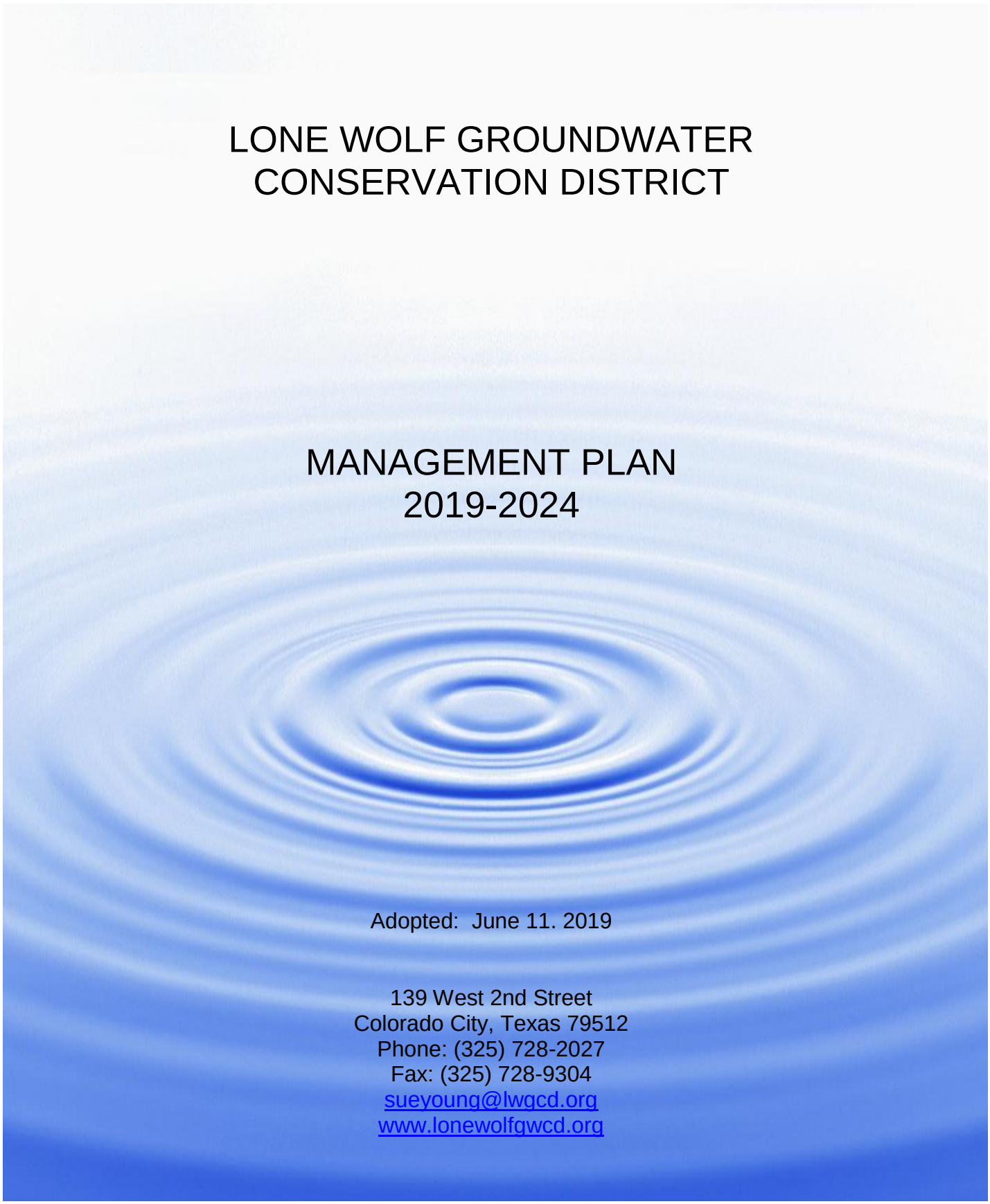
LONE WOLF GROUNDWATER CONSERVATION DISTRICT

MANAGEMENT PLAN 2019-2024



Adopted: June 11. 2019

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Lone Wolf Groundwater Conservation District

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(No attorney nor consultant hired by the District for correspondence with TWDB staff)

MISSION STATEMENT

The Mission of the Lone Wolf Groundwater Conservation District is to encourage conservation and the efficient, beneficial use of groundwater through monitoring and protecting the resource while upholding private property rights.

TIME PERIOD FOR THIS PLAN

This plan becomes effective upon approval of the District's Board of Directors and approval by the Texas Water Development Board. The plan remains in effect for five years after the date of certification by the Texas Water Development Board, or until a revised or amended plan is approved and certified.

STATEMENT OF GUIDING PRINCIPLES

The District recognizes that its groundwater resources are of utmost importance to the economy and environment, first to the residents of the District and then to the region. Also recognized is the importance of understanding the aquifers and aquifer characteristics for proper management of these resources. In addition, the integrity and ownership of groundwater play an important role in the management of this precious resource. One of the primary goals of the District is to preserve the integrity of the groundwater in the District from all potential contamination sources. This is accomplished as the District sets objectives to provide for the conservation, preservation, protection, recharge, prevention of waste and pollution, and efficient use of water including:

- Acquiring, understanding and beneficially employing scientific data on the District's aquifers and their hydrogeologic qualities and identifying the extent and location of water supplies within the District, for the purpose of developing sound management procedures;
- Protecting the private property rights of landowners of groundwater by ensuring that such landowners continue to have the opportunity to use the groundwater underlying their land;
- Promulgating rules for permitting and regulation of spacing of wells and transportation of groundwater resources in the District to protect the quantity and quality of the resource;
- Educating the public and managing for the conservation and beneficial use of the water;
- Educating the public and managing the prevention of pollution of groundwater resources;
- Cooperating and coordinating with other groundwater conservation districts with which the District shares aquifer resources.

