge | 35 | 10 | 15 | -1 | -1 |
| | 13206-001 | TRAVIS COUNTY MUD 4 | Barton Creek | 0.72 | 298.70 | 2.70 | 75.13 | activated sludge | 30 | 5 | 5 | 2 | -1 |
| | 13238-001 | SENNA HILLS MUD & SENNA HILLS LTD | Barton Creek | 0.16 | 70.30 | 2.50 | 112.08 | activated sludge | 30 | 5 | 5 | 2 | -1 |
| | 13594-001 | LOWER COLORADO RIVER AUTHORITY Lake | Barton Creek | 1.00 | 350.00 | 3.20 | 32.59 | activated sludge | 35 | 5 | 5 | 2 | -1 |
| | 13748-001 | DRIPPING SPRINGS ISD | Onion Creek | 0.02 | 3.44 | 4.88 | 0.00 | septic tank | 100 | -1 | -1 | -1 | -1 |
| | 13748-002 | Dripping Springs ISD | Onion Creek | 0.03 | 3.83 | 7.31 | 0.00 | activated sludge | 65 | -1 | -1 | -1 | -1 |
| | 13860-001 | GRANITE STONEBRIDGE HEALTH CENTER LLC | Onion Creek | 0.01 | 1.59 | 7.03 | 0.00 | septic tank | 100 | 30 | 30 | -1 | -1 |
| | 14077-001 | PRENTISS PROPERTIES ACQUISITION LP | Barton Creek | 0.00 | 0.00 | | 70.45 | Cycle-let | 30 | 5 | -1 | -1 | -1 |
| | 14146-001 | DRIPPING SPRINGS APARTMENTS LP | Onion Creek | 0.01 | 3.57 | 4.39 | 58.19 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 14208-001 | HAYS COUNTY DEVELOPMENT DIST NO 1 | Onion Creek | 0.30 | 120.00 | 2.80 | 72.31 | activated sludge | 30 | 5 | 5 | -1 | -1 |
| | 14235-001 | DRIFTWOOD EQUITIES LTD Salt Lick | Onion Creek | 0.01 | 2.30 | 4.87 | 2.53 | activated sludge | 35 | 10 | 15 | -1 | -1 |
| | 14293-001 | HAYS COUNTY WCID 1 Beltera | Onion Creek | 0.15 | 35.00 | 4.80 | 2.20 | not specified | 65 | 20 | 20 | -1 | -1 |

# TLAP Permits in the San Antonio and Barton Springs Edwards Contributing Zones

| Aquifer | Permit | Permittee | River Segment | Flow (MGD) | Irrig Area (acres) | Application Rate (ac-ft/ac/yr) | Effluent Storage (days) | Treatment Method | BOD Grab (mg/L) | Daily Average BOD (mg/L) | Daily Average TSS (mg/L) | Daily Average NH3 (mg/L) | Daily Average P (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Barton Springs** | | | | | | | | | | | | | |
| | 14309-001 | HAYS COUNTY MUNICIPAL UTILITY | Barton Creek | 0.15 | 34.44 | 4.88 | 2.22 | single stage nitrification | 65 | 20 | 20 | -1 | -1 |
| | 14358-001 | HAYS COUNTY MUD 5 Highpointe | Onion Creek | 0.30 | 68.87 | 4.88 | 2.22 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 14430-001 | TRAVIS COUNTY MUD NO 4 | Barton Creek | 0.60 | 220.00 | 3.06 | 76.03 | single stage nitrification | 30 | 5 | 5 | 2 | -1 |
| | 14435-001 | STONEWALL RIDGE UTILITIES LLC | Barton Creek | 0.01 | 1.15 | 4.87 | 0.00 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 14480-001 | DRIFTWOOD UTILITY COMPANY LLC Reunion | Onion Creek | 0.05 | 11.50 | 4.87 | 3.98 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 14480-002 | DRIFTWOOD UTILITY COMPANY LLC Reunion | Onion Creek | 0.10 | 22.10 | 4.88 | 4.88 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 14488-001 | CITY OF DRIPPING SPRINGS South Regional | Onion Creek | 0.16 | 37.43 | 4.86 | 2.05 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 14488-002 | CITY OF DRIPPING SPRINGS Scenic Greens | Onion Creek | 0.25 | 57.39 | 4.88 | 3.00 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 14587-001 | Austin Highway 290 (Headwaters | Barton Creek | 0.33 | 76.00 | 4.79 | 7.00 | activated sludge | 30 | 5 | 5 | 2 | 1 |
| | 14629-001 | SWEETWATER AND LAZY NINE MUD | Barton Creek | 0.49 | 199.50 | 2.75 | 60.05 | activated sludge | 35 | 10 | 15 | -1 | -1 |
| | 14664-001 | ROCKY CREEK WASTEWATER UTILITY LP | Barton Creek | 0.13 | 50.00 | 2.81 | 61.67 | activated sludge | 30 | 5 | 5 | 2 | -1 |
| | 14824-001 | FORESTAR Arrowhead Ranch | Onion Creek | 0.13 | 29.00 | 4.83 | 3.00 | activated sludge | 35 | 10 | 15 | -1 | -1 |
| | 14866-001 | BELLA VISTA DRIPPING, LP | Barton Creek | 0.02 | 5.28 | 4.88 | 3.00 | activated sludge | 35 | 10 | 10 | -1 | -1 |
| **San Antonio Edwards** | | | | | | | | | | | | | |

