Drainage Master Plan
City of Clovis, NM

Drainage Master Plan

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CITY OF CLOVIS, NM
DRAINAGE MASTER PLAN

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1.0 NEED AND JUSTIFICATION

1.1 Background

In 2014, the City of Clovis contracted with Molzen Corbin to prepare a new drainage master plan. Three previous drainage master plans had been completed by the City, and most of the improvements in those master plans have been completed. Therefore, a new drainage master plan was needed to update a capital improvement program for current outstanding drainage projects.

In addition, a recent FEMA Letter of Map Revision (LOMR) was prepared for the City of Clovis in 2014. This LOMR defined and delineated FEMA flood plains. This drainage master plan was intended to review those flood plains and make recommendations for reducing the properties within the flood plains to help address pending flood insurance rate increases that the Biggert-Waters Act intended to impose.

1.2 Need and Justification

The need for this drainage master plan is based on the fact that previous plans have expired, or have been built out in terms of the capital improvements. In addition, new FEMA regulations (Biggert-Waters Act of 2012) have caused flood insurance rate premiums to multiply significantly (possibly by a factor of 10) to be phased in a four-year period. Later congressional action modified Biggert-Waters, but the Act was only slightly modified.

1.3 Consultant Selection and Contract Authorization

Molzen Corbin was selected to perform the 2018 drainage master plan. Funding came from approximately $400,000 generated from the Ad Valorem tax which funds the City's drainage infrastructure.

1.4 Project Area

This master plan is intended to address storm drainage facility management in the City of Clovis. The contributing drainage area extends beyond the city limits and is shown in Exhibit 1 in the Appendix. Exhibits 1A, 1B, 1C, and 1D also show the drainage basins in larger scale, each exhibit covering the four quadrants of the drainage area.

2.0 CURRENT STATUS OF FLOOD PLAIN INSURANCE

2.1 General

The first issue to be addressed in this drainage master plan is the current status of FEMA, flood plain insurance rates and the established flood plain in Clovis. When this study began, FEMA began making changes in the flood insurance rate program and those changes are very significant in terms of cost to the community and the policyholders in Clovis. The Biggert-Waters Act of 2012 (Biggert-Waters) and the Homeowners Flood Insurance Affordability Act of 2014 (HFIAA) will have dramatic impacts on the citizens of Clovis. These will be addressed here.

2.2 Biggert -Waters Act of 2012

Hurricanes Katrina, Rita, and Super Storm Sandy basically bankrupted FEMA, and changes to the flood insurance program were needed as seen by Congress. For those businesses and residents paying flood insurance rates, Biggert-Waters will cost a property owner in the flood plain many times more than the previous premiums.

Biggert-Waters took effect on October 1, 2013. Flood insurance rates would have been doubled or tripled (some estimates even stated ten times as high as old rates) after this date. Biggert-Waters allowed for certain “grandfathering”. Those paying insurance before the Act (called Pre-FIRM), could continue to pay their subsidized rates after October 12, 2013, as long as they are current on their policy. However, if the property sells, the new owner will have to pay the new rates. If a policy is cancelled, the new policy requires the new rates. Pre-FIRM subsidized rates for commercial properties will not be grandfathered; they will be phased into the new rates immediately. While Biggert-Waters was quite complicated, it can be summarized as follows:

- New rates are significantly higher than the old rates, in many cases ten-fold.
- Those residents paying flood insurance rates before Biggert-Waters can continue at their old rates, as long as their policy is current and as long as they do not re-finance.

- When a property sells, the new owner must pay the new rates, many times higher than the old rates, making the property difficult to sell.
- Commercial properties pay the new rates and cannot continue with the old rates.
- If new FIRM's are issued in a community, all will be required to pay new rates, based on new risk assessment. Grandfathered rates no longer apply; the existing owner has to phase into the new rates with a 25% per year increase, which could be several times higher than the old (as mentioned above, perhaps as high as tenfold). In many instances, this could lead to foreclosure and then blighted properties since those properties may not be able to sell and the existing owner cannot afford the insurance.

Eventually, all properties in the flood plain will be affected at some point in the future. What happened in the past was that most properties paid much lower premiums than their risk or property value warranted, while at the same time, many other properties paid much higher premiums than their risk or property value warranted. It was essentially an "averaged out" system. Biggert-Waters changes all this so that rates are based on actual location risk and actual location value, but all rates will increase. Those who are affected by the new rates will begin to pay 25% more per year beginning in 2013, until their old Pre-FIRM rates are up to the level of the new rates. FEMA has already mailed out several notices to all policy holders, notifying them of the changes coming and their new rates.

This creates a huge impact on properties in flood plains, and there are many such properties in Clovis. Public entities, such as the City of Clovis will begin to get faced with pressure to take measures to reduce the amount of property in the flood plain. As property values fall, people will simply not be able to afford the premiums. This will also impact the commercial area as businesses in the flood plain are also impacted by these new Biggert-Waters rates, perhaps even more so, and even faster than residents. This will be a significant impact on local economic development.

There are other methods to reduce the flood insurance premiums. Certainly the most effective is to remove areas from the flood plain, and the drainage master plan should certainly focus on this effort. Meanwhile, FEMA offers a Community Rating System (CRS) which also helps to reduce area insurance premiums. Once established as a CRS, a community can do many things to gain discounts on insurance premiums. CRS establishes a total of 10 classes, with the top class, Class 10, realizing as much as a 45% discount. Currently, Clovis has achieved a CRS level of 8.

2.3 Homeowners Flood Insurance Affordability Act of 2014 (HFIAA)

This Act repealed and modified the Biggert-Waters Flood Insurance Reform Act of 2012. At face value, the new law slows flood insurance rate increases and offers relief to policyholders who experienced steep flood insurance premium increases in 2013 and early 2014. Flood insurance rates and other charges would be revised for new or existing policies beginning on April 1, 2015. In addition to insurance rates, other changes resulting from Biggert-Waters and HFIAA will be implemented that will affect the total amount a policyholder will pay for a flood insurance policy. The 25% per year increase in flood insurance rate was reduced to 18% per year under HFIAA.

Some of the changes implemented by the HFIAA include:

- Implements annual rate changes that set rates using rate-increase limitations set by HFIAA for individual premiums and rate classes:
  - Limiting increases for individual premiums to 18 percent of premium (as opposed to 25% in Biggert-Waters). These were to begin in 2014.
  - Limiting increases for average rate classes to 15 percent.
  - Mandatory increases for certain subsidized policyholders under Biggert-Waters and HFIAA.
- Increases the Reserve Fund assessments required by Biggert-Waters.
- Implements annual surcharges required by HFIAA.
- Guidance on substantially damaged and substantially improved structures, and additional rating guidance on buildings constructed before the community's first FIRM's became effective (known as pre-FIRM Structures).
- Implements a new procedure for properties newly mapped into the Special Flood Hazard Area (SFHA) and existing Preferred Risk Policy (PRP) Eligibility Extension, a cost saving

flood insurance coverage option for property owners whose buildings were newly mapped into a SFHA. The premiums will be the same as the PRP, which offers low-cost insurance to owners and tenants of eligible residential and non-residential buildings located in moderate to low risk areas for the first year (calculated before fees and assessments) to comply with provisions of HFIAA.

- Reformulates expense loading on premiums, reducing the expense load on the highest risk policies as an interim step, while investigating expenses on policies as required by Biggert-Waters.

Regarding the Reserve Fund:

Biggert-Waters required the establishment of a Reserve Fund to help cover costs when claims exceed the annual premium collected by the National Flood Insurance Program (NFIP). FEMA began collecting an assessment in 2013 to add money to the Reserve Fund. The Reserve Fund assessment initially applied to all policies other than PRP's in 2013. The assessment on those policies will increase in 2015. Starting in 2015, PRP's began contributing to the Reserve Fund.

2.4 Surcharges

One important aspect to the HFIAA was the incorporation of surcharges. HFIAA slowed the elimination of subsidies provided for in Biggert-Waters and amended most of the provisions mandating that certain policies transition immediately to full-risk rates. To compensate for the decrease in revenues, the new law calls for the addition of a surcharge on all policies that will be collected until, with limited exception, all subsidies are eliminated. The surcharge is a flat fee applied to all policies based on the occupancy type of the insured building and is not associated with the flood zone in which the building is located or the construction date of the building (e.g. pre- or post- FIRM). The surcharge also applies to a renter's contents-only policy based on the policyholder's occupancy of the building or unit.

Surcharges are as shown in Table 2-1.

TABLE 2-1
SURCHARGE SUMMARY

Occupancy Type	Annual Surcharge
Primary Residential: a single-family and individual condominium unit	$25
Non-Primary Residential: single-family and individual condominium unit	$250
Multifamily Residential: condominium and other buildings	$250
Non-Residential	$250

The problem with the surcharges is that FEMA will automatically assume the $250 surcharge on a property until a homeowner can prove the residence is the primary residence and not a secondary, or vacation home.

2.5 FEMA Flood Insurance Rate Summary

The Biggert-Waters Act of 2012 changed flood insurance premiums dramatically. While the HFIAA attempted to reduce some of the requirements and costs to policyholders, it did not eliminate the inevitable huge increase in flood insurance premiums. Some state chapters of the Realtors Association estimated that most rates would increase ten-fold. An existing rate of $100 per year would climb to $1,000 per year.

For low to moderate income homes, that would perhaps double or triple a homeowner's mortgage payment. While certain grandfathering was allowed to eliminate the huge increase, the homeowner would not be able to sell the home as the new owner would be faced with the full value of the new insurance rate. It was feared that a homeowner would not be able to afford the new rates nor be able to sell the property and as a result, foreclosed or abandoned properties would begin to rise and communities would see an increase in blighted neighborhoods.
This increases the attention on a community to assist in bringing down flood insurance rates. This can be done by accumulating Community Rating System (CRS) points which provide discounts to policyholders. Many of the initial points can be achieved without significant effort. For example, simply having the Flood Insurance Rate Maps (FIRM's) on file for residents review, or community outreach efforts to educate the community on the mapping availability and

how the flood insurance program works. Clovis has done much of this and has achieved a Level 8.

More importantly, the current status of flood insurance premiums highlight the need for a community to take on more detailed studies regarding surveying and engineering studies, in order to obtain more accurate field data. Letters of Map Revision (LOMR's) can then be filed with FEMA in an attempt to get areas removed from the flood plain.

Very often a property is mapped to be within a flood zone, hence requiring the property to be subject to flood insurance premiums. Oftentimes properties are in the zones because of general mapping assumptions or even errors in the mapping. In many instances, a simple elevation certificate prepared by a surveyor or engineer can show that a residence is indeed above the base flood elevation (BFE). In other cases, a generalized area can be hydraulically modeled using actual field survey data, rather than less accurate topo mapping (e.g. USGS quad maps) that may have been used by FEMA or their contractors in establishing the FIRM's.

3.0 GENERAL INFORMATION

3.1 General Description of Area (Largely from the Flood Insurance Study 2013)

The City of Clovis is located in east-central New Mexico at an average elevation of 4,275 feet above sea level according to the National Geodetic Vertical Datum of 1929 (NGVD). US 60/84 runs east-west through the City and US 70 runs from the east and turns south at the intersection with NM 209 in the City. The City of Clovis lies approximately 8 miles west of the New Mexico-Texas State line. The nearest city is the City of Portales, approximately 25 miles to the southwest. The City of Tucumcari is approximately 60 air miles to the northwest, and the City of Albuquerque, the commercial center of the State, is approximately 200 air miles to the west.

The City of Clovis lies on a rolling plain that slopes gently to the southeast and is dissected by several water courses, many of which terminate in sinkholes, which are locally called playas. All of the streams are *ephemeral* in character, flowing only during periods of heavy rainfall (as opposed to *intermittent*, which are "wetter" than ephemeral but are still not permanent flows, as they dry up in summer months). Most of the area outside the City is productive crop land, while the remaining area is rural.

The City of Clovis has a semi-arid continental climate, characterized by distinct seasonal changes and large annual diurnal temperature ranges. The rainy season occurs in the summer when afternoon thunderstorms produce much of the yearly moisture. Eighty percent of the moisture falls during the months of May through October.

The average annual mean temperature is approximately 58 degrees Farenheit (F). The highest recorded temperature was 110 degrees F in 1990. The lowest recorded temperature was -17 degrees F in January 1951. The Flood Insurance Study (FIS) 35009CV000B stated that the average annual rainfall is 1.5 inches, which is clearly an error. It is believed that the average annual rainfall is 18 to 20 inches.

3.2 Principal Flood Problems (Largely from the Flood Insurance Study 2013)

Flooding in the City of Clovis is caused by several arroyos, and the contributing drainage basin comprises approximately 26 square miles of area north of the Atchison, Topeka, and Santa Fe Railway track, which passes east-west through the City. An arroyo entering the west-northwest boundary of the City has been intercepted by the Martin Luther King Boulevard Worthington Ditch, which extends southward from the intersection of 21st and Thomas Streets (now Martin Luther King Boulevard). Refer to Exhibits 1 through 1D for the drainage area depictions. The ditch, constructed in approximately 1941, is an open trapezoidal drainage channel three miles in length, which carries flow south along the west side of Thomas Street (now Martin Luther King Boulevard) to the southwest corner of the corporate area and then southwesterly to the existing Conestoga Hills Playa. Overflow from the Thomas (Worthington) Ditch (believed at the time of the FIS) flows through the City generally parallel to the Atchison, Topeka, and Santa Fe Railway along Grand Avenue and is referred to as the West Second Street Drain in the FIS. A tributary to the Worthington Ditch flows through the Bella Subdivision and is designated the Thomas (Worthington) 2 flow path in the FIS.

Current (2018) modeling disputes this. Current modeling shows that the Circle of Trees Playa never discharges, hence reducing the flows to the Worthington Ditch. Furthermore, field surveys of the Worthington Ditch at Grand Avenue show that this crossing structure can handle the expected flows to the south and there is no overflow at Martin Luther King Boulevard at Grand Avenue to the east.

The Liebelt Channel, an intermittent stream designated the northwest drainage flow path, enters the northwest corner of the City of Clovis corporate area and flows southeasterly through the City. New Pond Playa is on Greene Acres Arroyo (Liebelt Channel) and is located at the intersection of Llano Estacado Boulevard and Wheaton Street. Greene Acres Lake is on Greene Acres Arroyo (Liebelt Channel) and is situated just west of Main Street and south of 21st Street.

The Northeast Drainage path flows through Sorgen Playa, which lies northwest of the intersection of Prince Street and Llano Estacado Boulevard, and serves as a collector of storm surface runoff from the outlying areas within the drainage basin. The northwest drainage flow path flows through residential areas to Goodwin Lake, which is located immediately south of Llano Estacado Boulevard and east of Prince Street. The northwest and northeast drainage flow paths combine in Hillcrest Park and continue across Norris Street to flow south through the Ingram Channel to Mabry Drive and on to Ingram Playa.

The West Second Street Drain extends in a wedge shape from the Thomas/Martin Luther King Street Ditch (Worthington Ditch) eastward to the intersection of Norris and Mabry Streets. Dennis Chavez Playa Lake is located in this drainage basin west of Thornton Street and immediately north of West 14th Street. At Mabry Drive, which runs parallel to the Atchison, Topeka, and Santa Fe Railway, all drainage paths combine.

3.3 Flood Protection Measures (Largely from the Flood Insurance Study 2013)

Flood-protection measures include control by zoning and two retention ponds: New Pond Playa and Greene Acres Lake. The City of Clovis has expanded New Pond Playa and added a spillway and a three-foot outlet conduit to allow the playa to serve as a retention pond. This conduit is gated so there is some manual control on releases. Greene Acres Lake serves as a retention pond. It also has a controlled gated outfall to Marshall Pond. Should this system become overwhelmed, the system will spill into an adjacent sports field east of Main Street. Facilities have been constructed to pump excess water out of the sports field. This gated outlet is used to release flows from Greene Acres in advance of a forecasted storm to ensure there is additional capacity in this pond.

Playa lakes are an essential part of the drainage control in the City of Clovis. Refer to Exhibit 2 for a playa lake location map.

Since the beginning of this Drainage Master Plan and not mentioned in the FIS, it should be noted that the City of Clovis and/or the New Mexico Department of Transportation have initiated and even completed several new projects that enhance drainage runoff conveyance through the City.

3.4 Mabry Drive US 60/70/84 from Prince Street (NM 209) to the East to Norris Street

This project was led by the NMDOT and included full roadway reconstruction with curb and gutter and a new storm drain system which discharges to the drainage channel south of Mabry just east of S. Tennessee Street, the historic discharge point. This project was completed in 2016. What is notable about this project is that the combined street and storm drain flow conveyance enables the City of Clovis to prepare Letters of Map Revision (LOMR's) to FEMA to eliminate many of the properties along this project from the flood plain, hence eliminating the need for flood insurance premiums. This project was completed and the storm drain was designed to a 50-year event, but the new curb and gutter may enable the street section to convey the remainder of the larger event flows. This can only be known in a detailed study for the LOMR.

In addition, one of the historical flooding areas in the past has been side streets north of Mabry in this location, particularly Lea, Oak, Maple, Hickory, Ash, Walnut, and Sycamore. This NMDOT project on Mabry included drop inlets into the new Mabry storm drain and should eliminate these areas from the flood plain. However, Grand still experiences flooding because upstream flows have not yet been intercepted. See Figure 3-1 below.

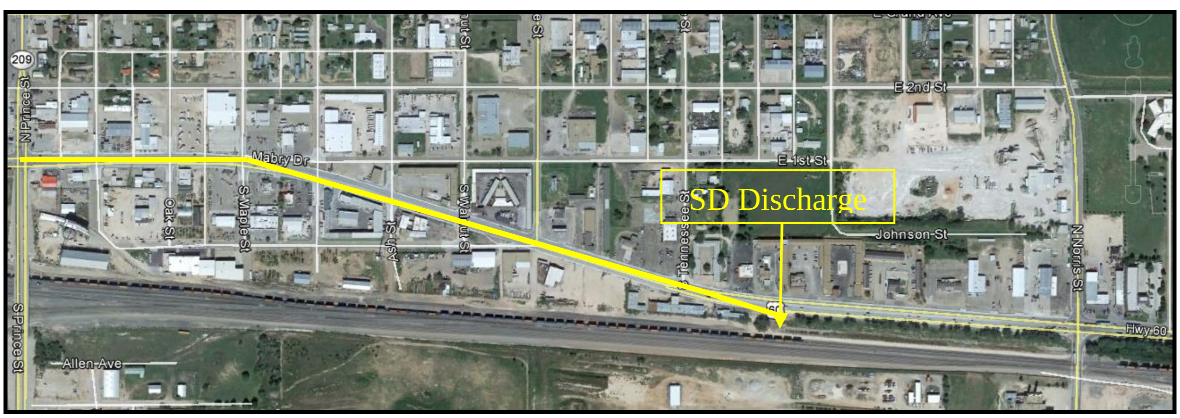

FIGURE 3-1
MABRY DRIVE IMPROVEMENTS

3.5 US 60/84 from 7th to Prince Street

This project is NMDOT lead and includes reconstruction of the entire street cross section, with curb and gutter and a new storm drain. This NMDOT project also includes consideration of some new detention/retention ponds along the course of the project, particularly at the curve by the Grand Avenue turn and by Rencher Street. These areas are leftover properties from when the original highway was realigned years ago and are now City parks.

This project includes a large storm drain that eventually discharges near Prince Street with the discharge outfall uncertain at this time. The plan for this outfall had been a detention pond on the east side of Prince Street and the south side of the railroad tracks. It was to discharge through two existing 36” storm drain pipes that convey flows to the Ingram Ditch at the US 70 crossing. It is currently being coordinated between this master plan and the NMDOT project designers.

Some discharge may go to the storm drain line in the recently completed Mabry Avenue project but some discharge will be diverted to the railroad storm drain line. Refer to Figures 3-2 and 3-3. Exhibit 3 shows a complete layout of this system.

FIGURE 3-2
US 60/84/70/GRAND AVENUE IMPROVEMENTS

FIGURE 3-3
BNSF STORM DRAIN

3.6 Wilhite Street

Wilhite from Prince Street (NM209) to Winchester Street was reconstructed and widened with curb, gutter and a new large diameter storm drain. This was completed in 2017. The roadway has been widened and improved with curb and gutter and a new large diameter storm drain. The storm drain turns south at Winchester and discharges into a playa lake known as the 801 Playa. The outfall is a 72" storm drain and was designed for a 10-year storm at 250 cfs. The slope on this pipe is 0.35%.

