Investigation of Elevated Nitrates in the Hoback Junction Area

Teton County, Wyoming

by

Wyoming Department of Environmental Quality,

Groundwater Section of the Water Quality Division

and

Teton County

and

Teton Conservation District

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Abstract: The Wyoming Department of Environmental Quality (WDEQ) received a complaint in February 2020 alleging that there were unpermitted Underground Injection Control (UIC) commercial septic systems operating at two properties in the Hoback Junction area. WDEQ conducted a joint inspection of the properties with Teton County and determined that one system did not require a WDEQ UIC Permit. The other system did require a UIC permit and had a non-permitted discharge to groundwater. The non-permitted discharge has since been removed and a County-approved system was constructed. WDEQ is currently working with the owner to address the identified non-compliance issues.

On June 16, 2020, a second complaint was submitted to WDEQ requesting an investigation to the cause of elevated nitrates in groundwater in the Hoback Junction area of Teton County, Wyoming. The complaint alleged that commercial and residential septic systems were the cause and/or contributing to nitrate exceedances in the area. Based on these complaints, WDEQ developed a Scope of Work to investigate nitrate issues in the Hoback Junction Area.

The Scope of Work was finalized in October 2020 and proposed:

1. Establishment of a working group of local and county agencies who were evaluating nitrate concerns in the area,
2. Review of available groundwater information in the area,
3. Develop an initial Conceptual Site Model, and
4. Draft a Site Assessment Report.

This report provides the findings and recommendations identified from the Scope of Work.

This report has been prepared by the Wyoming Department of Environmental Quality – Water Quality Division (DEQ/WQD)[1] and with substantial contributions from the staff of Teton County and Teton Conservation District.

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[1] This Report is specific to WDEQ's investigation and evaluation of data already collected and reported by various organizations and agencies including the Teton County Engineering Department and Teton County Conservation District. The conclusions and recommendations presented in this Report are those solely of WDEQ.

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DEFINITIONS AND ACRONYMS

The following abbreviations, acronyms, and terminology are used in this Report.

cfs	cubic feet per second
CSM	Conceptual Site Model
ft-amsl	feet above mean sea level
gpd	gallons per day
kg/d	kilograms per day
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
N_2	Nitrogen
OWTS	onsite wastewater treatment systems
pH	the units in which pH is measured are called "standard units" (the Negative logarithm of the hydrogen ion activity in moles per liter); the "s.u." designation may be omitted for brevity.
POWJH	Protect Our Waters Jackson Hole
RO	Reverse Osmosis
SOW	Scope of Work
UIC	Underground Injection Control
USEPA	United States Environmental Protection Agency
WDEQ	Wyoming Department of Environmental Quality
WOC	Wyoming Outdoor Council
WQD	Water Quality Division
WWQR	Wyoming Water Quality Rules
WSEO	Wyoming State Engineer's Office
WWDO	Wyoming Water Development Office
WYPDES	Wyoming Pollution Discharge Elimination Systems

1.0 INTRODUCTION

On February 10, 2020, the Wyoming Outdoor Council (WOC) and Protect Our Waters Jackson Hole (POWJH) submitted a complaint to the Wyoming Department of Environmental Quality (WDEQ) Water Quality Division (WQD) alleging that there were unpermitted Underground Injection Control (UIC) commercial septic systems at two facilities located in Hoback Junction, Teton County, Wyoming: Hoback Market and Hoback RV Park. The WDEQ/WQD conducted an inspection of the identified facilities and concluded that the Hoback Market was properly permitted, and no additional investigations were required of that facility. However, the Hoback RV Park was not properly permitted and had a non-permitted discharge. WDEQ worked with the owner to bring the facility into compliance with permitting requirements. Following the inspections of these two facilities, WOC submitted a second complaint on June 16, 2020, alleging that elevated nitrates in groundwater in the Hoback Junction Area were caused by commercial and residential septic systems and requested that the WDEQ investigate potential sources of nitrate exceedances. In t the Hoback Junction Area, nitrate in groundwater that supplies local public and private water supply wells has identified concentrations exceeding the U.S. Environmental Protection Agency (USEPA) maximum contaminant level (MCL) of 10 milligrams per liter (mg/L). The USEPA MCL for nitrate is set to protect against adverse health impacts, including blue-baby syndrome. (USEPA, 2023) In order to investigate the potential sources and impacts to groundwater from nitrate exceedances identified in the Hoback Junction Area, WDEQ developed a Scope of Work to investigate the nitrate issues. The Scope of Work (SOW) was finalized in October 2020 and proposed:

1. Establishment of a working group of local and county agencies who were evaluating nitrate concerns in the area,
2. Review of available groundwater information in the area,
3. Develop an initial Conceptual Site Model (CSM), and
4. Draft a Site Assessment Report (Report).

This Report provides the findings and recommendations identified from the scope of work.

1.1 PROJECT HISTORY

The WDEQ UIC Program conducted a joint inspection with Teton County to determine the permitting requirements for the two requested properties and worked with property owners to obtain proper permitting following a February 10, 2020 complaint. A second complaint dated June 16, 2020 requested that the WDEQ investigate and determine the cause of groundwater contamination in the Hoback Junction area. The request for investigation focused on an assessment of nitrate levels in the groundwater that supplies both public and private water wells in the area.

1.1.1 FEBRUARY 10, 2020, COMPLAINT AND REQUEST FOR INVESTIGATION, WYO. STAT § 35-11-701

The WOC and POWJH submitted a *Complaint and Request for Investigation, WYO. Stat § 35-11-701* (Complaint) on February 10, 2020 to the WDEQ. The Complaint requested that WDEQ evaluate and determine whether two facilities—Hoback Market and Hoback RV Park—required permits from the WDEQ UIC Program (Figure 1). In addition, the complaint alleged that the systems may not be functioning properly and therefore may be contributing to elevated nitrate concentrations in groundwater in the area.

<u>Hoback Market</u>

Wyoming Water Quality Rules (WWQR) Chapter 27 defines 5E3 Domestic Subsurface Fluid Distribution Systems (also called large capacity septic systems) as systems that receive more than 2,000 gpd of domestic sewage with only primary treatment such as effluent from a septic tank. In addition, any facility injecting domestic sewage within any five acres of land is considered a Class 5E3 facility whenever multiple 5E facilities under one owner inject a cumulative maximum peak design flow of more than 2,000 gpd of domestic sewage. WWQR Chapter 27, Section 13(j) requires that all 5E subclass UIC facilities conform to applicable construction standards found in WWQR Chapter 25.

WWQR Chapter 25, Section 5 provides that design flows to determine the volume of wastewater shall be determined using one of three methods: (1) design flow rates in Tables 1 and 2, (2) metered water supply data from the facility, or (3) metered water supply data from another facility where similar water demands have been demonstrated.

The WDEQ had conducted an inspection at Hoback Market on September 19, 2013. An average water use of 830 gpd and a peak summer water use of 1,200 gpd were reported during that inspection. The WDEQ conducted a more recent inspection at the facility on March 10, 2020. Water usage records recorded from 2017 to 2020 were provided by the operator. These records revealed an average daily water use ranging from 704 to 1,423 gpd.

Based on the permitted design flow of 1,700 gpd and reported water use, there is not sufficient evidence at this time to support that the septic system operated at the Hoback Market meets the definition of a 5E3 Domestic Subsurface Fluid Distribution System UIC facility requiring a WDEQ Class V UIC permit. However, the WDEQ requested, and the owner of the Hoback Market verbally agreed, to record and provide peak water usage during the summer of 2020 to verify that the flows are less than 1,700 gpd. The WDEQ's March 10, 2020 inspection did not reveal any evidence that the septic system was not functioning properly. The WDEQ is currently reviewing available water usage data and will use that information to ensure that, in coordination with Teton County, the septic system at Hoback Market is permitted appropriately.

Hoback RV Park (formerly Lazy J Corral RV Park)

On July 29, 1999, the WDEQ sent a letter of violation to the owner of the Lazy J Corral RV Park (now known as the Hoback RV Park) following an inspection of the facility on July 20, 1999. The letter indicated that the existing septic system, a 5E3 subclass facility, had failed; therefore, a new septic system was needed and would require a design capacity of less than 2,000 gpd to meet the minimum setback distance to the existing facility's water supply well.

The owner of Lazy J Corral RV Park subsequently submitted an application for a small wastewater system to replace the failed septic system. Teton County approved the small wastewater system under permit SWF1999-0114 on August 9, 1999. The replacement septic system reportedly served 24 RV spaces and a three (3) bedroom house. The septic system has a reported engineered design capacity of 1,950 gpd and a peak water usage of 1,100 gpd at full capacity recorded between July 23 and August 2, 1999.

The Lazy J Corral RV Park was sold to the current owner, Crowley Capital, LLC in 2019 and was renamed as the Hoback RV Park. The Hoback RV Park operated 23 RV spaces, a six (6) bedroom house (which was then separated into four (4) apartment units), and a laundry facility.

WDEQ conducted an inspection on March 10, 2020. The operator recorded daily water usage starting February 28 through April 7, 2020, which had water usage ranging from 1,681 to 2,106 gpd. The water usage exceeded 2,000 gpd three (3) days during that reporting period.

As a result of the reporting and inspection, evidence was found that the septic system has been periodically operated above the County-permitted design capacity of 1,950 gpd; therefore, the facility meets the definition of a 5E3 subclass UIC facility and requires a DEQ UIC Permit. In addition, the WDEQ noted during the March 10, 2020 inspection that the leachfield was failing due to surfacing liquid. WDEQ issued a Notice of Violation, Docket No. 6016-20, to Crowley Capital, LLC for:

1. Discharging domestic wastewater into a septic system at a rate greater than 2,000 gpd without a UIC Class V permit;
2. Operating the septic system with liquid waste visible on the ground surface;
3. Operating a water treatment system that was constructed without a WWQR Chapter 3 and Chapter 12 permit; and
4. Discharging water treatment brine into the subsurface without a UIC Class V permit.

A Settlement Agreement was executed on February 25, 2022 to bring the facility back into compliance. Activities associated with the Settlement Agreement are discussed in Section 3.2.1.1. of this Report.

