Cultural Resource Assessment

Sand Hill Energy Center

Del Valle, Travis County, Texas

September 2013
Revised April 2014
Revised May 2014

Prepared For
City of Austin dba Austin Energy

Submitted to:

U.S. Environmental Protection Agency
Region VI
Multimedia Planning and Permitting Division
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Acronyms

ACT	Antiquity Code of Texas
APE	Area of Potential Effects
AQA	Air Quality Analysis
Atlas	Texas Archeological Sites atlas
BACT	Best Available Control Technology
BgA	Bergstrom Silty Clay
BT	Backhoe Trenches
CO	Carbon Monoxide
CRM	Cultural Resource Management
CTA	Council of Texas Archeologists
CTG	Combustion Turbine Generator
DLN	Dry low- NOx
EPA	Environmental Protection Agency
Facility	Chemical Manufacturing Complex
FIP	Federal Implementation Plan
FM	Farm to Market Road
GE	General Electric
GHG	Greenhouse Gas
HHV	Higher Heating Value
HRSG	Heat Recovery Steam Generator
Inc.	Incorporated
Km	Kilometer
MW	Megawatt
NAFERA	Native American Free Exercise of Religion Act
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NNE	North-Northeast
NOx	Nitrogen Oxides
PNG	Pipeline Natural Gas

PSD	Prevention of Significant Deterioration
Qt, Figure 6-1	Quaternary Terrace
ROW	Right of Way
SAR	South Austin Regional
SCR	Selective Catalytic Reduction
SH1-4	First Four Units (simple cycle turbines)
SH 5	Existing combined cycle turbine and stack
SH6 and SH7	Two Newer Units (simple cycle turbines)
SH8	Proposed combined cycle turbine and stack
SHEC	Sand Hill Energy Center
SIL	Significant Impact Levels
Sprint	Spray inter-cooled turbine
STG	Steam Turbine Generator
TARL	Texas Archeological Research Laboratory
TCEQ	Texas Commission on Environmental Quality
TCP	Traditional Cultural Properties
THC	Texas Historical Commission
TRC	TRC Environmental Corporation
TxDOT	Texas Department of Transportation
VOC	Volatile Organic Compound
1 x 1	One-to-One

Section 1
Introduction

The City of Austin (dba Austin Energy) is proposing to build-out the Sand Hill Energy Center (SHEC) located in Del Valle, Travis County, Texas by adding to the existing combined cycle unit at the facility. The existing combined cycle unit at the SHEC was conceived and constructed to include this new unit when Austin's energy demands grew to the point where additional generating capacity would be required.

Construction of the proposed new unit would consist of the installation of a General Electric (GE) model 7FA.04 combustion turbine and a heat recovery steam generator (HRSG) with natural gas fired duct burners (the proposed Project). Fuel burned in the new combustion turbine and duct burner would be limited to pipeline natural gas (PNG). The new combustion turbine generator (CTG) is rated at 180.5 MW at International Standards Organization (ISO) conditions. The new combined cycle unit would share the existing 189 MW steam turbine generator (STG) which is part of the existing combined cycle unit. Proposed emission controls technology would include dry low-NOx (DLN) combustion and selective catalytic reduction (SCR) for nitrogen oxides (NOx) emission control and an oxidation catalyst to reduce emissions of carbon monoxide (CO) and volatile organic compounds (VOC). The City of Austin is submitting an amendment application to the Texas Commission on Environmental Quality (TCEQ) to authorize the addition of this second combustion turbine and HRSG at its SHEC facility.

Air emissions from the proposed Project are subject to the jurisdiction of both the U.S. Environmental Protection Agency (EPA) and the TCEQ. On December 23, 2010, EPA issued a Federal Implementation Plan (FIP) authorizing EPA to issue PSD permits in Texas for greenhouse gas (GHG) sources until Texas submits the required SIP revision for GHG permitting and it is approved by EPA (Federal Register, 2010). A separate PSD permit application for GHGs is being submitted to EPA Region 6 with a copy provided to TCEQ. All non-GHG emissions are subject to the jurisdiction of the TCEQ. Accordingly, SHEC is submitting applications to both agencies to obtain the requisite authorizations to construct.

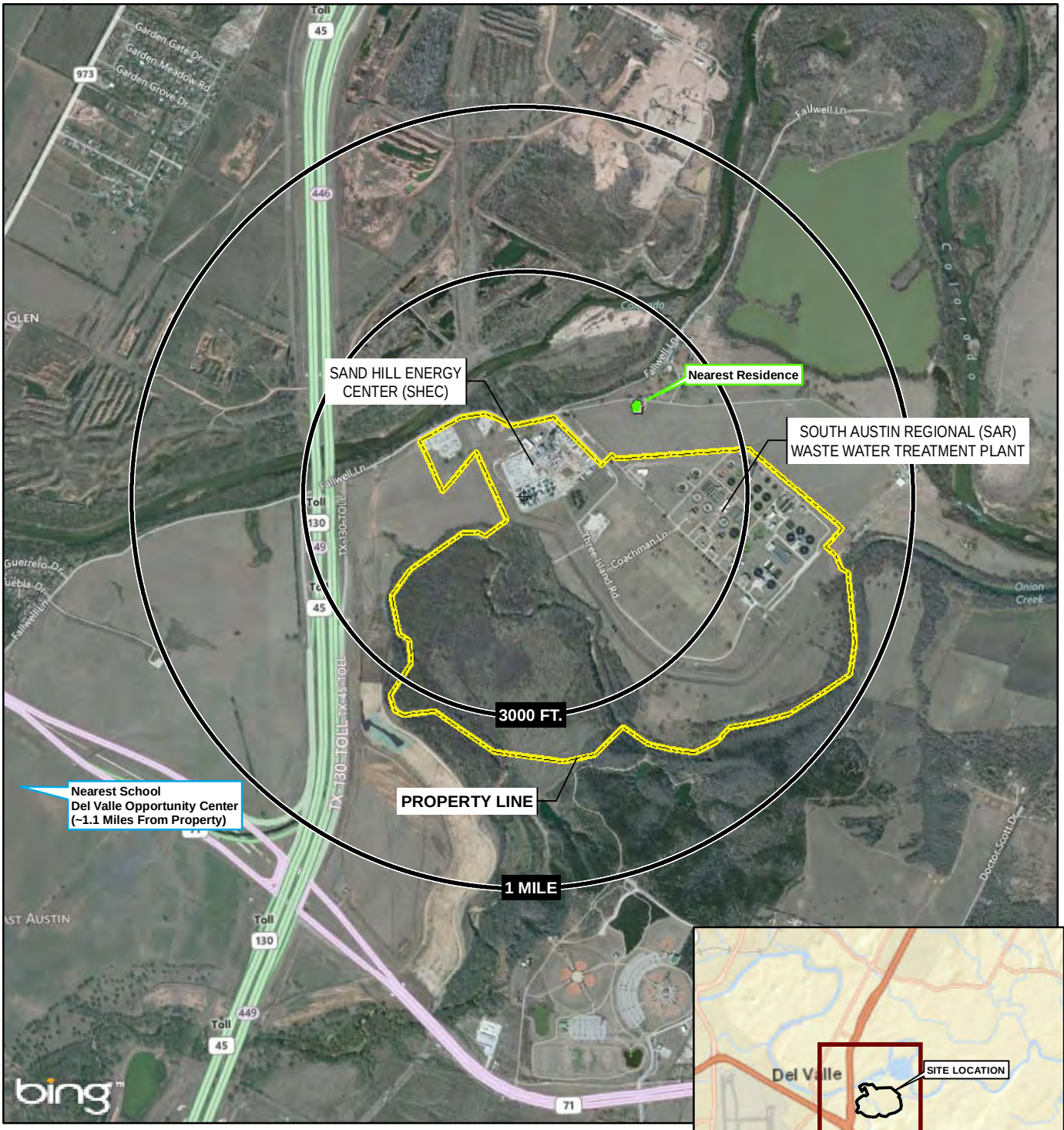
The Sand Hill Energy Center is located at 1101 Fallwell Lane, along the Colorado River, approximately one mile north-northeast (NNE) of the Highway 130 and Highway 71 intersection in Travis County. An area map of the site is illustrated in Figure 2-1. Figure 2-1 includes a circle of 3,000-ft radius and a circle of one-mile radius around the center of the

facility. The City of Austin property includes both the SHEC and the South Austin Regional (SAR) Waste Water Treatment Plant. Only the SHEC emissions are covered by the existing air permit. The area map includes current aerial photography to depict the land use surrounding the facility. The nearest non-industrial receptor outside of the SHEC site is a residence located immediately north of the plant, approximately 860 feet from the property line. No schools are located within 3,000 feet of this facility.

Section 2
Area Map

An Area Map of the Sand Hill Energy Center can be seen on the next page as Figure 2-1.

TRC - GIS



SOURCE:
ESRI ONLINE BING AERIAL, AND
DELORME WORLD BASE MAP

LEGEND

PROPERTY BOUNDARY

NEAREST RESIDENCE

N

0 2,000 FEET

1 " = 2,000 '

1:24,000

TRC

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Houston, TX 77042
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SAND HILL ENERGY CENTER
DEL VALLE, TRAVIS COUNTY, TEXAS

FIGURE 2-1
SITE LOCATION MAP

DRAWN BY:	PAPEZ J
APPROVED BY:	STANKO E
PROJECT NO:	196475-001-002
FILE NO.	196475-002am1.mxd
DATE:	AUGUST 2013

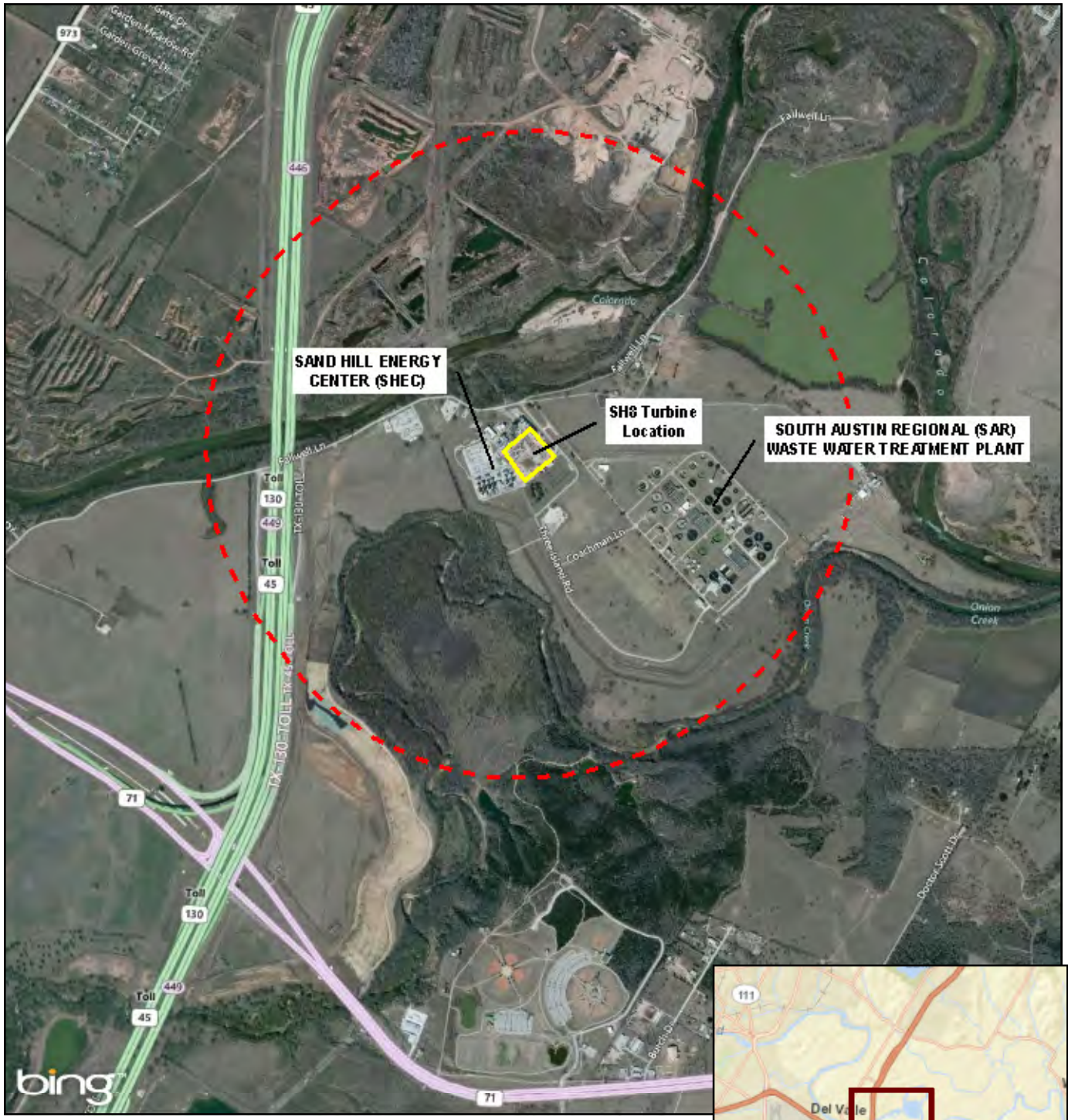
Section 3
Area of Potential Effect

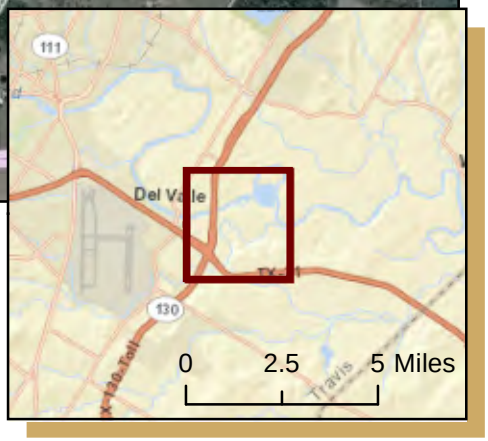
The Area of Potential Effects (APE) is defined in Section 106 of the National Historic Preservation Act of 1966 as the geographic area(s) within which an undertaking may directly or indirectly cause changes in the character or use of historic properties, if any such properties exist. Historic properties are defined as properties that are listed on the National Register of Historic Places or that are eligible for listing. Within the APE there will be two areas of focus. The first being defined as the area within the APE in which there is the potential for direct impact and this area is limited to the area of earth disturbing activities associated with construction. This area is comprised of 7 acres, including construction and laydown. For this area intensive cultural resource surveys have been conducted in 1979, 1981, 1982, and 2002 (discussed in greater detail in Section 7). The second area of focus is the portion of the APE that is outside the construction zone in which indirect impacts to cultural resources could occur. For the purposes of this report the indirect impacts APE is a 0.76 mile radius around the center of construction (1,161 acres). This radius was chosen for consistency with the Action Area examined in the Biological Assessment (under separate cover) and is based on approved air modeling results (Figure 3-1). There will be no new linear facilities (roads, pipelines, electrical transmission lines) build for this Project.

