BILLY CREEK WATERSHED SEPTIC SYSTEM ANALYSIS

February 1, 2024

Sara Chudnoff, PG

Table of Contents

Introduction

The Billy Creek Watershed (Watershed) is located in Southern Navajo County (County) and encompasses the Town of Pinetop-Lakeside (PTLS) and unincorporated portions of the County. Billy Creek Watershed is a 17,835-acre sub-watershed that is part of the larger Little Colorado Watershed, of which 9,468-acres are owned by the United States Forest Service (USFS) (Figure 1). Based on the United States Department of Agriculture (USDA)-USFS Watershed Condition Framework Billy Creek is classified as Functioning at Risk (the watershed is facing some degradation of some watershed conditions), due to poor water quality, aquatic biota and habitat conditions (USDA, 2022). Within the watershed there are two main creeks (Billy Creek and Walnut Creek) that flow E-SE to the W-NW and ultimately converge downstream of Rainbow Lake at the northwestern watershed boundary and converge with Porter Creek at the watershed Boundary. Common concerns and complaints in the community are algae in the lakes, declining stream flows, aging septic systems and a lack of community outreach addressing these issues.

Due to ongoing concerns of water quality and illness caused by septic systems in the Watershed the Pinetop Sanitary Lakeside District (PLSD) was founded in the 1970s. In the 1980's PLSD began construction on a wastewater treatment plant and sewer collection lines. Today there are 6,273 parcels in the Watershed connected to sewer and approximately 2,500 utilizing septic systems (Figure 2). It has been documented in the Watershed that septic systems have negatively impacted the local environment and have contributed to surface water and groundwater pollution. Issues pertaining to septic systems in the Watershed include density, age and the impact on fractured aquifer systems.

In June of 2022 Sara Chudnoff on behalf of PTLS applied for the Arizona Department of Environmental Quality (ADEQ) 604(b) FY21 Water Quality Management Planning grant to address and identify the above concerns within the Billy Creek Watershed. PTLS was awarded $80,000 to complete the project and on November 17, 2022 PTLS passed and adopted Resolution No. 22-1644 accepting the grant. Project work included surface water sampling of the creeks within the watershed, community outreach, spring surveys and a description of hydrogeology of the watershed and a septic system analysis (which is the subject of this report.

Purpose of Septic System Analysis

The purpose of this analysis and report is to utilize known information of the septic systems within the Watershed boundaries to identify the potential for septic system failure and overloading of nutrients and other contamination to the environment, which includes local surface water bodies and groundwater. This report will identify, rank and score the following septic system attributes: density, age, depth to groundwater, parcel size, distance to surface water bodies and distance to private and public supply wells. This identification, ranking and score will be assigned to parcels with septic systems in the watershed. A summary of the total score is available in Figure 10.

This study can also be used as a public outreach tool on the importance of septic system care and expansion of the Pinetop-Lakeside Sanitary District.

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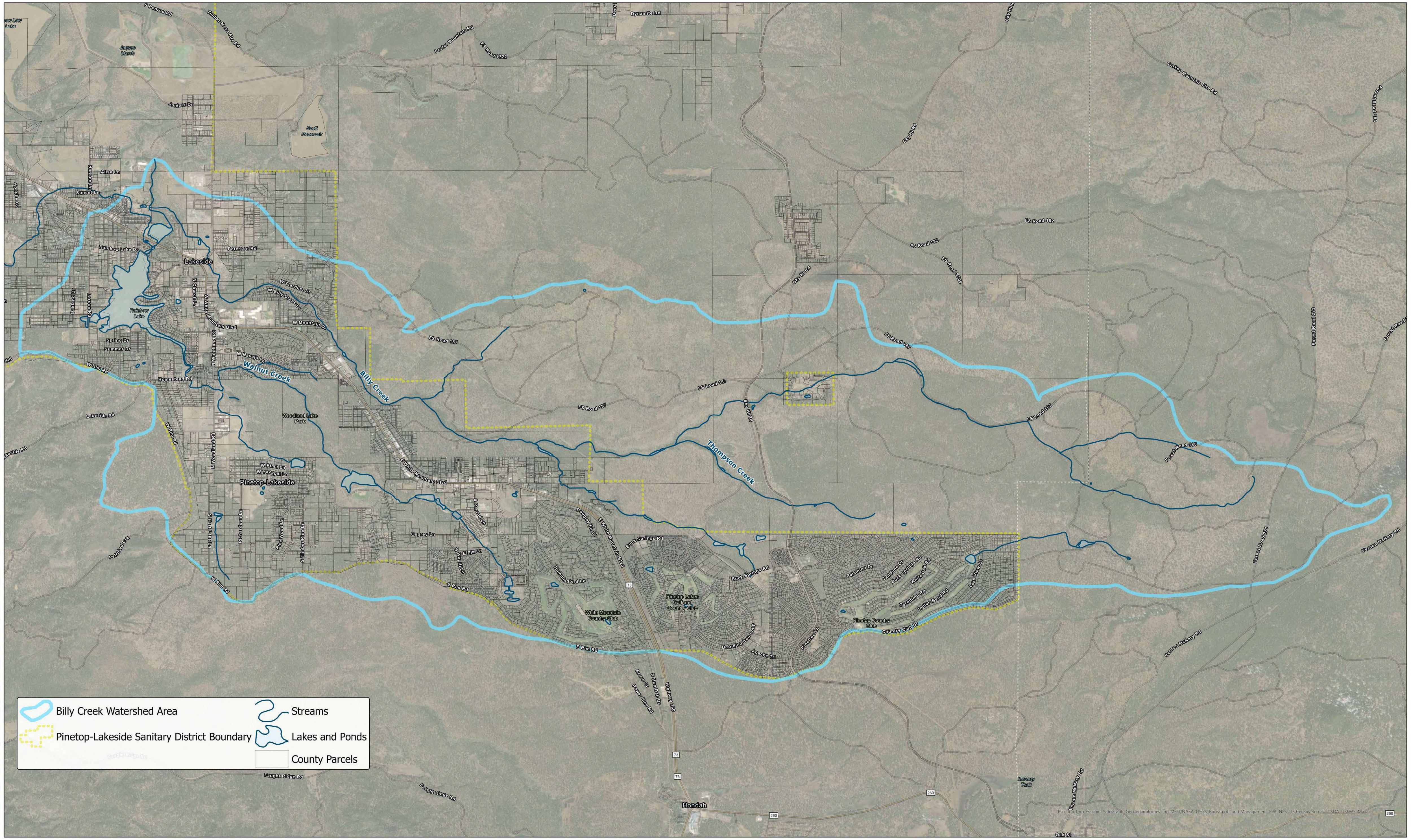