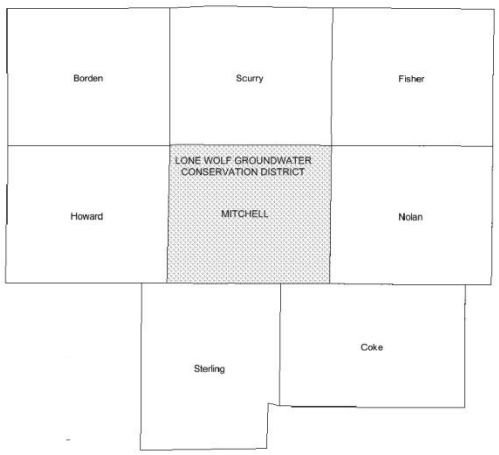
These objectives are best achieved through guidance from the locally elected board members who understand the county's conditions and can manage the resource for the benefit of the citizens of the District and region.

Since a basic understanding of the aquifers and their hydrogeologic properties, as well as a quantification of resources, is the foundation from which to build prudent planning measures, this management plan is intended as a tool to focus the thoughts and actions of those given the responsibility for the execution of District activities.

GENERAL DESCRIPTION OF THE DISTRICT

History

The Lone Wolf Groundwater Conservation District was initially authorized to operate with "temporary" status during the 76th Texas Legislature with the passage of Senate Bill 1911. Subsequent actions of the 77th Texas Legislature removed the temporary status and allowed for the creation of the Lone Wolf Groundwater Conservation District. House Bill 2529 and Senate Bill 2 formally authorized the creation of the District. The voters of Mitchell County approved the District on February 2, 2002.



Location of the Lone Wolf Groundwater Conservation District.

Location and Extent

The Lone Wolf Groundwater Conservation District is located in West Texas and consists solely of Mitchell County. The District covers 576,000 acres or 900 square miles. The Colorado River runs through the county giving the county seat its name of Colorado City.

The County's and District's economy are mainly derived from agriculture and oil production. Cotton and wheat, along with cattle and goat raising, make up the majority of the agricultural income. Mitchell County has developed several wind energy projects and is developing solar projects, which shall be a future economic staple for the area.

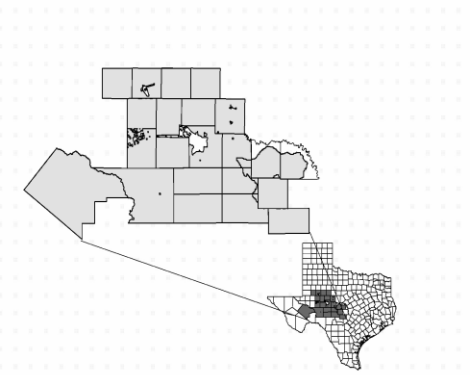
The boundaries of the District follow those of the County. The County is home to approximately 8,400 people and consists of three towns: Colorado City, Loraine and Westbrook.

Topography and Drainage

The District lies within the Colorado River Basin and the Great Plains. The topography of the area ranges from flat to rolling hills, but becomes rugged in the south portion of the County, especially in the vicinity of the Colorado River and major creeks. Farms and ranches dominate the area. Drainage from both sides of the county, east and west,

flows towards the Colorado River which splits the county in half. Tributaries in the area are intermittent and few springs exist.[1]

REGIONAL COOPERATION AND COORDINATION



Territory in the West Texas Regional Alliance.

The District is a member of the West Texas Regional Groundwater Alliance (WTRGA). This regional alliance consists of seventeen (17) locally created and locally funded districts that encompass approximately eighteen (18.2) million acres or twenty eight thousand three hundred sixty eight (28,368) square miles of West Texas. To put this in perspective, this area is larger than many individual states including Rhode Island (1,045 sq mi), Delaware (1,954 sq mi), Puerto Rico (3,425 sq mi), Connecticut (4,845 sq mi), Hawaii (6,423 sq mi), New Jersey (7,417 sq mi), Massachusetts (7,840 sq mi), New Hampshire (8,968 sq mi), Vermont (9,250 sq mi), Maryland (9,774 sq mi), and West Virginia (24, 230 sq mi). This West Texas region is as diverse as the State of Texas. Due to the diversity of this region, each member district provides its own unique programs to best serve its constituents.

In May of 1988, four (4) groundwater districts; Coke County UWCD, Glasscock County UWCD, Irion County WCD, and Sterling County UWCD adopted the original Cooperative Agreement. As new districts were created, they too adopted the Cooperative Agreement. In the fall of 1996, the original Cooperative Agreement was redrafted and the West Texas Regional Groundwater Alliance was created. The current member districts and the year they joined the Alliance are:

Coke County UWCD (1988)
Hickory UWCD # 1 (1997)
Kimble GCD (2004)
Menard County UWD (2000)
Plateau UWC & SD (1991)
Sutton County UWCD (1991)
Crockett County GCD (1992)
Hill Country UWCD (2005)
Lipan-Kickapoo WCD (1989)
Middle Pecos GCD (2005)
Santa Rita UWCD (1990)
Wes-Tex GCD (2005)
Glasscock GCD (1988)
Irion County WCD (1988)
Lone Wolf GCD (2002)
Permian Basin UWCD (2006)
Sterling County UWCD (1988)

This Alliance was created because the local districts have a common objective to facilitate the conservation, preservation, and beneficial use of water and related resources. Local districts monitor the water-related activities of the State's largest industries such as farming & ranching, oil & gas and municipalities. The Alliance provides coordination essential to the activities of these member districts to monitor these activities and to accomplish their objectives.

[1] Victor M. Shamburger, Jr., Report 50: Groundwater Resources of Mitchell and Nolan Counties, Texas, (Texas Water Development Board, June 1967) Page 12

The District is active in the Region F Water Planning Group. The group meetings provide input in developing and adopting the Regional Water Plans. The District will continue to be actively involved in future planning processes.

The District is a member of Groundwater Management Area 7, which covers all or part of thirty-three counties and includes twenty-one groundwater conservation districts. These Districts manage groundwater at the local level. The District actively participates in meetings and discussions to determine a feasible desired future condition of its aquifer.

GROUNDWATER RESOURCES

The data provided for this section of the management plan, unless otherwise noted, is obtained from a study conducted by Arcadis Geraghty and Miller for Mitchell County in October 1998. The study was conducted primarily to determine an alternate resource for the public water supply since the surface water resources were quickly evaporating due to drought. The study consisted of researching and reviewing available information (including published literature, reports, files, data, etc) which contain information pertinent to evaluating the groundwater resources available in the county.