A 0.76 mile radius APE from the center of the facility was searched, using the Texas Archeological Research Laboratory (TARL), to determine if other cultural resources have been documented and/or archeological projects have been conducted in the area. The APE size was determined modeling pollutant dispersion from project emissions. Modeling was conducted in accordance with the U.S. EPA's Guideline on Air Quality Models, and other applicable federal and state guidance. The results of this modeling will be presented in the PSD Air Quality Analysis (AQA) under separate covers. For the purpose of this report the APE is determined by the point at which the pollutant concentration reaches the significant impact levels (SIL). The methodology for determining the APE was conservatively delineated by applying the EPA's SILs. The boundary of the APE was based on preliminary air dispersion modeling prepared in support of the PSD air permit application for criteria pollutants. When pollutant concentrations are at or below the SIL the EPA has determined that no measurable adverse impacts occur.

For all pollutants subject to PSD review NO_2 is the only acid rain pollutant that is over the SIL at the source. For this reason the modeled radius of NO_2 was used to determine the APE. The APE for the project includes the SHEC plant site as well as the surrounding area within which effects from the project will be analyzed.

TRC - GIS





BASE MAP: ESRI ONLINE BING AERIAL AND DELORME WORLD BASEMAP

N

0 2,000 Feet

1 inch = 2,000 feet

1:24,000

LEGEND

7 Acre Construction APE

Search Radius APE

V:\PROJECTS\AUGUSTA\Texas\Sand_Hill_Energy\Austin_Energy_Sand_Hill_Aerial.mxd

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SAND HILL ENERGY CENTER
DEL VALLE, TRAVIS COUNTY, TEXAS

FIGURE 3-1
AREA OF POTENTIAL EFFECT

DRAWN BY:	RNCARR
APPROVED BY:	NSYLVESTER
PROJECT NO:	196475.1000.0000
FILE NO.	Austin_Energy_Sand_Hill_Aerial.mxd
DATE:	MAY 2014

Section 4
Project Description

The proposed addition is the combined cycle unit will be located to the southeast and adjacent to the existing GE 7FA combustion turbine combined cycle unit. Figure 4-1 depicts the site plan for the proposed Project, with new equipment indicated in red. This plot plan shows the scale, north direction, two benchmark locations, and all emission points associated with the facilities in this application. A process flow diagram for the proposed unit is included as Figure 4-2 and a process flow diagram that shows integration of the proposed unit with the existing combined cycle unit is included as Figure 4-3.

4.1 Need for the Facility and Conceptual Design

Austin Energy requires additional generation to support a fast growing population and job growth in both the City of Austin and Travis County. Austin has been the fastest growing city in the country for the past three years. Since 2010 the population of Travis County has increased by 96,623 individuals, an increase of 9.4% (U.S. Census, 2013). The existing STG at the SHEC was sized to allow for population growth and increased power demands by accommodating the installation of an additional combustion turbine and HRSG.

Based on the current average residential electricity usage per person of 5,683 kWh, and a population increase in Travis County of over 200,000 persons, the residential electricity demand would increase 1,136,968mWh/year (EERE, 2014). The maximum additional capacity of the new unit is approximately 206 MW and this translates to 1,443,6484 MWh annually based on a capacity factor of 80%. Therefore, the projected increase in residential demand alone (over a two year period) represents 79% of the additional power available from the project.

4.2 The Existing SHEC Facility

The existing facility equipment, operations and emissions are regulated under Prevention of Significant Deterioration (PSD) permit No PSDTX1012M1 and Texas Commission on Environmental Quality (TCEQ) Permit No. 48106. The current generating units include six natural gas fired GE LM6000 aero derivative design simple cycle combustion turbines and the existing natural gas fired GE Frame 7FA combustion turbine combined cycle unit including natural gas fired duct burners, a HRSG and a steam turbine generator. The six simple cycle units are designated in the permit as EPN's SH1, SH2, SH3, SH4, SH6 and SH7. The first four units (SH1-4) commenced operation in 2001 and the two newer units (SH6 and SH7) commenced operation in 2010. These units have a nominal output rating of 50 MW each and

serve as "peaking" units that start up to help meet demand during peak (higher) periods. The LM6000 turbines utilize GE's spray inter-cooled turbine (Sprint) design and power augmentation and include water injection and SCR for NOx control.

The existing combined cycle unit commenced operation in 2004 and is designated in the TCEQ PSD permit as EPN SH5 and has a GE 7FA.03 combustion turbine – a previous version of the 7FA model. The turbine is equipped with DLN (model DLN2.6) combustors. Its Heat Recovery Steam Generator (HRSG) is equipped with natural gas fired duct burners and SCR. The steam turbine generator for this unit was sized to accommodate the addition of a second similarly sized combustion turbine, with a space immediately adjacent to the southeast of the SH5 unit for the proposed SH8 unit, as shown in the plot plan in Figure 1-2. The current combined cycle unit is a one-on-one (1 x 1) configuration (one CTG with HRSG and one STG), but following the addition of the proposed new turbine and HRSG it will be a 2 x 1 configuration (two CTGs/HRSGs and one STG). The present combustion turbine has a nominal rated output of 164 MW and the steam turbine generator currently produces up to 157 MW but will be capable of up to 189 MW output with the addition of the proposed second combustion turbine. As such, the maximum combined generating output of the combined cycle unit will increase from 321 MW for the existing 1 x 1 configuration to 548 MW for the proposed 2 x 1 configuration. The STG was originally sized for the planned build-out to a 2 x 1 configuration.

The existing cooling tower was sized for the full STG capacity in the 2 x 1 configuration, so no new cooling tower capacity is needed. Saturated steam from the STG is condensed prior to being recirculated along with makeup water to the HRSG for reheating. Condenser cooling is provided by circulating water that is in turn cooled by ambient air in the direct-contact mechanical draft cooling tower. The water that is used in the cooling tower makeup is either potable City of Austin and/or reclaimed water that is treated onsite. The reclaimed water is obtained from the adjoining South Austin Regional (SAR) wastewater treatment plant.

Ancillary equipment includes two existing aqueous ammonia storage tanks (19% aqueous ammonia solution) that will store the SCR reagent for the units. One aqueous ammonia tank stores SCR reagent for all six simple cycle turbines. The aqueous ammonia goes to a vaporizer unit and is then injected into the flue gas upstream of the SCR catalyst. There are also four existing cooling towers and three natural gas fired inlet air heaters associated with the simple cycle units.

4.3 The Proposed Project

The new combined cycle unit (Sandhill Unit 8 (SH8)) is anticipated to operate as a base-loaded unit, with up to 8,760 full-load hours per year, but may also operate at partial loads, and/or start-up and shutdown as needed to meet electricity demand. The duct burners for the new unit will be rated at 681.5 MMBtu/hr based on the higher heating value (HHV) of the pipeline natural gas fuel, and may operate at full capacity for up to 8760 hours per year. The new combined cycle turbine is expected to start-up numerous times per year.

As described above, the new combustion turbine and HRSG will be located alongside the existing GE 7FA.03 turbine that is presently operating in combined cycle mode in a 1 x 1 configuration with a single CTG/HRSG supplying steam to a single STG. The existing STG is sized such that it will be able to accommodate the build-out with additional steam from the new HRSG of the proposed GE 7FA.04 combustion turbine; thus the new configuration will be 2 x 1 with two CTGs/HRSGs supplying steam to one STG.

The proposed combustion turbine will utilize DLN combustors and SCR to control NOx emissions. The proposed PNG-fired duct burner will have a maximum heat input capacity of 681.5 MMBtu/hr (HHV). An oxidation catalyst will be located in the HRSG downstream of the duct burners and upstream of the SCR ammonia injection grid and will control emissions of CO as well as VOC. GHG emissions from the proposed Project are discussed in detail in Section 3 of the Prevention of Significant Deterioration Greenhouse Gas Permit Application.

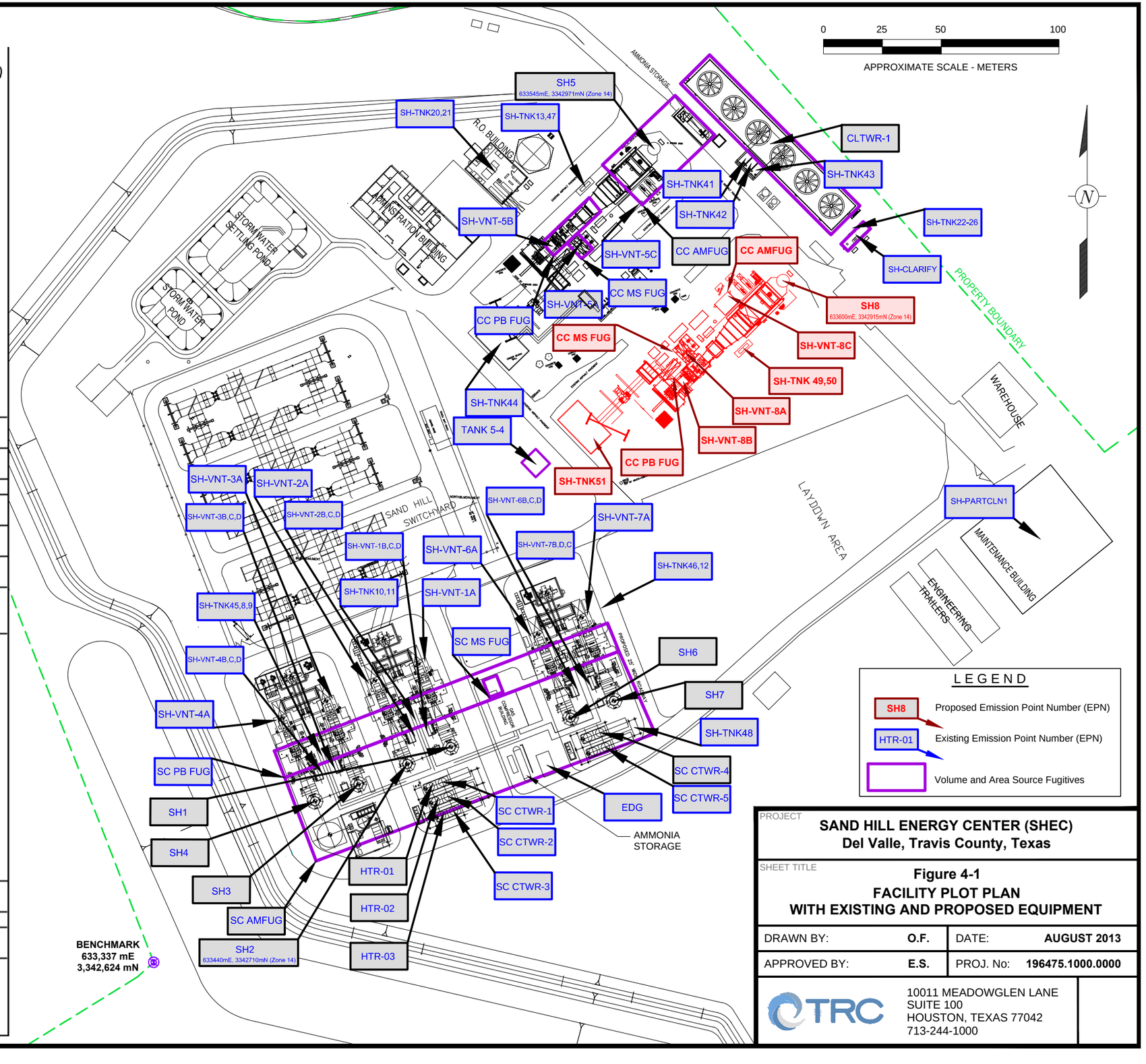
There are no upstream or downstream impacts that would preclude addition of the proposed unit to the SHEC, because the existing the plant natural gas piping and infrastructure is designed to handle a second GE 7FA combustion turbine and duct burner. The existing steam turbine was designed to achieve full capacity with a second GE 7FA and HRSG, which would improve the heat rate and thermal efficiency of the unit, providing more electricity per unit of natural gas consumed. The existing balance of plant equipment including circulating water, condensate water, cooling water systems and the cooling tower were designed to support an additional 7FA and HRSG. The existing condenser was constructed to support steam flow from a second HRSG operating in bypass. The plant switchyard is designed to support the electrical production of the additional unit. The plant access road is adequate to support construction and maintain operation of the additional unit. There would be small increases of natural gas fugitives from piping associated with the proposed CTG.

Because the existing cooling tower was sized for the build-out to the full STG capacity in 2 x 1 configuration, no new cooling tower capacity addition is needed to accommodate the proposed new unit, but the cooling tower would require additional make-up water. There would also be

an increased volume of process water and equipment cooling water usage. There would also be small increases in wastewater due to blow down from the new HRSG.

The cooling tower, which uses water from the adjacent City of Austin waste water treatment plant, and/or potable water will require additional make-up water.