The invert of the pipe is at the bottom of this playa. The playa should have a follow up project to excavate the bottom in order to improve the hydraulic capacity of the storm drain pipe by virtue of a lower hydraulic grade line. The playa should then be excavated in order to increase storage capacity. This will be a recommendation for a future project.

3.7 Flood Recurrence Intervals

For the flooding sources studied by detailed methods in the community, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude that is expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent-annual-chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance flood in any 2-percent-annual-chance flood is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). Maps and flood elevations should be amended periodically to reflect future changes.

3.8 Additional Background on the 1980 Flood Insurance Study (FIS)

The August 4, 1980 Flood Insurance Study for the City of Clovis assumed that all of the playa lakes in the watershed were full prior to the 1-percent-annual-chance storm and, consequently, the analysis did not account for the possible reduction in flood discharges as a result of playa storage. Since publication of that Flood Insurance Study, the USACE, Fort Worth District completed studies for the communities of Midland and Plainview, Texas, located in the High Plains region of western Texas. Both communities lie within watersheds containing playa lakes similar to those in the City of Clovis watershed, and the studies show that playa lake storage can have a significant effect on the flood discharges computed for the area. Based on conversations with the USACE, Fort Worth and Albuquerque Districts, the hydrologic analyses were modified to include playa lake storage effects. The USACE, Fort Worth District modeled playas using the reservoir routing method, and the study contractor adopted this procedure. Each playa was planimetered using the best available topographic mapping and the 1985 topographic mapping to determine its storage capacity. The USACE, Fort Worth District considered the playa lakes in the Midland and Plainview watersheds modeled with the reservoir routing method to be 33 to 50 percent full at the beginning of the 1-percent-annual-chance storm. Because this area receives less yearly rainfall than the High Plains region of Texas, and based on field observations and discussions with Curry County, the analysis for the restudy assumes the playa lakes to be 25 percent full at the beginning of the 1-percent-annual-chance storm. For playas with constructed outlet works, such as New Pond, the initial storage of the playa was set at the invert elevation of the outlet conduit. The study contractor compared the HEC-1 frequency-discharge peaks to frequency-discharge peaks generated by regional equations. The equations represent statewide small basins with areas of 10 square miles or less and a mean basin elevation of 7,500 feet or less, and the results compared favorably.

3.9 Systems Description from the 1980 Flood Insurance Study (FIS)

3.9.1 2013 FIS Definitions

The Flood Insurance Study (FIS) 35009CV000B delineated primary flow paths (streams) for that study. It is important to state these herein in order to make proper reference and coordination between this Master Plan and the FIS. The flow paths described in the FIS are as shown in Table 3-1.

TABLE 3-1
FIS STREAM NAMES

Stream Name	Description of Detailed Studied Streams
Northeast Drain	From the confluence with Ingram Lake to just downstream of Sorgen Lake.
Northeast Drain Distributary	From east of Humphrey Road to just upstream of Mabry Drive along Northeast Drain Channel.
Northeast Drain Distributary East	From west of Sugarbeet Road to east of Humphrey Road.
Northwest Drain	From the confluence with Northeast Drain to just downstream of New Pond Playa.
West 2nd Street Drain	From the confluence with Northeast Drain to intersection of 7th Street and Martin Luther King Boulevard.
Thomas (Worthington) Ditch 1	From Curry Road 9 to approximately 500 feet downstream of West 21st Street.
Thomas (Worthington) Ditch 2	From the confluence with Thomas (Worthington) Ditch 1 to approximately 1,200 feet downstream of the City of Clovis Boundary.

Please note that the Northeast Drain Distributary, as shown in the table above, used to be named the Northeast Drain in previous FIS report.

3.9.2 Northeast Drain

This system begins at the downstream end of Sorgen Lake. Upstream of Sorgen Lake is undeveloped farmland (Basins NE-1 and NE-2). Part of the flow is retained in a playa (RES-2).

From Sorgen Lake flows travel southward to Goodwin Lake in NE-3 and then down to Newman Pond in NE-4. From Newman Pond flows travel southeast and cross 7th Street to the Ingram Ditch which crosses Mabry east of Norris (Basin ING).

3.9.3 Northeast Drain Distributary

This system begins on Humphrey Drive at Llano Estacado and flows southward to Mabry Drive.

3.9.4 Northeast Drain Distributary East

From west of Sugarbeet Road to east of Humphrey Road (Bomer Playa).

3.9.5 Northwest Drain

This basin begins at New Pond, which is south of Llano Estacado and on each side of Wheaton Drive. Upstream of New Pond is undeveloped farmland (Basin NW-1 and NW-2), which also contains a playa, Reservoir-1 upstream, keeping some flow from reaching New Pond.

New Pond East contains a controlled principal spillway and an overflow emergency spillway. Priebe Playa, Basin NW-2 flows enter the New Pond Outfall on Martin Luther King downstream of New Pond. Flows enter Basin NW-7 and flow in a channel to Greene Acres Lake south of 21st Street and west of N. Main.

Greene Acres Pond lies in Basin NW-4. This playa has a controlled outlet which flows east across N. Main to Marshall Pond and then to the Zoo (Golf Course) Pond (Basin NW-5) and Newman Pond (Basin NW-5 and Basin NE-4). From Newman Pond flows join with the Northeast Basin in the upper Ingram Channel. Finally flows reach the Ingram Pond in the southeast corner of the study area.

3.9.6 West 2nd Street Drain

This basin begins at the intersection of 7th Street and Martin Luther King Boulevard (Basin TD-3). Flows travel south down Martin Luther King Boulevard to Grand Avenue, west on Grand Avenue to 1st Street, crossing Prince to Mabry and down Mabry to S. Tennessee. Basins TD-3, W2nd-1, W2nd-3, W2nd-4 are collected along the way. The ultimate outfall is the Ingram Lake.

3.9.7 Thomas (Worthington) Ditch 1

This system begins slightly south of 21st Street and flows along the west side of Martin Luther King Boulevard to Curry Road 9 (Brady Avenue). Flows accepted by this ditch include Basins TD-1, the Circle of Trees Playa, and TD-2. The flows cross Grand Avenue and the railroad tracks to Conestoga Hills Playa.

3.9.8 Thomas (Worthington) Ditch 2

This system extends from Worthington Ditch up to Circle of Trees Playa.

3.10 Playa Lakes

3.10.1 Greene Acres Lake

Greene Acres Lake is located in the heart of the City and has a permanent pool. It is south of 21st Street and west of Main Street. It is a recreational facility and the presence of the water is a necessary and desired feature. It has a gated outlet to the Marshall outfall that can be opened during a flood event so as to drain downstream towards the zoo area and eventually to the northeast system.

Upstream contributors to this lake include urban areas, New Pond, and Reservoir 1. Priebe Playa is also a contributor, if Priebe fills and spills onto downstream streets.

Downstream from Greene Acres lie the Zoo (Golf Course) (Hillcrest) Pond and the Newman Pond. At this point flows combine with other major systems.

3.10.2 Circle of Trees Playa

Circle of Trees Playa lies on the west side of town. It is in a rural area and is normally dry until a rainfall event occurs. Computations in this drainage Master Plan and field review of the area, indicate that this pond will not and never has overflown to the areas to the east. The current flood plain mapping indicates that this playa contributes to the flooding in the 2nd Street System.

In 2017, the City of Clovis purchased the Circle of Trees Playa, 30.52 acres that included the Circle of Trees Playa on the east side of Wheaton Road and south of 21st Street.

Upstream of Circle of Trees is largely undeveloped farmland or pasture. Downstream of Circle of Trees shows no evidence of the pond overflowing to the east. If flow should overtop the Circle of Trees, the flows would enter Worthington Ditch and head south to Conestoga Hills Playa.

3.10.3 Sorgen Lake

Sorgen Playa lies north of Llano Estacado and west of Prince Street. This playa is very large. It is normally dry until a rainfall event. It has no controlled nor uncontrolled outfall. The City of Clovis purchased 46.39 acres of land that includes the Sorgen Playa in 2017.

Upstream of Sorgen Playa lies undeveloped farmland. There is no outfall for this playa. If it overtops, flows would migrate to the Northeast System and reach Goodwin Lake.

3.10.4 New Pond

New Pond is a very large playa lake located on the northwest part of the City. There are two parts to New Pond, one west of Wheaton (18.80 acres) and one east of Wheaton (7.16 acres).

Both of the ponds are south of Llano Estacado. It is normally dry until a rainfall event. It has a gated outlet and emergency spillway. The gated outlet flows into the Liebelt Channel that traverses easterly to Martin Luther King Boulevard and to Greene Acres Lake.

The upstream areas contributing runoff to New Pond are undeveloped farm or range lands.

3.10.5 Ingram Lake

Ingram Lake is the final destination for nearly all the runoff from the City. It lies in the far southeast corner of the City and adjacent to the City Regional Landfill. It has a pond area that appears to retain a pool most of the time. But the vast majority of this pond area and storage is normally dry until a significant rainfall event.

3.10.6 Goodwin Lake

Goodwin Lake lies in the center of the City. It is normally dry until a significant rainfall event. Upstream areas include urban land and possibly Sorgen Lake, should it ever fill and spill.

There is no outlet to Goodwin Lake. If overtopped, it would flow southward into Newman Pond.

3.10.7 Dennis Chavez Lake

Dennis Chaves Lake has a permanent pool and encompasses approximately 9.58 acres. This permanent pool is enhanced with park and recreational amenities. The upstream contributing areas to Dennis Chavez Lake include heavily developed residential and commercial properties. It has no outfall and, as such, is prone to flooding during a 2” or more rainfall. In order to ameliorate the flooding, the City normally pumps water from Dennis Chavez down Jones Street to 11th Street where the discharge can gravity flow down Jones Street to Grand Avenue where it enters a drop inlet at Hinkle Street.

It is recommended that this lake be fitted with a pump station that will evacuate runoff during high flow events, to a force main to the proposed Cameo Pond.

3.10.8 Santa Fe Lake

Santa Fe Lake is a contaminated Superfund site and runoff is not allowed into the area. It is located northeast of County Road 8 and County Road K. It is now owned by KCLV and encompasses approximately 140.17 acres.

3.10.9 Senior Citizens Pond

Senior Citizens Pond is located between Maple and Ash Streets and between 7th and 9th streets. It is uniquely situated to allow some relief to storm drainage. The pond has no current outfall, and the contributing drainage area is developed urban areas. The proposed 7th Street improvement project intends to utilize this pond for surcharge and storage.

3.10.10 Van Soelen/Bomer Pond

This playa lies east of the City of Clovis and is split by 7th Street. While this pond is outside of the City and flood map area, this pond neither contributes to nor relieves any flooding from the City. However, it is considered a resource insofar of water reclamation.

3.10.11 Country Meadows/E-2/801 Playa

This playa is known by several different names. It is located just west of Country Meadows Road and south of Wilhite. This playa is the discharge point of the Wilhite Roadway Improvements. Downstream of Country Meadows Pond is Gouker Playa. Both of these playas are outside of the floodway areas of the City. Each playa is considered a valuable resource for water reclamation.

3.10.12 Ridley Pond (Hartley) (E-1)

Ridley Pond is located east of Prince Street and north of Wilhite. It receives significant runoff from areas north and North Prince Street. As such, it provides some relief to the flood plain areas causing water to pond in this location and not continue down Prince Street into the established flood plain.

3.10.13 Potential New Retention Facility

Cameo Pond is a new proposed facility for several reasons. The current worst flood plain issues in the City are located along 2nd Street. A new playa in this location could provide detention or surge storage for the storm drain system in Grand/1st/Mabry. A current project is being developed by the NMDOT to improve US 60/84 through this area and a new pond in this location would be beneficial to the storm drain system.

3.11 NPDES MS-4 Permitting

The City Clovis is in a closed basin. While drainage tends to flow from the northwest to the southeast, there is no clear outfall to the southeast. All runoff remains within the Clovis area. Therefore, the City of Clovis has never had to comply with MS-4 general permitting requirements.

3.12 FEMA Mapping

The 2011 LOMR was filed and is the basis of the current mapping. The Flood Insurance Rate Map (FIRM) is for the Community of Clovis and is shown on Map Number 35009C0590D.

4.0 HISTORICAL FLOODING

4.1 July 2, 2014

On this date, approximately 2.9 inches of rainfall flooded many areas of Clovis. In particular, Dennis Chavez Lake filled and flooded neighborhoods just south of the lake. City of Clovis personnel had to pump runoff from Dennis Chavez southward down Jones Avenue until gravity could carry the runoff to a drop inlet on 7th Street and Grand Avenue. Pumping continued for several days. Flooding on 14th Street at the pond is shown in Figures 4-1 and 4-2.

FIGURE 4-1
14TH STREET AT DENNIS CHAVEZ

Other areas flooded included streets north of Mabry and east of Prince. At that time Mabry sat at a higher elevation than adjacent properties. Since that time, NMDOT has reconstructed Mabry with a storm drain that can now accept these offsite flows.

The Greene Acres Lake overtopped Main Street during this event. This caused the channel surrounding Marshall Pond to also fill.

FIGURE 4-2
MAIN STREET AT GREENE ACRES/MARSHALL

4.2 Other

The FIS mentioned that during a period from June 4-20, 1923, the City of Clovis received 12.31 inches of recorded rainfall. Of this amount 6.98 inches were recorded on June 7^{th} and 8^{th}, followed by 2.62 inches on June 18^{th}. BNSF records show that a flood occurred on July 22, 1930, as a result of 3.85 inches of rainfall. The notes show that all the streets in the south part of the City were under water, which was two to four feet deep on 1^{st} Street near the train depot, with the water flowing east. See Figure 4-3 below.

FIGURE 4-3
1920'S FLOODING

Several other storms similar to that on July 2, 2014 have occurred since that time, each causing the same type and same amount of damage and in the same basic locations.

Other known flooding areas are at Cameo/Purdue and Grand from Prince to the west.

5.0 REVIEW OF PREVIOUS MATERIAL

5.1 1986 Drainage Master Plan

This drainage master plan was completed by Brewer and Associates. It provided a brief history of work completed previous to this work. This included:

1941 Worthington Ditch constructed
1941 Hasie and Greene Drainage Study for Cameo Street, BNSF, 21^{st} and Sycamore Streets
1941 Several drainage structures constructed at major intersections
1960 1^{st} Street Drainage Project by NMSHTD
1962 Drainage Master Plan by Hasie and Greene
1963 Bond election for flood control defeated
1969 Clovis General Plan by Gruen Associates
1970 N. Main Street Lake Outlet System by G. Herkenhoff & Associates
1980 FIS by Federal Insurance Administration
1981 Flood Ordinance by City of Clovis
1981 Subdivision Regulations by City of Clovis
1982 Bob Spencer Athletic Complex by Parks and Recreation Board
1983 West Grand Avenue Drainage Project by NMSHTD

This plan broke the City up into six primary basins for hydrologic analysis. These are shown in Figure 5-1.

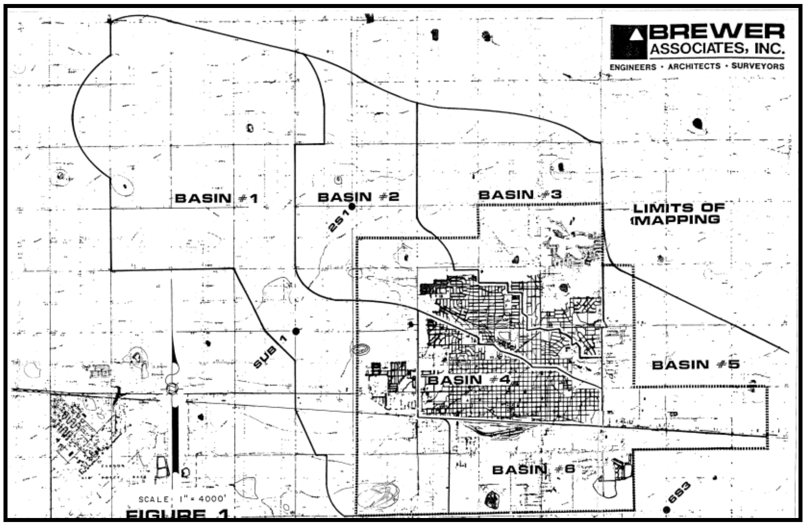

FIGURE 5-1
PRIMARY BASINS

Rainfall data used in this study was 2.28”, 2.7”, 3.0”, and 3.42” for the 10-year, 25-year, 50-year, and 100-year storm, respectively. These values are for the one-hour storm duration.

The recommendations from this report were as follows:

- Adopt a comprehensive drainage policy; this was completed.
- Control existing lakes (purchase) and purchase right-of-way for channels; this was partially done and is now a priority for the City.
- Maintain all drainage channels; this effort is on-going and important to the integrity of the drainage system.
- Build county roads to divert flows to playas; it is believed that some of this has occurred and needs to continue.
- Construct new drainage channel from Norris to Bomer Lake; this was later completed primarily with a storm drain. The extent of the storm drain was actually from Humphreys to Bomer Lake.
- Construct new crossings on Worthington Ditch; these were completed. The recommendation included a single barrel 4’ X 10’ and a double barrel 4’ X 10’ at Westgate and Jehovah’s Witness respectively. However, it appears that these were not completed. Instead triple 36” diameter culverts were installed at each locations.

- Construct channel along west side of Wheaton; this project was not completed.
- Reconstruct channels in Hillcrest Park; this was completed.
- Construct storm drain east from Norris and Llano Estacado; this was completed.
- Purchase property for Greene Acres outlet storm sewer; this was completed.
- Construct Greene Acres outlet storm sewer; this was completed.
- Increase storage capacity of Dennis Chavez Lake; this was completed.
- Increase storage capacity of Senior Citizens Pond; this was only partially completed.
- Construct storm system on Grand from Norris to Prince, and then from Prince to Rencher; this was not completed.
- Construct a storm sewer on 7th Street to Sycamore on 21st Streets; this was not completed.

5.2 1989 Drainage Master Plan

The 1989 drainage master plan was prepared by Boyle Engineering Corporation. This study analyzed the one-hour and six-hour duration storm and determined that the one hour-storm had more runoff volume than the six-hour storm and hence it was used as the design storm. However, this study also stated that it was based on the 25-year frequency (4 percent probability of occurring) storm rather than the 100-year frequency storm (1 percent probability of occurring).

5.2.1 Project 1A. Ingram Lake/Channel

This lake has an existing capacity of 395 acre-feet from a minimum pool elevation of 4,192 to an overflow elevation of 4,200. Construction of a berm to an elevation of 4,210 would increase the capacity to 1,355 acre-feet, which would contain the 100-year storm volume. In addition to berm construction, the existing channel from the lake, north to the railroad must be widened to 50 feet with 3:1 side slopes to accommodate the additional storm flows, with a major culvert crossing at Brady Avenue. This work was completed. It is shown in Figure 5-2.

FIGURE 5-2
INGRAM CHANNEL AND DAM

5.2.2 Project 1B. US 60/70/84 Railroad Crossing Structure

Approximately 1,000 feet east of the intersection of Norris and Mabry is where the 7th Street outfall channel will cross Mabry Drive and the AT&SF railroad. The Mabry Drive crossing will have to be constructed in phases for traffic handling and the railroad crossing will be tunneled or jacked under the tracks. This was completed, however a bridge, not a tunnel, was completed on the railroad tracks. This is shown in Figure 5-3.

FIGURE 5-3
INGRAM CHANNEL CROSSING

5.2.3 Project 1C. 7th Street Outfall Channel

The 7th Street Outfall Channel will be constructed from the intersection of Mockingbird Lane and 7th Street, south to US 60/70/84 just west of Big Country Ford. This channel will be grass lined with a 30- to 40-foot bottom width, 3:1 side slopes, and access road along one side. This was completed. This is also known as the upper reach of the Ingram Channel. It is shown in Figure 5-4.

