APPENDIX 3B

OCCURRENCE OF SIGNIFICANT RIVER ALLUVIUM AQUIFERS IN THE PLATEAU REGION

Occurrence of Significant River Alluvium Aquifers in the Plateau Region

Prepared for:

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and
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1.1 Introduction

The Plateau Region contains five river basins, four of which represent the headwaters of these rivers or their tributaries. Variable widths and thicknesses of floodplain deposits, or alluvium, are characteristic of these stream courses. Figure 1 illustrates the extent of all river alluvium in the Plateau Region. The Plateau Region Water Planning Group recognizes that river alluvium aquifers have not been adequately documented in the Plateau Regional Water Plan. The previous Plan published in 2006 recognized only the Frio River Alluvium Aquifer in Real County and estimated its water supply availability as a factor of recharge over a limited portion of the alluvial outcrop area.

This current study evaluates all river alluviums throughout the Region except in Val Verde County. River alluviums that were found to contain a viable aquifer were further analyzed to estimate reasonable and quantifiable annual water supply availability. Availability volumes that are considered relevant by the residing groundwater conservation district will be provided in the appropriate Chapter 3 tables of the 2011 Plateau Region Water Plan.

1.2 Origin and Hydrologic Characteristics

Precipitation runoff moves rapidly down gradient from the highlands of the Edwards Plateau. As the surface water gravity flows to the east and south, the various riverbeds continuously erode deeper into the Edwards limestone formations creating along the way spectacular canyons and relatively narrow floodplains. Once the streambed has incised through the Edwards and exposed the underlying Trinity - Glen Rose Limestone, the gradient of the river lessens. With a slower rate of flow, the active riverbed may meander from side to side, thus creating an ever-widening floodplain relative to the upstream canyons. Periods of intense rainfall often cause the rivers to overspill their banks with sediment-laden floodwaters that continuously contribute to the thickness of the developing floodplain. These floodplain deposits ranging in size from silt to gravel are collectively referred to as river alluvium.

Water in the form of rainfall, surface runoff from adjacent highlands, and occasional flood overflows percolate downward into the alluvial sediments where it generally moves slowly

through the floodplain system, eventually draining to the river where it contributes to the base flow of the river. This captured groundwater may accumulate in sufficient volumes to be considered a viable aquifer capable of supplying water to wells. However, due to the relatively thin nature of the water-bearing thickness, alluvial aquifers generally produce only low to moderate yields to wells.

1.3 Methodology

The evaluation of river alluviums entailed two phases, the consideration of the existence of groundwater in all river alluviums and the quantification of groundwater availability in those river alluviums that were considered to contain a viable aquifer. The potential for the existence of groundwater in sufficient quantities to allow flow to wells was evaluated based on the compilation and evaluation of recorded well data from: 1) wells listed in the TWDB groundwater database and retrieval through the Board's WIID system; 2) drillers logs also retrievable from the TWDB WIID system; and 3) well data housed with local groundwater conservation districts. All identified wells located within a mile of the river channels were placed on surface geologic maps (GAT sheets). The wells were then evaluated based on location in reference to a floodplain area, on well depth, and on driller's lithologic descriptions. The number of wells considered to be producing from alluvial aquifers in each river basin are listed in Table 1. Driller's lithologic log descriptions were also used to compute the average depth to the base of alluvial sediments.

Table 1. Alluvial Wells Used for Analysis per Basin

Basin	Well Count
Guadalupe	7
Medina	0
Sabinal	2
South Llano	0
West Nueces	4
Nueces	29
Frio	55 with locations
	158 RECRD database

In addition, managers of the Bandera County River Authority and Groundwater District, the Headwaters Groundwater Conservation District, and the Real-Edwards Conservation and Reclamation District were interviewed in regard to their knowledge of existing wells completed in the alluvial systems within their respective districts. Based on the above evaluation, only the Guadalupe, Nueces, and Frio River Alluviums were considered to contain viable aquifers.

Phase Two provided the quantification of annual groundwater availability from the three alluvial aquifers. The quantification process required certain assumptions. Due to the potential variable nature of these assumptions, other researchers could reach different conclusions. Two basic assessments are made for each aquifer, water in storage and recharge.

Water in storage within the aquifer is based on area of significant alluvial outcrop times the average saturated thickness times a specific yield of 15 percent. The area of significant alluvial outcrop is arbitrarily set at 70 percent of the total area of alluvial outcrop for the Guadalupe and Nueces Alluviums and 90 percent for the Frio Alluvium. Average saturated thickness is the average depth to the base of the lowest gravel layer in the alluvium minus the average depth to groundwater.

To test the assumption that only a portion (70-90 percent) of the total outcrop area contains sufficient volumes of water such that leakage to the river occurs, gain-loss study data were reviewed to determine stretches of the Frio River that appear to be receiving inflow from the adjacent alluvium. As can be seen in Figure 8, the data illustrates that the river is losing flow to the underlying bedrock in the upper two branches above Leakey where the alluvium coverage is narrow. From the confluence of the two upper branches downstream to the southern county line, the data shows that the river is gaining as groundwater in the alluvium and bedrock springs discharge to the river course.

Recharge is computed as total area of alluvial outcrop times the average annual rainfall times a recharge factor of 0.04 percent. Average annual rainfall in the Guadalupe, Nueces, and Frio basins is 29, 25 and 27 inches respectively.