EPN / FIN	SOURCE NAME	UTM COORDINATES Easting (m)	Northing (m)
EXISTING SOURCES			
SH1	GE LM 6000 Simple Cycle Gas Turbine 1	633,456	3,342,718
SH2	GE LM 6000 Simple Cycle Gas Turbine 2	633,438	3,342,710
SH3	GE LM 6000 Simple Cycle Gas Turbine 3	633,419	3,342,703
SH4	GE LM 6000 Simple Cycle Gas Turbine 4	633,401	3,342,695
SH5	GE 7FA.03 Combined Cycle Unit 5	633,535	3,342,976
SH6	GE LM 6000 Simple Cycle Gas Turbine 6	633,506	3,342,733
SH7	GE LM 6000 Simple Cycle Gas Turbine 7	633,524	3,342,740
HTR-01	Inlet Air Heater 1	633,448	3,342,701
HTR-02	Inlet Air Heater 2	633,451	3,342,695
HTR-03	Inlet Air Heater 3	633,453	3,342,689
SC CTWR-1	Simple Cycle Cooling Tower 1	633,453	3,342,703
SC CTWR-2	Simple Cycle Cooling Tower 2	633,456	3,342,697
SC CTWR-3	Simple Cycle Cooling Tower 3	633,458	3,342,691
SC CTWR-4	Simple Cycle Cooling Tower 4	633,521	3,342,721
CTWR-1	Cooling Tower 1 (Combined Cycle)	633,587	3,342,971
SC PB FUG	Simple Cycle Power Block Fugitives	633,388	3,342,704
SC MS FUG	Simple Cycle Natural Gas Meter Skid	633,475	3,342,738
CC PB FUG	Combined Cycle Power Block Fugitives	633,502	3,342,926
CC MS FUG	Combined Cycle Natural Gas Meter Skid	633,514	3,342,925
SC AMFUG	Simple Cycle Ammonia Fugitives	633,403	3,342,669
CC AMFUG	Combined Cycle Ammonia Fugitives	633,513	3,342,965
TANK 5-4	Oil/Water Separator	633,495	3,342,838
EDG	Emergency Diesel Generator	633,494	3,342,713
SH VNT-1A	Generator Lube Oil Vent-1A	633,448	3,342,754
SH-VNT-1B,C,D	Lube Oil Vents-1B,C,D	633,449	3,342,724
SH-VNT-2A	Generator Lube Oil Vent-2A	633,424	3,342,744
SH VNT 2B,C,D	Lube Oil Vents 2B,C,D	633,443	3,342,722
SH VNT 3A	Generator Lube Oil Vent 3A	633,408	3,342,738
SH VNT 3B,C,D	Lube Oil Vents 3B,C,D	633,409	3,342,708
SH VNT 4A	Generator Lube Oil Vent 4A	633,384	3,342,728
SH VNT 4B,C,D	Lube Oil Vents 4B,C,D	633,404	3,342,706
SH VNT 5A	Hydraulic Oil/Lube Oil Vent on Unit 5A Gas Turbine	633,513	3,342,930
SH VNT 5B	Generator Seal Oil Vent for Unit 5 Gas Turbine	633,502	3,342,930
SH VNT 5C	Lube Oil Vent on Unit 5C Steam Turbine	633,539	3,342,948
SH VNT 6A	Generator Lube Oil Vent 6A	633,493	3,342,764
SH VNT 6B,C,D	Lube Oil Vents 6B,C,D	633,512	3,342,742
SH VNT 7A	Generator Lube Oil Vent 7A	633,517	3,342,773
SH VNT 7B,D,C	Lube Oil Vents 7B,D,C	633,518	3,342,744
SH PARTCLN1	Parts Cleaner	633,709	3,342,806
SH TNK10,11	Underground Wash Water Tanks	633,444	3,342,728
SH TNK13,47	Underground Wash Water Tanks	633,478	3,342,961
SH TNK20,21	Nalco Tote Tanks	633,516	3,342,955
SH TNK22-26	Nalco Tote Tanks	633,630	3,342,938
SH TNK46,12	Oil/Water Seperator Tank for Units 6-7	633,523	3,342,776
SH TNK41	Circulating Water Pump/Lube Oil Reservoir	633,584	3,342,967
SH TNK42	Circulating Water Pump/Lube Oil Reservoir	633,586	3,342,965
SH TNK43	Circulating Water Pump/Lube Oil Reservoir	633,589	3,342,962
SH TNK44	Unit 5 Gas Compressor Oil Reservoir	633,480	3,342,889
SH TNK45	Oil/Water Seperator Tank for Units 1-4	633,404	3,342,713
SH TNK48	Underground Wash Water Tank	633,537	3,342,725
SH-CLARIFY	Water Treatment Chemical Storage Tanks	633,631	3,342,935
PROPOSED SOURCES			
SH8	GE 7FA.04 Combined Cycle Unit 8	633,590	3,342,923
CC AMFUG	Combined Cycle Ammonia Fugitives Unit 8	633,576	3,342,911
CC MS FUG	Combined Cycle Natural Gas Meter Skid Unit 8	633,553	3,342,885
CC PB FUG	Combined Cycle Power Block Fugitives Unit 8	633,553	3,342,874
SH TNK49,50	Underground Wash Water Tanks	633,583	3,342,886
SH TNK51	Unit 8 Gas Compressor Oil Reservoir	633,519	3,342,848
SH VNT 8A	Hydraulic Oil/Lube Oil Vent on Unit 8 Gas Turbine	633,559	3,342,885
SH VNT 8B	Generator Seal Oil Vent for Unit 8 Gas Turbine	633,558	3,342,872
SH VNT 8C	Lube Oil Vent on Unit 8 Steam Turbine	633,577	3,342,909



PROJECT

SAND HILL ENERGY CENTER (SHEC)
Del Valle, Travis County, Texas

SHEET TITLE

Figure 4-1
FACILITY PLOT PLAN
WITH EXISTING AND PROPOSED EQUIPMENT

DRAWN BY:	**O.F.**	DATE:	**AUGUST 2013**
APPROVED BY:	**E.S.**	PROJ. No:	**196475.1000.0000**

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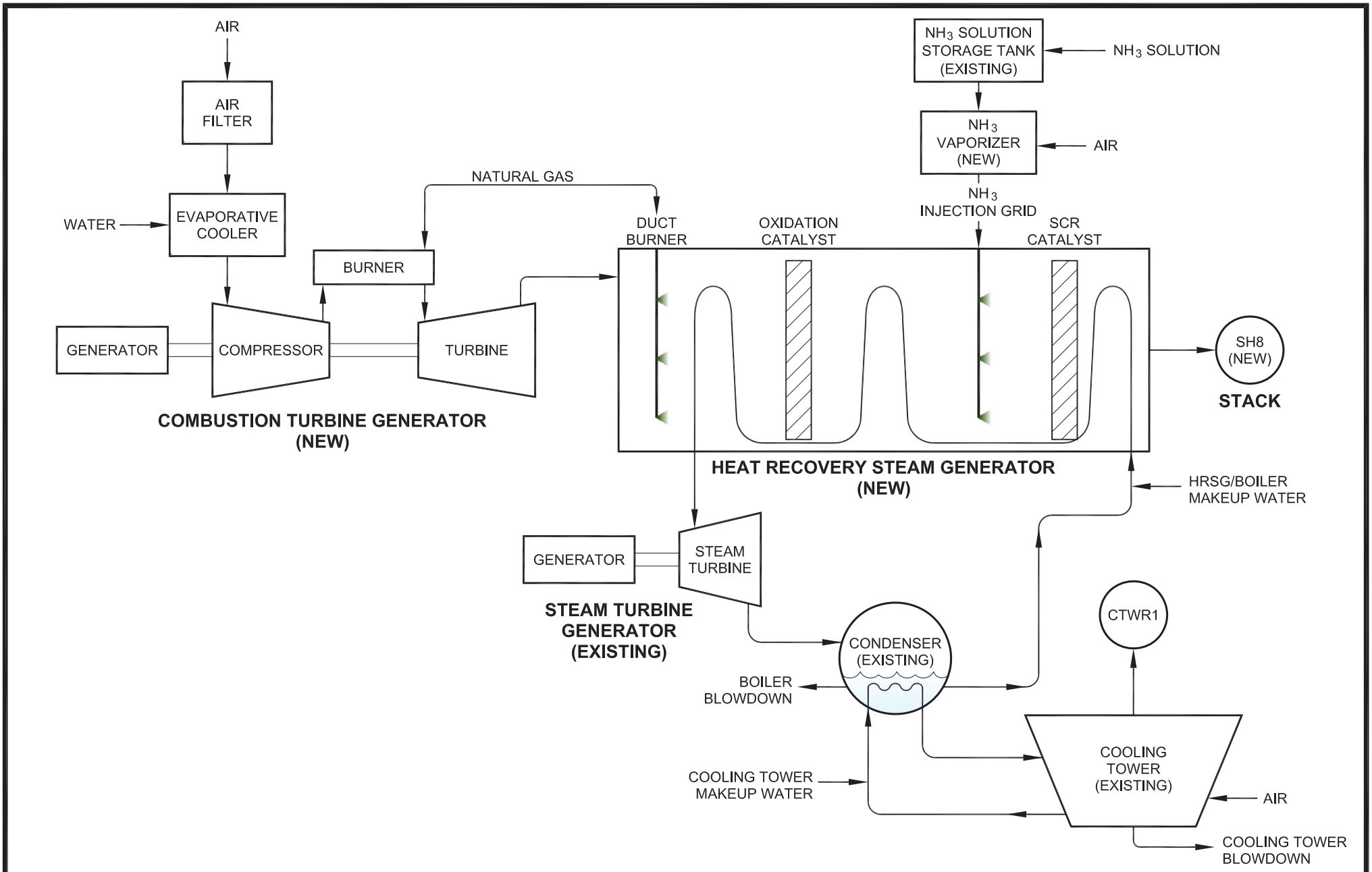
SUITE 100
HOUSTON, TEXAS 77042
713-244-1000

HOU L:\City of Austin\Sand Hill Energy Center - SHEC\ Fig 2-2 - CofA-SHEC - Process Flow Diagram.dwg 07/24/13



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713-244-1000

PROJECT

CITY OF AUSTIN
Sand Hill Energy Center (SHEC)
Del Valle, Travis County, Texas

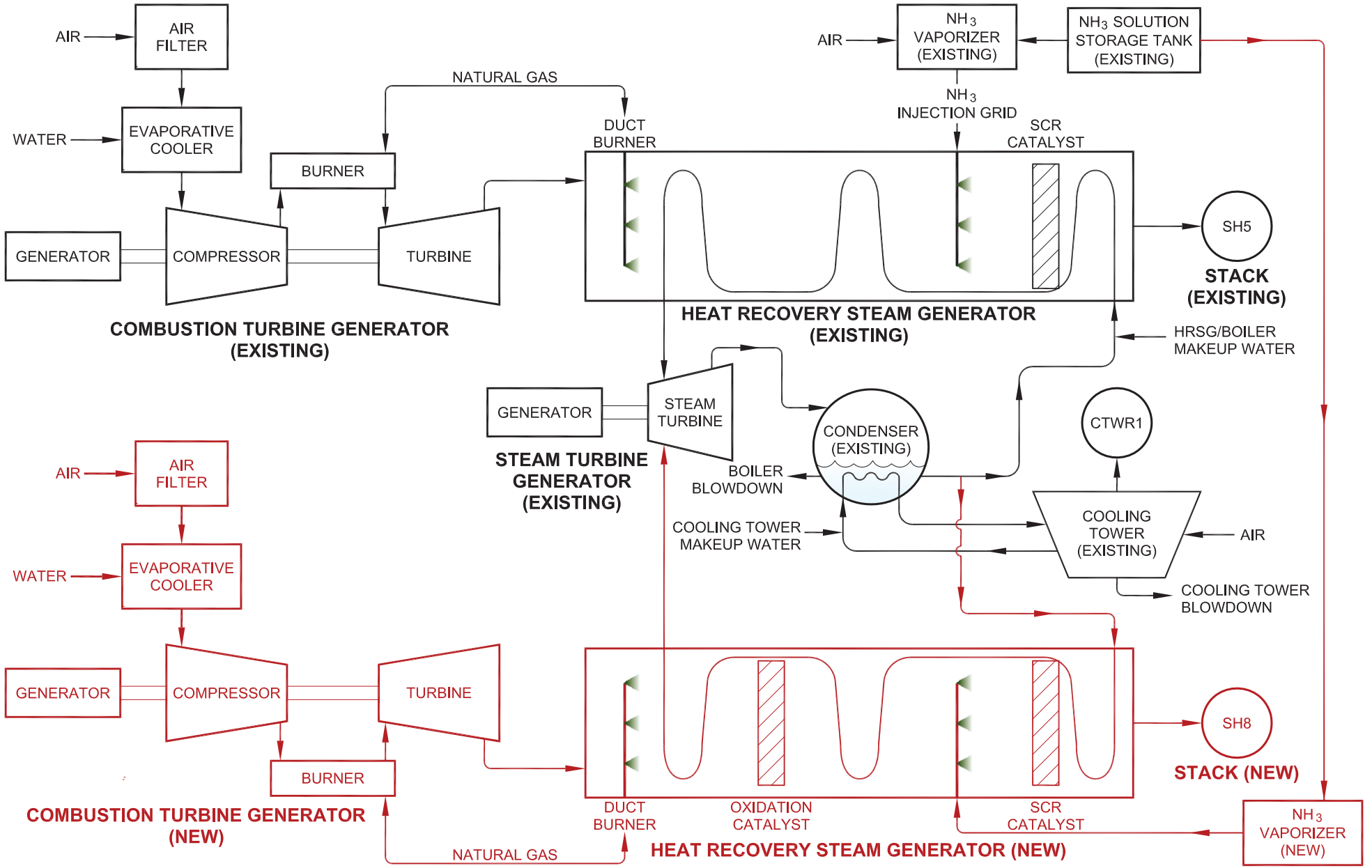
SHEET TITLE

PROCESS FLOW DIAGRAM - PROPOSED COMBINED CYCLE UNIT
Air Quality Modeling Protocol for Permit 48106

DRAWN BY:	**O.F.**
APPROVED BY:	**G.E.**
PROJ. No:	**196475.0000.0000**
DATE:	**JULY 2013**

Figure 4-2

HOU L:\City of Austin\Sand Hill Energy Center - SHEC\ Fig 2-3 n 5-2 - CofA-SHEC - PFD -Existing-n-New.dwg 08/19/13



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HOUSTON, TEXAS 77042
713-244-1000

PROJECT

SAND HILL ENERGY CENTER (SHEC)

Del Valle, Travis County, Texas

SHEET TITLE

PROCESS FLOW DIAGRAM FOR EXISTING AND PROPOSED COMBINED CYCLE UNIT

DRAWN BY:	O.F.
APPROVED BY:	D.S.
PROJ. No:	196475.0000.0000
DATE:	AUGUST 2013

Figure 4-3

Section 5
Environmental Setting

5.1 Introduction

An overview of the current environmental conditions is presented in this section. Sections included here are physiography, geology, soils, climate, and the biotic characteristics that focus on the general floral and faunal of the region. This followed by a brief statement concerning disturbances to the original natural conditions. The resume of the author can be found in Appendix A.

5.2 Physiography

The Sand Hill Energy Center just south of the Austin Energy in the southern part of Travis County, just west of the junction of Onion Creek and the Colorado River, is approximately 10 kilometers (km) east of the eastern edge of the Balcones fault zone/escarpment that runs along the western side of Austin. The escarpment was formed from a fault system that created a sharp visual and topographical break in the landscape. The area is situated at the western edge of the Blackland Prairie, a relatively flat and narrow ecological region that generally parallels the Balcones escarpment and extends from central Texas north to the Red River. This zone was originally characterized by grasslands with scattered trees. A short distance further east lays the Inner Gulf Coastal Plain that stretches to the Gulf of Mexico. The Colorado River crosses this ecological region in a northwestern to southeastern flow with Onion Creek a major tributary just to the east. The Colorado River and its tributaries cut deeply into the various limestone formations to the west of Austin and into deep alluvial deposits to the east.