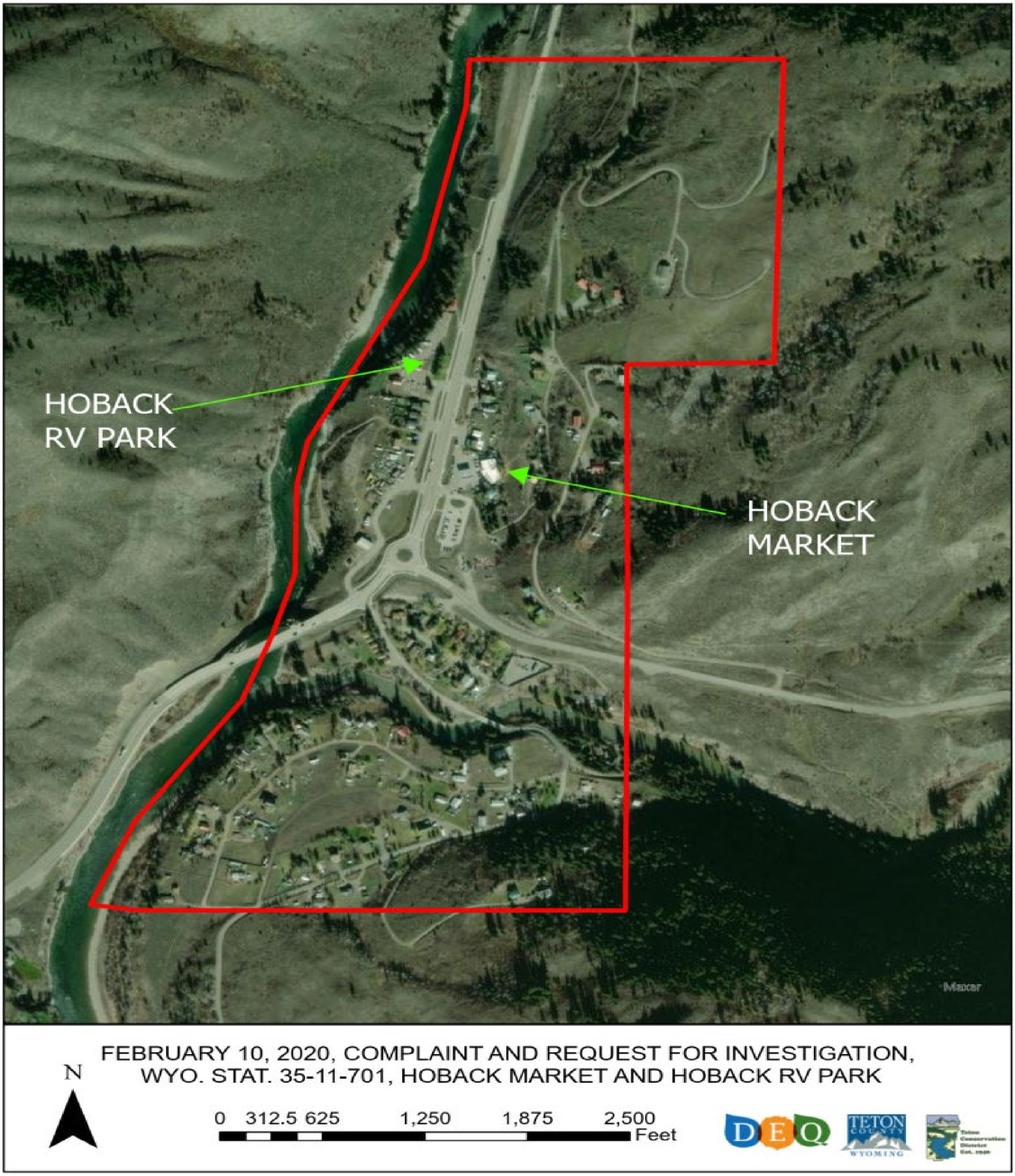

FIGURE 1 HOBACK RV PARK AND HOBACK MARKET LOCATIONS

1.1.2 JUNE 16, 2020 REQUEST FOR INSPECTION OF SMALL WASTEWATER SYSTEMS IN THE HOBACK JUNCTION AREA OF TETON COUNTY, WYOMING

On June 16, 2020, the WOC submitted a *Request for Inspection of Small Wastewater Systems in the Hoback Junction Area of Teton County, Wyoming* (Request) to the WDEQ. The Request asked WDEQ to conduct investigations into the potential sources of elevated nitrate concentrations in groundwater with a primary focus on conducting inspections of small wastewater systems located in the Hoback Junction area. WDEQ responded through correspondence dated June 18, 2020 that the WQD of the WDEQ had already begun an investigation in the area by collecting available water quality data and compiling that data together with information on private and public water supply wells, geology, hydrogeology, and potential sources of contamination.

1.1.3 WORKGROUP

In October 2020, stakeholders including the WDEQ/WQD, Teton County Engineering Department, and the Teton Conservation District formed a workgroup (Workgroup) to apply science-based approaches to the investigation of potential impacts of nitrates on groundwater and drinking water in the area. Both WDEQ/WQD and the Teton County Engineering Department are authorized to issue permits for wastewater systems. Teton Conservation District had been assisting the community to evaluate water quality samples collected from private domestic drinking water wells. Based on these activities having been conducted, the workgroup was tasked with compiling the information from their respective organization, identifying any data gaps, and developing a Conceptual Site Model (CSM) to understand nitrate sources, fate and transport of nitrates, and the potential receptors. Taking into consideration the outcomes of the activities conducted, the working group would determine what, if any, further actions may be needed.

The Workgroup was tasked with developing the criteria and identifying information needed to complete a review of all analytical, geological and land use material for the Hoback Junction Area. Such information included:

1. Past site use and ownership of the area of Hoback Junction
2. Identification of known and potential sources (point and non-point) of nitrate contamination
3. Wyoming State Engineer's Office (WSEO) water well permits in the area
4. Verify all Public Water Supply wells in the area
5. Available nitrate data from the USEPA for current Public Water Supply Wells, Teton County, Teton County Health Department, Wyoming Water Development Office (WWDO), and other resources identified in the WOC request for investigation
6. Geological Survey information regarding groundwater flow direction, geological information
7. Review all existing permits for the area. This will include Wyoming Pollutant Discharge Elimination System (WYPDES) permits, USEPA Drinking Water permits, UIC permits, and other permits
8. Evaluation of all facilities permitted through Teton County or WDEQ
9. Evaluation of all facilities that should be permitted through Teton County or WDEQ

In addition to document reviews, the Working Group was tasked with developing the criteria and identifying facilities in the Hoback Junction area which may require inspection. The Working Group was also tasked with developing a CSM for the Hoback Junction Area. The goal of a CSM is to provide a description of relevant site features and the surface and subsurface conditions to understand the extent of identified contaminants of concern and the risk they pose to receptors. Furthermore, the CSM assists in identifying data gaps to help guide investigations to remove or address potential sources which will ultimately lead to remediation of groundwater to address nitrate exceedances in the area. The CSM is an iterative or 'living document' that is developed and refined as information is obtained during review of the site history and continues through any site investigations.

A CSM includes:

1. Location of contamination or waste sources
2. Types and expected concentrations of contaminants
3. Potentially contaminated media and migration pathways
4. Potential human and ecological receptors
5. Modifications to the scope of services required
6. Potential interferences and other contingency plans

These items were referenced in the SOW for completion. However, as the primary focus of the investigation is the nitrate exceedances in groundwater used for drinking water and the potential sources that may lead to those exceedances, this Report focuses on the human receptor population as a function of land use in the investigation area.

2.0 STUDY AREA INFORMATION

2.1 POPULATION AND LAND USES

The Project Area consists of 127 properties which is a small subset of the Hoback Junction proper and surrounding area with a total population estimated to be around 1,874 people in 660 households (Census Reporter, 2022). The Project Area consists of 279 distinct lots with varying ownership and uses. The Project Area is zoned for Neighborhood Conservation, Auto-Urban Commercial, and Residential (Figure 5). Land cover data shows that within the community of Hoback Junction land cover is either Developed - Low Intensity or Developed - Open Space. In the areas surrounding the community land cover is classified as Evergreen Forest, Pasture / Hay, or Grassland / Herbaceous. In the Project Area, there are no designated irrigated land uses. However, in the developed areas of Hoback Junction, large animals are allowed to be kept on identified horse properties which are small, and dirt covered.

2.2 LOCATION AND PHYSICAL SETTING

The investigation area for Hoback Junction (herein referred to as the "Project Area" (Figure 2)) is bounded by the confluence of the east bank Snake River and north and south banks of the Hoback River and the intersection of US Routes 26, 89, 189, and 191, approximately 13 miles south of Jackson Hole, Wyoming. Although what might be described as "Hoback Junction proper" is roughly 500 acres (or about 0.75 square miles) in size, the overall Project Area is approximately 161 acres (or 0.25 square miles) in size. The Project Area is located in Township 39N, Range 116W Sections 23, 27, and 26.

The diversity and distribution of vegetation within the Project Area is influenced by elevation. The abundance of grasses, shrubs, a variety of woodland trees (primarily conifers), and other species generally increases with elevation. The dominant ecological zones are, generally sagebrush steppe/shrubland (mixed prairie grasses and shrubs; primarily sagebrush) on the plains, mixed deciduous and coniferous forest along drainages, sub-alpine spruce-fir forest on mountain flanks and at the highest elevations, alpine tundra. (Taboga, et al., 2014)

2.2 TOPOGRAPHY

The topography in the Project Area ranges from 5,879 feet above mean sea level (ft-amsl) at the river to 6,218 ft-amsl on the slope to the east of Snake River. The elevation change of 321 feet occurs over approximately 2,242 feet from west to east for a slope of 14%. (Niemi, 2024)

2.3 PRECIPITATION

The average annual precipitation of the Project Area is 22.3 inches per year. Based on precipitation averages from 1992 through 2021, Hoback Junction receives an average of 1.14 to 2.6 inches of precipitation per month. The driest months are July and August with average precipitation values of 1.14 and 1.24 inches. The wettest months are December, January, and February with average precipitation values of 2.58, 2.6, and 2.48 inches, respectively. (Cooperative Observer Water Year Precipitation, 2024)