The final computation of total (annual) groundwater availability is calculated as annual average recharge plus a portion of water in storage. To avoid over estimating availability, an assumption is made that only one-tenth of the volume of water in storage is available to be depleted in any one year. It is further assumed that any storage depletion would be replenished

by recharge in years when rainfall was above average. Summaries of these computations are provided for the three alluvial aquifers in Tables 2, 3 and 4.

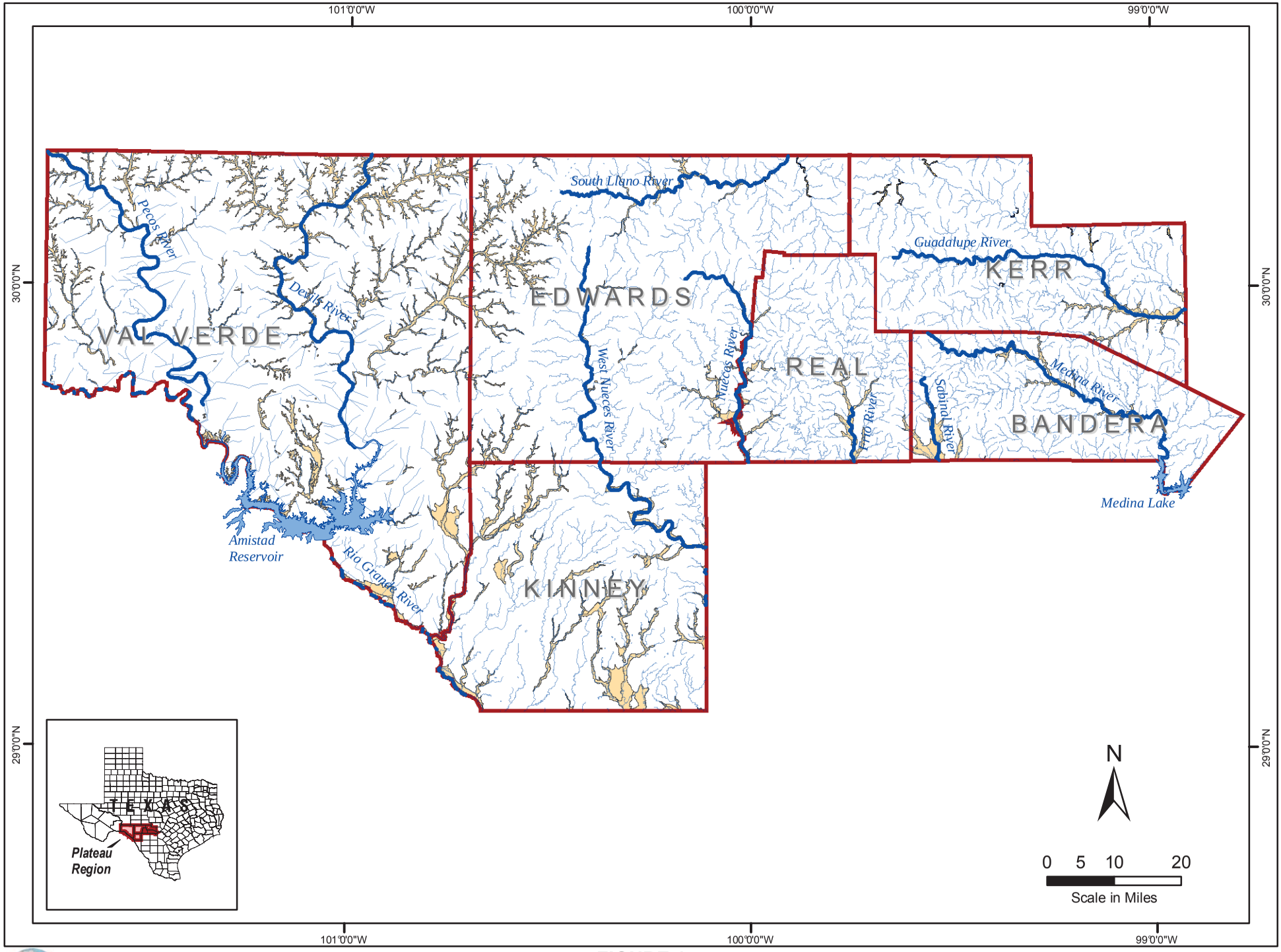

FIGURE 1
EXTENT OF ALL RIVER ALLUVIUM IN THE PLATEAU REGION

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2.0 River Basins

2.1 Guadalupe River Alluvium

Seven alluvial wells identified in the Guadalupe River Alluvium are shown on Figure 2. Note that these locations do not coincide with irrigation pivots that are visible along the river from SH 27 downstream from Kerrville; these pivots utilize surface water taken directly from the Guadalupe River. Many alluvial wells in Kerr County are not registered with Headwaters Groundwater Conservation District, therefore there are likely to be numerous unrecognized additional wells. Due to the minimal number of wells on file that are available to characterize the formation, only a limited analysis was performed on the main alluvial segment from Kerrville downstream to the county line. After consultation with the Headwaters Groundwater Conservation District, the groundwater availability estimated from this analysis is not included in the Plateau Region Water Plan Chapter 3 listing of water-supply sources.

