USE OF THE *DRASTIC* MODEL TO EVALUATE GROUNDWATER POLLUTION SENSITIVITY FROM ON-SITE WASTEWATER SYSTEMS IN THE MESILLA BASIN

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ABSTRACT

Groundwater contaminated by septic systems can have many undesirable impacts on both human and environmental quality of life. High concentrations of septic-system effluent that have reached groundwater without being fully treated at the environmental level can lead to harmful algal, bacterial, and chemical conditions in ground and surface water. Effluent exiting densely packed septic-system groups is a nonpoint source pollutant that travels underground, and detecting a source from high extraction concentrations is generally problematic. We have addressed this difficulty by adopting the *DRASTIC* model (a preliminary mapping system for hydrogeology components that govern groundwater pollution transmittance), modified to account for the unique geology of the Mesilla Basin, in an attempt to locate and map areas of high sensitivity to pollutants and cross reference them with areas of high septic-system density. The spatial variability of these areas of sensitivity and risk were used to determine appropriate venues for community outreach and septic-system training within the study area. The highest pollution sensitivity values occurred within the Rio Grande floodplain, where low depth to water values, high amount of recharge from agriculture, high hydraulic conductivities, and relatively flat sand and gravel hydrogeology are located. Groups of parcels with the highest risk values were dispersed around and up to 7.5 miles (12.1 km) outside of the floodplain, because septic-system density combined with pollution sensitivity were above median values. Pollution risk from septic systems was found to increase as parcel size decreased. The *DRASTIC* model may underestimate sensitivity in arid areas and can be further improved for assessment of septic-system pollution by adjusting for a pollutant that begins underground and is delivered with its own source of water.

Keywords: aquifer, *DRASTIC*, geographic information systems (GIS), groundwater, Mesilla Basin, pollution sensitivity, on-site wastewater systems

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1.0 INTRODUCTION

1.1 PROJECT OVERVIEW

This technical report is a review of the geographic information system (GIS) methods used for the project “Examination of risk to groundwater from on-site wastewater management systems in Doña Ana County” (Brown 2014). The GIS methods used by the project involved the mapping and examination of the spatial variability of groundwater pollution sensitivity in the Mesilla Basin of southern New Mexico and northern Chihuahua, Mexico. The pollution sensitivity model that was used for this project is called *DRASTIC* (Aller et al. 1987). It is a model used as a standardized, preliminary system for mapping hydrogeology components (depth to water, net recharge, aquifer media, soil media, topography, impact of vadose zone, hydraulic conductivity) that govern groundwater pollution transmittance. The *DRASTIC* model used in the project was tailored to the unique hydrogeology of the area and incorporated with parcel areas as a proxy for septic-system density and pollutant quantity. The groups of parcels in the Mesilla Basin study area were then ranked according to the pollution ‘risk’ proxy, and septic-system training and community outreach services were conducted for parcel groups deemed to be at highest ‘risk.’ The project was part of a joint effort with the Border Environment Cooperation Commission (BECC), the U.S. Environmental Protection Agency Border 2012 Program, New Mexico Water Resources Research Institute, New Mexico State University, and the Universidad Autónoma de Ciudad Juárez for the improvement of water resources and human health along the United States-Mexico border.

1.2 WATER RESOURCE SIGNIFICANCE

Groundwater reservoirs are the most significant resources of fresh water in the planet’s hydrologic cycle after glaciers and icecaps, which do not provide readily useable water. The total volume of readily available global groundwater has been estimated to be about 8.5 trillion acre-feet (10.5 million km^3), compared to the 75 billion (92,500 km^3) acre-feet stored in surface resources, such as lakes and streams (Shiklomanov 1993). In New Mexico, reservoirs of groundwater are also larger than reservoirs of surface water. Elephant Butte Reservoir is the largest body of surface water in New Mexico. At maximum capacity, Elephant Butte covers 35,825 acres (145 km^2) and can hold 2,024,586 acre-feet (2.5 km^3) of water (Ferrari 2008). The New Mexico Environment Department, Surface Water Quality Bureau (2012) reports that the long-term (1971-2000) total annual stream flow for New Mexico averages over 5.7 million acre-feet (7 km^3). Groundwater supplies throughout New Mexico are estimated to be 20 billion acre-feet (24,700 km^3), with 4.4 billion (5,427 km^3) being recoverable (NMED-SWQB 2012).

New Mexico residents rely heavily on groundwater for a number of activities–drinking and irrigation being the greatest by volume. Of the 3.82 million acre-feet (4.7 km^3) of water withdrawn from the hydrologic system in New Mexico for the year 2010, about 1.77 million acre-feet (2.2 km^3, 46.5%) came from groundwater and 1.67 million acre-feet (2.1 km^3, 94.0%) of that amount was used for farming (agriculture and livestock) or domestic (public and drinking) use (Longworth et al. 2013). About 78% of New Mexico's 2.08 million residents depend on groundwater for their drinking water supplies (NMED-SWQB 2012). Groundwater is used to a slightly smaller degree than surface water in New Mexico, but during times of drought groundwater is used increasingly to compensate for shortages in surface-water supply (NMED-SWQB 2012). The capacity and quality of groundwater water in New Mexico has great significance. The New Mexico Water Resources Research Institute has provided support for many other projects concerned with groundwater in New Mexico. Several reports dealing with groundwater capacity and quality have been published just for the Mesilla Valley (Updegraff and Gelhar 1978; Bahr 1979; Sammis 1980; Lansford, Creel, and Seipei 1980; Peterson, Khaleel, and Hawley 1984; Creel et al.1998; Kennedy 1999; Witcher et al.2004; and Hawley and Kennedy 2004).

1.3 ON-SITE WASTEWATER MANAGEMENT

Many residents of New Mexico use some type of on-site wastewater management (septic) system to handle their wastewater disposal needs. The United States Census Bureau (2004) reported that out of the 825,540 housing units in New Mexico, 240,977 (29.2%) used some form of on-site wastewater system (advanced treatment, septic, cesspool, or privy). Septic systems are small, private, underground, and self-contained sewage treatment plants. Within most septic environments, systems receive sewage discharge from parcels they serve into a watertight receptacle that allows primary separation and anaerobic (oxygen free) digestion of most of the solid waste. A clarified liquid effluent is released and dispersed over a large patch of soil for secondary nutrient extraction and aerobic (oxygen using) digestion. Since the soil is part of the treatment system, almost all sewage treatment units discharge some amount of pollutants into the environment (McCray et al. 2005).

Most on-site wastewater treatment systems are safe and appropriate for wastewater disposal as long as the conditions of the subsurface provide proper attenuation (McQuillan 2004; McQuillan, Brandt, and Beatty 2004; New Mexico Environment Department, Liquid Waste Program 2006; and NMED-SWQB 2012). Subsurface protection is reduced when systems are not designed properly (e.g., cesspits, straight pipe, hydraulic overload from water softeners), are not functioning properly (e.g., infrequent pumping schedule, root or fauna intrusion, clogged drain field), are in poor mitigation areas (e.g., low depth to water or bedrock, highly fractured, well sorted, unconsolidated), or are densely crowded together. These lead to a negative impact in groundwater quality. Regulations for the safe use of septic systems are dependent on space for the drain field, type of soil and its permeability, distance from other water sources (wells, streams, ponds, and groundwater), depth to bedrock or other impermeable media, size of the tank (chosen based on number of bedrooms or people using the system), and efficiency of the system.

Doña Ana County regulations require that homes and other facilities be removed from an on-site wastewater treatment system and connected to public sewage whenever a system line comes to or is within 300 feet (91 m) of a building (Peter J. Smith & Company, Inc. 2009). High septic-system densities in residential subdivisions with small lots can deposit increased concentrations of septic-system waste into groundwater resources, even if the systems are installed properly (McQuillan 2004; McCray et al. 2005). Septic systems installed on lots with sizes averaging as much as 0.84 acres (3,399 m^2) have been found to cause groundwater contamination in New Mexico, and this has led to efforts to determine the effectiveness of regulations that limit the installation of certain septic systems on lots less than 0.75 acre (3,035 m^2) (McQuillan, Brandt and Beatty 2004).

1.4 WATER STORAGE CONTAMINATION BY WASTEWATER DEPOSIT

The NMED-LWP (2006) reported that of the 1,250 contaminated public water supply systems tested in a New Mexico source-water assessment, more than half of the cases have been caused by nonpoint sources traced to septic systems. Nonpoint source pollution can come from a variety of other origins besides septic systems, such as: agriculture, grazing, construction, forest and flow alterations, industrial and municipal discharges, waste disposal, run-off, recreation, resource extraction, unpermitted spills and discharges, and natural deposition (NMED-SWQB

2012). However, “nonpoint sources of ground water pollution are predominantly household septic tanks or cesspools and are the major sources of contamination of New Mexico’s ground water” (NMED-SWQB 2012, ix).

Groundwater contaminated by septic-system effluent can contain harmful concentrations of viruses, bacteria, amino acids, solvents, pharmaceuticals, water softening salts, chloride, and metals, however, nitrogen and phosphorus compounds cause the most common undesirable impacts on the quality of the environment (McQuillan 2004; McCray et al. 2005). Phosphate and nitrate levels can reach excessive concentrations in the groundwater if the soil below the septic system is overloaded (McCray et al. 2005). Most phosphate in wastewater is hydrolyzed to soluble orthophosphate (PO_4^{3-}) in septic tanks and may not precipitate out of solution before reaching groundwater. Phosphate in this form is the most hazardous to the environment because it is abundant and readily used in plant growth and biological metabolism (McCray et al. 2005). This has the effect of forming algae and cyanobacteria plumes in surface waters that can create anoxic conditions that kill aquatic life and make the water susceptible to high concentrations of chemical and biological contaminants such as iron, manganese, and other bacteria (McQuillan 2004; McCray et al. 2005).

High concentrations of nitrate in consumed groundwater can also cause anoxic conditions in humans and animals by oxidizing ferrous iron (Fe^{2+}) to ferric iron (Fe^{3+}) in the hemoglobin, which causes a condition called methemoglobinemia, also known as ‘blue baby syndrome’ (NMED-LWP 2006; Yang and Wang 2010; NMED-SWQB 2012). Due to this and other effects on human health and environmental quality, regulatory standards on nitrate concentrations are set at 10 milligrams per liter (McCray et al. 2005). Using this standard and those set for iron, manganese, chloride, para-dichlorobenzene, and methamphetamine chemicals, the New Mexico Environment Department Liquid Waste Program (2006) has identified 355 miles (571 km) of river and stream segments and 1356 acres (5.5 km^2) of surface water in New Mexico that have been significantly impacted by nutrients that originated in septic systems.

Water quality standards and septic-system regulations are created to help prevent groundwater exposure from septic waste, but the standards are often put in place after the groundwater has already been compromised. Diagnostic parameters such as elevated chloride in groundwater have a positive correlation with nitrogenous septic waste in groundwater, because calcium hypochlorite is an inexpensive and therefore often used water disinfectant for tap water, which exits septic systems and does not degrade quickly in the environment (McQuillan 2004; McCray et al. 2005). However, determining the actual source of high chloride or nitrogenous content is difficult, since the septic waste is one of many nonpoint sources (NMED-SWQB 2012). Discovering the cause of compromised groundwater is much more complex than discovering that water has been compromised. A more straightforward course of action would be to predict where groundwater could be compromised and devise a plan of prevention before water quality standards are compromised.

1.5 CHOOSING A POLLUTION SENSITIVITY MODEL

There are several different types of groundwater vulnerability assessment models available (Aller et al. 1987). Most of these models were built using data that the researchers were able to obtain easily and have relatively simple formulas compared to the processes that they model. Finding ways to model the complexities of the environment while keeping the model as concise and manageable as possible is a challenge that the *DRASTIC* model (Aller et al. 1987) performs well enough to attract many researchers. Since its inception, the *DRASTIC* model has been used in hundreds of studies around the world, despite its design for use in the United States. In addition to being used in a nationwide project to evaluate pesticide vulnerability, the model has been used in several states to determine vulnerabilities for several pollutants. A detailed account of the *DRASTIC* model is given below in Section 3.2, and it is further elaborated in appendix A.

Despite the number of users, the *DRASTIC* model does have a number of disadvantages. The major problem that has been brought up by researchers is the subjectivity of the rating determinations and scales it employs. Since many of the factors are chosen, as opposed to being measured, this system is much more qualitative than quantitative (Soller 1992; Napolitano and Fabbri 1996; Babiker et al. 2005; Panagopoulos, Antonakos and Lambrakis 2006; Yang and Wang 2010). Some doubts have also been expressed over the choice of some parameters and the exclusion of others. Rosen (1994) claims that many scientifically defined factors are not directly accounted for, such as sorption capacity, travel time, and dilution. When the final index is calculated, many parameters that are important about a particular setting are superseded by those that have no bearing on its vulnerability (Merchant 2010; Vbra and Zaporozec 1994). Gogu and Dassargues (2000) assert that once an index value is calculated, there is no process for determining meaningful categories of vulnerability. Another disadvantage of the system is that accuracy testing is very difficult to carry out. Some researchers, such as Kalinski and others (1994); Secunda, Collin, and Melloul (1998); Rupert (2001); McLay and others (2001); and Worrall and Kolpin (2004), have tried to use statistical approaches to improve the quality of their *DRASTIC* groundwater vulnerability assessments. These researchers have attempted to correlate the final vulnerability values with contaminant parameters and measurements of land-use statistics. Some have met with success in testing accuracy, and others have noted the difficulty.

Beyond the drawbacks of the model, *DRASTIC* remains one of the most popular systems in use today because of its advantages. The use of the Delphi consensus method (a structured, iterative, questionnaire process that gathers expert opinions of correct answers), to obtain hydrogeological factors and their ratings and weights, provides the system with expert backing and structure (Aller et al. 1987). The number of hydrogeological factors and their interrelationship reduces the probability of overlooking important parameters, increases statistical accuracy, and provides a relatively good representation of the hydrogeological setting (Rosen 1994). The system also provides estimates for large regions with complex geological structures without the need for specialized methods, equipment, or data (Kalinski et al. 1994; McLay et al. 2001). Finally, the system is specifically designed to be a management tool that is inexpensive, simple to use, easy to understand, uses existing data, and is employable by a diverse collection of individuals with differing levels of expertise (Aller et al. 1987). Because of these advantageous features, it is the model adopted for use in the present study.

2.0 STUDY AREA

2.1 GEOGRAPHIC DESCRIPTION

The project covered the Mesilla Basin area in southern Doña Ana County, New Mexico; western El Paso County, Texas; and northern Chihuahua, Mexico (Figure 2-1). A main study area boundary was first created by digitizing a hand-drawn perimeter (personal interview with John W. Hawley by S. Walker on July 2, 2012) on a 1:24,000 scale surface hydrogeologic map (Hawley and Kennedy 2004). This area contained much of the cities of Las Cruces, New Mexico and El Paso, Texas and several small villages, towns, and colonias. Most of the wastewater systems in the main study area are located directly over shallow aquifers beneath the Mesilla drainage basin. The southern tip of the Jornada del Muerto Basin was included in the study area to determine the effects of dense clusters of wastewater systems on groundwater that flowed from it into the Mesilla Basin. This led to an expansion of the original boundaries to incorporate systems that could possibly have an effect on the aquifer. Septic systems located outside the boundaries of the main study area were grouped together into satellite study areas to observe the pollution sensitivity and possible effects that the systems may have in those areas. The satellite areas are found on the northern tip of the Mesilla Basin (Radium Springs), at the southern end of the Jornada del Muerto Basin (Jornada), west of Las Cruces on the West Mesa (Airport), east of Las Cruces on the piedmont slope of the Organ Mountains (Talavera), and Puerto de Anapra in Mexico (Anapra).

The main study area boundary encompasses 755,682 acres (1,181 mi^2, 3,058 km^2), with 58,004 acres in Texas, 95,176 acres in Chihuahua, and 602,502 acres in New Mexico. The satellite areas total 161,871 acres, with 53,492 in Radium Springs, 55,492 in Jornada, 41,141 in Airport, 9,053 in Talavera, and 2,235 in Anapra. The main study area extends 62 miles (99 km) along the length of the Rio Grande from Leasburg Dam to El Paso del Norte and ranges from 3 miles (4.8 km) wide in the upper Mesilla Valley to nearly 30 miles (48.3 km) from East Potrillo to the Franklin Mountains.

2.2 DEMOGRAPHIC DESCRIPTION

The communities of Radium Springs, Doña Ana, Las Cruces, San Ysidro, Fairacres, Mesilla, San Pablo, Mesquite, San Miguel, La Mesa, Vado, Berino, Chamberino, Anthony (New Mexico and Texas), El Paso, Vinton, La Union, Canutillo, Santa Theresa, Sunland Park, and

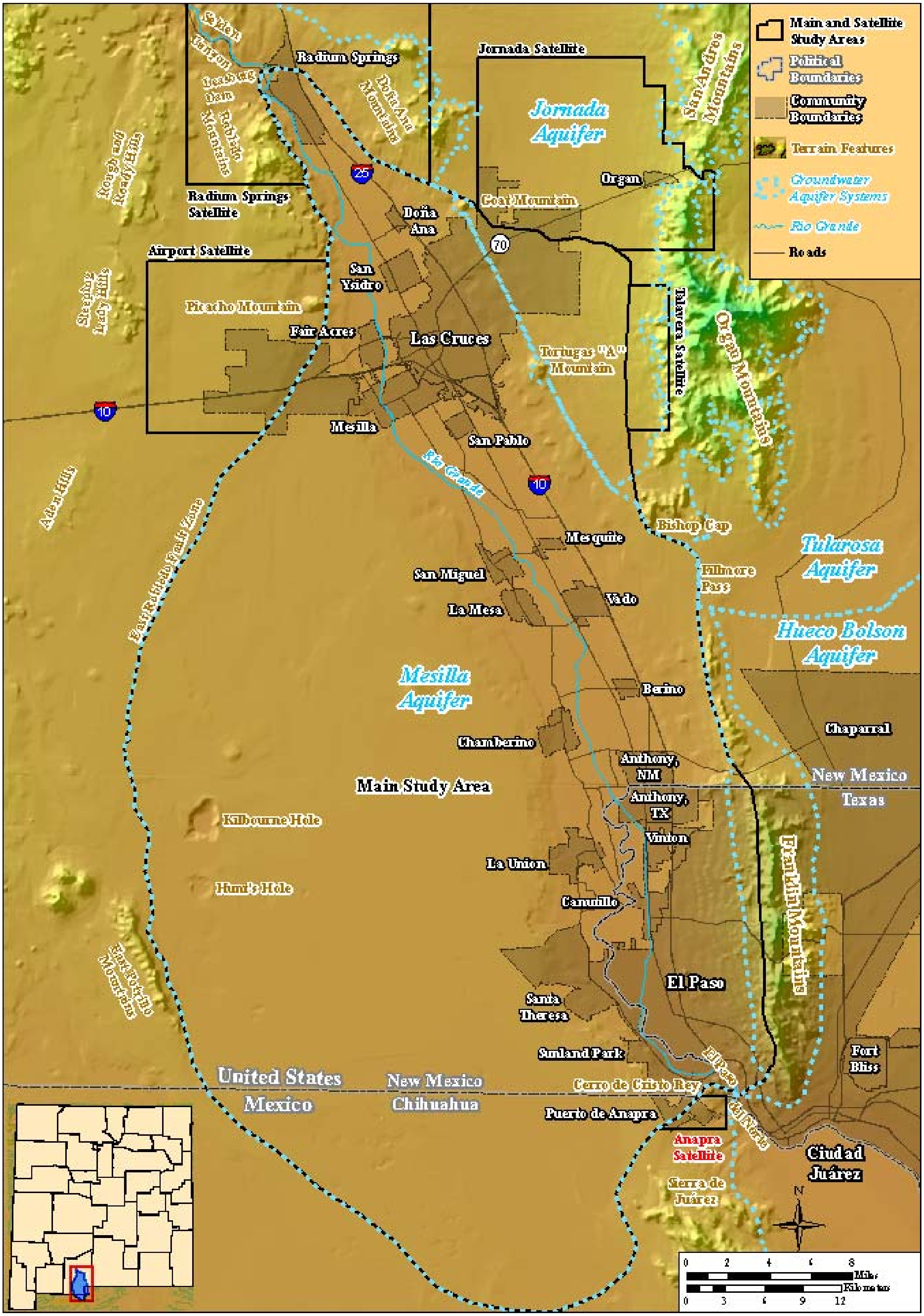


Figure 2-1: Study Area and Key Groundwater and Surface Features

Anapra are located in the main study area. The groundwater reservoir in this area supplies fresh water to over 400,000 people on both sides of the border (U.S. Census Bureau 2010; Instituto Nacional de Estadística y Geografía 2010). Of the 125,023 total parcels located in the study area, 114,822 (92% of total) are located within the main study area. 101,971 (81.6%) of the total parcels in the study area are over 0.1 acres [1 person low average = 50 gallons wastewater per day ÷ 500 gallons per day per acre minimum regulation (20.7.3 NMAC 2013)] and could possibly support a septic system. If the ratio of 29.2% of the homes in New Mexico supporting some type of septic system were applied to those parcels over 0.1 acres (405 m^2), there could be up to 34,800 septic systems in the study area.

2.3 GEOLOGY AND HYDROGEOLOGY OF THE AREA

The Mesilla catchbasin is a low-relief, gravelly to fine-grained sand filled structure nearly completely surrounded by mountain uplifts of less than 9000 feet (2743 m) elevation. The geology and hydrogeology of the Mesilla Basin area listed briefly in the section below are described in depth by Seager and others (1987); Seager (1995); Collins and Raney (2000); and Hawley and Kennedy (2004). A majority of the highlands terrain are basement-cored, fault-block uplifts, capped by Paleozoic and Mesozoic (541 to 65 Ma) sedimentary and Lower Tertiary (65 to 23 Ma) volcanic rocks, lifted and tilted 2 to 23 million years ago (Ma) during the Upper Tertiary. The fault-block mountains and hills include the San Andres Mountains, Doña Ana Mountains, Robledo Mountains, Aden Hills, Sleeping Lady Hills, Goat Mountain, Picacho Peak, Tortugas ‘A’ Mountain, Bishop Cap, Franklin Mountains, East Potrillo Mountains, and Sierra de Juárez.

A buried bedrock ridge separates the Mesilla structural basin from the Jornada del Muerto basin. This small fault-block uplift stretches from the Doña Ana Mountains southeast to Bishop Cap at the southern end of the Organ Mountains. The structure was later buried under ancestral Rio Grande and piedmont alluvium with only Goat Mountain and Tortugas Mountain remaining above the surface. This structure has been named the Jornada Horst (Woodward and Meyers 1997). The East Potrillo and East Robledo Fault zones are other structural features that have been partly buried by piedmont alluvium, basin-floor sediment, and eolian sand. The Organ Mountains, Cerro de Cristo Rey, and East Potrillo Mountains are a combination of Paleozoic and Mesozoic sedimentary fault-block uplifts, Tertiary intrusive granite and andesite, and extrusive rhyolite, which formed during the Early to Middle Cenozoic Time (50 to 25 Ma). Kilbourne Hole and Hunt

Hole are two maar volcanic craters on the western edge of the basin. These volcanic eruptions, caused by groundwater coming into contact with magma, along with less explosive flows along the East Potrillo Mountains and in the central mesa, covered the basin-fill surface with a basalt layer between 24,000 to 80,000 years ago.

Prior to the cutting of Selden Canyon, the ancestral Rio Grande flowed southward from the Rincon area through gaps around the Robledo Mountains and between the Doña Ana and Organ Mountains and into the Mesilla Basin. As early as three million years ago, the basin was a closed system that merged southward into the floor of the Bolson de Los Muertos in Chihuahua (Hawley, Kennedy and Creel 2001). The Rio Grande led to a deltaic distributary system that deposited basin fill into a set of basin lakes called Lake Cabeza de Vaca. At this time the Tularosa and Hueco basins to the east of the San Andres-Organ-Franklin Mountain chain were also being filled with an interbasin connection through Fillmore Pass (Gile, Hawley and Grossman 1981; Hawley 1986; Frenzel and Kaehler 1992). Ancient basin fill of the Mesilla Basin exists today on the flat area to the west of the Mesilla Valley called West Mesa. The Mesilla Valley itself has been cut below the West Mesa surface by the ancestral Rio Grande during the past 700,000 years (Gile, Hawley and Grossman 1981; Hawley 1986). The inner Mesilla Valley has since gone through stages of cutting and aggradation to form the river floodplain seen today (Hawley 1975).

The subsurface of the Mesilla Basin is composed primarily of the strata of the Upper Cenozoic Santa Fe Group. This material is primarily made up of fluvial and lacustrine sediment initially derived from local uplands transported by the ancestral Rio Grande. Beneath the central West Mesa area, Santa Fe Group deposits are between 1,500 and 2,500 feet (457-762 m) thick. The Santa Fe Group is informally subdivided into three litho-/hydro-stratigraphic units based on their sedimentary properties and relative age. The lower Santa Fe Group was laid down from around 25 to 10 Ma as coarse-grained alluvial fan deposits that grade to fine-grained, basin-floor sediment. Eolian sands, as thick as 600 feet (183 m) deep, are inter-bedded with piedmont deposits at the basin's eastern edge. The middle Santa Fe Group was laid down between 10 to 4 Ma, when tectonism in the area was most active, resulting in the greatest rates of uplift and erosion. The aggradation of the upper Santa Fe Group continued from 4 to 0.7 Ma and includes thick sequences of ancestral Rio Grande fluvial deposits dominated by sand and gravel. The inner valley is filled with as much as 100 feet (30 m) of channel and floodplain deposits that grade to valley-border alluvium primarily derived from erosion of Santa Fe Group basin-fill.

3.0 METHODOLOGY

3.1 DATA COLLECTION AND STORAGE

All data were acquired from public sources. Most raw data were vector shapefiles, with two raster images collected for land cover and topography of the study area and a tabular collection of wells for water depth. The raster and tabular data were converted to shapefiles for manipulation. All data manipulation was performed using ArcGIS 10.0 for Desktop (SP1), ArcGIS 3D Analyst (ArcScene), and Microsoft Excel (2010). All data were imported into a file geodatabase for final organization, compilation, and compression. Lists for each of the groupings of unprocessed data collected for the project are found in tables 3-1, 3-2, and 3-3 below.

Table 3-1: List of Unprocessed Vector Polygon Data Sources Used in Project

Item	**Source Data**	**Source**	**Scale**	**Year**
Boundaries				
New Mexico Counties	*tl_2010_35_cousub10.shp*	U.S. Department of Commerce, U.S. Census Bureau, Geography Division	1:24,000	2010
Texas Counties	*tl_2010_48_cousub.shp*			
New Mexico Cities	*tl_2010_35_place10.shp*			
Texas Cities	*tl_2010_48_place10.shp*			
Mexico Cities	*poligono de anapra.shp*	Universidad Autónoma de Cuidad Juárez, Dr. Alfredo Granados-Olivas	1:24,000?	2012
Aquifer Study Area	*MesillaAquifer.shp*	Hand drawn by John W. Hawley on December 15, on Mesilla Surface Geologic Map 57 (below)	1:24,000	2012
Land Use / Land Cover Data				
Mexico Land Use	*uso de suelo.shp*	Universidad Autónoma de Cuidad Juárez, Dr. Alfredo Granados-Olivas	1:250,000	2012
Surface Geology				
U.S. Mesilla Geology	*geology.shp*	Geologic Map 57 (Seager et al. 1987)	1:100,000	1987
Mexico Geology	*geologia.shp*	Universidad Autónoma de Cuidad Juárez, Dr. Alfredo Granados-Olivas	1:250,000	2012
SSURGO Soil Coverage Data				
New Mexico Soils	*soilmu_a_nm690.shp*	United States Department of Agriculture, Natural Resources Conservation Service	1:24,000	2008
White Sands Soils	*soilmu_a_nm719.shp*			2009
Texas Soils	*soilmu_a_tx624.shp*			2009
Cadastral Parcel Data				
Doña Ana County	*DAC_Parcel.shp*	Doña Ana County Assessor	Unknown	2012
El Paso County	*EPC_Parcels.shp*	Paso del Norte Mapa (www.pdnmapa .org, accessed on 02/23/2013)	Unknown	2012
Anapra, Chihuahua, Mexico	*anapra-surponienteb.shp*	Universidad Autónoma de Cuidad Juárez, Dr. Alfredo Granados-Olivas	1:24,000?	2013
Sewer Service Area Location				
Las Cruces Service Area	*DAC_LasCrucesWW_Service.shp*	Las Cruces Utilities, Waste Water Division (Received from NMSU SPaRC Laboratory on 06/13/2013)	Unknown	2013
El Paso, Haskell Service	*EPC_EPWU_Haskell.shp*	El Paso Water Utilities (Received from NMSU SPaRC Laboratory on 06/13/2013)	Unknown	2013
El Paso, Northwest Service	*EPC_EPWU_Northwest.shp*			

Table 3-2: List of Unprocessed Vector Polyline Data Sources Used in Project

Item	Source Data	Source	Scale	Year
Roads				
New Mexico	*tl_2010_35_prisecroads.shp*	U.S. Department of Commerce, U.S. Census Bureau, Geography Division	1:24,000	2010
Texas	*tl_2010_48_prisecroads.shp*			
Rivers				
Rio Grande	*NHD13030102.mdb*	United States Geological Survey, National Hydrology Dataset	1:24,000	2010
Subsurface Geological Structures				
Mesilla Faults	*sffault.shp*	WRRI Technical Completion Report No. 332, (Hawley and Kennedy 2004)	1:24,000	2004
Mesilla Bedrock	*sfbase.shp*			
Hydrogeology Cross-Section Reference				
Transects	*xsecs_2011.shp*	(Hawley and Kennedy 2004), updated	1:24,000	2011
Sewer Line Location				
Las Cruces City Sewer Lines	*CLC_WW_PipesGeneral.shp*	Las Cruces Utilities, Waste Water Division	Unknown	2006
Doña Ana County Sewer Lines	*Wastewater_Lines.shp*	Doña Ana County, GIS Department	Unknown	2010

Table 3-3: List of Unprocessed Raster and Tabular Data Sources Used in Project

Item	Source Data	Source	Scale	Year
Land Use / Land Cover Data				
National Land Cover Dataset	*nlcd2006_landcover_4-20-11.img*	United States Geological Survey, National Land Cover Dataset	30-meter	2006
10-meter Digital Elevation Model				
Study Area DEM	6 DEMs, split by the USGS, of the Mesilla Basin area between coordinates: -107.361 x 32.512, -106.261 x 32.512, -107.361 x 31.603, and -106.261 x 31.603	United States Geological Survey	1/3 arc second (10-m)	2009
Well Data				
Doña Ana & El Paso Counties	Selected USGS and Hawley and Kennedy Wells Throughout Doña Ana and El Paso Counties (Table B-1)	waterdata.usgs.gov/nwis/gw (USGS) and WRRI Technical Completion Report No. 332 (Hawley and Kennedy 2004)	1:24,000	2012 & 2004

3.2 *DRASTIC* Pollution Sensitivity Model

DRASTIC is a pollution sensitivity mapping model that focuses on seven hydrogeology factors (components) that govern pollution transmittance to groundwater (Aller et al. 1987). A ranking scheme determines the pollution potential of each component (component's pollution index) and overlays them for all areas of a study site. When the pollution indices for each component surface are added together, this creates the composite *DRASTIC* pollution sensitivity index. This describes an area's sensitivity for waterborne pollutants to reach groundwater from the surface, based on the facilitation or hindrance of the seven components to pollution transmittance. The components form the acronym naming the system: Depth to Water (D), Net Recharge (R), Aquifer Media (A), Soil Media (S), Topography (T), Impact of the Vadose Zone (I), and Hydraulic Conductivity (C). Each component has a set weight from 1 to 5 describing its importance in the model with respect to the other components. A component that has a weight of 5 is more significant than a component with a weight of 1. Within each component is a scaled rating system from 1 to 10 that is governed by variations throughout the component. Some ratings are explicitly calculated (e.g., depth to water of 0 to 5 feet = 10 and 5 to 15 feet = 9, topography of 0 to 2% slope = 10 and 2 to 6% slope = 9), and some are implicitly calculated through a subjective method (e.g., aquifer media of sand and gravel = 9 and massive limestone = 8, soil media of loamy sand = 8 and sandy loam = 7). Multiplying a component's rating and the weight returns its index value and adding them together returns the *DRASTIC* index:

$$DRASTIC_i = Dr \times Dw + Rr \times Rw + Ar \times Aw + Sr \times Sw + Tr \times Tw + Ir \times Iw + Cr \times Cw$$

Where: r = the rating for the component and w = the assigned weight for the component.

Further information about the starting weights and ratings of the original model by Aller and others (1987) can be found in appendix A starting on page 62. The following methods describe how the original model was manipulated based on the uniqueness of the Mesilla Basin study area. Certain components required more manipulation than others. In some cases, data were also more difficult to obtain than others. Some components were used to construct other components. Because of this, the completion order of component analyses proceeded differently than how they are covered below: that is, Net Recharge (R), Soil Media (S), Impact of the Vadose Zone (I), Topography (T), Depth to Water (D), Aquifer Media (A), and Hydraulic Conductivity (C). To maintain consistency, this report lists the components in the order of the *DRASTIC* acronym.

3.2.1 Depth to Water Component (D)

The Depth to Water component is represented by a surface of water-table elevation values interpolated from well-water depths subtracted from surface elevations (to get well-water elevations above sea level), and then subtracted from the values of a digital elevation model. The assigned weight of the component is 5. The component ratings were completed before the Aquifer Media and Hydraulic Conductivity components because the elevation surface was required to locate the hydrogeological media at the level of the water table. Well data for Doña Ana County, New Mexico and El Paso County, Texas were collected from the USGS and combined with the collection of wells found in Hawley and Kennedy (2004) to increase the number of well values for interpolating a surface. Well logs from Mexico were incomplete and did not provide enough temporal continuity, so measurements from the United States side of the border were used to determine the water table for both sides of the border. A table of well measurement information (Appendix B, Table B-1 on page 72) was compiled and sorted using scripting in Excel to reduce the entire recorded lifetime of each well to a single value denoting the highest watermark that the well ever measured. High watermark measurements yield a water-table surface nearest to the ground surface, which increases the sensitivity to a 'worst-case scenario.' This also removes variability in the surface over time, which negates some of the pumping draw-down that may have occurred and gives the surface a null date.

The water-table surface was built using wells that draw water from the shallow unconfined groundwater found at atmospheric pressure. To determine which wells met this criterion, data were sorted based upon location, depth to well bottom, and hydrogeological stratigraphy found at the depth (Figure 3-1). Wells not located in the main study area were excluded first. The remaining wells were sorted into floodplain wells and non-floodplain wells using a floodplain boundary contoured at 100 feet (30 m) above the valley floor. Wells in the floodplain were excluded if the depth to the bottom was greater than 300 feet (91 m), because it was determined that at this depth, the uncertainty of penetrating into a confined aquifer was too great (personal interview by S. Walker with J.W. Hawley on August 7, 2012). Wells in the floodplain with a depth to bottom of less than 100 feet were classified (Figure 3-1) as *certainly shallow*, as this is the maximum thickness of river alluvium in the floodplain. Those wells between 100 and 300 feet to bottom were classified as *uncertainly shallow* and used to build the preliminary water-table surface and check for statistical error. All wells were assumed to have screens at the bottom of the shaft.

Non-floodplain wells were excluded based on a different set of criteria than floodplain wells. Many wells on the West Mesa have to penetrate more than 300 feet to reach water and they were all classified as *uncertainly shallow* in order to check for statistical error. Each well was compared to cross-sectional diagrams of hydrogeological strata found in Hawley and Kennedy (2004) to determine the strata at the bottom of the well. If a well penetrated to the more densely

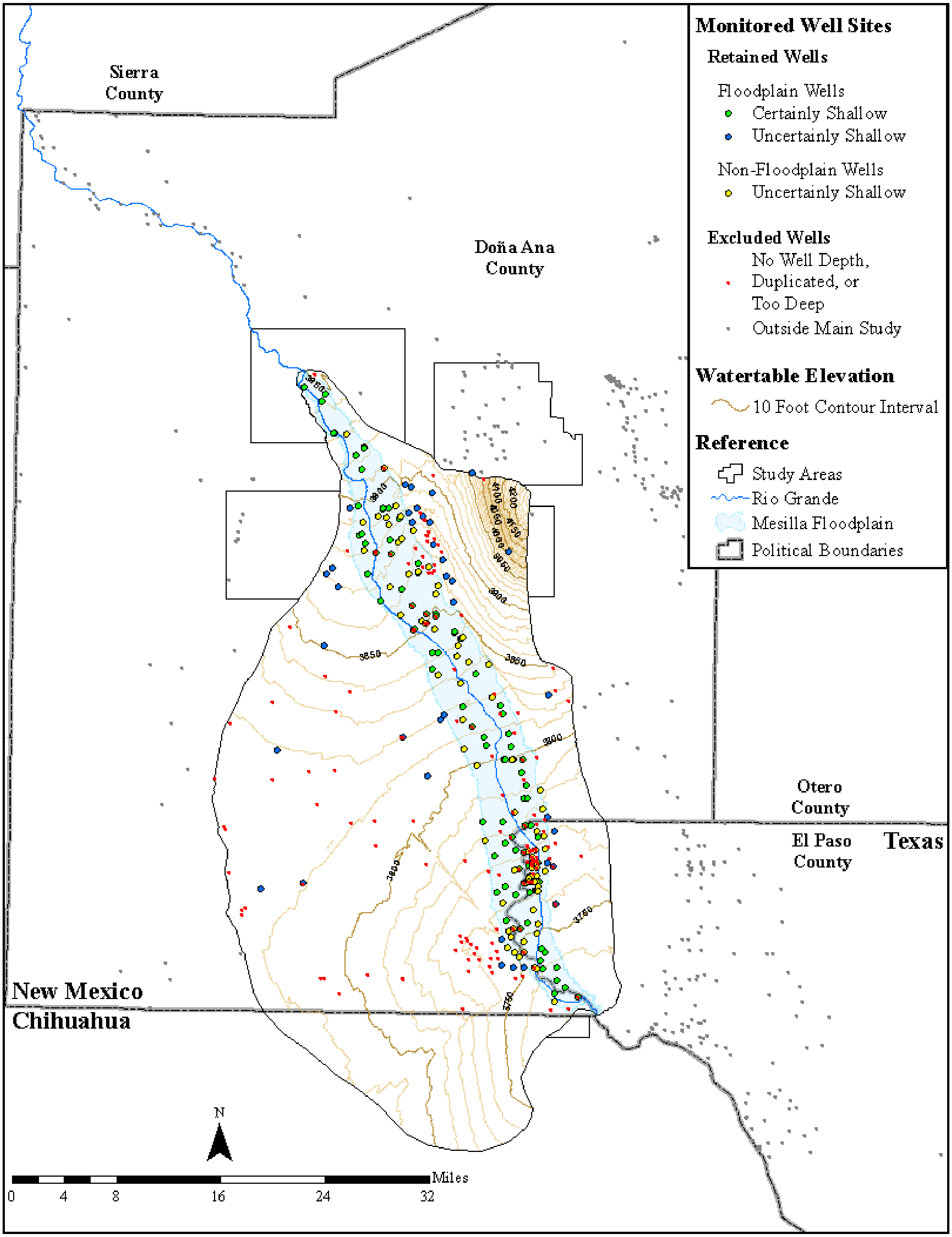


Figure 3-1: Wells and Water Table Contours Used in Project

packed and consolidated Middle or Lower Santa Fe hydrogeological group, that well was excluded. Since the hydrogeological groups vary in their depths across the entire aquifer, the exclusion was performed on a case by case basis. The Middle Santa Fe group in the southern third of the Mesilla groundwater system reaches to just under the river alluvium and has no Upper Santa Fe group above it. Wells in this area were excluded if they had bottom depths greater than 300 feet or if they reached the Lower Santa Fe group or bedrock at any depth.

Of the 779 wells found in both counties, 371 were outside the main study area and 195 of the wells had uncorrectable errors, were duplicated, too deep, or had bottom depths ending in the wrong hydrogeological group. Of the remaining 213 wells, 37 were classed as *uncertainly shallow* non-floodplain wells, 81 were classed as *uncertainly shallow* floodplain wells, and 95 were classed as *certainly shallow* floodplain wells.

Using the Geostatistical Wizard tool in the Geostatistical Analyst extension in ArcGIS for Desktop, a preliminary water-table surface was created using a simple kriging/cokriging model (a Gaussian interpolation method governed by prior covariances). This preliminary surface was checked using the built in cross-validation tool, which checks the model's accuracy by running the model without each well value in the set and compares the interpolated value at the well site against the actual value. If any *uncertainly shallow* wells had a predicted error of greater than 30 feet, those wells were excluded and the surface was recalculated until all errors were corrected. After the wells were tested using geostatistical calculations, eight were removed based on this predicted error.