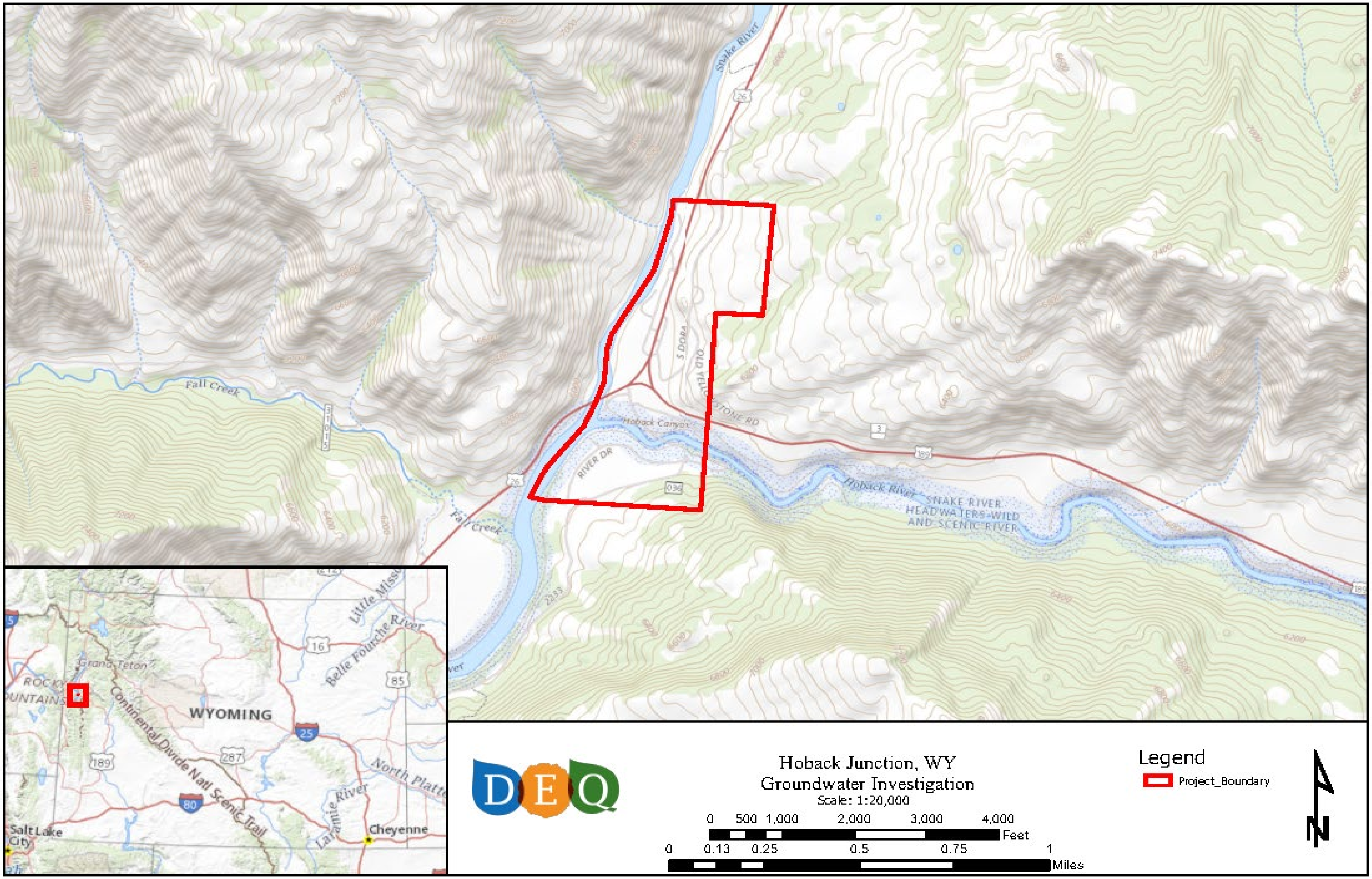

Figure 2 Project Area

2.4 GEOLOGY

2.4.1 SURFACE GEOLOGY

Quaternary geomorphological features and deposits dominate surface geology in the Project Area (Figure 3). The deposits in the Project Area have been deposited and re-worked by glacial, alluvial, and geologic hazard processes. The community of Hoback Junction is built mostly on dissected alluvial fan deposits created by the Hoback River flowing into the larger Snake River. (Watson, 1980)

Dissected alluvial fan deposits occur when a stream or river erodes an existing fan deposit. Fan deposits are present when streams and debris flow from slopes to level or nearly level plains. These deposits were then crosscut by the Hoback River after deposition. The deposits in the Project Area also contain alluvium deposited over time by the dynamic river systems in the area. Alluvium is defined as unconsolidated detrital material deposited during recent geologic times by a stream or other body of running water. It consists of sorted or semi-sorted sediment in the bed of a stream, in the floodplain or delta, or as a fan or cone at the base of a mountain slope. (Wittke, Carnes, & Lichtner, 2016) The steep slopes around the community are dominated by landslide deposits resulting from high snowpack and run-off flowing on and through poorly consolidated soils and fractured bedrock underlying the more secondary geologic deposits. Landslide deposits are defined as rock and soil that moves downhill, under gravitational influence.

2.4.2 BEDROCK GEOLOGY

The Project Area is underlain by two geologic bedrock formations, the Aspen Formation and the Bear River Formation (Figure 4). Both of these formations were deposited during the early Cretaceous when much of western North America was submerged under the Western Interior Seaway in moderately deep water as the western shores of the seaway moved east due to erosion and deposition from the western highlands that were uplifted during the Sevier and Laramide orogenies.

During the early Eocene, this landscape was affected by large thrust faults moving to the northeast. The resulting thrust sheets created the Hoback and Snake River Mountain ranges. This tectonic activity was composed entirely of Paleozoic and Mesozoic rock units like the Bear River and Aspen Formations. Much later the area was affected by thrust and gravitational faulting, however, this later activity was in the opposite direction from the Eocene faulting. The extensive history and active faulting in the areas

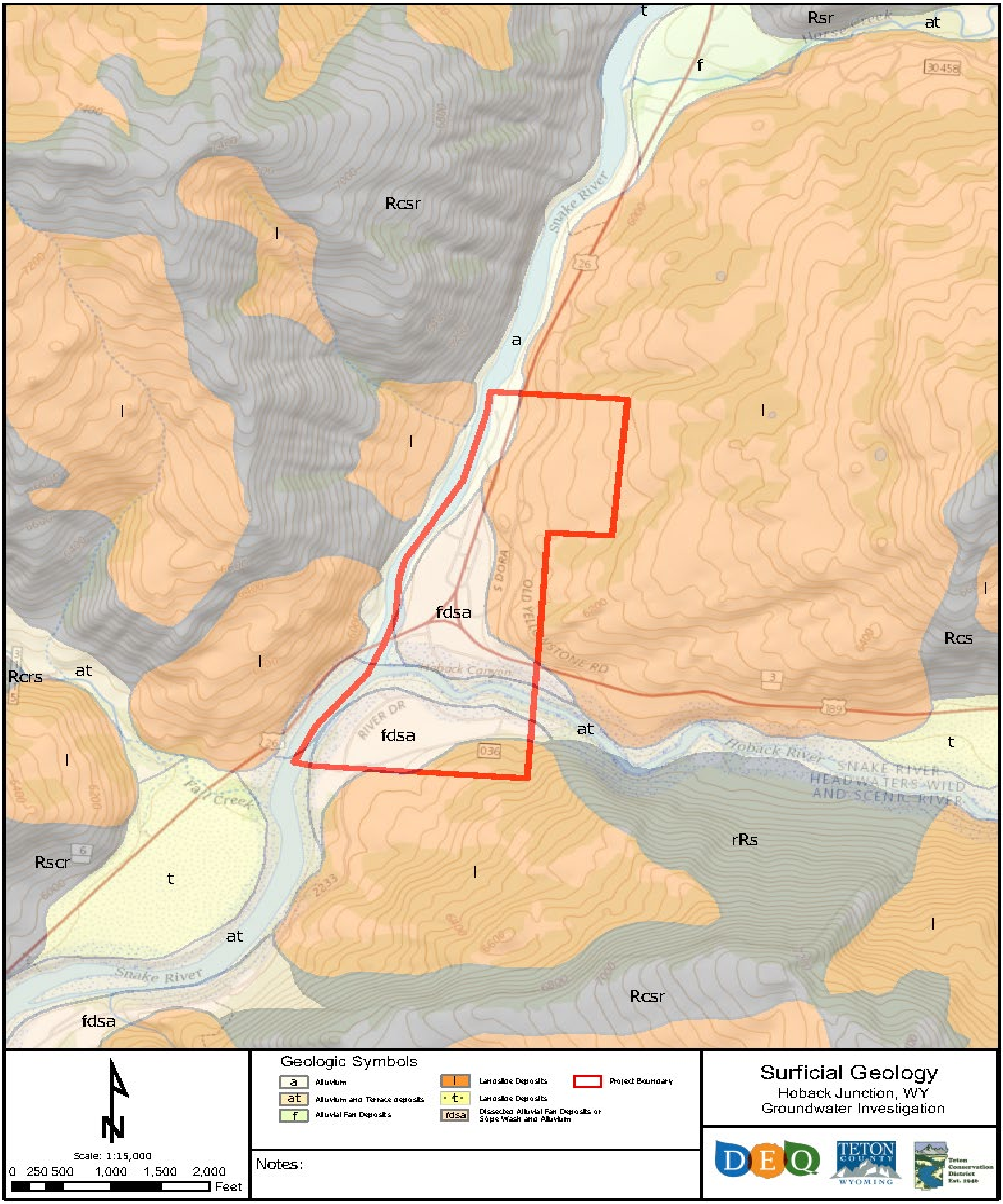

FIGURE 3 PROJECT AREA SURFICIAL GEOLOGY

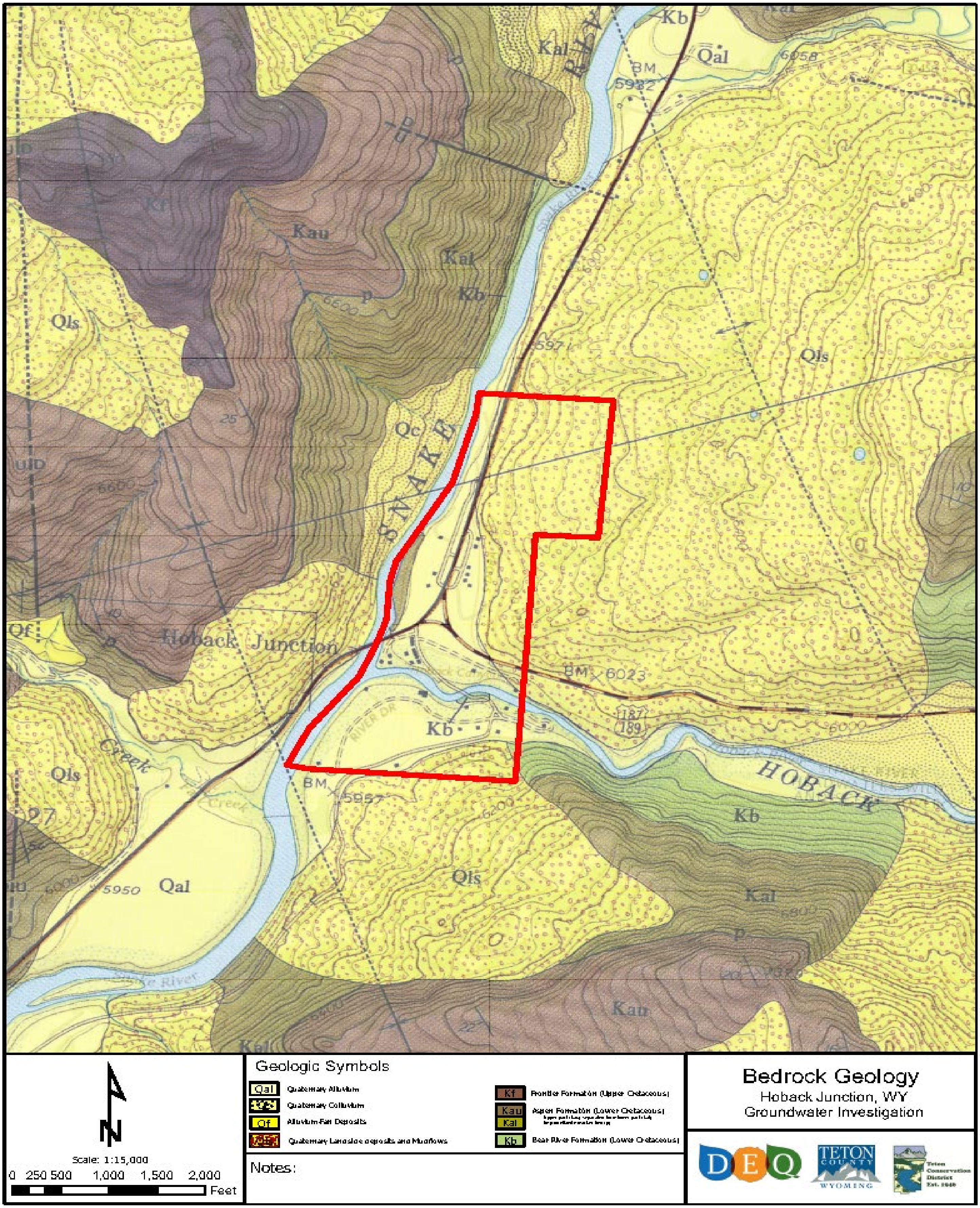

FIGURE 4 PROJECT AREA BEDROCK GEOLOGY

have resulted in fractures in the underlying bedrock allowing for high concentrations of secondary porosity. (Behrendt, et al., 1968, p. 30)

2.4.2.1 ASPEN FORMATION

The Aspen Formation consists of two units and is separated by a marker bed of distinctive porcellanite. These units are described as gray and greenish gray siltstones and salt and pepper sandstone; with interbedded varying colored porcellanite. In the Project Area, this unit is expected to be approximately 1,200 to 1,300 feet thick. The Aspen Formation conformably underlies the Cretaceous Frontier Formation and conformably overlies the Bear River Formation.