Although the Dockum aquifer underlies more than 40 counties in West Texas, its low water-yielding ability and generally inferior quality results in its categorization as a minor aquifer.

The boundaries of the Lone Wolf Groundwater Conservation District are coextensive with the boundaries of Mitchell County, Texas, covering 583,562 acres. The towns of Colorado City, Loraine and Westbrook are the main population centers in Mitchell County, Texas. The City of Colorado City currently obtains its water supply from water wells located near Loraine. Loraine obtains its water supply from water wells located within the city of Loraine. The City of Westbrook, as well as the Lake Colorado City customers purchase their water from Corix Utilities whose wells are located to the east of Colorado City.

Geology

The geologic rock formations of fresh water-bearing significance in Mitchell County consist of strata of Permian age, the Dockum Group of Triassic age, the Trinity and Fredericksburg Groups of Cretaceous age, the Ogallala Formation of Tertiary age and alluvium of Quaternary age. All of these strata outcrop in Mitchell County. Of paramount importance are the Santa Rosa Formation of the Dockum Group and the sands of the Trinity Group which constitute the principal source of groundwater in the area.[2]

2 Victor M Shamburger, Jr., Report 50: Groundwater Resources of Mitchell and Nolan Counties, Texas, (Texas Water Development Board, June, 1967) page 23

Historically, the uppermost Dockum shale rocks were thought to be correlative with the Chinle Formation found in New Mexico and Arizona. The sandstones below the Chinle were called the Santa Rosa and Trujillo Formations water bearing units and correlated with sandstones found in northeastern New Mexico. The Santa Rosa typically is composed of an upper sandstone unit, a middle shale member, and lower conglomerate sandstone. This division of the Triassic geology has commonly been used in West Texas and was the terminology followed in a report on the groundwater resources in Mitchell County prepared by Victor Shamburger and published by the Texas Water Development Board in June 1967. Although recent studies contest the historic Triassic correlations and nomenclatures and advance proposals for new divisions to the Triassic section found in Mitchell County, the Arcadis G&M report chose to base its findings from the TWDB 1967 report as it is apparent the stated debate will remain ongoing for quite some time.

Permian Strata

Strata of Permian age underlie much of the area but outcrop on the surface in the southeastern part of Mitchell County. The Permian strata consist mainly of red beds which are dense red silt shale with gray-green inclusions interbedded with tight reddish-brown, fine-grained laminated sandstones and occasional gypsum or anhydrite beds. The Permian beds dip westward at a slope of about 25 to 30 feet per mile, steepening considerably in the western part of Mitchell County.

Dockum Group (Santa Rosa and Chinle Foundations)

Strata of the Dockum Group occur on the surface or subsurface in much of Mitchell County. The Dockum Group is generally subdivided into the Santa Rosa Sandstone, the Tecovas Formation, the Trujillo Sandstone and the Cooper Canyon Formation by Lehman. The Cooper Canyon Formation is generally absent in the area except in the extreme western part of Mitchell County. The Cooper Canyon Formation is predominately red clay and shale with thin, ventricular, sandstone interbeds and it overlies the Trujillo Sandstone in the areas where the Cooper Canyon occurs. The Cooper Canyon Formation is generally unimportant as a source of water except for livestock because it yields only small quantities of water which are usually highly mineralized.

The Trujillo Sandstone is a cross-bedded unit composed of sandstones and conglomerates. The base of the unit (top of the Tecovas Formation) is marked by erosional unconformity. The Trujillo may be as much as 100 feet or more in thickness.
The Tecovas shale underlies the Trujillo and is composed of mostly dark gray mudstones and shales. The thickness of the unit may be as much as 45 to 50 feet in some areas.

The Santa Rosa Sandstone occurs beneath the Tecovas and it underlies unconformity on older Permian rocks. It consists of a basal conglomerate overlain by alternating beds of red and gray micaceous shale, clay and sand. The thickness of the formation ranges from a few feet to as much as 45 to 50 feet or more in other areas based on the work

done by Lehman and Lucas. The thickness of the entire Dockum Group ranges from a few feet to over 300 feet in the area northeast of Colorado City.[3]

Cretaceous Rocks (Trinity and Fredericksburg Groups)

The Cretaceous rocks which occur in the area are of Lower Cretaceous age and belong to the Trinity and Fredericksburg Groups. These rocks outcrop in southwestern and central Nolan County and underlie Tertiary Ogallala deposits in northwestern Nolan County. Cretaceous rocks are completely absent in Mitchell County, except for the extreme eastern part of the county.

Sands of the Trinity Group consist of moderate to loosely consolidated, white to purplish, fine to medium-grained quartz sand with occasional lenses of quartz gravel at the base of the unit. The thickness of the Trinity sands ranges from 60 to approximately 100 feet. The Trinity sand overlies the Dockum Group (Santa Rosa Formation) in Western Nolan County but it lies directly on Permian strata farther to the east.

The Fredericksburg Group consists of up to 220 feet of calcareous sediments which overlie the Trinity Group in Nolan County. These rocks are of little importance as a source of groundwater in the area.[4]

Tertiary Ogallala Formation

Ogallala sediments of Tertiary age occur in the northwestern part of Nolan County (around Roscoe), the northeastern part of Mitchell County and in west central and northwestern Mitchell County. Near Roscoe, the Ogallala sediments consist of up to 50 feet of caliche, sand and gravel interbedded with light-colored clay. In this area, the Ogallala sediments are generally above the regional water table and are not a source of groundwater. However, they appear to constitute an effective avenue for recharge to the underlying Santa Rosa Formation and Trinity sand.