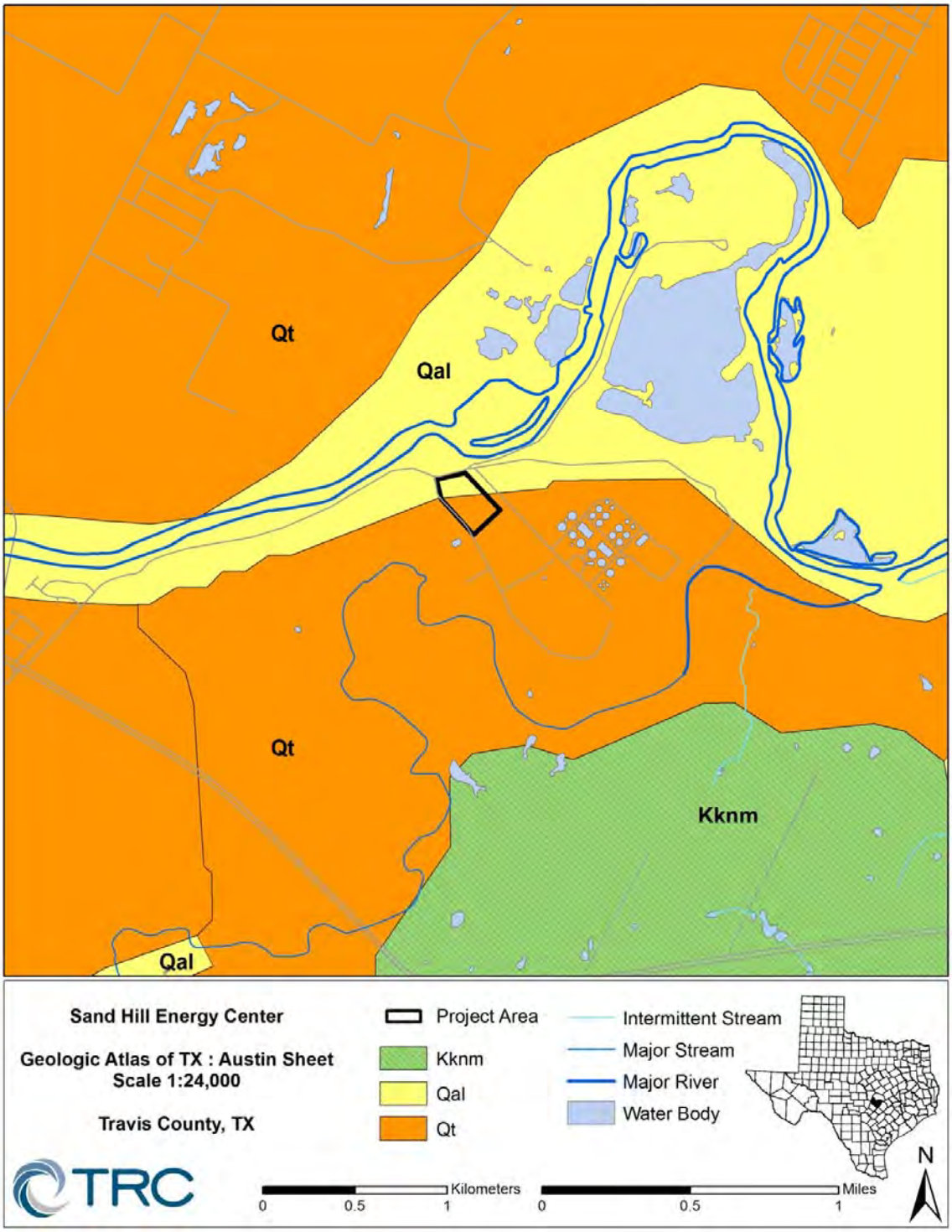
The Sand Hill Energy Center is situated on a high Quaternary alluvial terrace deposit at an elevation of 430 ft. above mean sea level with multiple lower recent terraces of the Colorado River just to the northwest of the Sand Hill Energy Center along the Colorado River. This high Pleistocene terrace is relatively flat with the exception of the manmade developments.

5.3 Geology

The project is mapped as Quaternary terrace (Qt, Figure 5-1) that overlooks the Colorado River, which is late Pleistocene in age and estimated to postdate 30,000 B.P. (Thurmond 1982:15). The alluvial deposits are likely a composite of the Colorado River and Onion Creek deposits. These generally consist of gravel, sand, silt, and clay in various proportions with gravel more prominent in the older, higher terraces. The gravels contain mostly dolomite, limestone, chert, quartz, and various igneous and metamorphic rocks from the Llano region and the Edwards

Plateau to the west (Barnes 1974). Navarro (Kemp Clay, Corsicana Marl, and Neylandvelle Formation) and Marlbrook Marl (upper Taylor marl) deposits of Upper Cretaceous age border the alluvial deposits to the north and south (Barnes 1974).

Figure 5-1 Geologic Deposits



Map of the geologic deposits. (Note: KKnm = Navarro Group and Marlbrook Marl; Qal = recent floodplain deposits; Qt = Pleistocene terraces).

5.4 Soils

Blackland prairies are distinguished from other prairies by its deep, fertile soils created by large quantities of invertebrate fauna and fungal flora. These vertisol soils contain gilgai, which helps store water to keep soils moist even during drought. It is found in predominantly clay soils and noticeably expands when wet and contracts when dry (cracking).

The original soils across the Sand Hill Energy Center were classified as part of the Bergstrom Series, specifically the Bergstrom silty clay loam (BgA), which are found on slopes from 0 to 1 percent. The soils typically occupy broad, smooth, nearly level benches on flood plains. The soil has a surface layer of dark-brown (10YR 3/3) silty clay loam about 25 inches thick. The next layer is reddish-brown (5YR 5/4) silt loam to a depth of about 60 inches (Werchan et al. 1974; NRCS 2012).

5.5 Climate

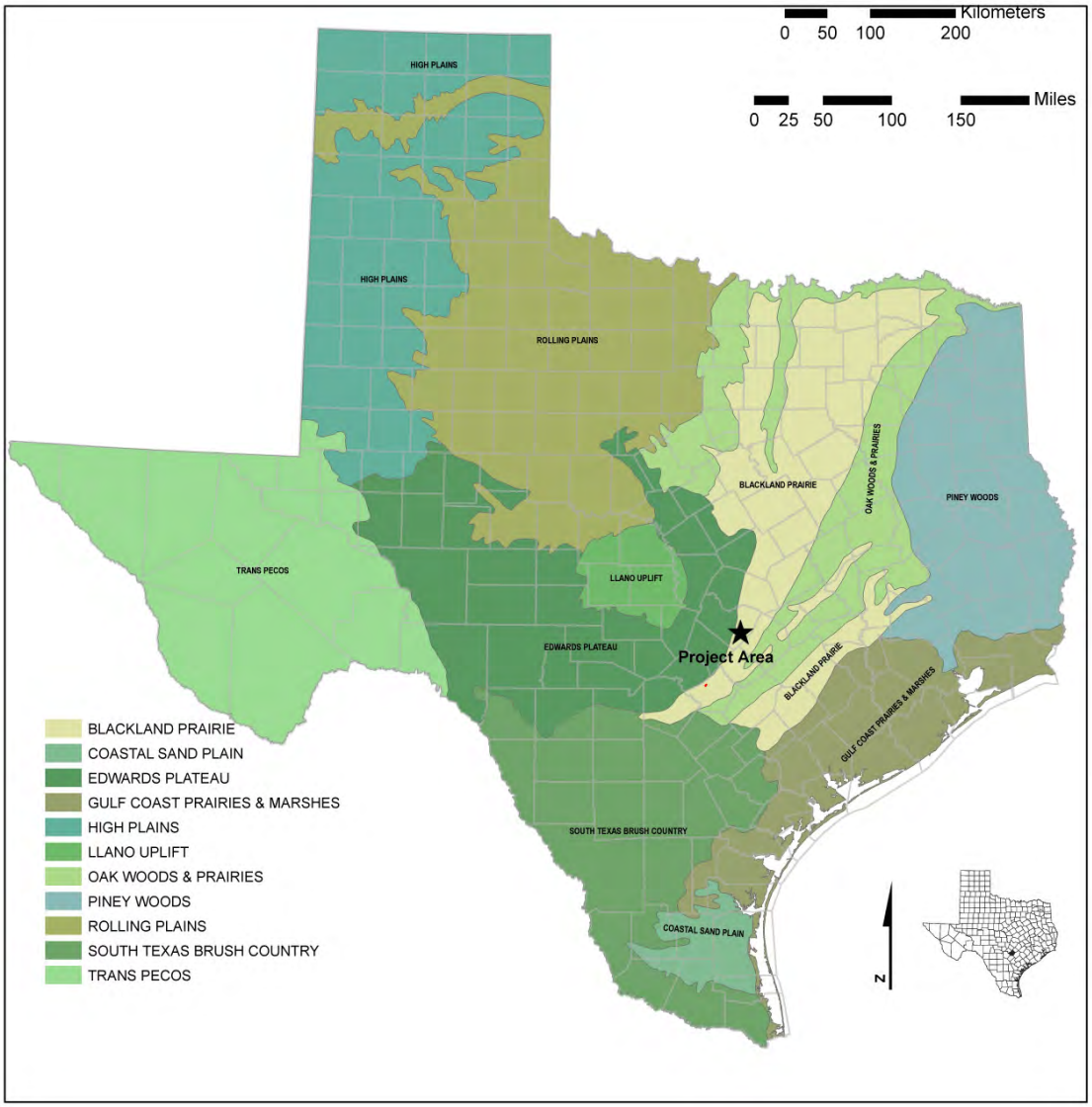
Travis County is humid subtropical with long, hot summers influenced by tropical Maritime air masses while short, mild winters are often modified by polar air masses. During the winter, less than 25 days reach below freezing temperatures. Lower winter temperatures are influenced by precipitation in the form of fog and light rain. Strong northerly winds accompanied by sharp drops in temperature occur in the winter (Werchan et al. 1974).

The 30-year average annual precipitation is 32.15 inches (81.66 cm) mainly in the form of rain as snow is usually immeasurable (NOAA, 2010). The growing season for most crops is between March and November (270 days) (Werchan et al. 1974). The sun shines 62 percent of the day light hours on an annual average (Werchan et al. 1974). The highest temperature recorded in Austin was 112°F (44.4°C) and the lowest temperature on record was -5°F (-20.5°C) on (NOAA, 2014). In summer, high temperatures over 90°F (32.2°C) occur 80 percent of the time with August being the hottest, driest month (Werchan et al. 1974).

5.6 Biotic Characteristics

Sand Hill Energy Center is in the Blackland Prairie that stretches 300 miles (483 km) in a long, thin strip from Bexar County, (San Antonio area) to most of Grayson, Fannin, and Lamar counties near the Texas-Oklahoma eastern border (Figure 5-2). It is defined by fine clay soils, upper cretaceous chalks, marls, limestone and shale as well as mostly prairie vegetation. High fire frequency influenced the Blackland Prairies growth. However, intensive land use and clearing have transformed the historically tall grass prairies.

Figure 5-2 Biotic Provinces in Texas



Blackland prairies are distinguished from other prairies by its deep, fertile soils created by large quantities of invertebrate fauna and fungal flora.

5.7 Flora and Fauna

In general, the Blackland Prairies form a distinct ecological region, distinguished from surrounding regions by predominantly prairie natural vegetation (see Figure 5-2). Dominant grasses include little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), yellow Indiangrass (*Sorghastrum nutans*), and switchgrass (*Panicum virgatum*). Some wooded areas of post oak (*Quercus stellata*), blackjack oak (*Quercus marilandica*), and eastern red cedar (*Juniperus virginiana*) are present. Riparian forests are also present and contain bur oak (*Quercus macrocarpa*), Shumard oak (*Quercus shumardii*), sugar hackberry (*Celtis laevigata*), and pecan (*Carya illinoinensis*). This region now contains a higher percentage of cropland than adjacent regions; pasture and forage production for livestock is common. Large areas of the region are being converted to urban and industrial uses. Before Anglo settlement, animal species included buffalo (*Bison bison*), pronghorn antelope (*Antilocapra americana*), mountain lion (*Puma concolor*), bobcat (*Lynx rufus*), black bear (*Ursus americanus*), collared peccary (*Tayassu tajacu*), among others. Typical game species today include mourning dove (*Zenaida macroura*) and northern bobwhite (*Colinus virginianus*) on uplands and eastern fox squirrel (*Sciurus niger*) along stream bottomlands. Other fauna typically associated with Texas-at-large (Blair 1950) and found within the region of interest include white-tailed deer (*Odocoileus virginianus*), jackrabbit (*Lepus* sp), raccoon (*Procyon lotor*), armadillo (*Dasypus novemcinctus*), northern river otter (*Lontra canadensis*), and coyote (*Canis latrans*). Historically, bison (*Bison bison*) roamed freely and spread seeds while they fed off the grasses and created fertile soils through their feces at the same time that fires kept woody species controlled.

5.8 Recent Disturbances

This area has been extensively disturbed by urban development. Prior to the development of the Sand Hill Energy Center the area was plowed and crops were grown across this entire area (Werchan et al. 1974; Sheet 71). The Austin Energy began construction at the Sand Hill Energy Center in 2001. Subsequently, this plant site officially opened in November 2004 with most of the plant site now covered in concrete and gravel. A flood control earthen levee surrounds the property. No native ecosystems remain within the Sand Hill Energy Center.

Section 6
Cultural Background

6.1 Introduction

Archeologists in Texas have assigned cultural regions to portions of Texas that generally correspond to various physiographic characteristics of the areas (Figure 6-1). The indigenous human inhabitants of central Texas practiced a generally nomadic hunting and gathering lifestyle throughout all of prehistory, and, in contrast to much of the rest of North America, mobility and settlement patterns do not appear to have changed markedly through time in this region. Below the Central Texas chronological scheme is presented and much of this summary is extracted from Collins (1995, 2004). The archeological manifestations of central Texas are divided into four broad time periods: the Paleoindian, Archaic, Late Prehistoric, and Historic periods. A brief synthesis of the key characteristics of these four periods is presented below.

6.2 Paleoindian Period (11,500 to 8800 B.P.)

The initial human occupations in North America can now be confidently extended back before 12,000 B.P. (Kelly and Todd 1988). Evidence from Meadowcroft Rockshelter in Pennsylvania suggests that humans were present in Eastern North America as early as 14,000 to 16,000 years ago (Adovasio et al. 1990), while more recent discoveries at Monte Verde in Chile provide unequivocal evidence for human occupation in South America by at least 12,500 years ago (Meltzer et al. 1997). Most archeologists presently discount claims of much earlier human occupation during the Pleistocene glacial period (cf. Butzer 1988).

The earliest generalized evidence for human activities in central Texas is represented by the Paleoindian period (11,500 to 8800 B.P. [Collins 1995]). This period coincided with improved climatic conditions following the close of the Pleistocene epoch that witnessed the extinction of herds of mammoth, horse, camel, and bison. Cultures representing various subperiods within this period are characterized by series of distinctive, relatively large, often fluted (Clovis and Folsom), lanceolate projectile points. These and other lanceolate projectiles including named types such as Plainview, San Patrice, Dalton, Golondrina, and other general categories including contracting stem forms like Angostura and Midland, parallel stem points like St. Mary's Hall and Scottsbluff, stemmed forms like Wilson and side-notched Big Sandy are frequently associated with spurred end scrapers, gravers, and a suit of informal tools.

For the latest discussion and updates of the named types and clustering of types the reader is referred to Bousman et al. (2004). Bousman et al. (2004) also provide a complete examination of the absolute chronology for the Paleoindian period and the stratigraphic association of some of the important Texas sites. Currently some 32 sites have been radiocarbon dated and some 243 dates are now available to facilitate the assignment of the various Paleoindian populations.

Figure 6-1 Cultural Regions of Texas

Archeological Regions in the State of Texas

1 - Red River	5 - Southeast Texas	9 - South Texas	13 - Panhandle
2 - Northeast Texas	6 - Coastal Texas	10 - West-central Texas	14 - Lower Pecos
3 - Deep East Texas	7 - North-central Texas	11 - Caprock Canyonlands	15 - Trans-Pecos
4 - Savanna & Prairie	8 - Central Texas	12 - Southern High Plains	16 - El Paso/Hueco Bolson

*map from Perttula, Timothy K., *The Prehistory of Texas,* Texas A&M University Press, 2004, page 7.

In central Texas, the Paleoindian period is divided into two subperiods based on recognizable differences in projectile point styles. The Early Paleoindian period is recognized by fluted projectile points (i.e., Clovis and Folsom). In Texas most Clovis points, over 400 specimens, occur in surface scatters with archeological materials from later periods. Clovis points have been collected from across the state, however actual Clovis sites are rare. Clovis distribution is not coincident with the distribution of later Paleoindian remains. The Late Paleoindian period is characterized by unfluted lanceolate points (i.e., Wilson, Golondrina-Barber, and St. Mary's Hall). Components with these types of points date between 10,000 and 8800 B.P. However, the Plainview points along with Dalton and San Patrice-like points require further documentation to specifically place them in time in Texas.