Table 2. Guadalupe River Alluvium Aquifer

Parameter	Estimated Value
Total Area of Alluvium Outcrop	8,928 ac
Area of Significant Alluvium Outcrop *(70%)*	6,250 ac
Average Depth to Base of Alluvium	30 ft
Average Depth to Water	20 ft
Average Saturated Thickness	10 ft
Saturated Volume of Alluvium *(Significant Area x Saturated Thickness)*	62,500 ac-ft
Volume of Water in Storage *(Sat. Vol. of Alluv. x Specific Yield [15%])*	9,375 ac-ft
Average Annual Recharge *(Total Outcrop Area x 29 in/yr x .04)*	857 ac-ft/yr
Total Groundwater Availability *(Recharge + 0.1 Vol. Water in Storage)*	1,795 ac-ft/yr

2.2 Medina and Sabinal River Alluviums

No alluvial wells are listed in the TWDB groundwater database in the Medina River Alluvium, and only two wells are identified in the upper reaches of the Sabinal River basin are shown on Figure 3. Due to the minimal number of alluvial wells identified in these basins and after consultation with the Bandera County River Authority and Groundwater District, no further analyses of groundwater availability from these particular alluviums were considered necessary.

2.3 South Llano River Alluvium

As no alluvial wells are listed in the TWDB groundwater database in the South Llano River Alluvium (Figure 4) and the indication that the existing alluvium is very thin, no further analyses of groundwater availability from this particular alluvium was considered necessary.

2.4 West Nueces River Alluvium

Only four alluvial wells identified in the West Nueces River Alluvium are shown on Figure 5. Due to the minimal number of alluvial wells identified in this basin and the indication that the existing alluvium is very thin, no further analysis of groundwater availability from this alluvium was considered necessary.

2.5 Nueces River Alluvium

Twenty-nine alluvial wells identified in the Nueces River Alluvium are shown on Figure 6. The Real-Edwards Conservation and Reclamation District is scheduled to collect additional well data for this aquifer system in the near future. As a result of a significantly larger outcrop area, the availability volume calculated for the Nueces Alluvium is greater than the volume reported for the Frio Alluvium. However, due to thinner average saturated thickness, average well yields may be less in the Nueces Alluvium. The Community of Barksdale pumps groundwater from this aquifer for public supply use. Analysis of potential groundwater availability in the Nueces River Alluvium is as follows:

Table 3. Nueces River Alluvium Aquifer

Parameter	Estimated Value
Total Area of Alluvium Outcrop	24,450 ac
Area of Significant Alluvium Outcrop *(70%)*	17,115 ac
Range in Depth to Base of Alluvium	17-35 ft
Average Depth to Base of Alluvium	25 ft
Range in Depth to Water	10-35 ft
Average Depth to Water	19 ft
Average Saturated Thickness	6 ft
Saturated Volume of Alluvium *(Significant Area x Saturated Thickness)*	102,690 ac-ft
Volume of Water in Storage *(Sat. Vol. of Alluv. x Specific Yield [15%])*	15,404 ac-ft
Average Annual Recharge *(Total Outcrop Area x 25 in/yr x .04)*	2,034 ac-ft/yr
Total Groundwater Availability *(Recharge + 0.1 Vol. Water in Storage)*	3,574 ac-ft/yr

2.6 Frio River Alluvium

The 32 alluvial wells identified in the Frio River Alluvium are shown on Figure 7. The Real-Edwards Conservation and Reclamation District has a total of 158 wells listed as being completed in the Frio River Alluvium; however, only 55 of these wells have location coordinates for display on Figure 7, some of which are duplicates of TWDB database wells. Of the 158 wells, 144 wells have sufficient well log data to calculate a saturated thickness (10 feet average) and average well yield of 31 GPM. The district feels that there may be several hundred additional undocumented wells in the Frio Alluvium. The City of Leakey, along with several other small public water supply corporations, pumps groundwater from this aquifer for public supply use. Analysis of potential groundwater availability in the Frio River Alluvium is as follows:

Table 4. Frio River Alluvium Aquifer

Parameter	Estimated Value
Total Area of Alluvium Outcrop	9,530 ac
Area of Significant Alluvium Outcrop *(90%)*	8,577 ac
Range in Depth to Base of Alluvium	15-42 ft
Average Depth to Base Alluvium*	32 ft
Range in Depth to Water	5-35 ft
Average Depth to Water*	22 ft
Average Saturated Thickness*	10 ft
Saturated Volume of Alluvium *(Significant Area x Saturated Thickness)*	85,770 ac-ft
Volume of Water in Storage *(Sat. Vol. of Alluv. x Specific Yield [15%])*	12,866 ac-ft
Average Annual Recharge *(Total Outcrop Area x 27 in/yr x .04)*	858 ac-ft/yr
Total Groundwater Availability *(Recharge + 0.1 Vol. Water in Storage)*	2,145 ac-ft/yr
** Averages based on data from 144 wells in RECRD database.*	