In the western part of Mitchell County, the Ogallala consists of up to 100 feet of unconsolidated buff-brown sand with a zone of coarse gravel at the base of the formation. In this area, the Ogallala sediments yield small quantities of usable water of variable quality to domestic and livestock wells.[5]

Hydrology

The water-bearing formation of primary interest in Mitchell County is the Santa Rosa Formation which consists of basal gravel and sand of Triassic age overlain by alternating beds of red and gray micaceous shale, clay and sand (which comprises the Tecovas Formation and the Trujillo Sandstone based on Lehman's nomenclature). These strata occur on the surface over most of the county. The Permian rocks only yield

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[3] Victor M. Shamburger, Jr., Report 50: Groundwater Resources of Mitchell and Nolan Counties, Texas, (Texas Water Development Board, June 1967) Page 23

[4] Victor M. Shamburger, Jr., Report 50: Groundwater Resources of Mitchell and Nolan Counties, Texas, (Texas Water Development Board, June 1967) Page 24

[5] Victor M. Shamburger, Jr., Report 50: Groundwater Resources of Mitchell and Nolan Counties, Texas, (Texas Water Development Board, June 1967) Page 30

small quantities of water to wells and are generally regarded as the base of the fresh water occurrence in the area. In the western part of the county, the Ogallala sediments yield small quantities of usable water of variable quality to domestic and livestock wells. The Permian beds dip westward at an approximate slope of 25 to 30 feet per mile for most of the county, but the dip steepens considerably in the western part of the county.

The literature indicates that the basal gravel and sand of the Santa Rosa Sandstone is highly productive and provides most of the water to wells in the area. In the area north and northeast of Colorado City, the upper part of the Dockum Group (probably the Trujillo Sandstone) is saturated and makes a significant contribution to well yields in the area. However, these upper sands apparently have a different water level than the lower Santa Rosa and generally contain water of inferior quality to that found in the basal sand and gravel.

Although the Santa Rosa/Trujillo Aquifer is very productive over most of the area, the literature indicates that the groundwater quality in the aquifer west of the Colorado River is poor and is not suitable for public consumption. In view of this, the remainder of this report focuses primarily on the Santa Rosa/Trujillo Aquifer and the upper productive sands of the Dockum Group in the area east of the river. The thickness of the Dockum Group as a whole in this area may be as much as 300 feet, but the saturated thickness is only approximately 50% or less of the total thickness. Reported yields for water supply wells in this area are up to 1,000 gallons per minute (gpm).

Santa Rosa/Trujillo Aquifer Water Table

Groundwater in the Santa Rosa/Trujillo Aquifer and the overlying rocks of the Dockum Group that are saturated (Trujillo Sandstone) occurs under either slightly artesian conditions or water table conditions. Pumping tests conducted on several wells completed in the Santa Rosa/Trujillo Aquifer and/or the Trujillo Sandstone in the area indicate that, under static condition, the water in the aquifer may be artesian, but with pumping and lowering of the water table below confining strata, water table conditions are produced.

Recharge to the aquifer results from infiltration and percolation of precipitation on the outcrop areas (including the overlying Ogallala and alluvium formations where they occur). The area west of Loraine (where the surface is fairly sandy) is highly conducive to recharge. Significant recharge also occurs along the creeks in the area where alluvium occurs on the surface along the stream channel. The amount of recharge to the Santa Rosa and the Trujillo Sandstone in this area has not been determined. A rough estimate of recharge in this area is approximately 0.5 inches per year which amounts to approximately 26.7 acre-feet per section of land.

The altitude as shown in TWDB maps of the water table in the Santa Rosa/Trujillo Aquifer and or the Trujillo Sandstone for the period of 1960-1961 shows that the direction of groundwater movement in the aquifer was to the west toward the Colorado River where significant discharge to the river occurred. West of the river, the direction of groundwater movement was to the east toward the river.

The static water levels in most (or all) of the Santa Rosa/Trujillo water wells in the area were as high as or higher in the mid-1990s than they were back in the early 1960s. This is reflected by the hydrographs of State observation wells which have historical records spanning the period from the early-1960s to the mid-1990s. Several of the hydrographs show that the water table/piezometric surface in the Santa Rosa/Trujillo Aquifer/Trujillo Sandstone responds quite rapidly and significantly to heavy pumping or cessation in pumping of water wells.

The fact that the water table in this area is at or above the levels in the early 1960s indicates a substantial cessation of groundwater withdrawal from the aquifer for irrigation purposes during that time. The elevation of the water table appears to be approximately 20 feet higher in the mid 1990s than in 1960-61. However due to the sustained drought conditions during the late 1990s, groundwater usage in Mitchell County increased dramatically with irrigation and municipal use. As part of this plan, the District will monitor the groundwater levels regularly to determine the continued effects of increased pumping.

Groundwater Reserves

The gross saturated thickness of the Santa Rosa/Trujillo sediments in the eastern part of Mitchell County range from less than 60 feet in the southern part of the area to over 200 feet in the north. In the areas situated north, northeast and east of Colorado City, the thickness of Santa Rosa/Trujillo sediments ranged from 140 feet to over 200 feet in 1960-61. Accounting for the additional 20 feet in the water table by the mid-1990s, the gross saturation of the aquifer in this area in the mid 1990s ranged from approximately 160 feet to over 220 feet.

An estimate of the amount of groundwater reserves in storage in the aquifer can be made knowing the saturated thickness of Santa Rosa/Trujillo sediments and the effective porosity of the sediments. The effective porosity of the aquifer represents the void space from which water can be drained by gravity expressed as a percentage of the total volume of sediments. No values of the effective porosity for the Santa Rosa/Trujillo Aquifer have been reported in literature. However, based on Arcadis Geraghty and Miller's experience in working with this and other aquifers in West Texas, a conservative value of 10 percent is assumed for the effective porosity of the aquifer. This value was used to estimate the amount of reserves in the aquifer.

Based on the range of gross saturated thickness of the aquifer discussed above for the areas north, northeast and east of Colorado City (160 feet to over 220 feet), the assumed effective porosity of the sediments of 10% and a recovery factor of 70%, the volume of recoverable groundwater presently in place in the aquifer is estimated to range from approximately 7,168 acre-feet per section to over 9,856 acre-feet per section depending on the location of the property. This represents groundwater reserves present in the aquifer that can be produced by pumping, and it does not include any recharge to the aquifer or exterior drainage from adjoining properties that may be captured once a well field is developed and production begins.