Paleoindian groups are often inferred to have been organized into egalitarian bands consisting of a few dozen individuals that practiced a fully nomadic subsistence and settlement pattern. Due to poor preservation of floral materials, subsistence patterns in central Texas are known primarily through the study of faunal remains. Subsistence focused on the exploitation of plants, large and small animals, fish, and shellfish, even during the Paleoindian period (Collins et al. 1989). Little evidence exists in this region for hunting of extinct mega fauna (the exception being at Wilson-Leonard in Bell County for the early subperiod), as has been documented elsewhere in North America. Rather, a broad-based subsistence pattern appears to have been practiced throughout most periods. The Folsom population appears to have focused on bison hunting in other areas but also included broad range of other taxa.

6.3 Archaic Period (8800 to 1200 B.P.)

The onset of the Hypsithermal drying trend marks the beginning of the Archaic period (8000 to 1200 B.P.). This climatic trend marked the beginning of a significant reorientation of lifestyle throughout most of North America, but this change was far less pronounced in central Texas. Elsewhere, the changing climatic conditions and corresponding decrease in the big game populations forced people to rely more heavily upon a diversified resource base composed of smaller game and wild plants. In central Texas, however, this hunting and gathering pattern is characteristic of most of prehistory. This period saw the intensification of hunting and gathering of local resources. With this came a more diversified tool kit, the development of an expanded ground stone assemblage, and an extensive use of heated rocks and are hallmarks of this period (Collins 1995). The use of the atlatl (i.e., spear thrower) and spear were the primary hunting instruments.

Traditionally, the long Archaic period is subdivided into Early, Middle, and Late subperiods based on changes in projectile points and other distinctive changes. In central Texas, the Early Archaic subperiod extends from 8800 to 6000 B.P., the Middle Archaic subperiod extends from

6000 to 4000 B.P., and the Late Archaic subperiod covers the 4000 to 1200 B.P. (Collins 1995). Changes in projectile point morphology are often used as markers differentiating these three subperiods, though other changes in material culture occurred as well (Quigg et al. 2011). Perhaps most markedly, burned rock middens appear during the Middle Archaic subperiod, continuing into and through the Late Archaic subperiod. Large cemeteries also appear during the Late Archaic subperiod and mark some type of social changes. In addition, the increasing density of prehistoric sites through time is often considered to constitute evidence of population growth, though differential preservation probably at least partially accounts for the lower numbers of older sites.

6.4 Late Prehistoric Period (1200 to 400 B.P.)

The onset of the Late Prehistoric period is defined by the appearance of the bow and arrow (Collins 1995). In central Texas, pottery also appears during the Late Prehistoric period (later than the bow and arrow and appearing earlier in east Texas by about 2500 B.P.). Agriculture came even later and only to some parts of Texas, mostly in the northeastern and northwestern parts. In Texas, unifacial arrow points appear to be associated with a small prismatic blade technology (Ricklis 1994). In central Texas, two subdivisions are recognized, the Austin and Toyah phases. Austin phase sites occur earliest to the north, which has led some researchers (e.g., Prewitt 1985) to suggest that the Austin phase populations of central Texas were migrants from the north and lacked the ceramic industry of the later Toyah phase. The Austin phase continued with an Archaic subsistence pattern but the bow and arrow were definitely in use at this time. The Toyah phase replaced the Austin phase. A cluster of traits including small-stemmed arrow points, pottery, large thin bifaces, and prismatic blades characterizes the Toyah phase (Arnn 2012; Carpenter et al. 2012; Johnson 1994; Kenmotsu and Boyd 2012). These latter groups subsisted on diverse resources including bison, deer, antelope, mussels and other wild game (Ricklis 1994; Dering 2008).

One of the primary indicators of Late Prehistoric period peoples is the introduction and use of pottery. Bone (Leon Plain) and shell tempered specimens are prevalent in occupations throughout central Texas in this period (Johnson 1994; Quigg and Peck 1995; Ricklis 1994). The increased use of pottery indicates a more sedentary existence that involves less frequent travel and focus on more intensive subsistence activities (Quigg 1997).

6.5 Protohistoric Period (500 to 200 B.P.) and Historic Period (200 B.P. to 50 B.P.)

Excavated archeological data is also scarce for these two periods, beginning with the arrival of the first Europeans exploring the broad unknown territories. This generally reflects a period from about 500 B.P. to the present. Identified cultural resource sites in the central Texas region have not been assigned to any specific native groups. Cultural material left behind by Native

inhabitance may not be characteristic enough to actually assign a cultural assemblage to historically named groups. Again, the lack of major excavations has limited the data necessary to address which historic groups were using this region at the time of European settlement.

Section 7
Previous Archeological Investigations

At least five previous archeological investigations have been conducted in this immediate area. In 1979, personnel from the Texas Water Development Board conducted a reconnaissance survey of the area for water related installations in which 75 prehistoric and 28 historic sites were found and recorded (McWilliams et al. 2000). Six sites that include 41TV442, 41TV458, 41TV459, 41TV460, 41TV461, and 41TV465 are adjacent the project area whereas the western end of prehistoric site 41TV462 is within the Sand Hill Energy Center.

The western third of 41TV462 sits in the northwestern part of the Sand Hill Energy Center. Artifacts observed during their survey included lithic debitage, burned rock, a single distal dart point fragment, and thin scatter of ca. A.D. 1880 glass and metal. The exposed cultural material was eroding out of the terrace edge over a distance of one mile (1.75 km) by nearly 55 yards (50 m) wide.

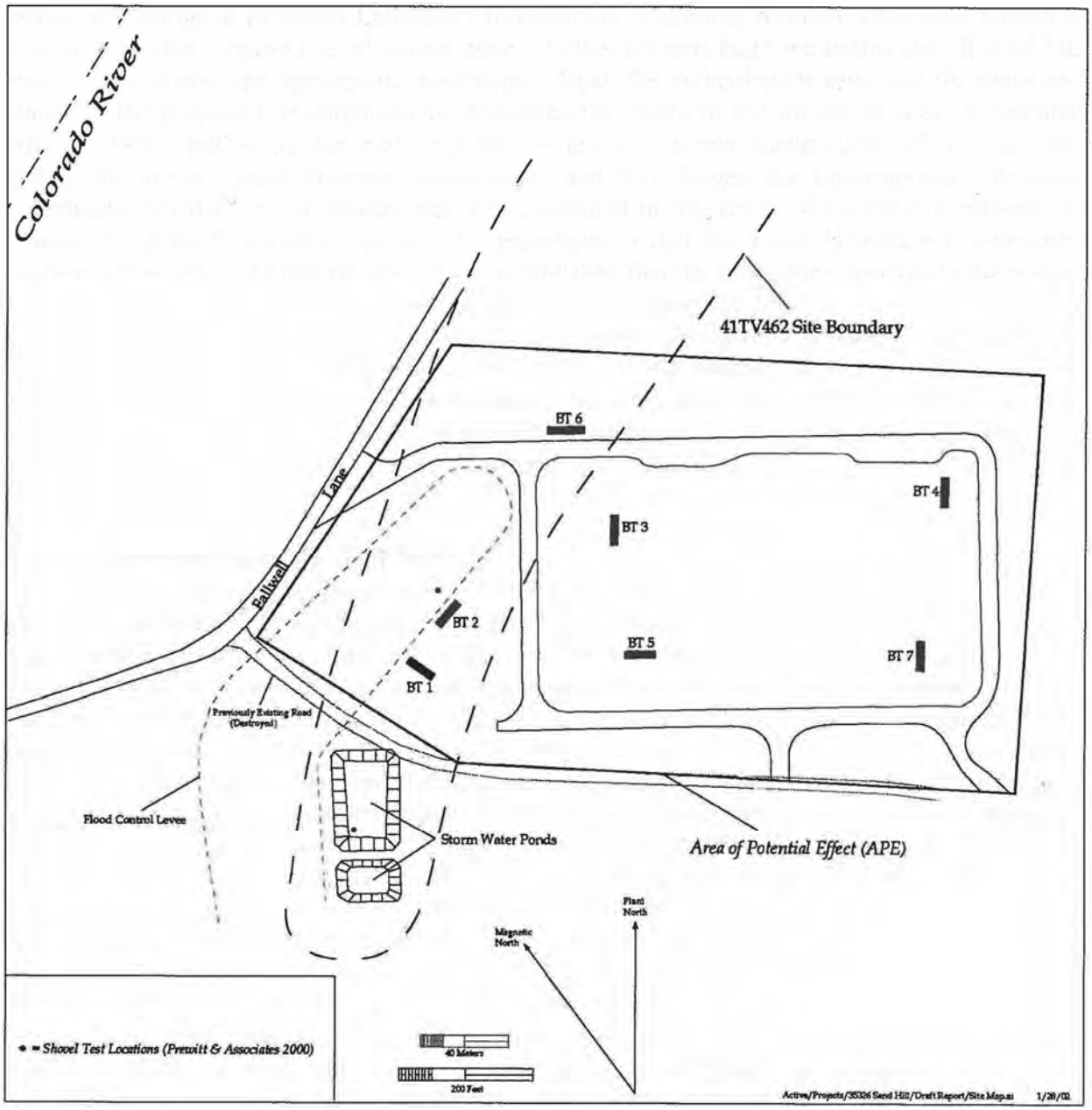
Additionally, the Texas Archeological Survey from the University of Texas conducted testing of 41TV456 and 41TV462 in 1981 (Brown 1981). Eight backhoe trenches and one test unit were excavated in the western part of 41TV462. The hand-excavated and screened unit yielded a total of 16 pieces of lithic debitage. Six pieces were recovered from the top 4 inches (10 cm) and the rest were recovered from depths of 12 to 32 inches (30 to 80 cm) below the surface (Brown 1981). Only one of the eight backhoe trenches yielded any cultural material, a single flake at 25 inches (65 cm) below surface.

A third investigation near the project area was conducted by archeologists from the University of Texas at Austin in which extensive backhoe trenching and formal test excavations were done on prehistoric site 41TV461 in 1982 (Thurmond 1982). Prewitt and Associates, Inc. (Prewitt) conducted investigations focused on the construction of a 7,382 ft. long by 426 ft. wide earthen levee and ditch around the current plant site at the South Austin Regional Waste Water Treatment Plant in the spring of 2000. As a part of their investigations of the 42 acre area a pedestrian survey as well as 15 backhoe trenches and 24 shovel tests were conducted within the facility's 42-acre project area (McWilliams et al. 2000). Their backhoe trenching did not yield any new prehistoric sites or deposits even though their trenching was near sites 41TV442, 41TV458, 41TV459, and 41TV461. Two shovel tests were conducted on the western extent of prehistoric site 41TV462 in which no cultural materials were observed. The Prewitt investigations also targeted a small historic site, 41TV460, located about 500 to 800 ft. (152 to 244 m) south of the current project zone. Site 41TV460 was originally a historic house that dated to ca. A.D. 1870s to 1930s that was impacted

by the ditch. The site was tested through 10 shovel tests which yielded 112 historic artifacts that include ceramics glass, metal, and miscellaneous classes.

In January of 2002 staff archeologists and geoarcheologist from TRC Environmental Corporation (TRC) under contract with the Austin Energy conducted further archeological surface and subsurface investigations of approximately 7 acres (2.8 ha) at the proposed expansion of the SH unit 8 (Figures 7-1 and 7-2) (direct area of impact). The purpose was to identify and explore the subsurface deposits for cultural materials as well as mitigate any cultural features identified during subsurface prospecting that would be impacted by the proposed construction of the expansion of the power facility at the Sand Hill Energy Center (Pritchard et al. 2002). Following an archeological site file search, review of background information, and a meeting with the Texas Historical Commission (THC) personnel, previously identified site 41TV462 was targeted in the field through the exaction of seven backhoe trenches across the proposed 7 acres (2.8 ha; see Figure 7-1). The trenches varied from 19.5 to 26 ft. (6 to 8 m) long and from 88 to 158 inches (225 to 400 cm) deep. Geoarcheologist, Grant Smith documented the deposits exposed in the trenches, while the archeologist inspected the trench walls for cultural artifacts and features (Figure 7-3). No prehistoric cultural debris of any kind was discovered in the walls of the trenches (Pritchard et al. 2002).

Figure 7-1 Potential Effect Investigated

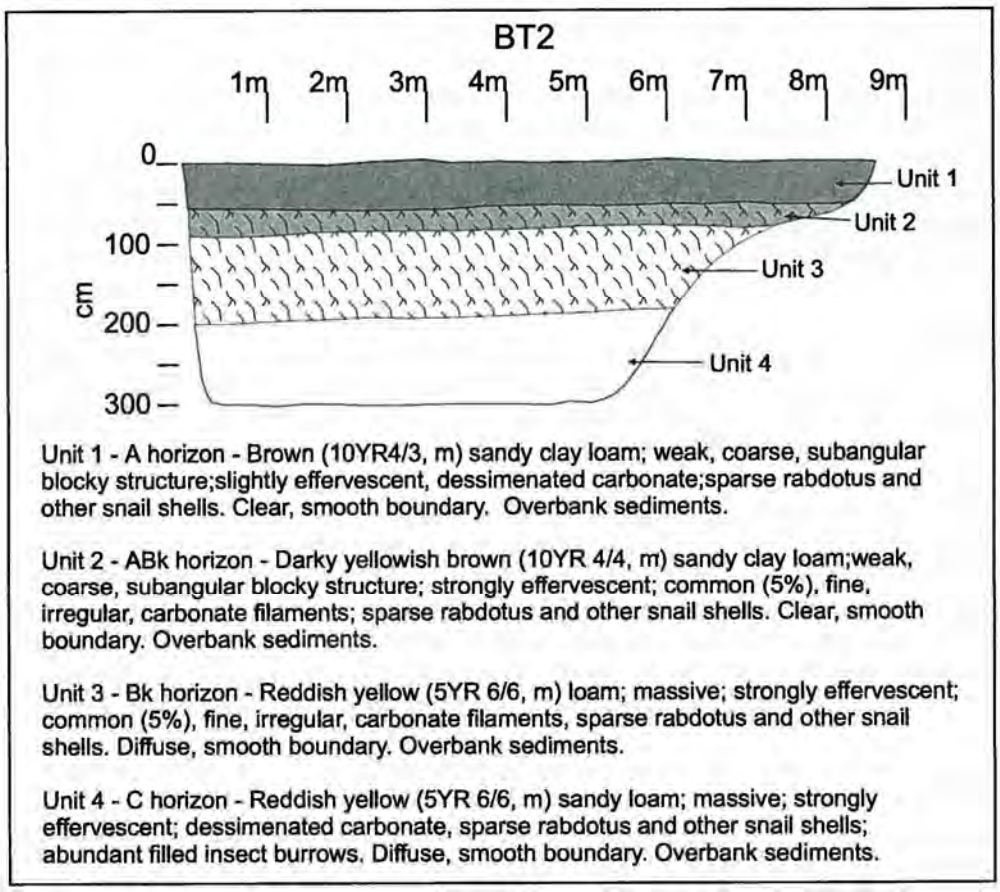


Sand Hill Energy Center showing area of potential effect investigated with backhoe trenches (BT) by TRC Environmental Corporation in 2002 and western boundary of archeological site 41TV462 (from Pritchard et al. 2002).

