

FINAL

Petronila Creek

Records Review, Site Reconnaissance Results, and Recommendations

Prepared for:

Railroad Commission of Texas
Oil and Gas Division
Site Remediation and Special Response

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MEMORANDUM
FINAL

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Date: August 16, 2006

Subject: Final – Petronila Creek Records Review, Site Reconnaissance Results, and Recommendations

The purpose of this memorandum is to report the results of the records review and site reconnaissance conducted along Petronila Creek near Driscoll, Texas and provide recommendations for further investigation. The Railroad Commission of Texas (RRC) applied for a non-point source grant prompted by Texas Commission on Environmental Quality (TCEQ) data that indicated chloride and total dissolved solids (TDS) content in Petronila Creek increased significantly between Gauging Station 13098 (located at United States Highway 77 [US 77]) and Gauging Station 13096 (located downstream of the Clara Driscoll oil field). The RRC was awarded the United States Environmental Protection Agency (USEPA) grant through the TCEQ to determine if oil and gas operations along Petronila Creek are contributing to the high salinity of the water. This preliminary investigation focused on the segment of Petronila Creek located near the Driscoll and Concordia areas as identified in the Bureau of Economic Geology (BEG) report *Geophysical Investigations of Salinization along Petronila Creek, Nueces and Kleberg Counties, Texas* dated August 2005. The objectives of the preliminary investigation were to gather and review available data about the areas, conduct a site reconnaissance, and provide recommendations to support development of a work scope for additional investigation.

BACKGROUND

Surface water quality investigations have been conducted by the Nueces River Authority (NRA) and the TCEQ (and its subcontractors) resulting from the failure of Petronila Creek to meet surface water quality standards for TDS, chloride, and sulfate. Petronila Creek begins at the confluence of Agua Dulce Creek and Banquete Creek west of Robstown in Nueces County. Petronila Creek flows generally southeast for about 70 kilometers (km) across Nueces County and into Kleberg County, where it ultimately empties into Alazan Bay, part of the Baffin Bay estuarine complex. Recent chemical analyses of surface water in Petronila Creek, its tributaries, and in drainage ditches, indicate that TDS and chloride concentrations are relatively low upstream from the US 77 bridge at Driscoll (Gauging Station 13098) but increase to levels that

commonly fail to meet surface water quality standards downstream from the US 77 bridge (Gauging Station 13096).

The RRC, Oil and Gas Division, has received a Section 319 Non-Point Source grant from the USEPA through the TCEQ to determine if oil and gas operations along Petronila Creek are contributing to the high saline water. The overall objective of the project is to determine the source(s) leading to the elevated TDS, chloride, and sulfate in Petronila Creek, and develop best management practices (BMPs) to reduce the TDS, chloride, and sulfate load in the creek.

As part of this TCEQ total maximum daily load (TMDL) project, an airborne geophysical survey, supporting ground-based measurements, and surface water analyses of Petronila Creek (Segment 2204) were conducted by the University of Texas BEG for the TCEQ. Segment 2204 includes the entire length of Petronila Creek (70 km) from the confluence of Agua Dulce Creek and Banquete Creek to Laureles Ranch. According to the BEG report, geophysical data and chemical analyses suggest that sources of salinity in Petronila Creek between US 77 and the estuarine-influenced zone include brine produced from local oil fields (North Clara Driscoll, Clara Driscoll, and Luby) some of which was discharged into ditches (referred to as tidal disposal) before the RRC ended that practice in 1987 and/or discharged into pits before the RRC's no pit order was implemented in 1969. Airborne geophysical data suggest that there are extensive areas of salinization between the drainage ditches and Petronila Creek that may provide continuing sources of salinity along the Driscoll, Concordia, and Luby segments of Petronila Creek. The Luby Field area, which is at the downstream limit of the survey area, will not be included in this RRC investigation because the BEG has indicated the area coincides with the zone of estuarine mixing (i.e., this portion of the study area also contains naturally-occurring saline from tidal influence). The approximate extent of the North Clara Driscoll and Clara Driscoll oil fields, as well as the Driscoll and Concordia areas as defined by the BEG, are depicted on Figure 1.

RECORDS SEARCH AND REVIEW

The records search and review task was completed by researching and reviewing existing documents for the project area. The following documents and data sources were obtained and reviewed to aid site reconnaissance activities; the significant findings are discussed below:

- Recent and Historical Aerial Photographs and Topographic Maps

  Petronila Creek, drainage ditches, and oil field features are depicted on a recent aerial photograph (2004) and topographic map (1989) presented as Figures 1 and 2. Historical aerial photographs from 1934, 1956, 1959, 1961, and 1979 and historical topographic maps

from 1969 and 1975 were reviewed to evaluate land use prior to and during oil field operations in the Driscoll and Concordia areas.

A review of the aerial photographs indicates that Petronila Creek is a meandering stream. Changes in color and surface features appear to indicate the location of former stream channels north and south of Petronila Creek in all of the aerial photographs. The predominate land use prior to oil and gas development was agriculture and rangeland as is apparent in the 1934 aerial photograph. In 1934, vegetation was more prevalent and extended north of Petronila Creek. The drainage ditches are present in the 1934 aerial photograph. Oil and gas operations were first observed in the 1956 aerial photograph. No aerial photographs of the area were available between 1934 and 1956. Dark black square or rectangular features which appear to be disposal pits due the their proximity to oil wells or tank battery locations are apparent in the North Clara Driscoll and Clara Driscoll oil fields from 1956 to 1979. The majority of the larger disposal pits were located in the North Clara Driscoll oil field. The use of the disposal pits appeared to decrease over time because fewer pits were observed in the 1979 aerial photograph. Disposal pits were observed along Petronila Creek in the following areas:

- Three disposal pits located immediately south of Petronila Creek between segments 5 and 6 were observed in the 1956 and 1959 aerial photographs. Each pit encompassed approximately 0.5 acres, and one of the pits was located on the south bank of Petronila Creek.
- An area immediately north of segment 7 along Petronila Creek appeared to be used for oil field disposal activities based on the number of surface pits observed in the 1956, 1959, and 1961 aerial photographs. This area encompassed approximately 12 acres through which a drainage ditch flows directly into Petronila Creek.

The approximate location of surface disposal pits (digitized from aerial photographs) in the North Clara Driscoll and Clara Driscoll oil fields, as well as other outlying areas, are depicted in Figure 3. Additionally, one disposal pit located north of segments 5 and 6 was observed in the aerial photographs from 1956 to 1979. This area is identified as Driscoll #3, which encompasses approximately 1.6 acres, and is currently undergoing monitoring and remediation under TCEQ oversight (discussed further in the environmental records review section below). Disposal pits were also observed near drainage ditches that lead directly into Petronila Creek in both the North Clara Driscoll and Clara Driscoll oil fields.

Approximately 15 aboveground storage tanks (ASTs) were observed west of the intersection of farm-to-market road (FM) 665 and county road (CR) 75 on aerial photographs from 1956

to 1979. The location of the former ASTs are shown on Figure 3. These tanks may have been used as a temporary oil storage facility. It should be noted that an injection well (API# 35504425) is located in the general vicinity of this area, indicating these ASTs could have been used for produced water storage prior to disposal. A 2.5-acre surface pond was first observed east of US 77 immediately south of Petronila Creek in the 1979 and 2004 aerial photographs. There also appears to be debris located on the property immediately south of the pond in the 1979 aerial photograph. The 2004 aerial photograph indicates that oil and gas operations have declined along Petronila Creek. Only a few wells appear to be operational which is apparent based on the reduced number of caliche covered roads and well pads observed on the 2004 aerial photograph.

Topography in the Driscoll and Concordia areas along Petronila Creek generally slopes in a southeastward direction toward the Gulf of Mexico. The topographic maps indicate the elevation along the banks of Petronila Creek ranges from 62 feet above mean sea level (AMSL) where US 77 crosses Petronila Creek to 48 feet AMSL where FM 892 crosses the creek. The bottom elevation of Petronila Creek ranges from 50 feet AMSL where US 77 crosses Petronila Creek to 25 feet AMSL where FM 892 crosses the creek. Further evidence that Petronila Creek is a meandering stream is apparent based on the topographic features presented along the axis of the creek. Former drainage features and oxbows depicted along Petronila Creek are indicators of former creek beds.