These estimates for groundwater reserves in the aquifer include the apparent poorer quality water that may exist in the upper part of the aquifer which may not be suitable for municipal purposes and may have to be sealed off during construction of water supply wells. The saturated thickness of this upper productive zone is not known with any degree of certainty and would need to be addressed in any subsequent exploratory work to verify the aquifer reserves, quality and productivity.

Groundwater Quality in the Santa Rosa/Trujillo Aquifer

State observation wells completed in the Dockum Group aquifer for which chemical analysis data were available in 1967 and more recent water quality data obtained from the TNRIS are available for a limited number of these observation wells. Data from these observation wells indicate the quality of the groundwater in the Santa Rosa/Trujillo Aquifer is considerably more mineralized in the western part of the county than in the eastern part of the county. Generally speaking, west of the Colorado River the groundwater quality in the aquifer is poor and is unsuitable for municipal purposes. However, east of the river, the water quality in the aquifer is less mineralized and is generally suitable for municipal purposes (with some exceptions). More recent water quality data, where available, confirm this conclusion. For example, State observation well 28-40-608 (located about 10 miles northwest of Colorado City) contained chloride, sulfate and total dissolved solids (TDS) of 560 milligrams per liter (mg/L), 337 mg/L and 1,891 mg/L, respectively, in 1963. In 1986, the chloride, sulfate and TDS concentration in this well were 519 mg/L, 386 mg/L and 1,893 mg/L, respectively. By contrast, State observation well 29-35-702 (located about eight miles east of Colorado City in Loraine) contained chloride, sulfate and TDS of 34 mg/L, 73 mg/L and 418 mg/L, respectively, for these same constituents in 1995. This also indicates that the groundwater quality in this well had not changed appreciably over the indicated time period. In fact, the quality in well 29-35-702 actually improved over the period.

Another important observation concerning the quality of groundwater in the Santa Rosa/Trujillo aquifer is the fact that the quality in the upper sands (Trujillo Sandstone) appears to be inferior to the quality in the deeper basal sands and gravels (Santa Rosa Sandstone). This appears to be true even for wells located east of the Colorado River.

Based on the available chemical quality data, it appears that wells completed in the lower (basal) sands or gravels (the Santa Rosa/Trujillo Aquifer) contain groundwater which would meet the TCEQ standards for municipal water supplies in terms of the chloride, sulfate and TDS content. These standards are 300 mg/L, 300 mg/L and 1,000 mg/L respectively, for these constituents.

The concentrations of nitrate in the groundwater are another important factor in determining the suitability of a water supply for municipal purposes. The MCL for nitrates in public water supplies (as established by the EPA) is 10 mg/L of nitrogen (or 45 mg/L as nitrates). Above this level, adverse health effects can result. The groundwater quality in the Santa Rosa/Trujillo Aquifer in the area east of Colorado City appears to be generally acceptable for municipal purposes from the standpoint of the

nitrate content of the water. However, several wells in the area do exhibit elevated nitrate concentrations above the MCL of 45 mg/L. For example, State Well 29-27-902 had nitrates of 81 mg/L in 1978 which increased to 109.9 mg/L in 1986. Well 29-34-515 had nitrate of 66 mg/L in 1963, well 29-34-801 had nitrate levels of 98 in 1946 and well 29-35-108 had nitrate levels of 320 in 1963. No recent nitrates data are available for these wells. The source could be septic systems or areas where nitrate-rich fertilizers are stored. Additional exploration would be necessary to identify and delineate the nature and extent of this problem.

Hydraulic Properties of the Santa Rosa/Trujillo Aquifer and Aquifer Productivity

The results of pumping tests conducted by the Texas Water Development Board in the 1960s on several water wells in the area completed in the Santa Rosa/Trujillo Aquifer were used to estimate the transmissivity and storage coefficient of the aquifer. The transmissivity of the aquifer is defined as the rate at which water flows through a vertical strip of the full saturated thickness of the aquifer one foot wide and under a unit hydraulic gradient. It is a measure of the ability of the aquifer to transmit water. High values indicate greater transmitting capabilities of the aquifer. The storage coefficient is defined as the volume of water released from storage or taken into storage per unit of surface area of the aquifer per unit change in head in the aquifer. For water table aquifers, the storage coefficient is the same as the specific yield (or effective porosity). As discussed earlier, in this area the Santa Rosa/Trujillo Aquifer appears to exhibit slightly artesian conditions under static conditions due to the stratified nature of the aquifer. However, when the aquifer is pumped and the water level lowered below confining strata, water table conditions may be produced. The specific yield (effective porosity) of an aquifer is the volume of water which can be drained by gravity from a unit volume of the aquifer expressed as a fraction or percentage of the unit volume.

The transmissivity values obtained from the pumping tests conducted by the Texas Water Development Board ranged from 5,868 gallons per day (gpd/ft) to 12,300 gpd/ft and averaged 8,845 gpd/ft. Because the tested wells were located over a wide area (east of Colorado City), this range of transmissivity values appears to be representative of the Santa Rosa/Trujillo Aquifer in this area.

The storage coefficient values from the pumping tests ranged from 0.00008 to 0.00044 which are typical of aquifers under artesian conditions. With sustained pumping of the aquifer and lowering of the water table below confining strata, water table conditions are expected to be produced. Storage coefficients (or specific yields) in the range of 0.01 to 0.35 are typical of aquifers under water table conditions.

Reported yields for Santa Rosa/Trujillo water supply wells in the north, northeast and east of Colorado City are up to 1,000 gpm. However, well yields and the productivity of the aquifer will vary across the area and depend on factors such as the lithology of the formation and the gross saturated thickness of the aquifer. The design of the wells also has a significant impact on the yield of the well. Therefore, it would be imperative to conduct exploration and testing to better assess these factors and to determine the productivity of the aquifer and well yields in specific areas of interest.

ADDITIONAL NATURAL AND ARTIFICIAL RECHARGE

Each year, annual precipitation in and around the district results in a recharge of the aquifer of approximately 18,108 acre-feet into the lower Dockum Aquifer while an estimated 11,998 acre feet of water discharges from the aquifer to springs and other surface water bodies. [6] According to GAM Run 19-004, an estimated 2,726 acre-feet flow into the district within the lower Dockum Aquifer while about 373 acre-feet flow out of the district. An additional 440 acre-feet of water flows from upper aquifers into the lower portion of the Dockum.[7] However, more can be done to help the recharge rate.