Several model iterations with 146 different parameter combinations were explored using both kriging and inverse distance weighting. Two quality assurance tests were used afterward to further check each model iteration's accuracy. The first compared the water-table shape and contours of each preliminary model surface (Figure 3-1) to a Mesilla groundwater surface contour map adapted from Hibbs and others (1997) and Hawley and Kennedy (2004, 6). Six of the 146 preliminary model iterations were found to match contours and shape closely and were finalized into geotiff images for further analysis. The second quality assurance test used ArcScene to place the geostatistical water-table surfaces into a three-dimensional environment along with a digital elevation model (Figure 3-2). The groundwater surface, colored blue in Figure 3-2, appeared as a body of water where its elevation values were greater than the DEM. If a body of water appeared

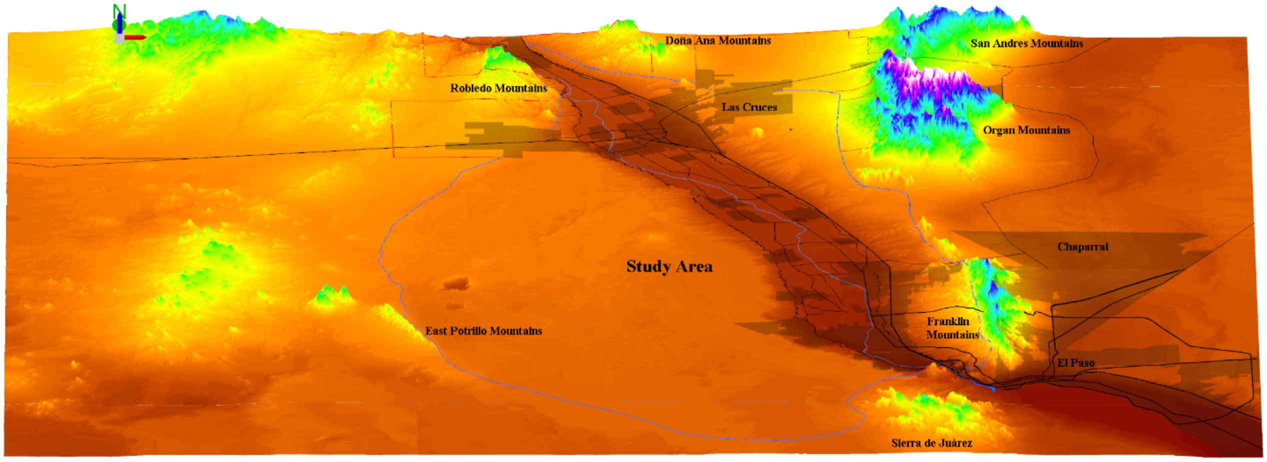


Figure 3-2: Three Dimensional Mesilla Basin DEM Used for Quality Assurance Test Two

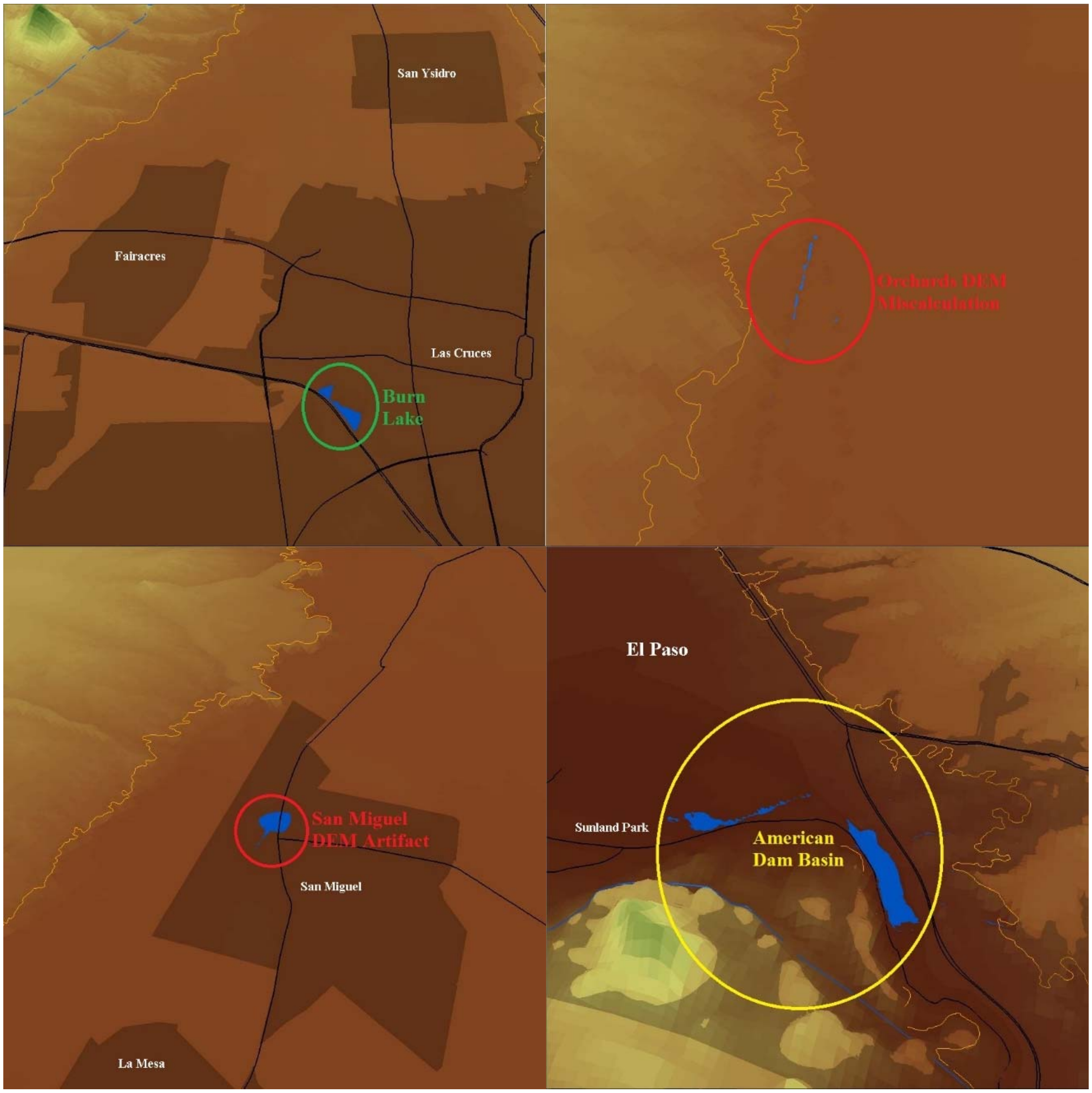


Figure 3-3: ArcScene Quality Assurance Test Two Results *Upper Left*: Burn Lake – Correct; *Upper Right*: Orchards West of Mesilla, NM – Incorrect; *Lower Left*: San Miguel, NM – Incorrect; *Lower Right*: American Dam Basin Northwest of El Paso – Questionable

where one did not exist in the real world, that model was found to be inconsistent. While all six models had small inconsistencies (Figure 3-3), the surface with the fewest inconsistencies was chosen as the water-table elevation surface and subtracted from the digital elevation model to become the depth to water surface. The best surface found for these well data was built using a simple kriging analysis that had no transformation. This was optimized using a K-Bessel differential equation to fit the semivariogram prediction model to the data points, with all other variables left at their default settings. The final raster values of the surface were converted to polygon features, clipped to the individual study areas, and reclassified according to the original charted values by Aller and others (1987) in appendix A, table A-1 on page 64.

3.2.2 Net Recharge Component (R)

The Net Recharge component map was built by reclassifying a 2006, 1:24,000 scale, USGS National Land Cover Dataset classification model (Fry et al. 2011) using the Net Recharge parameters determined by Creel and others (1998) and Kennedy (1999) for how much surface water per unit of area is available for each land-cover type (Table 3-4). The weight of this component is 4. This component was completed first, since a raster with land cover was already compiled and classified and a method of reclassifying the dataset had already been studied.

Table 3-4: Net Recharge Ratings, Weights, and Indices for 2006 USGS National Land Cover Codes

NLCD Code[1]	NLCD Classification[1]	Anderson LULC Level 1 Class[2]	Index Value[3]	R_r	R_w	R_i
11	Open Water	Water	36	9	4	36
81 / 82	Pasture/Hay / Cultivated Crops	Agricultural Land	36	9	4	36
90 / 95	Woody Wetlands / Emergent Herbaceous	Wetland	32	8	4	32
42	Evergreen Forest	Forest Land	24	6	4	24
21/ 22/ 23/ 24	Developed Land (All Densities)	Urban or Built-up Land	4	1	4	4
31	Barren Land (Rock/Clay/Sand)	Barren Land	4	1	4	4
52 / 71	Shrub/Scrub/ Grassland/Herbaceous	Rangeland	4	1	4	4

[1] As per Fry et al. (2011).
[2] As per Anderson et al. (1976).
[3] Modified for local conditions by Creel et al. (1998) page 43 and Kennedy (1999) page 94.

The Mesilla Valley lies in an arid environment where evapotranspiration exceeds precipitation, which is the secondary source of groundwater far behind percolation from the Rio Grande, canals, and streams (Frenzel and Kaehler 1992). This is the main reason that Creel and others (1998) and Kennedy (1999) used a 1:100,000 scale Level 1, Land Use/Land Cover classification model by Anderson and others (1976) to separate agriculture from surrounding areas that have much lower surface water percolation to groundwater. Net Recharge ratings for the classification were determined based on New Mexico climate research by Frenzel and Kaehler (1992). The values were also used in this project to reclassify a more up-to-date, higher resolution, model.

On page 17 of Creel and others (1998), the table of Net Recharge parameter ratings reported different values than the Net Recharge map on page 43. The values on the map were verified by S. Walker during an interview with Theodore Sammis (May 23, 2012) and expanded to classify the 13 land-cover subdivisions found in this project. The difference between the two reports only affected 0.044% of the total study area. The land-cover data for the Mexican side of the basin covered three different land-cover classifications: urban development, rangeland, and barren land. Since all three groups have a rating of 1 due to the aridity of the environment, a Net Recharge index value of 4 was given to the entire area south of the border.

3.2.3 Aquifer Media Component (A)

The Aquifer Media component was built using the water table created for the Depth to Water component, cross referenced with the hydrogeological cross-section drawings, fault-line locations, bedrock-elevation contours, and surface-hydrogeology layers from Hawley and Kennedy (2004). The weight assigned to this component is 3. All geology shapefiles extended into Mexico, so no additional material was required to map the aquifer south of the border. This was one of the last components to be created because it required the water-table surface to be completed beforehand and required complex interpolation and expert knowledge of the subsurface from interviews.

Eighteen transects (Figure 3-4) crossing the aquifer from several angles were traced using the 3D Analyst package in ArcGIS for Desktop to obtain elevations from the digital elevation model and the water-table elevation surface. The extent of each hydrogeological group at the water-table elevation along each transect was collected, exported, and plotted in Excel and on the Hawley and Kennedy (2004) cross sections themselves (Figure 3-5). Using known distances and depths of the subsurface materials from the cross sections, the media at the water-table level were interpolated between transects. A hand-drawn and digitized map of polygons was created to denote the assumed type of media present at the water-table surface across the entire study area (Figure 3-6).

To improve performance with interpolation, fault lines and bedrock elevations were incorporated in conjunction with some of the cross sections. Tabular information was added to each polygon using the ratings designed by Aller and others (1987) adjusted to high, medium, or low range, using Hawley and Kennedy (2004) and expert advice (personal interview by S. Walker with J.W. Hawley on December 15, 2012). Table 3-5 lists information about the subsurface hydrostratigraphic units and lithofacies assemblages used to classify the hydrogeology map. Hydrostratigraphic units (HSUs) are the specific types of geological media that form a distinct hydrologic unit with respect to groundwater flow. They are comparable to the mappable, hydrogeological settings of *DRASTIC*. Lithofacies (LFAs) are distinct strata of sedimentary media combined into groups based on color, grain size, texture, distribution, composition, structure, or post-depositional alteration. They are the building blocks of the hydrogeological model and the primary elements of HSUs.

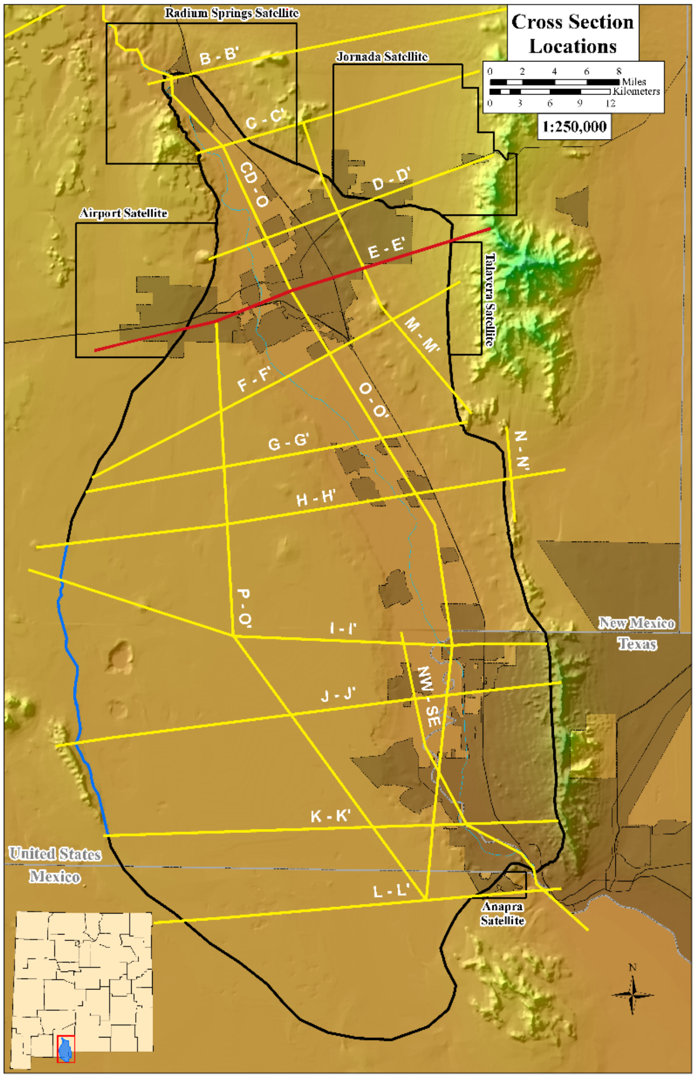


Figure 3-4: Transect Layer for Cross Sections Used in Project
(Cross Section E-E' Highlighted in Red)

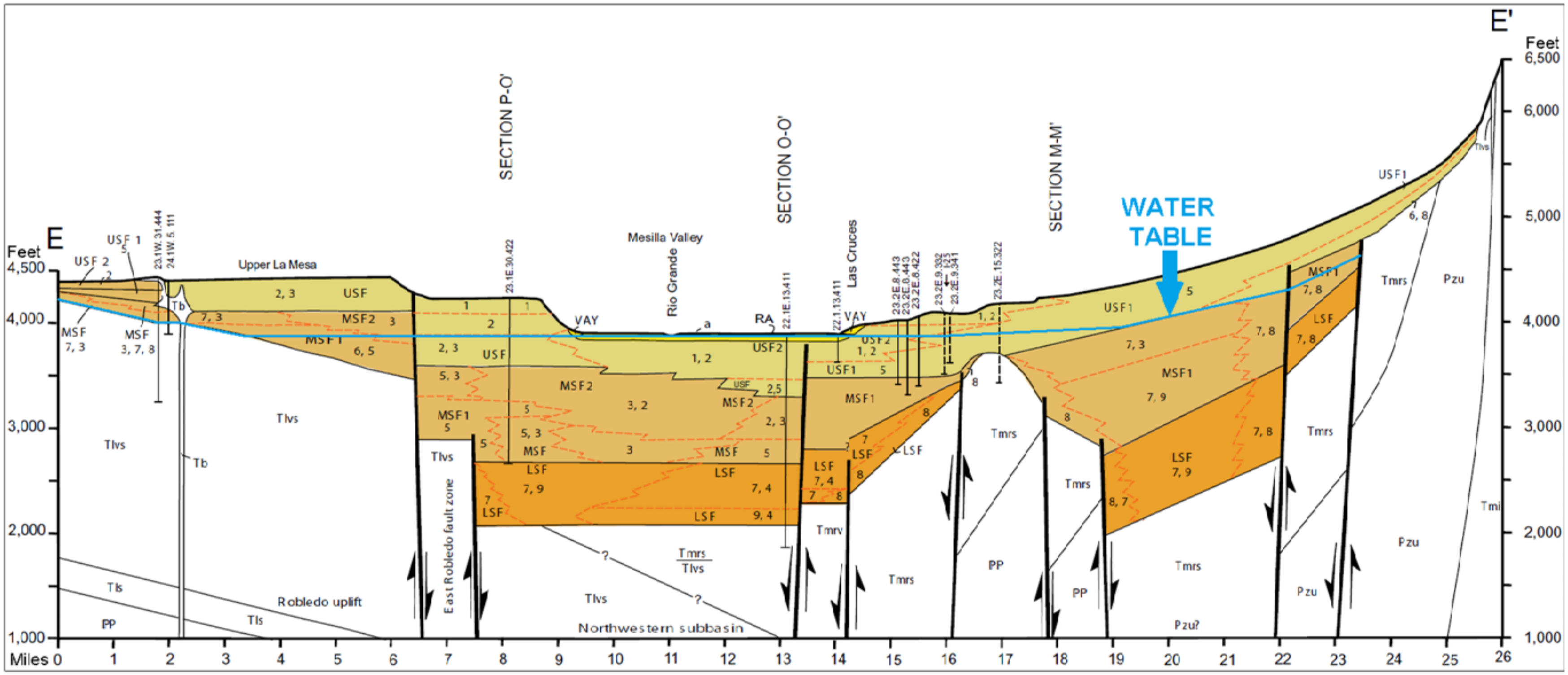


Figure 3-5: Water Table (Depth to Water) at Cross Section EE' (1:10 vertical exaggeration. Hawley and Kennedy 2004)

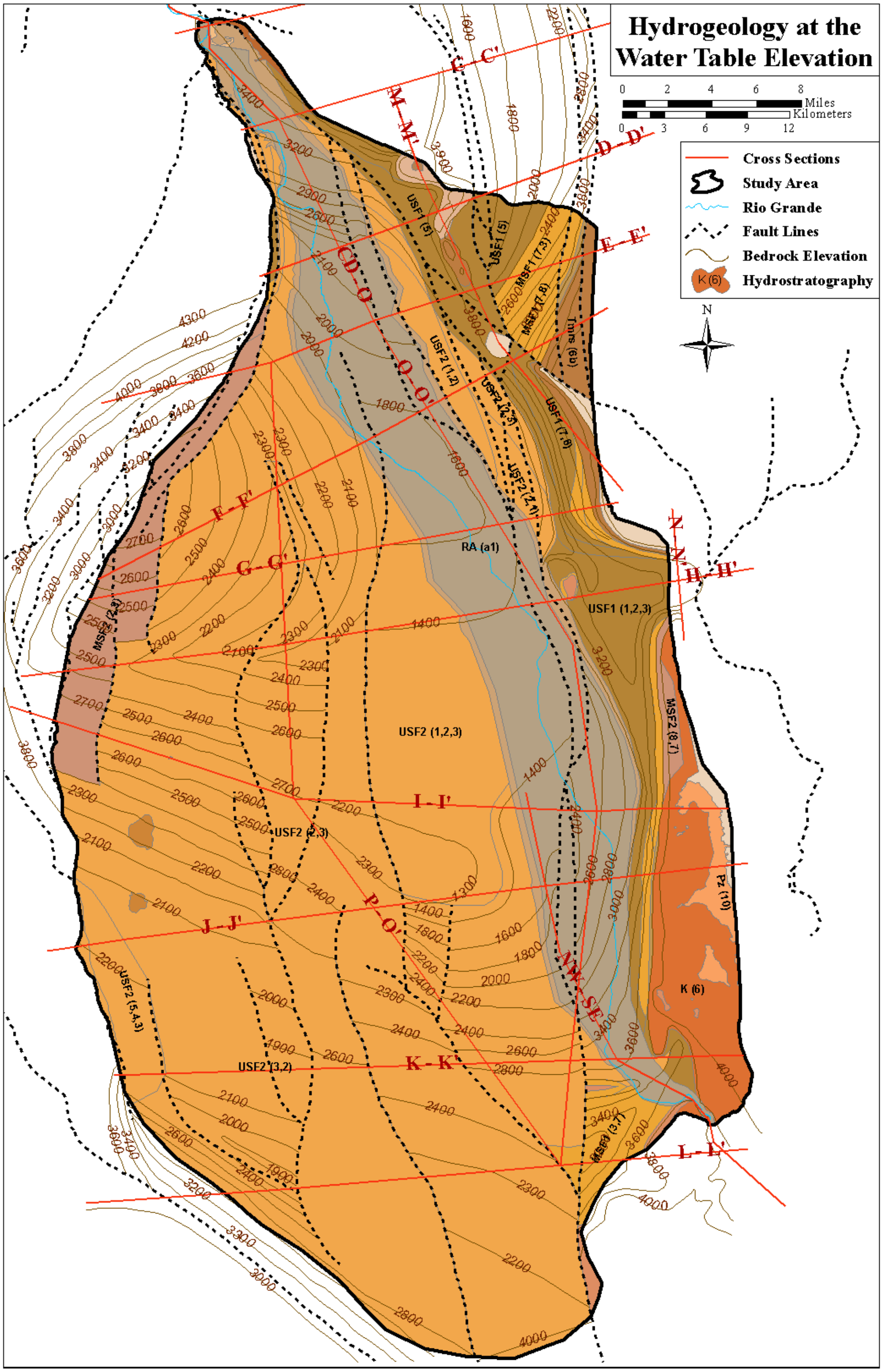


Figure 3-6: Hand Digitized Layer of Hydrogeological Media at the Water Table (by S. Walker 2012)

Table 3-5: Surface Hydrogeology Rating System – Hydrostratigraphic Units

HSU[1]	**LFA**[1]	**Name**[1]	**MediaRange**[2]	A_r[3]	A_w[2]	A_i
RA	a1	Fluvial Deposits	Sand and Gravel	9	3	27
TA	b	Ancestral Fluvial Deposits	Sand and Gravel	9	3	27
USF2		Basin Floor Upper Santa Fe	Sand and Gravel	9	3	27
!P	10	Limestone	Massive Limestone	8	3	24
LSF		Undivided Lower Santa Fe	Sand and Gravel with Silt and Clay	7	3	21
MSF1		Piedmont Slope Middle Santa Fe	Sand and Gravel with Silt and Clay	7	3	21
MSF2		Basin Floor Middle Santa Fe	Sand and Gravel with Silt and Clay	7	3	21
Qbm	3	Eruptive Volcanic Basalt	Sand and Gravel with Silt and Clay	7	3	21
USF1		Piedmont Slope Upper Santa Fe	Sand and Gravel with Silt and Clay	7	3	21
VAY	b	Valley Border Deposits	Sand and Gravel with Silt and Clay	7	3	21
Pzl	6b	Undiff Limestone, Sandstone	Bedded Sandstone, Limestone, Shale	5	3	15
Tls	6b	Sedimentary Sand/Mudstone	Bedded Sandstone, Limestone, Shale	5	3	15
K	6	Sarten/Dakota Sandstone	Massive Sandstone	4	3	12
Tmrp	6b	Part/ Densely Welded Rhyolite Ash	Massive Sandstone	4	3	12
Tmrs	6b	Pyroclastic/Volcaniclastic Rock	Massive Sandstone	4	3	12
Tmsp	6b	Sedimentary Tuffs	Massive Sandstone	4	3	12
KP	10	None	Basalt	2	3	6
P/ Pz/ Pzu	10	Limestone, Sandstone, and Mudstone	Basalt	2	3	6
Pzm	10	Undifferentiated Limestone and Shale	Basalt	2	3	6
Qb	5	Extrusive Volcanic Basalt	Basalt	2	3	6
Tb	10	Basalt Flows	Basalt	2	3	6
Tli	10	Intermediate Volcanic Rock	Metamorphic/ Igneous	2	3	6
Tlvs	10	Volcaniclastic Sedimentary	Basalt	2	3	6
Tmi	10	Intermediate Plutonic Rock	Metamorphic/ Igneous	2	3	6
Tmrv	10	Intermediate Rhyolite Lava	Metamorphic/ Igneous	2	3	6
Tri-Tlvs	10	Intrusive Volcaniclastic	Basalt	2	3	6

[1] As per Hawley and Kennedy (2004).

[2] As per Aller et al. (1987).

[3] As per J.W. Hawley, interviewed by S. Walker on December 15, 2012.

3.2.4 Soil Media Component (S)

The Soil Media component was built using 2008 and 2009, Natural Resources Conservancy Service (NRCS), 1:24,000 scale, Soil Survey Geographic databases (SSURGO) for the counties of Doña Ana (U.S. Department of Agriculture 2008) and El Paso (USDA 2009a) and Fort Bliss Military Reservation (USDA 2009b). These databases were described in detail using interpretation guides (Jaco 1971 and Bulloch and Neher 1980) and official soil series descriptions (USDA 1997). The assigned weight of this component is 2. This was one of the first components to be created since the dataset used for the Soil Media component was already delineated and simply required reclassification to generate a workable component map.

The NRCS SSURGO data obtained for this component are a collection of soil series that indicate depths and amounts of texture related materials required by the *DRASTIC* model, such as clay, loam, sand, and silt. Soil series are described based on individual layers of differing thickness called horizons. Horizons are made up of materials with distinct physical characteristics, primarily color and texture. Descriptions of material type are also included, such as organic, mineral, structural, and chemical composition. The series data are mapped by county boundaries, except where they extend onto federally controlled land. Data gathered for each individual soil survey matches based on tabular fields, but does not match based on soil series names or extents. Many boundaries between series have marked differences, even when the actual site is homogeneous. Doña Ana County, El Paso County, and Fort Bliss SSURGO data are the only series available for use in the study area. The White Sands series was unavailable, leading to a notch being cut from the Jornada satellite boundary after its creation.

The SSURGO soil series provided a large number of different soil types beyond the nine that Aller and others (1987) had originally described for *DRASTIC*. Using the original soil types and ratings as a base, a table of expanded ratings for each soil type (Appendix B, Table B-2 on page 84) was designed with expert advice (personal interview by S. Walker with C. Monger on June 26, 2012). Soil horizon ratings were combined together into a single rating for each series (Appendix B, Table B-3 on page 85) using a formula for vertical hydraulic conductivity perpendicular to layering (Fetter 2001). For example, the Belen clay loam series consisting of 11 inches of clay loam soil type (11 inches × rating of 3 = 33 inches) on the surface, 15 inches of silty clay soil type (15 inches × 2 = 30 inches) underneath, and 34 inches of very fine sand soil type at the bottom (34 inches × 7 [very fine has -2 rating to sand’s 9] = 238 inches) has a total rating (33 inches + 30 inches + 238 inches ÷ 60 inches total depth) of 5 for the series. Soil data from Mexico were much less complex, having a scale of 1:250,000 and a taxonomic specificity of soil order. Soil orders were converted to soil horizons by using average ratings across the order. This allowed the data to be incorporated into the project’s soil type index chart, but the scale issue could not be adjusted.

3.2.5 Topography Component (T)

The Topography component was built from a USGS (2009), one-third arc second, National Elevation Dataset (NED) digital elevation model (DEM). These data included the full extent of the Mesilla groundwater basin in Mexico. The weight of this component is 1. The entire dataset for all study areas was 286 megabytes in size and had to be clipped to smaller chunks or separated into slope classes for geoprocessing, since ArcGIS has a two gigabyte memory limit outside of file or SDE geodatabases. Each raster cell was given a percent slope based upon the heights of each of its eight neighbors. The rasters were converted into topologically connected polygons so that ratings, weights, and indices (Aller et al. 1987) for the slopes could be added to the geometry. Polygons were conglomerated and smoothed into larger homogeneous shapes, but the large number of polygons exceeded memory limitations and had to be broken into five individual slope class layers. Each slope class was dissolved and given a single index value before being merged into a single shapefile.

3.2.6 Impact of the Vadose Zone Component (I)

The Impact of the Vadose Zone component was built from a 2004, 1:100,000 scale, surface hydrogeology layer (*geology.shp,* Seager et al. 1987) depicted in Hawley and Kennedy (2004). The assigned weight of the component is 5. The range of ratings from the *DRASTIC* model were broken into low, medium, and high values to classify the surface hydrogeology. The hydrogeology layer from Hawley and Kennedy (2004) divides the geology near the ground surface of the Mesilla, Jornada, and Tularosa Basins into groups of features with different hydrogeological properties and structures. Appendix B, Table B-4 on page 91 has full descriptions of each hydrogeology layer. Table 3-6 depicts all hydrogeology features in the study area; listing their geomorphology, maximum depths, and vadose zones based on properties found in Hawley and Kennedy (2004). A *DRASTIC* vadose range was tailored with expert advice (personal interview by S. Walker with J.W. Hawley on July 17, 2012) for each hydrogeology type based on its known formation, components, and porosity. The rating value was then selected from the range of values for each vadose range based on the location of the hydrogeology and its amount of fracturing.

The hydrogeology shapefile layer used in Hawley and Kennedy (2004) extended slightly over four miles (6.4 km) into Mexico, with the final six miles (9.7 km) of the aquifer being covered by the Mexican hydrogeology shapefile layer (*geología.shp*). This layer had a scale of 1:250,000 and described the hydrogeology of the area in simple geomorphic terms, such as ‘sedimentaria’ (sedimentary) or ‘suelo’ (soil). These geomorphic terms were reclassified using the Hawley and Kennedy (2004) vadose ranges and ratings were chosen based on location and fracturing.

Table 3-6: Surface Hydrogeology Rating System for Vadose Zones

Hydrogeology[1]	**Geomorphology Zone**[1]	**Vadose Zone**[1]	**Vadose Range**[2]	I_r[3]	I_w[2]	I_i
RA	Rio Grande Valley	Mostly saturated	Sand/Gravel	9	5	45
TA	Rio Grande Valley	Entirely vadose	Sand/Gravel	9	5	45
USF2	Santa Fe Group	Partly vadose	Sand/Gravel	9	5	45
USLM	Santa Fe Group	Entirely vadose	Sand/Gravel	9	5	45
!P	Bedrock/Pre-Santa Fe		Thin Bed Sand/Lime/Shale Seq	4	5	20
E	Piedmont Slope	Entirely vadose	Sand/Gravel with Silt/Clay	4	5	20
E/Qb	Basalt Capping		Basalt	4	5	20
Kl	Bedrock/Pre-Santa Fe		Thin Bed Sand/Lime/Shale Seq	4	5	20
MSF1	Santa Fe Group	Mostly saturated	Sand/Gravel with Silt/Clay	4	5	20
PA/ PAO/ PAU/ PAUc/ PAY	Piedmont Slope	Entirely vadose	Sand/Gravel with Silt/Clay	4	5	20
Pz/ Pzm	Bedrock/Pre-Santa Fe		Thin Bed Sand/Lime/Shale Seq	4	5	20
Pzl	Bedrock/Pre-Santa Fe		Limestone	4	5	20
Qb/ Qba/ Qbac/ Qbc	Basalt Capping		Basalt	4	5	20
Tb/ Tba	Bedrock/Pre-Santa Fe		Basalt	4	5	20
Tli/ Tmi/ Tmrv	Bedrock/Pre-Santa Fe		Metamorphic / Igneous	4	5	20
Tls/ Tmsp	Bedrock/Pre-Santa Fe		Thin Bed Sand/Lime/Shale Seq	4	5	20
USF1/ USLc	Santa Fe Group	Mostly vadose	Sand/Gravel with Silt/Clay	4	5	20
VA/ VAY	Rio Grande Valley	Mostly vadose	Sand/Gravel with Silt/Clay	4	5	20
VAO	Rio Grande Valley	Entirely vadose	Sand/Gravel with Silt/Clay	4	5	20
K	Bedrock/Sedimentary		Sandstone	3	5	15
Qt	Basalt Capping		Sandstone	3	5	15
Tmrp	Bedrock/Pre-Santa Fe		Sandstone	3	5	15
Tlvs	Bedrock/Pre-Santa Fe		Shale	2	5	10
BF	Basin Floor	Mostly vadose	Silt / Clay	1	5	5
BFP	Basin Floor	Entirely vadose	Silt / Clay	1	5	5

[1] Hawley and Kennedy (2004).

[2] Aller et al. (1987).

[3] As per J.W. Hawley, interviewed by S. Walker on July 17, 2012.

3.2.7 Hydraulic Conductivity Component (C)

The Hydraulic Conductivity component was built last in conjunction with the Aquifer Media component, since hydraulic conductivity is an attribute of the hydrogeologic media. The weight assigned to this component is 3. Polygons created for the Aquifer Media component were classified with both hydrostratigraphic units (HSUs) and lithofacies assemblages (LFAs). A table was created for this component using LFAs reclassified with *DRASTIC* Hydraulic Conductivity ratings (Aller et al. 1987), entries from Hawley and Kennedy (2004), and expert advice (personal interview by S. Walker with J.W. Hawley on December 15, 2012). Table 3-7 lists the reclassified ratings for each of the LFAs.

Many LFAs had a range of hydraulic conductivities that had to be averaged to obtain one value to enter into each polygon. For example, LFA 2 has a *high to moderate* conductivity. *High* ranges from 30 to 100 feet per day (average 65) and *moderate* ranges from 3 to 30 feet per day (average 16.5). *High to moderate* ranges from 3 to 100 feet per day with an average of 40.75. All calculations are found in appendix B on tables B-5, B-6, and B-7.

Table 3-7: Hydrogeology Rating System – Lithofacies Assemblages

LFA Values[1]	**Hydraulic Conductivity**[1]	**K** [feet per day][1]	**K** [gallons per day per square foot][2]	**C_r**[3]	**C_w**[3]	**C_i**
1/ a1	High	65	486.2338	4	3	12
1,2	High-High Moderate	56.92	425.7912	4	3	12
1,2,3/ 1,3/ 2,1	High Moderate	48.83	365.27379	4	3	12
2/ a	High to Moderate	40.75	304.83119	4	3	12
2,3	High Moderate	32.67	244.38859	2	3	6
3,2	Moderate High	24.58	183.87118	2	3	6
3/ 4/ 5a/ a2	Moderate	16.5	123.42858	2	3	6
3,5	Moderate	15.01	112.28261	2	3	6
5,4,3	Moderate	14.27	106.74702	2	3	6
5/ 5b/ 6/ 6a/ a3/ b/ 5,6/ 6,5	Moderate to Low	12.03	89.990656	1	3	3
3,7	Moderate Low	11.52	86.17559	1	3	3
3,9	Moderate Low	11.02	82.43533	1	3	3
5,6,7,8	Moderate Low	8.89	66.501823	1	3	3
6,8	Moderate Low	8.54	63.883641	1	3	3
7,3	Moderate Low	6.53	48.847796	1	3	3
9,3	Low Moderate	5.53	41.367276	1	3	3
6b	Low to Moderate	4.83	36.130912	1	3	3
7/ 8/ c/ 7,8/ 8,7	Low	1.55	11.594806	1	3	3
9/ 10	Very Low	0.05	0.374026	1	3	3

[1] As per Hawley and Kennedy (2004).

[2] Conversion rate is 1 foot per day × 7.48052 gallons per cubic foot (Fetter 2001).

[3] As per Aller et al. (1987).

3.2.8 DRASTIC Pollution Sensitivity Index (DRASTIC$_i$)

The *DRASTIC* index map was created by adding each of the seven component index maps together using the Union tool in ArcGIS for Desktop. The Union tool was preferred over the Intersect tool, since the Intersect tool only creates new feature areas where all layers overlap and removes the areas that don't overlap. The Union tool allows topological errors to be detected because it creates feature areas at any place covered by any layer, placing null values where component layers do not overlap completely. Polygons that had component fields with null index values were either deleted because they were non-overlapping edges or adjusted so that polygon topology was adjoined. Once the *DRASTIC* data layer was topologically clean, a new field was created and filled with the sum from each of the component index values. Divisions for a seven tiered ranking system (Very Low, Low, Below Average, Average, Above Average, High, and Very High) were calculated using a Jenks (1967) natural breaks classification.

3.3 POLLUTION RISK CALCULATIONS

To determine the amount of risk that a group of parcels would have for polluting groundwater, this project used housing density and property size as indicators for application and concentration of septic pollutants. In this project, individual parcels had many different *DRASTIC* sensitivity index values and there was no way to determine where on each property a septic system might be located if a property had a septic system. If the property had a septic system, an area weighted average assumes that the system has a potential sensitivity index value somewhere between the lowest value on the property and the highest value, with the greatest chance of the system having the value that covers the greatest area. So, an area weighted average *DRASTIC* sensitivity index value was calculated for each property to simplify the pollution sensitivity. To simplify the pollution risk, each property was assumed to have up to one septic system on it and the property size acted as a limit for the number of systems that could be placed in close proximity to each other. This made the property itself a unit of pollution, with size and density of parcels governing the level of risk. While a single tiny parcel would have a high level of risk based on its size, the same parcel in the midst of several large parcels would not be as high risk as many tiny parcels packed together.

3.3.1 Area Weighted Mean DRASTIC Pollution Sensitivity Index (DRASTIC$_{AWM}$)

This layer was built by calculating the area weighted average *DRASTIC* pollution sensitivity for each parcel in the study area. The cadastral layer obtained from Doña Ana and El Paso Counties covered all study areas in the United States. A cadastral layer obtained for Mexico only covered parcels in the town of Anapra and nothing else in the groundwater study area. All of the parcels were combined together and corrected for topological reporting differences between political agencies. Preference was given to the edge of the parcel that fell closest to the property edge as seen on 2012, ESRI, satellite imagery (world imagery basemap). The Union tool was again used to remove topology errors.

Each parcel was given a unique name based on its county and parcel code. These numbers remained connected to each *DRASTIC* divided parcel piece and were used to reassemble the pieces of each parcel after area weighting. This weighting was performed by calculating the area of each parcel piece and multiplying it by the *DRASTIC* index score. When the parcel pieces were dissolved into whole parcels again, the area weighted *DRASTIC* values were added together and divided by the area of the whole parcel to create an area weighted average *DRASTIC* pollution sensitivity index. For example, if a parcel covered one-square acre and half of it was filled with a pollution sensitivity value of 120 (0.5 acre × 120 = 60) and one-quarter was filled with 100 (0.25

acre × 100 = 25) and 80 (0.25 acre × 80 = 20), the parcel would have a sensitivity value of 105 ((60+25+20) acre ÷ 1 acre).

Area weighted mean *DRASTIC* parcels remained in the seven tiered ranking system used for the *DRASTIC* pollution sensitivity index and were also binned into groups of one-half acre to determine basic statistics. After recombining averaged parcels and removing several parcels known to be roads and those under 0.1 acres (405 m^2), the number of parcels in the total study area was reduced to 116,000 parcels with areas between 0.1 and 3070 acres (12.4 km^2). Of this total number of parcels, 79,600 (68.5%) were less than one-half acre, 12,200 (10.6%) were between one-half and one acre, 7,440 (6.4%) were between one and one-and-a-half acres, 2,610 (2.2%) were between one-and-a-half and two acres, and 14,100 (12.1%) are over two acres.

3.3.2 DRASTIC Parcel Pollution Risk: $DRASTIC_{AWM}$ per Acre ($DRASTIC_{PR}$)

The parcel pollution risk map was created by taking the area weighted mean *DRASTIC* pollution sensitivity parcels and dividing the area of each parcel into the index values. The scale ranged in value from 0.04 to 1159.5 and was roughly divided into eight equal distributions (quantile breaks) of 11,300 parcels, centered on a median of 347.12. This allowed each tier to be compared equally against the others and provided a scale that had half of the values on each side of the median. The number of parcels in each half-acre size bin was counted depending on which risk tier it fell into.

Parcel groups were pinpointed for community outreach septic-system training by choosing groups of twenty or more parcels adjoining each other that had above median *DRASTIC* parcel pollution risk. Las Cruces Wastewater Utilities and Doña Ana County Wastewater Utilities provided main sewage-pipe diagrams for use in the project. El Paso Water Utilities and their branches provided service-area border diagrams without sewage lines. Sunland Park, Anthony, and Anapra have wastewater treatment plants, but no information about their service areas or pipes was obtained. All sewage line layers were merged and a 300-foot buffer layer was created around the pipe locations to determine which parcels needed to be connected to sewage by regulation.

Metadata, if found with the sewage layers, did not indicate whether sewage lines were mains or laterals. To account for this uncertainty, parcel groups were classified according to the distance and locations of lines and service areas or proximity to a treatment plant (Figure 3-7).

Parcels of above median or higher risk that intersected the 300-foot buffer or fell within the El Paso Service Area had their *DRASTIC* $_{PR}$ reduced to 0 to indicate that they were on city sewage service. Groups of parcels surrounded by sewage lines or with a wastewater facility within a half mile (0.8 km) were classified as *Unlikely* on septic. Parcel groups between 300 and 500 feet (91-152 m) of sewage lines or in communities with sewage treatment plants were classified as *Uncertain* on septic. Parcel groups outside of 500 feet in areas with no sewage service were classified as *Likely* on septic.

A list of parcel groups and their classifications was sent to the New Mexico Environment Department to determine how many of them were actually on septic systems. Many were verified, but some remained unverified. If a group of parcels was verified as being on septic systems, their classification was changed to *Verified* on septic or *Partial* on septic, otherwise it was classified as verified *On Sewage*.

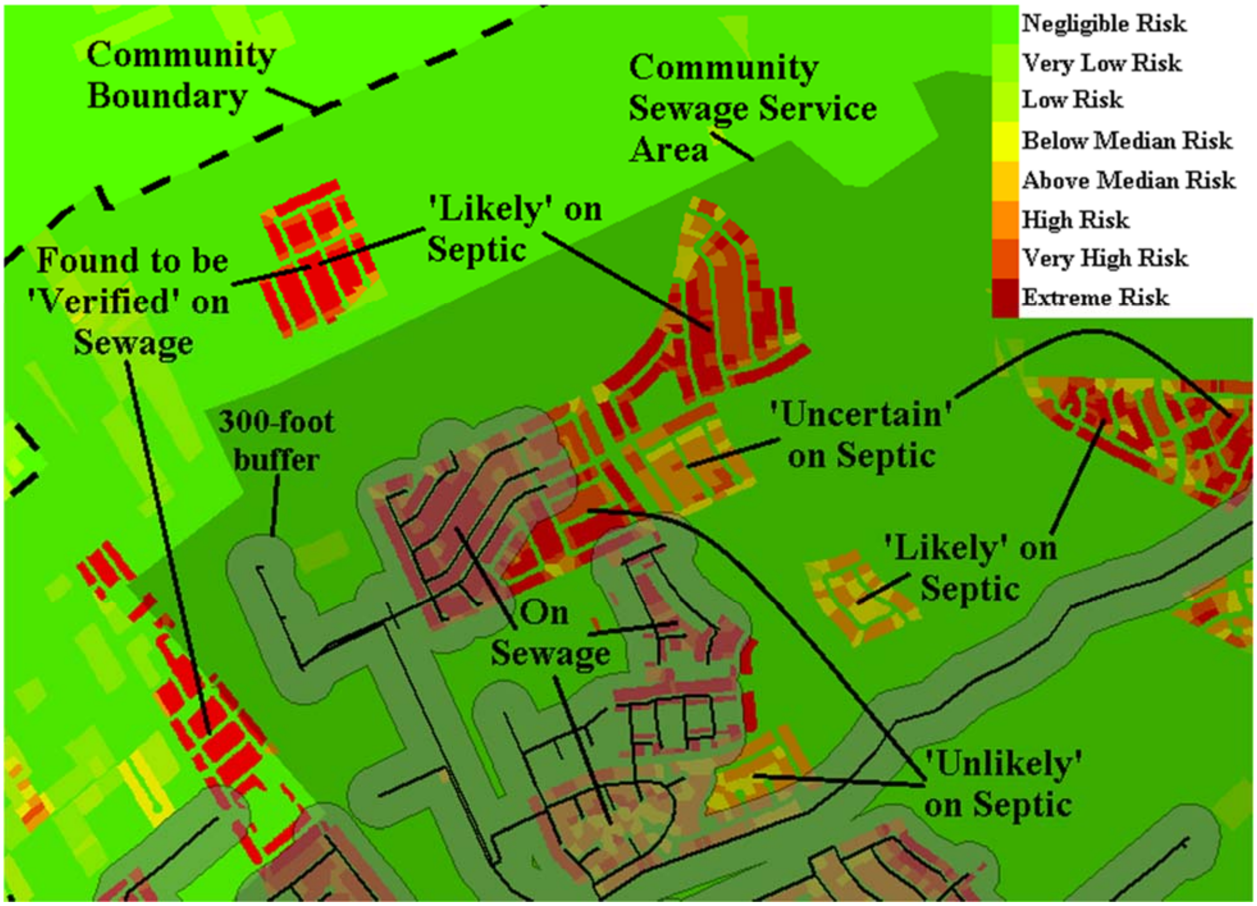


Figure 3-7: Determining Parcel Group Pollution Risk Using Sewage Proximity

4.0 RESULTS

4.1 *DRASTIC* POLLUTION SENSITIVITY RESULTS

The results of the *DRASTIC* pollution sensitivity model indicate areas where the combined component multipliers show an increased likelihood of contamination of the groundwater, without taking the specifics (volume, transport, type, etc.) of a pollutant into account. Values are continuous across political, property, and study area boundaries and are listed based on the amount of area that they cover, both in total acreage and percentage of the study area.