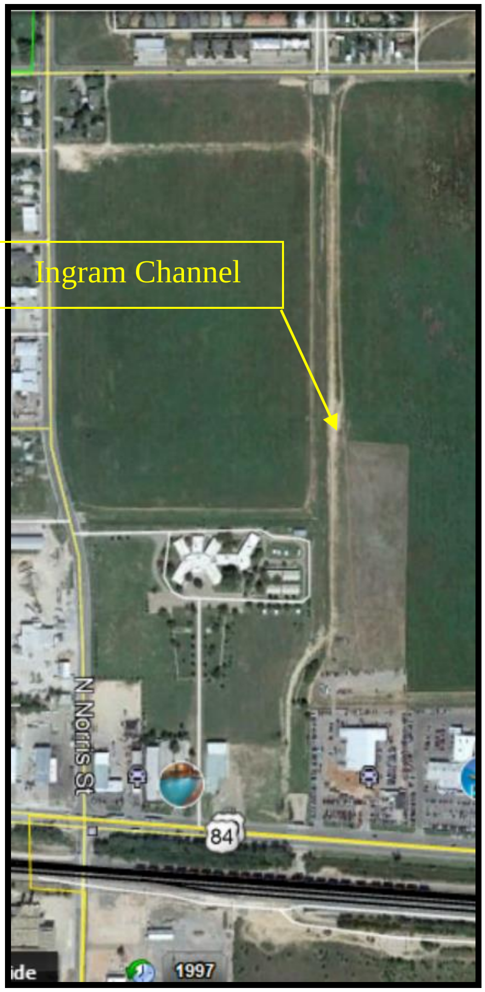

FIGURE 5-4
7th STREET OUTFALL (INGRAM)

5.2.4 Project 1D. Grand Avenue Outfall

The Grand Avenue Outfall Channel will intercept storm flows at the intersection of Norris Street and Grand Avenue. The storm flows will be collected by a series of drop inlets and storm drain pipe that will discharge into a grass lined channel with a 10-foot bottom width and 3:1 side slopes that will run east from this intersection to the 7th Street outfall. This was completed. Figure 5-5 shows the channel in place. The channel is not actually at Grand, but rather at Norris/2nd to the Ingram Channel.

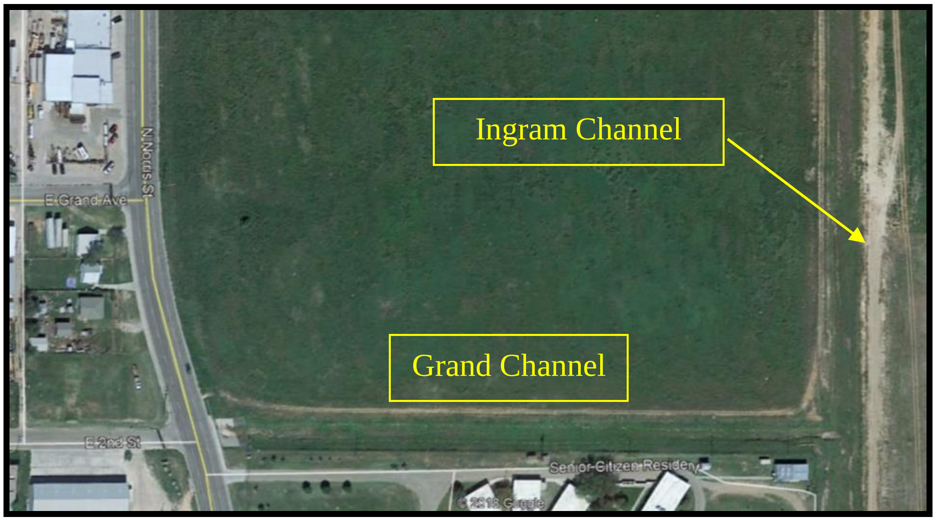

FIGURE 5-5
W. GRAND CHANNEL AT NORRIS

5.2.5 Project 2A. New Pond Improvements

This project proposed increasing the storage volume of New Pond, particularly by raising the elevation of Wheaton Road and expanding the ponding capacity on the west side of Wheaton. This project was completed. This is shown in Figure 5-6 below.

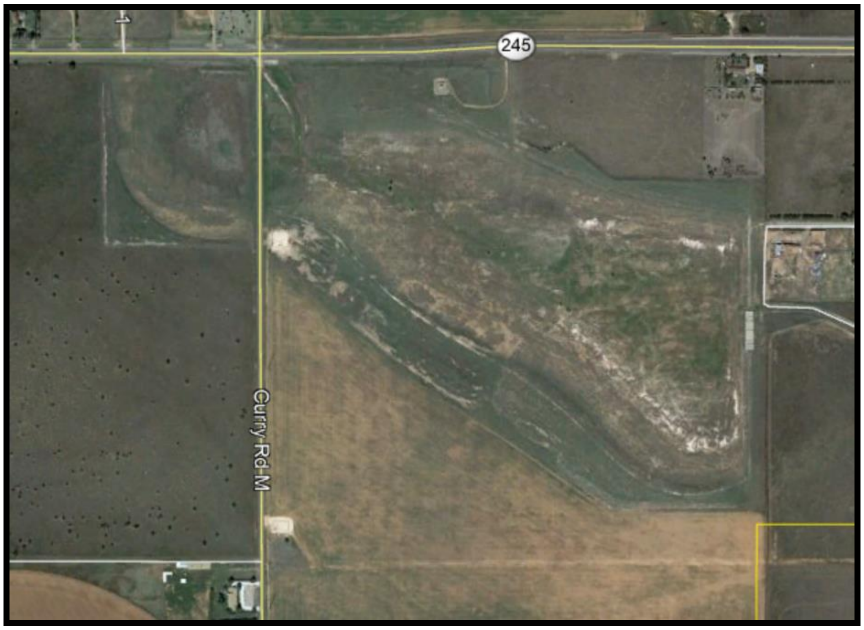

FIGURE 5-6
NEW POND/WHEATON

5.2.6 Project 2B. Sunrise Addition Outfall

The Sunrise Addition currently does not have a dedicated easement for drainage. This project requires the right-of-way be purchased and a grass lined channel with a 5-foot bottom width and 3:1 side slopes be built from the southeast corner of this subdivision to Prince Street. This project was completed. This project is shown in Figure 5-7 below.

FIGURE 5-7
SUNRISE OUTFALL

5.2.7 Project 2C. Bob Spencer Park Channel

This project is located in northwest Clovis, adjacent to the major drainage path below New Pond. It envisioned a major culvert crossing over Martin Luther King and constructing a grass lined channel with a 10-foot bottom width and 4:1 side slopes along the southern boundary of the park. Fill from New Pond was used to raise and level the park. Ultimately, this flow reaches Greene Acres Lake. This project was completed.

5.2.8 Project 3A. Norris Storm Drain Crossing

This project was a series of box culverts and open channels that pass flows from the park to the beginning of the 7th Street Outfall Channel. A concrete box culvert was constructed under Norris Street at Marlene Boulevard and was connected to a concrete lined channel that extends down the middle of Marlene to another box culvert structure that connects Marlene to Bob White Court. Marlene Boulevard is now a one way traffic street on either side of the open channel in this reach. Flows pass through the existing playa lakes to another culvert crossing at Marlene and Mockingbird. From here, another open channel connects this box culvert to another similar structure at Mockingbird and 7th. Flows enter the open channel to the south in what becomes Ingram Ditch. This work was completed.

5.2.9 Project 3B. Hillcrest Park Channel Improvements

The Hillcrest Park project was intended to be a grass lined open channel connecting the intersection of 13th and Sycamore to the box culvert at Norris and Marlene. This channel is believed to be 30 feet in width with 6:1 side slopes. The channel bypasses the zoo area to ameliorate zoo flooding. A culvert allows minor flows to pass into the zoo area to provide recreational ponds. This project was completed.

5.2.10 Project 4. Greene Acres Outfall

Previously, Greene Acres Lake was a playa with no outfall. This project constructed a storm drain that allowed the lake to be emptied to an elevation of 4,260. This was to assure that Greene Acres Lake had enough storage capacity to handle a 25-year volume storm. The storm drain conveys flows to the intersection of Fairmont and Prince. Flows then proceed to the Hillcrest Park Channel.

5.2.11 Project 5. Greene Acres Lake Improvements

This project was intended to increase the storage capacity from 170 acre-feet to 204 acre-feet above the minimum pool elevation of 4,260. This additional storage was required to hold the 25-year storm. A portion of this additional capacity came from excavation of the Marshall Junior High School football field down to elevation 4,260. The remainder of the needed storage came from excavation in the Greene Acres Lake area.

5.2.12 Project 6. Chavez Lake Improvements

Chavez Lake is a natural playa lake, located along 14th Street between Hull and Edwards Streets. The improvements at this lake were to consist of increasing the storage capacity from 27 acre-feet above a minimum pool elevation of 4260. An 18 inch storm drain was to connect Chavez Lake to Greene Acres Lake, allowing the two lakes to act as a single lake. Storm flows that collect in Chavez Lake will drain into Greene Acres Lake and thence through the Greene Acres outfall line. The storage increase was completed but the storm drain connection to Greene Acres Lake was not.

5.2.13 Project 7A. Goodwin Lake Improvements

This proposed project consisted of expanding the storage volume from 78 acre-feet to 138 acre-feet. The additional storage would be able to contain the 25-year storm volume and provide protection for downstream residences. In addition, the project recommended a new storm drain from the North Plains Mall to the lake. These flows historically proceeded down 21st Street to Sycamore. This project was not completed.

5.2.14 Project 7B. Colonial Park South Outfall

The proposed improvements were to be the acquisition of an easement and channel construction from Llano Estacado south to Goodwin Playa. The channel was to be grass lined with a 10-foot bottom width and 3:1 side slopes along the west side of Lawn Haven Cemetery. Instead of a channel, a storm drain was completed from Llano Estacado to Goodwin Playa in the same right-of-way. Portions of this project were completed. The downstream improvements to the east were not completed.

5.2.15 Project 8A. Sycamore Street Storm Drain

The Sycamore Street Storm Drain was proposed to begin at the intersection of 21st and Sycamore and run down Sycamore to the Hillcrest Park channel. It was proposed to be a 72-inch diameter pipe. A series of drop inlets from Lexington Road to 21st Street were to intercept flows above the intersection of Sycamore and 21st, thereby preventing flows from continuing down Avondale and Willshire Boulevards. This project was completed.

5.2.16 Project 8B. 21st Street Storm Drain

This project was proposed to begin at the intersection of Prince and 21st Street and connect to the storm drain at the intersection of 21st and Sycamore (Project 8A above). A series of drop inlets was proposed along the storm drain to intercept runoff and keep the intersection of 21st and Prince open during runoff events. This project was completed.

5.2.17 Project 9. New Pond Outfall

This project included a channel downstream of the New Pond spillways. It proposed culvert crossings under Thomas (now Martin Luther King Boulevard) and improvements through Bob Spencer Park. This was proposed as a grass lined channel with a 10-foot bottom width and 3:1 side slopes. Its principal benefit was believed to be to allow development to occur in the area. This project was completed.

5.2.18 Project 10. Colonial Park East Outfall

This project proposed to intercept runoff from the intersection of Norris and Llano Estacado to the Section 33 Playa Lake. The channel was proposed to be a 10-foot bottom width with 4:1 side slopes. The intent of this project was to keep runoff from continuing south on Norris and overloading that downstream system. The proposed project was to also have included purchase of the land for the Section 33 Playa. Portions of this project were completed. The playa was purchased but the downstream sections to the east were not completed.

5.2.19 Project 11A. Thomas/MLK/ Worthington Ditch Improvements South of Grand

This project proposed a new culvert crossing at Avenue M, enlarging the box culvert at Brady and construction of a grass lined channel from Brady to the Conestoga Hills Lake. This project was completed. However, no channel improvements were made south of Brady to Conestoga Hills Playa.

5.2.20 Project 11B. Conestoga Hills Lake Channel Improvements

The lake capacity as stated was 585 acre feet, or the 50-year storm volume. The proposed improvements include acquisition of the lake property, easements from Martin Luther King and Wheaton in order to also construct channels in those locations. Not all of this project was completed.

5.2.21 Project 11C. Thomas (Worthington) Ditch Improvements North of Grand

The proposed project included replacement or enlargement of all the culvert crossings between Aspen and 21st Street. The existing box culverts at 7th Street are capable of passing the 25-year storm and were not believed to be in need of improvement. The Thomas/MLK/Worthington Ditch was also recommended to be improved by widening to a 20-foot bottom width from Jefferson to 7th Street to increase the ditch capacity. Not all of this work was completed. There is no consistency in the size or number of culverts on roadway or driveway crossings.

5.2.22 Project 12. Thornton Street Storm Drain Crossing

This proposed project included a 72-inch diameter culvert to pass runoff across Thornton. This pipe was to discharge into the existing channel east of Thornton. The intention was to keep Thornton passable during a 10-year event. This project was not completed.

5.2.23 Project 13. Senior Citizens Park Improvements

This proposed project was to increase the storage volume from 27 acre-feet to 31 acre-feet to contain the 25-year storm volume. The project was to include walking paths, sidewalks, and security fencing. This project was completed, however, no walking paths, sidewalks, or security fencing were part of those improvements.

5.2.24 Project 14. Santa Fe Avenue Outfall

This proposed project was to include a drainage channel and storm drain connection to the existing 48 inch storm drain in Norris. It is the area bounded by Santa Fe Avenue on the north and Mabry on the south. This project was completed independent of the recent Mabry (NMDOT) reconstruction project.

5.2.25 Project 15. Wheaton Street Channel Improvements

The proposed project included widening the existing ditches along the west side of Wheaton Street to 10-foot bottom widths and 3:1 side slopes from Wilhite to Conestoga Hills Playa Lake. Runoff north of Wilhite would be channeled east along Wilhite, while runoff south of Wilhite would be collected in road ditches and directed into New Pond. Runoff north of 21st Street and Wheaton would be directed to the south into the existing playa in the northwest corner of Section 11 (Circle of Trees). This existing Playa was believed to have 64 acre-feet of storage. The proposed project suggested elevating the berm along the southeast side of the playa, which would increase the storage to 160 acre-feet, i.e., the 100-year event. The Wheaton Channel would then continue south to 7th Street. The existing box culverts at 7th were believed to be capable of passing the 25-year storm. The channel improvements would then continue south to the railroad, with a new culvert beneath the railroad and thence to Brady. A new culvert crossing at Brady was proposed and channel improvements down to Conestoga Hills. This project has not been completed.

5.2.26 Project 16. Wilhite Road Channel Improvements

The proposed project was to have begun at the intersection of Prince and Wilhite and run east along the north side of Wilhite to east of Norris. The channel was to then turn south to Country Meadows Lake (Section 33 Playa, i.e., the 801 Playa). The proposal was to also include acquisition of the property containing Country Meadows Lake (i.e., the 801 Playa). This project was recently completed with significant roadway and storm drain improvements to Wilhite in 2017.

5.2.27 Project 17. Sorgen Lake Improvements

The report stated that this playa had a capacity of 340 acre-feet which is "much greater" than the 100-year storm. However, at the top elevation, Llano Estacado would be submerged. The proposed project was to elevate the roadway to the top elevation, acquire the Sorgen Playa property, and acquire easements for channels and channel improvements. One channel was to begin at Prince, thence west into Sorgen. The other channel was to expand the County road ditch north of Thornton and Wilhite to a quarter mile south of that intersection. Flows would then be directed via culvert under Thomas/MLK that would flow to Sorgen. It appears that these projects were completed.

5.2.28 Project 18. Hartley Playa (Ridley Playa) Improvements

The report stated that Hartley Playa had 380 acre-feet of storage, which is capable of storing the 100-year flow. The proposed improvements were channels, road ditches, and improved inlets to divert runoff to this Playa. This project was completed.

5.2.29 Project 19. Section 4 Playa Improvements

This playa is in the far northwest area of the City, south of Llano Estacado and west of Curry County Road N. The report stated that this playa had 500 acre-feet of storage, which was able to contain only a 50-year storm. The proposed improvements included enlarging the county road ditches north of this playa and providing culvert crossings that will prevent runoff from going east towards the City. This project was probably not completed. It is far northwest of the City. While a strategic point, as it keeps runoff out of the City of Clovis, every effort should be made to utilize this location for runoff storage.

5.2.30 Project 20. Priebe Lake Improvements

The report stated that this playa had a capacity of 206 acre-feet, capable of storing the 100-year volume. The proposed improvements included improving county road ditches to the north and provide entrances into this playa that will then prevent runoff from entering Llano Estacado. This project was completed. The City is currently removing silt from this playa.

5.2.31 Project 21. Grand Avenue Storm Drain

This project proposed a storm drain from Grand Avenue and Prince Street to Norris. This system would connect to the Grand Avenue outfall improvements. This project was not completed and it will be included in the recommended improvements of this report.

5.2.32 Project 22. Lockwood Addition Outfall

This project was to have provided an outfall for this area. The improvements were to include a drainage easement from the end of Woodson Way, south to Kimberly Lane, and construction of a grass lined channel with a 10 foot bottom width and 4:1 side slopes. It does not appear that this project was completed.

5.3 1992 Flood Insurance Study and New Pond Improvements

This report was completed by Boyle Engineering. It stated that a FIS was completed in 1981 which established flood plains in Clovis. The 1981 study enrolled the City of Clovis in the Flood Insurance Program. This was an interesting study in that it ran models of the playas empty, half full, and full. The results are listed in Table 5-1.

TABLE 5-1
FLOW RATES

Watershed	Clovis FIS	HEC-1 Playas Full	HEC-1 Playas Half Full	HEC-1 Playas Empty
NE Drain	3300	3300	2000	800
NW Drain	4500	3800	2400	1200
Combined	6200	6600	4000	1800
Thomas (Worthington) & W 2nd	2490	2500	2200	2000
All Basins	8100	8400	5800	3700

While this study did not change the established flood plains in Clovis, it did point out that new hydrologic modelling, in fact, reduced flow rates that were used in the establishment of the flood plain.

5.4 1994 Marlene Avenue Report and Storm Drain

This project was crucial to the midtown area in Clovis. The Marlene System established the Marlene Pond and included significant storm drain improvements to carry runoff from the Greene Acres Lake to 7th Street at the Ingram Channel.

5.5 1997 Report and Design Ingram Dam to 7th Street Channel

This project included improvements to Ingram Dam. Ingram Dam now has a principal spillway and an emergency overflow spillway to safely allow overflows over the dam embankment. The channel into Ingram Dam is now improved significantly from the dam, northward to the BNSF crossing and the Mabry crossing and all the way to 7th Street at Marlene.

5.6 1998 Dennis Chavez Lake Dredge, Report and Construction

Due to frequent flooding in this neighborhood, a dredging project was completed to increase the storage capacity of this playa, as it has no outfall. According to that design report, the current condition of Dennis Chavez Lake had 20.3 acre-feet of "good storage". Meaning that 20.3 acre-feet could be stored in the lake without any significant impacts to the park, roadway, homes, or other structures.

The report indicated that the contributing drainage area to this lake only extended to 21st Street and Martin Luther King Boulevard. The contributing drainage area also included some areas north of 21st, but rather minor in size. The report stated that the 100-year 6-hour storm had a rainfall amount of 4.7" and produced a total of 80.33 acre-feet of runoff. The curve number used was 77.

The recommendation was to dredge the lake by approximately 20 feet, which would provide a total of 82.5 acre-feet of storage, somewhat larger than the 100-year volume. This project was completed and additional storage was provided.

However, flooding continues to occur in this location, even with rainfall amounts of less than the design storm of 4.7”. Approximately 2.9” of rainfall cause the area to flood and City crews must begin pumping operations.

The issue is probably due to the fact that this lake has a permanent pool. If the lake was dry and the 100-year storm were to occur, the lake could probably have capacity to hold the 100-year storm. Since the contributing drainage area is mostly developed urban areas, it is not likely that sediment is accumulating to reduce storage.

Dennis Chavez Lake is in need of a controlled outlet that will provide pumping of water from this area to a storm drain. When storms are anticipated, the City could begin draining the lake before the rainfall occurs to provide additional storage.

This report will recommend that a pump station and permanent outfall be provided for Dennis Chavez Lake, due to the continuing flooding at this location.

5.7 1999 Southside Marshall Field Drainage Improvements

This project provided a creative solution to the Greene Acres Lake flooding. Greene Acres Lake now has a gated outlet. When storms occur, the gate can be opened, Greene Acres Lake drained somewhat, and Marshall Field accepts the runoff from Greene Acres. Marshall Field is a football field with a “track” surrounding the field. When Marshall Field floods, it causes no property damage. Soon after, the waters recede and the track is filled, which allows the football fields to dry and be used.