2.4.2.2 BEAR RIVER FORMATION

The Bear River Formation is divided into upper, middle, and lower units. The upper and lower units are described as a black to dark gray hard splintery siliceous shale. The shale units have high secondary porosity due to high concentrations of fractures and parting between bedding planes. Massive gray cross-bedded tan weathering sandstone in the middle unit forms prominent ridges and cliffs, with minor carbonaceous shale interbeds. In the Project Area, this unit is expected to be approximately 540 feet thick. The high concentrations of secondary porosity in the shale units allow water to move through this formation easily and decrease the structural stability of the unit. In the Snake River Canyon, the Wyoming Department of Transportation has mapped several landslides that are seated within the Bear River Formation.

2.4.3 HYDROLOGY

2.4.3.1 WATERSHED/SURFACE WATER

This Project Area is located in the Snake/Salt River Planning Basin, which is a part of the Columbia River drainage that flows into the Pacific Ocean. The portion of this planning basin that is in Wyoming covers approximately 5,100 square miles. It includes portions of four counties; Teton, Fremont, Sublette, and Lincoln counties, as well as two National parks; Yellowstone and Grand Teton. The Snake/Salt basin is composed of several sub-basins, and this project falls into the Greys-Hoback sub-basin. Water quality in this basin is a major concern; however, it is mostly considered to be fairly good due to the quality of water coming into the basin.

The WWDO divided this sub-basin into three watersheds for the 2012 Basin Plan update and that division will be used here. The Lower Snake River Watershed, The Hoback River Water Shed, and the Greys River Watershed. The Lower Snake River Watershed, where the Project Area is located begins at the confluence of the Gros Ventre and Snake Rivers, then continues to the confluence of the Snake and Hoback Rivers, and finally to Palisades Reservoir. The Town of Jackson and the rural area developed between Jackson and Hoback Junction are included in this watershed. There are impacts in the watershed that can affect water quality on a local basis from increasing development in the area.

Much of the Snake/Salt River Basin is comprised of wildland consisting of forests, sagebrush steppes, and grasslands. There are several federally designated wilderness areas within the basin. These wildland watersheds provide high-quality surface water to the basin. Environmental and recreational land uses are important in the basin; therefore, considerable monitoring has been conducted to evaluate and help protect these high-quality water resources. Most water quality problems identified in the basin result from human activities and management. Because the area for development is relatively small, human activities have been concentrated. This leads to potential impacts on streams and water quality such as loss of stream habitat due to sedimentation and channel alteration along with bacterial contamination. (Wyoming Water Development Office, 2014)

2.4.3.2 FLAT CREEK

Flat Creek, from Cache Creek downstream to the confluence with the Snake River, was placed on Wyoming's 303(d) List (i.e., list of impaired waterbodies) in 2002 due to physical habitat alterations and sedimentation. (Wyoming Department of Environmental Quality, 2020) In 2020, the segment of Flat Creek from Highschool Road downstream to the confluence with the Snake River was added to the 303(d) List due to exceedances of Wyoming's E. coli criteria. An Advanced Restoration Plan was completed by the Teton Conservation District in 2019 to provide a road map to address these impairments. (Teton Conservation District, 2019) Portions of Flat Creek have been rehabilitated. (Wyoming Water Development Office, 2014)

2.4.3.3 FISH CREEK

Fish Creek in this watershed has headwater in Grand Teton National Park and parallels the Snake River as it flows south out of the park. Fish Creek flows through the town of Wilson and in the 1990's residents noticed excessive algal growth, and studies are underway to address these concerns. Fish Creek is currently proposed to be listed as impaired due to nutrients (Total Nitrogen and Total Phosphorus). Fish Creek was also listed as impaired for recreation designation due to high levels of E. Coli. Water quality monitoring is currently conducted under the Teton Conservation District. (Teton Conservation District, n.d.)

2.4.4 GROUNDWATER

An "aquifer" is any geologic unit from which useful supplies of groundwater can be economically extracted. Thus, this designation is strongly dependent upon the type of use, the desired quantity of water, and the necessary water quality. Groundwater in the Snake/Salt River basin is abundant due to the high annual precipitation rate and the local hydrogeology. It is estimated that there are nearly 32.5 million acre-feet of groundwater resources potentially available. (Wyoming Water Development Office, 2014)

Aquifers in the basin are made up of unconsolidated sedimentary deposits and consolidated bedrock formations ranging from Precambrian to Quaternary in age. The hydrogeologic units vary widely and have been described as occurring in five major groups, based on lithologic properties, geologic time, and stratigraphic columns for the area. From youngest to oldest they are volcanic and intrusive formations, Cenezoic aquifer group, Mesozoic aquifer group, Paleozoic aquifer group, Precambrian aquifer group. In the Project Area, the Cenzoic and Mezosoic aquifers are the dominant sources of groundwater. The Cenozoic aquifers in some cases are relatively flat-lying or mirror the topography, they overly the intensely faulted and fractured Mesozoic bedrock. These fractures usually enhance the permeability of the bedrock and can greatly increase the ability for groundwater to flow.

Ambient groundwater in the basin can range from very good to very poor depending on the geochemistry of the soils, sediments, and bedrock that the water encounters. Total dissolved solids within the groundwater will generally increase with depth and distance from recharge. The time that the groundwater is in contact with soluble minerals will also greatly increase the amount of total dissolved solids present in the groundwater aquifers. Generally, the groundwaters in the basin are high in salts from the contact with evaporite minerals contained within the various geologic formations present.

In the Project Area, the aquifers are mapped as Mesozoic aquifers (Bear River Formation and Aspen Formation) overlain by Cenozoic aquifers (unconsolidated Quaternary and Tertiary deposits). The Quaternary deposits are poorly sorted landslide deposits and alluvial deposits along the Hoback and Snake Rivers. The poorly sorted nature of these deposits will allow groundwater to move fairly quickly locally. The Mesozoic aquifers are heavily deformed and fractured providing high rates of secondary porosity that also allows groundwater flow rate to be fairly high. These high flow rates mean that the groundwater does not stay in contact with the geologic formations for extended periods, so geologically derived constituents in the groundwater should be minimal. (Wyoming Water Development Office, 2014)

3.0 CONCEPTUAL SITE MODEL

3.1 CONTAMINANT OF CONCERN – NITRATE

Understanding nitrate fate and transport within groundwater is an important consideration for water resources projects since excess nitrate loading can have negative impacts on human health and/or ecological receptors. In humans, nitrate becomes harmful due to its conversion to the more toxic nitrite

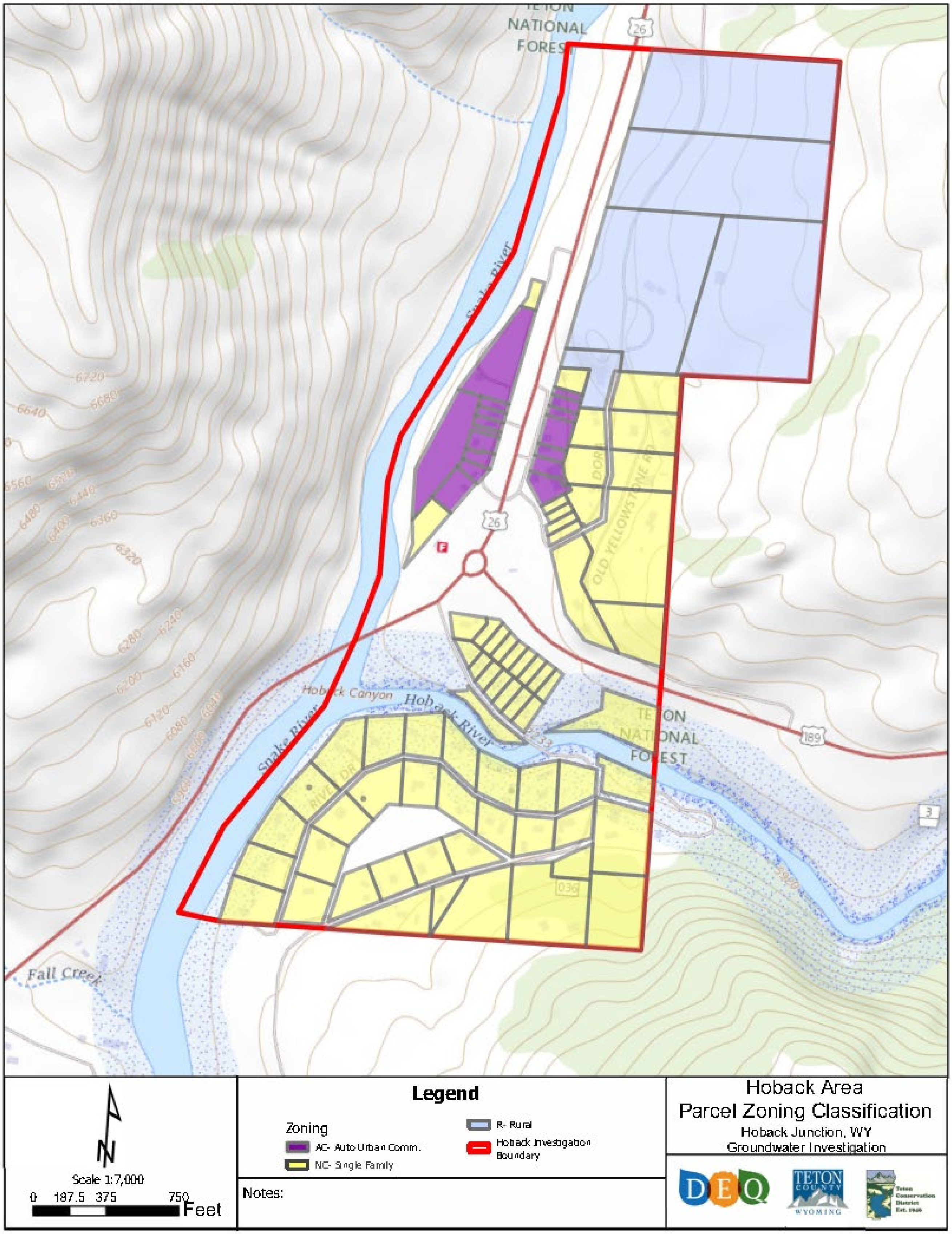

FIGURE 5 PROJECT AREA LAND USES

(U.S. Environmental Protection Agency, 1993). In addition, nitrate is a potential carcinogenic agent and exposure to high levels has been identified as a potential cause of gastric cancer and can cause methemoglobinemia (blue baby syndrome) where cells are starved of oxygen. (U.S. Environmental Protection Agency, 1993) In surface water ecosystems, high levels of nitrate can cause eutrophication of the water body, leading to algae blooms and excessive plant growth, which can lead to anoxic conditions. The USEPA regulates the MCL of nitrate in drinking water at 10 mg/L.