4.1.1 Depth to Water Index (D_i*)*

The highest index values (D_i=50 to 10), representing the smallest depth to groundwater, are naturally found in the floodplain valley closest to the river (Figure 4-1). The lowest index value (D_i=5), representing greater than 100 feet to water, covers the entire study area outward from the floodplain. Table 4-1 shows that 80.1% of the main study area, 95.4% of the Radium Springs satellite area, and 100% of the other satellite areas have a depth to water of 100 feet or greater. In the main study area, 1.5% have 5 or fewer feet to water (D_i=50), 10.9% (D_i=45) between 5 and 15 feet (D_i=45), 3% between 15 and 30 feet (D_i=35), 1.4% between 30 and 50 feet (D_i=25), 1.6% between 50 and 75 feet (D_i=15), and 1.5% between 75 and 100 feet (D_i=10). The Radium Springs satellite also has some area (4.6%) with less than 100 feet to water, because the Rio Grande flows through Selden Canyon northwest of Leasburg Dam through an alluvium filled channel with depths of up to 75 feet (23 m).

Table 4-1: Depth to Water Pollution Sensitivity Index Results

Depth to Water [feet]	**0 to 5**	**5 to 15**	**15 to 30**	**30 to 50**	**50 to 75**	**75 to 100**	**100+**
D_i [sensitivity points]	**50**	**45**	**35**	**25**	**15**	**10**	**5**
Main Study Area [acres] (percent total area)	**1.14×10^{4}** (1.5%)	**8.21×10^{4}** (10.9%)	**2.28×10^{4}** (3.0%)	**1.06×10^{4}** (1.4%)	**1.22×10^{4}** (1.6%)	**1.14×10^{4}** (1.5%)	**6.05×10^{5}** (80.1%)
Radium Springs [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**4.57×10^{2}** (0.9%)	**5.79×10^{2}** (1.1%)	**7.08×10^{2}** (1.3%)	**7.28×10^{2}** (1.4%)	**5.10×10^{4}** (95.4%)
Jornada Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**5.60×10^{4}** (100.0%)
Airport Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**4.11×10^{4}** (100.0%)
Talavera Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**9.05×10^{3}** (100.0%)
Anapra Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**2.24×10^{3}** (100.0%)

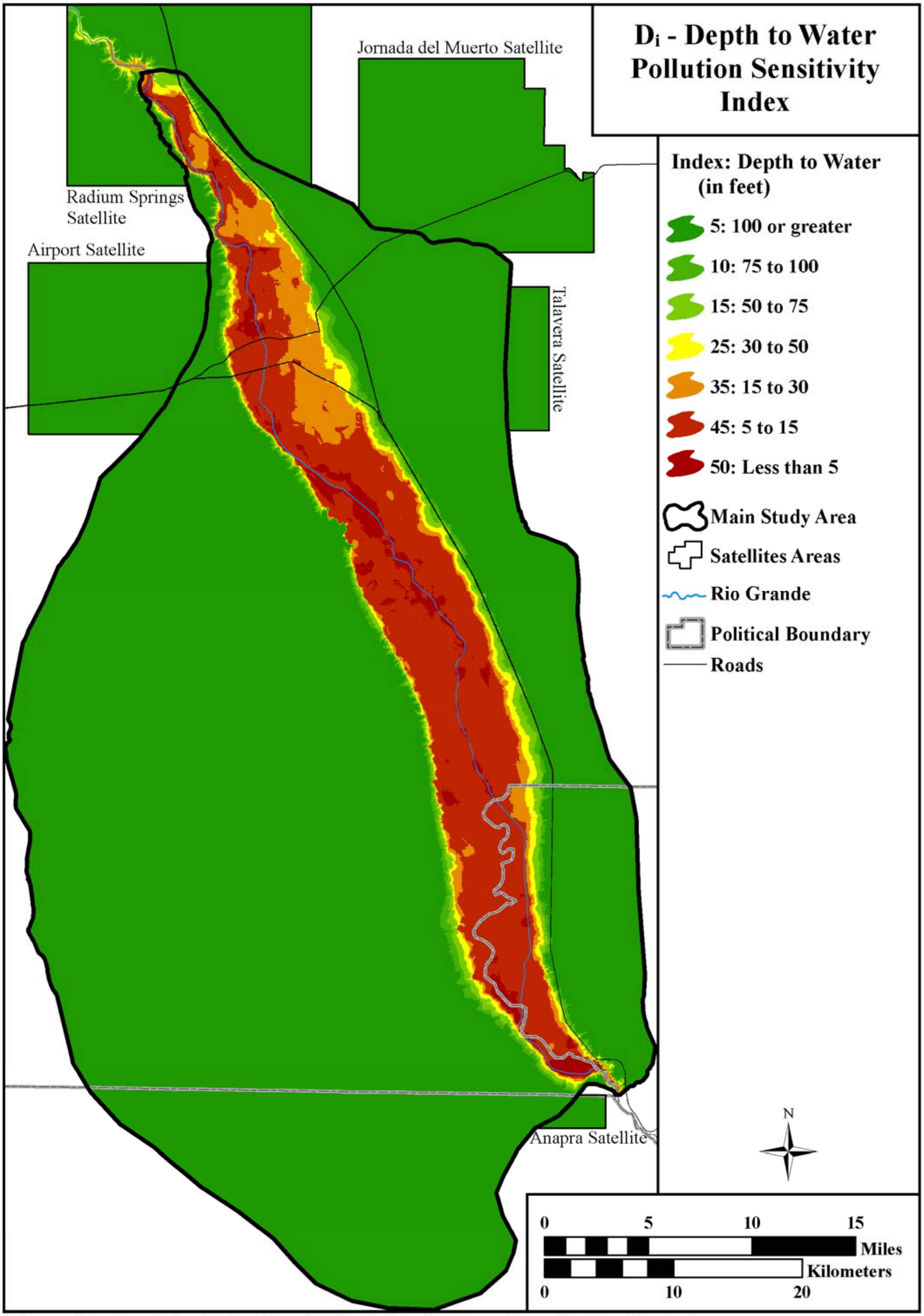


Figure 4-1: Depth to Water Sensitivity Index (D_i) Locations for the Study Area

4.1.2 *Net Recharge Index (*R_i*)*

The highest index values (R_i=36 to 12), representing the largest concentration (>2 inches per unit area) of recharge from activities and land cover that improve surface to water-table percolation, are located within agricultural areas and along mountain tops (Figure 4-2). A majority of the agricultural areas, which have the highest index values (R_i=36), are located within the floodplain valley. The lowest index value (R_i=4), representing less than 2 inches of recharge per unit area, cover most of the study area outward from the floodplain and parts of the floodplain with urban built-up cover. This is the most categorically homogenous component in the model, with 90.5% of the area across all study areas being covered by the Urban/Built-Up/Barren/Rangeland group (Table 4-2). This group covers 88.7% in the main study area, 98.9% in the Radium Springs satellite, 98.3% in the Jornada satellite, 99.7% in the Airport satellite, 99.4% in the Talavera satellite, and 100% in the Anapra satellite. Only 11.3% of the Agriculture/Water group (R_i=36) in the main study area and 1.5% of the Forest Land group (R_i=24) in Jornada were over 1% coverage.

Table 4-2: Net Recharge Pollution Sensitivity Index Results

USGS Land Cover Class	**Agriculture, Water**	**Wetland**	**Forest Land**	**(None)**	**Urban, Built-Up, Barren, Rangeland**
Recharge Range [inches]	**10+**	**10 to 7**	**7 to 4**	**4 to 2**	**2 to 0**
R_i [sensitivity points]	**36**	**32**	**24**	**12**	**4**
Main Study Area [acres] (percent total area)	**8.51×10^{4}** (11.3%)	**2.87×10^{2}** (0.0%)	**4.80×10^{1}** (0.0%)	**0.00×10^{0}** (0.0%)	**6.70×10^{5}** (88.7%)
Radium Springs [acres] (percent total area)	**3.48×10^{2}** (0.7%)	**6.30×10^{1}** (0.1%)	**1.59×10^{2}** (0.3%)	**0.00×10^{0}** (0.0%)	**5.29×10^{4}** (98.9%)
Jornada Satellite [acres] (percent total area)	**7.90×10^{1}** (0.1%)	**1.10×10^{1}** (0.0%)	**8.58×10^{2}** (1.5%)	**0.00×10^{0}** (0.0%)	**5.50×10^{4}** (98.3%)
Airport Satellite [acres] (percent total area)	**1.03×10^{2}** (0.3%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**4.10×10^{4}** (99.7%)
Talavera Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**1.10×10^{1}** (0.1%)	**3.90×10^{1}** (0.4%)	**0.00×10^{0}** (0.0%)	**9.00×10^{3}** (99.5%)
Anapra Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**2.24×10^{3}** (100%)

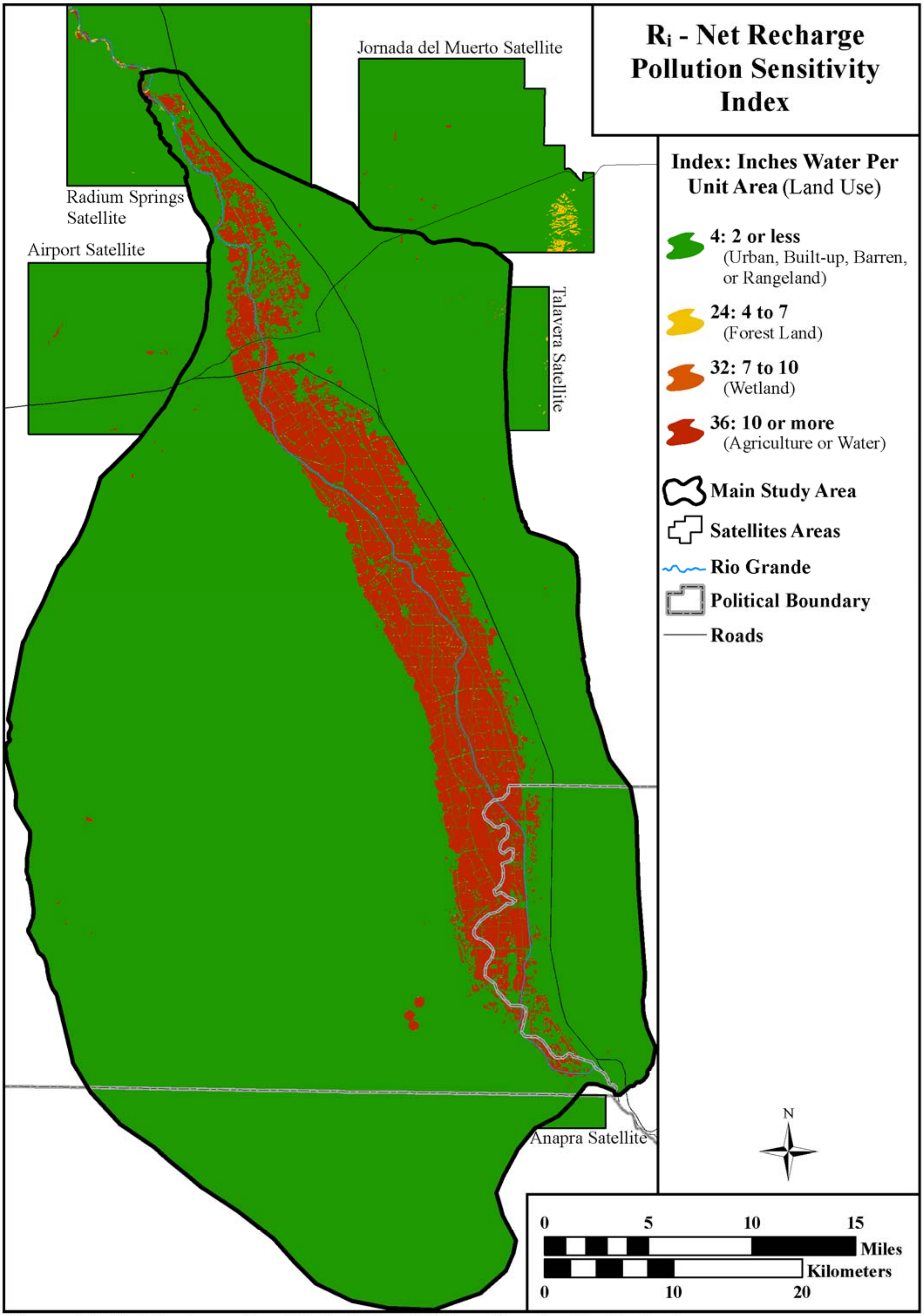


Figure 4-2: Net Recharge Sensitivity Index (R_i) Locations for the Study Area

4.1.3 *Aquifer Media Index (A_i)*

The highest index value (A_i=27) at the water-table surface representing Sand and Gravel, has the least amount of pollution attenuation and is located primarily within and west of the floodplain and in the Jornada and Radium Springs satellites (Figure 4-3). The lowest index values (A_i=6 to 24), representing several different categories of more consolidated material, fall within the rest of the areas depending on the subsurface geomorphology. Table 4-3 shows 76.2% of the main study area at the water-table surface is covered by the Sand and Gravel, group (A_i=27), 16.6% is Sand and Gravel with Silt and Clay group (A_i=21), 5.1% is Massive Sandstone group (A_i=12), and 2.1% are Metamorphic/Igneous or Basalt and Massive Limestone groups. 82.1% of the Radium Springs and 87.5% of the Airport satellite areas have Metamorphic/Igneous or Basalt features (A_i=6) at the water-table level, due to the large areas covered by the Doña Ana and Robledo uplifts. The aquifer media in the Jornada satellite area is covered by 60.3% Sand and Gravel with Silt and Clay (A_i=21) and 32.8% Metamorphic/Igneous or Basalt materials (A_i=6). These come from the San Andres Mountains and their piedmont alluvium. The Talavera satellite on the slope of the Organ Mountains is 97.4% covered by the Massive Sandstone group (A_i=12) at the water-table level. The Anapra satellite contains 62.6% of the Metamorphic/Igneous or Basalt (A_i=6) group and 30.6% of the Massive Sandstone (A_i=12) group at the water-table level, from the areas between the Cerro de Cristo Rey and the Sierra de Juárez uplifts.

Table 4-3: Aquifer Media Pollution Sensitivity Index Results

Aquifer Media Range [hydrogeologic unit]	**Sand and Gravel**	**Massive Limestone**	**Sand-Gravel with Silt-Clay**	**Thin Bed Sand/ Lime/Shale Seq.**	**Massive Sandstone**	**Metamorph/Igneous or Basalt**
Water Table Media [hydrostratigraphic units]	**RA/TA/ USF2**	**!P**	**LSF/MSF1/MSF2/ Qbm/USF1/VAY**	**Pzl**	**K/Tmrp/ Tmrs/Tmsp**	**KP/P/Pz/Pzu/Qb/Tb/Tli Tlvs/Tmi/Tmrv/Tri-Tlvs**
A_i [sensitivity points]	**27**	**24**	**21**	**15**	**12**	**6**
Main Study Area [acres] (percent total area)	**5.75×10^5** (76.2%)	**5.50×10^3** (0.7%)	**1.26×10^5** (16.6%)	**0.00×10^0** (0.0%)	**3.83×10^4** (5.1%)	**1.07×10^4** (1.4%)
Radium Springs [acres] (percent total area)	**2.44×10^3** (4.6%)	**6.97×10^2** (1.3%)	**3.14×10^3** (5.9%)	**3.34×10^2** (0.6%)	**2.98×10^3** (5.6%)	**4.39×10^4** (82.1%)
Jornada Satellite [acres] (percent total area)	**3.84×10^3** (6.9%)	**0.00×10^0** (0.0%)	**3.37×10^4** (60.3%)	**0.00×10^0** (0.0%)	**0.00×10^0** (0.0%)	**1.84×10^4** (32.8%)
Airport Satellite [acres] (percent total area)	**0.00×10^0** (0.0%)	**0.00×10^0** (0.0%)	**4.89×10^3** (11.9%)	**1.64×10^2** (0.4%)	**7.30×10^1** (0.2%)	**3.60×10^4** (87.5%)
Talavera Satellite [acres] (percent total area)	**0.00×10^0** (0.0%)	**0.00×10^0** (0.0%)	**0.00×10^0** (0.0%)	**0.00×10^0** (0.0%)	**8.82×10^3** (97.4%)	**2.32×10^2** (2.6%)
Anapra Satellite [acres] (percent total area)	**0.00×10^0** (0.0%)	**0.00×10^0** (0.0%)	**1.51×10^2** (6.8%)	**0.00×10^0** (0.0%)	**6.84×10^2** (30.6%)	**1.40×10^3** (62.6%)

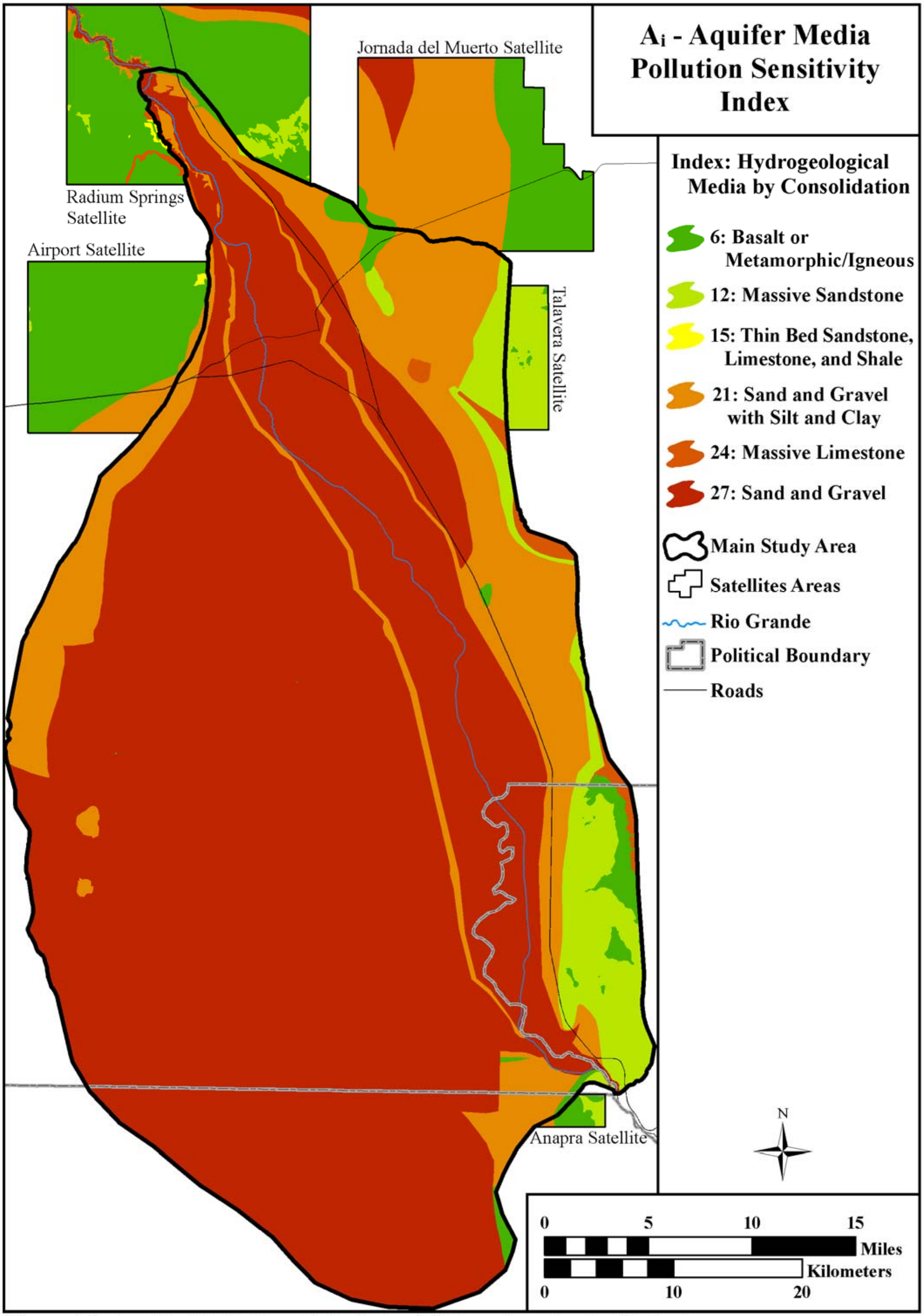


Figure 4-3: Aquifer Media Sensitivity Index (A_i) Locations for the Study Area

4.1.4 *Soil Media Index* (S_i)

This component is the most categorically heterogeneous in the model. It has an assorted patchwork of index categories throughout the floodplain flanked by more homogenous groupings on the slopes around its perimeter (Figure 4-4). Heterogeneity in the floodplain depicts a soil surface where consolidation amounts change constantly due to agricultural practices and alluvial deposit. In the main study area, the mesa to the southwest of the floodplain is a large homogenous area taking up most of the 47.4% of the Sandy Loam (S_i=14) group and broken by surface expressions from lava flows and windswept sand (Table 4-4). The Clay/Dumps/Pits/Rock Outcrops (S_i=2) group cover a majority of the Radium Springs (47.0%) and Airport (43.6%) satellite areas. The Radium Springs satellite also has the highest prevalence (18.1%) of Sand (S_i=18) of the areas, based on percentage of area. The Jornada satellite area has nearly equal amounts of Sand (S_i=18), Loamy Sand (S_i=16), Gravelly Loam (S_i=12), Loam/Silty Loam (S_i=10) and Sandy Clay Loam/Silt (S_i=8) categories totaling 77.8% of its total areal coverage. The Talavera satellite area has a high prevalence (51.7%) of the Clay Loam/Silty Clay Loam (S_i=6) group and Anapra has mostly (41.2%) Gravelly Loam (S_i=12) covering it.

Table 4-4: Soil Media Pollution Sensitivity Index Results

Soil Media Range [soil families]	**Thin, Absent, or Gravel**	**Sand**	**Loamy Sand**	**Sandy Loam**	**Gravelly Loam**	**Loam/ Silty Loam**	**Sandy Clay Loam/ Silt**	**Clay Loam /Silty Clay Loam**	**Sandy Clay/ Silty Clay**	**Clay/ Dumps/ Pits/Rock Outcrops**
S_i [sensitivity points]	**20**	**18**	**16**	**14**	**12**	**10**	**8**	**6**	**4**	**2**
Main Study Area [acres] (percent total area)	**3.60×10^{2}** (0.0%)	**1.61×10^{4}** (2.1%)	**1.42×10^{5}** (18.8%)	**3.58×10^{5}** (47.4%)	**4.59×10^{4}** (6.1%)	**3.23×10^{4}** (4.3%)	**4.83×10^{4}** (6.4%)	**2.49×10^{4}** (3.3%)	**1.09×10^{3}** (0.1%)	**8.61×10^{4}** (11.4%)
Radium Springs [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**9.67×10^{3}** (18.1%)	**1.22×10^{4}** (22.9%)	**2.37×10^{3}** (4.4%)	**1.23×10^{3}** (2.3%)	**2.77×10^{3}** (5.2%)	**8.10×10^{1}** (0.2%)	**9.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**2.51×10^{4}** (47.0%)
Jornada Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**7.73×10^{3}** (13.8%)	**7.55×10^{3}** (13.5%)	**5.27×10^{3}** (9.4%)	**8.85×10^{3}** (15.8%)	**9.20×10^{3}** (16.4%)	**1.02×10^{4}** (18.3%)	**2.01×10^{3}** (3.6%)	**0.00×10^{0}** (0.0%)	**5.12×10^{3}** (9.1%)
Airport Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**3.25×10^{3}** (7.9%)	**2.49×10^{3}** (6.0%)	**1.12×10^{4}** (27.3%)	**4.06×10^{3}** (9.9%)	**3.82×10^{2}** (0.9%)	**1.16×10^{3}** (2.8%)	**6.30×10^{2}** (1.5%)	**0.00×10^{0}** (0.0%)	**1.79×10^{4}** (43.6%)
Talavera Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**1.45×10^{3}** (16.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**4.68×10^{3}** (51.7%)	**0.00×10^{0}** (0.0%)	**2.92×10^{3}** (32.3%)
Anapra Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**4.07×10^{2}** (18.2%)	**3.38×10^{2}** (15.1%)	**9.20×10^{2}** (41.2%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**5.70×10^{2}** (25.5%)

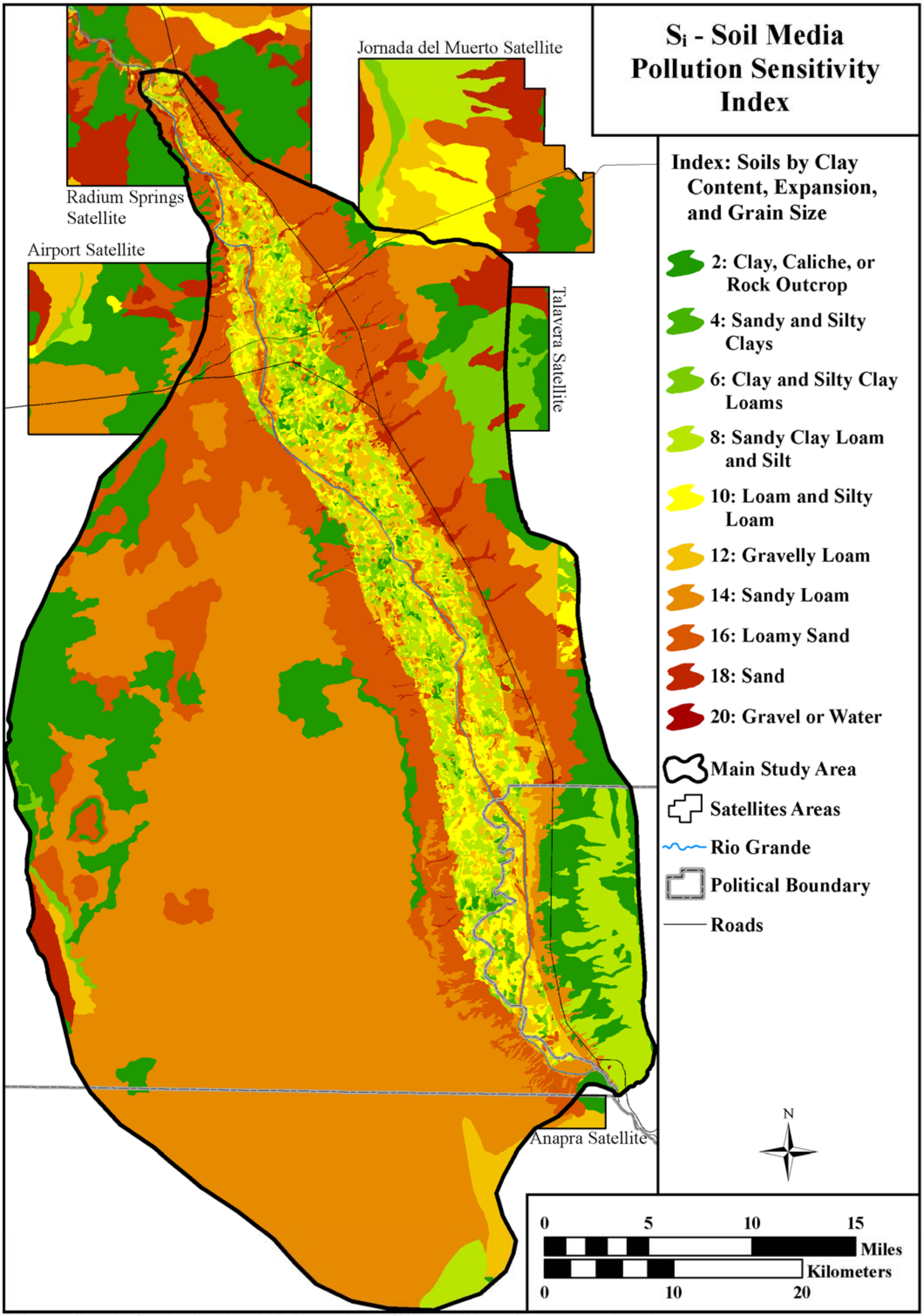


Figure 4-4: Soil Media Sensitivity Index (S_i) Locations for the Study Area

4.1.5 Topography Index (T_i*)*

The highest index value (T_i=10) covers large swaths (68.8%) of the entire study area (Figure 4-5), as the basin is mostly flat (less than 2% slope). The lowest index values (T_i=1 to 9), representing slopes of greater than 2%, lie in areas one to four miles (6.4 km) just west of the floodplain, around the perimeters of Kilbourne Hole and Hunt Hole, throughout the Radium Springs satellite area, and most of the area east of I-25 and I-10 south of Las Cruces. Table 4-5 shows that flat (T_i=10) surfaces cover 77.6% of the main study area, 77.1% of the Airport satellite area, and 38.6% of the Anapra Satellite area. The Jornada satellite area is the next most flat with 40.9% of its total area covered with 2 to 6% slope (T_i=9). The satellite areas with the least slope are Radium Springs, with 63.8% of its area and Talavera with 32.0% of its area covered with greater than 18% slope (T_i=1).

Table 4-5: Topography Pollution Sensitivity Index Results

Topography Range [percent slope]	**0 to 2**	**2 to 6**	**6 to 12**	**12 to 18**	**18+**
T_i [sensitivity points]	**10**	**9**	**5**	**3**	**1**
Main Study Area [acres] (percent total area)	**5.86×10^5** (77.6%)	**9.81×10^4** (13.0%)	**3.80×10^4** (5.0%)	**1.42×10^4** (1.9%)	**1.91×10^4** (2.5%)
Radium Springs [acres] (percent total area)	**2.33×10^3** (4.3%)	**4.29×10^3** (8.0%)	**7.55×10^3** (14.1%)	**5.19×10^3** (9.7%)	**3.41×10^4** (63.8%)
Jornada Satellite [acres] (percent total area)	**9.96×10^3** (17.8%)	**2.29×10^4** (40.9%)	**1.11×10^4** (19.9%)	**2.82×10^3** (5.0%)	**9.18×10^3** (16.4%)
Airport Satellite [acres] (percent total area)	**3.17×10^4** (77.1%)	**4.13×10^3** (10.0%)	**2.23×10^3** (5.4%)	**9.87×10^2** (2.4%)	**2.07×10^3** (5.0%)
Talavera Satellite [acres] (percent total area)	**5.14×10^2** (5.7%)	**2.69×10^3** (29.7%)	**2.06×10^3** (22.8%)	**8.84×10^2** (9.8%)	**2.90×10^3** (32.0%)
Anapra Satellite [acres] (percent total area)	**8.63×10^2** (38.6%)	**4.97×10^2** (22.3%)	**3.42×10^2** (15.3%)	**2.05×10^2** (9.2%)	**3.27×10^2** (14.6%)

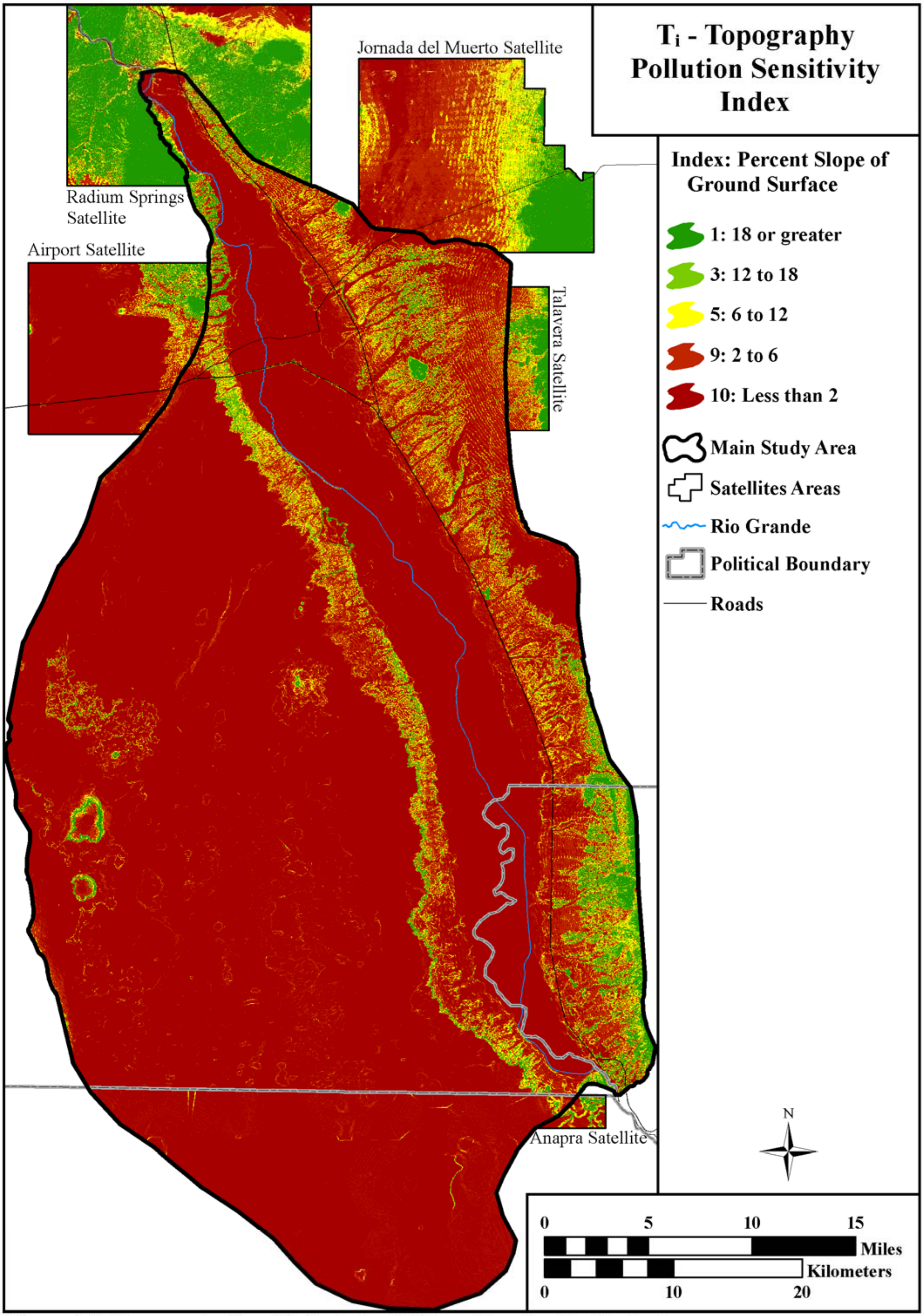


Figure 4-5: Topography Sensitivity Index (T_i) Locations for the Study Area

4.1.6 *Impact of Vadose Zone Index (*I_i*)*

A majority (65.1%) of the study area (Table 4-6), mostly located in the floodplain and on the mesa to the west and southwest, is covered in the well-sorted, low protection, Sand and Gravel (I_i=45) category (Figure 4-6). A swath of this category is also located just west of the floodplain and east of I-25 and I-10 south of Las Cruces, but is striated by wide sections of the Sand and Gravel with Silt and Clay or Metamorphic/Igneous or Thin Bedded Sandstone, Limestone, Shale Sequences or Limestone or Basalt category (I_i=20). The western edge of the main study area and the Radium Springs, Jornada, Talavera, north Airport, and east Anapra satellite areas contain conglomerations of the lowest index, pollution mitigating, values (I_i=5 to 20) from the range uplifts and pyroclastic eruptions. The Sand and Gravel (I_i=45) category covers 74.4% of the main study area, 63.5% of the Airport satellite area, and 51.8% of the Anapra satellite area. A vast amount of Sand and Gravel with Silt and Clay (I_i=20) from piedmont alluvium and Thin Bedded Sandstone, Limestone, and Shale Sequence (I_i=20) from piedmont bases cover 65.4% of the Radium Springs satellite area and 75.6% of the Talavera satellite area. The Jornada satellite area is primarily covered by (91.7%) the same category, because the basin is closed and has poor flow characteristics to sort out smaller silt and clay particles.

Table 4-6: Impact of Vadose Zone Pollution Sensitivity Index Results

Impact of Vadose Zone Range [hydrogeologic unit]	**Sand and Gravel**	**Sand-Gravel with Silt-Clay/Metamorph-Igneous/Thin Bed Sandstone, Limestone, Shale Sequence/Limestone/Basalt**	**Sandstone**	**Shale**	**Confining Silt/Clay**
Surface Hydrogeology [hydrostratigraphic units]	**RA/TA/ USF2/ USLM**	**!P/E/Kl/MSF1/PA/PAO/PAU/PAUc/Pz/ Pzl/Pzm/Qb/Qba/Qbac/Qbc/Tb/Tii/Tls/ Tmi/Tmrv/Tmsp/USF1/USFc/VA/VAO/ VAY**	**K/Qt/ Tmrp**	**Tlvs**	**BF/BFP**
I_i [sensitivity points]	**45**	**20**	**15**	**10**	**5**
Main Study Area [acres] (percent total area)	**5.62×10^{5}** (74.4%)	**1.76×10^{5}** (23.3%)	**9.64×10^{3}** (1.3%)	**2.71×10^{2}** (0.0%)	**7.64×10^{3}** (1.0%)
Radium Springs [acres] (percent total area)	**7.06×10^{3}** (13.2%)	**3.50×10^{4}** (65.4%)	**2.20×10^{3}** (4.1%)	**9.19×10^{3}** (17.2%)	**3.70×10^{1}** (0.1%)
Jornada Satellite [acres] (percent total area)	**6.88×10^{2}** (1.2%)	**5.13×10^{4}** (91.7%)	**0.00×10^{0}** (0.0%)	**1.56×10^{2}** (0.3%)	**3.81×10^{3}** (6.8%)
Airport Satellite [acres] (percent total area)	**2.61×10^{4}** (63.5%)	**1.25×10^{4}** (30.4%)	**7.30×10^{1}** (0.2%)	**1.99×10^{3}** (4.8%)	**4.44×10^{2}** (1.1%)
Talavera Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**6.84×10^{3}** (75.6%)	**2.18×10^{3}** (24.1%)	**3.40×10^{1}** (0.4%)	**0.00×10^{0}** (0.0%)
Anapra Satellite [acres] (percent total area)	**1.16×10^{3}** (51.8%)	**1.01×10^{3}** (45.2%)	**6.70×10^{1}** (3.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)

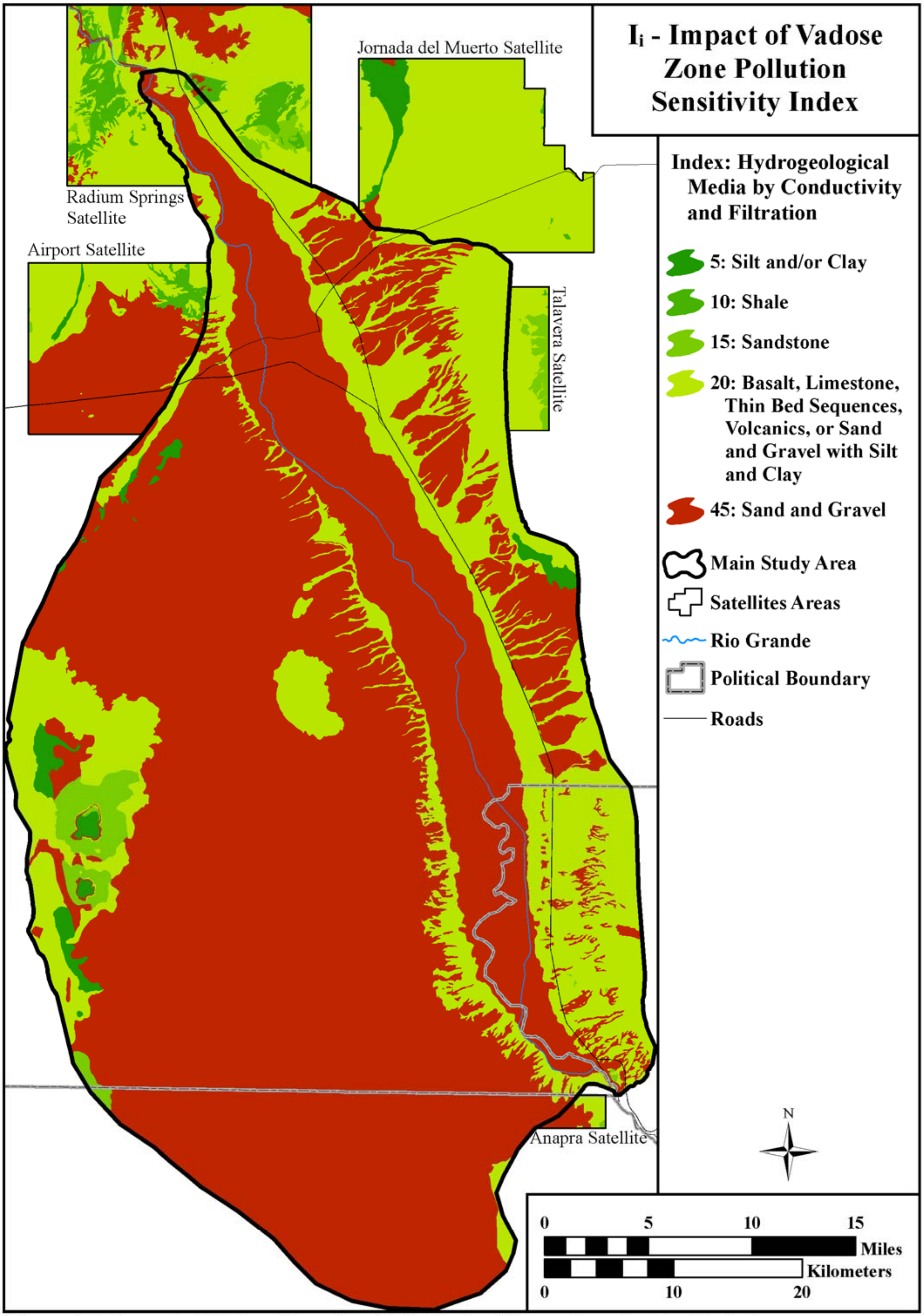


Figure 4-6: Impact of Vadose Zone Sensitivity Index (I_i) Locations for the Study Area

4.1.7 *Hydraulic Conductivity Index (*C_i*)*

The highest index value (C_i=12), representing 300 to 700 gallons per day per square foot (gpd/ft^2), occurs near and within the floodplain (Figure 4-7). This index covers 26.6% of the main study area. From the Rio Grande, passing through Selden Canyon (Table 4-7), 4.6% of the Radium Springs satellite is also covered by this index value. An area of the highest index value lies to the east of the floodplain and south of the Talavera satellite area, revealing the telltale instance of past hydrologic flow through Fillmore Pass between the Mesilla and Tularosa Basins. Another swath of this higher index lies on the other side of the floodplain in the center of the main study area, from higher conductivity materials that had descended from seismic activity down to the level of the water table. Seismic activity also pushed lower conductivity materials up into the irregularly shaped sections west of the Anapra satellite and southwest of the Talavera satellite. A Hydraulic Conductivity index of 6, representing 100 to 300 gpd/ft^2, covers 55.6% of the main study area. A portion of the Jornada and Radium Springs satellites are covered by this medial conductivity index, revealing past signs of flow from the ancient Rio Grande through this now closed basin. The rest (17.9%) is covered by the 1 to 100 gpd/ft^2 (C_i=3) category. A majority (95.3%) of all satellite areas are also covered by this lowest index category.