BILLY CREEK WATERSHED ASSESSMENT

STUDY AREA OVERVIEW

PACE Advanced Water Engineering

0 2,000 4,000 8,000 Feet

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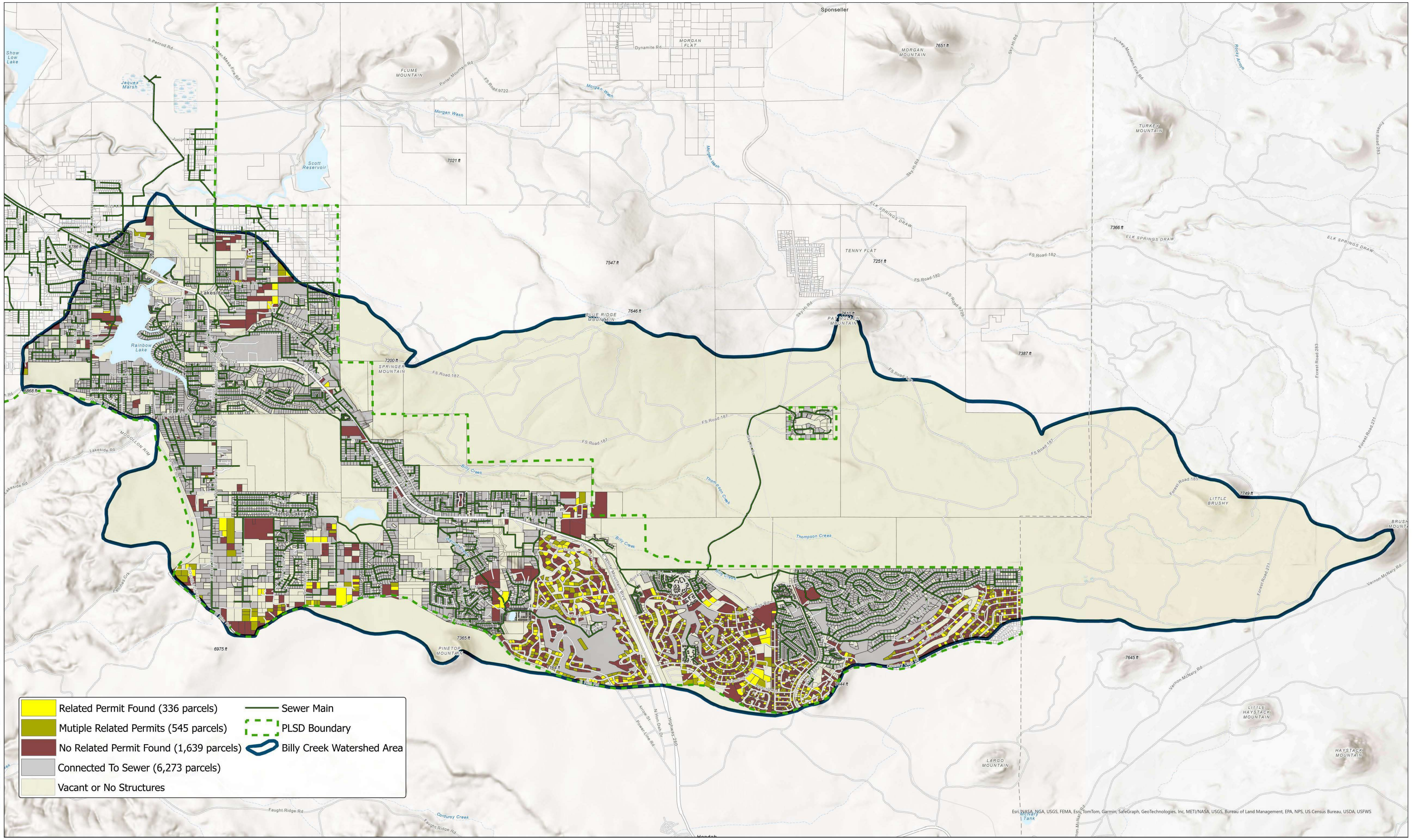
Figure 1



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BILLY CREEK WATERSHED ASSESSMENT

INITIAL PARCELS CONNECTED TO PLSD SEWER

PACE

0 2,000 4,000 8,000 Feet

Date: 1/29/2024

Job Number: C098

Figure 2

Background

In August 1977 the Environmental Protection Agency (EPA) with cooperation of the Arizona Department of Health (ADH) and the Arizona National Guard (ANG) published Working Paper No. 734 regarding eutrophication (too much nutrients) in Rainbow Lake. This report concluded that Rainbow Lake was eutrophic and nutrient rich as a result of phosphorus and nitrates, from direct discharge and non-point source from septic systems.

On April 7, 1984 *Microbial Contamination of Groundwater in the Pinetop-Lakeside Area of Northern Arizona* authored by Carl Mohrbacher et al., was published in the Hydrology and Water Resources in Arizona and the Southwest Journal. Due to "occasional outbreaks of gastroenteritis during the summer vacation period. The Arizona Bureau of Water Quality control [sic] conducted a well-sampling project to determine the extent of bacterial contamination" (Mohrbacher et al., 1984) in the local aquifer. The aquifer is "thin soils and fractured crystalline rock aquifers," which subsequently makes the aquifer "vulnerable to biological degradation" from the many on-site septic systems (Mohrbacher et al., 1984).

This report summarized the results of 20 wells that were sampled in September and October of 1983 over the course of three weekends (two sampling events when it was dry and one sampling event after a multi-day rainstorm). The wells were sampled for "coliforms, fecal coliforms, fecal streptococci, coliphages, enteric viruses, and various physical and chemical properties" (Mohrbacher et al., 1984).

The study found that "microbial contamination of the groundwater was observed, which increased dramatically after a period of heavy rainfall" (Mohrbacher et al., 1984) in 90% of the wells sampled, indicating rapid downward transport of contaminants from the surface into the aquifer.

In 1994 Rainbow Lake was listed as an impaired water due to excessive nutrients and numeric pH and in June 1999 the Arizona Department of Environmental Quality (ADEQ) published Open File Report 09-02 *Total Maximum Daily Load For Rainbow Lake*, prepared by Tetra Tech, Inc. The study focused only on the Rainbow Lake sub-watershed for the following:

1. Source analysis for loading
2. Development of a nutrient mass balance for Rainbow Lake
3. Link pollutant loads to water quality endpoints
4. Assign loading to source categories

This report calculated watershed nutrient loading from the following:

1. Rural Land Use
2. Residential and Commercial Loads
3. Groundwater Loads
4. Septic System Loads

One of the biggest limitations in the report was that no accurate information for septic systems was available, therefore the number of septic systems used in the modeling for nutrient loading was undercounted. Modeling also assumed that all septic systems were properly constructed and that there was no impact from phosphorus, and as a result likely underestimated nitrate loading from septics.

The report recommended several measures to be implemented to reduce nonpoint source pollution to Rainbow Lake and its tributaries. This included a septic survey and expansion of the Sanitary District, implementation of a program to educate residents on best management practices for land use (soil amendments) and direct measures at Rainbow Lake to mitigate issues. The report also recommended a water quality monitoring program at Rainbow Lake to see if objectives of the report were being met.

After publication of this report several measures were undertaken at Rainbow Lake to help reduce algae and other excessive plant growth and monitor water quality. David Newlin, Executive Director of the Little Colorado River Plateau Resource Conservation and Development (RC&D) and Co-Chair of the Rainbow Lake Coalition was actively involved with the implementation of projects to address the algae and plant growth at Rainbow Lake. For preparation of the 604(b) grant proposal Mr. Newlin was consulted in the summer of 2022 to discuss the treatment history of Rainbow Lake. A number of measures were taken such as weed harvesting and adding additives to the water. Between these measures, drought, and the introduction of the white sterile Amur carp, phosphate and nitrate levels dropped in Rainbow Lake and algae and plant growth declined significantly. During this time residents formed the Friends of Rainbow Lake (Rainbow Lake Coalition*)* and began to collect water samples for analysis of coliforms, temperature and pH.

In 2018 the group worked with ADEQ Arizona Water Watch (AWW) to put together a sampling plan and in 2019 Friends of Rainbow Lake discontinued monitoring for AWW. The reasons for this discontinuation were discussed with Meghan Smart with the ADEQ AWW program in the summer of 2022 and Mr. Newlin. According to Ms. Smart due to Walnut Creek's intermittent flow it was difficult for volunteers to get out during storm events to collect water samples. She did express the need for wet-dry mapping in the area. According to Mr. Newlin the group lost interest since the mitigation measures at the Lake were successful.

The work done at Rainbow Lake has been successful, but has not addressed a reduction of nonpoint source pollution in the watershed. Because there has not been a reduction of nutrients in the watershed the following is still occurring:

- Algae and plant growth is still observed in Pine Lake and Woodland Lake, indicating excessive nutrients are still prevalent in the watershed.
- Monitoring on Walnut Creek and Billy Creek has not been implemented, and monitoring efforts that were focused at Rainbow Lake have ceased.
- Homes continue to be built utilizing septic systems throughout the watershed.
- Widespread outreach and education about how to properly care for your septic system is not available through the County or PTLS.
- A push for expansion of the Sanitary District has not occurred.
-

Dave Smith, manager of PLSD, was consulted in the summer of 2022 to discuss the history of PLSD and how growth occurs. PLSD formed in the 1970s and the first treatment plant and sewer lines were constructed in the 1980s. In the last ten years the PLSD has grown 1% to 2% a year, with around 800 new connections (approximately 214 septic systems were installed in the watershed over this same period). A key constraint is who is responsible for covering infrastructure expansion costs? The cost to annex into the PLSD can be quite cost prohibitive and cumbersome. Property owners adjacent to a main must connect, and at the time of this report the hookup fee was $6,522.00. Property owners adjacent to the district may request annexation into the district and must cover the annexation cost ($5,682.00 per acre) in addition to the hookup fee and all related construction (at the time of this report it was estimated that the cost to extend a main was $200/foot). For better overall planning PLSD prefers that an entire neighborhood is annexed, rather than annexing one home at a time. For a neighborhood or group of continuous properties to annex, two-thirds of the property owners must vote in favor and then collectively subsidize the costs of annexation, construction, and connection fees.