# TLAP Permits in the San Antonio and Barton Springs Edwards Contributing Zones

| Aquifer | Permit | Permittee | River Segment | Flow (MGD) | Irrig Area (acres) | Appli-cation Rate (ac-ft/ac/yr) | Effluent Storage (days) | Treatment Method | BOD Grab (mg/L) | Daily Average BOD (mg/L) | Daily Average TSS (mg/L) | Daily Average NH3 (mg/L) | Daily Average P (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **San Antonio Edwards** | | | | | | | | | | | | | |
| | 04237-000 | EQUITECH BIO INC | Guadalupe above | 0.00 | 0.16 | 3.57 | 0.00 | not specified | -1 | -1 | -1 | -1 | -1 |
| | 11291-001 | FLYING L PUD | Medina River above | 0.11 | 178.00 | 0.71 | 0.00 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 11683-001 | ALTO FRIO BAPTIST ENCAMPMENT | Upper Frio River | 0.02 | 2.00 | 11.20 | 0.00 | aerated lagoon | 100 | -1 | -1 | -1 | -1 |
| | 11867-001 | City of Fair Oaks Ranch | Upper Cibolo Creek | 0.50 | 280.00 | 2.00 | 103.11 | activated sludge | -1 | -1 | -1 | -1 | -1 |
| | 11976-001 | Texas Lehigh Cement Company LP | Plum Creek | 0.00 | 3.00 | 1.01 | 0.00 | activated sludge | 100 | 30 | -1 | -1 | -1 |
| | 12014-001 | TEXAS PARKS & WILDLIFE DEPT Guadalupe River | Guadalupe above | 0.02 | 6.10 | 2.94 | 28.51 | activated sludge | 100 | -1 | -1 | -1 | -1 |
| | 12080-001 | US DEPT OF THE ARMY Camp Bullis Miltary | Salado Creek | 0.69 | 189.75 | 4.07 | 65.64 | activated sludge | 65 | 20 | -1 | -1 | -1 |
| | 12334-001 | CITY OF CAMP WOOD | Nueces River above | 0.10 | 14.00 | 8.08 | 19.03 | facultative lagoon | 100 | -1 | -1 | -1 | -1 |
| | 12404-001 | Kendall City UC | Upper Cibolo Creek | 0.15 | 40.00 | 4.20 | 173.79 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 13321-001 | VILLAGE OF WIMBERLEY & GBRA | Upper Blanco River | 0.05 | 19.00 | 2.95 | 142.07 | activated sludge | 35 | -1 | -1 | -1 | -1 |
| | 13449-001 | CAMP RECOVERY CENTERS LP | Guadalupe above | 0.02 | 4.00 | 4.76 | 12.27 | activated sludge | 65 | -1 | -1 | -1 | -1 |
| | 13449-001 | CAMP RECOVERY CENTERS LP | Guadalupe above | 0.02 | 0.34 | 55.30 | 12.27 | activated sludge | 65 | -1 | -1 | -1 | -1 |
| | 13755-001 | RIVER INN ASSN OF UNIT OWNERS INC | S. Fork Guadalupe | 0.01 | 0.92 | 8.30 | 0.00 | activated sludge | 65 | 20 | -1 | -1 | -1 |