Figure 7-2 Air Photograph – Cultural Resources Investigation

Air Photograph of Sand Hill Energy Center with TRC 2002 cultural resources investigation area overlaid, showing backhoe trenches (BT) and western boundary of archeological site 41TV462 (in black dashed line from Pritchard et al. 2002).

Figure 7-3 Representative Stratigraphy



Representative stratigraphy from archeological site 41TV462 at Backhoe Trench 2 (from Pritchard et al. 2002).

Section 8
Site File Search

A site file search was performed by TRC archeologists on June 19, 2013 using the Texas Archeological Sites Atlas (Atlas) maintained by the Texas Historical Commission (THC). One cultural resource site 41TV462 (a prehistoric archeological site) was previously recorded in the western part of the Sand Hill Energy Center (see Figure 7-1).

Table 8-1
Listing of Cultural Resources in the 0.76 Mile Radius of the Sand Hill Energy Facility

Quad	County	THC Site Number	Cultural Affiliation	NHRP Eligible	Potential for Impact from Project	Site Description
Webberville	Travis	41TV462	Prehistoric/ historic	Potentially*	No impact as it is located outside construction zone	Artifact scatter; deep (2-4m) subsurface prehistoric cultural deposits; historic surface scatter
Webberville	Travis	41TV422	Prehistoric	Potentially*	No impact as it is located outside construction zone	Artifact scatter; subsurface cultural deposits
Webberville	Travis	41TV450	Prehistoric	Potentially**	No impact as it is located outside construction zone	Artifact scatter; possible subsurface cultural deposits; impacted by dirt road and plowing
Webberville	Travis	41TV451	Prehistoric	No***	No impact as it is located outside construction zone	Quarry; surface scatter
Webberville	Travis	41TV454	Prehistoric	No***	No impact as it is located outside construction zone	Low density artifact scatter; limited subsurface; plowed
Webberville	Travis	41TV455	Prehistoric	No***	No impact as it is located outside construction zone	Surface and subsurface artifacts; “possible open campsite and procurement area”; plowed
Webberville	Travis	41TV456	Prehistoric/historic	No***	No impact as it is located outside construction zone	Prehistoric artifact scatter; historic structure remains heavily disturbed by subsequent impacts
Webberville	Travis	41TV457	Prehistoric/ historic	No***	No impact as it is located outside construction zone	Prehistoric artifact scatter; historic structure remains; heavily disturbed by subsequent impacts
Webberville	Travis	41TV458	Prehistoric	Potentially**	No impact as it is located outside construction zone	Artifact scatter; plowed; “potentially buried remains
Webberville	Travis	41TV459	Prehistoric	Potentially*	No impact as it is located outside	Artifact scatter; subsurface deposits

Table 8-1
Listing of Cultural Resources in the 0.76 Mile Radius of the Sand Hill Energy Facility

Quad	County	THC Site Number	Cultural Affiliation	NHRP Eligible	Potential for Impact from Project	Site Description
					construction zone	
Webberville	Travis	41TV460	Historic	No***	No impact as it is located outside construction zone	Historic structure remains; house appears on 1896 Austin quad; fire in 1978 significantly impacted site
Webberville	Travis	41TV461	Prehistoric	Potentially**	No impact as it is located outside construction zone	Artifact scatter; plowed; possible subsurface deposits
Webberville	Travis	41TV462	Prehistoric	No***	No impact as the site is not eligible for listing per THC determination	Prehistoric artifact scatter.
Webberville	Travis	41TV465	Historic	No***	No impact as it is located outside construction zone	Historic structural remains; artifact scatter with remains of cellar and brick piers
Webberville	Travis	41TV1991	Historic	No***	No impact as it is located outside construction zone	Historic dump and possible structural remains; heavily impacted by bulldozing

**Site eligibility has not been determined by the THC*
*** Lack of site information precludes site determination*
**** Site has been determined to be not eligible by the THC*

Section 9
Interdependent and Interrelated Actions

There will be no interdependent or interrelated actions associated with this Project. No new linear features; roads, pipelines, waterlines, electric transmission lines that will be built that would not have been built but for this Project.

Section 10
Recommendations and Conclusion

Recommendations

Within the existing Austin Energy's Sand Hill Energy Center, prehistoric site 41TV462, previously revealed surveys documented an absence of intact archeological deposits, well-defined intact cultural features, poor preservation of animal bones and other organic remains, limited diversity of artifact classes, and vertically dispersed artifact of previous encountered remains within multiple soil zones (Prichard et al. 2002). These facts support the assertion that archeological deposits in this setting cannot be considered significant cultural remains. Therefore, TRC recommends that the portion of site 41TV462 previously investigated within the Sand Hill Energy Center is not eligible for listing on the National Register of Historic Places or designated as a State Archeological Landmark. This recommendation has been verified by the THC and their clearance that the project may proceed (Appendix B). In addition, no further work of an archeological nature is warranted within the existing Sand Hill Energy Center.

There will be no indirect or off site impacts, to cultural resources. There are no structures, battlefields, historic sites, or other areas of historic significance on or eligible to be on the National Register of Historic Places within the APE and therefore there will be no view shed impacts to such places.

Conclusion

Based on field investigations and the determination of the THC no further cultural investigations are warranted.

Section 11
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Appendix A
Resume of Author

J. Michael Quigg, M.A.

EDUCATION

M.A. Archaeology, The University of Calgary: 1973.
B.A. Anthropology, University of Northern Colorado, 1971.

PROFESSIONAL REGISTRATION AND CERTIFICATIONS

- Permitted to perform cultural resource investigations by the Bureau of Land Management (BLM) in Texas, Oklahoma, Wyoming, Montana, and New Mexico.
- Member of Council of Texas Archeologists (CTA).
- Texas Department of Transportation pre-certification (No. 4265) for service 2.10.1, 2.11.1, 2.8.1 (archeological survey, historical and archival research, and mitigation).

EXPERIENCE

Mr. Quigg has 36 years of archeological experience involved in all aspects of cultural resource management (CRM) including private consulting, managing a cultural resource firm, directing CRM program, and government regulation. Mr. Quigg has managed and conducted over 60 individual cultural resource projects for Government agencies, oil and gas firms, mining, highways, transmission lines, water pipelines, and reservoir construction projects in Alberta, Montana, Colorado, Texas, and New Mexico

REPRESENTATIVE PROJECTS

- **Data Recovery at Three Prehistoric Sites at the Landis Property, Texas Panhandle, 2007 - 2010, for the Bureau of Land Management**. Mr. Quigg served as Project Manager, Principal Investigator, Field Director for this intensive (451 m^2) testing, excavation, analysis and reporting. The three open sites were of different ages, with different stratigraphy, and provided diverse cultural assemblages for hunter-gatherers. Multiple outreach programs were conducted on-site for local individuals and groups as well as development of the Texas Beyond History webpage for the site. The technical report was two volumes (ca. 1200 pages) that integrated interdisciplinary approaches that included 16 technical analyses. Mr. Quigg is an author or co-author on 3 peer-reviewed journal articles that have been published from the data gathered from the project.

- **Data Recovery at 41YN452 in 2007 for Texas Department of Transportation, in North Central Texas.** Mr. Quigg served as Principle Investigator, Project Manager, and part time Field Director, on this 50.3-m^3-multiple block excavation in 60 to 110 cm deep deposits that targeted a Late Archaic component in the right-of-way of FM 3109 for TxDOT. A two volume technical report (740 pages) integrated multiple technical analyses that provided great insight to human behaviors.

- **Data Recovery at 41RB112, 2006, for Texas Department of Transportation, Texas Panhandle.** Mr. Quigg served as Principle Investigator, Project Manager, and part time Field Director, on this 103-m^3-multiple block excavation of .50+ cm deep deposit with two well-defined Plains Village period components (with pithouses) in the right-of-way of SH 70 for TxDOT. He directed this multidisciplinary data analyses and reporting phase. A two volume technical report (1200 pages) has been submitted to TxDOT.

- **Data Recovery at 41TV2161, 2006, for Texas Department of Transportation, Central Texas.** Mr. Quigg served as Principle Investigator, Project Manager, and part time Field Director, on this 40-m^3-block excavation of 2.0+ m deep cultural deposits in the right-of-way of SH 130 for TxDOT. The project is ongoing with data analysis and reporting to continue.

- **Data Recovery at the Varga Site (41ED28), 2002-2003, for Texas Department of Transportation, Southwest Texas.** Mr. Quigg served as Principle Investigator, Project Manager, and report author on this 104-m^3-block excavation of a 1.2 m deep four-component campsite in the right-of-way development. He oversaw a field crew of nine archeologists in the hand-excavations of two major blocks, and directed this multidisciplinary data analyses and reporting phase. He managed the contract and budget, and coordinated with the client and other technical scientists. Included the text development for an outreach exhibit for Texas Beyond History web page, and brochure on site investigations.

- **Data Recovery at the Boiler Site (41WB557), 2000, for Texas Department of** Transportation**, South Texas.** Mr. Quigg served as Principle Investigator, Project Manager, Field Director, and primary report author on this 142-m^3-block excavation of 1.5 m deep cultural deposits in the right-of-way for the planned Texas Department of Transportation improvement. He directed a field crew of 12 archeologists in the hand-excavations of two major blocks, directed the multidisciplinary data analyses, wrote a 550 page technical report, managed the contract and budget, and coordinated with the client.

- **Data Recovery at 41ZP364, 2000, for the Bureau of Land Management and International Boundary and Water Commission in South Texas.** Mr. Quigg served as the Principal Investigator, Project Manager, and Field Director on this geoarcheological and archaeological investigation. The investigations included 21 backhoe trenches that guided the hand excavations of 48 m^2 and two small block areas of 20 and 16 m^2. He directed the subsequent laboratory work, analysis, and wrote most of the 350 page technical report that included multidisciplinary investigations.

- **Mitigation Excavation at Two Prehistoric Sites, Texas Department of Transportation, 1990, Central Texas.** Mr. Quigg served as the Field Supervisor at Barton (41HY202) and Mustang Branch Sites (41HY209) under a Section 106 investigation clearing the right-of-way for new construction. He directly supervised 20 archeologists for six months in the excavation of two stratified camps, a lithic workshop, and a burned rock midden. The intensive excavations encompassed 330 m^2 and involved a vast array of cultural materials. He oversaw and guided the faunal analysis.

- **West Amarillo Creek Remedial Testing at 41PT185, 41PT186, and 41PT245 for the BLM in Northwestern Texas in 2007.** As Project Manager and Principal Investigator Mr. Quigg directed the basin wide geomorphic investigations (48 trenches), followed by the hand excavation of 48.0 m^3 at selected locations at these prehistoric sites. A status report, draft and final interim reports were authored by Mr. Quigg with subsequent analysis and reporting.

- **Gages Creek Eligibility Assessment of 41YN450 and 41YN452, Texas Department of** Transportation**, 2006, North-central Texas.** As Project Manager and Principle Investigator Mr. Quigg directed the National Register field assessment of these two prehistoric sites buried in the TxDOT right-of-way in Young County. Field assessment included hand excavations (6.5 m^3) and mechanical trenching (n=7) in terrace deposits that documented buried cultural remains. He directed the preliminary data analysis and coauthored the interim report submitted to TxDOT. Site results and recommendations were presented to the client and government review agencies, who concurred with the recommendations.

- **Survey and Eligibility Assessment of Two Prehistoric Sites at Boot Ranch, 2005, Central Texas.** Mr. Quigg served as Principle Investigator and project manager. He oversaw the survey of 377 ac including 67 shovel tests, documentation of nine sites, the assessment of two sites including 15 units, 53 m in eight trenches, mapping of sites, and profiling. He coauthored the report that presented the data findings, recommendations. The report and recommendations were accepted by the Army Corps of Engineers.

- **Eligibility Assessment of 41RB112, Texas Department of Transportation, 2005, Texas Panhandle.** Mr. Quigg served as Principle Investigator and field director. He directed a 10 person crew in the hand excavations and profiling of this two part site. He authored the interim report that presented the data findings, recommendations, and a data recovery plan that included research questions and field approach to follow. The report and recommendations were accepted by the Texas Historical Commission.

- **Eligibility Assessment of 41BL278, Texas Department of Transportation, 2004, Central Texas.** Mr. Quigg served as Principle Investigator, project manager, and field director. He directed the hand-excavations on 10 units (4.1-m^3), backhoe trenching, site mapping, exposure profiling, and oversaw the geoarcheological investigations. He coauthored the

interim report that presented the data findings, recommendations. The report and recommendations were accepted by the Texas Historical Commission.

- **Eligibility Assessment of Three Prehistoric Sites along FM 580W Over Lynch Creek, Texas Department of Transportation, 2004, Central Texas.** Mr. Quigg served as Principle Investigator and field director. He directed the hand-excavations of 21 units (17.4-m^3), trenching of deposits (n=5), mapping of sites, profiling, and oversaw the geoarcheological assessment. He coauthored the interim report that presented the data findings, recommendations, and a data recovery plan that included research questions and field approach to follow. The report and recommendations were accepted by the Texas Historical Commission.

- **Eligibility Assessment of 41EP4439, Texas Department of Transportation, 2002, West Texas.** Mr. Quigg served as Principle Investigator and oversaw the project that included 20 backhoe trenches, 20 manual units, and geoarcheological investigations. The final report that presented the data findings, recommendations. The report and recommendations were accepted by the Texas Historical Commission.

- **Noodle Creek Eligibility Assessment, Texas Department of Transportation, 2002, North Texas.** Mr. Quigg was Project Manager and directed the National Register field assessment of site 41JS102 in the highway right-of-way next to the Noodle Creek Bridge crossing in Jones County. Field assessment included hand excavations and mechanical trenching in terrace deposits that documented buried cultural remains. Subsequently, he directed the data analysis and report writing. Site results and recommendations were presented to the client and government review agencies, who concurred with the recommendations.

- **USA #3 Assessment, TransTexas Oil And Gas Corp, 1997, South Texas**. Mr. Quigg was Project Manager and Field Director of the assessment of two prehistoric sites (41ZP39 and 41ZP176) in a well pad and pipeline ROW development zone at Falcon Reservoir. The site file search was followed by shovel testing and unit excavations that documented the buried nature of two sites. Site results and recommendations were presented to the client and government review agencies. The investigations resulted from the Archeological Resource Protection Act.

- **Pershing Field Assessment, Fort Sam Houston, 1997, Southern Texas.** Mr. Quigg served as Project Manager and Filed Director of the archeological and geomorphologic assessment of 50 acres of undeveloped land on Fort Sam Houston. The natural terrace deposits were assessed through the excavation of 19 backhoe trenches to evaluate the potential for intact buried archeological remains. One prehistoric surface site was evaluated with shovel tests. The recovered data was assessed and recommendations were presented in a report coauthored by Mr. Quigg. The investigations were part of an Environmental Assessment document.