Table 4-7: Hydraulic Conductivity Pollution Sensitivity Index Results

Hydraulic Conductivity [gallons per day/foot^2]	**2,000+**	**2,000 to 1,000**	**1,000 to 700**	**700 to 300**	**300 to 100**	**100 to 0**
Hydraulic Conductivity [feet/day]	**267+**	**267 to 134**	**134 to 94**	**94 to 40**	**40 to 13**	**13 to 0**
Lithofacies Values	**None**	**None**	**None**	**a1/ 1,2/ 1-3/ 1,3**	**2,1/ 2,3/ 3,2/ 3/ 3,5/ 5-3**	**b/ 3,7/ 3,9/ 5/ 5,6/ 5-8/ 6/ 6b/ 6,5/ 6,8/ 7/ 7,3/ 7,8/ 8/ 8,7/ 9,3/ 10**
C_i [sensitivity points]	**30**	**24**	**18**	**12**	**6**	**3**
Main Study Area [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**2.01×10^{5}** (26.6%)	**4.20×10^{5}** (55.6%)	**1.35×10^{5}** (17.9%)
Radium Springs [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**2.44×10^{3}** (4.6%)	**0.00×10^{0}** (0.0%)	**5.11×10^{4}** (95.4%)
Jornada Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**3.84×10^{3}** (6.9%)	**5.21×10^{4}** (93.1%)
Airport Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**1.39×10^{3}** (3.4%)	**3.98×10^{4}** (96.6%)
Talavera Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**9.05×10^{3}** (100.0%)
Anapra Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**2.24×10^{3}** (100.0%)

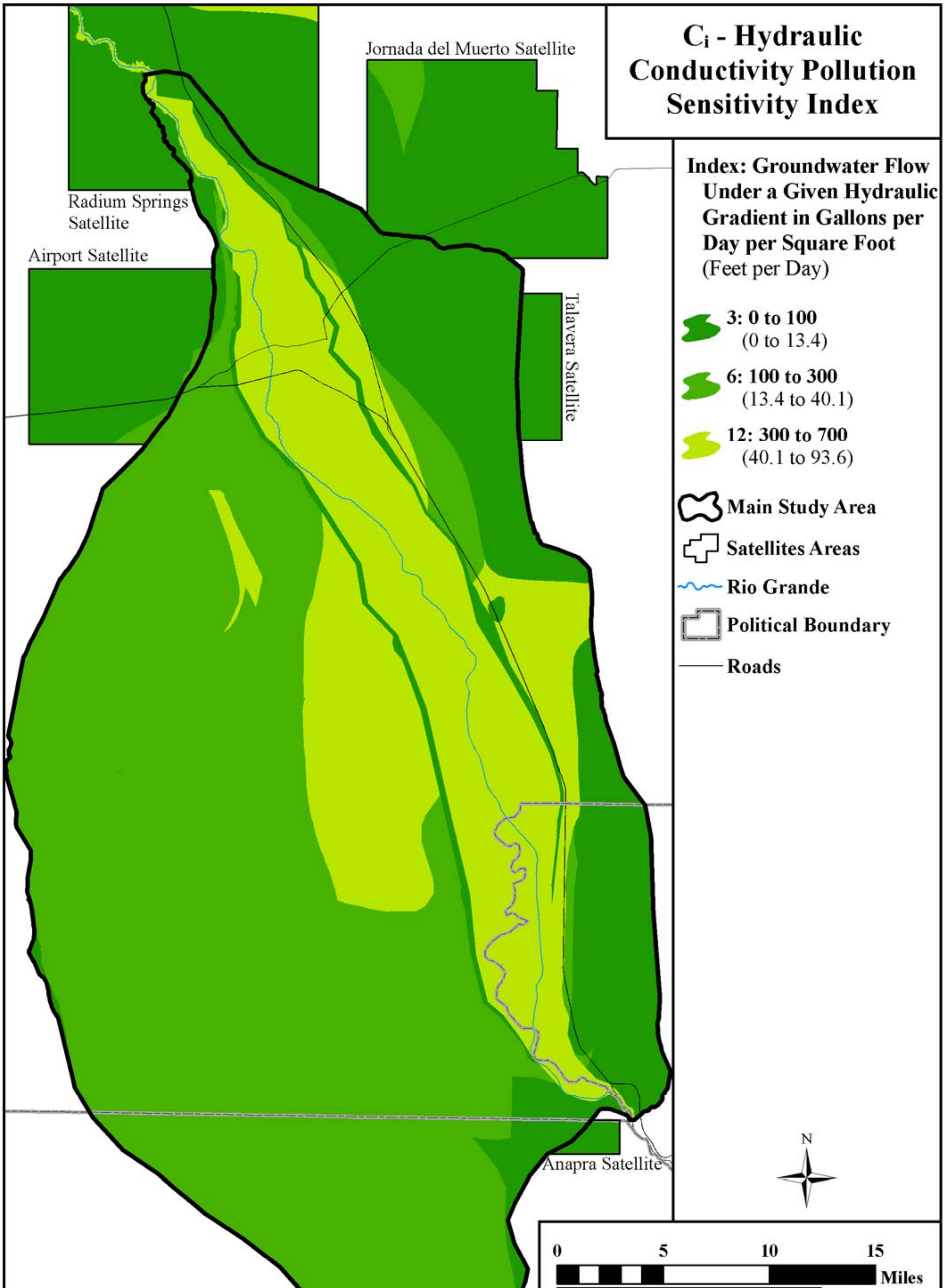


Figure 4-7: Hydraulic Conductivity Sensitivity Index (C_i) Locations for the Study Area

4.1.8 *DRASTIC Pollution Sensitivity Index* (*DRASTIC*$_i$)

A majority (51.4%) of the main study area (Table 4-8) is covered by the Average Risk (*DRASTIC*$_i$=106 to 124) category, bisected by the floodplain covered mainly by the Above Average and higher sensitivity (*DRASTIC*$_i$=125 to 200 maximum) categories, with Below Average or lower categories (*DRASTIC*$_i$=105 to 31 minimum) covering most of the area east of the floodplain and areas on the far western edge (Figure 4-8). Within the main study area, 10.5% have Very High sensitivities (*DRASTIC*$_i$=168 to 200), 3.4% have High sensitivities (*DRASTIC*$_i$=145 to 167), 1.6% have Above Average sensitivities (*DRASTIC*$_i$=125 to 144), 12.5% have Below Average sensitivities (*DRASTIC*$_i$=88 to 105), 12.0% have Low sensitivities (*DRASTIC*$_i$=69 to 87), and 8.7% have Very Low sensitivities (*DRASTIC*$_i$=31 to 68). Approximately 100% of the High and Very High categories and 95% of the Above Average category are located in the floodplain. Three center-pivot irrigation circles just north of the New Mexico-Mexico border are also of Above Average sensitivity. The Average sensitivity area covers a large swath of the western mesa from Interstate-10 south into Mexico, and also a small patch south of Tortugas 'A' Mountain and southwest of Fillmore Pass. The Below Average, Low, and Very Low sensitivity areas cover 33.2% of the main study area, and lie mainly along the piedmont slopes of hills and mountains on the perimeter of the basin and on the mesa where volcanic ejecta have covered the surface.

Table 4-8: *DRASTIC* Pollution Sensitivity Index Results

Nominal Value	**Very High**	**High**	**Above Average**	**Average**	**Below Average**	**Low**	**Very Low**	**Total Area**
***DRASTIC*$_i$** [sensitivity points]	**200 to 168**	**167 to 145**	**144 to 125**	**124 to 106**	**105 to 88**	**87 to 69**	**68 to 31**	
Main Study Area [acres] (percent total area)	**7.91×10^{4}** (10.5%)	**2.56×10^{4}** (3.4%)	**1.18×10^{4}** (1.6%)	**3.89×10^{6}** (51.4%)	**9.41×10^{4}** (12.5%)	**9.10×10^{4}** (12.0%)	**6.55×10^{4}** (8.7%)	**755,682** (82.4%)
Floodplain Area [acres] (percent of Main Study)	**7.91×10^{4}** (100%)	**2.56×10^{4}** (100.0%)	**1.12×10^{4}** (95.4%)	**9.37×10^{3}** (2.4%)	**1.77×10^{4}** (18.8%)	**4.98×10^{3}** (5.5%)	**4.36×10^{3}** (6.7%)	**132,358** (17.5%)
Radium Springs [acres] (percent total area)	**1.91×10^{2}** (0.4%)	**2.53×10^{2}** (0.5%)	**2.44×10^{2}** (0.5%)	**9.57×10^{2}** (1.8%)	**2.07×10^{3}** (3.9%)	**5.95×10^{3}** (11.1%)	**4.38×10^{4}** (81.9%)	**53,492** (5.8%)
Jornada Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**5.60×10^{1}** (0.1%)	**3.65×10^{2}** (0.7%)	**3.17×10^{4}** (56.7%)	**2.38×10^{4}** (42.5%)	**55,950** (6.1%)
Airport Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**2.00×10^{0}** (0.0%)	**1.56×10^{2}** (0.4%)	**5.24×10^{3}** (12.7%)	**2.11×10^{4}** (51.2%)	**1.47×10^{4}** (35.6%)	**41,141** (4.5%)
Talavera Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**5.00×10^{0}** (0.1%)	**7.52×10^{2}** (8.3%)	**8.30×10^{3}** (91.6%)	**9,053** (1.0%)
Anapra Satellite [acres] (percent total area)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**0.00×10^{0}** (0.0%)	**3.32×10^{2}** (14.9%)	**8.31×10^{2}** (37.2%)	**1.07×10^{3}** (47.9%)	**2,235** (0.2%)

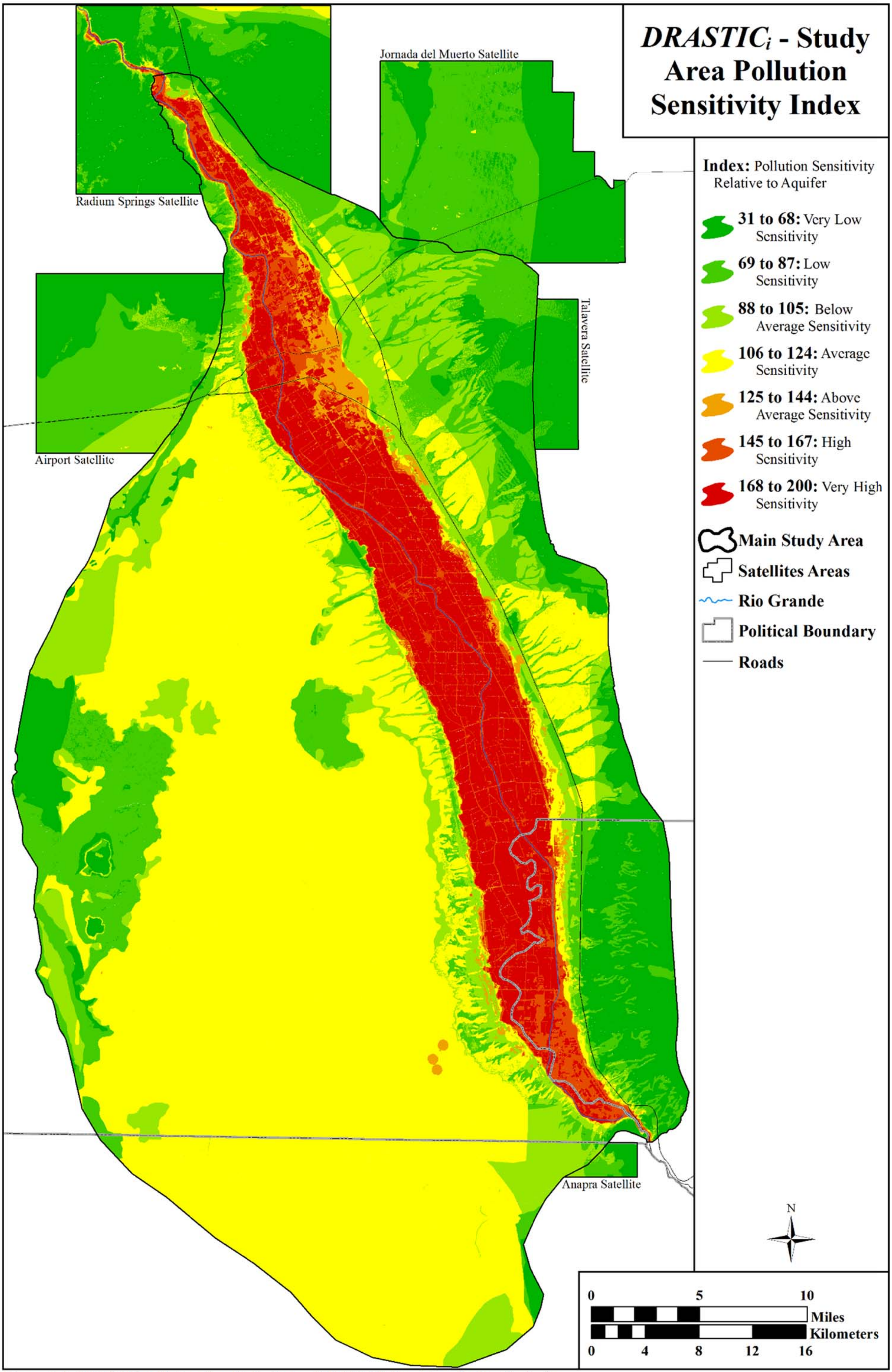


Figure 4-8: *DRASTIC* Pollution Sensitivity Index (*DRASTIC$_i$*) Locations for the Study Area

The satellite areas have predominantly (93.9%) Low and Very Low (DRASTICi=31 to 87) pollution sensitivities. Only the Radium Springs (687 acres, 2.8 km2, 1.3%) and Airport (2 acres, 0.01 km2, 0.0%) satellites have any area with Above Average or higher (DRASTICi= 125 to 200) sensitivities. In the Radium Springs satellite, 0.4% is in the Very High category (DRASTICi=168 to 200), 0.5% is in the High category (DRASTICi= 145 to 167), and 0.5% is in the Above Average category (DRASTICi= 125 to 144). The Jornada satellite is predominantly (56.7%) of Low (DRASTICi= 69 to 87) sensitivity, with 42.5% in the Very Low category (DRASTICi=69 to 87), 0.7% in the Below Average category (DRASTICi=88 to 105), and 0.1% in the Average category (DRASTICi=106 to 124).

4.2 *DRASTIC* POLLUTION RISK RESULTS

The results of the *DRASTIC* pollution risk assessment indicate areas where sensitivity is combined with a suspected volume of a pollutant to determine the location of areas that have an increased chance to contaminate the groundwater. The pollution risk results are reported through numbers of parcels instead of by area, since the smallest unit of study is the cadastral unit and they cross study and satellite areas.

4.2.1 Area Weighted Mean DRASTIC Pollution Sensitivity Index (DRASTIC$_{AWM}$)

When the *DRASTIC* results are averaged into each individual parcel, the map of the results retains nearly the same placement and sensitivity coverage as the original *DRASTIC* pollution sensitivity map. Most of the individual component details in the original *DRASTIC* sensitivity layer are averaged into individual parcels, leading to maximum sensitivity value of 196 instead of 200. The overall sensitivity index values remain in relatively the same place, however. The differences between the *DRASTIC* sensitivity index and the area weighted mean of the index, are that integer values change to decimal values (results of averaging) and units of measurement change from polygon area (acres) to individual parcels (group of 20 parcels).

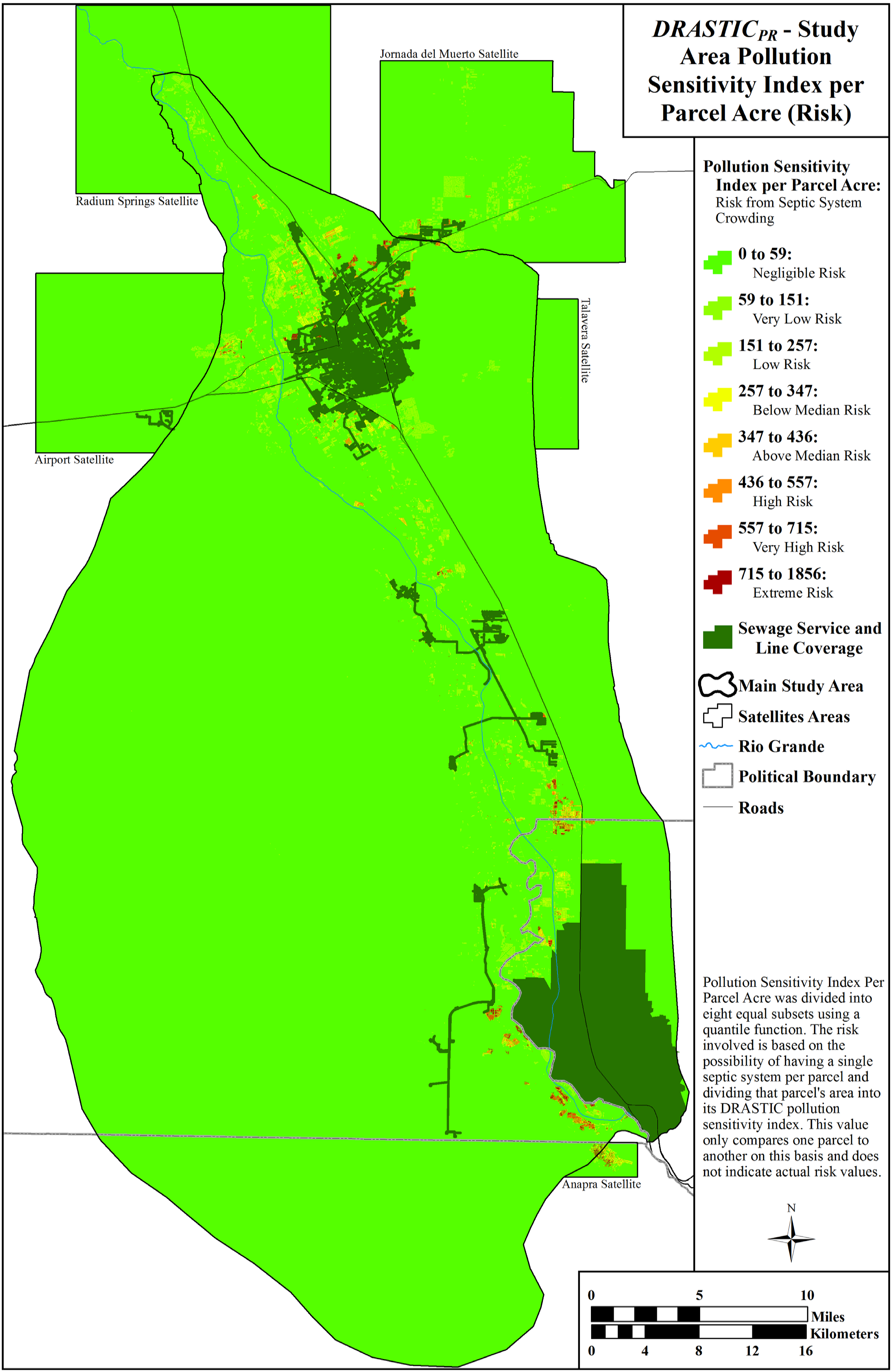
Of the total number of parcels (Table 4-9) in the total study area, 10.5% parcels fell in the Very High ($DRASTIC_{AWM}$=167 to 196) sensitivity classification; 11.8% parcels fell in High ($DRASTIC_{AWM}$=144 to 167); 6.4% fell in Above Average ($DRASTIC_{AWM}$=124 to 144); 9.4% fell in Average ($DRASTIC_{AWM}$=105 to 124); 25.3% fell in Below Average ($DRASTIC_{AWM}$=87 to 105); 15.8% fell in Low ($DRASTIC_{AWM}$=68 to 87); and 20.8% fell in Very Low ($DRASTIC_{AWM}$=31 to 68). A majority (20.8%) of the parcels with an area less than one-half acre had a *DRASTIC* pollution sensitivity of Below Average. A majority (2.2%) of the half- to one-acre parcels had a High sensitivity. One- to one-and-a-half acre parcels were predominantly (1.7%) of Low sensitivity and 0.7% of the one-and-a-half to two acre parcels had Very High sensitivity.

Table 4-9: Area Weighted Mean *DRASTIC* Pollution Sensitivity Index Results

Nominal Value	**Very High**	**High**	**Above Average**	**Average**	**Below Average**	**Low**	**Very Low**	**Total Parcels**
Average Parcel *DRASTIC* Index (*$DRASTIC_{AWM}$*)	**167 to 196**	**144 to 167**	**124 to 144**	**105 to 124**	**87 to 105**	**68 to 87**	**31 to 68**	
Parcels between 0.1 and 2.0 acres (percent total parcels in each bin)	**8.12×10^3** (67.0%)	**1.25×10^4** (91.5%)	**6.93×10^3** (92.8%)	**9.21×10^3** (84.8%)	**2.73×10^4** (92.9%)	**1.57×10^4** (85.5%)	**2.21×10^4** (91.9%)	**1.02×10^5** (87.9%)
Parcels between 0.1 and 0.5 acres (percent total parcels)	**3.29×10^3** (2.8%)	**8.47×10^3** (7.3%)	**5.32×10^3** (4.6%)	**7.37×10^3** (6.4%)	**2.41×10^4** (20.8%)	**1.07×10^4** (9.3%)	**2.03×10^4** (17.5%)	**7.96×10^4** (68.6%)
Parcels between 0.5 and 1.0 acres (percent total parcels)	**2.24×10^3** (1.9%)	**2.55×10^3** (2.2%)	**1.08×10^3** (0.9%)	**1.01×10^3** (0.9%)	**1.89×10^3** (1.6%)	**2.52×10^3** (2.2%)	**9.62×10^2** (0.8%)	**1.22×10^4** (10.6%)
Parcels between 1.0 and 1.5 acres (percent total parcels)	**1.79×10^3** (1.5%)	**1.10×10^3** (0.9%)	**3.67×10^2** (0.3%)	**6.11×10^2** (0.5%)	**9.70×10^2** (0.8%)	**1.98×10^3** (1.7%)	**6.12×10^2** (0.5%)	**7.43×10^3** (6.4%)
Parcels between 1.5 and 2.0 acres (percent total parcels)	**8.05×10^2** (0.7%)	**3.82×10^2** (0.3%)	**1.57×10^2** (0.1%)	**2.19×10^2** (0.2%)	**3.70×10^2** (0.3%)	**4.56×10^2** (0.4%)	**2.19×10^2** (0.2%)	**2.61×10^3** (2.2%)
Total parcels in each bin (percent total parcels)	**1.21×10^4** (10.5%)	**1.37×10^4** (11.8%)	**7.46×10^3** (6.4%)	**1.09×10^4** (9.4%)	**2.94×10^4** (25.3%)	**1.84×10^4** (15.8%)	**2.41×10^4** (20.8%)	**1.16×10^5** (100%)

4.2.2 *DRASTIC Parcel Pollution Risk: $DRASTIC_{AWM}$ per Acre ($DRASTIC_{PR}$)*

Dividing individual parcel area (in acres) into each parcel's *DRASTIC* index value completely changes the spatial layout of the values (Figure 4-9). To compare parcels, bins with nearly equal (with breaks only occurring between different parcel area values) amounts of parcels were created to classify them (Table 4-10). All of the parcels that fell in the High ($DRASTIC_{PR}$= 436 to 557), Very High ($DRASTIC_{PR}$=557 to 715), or Extreme ($DRASTIC_{PR}$=715 to 1856) pollution risk bins were less than a half-acre. The percentage of the smaller parcels in each bin decreases as pollution risk values decrease. For example, parcels at a half-acre or less fill 98.7% of the Above Median ($DRASTIC_{PR}$=347 to 436) bin; 88.3% of the Below Median ($DRASTIC_{PR}$=257 to 347) bin; 54.5% of the Low ($DRASTIC_{PR}$ = 151 to 257) bin; 7.7% of the Very Low ($DRASTIC_{PR}$=59 to 151) bin; and none of the Negligible bin ($DRASTIC_{PR}$=0 to 59). Parcels in the Negligible pollution risk bin that are less than two acres make up 13.7% of the total. Most (95.4%) of the parcels that have above median pollution risk fall within community boundaries, even up to 7.5 miles (12.1 km) outside of the floodplain.



Pollution Sensitivity Index Per Parcel Acre was divided into eight equal subsets using a quantile function. The risk involved is based on the possibility of having a single septic system per parcel and dividing that parcel's area into its DRASTIC pollution sensitivity index. This value only compares one parcel to another on this basis and does not indicate actual risk values.

Figure 4-9: *DRASTIC* Pollution Risk (*DRASTIC$_{PR}$*) Locations for the Study Area

Table 4-10: *DRASTIC* Parcel Pollution Risk Results

Nominal Value	**Extreme**	**Very High**	**High**	**Above Median**	**Below Median**	**Low**	**Very Low**	**Negligible**	**Total Parcels**
***DRASTIC* Index Value Per Acre (*DRASTIC*$_{PR}$)**	**715 to 1856**	**557 to 715**	**436 to 557**	**347 to 436**	**257 to 347**	**151 to 257**	**59 to 151**	**0 to 59**	
Parcels between 0.1 and 2.0 acres (percent of total)	1.45×10^4 (100%)	1.45×10^4 (100%)	1.45×10^4 (100%)	1.45×10^4 (100%)	1.45×10^4 (100%)	1.45×10^4 (100%)	1.29×10^4 (89.3%)	1.99×10^3 (13.7%)	1.02×10^5 (87.9%)
Parcels between 0.1 and 0.5 acres	1.45×10^4 (100%)	1.45×10^4 (100%)	1.45×10^4 (100%)	1.43×10^4 (98.7%)	1.28×10^4 (88.3%)	7.90×10^3 (54.5%)	1.11×10^3 (7.7%)	0.00×10^0 (0.0%)	7.96×10^4 (68.6%)
Parcels between 0.5 and 1.0 acres	0.00×10^0 (0.0%)	0.00×10^0 (0.0%)	0.00×10^0 (0.0%)	1.85×10^2 (1.3%)	1.70×10^3 (11.7%)	5.33×10^3 (36.8%)	4.97×10^3 (34.3%)	5.80×10^1 (0.4%)	1.22×10^4 (10.6%)
Parcels between 1.0 and 1.5 acres	0.00×10^0 (0.0%)	0.00×10^0 (0.0%)	0.00×10^0 (0.0%)	0.00×10^0 (0.0%)	0.00×10^0 (0.0%)	1.26×10^3 (8.7%)	5.25×10^3 (36.2%)	9.27×10^2 (6.4%)	7.44×10^3 (6.4%)
Parcels between 1.5 and 2.0 acres	0.00×10^0 (0.0%)	0.00×10^0 (0.0%)	0.00×10^0 (0.0%)	0.00×10^0 (0.0%)	0.00×10^0 (0.0%)	0.00×10^0 (0.0%)	1.61×10^3 (11.1%)	1.00×10^3 (6.9%)	2.61×10^3 (2.2%)
Total Parcels	1.45×10^4	1.45×10^4	1.45×10^4	1.45×10^4	1.45×10^4	1.45×10^4	1.45×10^4	1.45×10^4	1.16×10^5

4.2.3 *Parcel Groups with High DRASTIC Pollution Risk*

After separating out all parcels with Above Average and higher pollution risk (*DRASTIC*$_{PR}$=347 to 1856) and removing parcels determined to be within reach of a sewage system (Table 4-11), large groupings of twenty or more parcels were sought to determine locations of parcel groups that could possibly have a high potential of septic-system pollution. A list of 79 parcel groups was sent to the New Mexico Environment Department to verify if they were on septic or sewage (Appendix B, Table B-8). The list was returned with 28 of the parcel groups being verified *On Sewage*, 8 being *Verified* on septic, 2 being on *Partial* septic, and 41 left unverified. Using this classification, 16 of the unverified parcel groups were *Likely* on septic, 18 were *Uncertain* on septic, and 7 were *Unlikely* on septic.

Of the communities that have sewage treatment plants, Sunland Park had the greatest number of high risk parcels (2990 in ten parcel groups), followed by Anthony, NM/TX (2310 in seven parcel groups), and Anapra (1280). The number of parcels that are serviced by the sewage-treatment systems in these communities is unknown. Of the communities without sewage treatment plants or in areas where they do not receive service, Santa Theresa has 1240 high risk parcels in eight parcel groups, Doña Ana County has 710 parcels in nine parcel groups, Las Cruces has 692 parcels in seven parcel groups, Canutillo has 357 parcels in three parcel groups, San Ysidro has 165 parcels in three parcel groups, Mesquite has 148 parcels in one parcel group, Fairacres has 29 parcels in one parcel group, and San Pablo has 20 parcels in one parcel group. Of the communities with sewage treatment, Sunland Park has the greatest number (2860 parcels, 95.7%) of Very High *DRASTIC* pollution risk values. Of the communities without sewage, Santa Theresa has the greatest number of Extreme (240 parcels, 19.4%) and Very High (585 parcels, 47.2%) *DRASTIC* pollution risk values.

Table 4-11: Communities with Higher Than Median *DRASTIC* Pollution Risk

Community	Groups	Treatment	Parcels with Above Median Risk				
			Extreme	Very High	High	Above Median	Total
Sunland Park	10	Septic/Sewage	1.01×10^{2}	2.86×10^{3}	2.80×10^{1}	0.00×10^{0}	2.99×10^{3}
Anthony	7	Septic/Sewage	2.18×10^{2}	1.06×10^{3}	1.03×10^{3}	0.00×10^{0}	2.31×10^{3}
Anapra	1	Septic/Sewage	0.00×10^{0}	1.28×10^{3}	0.00×10^{0}	0.00×10^{0}	1.28×10^{3}
Doña Ana Cty	9	Septic/Sewage	2.00×10^{1}	3.50×10^{1}	1.72×10^{2}	4.83×10^{2}	7.10×10^{2}
Las Cruces	7	Septic/Sewage	0.00×10^{0}	3.26×10^{2}	3.08×10^{2}	5.80×10^{1}	6.92×10^{2}
Santa Theresa	8	Septic	2.40×10^{2}	5.85×10^{2}	1.58×10^{2}	2.36×10^{2}	1.24×10^{3}
Canutillo	3	Septic	2.31×10^{2}	0.00×10^{0}	1.26×10^{2}	0.00×10^{0}	3.57×10^{2}
San Ysidro	3	Septic	0.00×10^{0}	0.00×10^{0}	6.30×10^{1}	1.02×10^{2}	1.65×10^{2}
Mesquite	1	Septic	0.00×10^{0}	1.48×10^{2}	0.00×10^{0}	0.00×10^{0}	1.48×10^{2}
Fairacres	1	Septic	0.00×10^{0}	2.90×10^{1}	0.00×10^{0}	0.00×10^{0}	2.90×10^{1}
San Pablo	1	Septic	0.00×10^{0}	0.00×10^{0}	2.00×10^{1}	0.00×10^{0}	2.00×10^{1}

5.0 DISCUSSION AND CONCLUSION

5.1 *DRASTIC* MODEL PREDICTIONS

Several steps were taken in this project to improve the accuracy and precision of the predictions, but there were never any plans to check the quality assurance of the results. No water quality studies or field measurements were performed to assess the ability of the model to predict pollution sensitivity or risk. This project only used the information that the model provided to determine some of the best places to bring training to the public. This does not mean that the results of the project are unusable as a building block in a more formal hydrogeological undertaking. The model was originally built as a preliminary tool to locate sensitive areas for more extensive studies, specifically to guide our community outreach efforts and inform relevant agencies of potential risk to groundwater contamination.

The components of the model provided some insight about the Mesilla Basin. A silhouette of the cities of Las Cruces and El Paso can be seen in the Net Recharge component (Figure 4-2), which affects the final *DRASTIC* pollution sensitivity results by one or two sensitivity brackets (Very High to High or Above Average). This is mainly because urban development generally causes poor onsite groundwater recharge, but Las Cruces also has a silhouette in the Depth to Water component. Increased depth to water values can come from lowered water-table levels or increased terrain height above the flood plain, as is seen in the West Mesa. Since the Topography component does not show higher terrain where the Las Cruces silhouette lies, it is possible that the water-table depth was lower in the area even before the wells were being monitored.

Another interesting development from the Net Recharge component is how roads decrease pollution sensitivity and center pivot irrigation plots (the three circles in southern half) increase sensitivity, despite being more than 300 feet (91 m) above the water-table level. This does not mean that more pollution will be located here, but it does indicate that a pollutant in the irrigation area could have a greater chance of reaching the aquifer than in the surrounding areas. The actual likelihood (risk) for pollution events to occur require a pollutant as well as a sensitive environment. This is seen on the map with sensitivity index per parcel acre (Figure 4-9). Higher risk is found where dense clusters of septic systems on small parcels are found, even when those parcels are in low-sensitivity areas. Conversely, not all parcels in the highest sensitivity area were found to be at great risk using this methodology, at least from septic systems. While small parcels with high risk still dot the high sensitivity rural areas, a lack of dense groups can greatly reduce the risk.

Since parcel pollution risk is created by dividing area weighted mean sensitivity scale by parcel area, a somewhat linear correlation between pollution risk and parcel area was expected. Instead, there was an exponential correlation (Figure 5-1) ($DRASTIC_{PR}$ = 87.7 × Parcel Area$^{-0.979}$, R^2 =0.93). This analysis (Figure 5-1) of the pollution risk in each parcel was beyond the scope of objectives of the original BECC project. It is, however, a clear indication that as the size of parcel decreases, the possible density of on-site wastewater discharge and the pollution risk from individual septic systems increases.

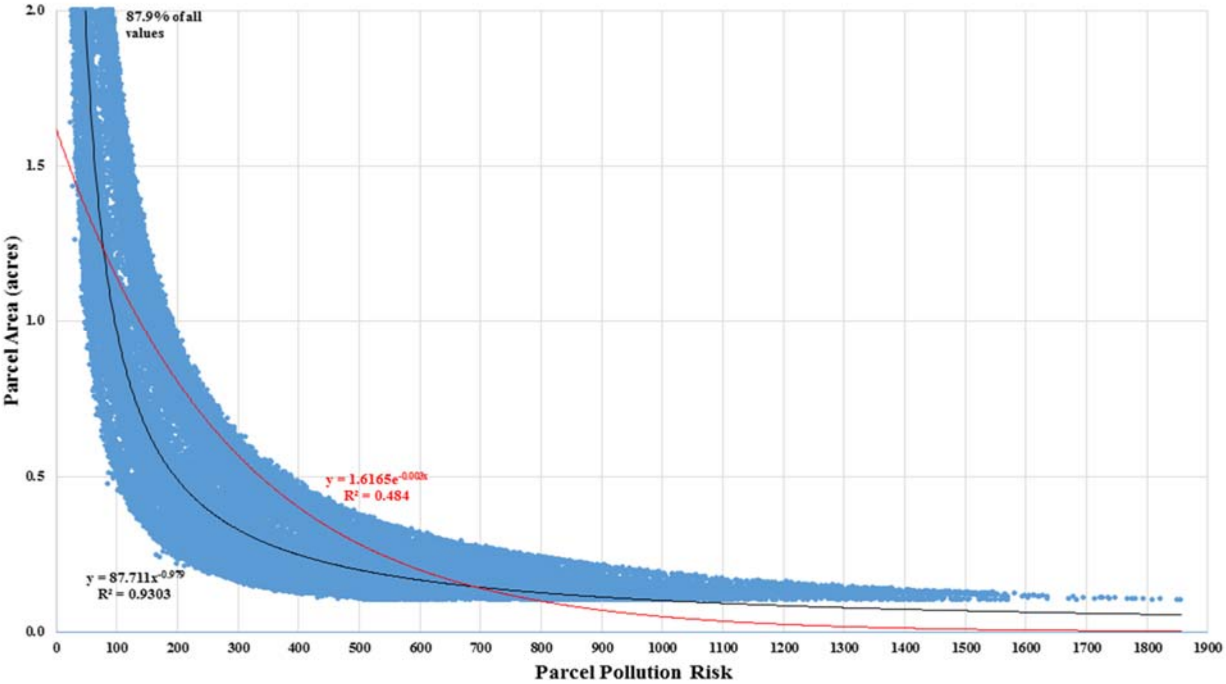


Figure 5-1: Correlation Between Parcel Area and Parcel Pollution Risk

5.2 *DRASTIC* COMPONENT ASSUMPTIONS

It was necessary to make assumptions about the behavior of the environment to keep the project moving forward. Considering the scale of this project, we had to assume that the water table was relatively flat, even though it is a constantly changing environment. The water table is actually broken in many areas due to uneven layers of subsurface hydrogeology and conic depressions from well pumping. A water-table surface was created using the highest values across the monitored life of each well in an attempt to account for these assumptions; however, there was no way to verify this method.

After the surface was created, it was extended into the Selden Canyon area to build the Depth to Water component for the Radium Springs satellite. This was performed without using any well logs from that area, because water-table surfaces interpreted for the Selden Canyon area never matched the elevations of the main study area, nor provided surfaces that fit properly under a digital elevation model. As a result, the water depths in the Radium Springs Satellite are not listed at less than 15 feet to water, even though the river flows through this pass and the water table is generally within 15 feet of the floodplain surface.

The Net Recharge component was built using previous research with *DRASTIC* by Creel and others (1998) and Kennedy (1999) and was used to obtain values for the land-cover ratings (Section 3.2.2). They acquired climate calculations performed by Frenzel and Kaehler (1992) to find that irrigated land provided 10 or more inches of recharge per unit area and non-irrigated land provided less than 2 inches. When comparing such results for Net Recharge against those found in *DRASTIC*, Aller and others (1987) stated that irrigation was estimated to provide up to four inches per year to recharge values. They also declared that a range of 10 or more inches should be used for recharge of the predefined *DRASTIC* hydrogeological setting of River Alluvium without Overbank Deposits. Since this was indicated for an area matching the flood plain along the Mesilla Basin where a majority of the irrigated agriculture lies, the estimates that Creel and others (1998) provided were assumed to be correct.

The hydrogeological cross sections provided by Hawley and Kennedy (2004) are interpolations along a transect line between deep borehole (well) control points and are assumptions of the hydrogeological media between wells. The Aquifer Media and Hydraulic Conductivity index maps (Sections 3.2.3 and 3.2.7) are interpolations between those cross sections and are assumptions based on assumptions. In terms of accuracy, these assumptions were still better than saying that the entire basin was filled with sand and gravel of a single hydraulic conductivity. Also, we made an assumption that a pollutant reaching the aquifer media at the water-table level would stay in that media and hydraulic conductivity even if it went lower into the aquifer. The Aquifer Media and Hydraulic Conductivity component maps assume that the material at the water-table level continue all the way to the base-bedrock layer. This is certainly not the case as depicted in the Hawley and Kennedy (2004) cross sections. In actuality, the layers of aquifer from bedrock to surface are as varied vertically as they are horizontally.

5.3 *DRASTIC* DATA DIFFICULTIES

Several assumptions were made during the project that had to do with data collection. It was safe to assume that the aquifer characteristics on either side of political boundaries were the same at the scale of this project, but the way in which data were collected and stored by agencies on both sides of political lines made it appear to be different. This was remedied by using data with similar schemas or collected from one side to describe events on both sides. This did not work in all cases and boundary lines are apparent in some components. Different scales and precisions were also prevalent across the U.S.-Mexico border, but this issue was less important since no parcels cross the borderline. High precision was not really necessary for Mexico, except in Anapra where most of the community does not reside over the shallow aquifer.

Lack of data and metadata was also an issue while building this project and some assumptions had to be made to use the data available or to continue without some data. Without a complete dataset of all of the sewage facilities in the study area, we had to assume that sewage lines that were provided for the study area were main sewage lines. Lateral or sewage lines would have extended the reach of the sewer systems into parcel groups, taking the guesswork out of verifying where septic systems were located. We also had to assume that the El Paso wastewater service area covered the entire area with sewage lines. Out of the 51 parcel groups that were not verified as being *On Sewage*, 8 parcel groups with above average pollution risk were found in communities that have sewage treatment plants, but we did not have a layout of their service area or sewage lines to determine if they were at risk.

5.4 RECOMMENDATIONS FOR USING THE *DRASTIC* MODEL WITH SEPTIC SYSTEMS

Aller and others (1987) explained that the *DRASTIC* model had four basic assumptions: 1) that the contaminant would be introduced at the ground surface, 2) that the contaminant would be carried to the groundwater by precipitation, 3) that the contaminant would have the mobility of water, and 4) that the evaluated area would be larger than 100 acres. Aller and others (1987) also explained that failure to heed the assumptions of the model would not necessarily invalidate it, but could reduce its predictive effectiveness. This being said, the *DRASTIC* model was not designed for use on septic systems. Aller and others (1987) did mention that wastewater was a source of water that carried pollutants and did mention that certain pollutants came from wastewater, but they did not describe how the model should be adjusted to account for the delivery of those pollutants. While septic systems can be studied on a scale larger than 100 acres (0.4 km^2) and have discharged pollutants with the mobility of water, these pollutants are introduced several feet below the ground surface and are only slightly affected by precipitation. Septic-system effluent is its own transport medium, carrying waterborne pollutants further into the soil by the flushing of water. Because of this, two of the model's assumptions (introduced at ground surface and carried by precipitation) are nearly rejected. "Wastewater pollutants are the same as any other surface-dispersed, waterborne pollutant" was one of the main assumptions made during the project and only realized after the model was run and the results were studied to in fact be not well justified. A few alterations could be made to *DRASTIC* variables to improve model performance if a pollutant was delivered at the subsurface using its own transport water. These are stated below:

- Depth to water values should be 1 to 6 feet less than the surface measurements to account for the septic tank depth. This change would account for an increase of no more than 10 (from a rating of 9 to a rating of 7 multiplied by a weight of 5) sensitivity index points, as the maximum change from one rating to the next is by a value of 2.
- Net recharge for a drain field should be well over 10 inches per unit area, but only for those parcels that are verified as having a septic system. To calculate water coming from septic systems, the model would have to start with cadastral units and septic-system locations before the Net Recharge component was built. This would be a complex step, but would improve the results. In drier climates, this change could account for an increase of up to 32 (from a rating of 1 to a rating of 9 multiplied by a weight of 4) sensitivity index points.
- The Aquifer Media component would not be affected by septic systems and should not be changed.
- Much of the attenuation from soil media would be negated by the deposit of wastewater pollutants close to the bottom of the layer. An average depth for drain fields could be determined and protection from that point down in the soil series could be used. Typical depths of drain field are 1 to 3 feet. If half of the soil series were negated, this would account for an increase of up to 9 (half of the maximum from a rating of 1 to a rating of 10 multiplied by a weight of 2) sensitivity index points or remove up to 20 points from the entire model if the component were not used.
- Topography would not affect wastewater systems, since drain fields are generally placed in relatively level ground with only a slight decline. However, while topography may not have a direct effect on the dispersion of wastewater pollutants, it does have an effect on other forms of recharge and cannot be discarded as easily as soil media might. This component should be left alone, since its weight does not contribute as much to the total index anyway. Since most homes are built on flat ground, this might not affect the number of sensitivity index points.