Surface water features are depicted north and south of Petronila Creek in both the 1969 and 1975 topographic maps. These surface water features appear to be disposal pits based on their relative shapes and because their locations correlate with disposal pits observed in aerial photographs. The 1969 topographic map depicts nine disposal pits in the North Clara Driscoll oil field and two disposal pits in the Clara Driscoll oil field. The 1975 topographic map depicts an additional 14 disposal pits in the North Clara Driscoll oil field and one additional disposal pit in the Clara Driscoll oil field. The two disposal pits depicted in the Clara Driscoll oil field during 1969 are no longer present in the 1975 topographic map. These maps do not depict all the oil and gas operations located in the area.

- United States Department of Agriculture (USDA) Soil Conservation Service *Soil Survey, Nueces County, Texas (June 1992)*

  The soil survey report and the ArcView Geographic Information System (GIS) database file for Nueces County were obtained from the USDA Natural Resources Conservation Service (NRSC). The GIS database file was used to depict the soil type outlines near Petronila Creek shown in Figure 4. The predominate soil type in the Driscoll and Concordia oil

field/agricultural areas is the Victoria Clay, 0 to 1 percent slopes (VcA). The Victoria Clay consists of slowly permeable dark, calcareous, crumbly soils that crack when dry, and when wet, they swell and take in water slowly. The dark grey surface layer is heavy clay that contains lime and is about 3 feet thick. Because Victoria soils dry and crack almost every summer, their subsoil can take in and store much water in a short time during heavy rains in the fall. Water accumulates in some of the low areas when rainfall is heavy. Large drainage ditches remove excess water so that it seldom interferes with cultivation. Nearly all of the Victoria soils are cultivated and produce moderate to high yields of locally grown crops. Although internal and surface drainage are slow, in most places these soils drain well for agriculture tillage.

The predominate soil type along the central axis of Petronila Creek is identified as Clayey alluvial land (Cd). This land occurs in and along the narrow, shallow channels of natural waterways that cross and drain the coastal terraces of Nueces County. The soil consists of 4 to 6 feet or more of slowly drained low permeability, sandy clay (0 to 50 inches) and calcareous clay (50 to 60+ inches) stratified with fine sandy loam. The soil is extremely variable. Nearly all Clayey alluvial land is frequently flooded during periods when rainfall in the contributing watersheds is above average or prolonged. Nearly all of this land has native vegetation, mainly mesquite trees and thorny shrubs. Sparse areas designated as Oil-Waste Land (Oa) are located in both the North Clara Driscoll and Clara Driscoll oil fields. This land has been damaged by oil, saltwater, mud, or other byproducts of oil and gas exploration and production to such an extent that its productivity has been seriously reduced or destroyed. Some of this land has been covered by sterile mud, slush, saltwater, and oil to a depth of 1 to 4 feet, and it is still bare of vegetation. Other areas that were severely to moderately damaged have gradually improved, and some parts are returned to agricultural production each year. A total of seven discrete areas were designated with the Oil-Waste Land classification near the Driscoll and Concordia areas as depicted in Figures 3 and 5.

- Oil and Gas Records in Nueces County near Petronila Creek

  The RRC supplied TRC with ArcView GIS database files that were used to depict all of the registered oil and gas well locations in Nueces County surrounding Petronila Creek. The database also included information which was used to present the approximate locations of pipelines in the area. Additional information including well permitting and history of reported blowouts was available on the RRC website. The oil and gas well and pipeline locations are presented on Figure 5. The majority of abandoned and/or active producing oil and gas wells are located in the North Clara Driscoll and Clara Driscoll oil fields. There are a number of dry hole locations depicted within the Concordia area. Several major pipelines

transect the Driscoll and Concordia areas. The location of active and/or abandoned oil field production/gathering lines from individual oil and gas wells are unknown. Historically, a total of 16 injection wells were permitted for disposal purposes in the North Clara Driscoll and Clara Driscoll oil fields. According to the RRC website, only five commercial disposal wells are currently permitted to operate in Nueces County. One of the five commercial disposal wells (API# 35533000) is located east of US 77 immediately south of Petronila Creek. It should be noted that TDS, chloride, sulfate, and specific conductivity values increase between BEG sample locations 2 and 3, which are directly north of the permitted injection well (API# 35533000). The eleven injection wells in the Driscoll and Concordia areas are depicted in Figures 3 and 5. According to the RRC website, only one blowout was on record to have occurred; it was on the Russ and Daimwood Lease (well #3; API 35530839) located in the Clara Driscoll oil field. The operator (Western Gulf) reported that the blowout occurred on January 20, 1980. The location of well #3 is immediately south of Petronila Creek segment 4 as shown on Figures 3 and.5.

- BEG's Geologic Atlas of Texas Corpus Christi Sheet (1975)

  Based on the geologic map, the Beaumont Formation is the only formation in direct contact with Petronila Creek in the Driscoll and Concordia areas. The Beaumont Formation consists of mostly clay, silt, sand, and gravel; includes mainly stream channel, point bar, natural levee, and backswamp deposits, and to a lesser extent coastal marsh, mud flat, lagoonal, recent and older lake, clay dune, and sand dune deposits; and has a thickness of ±100 feet.

- Texas Water Development Board (TWDB) Report 73 – Ground-Water Resources of Nueces and San Patricio Counties, Texas (May 1968)

  The TWDB report provided a general background of the hydrogeology of the county with some specifics about dissolved-mineral constituents and properties of the groundwater. The principal water-bearing units in Nueces County are the Goliad Sand, Lissie Formation, and Beaumont Clay (Gulf Coast Aquifer). These units crop out in belts that trend northeast to southwest (i.e., parallel to the coast) and dip to the southeast at an angle greater than the slope of the land surface. Most of these units become thicker and finer-grained downdip. The heterogeneous character of the stratigraphic units makes correlation of individual beds difficult even within short distances. The deposits are generally lenticular; the lenses of clay, sand, or gravel pinch out, coalesce, or grade into each other within short distances. The contacts between the units are difficult to pick; but, for all practical purposes, the contacts are of no particular importance because the units are in hydrologic continuity. Groundwater flows southeastward toward the Gulf of Mexico and occurs under unconfined and confined

conditions. The groundwater elevations during 1964-1965 ranged from 20 feet AMSL in the North Clara Driscoll oil field to 20 feet below MSL (BMSL) on the south end of the Driscoll oil field. The chloride content of 203 water samples from wells located in Nueces and San Patricio Counties ranged from 54 to 5,000 parts per million (ppm). The sulfate content in water from 171 wells ranged from 0.2 to 1,280 ppm; the concentration exceeded 250 ppm in 38 wells, 34 of which were in Nueces County. The TDS content in water from 173 wells ranged from 305 to 9,580 ppm. Only about 25 percent of the samples collected contained fresh water (TDS < 1,000 ppm).

According to the saltwater disposal inventory, 63,097,453 barrels (bbl) of saltwater were produced in conjunction with the production of oil in Nueces County in 1961. The open-surface pit method of disposal was the most hazardous with regard to contamination of fresh water at shallow depths. In 1961, 46,562,421 bbl of saltwater were disposed in open-surface pits in Nueces and San Patricio Counties. It is probable that a portion of this saltwater penetrated the surface and contributed salinity to the groundwater. Saltwater in open-surface pits was allowed to evaporate, but the salt residue remains as a source of potential contamination. Generally, contamination of groundwater from oil field disposal pits is indicated by an increase in the chloride content without an accompanying increase in the sulfate content. The most satisfactory method of saltwater disposal to prevent contamination of groundwater is through the use of injection wells, but in 1961, only 23.9 percent of the total quantity of saltwater produced from oil wells in Nueces County was disposed of by this method. Although unlikely, the water-bearing units may also be impacted by saltwater leaks from producing oil wells and/or injection wells.

- Texas Department of Water Resources (TDWR) Report 236 – *Stratigraphic and Hydrogeologic Framework of Part of the Coastal Plain* Texas (July 1979)

  Further evaluation of the stratigraphy and hydrogeology of the Coastal Plain of Texas was conducted by the TDWR. The TDWR report separated the Gulf Coast Aquifer as defined by the TWDB into two different aquifers; from youngest to oldest, the Chicot and Evangeline. The Chicot is the youngest aquifer in the Coastal Plain of Texas which encompasses the Beaumont Clay of Pleistocene age and any overlying Holocene alluvium in Nueces County. The Evangeline is composed of the Goliad formation in Nueces County. It is believed that the base of the Chicot in some areas has been delineated as the base of the Pleistocene. The problem that arises is the base of the Pleistocene is difficult to pick from electric logs. In practice, the delineation of the Chicot in the subsurface, at least on the sections in Southeast Texas, has been based on the presence of a higher sand-clay ratio in the Chicot than in the underlying Evangeline. In some places, a prominent clay layer was used as the boundary.