# TLAP Permits in the San Antonio and Barton Springs Edwards Contributing Zones

| Aquifer | Permit | Permittee | River Segment | Flow (MGD) | Irrig Area (acres) | Appli-cation Rate (ac-ft/ac/yr) | Effluent Storage (days) | Treatment Method | BOD Grab (mg/L) | Daily Average BOD (mg/L) | Daily Average TSS (mg/L) | Daily Average NH3 (mg/L) | Daily Average P (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **San Antonio Edwards** | | | | | | | | | | | | | |
| | 13783-001 | BANDERA ISD Hill Country Elementary | Medina River | 0.01 | 1.10 | 12.20 | 0.08 | activated sludge | 65 | 20 | -1 | -1 | -1 |
| | 13812-002 | COMAL ISD Arlon Seay Intermediate School | Upper Cibolo Creek | 0.01 | 1.65 | 4.62 | 0.00 | septic tank | 100 | -1 | -1 | -1 | -1 |
| | 13812-003 | COMAL ISD Spring Branch Middle School | Upper Cibolo Creek | 0.01 | 2.98 | 4.88 | 0.00 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 13812-004 | COMAL ISD Smithson Valley Middle School | Guadalupe above | 0.01 | 2.98 | 4.88 | 0.00 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 13989-001 | AQUA UTILITIES INC | Cypress Creek | 0.38 | 175.00 | 2.40 | 83.40 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 14157-001 | BOY SCOUTS OF AMERICA ALAMO AREA | N. Fork Guadalupe | 0.00 | 4.30 | 0.98 | 17.38 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 14167-001 | MONARCH UTILITIES 1 LP | Medina Lake | 0.03 | 10.00 | 2.80 | 91.89 | activated sludge | -1 | -1 | -1 | -1 | -1 |
| | 14280-001 | THOUSAND TRAILS INC | Medina Lake | 0.02 | 2.18 | 9.76 | 0.00 | activated sludge | 35 | 10 | 15 | -1 | -1 |
| | 14295-001 | COMAL ISD Smithson Valley High School | Upper Cibolo Creek | 0.03 | 6.20 | 4.88 | 0.00 | septic tank | 65 | 20 | 20 | -1 | -1 |
| | 14385-001 | GUADALUPE BLANCO RIVER AUTHORITY | Guadalupe River above | 0.19 | 102.00 | 2.11 | 0.00 | membrane bioreactor | 30 | 5 | 5 | 2 | -1 |
| | 14485-001 | BRUCE ROBERT HAROLD Boerne Stage Field | Lower Leon Creek | 0.00 | 0.54 | 3.11 | 52.14 | aerobic treatment | 100 | -1 | -1 | -1 | -1 |
| | 14533-001 | COMAL ISD Canyon Lake High School | Upper Blanco River | 0.04 | 9.20 | 4.87 | 3.00 | aeration basin | 65 | 20 | 20 | -1 | -1 |
| | 14541-001 | CHERRY SPRINGS INVESTMENT INC La | N. Fork Guadalupe | 0.02 | 4.48 | 4.88 | 3.08 | activated sludge | 100 | -1 | -1 | -1 | -1 |

# TLAP Permits in the San Antonio and Barton Springs Edwards Contributing Zones

| Aquifer | Permit | Permittee | River Segment | Flow (MGD) | Irrig Area (acres) | Appli-cation Rate (ac-ft/ac/yr) | Effluent Storage (days) | Treatment Method | BOD Grab (mg/L) | Daily Average BOD (mg/L) | Daily Average TSS (mg/L) | Daily Average NH3 (mg/L) | Daily Average P (mg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **San Antonio Edwards** | | | | | | | | | | | | | |
| | 14603-001 | PRESBYTERIAN MO RANCH ASSEMBLY | N. Fork Guadalupe | 0.05 | 15.00 | 3.73 | 0.00 | activated sludge | 30 | 5 | 10 | -1 | -1 |
| | 14615-001 | RANCHO DEL LAGO INC Rockin' J Ranch | Upper Blanco River | 0.15 | 37.80 | 4.45 | 112.00 | activated sludge | 30 | 5 | 5 | 3 | 3 |
| | 14637-001 | RIVER CROSSING CARRIAGE HOUSES LTD | Guadalupe River above | 0.02 | 225.60 | 0.08 | 308.08 | activated sludge | 65 | 20 | 20 | -1 | -1 |
| | 14670-001 | TIMBERWOOD DEVELOPMENT CO LP | Salado Creek | 0.02 | 0.00 | | 3.00 | septic tank | 65 | -1 | -1 | -1 | -1 |
| | 14760-001 | HILL COUNTRY UTILITIES LLC | Medina River above | 0.03 | 8.00 | 4.20 | 58.65 | activated sludge | 35 | 10 | 15 | -1 | -1 |
| | 14806-001 | Whitewater Land, Heiser Hollow Water | Guadalupe below | 0.20 | 46.00 | 4.87 | 0.00 | septic and textile filter | 65 | 20 | 20 | -1 | -1 |
| | 14839-001 | BANDERA COUNTY Jail and Justice Center | Medina River above | 0.01 | 2.63 | 4.88 | 3.00 | disk filtration | 100 | -1 | -1 | -1 | -1 |
| | 14959-001 | Two Seventy Seven, GBRA, Park Village | Upper Cibolo Creek | 0.20 | 49.24 | 4.44 | 3.00 | membrane bioreactor | 65 | 5 | 5 | 2 | 1 |
| | 14975-001 | DH/JB Partnership, Johnson Ranch | Upper Cibolo Creek | 0.08 | 17.22 | 4.88 | 0.00 | activated sludge | 65 | 20 | 20 | -1 | -1 |

# *Appendix B. TLAPs for which No Permits Were Located*

The following permits were identified on a TCEQ-supplied Geographical Information System shape file. No corresponding permits were located, however, in TCEQ Central Records.

| Permit Number | PERMITTEE | STATUS | Aquifer |
|---|---|---|---|
| **11962-001** | TEXAS PARKS & WILDLIFE DEPT | Current | San Antonio Edwards |
| **14131-001** | BEXAR METROPOLITAN WD | Current | San Antonio Edwards |
| **14333-001** | STEVENS, HOMER THRALL | Current | San Antonio Edwards |
| **14397-001** | ANDERSON RAY | Current | San Antonio Edwards |
| **14733-001** | DH JB PARTNERSHIP LTD | Current | San Antonio Edwards |
| **14741-001** | BULVERDE/46 PARTNERS LTD | Current | San Antonio Edwards |