- The Impact of the Vadose Zone and Hydraulic Conductivity components would not be affected by septic systems and should not be changed.

5.5 CONCLUSIONS

This report explains the reasoning and tools used in an analysis performed over the entirety of the Mesilla Basin aquifer, a portion of the Jornada del Muerto Basin aquifer, and several surrounding areas just outside the aquifer. The analysis, using a version of the *DRASTIC* model tailored to the study area, provided a spatial study of the variability of the pollution sensitivity in the area, which was cross-referenced with on-site wastewater systems as a pollution source. This provided a spatial set of values indicating an ordinal range of risk of pollution from on-site wastewater systems to the underlying aquifer. The highest *DRASTIC* pollution sensitivity index values occurred in the Rio Grande floodplain, where low depth to water values, high amount of recharge from agriculture, high hydraulic conductivities, and where relatively flat sand and gravel hydrogeology are located. The high index values correspond to poor attenuation and high pollution sensitivity.

DRASTIC pollution sensitivity index values were cross referenced with cadastral units throughout the study area to determine an area weighted pollution sensitivity. The area weighted *DRASTIC* layer had nearly the same spatial variability as the *DRASTIC* pollution sensitivity index layer, because the sensitivity values were averaged in each parcel. Assuming one on-site wastewater system per property allows the size of property to be used to limit the density that the systems can be placed. Property size was used as another modeling factor by dividing the parcel size into the average *DRASTIC* value to obtain pollution sensitivity per unit area. High density parcel groups were found to display the greatest risk for pollution from wastewater systems, even over some high sensitivity properties found in the floodplain. Pollution risk from on-site wastewater systems was determined to increase as parcel size decreased.

Many of the parcels having high pollution sensitivity per unit area had no pollution risk from on-site wastewater systems, because they were on public sewage systems. Cross-referencing the *DRASTIC* pollution risk map with a sewage line and service area layer, we excluded most of the parcel groups with the highest risk values throughout the study area. Many of the parcel groups not excluded could not be verified as being on septic. A number of those that were verified were chosen for community outreach and instructional workshops to inform the property owners of the relationships between their on-site wastewater systems and the aquifer system below.

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APPENDIX A. THE *DRASTIC* POLLUTION SENSITIVITY MODEL

A.1 HYDROGEOLOGICAL SETTINGS AND ASSUMPTIONS

The *DRASTIC* model is described in full detail in *DRASTIC: A Standardized System for Evaluating Ground Water Pollution Potential Using Hydrogeologic Settings* by Aller and others (1987) and is briefly summarized here to help elucidate the process and components that were tailored to the Mesilla Basin. A thorough collection of overviews, descriptions, procedures, applications, hydrogeologic setting examples, and appendix material can be found in the above referenced document.

DRASTIC is a model that is built around hydrogeologic settings and a ranking scheme that helps users evaluate the pollution potential of the groundwater in one area relative to another connected area. Hydrogeological settings are a selection of geologic and hydrologic factors that assist or prevent the transmission of a pollutant to a source of water. Factors include the starting location of a pollutant, its travel distance, the length of time the pollutant remains in contact with materials, the volume of the pollutant, the volume of transport media moving the pollutant, and hydrogeological materials that must be passed through, and type of pollutant being transmitted. The factors themselves were chosen by a committee of hydrogeologists based on their relative importance and availability of mappable data.

If data concerning a study area are not available, an extensive set of predetermined hydrogeological settings is available in the document by Aller and others (1987), based on geomorphologies of several published groundwater regions. In the examples, there are thirteen different hydrogeological regions broken into four to sixteen different hydrogeological settings each. The Mesilla Valley floodplain is considered an Alluvial Plains region and has a hydrogeological setting of 2Hb, representing River Alluvium without Overbank Deposits. A typical *DRASTIC* Index value for such a setting is 191.

If data concerning a study area are available, the *DRASTIC* model allows the building of maps tailored specifically to the study area. The model scheme provides the common hydrogeological factors described below with a weight that describes the ability of that factor to facilitate or inhibit the fate of a waterborne pollutant. Each weight is a constant value that is never changed and has been determined through the consensus of a committee of hydrogeologists. Each factor is also broken into ranges and are given a rating from 1 to 10 to indicate their individual ability to help or hinder a pollutant’s fate. The range of the factor is either an explicit value (such as 15 feet to water) or a type of material with an implicit value (such as sandstone, which may be heavily fractured). When a factor’s weight and rating are multiplied together, an index value is created that describes that factor’s total pollution attenuating ability for that mappable unit (a unit of area with common hydrogeological factors). The *DRASTIC* model uses a set of seven hydrogeological factors arranged in order to spell the acronym naming the system: Depth to Water (*D*), Net Recharge (*R*), Aquifer Media (*A*), Soil Media (*S*), Topography (*T*), Impact of the Vadose Zone (*I*), and Hydraulic Conductivity (*S*). Figure A-1 shows how each factor interacts.

The ***DRASTIC pollution sensitivity index*** **(*DRASTIC*$_i$)** is the composite index value that is calculated from the indices of the hydrogeological factors in the model. The *DRASTIC* index is calculated by adding up each of the component index layers for each mappable unit in an entire study area using the formula:

$$DRASTIC_i = Dr\times Dw + Rr\times Rw + Ar\times Aw + Sr\times Sw + Tr\times Tw + Ir\times Iw + Cr\times Cw$$

Where: r = the rating for the component and w = the assigned weight for the component.

Using a geographic information system (GIS) to store the layers for each component and combine them over the study area is a straightforward process. When the model was first employed in the late 1980s, this arduous task was done using transparent acetate sheets. The *DRASTIC* index is a discrete, numerical value that ranges from 65 to 223 for typical component index values or 23 to 223 for the absolute range of the model. There are no gradations between the values of bounded mappable units and they are not able to be contoured. Groundwater pollution sensitivity increases as the *DRASTIC* index value becomes larger, but these values are ordinal (ranked higher versus lower without exact division) and only have meaning when compared to values in the same study area of the same aquifer. For example, the *DRASTIC* model can only assume that an index value of 200 has a greater sensitivity than an index value of 150. No specific amount of risk (e.g., probability, odds, or percent chance) can be applied to the maximum *DRASTIC* index value, because risk also requires knowledge of the volume and abilities of a pollutant.

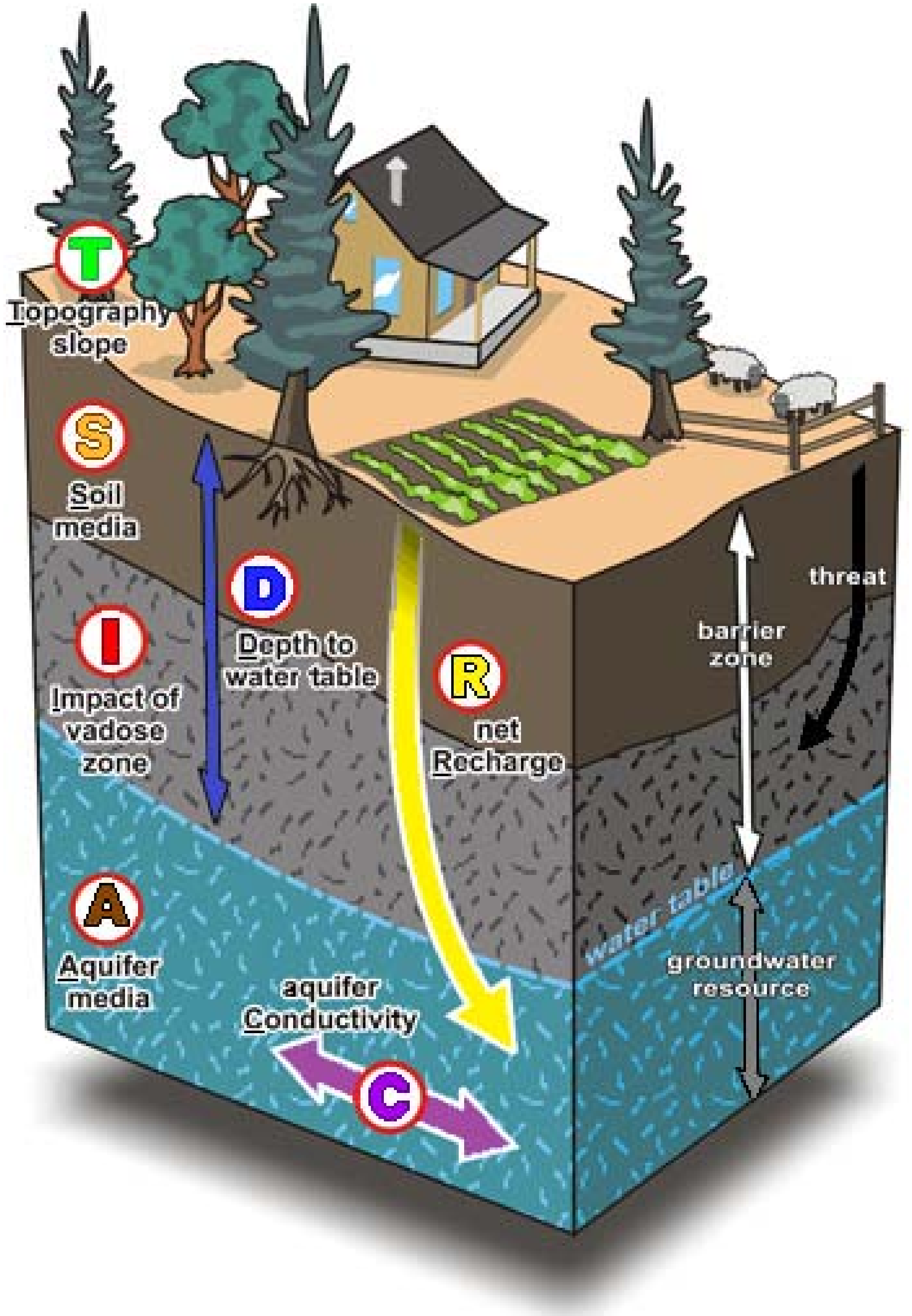

Figure A-1: Interaction and Location of *DRASTIC* Components (Original by Richard Franklin & Robert Turner, Geological Survey of Canada. Modified version by Cyrille Medard de Chardon, Simon Fraser University and Steve Walker, New Mexico Water Resources Research Institute)

An inherent set of generalizations about groundwater flow and pollutant movement are incorporated into the scores and weights of each of the factors. A set of assumptions were also developed to govern how the model is to be used. The user of the model assumes that:

- the pollutant will be introduced at the ground surface,
- the pollutant will be transported to the groundwater by precipitation,
- the contaminant will have the mobility of water, and
- the area being evaluated using *DRASTIC* will be 100 acres (0.4 km^2) or larger.

If these assumptions are not followed, the model may need to be examined further before it can be considered accurate. The model is not designed for a number of uses. *DRASTIC* is not designed to be the sole provider of information about the suitability of a site for mass-waste disposal or land use, nor is it meant to replace specific on-site investigations by a professional hydrogeologist. While the *DRASTIC* model provides many of the thought processes that a hydrogeologist may provide when evaluating the groundwater pollution sensitivity of an area, this model is only a screening tool for assessment.

A.2 MODEL COMPONENTS

The following section describes each individual hydrogeological factor, the location of each component in Figure A-1 above, the ranges, ratings, weights, and indices of each factor and the most common location to find data for building each factor.

Depth to Water **(*D*)** is used to indicate how much hydrogeological media (e.g., rock, silt, sand) must be penetrated by a pollutant to reach the water table from the ground surface. This component covers the entire, unsaturated ‘barrier zone’ between the ground surface and the water table surface, encompassing the soil and vadose layers. Depending on the depth, this equates to the amount of time that a contaminant stays in contact with the hydrogeological media and thus time for filtration, biodegradation, sorption, and volatilization. A shallower water table implies a greater chance for the contaminant to reach and pollute the aquifer. Shallow water tables of 5 feet or less to water receive the highest sensitivity rating of $D_r = 10$, while water tables of 100 feet or greater receive a $D_r = 1$ for sensitivity. A weight (D_w) of 5 is given to this factor for its impact on pollution and provides a range of 5 to 50 for its pollution sensitivity index (D_i). Generally, depths to water are determined through published water-level maps or interpolated surfaces built from well logs.

Table A-1: ***DRASTIC*** **Depth to Water Component - Ranges, Ratings, and Indices**

Range [feet]	**Rating (D_r)**	**Weight (D_w)**	**Index (D_i)**
0 to 5	10	5	50
5 to 15	9	5	45
15 to 30	7	5	35
30 to 50	5	5	25
50 to 75	3	5	15
75 to 100	2	5	10
100+	1	5	5

Net Recharge (R) describes the average amount of water per unit of land area that percolates through the hydrogeological media and provides the transportation for a waterborne pollutant to reach the water table from the ground surface. This component starts from the ground surface and travels through the soil media and vadose zone to rest in the aquifer itself. The greater the amount of recharge available for the transport of a contaminant, the greater the chance for the contaminant to reach and pollute the aquifer, to a point. Increasingly higher amounts of recharge also provide a greater quantity of water for dispersion and dilution of a contaminant. However, the model does not take this into account beyond the explanation of the occurrence. Distribution, intensity, or duration of the recharge events are also not taken into account and assumed to be constant throughout the year. Regardless, more than 10 inches of recharge per unit area receive the highest sensitivity value of $R_r = 9$ for this component, while 2 inches or less receive a $R_r = 1$ for a rating. A weight (R_w) of 4 is given to this factor for its impact on pollution and provides a range of 4 to 36 for its pollution sensitivity index (R_i). Values may be estimated through the use of climate maps that provide average annual precipitation values, subtracting runoff and evapotranspiration values.

Table A-2: ***DRASTIC*** **Net Recharge Component - Ranges, Ratings, and Indices**

Range [inches]	**Rating (R_r)**	**Weight (R_w)**	**Index (R_i)**
0 to 2	1	4	4
2 to 4	3	4	12
4 to 7	6	4	24
7 to 10	8	4	32
10+	9	4	36

The ***Aquifer Media (A)*** component refers to the type of hydrogeological material in which the groundwater of the aquifer resides. Aquifer media is the saturated portion under the water table, vadose zone, and soil media. The amount of water that can be stored and released (yield), its ease of movement (conductivity), and the attenuation ability of the material is dependent on the type of aquifer media and amount of fracturing present.

Aquifer Media and Hydraulic Conductivity go hand in hand, as together they influence the amount of attenuation time a pollutant has in contact with the media before moving to an extraction point or spreading further into the aquifer. Flow through aquifer media is governed by primary porosity through grain size and sorting (consolidation) and secondary porosity through faults, channels, and fractures in the material. The more porosity an aquifer medium has, the lower the attenuation and the higher the pollution sensitivity.

Since aquifer media have a variety of different ranges depending on rock or soil with a variety of structures and building materials, this component uses a subjective rating structure with a complex layout. Aquifer media types are arranged based on consolidation, grain size, or channels and given a range of numerical ratings indicating how much fracturing can adjust the attenuation abilities of the material. Low yield Massive Shale is rock made from tightly packed, fine grained, silt or mud and has ratings from $A_r = 1$, if it has few fractures, to $A_r = 3$ if it has many. High yield Karst Limestone is made of materials that have been dissolved by solution with large channels and openings and has ratings from $A_r = 9$, if unfractured to $A_r = 10$ if fractured.

Some aquifer media have a large range of ratings, indicating the importance of fracturing to the pollution sensitivity in those materials. Volcanic basalt is chemically non-reactive to most water-based pollutants and can be very impervious to water movement through its body, leading to a low rating of $A_r = 2$. However, fractures increasingly improve the abilities of this media to move a pollutant long distances without much attenuation, leading to a high rating of $A_r = 10$. A weight (A_w) of 3 is given to this factor for its impact on pollution and provides a range of 3 to 30 for its pollution sensitivity index (A_i). Data about hydrogeological media at the aquifer level are generally found in published geologic or hydrologic reports about well and borehole loggings.

Table A-3: *DRASTIC* Aquifer Media Component - Ranges, Ratings, and Indices

Range [Hydrogeologic Media]	**Rating (A_r)**	**Weight (A_w)**	**Index (A_i)**
Massive Shale	1 to 3	3	3 to 9
Metamorphic/Igneous	2 to 5	3	6 to 15
Weathered Metamorphic/Igneous	3 to 5	3	9 to 15
Glacial Till	4 to 6	3	12 to 18
Bedded Sandstone, Limestone, and Shale Sequences	5 to 9	3	15 to 27
Massive Sandstone	4 to 9	3	12 to 27
Massive Limestone	4 to 9	3	12 to 27
Sand and Gravel	4 to 9	3	12 to 27
Basalt	2 to 10	3	6 to 30
Karst Limestone	9 to 10	3	27 to 30

The ***Soil Media (S)*** component is the uppermost six feet of weathered earth containing the largest concentration of biological material. It sits above the vadose zone and together with the vadose, provides shape and slope for the Topography component. Soils are made up of three basic inert types of material: sand, silt, and clay. Fine textured clay and silt materials combined with organic matter, microbes, and an array of reactive gases, provide a significant impact on the attenuation of pollutants. Shrinking and swelling of clay also affects permeability, intercepting water and waterborne pollutants and slowing or preventing their passage downward to an aquifer. For these reasons, the greater the shrink and swell ability of the clay and the smaller the grain sizes, the greater the attenuation of the soil and the smaller the pollution sensitivity. The scale of values (Table A-4) is arranged so that the soils with the highest clay, silt, and fine material contents have the lowest ratings and those which are too thin, clean, well-sorted, more permeable, or have large-grain size have higher pollution potential ratings. Non-shrinking and non-aggregated clay receives a value of S_r = 1 for its ability to hold its shape when water is applied, preventing nearly all water and waterborne pollutants from passing through it. Gravel receives a value of S_r = 10, since it has a grain size of greater than 5/64 inch (two millimeters) allowing water and waterborne pollutants to pass through it nearly unchecked. A weight (S_w) of 2 is given to this factor for its impact on pollution and provides a range of 2 to 20 for its pollution sensitivity index (S_i). The best resource of soil information comes from soil-series data compiled the National Resources Conservation Service published by the United States Department of Agriculture. A soil series will provide a large amount of information about the soil drainage, textures, thicknesses, and compositions of the various layers within the series.

Table A-4: ***DRASTIC*** **Soil Media Component - Ranges, Ratings, and Indices**

Range [Hydrogeologic Media]	**Rating (S_r)**	**Weight (S_w)**	**Index (S_i)**
Thin or Absent and Gravel	10	2	20
Sand	9	2	18
Peat	8	2	16
Shrinking and/or Aggregated Clay	7	2	14
Sandy Loam	6	2	12
Loam	5	2	10
Silty Loam	4	2	8
Clay Loam	3	2	6
Muck	2	2	4
Nonshrinking and Nonaggregated Clay	1	2	2

The ***Topography (T)*** component describes how slope and terrain of the land-surface impacts runoff and infiltration of surface water carrying a pollutant. Topography represents the shape of the land surface, made up of the soil and vadose zone layers. Steeper slopes increase water velocity, reducing the amount of time that a waterborne pollutant has to infiltrate into the soil. However, steep slopes also provide extra erosional force to carry away top-soil and add to the pollution of surface water resources. The flatter the ground surface in the study area, the greater the infiltration rate and the higher the pollution sensitivity. Flat or nearly flat ground at 2% slope or less receives a rating of $T_r = 10$, while more steep slopes of more than 18% receive a rating of $T_r = 1$. A weight (T_w) of 5 is given to this factor for its impact on pollution and provides a range of 1 to 10 for its pollution sensitivity index (T_i). In the late 1980s, when the model was created, the best source of topographical information about an area came from United States Geological Survey 7½-minute quadrangle, topographic maps. While these are still in use today, digital elevation models are the easiest data to obtain.

Table A-5: ***DRASTIC*** **Topography Component - Ranges, Ratings, and Indices**

Range [percent slope]	**Rating (T_r)**	**Weight (T_w)**	**Index (T_i)**
0 to 2	10	1	10
2 to 6	9	1	9
6 to 12	5	1	5
12 to 18	3	1	3
18+	1	1	1

Impact of the Vadose Zone (I) describes the ability of the unsaturated or discontinuously saturated portion of hydrogeological media above the water table to continue the attenuation processes that were started at the soil level. The Impact of the Vadose Zone component is the lower most section of the 'barrier zone' between the soil media and the aquifer media. The Aquifer Media component has a number of similarities to the Impact of the Vadose Zone component. For both, type and structure of the material that water and a waterborne pollutant travel through determines the amount of pollutant attenuated or conveyed to the aquifer. Flow through both materials is governed by primary and secondary porosities, however, there are differences in the forces involved with moving liquids through the unsaturated media of the vadose, as opposed to saturated media of an aquifer. This is depicted in the range of ratings for each media type. The impermeable silt/clay media type retards movement of water through it to the aquifer, giving it a rating of $I_r = 1$, for no fractures to $I_r = 2$, for fractures. Again, karst limestone receives higher sensitivity values, with a slightly lower sensitivity of $I_r = 8$, for no fractures to $I_r = 10$ with fractures. A weight (I_w) of 5 is given to this factor for its impact on pollution and provides a range of 5 to 50 for its pollution sensitivity index (I_i). Information about surface hydrogeological material below the soil is also found in published geologic or hydrologic reports about well and borehole logs.

Table A-6: *DRASTIC* Impact of the Vadose Zone Component - Ranges, Ratings, and Indices

Range [Hydrogeologic Media]	**Rating (I_r)**	**Weight (I_w)**	**Index (I_i)**
Confining Layer	1	5	5
Silt/Clay	2 to 6	5	10 to 30
Shale	2 to 5	5	10 to 25
Limestone	2 to 7	5	10 to 35
Sandstone/ Bedded Limestone, Sandstone, Shale/ Sand and Gravel with Silt and Clay	4 to 8	5	20 to 40
Metamorphic/Igneous	2 to 8	5	10 to 40
Sand and Gravel	6 to 9	5	30 to 45
Basalt	2 to 10	5	10 to 50
Karst Limestone	8 to 10	5	40 to 50

Hydraulic Conductivity (C) describes the ability of aquifer media to transmit water under a given hydraulic gradient. Hydraulic Conductivity shares the same space as the Aquifer Media component, but represents a force instead of an area or type of material. Hydraulic conductivity is dependent on more than just the permeability or porosity of a media, as it also depends on the density and viscosity of the fluid being transmitted. Since it is assumed that the pollutant has the mobility of water, density and viscosity variations are the same as water. If water entered a media at constant pressure, hydraulic conductivity would represent the amount of discharge from the media after a set of forces (e.g., gravity, friction, ionic attraction) were applied. The higher the amount of hydraulic conductivity, measured in gallons per day per square foot (gpd/ft^2) by Aller and others (1987), the easier a pollutant moves through the aquifer and the greater the pollution sensitivity. A low hydraulic conductivity value of 100 gpd/ft^2 or less has a pollution sensitivity rating of C_r = 1, while a high value of greater than 2,000 gpd/ft^2 receives the maximum rating of C_r = 10. A weight (C_w) of 3 is given to this factor for its impact on pollution and provides a range of 3 to 30 for its pollution sensitivity index (C_i). Hydraulic conductivity values are determined through pumping tests, which examine the specific yield coming from a pumping well and the draw down and distance of an observation well within the pumping well's cone of depression. The value is calculated and published in hydrogeological reports, providing the hydraulic conductivities of each specific strata in the area.

Table A-7: *DRASTIC* Hydraulic Conductivity Component - Ranges, Ratings, and Indices

Range [gallons per day per square foot]	**Rating (C_r)**	**Weight (C_w)**	**Index (C_i)**
1 to 100	1	3	3
100 to 300	2	3	6
300 to 700	4	3	12
700 to 1,000	6	3	18
1,000 to 2,000	8	3	24
2,000+	10	3	30

APPENDIX B. MISCELLANEOUS TABLES

Table B-1: Monitored Wells in Doña Ana and El Paso Counties

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	322841106551601	21S.01W.14.313 (USBR-41)	32.478	-106.922	RA	29	8/31/1989	11	3949	Cert FP
USGS	322816106533201	21S.01W.24.214 (USBR-42)	32.471	-106.893	RA	29	8/31/1989	11	3939	Cert FP
USGS	322750106535001	21S.01W.24.324	32.463	-106.898	RA	34	1/8/1963	8	3945	Cert FP
USGS	322541106524901	22S.01E.06.124 (USBR-43)	32.428	-106.881	RA	28	8/31/1989	9	3926	Cert FP
USGS	322446106502401	22S.01E.09.241 (OLD USBR-26)	32.413	-106.841	RA	23	2/1/1987	7	3923	Cert FP
USGS	322446106502402	22S.01E.09.241A (USBR-26)	32.412	-106.841	RA	28	2/15/1996	6	3924	Cert FP
USGS	322412106510601	22S.01E.09.333 (USBR-20)	32.403	-106.852	RA	22	2/27/2003	6	3922	Cert FP
USGS	322312106503601	22S.01E.16.433 (USBR-19)	32.388	-106.844	RA	28	6/19/1984	7	3916	Cert FP
USGS	322047106505001	22S.01E.33.341 (USBR-15)	32.347	-106.848	RA	22	6/18/1984	6	3900	Cert FP
USGS	322040106485301	22S.01E.35.334 (OLD USBR 18)	32.345	-106.815	RA	28	6/18/1984	12	3898	Cert FP
USGS	322040106485302	22S.01E.35.334B (USBR-18)	32.345	-106.815	RA	30	6/14/1989	11	3899	Cert FP
USGS	322041106485601	22S.01E.35.434B (USBR-17)	32.345	-106.808	RA	42	2/14/1996	9	3901	Cert FP
USGS	322003106473501	23S.01E.01.413 (USBR-44)	32.334	-106.794	RA	29	8/31/1989	19	3881	Cert FP
USGS	321853106504001	23S.01E.09.433 (USBR-16)	32.315	-106.845	RA	26	2/8/2010	4	3890	Cert FP
USGS	321838106481801	23S.01E.14.241 (USBR-45)	32.311	-106.806	RA	28	8/30/1989	16	3874	Cert FP
USGS	321820106501601	23S.01E.16.424 (USBR-12)	32.305	-106.838	RA	24	6/18/1984	13	3853	Cert FP
USGS	321745106492505	23S.01E.22.232E (LC-1E)	32.296	-106.824	RA	10	7/9/1998	4	3885	Cert FP
USGS	321745106492105	23S.01E.22.241E (LC-2E)	32.296	-106.823	RA	10	7/9/1998	4	3884	Cert FP
USGS	321740106481003	23S.01E.23.244C (LC-3C)	32.295	-106.803	RA	50	1/10/1996	16	3874	Cert FP
USGS	321619106495801	23S.01E.27.334 (USBR-11)	32.272	-106.834	RA	12	2/1/2002	5	3877	Cert FP
USGS	321704106460401	23S.02E.29.113 (USBR-47)	32.284	-106.768	RA	29	8/30/1989	17	3863	Cert FP
USGS	321518106471701	24S.01E.01.223 (USBR-46)	32.255	-106.789	RA	35	2/11/1999	11	3870	Cert FP
USGS	321432106485401	24S.01E.11.112 (USBR-48)	32.242	-106.816	RA	28	8/30/1989	5	3865	Cert FP
USGS	321412106462603	24S.02E.07.234B (EBID-2-NEST)	32.237	-106.775	RA	80	2/9/1987	14	3857	Cert FP
USGS	321342106452201	24S.02E.08.434 (OLD USBR-13)	32.228	-106.757	RA	24	2/1/1986	10	3853	Cert FP
USGS	321342106443301	24S.02E.09.433 (USBR-14)	32.229	-106.743	RA	25	2/14/1996	9	3853	Cert FP
USGS	321332106443703	24S.02E.16.124C (M-4C)	32.226	-106.744	RA	40	9/20/2001	9	3853	Cert FP
USGS	321304106451406	24S.02E.17.423E (M-3E)	32.217	-106.755	RA	35	1/19/2000	6	3854	Cert FP
USGS	321237106462004	24S.02E.19.214D (M-1D)	32.210	-106.773	RA	10	9/1/1998	7	3852	Cert FP
USGS	321241106461604	24S.02E.19.223D (M-2D)	32.211	-106.772	RA	11	9/1/1998	7	3852	Cert FP
USGS	321230106430401	24S.02E.22.242 (OLD USBR-10)	32.208	-106.718	RA	19	2/9/1989	8	3844	Cert FP
USGS	321230106430402	24S.02E.22.242B (USBR-10)	32.209	-106.719	RA	31	2/9/1994	7	3845	Cert FP
USGS	321206106423601	24S.02E.23.342 (OLD USBR-9)	32.202	-106.711	RA	21	2/1/1986	9	3840	Cert FP
USGS	321206106423602	24S.02E.23.342B (USBR-9)	32.201	-106.710	RA	31	2/9/1994	8	3840	Cert FP
USGS	321112106445201	24S.02E.28.334 (USBR-8)	32.185	-106.748	RA	24	1/29/1993	5	3845	Cert FP
USGS	320946106412401	25S.02E.01.411 (USBR-25)	32.162	-106.691	RA	12	2/15/1996	7	3829	Cert FP
USGS	321001106445101	25S.02E.04.114 (USBR-7)	32.167	-106.748	RA	28	1/27/1993	11	3837	Cert FP
USGS	320734106422401	25S.02E.23.212 (USBR-6)	32.126	-106.706	RA	28	2/27/2001	7	3822	Cert FP
USGS	320615106413302	25S.02E.25.322B (USBR-5)	32.104	-106.693	RA	21	6/14/1989	7	3814	Cert FP
USGS	320738106392401	25S.03E.17.433	32.127	-106.657	RA	60	2/21/1985	9	3814	Cert FP
USGS	320706106390901	25S.03E.20.421 (USBR-24)	32.119	-106.654	RA	16	6/28/1989	6	3813	Cert FP
USGS	320456106383001	25S.03E.28.343A (USBR-27)	32.097	-106.645	RA	20	2/17/1994	8	3807	Cert FP
USGS	320530106413201	25S.03E.31.143 (USBR-4)	32.091	-106.679	RA	18	2/22/1997	7	3808	Cert FP
USGS	320457106413201	26S.02E.01.211 (USBR-3)	32.083	-106.675	RA	18	2/1/1987	6	3806	Cert FP
USGS	320405106373101	26S.03E.03.344	32.068	-106.627	RA	26	8/30/1977	8	3804	Cert FP
USGS	320405106373102	26S.03E.03.344A	32.068	-106.627	RA	36	1/25/1999	9	3803	Cert FP
USGS	320456106382801	26S.03E.04.122 (USBR-21)	32.083	-106.642	RA	20	6/28/1984	8	3803	Cert FP
USGS	320403106390401	26S.03E.08.221 (USBR-23)	32.068	-106.652	RA	24	1/1/1946	8	3801	Cert FP
USGS	320404106381901	26S.03E.09.221A (USBR-22)	32.068	-106.639	RA	16	2/28/1996	6	3799	Cert FP
USGS	320311106373901	26S.03E.15.112 (USBR-28)	32.053	-106.629	RA	16	1/27/1993	6	3800	Cert FP
USGS	320210106371701	26S.03E.22.211 (USBR-30)	32.039	-106.622	RA	12	2/22/1997	4	3791	Cert FP
USGS	320128106372401	26S.03E.27.211 (USBR-32)	32.025	-106.624	RA	18	2/28/1996	5	3789	Cert FP
USGS	320128106371501	26S.03E.27.212 (USBR-31)	32.025	-106.620	RA	16	2/22/1995	4	3789	Cert FP
USGS	315953106403901	26S.03E.31.341, P-1, 10123	31.998	-106.678	RA	90	1/13/1960	17	3783	Cert FP
USGS	315953106391501	26S.03E.32.441 (USBR-39)	31.998	-106.652	RA	18	2/28/1996	7	3783	Cert FP
USGS	315940106372301	27S.03E.03.211A (ISC-1A)	31.994	-106.623	RA	90	3/12/2003	6	3785	Cert FP
USGS	315823106384001	27S.03E.09.1334	31.975	-106.648	RA	34	11/18/1998	6	3781	Cert FP
USGS	315804106375901	27S.03E.09.444 (USBR-38)	31.966	-106.634	RA	20	6/20/1984	3	3776	Cert FP
USGS	315754106372401	27S.03E.15.213A (ISC-2A)	31.965	-106.623	RA	76	1/28/2008	10	3772	Cert FP
USGS	315737106392501	27S.03E.17.1414	31.961	-106.661	RA	32	11/18/1998	9	3775	Cert FP

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	315646106374401	27S.03E.22.134A (ISC-3A)	31.946	-106.629	RA	81	3/12/2003	11	3769	Cert FP
USGS	315701106370201	27S.03E.22.221 (USBR-49)	31.950	-106.618	RA	28	8/31/1989	6	3769	Cert FP
USGS	315537106384801	27S.03E.28.314 (USBR-1)	31.927	-106.647	RA	30	6/26/1984	7	3764	Cert FP
USGS	315515106392801	27S.03E.32.124A (USBR-2)	31.919	-106.658	RA	22	2/19/1993	6	3767	Cert FP
USGS	315453106374701	27S.03E.33.4222	31.917	-106.633	RA	32	12/27/1976	8	3764	Cert FP
USGS	315511106365401	27S.03E.35.113 (USBR-50)	31.920	-106.616	RA	29	2/25/1997	9	3759	Cert FP
USGS	315318106384301	28S.03E.09.1324	31.888	-106.646	RA	28	12/28/1973	8	3760	Cert FP
USGS	314825106345001	29S.04E.07.1112	31.808	-106.582	RA	72	1/4/1984	4	3732	Cert FP
USGS	314817106325801	29S.04E.08.223A (ISC-4A)	31.805	-106.550	RA	75	9/24/2007	5	3729	Cert FP
USGS	314816106325901	ISC4WT	31.805	-106.550	RA	34	8/26/2009	5	3731	Cert FP
USGS	315856106382001	JL-49-03-303	31.982	-106.639	RA	80	12/1/1998	8	3782	Cert FP
USGS	315245106373201	JL-49-03-916 (OLD USBR-36)	31.879	-106.626	RA	16	2/1/1986	7	3748	Cert FP
USGS	315854106361801	JL-49-04-119	31.982	-106.606	RA	50	10/1/1976	9	3781	Cert FP
USGS	315943106365001	JL-49-04-121 (USBR-29)	31.995	-106.614	RA	16	2/1/1985	6	3783	Cert FP
USGS	315557106361401	JL-49-04-430	31.933	-106.604	RA	50	7/24/1984	3	3767	Cert FP
USGS	315557106361101	JL-49-04-431	31.933	-106.604	RA	50	12/5/1986	5	3765	Cert FP
USGS	315712106364301	JL-49-04-466	31.953	-106.613	RA	59	7/20/1990	5	3766	Cert FP
USGS	315712106362301	JL-49-04-470	31.954	-106.607	RA	58	10/19/1990	7	3767	Cert FP
USGS	315712106361801	JL-49-04-474	31.954	-106.606	RA	47	8/19/1993	6	3767	Cert FP
USGS	315712106361201	JL-49-04-478	31.954	-106.604	RA	52	6/23/1994	9	3768	Cert FP
USGS	315309106364801	JL-49-04-701 (USBR-37)	31.886	-106.617	RA	16	2/18/1999	5	3751	Cert FP
USGS	315042106355701	JL-49-12-101 (OLD USBR-35)	31.845	-106.600	RA	14	2/1/1987	6	3742	Cert FP
USGS	315042106355702	JL-49-12-101B (USBR-35)	31.845	-106.601	RA	31	2/25/1997	6	3742	Cert FP
USGS	315115106353401	JL-49-12-117 (OLD USBR-33)	31.854	-106.593	RA	20	2/1/1987	6	3742	Cert FP
USGS	315115106353402	JL-49-12-117B (USBR-33)	31.854	-106.594	RA	32	2/21/2002	3	3744	Cert FP
USGS	315006106354601	JL-49-12-118	31.835	-106.596	RA	80	1/22/1959	9	3738	Cert FP
USGS	315127106355001	JL-49-12-131	31.858	-106.598	RA	67	1/9/2001	7	3746	Cert FP
USGS	315011106343801	JL-49-12-201	31.836	-106.578	RA	50	1/15/1991	5	3740	Cert FP
USGS	314854106340101	JL-49-12-501 (USBR-34)	31.815	-106.568	RA	18	6/20/1984	3	3732	Cert FP
USGS	314920106343801	JL-49-12-502	31.822	-106.578	RA	48	1/9/2001	7	3732	Cert FP
USGS	321859106503101	MES16R	32.317	-106.842	RA	34	8/25/2009	9	3888	Cert FP
USGS	320404106385801	MES23R	32.068	-106.650	RA	34	8/26/2009	9	3800	Cert FP
USGS	315953106390601	MES39R	31.998	-106.652	RA	34	8/27/2009	9	3785	Cert FP
USGS	322540106525101	MES43R	32.428	-106.881	RA	35	8/25/2009	9	3931	Cert FP
USGS	321105106442101	MES8R	32.185	-106.739	RA	34	4/27/2010	9	3839	Cert FP
Hawley	322537106515201	22S.01E.05.142	32.427	-106.865	USF1	406	6/2/1975	12	3928	Uncert FP
Hawley	322323106485201	22S.01E.14.341A	32.390	-106.815	USF2	324	5/16/1974	47	3903	Uncert FP
USGS	322054106475201	22S.01E.36.314	32.348	-106.798	USF2	191	11/4/1987	20	3890	Uncert FP
USGS	322011106473301	23S.01E.01.411 (LC-33)	32.336	-106.792	USF2	605	2/6/1997	45	3860	Uncert FP
Hawley	322003106483401	23S.01E.02.413	32.334	-106.810	USF2	500	3/22/1973	17	3887	Uncert FP
USGS	322010106491401	23S.01E.03.422	32.336	-106.821	USF2	142	1/9/1967	10	3894	Uncert FP
Hawley	321946106502801	23S.01E.04.434	32.330	-106.842	USF2	717	5/26/1975	8	3892	Uncert FP
USGS	321934106482601	23S.01E.11.214A (LC-31)	32.326	-106.808	USF2	617	5/13/1976	10	3893	Uncert FP
USGS	321827106473501	23S.01E.13.411B (LC-29)	32.308	-106.794	USF2	629	1/24/1995	25	3865	Uncert FP
USGS	321753106501601	23S.01E.21.224	32.298	-106.838	USF2	295	3/15/1995	12	3878	Uncert FP
Hawley	321647106490602	23S.01E.26.133A	32.312	-106.790	USF2	352	10/15/1974	9	3871	Uncert FP
Hawley	321528106481401	23S.01E.35.444	32.258	-106.804	USF2	410	2/1/1976	88	3791	Uncert FP
USGS	321914106462501	23S.02E.07.411 (LC-10)	32.321	-106.774	USF1	381	1/24/1995	73	3862	Uncert FP
USGS	321650106451201	23S.02E.29.243A (NMSU-2)	32.280	-106.754	USF	485	12/1/1963	51	3852	Uncert FP
USGS	321624106460201	23S.02E.29.331 (LC-30)	32.274	-106.767	USF	470	10/6/1976	24	3851	Uncert FP
Hawley	321629106460	23S.02E.29.331B	32.275	-106.768	USF2	280	6/20/1977	19	3857	Uncert FP
Hawley	321621106464701	23S.02E.30.243A	32.273	-106.780	USF	804	12/2/1975	34	3844	Uncert FP
USGS	321534106442701	23S.02E.33.43	32.260	-106.741	USF2	275	4/29/1994	42	3848	Uncert FP
USGS	321335106472101	24S.01E.13.221A (EBID-5)	32.226	-106.789	USF2	370	2/9/1987	8	3855	Uncert FP
USGS	321501106443801	24S.02E.04.322	32.250	-106.744	USF2	312	7/28/1986	25	3841	Uncert FP
USGS	321308106453801	24S.02E.17.322 (EBID-3)	32.220	-106.762	USF2	464	2/8/1993	13	3847	Uncert FP
USGS	321307106452202	24S.02E.17.414A(EBID1-FarNest)	32.218	-106.757	USF	312	2/8/1993	10	3848	Uncert FP
USGS	321239106444501	24S.02E.21.123 (EBID-4)	32.211	-106.745	USF	480	1/16/1992	10	3845	Uncert FP
Hawley	321210106422802	24S.02E.23.413	32.203	-106.708	USF	290	1/4/1974	13	3836	Uncert FP
Hawley	321137106424501	24S.02E.26.134	32.194	-106.713	USF	356	1/12/1976	12	3833	Uncert FP
Hawley	321052106425101	24S.02E.35.114	32.181	-106.715	USF	370	1/9/1976	10	3833	Uncert FP
Hawley	321030106415501	24S.02E.36.313	32.175	-106.699	USF	303	9/19/1972	47	3795	Uncert FP
Hawley	321025106402201	24S.03E.31.413	32.174	-106.673	USF	400	1/8/1975	58	3827	Uncert FP
USGS	320939106441701	25S.02E.04.421	32.161	-106.739	USF	232	3/15/1995	13	3831	Uncert FP