Differences in hydraulic conductivity or water levels in some areas also serve to differentiate the Chicot from the Evangeline. The high percentage of sand in the Chicot in Southeast Texas, where the aquifer is noted for its abundance of water, diminishes southwestward. Southwest of Goliad and Refugio Counties, the higher clay content of the Chicot and absence of fresh to slightly saline water in the unit is sharply contrasted with the underlying Evangeline aquifer that still retains relatively large amounts of sand and good water quality. According to the cross sections through nearby San Patricio and Kleberg Counties, the thicknesses of the Chicot and Evangeline aquifers at wells, which are located the same approximate distance inland as Petronila Creek, range from 400 to 600 feet and 1400 to 1600 feet, respectively.

- Water Well Report and Water Well Database Review

  A water well search was completed by reviewing data obtained from a commercial water well search company, the TWDB water well database, and the Texas Department of Licensing and Regulation (TDLR) water report database. A summary of the water well information including the well registration number, well type, well total depth, completion aquifer, availability of chemical analysis data, and source of the well information are presented in Attachment A. The location of the water wells are depicted on Figure 5.

  A Water Well Report covering 0.5-miles on either side of Petronila Creek was provided by Banks Information Solutions, Inc. (Banks). The search began immediately west of where US 77 crosses Petronila Creek and continued for approximately 27 km downstream. The water well report indicated the presence of 11 water wells screened in the Evangeline.

  A review of the TWDB database identified 28 water wells located near Petronila Creek. Based on the Banks and TWDB well reports, Chemical data was available for one water well (8319203) screened within the Chicot aquifer and for eight water wells (8319101, 8319104, 8319902, 8319402, 8319801, 8327103, 8327501, and 8327602) screened within the Evangeline aquifer.

  A search of the TDLR database indicated the presence of 3 water wells and 19 groundwater monitoring wells. The majority of the monitoring wells are installed in four separate areas associated with oil and gas production and/or pipeline releases near Petronila Creek. One of the monitoring wells was installed at a leaking petroleum storage tank (LPST) vehicle fueling station site located in Driscoll. All of the monitoring wells are installed in the Chicot aquifer. TDLR well reports indicate shallow groundwater is 12.5 feet below ground surface (bgs). The geology typically consists of clay and silty clay from ground surface to approximately 14

feet bgs followed by sand and clayey sand to approximately 30 feet bgs. The majority of the wells are completed to a total depth ranging from 25 to 30 feet bgs.

A comparison of the TDS, chloride, and specific conductance results from non-impacted areas indicates the average concentrations in the Evangeline are slightly lower than the results reported for the single Chicot well. The opposite was true of the average sulfate concentration for the Evangeline wells, which was slightly higher than the single Chicot well. Locations where known impacts have occurred (discussed in environmental records search) to the Chicot indicate elevated TDS concentrations relative to the single non-impacted Chicot well. The groundwater chemical data from the Banks report, TWDB database, and environmental records search are presented in Attachment B.

- BEG's Geophysical Investigations of Salinization along Petronila Creek, Nueces and Kleberg Counties, Texas (August 2005).

  The BEG's airborne geophysical survey was conducted (laterally and vertically) along Petronila Creek in the North Clara Driscoll, Clara Driscoll, Concordia and Luby areas to investigate the extent and intensity of salinization degrading surface water quality in the creek. The report discussed potential sources that may be contributing to the degradation of surface water quality along Petronila Creek. Possible sources leading to the downstream increase in salinity include (a) the presence of primary saline pore water in Beaumont Formation strata that were deposited in a late Pleistocene coastal environment; (b) salt particles blown inland and deposited by prevailing onshore winds; (c) extensive inland flooding of saline gulf and estuarine water during recurrent tropical storms; and (d) surface and near-surface discharge of saline water during hydrocarbon exploration and production, including brine pits, direct discharge into creeks and ditches, and perhaps leaking tanks, pipelines, producing wells, or injection/disposal wells. Water produced from area oil fields is highly saline with a TDS concentration of 49,300 milligrams per liter (mg/L) and a chloride concentration of 28,904 mg/L in water produced from the Vicksburg Formation in the Clara Driscoll Oil Field, and chloride concentrations of 36,500 to 55,700 mg/L in produced water from the Petronila Creek area.

  The airborne survey indicated three areas along Petronila Creek (the Driscoll, Concordia, and Luby areas) where high apparent ground conductivities indicate that near-surface salinization is likely to be increasing the TDS, chloride, and/or sulfate load of the creek. Reconnaissance ground-based geophysical measurements showed elevated electrical conductivities associated with salinized ground along the creek and tributary drainage ditches. Flow measurements and chemical analyses of Petronila Creek were collected at points within the Driscoll and

Concordia areas coincident with the airborne survey. The data were used to calculate TDS loading, which was 602 kilograms per day (kg/day) at the upstream end of the Driscoll segment (flow rate of 0.1 cubic feet per second and TDS concentration of 2,460 mg/L), 20,762 kg/day within the Driscoll segment (flow rate of 0.562 cubic feet per second and TDS concentration of 15,100 mg/L), and 82,103 kg/day within the Concordia segment (flow rate of 1.974 cubic feet per second and TDS concentration of 17,000 mg/L). Similar proportional loading increases were calculated for chloride and sulfate. The Luby area coincides with the zone of estuarine mixing at the downstream limit of the survey area.

The airborne geophysical survey was conducted at frequencies ranging from 39,030 to 450 hertz (Hz), which equates to an average of 2 to 28 meters below grade, respectively. Figure 18 of the BEG report depicts apparent conductivity at 4,170 Hz (10 meters below grade) along Petronila Creek in the North Clara Driscoll, Clara Driscoll, and Luby areas. This figure identifies areas along and beneath Petronila Creek where elevated conductivities are present. To aid in data presentation, BEG Figure 18 has been posted on Figures 1 through 5.

The combined section of the conductivity data for the Driscoll area from segment 1 to 11 (Figure 26 of the BEG report) indicated the presence of elevated conductivity from the surface to 5 meters below grade beginning approximately 0.25 kilometers downstream of US 77 (segment 2). The elevated conductivity increases in depth from 5 to 10 meters below grade approximately 1 km prior to reaching FM 665 (between segments 10 and 11). Surface water data indicates TDS, chloride, sulfate, and specific conductivity concentrations sharply increase from BEG sample location 1 (located upstream of the Driscoll area) to BEG sample location 4 (downstream end of the Driscoll area) as shown on Figure 6. The BEG also reported a TDS concentration of 26,500 mg/L in the drainage ditch at CR 24 which flows south through the North Clara Driscoll oil field toward Petronila Creek.

The combined section of the conductivity data from the Concordia area from segment 11 to 26 (Figure 30 of the BEG report) indicated shallow (surface to 8 meters below grade) presence of elevated conductivity from the beginning of the area (segment 11) to the drainage ditch (segment 22) located downstream from FM 892. Elevated conductivity zones are also present to 10 meters below grade between Beatty Road to the drainage ditch (segment 22). The elevated conductivities from surface to 10 meters below grade end immediately after the drainage ditch (segment 22). Surface water data indicates TDS, chloride, sulfate, and specific conductivity concentrations continue to increase through the Concordia area based on BEG sample locations 6 and 7 as shown on Figure 6.

The BEG collected nine surface water samples on February 5, 2005 and submitted the samples to the Kansas Geological Survey for laboratory analysis. Seven of the nine samples were collected from Petronila Creek. The remaining two samples were collected from drainage ditches located in the Clara Driscoll and Luby oil fields. The samples were analyzed for sixteen parameters. The analytical results were reported in Appendix B of the BEG report. The BEG surface water results for TDS, chloride, sulfate, and specific conductivity are summarized in Table 1 and presented on Figure 3.

The highest TDS, chloride, sulfate, and specific conductivity surface water concentrations were observed in the drainage ditch located immediately north of CR 18 in the central portion of the Clara Driscoll oil field that flows west to east toward Petronila Creek. Figure 6 presents the BEG surface water results for TDS, chloride, sulfate, and specific conductivity from Petronila Creek in relation to the creek segments. BEG sample location 1 was located approximately 8 km upstream from BEG sample location 2. Analytical data for BEG sample location 1 is not presented on Figure 3 because that portion of Petronila Creek was not included in the BEG aerial survey. Additionally, analytical data for BEG sample location 9 is not presented on Figure 3 because it is located in the Luby area, which is not included in this investigation. The location of BEG sample locations 1 and 9 are depicted on BEG Figure 18 (included on Figure 3). It should be noted that the TDS concentrations presented on BEG Figure 18 are inconsistent with the Kansas Geological Survey analytical results presented in Appendix B of the BEG report. The reason for this discrepancy is unknown.