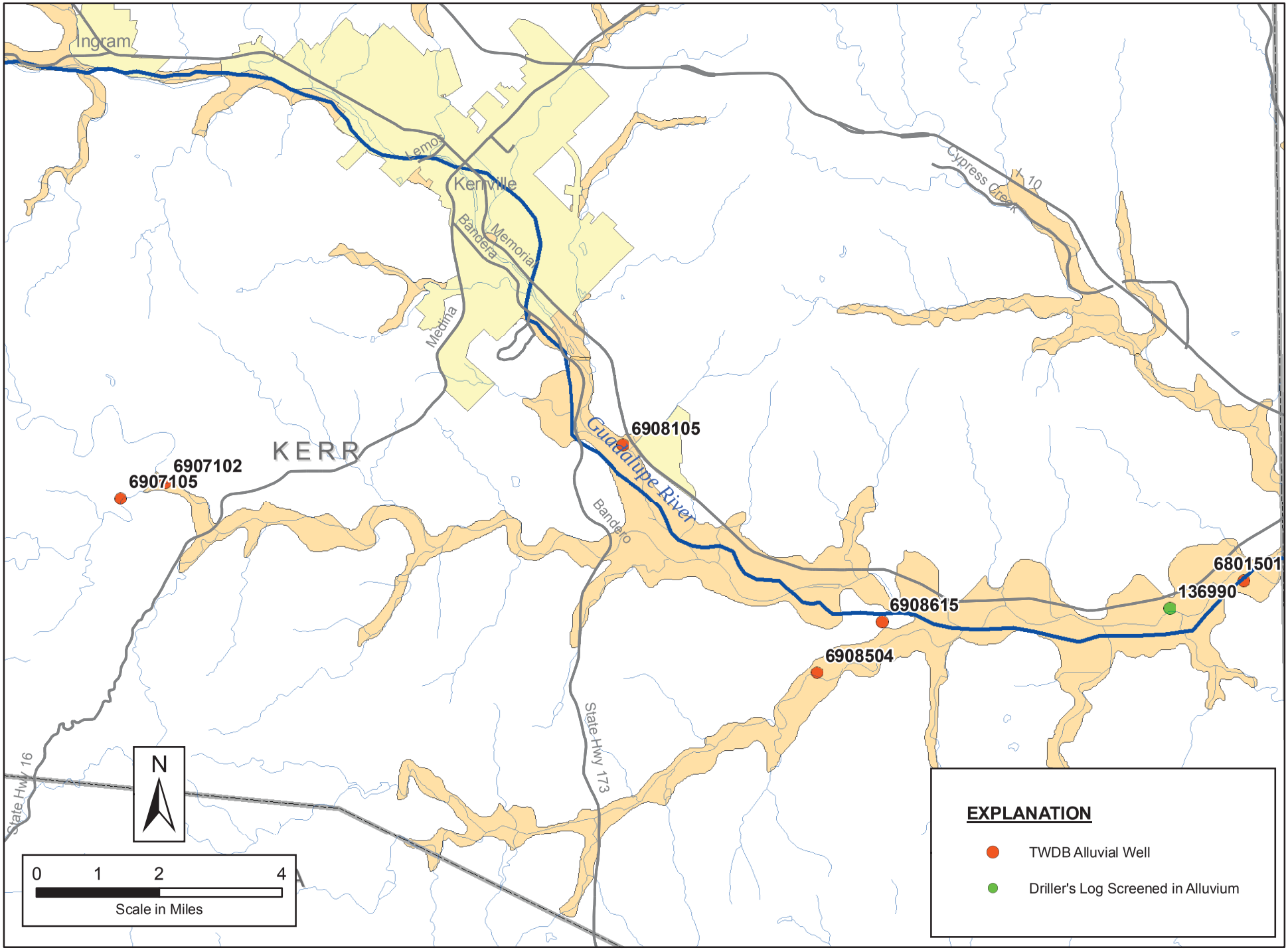

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FIGURE 2
RIVER ALLUVIUM IN THE GUADALUPE RIVER
EASTERN KERR COUNTY, TEXAS