5.8 2006 Newman Pond

The Newman Pond is located north of Marlene, east of Mockingbird, and south of Bob White Court. This pond receives flows from a storm drain under Bobwhite Court, detains these flows and then releases the flows at the Marlene/Mockingbird intersection. From this point the storm drain conveys the flows to the Ingram Ditch at Marlene and 7th Street. The upstream system begins at Fred Daugherty Avenue and Hammond. The storm drain travels from this point down Fred Daugherty, Howard Cowper, Peacock Plaza, Chapparal Circle, Chapparal Avenue, and then south to Newman Pond at Bob White Court. The storm drain is 36 inches in diameter, expanding to a 42 X 31 inch at the intersection of Chapparal Avenue and Chapparal Circle. It was constructed in 2006 and was presumably designed for a 25-year one-hour storm.

5.9 2007 City of Clovis Comprehensive Plan

While the comprehensive plan does not directly address drainage issues, the 2007 comprehensive plan does address the City's desire for orderly and controlled development. As such, it affects and impacts drainage management. As undeveloped lands become developed, pervious lands turn to impervious lands, which increase drainage runoff that must be controlled.

The comprehensive plan indicates different types of development: residential; commercial; and industrial. The comprehensive plan should then include dedicated areas for certain items like school sites, park sites, and drainage facilities. Where possible, the comprehensive plan should ensure that dedicated drainage facilities, especially rights-of-way for channels, storm drains, and detention ponds are preserved for orderly development.

The comprehensive plan was reviewed during the development of this master plan.

5.10 2010 FEMA Study Update and New Drainage Ordinance

A Flood Insurance Study (FIS) and Flood Insurance Rate Maps were completed in 2010. The FIS Number was 35009C000A. This study indicated that FIRM effective dates prior to this study were February 4, 1981 and again on August 23, 1999.

A brief summary of the peak flow rates from this study were as follows:

Thomas (Worthington) Ditch at Grand Avenue	1,720 cfs
Thomas (Worthington) Ditch 2 Inflow to Circle of Trees	720 cfs

At Jefferson Street	420 cfs
At Seventh Street	840 cfs
Priebe Playa Inflow	1,670 cfs
New Pond Inflow	2,090 cfs
Greene Lake Inflow	1,960 cfs
Sorgen Playa Inflow	2,960 cfs
Goodwin Playa Inflow	1,670 cfs
Hillcrest Park	2,080 cfs
Mabry/Norris	2,030 cfs
Maybry/Humphrey (all flows combined)	4,060 cfs

5.11 2011 LOMR

This 2011 project was a study conducted of the entire City of Clovis and essentially established the current flood plain. Flood Insurance Rate Maps were published and are contained in Map Number 35009C0590D.

A FIS was published containing certain details of the mapping effort. The FIS Number was 35009CV000B. Additional information regarding this study was presented in earlier sections of this report.

5.12 2012 FIS

A FIS was published containing certain details of the mapping effort. The FIS Number was 35009CV000B. Additional information regarding this study was presented in earlier sections of this report.

Northeast Drain	
Wallace	762 cfs
Goodwin Lake	1,150 cfs
N. Norris/Marlene	1,565 cfs

	Mockingbird/7th	2,464 cfs
	Confluence w/ NE Distributary	1,464 cfs
	BNSF	3,112 cfs
NE Distributary		
	At Confluence with NE Drain	1,798 cfs
Northwest Drain		
	At Taylor Lane	389 cfs
	At N. MLK/W Manana	761 cfs
	At Sunland/Harrison	1,764 cfs
	At E 21st/N Main	966 cfs
Thomas (Worthington) Ditch 1		
	W 21st/N MLK	276 cfs
	Confluence w/ Thomas (Worthington) Trib.	715 cfs
	W 7th/N MLK	1,034 cfs
	Santa Fe Road/N MLK	1,143 cfs
Thomas (Worthington) Ditch 2		
	Wheaton	848 cfs
W Second Street Drain		
	N Upsilon/W 7th	312 cfs
	N Upsilon	412 cfs
	N Upsilon/W Grand	912 cfs
	L Casillas/Reid	2,047 cfs

5.13 2012 CLOMR

The Conditional Letter of Map Revision (CLOMR) was prepared specifically for the Prominade Park development located in the northeast area of Clovis. The CLOMR is conditional, meaning that a study can be submitted for FEMA review before construction begins, in order to determine if the flood plain provisions are being adequately addressed or flood plain limits established after the development is constructed. It provides some assurance to a developer that they may proceed with their development with adequate flood plain protections.

5.14 2013 MLK Construction Drawings and Drainage Report

This project was for the primary purpose of extending a significant sanitary sewer line on Martin Luther King from 21st to Llano Estacado. The roadway typical section was also reconstructed from a rural section to a roadway with curb and gutter. The culvert crossings on the New Pond outfall towards Bob Spencer Park were reconstructed and the curb and gutter required more controlled drainage runoff into drop inlets and into this channel. The 100-year discharge for this culvert crossing was 91 cfs.

5.15 2014 Current Norris Street Improvements

This project included various drop inlets and storm drain along Norris, which discharge to an open channel at 2nd Street. 2nd, Grand and 4th Streets have transverse drop inlets on the west side of the street which capture all of the street flows and convey these flows to a storm drain. The outfall channel extends from Norris east to the Ingram Ditch. This project is complete.

5.16 2014 NMDOT US 60/84 Improvements, Prince to 7th Street

This project is a NMDOT lead for the purpose of making roadway improvements to US 60/84 from the Veteran's Park through W. Grand and 1st Street to approximately Prince Street. As a part of the project, a new storm drain will be installed. In addition, several ponds are being proposed for retention of high flows. One of the proposed ponds is the Cameo Pond, which is located on the north side of Grand and the east side of Cameo Street. This land must first be purchased by the City for construction of a pond. It is felt that this pond will be useful in detaining flows from the upstream end of this project and released slowly as the storm drain system empties.

Other ponds are being considered throughout the project length, mostly on surplus land, that will enable surcharges to be stored in these areas rather than on the street itself.

At the present time, this drainage master plan included an option of a proposed Cameo Pond which would store around 100 acre feet of runoff. This has been closely coordinated with the NMDOT project to improve US 64/80 which also has plans for some storage in a pond located at Cameo. The NMDOT project requires approximately 20 acre-feet of storage. This Master Plan has included ponds at Cameo for an estimated 100 acre-feet of storage to accommodate Dennis Chavez Lake and other upstream watershed runoff.

Exhibit 11A now shows that master planned improvements can be incorporated with the NMDOT project improvements. The NMDOT pond excavation can proceed first, as long as the property can be acquired and expansion of these ponds can be made later for the drainage master plan requirements.

It is estimated that this new pond at Cameo can reduce the downstream flood plain by 50 percent or more. The benefit to the downstream flood plain area depends on more than just this pond, i.e., proving that the Circle of Trees Playa never overflows and improvements are made to the Worthington Ditch and other projects to make sure that flows are directed south and not east along US 60/84.

5.17 Summary of Previous Work

The previous work for drainage improvements has been rather extensive, covering many of the most severe flooding problems in the City. Projects covered virtually all areas of the City. The design criteria for all previous projects has not been consistent, meaning that not all were designed for the 100-year storm event. Some were designed to the 25- or 50-year event. This can be problematic for the flood plain, which is based on the 100-year design.

Analysis of previous work assists in recognizing future needed projects. The current flood plain indicates areas which need focus for infrastructure improvements. The next areas of concern are primarily the US 60/70 corridor, the northeast areas, Wilhite, and 7th Street. Additional west to east conveyance paths should also be considered in order to intercept additional flows before they reach 1st Street and Mabry.

The Wilhite area has been somewhat addressed with the recently completed project from Prince to the 801 Playa. Wilhite was reconstructed and included a storm drain which discharges to this playa. Future improvements include channelization of an outfall channel from the 801 Playa to Gouker Pond. New development in this area includes this channel.

7th Street has also been somewhat addressed from Main Street east, with a project that has been designed and will go to construction soon. This includes reconstruction of the roadway with a storm drain that discharges to the Ingram Ditch near Marlene. This storm drain includes a 60" stub-out to the west at Main for future extension in 7th to near Reid Street.

The US 60/70 Corridor has also been addressed somewhat in the recently completed roadway reconstruction with a storm drain from Prince to the outfall to the Ingram Ditch near Tennessee Street. In addition, the US 60/84 Corridor, Grand Avenue and First Street from Martin Luther King Boulevard to Prince Street is also under design to include roadway reconstruction and a new storm drain. This is a NMDOT led project and is expected to be in construction in 2022.

Grand Avenue from Prince Street to Norris is another needed project and is not yet under design. This area experiences flooding currently and improvements on this corridor will intercept flows that now reach US 60/70 or Mabry.

In addition, several projects to improve the playa lake ability to ameliorate flooding will also be considered.

6.0 DRAINAGE ORDINANCE

6.1 Existing Ordinance

Design/Evaluation Storm – FEMA's national standard for floodplain evaluation is the 100-year, 24-hour storm. The City of Clovis previously adopted the 25-year, 1-hour storm as its design storm and has used this storm for the design of most of its significant storm drainage facilities with the exception of New Pond, which was for the 100-year 6-hour storm. The peak rates of runoff generated by the 25-year, 1-hour storm are relatively large within the urbanized portions of the city and come very near to equaling those generated by the 100-year, 24-hour storm. The result is that most recently designed storm drains and channels function well, even when evaluated with the larger storm. Therefore, in many areas of Clovis, the resulting floodplains are only marginally larger when evaluated with the 100-year storm when compared to the results from a 25-year, 1-hour storm.

While peak rates of runoff from the FEMA storm are somewhat larger than those from Clovis' design storm, the runoff volumes are significantly higher (as would be expected from a 120% increase in rainfall volume: 2.72 inches verses 5.97 inches). The impact from this increased rainfall volume is most dramatic in the evaluation of ponds and playa lakes. All ponds and playas designed for the 25-year, 1-hour storm volume will spill and create downstream flooding when evaluated with the 100-year, 24-hour storm. In general, a pond or playa designed for the 25-year, 1-hour storm will have little or no impact on the size of the downstream floodplain.

- FEMA requires the 100-year, 24-hour storm for floodplain evaluation.
- The 100-year, 24-hour storm produces somewhat higher peak rates of runoff and substantially higher runoff volumes.
- Floodplains based on the 100-year, 24-hour storm will always be larger than those based on the 25-year, 1-hour storm.
- Ponds and playas designed for the 25-year, 1-hour storm have little impact on reducing or preventing downstream (FEMA) flooding from a 100-year, 24-hour storm.

It is recommended that the City of Clovis adopt the 100-year, 24-hour storm as its design and evaluation storm.

6.2 Drainage Policy Relating to Development

There are several general drainage policy approaches common to the regulation of development when it comes to drainage design criteria. The three listed below are the most common (although there are numerous examples of permutations within each general policy) and generally describe the range of community philosophies that exist around the arid southwest.

6.2.1 Downstream Capacity

If the drainage Master Plan recommends a set of system improvements that eliminate flooding on all private property based on existing hydrologic conditions in their respective watersheds, that will, in effect, establish a policy of setting future developed discharges at existing (pre-development) rates (and in some cases volumes). This will, in most cases, require ponding somewhere near the new development of about 50% of the developed runoff volume with a slow release rate (release in 24 hours) or it would require/allow the developer to upgrade the downstream system to prevent the downstream capacity from being exceeded. In some cases, the cost associated with the system improvements required to eliminate a particular downstream floodplain may exceed the perceived benefits. It may be shown as a recommended improvement in the Master Plan, but its priority would be low. This would effectively require onsite mitigation (ponding) regardless. This circumstance may make some land more readily developable than other lands depending on the cost of improving the downstream drainage system.

- Allowing development to increase downstream flooding is contrary to NM Case Law.
- Once understood a Downstream Capacity based drainage policy is viewed as fair.
- Most of the time a Downstream Capacity based drainage policy creates drainage treatment options for development from which a financial decision can be made.

- A Downstream Capacity based policy creates opportunities for public/private and private/private partnerships to solve drainage problems on a more regional and cost effective basis.

6.2.2 Free Discharge

If the drainage Master Plan assumes that undeveloped areas within the City's growth boundary are fully developed and proposes a set of system improvements that accommodate those flows while eliminating all flooding of private property, it would establish the policy of the City building (perhaps through various funding options and developer cost sharing agreements) larger facilities initially which will have capacity to accept the increased flows without increasing or creating flooding. This would be considered a very development friendly policy. The overall cost to the community (public plus private) would be lower in capital costs, administrative costs, and life cycle costs since it is almost always more efficient to solve drainage problems regionally than on site. However, this is often difficult to sell to the general public who may perceive this as government subsidizing development.

- A Free Discharge Based Policy is in the long run, the most cost effective and development friendly policy.
- A Free Discharge Based Policy requires an upfront public capital investment but should generate considerable life cycle and administrative savings over the life of the projects.
- If the funding is not available to construct the needed facilities up front, temporary facilities have to be constructed until the permanent improvements are in place. This may result in the loss of any savings in both capital and administrative costs.

6.2.3 100% Onsite Ponding

If the undeveloped areas within the City's growth boundary are modeled as zero discharge (100% ponding of **all** runoff from 100-year, 24-hour storm on the site), it could have these potential system impacts:

- 100% Onsite Ponding might eliminate many of the existing floodplains in the northern part (non-US 60/84) areas of the City.
- 100% Onsite Ponding would certainly reduce the size of any downstream system improvements required to eliminate floodplains.
- 100% Onsite Ponding would be viewed by some as very development un-friendly.
- 100% Onsite Ponding would immediately create some winners and some losers, depending on location. (This is already true, but not apparent to most land owners and developers.)
- 100% Onsite Ponding will create long term maintenance and administrative problems for both the City and future property owners.

It is recommended that the City of Clovis adopt a Downstream Capacity based drainage policy.

6.2.4 Examples of Other Municipal Ordinances

- Village of Los Lunas. The Village of Los Lunas drainage ordinance closely follows the City of Albuquerque Development Process Manual (DPM). However one difference is that the Village allows on-site retention ponds whereas the City of Albuquerque does not. These retention ponds are designed for a 100-year, 24-hour storm. In Los Lunas, there are no sufficient outfalls to the Rio Grande in order to govern drainage of these ponds. Middle Rio Grande Conservancy District (MRGCD) irrigation ditches and canals prevent this from happening. Nevertheless, these retention ponds appear to be working well.
- City of Albuquerque. The City of Albuquerque prohibits retention ponds unless on a temporary basis. Generally, the City of Albuquerque requires that the infrastructure be designed to a 100-year 6-hour storm with one driving lane in each direction to be dry for emergency vehicle access and for homeowner access. Standard curb and gutter heights are eight inches rather than a more standard six inches to increase the street capacity. Detention ponds are designed to a 100-year, 24-hour storm to accommodate for the additional volume of runoff.

6.3 Recommendations for Ordinance Changes

It is recommended that the City of Clovis amend the local drainage ordinance and policy to accommodate the 100-year, 6-hour storm for runoff and the 100-year, 24-hour storm for ponding. This will enable the City of Clovis to grow in such a way so as to not adversely impact the local established flood plain areas. If a lesser storm is used for site development, then the established flood plain only gets worse.

Variances to this policy could be given on a case by case basis. For example, on smaller development, a site could provide its own retention pond if there is not an available outfall.

6.4 Differences Between Design Storms

For a perspective on design storm effects, this section is intended to provide general guidance in the magnitudes of difference in the considered design events. First, the rainfall depths for the different design events are as follows:

25 year, 1-hour	2.72”
100 year, 6-hour	4.89”
100-year, 24-hour	5.97”

While the rainfall depths appear to differ significantly, they actually produce similar peak flow rates for design. The 100 year, 6-hour rainfall is 1.80 times as large as the 25 year, 1-hour event. However, it may produce the same peak flow rate on a watershed as the 25-year, 1-hour event. That is because the 2.72 inches of rainfall is spread over 1 hour, a very intense but short storm. The 100-year, 6-hour storm has a higher rainfall depth but it is spread out over six hours, producing a larger volume of runoff but not necessarily a significantly higher peak discharge rate.

However, there are differences in runoff volumes from these storms. These are summarized in Table 6-1.

TABLE 6-1
RAINFALL/RUNOFF COMPARISONS

Event	P, in.	CN 60	CN 70	CN 80	CN 90
25-year,1-hour	2.72	0.24	0.56	1.04	1.73
100-year, 6-hour	4.89	1.24	1.96	2.80	3.77
100 year, 24-hour	5.97	1.90	2.78	3.75	4.82

For the 25-year, 1-hour storm, 2.72 inches of rainfall produces 0.25 inches of runoff for a watershed with a curve number of 60, i.e. relatively natural, undeveloped ground cover. This same storm produces 1.73 runoff for a curve number of 90, which represents a very developed and mostly impervious water shed.

For undeveloped lands, a curve number of 60, the 100-year, 6-hour storm produces five times as much runoff than the 25-year, 1-hour storm. However, the same comparison for developed lands, a curve number of 90, shows that the 100-year, 6-hour runoff is only two times the runoff volume produced.

Obviously, the comparison depends on the curve number of the land cover. Similarly, for the 100-year events, the 24-hour storm yields 1.5 times as much runoff than the six hour storm for the 60 curve number but only 1.3 times as much runoff for a curve number of 90.

6.4 Regional Pond Concept

The City of Clovis is interested in implementing a regional pond concept for future development. This concept is intended to allow future development, but at the same time ensure that developers are paying their fair share of storm drain infrastructure costs.

Consider an area that is to be developed. In the Figure 6-1, the gray shade is the drainage area that flows to a theoretical regional pond and a single discharge point or outfall as labelled. In this area, three developments are being considered.

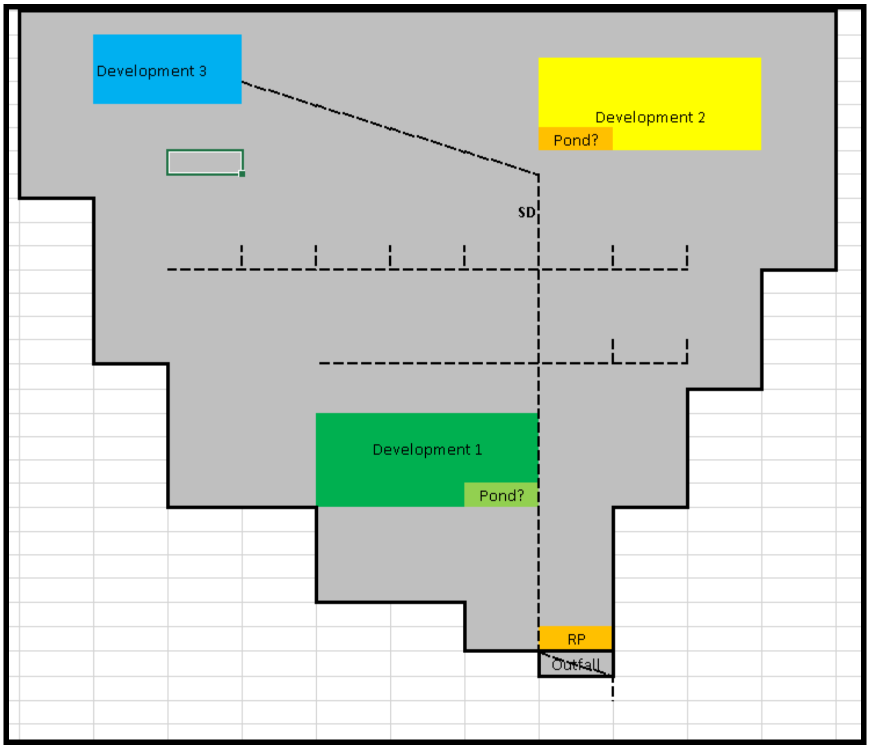

FIGURE 6- 1
THEORETICAL WATERSHED AND DEVELOPMENT

A developer should be able to develop the property, but not so as to cause adverse conditions downstream or upstream. The development must accommodate off-site flows and the development flows (existing vs. developed flow conditions) so as to not cause adverse downstream conditions. However, these individual and small developments do not necessarily address the big picture of the entire watershed and the infrastructure needed to accommodate drainage once the entire drainage area is developed. Yet, the City needs to be able to accommodate the development needs for the residents and businesses of the community, even though the drainage infrastructure is not yet in place.