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	320906106423601	25S.02E.11.144	32.152	-106.711	USF2	130	7/22/1958	6	3827	Uncert FP
USGS	320641106421801	25S.02E.26.221	32.111	-106.706	RA	120	1/20/1999	8	3817	Uncert FP
Hawley	320814106400101	25S.03E.18.224	32.137	-106.667	USF2	250	1/16/1976	8	3819	Uncert FP
USGS	320445106421001	26S.02E.02.223	32.079	-106.703	USF2	147	3/21/1995	21	3799	Uncert FP
Hawley	320336106411105	26S.02E.12.421D	32.060	-106.687	USF	151	12/1/1976	9	3799	Uncert FP
USGS	320405106382601	26S.03E.04.433	32.068	-106.641	USF	130	2/15/1994	7	3803	Uncert FP
Hawley	320205106361001	26S.03E.23.232	32.035	-106.603	MSF	232	9/12/1972	62	3772	Uncert FP
USGS	320049106354801	26S.03E.26.4244	32.014	-106.599	MSF	300	1/9/1958	33	3787	Uncert FP
USGS	320032106381501	26S.03E.33.221, Hornet 1, K-2A	32.009	-106.637	MSF	215	11/17/1998	10	3783	Uncert FP
Hawley	315837106402501	27S.03E.07.2311	31.977	-106.674	MSF2	211	12/28/1967	19	3779	Uncert FP
USGS	315835106402501	27S.03E.07.2313, 10131, P-4	31.977	-106.674	MSF2	149	12/9/1991	16	3781	Uncert FP
USGS	315639106380401	27S.03E.21.4221, Q-58, 10135	31.944	-106.635	MSF	130	1/15/1960	10	3767	Uncert FP
USGS	315427106385701	28S.03E.04.1113, 10138, Q-105	31.908	-106.649	MSF2	140	11/20/1998	8	3760	Uncert FP
Hawley	315234106382801	28S.03E.16.124	31.876	-106.642	MSF2	148	1/14/1959	7	3753	Uncert FP
USGS	315245106380601	28S.03E.16.221A (ISC-7A)	31.879	-106.636	MSF	198	1/28/2008	10	3751	Uncert FP
USGS	315204106381601	28S.03E.16.4311	31.870	-106.639	MSF	148	12/13/1966	4	3752	Uncert FP
USGS	315126106381801	28S.03E.21.144, ST-7, 10158	31.859	-106.643	MSF	245	12/13/1995	53	3750	Uncert FP
Hawley	315112106380101	28S.03E.21.441	31.853	-106.634	MSF	205	6/14/1974	36	3749	Uncert FP
USGS	315110106371701	28S.03E.22.432A (ISC-6A)	31.853	-106.622	MSF	222	1/28/2008	3	3749	Uncert FP
USGS	315013106362601	28S.03E.26.344A (ISC-5A)	31.837	-106.608	MSF	168	1/26/2010	5	3742	Uncert FP
USGS	315049106373601	28S.03E.27.124, ST-18	31.848	-106.627	MSF	254	6/14/1974	42	3746	Uncert FP
Hawley	315008106361601	28S.03E.35.212	31.836	-106.605	MSF	235	1/13/1959	5	3742	Uncert FP
Hawley	314756106345101	29S.04E.07.311	31.799	-106.581	MSF1	274	1/15/1957	56	3722	Uncert FP
USGS	315916106362201	JL-49-04-112	31.988	-106.607	MSF	260	2/2/1960	19	3771	Uncert FP
USGS	315733106364401	JL-49-04-115	31.959	-106.613	MSF	202	9/20/1958	6	3769	Uncert FP
USGS	315757106370201	JL-49-04-116	31.966	-106.618	MSF	277	1/27/1975	9	3772	Uncert FP
USGS	315901106355001	JL-49-04-118	31.984	-106.598	MSF	264	6/2/1952	44	3776	Uncert FP
USGS	315804106354301	JL-49-04-138	31.968	-106.596	MSF	190	1/10/1952	49	3771	Uncert FP
USGS	315803106362801	JL-49-04-188	31.968	-106.608	MSF	242	3/19/2004	16	3766	Uncert FP
USGS	315617106365601	JL-49-04-403	31.938	-106.616	MSF	160	2/16/1953	5	3765	Uncert FP
USGS	315617106364201	JL-49-04-405	31.938	-106.612	MSF	170	1/14/1959	5	3765	Uncert FP
USGS	315619106362101	JL-49-04-406	31.939	-106.606	MSF	152	7/8/1952	6	3766	Uncert FP
USGS	315551106372101	JL-49-04-407	31.931	-106.623	MSF	200	1/12/1960	7	3761	Uncert FP
USGS	315552106371001	JL-49-04-408	31.931	-106.620	MSF	200	4/17/1959	6	3762	Uncert FP
USGS	315607106365901	JL-49-04-409	31.935	-106.617	MSF	156	1/10/1978	7	3766	Uncert FP
USGS	315556106364302	JL-49-04-411	31.932	-106.612	MSF	194	4/17/1959	6	3761	Uncert FP
USGS	315557106361801	JL-49-04-412	31.933	-106.606	MSF	160	7/8/1952	5	3769	Uncert FP
USGS	315520106362701	JL-49-04-413	31.922	-106.608	MSF	160	1/27/1975	5	3762	Uncert FP
USGS	315523106362201	JL-49-04-414	31.923	-106.607	MSF	200	1/14/1959	5	3759	Uncert FP
USGS	315537106361501	JL-49-04-415	31.927	-106.605	MSF2	122	7/8/1952	5	3769	Uncert FP
USGS	315556106363101	JL-49-04-417	31.932	-106.609	MSF	200	10/20/1958	6	3760	Uncert FP
USGS	315557106365801	JL-49-04-420	31.933	-106.617	MSF	202	7/8/1952	6	3768	Uncert FP
USGS	315708106362301	JL-49-04-423	31.952	-106.607	MSF	200	7/1/1986	9	3766	Uncert FP
USGS	315652106362301	JL-49-04-424	31.948	-106.607	MSF	221	1/27/1975	12	3765	Uncert FP
USGS	315652106364301	JL-49-04-426	31.948	-106.612	MSF	219	1/27/1975	7	3765	Uncert FP
USGS	315517106361401	JL-49-04-428	31.921	-106.604	MSF	210	1/27/1975	3	3761	Uncert FP
USGS	315654106362201	JL-49-04-433	31.948	-106.607	MSF	242	3/19/2004	19	3756	Uncert FP
USGS	315637106354301	JL-49-04-436	31.944	-106.596	MSF	190	1/10/1952	54	3766	Uncert FP
USGS	315401106363701	JL-49-04-712	31.900	-106.611	MSF	116	1/9/1982	6	3758	Uncert FP
USGS	315308106361001	JL-49-04-718	31.886	-106.603	MSF	150	12/4/1986	5	3753	Uncert FP
USGS	315228106361601	JL-49-12-107	31.875	-106.605	MSF2	110	12/4/1986	4	3752	Uncert FP
USGS	315152106371901	JL-49-12-108	31.865	-106.622	MSF2	128	1/16/1993	6	3748	Uncert FP
Hawley	322220106471001	22S.01E.25.222	32.372	-106.787	USF2	405	3/15/1976	160	3898	Uncert NFP
Hawley	322040106512601	22S.01E.32.443	32.345	-106.858	USF2	207	11/6/1972	72	3890	Uncert NFP
Hawley	322148106450201	22S.02E.29.424	32.363	-106.751	USF2	485	9/13/1974	444	3845	Uncert NFP
Hawley	3222101064640	22S.02E.30.123	32.370	-106.778	USF2	294	3/15/1976	209	3891	Uncert NFP
USGS	322045106461001	22S.02E.31.444 (LC-23)	32.346	-106.770	USF2	596	1/1/1965	217	3851	Uncert NFP
USGS	321640106524601	23S.01E.30.322 (CLC-37)	32.278	-106.880	USF2	645	2/4/2003	315	3874	Uncert NFP
Hawley		23S.01E.33.422	32.257	-106.872	USF	209	4/15/1905	12	3873	Uncert NFP
USGS	321615106531601	23S.01W.25.444 (LC Sludge Well)	32.271	-106.888	USF	380	2/1/1985	327	3870	Uncert NFP
Hawley	322013106454401	23S.02E.05.321	32.337	-106.763	USF1	620	10/7/1977	222	3834	Uncert NFP
Hawley	322027106464901	23S.02E.06.114	32.341	-106.781	USF2	402	3/10/1972	119	3859	Uncert NFP
USGS	321945106461501	23S.02E.07.122 (LC-11)	32.330	-106.776	USF2	360	1/1/1965	77	3867	Uncert NFP
Hawley	321947106450801	23S.02E.08.224	32.330	-106.753	USF1	550	3/21/1974	275	3838	Uncert NFP

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	321819106445201	23S.02E.16.314 (LC-24)	32.305	-106.748	USF1	591	1/13/2009	199	3826	Uncert NFP
USGS	321714106441301	23S.02E.21.444 (NMSU-4)	32.289	-106.735	USF1	507	2/1/1994	178	3879	Uncert NFP
Hawley	321614106434601	23S.02E.34.123	32.271	-106.730	USF2	342	12/4/1972	169	3841	Uncert NFP
Hawley	321555106432201	23S.02E.34.412	32.265	-106.723	USF1	486	12/1/1972	180	3852	Uncert NFP
USGS	321758106385701	23S.03E.20.222	32.300	-106.650	USF1	285	3/1/1972	181	4404	Uncert NFP
Hawley	321128106531601	24S.01W.25.422	32.191	-106.888	USF2	370	2/3/1975	370	3848	Uncert NFP
Hawley	321430106431401	24S.02E.03.434	32.242	-106.721	USF	550	11/29/1972	120	3844	Uncert NFP
Hawley	320658106434901	25S.02E.22.314	32.116	-106.731	USF2	200	1/19/1976	19	3846	Uncert NFP
USGS	320638106440502	25S.02E.28.222B (Old Ranch Well)	32.111	-106.735	USF2	120	2/8/1994	103	3819	Uncert NFP
USGS	320526106470101	25S.02E.31.312A (Fletch Deerman)	32.091	-106.784	USF2	400	1/28/1999	354	3817	Uncert NFP
Hawley	320824106353801	25S.03E.13.112	32.140	-106.594	USF2	600	1/29/1985	387	3815	Uncert NFP
USGS	320425106565201	26S.01W.04.412	32.074	-106.949	USF2	445	2/7/1995	387	3824	Uncert NFP
Hawley	320250106450201	26S.02E.17.2444	32.047	-106.751	USF2	340	4/5/1976	321	3803	Uncert NFP
Hawley	320013106353401	26S.03E.36.144	32.004	-106.593	MSF	240	4/1/1959	114	3776	Uncert NFP
USGS	315536106544601	27S.01W.26.433	31.926	-106.911	USF2	314	10/17/1973	284	3811	Uncert NFP
Hawley		27S.01W.32.124	31.919	-106.966	USF2	280	7/2/1973	216	3814	Uncert NFP
Hawley	315204106390201	28S.03E.17.441	31.868	-106.651	MSF	250	6/18/1975	77	3755	Uncert NFP
USGS	315007106370201	28S.03E.27.434 (ST-21)	31.836	-106.621	USF	300	1/22/1993	71	3751	Uncert NFP
Hawley	315010106380601	28S.03E.28.444	31.836	-106.636	USF	325	6/14/1974	128	3772	Uncert NFP
Hawley	315020106390001	28S.03E.29.442	31.839	-106.651	USF	268	6/14/1974	63	3845	Uncert NFP
USGS	315919106350901	JL-49-04-163	31.989	-106.584	MSF	205	1/7/2000	148	3752	Uncert NFP
USGS	315711106354201	JL-49-04-439	31.953	-106.593	USF2	135	2/12/1953	79	3766	Uncert NFP
USGS	315656106350701	JL-49-04-498	31.949	-106.585	MSF	300	1/20/2004	165	3735	Uncert NFP
USGS	315427106341801	JL-49-04-804	31.908	-106.581	MSF	300	1/12/1994	130	3758	Uncert NFP
USGS	322311106415401	Well K, 22S.02E.24.113,	32.386	-106.698	USF1	420	9/15/2011	360	4082	Uncert NFP
USGS	320653106521001	25S.01E.19.424A (Bauman Ranch)	32.119	-106.872			2/16/1982	320	3834	No Depth
USGS	320707106521602	25S.01E.19.424B (Bauman Ranch)	32.119	-106.872			2/28/1985	307	3847	No Depth
Hawley	320737106571601	25S.01W.16.331	32.127	-106.955			5/11/1968	395	3831	No Depth
USGS	320053106533701	26S.01W.25.412B	32.015	-106.894			2/13/1990	375	3819	No Depth
USGS	315944106460101	26S.02E.32.333	31.998	-106.769			2/20/1984	332	3796	No Depth
USGS	315656106445801	27S.02E.21.111	31.949	-106.751			3/26/1986	304	3788	No Depth
USGS	315637106394801	27S.03E.19.4222	31.943	-106.669			1/11/2001	73	3771	No Depth
USGS	315150106415801	28S.02E.23.222	31.864	-106.702			3/6/1984	334	3777	No Depth
USGS	314914106530501	29S.01E.06.111	31.821	-106.886			2/24/1989	326	3804	No Depth
Hawley	322324106485201	22S.01E.14.341	32.390	-106.815	USF2	369	5/17/1974	49	3911	Duplicate
USGS	321745106492501	23S.01E.22.232A (LC-1A)	32.296	-106.824	USF2	305	11/6/1984	6	3883	Duplicate
USGS	321745106492502	23S.01E.22.232B (LC-1B)	32.296	-106.824	USF2	105	7/14/1995	2	3886	Duplicate
USGS	321745106492503	23S.01E.22.232C (LC-1C)	32.296	-106.824	RA	41	8/25/2010	2	3886	Duplicate
USGS	321745106492504	23S.01E.22.232D (LC-1D)	32.296	-106.824	RA	10	7/9/1998	4	3885	Duplicate
USGS	321745106492101	23S.01E.22.241A (LC-2A)	32.296	-106.823	USF2	310	1/31/1995	15	3873	Duplicate
USGS	321745106492102	23S.01E.22.241B (LC-2B)	32.296	-106.823	USF2	110	7/14/1995	7	3881	Duplicate
USGS	321745106492103	23S.01E.22.241C (LC-2C)	32.296	-106.823	RA	40	7/20/2009	5	3883	Duplicate
USGS	321745106492104	23S.01E.22.241D (LC-2D)	32.296	-106.823	RA	10	7/9/1998	4	3884	Duplicate
USGS	321740106481001	23S.01E.23.244A (LC-3A)	32.295	-106.803	USF2	332	1/10/1996	18	3871	Duplicate
USGS	321740106481002	23S.01E.23.244B (LC-3B)	32.295	-106.803	USF2	120	9/17/1996	13	3877	Duplicate
USGS	321410106462701	24S.02E.07.231 (EBID-2-NEST)	32.237	-106.775	USF2	460	7/31/1975	13	3857	Duplicate
USGS	321412106462601	24S.02E.07.234 (EBID-2-NEST)	32.237	-106.775	USF2	310	2/9/1987	16	3855	Duplicate
USGS	321412106462602	24S.02E.07.234A (EBID-2-NEST)	32.237	-106.775	USF2	125	2/9/1987	15	3856	Duplicate
USGS	321342106452202	24S.02E.08.434A (USBR-13)	32.228	-106.757	RA	30	2/14/1996	8	3855	Duplicate
USGS	321332106443701	24S.02E.16.124A (M-4A)	32.226	-106.744	USF2	307	10/24/2000	12	3850	Duplicate
USGS	321332106443702	24S.02E.16.124B (M-4B)	32.226	-106.744	USF2	120	10/4/1995	11	3851	Duplicate
USGS	321304106451504	24S.02E.17.423C (M-3C)	32.217	-106.755	USF2	310	2/8/1993	10	3850	Duplicate
USGS	321304106451505	24S.02E.17.423D (M-3D)	32.217	-106.755	USF2	121	1/22/2001	9	3851	Duplicate
USGS	321237106462001	24S.02E.19.214A (M-1A)	32.210	-106.773	USF2	320	10/24/2000	9	3850	Duplicate
USGS	321237106462002	24S.02E.19.214B (M-1B)	32.210	-106.773	USF2	125	9/22/1995	7	3852	Duplicate
USGS	321237106462003	24S.02E.19.214C (M-1C)	32.210	-106.773	RA	45	8/25/2010	6	3853	Duplicate
USGS	321237106462005	24S.02E.19.214E (M-1E)	32.210	-106.773	RA	12	9/1/1998	8	3852	Duplicate
USGS	321237106462006	24S.02E.19.214F (M-1F)	32.210	-106.773	RA	13	9/1/1998	7	3852	Duplicate
USGS	321241106461601	24S.02E.19.223A (M-2A)	32.211	-106.772	USF2	319	10/24/2000	9	3850	Duplicate
USGS	321241106461602	24S.02E.19.223B (M-2B)	32.211	-106.772	USF2	120	7/13/1995	7	3852	Duplicate
USGS	321241106461603	24S.02E.19.223C (M-2C)	32.211	-106.772	RA	50	6/27/2005	6	3853	Duplicate
USGS	320615106413301	25S.02E.25.322 (OLD USBR-5)	32.104	-106.693	RA	21	2/1/1986	9	3812	Duplicate
Hawley	320528106470201	25S.02E.31.133	32.091	-106.784	USF2	400	1/14/1975	356	3814	Duplicate
USGS	320310106520601	26S.01E.18.222B	32.053	-106.872	MSF2	600	2/16/1984	393	3820	Duplicate

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	320405106373103	26S.03E.03.344B	32.068	-106.627	RA	48	1/16/1992	9	3803	Duplicate
USGS	320405106373104	26S.03E.03.344C	32.068	-106.627	RA	75	1/16/1992	9	3803	Duplicate
USGS	320405106373105	26S.03E.03.344D	32.068	-106.627	MSF	150	2/8/1993	10	3802	Duplicate
USGS	320141106390602	26S.03E.20.423B LMV-2B	32.028	-106.652	K	1880	1/6/2009	19	3777	Duplicate
USGS	315940106372302	27S.03E.03.211B (ISC-1B)	31.994	-106.623	MSF2	310	3/12/2003	15	3776	Duplicate
USGS	315940106372303	27S.03E.03.211C (ISC-1C)	31.994	-106.623	MSF2	810	3/12/2003	38	3753	Duplicate
USGS	315940106372304	27S.03E.03.211D (ISC-1D)	31.994	-106.623	LSF	1310	3/12/2003	38	3753	Duplicate
USGS	315754106372402	27S.03E.15.213B (ISC-2B)	31.965	-106.623	MSF	295	2/23/2011	17	3765	Duplicate
USGS	315754106372403	27S.03E.15.213C (ISC-2C)	31.965	-106.623	LSF	895	1/28/2008	55	3727	Duplicate
USGS	315754106372404	27S.03E.15.213D (ISC-2D)	31.965			1275	1/28/2008	54	3728	Duplicate
USGS	315622106391705	27S.03E.20.432D LMV-3B	31.940	-106.655	LSF	1765	1/20/2004	33	3747	Duplicate
USGS	315646106374402	27S.03E.22.134B (ISC-3B)	31.946	-106.629	MSF	331	1/27/2010	20	3760	Duplicate
USGS	315646106374403	27S.03E.22.134C (ISC-3C)	31.946	-106.629	LSF	912	3/12/2003	41	3739	Duplicate
USGS	315646106374404	27S.03E.22.134D (ISC-3D)	31.946	-106.629	K	1322	3/12/2003	41	3739	Duplicate
USGS	315326106592502	28S.01W.07.113B	31.891	-106.991	MSF2	600	2/22/1984	309	3802	Duplicate
USGS	315245106380602	28S.03E.16.221B (ISC-7B)	31.879	-106.636	MSF	427	1/27/2010	10	3751	Duplicate
USGS	315110106371702	28S.03E.22.432B (ISC-6B)	31.853	-106.622	LSF	404	1/27/2010	2	3750	Duplicate
USGS	315013106362602	28S.03E.26.344B (ISC-5B)	31.837	-106.608	Tli-K	306	1/26/2010	4	3743	Duplicate
USGS	314817106325802	29S.04E.08.223B (ISC-4B)	31.805	-106.550	MSF1	166	1/26/2010	5	3729	Duplicate
USGS	315245106373202	JL-49-03-916B (USBR-36)	31.879	-106.626	RA	29	6/29/1989	5	3750	Duplicate
USGS	315733106364501	JL-49-04-106	31.959	-106.613	LSF	1090	10/16/1958	20	3754	Duplicate
USGS	315556106364301	JL-49-04-410	31.932	-106.612	MSF	462	1/27/1975	7	3763	Duplicate
USGS	315652106362302	JL-49-04-425	31.948	-106.607	MSF	447	1/27/1975	23	3752	Duplicate
USGS	315712106364302	JL-49-04-467	31.953	-106.613	MSF	159	9/22/1986	6	3765	Duplicate
USGS	315712106364303	JL-49-04-468	31.953	-106.613	MSF	299	3/19/1992	12	3759	Duplicate
USGS	315712106364304	JL-49-04-469	31.953	-106.613	LSF	800	3/19/1992	16	3755	Duplicate
USGS	315712106362302	JL-49-04-471	31.954	-106.607	MSF	158	3/19/1993	10	3764	Duplicate
USGS	315712106362303	JL-49-04-472	31.954	-106.607	MSF	298	3/19/1992	17	3757	Duplicate
USGS	315712106361802	JL-49-04-475	31.954	-106.606	MSF	158	3/19/1992	10	3763	Duplicate
USGS	315712106361803	JL-49-04-476	31.954	-106.606	MSF	300	3/19/1992	17	3756	Duplicate
USGS	315712106361804	JL-49-04-477	31.954	-106.606	LSF	799	3/19/1992	19	3754	Duplicate
USGS	315712106361202	JL-49-04-479	31.954	-106.604	MSF	156	3/19/1993	15	3762	Duplicate
USGS	315712106361203	JL-49-04-480	31.954	-106.604	MSF	334	3/19/1992	21	3756	Duplicate
USGS	315712106361204	JL-49-04-481	31.954	-106.604	LSF	803	3/19/1992	22	3755	Duplicate
USGS	315656106350702	JL-49-04-499	31.949			660	1/20/2004	171	3729	Duplicate
Hawley		21S.01W.11.443	32.493	-106.907	Tlvs	930	12/11/1973	64	3956	Too Deep
Hawley	322300106445701	22S.02E.21.131	32.383	-106.750	Tlvs	1000	5/22/1905	470	3860	Too Deep
Hawley	322246106405801	22S.02E.24.422	32.380	-106.683	MSF	1175	3/31/1976	381	4100	Too Deep
Hawley	321750106513801	23S.01E.20.213A	32.297	-106.861	MSF2	420	1/27/1975	170	3865	Too Deep
USGS	321745106492106	23S.01E.22.241F (LC-2F)	32.296	-106.823	MSF2	650	12/17/2002	20	3868	Too Deep
USGS	321740106481004	23S.01E.23.244D (LC-3D)	32.295	-106.803	MSF2	640	12/17/2002	25	3865	Too Deep
Hawley	322028106455501	23S.02E.05.113	32.341	-106.766	MSF2	676	10/7/1977	232	3838	Too Deep
USGS	321956106453101	23S.02E.05.342 (LC-28)	32.333	-106.760	MSF1	751	3/29/1973	218	3845	Too Deep
Hawley	3219571064534	23S.02E.05.342B	32.332	-106.761	MSF1	736	7/16/1991	237	3826	Too Deep
Hawley	321910106451301	23S.02E.08.422	32.320	-106.754	MSF1	682	2/15/1977	240	3840	Too Deep
Hawley	321856106452801	23S.02E.08.433	32.316	-106.758	MSF1	632	10/7/1977	203	3834	Too Deep
USGS	321853106452101	23S.02E.08.443 (LC-27)	32.315	-106.756	MSF1	730	1/19/2010	211	3836	Too Deep
Hawley	321843106444801	23S.02E.09.332	32.312	-106.747	MSF1	612	2/17/1977	233	3830	Too Deep
Hawley	321842106444801	23S.02E.16.1142	32.312	-106.747	MSF1	680	3/19/1975	237	3843	Too Deep
Hawley	321822106443101	23S.02E.16.413	32.306	-106.743	MSF1	630	10/7/1977	328	3767	Too Deep
USGS	321832106451301	23S.02E.17.243 (LC-26)	32.309	-106.756	MSF1	700	1/13/2009	169	3844	Too Deep
USGS	321806106461501	23S.02E.18.441 (LC-32)	32.301	-106.771	MSF1	700	2/3/1994	48	3842	Too Deep
USGS	321733106454301	23S.02E.20.322 (LC-35)	32.292	-106.763	MSF	685	2/3/1994	35	3845	Too Deep
USGS	321753106441401	23S.02E.21.223 (CLC-34)	32.298	-106.738	LSF	698	1/21/2005	236	3846	Too Deep
USGS	321700106444501	23S.02E.28.123 (NMSU-3)	32.283	-106.746	MSF	665	2/2/1990	120	3846	Too Deep
USGS	321637106444001	23S.02E.28.314 (NMSU-8)	32.276	-106.746	MSF	626	1/30/1996	99	3855	Too Deep
USGS	321623106445601	23S.02E.28.333 (NMSU-9)	32.274	-106.749	MSF	525	2/1/1994	78	3854	Too Deep
USGS	321651106454301	23S.02E.29.141 (NMSU-14)	32.281	-106.762	MSF	712	2/8/1994	32	3850	Too Deep
USGS	321628106451501	23S.02E.29.441 (NMSU-10)	32.274	-106.754	MSF	766	2/1/1994	63	3849	Too Deep
USGS	321703106464701	23S.02E.30.123 (CLC-58)	32.284	-106.780	MSF	700	1/13/2004	33	3853	Too Deep
USGS	321248106560001	24S.01W.22.121 (Norwood Ranch)	32.211	-106.934	MSF	355	2/3/1968	320	3910	Too Deep
Hawley	321338106423301	24S.02E.14.122	32.227	-106.710	MSF	512	3/31/1976	101	3822	Too Deep
USGS	321307106452203	24S.02E.17.414B (EBID-1-FarNest)	32.218	-106.757	MSF	618	2/13/1989	15	3843	Too Deep
USGS	321304106451401	24S.02E.17.423A (EBID-1-NEST)	32.218	-106.754	MSF	686	1/22/2001	8	3851	Too Deep

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	321304106451503	24S.02E.17.423B (M-3B)	32.218	-106.755	MSF	599	2/13/1989	14	3845	Too Deep
USGS	320927106531201	25S.01E.06.331 (James Hay)	32.157	-106.887	MSF	400	2/15/1991	366	3844	Too Deep
USGS	320924106531201	25S.01E.06.333 (Afton Testhole)	32.157	-106.887	MSF	680	2/7/1995	364	3845	Too Deep
USGS	320824106510801	25S.01E.16.111 (Afton Sod Farm)	32.141	-106.854	LSF	1650	2/7/1995	351	3839	Too Deep
Hawley	321003106430201	25S.02E.03.224	32.168	-106.718	LSF	2030	11/4/1974	79	3756	Too Deep
Hawley	320633106424701	25S.02E.26.114	32.109	-106.714	MSF2	704	4/20/1974	14	3809	Too Deep
USGS	320526106470102	25S.02E.31.312B (Fletch Deerman)	32.091	-106.786	MSF1	1000	2/19/1985	350	3821	Too Deep
USGS	320612107003601	25S.02W.26.421 UPRR	32.103	-107.009	MSF	472	3/21/2006	435	3833	Too Deep
Hawley	321013106351901	25S.03E.01.211	32.170	-106.589	P	580	5/2/1974	427	3825	Too Deep
Hawley	320842106350701	25S.03E.12.441	32.145	-106.586	MSF2	615	4/14/1975	388	3819	Too Deep
Hawley	320826106395501	25S.03E.17.111A	32.141	-106.666	MSF2	716	7/29/1973	27	3800	Too Deep
Hawley	320706106392501	25S.03E.20.411A	32.118	-106.657	MSF	582	1/19/1976	11	3808	Too Deep
Hawley	320710106375801	25S.03E.21.244	32.120	-106.633	MSF2	373	1/21/1976	103	3805	Too Deep
Hawley	320550106381501	25S.03E.28.434	32.097	-106.638	MSF	1307	12/13/1975	38	3782	Too Deep
USGS	320811106335801	25S.04E.18.243, K-13	32.134	-106.569	MSF	768	1/22/1955	381	3819	Too Deep
USGS	320309106521601	26S.01E.18.222A	32.053	-106.872	MSF2	430	5/6/1976	393	3820	Too Deep
USGS	315955106490301	26S.01E.35.332	31.998	-106.819	MSF	500	6/25/1968	358	3800	Too Deep
USGS	320303106542401	26S.01W.14.224 UPRR	32.051	-106.906	MSF2	510	3/12/2010	390	3827	Too Deep
USGS	320227106570801	26S.01W.16.334	32.041	-106.953	MSF	1000	2/22/1990	386	3824	Too Deep
Hawley	320054106533901	26S.01W.25.414	32.015	-106.895	MSF	563	1/1/1969	375	3822	Too Deep
USGS	320230107013501	26S.02W.15.434	32.041	-107.028	MSF	437	2/11/1987	408	3842	Too Deep
Hawley	320414106362801	26S.03E.02.342	32.071	-106.608	MSF	718	3/27/1973	89	3809	Too Deep
Hawley	320414106395801	26S.03E.06.442	32.071	-106.667	MSF	597	1/16/1976	12	3799	Too Deep
Hawley	320242106372701	26S.03E.15.322	32.045	-106.625	MSF	1212	12/18/1975	35	3765	Too Deep
USGS	320141106390601	26S.03E.20.423A LMV-2A	32.028	-106.652	LSF	700	2/6/2007	8	3788	Too Deep
USGS	320032106381101	26S.03E.33.214	32.009	-106.637	LSF	1050	1/17/1997	23	3770	Too Deep
Hawley	320022106363201	26S.03E.35.141	32.006	-106.610	LSF	800	6/18/1976	33	3757	Too Deep
Hawley	320005106354601	26S.03E.36.321	32.001	-106.597	MSF	400	4/9/1973	86	3760	Too Deep
USGS	315941106505801	27S.01E.04.121 (Lanark Test Hole)	31.994	-106.849	MSF	560	2/13/1990	383	3806	Too Deep
USGS	315811106490401	27S.01E.11.331 UPRR	31.970	-106.817	MSF2	510	3/21/2006	361	3803	Too Deep
USGS	315535106543602	27S.01W.26.433A	31.926	-106.911	MSF2	475	2/23/2001	285	3810	Too Deep
USGS	315720106415601	27S.02E.13.331, MT-3, (La Union)	31.955	-106.700	MSF2	722	2/13/1987	317	3781	Too Deep
Hawley	315908107005001	27S.02W.02.411	31.986	-107.014	MSF	406	6/25/1974	381	3824	Too Deep
USGS	315902107005501	27S.02W.02.413	31.987	-107.015	MSF	406	2/13/1990	367	3836	Too Deep
USGS	315611107002601	27S.02W.25.111	31.937	-107.008	MSF2	600	1/11/1969	361	3812	Too Deep
USGS	315852106382401	27S.03E.04.344	31.981	-106.641	MSF	320	2/27/1995	21	3767	Too Deep
USGS	315918106391301	27S.03E.05.4211, 10129, Q-223	31.988	-106.655	MSF2	390	12/3/1986	9	3778	Too Deep
Hawley	315715106370301	27S.03E.15.444	31.954	-106.618	LSF	1200	12/14/1953	2	3769	Too Deep
Hawley	315622106391701	27S.03E.20.432	31.940	-106.655	MSF2	706	7/24/1975	13	3767	Too Deep
Hawley	314915106525101	28S.01E.31.330	31.821	-106.881	MSF2	400	4/5/1976	327	3810	Too Deep
USGS	314932106493401	28S.01E.34.414	31.826	-106.825	MSF	533	9/4/1986	327	3800	Too Deep
USGS	315349106585701	28S.01W.06.323	31.898	-106.985	MSF2	580	1/6/1966	275	3832	Too Deep
USGS	315336106582801	28S.01W.06.333	31.895	-106.991	MSF2	580	2/22/2001	304	3806	Too Deep
USGS	315326106592501	28S.01W.07.113A	31.891	-106.991	MSF2	565	2/22/1984	309	3802	Too Deep
USGS	315154106414401	28S.02E.13.332, ST-25, P-16	31.868	-106.697	MSF2	607	6/13/1974	334	3776	Too Deep
Hawley		28S.02E.13.343	31.865	-106.696	MSF2	607	6/13/1974	335	3775	Too Deep
USGS	315212106420901	28S.02E.14.421, ST-26	31.871	-106.704	MSF2	536	7/10/1973	330	3780	Too Deep
USGS	315118106422601	28S.02E.23.324, ST-14, 10143	31.855	-106.711	MSF2	552	11/8/1974	329	3782	Too Deep
Hawley	315144106412401	28S.02E.24.213	31.862	-106.691	MSF2	618	6/13/1974	337	3772	Too Deep
USGS	315101106410701	28S.02E.24.444, ST-29,10067	31.851	-106.686	MSF2	524	4/24/1975	307	3773	Too Deep
USGS	315033106412701	28S.02E.25.233	31.845	-106.693	MSF2	565	11/7/1974	307	3774	Too Deep
Hawley	314921106464401	28S.02E.31.344	31.823	-106.779	MSF	400	4/11/1968	307	3795	Too Deep
USGS	314952106413501	28S.02E.36.142	31.831	-106.694	MSF2	565	2/17/1972	335	3778	Too Deep
USGS	315238106392301	28S.03E.17.214, ST-12, 10162	31.879	-106.657	MSF2	330	8/9/1974	69	3761	Too Deep
USGS	315124106410001	28S.03E.19.133, ST-27, 10175	31.858	-106.683	MSF2	537	1/1/1974	307	3775	Too Deep
USGS	315144106394101	28S.03E.20.123, ST-28	31.863	-106.663	MSF	333	1/26/1979	126	3758	Too Deep
USGS	315114106392201	28S.03E.20.422	31.855	-106.656	K	1980	11/5/1974	123	3751	Too Deep
Hawley	315046106395201	28S.03E.29.132	31.846	-106.665	MSF	360	6/14/1974	173	3767	Too Deep
Hawley	315046106391701	28S.03E.29.231	31.846	-106.655	MSF	360	6/14/1974	130	3764	Too Deep
USGS	315013106395301	28S.03E.29.344 (ST-31)	31.837	-106.665	MSF	550	11/5/1974	324	3741	Too Deep
USGS	315046106403201	28S.03E.30.141	31.845	-106.679	MSF	601	6/13/1974	320	3771	Too Deep
USGS	314941106393201	28S.03E.32.143 (ST-11)	31.830	-106.662	MSF	605	12/25/1976	326	3769	Too Deep
Hawley	314926106375501	28S.03E.34.331	31.824	-106.632	MSF	1004	9/13/1966	248	3749	Too Deep
USGS	314936106372201	28S.03E.34.413 Sunland Park No.4	31.827	-106.623	MSF	320	4/26/1996	164	3720	Too Deep

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	314810106513601	29S.01E.08.124	31.804	-106.862	MSF2	565	1/13/1982	322	3799	Too Deep
USGS	314918106464401	29S.02E.06.122B	31.822	-106.779	MSF	490	2/12/1987	307	3801	Too Deep
USGS	314723106420001	29S.02E.13.113A	31.789	-106.700	MSF2	500	2/19/1993	307	3775	Too Deep
Hawley	314724106350701	29S.03E.13.223	31.790	-106.586	K	450	7/31/1975	177	3743	Too Deep
Hawley	314730106334301	29S.04E.17.112	31.792	-106.562	MSF	420	1/15/1953	39	3730	Too Deep
USGS	315758106365701	JL-49-04-104	31.966	-106.616	LSF	1149	2/11/1958	14	3764	Too Deep
USGS	315807106362901	JL-49-04-105	31.969	-106.609	LSF	950	10/2/1958	14	3761	Too Deep
USGS	315734106364201	JL-49-04-107	31.960	-106.612	MSF	550	2/5/1997	5	3769	Too Deep
USGS	315819106370701	JL-49-04-110	31.972	-106.619	MSF	506	1/27/1975	16	3765	Too Deep
USGS	315803106364501	JL-49-04-111	31.967	-106.613	LSF	1063	4/6/1992	16	3760	Too Deep
USGS	315817106370601	JL-49-04-113	31.971	-106.619	LSF	1206	9/11/1961	23	3760	Too Deep
USGS	315915106354701	JL-49-04-117	31.988	-106.597	MSF	336	1/4/1988	59	3764	Too Deep
USGS	315955106362201	JL-49-04-149	31.996	-106.607	LSF	600	1/12/2000	29	3768	Too Deep
USGS	315817106352301	JL-49-04-177	31.971	-106.591	MSF	310	1/24/1998	93	3757	Too Deep
USGS	315732106362201	JL-49-04-189	31.959	-106.607	MSF	641	3/19/2004	63	3713	Too Deep
USGS	315803106363001	JL-49-04-190	31.968	-106.609	MSF	646	3/19/2004	61	3721	Too Deep
USGS	315742106325001	JL-49-04-205	31.962	-106.548	KP	517	5/7/1953	467	3801	Too Deep
USGS	315831106345401	JL-49-04-210	31.975	-106.582	LSF	500	1/5/2000	160	3760	Too Deep
USGS	315717106362201	JL-49-04-401	31.955	-106.607	LSF	900	10/31/1958	16	3758	Too Deep
USGS	315703106364301	JL-49-04-402	31.951	-106.612	LSF	1060	2/4/1957	-1	3771	Too Deep
USGS	315627106363701	JL-49-04-416	31.941	-106.611	LSF	1013	9/20/1959	9	3759	Too Deep
USGS	315554106365701	JL-49-04-418	31.932	-106.617	MSF	545	3/26/2001	2	3767	Too Deep
USGS	315717106364001	JL-49-04-419	31.955	-106.612	LSF	1072	2/25/1957	1	3772	Too Deep
USGS	315551106372201	JL-49-04-421	31.931	-106.623	MSF	550	9/10/1962	9	3763	Too Deep
USGS	315720106362201	JL-49-04-422	31.956	-106.607	MSF	400	1/27/1975	15	3765	Too Deep
USGS	315712106362304	JL-49-04-473	31.954	-106.607	LSF	799	3/19/1992	19	3755	Too Deep
USGS	315728106352201	JL-49-04-482	31.958	-106.590	LSF	538	4/5/1985	141	3724	Too Deep
USGS	315428106344801	JL-49-04-801	31.908	-106.581	MSF	315	12/26/1990	133	3757	Too Deep
USGS	325205106301901	17S.04E.02.211	32.868	-106.506		670	2/20/1990	210	3929	OutOfStudy
USGS	324637107101001	18S.03W.05.124	32.777	-107.175			2/14/1989	96	4544	OutOfStudy
USGS	324418107075901	18S.03W.15.432	32.738	-107.133		170	2/7/1985	98	4357	OutOfStudy
USGS	324215107062401	18S.03W.36.114	32.704	-107.107			1/12/1994	12	4244	OutOfStudy
USGS	324628107163401	18S.04W.05.1233	32.778	-107.278	RA	15	4/23/1994	7	4095	OutOfStudy
USGS	324625107164701	18S.04W.05.133	32.774	-107.281	RA	68	2/17/1994	11	4119	OutOfStudy
USGS	324612107163801	18S.04W.05.314	32.770	-107.278	RA	20	4/23/1994	8	4101	OutOfStudy
USGS	324510107162601	18S.04W.08.342	32.753	-107.274	RA	18	4/23/1994	8	4094	OutOfStudy
USGS	324422107152201	18S.04W.16.342	32.739	-107.257	RA	23	3/25/1996	12	4082	OutOfStudy
USGS	324501107162101	18S.04W.17.211	32.750	-107.272			7/27/1959	7	4093	OutOfStudy
USGS	324419107160801	18S.04W.17.4322	32.739	-107.270	RA	23	4/24/1994	12	4088	OutOfStudy
USGS	324236107133701	18S.04W.26.3323	32.710	-107.227	RA	17	5/2/1994	6	4071	OutOfStudy
USGS	324257107142601	18S.04W.27.1441	32.716	-107.241	RA	20	4/22/1994	8	4076	OutOfStudy
USGS	324202107143101	18S.04W.34.1344	32.701	-107.243	RA	24	4/28/1994	12	4064	OutOfStudy
USGS	324205107121401	18S.04W.36.322	32.700	-107.209			3/28/1991	13	4057	OutOfStudy
USGS	324129106470801	19S.01E.01.222	32.691	-106.786		249	3/1/1972	236	4069	OutOfStudy
USGS	323844106554601	19S.01W.22.124	32.647	-106.930	RA	35	2/18/1983	321	4038	OutOfStudy
USGS	323917107031601	19S.02W.16.3213	32.654	-107.055	RA	18	5/5/1994	6	4034	OutOfStudy
USGS	323930107041401	19S.02W.17.1414	32.658	-107.071	RA	23	5/5/1994	11	4025	OutOfStudy
USGS	323852107033801	19S.02W.20.222A	32.648	-107.061	RA	18	3/20/1994	7	4022	OutOfStudy
USGS	323802107024101	19S.02W.21.443	32.635	-107.045	RA	17	5/6/1994	6	4009	OutOfStudy
USGS	323818107020901	19S.02W.22.323	32.639	-107.036			5/21/1976	8	4001	OutOfStudy
USGS	323733107011001	19S.02W.26.321	32.626	-107.019	RA	18	5/6/1994	6	3998	OutOfStudy
USGS	323733107011002	19S.02W.26.321 H-26	32.626	-107.019	RA	23	4/30/2009	8	4000	OutOfStudy
USGS	323722107002801	19S.02W.26.4424	32.622	-107.008	RA	23	5/4/1994	10	4002	OutOfStudy
USGS	323645107010101	19S.02W.35.322	32.612	-107.013			7/23/1958	5	4003	OutOfStudy
USGS	324041107100001	19S.03W.05.434	32.678	-107.167	RA	16	4/24/2006	3	4053	OutOfStudy
USGS	324021107114301	19S.03W.07.131A	32.673	-107.196	RA	17	4/27/1994	7	4051	OutOfStudy
USGS	323959107075401	19S.03W.10.4322	32.667	-107.132	RA	21	4/18/1994	10	4043	OutOfStudy
USGS	324007107072101	19S.03W.11.323	32.669	-107.123	RA	65	4/18/1995	3	4047	OutOfStudy
USGS	324004107070201	19S.03W.11.413	32.668	-107.117			7/23/1958	4	4042	OutOfStudy
USGS	323920107064601	19S.03W.14.2434	32.656	-107.113	RA	23	5/7/1994	11	4034	OutOfStudy
USGS	323926107075102	19S.03W.15.243 H-21	32.657	-107.131	RA	29	11/14/2007	9	4031	OutOfStudy
USGS	324122107120801	19S.04W.01.214	32.690	-107.203	RA	22	4/28/1994	12	4057	OutOfStudy
USGS	324122107120802	19S.04W.01.214 H-13	32.690	-107.203	RA	28	5/13/2009	11	4051	OutOfStudy
USGS	324059107122301	19S.04W.01.3234	32.683	-107.207	RA	20	4/27/1994	7	4058	OutOfStudy