Septic Systems and Water Quality

Septic System Overview

In the 1860's John Mouras, a French homeowner invented the first septic system, which he then went on to patent in 1881 (Central Arizona Governments, 2020). Today, approximately 25% of households utilize septic systems or cluster systems (UF/IFAS, 2020). A septic system serves one household and a cluster system treats between 2 and 10 households. For the purpose of this report we will be discussing and focusing on the three types of septic systems; conventional, alternative and innovative.

A conventional system has two components; a holding tank and a leach field. This system "relies upon gradual seepage of wastewater into the surrounding soils, these systems can only be considered where favorable soil characteristics and geology exist for treatment and subsequent disposal of the treated wastewater into the environment" (EPA, 1999). Favorable soil characteristics include "thickness of unsaturated soil (i.e., depth to water table), permeability, texture, and clay mineralogy" (Toor et al., 2020). A conventional system that is well maintained and properly designed and constructed will remove approximately 30% of the nitrogen that passes through it (Albertin, 2021).

When "favorable soil characteristics" and other factors such as lot size, septic system density, depth to water, or background groundwater quality do not exist, an alternative or innovative system is utilized. Alternative or innovative systems utilize additional features such as in-situ treatment to increase bacteria activity, introduce additional soils for the leach field, or implement a leach field dosing schedule. An alternative or innovative system when properly designed, constructed and well maintained, will remove 50% to 80% of the nitrogen that passes through it (UF/IFAS, 2023).

According to the EPA a properly sited, designed, constructed and maintained septic system has an average lifespan of 15-40 years. Under the same criteria the UF/IFAS estimates an average lifespan of 30 years, and the Maryland On-Site Sewage Disposal Task Force estimates an average lifespan of 12-20 years. Arizona Regulation A.A.C. R18.9-A312.B.1 states that a septic system should be designed to "satisfy a 20-year operational life" (A.A.C. R18.9-A312.B.1). In addition to septic system construction, ongoing maintenance includes inspecting and pumping the holding tank every 3-5 years, or more frequently, depending on the size of the household. Proper operation includes refraining from flushing anything but human waste and toilet paper, reducing or eliminating the use of a garbage disposal, ensuring nothing is poured down the drain. The use of chemical drain cleaners may kill or harm the organisms in the septic tank and potentially get into nearby surface water sources or the local aquifer. The leach field must also be maintained and protected such as safeguarding that vehicles do not drive over or park on the it, ensuring no plant roots are close enough to grow into it, and ensuring excess water is not flowing over it in great quantities or velocities (EPA, 2024).

Septic system failure is when a system no longer functions as designed and elevated levels of contaminants are released to the surface and/or subsurface. Septic system failure may occur when a system is not properly maintained, was not properly designed or constructed, or has reached its life expectancy.

Water Quality Concerns

Regardless of what type of system is installed, removing 100% of the pollutants is not possible and therefore all septic systems are a nonpoint source pollutant. Septic system leachate is known to be a source of nitrates, phosphates, pathogens, heavy metals, household chemicals, PFAS (Polyfluoroalkyl substances), "pharmaceuticals, personal care products" (Schaider et al., 2016) and other organics are introduced to the subsurface.

In the early 2010s the Silent Spring Institute conducted a study to analyze organic wastewater compounds (OWCs) in domestic wells in Cape Cod, MA. Within the region, 80% of the residents rely on septic systems and 20% rely on domestic wells. For this study 20 wells with varying housing density (<0.1 – 2.3 homes per acre) and nitrate and boron concentrations were selected for sampling and analysis of 117 OWCs (many of the OWCs sampled for do not have Maximum Contaminant Levels (MCLs) established by EPA). Of the 20 wells sampled, 50% were found to be highly impacted by nitrate, 85% had at least one OWC in detectable concentrations, and seven or more OWCs were detected in 25% of the wells. Of the OWCs detected the most common was acesulfame (an artificial sweetener).

Additionally, 65% of the wells had detectable pharmaceuticals, >50% of the wells had at least one of the following PFAS: PFOS, PFHxS, PFBS and PFHxA, 30% of the wells had PFHpA, and 30% of the wells had all 5 types of PFAS listed above. This report concluded that it "is the first study to show PFASs in domestic wells that are not impacted by production facilities, aqueous fire forming foams, or aviation sources" (Schaider et al., 2016). Likewise, the detection of nitrate, boron and the artificial sweetener further supports that "domestic well water quality is affected by OWCs from septic systems" (Schaider et al., 2016).

While the Silent Spring's study focused on domestic wells between 10 and 132 feet deep in sand and gravel aquifers, several other studies have looked at the age of the groundwater relative to detectable contaminants. A California study published in 2011 summarized the results of 1,231 sites that were sampled in the State for general chemistry and pharmaceuticals. The study found that "occurrence of pharmaceutical compounds was found to be strongly correlated with the presence of modern water" and not the depth of the well (Fram et al., 2011). Modern groundwater is "defined as groundwater comprised of precipitation that fell more recently than the year 1953" (Thaw et al., 2022).

This is an important metric to examine as it shows contamination from land-use at the surface can impact deep wells that are thought to be protected by thick overburden. While there are multiple factors, the most important is the flow path. Surface water and contamination will flow faster through a fractured system than sand and gravel. This is especially pertinent to Billy Creek Watershed, where there are thin soils overlaying fractured basalt and sandstone aquifers. Additionally "groundwater pumping can speed up downward flow rates and enable groundwater to reach deep depths while it is still young enough to be considered modern" (Thaw et al., 2022), which is problematic since modern water typically contains contaminants.

Local regulators typically oversee the permitting of septic systems within their jurisdiction. Many use a minimum vertical and horizontal setback, which is problematic as the "setback distances are intended to ensure a minimum residence time for septic tank leachate to the subsurface that allows decay, absorption and dilution of chemical and microbiological contaminants…However, the prescribed distances may fail to protect water quality in two ways: The physical assumptions used to estimate the residence time may be incorrect, leading to subsurface residence times that are too short to allow contaminant decay; or the prescribed residence times themselves may be too short to allow sufficient remediation of septic tank leachate" (Bremer et al., 2012). This is also flawed as it does not take into consideration the groundwater flow direction and pumping zone of influences.

Billy Creek Watershed Septic System Analysis

Land Use and Septic System Design Considerations

In order to protect human health, groundwater and surface water sources a number of factors should be considered prior to the approval of a conventional or alternative septic system. Navajo County has been delegated by AZDEQ to permit septic systems within the County. The County is responsible for ensuring the Arizona State regulations for septic systems are followed. The following section will discuss how septic system density/lot size, depth to water/supply well setback/flow direction, distance to nearest stream are evaluated by the County when permitting a septic system and how that may lead to unwanted contamination to local surface water bodies and groundwater.

Density/Lot Size

On the Navajo County website a "Notice of Intent to Discharge Under a General Aquifer Protection Permit for an On-Site Wastewater Treatment Facility" (NOI Permit) is available. Nowhere in this application is septic system density evaluated. A document was published by Navajo County and was reviewed in 2008 titled "Navajo County Septic System Protocols and Guidance Manual for Understanding Septic Systems", this document is no longer available on the Navajo County website (as of January 2024). Within this document on page 8 under the "Site Suitability" it states: "Developments must be within acceptable density limits of on-site systems, and within the capacity of the soil and aquifer to accept wastewater discharges," (Navajo County, 2008). Navajo County was contacted to explain the meaning behind this statement and as of the date of this publication they have not provided a response.

Other entities have provided recommended density limits for septic system, most notably the U.S. Congress Office of Technology Assessment (OTA) which stated "Major factors affecting the potential of septic systems to contaminate groundwater in general are the density of systems per unit area and hydrogeological conditions. Areas with a density of more than 40 systems per square mile (1 unit per 16 acres) are considered regions with potential for contamination" (OTA, 1984).

In December of 2004, Dennis McQuillan, et al., with the New Mexico Environment Department published "Hydrogeologic Analysis of On-Site Septic System Lot Size." The purpose of this publication was two-old: model nitrogen mass loading from areas developed with septic systems and the impact to background water quality and summarize 10 studies that evaluated septic system lot sizes and the impacts to water quality. Results of the summary showed areas within the State of Mexico where 1.5 acre lots had groundwater impacts to the background water quality in excess of 10 mg/L. The significance of nitrate values of 10 mg/L, is that is the maximum contaminate level set by the EPA.