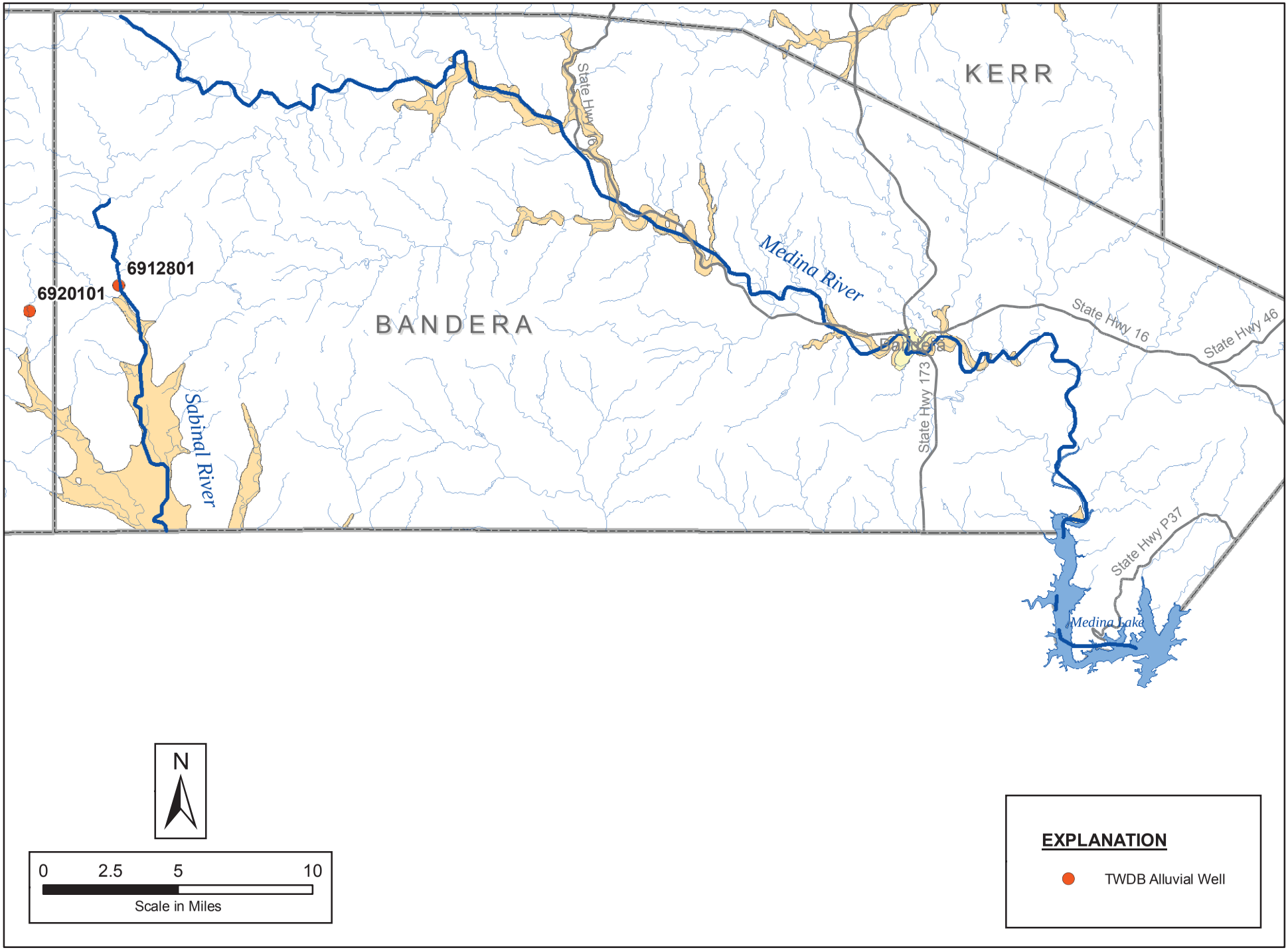

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FIGURE 3
RIVER ALLUVIUM IN THE MEDINA AND SABINAL RIVERS
BANDERA COUNTY, TEXAS

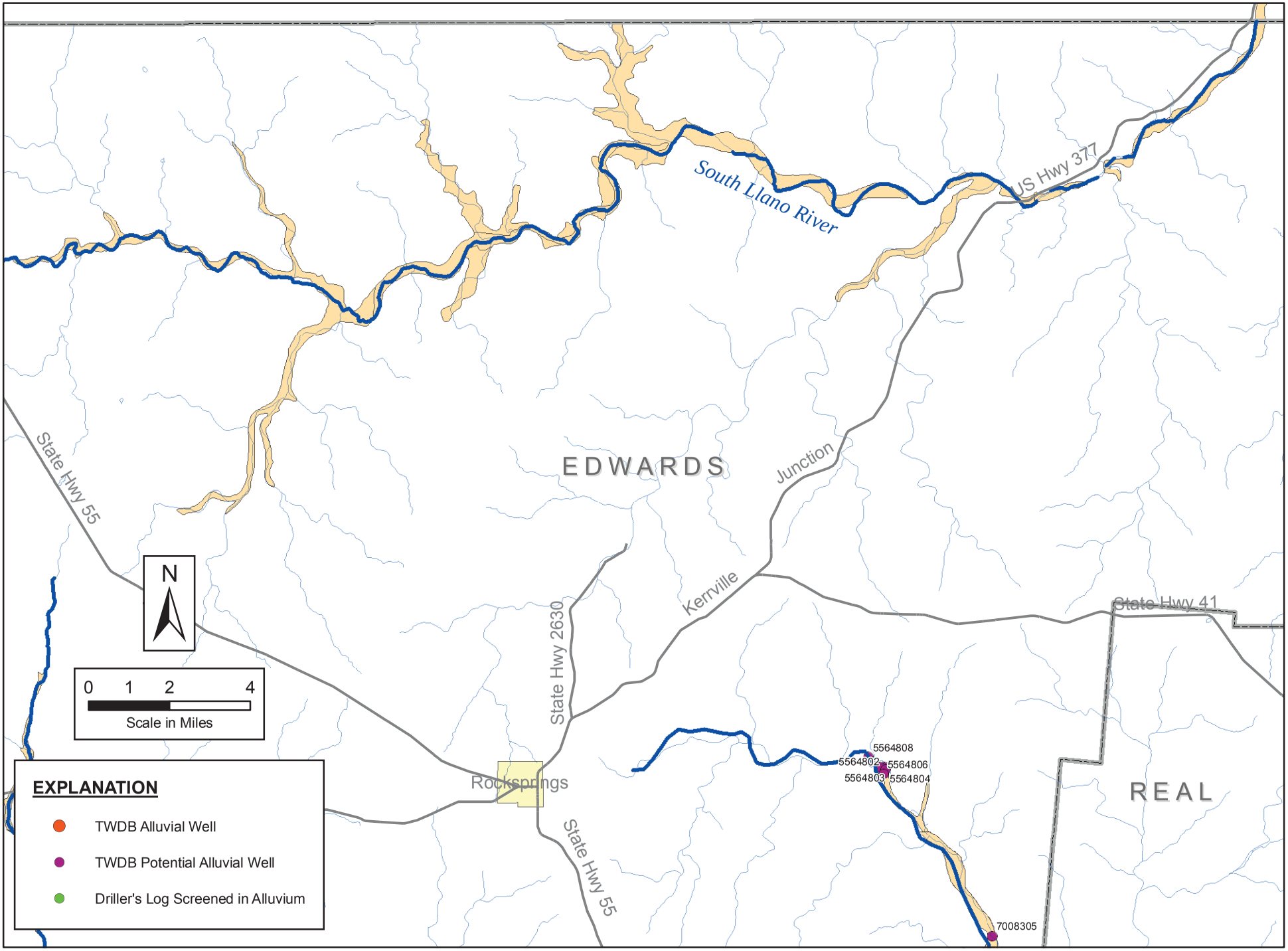

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FIGURE 4
RIVER ALLUVIUM IN THE SOUTH LLANO RIVER
EDWARDS COUNTY, TEXAS