- Environmental database search using a 0.5-mile linear search along Petronila Creek

  An ASTM Environmental FirstSearch Report covering 0.5-miles on either side of Petronila Creek was provided by Banks. The search began immediately west of where US 77 crosses and Petronila Creek and continued for approximately 27 km downstream. The environmental search was completed in order to determine if any neighboring properties contained sites which could environmentally impact Petronila Creek. One site was identified in the Banks report, which was a proposed solid waste landfill for Nueces County precincts 2 and 3. The location of the proposed landfill was located between segments 2 and 3 east of where US 77 crosses Petronila Creek. Records were obtained from the TCEQ that indicate the Texas Water Quality Board raised concerns that the proposed landfill presented a potential hazard to surface and groundwater quality because of permeable groundwater-bearing sediments. Ultimately, the landfill was not constructed; TCEQ

Table 1. Summary of BEG Surface Water Analytical Results for February 5, 2005

BEG Sample ID	Area	TDS (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Specific Conductivity[1] (uS/cm)
1	NA (Upstream, considered background)	233	19	6	415
2	Driscoll	2,300	838	424	3,830
3	Driscoll	7,970	3,800	1,050	12,900
4	Driscoll	12,770	6,640	1,240	20,700
5	NA (Drainage Ditch in Clara Driscoll oil field)	28,100	14,780	2,630	41,600
6	Concordia	13,400	6,940	1,280	21,600
7	Concordia	14,330	7,510	1,330	22,800
8	Luby	15,180	7,810	1,540	23,700
9	Luby	9,870	5,030	1,100	15,800

[1] The data for specific conductivity is presented because elevated results correlate with elevated TDS, chloride, and sulfate concentrations
mg/L = milligrams per liter
uS/cm = microsiemens per centimeter

records indicate the site never received waste. However, during the site reconnaissance, a high volume of trash/debris was observed in the area. These materials could have been disposed after the documented inspections which indicated the site had not received any waste. However, observations from the 1979 aerial photograph and the field reconnaissance indicate the area likely received trash/debris.

- Environmental Records Search

  Environmental records from oil field and/or pipeline releases were obtained for the Driscoll and Concordia areas. LPST records from the town of Driscoll were also obtained. Three separate releases with the same Solid Waste Registration (SWR) number (39988) were located in both the North Clara Driscoll (Driscoll #3) and Clara Driscoll (Driscoll #1 and #2) oil fields. The environmental cleanup at these three sites is being supervised by the TCEQ. The following is a summary of the SWR release sites:

- The Driscoll #1 site had a release of approximately 650 bbl of unleaded gasoline that occurred from Coastal State Crude Gathering's (CSCG) four-inch Valley Product Pipeline (VPP) on January 16, 1987. The site is located 1.4 miles east of the intersection of FM 665 and US 77, and approximately 0.5 miles south of FM 665 as depicted on Figure 3. The release was reportedly caused by external corrosion. Immediately following the release, vacuum trucks recovered 54 bbl of free-phase hydrocarbon (FPH). It was determined that the release affected both soil and groundwater. Chemicals of concern (COCs) at the site include benzene, toluene, ethylbenzene, xylenes (BTEX), methyl tertiary-butyl ether (MTBE), total petroleum hydrocarbons (TPH), naphthalene, 2,4-dimethyl phenol, and phenol. A groundwater monitoring program was conducted between 1990 and 2004. Reported TDS concentrations range from 12,000 to 22,000 mg/L. The predominate groundwater flow direction is east toward Petronila Creek. During August 2005, El Paso Merchant Energy – Petroleum Company (El Paso) plugged and abandoned the 11 monitoring wells at the site after receiving approval from TCEQ that no further action would be required because the Remedy Standard had been achieved. El Paso filed a deed restriction with Nueces County for the property. The horizontal extent of the area covered by the deed restriction is presented on the county property map and identified as "Questionable Groundwater."

- The Driscoll #2 site had a release of approximately 40 bbl of unleaded gasoline that occurred from CSCG's four-inch VPP on April 19, 1990. The site is located 1.2 miles east of the intersection of FM 665 and US 77 as depicted on Figure 3. The release was reportedly caused by external corrosion. Immediately following the release, vacuum trucks recovered 10 bbl of FPH. COCs at the site include BTEX, MTBE, TPH, naphthalene, and phenanthrene. A groundwater monitoring program that began in 1990 is currently ongoing. Reported TDS concentrations range from 1,500 to 15,000 mg/L. The predominate groundwater flow direction is northeast towards Petronila Creek.

- The Driscoll #3 site had a release of approximately 560 bbl of unleaded gasoline that occurred from CSCG's four-inch VPP on June 6, 1991. The site is located 1.3 miles east of the intersection of County Road 24 and US 77 as depicted on Figure 3. In September 1991, two six-inch diameter recovery wells and a FPH recovery system were installed and approximately 500 gallons of FPH were recovered. COCs at the site include BTEX, MTBE, TPH, naphthalene, and 2-methyl naphthalene. A groundwater monitoring program that began in 1991 is currently ongoing. Reported TDS concentrations range from 6,800 to 72,900 mg/L. The predominate groundwater flow direction is south toward Petronila Creek. According to an El Paso groundwater monitoring report, a former disposal pit was located approximately 200 feet south of the release area. Additionally,

an injection well (API #355) was located approximately 200 feet north of the release area. Aerial photographs and RRC records confirm the presence of a former disposal pit and injection well.

A technical letter dated October 30, 2003 was submitted to the TCEQ by Rosengarten, Smith & Associates, Inc. (RSA) titled *Confined Conditions Response for Driscoll Sites* which discussed the groundwater conditions at the Driscoll #1, Driscoll #2, and Driscoll #3 sites. The letter was submitted in response to the TCEQ's concern that the shallow groundwater-bearing unit (GWBU) at the Driscoll sites may not represent confined conditions. RSA's letter indicated that a clay and/or silty clay unit located above the saturated unit serves as a confining layer; thus, groundwater is present under confined conditions.

A release of approximately 96 bbl of light plant distillate (LPD) and 96 bbl of butane from ExxonMobil Pipeline Company's (EMPCo's) King Ranch to Viola eight-inch pipeline was discovered on March 11, 2004. The site is located south of CR 24 approximately 0.6 miles northeast of Petronila Creek as depicted on Figure 3. The release was reportedly caused by external corrosion. Approximately 1,300 cubic yards of impacted soils were removed. According to EMPCo personnel, approximately 3 bbl of condensate were recovered during spill response activities. A site assessment and groundwater monitoring program is ongoing to evaluate the hydrocarbon release. COCs at the site include BTEX and TPH. The presence of FPH has also been reported. Reported TDS concentrations range from 874 to 2,340 mg/L. The predominate groundwater flow direction is south toward Petronila Creek. The environmental cleanup at this site is being supervised by the RRC.

Records were reviewed from four LPST sites (99574, 102301, 102397, and 115905) under TCEQ jurisdiction that are located along the east side of US 77 in the town of Driscoll. All of these sites were associated with vehicle fueling stations where underground storage tanks (USTs) leaked gasoline into the soil and/or groundwater. COCs include BTEX, MTBE, and TPH. Additionally, TDS samples were collected for groundwater classification purposes. The TDS concentrations ranged from 1,160 to 6,490 mg/L. The location of each LPST site and associated TDS results are presented on Figure 3. Groundwater analytical data indicated the extent of impacts have been fully delineated at these four sites which are nearest to the Clara Driscoll oil field. At the four LPST sites in Driscoll, the predominate flow direction is east-southeast towards Petronila Creek.

- Kenedy County Groundwater Conservation District

  The Kenedy County Groundwater Conservation District (GCD) was included as part of the records search because the Kenedy County GCD includes portions of Kleberg and Nueces

Counties that are within the study area. The Kenedy County GCD had recently formed so records were not available at the time of the records search.

FIELD RECONNAISSANCE

After completing the records review, TRC mobilized to the site to conduct the field reconnaissance portion of the preliminary investigation that consisted of a general assessment and survey of the project area and interviews with individuals familiar with the area. The driving and walking tour were conducted on May 11 and 12, 2006.