Once fully developed, the drainage area shown above might have a storm drain system as shown, with a regional pond for controlled outfall. However, that system will not be fully known until the entire area is developed. The issue is how to accommodate individual developments and have them pay for their fair share of the ultimate infrastructure, when that infrastructure is not yet known.

In Clovis, there may be two small, 10-12 lot subdivisions being considered for construction, as shown in the Figure 6-1 as Development 1 and Development 2. If these are to be considered for approval as stand-alone developments, they may be approved as long as they have their own retention ponds to contain (retain) the 100-year flow. Once the entire area is fully developed, and all the proper storm drains are installed, then the retention ponds can be filled and those lots then developed to the benefit of the developer and the developer can re-coup his investment cost.

The problem with this scenario is that these two developers, Development 1 and Development 2 have not contributed anything towards the complete infrastructure cost of the storm drain system and the regional pond. The City, at some point in time, would be responsible for the cost of the storm drains shown and the regional pond shown. Yet the City should be able to have a mechanism to recover some of their costs of the infrastructure, since the infrastructure need was based upon these individual developments.

In an ideal condition, and a condition that actually exists in Albuquerque, where there are much larger developments in a particular area, Figure 6-1 would be addressed in what is known as a Sector Development Plan. In that case, the developer presents a Sector Development Plan for the entire watershed, complete with a final build-out that includes not only the full infrastructure cost for storm drainage, but also for water and sewer infrastructure needed for full development. In addition, such a Sector Development Plan would address street widths and rights-of-way (residential, collector, and arterial), as well as bike trails and other necessities.

Drainage is based on three factors:

Contribution
Access
Protection

Contribution is the amount of runoff and area that contributes to the downstream facility and should always be minimized. Lawsuits are born from upstream properties who contribute more runoff from after development versus before development.

Access means access to streets and roads for emergency vehicles trying to access properities. Many municipalities design storm drainage infrastructure to keep one lane open in each direction for emergency vehicle access during a storm event.

Protection means protection from upstream properties that may flood an individual area. A dam upstream protects many properties that are downstream.

When a small development is considered for approval in a large watershed, it would be cost prohibitive for that developer to design a storm drain system for the entire watershed when that developer does not know how the watershed will develop. Yet even this smaller developer needs to pay for their fair share of the storm drain infrastructure.

7.0 ESTABLISHMENT OF A DRAINAGE USE (UTILITY) FEE

7.1 Intent

Utility systems are generally funded through user fee systems. Drinking water can be metered and billed for each individual user. Sanitary sewer can be based on a facility's water use and billed. Gas and electric can also be individually metered and billed. Hence, the utility is sustained by a user fee system.

Storm drainage has typically been excluded from this user fee system. While an infrastructure in municipalities just like water, sewer, electric and gas, it cannot be easily measured or metered. Determination of a fair user fee system for storm drainage has had much recent nationwide discussion.

The nature of storm drainage makes establishment of a user fee system difficult. There are three primary elements of a storm drain system and hence its cost. These elements are:

- Contribution
- Protection
- Access

An individual property contributes to the downstream storm drain system. The larger the property or the more impervious area a property has, the larger the downstream system must be. As a result, user fees based on property area, would seem fair as larger properties would contribute more runoff to the system.

A property is also benefitted in protection. An upstream system may protect an individual property from flood damage. A drainage improvement upstream of an individual property, such as a diversion channel, may benefit downstream properties by diverting runoff away from a downstream property.

Finally, access is another benefit a property receives in storm drain systems. When properly designed storm drains can be constructed in streets to keep at least one driving lane open, residents, businesses, and more importantly emergency service vehicles can access properties. The intent of a user fee system is to enable the governing authority to create a user-based funding stream that will fund drainage infrastructure projects.

7.2 Existing Drainage Facility Funding

Currently, the City of Clovis funds drainage improvements through a gross receipts tax at 3.9255 mils. This tax generates approximately $400,000 per year. Generally, storm drain systems are far more expensive than their water or sewer counterparts. While a 12-inch diameter water line can deliver water to a large area, a 12-inch storm drain is almost insignificant in carrying runoff. Storm drain systems are generally 18-inch to as much as 66-inch or more in diameter, depending upon the amount of water being transported, making storm drainage projects significantly more expensive than other utilities.

Yearly tax of $400,000 is simply too small a funding stream to construct effective drainage projects. As a result, other grant funds or other funding mechanisms are needed to match these funds.

7.3 Mechanisms

In addition to frequent flooding in some parts of Clovis and the safety and inconvenience related impacts of regularly flooded streets in many other parts of the city, the residents and businesses of Clovis currently send over $380,000 (per City and County records) per year out of the City (i.e., monies sent to FEMA in Washington, DC, and not monies spent in the City of Clovis) in the form of flood insurance premiums. The reduction of FEMA mapped flood plain areas would benefit these residents and businesses, as well as the general economic climate in Clovis. Improving storm drainage infrastructure to reduce the frequency, duration, and magnitude of street flooding will have other non-monetary benefits for the City as a whole. The capital requirements for accomplishing these objectives and for operating and maintaining additional infrastructure are greater than the current funding levels for drainage. At the very least, it would be far better to have Clovis residents spend their dollars on a local drainage infrastructure user fee than sending those same dollars to FEMA in Washington, D.C. This would more directly impact their properties.

The question of how to fund stormwater and flood control, ongoing operations and maintenance, and additional infrastructure projects is common to all New Mexico municipalities. Most, if not all, fund operations and maintenance through their general fund or through a special gross receipts tax increment. Capital projects are usually funded through general obligation bonds or with money from the Legislature and less frequently from general fund sources. Because inadequate funding for storm drainage and flood control is common to all municipalities, the idea of creating a drainage utility, as other states have done, is frequently discussed. The conversation ends once it is recognized that neither the New Mexico Constitution nor the New Mexico Legislature has authorized municipalities or counties to form utilities for storm drainage and flood control purposes. Therefore, what are the funding options for storm drainage and flood control beyond competing for money from the general fund or special sales tax increment?

7.3.1 Property Tax Increment for Drainage

The City of Clovis has available Ad Valorem property taxing authority of 3.9255 mills that it can enact to raise additional funds as needed for drainage and flood control. State law limits the tax rate for flood control to 5.0 mills ($5.00 per $1000 of assessed valuation). Each 1.0 mill will generate approximately $545,200 in tax revenues based on the Revenue Summary prepared by the City for FY 2015. The tax rate (up to the voter approved maximum) may be changed by the Clovis City Commission up to the voter authorized limit by a majority vote of the commissioners present at a duly constituted and advertised commission meeting. The City Commission may authorize the issuance of revenue bonds which are covered by Ad Valorem taxes, if done so in accordance with Section 3-31-4 NMSA 1978. Such bonds can be backed by the general or the local drainage tax.

7.3.2 Curry County Flood Commissioner's Office

Curry County has the statutory authority (*New Mexico Statutes Annotated, Chapter 4 - Counties. Article 50 - Flood Control, Section 4-50-1-17 – County Flood Commissioner*) to create a flood commissioner and through that office, levy up to $1.50 per $1000 of assessed valuation on all property within five miles of a river or stream that either contributes to or is subject to flooding conditions destructive to property or dangerous to human life. If a Flood Commissioner is established and the jurisdictional and taxing boundaries coincided with the Clovis city limits, a $1.5 mill levy would raise approximately $817,000 per year.

NMSA Section 4-50-1. County flood commissioner; appointment; salary - Subject to the approval of the board of county commissioners, there is created the office of county flood commissioner in each county through which runs any river or stream which is subject to flood conditions destructive to property or dangerous to human life. County flood commissioners shall be appointed by the governor to serve for a term of two years, or until their successors are appointed and qualify, and they shall each receive a salary of one dollar ($1.00) a year payable from the county flood fund.

7.3.3 Flood Control District

A Special Flood Control District (*New Mexico Statutes, Chapter 72 – Water Law-Article 18 – Flood Control Districts*) may be formed by the district court and ratified by the voters from within the boundaries of the district for the purpose of providing drainage and flood control. Districts formed under this authority have relatively broad powers to levy taxes, sell bonds, condemn property, establish land use policies to protect the capacity and function of its facilities and construct and maintain drainage and flood control facilities within the district's boundaries. Flood Control Districts can levy taxes for operations and maintenance and may issue general obligation bonds with voter approval. District boundaries can span all or part of multiple municipalities and encompass lands within and outside of municipal and county limits.

7.3.4 Improvement District

Improvement Districts', including Special Assessment Districts, Public Improvement Districts and Tax Increment Districts (*Section 3-Municipalities-Article 33-Improvement Districts NMSA 1978*) allows a municipality to levy a tax for the construction of public infrastructure including "Enhanced Services" which can include fire stations, parks and public area landscaping. These districts are financed with municipal bonds (backed by gross receipts tax). However, funding of operations and maintenance is limited to those purposes related to "Enhanced Services" such as public safety, fire protection, street and sidewalk cleaning, and landscape maintenance in public areas, but it does not allow for the maintenance of basic infrastructure such as drainage and flood control facilities. Storm drainage and flood control infrastructure can be constructed using this tool, but the operations and maintenance funds would have to come from other sources. The procedure for the creation of an improvement district, the sale of bonds and the imposition of a property tax for public improvements is relatively ornate but thoroughly described in Article 33 of Section 3 NMSA 1978.

7.3.5 Drainage Utility

There currently is no authority provided to municipalities or counties in the New Mexico Constitution or State Statutes that would allow a municipality or county to create and operate a utility whose purpose is drainage and flood control. Many states have given such authority to its municipalities and counties and there are hundreds of drainage utilities in operation around the country. Many were created more than 20 years ago and for that very reason, the idea is attractive to New Mexico municipalities and counties as it allows for the creation of a revenue source that does not compete with other general fund activities. Recently, US EPA's push to regulate urban stormwater quality pushed a large number of cities both large and small around the country to create drainage utilities in order to pay for the higher level of service required to satisfy water quality regulations. Stormwater from Clovis does not flow to "Waters of the US" and therefore, is not subject to US EPA stormwater quality regulations.

Drainage utilities generally charge a monthly fee and collect it with the other municipal utility bills. The uses of funds collected are limited to drainage and flood control operations and capital needs. Most rate structures have some relationship to the amount of service received – the greater the amount of storm runoff a property discharges, the higher the rate. Commercial, institutional, and industrial properties tend to have a much larger amount of paved area and therefore, pay significantly higher drainage utility fees than single family residential properties. Administration of the rate structure can be simple or very complex, depending on the approach chosen for determining the level of service each property receives. Review of practices from multiple municipalities with drainage utilities shows a general trend that smaller municipalities have the simplest systems and larger ones tend to be much more complex.

A survey was conducted of several cities that are operating drainage utilities. A summary of the results follow in Table 7-1. Surveyed cities were selected based on either their geographic proximity to Clovis (Lubbock and Amarillo) or their nearness in size in order to provide a range of information to consider. As a review of the results will indicate, the method of determining the drainage utility fee and the range of fees charged are quite variable. The data gives the appearance of each city determining how much money they need/want to raise each year and then devising a system that is both politically acceptable and is related to the level of service provided. Consideration of the data also indicates a wide range of administrative burdens on the part of the cities; some using a simple flat fee based on whether a property is residential or commercial, while some systems require the measuring of paved areas on each lot and then giving credit for the amount and effectiveness of on-site drainage treatment provided.

The monthly charges for residential properties ranged from $1.30 per month to $25.58 per month with the average being $5.27 per month. The monthly charges for non-residential properties ranged from $0.14 per month per 1000 square feet of impervious area to $4.48 per month per 1000 square feet of impervious area with the average being $1.42 per month per 1000 square feet of impervious area. (If a one-acre commercial site is 80% impervious, its monthly charge would be $49.48 per month at the average non-residential rate). Assuming that Clovis has 14,500 residential and 4,000 non-residential properties, a drainage utility with fees equivalent to the averages would generate $2,466,730.00 per year ($916,980 plus $2,375,040 respectively).

Table 7-1 provides examples of other communities in the southwest who have implemented drainage utility fees and how those fees are structured. Table 7-2 provides an estimate of property classifications and their approximate size for the City of Clovis. Table 7-3 provides an estimate of the amount of revenue that the City of Clovis can expect from such a drainage utility fee.

TABLE 7-1
DRAINAGE UTILITY FEE SURVEY

		Single Family Residential		Non-Residential & Multifamily			Credits?
City	**Population**	**System**	**Monthly Drainage Fee**	**System**	**Monthly Drainage Fee**	**Commercial Cap**	**Credit for Onsite Treatment?**
El Paso, Texas	650,000	3 Tiers Based on Impervious Area	$1.49 to $5.94/month	Impervious Area	$3.03/2000 sf ($1.52/1000 sf)	No	Up to 25%
Lubbock, Texas	230,000	4 Tiers based on Impervious Area	$8.80 to $25.58/month	Impervious Area	$25.58/5700 sf ($4.48/1000 sf)	Yes, capped at 150,000 sf	No
Abilene, Texas	117,000	3 Tiers Based on Water Meters or Area Under Roof	$1.85 to $2.95/month	Impervious Area	$0.0005/sf ($0.50/1000 sf) $5.00 min	Yes, capped at $25.00/month	No
Amarillo, Texas	191,000	3 Tiers Based on Impervious Area	$1.71 to $3.79/month	Impervious Area	$39.15/ac ($0.90/1000 sf)	No	No
Keller, Texas	40,000	Flat	$8.00/month	Impervious Area	Ratio to Equivalent Residential Unit	Yes, $66.24/month	No
Eagle Pass, Texas	26,000	Flat	$3.00/month	Total Area	$6.00/acre ($0.14/1000 sf)	No	No
Colorado Springs, Colorado	674,000	Basin Fee Capital Cost (Per Acre)	$0.00 to $13,404/ac	Basin Fee Capital Cost (per acre)	$0.00 to $13,404/ac	No	Cash in Lieu
Flagstaff, Arizona	66,000	4 Tiers Based on Impervious Area	$1.30 to $6.50/month	Impervious Area	$0.87/1000 sf	No	Up to 19.25%
Murray City, Utah	48,500	Flat	$3.55/month	Impervious Area	$2.37/1000 sf	No	Up to 45% for Non-SFR only
Edmond, Oklahoma	81,500	Flat	$3.00/month	Impervious Area	$0.62/1000 sf	No	No

TABLE 7-2
ESTIMATE OF CLOVIS PROPERTIES

Single Family Residential	14,288
Multifamily	2,501
Commercial	1,000
Total Parcels	19,000

TABLE 7-3
PROJECTED REVENUES FROM UTILITY FEES

Land Use	Lowest Monthly Rates	Projected Annual Revenue	Highest Monthly Rates	Projected Annual Revenue
Single Family Residential	$3.00	$514,368.00	$ 25.58	$4,385,844.48
Multifamily	$5.00	$187.29	$4,480.00	$5,483,520.00
Commercial	$5.00	$120,000.00	$4,480.00	$53,760,000.00
Total Annual Revenues		$634,555.29		$63,629,364.48

7.4 FEMA Grants

There are grant programs available from FEMA on the State level. The City has utilized these grants in the past. This is normally a combined effort between the City and County.

8.0 EXISTING CONDITIONS

8.1 Drainage Modeling and Calibration

8.1.1 Pond Pack

The existing flood plain maps and most recent drainage model was created by software known as Pond Pack which is a Bentley Systems product.

8.1.2 HECRAS and HEC HMS

HEC-RAS and HEC-HMS were used in this current master plan. This software is public domain and is virtually free to any future engineering work that might come from this drainage master plan. The first step undertaken in this current drainage master plan was to establish the drainage model, HEC-HMS, for the entire city and compare the results to the earlier model. This was done because simply using a different software package is not valid justification for amending the flood plain maps.

Significant differences were seen in the two models. This is largely due to field validation, accurate field surveys, and obtaining more accurate data than the previous study. A number of field surveys were completed to make more accurate representations in the model of actual field conditions.

For example, in the previous study, Lidar mapping or other mapping was used to assume certain terrain conditions. One of the more significant differences that was discovered was the bridge crossing structure of the Ingram Ditch under Mabry (US 60/70/84) as shown in Figures 8-1 and 8-2. The previous LOMR modelled this location as a simple triangular section. In reality, the channel is a concrete lined trapezoid with 2:1 side slopes.

FIGURE 8-1
INGRAM CHANNEL AT MABRY

FIGURE 8-2
INGRAM CHANNEL AT MABRY

Obviously, this trapezoidal section can convey far more flow than the triangular section that was used in the LOMR model. As a result of this and other findings, this report utilized a field survey contract to obtain more detailed information on key locations throughout the study area. This additional detail enabled the modelling to be much more accurate than the previous study.

Another example of field survey validation can be seen at the Thomas (Worthington) Ditch crossing of Grand Avenue.

Once again, the survey at Thomas (Worthington) Ditch and Grand shows a structure that when modelled correctly, can convey more flow than the previous model portrayed using a triangular section.

Exhibit 4 shows the location of all the field surveys undertaken in this study to more accurately model the structures that are present in the study area. This field validation also led to differences in other hydrologic modelling factors. For example, times of concentration used in this study differed from the previous study due to the field verification and surveys of the actual drainage areas. These factual differences can be used to make flood plain map amendments.

9.0 FUTURE CONDITIONS

9.1 Playas Empty Before Storm

Generally, playa lakes are empty before a design storm hits the area. Playas do retain water for a few days after most rainfall events, but dry in a few days. The exceptions to this are Greene Acres Lake and Dennis Chavez Playa, which both retain a permanent pool for recreational use.

As discussed below, FEMA required the hydrologic model to be run, assuming that all playas are 25% full. Therefore, if there were a means to ensure that the playas were indeed dry at the time of the storm event, a significant reduction in flood plain inundation could be realized.

Some playas, in particular Circle of Trees Lake, can be shown (historically) to never overflow to an outfall. This is evident on aerial photos and in simply walking the grounds around the playa. However, some playas will require a more positive means to evacuate flow prior to the storm event. This can be done by several means.

First, storm drains can be constructed to evacuate the lowest elevation on the pond. This was done on the New Pond outfall which has a gated outlet that enables the gate to be closed during a flood event and then opened to slowly release flows to the downstream channel after the peak has passed. This also ensures that New Pond can be dry when the significant event occurs. This will likely be unfeasible on most of the remaining playas due to the high cost.

Second, pump stations can be constructed to begin playa evacuation before a significant event is forecast or prior to monsoon season in general. Dennis Chavez Lake is one good example of a potential pump station location. Dennis Chavez Lake is in a low spot and cannot gravity drain to any other system. The “natural” or most convenient outfall is to the south along Jones Street, which requires pumping until it can gravity flow south of 10th Street.

9.2 Playas 25% Full Before Storm

FEMA has stated in the LOMR that Playa Lakes must be considered to be 25% full before the modeled storm begins. The simple solution to this 25% full requirement is to simply excavate the 25% volume in terms of earthwork to provide each playa with the needed capacity. While this may seem to be a logical solution, it may not be entirely practical. A quick computation of the volumes of the playa lakes show that 25% of this volume computes to 1,066 acre feet or nearly 2,000,000 cubic yards of material. This is probably excessive in terms of finding a location to store this material, unless there is a nearby project requiring this amount of fill.

Excavating the pond volume by 25% might be a reasonable solution on one or more ponds, on a case by case basis, but would not be a reasonable practical global solution.

Exhibits 5, 6, and 7 in the Appendix illustrate the modelling results that were obtained for this Study. Exhibit 5 illustrates the revised 100 year flood plain if the ponds were modelled as empty. Exhibit 6 illustrates the revised 100 year flood plain with the ponds 25% full. This condition is based on the modelling done for this study. It includes some field verification of certain facilities by survey or observation. For example, this model did not include overrun of the Circle of Trees Pond since there is no evidence that this has ever occurred, nor does the topography indicate that it can occur. Figure 26 illustrates the ponds at 25% full versus the 25-year, 1-hour storm with ponds empty.

9.3 Improvements to Reduce Floodplain Extents

Reduction of the flood plain has a very high potential in Clovis for many reasons. These are summarized in the following sections.

9.3.1 Improved Mapping/Survey

As described elsewhere in this report, this current study refined the existing study by obtaining more accurate data through the use of field surveys on certain areas. One example is the Ingram

Ditch as it crosses Mabry Drive. The previous model used a triangular estimation, whereas field survey showed a much larger trapezoidal section. Having more capacity in this location means that backwater effects are not seen upstream on Ingram Ditch to the north. Another location is the box culvert structure on Grand Avenue at the Thomas (Worthington) Ditch. Again, having better mapping shows that this structure has much more capacity than originally modelled and in fact, can pass the flows to the south to Conestoga Pond and these flows do not contribute to flooding down Grand and hence to 1st Street at Prince.