There are several potential sources of nitrogen contribution to groundwater, including agriculture, wastewater treatment plants, onsite wastewater treatment systems (OWTS) (i.e. septic systems), industrial sources, and natural sources such as rainwater and geologic materials. Contributions from each source will vary depending on local conditions and land uses within a watershed. The USEPA identifies that nationally, the largest contribution of nitrogen to groundwater generally comes from agricultural sources due to the application of fertilizers as well as animal waste. However, the contribution of nitrogen due to the treatment of wastewater by OWTS comprises a significant portion of the nitrogen load to groundwater nationally. (U.S. Environmental Protection Agency, 1993) This contribution from OWTS may be especially important in areas where OWTS are located in high-density development, very porous geological conditions, or shallow groundwater. This may cause issues for private well owners if there is a dependence on shallow groundwater for drinking water supplies. (Hitt & Nolan, 2005)

3.1.1 NITROGEN CYCLE

Nitrogen is naturally present in the environment in several forms (Table 1). The process of the transformation of nitrogen compounds through the biosphere is described as the nitrogen cycle. The nitrogen cycle is a repeating biogeochemical process where nitrogen is converted to various chemical forms as it circulates through both living and non-living things such as animals, plants, the atmosphere, soil, water, and bacteria. In general, there are four processes involved in the nitrogen cycle: fixation, ammonification, assimilation, nitrification, and denitrification.

TABLE 1 FORMS OF NITROGEN IN THE ENVIRONMENT

Nitrogen Compound	Formula
Ammonia	NH_3
Ammonium Ion	NH^{+4}
Nitrogen Gas	N_2
Nitrate Ion	NO^{-2}
Nitrite Ion	NO^{-3}

1. Fixation (immobilization) refers to the incorporation of inert gaseous nitrogen (N_2) into an organic chemical compound that can be used by plants and animals. Fixation is accomplished primarily by the activity of specialized microorganisms (nitrogen-fixing bacteria) and the relationship between these microorganisms and plants. (U.S. Environmental Protection Agency, 1993). Atmospheric fixation by lightning can play a small but significant role by converting N_2 to nitrate.

2. Ammonification refers to the change of organic nitrogen to the ammonium form. This process usually occurs during the decomposition of plant and animal matter, including fecal material.

3. Assimilation is a biochemical process where ammonium or nitrate compounds are converted to form plant proteins and other nitrogen-containing compounds. This is an important mid-step in the process since animals require protein from plants and/or other animals and are not capable of converting inorganic nitrogen into organic nitrogen. (Canter, 1996)

4. Nitrification refers to the conversion of ammonium to nitrite and then nitrate. Although a two-step process, the conversion from nitrite to nitrate occurs rapidly and therefore it is generally assumed that the transformation from ammonium to nitrate happens in a single step. (Canter, 1996) (U.S. Environmental Protection Agency, 1993)

5. An important process to remove nitrogen is denitrification. Denitrification is a biological process that converts nitrate back to nitrogen gas. The bacteria responsible for denitrification will, in the absence of oxygen, use nitrate to oxidize dissolved organic carbon (introduced to the system from organic matter in the soil), with the end result of the process being the removal of nitrate and creation of nitrogen gas. (U.S. Environmental Protection Agency, 1993) It is important to note that conditions must be anoxic in order for denitrification to occur since denitrifying bacteria will preferentially use oxygen in the oxidation process because it yields more energy.

The various processes involved in the nitrogen cycle can be affected by temperature, pH, bacterial communities, oxidation/reduction potential, available substrate, nutrients, and oxygen. (Canter, 1996)

3.2 SOURCES

Potential groundwater contaminant sources in the Snake/Salt River Basin were previously assessed in the 2014 Snake/Salt River Basin Water Plan Update, Groundwater Study. Potential sources include industrial, retail, private, and public facilities that manufacture, process, use, store, sell, dispose, or otherwise handle substantial volumes of waste and other substances with physical and chemical characteristics that, released to the environment, could migrate to groundwater. In addition, many human activities have the potential to contaminate underlying groundwater resources. Possible sources of contamination include farming and ranching, resource development such as mineral extraction and logging, construction, transportation, residential, industrial and commercial development, and recreational activities. The Workgroup evaluated potential sources in the area that may lead to nitrate exceedances in the area.

3.2.1 SEPTIC SYSTEMS

Properties within the Project Area are not connected to a municipal wastewater collection system or a local wastewater treatment plant. Wastewater handling is through the use of onsite septic systems with leach fields. Locations of septic systems within the study area are shown in Figure 6.

3.2.1.1 LARGE-CAPACITY SEPTIC SYSTEMS

Large-capacity septic systems are permitted through the WDEQ/WQD UIC Program. A septic system that discharges greater than 2,000 gpd of domestic waste or that treats any amount of non-domestic waste requires a UIC permit. Within the Project Area, two facilities have been monitored by the UIC program in the past.

<u>Hoback RV Park</u>

The Hoback RV Park facility was previously covered under a delegated county permit; however, the March 10, 2020 inspection of the facility found recorded daily water usage exceeding 2,000 gpd and therefore, was operating without a WDEQ UIC permit. As discussed in Section 1.1.1 of this Report, a Notice of Violation, Docket No. 6016-20 was issued and WDEQ and the current owner, Crowley Capital, LLC for the unpermitted discharge. WDEQ and Crowley Capital, LLC entered into a Settlement Agreement (executed on February 25, 2022) which outlined the activities required to return to compliance. Such activities included connecting the water treatment brine discharge line to a holding tank and construction of a new leachfield. A holding tank, permitted under a WDEQ Water & Wastewater Permit to Construct No. 20-232 was installed and connection completed in September 2020. The construction of a new leachfield was completed in December 2020 and the abandonment of the former leachfield was completed on July 2, 2021.

A groundwater investigation plan to determine the extent of impacts caused from the illegal discharge of brine was also required. Groundwater sampling of monitoring wells upgradient and downgradient of the discharge did not indicate impacts specific to the discharge. (Nelson Engineering, 2022)

Finally, Crowley Capital, LLC agreed to fund a Supplemental Environmental Project in the Hoback Junction Area to 1) organize a water and sewer district, and 2) fund a Level II Study. A Level II Study is typically funded through WWDO. With this funding, Level II Study could be expedited. The Hoback Junction Water and Sewer District was formed in February 2023.

<u>Hoback Market</u>

Teton County approved a small wastewater system permit, SWF1998-0077, on July 2, 1998 for the replacement of the septic system serving the Hoback Market with a reported engineered design capacity of 1,700 gallons per day (gpd). Teton County subsequently approved a small wastewater system permit, SWF2016-0034, on April 20, 2016. This permit approved modifications to the existing system including the installation of a 2,000-gallon concrete traffic-rated single-compartment septic tank.

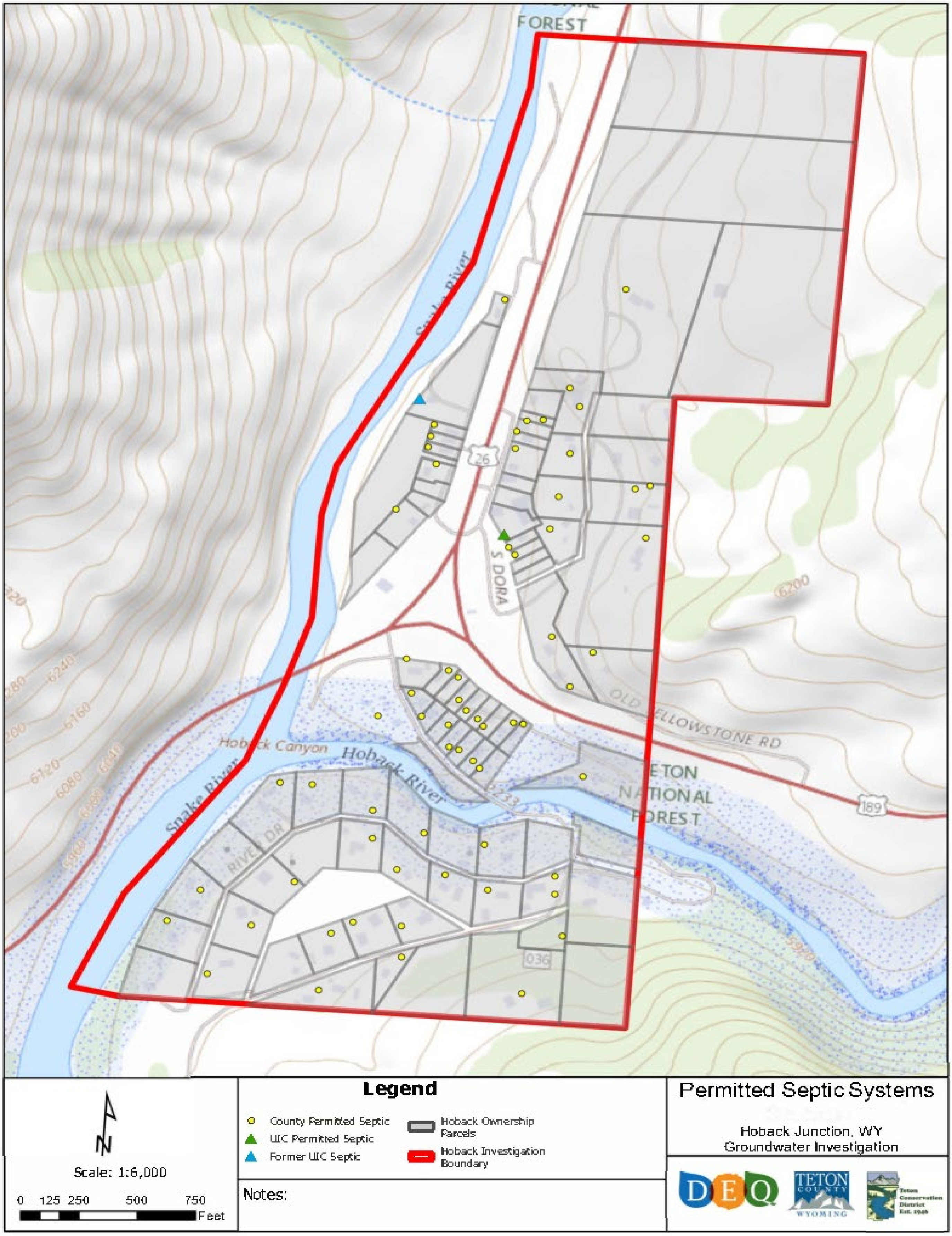

FIGURE 6 PROJECT AREA PERMITTED SEPTIC SYSTEMS

The facility also has received a water and wastewater permit to install a water treatment system to remove nitrates from the water before discharging it into a septic system. The drainfield associated with this system is located under a paved parking lot. However, representatives from the WDEQ Water and Wastewater Section and Teton County Engineering Department determined that the construction of the system was appropriate.