Appendix B
TRC Cultural Report
on the Sand Hill site with THC Concurrence

TRC

ANTIQUITIES CODE OF TEXAS REVIEW
NO SIGNIFICANT SITES
PROJECT MAY PROCEED
by _____
for Mark Wolfe
Executive Director, THC
Date 1/24/2002
Track# _____

Sand Hill Energy Center: An Archeological and Geoarcheological Investigation at 41TV462 and the Proposed Location of the Expansion Facility Travis County, Texas

Prepared for:

The City of Austin
Department of Public Works
P. O. Box 1088
Austin, Texas

Prepared by:

Shane Pritchard, Grant D. Smith, and
J. Michael Quigg

TRC Environmental, Inc.
505 East Huntland Drive, Suite 250
Austin, Texas 78752

J. Michael Quigg
Principal Investigator

TRC Project # 35326

January 2002

PERMIT #2787

TRC

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January 2002

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MANAGAMENT SUMMARY

On January 21st and 22nd TRC archeologists, under contract with the City of Austin, conducted an archeological surface and subsurface investigation of approximately 7 acres (2.8 ha) at the proposed expansion project of the Sand Hill Power Plant. The archeological work was conducted under Texas Antiquities Permit No. 2787. The purpose of this archeological investigation was to identify and explore the subsurface deposits for cultural materials as well as mitigate any cultural features identified during subsurface prospecting that would be impacted by the proposed construction of the expansion of the power facility at the Sand Hill Energy Center.

The investigations involved a file search at the Texas Archeological Research Laboratory at the University of Texas at Austin, a surface inspection of the project area, and the mechanical excavation of seven backhoe trenches. As a result of the file search, site 41TV462 was identified as being partially within the northwestern part of the proposed development. To locate any buried cultural deposits affiliated with that part of site 41TV462, three 21 to 26.5 ft (7 to 8 m) long backhoe trenches (BTs 1, 2, and 6) were excavated to an approximate depth of 11.5 ft (3.5 m) across the northwestern part of the development zone. No cultural materials were observed on the surface or in the trenches. Because of the lack of cultural materials observed during these field investigations, TRC recommends that the part of archeological site 41TV462 within the development zone is not eligible for inclusion to the National Register of Historic Places. Four other trenches were excavated across the remaining part of the proposed development. Again, no cultural materials were observed in any of the trenches. Since this proposed development area, including part of previously recorded site 41TV462, appears not to be eligible for the National Register, and no cultural materials were discovered in any part of the development, TRC recommends that the City of Austin's development of the new generating facilities be allowed to proceed without additional archeological investigations.

1.0 INTRODUCTION

On January 21st and 22nd TRC archeologists, under contract with the City of Austin, conducted an archeological surface and subsurface investigation of approximately 7 acres (2.8 ha) at the proposed expansion project of the Sand Hill Power Plant (Figure 1). The investigations were conducted under Texas Antiquities Committee Permit No. 2787 to Principal Investigator, J. Michael Quigg.

The City of Austin plans to construct an administration facility and potentially four combined cycle gas-fired electric generators at the existing Sand Hill Energy Center. Each combined cycle unit consists of two gas turbines, one steam turbine, and two heat recovery steam generators. The planned operation is for the simple cycle units to be peaking units and the combined cycle units to be base load. The fuel source is natural gas. Water from the Colorado River combined with reuse water from the South Austin Regional Wastewater Treatment Plant will be used as makeup water for the cooling towers.

The proposed water intake and discharge line linking the Colorado River to the northwestern corner of the proposed facility will be investigated under a separate archeological permit after the precise location has been determined. The administration facility and the area for the generators was scheduled for construction in the immediate future, and that area was the target of this archeological investigation. The proposed depth of disturbance varies considerably with some of the pilings to extend to a depth of 28 ft below surface (8.5 m), although most disturbances are to be restricted to the top 18 ft (5.5 m).

Currently a flood control earthen berm/levee and drainage ditch exists along the northwestern side of the proposed development in the same vicinity as a previously recorded archeological site, 41TV462 (Figure 2). The berm/levee is about 3 ft tall (one meter) and about 200 ft wide (60 m) in the project area and is currently fenced. The berm/levee in circles around three quarters of the existing Wastewater Treatment and energy facility. Water, electrical, and large gas lines are currently in the ground in this area of the berm/levee and parallel to existing gravel roads. An above ground gas metering station exists on the northeastern side of the entrance road and three small above ground gas heads exist in the southwestern corner of the parcel.

2.0 RESEARCH DESIGN

Cultural resource investigations are required to comply with the Texas Antiquity Code and designed for the identification and protection of significant cultural resources that might be endangered by development.

The purpose of the archeological field investigation was to explore the subsurface deposits through backhoe trenching within the proposed development zone for signs of cultural remains, including those in part of previously known site 41TV462. If buried cultural features were discovered, then it would be necessary to mitigate those detected features through hand excavation and documentation. After the field investigation was complete, the recovered data would be assessed, and specific recommendations would be made to the Texas Historical Commission concerning possible future investigations.

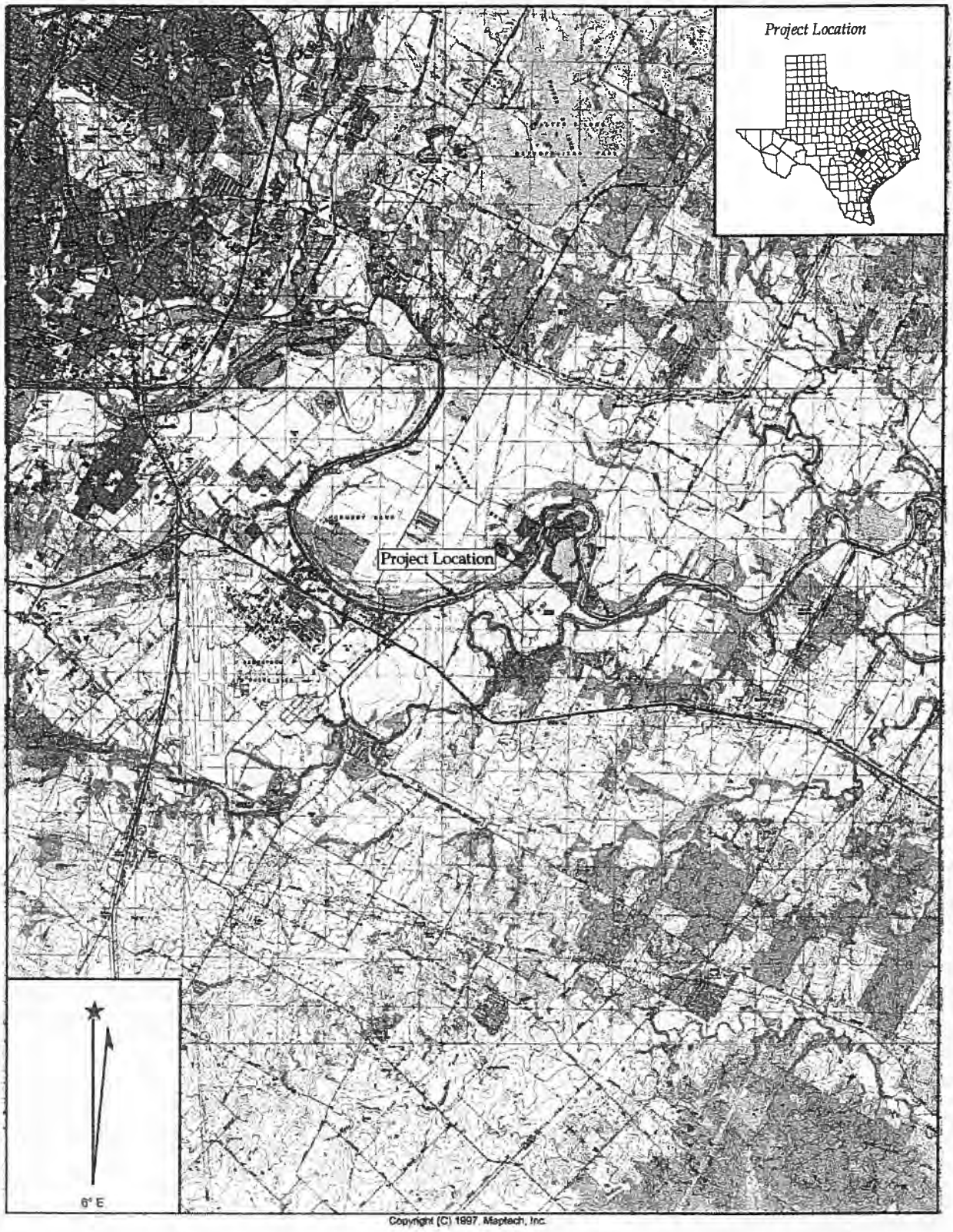


Figure 1. General Project Location in Southwestern Travis County

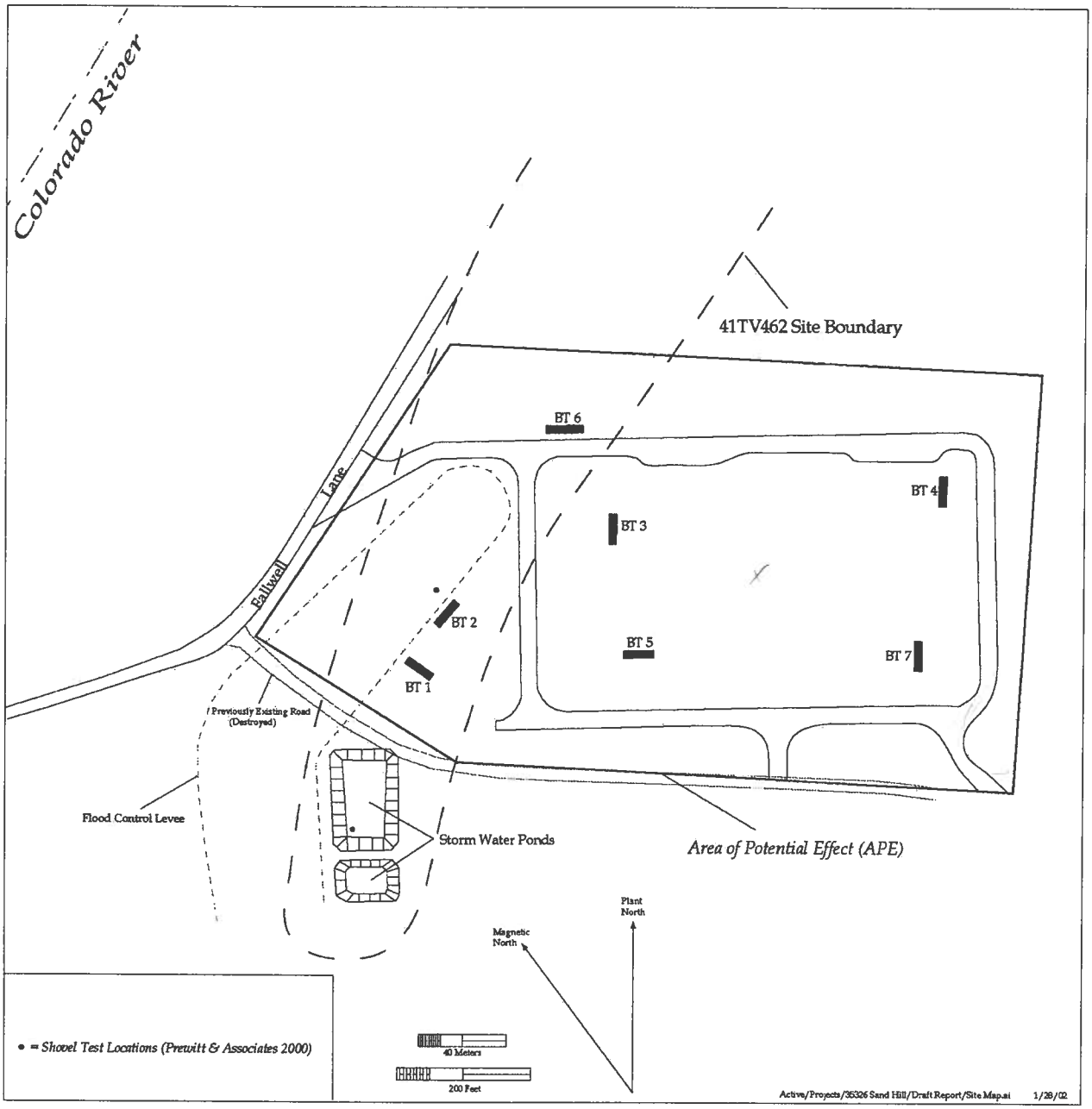


Figure 2. Area of Potential Effect at the Sand Hill Energy Center and Locations of TRC's Backhoe Trenches

3.0 METHODS

The initial step in the investigation was to conduct an archeological file search at the Texas Archeological Research Laboratory to determine if cultural resource sites were known in or adjacent to the proposed development zone. If other projects had been in this area, it would be necessary to review the appropriate documents. Next, the archeologists reviewed the maps and plans for the proposed development to determine the limits of the impact or area of potential effect (APE). Following the gathering and review of various background information, Mr. Quigg, the archeological Principal Investigator, and Eric Stager, the Environmental Program Coordinator for the City of Austin, met with personnel of the Texas Historical Commission on January 16, 2002 to establish the specific requirements that the Texas Historical Commission deemed appropriate. At that meeting it was established that the subsurface deposits in the project and in the area of site 41TV462 would be targeted for exploration through the excavation of six backhoe trenches looking primarily for buried cultural features, specifically that might be associated with previously recorded site 41TV462. Determining the specific placement of backhoe trenches was based on the location of site 41TV462 relative to the proposed construction, backhoe access, as well as applying complete coverage of the APE. The minimum length and depth of the backhoe trenches was established at 15 ft long by at least 6.5 ft deep (5 m long by 2 m deep).

4.0 ENVIRONMENTAL SETTING

The project lies just south of the City of Austin, in the southeastern part of Travis County near the confluence of Onion Creek with the Colorado River. The proposed development is on a high terrace (T4) of the Colorado River just west of the junction of Onion Creek and Colorado River. The elevation of the project area is approximately 430 ft (131 m) above mean sea level. The current APE is predominately a sparse grassland with an unpaved oval road centered across the area. Wooded areas are restricted to the lower terraces of the Colorado River and Onion creek. The near surface has been disturbed during recent construction of the current power generation plant immediately southwest of the proposed development and south of the storm water ponds along with the associated flood control berm and ditch across the northwestern APE, road construction and maintenance activities, installation of electrical and gas lines, run-off ponds just outside and west of the APE, and previous plowing activities prior to any modern developments. Sub-surface disturbances are thought to be limited to narrow water, electric, phone, cable, and gas pipeline not exceeding a depth of three meters.

The proposed Sand Hill Energy Center will be built in Quaternary alluvial terrace deposits with three or more lower terraces of the Colorado River just northwest of the APE (Barnes 1981). These terraces are composed of stratified clays, silts, sands and gravels. Bore logs in the highest terrace indicate at least 22 ft (6.7 m) of clay above a sander layer; the water table is at nearly 28 ft. (8.5 m). The soils are classified as the Bergstrom and Lewisville series (Werchan et al. 1974). Bergstrom soils are Cumulic Haplustolls consisting of a 28 inch (71 cm) thick very dark grayish brown mollic A horizon atop a 30 inch (77 cm) thick reddish brown Bw horizon formed in a light reddish brown silty alluvium. Lewisville soils are Typic Haplustolls that consist of a 16.9 inch (43 cm) thick very dark grayish brown mollic A horizon atop a 6.3 inch (16 cm) thick brown Bw horizon formed in a very pale brown silty alluvium.