Brush Control

The Lone Wolf Groundwater Conservation District supports brush control as a management practice to maintain and improve groundwater supplies in the District and region. The District, in fact, wrote a grant for the Mitchell and Nolan Soil and Water Conservation Districts in 2002 for a brush control program along the 41,000 acre Champion Creek Watershed. The $1.3 million grant was funded in the fall of 2002.. The District will continue to work with the local SWCD and state USGS offices to support new and ongoing brush control management projects.

The Texas Water Resources Institute, according to the 2001 Region F Water Plan, estimates that one acre-foot of water is lost annually for every 10 acres of brush. Much of the brush consists of mesquite, salt cedar and juniper. As these plants were introduced into the area they spread from the riverbanks to the plains replacing native grasslands. Some of the potential concerns associated with brush are increased erosion, competition for water with grasses, and reduced runoff infiltration.

Recharge Enhancement

Recharge enhancement is the process in which surface water is intentionally directed to areas where permeable soils or fractured rock allow rapid infiltration of the surface water into the subsurface to increase localized groundwater recharge. This includes any man-made structure that would slow down or hold surface water to increase the probability of groundwater recharge.

To determine possible sites for recharge, Region F utilized the geographic information system (GIS) to map the region. Mitchell County is identified as being mostly moderate to some favorable conditions for recharge enhancement. However, topography, drainages, soil properties and the extent and hydraulic characteristics of aquifer outcrops on a local scale would need to be studied before a site could be selected. Consideration should also be given to the potential reduction of surface runoff and how that affects existing surface water reservoirs. Further study is needed to determine the quantity of increased groundwater supplies from enhanced recharge structures and the potential impacts to surface water rights.

Weather Modification to Enhance Yields

Weather modification is defined as an attempt to increase the efficiency of a cloud to return more of the water drawn into the cloud as precipitation. Hail suppression and rainfall enhancement are common forms of weather modification. Early forms of weather modification began in Texas in the 1880s by firing cannons to induce convective cloud formation. Efforts to enhance rainfall in Texas continue to this day. Most efforts to increase rainfall take place in the spring and summer and are halted during the winter months.

A common agent for cloud seeding is Silver iodide, AgI, which is released from flares located on a plane. Silver iodide enhances ice crystal concentrations in clouds, encouraging larger drops to form thereby increasing the likelihood that precipitation will reach the ground. Environmental concerns have been raised with regard to using a heavy metal as a seeding agent, but research conducted along the Oklahoma border indicated only trace amounts, much smaller than allowed by law, of silver in livestock grazing or in soil downwind.

The Lone Wolf Groundwater Conservation District has participated in a weather modification program for the past four years although the actual effects are difficult to measure. To accurately estimate the benefit of weather modification requires an approximation of how much rainfall would have occurred naturally without weather modification. Research has suggested increases of 15 percent or more of precipitation in areas included in weather modification. Local experiences have shown increases of 27 percent in rainfall. Other methods of measuring the effects of rainfall enhancement, such as dry land farm production, have shown positive benefits of weather modification. Dry land farming has increased in regions participating in rainfall enhancement.

MANAGEMENT OF GROUNDWATER SUPPLIES

Preservation and protection of groundwater quality and quantity has been the guiding principle of the District since its creation while striving to maintain the economic viability of all groundwater user groups, public and private. In consideration of the economic and cultural activities occurring within the District, the District will continue to identify and engage in such activities and practices, that if implemented, would result in preservation and protection of the groundwater. An observation network has been established and maintained for monitoring changing storage conditions of groundwater supplies within the District. The District will continue to make regular assessments of groundwater supply and storage conditions and make them available to the public. Additional monitor wells, both water quality and water level, are continually being added to the well monitor program, along with expansion of programs including the rainfall monitoring program.

The District has adopted rules to regulate groundwater withdrawals by means of spacing regulations and well density (number of wells per section). The District will amend these rules, within the limitations imposed by Chapter 36 of the Texas Water Code, as necessary to regulate groundwater withdrawals by means of additional spacing and/or production limits. District rules also address permitting and registration of wells, waste, well drilling and completion of wells, as well as capping and plugging of unused or abandoned wells. These rules are intended to provide equitable conservation and preservation of the groundwater resources.

The District may deny a drilling permit in accordance with the provisions of the District rules. The relevant factors to be considered in granting, denying, or limiting a permit include:

1) the purpose of the District rules, including but not limited to, preserving and protecting the quality and quantity of the aquifer resources, and protecting existing uses;
2) the equitable conservation and preservation of the resource; and
3) the economic hardship resulting from denial or limitation of a permit.

In pursuit of the District's mission of preserving and protecting the resource, the District will enforce the terms and conditions of permits and the rules of the District by injunction, mandatory injunction, or other appropriate remedies in a court of competent jurisdiction as provided by Chapter 36.102, Texas Water Code.

The District is aware of the importance of brackish groundwater as a potential future water supply. Therefore, the District takes steps within its authority to protect brackish groundwater resources, including participating in proceedings at the Texas Railroad Commission regarding injection wells or other permitted activities that could put either fresh water or brackish water resources at risk. With advances in desalination technology, water that is not economically usable today may prove to be an important resource in the future, and the District believes expending resources to preserve that brackish water in its current state and prevent any third party pollution of same is in the best interests of the public, landowners, the District, the area, and the state. To that

end, the District has partnered with Mitchell County in developing a desalination plant that will provide potable water to the unincorporated areas of the county (those not served by the cities).

The District also recognizes the importance of public education to encourage efficient use, promote conservation, prevent waste, and preserve the integrity of groundwater. District personnel will seek opportunities to educate the public on water conservation issues and other matters relevant to the protection of groundwater resources through public meetings, newspaper articles, newsletters, speaking engagements, and other means that may become available.

By implementing more public education programs specifically aimed at irrigation conservation, rainwater harvesting and additional brush control methods, the District anticipates additional groundwater being available to offset future needs.