Site Survey Assessment

Due to the large project area, the initial step in the field reconnaissance consisted of the RRC District 4 personnel providing TRC with a driving and walking tour of the project area. Some areas were more accessible than others due to physical constraints (lack of roads, heavy vegetation, etc.) and approval by the property owners. Accessibility in the North Clara Driscoll oil field was poor because former leases have been reclaimed for agriculture use. The Clara Driscoll oil field was fairly accessible because oil and gas production is still occurring in the area.

Due to the number of different property owners in the project area, TRC obtained property maps from the Nueces County Appraisal District. These maps will be used to help identify property owners and coordinate access for future investigation activities. Land along Petronila Creek is predominately used for agriculture with oil and gas production still occurring in some areas. If lease roads are present, Petronila Creek is fairly accessible via the lease roads from paved county roads. Where lease roads are not present, the only access to the creek is via agriculture roads or traveling along the banks of the creek from a county road or another lease road. Vehicle use is limited in some areas due to agriculture use along the banks of the creek. Access using a small all-terrain vehicle (ATV) along Petronila Creek is the most feasible method of travel from the lease or paved roads.

The use of a boat along Petronila Creek is not feasible due to the limited access and shallow to dry conditions of the creek. It was determined during the driving tour that the best way to access Petronila Creek for surface water sampling would be by walking.

A more detailed (i.e., walking) survey was performed to check pertinent information identified during the records review and/or during the driving tour. This included field checking former disposal pits, drainage ditches, water wells, environmental release sites, problem oil and gas wells, and tank batteries. Information gathered during the driving tour and site walk were discussed while conducting an interview with RRC District 4 cleanup coordinator LeRoy Staiger

and are presented in the following section. The coordinates of all pertinent information were surveyed using a hand-held global-positioning system (GPS) unit and depicted on the attached figures.

During the tour, TRC evaluated the current and former land uses within the project area and the general accessibility of the project area with respect to potential future tasks such as soil boring and well drilling, and geophysical surveys.

Site Interview and Reconnaissance

An interview was conducted with RRC District 4 cleanup coordinator LeRoy Staiger while conducting the site driving and walking tour. No other property owners or individuals were interviewed. A summary of the most relevant information obtained from the interview and the site driving and walking tour is discussed below.

RRC District 4 cleanup coordinator LeRoy Staiger accompanied TRC during the site driving and walking tour. Mr. Staiger, who has worked for the RRC for 5 years, provided TRC with a general background of the operations that had occurred in the area. Mr. Staiger also indicated there is no state funded well plugging occurring in the project area because no orphan wells have been found in the Clara Driscoll oil field. Drilling began in Nueces County during the 1920s, and oil production in the area is predominately crude. Operators historically disposed of produced water in surface pits usually located adjacent to either an oil well or tank battery location. Each well did not have a disposal pit. The operators would fill the disposal pits with produced water and let the water evaporate. Over time, the salinity in the disposal pits would increase as more and more water was disposed in the pit. Residual salinity in the disposal pits could serve as continual sources by flushing during rain events. Drought conditions have persisted in the area since the fall of 2005 and there has not been much precipitation within the last year. Mr. Staiger also indicated that operators would sometimes apply produced water to lease roads for dust control. Land has been damaged by oil field operations to such an extent that its productivity has been seriously reduced or destroyed; this was visually apparent in the North Clara Driscoll and Clara Driscoll oil fields. These impacted surface areas predominately correlated with oil field disposal pits observed in historical aerial photographs, historical topographic maps, and information presented in the soil survey. Some of this land still cannot be used as apparent by these areas being completely surrounded by land used for agriculture. Other areas that were damaged have gradually improved, and portions of them have been restored to agricultural production.

Drainage ditches were installed in the area to decrease flooding and aid in drainage for agriculture land. Mr. Staiger indicated that the ditches are likely convenient dumping locations.

Produced water from local oil fields (North Clara Driscoll, Clara Driscoll, and Luby) was discharged directly into creeks and ditches before the RRC ended the practice in 1987. This was known as tidal disposal. The effects of dumping were heavily apparent along the portion of Petronila Creek between US 77 and FM 665, as well as the drainage ditches flowing into the creek. The most visually impacted surface area was observed in the drainage ditch that is immediately north of CR 18. Salt crystals were observed in surface soils within the ditch and the amount of stressed vegetation increased eastward from CR 77 to CR 75 toward Petronila Creek. Former field production/gathering lines were observed crossing drainage ditches in the North Clara Driscoll and Clara Driscoll oil fields. Some of these lines were observed to be open ended and located on the ditch sidewalls. Other completely intact lines were observed crossing the entire portion of the ditch. There is potential that some of these lines could have discharge fluids directly into the drainage ditches.

Trash and debris piles were observed along Petronila Creek and drainage ditches included car parts, rubber tires, concrete rubble, and retired oil field equipment. It appeared that the county was conducting maintenance of the drainage ditch located in the North Clara Driscoll oil field because there were numerous piles of soil with trash and debris stockpiled along the edge of the ditches. An area with a high volume of trash and debris was located east of US 77 and Petronila Creek at the former Nueces County 2 and 3 proposed landfill location as depicted on Figure 3. Although the proposed landfill was reported to have never received any waste, it was visually apparent during the site reconnaissance that the area was used for dumping over an extended period of time.

An operating salt water disposal (SWD) facility with injection well API# 35533000 and 19 ASTs was observed southwest of the proposed landfill location. Surface staining at the SWD facility indicated releases have occurred to surrounding surface soils. Mr. Staiger indicated the current operator of the injection well is Driscoll SWD. No one was present at the SWD during the time of the visit. The top of injection well API #35504425 located in the Clara Driscoll oil field west of the intersection of FM 665 and CR 75 appeared to be damaged because the well casing appeared to be open at the surface. This injection well was located in the general vicinity of approximately 15 ASTs that may have been used as a temporary oil storage facility. These ASTs could have been used for produced water storage prior to disposal.

A limited visual search identified the presence of only two water wells during the site reconnaissance, industrial well 8319801 located near the intersection of CR 18 and 37B and a non-registered domestic well with a windmill located approximately 1.3 miles east of US 77 and approximately 0.2 miles north of FM 665. The presence of private domestic water wells was not investigated during the field reconnaissance. It is likely there are additional water wells at

nearby homesteads that are registered with the TWDB but have not been incorporated into the TWDB database. The located industrial well (8319801) is installed in the Evangeline aquifer. It is not known what aquifer the domestic well with a windmill is screened within. The depth to water at the domestic well with a windmill was gauged to be 22.5 feet bgs, and the total depth was greater than 100 feet. The locations of the Driscoll #2, Driscoll #3, and King Ranch to Viola pipeline release sites were confirmed by the presence of groundwater monitoring wells. No monitoring wells were observed at the Driscoll #1 site because they were abandoned according to records obtained from the TCEQ. No seeps were observed along Petronila Creek during the field reconnaissance.

CONCLUSIONS AND RECOMMENDATIONS

The records review and site reconnaissance identified several potential sources in the Driscoll and Concordia areas that could be contributing high salinity to Petronila Creek. It is expected that impacted areas nearest to the creek and/or drainage ditches would have the most effect on groundwater quality in Petronila Creek. Following this assumption, the following recommendations for future investigation activities for areas most likely to impact Petronila Creek are made based on the completed records review and site reconnaissance of the Driscoll and Concordia areas:

- Conduct a meeting with the BEG to discuss the information presented in this memorandum and develop any other recommendations.
- Evaluation of seasonal flow effects, which may include periodic sampling of key surface locations (Petronila Creek and drainage ditches) during different flow regimes (i.e., different seasons, after precipitation events, etc.). This would also include collection of flow data into and out of the Driscoll and Concordia areas. This is recommended based on the lack of continuous data available along certain Petronila Creek segments and the drainage ditches.
- Water sampling is recommended for water wells screened within the Chicot aquifer contingent on access from the well owners.
- Groundwater monitoring reports for sites under ongoing environmental investigation near Petronila Creek will be reviewed periodically for any additional data that may aid in the investigation.
- The sharp increase in TDS, chloride, sulfate, and conductivity in Petronila Creek between segments 2 and 3 may be related to either historical refuse dumping in the area and/or impacts associated from operation of a nearby injection well/SWD facility. In addition, a pond was recently built at this location along Petronila Creek. Interviews should be

conducted with Nueces County, City of Driscoll, and nearby property owners about the refuse dump area and pond. Subsurface soil and groundwater investigation activities are recommended in this area.