9.3.2 Projects

As projects are completed which include storm drain conveyance, the potential exists for new mapping and reduced flood plain areas. For example, the flood plain areas concentrate heavily on 1st Street and Mabry as flows proceed eastward. One project, a new storm drain on Mabry from Prince to Tennessee has already been completed. A second project, 7th Street reconstruction includes a new storm drain down 7th Street to the Ingram Ditch. This system will significantly reduce flows that now reach Mabry. Combined, these two systems will create a beneficial impact on flood plain mapping.

A third project, recommended in this plan is a new storm drain in Grand, from Prince to Norris. This would result in a third east/west storm drain system, reducing the flows now getting to Mabry Drive.

Flood plain map revisions should be considered after each of these projects is completed.

9.3.3 Elimination of the 25% Full Requirement

As already mentioned, FEMA previously required that the hydrologic model assume the playas to be 25% full. However, it is still felt that this requirement should be re-visited in future models to see if that requirement can be waived through various means. In some cases, it may in fact be feasible to excavate the 25% volume from the individual playa. However, that would be on a case by case basis. Were there a need for fill material for a large project in the vicinity, the City can entertain that option.

Another avenue that can be pursued is the potential of obtaining data that may prove that the playas can be drained prior to a storm event through various methods. One of those methods being considered is to install a pump station which can pump the bottom 25% storage to a sanitary sewer system, which the City has pursued with NMED and the State Engineer's Office; the proposal was met with interest.

Another critical option to be considered is the fact that Circle of Trees Playa shows no indication of ever having spilled downstream despite how full Circle of Trees may have been at the time of the storm. That is evident on the ground, through contours and measurements taken, and through interviews and comments by many citizens.

Coupled with that evidence on Circle of Trees is the data presented in this report concerning the infiltration and evaporation of the playas and how these factors impact the pond levels of the playas. First, the report analyzed each of the playas in Clovis and measured the infiltration/evaporation of each playa. The report presented pond rating curves of a full pond and an analysis of how infiltration and evaporation will enable that pond to empty.

These data were done in a sensitivity analysis. This means that the calculations looked at the infiltration and evaporation in summer months and winter months. Obviously, summer infiltration/evaporation is somewhat higher than winter months. The data presented showed the worst and best case scenarios so that better estimates can be made. The analysis also considered the soil types in the playa lakes. Some soils are more conducive than others for infiltration.

In the case of the Circle of Trees Playa, a case can be made for the fact that this playa has not nor will not overflow in a flood situation. Adding to that, the playa lake report shows that the soils in this particular area are very conducive to infiltration. In fact, the analysis shows that Circle of Trees will drain itself in a four day time period from infiltration and evaporation alone. This data further assists in substantiating the case that the Circle of Trees Playa could indeed be modelled without the 25% requirement.

While this data works for Circle of Trees, it also helps in showing that some of the other playas, but not all, have equally good infiltration/evaporation characteristics that could influence the 25% full requirement. Some of the better data seen are shown in Table 9-1. This table is based winter conditions and high K_{sat} rates.

TABLE 9-1
PLAYA LAKES I/E TIME TO DRAIN

Playa	Days to Drain
Bomer	7.6
Circle of Trees	4.0
E-2	1.5
E-3	1.5
Zoo (Golf Course)	1.0
New Pond East	3.0
Senior Pond	2.0
Sorgen South	2.5

Not all of the playas resulted in such low times to drain. All are dependent on their particular soil characteristics. What this data does show is that there is a very good potential for further analysis to indicate which playas could have just cause for elimination of the 25% requirement.

All of the playa data is contained in Appendix C of this report.

10.0 PLAYA LAKES INFILTRATION/EVAPORATION/RECHARGE POTENTIALS

10.1 General Information

Dr. Ken Rainwater, PE, PhD from Texas Tech University was contacted by Molzen Corbin to review and interpolate playa data for the Clovis Drainage Master Plan. Their contribution to the Master Plan consisted of two main tasks. The first task was to determine the potential for recharge through the local playas and ponds based on previously published data for the area. This task focused heavily on the depth to groundwater in relation to recharge potential from the playa and ponds. The second task was to collect shallow groundwater data for the City of Clovis vicinity from the state of New Mexico's Internet Water Database. The data was to be analyzed and used to characterize the typical ranges of depth to groundwater and saturation thickness.

10.1.1 Previous Publication and Findings

The Southern High Plains (SHP) of Texas and New Mexico wetlands system consists primarily of playas; these are ephemeral digressional recharge basins that function as storm water runoff catchments. These wetlands and playas support various wildlife and plant species, function as areas of water storage, flood control mechanisms, and are the primary source of recharge to the nearby aquifer system. This aquifer system is the main source of water for irrigation, livestock, and many municipalities in the area. Land use around the playas is generally grassland or cultivated land for crop production. The areas surrounding the playas play a key role because they control the quantity and quality of water that makes it to the playas, and eventually recharges the groundwater system. Playas generally have 0.3 to 1.5 meters of hydric soils and vertisol clays in their bottoms, with Randall or Ranco Clays being more prominent in the SHP. The characteristic of the clays that lines the bottom of the playas greatly contributes to the effect of the surrounding lands and soils, and the infiltration rates of the playas.

The groundwater data used in this study came from the New Mexico Water Rights Reporting System (NMWRRS) maintained by the New Mexico Office of the State Engineer. The study looked at several sets of well data for the 144 square mile study area. Within this area, the average depth to water was found to be 329 feet at the time of the study. The groundwater data also indicated that in and immediately surrounding the City of Clovis, depth to groundwater values were closer to one-hundred (100) feet or less, with some areas having depth to groundwater as low as fifty (50) feet. Increased urbanization resulting in increased runoff to urban playas may have been the reason for these relatively shallow groundwater depths, as seen previously in similar areas such as Lubbock, Texas.

Dr. Rainwater and his associates reviewed several studies that have been conducted in this specific region to better understand the playas, how surrounding lands may affect them, how soil material affects infiltration, the effects of evaporation, and the role of the playas in the water system. These studies concluded that playas surrounded by croplands have faster infiltration losses than those surrounded by grasslands, and the clay that lines the playa bottoms does not prevent recharge into the groundwater. These two conclusions work in conjunction since it has been found that when the clays lining the playa bottoms are dry for an extended period of time, they form large cracks. Those large cracks then become filled with coarser material from the runoff of the surrounding areas, which increase the infiltration flux. Croplands generally have greater sedimentation runoff than grassland because grassland vegetation limits soil erosion. It was also found that playas surrounded by cropland had 8.5 times more sediment than those surrounded by grassland, and therefore, drastically changing the shape of the playa and the hydrolic-soil defined volume. Playas surrounded by grasslands saw much lower decrease in their volumes, usually decreasing by one third of the original volume or less.

Additionally, these past studies determined that there are three distinct periods of infiltration of playas: the first is flooding, generally infiltrating at a high rate due to cracks in the dry clay; the second is a sharp decrease in infiltration due to clay swelling and becoming less permeable; and the third, soil is saturated and infiltration rate becomes constant. Since playas surrounded by grasslands have lower infiltration rates, they tend to hold water for longer periods of time, known as the hydroperiod, which can range from a few days to a few months. This period is vital for plants and animals in the surrounding areas, as these playas may be their main and potentially single source of water. It was originally thought that playas lost most of their water through evaporation, and infiltration was minimal. However, several researchers have concluded that it is in fact the opposite, and more infiltration and recharge takes place than previously thought.

One of the studies reviewed consisted of ten pairs of playas in ten SHP counties; a pair consisting of one playa surrounded by cultivated cropland and the other by grassland. The pairs were similarly sized and had minimum differences in rainfall and surrounding soils. The surrounding areas were carefully looked at and delineated to consider both local topography and influences of roadways and ditches surrounding the playas. The intention of the research was to develop a hydrologic budget model, an accounting of all inflow and outflow of the water system in the area, and directly compare the effects of surrounding lands on the playas.

The hydrologic budget was an application of the law of conservation of mass for the playa lakes. The continuity equation was used to quantify the information. The inputs for this equation were precipitation and runoff, and the outputs were evaporation and infiltration. The water budget developed for this project consisted of the change in storage for the playa, approximated based on water level measurement and movement of the water surface caused by winds and existing land conditions, and an overall estimate of the infiltration through the playa floor. Special onsite weather monitoring stations were constructed for the field efforts of this study; the weather was monitored in that specific area, as well as water depth data.

The results yielded from this study confirmed that playas surrounded by croplands had much higher infiltration rates than those surrounded by grasslands, with some having three (3) to six (6) times longer hydroperiods than their paired grassland playa. This study is ongoing and it is hoped that as it furthers more data and findings will be available. Dr. Rainwater's research and conclusion of these previous studies evaluated in his report can be viewed in further detail in Appendix C of this report.

10.1.2 Task 2 – Clovis Playa Information

The second task given to Dr. Rainwater and his staff was specific to the Clovis Drainage Master Plan, and consisted of a study of data provided for twenty-two (22) playas located in the Clovis, New Mexico area. Topographic information and hydrologic soil characters for the playas were supplied to Dr. Rainwater and his associates by Molzen Corbin and included soil types, ranges of saturated hydraulic conductivities, minimum and maximum ground surface elevations, total depth, and minimum and maximum areas associated with the minimum and maximum depths. The minimum and maximum elevations were assumed to be the closest contours at the site of the playas, and the total depths to be four (4) to forty (40) feet. Although Clovis is not in Texas, it does reside in Quadrant 304 of the Texas Water Development Board (TWDB), and therefore information regarding the free water and lake evaporation data for the twenty-two (22) areas supplied on the TWDB website was considered pertinent to this study.

Dr. Rainwater's task was to provide valuable insight into the potential for recharge from the playas with the information supplied. The intention of the detailed study for the individual playas in the Clovis area was to provide potential predicted behaviors of the playas for planning purposes. Rain events considered in this study, with adequate intensity and duration to meet the design storm conditions, were generally treated as single events. The rain events occurred at different times of the year, so evaporation rates varied depending on the season. The infiltration method that was utilized in this study was to use average infiltration rates observed in the urban and rural playa field studies of approximately 7mm/day.

The volume and area for each playa was calculated and plotted against the corresponding elevation. This yielded expected results that consisted of increases in elevation resulting in an increase in both volume and area, as the pond increased in size. Through various data interpolation, discussed in Appendix C, it was determined that evaporation in the playas has minimal impact on those lined with Ranco Clay, while playas not lined with Ranco Clay saw similar evaporation and infiltration rates. In addition to these observations made for this study and past studies, Dr. Rainwater developed rating curves to describe the losses of water from the playas, caused by evaporation and infiltration, as the water surface recedes from the maximum elevation to the minimum. Information regarding the rating curves can be found in Appendix C. The rating curves contain information necessary for developing water budgets and this drainage master plan. To further this study and the information determined, future site specific geotechnical soil characteristics and observations of playa drainage over time would be valuable information in collaboration with this study's findings.

Each Playa was studied and estimated and detailed results are shown in Appendix C. The study showed that infiltration and evaporation (I/E) effects on the playa lakes are very significant. However, these values vary depending on many factors such as the K_{sat} (infiltration rate, iph), seasonal evaporation rates, depth of water, and other factors. Table 10-1 shows the results for Sorgen Lake North, while Table 10-2 shows the results from Circle of Trees Playa.

TABLE 10-1
SORGEN LAKE NORTH I/E CHARACTERISTICS

	Sorgen North High K_{sat}, Summer	Sorgen North High K_{sat} Winter	Sorgen North Low K_{sat}, Summer	Sorgen North Low K_{sat}, Winter
K_{sat}	.06	.06	0.011	0.011
Min. Elev., ft	4278	4278	4278	4278
Max. Elev., ft	4294	4294	4294	4294
Depth, ft	16	16	16	16
Min. Area, ac	14.18	14.18	50.9	14.18
Max. Area, ac	50.9	50.9	50.9	50.9
Evap. Rate, iph	0.011	0.0033	0.011	0.0033
Time to Drain, d	111.9	126.5	347.8	126.5
Evap. Depth, ft	2.57	0.82	8	0.82
Infilt. Depth, ft	13.43	15.18	8	15.18
Evap. V, af	78.67	25.13	244.55	25.13
Infilt. V, af	410.4	464.0	244.6	464

TABLE 10-2
CIRCLE OF TREES I/E CHARACTERISTICS

	Cir. Of Trees High K_{sat}, Summer	**Cir. of Trees High K_{sat} Winter**	**Cir. Of Trees Low K_{sat}, Summer**	**Cir. of Trees Low K_{sat}, Winter**
K_{sat}	1.98	1.98	0.57	0.57
Min. Elev., ft	4304	4304	4304	4304
Max. Elev., ft	4320	4320	4320	4320
Depth, ft	16	16	16	16
Min. Area, ac	0.12	0.12	0.12	0.12
Max. Area, ac	38.3	38.3	38.3	38.3
Evap. Rate, iph	0.011	0.0033	0.011	0.0033
Time to Drain, d	4	4	13.8	14
Evap. Depth, ft	0.09	0.03	0.32	0.09
Infilt. Depth, ft	15.91	15.97	15.68	15.91
Evap. V, af	0.89	0.25	3.04	0.87
Infilt. V, af	153	153.7	150.9	153.0

Tables 10-1 and 10-2 illustrate two individual conditions; one for Sorgen Playa and one for the Circle of Trees Playa. These two playas are on opposite ends of the spectrum regarding I/E effects. The report was based on known and published data, not so much on actual field data from the individual playas. As a result, the computations were to illustrate a "sensitivity analysis" of sorts. Each playa was analyzed for both summer and winter conditions. The best case scenario is the summer months which have higher evaporation and infiltration rates, while winter months have lower rates. The tables easily shows the differences in those conditions. The analysis is also dependent on individual playa lake soils conditions and playa lake size and depth. The analysis prepared a routing curve for each full playa, with no inflow just outflow via the infiltration and evaporation.

There are significant differences between these two playas, (and all the playas) depending mostly upon their soils condition and adjacent land condition. What should be noted from the tables is that I/E enables the Circle of Trees Playa to drain in only four days while Sorgen takes 112 days, depending upon the condition. Many of the playa lakes have similar low drain rates due to I/E effects, while some others have higher rates. This data could significantly reinforce the argument of waiving the 25% full requirement for at least some of the playas, especially the Circle of Trees Playa which now contributes significantly to flooding along Grand and 1st Streets in the flood plain drainage models. This data could assist in substantiating that the Circle of Trees Playa does not overflow and does not contribute to downtown flooding.

11.0 RECOMMENDED IMPROVEMENTS

11.1 Playa Lake Water Rights/Reuse

During the course of this master plan, the City of Clovis began to take measures to take advantage of the playa lakes and the water they store. In the drought-prone arid southwest, water is a precious commodity. Clovis has the advantage of a playa lake system that is in place. Most of the playas do not drain and runoff collected in them evaporate and infiltrate. Exhibit 2 shows a complete playa lake map of the vicinity.

In order to preserve these valuable water resources, the City of Clovis has initiated activities to: 1) purchase the lands that the playas occupy (land ownership will then be clearly established); 2) purchase the water rights for the runoff in those playas; 3) coordinate, as well as design and construction of pumping facilities to discharge much of the playa lake runoff into the sanitary sewer system, and 4) treat and put into the effluent re-use system to irrigate open space areas. This approach will enable the City to preserve all of its available water resources.

11.1.1 Available Runoff for Re-Use

One of the first issues to be addressed is the actual potential volume of water that can be captured and treated as effluent. To do this, a computation was made to analyze the average annual rainfall expected in Clovis, convert this to a runoff volume, and obtain a total amount of runoff, in acre-feet, that the average annual rainfall will allow. The analysis was done on a month by month basis.

Using the precipitation depth value, an expected runoff volume can be computed using the SCS runoff equation, Runoff (in.) = ((P-0.2)S^2) / (P+0.8S). P is the precipitation depth in inches. S is defined as (1000/CN)-10. CN is defined as the watershed curve number, assumed as 60. Therefore S is 67. The runoff value in inches can then be multiplied by the drainage area to obtain acre-feet of runoff.

The results are in Table 11-1 and Table 11-2.

TABLE 11-1
ANNUAL PLAYA RUNOFF VOLUMES

Month	Mean P In.	Runoff In.	Cir of Trees 663 af	New Pond 2389 af	Priebe 1368 af	Sorgen N 1692 af	Sorgen S 942 af	E1 Ridley 862 af	E2 Country Meadows, 815 af	Total, af
Jan	0.35	0.17	9.4	33.9	19.4	24.0	13.4	12.2	12.2	124.5
Feb	0.38	0.16	8.8	31.7	18.1	22.4	12.5	11.4	11.4	116.4
Mar	0.72	0.06	3.4	12.4	7.1	8.8	4.9	4.5	4.5	45.5
Apr	0.81	0.04	2.5	8.9	5.1	6.3	3.5	3.2	3.2	32.6
May	1.93	0.05	2.7	9.8	5.6	6.9	3.8	3.5	3.5	35.9
Jun	2.39	0.14	8.0	28.8	16.5	20.4	11.3	10.4	10.4	105.8
Jul	2.75	0.25	13.7	49.4	28.3	35.0	19.5	17.8	17.8	181.6
Aug	3.03	0.34	19.0	68.5	39.2	48.5	27.0	24.7	24.7	251.8
Sep	1.84	0.04	2.0	7.1	4.1	5.0	2.8	2.6	2.6	26.2
Oct	1.66	0.02	0.8	3.0	1.7	2.2	1.2	1.1	1.1	11.2
Nov	0.52	0.11	6.2	22.5	12.9	15.9	8.9	8.1	8.1	82.7
Dec	0.50	0.12	6.6	23.7	13.6	16.8	9.3	8.6	8.6	87.1
Total	16.88	1.51	83.2	299.6	171.6	212.2	118.2	108.1	102.2	1,095

TABLE 11-2
ANNUAL PLAYA RUNOFF VOLUMES IN MG

Land Cond.	Cir of Trees 663 ac	New Pond 2389 ac	Priebe 1368 ac	Sorgen N 1692 ac	Sorgen S 942 ac	E1 Ridley 862 ac	E2 Country Meadows, 801 815 ac	Total
CN 60	27.095	97.632	55.906	69.147	38.497	35.227	33.306	356.813
CN 70	43.811	157.867	90.398	111.809	62.248	56.961	53.856	576.953
CN 80	82.366	296.792	169.950	210.201	117.027	107.088	101.249	1084.675
CN 90	153.273	552.291	316.255	391.158	217.772	199.278	188.412	2018.441

Table 11-2 is useful for the WWTP in understanding how much flow could be expected each year at the WWTP for treatment. As can be seen, the total runoff is very, very dependent upon the curve number assumed for the watershed. A 16% increase in curve number results in a 61% increase in the runoff volume.

11.1.2 Land Purchase

In order to purchase the water rights for the playa lakes, it is necessary for the City of Clovis to first purchase the lands upon which the playa lakes occupy. In the past year, the City of Clovis has purchased the Circle of Trees Playa and the Bomer Playa on east 7th Street. The City already owns Greene Acres, Dennis Chavez Lake, and others.

11.1.3 Water Rights

Along with the purchase of the playa lakes, the City is in the process of procuring or claiming water rights for the runoff in the playas. The City has already conducted several meetings with the NM State Engineer's Office regarding this purchase and have gained approval. Purchase of these water rights is similar to a rancher building a pond and claiming water rights for approximately 10 acre-feet of the water stored in that pond. These are known as Farm Rights and the City is continuing to pursue that avenue in acquiring the rights to the water stored in these playa lakes.

11.1.4 Effluent Re-Use

While it is very unconventional to intentionally put storm drainage into sanitary sewer systems, the City of Clovis is pursuing this avenue. The City of Clovis WWTP has excess capacity due primarily to a nearby cheese plant treating their own wastewater.

Storm drainage runoff introduced into the WWTP will or can unbalance the microbiological community in the plant. If the runoff can be introduced slowly so as to not disrupt the treatment process, the process may work. The WWTP operator has been informed of this proposed practice and is willing to accept this runoff into the plant. This process should be carefully monitored, so that the runoff does not interfere with the treatment process. NMED, NM State Engineer's Office, the City, and WWTP operators are all aware of the issues and are currently all in agreement with this proposed process.