3.2.1.2 SMALL CAPACITY SEPTIC SYSTEMS

Small-capacity septic systems are systems that accept less than 2,000 gpd of domestic waste and are permitted by delegated counties. Teton County, as a county with delegated authority, is responsible for permitting small-capacity septic systems. In the Project Area, approximately 53 small-capacity septic system permits were identified within Hoback Junction and the J-W subdivision by Teton County (Figure 6). In the Project Area there are 279 distinct lots, and 77 of those lots have either a buried septic system, a mounded septic system, multiple types of systems, or advanced treatment systems as designated by Teton County, leaving 202 lots to be defined as either vacant/undeveloped or unknown. The difference between the number of permits provided and the number of lots with systems as designated above leaves 136 septic systems with unknown permit status. It is unknown at the time of this Report the age of the septic systems or whether the existing septic systems are failing.

3.2.1.3 WASTEWATER STRENGTH AND LOADING ESTIMATES

The WDEQ utilizes the Wehrmann Model to estimate nitrate loading from septic systems for subdivisions. This is a double dilution model that considers the dilution of septic effluent by existing groundwater and was developed based on information collected in Illinois. (Wehrmann, 1983) For the Wehrmann model, the WDEQ uses a value of 40 mg/L to represent the nitrate concentration found in standard domestic septic effluent. The use of enhanced treatment system septic systems may reduce the nitrate loading, while disposal of reverse osmosis (RO) brines and low-volume water use systems (e.g., low flow toilets) may cause an increase in the septic system nitrate values (i.e. high strength wastes). Potential impacts to groundwater from subdivision septic system density are estimated based on the size of the development, the number of lots, and the average number of bedrooms for the houses within the development.

Estimates of nitrate loading for the study using the Wehrmann model would not consider the rather complex local geology and would not be able to explain potentially localized areas of high nitrates, as the proximity of a septic system to a water well is not taken into consideration for the model.

3.2.2 AGRICULTURE

Agricultural-related sources of nitrates can include inputs from livestock manure and fertilizer use. There is limited land use in the area related to agricultural purposes. In general, agricultural land uses are limited to small-scale livestock handling such as cows and horses (Figure 7). There are no confined

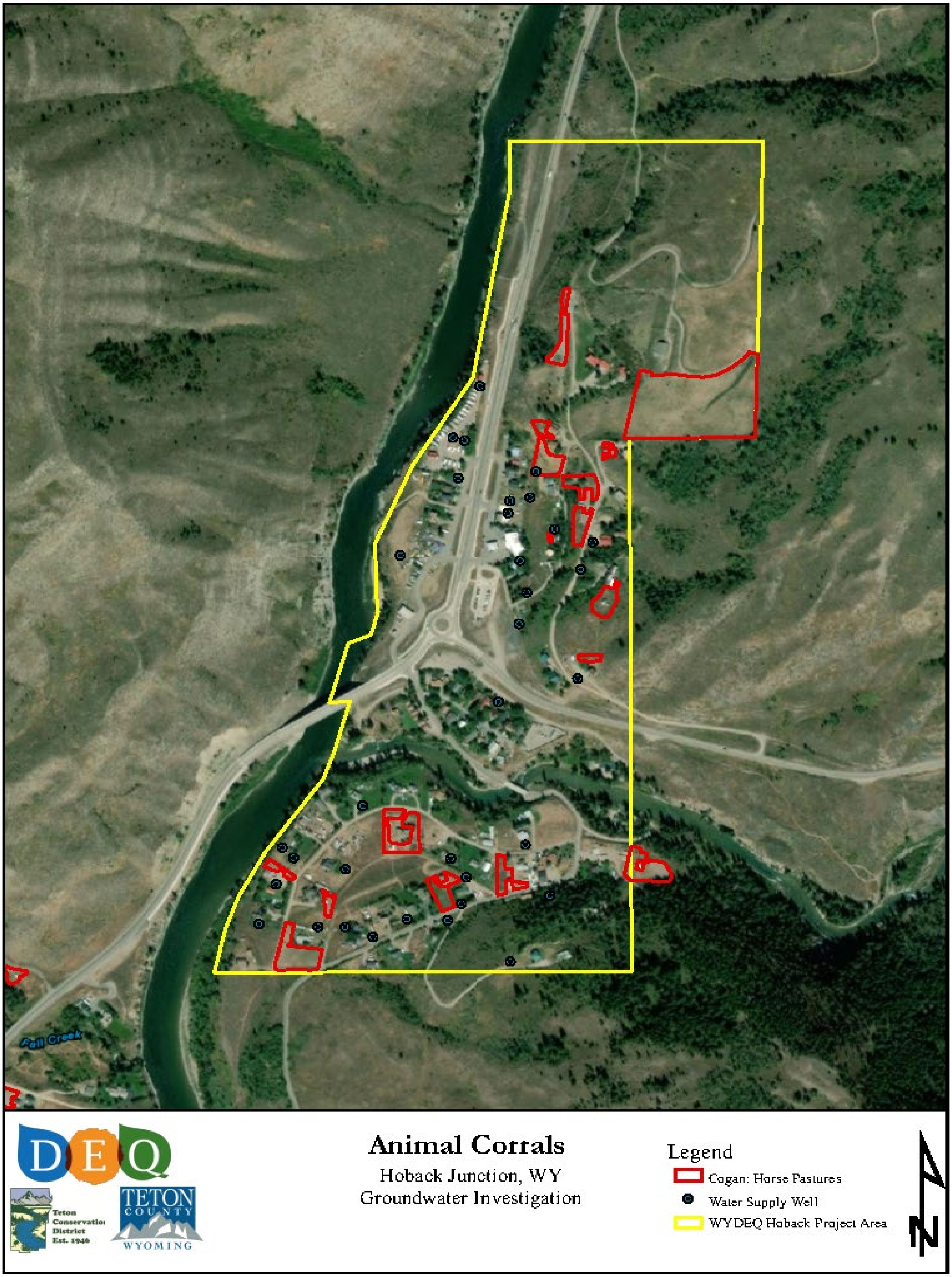

FIGURE 7 PROJECT AREA ANIMAL CORRALS

animal feeding operations in the area or areas of crops that would require fertilizer application. There may be small-scale fertilizers applications by homeowners in the area. Nitrogen loading from cattle manure waste is estimated to be 0.15 to 0.20 kilograms/day (kg/d) for beef cattle and 0.19 to 0.27 kg/d for dairy cattle per animal. (U.S. Environmental Protection Agency, 1991)

3.2.3 NATURALLY OCCURRING NITROGEN/NITRATE

Nitrogen in soils and bedrock (geologic nitrogen) can be sources for nitrogen to leach into groundwater systems (Figure 8). Nitrogen concentrations can be less than 100 milligrams per kilogram (mg/kg) for some granites, to over 1000 mg/kg in sedimentary and metasedimentary rocks. (Holloway & Dahlgren, 2002) Example N_2 concentrations of rudimentary rock types local to the western United States include the Fort Union Shale (300 to 500 mg/kg) and Pierre Shale (hydrothermally altered) 300 to 760 mg/kg. Metamorphic rocks, such as schists, contain concentrations of nitrates from less than 20 mg/kg to approximately 1800 mg/kg. Organic rock types such as coals, marlstone, and oil shales can contain nitrogen ranging from 400 mg/kg to over 14,000 mg/kg. There is no information for the area regarding nitrogen concentrations in bedrock, or soil.

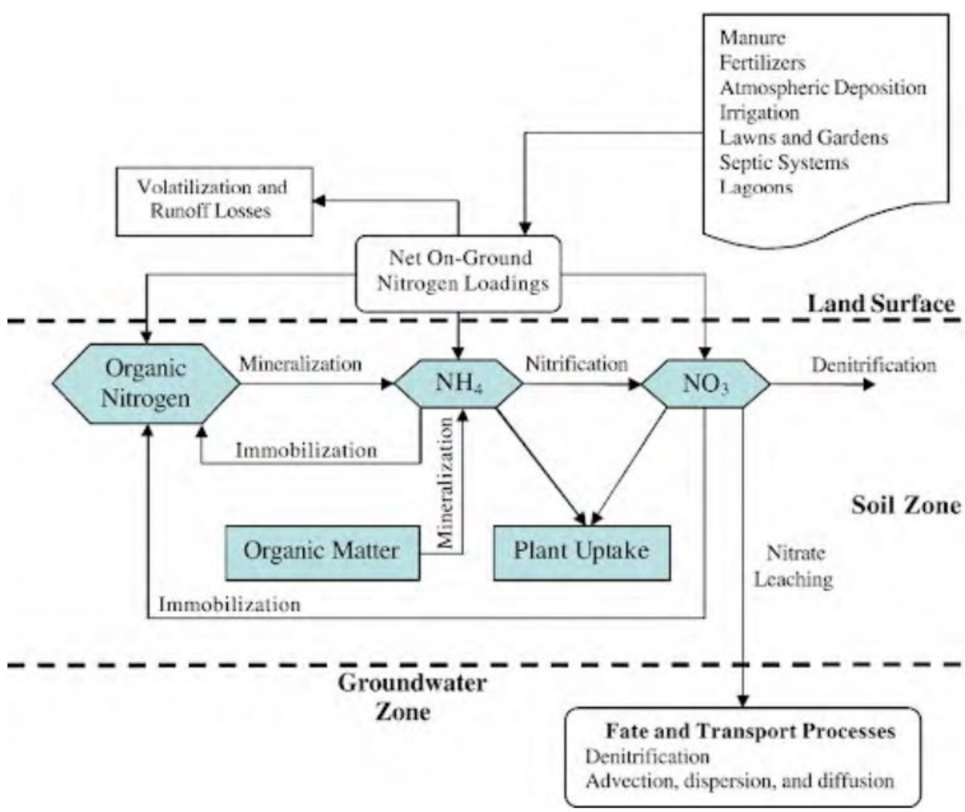

FIGURE 8 NITRATE BEHAVIOR IN THE SUBSURFACE

Additional nitrate input into the groundwater system can come from precipitation. Precipitation information available from the National Atmospheric Deposition Program estimates that the mean nitrate concentration in rainwater in the northwest area of Wyoming is 0.5 mg/L. This results in an estimated annual wet deposition of nitrate at the rate of 2 kilograms per hectare. (National Atmospheric Deposition Program, 2023)

3.2.4 OTHER SOURCES

Other potential sources of nitrate to groundwater within the Project Area could include waste from wildlife and pets, decaying organic matter, surface water, and disposal of water treatment system brines (such as from RO-systems) into septic systems or onto the ground. There is no information for the Project Area regarding the density of pets or wildlife in the area. There are no WYPDES outfalls located within the Project Area. The closest WYPDES outfall is located 1.7 miles upstream of the Project Area. In addition, based on limited sampling data available for the surface water in the vicinity of the Project Area (Snake River and Hoback River), nitrate has not been detected at any significant concentration. Other than disposal of water treatment system brines, the other potential sources are likely to have a limited impact on groundwater nitrate concentrations.