- Former disposal pits located between segments 5 and 6, and north of segment 7 are in close proximity to Petronila Creek and may be directly impacting surface water quality. Subsurface soil and groundwater investigation activities are recommended for these areas.
- TDS concentrations reported for the Driscoll #1, #2, #3 sites are equal or above concentrations reported for Petronila Creek. Subsurface soil and groundwater investigation activities are recommended between these sites and Petronila Creek or the drainage ditches.
- A TDS concentration of 26,500 mg/L was reported in the drainage ditch located in the North Clara Driscoll oil field. Since this ditch feeds directly into Petronila Creek, the source of the high TDS should be investigated.
- The highest surface water concentrations for TDS, chloride, and sulfate occurred along the drainage ditch bisecting the Clara Driscoll oil field. Additionally, impacted soil and stressed vegetation were visually observed in the ditch. Since this ditch feeds directly into Petronila Creek, investigation activities should include soil and groundwater sampling along the drainage ditch to determine the extent of salinity sources.

FIGURES

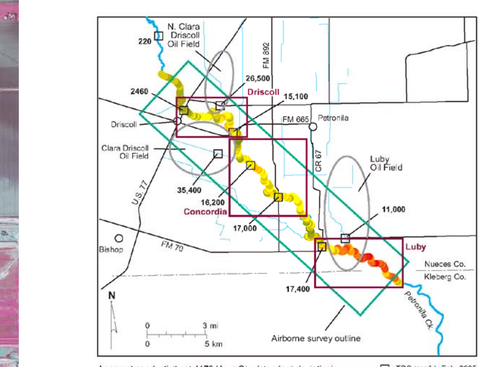


Figure 18. Apparent conductivity measured at 4170 Hz along the axis of Petronila Creek (colored dots). Also shown are the Driscoll, Concordia, and Luby high-conductivity areas (red rectangles) and Petronila Creek and tributary TDS concentrations measured in February 2005 at the time of the airborne survey (black squares). The 4170-Hz frequency explores from the land surface to an average depth of about 10 m.

LEGEND

- Creek Segments for Petronila Creek (Kilometer Markers)
- Surface Drainage (Petronila Creek and drainage ditches)
- Extent of the Driscoll and Concordia areas as designated by the BEG (indicate near-surface salinization)

SOURCE:

1. Railroad Commision of Texas ArcView GIS Database (oil and gas well locations).
2. Texas Water Develoment Board (water and gas well locations).
3. Texas Department of Licensing and Regulation (soil borings, monitoring wells, and water wells).
4. U.S.G.S. Digital Ortho Quarter Quads (DOQQs) for Concordia NE (2004), Concordia NW (2004), Driscoll East NE (2004), Driscoll East NW (2004), Driscoll East SE (2004), and Driscoll East SW (2004), Texas DOQQs.

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SITE LOCATION MAP

RAILROAD COMMISSION OF TEXAS
PETRONILA CREEK

PROJECT NO.: 51854 | DATE: 6/10/2006

TRC
505 EAST HUNTLAND DRIVE
SUITE 250
AUSTIN, TEXAS 78752
512-329-6080

FIGURE 1

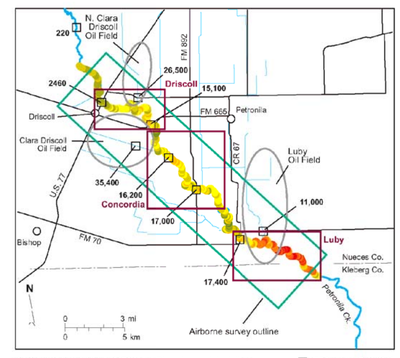


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CR 30
CR 28
CR 24
CR 18 (Beatty Road)
CR 16
CR 14
CR 75
CR 77
CR 73
CR 37A
CR 37B
CR 67
FM 892
FM 665
FM 3354
FM 70
US 77
N. CLARA DRISCOLL OIL FIELD
CLARA DRISCOLL OIL FIELD
MINNIE BOCK OIL FIELD
DRISCOLL
CONCORDIA
PETRONILA CREEK
Driscoll
Petronila
Concordia
Bishop
BISHOP MUNICIPAL AIRPORT
Radio Tower
Florida Gas Camp
Gas Wells
Water Tank
Oil Wells
Oil Well
Gas Well
PACIFIC
MISSOURI
PIPELINE
Petronila Creek
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LEGEND

- Creek Segments for Petronila Creek (Kilometer Markers)
- Surface Drainage (Petronila Creek and drainage ditches)
- Extent of the Driscoll and Concordia areas as designated by the BEG (indicate near-surface salinization)

SOURCE:

1. U.S.G.S.7.5-Minute Series Topographic Maps for Concordia (1989), Driscoll East (1989), Driscoll West (1989), and Kingsville East (1989), Texas.
2. BEG Airborne Geophysical Survey Report (ground conductivity and hydrochemical analysis).

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TOPOGRAPHIC MAP

RAILROAD COMMISSION OF TEXAS
PETRONILA CREEK

PROJECT NO.: 51854 | DATE: 6/10/2006

TRC
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512-329-6080

FIGURE 2

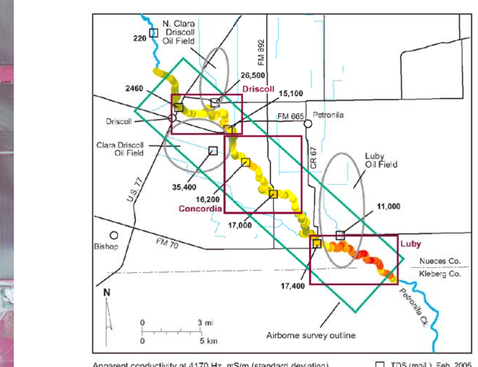


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LEGEND

- Injection / Disposal
- Injection / Disposal from Oil
- Injection / Disposal from Oil / Gas
- Surface Drainage (Petronila Creek and drainage ditches)
- Creek Segments for Petronila Creek Area (Kilometer Markers)
- 7810 Chloride Result (mg/L)
- 15180 Total Dissolved Solids (mg/L)
- 23700 Specific Conductivity (mg/L)
- Ground Conductivity Samples (BEG February 2005)
- Hydrochemical Analysis Samples (BEG February 2005)
- TRC Field Measurement/Sample Location (May 2006)
- Environmentally Impacted Sites
- Digitized Pit Locations
- Oil-Waste Land Areas
- Gauging Stations

SOURCE:

1. Railroad Commision of Texas ArcView GIS Database (oil and gas well locations)
2. Texas Water Develoment Board (water and gas well locations).
3. Texas Department of Licensing Regulation (soil borings, monitoring wells, and water wells).
4. U.S.G.S.Digital Ortho Quarter Quads (DOQQs) for Concordia NE (2004), Concordia NW (2004), Driscoll East NE (2004), Driscoll East NW (2004), Driscoll East SE (2004), and Driscoll East SW (2004), Texas DOQQs.
5. BEG Airborne Geophysical Survey Report (ground conductivity and hydrochemical analysis).
6. United States Depatment of Agriculture, Soil Survey, Nueces County, Texas (June 1992).

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AREAS OF CONCERN

RAILROAD COMMISSION OF TEXAS
PETRONILA CREEK

PROJECT NO.: 51854 | DATE: 6/19/2006

TRC
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512-329-6080

FIGURE 3

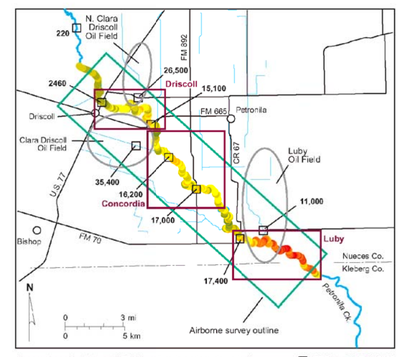


Figure 18. Apparent conductivity measured at 4170 Hz along the axis of Petronila Creek (colored dots). Also shown are the Driscoll, Concordia, and Luby high-conductivity areas (red rectangles) and Petronila Creek and tributary TDS concentrations measured in February 2005 at the time of the airborne survey (black squares). The 4170-Hz frequency explores from the land surface to an average depth of about 10 m.