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	324033107115501	19S.04W.12.241	32.676	-107.199	RA	70	1/25/1999	10	4056	OutOfStudy
USGS	323745107165201	19S.04W.29.133	32.630	-107.281		172	1/28/2009	141	4348	OutOfStudy
USGS	323906106274301	19S.05E.17.331 MAR-1SW	32.652	-106.462		550	3/2/1995	212	3920	OutOfStudy
USGS	323854106274101	19S.05E.17.333	32.648	-106.462		650	2/21/1995	218	3917	OutOfStudy
USGS	323857106273201	19S.05E.17.334 MAR-2SW	32.649	-106.459		650	2/24/1995	214	3924	OutOfStudy
USGS	323842106281201	19S.05E.19.413 MAR-4	32.645	-106.471		750	2/1/1967	235	3988	OutOfStudy
USGS	323403106484001	20S.01E.14.144	32.568	-106.812		356	1/24/1994	318	4045	OutOfStudy
USGS	323446106551801	20S.01W.11.313	32.579	-106.922			2/15/2001	305	4035	OutOfStudy
USGS	323202106444801	20S.02E.28.334	32.534	-106.747		365	12/8/1967	248	4062	OutOfStudy
USGS	323527107000701	20S.02W.01.343	32.591	-107.003	RA	15	5/15/2008	3	3996	OutOfStudy
USGS	323601107010001	20S.02W.02.1444	32.600	-107.017	RA	15	1/17/1996	5	3998	OutOfStudy
USGS	323335107171601	20S.04W.19.122	32.562	-107.290		650	1/27/1977	193	4390	OutOfStudy
USGS	323326107175101	20S.04W.19.131	32.558	-107.298		530	1/28/1966	132	4425	OutOfStudy
USGS	323243107134301	20S.04W.22.444	32.549	-107.231		200	1/25/1978	143	4835	OutOfStudy
USGS	323104106251101	20S.05E.34.133	32.518	-106.420		1000	3/18/1989	292	3886	OutOfStudy
USGS	323104106253901	20S.05E.34.333 (SMR3)	32.518	-106.428		1000	3/31/2004	296	3885	OutOfStudy
Hawley		21S.02E.11.324	32.495	-106.710	USF	600	3/22/1973	239	4065	OutOfStudy
Hawley		21S.02E.12.222	32.504	-106.685	USF1	600	3/22/1973	239	4065	OutOfStudy
Hawley		21S.03E.16.411	32.482	-106.639	LSF	1893	10/1/1973	518	4083	OutOfStudy
Hawley		21S.03E.19.333	32.462	-106.683	USF1	347	11/20/1978	314	4076	OutOfStudy
Hawley		21S.03E.31.244	32.439	-106.667	USF1	461		410	4090	OutOfStudy
Hawley		21S.03E.33.142	32.442	-106.640	USF1	720	3/16/1976	594	4056	OutOfStudy
USGS	322947106311101	21S.04E.10.233 (HTA-24)	32.496	-106.520		163	12/10/2008	59	5633	OutOfStudy
USGS	322943106312801	21S.04E.10.321 (HTA34)	32.495	-106.525		103	1/9/2007	40	5755	OutOfStudy
USGS	322943106312301	21S.04E.10.322A (HTA-12)	32.495	-106.523		155	4/9/2007	62	5693	OutOfStudy
USGS	322935106311801	21S.04E.10.324 (HTA-23)	32.493	-106.521		135	6/17/2009	85	5595	OutOfStudy
USGS	322941106311301	21S.04E.10.411B (HTA-11)	32.495	-106.521	RA	85	4/15/2008	64	5627	OutOfStudy
USGS	322941106311502	21S.04E.10.411C (HTA-10A)	32.494	-106.521	RA	80	1/9/2008	61	5627	OutOfStudy
USGS	322939106311701	21S.04E.10.411D (HTA-14)	32.494	-106.521		110	9/23/1997	89	5607	OutOfStudy
USGS	322943106311401	21S.04E.10.411E (HTA-20)	32.495	-106.520	RA	100	4/16/2008	72	5627	OutOfStudy
USGS	322944106311601	21S.04E.10.411G (HTA-29)	32.496	-106.521		158	10/4/2007	76	5647	OutOfStudy
USGS	322943106310501	21S.04E.10.412 (HTA-25)	32.495	-106.518		120	1/21/2000	81	5562	OutOfStudy
USGS	322938106311601	21S.04E.10.413A (HTA-13)	32.494	-106.521		120	4/15/1998	98	5592	OutOfStudy
USGS	322933106310901	21S.04E.10.413B (HTA-21)	32.493	-106.519		110	1/22/2000	64	5556	OutOfStudy
USGS	322938106310801	21S.04E.10.414A (HTA-15)	32.494	-106.519		102	9/23/1997	79	5564	OutOfStudy
USGS	322937106310901	21S.04E.10.414B (HTA-16)	32.494	-106.519		103	9/23/1997	82	5559	OutOfStudy
USGS	322936106311001	21S.04E.10.414C (HTA-17)	32.493	-106.519		110	9/23/1997	82	5560	OutOfStudy
USGS	322937106310902	21S.04E.10.414D (HTA-16D)	32.494	-106.519		159	4/16/1998	79	5559	OutOfStudy
USGS	322939106305701	21S.04E.10.421 (HTA-30)	32.494	-106.516		200	1/22/2000	90	5478	OutOfStudy
USGS	322940106305101	21S.04E.10.422 (HTA-26)	32.494	-106.514		200	1/21/2000	98	5434	OutOfStudy
USGS	322935106310301	21S.04E.10.423 (HTA-19)	32.493	-106.518		147	4/16/1998	123	5472	OutOfStudy
USGS	322924106310501	21S.04E.10.434 (HTA-22)	32.490	-106.518		110	1/22/2000	86	5471	OutOfStudy
USGS	322932106305601	21S.04E.10.441 (HTA-18)	32.492	-106.515		130	4/14/1998	107	5430	OutOfStudy
USGS	322927106305101	21S.04E.10.442 (HTA-27)	32.491	-106.514		179	1/23/2000	98	5397	OutOfStudy
USGS	322923106304601	21S.04E.11.333 (HTA-28)	32.490	-106.513		145	1/20/2000	75	5376	OutOfStudy
USGS	322924106302601	21S.04E.11.343 (HTA32)	32.490	-106.508	RA	75	5/10/2005	32	5311	OutOfStudy
USGS	322938106291101	21S.04E.12.414 (Bonney Spring)	32.494	-106.486	RA	62	1/12/2007	28	5012	OutOfStudy
USGS	322857106292801	21S.04E.13.143 (HTA43)	32.483	-106.492	RA	99	1/7/2008	69	4888	OutOfStudy
USGS	322901106290101	21S.04E.13.232 (HTA51)	32.484	-106.484		145	6/9/2005	83	4752	OutOfStudy
USGS	322837106294301	21S.04E.13.331 (HTA42)	32.477	-106.496		137	4/10/2003	65	4929	OutOfStudy
USGS	322910106303601	21S.04E.14.114 (HTA-3)	32.487	-106.510		161	6/10/1905	48	5307	OutOfStudy
USGS	322913106301801	21S.04E.14.122 (HTA4)	32.487	-106.506	RA	72	5/10/2005	30	5239	OutOfStudy
USGS	322902106302201	21S.04E.14.142 (HTA31)	32.484	-106.507	RA	85	4/10/2007	42	5210	OutOfStudy
USGS	322906106300301	21S.04E.14.223 (HTA46)	32.485	-106.501		145	10/9/2002	83	5076	OutOfStudy
USGS	322848106305501	21S.04E.15.422 (HTA33)	32.480	-106.516		107	1/10/2007	54	5315	OutOfStudy
USGS	322310106305101	21S.04E.22.222 (EMRE Windmill)	32.473	-106.848			8/1/1979	36	5176	OutOfStudy
USGS	322756106311601	21S.04E.22.411 (HTA5)	32.466	-106.522			10/4/2007	65	5295	OutOfStudy
USGS	322804106301701	21S.04E.23.233B (EMRE-1)	32.468	-106.505		180	1/22/2000	93	4951	OutOfStudy
USGS	322800106300901	21S.04E.23.233C (EMRE-2)	32.467	-106.503	RA	100	1/22/2000	56	4938	OutOfStudy
USGS	322745106300201	21S.04E.23.432 (HTA44)	32.463	-106.501		139	10/9/2002	94	4844	OutOfStudy
USGS	322702106294401	21S.04E.25.311 (HTA36)	32.451	-106.496	RA	97	10/2/2006	62	4737	OutOfStudy
USGS	322704106290601	21S.04E.25.412 (HTA35)	32.451	-106.486		159	10/9/2002	70	4549	OutOfStudy
USGS	322639106294701	21S.04E.35.222 (HTA37)	32.444	-106.497		138	7/12/2007	87	4609	OutOfStudy
USGS	322624106300201	21S.04E.35.232 (HTA38)	32.440	-106.501		119	10/3/2006	83	4641	OutOfStudy

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	322612106294901	21S.04E.35.422 (HTA39)	32.437	-106.497	RA	149	6/17/2009	75	4574	OutOfStudy
USGS	322609106291401	21S.04E.36.411 (HTA40)	32.436	-106.488		199	10/3/2006	78	4435	OutOfStudy
USGS	322941107171701	21S.04W.07.433	32.495	-107.288		474	2/25/1970	391	4419	OutOfStudy
USGS	322834106273201	21S.05E.17.334 (HTA50)	32.476	-106.459		516	1/15/2002	497	3870	OutOfStudy
USGS	322838106264401	21S.05E.17.424 (SMR2)	32.479	-106.447		747	9/29/1960	304	3892	OutOfStudy
USGS	322823106283501	21S.05E.19.112 (HTA45)	32.473	-106.477		139	7/10/2002	74	4564	OutOfStudy
USGS	322827106280101	21S.05E.19.212 (HTA47A)	32.474	-106.468		184	4/10/2003	71	4421	OutOfStudy
USGS	322735106271301	21S.05E.20.434 (SMR4)	32.460	-106.451		580	12/29/1967	274	3888	OutOfStudy
USGS	322731106281901	21S.05E.30.122 (HTA41)	32.459	-106.472		125	10/11/2002	104	4398	OutOfStudy
USGS	322635106264401	21S.05E.32.222 T-13	32.443	-106.446		522	5/17/1967	209	3847	OutOfStudy
USGS	322248106584701	22S.01W.19.322	32.376	-106.986		400	1/21/1982	152	4303	OutOfStudy
USGS	322233106590902	22S.01W.19.332	32.376	-106.986		250	1/27/2009	173	4287	OutOfStudy
USGS	322233106590901	22S.01W.19.332 (Hawkins Well)	32.376	-106.986		250	1/23/1984	156	4304	OutOfStudy
Hawley	322316106411001	22S.02E.13.443	32.388	-106.687		670	6/3/1975	408	4067	OutOfStudy
Hawley	322352106462401	22S.02E.15.142	32.398	-106.727		850	2/15/1994	285	4068	OutOfStudy
Hawley	322222107031401	22S.02W.21.343	32.373	-107.054		280	11/15/1973	240	4368	OutOfStudy
Hawley	322519106361001	22S.03E.02.412	32.422	-106.603		253	3/22/1973	56	4959	OutOfStudy
Hawley	322548106405701	22S.03E.06.111	32.430	-106.683	USF1	1202	9/3/1976	354	4076	OutOfStudy
Hawley	3224101063958	22S.03E.07.444	32.403	-106.667	USF1	564	3/1/1974	452	4076	OutOfStudy
Hawley	322440106392701	22S.03E.08.144	32.411	-106.658	Tmrv	590	11/27/1978	482	4073	OutOfStudy
USGS	322538106285701	22S.04E.01.223 (HTA48)	32.427	-106.483	USF1	159	10/8/2002	113	4293	OutOfStudy
USGS	322508106291001	22S.04E.01.431 (HTA49)	32.419	-106.487	USF	419	1/2/2002	323	4089	OutOfStudy
USGS	322503106290801	22S.04E.01.431 T-9	32.418	-106.486	USF1	598	3/14/1989	368	4043	OutOfStudy
USGS	322434106295001	22S.04E.11.224 T-8	32.410	-106.498	USF1	1060	7/7/1966	551	3890	OutOfStudy
USGS	322446106290801	22S.04E.12.214 SW-20	32.413	-106.486		838	1/21/1965	462	3892	OutOfStudy
USGS	322424106290301	22S.04E.12.414 SW-19	32.407	-106.485		800	7/22/1964	409	3885	OutOfStudy
USGS	322405106290101	22S.04E.12.434 SW-18	32.401	-106.484		800	5/6/1964	402	3862	OutOfStudy
USGS	322339106304301	22S.04E.14.133 T-6	32.394	-106.512		515	8/15/1991	187	4320	OutOfStudy
USGS	322323106314701	22S.04E.15.331 BLM WELL	32.390	-106.530		295	3/1/1985	47	4575	OutOfStudy
USGS	322250106302501	22S.04E.23.214 OS-12	32.381	-106.507		570	3/14/1989	223	4147	OutOfStudy
USGS	322309106290201	22S.04E.24.212A SW-10A	32.386	-106.484		805	2/23/1995	393	3880	OutOfStudy
USGS	322226107172702	22S.04W.19.343	32.376	-107.291			1/28/1983	184	4429	OutOfStudy
USGS	322106107171101	22S.04W.31.411	32.345	-107.292			2/16/1982	73	4437	OutOfStudy
USGS	322417106281501	22S.05E.07.342	32.405	-106.471		970	1/1/1964	314	3871	OutOfStudy
USGS	322401106245201	22S.05E.15.221	32.488	-106.415		315	1/11/1968	131	3819	OutOfStudy
USGS	322402106263701	22S.05E.16.111 T-4	32.401	-106.444		336	6/21/1953	223	3828	OutOfStudy
USGS	322256106282601	22S.05E.19.141 SW-22	32.382	-106.474		733	5/11/1993	353	3864	OutOfStudy
USGS	322237106282801	22S.05E.19.323 SW-21	32.377	-106.475		700	2/22/1995	337	3870	OutOfStudy
USGS	322311106274101	22S.05E.20.111 T-5	32.386	-106.462		351	12/22/1967	270	3880	OutOfStudy
USGS	322209106260201	22S.05E.28.144	32.369	-106.434		225	1/17/2008	196	3808	OutOfStudy
USGS	322209106255401	22S.05E.28.233b	32.369	-106.432		223	1/17/2008	190	3808	OutOfStudy
USGS	322201106260201	22S.05E.28.234 T-34	32.367	-106.434		400	3/17/1989	190	3825	OutOfStudy
USGS	322155106270201	22S.05E.29.412 T-11	32.365	-106.451		576	3/14/1989	272	3728	OutOfStudy
USGS	322220106281701	22S.05E.30.122	32.372	-106.472		420	2/23/1995	307	3883	OutOfStudy
USGS	322053106274501	22S.05E.31.424 OS-9	32.348	-106.463		348	9/10/1947	234	3894	OutOfStudy
USGS	322108106254701	22S.05E.33.244 T-15	32.352	-106.430		670	6/24/1969	179	3811	OutOfStudy
Hawley	322536107051601	22S.2W.6.14233	32.427	-107.088		3007	1/8/1973	746	4014	OutOfStudy
USGS	322011106591901	23S.02W.01.411 (Corralitos Ranch)	32.336	-106.998		300	2/5/2002	181	4259	OutOfStudy
USGS	321945106595001	23S.02W.12.122 (Corralitos Ranch)	32.328	-107.001		300	1/23/1984	175	4288	OutOfStudy
USGS	321814107000401	23S.02W.12.341 (Corralitos Ranch)	32.317	-107.004		300	2/27/2002	165	4264	OutOfStudy
USGS	321828107000501	23S.02W.13.134 (Corralitos Ranch)	32.309	-107.004	Tlvs	260	2/5/2002	150	4281	OutOfStudy
Hawley		23S.02W.13.311	32.306	-107.007		300	1/4/1977	134	4304	OutOfStudy
Hawley	321545107005201	23S.02W.35.411	32.263	-107.015		1050		720	3710	OutOfStudy
Hawley	322029106370701	23S.03E.03.232	32.341	-106.619		120	3/19/1973	32	5043	OutOfStudy
USGS	321828107165501	23S.04W.18.311	32.305	-107.297			1/27/1975	14	4398	OutOfStudy
USGS	322010106272701	23S.05E.05.321 T-18	32.336	-106.458	Tmrs	704	2/22/1995	234	3831	OutOfStudy
USGS	321910106250701	23S.05E.10.413 T-16	32.320	-106.421	Tlvs	710	1/21/1997	178	3802	OutOfStudy
USGS	321647106251301	23S.05E.27.142 T-17	32.281	-106.421	USF1	564	3/24/1970	242	3778	OutOfStudy
USGS	321600106252501	23S.05E.34.132A (SC-3A)	32.267	-106.424		810	12/31/1991	262	3778	OutOfStudy
USGS	321104107001701	24S.02W.36.111 (Arrington N)	32.184	-107.006			3/30/2005	314	4008	OutOfStudy
USGS	321104107001702	24S.02W.36.111A (Arrington N)	32.184	-107.006		420	3/2/2011	313	4009	OutOfStudy
USGS	320947107042201	25S.02W.05.133 (Pipeline Well)	32.164	-107.075		140	1/30/2009	110	4322	OutOfStudy
Hawley	320604107051201	25S.02W.30.323	32.101	-107.087		220	1/22/1973	217	4071	OutOfStudy
USGS	320602107045601	25S.02W.30.324 (McKenna Ranch)	32.102	-107.088			2/3/1992	213	4075	OutOfStudy

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	321000107065601	25S.03W.02.214 (Aden Station)	32.167	-107.116	Tlvs	527	2/5/1996	376	4123	OutOfStudy
USGS	320832106313701	25S.04E.10.334 HBNM-1, K-31	32.142	-106.527	USF2	457	9/10/1985	381	3744	OutOfStudy
USGS	320906106302901	25S.04E.11.123, K-29, Doña Ana 3	32.152	-106.510		800	12/27/1979	358	3749	OutOfStudy
USGS	320914106292701	25S.04E.12.121, Doña Ana 2A	32.154	-106.492		660	12/13/1999	338	3743	OutOfStudy
USGS	320733106324901	25S.04E.16.333, K-14, 10114	32.128	-106.547	USF2	900	1/22/1955	349	3821	OutOfStudy
USGS	320544106301501	25S.04E.35.213, K-16, 10116	32.092	-106.503		544	6/22/1953	356	3751	OutOfStudy
USGS	320808106255701	25S.05E.16.232, HBNM-2, L-41	32.136	-106.434		345	9/9/1985	309	3751	OutOfStudy
USGS	320500106283501	25S.05E.31.334, L-3, (Petite Well)	32.083	-106.476		428	4/16/1936	336	3739	OutOfStudy
Hawley	320305107034901	26S.02W.17.214	32.051	-107.064	Tlvs	450	6/25/1974	444	3829	OutOfStudy
USGS	320040107054601	26S.03W.25.443	32.011	-107.097	Tlvs	800	3/20/2007	476	3892	OutOfStudy
USGS	320430106261301	26S.05E.04.312, L-25, 10126	32.074	-106.442		504	9/8/1964	339	3734	OutOfStudy
USGS	320207106255701	26S.05E.21.213, L-22, 10118	32.035	-106.438		700	12/27/1979	347	3701	OutOfStudy
USGS	320141106251201	26S.05E.22.314, 10119, L-31	32.028	-106.424		425	1/15/1976	316	3707	OutOfStudy
USGS	320010106252701	26S.05E.33.244, L-12, 10127	32.002	-106.429		545	1/6/1954	323	3723	OutOfStudy
Hawley	315322106592501	28S.01W.19.111	31.847	-106.991	USF	521	4/23/1973	351	3814	OutOfStudy
USGS	315004107051901	28S.02W.31.111A	31.835	-107.089			3/2/1984	316	3837	OutOfStudy
USGS	315004107051902	28S.02W.31.111B	31.835	-107.089			2/22/1991	321	3832	OutOfStudy
USGS	314916107083901	28S.03W.33.443	31.824	-107.146			3/2/1984	226	3916	OutOfStudy
USGS	314858107045501	29S.02W.06.231	31.816	-107.083	MSF	715	2/26/1985	264	3845	OutOfStudy
USGS	314708107062501	29S.03W.13.143	31.785	-107.108			2/20/1985	192	3858	OutOfStudy
USGS	323017106385501	BLM-10-517	32.505	-106.649		532	5/26/2010	470	4067	OutOfStudy
USGS	323029106385501	BLM-7-509	32.508	-106.649		525	3/30/2009	471	4062	OutOfStudy
USGS	322539106412903	CLC Deep	32.427	-106.691		1000	1/13/2011	385	4033	OutOfStudy
USGS	322539106412902	CLC Middle	32.427	-106.691		728	1/13/2011	385	4033	OutOfStudy
USGS	322539106412901	CLC Shallow	32.427	-106.691		485	1/13/2011	385	4033	OutOfStudy
USGS	322503106402601	CLC-40, LRG-430, S-26	32.417	-106.674		1170	11/5/2009	459	4019	OutOfStudy
USGS	322529106402701	CLC-41, LRG-430, S-28	32.425	-106.674		980	11/5/2009	446	4023	OutOfStudy
USGS	322557106393701	CLC-42, LRG-430, S-29	32.433	-106.660		1175	4/2/2012	495	4037	OutOfStudy
USGS	322557106391801	CLC-43, LRG-430, S-30	32.432	-106.655		1150	12/4/2009	511	4051	OutOfStudy
USGS	322526106423101	CLC-68, LRG-3290	32.424	-106.709		1030	5/13/2009	308	4060	OutOfStudy
USGS	322552106423301	CLC-69, LRG-3291	32.431	-106.709		815	12/4/2009	310	4039	OutOfStudy
USGS	315816106252701	JL-49-05-204	31.971	-106.425		515	1/5/1960	332	3709	OutOfStudy
USGS	315959106252901	JL-49-05-205	32.001	-106.427		520	7/28/1944	317	3725	OutOfStudy
USGS	315816106243101	JL-49-05-301	31.971	-106.409		671	6/13/1960	316	3699	OutOfStudy
USGS	315832106234201	JL-49-05-303	31.976	-106.396		870	5/16/1955	338	3706	OutOfStudy
USGS	315831106231201	JL-49-05-304	31.975	-106.387		753	7/15/1955	338	3717	OutOfStudy
USGS	320002106243301	JL-49-05-309	32.001	-106.410		795	12/29/1965	313	3712	OutOfStudy
USGS	315907106243501	JL-49-05-321	31.986	-106.410		500	12/6/1988	380	3674	OutOfStudy
USGS	315915106245101	JL-49-05-322	31.988	-106.416		500	2/6/1996	364	3686	OutOfStudy
USGS	315932106245101	JL-49-05-323	31.992	-106.416		500	10/11/1988	353	3685	OutOfStudy
USGS	315632106252401	JL-49-05-503	31.942	-106.424		570	12/6/1963	349	3676	OutOfStudy
USGS	315725106242401	JL-49-05-601	31.957	-106.407		690	1/6/1959	299	3697	OutOfStudy
USGS	315725106232801	JL-49-05-602	31.957	-106.392		699	1/6/1959	310	3695	OutOfStudy
USGS	315633106242301	JL-49-05-603	31.943	-106.407		657	1/6/1959	291	3692	OutOfStudy
USGS	315637106232701	JL-49-05-604	31.944	-106.391		802	2/13/1958	279	3691	OutOfStudy
USGS	315632106223201	JL-49-05-605	31.942	-106.376		769	1/26/1962	296	3690	OutOfStudy
USGS	315540106232601	JL-49-05-607	31.928	-106.391		826	1/3/1963	250	3675	OutOfStudy
USGS	315711106242401	JL-49-05-614	31.953	-106.408		810	11/30/2000	316	3674	OutOfStudy
USGS	315715106232301	JL-49-05-618	31.954	-106.391		705	12/18/1990	353	3646	OutOfStudy
USGS	315657106231201	JL-49-05-621	31.950	-106.388		709	12/24/1986	342	3646	OutOfStudy
USGS	315655106231501	JL-49-05-622	31.949	-106.389		709	12/24/1986	340	3645	OutOfStudy
USGS	315657106241301	JL-49-05-625	31.950	-106.405		751	12/24/1986	340	3642	OutOfStudy
USGS	315654106241701	JL-49-05-626	31.949	-106.406		751	12/24/1986	342	3642	OutOfStudy
USGS	315655106241001	JL-49-05-628	31.949	-106.404		625	1/7/1998	344	3636	OutOfStudy
USGS	315655106241002	JL-49-05-629	31.949	-106.404		490	8/14/1992	345	3635	OutOfStudy
USGS	315659106241101	JL-49-05-630	31.950	-106.404		625	1/11/1994	346	3635	OutOfStudy
USGS	315659106241102	JL-49-05-631	31.950	-106.404		480	1/11/1994	347	3634	OutOfStudy
USGS	315651106241801	JL-49-05-632	31.948	-106.406		625	8/18/1992	350	3633	OutOfStudy
USGS	315651106241802	JL-49-05-633	31.948	-106.406		480	8/19/1992	349	3634	OutOfStudy
USGS	315448106242401	JL-49-05-901	31.913	-106.407		727	7/30/1956	257	3685	OutOfStudy
USGS	315445106224801	JL-49-05-906	31.913	-106.381		950	12/28/1967	251	3672	OutOfStudy
USGS	315305106232002	JL-49-05-918	31.885	-106.390		940	1/31/1995	316	3606	OutOfStudy
USGS	315240106233601	JL-49-05-919	31.878	-106.394		351	10/20/1995	313	3603	OutOfStudy
USGS	320001106213501	JL-49-06-102	32.000	-106.361		520	1/7/1954	331	3715	OutOfStudy

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	315817106202601	JL-49-06-111	31.971	-106.342		560	5/20/1986	309	3705	OutOfStudy
USGS	315725106214001	JL-49-06-401	31.957	-106.362		451	12/29/1965	308	3690	OutOfStudy
USGS	315724106222501	JL-49-06-402	31.957	-106.374		670	10/30/1963	326	3687	OutOfStudy
USGS	315717106222801	JL-49-06-405	31.955	-106.375		710	11/21/1986	354	3661	OutOfStudy
USGS	315636106191901	JL-49-06-501	31.943	-106.322		450	1/6/1954	267	3685	OutOfStudy
USGS	315636106191902	JL-49-06-503	31.943	-106.322		601	1/29/1985	272	3701	OutOfStudy
USGS	315541106171701	JL-49-06-603	31.928	-106.287		600	6/6/1985	319	3679	OutOfStudy
USGS	315305106222001	JL-49-06-701	31.884	-106.369		819	1/25/1955	273	3671	OutOfStudy
USGS	315452106203201	JL-49-06-702	31.913	-106.340		450	2/4/1952	273	3700	OutOfStudy
USGS	315452106203202	JL-49-06-703	31.915	-106.343		550	6/12/2007	339	3644	OutOfStudy
USGS	315331106171001	JL-49-06-901	31.891	-106.286		550	7/23/1983	319	3686	OutOfStudy
USGS	315146106255201	JL-49-13-216	31.862	-106.432		532	12/23/1981	277	3635	OutOfStudy
USGS	315004106260801	JL-49-13-220	31.835	-106.437		900	2/28/1992	297	3599	OutOfStudy
USGS	315212106245101	JL-49-13-301	31.870	-106.416		640	3/20/1965	224	3658	OutOfStudy
USGS	315132106242002	JL-49-13-307	31.859	-106.406		812	12/29/1980	271	3626	OutOfStudy
USGS	315211106241901	JL-49-13-311	31.870	-106.407		812	1/8/1979	267	3633	OutOfStudy
USGS	315131106231901	JL-49-13-312	31.859	-106.390		935	12/12/1990	301	3604	OutOfStudy
USGS	314908106275701	JL-49-13-402	31.819	-106.466		1000	3/26/1995	337	3880	OutOfStudy
USGS	314831106260001	JL-49-13-506	31.809	-106.435		736	4/15/1953	230	3652	OutOfStudy
USGS	314937106252101	JL-49-13-511	31.827	-106.423		753	1/20/1975	239	3630	OutOfStudy
USGS	314815106260501	JL-49-13-524	31.821	-106.436		1045	12/17/1985	271	3609	OutOfStudy
USGS	314852106254801	JL-49-13-525	31.815	-106.431		850	1/27/1995	303	3574	OutOfStudy
USGS	314752106234501	JL-49-13-610	31.798	-106.396		754	1/27/1956	262	3663	OutOfStudy
USGS	314933106234102	JL-49-13-625	31.826	-106.395		1026	3/5/1977	307	3607	OutOfStudy
USGS	314933106241701	JL-49-13-626	31.826	-106.405		1120	12/22/1980	290	3610	OutOfStudy
USGS	314940106233701	JL-49-13-628	31.830	-106.394		1035	1/2/1986	316	3597	OutOfStudy
USGS	314853106245001	JL-49-13-630	31.815	-106.416		990	12/19/1990	291	3592	OutOfStudy
USGS	314951106230702	JL-49-13-634	31.831	-106.386		900	7/5/1994	320	3601	OutOfStudy
USGS	314603106290401	JL-49-13-725	31.768	-106.484		220	7/20/1976	114	3628	OutOfStudy
USGS	314713106260001	JL-49-13-807	31.787	-106.434		542	12/29/1948	136	3668	OutOfStudy
USGS	314518106255001	JL-49-13-808	31.756	-106.432		622	1/22/1951	18	3678	OutOfStudy
USGS	314516106251401	JL-49-13-823	31.755	-106.421		770	1/6/1961	25	3670	OutOfStudy
USGS	314553106272301	JL-49-13-828	31.766	-106.456		535	5/16/1975	84	3616	OutOfStudy
USGS	314608106261001	JL-49-13-830	31.769	-106.437		788	12/9/1976	92	3608	OutOfStudy
USGS	314631106264101	JL-49-13-832	31.775	-106.447		160	6/21/1976	47	3652	OutOfStudy
USGS	314619106271202	JL-49-13-833	31.772	-106.454		960	12/20/1977	107	3593	OutOfStudy
USGS	314615106270701	JL-49-13-837	31.771	-106.452	RA	96	6/1/1984	75	3629	OutOfStudy
USGS	314612106271701	JL-49-13-840	31.770	-106.453	RA	98	6/1/1984	73	3627	OutOfStudy
USGS	314513106253502	JL-49-13-842	31.754	-106.427	RA	79	9/8/1988	34	3657	OutOfStudy
USGS	314559106253301	JL-49-13-845	31.766	-106.426		130	9/8/1988	63	3633	OutOfStudy
USGS	314632106265401	JL-49-13-846	31.776	-106.449		530	12/1/1995	98	3602	OutOfStudy
USGS	314652106235701	JL-49-13-903	31.781	-106.401		750	12/21/1979	241	3629	OutOfStudy
USGS	314556106234701	JL-49-13-909	31.762	-106.390		671	11/1/1958	69	3661	OutOfStudy
USGS	314648106230001	JL-49-13-914	31.780	-106.384		838	1/3/1963	280	3650	OutOfStudy
USGS	314505106240501	JL-49-13-935	31.751	-106.402		192	9/20/1979	35	3655	OutOfStudy
USGS	314632106244601	JL-49-13-938	31.776	-106.413		215	6/2/1976	116	3658	OutOfStudy
USGS	314510106241301	JL-49-13-939	31.753	-106.404		120	12/21/1979	38	3657	OutOfStudy
USGS	314538106230501	JL-49-13-941	31.761	-106.385		102	5/19/1982	70	3645	OutOfStudy
USGS	314607106244701	JL-49-13-945	31.769	-106.414		109	9/18/1984	60	3637	OutOfStudy
USGS	314609106244501	JL-49-13-949	31.770	-106.414		620	12/26/1984	125	3580	OutOfStudy
USGS	314639106231901	JL-49-13-952	31.778	-106.389		290	1/26/1988	247	3422	OutOfStudy
USGS	314517106231501	JL-49-13-953	31.755	-106.388		230	3/21/1989	189	3625	OutOfStudy
USGS	314624106241801	JL-49-13-954	31.773	-106.406		179	9/21/1989	134	3631	OutOfStudy
USGS	314551106224801	JL-49-13-956	31.763	-106.381		665	8/15/1990	185	3585	OutOfStudy
USGS	314638106232801	JL-49-13-957	31.777	-106.392		882	10/5/1992	290	3564	OutOfStudy
USGS	315121106204401	JL-49-14-102	31.856	-106.347		404	1/18/1955	254	3699	OutOfStudy
USGS	315124106181901	JL-49-14-201	31.856	-106.304		501	2/21/1952	316	3687	OutOfStudy
USGS	315123106174501	JL-49-14-202	31.856	-106.296		520	2/5/1985	308	3664	OutOfStudy
USGS	315004106163902	JL-49-14-303	31.835	-106.277		500	12/30/1982	327	3677	OutOfStudy
USGS	314930106221201	JL-49-14-415	31.825	-106.371		960	1/15/1976	319	3619	OutOfStudy
USGS	314836106180201	JL-49-14-504	31.811	-106.301		500	9/3/1967	329	3671	OutOfStudy
USGS	314836106180301	JL-49-14-521	31.811	-106.301		480	12/20/1989	359	3641	OutOfStudy
USGS	314811106152601	JL-49-14-612	31.803	-106.258		660	12/7/1989	327	3671	OutOfStudy
USGS	314912106153701	JL-49-14-617	31.820	-106.261		720	1/5/1997	310	3670	OutOfStudy

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	314510106220201	JL-49-14-713	31.753	-106.368		562	12/29/1980	102	3628	OutOfStudy
USGS	314500106212201	JL-49-14-720	31.750	-106.357		190	1/1/1978	116	3638	OutOfStudy
USGS	314711106154401	JL-49-14-905	31.787	-106.264		495	4/4/1984	346	3664	OutOfStudy
USGS	314704106131201	JL-49-15-701	31.786	-106.222		596	6/19/1953	341	3682	OutOfStudy
USGS	314506106145901	JL-49-15-704	31.752	-106.250		650	3/23/1994	326	3659	OutOfStudy
USGS	314518106135201	JL-49-15-705	31.755	-106.232		660	1/15/1996	320	3692	OutOfStudy
USGS	314458106292101	JL-49-21-101	31.750	-106.490	RA	50	3/26/1968	30	3680	OutOfStudy
USGS	314458106292102	JL-49-21-104	31.750	-106.491		150	6/19/1989	76	3633	OutOfStudy
USGS	314417106224501	JL-49-21-304	31.738	-106.380	RA	50	7/18/1968	11	3671	OutOfStudy
USGS	314442106240801	JL-49-21-306	31.745	-106.403	RA	52	7/9/1969	7	3680	OutOfStudy
USGS	314440106240802	JL-49-21-313	31.745	-106.404	RA	30	12/16/1986	9	3677	OutOfStudy
USGS	314441106240801	JL-49-21-315	31.745	-106.404	RA	30	12/24/1990	9	3679	OutOfStudy
USGS	314421106233403	JL-49-21-318	31.740	-106.393		363	10/20/1994	85	3598	OutOfStudy
USGS	314421106233404	JL-49-21-319	31.740	-106.393		196	10/20/1994	34	3649	OutOfStudy
USGS	314421106233405	JL-49-21-320	31.740	-106.393		129	10/20/1994	23	3659	OutOfStudy
USGS	314421106233406	JL-49-21-321	31.740	-106.393		1059	1/28/1993	97	3586	OutOfStudy
USGS	314421106233407	JL-49-21-322	31.740	-106.393		674	5/17/1994	101	3582	OutOfStudy
USGS	314421106233408	JL-49-21-323	31.740	-106.393		581	1/28/1993	90	3593	OutOfStudy
USGS	314421106233409	JL-49-21-324	31.740	-106.393	RA	38	6/6/1995	9	3675	OutOfStudy
USGS	314259106221901	JL-49-22-108	31.716	-106.372	RA	50	9/22/1970	6	3672	OutOfStudy
USGS	314434106210001	JL-49-22-126	31.743	-106.351		560	3/3/1978	69	3641	OutOfStudy
USGS	314301106222401	JL-49-22-136	31.719	-106.375	RA	25	12/31/1986	6	3673	OutOfStudy
USGS	314301106222301	JL-49-22-138	31.718	-106.374	RA	25	12/15/2000	4	3677	OutOfStudy
USGS	314401106174101	JL-49-22-215	31.734	-106.295		370	3/9/1978	229	3651	OutOfStudy
USGS	314111106203701	JL-49-22-409	31.687	-106.344	RA	15	7/1/1984	4	3669	OutOfStudy
USGS	314157106193101	JL-49-22-501	31.700	-106.326	RA	50	9/23/1970	7	3663	OutOfStudy
USGS	314158106175501	JL-49-22-515	31.700	-106.299		147	11/16/1956	16	3652	OutOfStudy
USGS	314027106193601	JL-49-22-536	31.674	-106.327	RA	96	1/24/1975	10	3657	OutOfStudy
USGS	314019106193801	JL-49-22-539	31.672	-106.329	RA	92	10/9/1973	9	3657	OutOfStudy
USGS	314011106181001	JL-49-22-541	31.670	-106.304	RA	100	10/5/1973	12	3653	OutOfStudy
USGS	314120106194301	JL-49-22-554	31.689	-106.330	RA	72	12/15/1976	7	3666	OutOfStudy
USGS	314058106161701	JL-49-22-601	31.683	-106.273	RA	50	6/20/1969	8	3657	OutOfStudy
USGS	314142106173001	JL-49-22-602	31.696	-106.292		126	1/6/1978	12	3655	OutOfStudy
USGS	314226106170301	JL-49-22-613	31.705	-106.286		312	12/10/1963	108	3657	OutOfStudy
USGS	314106106155001	JL-49-22-618	31.685	-106.264		240	1/7/1982	89	3656	OutOfStudy
USGS	314131106161501	JL-49-22-619	31.692	-106.271		233	1/2/1981	92	3658	OutOfStudy
USGS	313843106175701	JL-49-22-805	31.645	-106.300	RA	26	8/14/1951	8	3651	OutOfStudy
USGS	313939106191201	JL-49-22-809	31.661	-106.321	RA	85	1/24/1975	6	3658	OutOfStudy
USGS	313850106190701	JL-49-22-825	31.647	-106.319	RA	74	11/19/1956	14	3646	OutOfStudy
USGS	313849106190501	JL-49-22-826	31.647	-106.319	RA	83	2/18/1986	5	3655	OutOfStudy
USGS	313748106174701	JL-49-22-834	31.630	-106.297	RA	72	12/27/1967	4	3654	OutOfStudy
USGS	313817106184701	JL-49-22-842	31.638	-106.314	RA	25	12/24/1984	3	3659	OutOfStudy
USGS	313817106183401	JL-49-22-843	31.638	-106.310	RA	28	3/19/1986	2	3658	OutOfStudy
USGS	313829106183301	JL-49-22-844	31.642	-106.310	RA	27	1/6/2004	1	3660	OutOfStudy
USGS	313932106162201	JL-49-22-902	31.659	-106.273	RA	29	8/14/1951	7	3648	OutOfStudy
USGS	313914106150601	JL-49-22-909	31.654	-106.253	RA	80	12/18/1962	6	3647	OutOfStudy
USGS	313841106165101	JL-49-22-922	31.645	-106.281	RA	85	8/3/1981	8	3646	OutOfStudy
USGS	313942106141401	JL-49-23-702	31.662	-106.238		235	12/31/1988	119	3651	OutOfStudy
USGS	313807106143501	JL-49-23-704	31.636	-106.245		50	8/4/1981	8	3640	OutOfStudy
USGS	313942106141402	JL-49-23-708	31.662	-106.238		310	12/20/1990	122	3653	OutOfStudy
USGS	313804106043001	JL-49-24-802	31.635	-106.076		560	12/7/2000	423	3629	OutOfStudy
USGS	313713106180601	JL-49-30-208	31.620	-106.302	RA	31	12/24/1984	4	3652	OutOfStudy
USGS	315511106171101	JL-49-30-303	31.587	-106.287	RA	50	6/22/1970	5	3643	OutOfStudy
USGS	323018106400001	JP-1-424	32.505	-106.667		440	10/29/2010	382	4064	OutOfStudy
USGS	323039106400001	JP-2-447	32.511	-106.667		462	5/26/2010	388	4060	OutOfStudy
USGS	322225106254201	MPL-05	32.374	-106.428		205	7/16/2008	184	3809	OutOfStudy
USGS	322210106253201	MPL-06	32.369	-106.426		190	7/14/2008	169	3807	OutOfStudy
USGS	322152106254301	MPL-07	32.364	-106.429		210	1/17/2008	176	3807	OutOfStudy
USGS	322145106263601	MPL-08	32.362	-106.443		275	7/14/2008	245	3814	OutOfStudy
USGS	322222106263501	MPL-10	32.373	-106.443		270	1/17/2008	239	3811	OutOfStudy
USGS	322225106265801	MPL-12	32.374	-106.450		260	2/17/2008	206	3875	OutOfStudy
USGS	322137106253601	MPL-17	32.360	-106.427		220	1/17/2008	175	3805	OutOfStudy
USGS	322218106252801	MPL-18	32.372	-106.424		230	7/14/2008	170	3808	OutOfStudy
USGS	322147106265001	MPL-25	32.363	-106.447		275	7/14/2008	253	3825	OutOfStudy

Agent[1]	USGS Well Number	Well Name	Lat	Long	Well Geo[2]	Well Depth	Measure Date	D2W	Well Elev	Keep/Lose Reason[3]
USGS	322148106261001	MPL-29	32.363	-106.436		225	7/14/2008	213	3810	OutOfStudy
USGS	323039106392301	PL-3-453	32.511	-106.656		469	3/31/2011	433	4066	OutOfStudy
USGS	321757106241401	SCMW-03 (No TR)	32.299	-106.404			9/12/2008	182	3789	OutOfStudy
USGS	322207106264901	SMW-03	32.369	-106.447		277	1/17/2008	254	3820	OutOfStudy
USGS	322413106392101	Well A, 22S.03E.17.142	32.404	-106.656		800	3/10/2009	556	4017	OutOfStudy
USGS	322438106421901	Well B, 22S.02E.02.11, LRG-01683	32.411	-106.705		450	3/5/2009	365	4029	OutOfStudy
USGS	322411106422801	Well C, 22S.02E.11.344	32.403	-106.709		490	2/14/1984	318	4077	OutOfStudy
USGS	322400106440201	Well D, 22S.02E.15.11, LRG-04300	32.400	-106.734		430	3/26/2009	288	4057	OutOfStudy
USGS	322734106432801	Well E, 21S.02E.27.211	32.459	-106.725		572	3/26/2009	255	4045	OutOfStudy
USGS	322839106424501	Well F, 21S.02E.14.34, LRG-13964	32.477	-106.712		333	1/20/2010	235	4067	OutOfStudy
USGS	322953106424201	Well G, 21S.02E.11.143	32.498	-106.712		320	1/19/2010	239	4070	OutOfStudy
USGS	322811106393401	Well I, 21S.03E.20.1	32.470	-106.660		560	3/27/2009	455	4049	OutOfStudy
USGS	322620106401301	Well J, 21S.03E.31.41, LRG-00567	32.439	-106.670		515	8/4/2010	439	4037	OutOfStudy
USGS	322651106412901	Well L, 21S.02E.25.43	32.447	-106.692		350	3/5/2009	259	4148	OutOfStudy
USGS	323106106395601	WW-1-452	32.518	-106.666		468	2/27/2009	398	4059	OutOfStudy

[1] *USGS*. Downloaded at waterdata.usgs.gov/nwis/gw (accessed September 6, 2012). *Hawley*: Extracted from Hawley and Kennedy (2004).

[2] Geology types present at the bottom of the well based on depth cross-referenced with cross sections in WRRI TR 332 (Hawley and Kennedy 2004), with descriptions found in Table B-4. Not all were completed.

[3] *Cert FP* - Certainly shallow in floodplain. *Uncert FP* - Uncertainly shallow in floodplain. *Uncert NFP* - Uncertainly shallow non-floodplain. *No Depth* - Well did not have measurements. *Duplicate*: Both USGS and Hawley has this well on file. *Too Deep* - Well met depth or bottom geology strata requirements for exclusion. *OutOfStudy* - Well is not in main study area.