3.3 MIGRATION PATHWAYS AND RECEPTORS

Potential migration pathways for nitrates to receptors are identified and evaluated to assess exposure risks, and identification of incomplete pathways is also conducted.

3.3.1 IDENTIFICATION OF HUMAN AND ECOLOGICAL RECEPTORS

The identification of potential receptors is the key function of the CSM. Human and ecological receptors include those that are impacted or threatened by the contaminant of concern located within the investigation area or present along an identified migration pathway. For the purposes of this project, the human receptor evaluation is the primary evaluation being conducted.

The public is typically exposed to nitrates via ingestion of water and foods that contain the chemical. Inhalation and dermal exposure may be possible; however, these routes are not as prominent. Oral exposure to nitrates from contaminated drinking water and food is the prominent route. (Agency for Toxic Substances and Disease Registry, 2017) The primary population that are currently or potentially exposed to nitrate concerns are the residents and future residents within the Hoback Study area.

3.3.2 GROUNDWATER

Teton Conservation District has assembled groundwater chemistry data from multiple sources, including Public Water Systems with monitoring data available through the USEPA, and private drinking water well data collected through the Teton Conservation District Drinking Water Well Testing Program (Figure 9). A significant amount of data is available within the Project Area, but this data needs to be used carefully, given the potential for any of these water systems to have water treatment. Both public and private drinking water wells could have water softeners or water filters, and in the case of Public

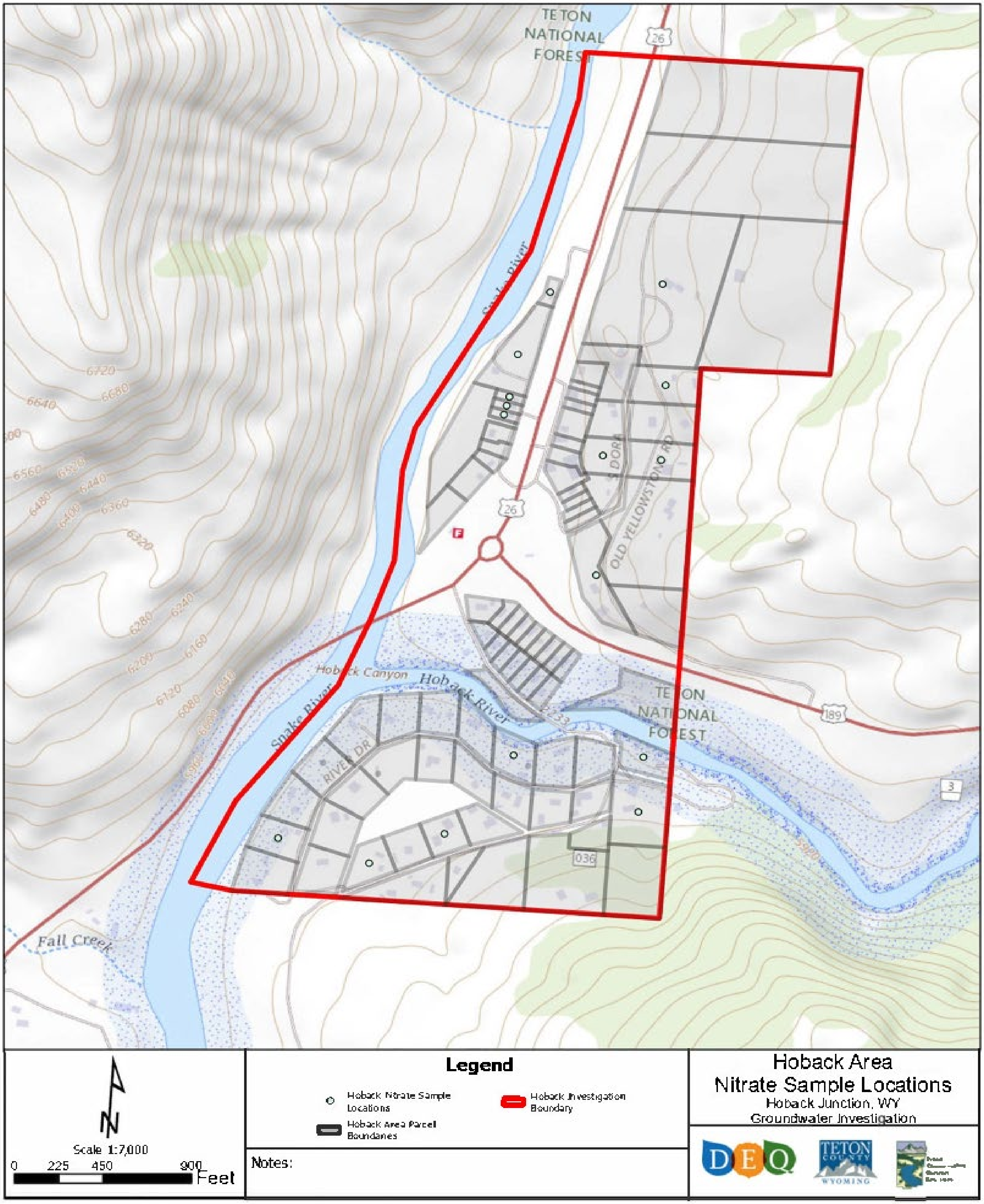

FIGURE 9 PROJECT AREA TETON CONSERVATION DISTRICT DRINKING WATER WELL TESTING PROGRAM LOCATIONS

Water Systems that have experienced high nitrate concentrations, most have been required to install nitrate treatment. Data available through the USEPA for public water systems is collected after treatment, and when observing data from systems with nitrate treatment, nitrate concentrations decrease following the implementation of treatment, but this does not reflect changes in nitrate groundwater conditions.

Data from drinking water wells north of the Hoback River show increasing trends in nitrate, with nitrate exceeding the USEPA MCL of 10 mg/L in some cases. In some cases, nitrite has also been found. Within the Project Area, isolated areas with concentrations of nitrate above background concentrations can be found. In addition, areas of development along Horse Creek and Camp Creek, approximately 1 mile north and 3.5 miles east, respectively, of the Project Area, also exhibit areas of elevated nitrate in groundwater.

Teton County owns property within the Hoback Study Area, and their water system has been monitored intermittently and has data available. Results from Teton County's sampling have not shown exceedance of the nitrate MCL but do show elevated concentrations of nitrate.

3.3.2.1 PRIVATE AND PUBLIC WELLS

In the Project Area, there are 51 water supply wells present, and the permitting authority of the majority is unknown. Of the 51 wells present, 5 are public water supply wells regulated by the USEPA, and five are permitted through the WSEO (Figure 10). Within the Project Area, an analysis of proximity to the known septic systems was conducted using ArcGIS to establish a 100-foot buffer from the centroid of all known leachfields (Figure 11). The number of supply wells within the 100-foot buffers was counted, and 11 wells in the Project Area were identified as being within 100 feet of a leachfield centroid. If this analysis had been conducted from the edge of leachfield the number of supply wells would likely have been much higher. Based on the static water level recorded for 3 of the 5 WSEO wells, the average static water level depth is approximately 60 feet below the ground surface and the seasonal variation of the groundwater elevation is not known.

3.3.3 SURFACE WATER

Surface water receptors for nitrate-related discharges include the Hoback River and the Snake River (Figure 2). Both rivers would be expected to receive flow from groundwater to surface water, and surface water runoff from the study area. No surface water sampling has been conducted in the vicinity of the study area to determine if groundwater discharges are impacting surface water. Surface water sampling in the Snake River downstream of the Town of Jackson wastewater lagoons has not detected significant concentrations of nitrates in the Snake River. Based on the peak in-stream flows of both rivers (228 cubic feet per second (cfs) for Hoback River, and 1,475 cfs for Snake River (U.S. Geological Survey, 2024) potential impacts to surface waters from the study area would likely not be detectable.