LEGEND

- Creek Segments for Petronila Creek (Kilometer Markers)
- Surface Drainage (Petronila Creek and drainage ditches)

Ba	Banquete clay
Bn	Banquete clay, low
CcA	Clareville loam, 0 to 1 percent slopes
CcB	Clareville loam, 1 to 3 percent slopes
Cd	Clayey alluvial land
Gu	Gullied land
HaA	Hidalgo fine sandy loam, 0 to 1 percent slopes
Oa	Oil-waste land
Of	Orelia fine sandy loam
VcA	Victoria clay, 0 to 1 percent slopes
VcB	Victoria clay, 1 to 4 percent slopes
Vd2	Victoria clay, eroded
Vt	Victoria clay, low
WaB	Willacy fine sandy loam, 1 to 4 percent slopes

SOURCE:

1. U.S.G.S.Digital Ortho Quarter Quads (DOQQs) for Concordia NE (2004), Concordia NW (2004), Driscoll East NE (2004), Driscoll East NW (2004), Driscoll East SE (2004), and Driscoll East SW (2004), Texas DOQQs.
2. BEG Airborne Geophysical Survey Report (ground conductivity and hydrochemical analysis).
3. United States Depatment of Agriculture, Soil Survey, Nueces County, Texas (June 1992).

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SOIL SURVEY

RAILROAD COMMISSION OF TEXAS
PETRONILA CREEK

PROJECT NO.: 51854 | DATE: 6/19/2006

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512-329-6080

FIGURE 4

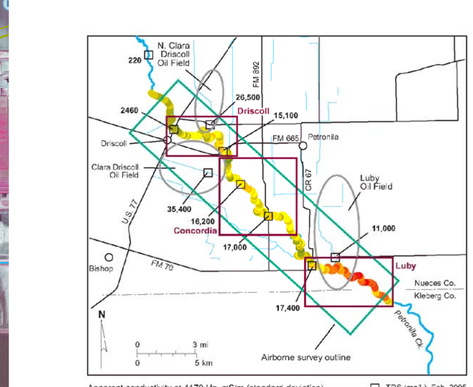


Figure 18. Apparent conductivity measured at 4170 Hz along the axis of Petronila Creek (colored dots). Also shown are the Driscoll, Concordia, and Luby high-conductivity areas (red rectangles) and Petronila Creek and tributary TDS concentrations measured in February 2005 at the time of the airborne survey (black squares). The 4170-Hz frequency explores from the land surface to an average depth of about 10 m.

LEGEND

- Permitted Location
- Dry Hole
- Oil
- Gas
- Oil / Gas
- Plugged Oil
- Plugged Gas
- Canceled / Abandoned Location
- Plugged Oil / Gas
- Injection / Disposal
- Interstate and Intrastate Gas and Liquids Pipelines
- Surface Drainage (Petonila Creek and drainage ditches)
- Creek Segments for Petronila Creek (Kilometer Markers)
- Commercial or Industrial Well
- Domestic or Irrigation Well
- Oil and Gas & Rig Supply Well
- Public Supply Well
- Monitoring Well

SOURCE:

1. Railroad Commision of Texas ArcView GIS Database (oil and gas well locations).
2. Texas Water Develoment Board (water and gas well locations).
3. Texas Department of Licensing Regulation (soil borings, monitoring wells, and water wells)
4. U.S.G.S.Digital Ortho Quarter Quads (DOQQs) for Concordia NE (2004), Concordia NW (2004), Driscoll East NE (2004), Driscoll East NW (2004), Driscoll East SE (2004), and Driscoll East SW (2004), Texas DOQQs.
5. BEG Airborne Geophysical Survey Report (ground conductivity and hydrochemical analysis).

NOTES:

1. Water well labels are TWDB or TDLR well registration numbers.
2. Water wells with well ID number in a white box indicate historical groundwater data available from the TWDB.

N

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Feet

OIL FIELD AND PIPELINE MAP

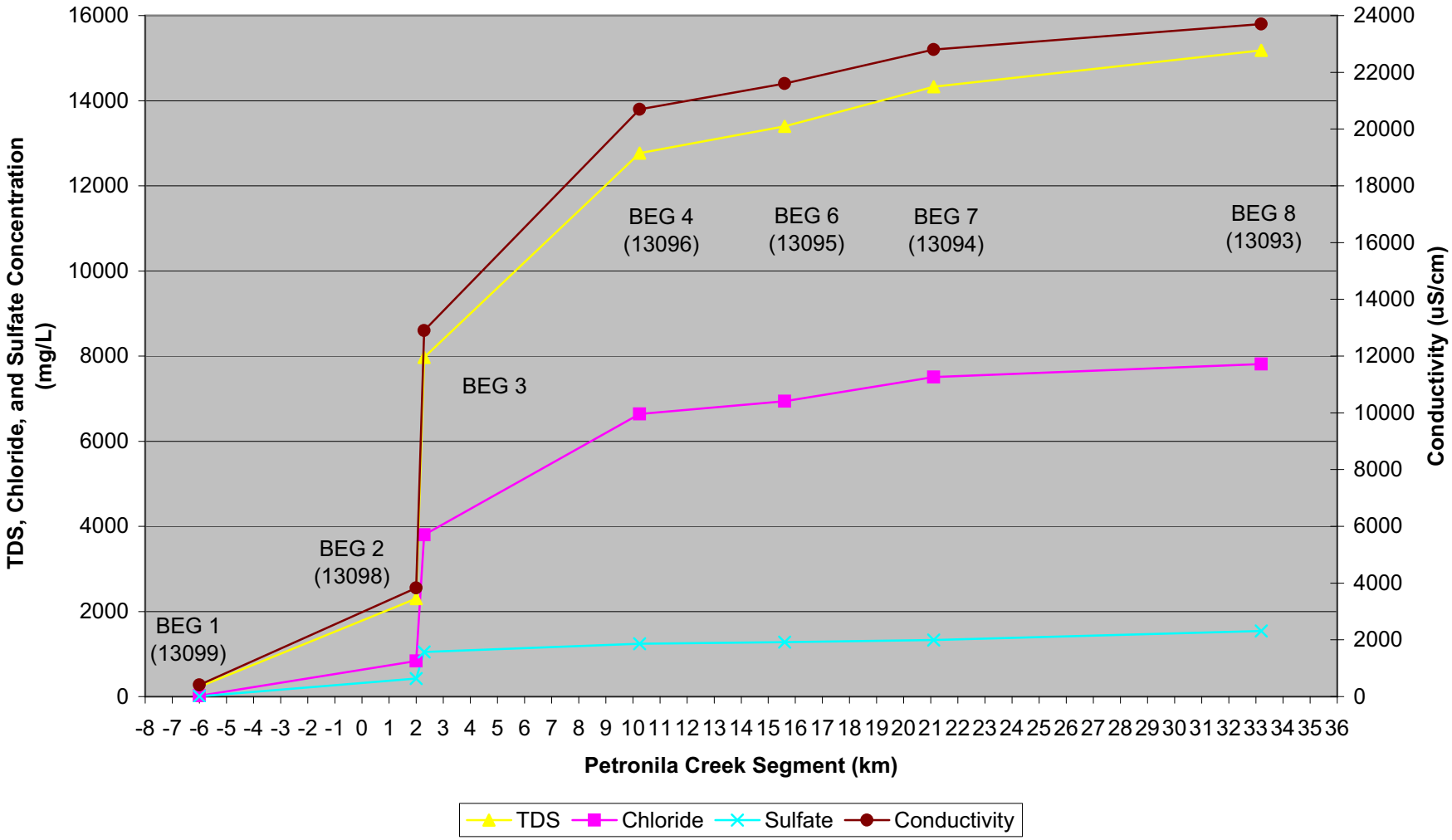
RAILROAD COMMISSION OF TEXAS
PETRONILA CREEK

PROJECT NO.: 51854 | DATE: 6/19/2006

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SUITE 250
AUSTIN, TEXAS 78752
512-329-6080

FIGURE 5

FIGURE 6
Analytical Results for Surface Water Samples Collected during February 2005 from Petronila Creek