Hansen Allen & Luce, Inc. (HAL), an engineering firm in Utah was contracted to complete a septic density study of Tooele County in Utah. The subsequent report summarized 14 water quality studies related to septic systems that were done throughout the United States (summary can be found on page 2-2 of the report). All 14 reports "confirm that excessive densities of septic systems can result in water quality degradation" (HAL, 2016). In 2022 the Utah Geological Survey completed Report of Investigation 284 "Analysis of Septic-Tank Density for Four Communities in Iron County, Utah." This work focused on using a mass-balance approach to recommend a suitable septic density that would not degrade the background nitrate water quality by more than 1 mg/L. The recommended densities that this report came up with ranged from 5 acres per system to 23 acres per system (Schlossnagle et al., 2022). Simply put "systems that are sited in densities that exceed the treatment capacity of regional soils…can cause problems", (EPA, 2024).

Depth to Water/Supply Well Setback/Flow Direction

Minimal vertical distance to the high-water table has been defined by the State of Arizona. A minimum setback of 100-feet from any private or public supply well, and 200-feet from a surface water source that serves as a drinking water intake must be met. However, the State and Navajo County do not require any information regarding groundwater direction in their NOI Permit. In many of the reports cited here, depth to water, setbacks, groundwater flow direction and the local hydrogeology should be considered together when permitting a system. As discussed above it is known that septic systems do not provide complete treatment of all waste flowing into it. The subsequent plume that occurs underneath a leach field will move downward, sometimes rapidly post-precipitation as seen in the 1984 Mohrbacher publication, and then laterally once it enters the aquifer. Even at a minimum setback of 100-feet from a well there is potential that a shallow well or a deep well in a fractured bedrock aquifer system may have a zone of influence that overlaps with the leach field.

Distance to Nearest Stream

The State and Navajo County require a minimum setback from perennial and intermittent streams of 100-feet. Once again this is assuming sufficient treatment by soils before the partially treated water released from a leach field reaches a perennial or intermittent stream.

Analysis and Results

To evaluate the potential for septic system failure and overloading of nutrients and other contaminates to the environment within the Watershed an analysis was completed to score the following attributes at each parcel (listed from most critical to least): density, age, depth to water, lot size, distance to nearest stream, distance to nearest well. Based on research done for this report and the many studies cited and discussed above, it was important to weight (multiplier of influence) some attributes more heavily than others, as they will have a greater impact to the environment (Table 1). Each attribute was broken down into 5 sub-categories and then assigned a score. PACE Advanced Water Engineering was contracted to model the attributes in ArcPro and produce figures for this report. Through the duration of the modeling and production, Sara Chudnoff provided technical support and data where needed.

Table 1: Attributes Utilized for Analysis of Parcels with Septic Systems

Attribute	Score = 1	Score = 2	Score = 3	Score = 4	Score = 5
Density - per acre (multiplier of 5)	1	2	3	4	5 or more
Age of System – years (multiplier of 3)	</= 10	10-20	20-30	30-40	>/= 40 years
Depth to Water-feet (multiplier of 1.5)	>200	150 - 199	100 - 149	50 - 99	</= 49
Lot Size - acre	>/= 1	</= 1 to ¾	</= ¾ to ½	</= ½ to ¼	</= ¼
Distance to Nearest Stream - feet	>/= 401	301 - 400	201 - 300	101 - 200	</= 100
Distance to Nearest (Permitted) Well - feet	>/= 401	301 - 400	201 - 300	101 - 200	</= 100

Data Collection

PACE has an established relationship with PLSD to develop a cloud-based database of the sewer lines, infrastructure and connections. For this report the sewered lot information was obtained from the PACE/PLSD.

Septic permit information was obtained for 881 parcels from Navajo County. For all parcels with associated septic information (new install, inspection, repair, etc.) they provided (where available): APNs, parcel address, XY coordinates, open and close dates, comments and additional data. This information was used to identify parcels with septic system and system age. If a permit close date was available, it was used to calculate the age of the system. If the close date was not available, the permit open date was used.

1,631 parcels with dwellings did not have septic information available from Navajo County. For these parcels an assumption was made that the age of the dwelling onsite would correspond to the age of the septic system. Navajo County Assessor's office provided APNs and building dates for all of these parcels, and those building dates were used to calculate the assumed age of the septic system on site. In consideration of time and budget, visual confirmations were not completed at all sites.

Depth to water was obtained from the ADWR Well Registry (Wells 55). All well information from this registry was downloaded into an Excel file, and wells with no known elevation or water level were removed. The compiled information was uploaded into ArcPro, where there was a known depth to water within a quarter mile. The ArcPro inverse distance weighting tool was used to project depth to water at that parcel.

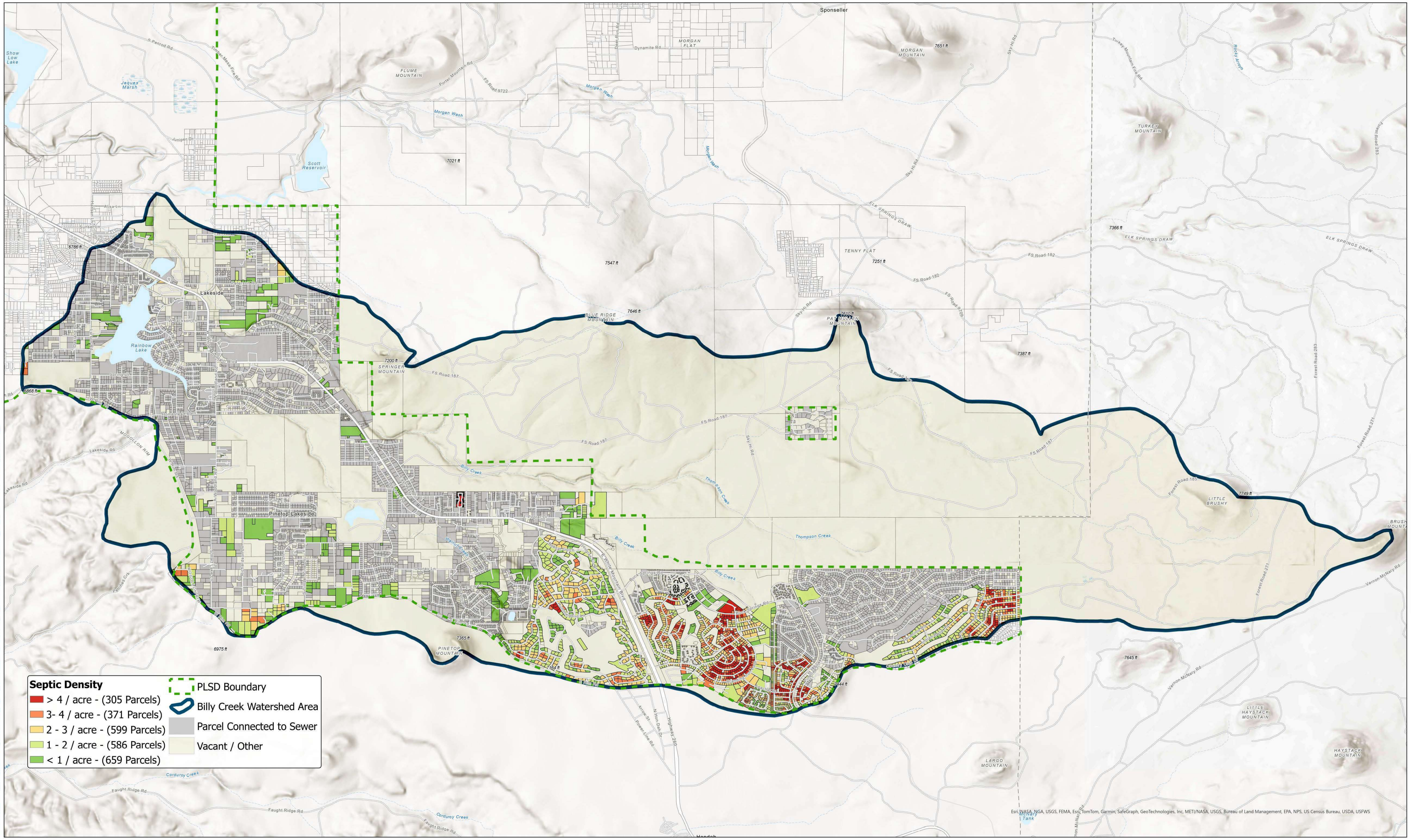
ArcPro was used to calculate parcel sizes based on local coordinates.