11.2 Echols Area

During the course of this study, it was observed that flooding occurs in the Echols/Purdue vicinity. This drainage area is bound on the north by 21st Street, on the west by Martin Luther King, on the east by Echols, and on the south by Purdue as shown in Figure 11-1. A preliminary drainage report showed that the 25-year, 1-hour peak flow was 148 cfs and the street capacity is only 30 cfs. Surprisingly, this area is not in the established flood plain. However, it does experience flooding. Figure 11-2 shows a proposed storm drain route to the Dennis Chavez Lake.

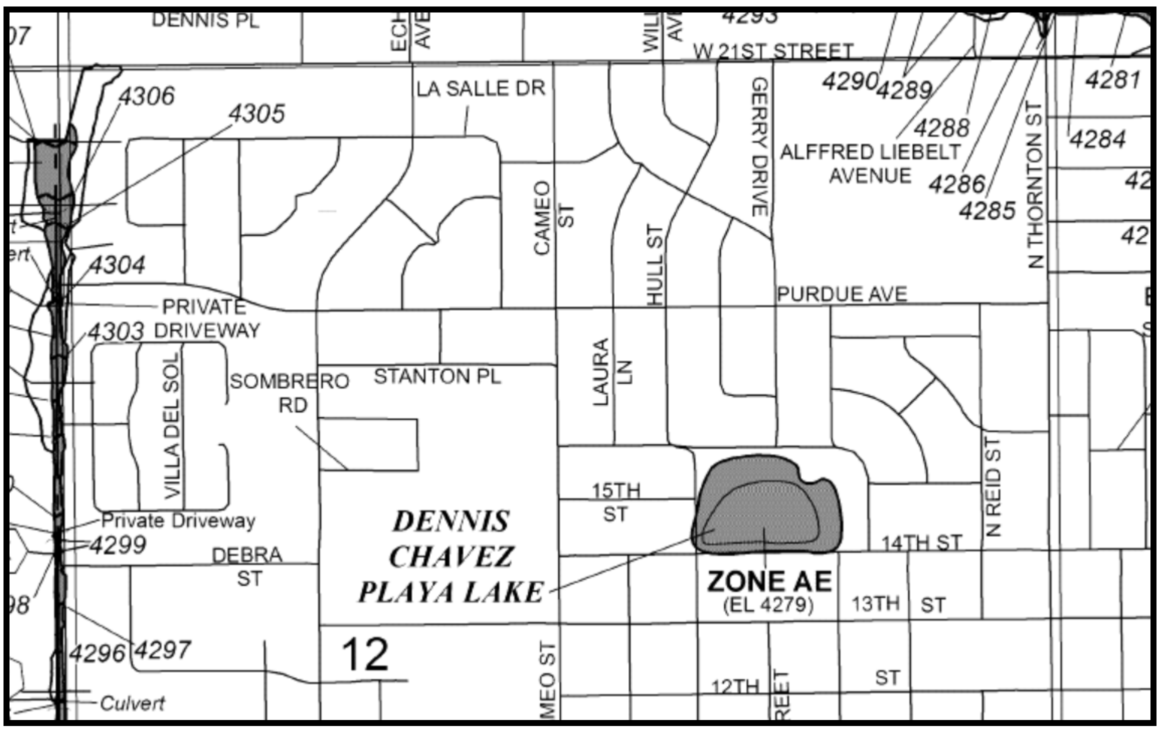

FIGURE 11-1
ECHOLS AREA FLOOD PLAIN

FIGURE 11-2
ECHOLS AREA SD

One of the considered projects was a storm drain down Echols, from Purdue to the new Cameo Pond. In the DMP model, this area was not included in the Dennis Chavez Lake drainage area. It was modelled in a separate area that assumed that flows would reach the Cameo Pond. However, it appears that flooding in this area warrants a storm drain to the Cameo Pond.

Later indications were that flooding actually occurs in the Purdue/Cameo Intersection.

Exhibit 7 illustrates a plan and profile view of a potential storm drain that would begin at Echols/Purdue and extend southward in Cameo Street to Dartmouth Street, where it would discharge to the Dennis Chavez Lake. The storm drain can be installed at approximately 0.0033 ft./ft. A 24" storm drain can accommodate only 13 cfs. Larger sizes such as 36", 42", 48", 60" and 72" can carry 38 cfs, 58 cfs, 83 cfs, 149 cfs, and 243 cfs respectively. Most likely, the 48" at 83 cfs would be the most cost effective system even though it cannot carry the full design flow.

11.3 Grand Avenue

The Grand Avenue storm drain system is a proposed system to extend from Prince Street to Norris, including a new storm drain and a resulting street reconstruction to accommodate this storm drain. There is currently flooding being realized in this area and a storm drain along this reach would be beneficial to eliminate minor storm flood problems. This area is not currently in the established flood plain but is on the fringe. However, local observations indicated that this is indeed a flooding problem. Figure 11-3 shows the flood plain in this area.

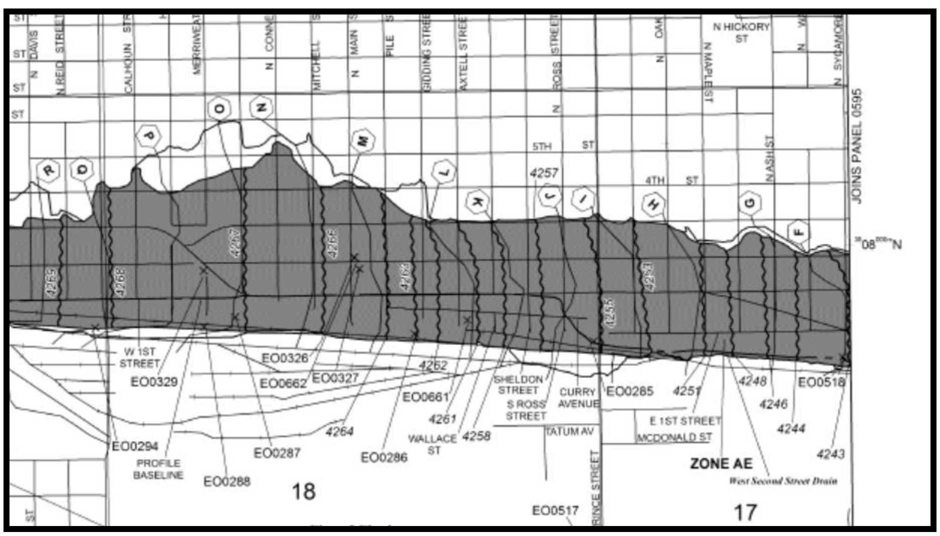

FIGURE 11-3
GRAND AVENUE EAST

The project is illustrated in Exhibit 8 in plan and profile view. While there is slope available along this segment, it is very flat. The storm drain will be beneficial for minor storms but may be more significant when analyzed with other projects.

During the course of this analysis, it was realized that most flooding occurs along US 70 throughout the entire City. The solutions that began to emerge was to utilize other east/west corridors, north of US 60/70/84, to attempt to intercept flows before they get to US 60/70/84. This is being done in several ways.

First, Mabry has been reconstructed from Prince to Tennessee, along with a significant storm drain system discharging to the eastern arm of the Ingram Ditch. This system should greatly increase the conveyance capacity along Mabry and US 60/70/84.

Second, the City has completed the design of another project, which is the reconstruction of 7th Street from Main Street to the Ingram Channel at Marlene Boulevard. Construction should begin in 2018. The 7th Street system should intercept many, if not most of the flows that now flood Grand from Prince to Norris. However, a smaller storm drain system down Grand will intercept any flows that bypass 7th Street and Grand Avenue which should then be relieved from the flooding, whether minor storms or the 100-year event.

In conjunction with the Mabry system already in place, the 7th Street project and the proposed Grand Avenue storm drain system should intercept a large percentage of the flows to Mabry. While the Mabry system may have been designed for the 50-year event, it may actually accommodate the 100-year event once the 7th Street system is constructed and certainly after the Grand Avenue system is in place.

The Grand Avenue system from Prince to Norris shows a constant slope of 0.0041 ft/ft. At this time it cannot be determined what size of system is needed on Grand. The new street system could be expected to carry up to 50 cfs and a 36” diameter storm drain could carry an additional 50 cfs for a combined capacity of 80 cfs.

The design of this system should commence once the 7th Street system is completed. The 7th Street system will cut off many of the contributing areas to the Grand Avenue system (Figure 11-4) and the design flows can be computed at that time. A capacity of 80 cfs may be in accordance with the 100-year flow. However due to the lack of space in the subsurface terrain in

Grand because of other utilities, the design may be simply a matter of budget and what size system fits in the roadway section. Exhibit 8 illustrates a plan and profile view of this proposed system. A general depiction of the system is shown in Figure 11-4 below.

FIGURE 11-4
GRAND AVENUE EAST

11.4 Dennis Chavez Lake

Dennis Chavez Lake is a multi-use facility with no drainage outfall. The permanent pond is appreciated by the neighborhood, but because there is no outfall, during large flood events the neighborhoods to the south of Dennis Chavez experience flooding up to the floor elevations. Again, surprisingly, this area is not in the mapped FEMA flood plain. The lake itself is, but the surrounding neighborhoods are not, especially the downstream neighborhoods, which experience flooding when this lake is taxed (see Figure 11-5).

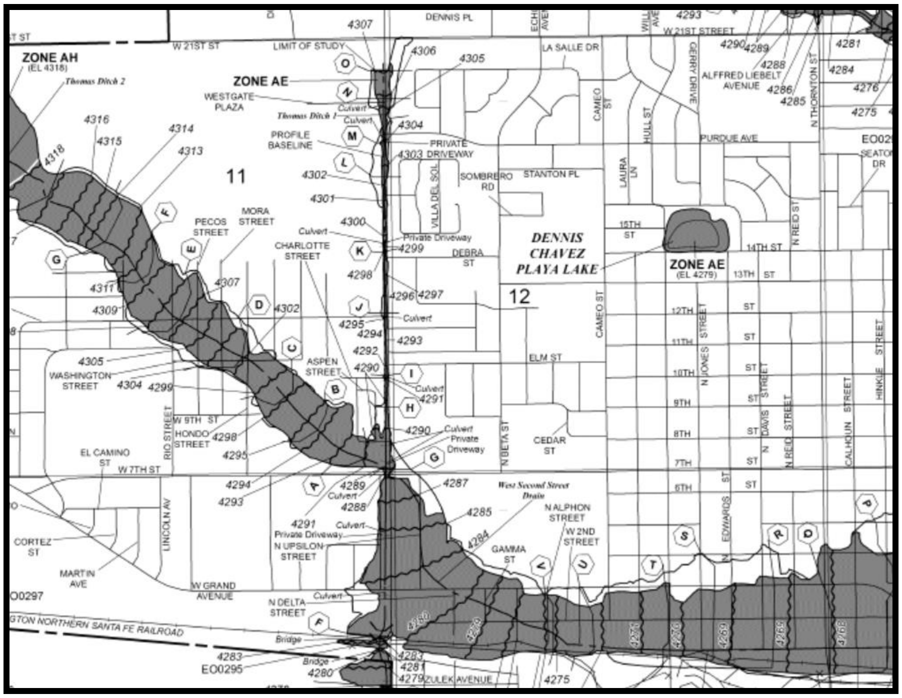

FIGURE 11-5
DENNIS CHAVEZ LAKE FLOOD PLAIN

In the past, the City has mobilized portable pumps that pump water out of Dennis Chavez into an 8" PVC pipe laid along Jones Street to the south until the pipe daylights at 10th Street. From this point, the runoff flows by gravity down Jones to Grand and then east along Grand to a drop inlet located at the Grand and 1st Street intersection.

It is understood that the City has now installed a more permanent pump at this lake to pump water into the sanitary sewer system in order to protect these homes south of Dennis Chavez Lake.

A more desirable permanent solution is to install a permanent pump station at Dennis Chavez and a new force main down Jones to 10th Street until it can flow by gravity to the proposed new Cameo Pond (Figure 1-3), where the flow can be stored until flood flows recede and released to the new US 60/84 project storm drain. Furthermore, this and other pump stations should be connected to a SCADA system enabling City of Clovis staff to better control pump stations and valves on the storm drain system throughout the City. This system is shown in Figure 11-6.

During the course of this study, the City has initiated efforts to purchase the land for the Cameo Pond. Exhibits 9-11 show various alternatives to the pond layouts for the land purchase.

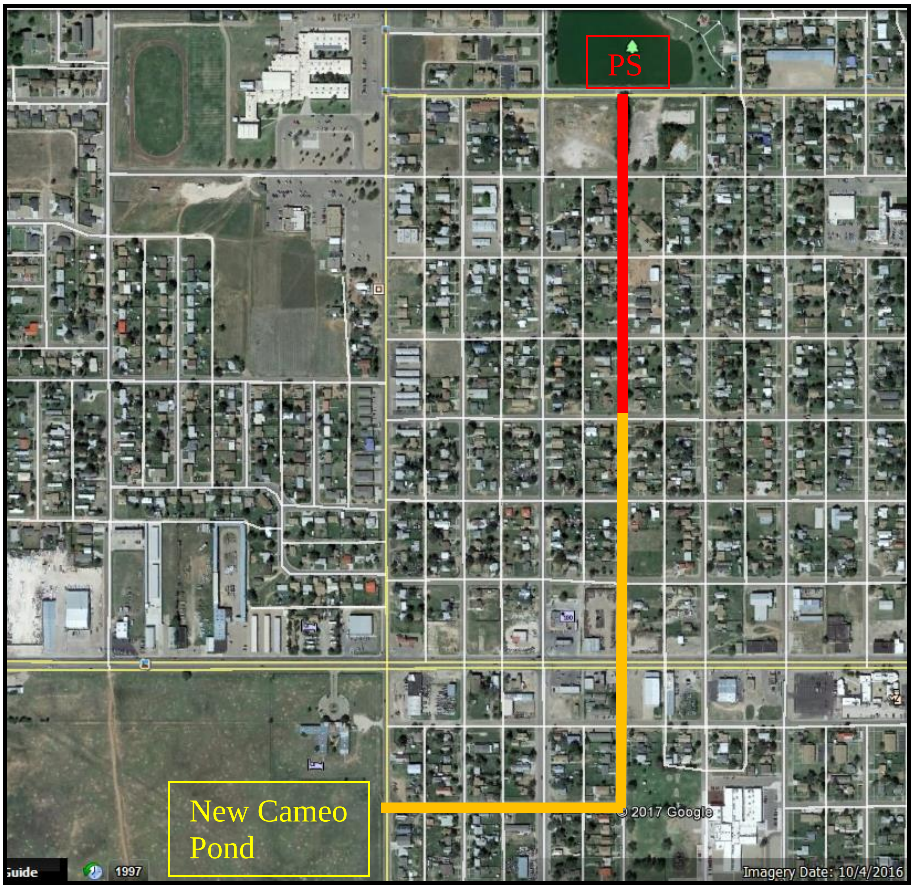

FIGURE 11-6
DC PUMP STATION, FORCE MAIN AND GRAVITY TO CAMEO POND

11.5 Wilhite Area

The drainage master plan identified a proposed new storm drain system along Wilhite (CR 13) from Prince to the pond/playa known as E2 or the 801 Pond located just south of Wilhite and south of Winchester Drive. This project has now been completed through other resources. This area was not in the established FEMA Flood Plain. However, interception of these flows and conveyance of the flows eastward to the 801 Pond helps significantly in the amelioration of flooding along the southern end of Clovis. The flood plain limits are illustrated in Figure 11-7.

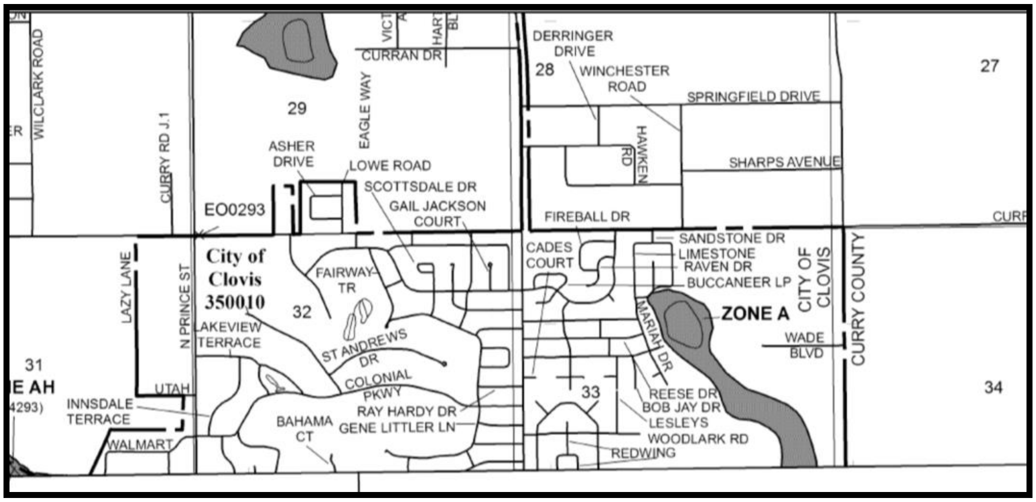

FIGURE 11-7
WILHITE SYSTEM

This is one of the prime locations for a pump station to pump water from this playa to the sanitary sewer system located at Country Meadows and Mariah Drive. In fact, in 2016 the City of Clovis presented a legislative funding request to the State legislature for this project, which was not approved. Approval of this discharge process was obtained by the City, from NMED and the State Engineer's Office.

Furthermore, this drainage master plan also recommended connection of this particular playa lake (Country Meadows or 801 Pond) be connected to the playa located at the NE corner of Llano Estacado and Humphrey Road (Gouker Pond or E-3 as identified in the modelling). This can be done via an open channel or pipe, with the channel being the most cost effective option. However, it traverses land that appears to be farmland and land acquisition may be required.

Doing so essentially takes runoff outside of the City limits and therefore reduces the floodplain in the City by virtue of this diversion. Once again, the flood plain limits can be reduced in size due to this project and diversions as shown in Figure 11-4 to other playas. Final discharge of this lower pond is to farm fields which should not present a problem for the City. See Exhibit 12 for additional layout of this area. This system is also depicted in Figure 11-8.

FIGURE 11-8
COUNTRY MEADOWS TO GOUKER PLAYA OUTFALL

11.6 Mabry Area

This project includes improvements from Prince Street to the outfall located at Tennessee Drive and have been completed by the NMDOT, which included a new large diameter storm drain that outfalls to the eastern leg of Ingram Ditch. While this project did include a large diameter storm drain, it should eliminate flooding on several streets north of Mabry which have been problematic in the past. These include Walnut, Oak, Hickory and Ash. The Mabry system has drop inlets on the north side of the street to capture these flows. The discharge point is shown in Figure 11-9.

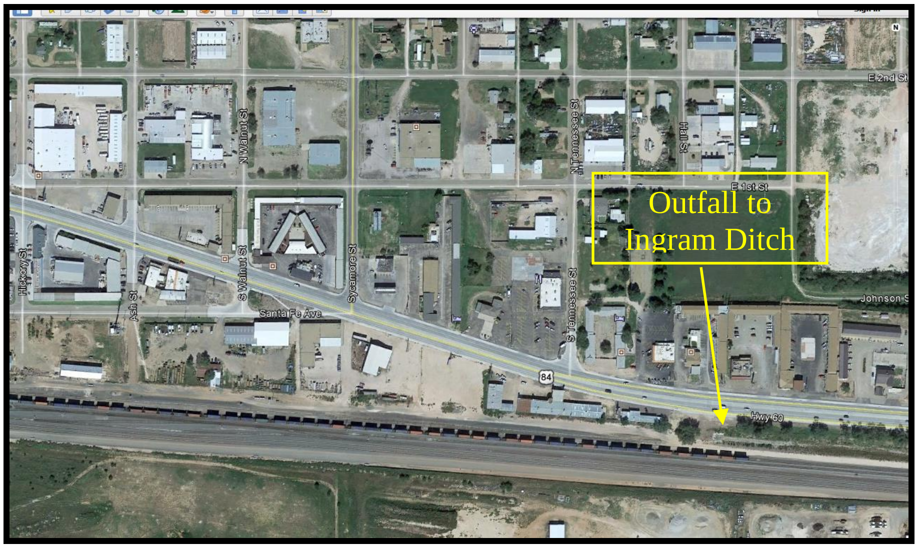

FIGURE 11-9
MABRY OUTFALL

See Exhibit 13 for additional layout of this area.