ATTACHMENT A

Summary of Water Wells Near Petronila Creek

ATTACHMENT A
SUMMARY OF WATER WELLS NEAR PETRONILA CREEK

Well Registration Number	Well Type	Well Depth (feet bgs)	Aquifer	Chemical Analysis	Source
83197	Domestic	400	Evangeline	N	Banks
83198	Domestic	380	Evangeline	N	Banks
83198	Domestic	765	Evangeline	N	Banks
83198	Domestic	420	Evangeline	N	Banks
83273	Domestic	871	Evangeline	N	Banks
83273	Industrial	465	Evangeline	N	Banks
8319801	Oil and Gas	900	Evangeline	Y	Banks
83194H	Rig Supply	435	Evangeline	N	Banks
83198D	Domestic	527	Evangeline	N	Banks
83198G	Industrial	380	Evangeline	N	Banks
G1780020A	Public Supply	671	Evangeline	N	Banks
8319802	Other	6,006	NA	N	Banks
8319803	Other	5,116	NA	N	Banks
8319101	Domestic	339	Evangeline	Y	TWDB
8319102	Rig Supply	242	Chicot	N	TWDB
8319103	Rig Supply	224	Chicot	N	TWDB
8319104	Domestic	408	Evangeline	Y	TWDB
8319201	Domestic	500	Evangeline	N	TWDB
8319203	Domestic	170	Chicot	Y	TWDB
8319205	Domestic	322	Evangeline	N	TWDB
8319206	Electric Line	3,816	NA	N	TWDB
8319401	Commercial	700	Evangeline	N	TWDB
8319402	Commercial	405	Evangeline	Y	TWDB
8319501	Domestic	325	Evangeline	N	TWDB
8319601	Irrigation	900	Evangeline	N	TWDB
8319603	Domestic	428	Evangeline	N	TWDB
8319605	Electric Line	7,509	NA	N	TWDB
8319606	Electric Line	6,244	NA	N	TWDB
8319701	Unused	441	Evangeline	N	TWDB
8319702	Oil and Gas	7,404	NA	N	TWDB
8319901	Domestic	245	Chicot	N	TWDB
8319902	Domestic	754	Evangeline	Y	TWDB
8327101	Electric Line	800	Evangeline	N	TWDB
8327103	Domestic	1,056	Evangeline	Y	TWDB
8327104	Domestic	854	Evangeline	N	TWDB
8327105	Electric Line	7,258	NA	N	TWDB
8327201	Domestic	830	Evangeline	N	TWDB
8327202	Rig Supply	400	Evangeline	N	TWDB
8327501	Domestic	800	Evangeline	Y	TWDB
8327602	Domestic	900	Evangeline	Y	TWDB
8327603	Domestic	875	Evangeline	N	TWDB
33621	Monitor	24	Chicot	NA	TDLR
34540	Rig Supply	420	Evangeline	NA	TDLR
45114	Monitor	25	Chicot	NA	TDLR
55900	Monitor	26	Chicot	NA	TDLR
58083	Monitor	30	Chicot	NA	TDLR
58085	Monitor	45	Chicot	NA	TDLR
58086	Monitor	25	Chicot	NA	TDLR
58090	Monitor	25	Chicot	NA	TDLR
58091	Monitor	25	Chicot	NA	TDLR

ATTACHMENT A
SUMMARY OF WATER WELLS NEAR PETRONILA CREEK

Well Registration Number	Well Type	Well Depth (feet bgs)	Aquifer	Chemical Analysis	Source
58092	Monitor	27	Chicot	NA	TDLR
58093	Monitor	37	Chicot	NA	TDLR
58094	Monitor	25	Chicot	NA	TDLR
58095	Monitor	39	Chicot	NA	TDLR
58755	Domestic	403	Evangeline	NA	TDLR
58764	Domestic	387	Evangeline	NA	TDLR
60494	Monitor	18	Chicot	NA	TDLR
60495	Monitor	18	Chicot	NA	TDLR
60497	Monitor	18	Chicot	NA	TDLR
84619	Monitor	30	Chicot	NA	TDLR
84620	Monitor	30	Chicot	NA	TDLR
84621	Monitor	30	Chicot	NA	TDLR
84622	Monitor	30	Chicot	NA	TDLR

Notes:
NA = Not available
Chemical analysis column indicates data avaliable from Banks report or TWDB database
Banks = Banks Water Well Report
TWDB = Texas Water Development Board
TDLR = Texas Department of Licensing and Regulation
bgs = below ground surface

ATTACHMENT B

Water Well Analytical Data Near Petronila Creek

ATTACHMENT B
WATER WELL ANALYTICAL DATA NEAR PETRONILA CREEK

Well Number	Site ID	Sample Date	Aquifer	Well Type	Silica (mg/L)	Calcium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Potassium (mg/L)	Strontium (mg/L)	Carbonate (mg/L)	Bicarbonate (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	pH	TDS (mg/L)	Total Alkalinity (mg/L)	Total Hardness (mg/L)	Percent Sodium	SAR	RSC	Specific Conductance (umhos/cm)
8319203	NA	12/9/1965	Chicot	Domestic or Irrigation	17	36	9.5	795			0	290.08	348	890		1.2	7.6	2239	237.7	129	93	30.46	2.18	3860
MW-3	Driscoll #1	6/4/1994	Chicot	Monitoring														22000*						
MW-1	Driscoll #2	7/7/1994	Chicot	Monitoring														15000*						
MW-13	Driscoll #3	9/22/1999	Chicot	Monitoring														72900*						
MW-2	King Ranch to Viola	3/21/2005	Chicot	Monitoring														2340*						
MW2-1	LPST #99574	10/25/1991	Chicot	Monitoring														6490*						
MW-4	LPST #102301	6/24/1992	Chicot	Monitoring														1160*						
MW-1	LPST #102397	2/14/1992	Chicot	Monitoring														4170*						
MW-4	LPST #115905	12/8/2004	Chicot	Monitoring														2500*						
8318601	NA	3/26/1955	Evangeline	Public Supply	20	40	20	824			0	193.06	932	600			7.6	2530	158.2	182	90	26.56	0	
		3/18/1992			17	23	6.1	671	6.4	3.2	0	202.58	606	571	1.09	0.09	8.24	2004	166	86	94	32.14	1.67	3040
8318602	NA	12/8/1965	Evangeline	Public Supply	17	28	6.8	714			0	200.05	628	590		1	7.5	2083	163.93	97	94	31.27	1.32	3420
8319104	NA	3/10/2005	Evangeline	Domestic or Irrigation	20.1	18.9	8.85	579	4.17	2.55	0	306.3	294	587	1.36	2.21	7.84	1669	251	87	94		3.34	2850
8319402	NA	5/22/1990	Evangeline	Commercial	19	15	6.7	504	5.7	2.27	0	317.29	309	413	1.17	0.17	7.9	1432	260	67	94	27.2	3.9	2320
8319801	NA	2/17/1977	Evangeline	Test Well	11	8.6	2.2	588			21.6	208.68	448	478	1.4	< 0.4	9.1	1661	207	30	97	46.33	3.53	3150
8319902	NA	12/9/1965	Evangeline	Domestic or Irrigation	17	8.5	2.4	483			0	275.08	266	408	0.9	0.5	7.9	1321	225.41	30	97	37.93	3.89	2270
8327103	NA	12/8/1965	Evangeline	Domestic or Irrigation	15	25	6	696			0	174.05	708	510		1.8	7.7	2047	142.62	87	94	32.45	1.11	3230
8327501	NA	3/19/1992	Evangeline	Domestic or Irrigation	19	19	3	496	4.6	1.74	0	236.75	319	405	0.75	< 0.04	8.13	1384	194	61	94	27.91	2.69	2150
		7/15/1997			21.1	17.7	2.56	462	2.9	1.77	0	223.32	266	388	1.23	< 0.18	8.01	1273	183	56	94	27.17	2.57	1812
		3/20/2001			18.9	17.3	2.79	467	2.9	1.69	0	233.09	317	416	0.94	< 0.09	8.53	1359	191	56	94	27.48	2.73	2260
8327602	NA	12/8/1965	Evangeline	Domestic or Irrigation	7.3	11	1.1	477			10	121	419	365	0.8	0.8	8.4	1351	115.81	32	97	36.94	1.68	2300
		6/21/1972			12	15.6	3.5	494			2.4	207.46	357	421	1.1	< 0.4	8.4	1409	174	53	95	29.43	2.41	2626
		3/19/1992			16	17	3.1	491	4.1	1.02	2.4	214.78	342	407	0.89	< 0.04	8.54	1390	180	56	95	28.76	2.5	2220
8328102	NA	12/9/1965	Evangeline	Industrial	13	12	2.4	571			0	226.07	386	488	1.7	1.5	7.9	1586	185.25	39	96	40.2	2.91	2750

Notes:
*Highest TDS result reported from environmental records search
mg/L = milligrams per liter
umhos/cm = micromhos per centimeter
NA = Not applicable
TDS = total dissolved solids
SAR = sodium absorption ratio (unitless)
RSC = residual sodium carbonate (unitless)