Distance to surface water was derived from streams and water bodies in the National Hydrography Dataset.

Wells 55 and the Arizona Groundwater Site Inventory (AGSI) within, and near, the boundaries of the Watershed were used to find the distance to the nearest well. Many wells in the Wells 55 dataset are mapped with township, range and section, and do not represent precise locations. The degree of accuracy of this dataset and its influence on each attribute listed below is unknown.

Density

As cited by the OTA in 1984 more than 1 system per acre has the potential to contaminate the environment. A summary of 14-studies completed by HAL in 2016 “confirm that excessive densities of septic systems can result in water quality degradation” (HAL, 2016), and a mass-balance approach taken by Utah Geological Survey recommended between 5 and 23 acres per system to prevent additional degradation of the aquifer. Figure 3 is the septic density within Billy Creek Watershed. Of the 2,520 parcels with septic systems, 75% of those parcels have multiple septics nearby which amounted to system densities between >4 and 2 systems per acre, far exceeding any recommended density.



BILLY CREEK WATERSHED ASSESSMENT

BILLY CREEK WATERSHED
SEPTIC SYSTEM DENSITY

0 2,000 4,000 8,000 Feet

Date: 1/31/2024

Job Number: C098

Figure 3

Age

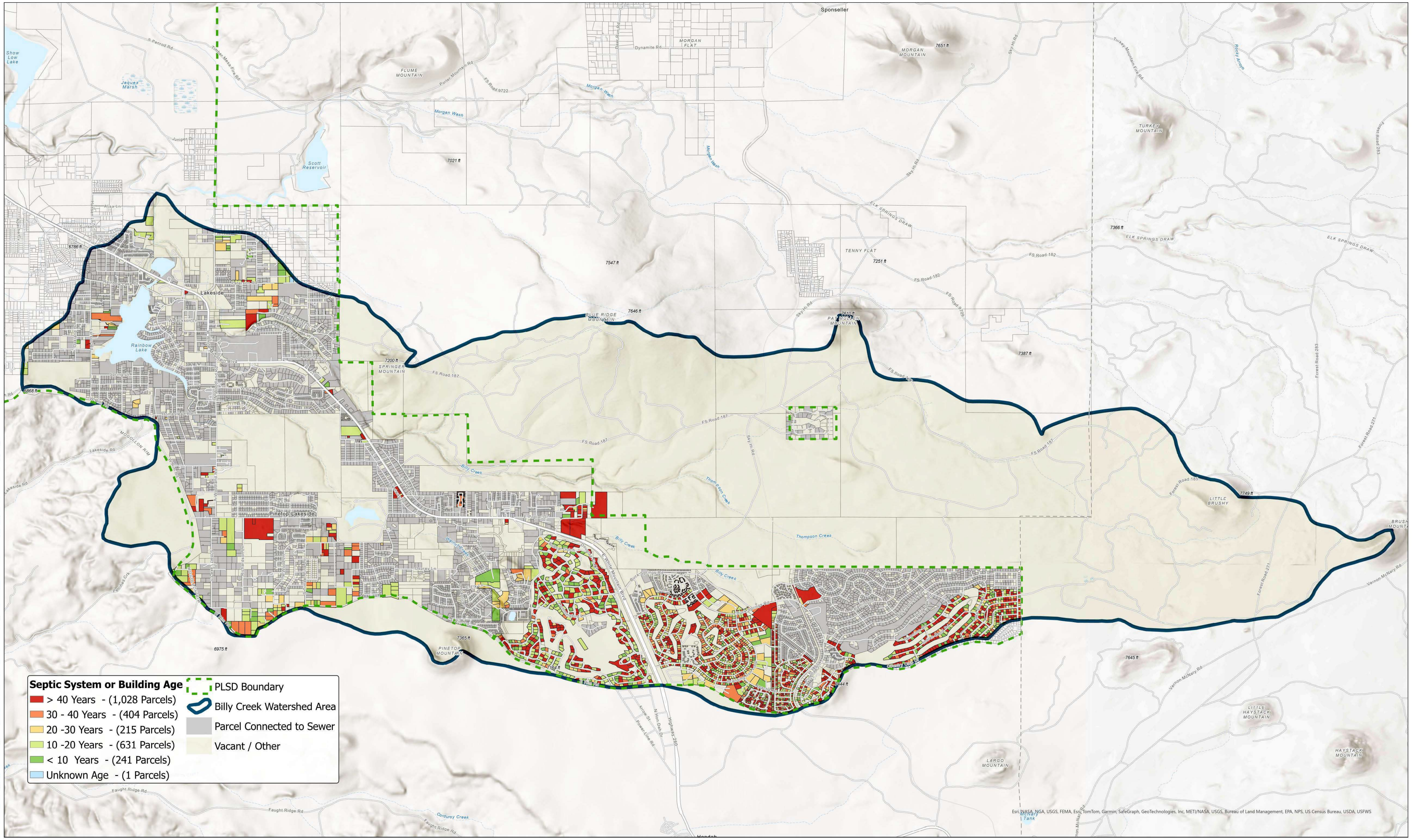
A properly sited, designed, constructed and maintained septic system has an average lifespan of 15-40 years (EPA, 2024). Arizona Regulation A.A.C. R18.9-A312.B.1 states that a septic system should be designed to "satisfy a 20-year operational life" (A.A.C. R18.9-A312.B.1). Neither the State nor Navajo County has implemented programs to ensure proper maintenance occurs at the frequency noted, nor do they require replacement or inspection after the 20-year operational life. Figure 4 is the age of the septic systems in the watershed, 66% of the systems are over 20-years old, indicating they may have surpassed their designed life expectancy.

Groundwater Depth

A vertical separation between the leach field and top of the seasonally high water table is specified by the County. Figure 5 shows the modeled depth to water at parcels within a quarter mile of wells with available depth to water and elevation information. 91% of the parcels have a depth to water >100-feet.

Parcel Size

Navajo County does not have a minimum lot size for septic systems, however setbacks will drive the size of a lot. Previous studies have shown impacts from septic systems on lots as large as 1.5 acres to the aquifer. Figure 6 shows the lot sizes for all parcels with septic systems. 92% of the lots with septic systems are less than 1-acre in size.



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BILLY CREEK WATERSHED ASSESSMENT