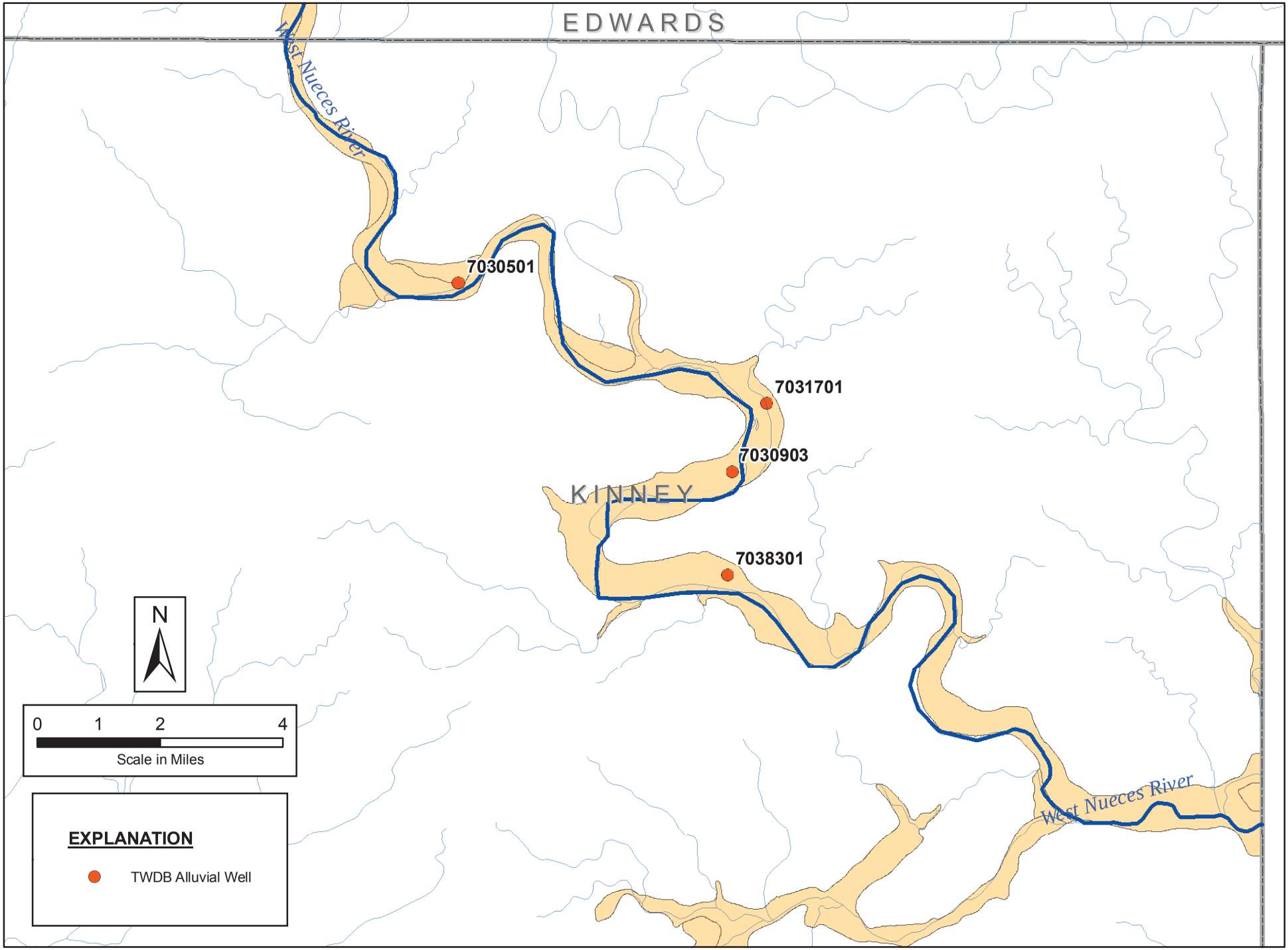

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FIGURE 5
RIVER ALLUVIUM IN THE WEST NUECES RIVER
NORTHEASTERN KINNEY COUNTY, TEXAS