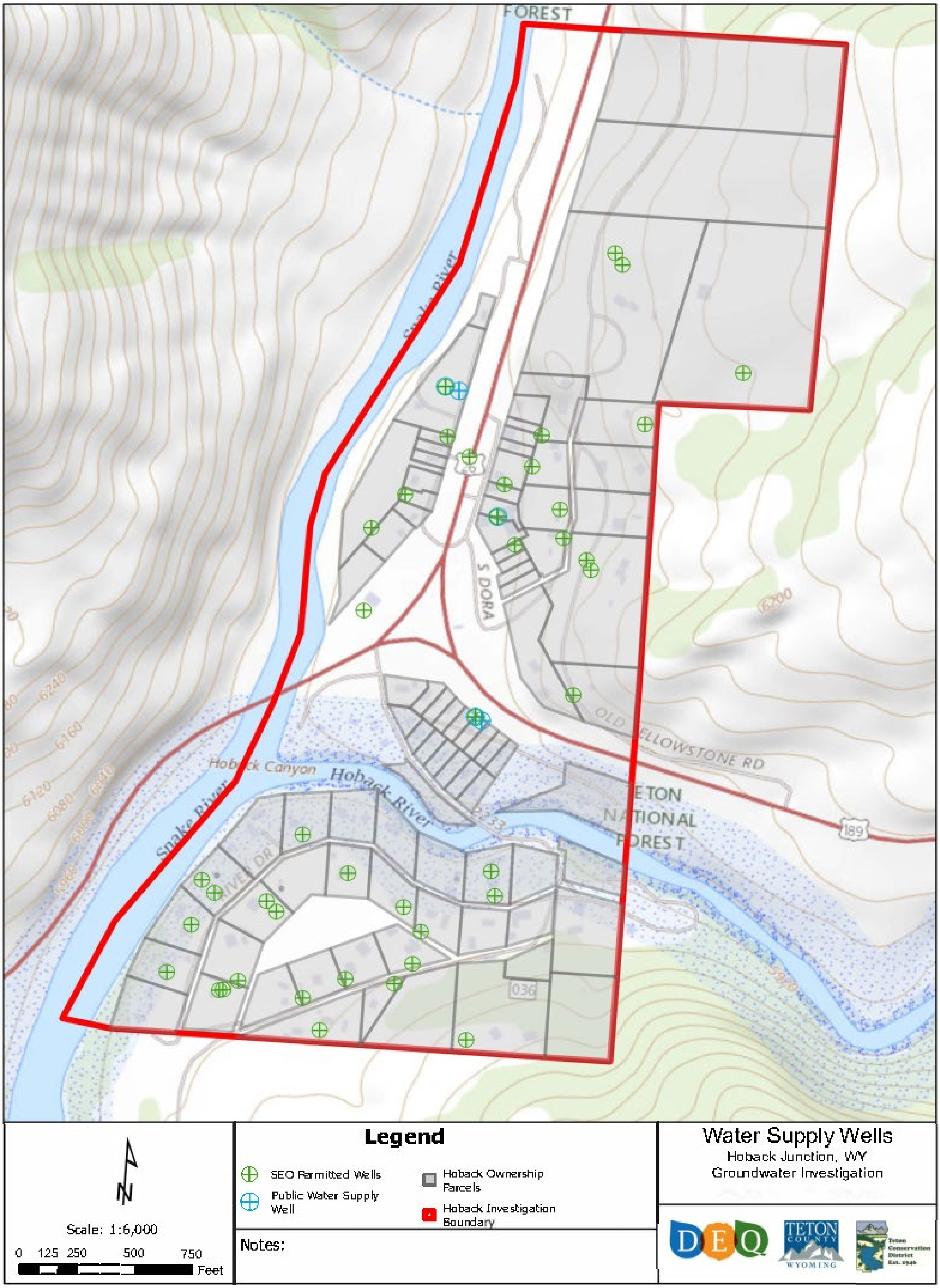

FIGURE 10 PROJECT AREA SEO PERMITTED AND PUBLIC WATER SUPPLY WELLS

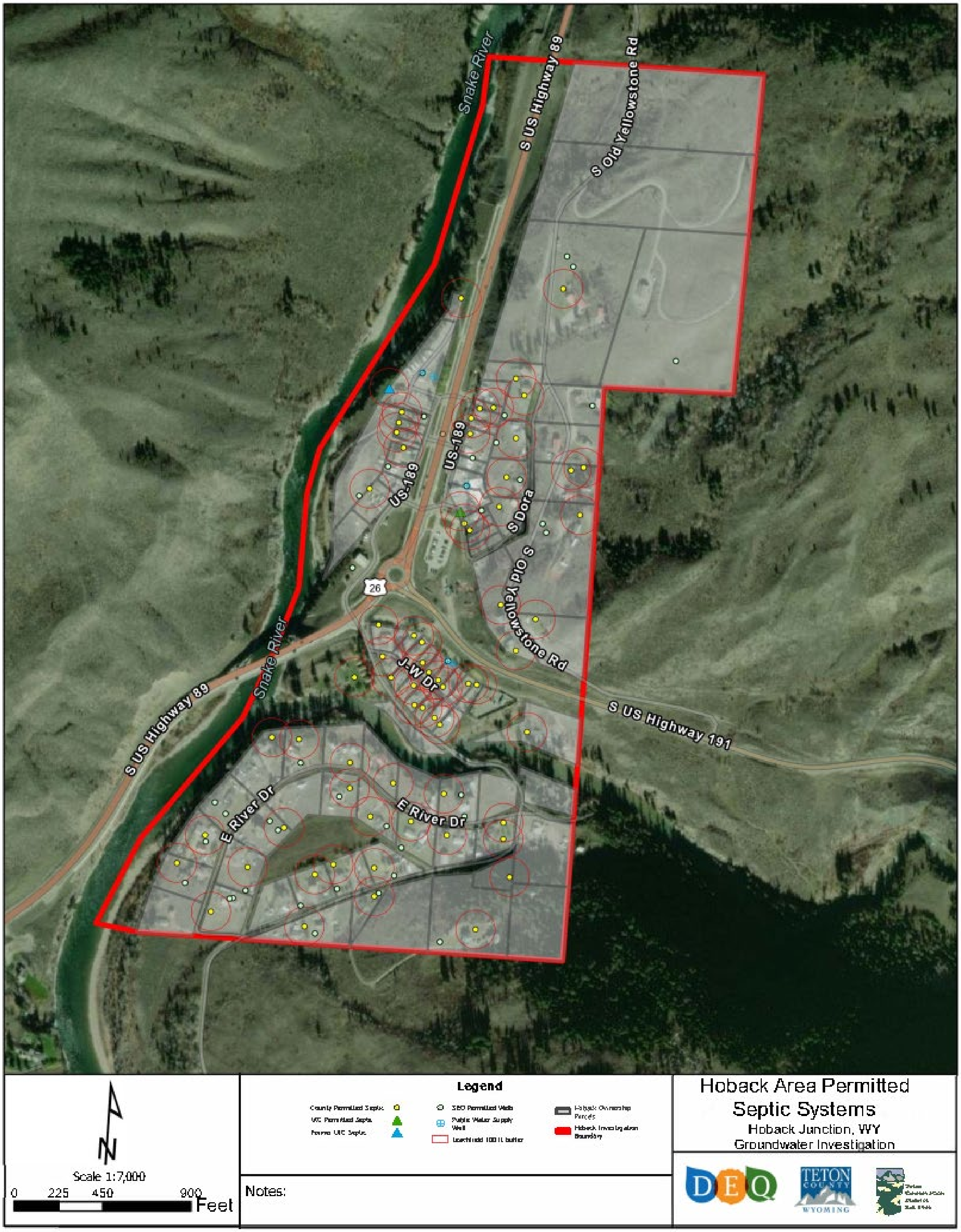

FIGURE 11 PROJECT AREA PERMITTED SEPTIC SYSTEM WITH BUFFER

3.3.4 FATE AND TRANSPORT OF NITRATES IN THE ENVIRONMENT

The transport of nitrogen through the environment primarily occurs by precipitation, dust fall, sedimentation, wind, groundwater, surface water movement, surface runoff, and volatilization.
(U.S. Environmental Protection Agency, 1993) Nitrogen can enter soils from the application of wastewater, sewage sludge, commercial fertilizers, plant and animal matter, and precipitation. In addition, nitrogen-fixing bacteria in the soil can convert nitrogen gas into organic forms usable by plant life. Nitrates can enter groundwater from soil leaching and surface water/wastewater infiltration. Nitrate leaching from the unsaturated zone is complex because it involves a multitude of interacting factors like soil type, rainfall patterns, land use practices, fertilizer application, and groundwater depth, meaning that managing nitrate levels requires careful consideration of these variables to effectively mitigate leaching and protect water quality across different land uses.

4.0 DATA GAPS

Based on a review of the available information, the workgroup has identified a number of gaps in data that could provide additional information for the CSM and assist in characterizing and identifying potential sources of nitrates in the groundwater within the Project Area. In addition, additional detailed information is required to determine a nitrate mass balance that could assist with determining the loading of the various nitrate sources to groundwater (e.g. bedrock nitrogen, plant uptake, precipitation infiltration rates, septic system waste strength).

1. There are three wells located at the Teton County Employee housing property; the data collected was from one well. Construction and location information of the three wells should be reviewed to determine if sampling more than one well would provide additional useful information. Currently, the two wells that were not sampled are not in use and would require redevelopment prior to collecting groundwater samples.

2. The groundwater samples collected by homeowners were screened by the Teton Conservation District and only samples that were assumed to be raw water (i.e., untreated water), based upon the sample's specific conductance and other chemical parameters being within a typical range for the immediate vicinity, were included in this report. However, there is no way to guarantee that some level of treatment hadn't occurred. In addition, these samples were collected by homeowners and while directions were followed and a chain of custody form was used, it cannot be guaranteed that all sampling procedures and best practices for sample collection were followed.

3. Groundwater level information was obtained from the WSEO statements of completion. This data is of limited use as the water levels would have been collected at different times of the year, by various collection methods, and at unknown times after the completion or development of the well. To be able to determine local groundwater flow, groundwater levels would need to be collected from water wells within the study area using the same data collection method, and within a reasonable timeframe.

4. Based on a review of septic system records from the county in relation to developed lots, there appear to be some lots that do not have permitted septic systems or may be utilizing a septic system on an adjacent property. Outreach to property owners within the Project Area would need to be conducted to determine septic system use for these properties.

5.0 CONCLUSIONS

Estimating nitrate loading to the groundwater from the various potential sources was not part of the scope of this project. The purpose of the development of this CSM was to review potential sources that could be contributing nitrate to the groundwater within the Project Area. Based on the results of the data review, it appears that the major known source of nitrates in groundwater is related to the density of domestic septic systems in the area. Other sources of nitrate to groundwater are undetermined (e.g., bedrock contribution), likely minor based on land use (i.e. livestock and fertilizer), or minor based on input (e.g., precipitation).

6.0 RECOMMENDATIONS

In February 2023, the local community of Hoback Junction formed a water and sewer district. The formation of the district will allow the community to pursue funding for studies related to the development of a public water system for the area through WWDO. In correspondence dated October 3, 2024, WWDO reported that it had received a report from Nelson Engineering intended to replace a traditional Wyoming Water Development Program Level II Study and will be used as the basis for a Level III Construction Application.

Based on the results of the CSM, the Workgroup has the following recommendations:

1. Water Sources

    1.1 Based on the potential growth of the area, existing development density, and the limited groundwater in the area, the agencies support the effort of the local community to develop a public water system for the area.

    1.2 If a water system is developed for the Project Area, it is recommended that the community develop a source water protection plan to protect the water system.

2. Waste Handling

    2.1 In addition to the development of a public water system, it is recommended that the community also review the potential for the development of a community-based wastewater treatment system. Key factors to consider include: treatment technology suitability based on local conditions, capacity to handle anticipated wastewater volume, efficient collection system design, cost-effectiveness, environmental impact, ease of operation and maintenance, community engagement, regulatory compliance, and potential for water reuse. The review should take into account the specific needs and constraints of the community, such as land availability, topography, population density, and local regulations.

2.2 If on-lot water wells and small wastewater septic systems will still be used in the Project Area for future development, it is recommended that the county review septic system installation requirements based on factors such as soil analysis (percolation test), terrain, and water usage (household size). Evaluation of such factors may assist in determining whether a conventional system (e.g., septic tank, conventional system, or chamber system) or an alternative system (e.g., mound systems, aerobic treatment unit, or recirculating sand filter system to name a few) would be better suited for use.

3. If a public water system will not be developed for the community, it is recommended that a groundwater sampling program be conducted to determine the extent of nitrate impacts, identify water supplies with nitrate issues, and provide information regarding household water treatment options.

4. Public outreach and information should be developed and made available to the community regarding proper septic system operation and maintenance. This should include proper disposal of any RO-system brines.

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