ACTIONS, PROCEDURES, PERFORMANCE AND AVOIDANCE

FOR PLAN IMPLEMENTATION

The District will implement the provisions of this plan and will utilize the provisions of this plan as a guide for determining the direction and/or priority for District activities. All operations of the District will be consistent with the provisions of this plan.

The District first adopted rules in 1999, has amended the rules periodically and will continue to amend the rules as necessary. Rules adopted or amended by the District shall be pursuant to TWC Chapter 36 and the provisions of this plan. The promulgation and enforcement of the rules will be based on the best scientific and technical evidence available.

The District maintains a website www.lonewolfgwcd.org which contains District Rules, activities, forms, notices of Board meeting and hearings, agendas, and other pertinent information.

The District shall treat all citizens with equality. For good cause, the District, in its discretion and after notice and hearing if required, may grant an exception to the District rules. In so doing, the Board shall consider the potential for adverse effects on adjacent owners and aquifer conditions. The exercise of said discretion by the Board shall not be construed as limiting the power of the Board.

All activities of the District will be undertaken in cooperation and coordination with the appropriate state, regional and local water management entities**.**

TECHNICAL DISTRICT INFORMATION REQUIRED BY TEXAS ADMINISTRATIVE CODE

Estimate of the modeled available groundwater in the District based on the desired future conditions. Texas Water Code §36.001 defines modeled available groundwater as "the amount of water that the executive administrator determines may be produced on an average annual basis to achieve a desired future condition established under Section 36.108".

The joint planning process set forth in Texas Water Code §36.108 must be collectively conducted by all groundwater conservation districts within the same GMA. The District is a member of GMA 7. GMA 7 adopted a DFC for the Dockum Aquifer on November 22, 2016. The adopted DFC was then forwarded to the TWDB for the development of the MAG calculations. The complete submittal package for the DFC can be found at: www.twdb.texas.gov/groundwater/dfc/GMA7_DFC. The portions of the explanatory report relevant to Lone Wolf GCD are found in GMA7 Explanatory Report - Final (Appendix A).

The Desired Future Condition for the Dockum Aquifer is based on the HPAS GAM, Scenario 17 as described in GMA 7 Explanatory Report - Final (Appendix A). The resolution adopted by GMA 7 stated that the Dockum Aquifer is not relevant for joint planning purposes in Mitchell County, which coincides with the boundaries of the Lone Wolf Groundwater Conservation District (Appendix A of Appendix A).

Estimated Modeled Available Groundwater for the Dockum Aquifer in Mitchell County is not available based on the fact that the Dockum is not relevant for joint planning purposes in the county (reference: GAM Run 16-026 MAG Version 2, Appendix B; and GMA 7 Explanatory Report - Final, Appendix A).

Estimate of the annual amount of groundwater being used within the District on an annual basis: 13,391 acre feet. Please refer to Appendix C: Estimated Historical Groundwater Use and 2017 State Water Plan Datasets – page 3.

Estimate of the annual amount of recharge from precipitation to the Dockum Aquifer: 18,108 acre feet. (Appendix D: GAM Run 19-004: Lone Wolf Groundwater Conservation District Management Plan – Table 1).

Estimate of the volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams and rivers: 11,998 acre feet. (Appendix D: GAM Run 19-004: Lone Wolf Groundwater Conservation District Management Plan – Table 1).

Estimate of the annual volume of flow into the District within the Dockum Aquifer: 2,726 acre feet. (Appendix D: GAM Run 19-004: Lone Wolf Groundwater Conservation District Management Plan – Table 1).

Estimate of the annual volume of flow out of the District within the Dockum Aquifer: 373 acre feet (Appendix D: GAM Run 19-004: Lone Wolf Groundwater Conservation District Management Plan – Table 1).

Estimate of the net annual volume of flow from the overlying units of the Dockum Aquifer: 440 acre feet: (Appendix D: GAM Run 19-004: Lone Wolf Groundwater Conservation District Management Plan – Table 1).

Estimate of the projected annual surface water supply within the District: 395 acre feet (Appendix C: Estimated Historical Groundwater Use and 2017 State Water Plan Datasets – page 4).

Estimate of the projected total annual demand for water within the District: 19,575 acre feet. Please refer to Appendix C: Estimated Historical Groundwater Use and 2017 State Water Plan Datasets – page 5.

Estimate of the projected annual water supply needs: -4847 acre feet. Please refer to Appendix C: Estimated Historical Groundwater Use and 2017 State Water Plan Datasets – page 6. The negative value depicted in the water supply needs is attributed to steam electric power. The power plant located at Lake Colorado City is being dismantled and will eventually have no need for the surface water being used.

Water management strategies: Please refer to Appendix C: Estimated Historical Groundwater Use and 2017 State Water Plan Datasets – page 7. The management strategies will be attainable through education for the most part. The reuse of effluent water should lower municipal usage and the steam electric deficit will be eliminated with the Morgan Creek plant closing and new power plants coming on line.

METHODOLOGY FOR TRACKING PROGRESS

The methodology that the District will use to track its progress on an annual basis, in achieving all of its management goals will be as follows:

> The District manager will prepare and present an annual report to the Board of Directors on District performance in regards to achieving management goals and objectives for the previous fiscal year, during the first meeting of each new fiscal year. The report will include the number of instances each activity was engaged in during the year.

The annual report will be maintained on file at the District office and will apply to all management goals contained in this plan.

GOALS, MANAGEMENT OBJECTIVES AND PERFORMANCESTANDARDS

The Management Plan Goals and Objectives of the Lone Wolf Groundwater Conservation District are as follows:

Goal

1.0 ***Providing the Most Efficient Use of Groundwater***

Objective

1.1 Gather well production data and intended use (irrigation, domestic, etc) on all new wells permitted in the District each year. Information gathered will be compiled and entered into the District's database. Annual reports detailing the number of wells drilled, production data and intended use of the wells will be maintained at the District office.

Standard

1.1.1 Data gathered and reports generated monthly and annually detailing the number and type of wells drilled.

Objective

1.2 The Lone Wolf Groundwater Conservation District has developed and enforces a set of rules outlining, among other things, the District's policies and water well spacing requirements. The Board will review the rules of the District for possible updates and revisions at least every odd numbered year. Minutes of the meeting will be maintained at the District office.