BILLY CREEK WATERSHED
SEPTIC SYSTEM AGES

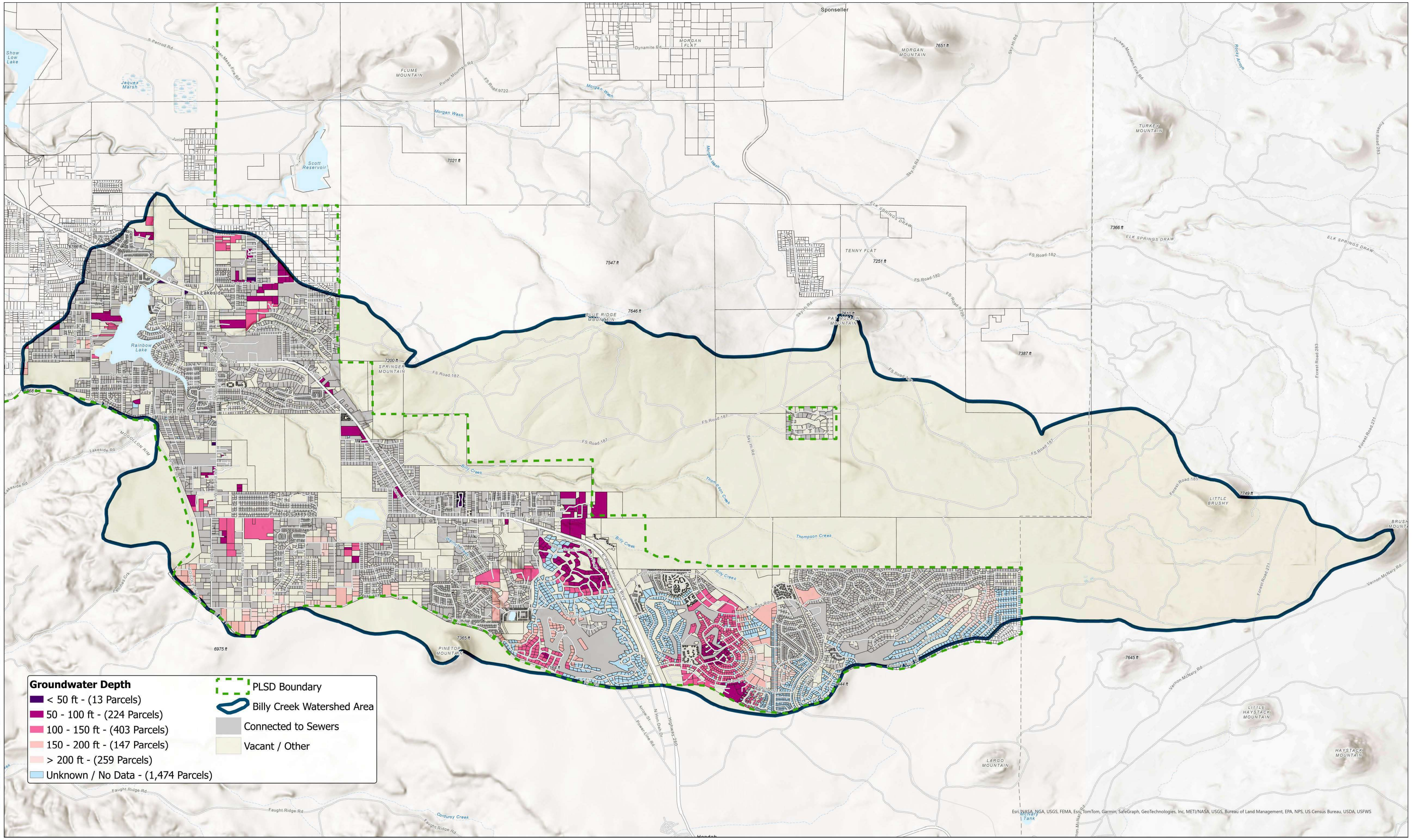
PACE Advanced Water Engineering

0 2,000 4,000 8,000 Feet

Date: 1/29/2024

Job Number: C098

Figure 4



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BILLY CREEK WATERSHED ASSESSMENT

BILLY CREEK WATERSHED
GROUNDWATER DEPTH

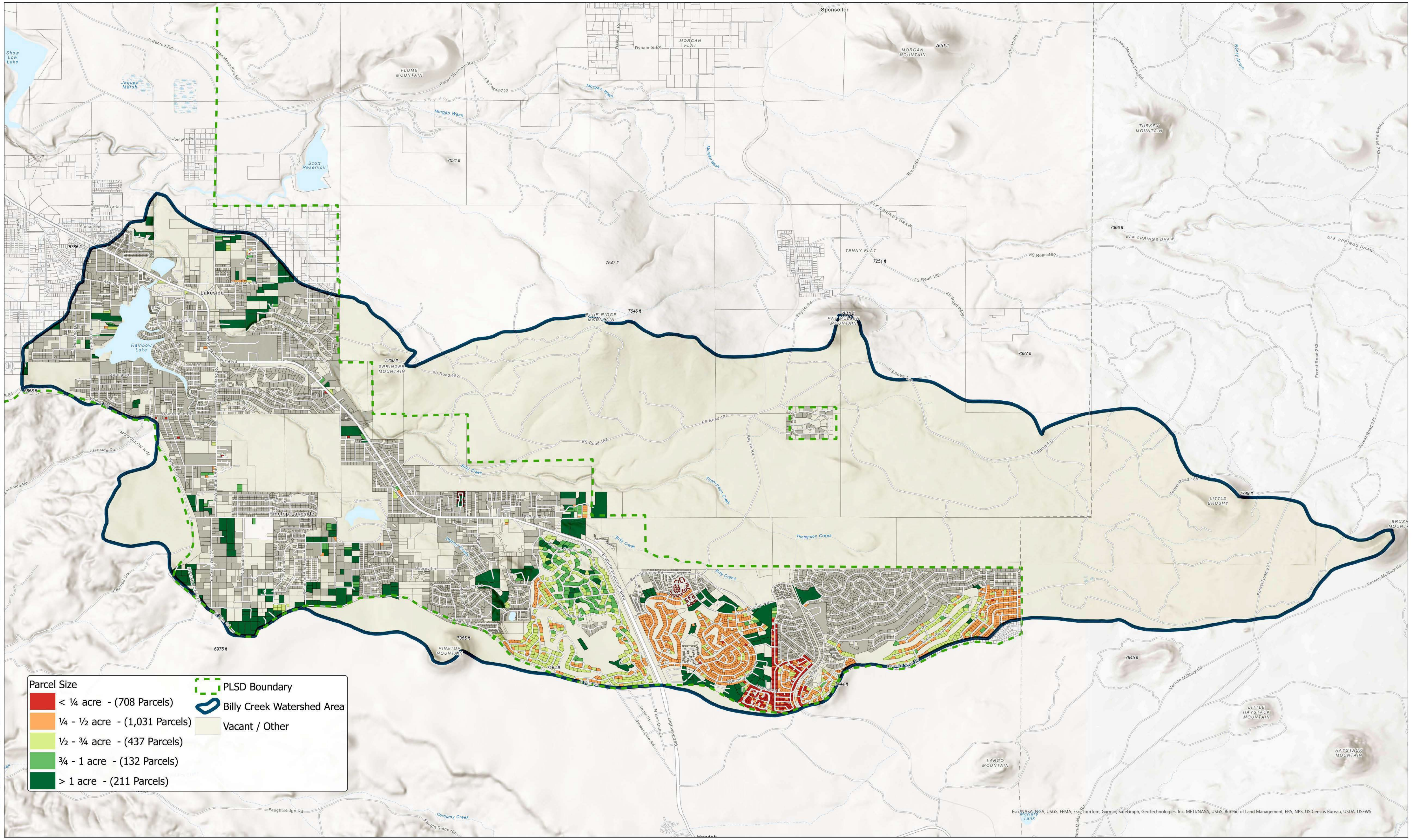
PACE Advanced Water Engineering

0 2,000 4,000 8,000 Feet

Date: 1/29/2024

Job Number: C098

Figure 5



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BILLY CREEK WATERSHED ASSESSMENT