5.0 PREVIOUS ARCHEOLOGICAL INVESTIGATIONS

The file search at the Texas Archeological Research Laboratory yielded considerable archeological information concerning the immediate area of the proposed new development. At least four previous archeological investigations had been conducted in this immediate area. In 1979, personnel from the Texas Water Development Board conducted a reconnaissance survey of the area for water related installations in which 75 prehistoric and 28 historic sites were found and recorded (Whitsett and Fox 1979 as cited in McWilliams et al. 2000). Several sites including 41TV442, 41TV458, 41TV459, 41TV460, 41TV461, and 41TV465 are adjacent the project area whereas the western end of prehistoric site 41TV462 is within the development area.

The western third of 41TV462 sits in the northwestern part of the APE. Whitsett and Fox (1979) recorded 41TV462 as a multi-component archaic to historic period resource in excellent condition and of immense size along the upper terrace edge of the Colorado River. Artifacts observed during their survey included lithic debitage, burned rock, a single distal dart point fragment, and thin scatter of ca. 1880 glass and metal. The exposed cultural material was found eroding out of the terrace edge over a distance of one mile (1.75 km) by nearly 55 yards (50 m) wide.

Additionally, the Texas Archeological Survey conducted testing of 41TV456 and 41TV462 in 1981 (Brown 1981). Eight backhoe trenches and one test unit were excavated in the western part of 41TV462. The hand excavated and screened unit yielded a total of 16 pieces of lithic debitage. Six of the pieces were recovered from the top 4 inches (10 cm) of the unit and the rest were recovered from depths of 12 to 32 inches (30 to 80 cm) below the surface (Brown 1981). Only one of the eight backhoe trenches yielded any cultural material, a single flake at 25 inches (65 cm) below surface.

A third investigation near the project area was conducted by archeologists from the University of Texas at Austin in which extensive backhoe trenching and formal test excavations were done on prehistoric site 41TV461 in 1982 (Thurmond 1982). Finally, Prewitt and Associates conducted investigations focused on the construction of a levee and ditch around the current plant site at the South Austin Regional Waste Water Treatment Plant in the spring of 2000. As a part of their investigations, a pedestrian survey as well as 15 backhoe trenches and 24 shovel tests were conducted within the facility's 42-acre project area (McWilliams et al. 2000). Their backhoe trenching did not yield any new prehistoric sites or deposits even though their trenching was near sites 41TV442, 41TV458, 41TV459, and 41TV461. Two shovel tests were conducted on the western extent of prehistoric site 41TV462 in which no cultural materials were observed. The Prewitt investigations also targeted a small historic site, 41TV460, located about 500 to 800 ft (152 to 244 m) south of the current project zone.

6.0 FIELD RESULTS

On January 21 and 22, 2002 personnel from TRC conducted the excavation of seven backhoe trenches across the proposed 7 acre (2.8 ha) development area with the main focus on the area believed to contain prehistoric site 41TV462 (Figure 2). The trenches varied from 19.5 to 26 ft (6 to 8 m) long and from 88 to 158 inches (225 to 400 cm) deep. Grant Smith, TRC geomorphologist, documented the deposits and archeologists Mike Quigg and Shane Pritchard

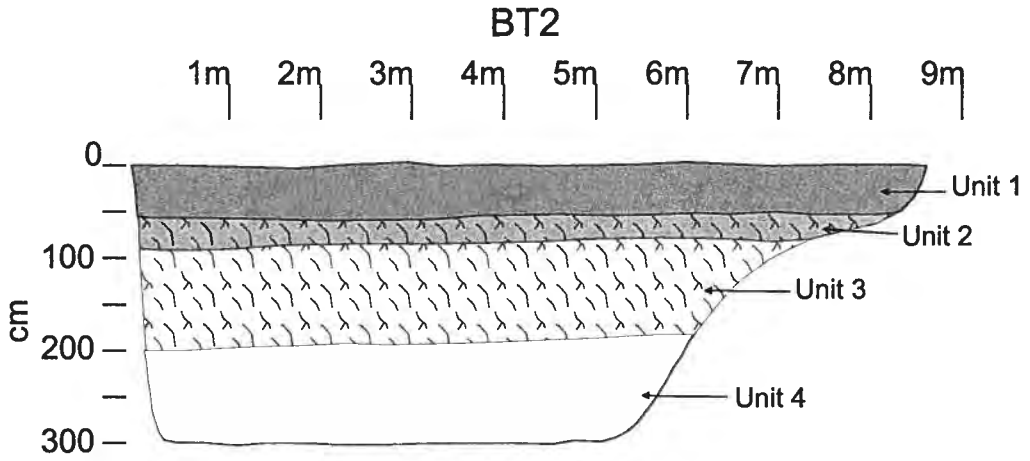
also inspected the trench walls for cultural features and other cultural debris. At least three backhoe trenches (BT 1, 2, and 6) were placed in the northwestern part of the development in the vicinity of the known archeological site 41TV462. No prehistoric cultural debris of any kind was discovered in the cleaned sidewalls of the inspected trenches.

The soil stratigraphy documented in these seven trenches indicates a general consistency across the entire project area. This consistency is not surprising for deposits covering a flat, restricted area of a few hundred square meters. Few inclusions, rocks, tree roots, etc. of any kind were present within the deposits. It appears that there is a trend for the sediments to increase in clay content towards the eastern portion of the project. This area is furthest away from the current stream channel and, thus, probably reflects the fining of flood sediments away from the channel as they spilled onto the terrace. The general trend in the stratigraphy is of a fining upwards sequence, that is, the coarsest sediment units are lowest in the profile and the finest sediments are at the top. Fining upwards sequences are typical for alluvial terrace profiles and result from overbank aggradation. The following section discusses the individual stratigraphic units observed in the backhoe trenches and their implications for the archaeological investigations.

The backhoe trenches revealed four to five pedogenic units (Figure 3). The uppermost unit (Unit 1) was mixed with a gravel-rich fill in a mollic A horizon developed in clay-rich overbank sediments. Unit 1 had a gradational contact with an underlying ABk horizon (Unit 2) that probably started out as an A horizon, but that developed B horizon characteristics as additional overbank sediments accumulated on the terrace. The ABk horizon also had a gradational contact with the underlying unit (Unit 3). The third unit consisted of a reddish Bk horizon with a loam texture and visible pedogenic carbonate filaments. At depth, these carbonate filaments gradually decrease in abundance. Where the carbonates disappear completely, the sediments are considered to be unaltered parent material (C horizon). These unaltered sediments representing a C horizon are considered Unit 4.

In trenches, 3 through 7, the upper 2 to 12 inches (5 to 30 cm) consisted of a gravel-rich fill. This fill appeared to incorporate some of the underlying natural sediments and often had a swirled or variegated color that suggests that the sediments may have been graded or otherwise mixed by prior historic land modification activities. Much of the surface in these areas had the appearance of a slightly improved parking lot, and it could be that these areas were covered with gravel to allow vehicular activities to occur without difficulty after heavy rains. This gravel was not present in the BTs 1 or 2, but these trenches were northwest of a current gravel road that separates them from the other backhoe trench localities. Thus, this northwestern area may not have been used in the same manner as the eastern area that was covered with gravel.

The first natural unit observed in the backhoe trenches (Unit 1) consisted of 10 to 22 inches (25 to 55 cm) of brown (10YR 4/3, moist) sandy clay loam to clay loam. This unit typically exhibited a weak, coarse, subangular blocky structure. The sediments reacted when tested with weak hydrochloric acid, but no visible carbonates were present, indicating that the



Unit 1 - A horizon - Brown (10YR4/3, m) sandy clay loam; weak, coarse, subangular blocky structure;slightly effervescent, dessimenated carbonate;sparse rabdotus and other snail shells. Clear, smooth boundary. Overbank sediments.

Unit 2 - ABk horizon - Darky yellowish brown (10YR 4/4, m) sandy clay loam;weak, coarse, subangular blocky structure; strongly effervescent; common (5%), fine, irregular, carbonate filaments; sparse rabdotus and other snail shells. Clear, smooth boundary. Overbank sediments.

Unit 3 - Bk horizon - Reddish yellow (5YR 6/6, m) loam; massive; strongly effervescent; common (5%), fine, irregular, carbonate filaments, sparse rabdotus and other snail shells. Diffuse, smooth boundary. Overbank sediments.

Unit 4 - C horizon - Reddish yellow (5YR 6/6, m) sandy loam; massive; strongly effervescent; dessimenated carbonate, sparse rabdotus and other snail shells; abundant filled insect burrows. Diffuse, smooth boundary. Overbank sediments.

Figure 3. Representative Stratigraphy from Site 41TV462 at Backhoe Trench 2

calcareous nature is probably inherent to the parent material instead of being pedogenic in nature. A few *Rabdotus* and other snail shells were sparsely preserved within the unit. Its lower contact tended to be clear to gradational with the underlying soil horizon. The thickness and color of this unit suggests that it is a mollic A horizon. The texture of the sediments and their proximity to the Colorado River suggest that they are the result of overbank flooding of the river.

Though the range of Unit 1's thickness is stated as being between 10 to 22 inches (25 and 55 cm), it is more typically between 18 to 22 inches (45 and 55 cm). The only case where it was 18 inches (25 cm) thick was in BT 1. This difference may be due to modification of the surface on the far northwestern part of the project. Whereas the rest of the study area is relatively flat-lying, the land surface at BT 1 is slightly lower than that at BT 2. It is our suggestion that either the area was partially scraped during a previous construction activity or that moderate erosion has occurred on the northwestern part. For whatever reason, the uppermost unit is thinner. The coarsest texture of the Unit 1 sediments (sandy clay loam) occurs in this western area. Other portions of the study area tended to have a clay loam texture. If the change in elevation is due to erosion, it may be that the richer clay sediments in the eastern portions were less susceptible to erosion than the slightly sandier sediments of the western portion. This change in sediment texture is probably due to the lateral terrace distance from the Colorado River. During overbank flooding, the coarsest sediments tend to be deposited closest to the river with only finer-grained sediments being deposited further away. Overall, the sediments of Unit 1 tend to suggest relatively gentle or low energy overbank deposition that would be good for the preservation of cultural materials. The extent of soil formation processes in the area (e.g. bioturbation by roots and insects, humate staining, etc) has, however, either destroyed or masked any detailed stratigraphic information such as laminations from individual flood events. As a result, it is unclear how many overbank depositional events are present in the Unit 1 sediments.

The Unit 1 sediments have a conformable and gradational contact with the underlying horizon (Unit 2). The colors lighten slightly to a dark yellowish brown (10YR 4/4, moist) and the sediments are generally not as fine-grained as the overlying A horizon, though they still exhibit a clay loam to sandy clay loam texture. The sediments effervesce when tested with hydrochloric acid and fine, irregular carbonate filaments are common (5 percent) throughout Unit 2. As with all of the natural units, snail shells are sparsely preserved through the sediments. This unit has a gradational contact with the underlying reddish sediments.

The Unit 2 appears to be a transitional horizon between A horizon and Bk horizon characteristics. Because of these transitional properties, it is classified as an ABk horizon. Possibly, Unit 2 was once a surface A horizon, but subsequent sediment accumulation on the site resulted in its burial and the development of subsurface pedogenic properties including carbonate accumulations. In overbank depositional environments cumulic soil profiles commonly develop. The fact that this unit has an apparent gradational contact with the underlying sediments may be due more to gradational changes in pedogenic properties than due to relatively continuous geological deposition. It is our interpretation that the contact between Unit 2 and Unit 3 is an unconformity, but that pedogenic processes have blurred this boundary. The reasons for this interpretation are elaborated below.

Unit 3 consists of a reddish yellow (5YR 6/6, moist) loam that is massive and exhibits visible carbonate filaments. The filaments are common (5 percent) and are fine and irregular in shape. This is considered a Stage I carbonate accumulation (after Gile et al. 1966; Birkeland 1984). Their presence results in the classification of Unit 3 as a Bk horizon. As with most units, snail shells are sparsely distributed throughout the profile and include *Rabdotus*. Insect burrows also become more common in this zone and continue to be abundant in Unit 4. The carbonates

in Unit 3 gradually decrease in abundance with depth. A diffuse boundary occurs as these carbonates gradually decrease.

Unit 4 is marked by the absence of carbonates. Unit 4 is similar in color to Unit 3, but has a slightly sandier texture. Instead of a loam, it is classified as a sandy loam. This fining upwards sequence is typical of overbank deposition and reflects the decreased capacity of flood events to transport sandy sediments as the floodplain aggrades. This unit lacks the carbonate filaments observed in Unit 3 and exhibits no soil structure. Filled insect burrows are common in some portions, though these observations were made in clods from the back dirt because the trench was too deep to safely allow direct observation. It is not clear whether burrows are evenly distributed throughout Unit 4 or if there is a zone where they are more abundant. In any case, it appears that some of these burrows are over 10 ft (3 m) below the current ground surface, which seems excessive for modern insects. They may represent insect activity at a time when these sediments were closer to the surface.

One of the key questions was how much Holocene sediment was present on this Pleistocene terrace. This directly effects how deep archeologists can expect to encounter cultural materials. The boundary between Holocene and Pleistocene sediments is not obvious, especially considering the gradational to diffuse contacts between the four units observed in the backhoe trenches. There is no clearly defined gravel layer or a shift to very mature soil properties like clay cutans or Stage II or greater carbonate accumulations. The only property that may indicate a shift to older sediments is color. Units 1 and 2 tend to have fairly yellow hues (10YR) while Units 3 and 4 have red hues (5YR). Redding or rubification of sediments is a phenomenon of soil development that is thought to result from gradual oxidation of iron in the soil. Thus, redder soils are typically older than non-rubified ones (after Birkeland 1984; Buol et al. 1997). As a result, it is suggested that Units 3 and 4 may represent Pleistocene sediments that comprised the original terrace and that Units 1 and 2 represent subsequent Holocene overbank deposition that blanketed the terrace. If this is the case, the depth to the Unit 2/3 contact represents the maximum depth archaeologist can expect to find Holocene and, thus, in situ cultural materials. In most profiles the depth of this contact is approximately 31.5 to 43 inches (80 to 110 cm) below the current ground surface (Figure 3).

The relatively gentle nature of overbank deposition represented by the clay loam to sandy clay loam Holocene sediments suggests an environment favorable for the in situ preservation of cultural material, if present. Though previous investigations indicated sparse cultural materials preserved in the 12 to 31.5 inch (30 to 80 cm) range below the surface (Brown 1981), we did not encounter any such materials during our examinations.

7.0 RECOMMENDATIONS

The seven backhoe trenches did not yield any prehistoric cultural material. It appears that significant cultural deposits associated with prehistoric site 41TV462 are not present within this proposed 7 acre Sand Hill Plant site and development zone. The lack of significant cultural deposits indicates that the part of 41TV462 within the development zone is not eligible for inclusion to the National Register of Historic Places. TRC recommends that the plant site

development across this high terrace of the Colorado River be allowed proceeding without further archeological investigations.

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