Standard

1.2.1 Written rules maintained at the District office. Rules reviewed for possible updates at least every other year.

Objective

1.3 Each year the District will provide informative speakers to schools, civic groups, social clubs and organizations for presentations to inform a minimum of 20 citizens on the activities and programs, the geology and hydrology of groundwater and the principles of water conservation relating to the best management practices for the efficient use of groundwater.

Standard

1.3.1 Number of citizens in attendance at District presentations concerning the principles of water conservation relating to the best management practices for the efficient use of groundwater each year.

Goal

2.0 ***Controlling and Preventing Waste of Groundwater***

Objective

2.1 Each year the District will take water quality samples from at least two wells in order to monitor water quality trends and prevent the waste of groundwater by contamination.

Standard

2.1.1 Number of wells sampled for water quality analysis by the District to monitor water quality trends each year.

Objective

2.2 Investigate all wasteful practices reported to the District. All reports of wasteful practices will be documented and investigated to ensure compliance with and enforcement of state and local groundwater laws and rules.

Standard

2.2.1 Prompt investigation of all reported wasteful or detrimental activities relating to groundwater.

Objective

2.3 All wells drilled within the District will be registered or permitted.

Standard

2.3.1 All wells drilled will be sequentially numbered

Goal

3.0 ***Controlling and Preventing subsidence***

Objective

3.1 The geologic framework of the District precludes significant subsidence from occurring. According to the Vulnerability of Major and Minor Aquifers of Texas to Subsidence report (http:// www.twdb.texas.gov/groundwater/models/research/subsidence/ subsidence.asp), the southern most portion of the Dockum is unlikely susceptible to subsidence. Therefore, this management goal is not applicable to the operations of the District.

Standard

3.1.1 This goal is not applicable

4.0 ***Addressing Conjunctive Surface Water Management Issues***

Goa
l

Objective

4.1 There are no surface water management entities within the District. Although the CRMWD and UCRA operate around and sometimes in Mitchell County, each has indicated this item does not apply to them. Therefore, this management goal is not applicable to the operations of the District.

Standard

4.1.1 This goal is not applicable

Goal

5.0 ***Addressing Natural Resource Issues that Impact the Use and Availability of Groundwater and Are Impacted by the Use of Groundwater***

Objective

5.1 The District will promote at least once per year by way of press releases, community awareness programs, advertisements or a combination thereof the importance of plugging and/or capping all wells not in use. District staff will maintain a file indicating the methods of promotion used each year.

Standard

5.1.1 Annually publicize the importance of plugging or capping wells.

Goal

6.0 ***Addressing Drought Conditions***

Objective

6.1 The District has developed and maintains a drought contingency plan that includes recommended rationing and conservation techniques.

Standard

6.1.1 At least annual review of Drought Contingency Plan.

Objective

6.2 Monthly review of applicable data including the Palmer Drought Severity Index (PDSI) by Texas Climatic Divisions to determine status of drought conditions and, if necessary, report to the Board on need to implement drought contingency plan.

Standard

6.2.1 Each year complete and distribute to the District Board an Annual Report on drought conditions in preceding year.

Objective

6.3 Monthly the District will monitor the Palmer Drought Severity Index (PDSI) by Texas Climatic Divisions. If PDSI indicates that the District will experience severe drought conditions, the District will notify all public water suppliers within the District.

Standard

6.3.1 The District staff will monitor the PDSI and report findings and actions to the District Board on a monthly basis.

Goal

7.0 ***Addressing Conservation***

Objective

The District has developed and maintains a water level monitoring program that includes at least 15 water wells throughout the District. The District will gather water levels at least twice a year on each of the designated wells to determine the effects of pumping and weather conditions on the aquifer. Data files are maintained at the District office. Annual reports are presented to the Board on the status of the water level monitoring program.

Standard

7.1.1 The number of water wells monitored for levels each year. Annual reports submitted to the District Board.

Objective

7.2 District staff writes or sponsors at least four media releases per year on various issues relating to conservation. These articles are sent to local media outlets for publication. The District maintains a file detailing all newspaper articles and radio and television coverage on conservation issues.

Standard

7.2.1 The number of media releases sent to local media outlets.

Goal

8.0 ***Addressing Recharge Enhancement***

Objective

8.1 The diverse topography and limited knowledge of any specific recharge sites makes any type of recharge enhancement project economically unfeasible.

Standard

8.1. 1 This goal is not applicable

Goal

9.0 ***Addressing Rainwater Harvesting***

Objective

9.1 The District provides literature for the public, as well as public seminars, regarding rainwater harvesting systems. The District has provided barrels for the seminars and subsequent instruction. The District maintains a rainwater harvesting system at the office, from which the public can be educated on developing home and corporate systems.

Standard

9.1.1 Number of systems installed each year.

Goal

10.0 ***Addressing Precipitation Enhancement***

Objective

10.1 The District participates in a weather modification project in cooperation with other entities in the west Texas and panhandle region.

Standard

10.1.1 Number of clouds seeded in the District per year.

Objective

10.2 The District maintains a rainfall database from cooperators across the District. The rainfall totals are reported quarterly and are coordinated with the cloud seeding operation.

Standard

10.2.1 Number of cooperators and data gathered reported annually to District Board.

Goal

11.0 ***Addressing Brush Control***

Objective

11.1 The District supports brush control as a management practice to maintain and improve groundwater supplies in the District and the region. Most

programs are funded and administered by the SWCD and the District will support new and ongoing brush control management projects.

Standard
11.1.1 None.

Goal
12.1 ***Addressing the Desired Future Conditions Established Under TWC 36.108***

Objective
12.1 Although the Dockum Aquifer in Mitchell County is classified as "Not Relevant for Purposes of Joint Planning" and as such no DFC is required, the District will continue to manage groundwater though its management plan and regulate groundwater through its rules.

Standard
12.1.1 Develop, in conjunction with neighboring counties, a local scale groundwater flow model for the Dockum Aquifer.

Standard
12.1.2
The water well monitoring program allows the District to closely monitor the static and draw down levels of the water tables across the District gathering seasonal and long term water level declines, and respond accordingly.

APPENDICES