BILLY CREEK WATERSHED
LOT SIZE

PACE Advanced Water Engineering

0 2,000 4,000 8,000 Feet

Date: 1/29/2024

Job Number: C098

Figure 6

Distance to Surface Water

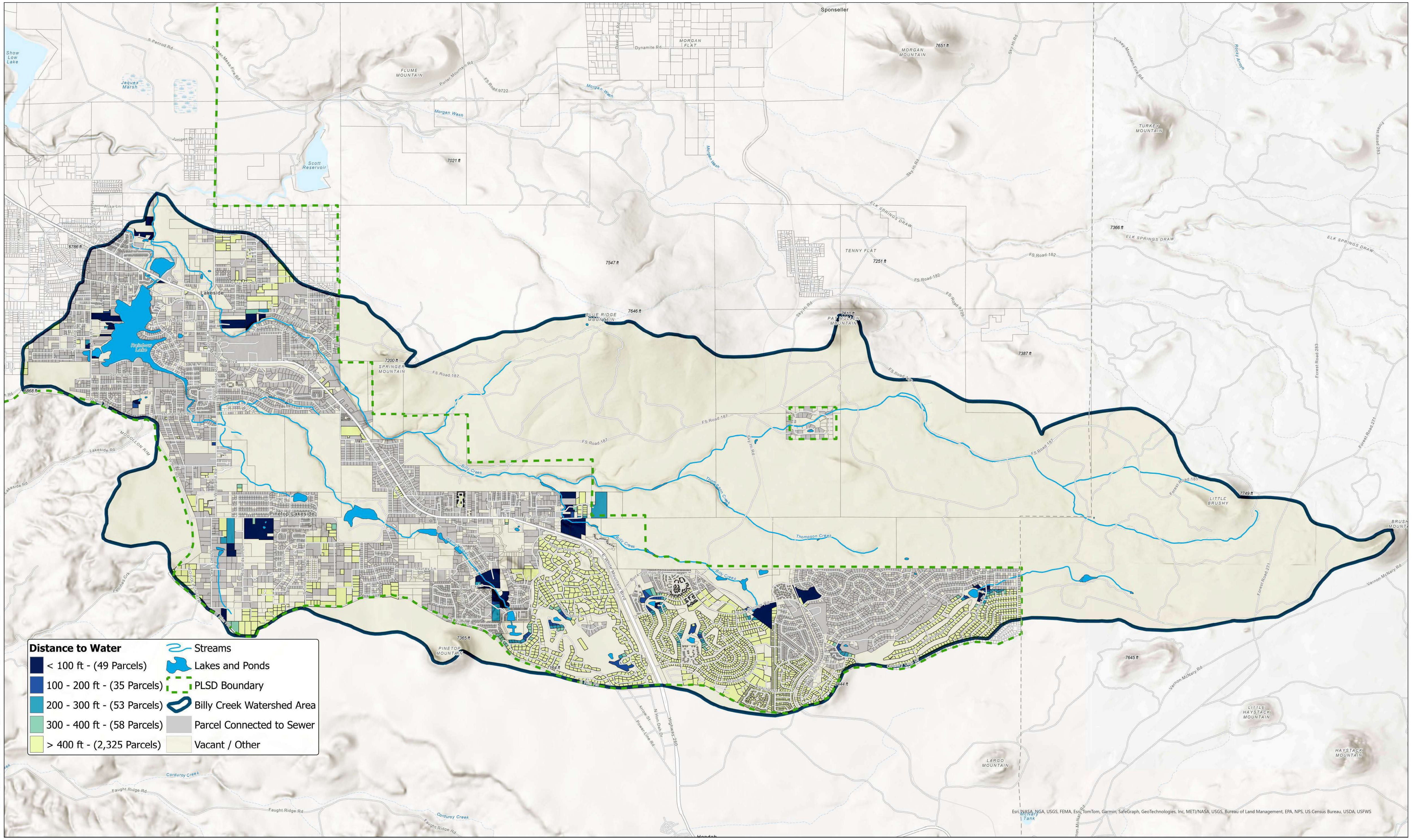
Navajo County has a minimum setback of 100-feet from a perennial or intermittent stream(s), lakes, reservoirs, or canals. Figure 7 is an overview of lots with septic systems and distance to nearest surface water source. 2% of the lots were within 100-feet of a surface water body, it is unknown if the actual septic system is within 100-feet of a surface water body.

Distance to Nearby Wells

Navajo County has a minimum setback of 100-feet from a nearby public or private supply wells. This metric does not factor in flow direction or zone of pumping influence. Figure 8 is an overview of parcels with septic and the nearest well as identified by the Wells 55 registry and the AGSI, 8% of the parcels are within 100-feet of a well.

Parcel Scores

Figure 9 is a summary of the score assigned for each attribute at the applicable parcel, and then the 6 attribute score for each parcel was added up. Twenty-five parcels had a score greater than 50, and 373 parcels had a score between 41 and 50, indicating many of the attributes used to assess risk of contamination to the environment were exceeded. As expected those lots tend to have a high density of systems per acre and high number of systems over 20-years. Figure 10 is a map of well types and the ranked parcels. As noted the accuracy of the Wells 55 registry is unknown, however a number of public supply wells are within the areas with a score over 40.



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BILLY CREEK WATERSHED ASSESSMENT

BILLY CREEK WATERSHED
DISTANCE FROM STREAMS, LAKES, AND PONDS

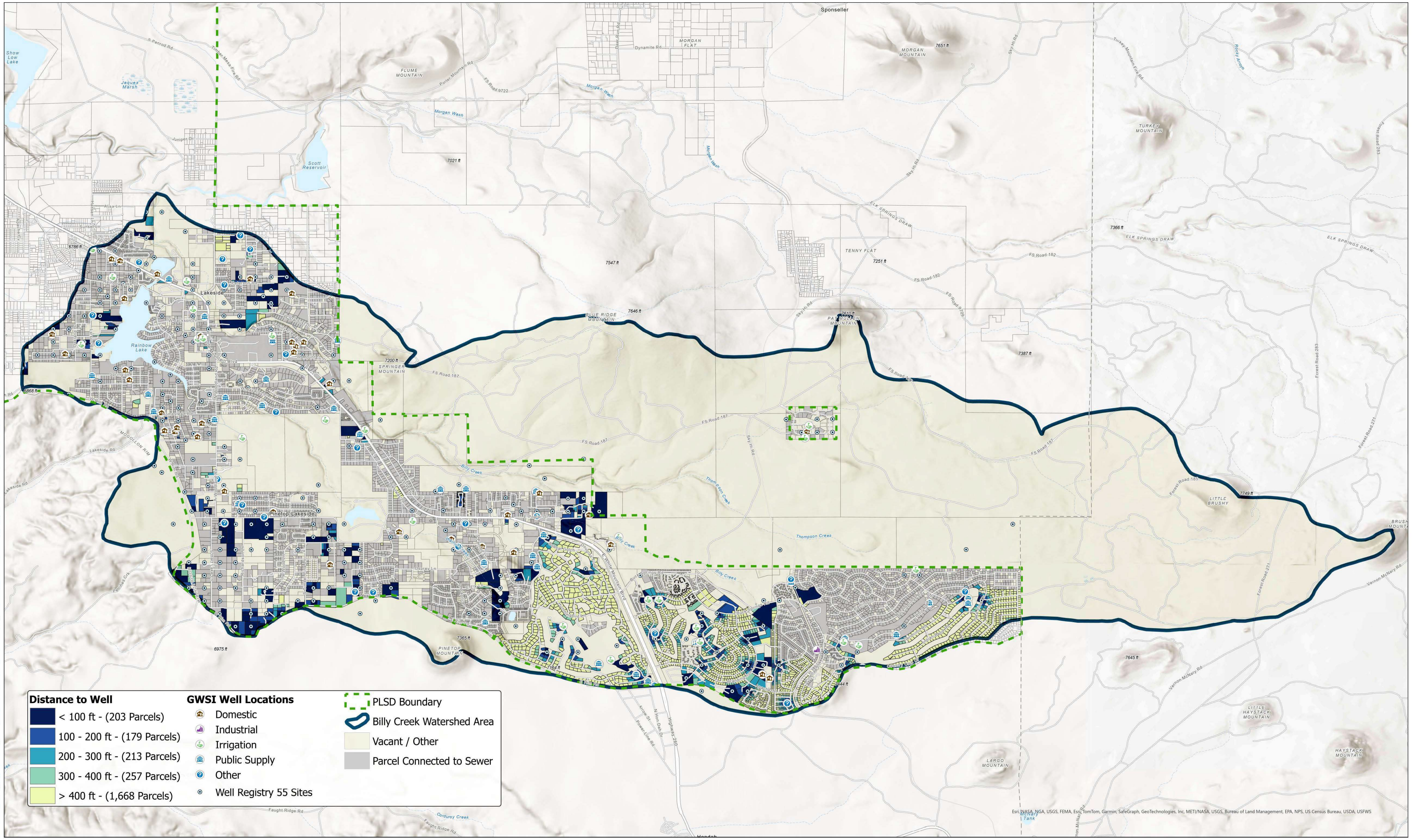
PACE Advanced Water Engineering

0 2,000 4,000 8,000 Feet

Date: 1/29/2024

Job Number: C098

Figure 7



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BILLY CREEK WATERSHED ASSESSMENT