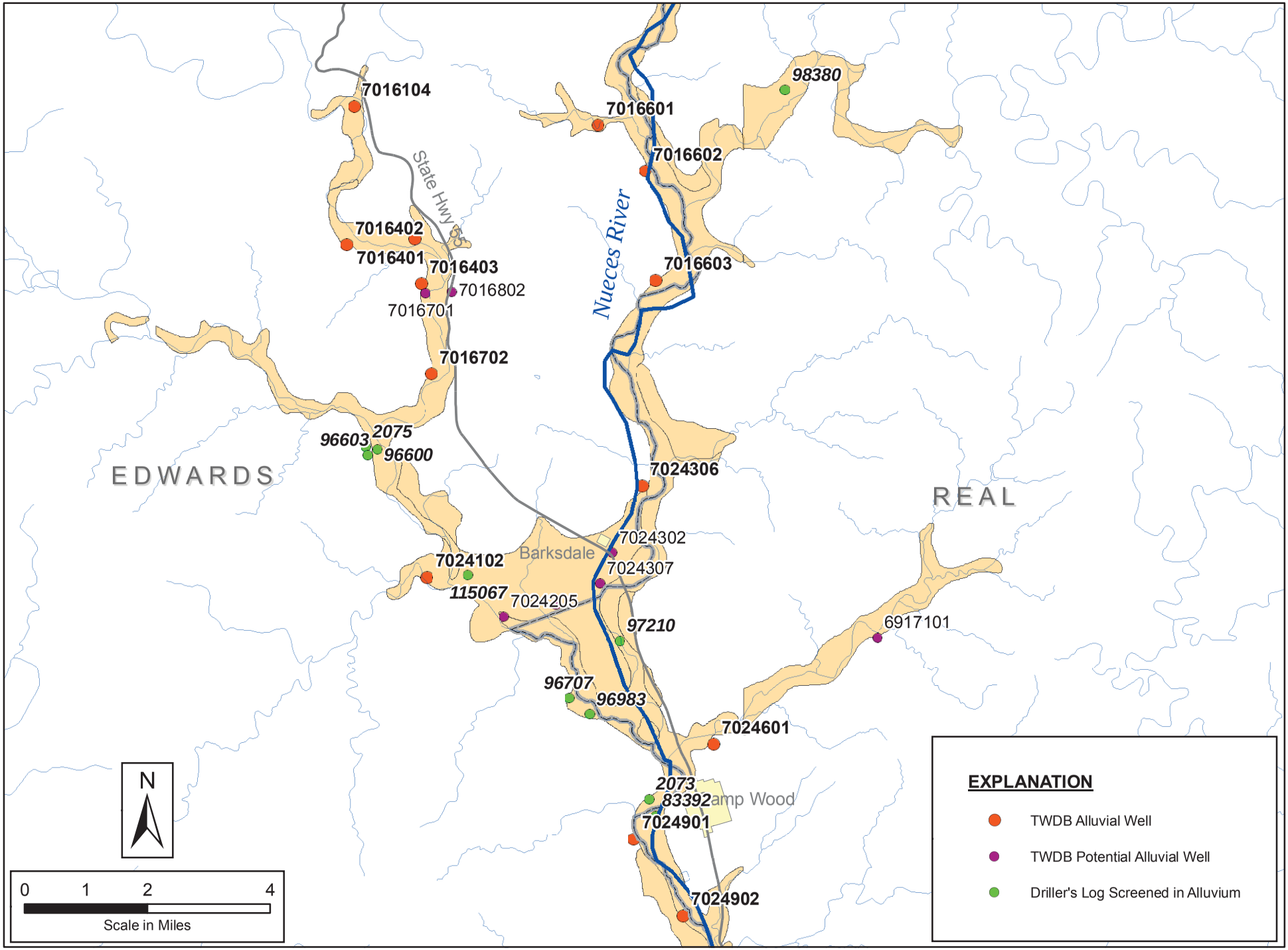

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FIGURE 6
RIVER ALLUVIUM IN THE NUECES RIVER
EDWARDS AND REAL COUNTIES, TEXAS