Table B-2: Soil Family Rating System Used in Project

Soil Family	S_r
Bedrock	1
Caliche	1
Cemented	1
Clay	1
Clay Loam	3
Dumps	1
Extremely Gravelly Loamy Sand	9
Extremely Gravelly Sandy Loam	9
Fine Sand	8
Fine Sandy Loam	6
Gravel	10
Gravelly Coarse Sand	10
Gravelly Fine Sand	9
Gravelly Fine Sandy Loam	7
Gravelly Loam	6
Gravelly Loamy Sand	9
Gravelly Sandy Loam	8
Lime Coated Basalt Rock	1
Limestone	1
Loam	5

Soil Family	S_r
Loamy Fine Sand	7
Loamy Sand	8
Loamy Very Fine Sand	6
Pits	1
Rock Outcrop	1
Sand	9
Sandy Clay Loam	4
Sandy Loam	7
Silty Clay	2
Silty Clay Loam	3
Silty Loam	5
Stony Clay Loam	4
Stony Loam	6
Very Fine Sand	7
Very Fine Sandy Loam	5
Very Gravelly Fine Sandy Loam	8
Very Gravelly Loam	7
Very Gravelly Loamy Sand	9
Very Gravelly Sandy Loam	9
Water	10

Table B-3: Soil Series Rating System Used in Project

MUSYM	Soil Series[1,2,3]	County	Soil Family Components[4]	Thickness (in)	Rating	Score	Total Thickness	S_r	S_w	S_i
12	Infantry-Sonic complex	BASE	Very Gravelly Fine Sandy Loam	3	8	24	60	6	2	12
			Extremely Gravelly Sandy Loam	8	9	72				
			Cemented	4	1	4				
			Extremely Gravelly Loamy Sand	38	9	342				
			Loamy Sand	7	8	56				
21	Hueco	BASE	Loamy Fine Sand	5	7	35	60	4	2	8
			Fine Sandy Loam	25	6	150				
			Caliche	4	1	4				
			Loam	26	5	130				
22	Copia-Nations complex	BASE	Loamy Fine Sand	5	7	35	60	7	2	14
			Loamy Fine Sand	55	7	385				
24	Piquin	BASE	Very Gravelly Sandy Loam	2	9	18	60	9	2	18
			Gravelly Sandy Loam	7	8	56				
			Very Gravelly Sandy Loam	21	9	189				
			Gravelly Sandy Loam	20	8	160				
			Gravelly Coarse Sand	10	10	100				
28	Crossen-Tinney complex	BASE	Loam	3	5	15	60	3	2	6
			Gravelly Loam	6	6	36				
			Caliche	13	1	13				
			Very Gravelly Loam	38	7	266				
29	Tinney	BASE	Loam	17	5	85	60	5	2	10
			Sandy Clay Loam	19	4	76				
			Loam	24	5	120				
30	Crossen	BASE	Gravelly Loam	7	6	42	60	3	2	6
			Caliche	13	1	13				
			Very Gravelly Loam	40	7	280				
42	Copia-Patriot complex	BASE	Sand	3	9	27	60	7	2	14
			Loamy Fine Sand	57	7	399				
52	Rock outcrop-Bissett complex	BASE	Very Gravelly Loam	9	7	63	60	1	2	2
			Bedrock	51	1	51				
53	Rock outcrop-Bissett complex	BASE	Very Gravelly Loam	9	7	63	60	1	2	2
			Bedrock	51	1	51				
72	Yippin	BASE	Loamy Sand	5	8	40	60	7	2	14
			Sandy Loam	55	7	385				
156	Missile	BASE	Very Gravelly Fine Sandy Loam	2	8	16	60	5	2	10
			Extremely Gravelly Sandy Loam	6	9	54				
			Cemented	4	1	4				
			Loam	6	5	30				
			Gravelly Loam	42	6	252				
W	Water	BASE	Water	60	10	600	60	10	2	20

MUSYM	Soil Series[1,2,3]	County	Soil Family Components[4]	Thickness (in)	Rating	Score	Total Thickness	S_r	S_w	S_i
Ad	Adelino sandy clay loam	DANM	Sandy Clay Loam	21	4	84	60	5	2	10
			Sandy Clay Loam	19	4	76				
			Sandy Loam	20	7	140				
Ae	Adelino clay loam	DANM	Clay Loam	5	3	15	60	4	2	8
			Clay Loam	11	3	33				
			Silty Clay Loam	11	3	33				
			Loam	33	5	165				
AF	Rock outcrop-Aftaden association	DANM	Loamy Sand	2	8	16	60	1	2	2
			Fine Sandy Loam	16	6	96				
			Lime Coated Basalt Rock	42	1	42				
Ag	Agua loam	DANM	Loam	12	5	60	60	6	2	12
			Loam	23	5	115				
			Fine Sand	25	8	200				
Ah	Agua clay loam	DANM	Clay Loam	12	3	36	60	5	2	10
			Loam	24	5	120				
			Sand	24	9	216				
AJ	Agua Variant soil, moderately wet	DANM	Fine Sandy Loam	11	6	66	60	6	2	12
			Very Fine Sandy Loam	17	5	85				
			Fine Sand	32	8	256				
AK	Agua variant and Belen variant soils	DANM	Fine Sandy Loam	13	6	78	60	7	2	14
			Very Fine Sandy Loam	10	5	50				
			Fine Sand	37	8	296				
AL	Rock outcrop-Akela complex	DANM	Very Gravelly Sandy Loam	14	9	126	60	1	2	2
			Caliche	46	1	46				
AM	Aladdin-Coxwell association	DANM	Gravelly Fine Sandy Loam	60	7	420	60	7	2	14
An	Anapra silt loam	DANM	Silty Loam	16	5	80	60	5	2	10
			Silty Clay Loam	12	3	36				
			Fine Sand	32	8	256				
Ao	Anapra clay loam	DANM	Clay Loam	30	3	90	60	4	2	8
			Fine Sand	30	8	240				
Ap	Anthony-Vinton fine sandy loams	DANM	Fine Sandy Loam	13	6	78	60	6	2	12
			Loamy Very Fine Sand	16	6	96				
			Fine Sandy Loam	31	6	186				
Ar	Anthony-Vinton loams	DANM	Loam	16	5	80	60	6	2	12
			Loamy Very Fine Sand	13	6	78				
			Fine Sandy Loam	31	6	186				
As	Anthony-Vinton clay loams	DANM	Clay Loam	15	3	45	60	5	2	10
			Loamy Very Fine Sand	14	6	84				
			Fine Sandy Loam	31	6	186				
At	Armijo loam	DANM	Loam	10	5	50	60	2	2	4
			Clay	21	1	21				
			Clay Loam	21	3	63				
			Loamy Sand	8	8	64				

MUSYM	Soil Series[1,2,3]	County	Soil Family Components[4]	Thickness (in)	Rating	Score	Total Thickness	S_r	S_w	S_i
Aw	Armijo clay loam	DANM	Clay Loam	15	3	45	60	2	2	4
			Clay	9	1	9				
			Silty Clay Loam	9	3	27				
			Silty Clay	9	2	18				
			Very Fine Sandy Loam	18	5	90				
Ax	Armijo clay	DANM	Clay	60	1	60	60	1	2	2
Be	Belen loam	DANM	Loam	12	5	60	60	3	2	6
			Clay	12	1	12				
			Silty Loam	36	5	180				
Bf	Belen clay loam	DANM	Clay Loam	11	3	33	60	4	2	8
			Silty Clay	15	2	30				
			Very Fine Sand	34	7	238				
Bg	Belen clay	DANM	Clay	11	1	11	60	2	2	4
			Clay	10	1	10				
			Silty Clay Loam	9	3	27				
			Very Fine Sandy Loam	30	5	150				
BH	Belen Variant soils	DANM	Silty Clay	21	2	42	60	4	2	8
			Very Fine Sandy Loam	11	5	55				
			Very Fine Sand	28	7	196				
BJ	Berino-Bucklebar association	DANM	Sandy Loam	2	7	14	60	5	2	10
			Sandy Loam	16	7	112				
			Sandy Clay Loam	15	4	60				
			Sandy Clay Loam	27	4	108				
BK	Berino-Doña Ana association	DANM	Fine Sandy Loam	8	6	48	60	6	2	12
			Sandy Clay Loam	13	4	52				
			Sandy Loam	39	7	273				
BL	Berino-Pintura complex	DANM	Loamy Fine Sand	8	7	56	60	6	2	12
			Sandy Clay Loam	20	4	80				
			Sandy Loam	32	7	224				
Bm	Bluepoint loamy sand, 1 to 5% grade	DANM	Loamy Sand	60	8	480	60	8	2	16
Bn	Bluepoint loamy sand, 5 to 15% grade	DANM	Loamy Sand	18	8	144	60	7	2	14
			Loamy Fine Sand	42	7	294				
BO	Bluepoint loamy sand, 1 to 15% grade	DANM	Loamy Sand	60	8	480	60	8	2	16
BP	Bluepoint-Caliza-Yturbide complex	DANM	Loamy Sand	15	8	120	60	8	2	16
			Very Gravelly Sandy Loam	5	9	45				
			Loamy Sand	40	8	320				
Br	Brazito loamy fine sand	DANM	Loamy Fine Sand	5	7	35	60	8	2	16
			Fine Sand	55	8	440				
Bs	Brazito very fine sandy loam, thick surface	DANM	Very Fine Sandy Loam	15	5	75	60	7	2	14
			Fine Sand	45	8	360				
CA	Cacique-Cruces association	DANM	Loamy Sand	2	8	16	60	2	2	4
			Sandy Clay Loam	12	4	48				
			Sandy Loam	11	7	77				
			Caliche	35	1	35				

MUSYM	Soil Series[1,2,3]	County	Soil Family Components[4]	Thickness (in)	Rating	Score	Total Thickness	S_r	S_w	S_i
Cb	Canutillo and Arizo gravelly sandy loams	DANM	Gravelly Sandy Loam	15	8	120	60	9	2	18
			Very Gravelly Loamy Sand	5	9	45				
			Very Gravelly Sandy Loam	40	9	360				
CH	Cave-Harrisburg association	DANM	Fine Sandy Loam	3	6	18	60	1	2	2
			Gravelly Sandy Loam	6	8	48				
			Caliche	51	1	51				
DR	Doña Ana-Reagan association	DANM	Clay Loam	2	3	6	60	4	2	8
			Sandy Clay Loam	14	4	56				
			Sandy Clay Loam	44	4	176				
DS	Dumps	DANM	Dumps	60	1	60	60	1	2	2
Ge	Glendale loam	DANM	Loam	12	5	60	60	4	2	8
			Clay Loam	28	3	84				
			Very Fine Sandy Loam	20	5	100				
Gf	Glendale clay loam	DANM	Clay Loam	12	3	36	60	3	2	6
			Clay Loam	28	3	84				
			Very Fine Sandy Loam	20	5	100				
Gg	Glendale clay loam, alkali	DANM	Clay Loam	12	3	36	60	3	2	6
			Clay Loam	22	3	66				
			Clay Loam	26	3	78				
GP	Gravel pit	DANM	Pits	60	1	60	60	1	2	2
HD	Haplargids, dissected	DANM	Very Gravelly Sandy Loam	12	9	108	60	6	2	12
			Sandy Loam	24	7	168				
			Loam	24	5	120				
Hf	Harkey fine sandy loam	DANM	Fine Sandy Loam	13	6	78	60	5	2	10
			Very Fine Sandy Loam	22	5	110				
			Silty Loam	21	5	105				
			Fine Sand	4	8	32				
Hg	Harkey loam	DANM	Loam	18	5	90	60	5	2	10
			Very Fine Sandy Loam	20	5	100				
			Silty Loam	22	5	110				
Hh	Harkey loam, saline-alkali	DANM	Loam	10	5	50	60	5	2	10
			Very Fine Sandy Loam	37	5	185				
			Loamy Sand	13	8	104				
Hk	Harkey clay loam	DANM	Clay Loam	12	3	36	60	5	2	10
			Fine Sandy Loam	24	6	144				
			Silty Loam	24	5	120				
Mo	Mimbres silty clay loam	DANM	Silty Clay Loam	10	3	30	60	3	2	6
			Silty Clay Loam	9	3	27				
			Silty Clay Loam	41	3	123				
NB	Nickel-Badland complex	DANM	Sandy Loam	2	7	14	60	9	2	18
			Very Gravelly Sandy Loam	58	9	522				
NU	Nickel-Upton association	DANM	Gravelly Sandy Loam	5	8	40	60	9	2	18
			Very Gravelly Sandy Loam	55	9	495				
OP	Onite-Pajarito association	DANM	Fine Sandy Loam	8	6	48	60	7	2	14
			Sandy Loam	13	7	91				
			Loamy Sand	39	8	312				

MUSYM	Soil Series[1,2,3]	County	Soil Family Components[4]	Thickness (in)	Rating	Score	Total Thickness	S_r	S_w	S_i
OR	Onite-Pintura complex	DANM	Loamy Fine Sand	5	7	35	60	7	2	14
			Sandy Loam	55	7	385				
Pa	Pajarito fine sandy loam	DANM	Fine Sandy Loam	12	6	72	60	6	2	12
			Fine Sandy Loam	16	6	96				
			Fine Sandy Loam	32	6	192				
Pb	Pajarito-Pintura complex	DANM	Loamy Fine Sand	10	7	70	60	7	2	14
			Fine Sandy Loam	14	6	84				
			Very Fine Sand	36	7	252				
PN	Pinaleno-Nolam association	DANM	Very Gravelly Fine Sandy Loam	2	8	16	60	9	2	18
			Very Gravelly Sandy Loam	18	9	162				
			Very Gravelly Sandy Loam	17	9	153				
			Very Gravelly Loamy Sand	23	9	207				
RE	Riverwash	DANM	Very Gravelly Loamy Sand	60	9	540	60	9	2	18
RF	Riverwash-Arizo complex	DANM	Gravelly Loamy Sand	12	9	108	60	9	2	18
			Sand	24	9	216				
			Gravel	24	10	240				
RG	Rock outcrop-Argids association	DANM	Rock Outcrop	60	1	60	60	1	2	2
RH	Rock outcrop-Argids, cool, assoc	DANM	Rock Outcrop	60	1	60	60	1	2	2
RL	Rock outcrop-Lozier association	DANM	Stony Loam	11	6	66	60	1	2	2
			Rock Outcrop	49	1	49				
RT	Rock outcrop-Torriorthents association	DANM	Stony Loam	5	6	30	60	1	2	2
			Rock Outcrop	55	1	55				
SH	Simona-Harrisburg association	DANM	Loamy Sand	8	8	64	60	1	2	2
			Sandy Loam	6	7	42				
			Caliche	46	1	46				
ST	Stellar association	DANM	Clay Loam	60	3	180	60	3	2	6
TE	Tencee-Upton association	DANM	Sandy Loam	8	7	56	60	1	2	2
			Caliche	52	1	52				
TF	Terino-Casito association	DANM	Very Gravelly Sandy Loam	2	9	18	60	3	2	6
			Sandy Clay Loam	13	4	52				
			Cemented	17	1	17				
			Very Gravelly Sandy Loam	28	9	252				
Vf	Vinton variant fine sandy loam	DANM	Fine Sandy Loam	14	6	84	60	6	2	12
			Loamy Fine Sand	18	7	126				
			Silty Clay Loam	10	3	30				
			Sand	18	9	162				
Vg	Vinton variant sandy clay loam	DANM	Sandy Clay Loam	16	4	64	60	2	2	4
			Fine Sand	17	8	136				
			Clay	27	1	27				
WH	Wink-Harrisburg association	DANM	Loamy Fine Sand	4	7	28	60	7	2	14
			Fine Sandy Loam	24	6	144				
			Sandy Loam	32	7	224				
WP	Wink-Pintura complex	DANM	Fine Sand	10	8	80	60	7	2	14
			Fine Sandy Loam	10	6	60				
			Sandy Loam	40	7	280				

MUSYM	Soil Series[1,2,3]	County	Soil Family Components[4]	Thickness (in)	Rating	Score	Total Thickness	S_r	S_w	S_i
AGB	Agustin association	EPTX	Gravelly Loam	30	6	180	60	6	2	12
			Very Gravelly Loam	30	7	210				
BPC	Bluepoint association, rolling	EPTX	Loamy Fine Sand	60	7	420	60	7	2	14
DCB	Delnorte-Canutillo association, undulating	EPTX	Very Gravelly Sandy Loam	11	9	99	60	2	2	4
			Gravelly Loam	6	6	36				
			Caliche	24	1	24				
			Very Gravelly Sandy Loam	19	9	171				
DCD	Delnorte-Canutillo association hilly	EPTX	Very Gravelly Sandy Loam	11	9	99	60	3	2	6
			Very Gravelly Loam	8	7	56				
			Caliche	14	1	14				
			Gravelly Fine Sand	27	9	243				
Ga	Gila fine sandy loam	EPTX	Fine Sandy Loam	15	6	90	60	5	2	10
			Fine Sandy Loam	12	6	72				
			Silty Loam	11	5	55				
			Silty Clay Loam	11	3	33				
			Loamy Fine Sand	11	7	77				
Gc	Gila loam	EPTX	Loam	17	5	85	60	6	2	12
			Fine Sandy Loam	12	6	72				
			Loamy Fine Sand	11	7	77				
			Silty Loam	10	5	50				
			Gravelly Sandy Loam	10	8	80				
Gd	Glendale loam	EPTX	Loam	19	5	95	60	3	2	6
			Silty Clay Loam	41	3	123				
Ge	Glendale silty clay loam	EPTX	Silty Clay Loam	17	3	51	60	3	2	6
			Silty Clay Loam	35	3	105				
			Silty Loam	8	5	40				
Gs	Glendale silty clay	EPTX	Silty Clay	18	2	36	60	3	2	6
			Silty Clay Loam	35	3	105				
			Silty Loam	7	5	35				
Ha	Harkey loam	EPTX	Loam	17	5	85	60	5	2	10
			Very Fine Sand	12	7	84				
			Fine Sandy Loam	11	6	66				
			Loam	20	5	100				
IN	Igneous Rock land-Brewster Association	EPTX	Stony Clay Loam	10	4	40	60	1	2	2
			Bedrock	50	1	50				
LM	Rock outcrop-Lozier association	EPTX	Stony Loam	5	6	30	60	1	2	2
			Rock Outcrop	55	1	55				
LOD	Lozier association, hilly	EPTX	Stony Loam	5	6	30	60	1	2	2
			Limestone	55	1	55				
Mg	Made land, Gila soil material	EPTX	Loamy Fine Sand	10	7	70	60	8	2	16
			Fine Sand	50	8	400				
PAA	Pajarito association, level	EPTX	Fine Sandy Loam	18	6	108	60	6	2	12
			Fine Sandy Loam	18	6	108				
			Fine Sandy Loam	24	6	144				

MUSYM	Soil Series[1,2,3]	County	Soil Family Components[4]	Thickness (in)	Rating	Score	Total Thickness	S_r	S_w	S_i
Sa	Saneli silty clay loam	EPTX	Silty Clay Loam	18	3	54	60	2	2	4
			Clay	16	1	16				
			Loamy Fine Sand	8	7	56				
			Fine Sand	18	8	144				
Sc	Saneli silty clay	EPTX	Silty Clay	12	2	24	60	3	2	6
			Clay	12	1	12				
			Fine Sand	18	8	144				
			Silty Loam	9	5	45				
			Loam	9	5	45				
Tg	Tigua silty clay	EPTX	Silty Clay	10	2	20	60	1	2	2
			Clay	40	1	40				
			Very Fine Sandy Loam	10	5	50				
Vn	Vinton fine sandy loam	EPTX	Fine Sandy Loam	10	6	60	60	6	2	12
			Very Fine Sandy Loam	25	5	125				
			Fine Sandy Loam	25	6	150				

[1] Sources: *BASE* –USDA, NRCS Revised December 2000. 1997 National Resources Inventory. USDA, NRCS 2009a. *DANM* – Bulloch and Neher 1980. USDA, NRCS 2008. *EPTX* - Jaco 1971.USDA, NRCS 2009a

[2] Associations and Complexes take their first name from the underlying material and substitutes the A-horizon of the second name and B-horizon of the third name (personal interview by S. Walker with Curtis Monger on June 26, 2012).

[3] Soils with slope elements are treated like normal soils for components, but slope is calculated in the Topography component.

[4] Caliche and cemented soils are mostly impermeable, but still affected by thickness. If the thickness of caliche is large enough that the high impermeability can surpass the permeability of the other horizons, the soil type becomes impermeable.

Table B-4: Detailed Descriptions of Surface Hydrogeology Used in Project[1]

HSU	Zone	Description	Age Laid	Max Thick (ft)	Zone	LFA	Vadose Range	I_r	I_w	I_i
!P	Bedrock/ Pre-Santa Fe	Undifferentiated; primarily limestone, sandstone and red-bed mudstones	Permian and Pennsylvanian				Thin Bedded Sandstone, Limestone, Shale Sequence	4	5	20
BF	Basin Floor	Undifferentiated deposits of ephemeral drainage ways (alluvial flats) on the floors of the Mesilla and southern Jornada structural basins (Jornada Draw); has some intercalated gypsum (selenite) and weak to strong argillic and calcic soil profile development, includes many small areas of HSU-BFP. Undivided alluvial flat deposits, including fills of small playa depressions	Late to Middle Quaternary	100	Primarily, Entirely vadose	c	Silt/Clay	1	5	5

HSU	Zone	Description	Age Laid	Max Thick (ft)	Zone	LFA	Vadose Range	I_r	I_w	I_i
BFP	Basin Floor	Playa lake deposits in shallow depressions on basin floor alluvial flats in the Mesilla and southern Jornada basins (Flat and Isaacks Lakes); has some intercalated gypsum (selenite) and local Vertisol development in local depressions on basin-floor alluvial plains (unit BF)	Late to Middle Quaternary	20	Entirely vadose	c	Silt/Clay	1	5	5
E	Piedmont Slope	Eolian Sand - Stipple pattern or superposed symbols (e.g., E/TA, E/PAU, E/Qb) indicate HSUs or bedrock units with thin (<10 ft.) eolian cover.	Late Quaternary Upper Quaternary	30	Entirely vadose		Sand and Gravel with Silt and Clay	4	5	20
E/Qb	Basalt Capping	Olivine basalt flows and cinder cones with eolian sand covering them	Late Quaternary				Basalt	4	5	20
K	Bedrock/ Sedimentary	Sarten and Dakota Sandstone; yellow, tan, and gray, weathering, soft sandstone, shale and siltstone and massive, cross-bedded, gray quartzite; minor pelecypod coquina; approximately 260 ft. thick in southern San Andres Mountains	Upper Cretaceous	260			Sandstone	3	5	15
Kl	Bedrock/ Pre-Santa Fe	Marine rocks; limestone pebble conglomerate, sandy limestone, calcareous sandstone, pelecypod coquina, and silty, shaly limestone; approximately 1550 ft. exposed in East Potrillo Mountains; 1050 ft. reported in the Grimm and others deep oil test, 15 mi northeast of East Potrillo Mountains	Lower Cretaceous				Thin Bedded Sandstone, Limestone, Shale Sequence	4	5	20
MSF1	Santa Fe Group	Middle Santa Fe HSUs, piedmont-slope facies: mostly coalescent alluvial-fan deposits. Unit is only exposed in parts of the Rincon Hills, Sand Diego Mountain (Tonuco) and Sierra de las Uvas uplifts. Correlative with main body of Rincon Valley Formation piedmont facies. Primarily conglomeratic piedmont	Middle to Late Miocene, Upper Tertiary	1000	Mostly saturated	5 to 7 to 8	Sand and Gravel with Silt and Clay	4	5	20
PA	Piedmont Slope	Undifferentiated alluvial deposits of major ephemeral streams with headwaters in mountain areas bordering the Mesilla and southern Jornada structural basins. Younger (PAY) and older (PAO) piedmont-slope deposits, undivided, stippled where up to 10 ft. of Late Quaternary eolian cover is present	Late to Middle Quaternary	30	Entirely vadose	5, 6	Sand and Gravel with Silt and Clay	4	5	20
PAO	Piedmont Slope	Older piedmont-slope deposits (mostly alluvial fans and terraces) with calcic and argillic paleosols	Middle Pleistocene	15	Entirely vadose	5, 6	Sand and Gravel with Silt and Clay	4	5	20
PAU	Piedmont Slope	Undifferentiated piedmont-slope deposits (PA) and uppermost Santa Fe basin fill (USF1). Older and younger piedmont-slope deposits and correlative Upper Santa Fe piedmont facies (5 to 8), undivided	Middle to Early Pleistocene	50	Entirely vadose	5 to 8	Sand and Gravel with Silt and Clay	4	5	20

HSU	Zone	Description	Age Laid	Max Thick (ft)	Zone	LFA	Vadose Range	I_r	I_w	I_i
PAUc	Piedmont Slope	Undifferentiated coarse-grained piedmont deposits (PA) and uppermost Santa Fe basin fill (USF1, USFc). Older and younger course-grained piedmont facies, undifferentiated, thin over upper and middle Santa Fe group	Middle to Early Pleistocene, Quaternary and Tertiary	50	Entirely vadose	6, 8	Sand and Gravel with Silt and Clay	4	5	20
PAY	Piedmont Slope	Younger piedmont-slope deposits (mostly alluvial fans and terraces) with weak soil-profile development	Late Quaternary	15	Entirely vadose	5, 6	Sand and Gravel with Silt and Clay	4	5	20
Pz	Bedrock/ Pre-Santa Fe	Pzu/Pzm/Pzl Undifferentiated	Paleozoic				Thin Bedded Sandstone, Limestone, Shale Sequence	4	5	20
Pzl	Bedrock/ Pre-Santa Fe	Undifferentiated; primarily limestone and dolomite, with thin basal (Cambro-Ordovician) sandstone. Primarily carbonate types	Lower Paleozoic, Cambrian, Silurian				Limestone	4	5	20
Pzm	Bedrock/ Pre-Santa Fe	Undifferentiated, primarily carbonate types, with shale	Middle Paleozoic, Devonian, Mississippian				Thin Bedded Sandstone, Limestone, Shale Sequence	4	5	20
Qb	Basalt Capping	Olivine basalt flows and cinder cones associated with extrusive-volcanic centers in the southwestern Mesilla Basin - West Potrillo Mountains, Black Mountain, Little Black Mountain, and Afton volcanic fields. Mostly, if not entirely, alkali-olivine basalt	Middle to Late Pleistocene				Basalt	4	5	20
Qba	Basalt Capping	Alkali-olivine basalt of Aden Shield Volcano	Late Pleistocene				Basalt	4	5	20
Qbac	Basalt Capping	Alkali-olivine basalt of the lava-lake basalt of Aden Crater	Late Pleistocene				Basalt	4	5	20
Qbc	Basalt Capping	Cinder Cones					Basalt	4	5	20
Qt	Basalt Capping	Air-fall tuffs and breccia, including base-surge deposits; associated with Potrillo Maar, Kilbourne Hole, and Hunt's Hole volcanoes	Late Pleistocene				Sandstone	3	5	15
RA	Rio Grande Valley	Channel and floodplain deposits of the Rio Grande; up to 30 m. saturated thickness; primarily lithofacies assemblages	Late Quaternary, Holocene and Late Pleistocene	100	Mostly saturated	a1, a2	Sand and Gravel	9	5	45
TA	Rio Grande Valley	Channel and overbank deposits associated with ancestral river terraces, terrace deposits of the Rio Grande;	Middle Quaternary, Holocene and Late Pleistocene	60	Entirely vadose	a1	Sand and Gravel	9	5	45
Tb	Bedrock/ Pre-Santa Fe	Basalt flows and plugs	Miocene				Basalt	4	5	20
Tba	Bedrock/ Pre-Santa Fe	Basaltic-andesite and other intermediate compositions (including Uvas Basalts)	Oligocene				Basalt	4	5	20

HSU	**Zone**	**Description**	**Age Laid**	**Max Thick (ft)**	**Zone**	**LFA**	**Vadose Range**	I_r	I_w	I_i
Tli	Bedrock/ Pre-Santa Fe	Intermediate volcanic rocks, including latite, dacite, and andecite intrusions, flows, and laharic breccia; aphyric to moderately porphyritic, and generally fine grained, locally intercalated with clastic sedimentary rocks derived from Tli. Includes intrusions in the Vado Hill to Paso del Norte, and Mt. Riley-Cox areas and correlative with Tlvs. Silicic to intermediate intrusive rocks, mainly dikes and small plugs	Eocene, Lower Tertiary				Metamorphic/ Igneous	4	5	20
Tls	Bedrock/ Pre-Santa Fe	Mostly sedimentary rocks, sandstones, mudstones, and conglomerates with minor or no volcaniclastic constituent, including Love Ranch Formation	Lower Eocene and Paleocene				Thin Bedded Sandstone, Limestone, Shale Sequence	4	5	20
Tlvs	Bedrock/ Pre-Santa Fe	Volcaniclastic sedimentary rocks and some andesite flows and breccias, including Palm Park, Rubio Peak, and Orejon Andesite Formations; interbedded andesite and dacitic flows, laharic breccia, and other volcaniclastic rocks in the Organ Mountains, generally dark-gray, greenish-gray, or purple-gray; conspicuous epidote alteration; approximately 2000 ft. thick; correlative with Palm Park and Rubio Peak Formations	Eocene, Lower Tertiary				Shale	2	5	10
Tmi	Bedrock/ Pre-Santa Fe	Intermediate to silicic plutonic rocks, including monzodiorite to syenite stocks in the Organ and Doña Ana Mountains, Intermediate intrusive rocks, including scattered andesite prophyry bodies	Oligocene, Middle Tertiary				Metamorphic/ Igneous	4	5	20
Tmrp	Bedrock/ Pre-Santa Fe	Undifferentiated ash-flows, partly to densely welded, mostly rhyolitic. Tuff of Achenback Park; dark gray to dark reddish-brown, densely welded, purniceous ash flow tuff as much as 3100 ft. thick in the Organ Cauldron; compound cooling unit; compositionally zoned from aphyric rhyolite at the base of aphyric at the top; including Tuff of Cox Ranch, Achenback Park, and Cueva Tuff. Tuff of Cox Ranch is densely welded, dark-brown to gray, aphyric, purniceous, rhyolitic ash flow tuff with SiO2 content of approximately 76N	Oligocene				Sandstone	3	5	15
Tmrv	Bedrock/ Pre-Santa Fe	Silicic to intermediate composition lavas, mainly rhyolite, latite and dacite domes and flows; with some dacite breccias, silicic ash flows tuffs and andesite flows. Includes Soledad Rhyolite in Organ Mountains and flow-banded rhyolite dikes and roots of rhyolite domes in the Doña Ana Mountains and at Picacho Mountain	Oligocene, Middle Tertiary				Metamorphic/ Igneous	4	5	20

HSU	Zone	Description	Age Laid	Max Thick (ft)	Zone	LFA	Vadose Range	I_r	I_w	I_i
Tmsp	Bedrock/ Pre-Santa Fe	Sedimentary rocks and tuffs	Oligocene, Middle Tertiary				Thin Bedded Sandstone, Limestone, Shale Sequence	4	5	20
USF1	Santa Fe Group	Upper Santa Fe HSUs, medial to distal piedmont facies, mostly coalescent alluvial-fan deposits, includes Camp Rice Formation, stippled where up to 3 m. of upper Quaternary eolian cover is present with calcic and argillic paleosols	Early to Middle Pleistocene, to Late Miocene	330	Mostly vadose	5 to 7 (6)	Sand and Gravel with Silt and Clay	4	5	20
USF2	Santa Fe Group	Upper Santa Fe HSUs, basin-floor facies: fluvial (channel and overbank) deposits of the ancestral Rio Grande; undivided, includes upper Camp Rice and Fort Hancock Formation subdivisions, stippled where up to 3 m. of upper Quaternary eolian cover is present	Pliocene to Middle Pleistocene, Early to Late Miocene	1000	Partly vadose	1 to 3 (4)	Sand and Gravel	9	5	45
USFc	Santa Fe Group	Upper Santa Fe HSUs, conglomeratic piedmont-slope facies: mostly proximal alluvial-fan deposits	Late Pliocene to Early Pleistocene, Pliocene to Late Miocene	200	Mostly vadose	8, 6b	Sand and Gravel with Silt and Clay	4	5	20
USL M	Santa Fe Group	Upper Santa Fe HSUs, surficial basin-floor facies, sandy, fluvial and eolian sediments and petrocalcic paleosols associated (with partially indurated calcic paleosols) with the La Mesa geomorphic surface; stippled where up to 3 m. of upper Quaternary eolian cover is present	Early Pleistocene, Middle Pleistocene to Pliocene	20	Entirely vadose	2	Sand and Gravel	9	5	45
VA	Rio Grande Valley	Undifferentiated alluvial deposits of (VAY and VAO) of major ephemeral tributaries in areas bordering the inner valley of the Rio Grande system; includes thin hillslope-colluvial and eolian sediments	Late to Middle Quaternary	120	Mostly vadose	b, 5, 6	Sand and Gravel with Silt and Clay	4	5	20
VAO	Rio Grande Valley	Older valley fill deposits, associated with graded surface fans and terraces formed during at least two major episodes of entrenchment and partial backfilling of major tributaries to the Rio Grande; with calcic paleosols. Includes tongues of ancestral river alluvium; overlap and intertongued with TA	Middle Pleistocene	100	Entirely vadose	a, b, 5 to 6(8)	Sand and Gravel with Silt and Clay	4	5	20
VAY	Rio Grande Valley	Younger valley fill deposits (mostly alluvial fans and terraces) associated with entrenchment and backfilling of major tributaries to the Rio Grande valley; weak soil profile development; overlap and intertongued with RA	Late Quaternary	100	Mostly vadose	b, 5, 6	Sand and Gravel with Silt and Clay	4	5	20

[1] Excerpted from Hawley and Kennedy (2004).

Table B-5: Hydrogeology Rating System Calculations for Lithofacies[1]

Lithofacies	Hydraulic Conductivity	K (ft/day)	K (gpd/ft^2)	Rating	Index
1	High	65.0	486.2	4	12
2	High to Moderate	40.8	304.8	4	12
3	Moderate	16.5	123.4	2	6
4	Moderate	16.5	123.4	2	6
5	Moderate to Low	12.0	90.0	1	3
5a	Moderate	16.5	123.4	2	6
5b	Moderate to Low	12.0	90.0	1	3
6	Moderate to Low	12.0	90.0	1	3
6a	Moderate to Low	12.0	90.0	1	3
6b	Low to Moderate	4.8	36.1	1	3
7	Low	1.6	11.6	1	3
8	Low	1.6	11.6	1	3
9	Very Low	0.1	0.4	1	3
10	Very Low	0.1	0.4	1	3
a	High to Moderate	40.8	304.8	4	12
a1	High	65.0	486.2	4	12
a2	Moderate	16.5	123.4	2	6
a3	Moderate to Low	12.0	90.0	1	3
b	Moderate to Low	12.0	90.0	1	3
c	Low	1.6	11.6	1	3

[1] Excerpted from Hawley and Kennedy (2004).

Table B-6: Hydrogeology Rating System Calculations for New Lithofacies Divisions

Lithofacies[1]	Hydraulic Conductivity[2]	K (ft/day)	K (gpd/ft^2)	Rating	Index
1,2	= 2×1 + 1×2	56.9	425.8	4	12
1,2,3	= 3×1 + 2×2 + 1×3	48.8	365.3	4	12
1,3	= 2×1 + 1×3	48.8	365.3	4	12
2,1	= 2×2 + 1×1	48.8	365.3	2	6
2,3	= 2×2 + 1×3	32.7	244.4	2	6
3,2	= 2×3 + 1×2	24.6	183.9	2	6
3,5	= 2×3 + 1×5	15.0	112.3	2	6
5,4,3	= 3×5 + 2×4 + 1×3	14.3	106.7	2	6
5,6	= 2×5 + 1×6	12.0	90.0	1	3
6,5	= 2×6 + 1×5	12.0	90.0	1	3
3,7	= 2×3 + 1×7	11.5	86.2	1	3
3,9	= 2×3 + 1×9	11.0	82.4	1	3
5,6,7,8	= 4×5 + 3×6 + 2×7 + 1×8	8.9	66.5	1	3
6,8	= 2×6 + 1×8	8.5	63.9	1	3
7,3	= 2×7 + 1×3	6.5	48.9	1	3
9,3	= 2×9 + 1×3	5.5	41.4	1	3
7,8	= 2×7 + 1×8	1.6	11.6	1	3
8,7	= 2×8 + 1×7	1.6	11.6	1	3

[1] Excerpted from hydrogeological cross sections found in Hawley and Kennedy (2004).

[2] "A Lithofacies Assemblage that has more than one ranking is a combination of all ranks, with the first number indicating the highest concentration followed by the next highest concentration" (Quoted from personal interview by S. Walker with John Hawley on December 15, 2012). This number is weighted by multiplying the first by the total number of ranks, the second by the total -1, and so forth, then adding them and dividing by the total weight. [i.e. (3×A + 2×B + 1×C) / 6]

Table B-7: Summary of Groundwater Production Potential for Lithofacies[1]

Rating	K (ft/day)	Ave	K (gpd/ft2)
High	30 to 100	65	224 to 748
High to Moderate	3 to 100	40.75	22 to 748
Moderate	3 to 30	16.5	22 to 224
Moderate to Low	0.1 to 30	12.03	0.75 to 224
Low to Moderate	0.1 to 30	4.83	0.75 to 224
Low	0.1 to 3	1.55	0.75 to 22
Very Low	0 to 0.1	0.05	0 to 0.75

[1] Excerpted from Hawley and Kennedy (2004).

Table B-8: Pollution Risk Results Sent to New Mexico Environment Department

#	Community	On Septic	*DRASTIC*$_{PR}$	Parcels	Area	Ave Parcel Size (ac)	Ave *DRASTIC*	Workshop
38	DA County	Verified	954	20	3.55	0.18	154	Here
68	Santa Theresa	Verified	682	125	23.0	0.18	110	
26	DA County	Verified	587	35	8.47	0.24	127	
20	San Ysidro	Verified	441	63	21.2	0.34	148	Here
12	DA County	Verified	440	46	15.5	0.34	148	Here
16	San Ysidro	Verified	423	69	23.7	0.34	145	Here
23	San Ysidro	Verified	420	33	11.7	0.35	147	Here
4	DA County	Verified	419	326	79.6	0.24	102	
5	Las Cruces	Partial	462	35	4.54	0.13	60	
65	Santa Theresa	Likely	947	83	14.5	0.18	156	
63	Santa Theresa	Likely	912	124	22.0	0.18	155	
69	Santa Theresa	Likely	798	33	4.03	0.12	95	
60	Canutillo	Likely	772	127	27.9	0.22	155	
59	Canutillo	Likely	738	104	29.3	0.28	157	
64	Santa Theresa	Likely	691	157	25.6	0.16	108	
44	Mesquite	Likely	641	148	43.0	0.29	165	Here
61	Santa Theresa	Likely	616	303	56.7	0.19	113	
37	Fairacres	Likely	590	29	8.18	0.28	157	
58	Canutillo	Likely	556	126	28.4	0.23	112	
67	Santa Theresa	Likely	512	158	32.5	0.21	104	
42	DA County	Likely	444	77	29.9	0.39	169	
66	Santa Theresa	Likely	434	236	55.6	0.24	101	
8	Las Cruces	Likely	427	58	13.1	0.23	95	
1	DA County	Likely	402	104	48.0	0.46	184	
43	DA County	Likely	370	53	26.5	0.50	185	
73	Sunland Park	Uncertain	831	59	13.6	0.23	190	
76	Sunland Park	Uncertain	793	42	8.03	0.19	135	
71	Sunland Park	Uncertain	714	406	65.3	0.16	111	
13	Las Cruces	Uncertain	693	163	24.7	0.15	100	
62	Sunland Park	Uncertain	691	411	60.2	0.15	98	
78	Sunland Park	Uncertain	664	21	3.22	0.15	99	
72	Sunland Park	Uncertain	661	475	72.4	0.15	99	
70	Sunland Park	Uncertain	637	50	8.97	0.18	110	
79	Anapra	Uncertain	629	1277	187	0.15	84	
77	Sunland Park	Uncertain	603	1295	202	0.16	91	

#	**Community**	**On Septic**	***DRASTIC*$_{PR}$**	**Parcels**	**Area**	**Ave Parcel Size** (ac)	**Ave *DRASTIC***	**Workshop**
75	Sunland Park	Uncertain	598	202	30.6	0.15	90	
21	Las Cruces	Uncertain	581	163	28.0	0.17	96	
55	Anthony	Uncertain	552	245	38.3	0.16	85	
14	Las Cruces	Uncertain	543	39	7.56	0.19	101	
24	DA County	Uncertain	539	26	7.53	0.29	149	Here
74	Sunland Park	Uncertain	513	28	10.2	0.36	181	
25	Las Cruces	Uncertain	512	132	23.4	0.18	88	
22	Las Cruces	Uncertain	499	102	17.2	0.17	84	
57	Anthony	Unlikely	882	46	6.91	0.15	130	
53	Anthony	Unlikely	715	172	31.7	0.18	118	
49	Anthony	Unlikely	695	284	48.5	0.17	113	
56	Anthony	Unlikely	666	780	137	0.18	108	
54	DA County	Unlikely	556	23	6.98	0.30	163	
51	Anthony	Unlikely	503	112	23.6	0.21	101	
52	Anthony	Unlikely	484	672	147	0.22	98	
40	San Pablo	Partial	436	20	7.19	0.36	156	
27	Las Cruces	On Sewage	0	167	21.4	0.13	179	
41	San Pablo	On Sewage	0	86	29.5	0.34	170	
28	Las Cruces	On Sewage	0	45	7.90	0.18	153	
47	Anthony	On Sewage	0	97	20.7	0.21	124	
48	Anthony	On Sewage	0	55	15.0	0.27	121	
46	Anthony	On Sewage	0	108	19.1	0.18	114	
29	DA County	On Sewage	0	67	7.91	0.12	114	
18	Las Cruces	On Sewage	0	123	15.1	0.12	114	
45	DA County	On Sewage	0	94	14.9	0.16	112	
10	Las Cruces	On Sewage	0	143	19.5	0.14	109	
30	DA County	On Sewage	0	47	8.67	0.18	107	
36	DA County	On Sewage	0	22	3.36	0.15	104	
11	Las Cruces	On Sewage	0	334	52.4	0.16	102	
15	Las Cruces	On Sewage	0	38	8.79	0.23	102	
50	Anthony	On Sewage	0	70	11.6	0.17	101	
33	DA County	On Sewage	0	108	18.8	0.17	100	
39	Las Cruces	On Sewage	0	91	16.3	0.18	100	
19	Las Cruces	On Sewage	0	171	30.9	0.18	96	
17	Las Cruces	On Sewage	0	63	13.5	0.21	95	
31	DA County	On Sewage	0	30	5.88	0.20	93	
35	DA County	On Sewage	0	30	5.92	0.20	90	
34	DA County	On Sewage	0	20	2.21	0.11	88	
6	Las Cruces	On Sewage	0	235	30.1	0.13	88	
32	DA County	On Sewage	0	41	7.76	0.19	84	
3	Las Cruces	On Sewage	0	137	15.3	0.11	75	
7	Las Cruces	On Sewage	0	78	10.6	0.14	73	
2	DA County	On Sewage	0	68	10.6	0.16	72	
9	Las Cruces	On Sewage	0	125	18.1	0.15	69	