BILLY CREEK WATERSHED DISTANCE FROM WELLS

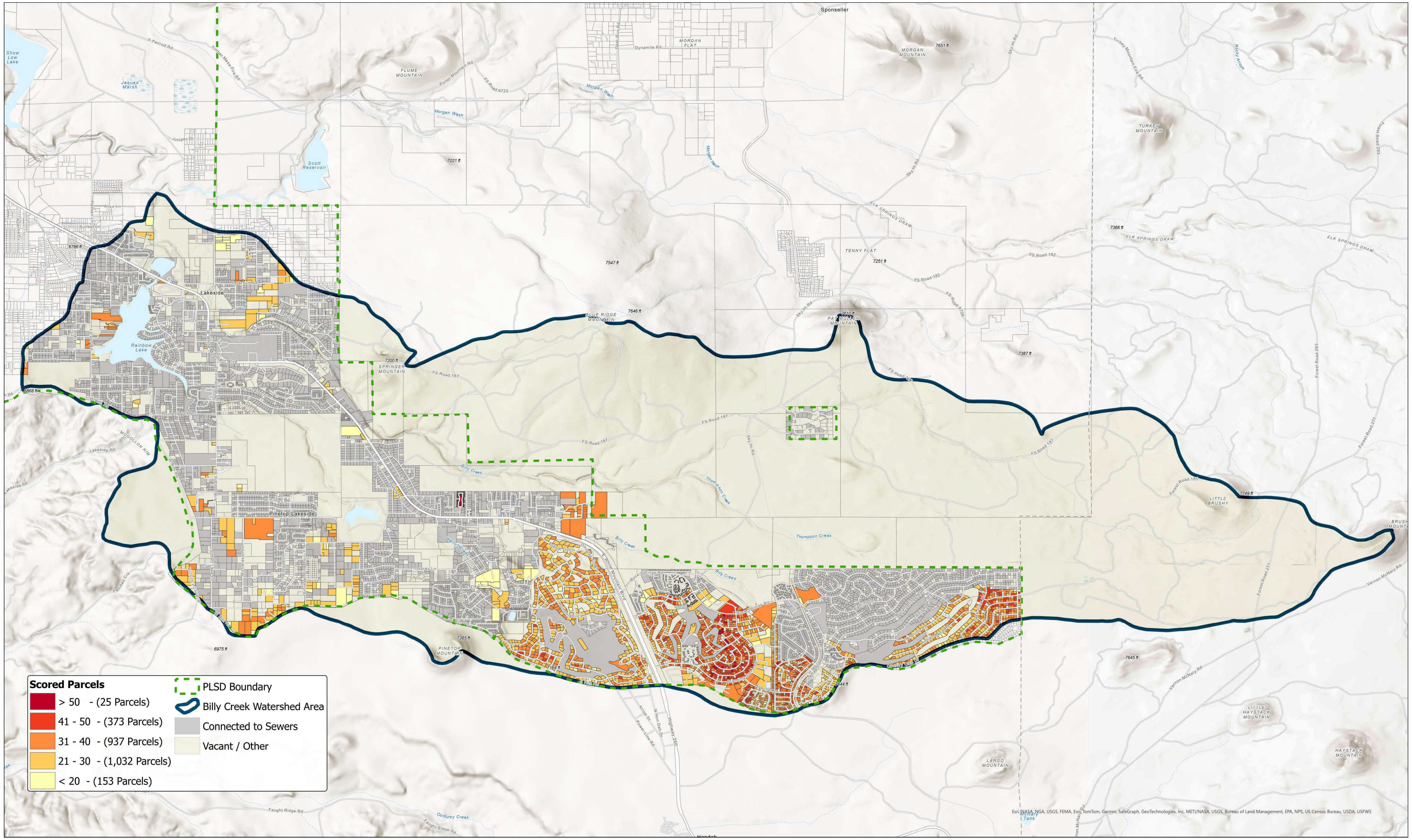
PACE Advanced Water Engineering

0 2,000 4,000 8,000 Feet

Date: 1/29/2024

Job Number: C098

Figure 8



P:\C098\GIS\Projects\C098 Billy Creek Watershed Assessment\C098 Billy Creek Watershed Assessment.aprx - C098 - 9 - Score Overview

BILLY CREEK WATERSHED ASSESSMENT

BILLY CREEK WATERSHED FINAL SCORES

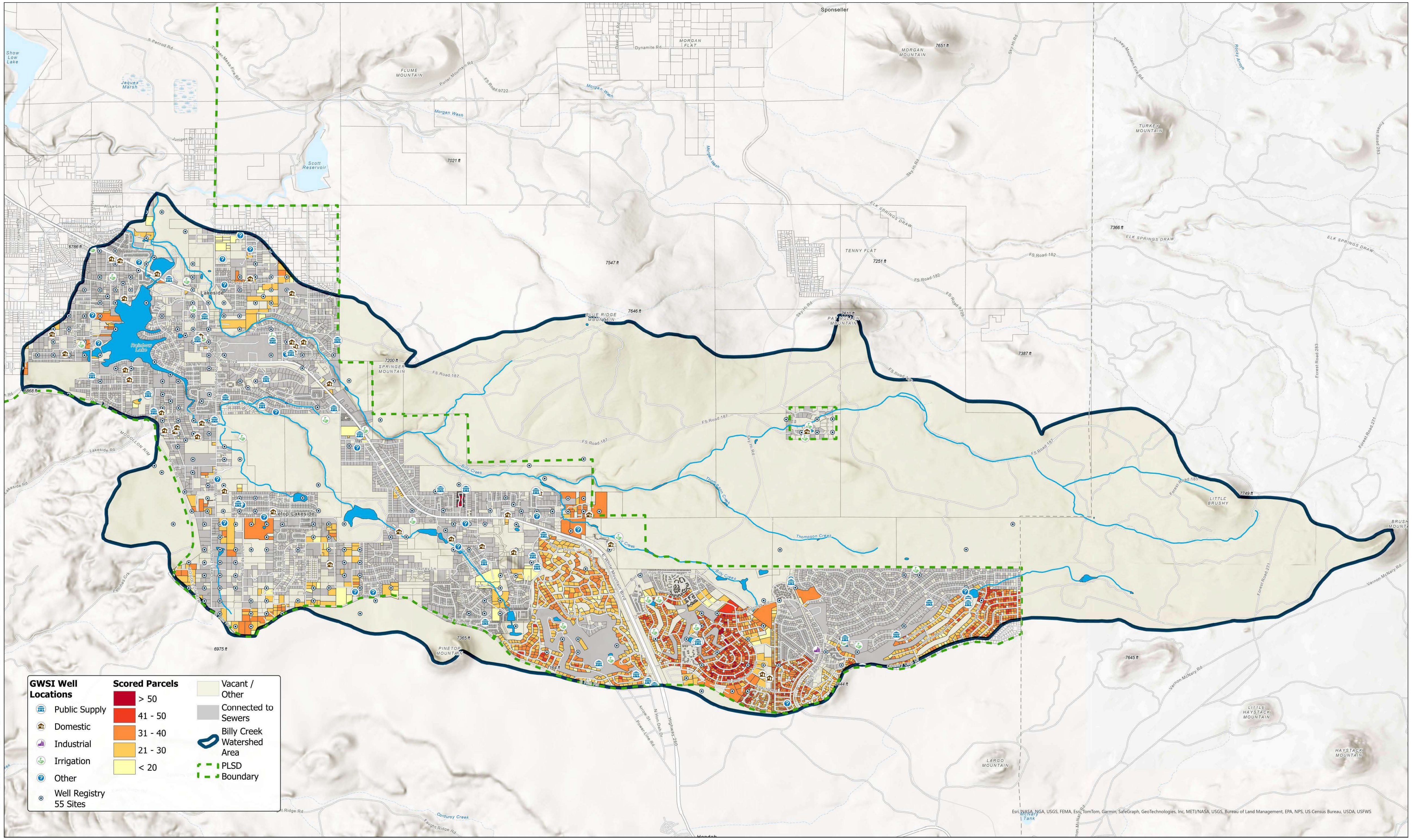
PACE Advanced Water Engineering

0 2,000 4,000 8,000 Feet

Date: 1/29/2024

Job Number: C098

Figure 9



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BILLY CREEK WATERSHED ASSESSMENT

BILLY CREEK WATERSHED PROTECTED WATER SOURCES

PACE Advanced Water Engineering

0 2,000 4,000 8,000 Feet

Date: 1/29/2024

Job Number: C098

Figure 10

Conclusions

Based on the results of this study is shown that there is a high probability that septic system failure may be impacting the environment. The following recommendations will help the community address the impacts from septic systems

- Initiate a public information campaign to help homeowners understand the required maintenance and care their septic systems need.
- Initiate a campaign for vacation rentals so that guests understand what is ok to flush/dump.
- Explore funding opportunities and expansion of the Pinetop-Lakeside Sanitary District to help prevent and reduce contamination to the aquifer.
- Explore programs to help fund septic system replacement/inspections.
- Provide information to domestic well owners of the potential impacts to wells from septic systems.
- Provide free/low cost water sampling for domestic well owners for nitrate, boron and artificial sweeteners to determine if there are impacts to the well.
- Define source water protection areas that take into consideration groundwater depth, flow direction, pumping zone of influence and septic system attributes provided in this report.

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