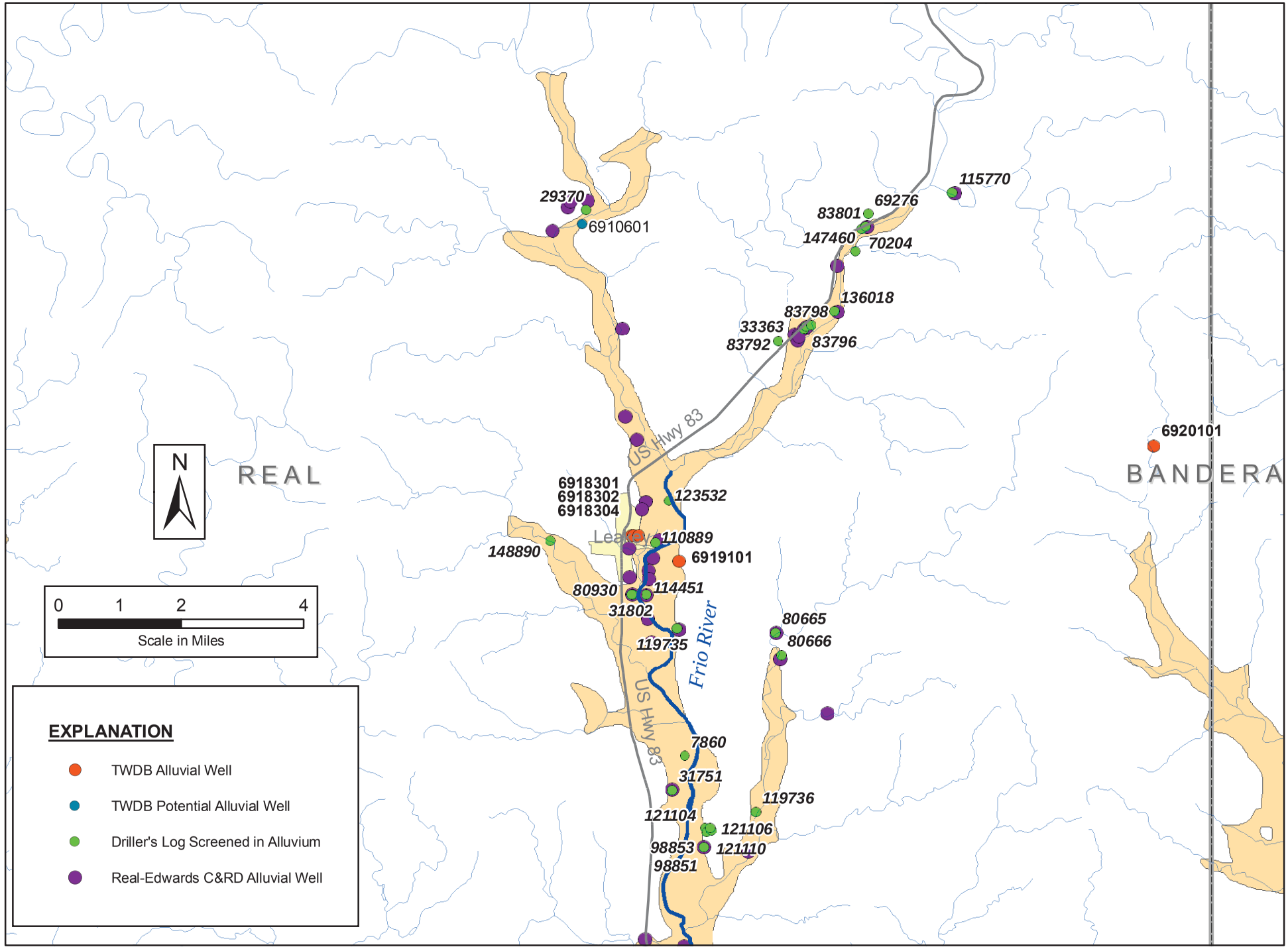

FIGURE 7
RIVER ALLUVIUM IN THE FRIO RIVER
REAL COUNTY, TEXAS

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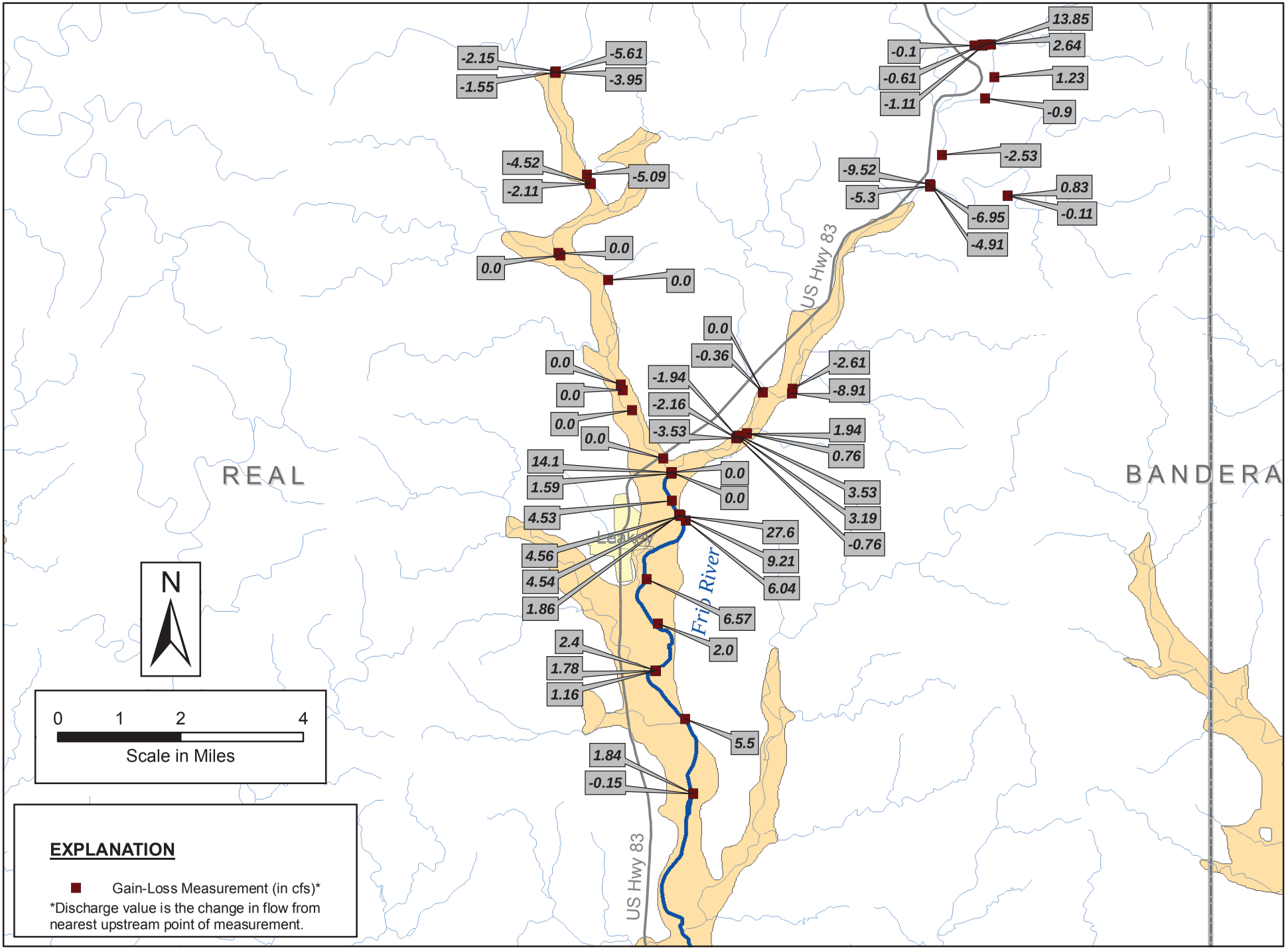

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FIGURE 8
GAIN-LOSS DATA IN THE FRIO RIVER
REAL COUNTY, TEXAS