11.7 US 60/84, Grand to Prince

This NMDOT led project will attempt to correct the severe deficiencies in the pavement section, the curb and gutter, and sidewalk issues and include a major storm drain to accommodate storm drain runoff from Wheaton Street to Prince Street along US 60/84. This corridor becomes Grand Avenue and thence 1st Street until it reaches Prince Street.

As mentioned earlier, this corridor is one of the most severe in terms of flood plain areas. The more that can be accomplished with this storm drain system, the more chance the City has of eliminating areas from the flood plain. The flood plain area is shown in Figures 11-10 through 11-12.

The first impact of this project to the flood plain is simply the presence of a newer and larger storm drain system. However, in connection with this project, two other efforts are being made to reduce the flood plain in this area.

The significant element to Figure 11-5 is that the City and this study believe that the Circle of Trees Playa does not, in fact, overflow. Figure 11-5 indicates that the Circle of Trees Playa contributes to the flooding along Grand and First. Field surveys and modelling show that this does not occur.

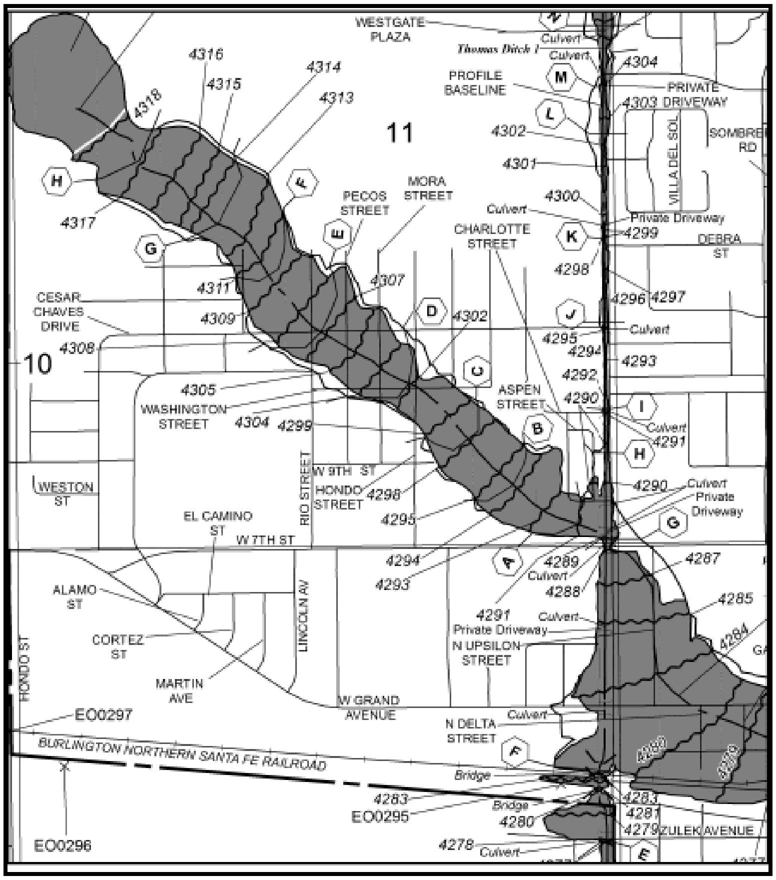

FIGURE 11-10
FLOOD PLAIN AREAS ON GRAND/MLK

Figures 11-11 and 11-12 show the extremeties of the flood plain areas along US 60/84/First Street in Clovis. The current NMDOT Project will install large diameter storm drains which should improve this situation. That, in conjuction with the contention that Circle of Trees Playa does not overflow, should decrease the flood plain limits in this vicinity.

The NMDOT project is still under design. This project has indicated a need for storage of approximately 20 acre-feet in the proposed new Cameo Pond. This project also envisions a new detention pond located east of Prince and south of the railroad tracks, and then utilizing the two existing parallel 36” storm drains that discharge in the Ingram Channel near the Ingram/Mabry crossing. These details are still being finalized with NMDOT. Exhibit 24 shows the latest project layout for this NMDOT project and the facilities that are being considered (March 2018).

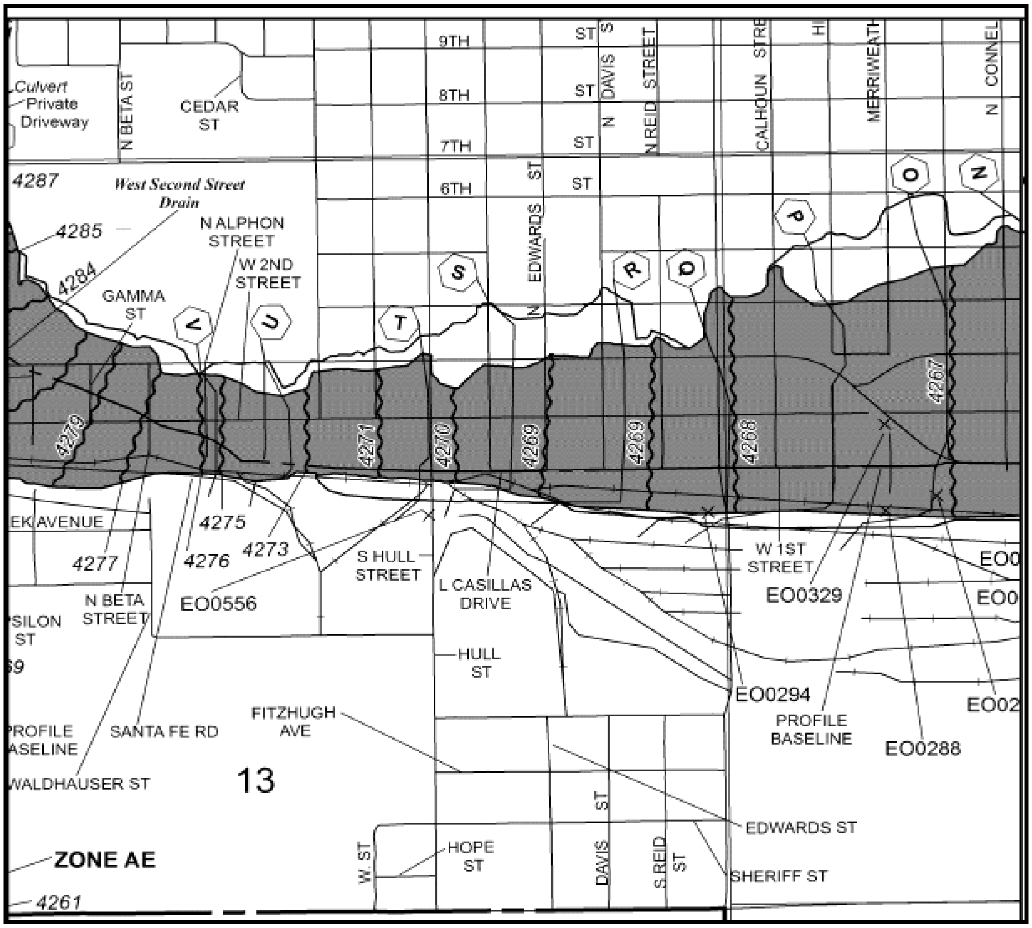

FIGURE 11-11
FLOOD PLAIN AREAS ON MABRY

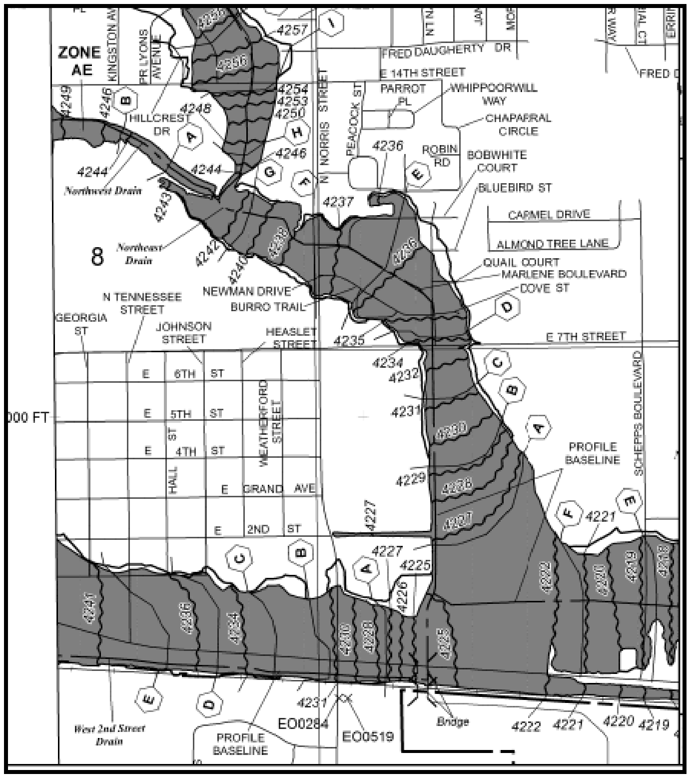

FIGURE 11-12
FLOOD PLAIN AREAS ON MABRY

11.8 SW Channel

This project was suggested in an earlier drainage master plan. It proposed a SW area drainage channel that extended along Wheaton Street from US 60/84 to the Conestoga Lake Playa. This project would divert flows away from the Grand/7th Street area. Although this project was never completed, it should be considered as it diverts flows away from the west side of the City, most especially from the US 60/84 corridor, southward to Conestoga Playa and renders flows harmless to the City and city flood plain areas.

This project should be solidified in the City's CIP and right-of-way for this project should be preserved and secured. It will require a railroad crossing and right-of-way acquisition in order to construction a 10-foot wide bottom and 4:1 side slope conveyance structure. In addition, new box culverts on Brady Avenue would be required. This would be considered a lower priority project.

11.9 Liebelt Low Water Crossings

Several areas on the Liebelt Channel from MLK Boulevard to Greene Acres Lake are on collector streets and are constructed as low water crossings. Projects should be planned to improve these areas for at least partial flood protection. If a 100-year designed structure cannot be fit in these locations, then at least a 50-year or 25-year designed structure could improve the access for most of the rain events.

Two locations are being considered. The first is on Thornton just north of 21st Street (see Figure 11-13) and the second is on Sandy Lane (see Figure 11-14). The previous 1989 Boyle Engineering Drainage Master Plan called for the Thornton low water crossing to be a 72-inch culvert. In this master plan, this crossing was modified to three 24-inch diameter culverts in lieu of the 72-inch culvert previously proposed as this would be less expensive and probably more feasible in construction considering the grade differential in the roadway elevations. The three 24-inch culverts had the same flow area, actually more, than the single 72-inch culvert.

The same proposal was made for the Sandy Lane crossing. However, these two low water crossings, estimated to be for the 10 year flow, should be coordinated with another project: the concrete lining of Liebelt, so that the low water crossings are not done in front of the Liebelt Channel improvements. If the Liebelt Channel improvements cannot be made in the near future, then the low water crossings can be considered.

FIGURE 11-13
THORNTON LOW WATER

Exhibit 14 shows additional information at the Thornton low water crossing.

FIGURE 11-14
SANDY LANE LOW WATER

11.10 7th Street System, Reid Street to Main Street

There is a current storm drain project under design to extend a storm sewer in 7th Street from Main to the Ingram Channel. An extension to this system should be considered from Main westward to approximately Reid Street (see Figure 11-15). One reason for this is that the NMDOT project on US 60 is only accommodating runoff from areas south of 7th Street. This 7th Street extension would then intercept flows north of Seventh in this area, preserving the capacity in the US 60 Storm Drain. Additional detail for this project is contained in Exhibits 3 and 23.

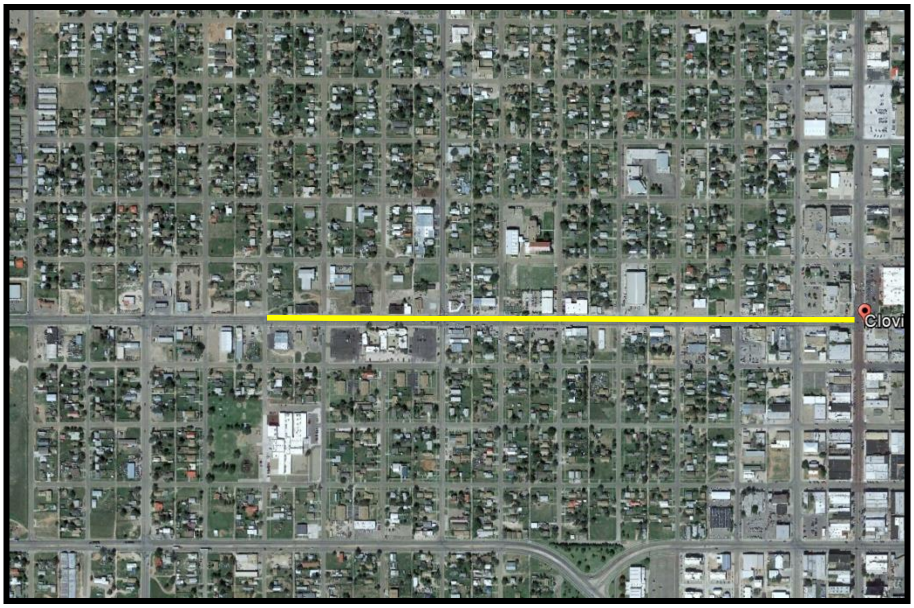

FIGURE 11-15
7TH STREET

Exhibits 4 and 23 show additional detail for this project.

<u>11.11 Worthington Ditch Lining</u>

Concrete lining the Worthington Ditch from the railroad crossing to just south of 21st Street would both improve ditch capacity and reduce maintenance. While the existing model shows that the Worthington Ditch is more than capable of carrying the flows in its current state, the concrete lining should enhance flood protection in downstream areas. The more flow that can be intercepted and carried on the west side of the City, the more that the flood plain areas in the downtown area can be reduced.

Exhibits 15 and 16 show a plan and profile view of this channel, as well as the proposed typical section.

11.12 Worthington Ditch Crossing Structures

There are ten crossings of the Worthington Ditch from the railroad tracks to 21st Street. All of these crossings are of different sizes and numbers. It is obvious that they were not designed to carry the design flow and some of these crossings are of smaller capacity downstream than upstream. This project would include replacement of these crossings with more appropriately designed culverts. Figure 11-16 below shows some of these locations. Periodic replacement of these crossings is recommended. However, if a project is to be considered to fully concrete line this channel in the near future, then these low water crossings may not be necessary. Instead, they can be appropriately designed to match the channel cross section so that the Worthington Ditch can carry its full and intended design flow.

FIGURE 11-16
WORTHINGTON DITCH CROSSINGS

11.13 Norris from Llano Estacado to Hillcrest

Norris Street is a major arterial in a north/south direction and lies on the eastern part of the City. A storm drain from Llano Estacado, the “Circle” to the south should be considered. It would discharge to the Marlene System.

This area is not in the established FEMA Flood Plain. It is simply an observation after storm water flows and what is needed in this particular area. Figure 11-17 shows the flood plain limits along Norris and Figure 11-18 shows an aerial view of this street from north to south.

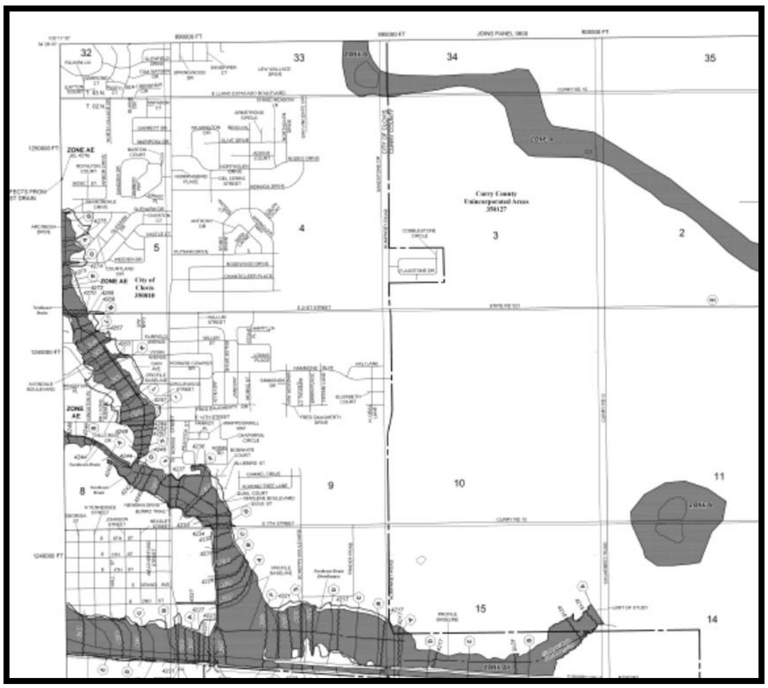

FIGURE 11-17
NORRIS FLOOD PLAIN

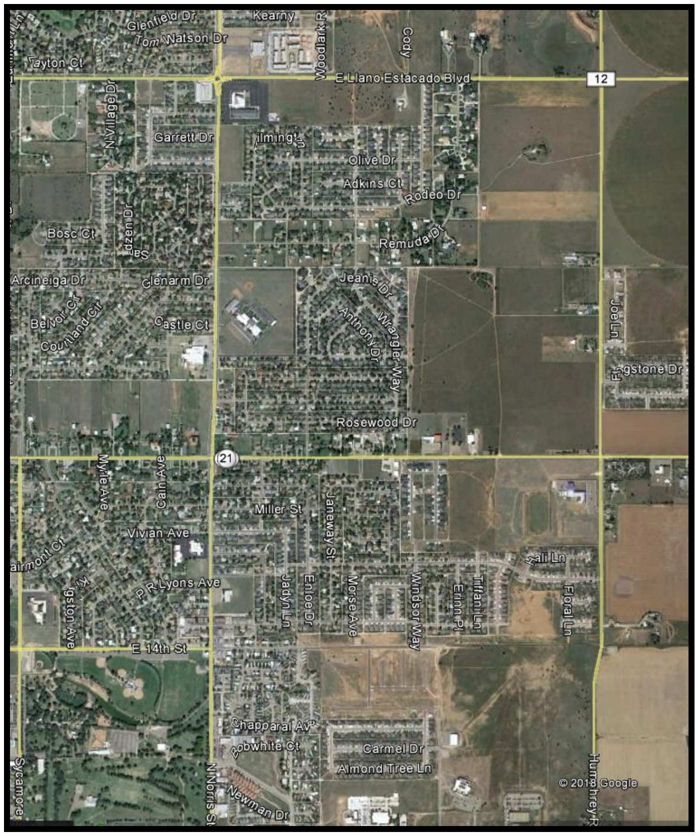

FIGURE 11-18
NORRIS AERIAL

Flows generally travel from west to east, and from north to south by the natural terrain. Exhibit 17 shows a profile view of Norris along this stretch. There is positive grade from the north end to the south end. A storm drain in this corridor will be effective in capturing street flow and conveying it to the Newman Pond area.

It was estimated that the street section in Norris, some 42 feet wide and at a slope of 0.006 ft/ft would carry approximately 45 to 50 cfs, flowing top of curb to top of curb. A 42-inch storm drain in this street would carry a total of 63 cfs, thence drying the street for access during flood events. Drying the lanes means improved access to homes and most importantly for emergency service vehicles.

11.14 Ingram Ditch Lining

Ingram Channel is currently a grass lined channel from 7th Street to Mabry. It has a bottom width of 30 feet with 4:1 side slopes and a longitudinal slope of 0.0039 ft/ft. As a grass lined facility, it has a capacity of 2,715 cfs at a 6.5 foot depth. Concrete lining this channel would increase the capacity to over 4,000 cfs at 6.5 foot deep, bottom width of 20 feet and side slopes of 2:1. With the new 7th Street project pending construction, planning a storm drain outfall at this point would make a significant difference in the conveyance of this system and may get the areas adjacent to the channel out of the established flood plain.

The upper reaches of this channel are shown in Figure 11-19 below. This is the area from 7th Street to Mabry. The existing flood plain is shown in Figure 11-20 below to illustrate the extent of the existing flood plain that could be contained within the channel. Figure 11-21 shows the lower reach of Ingram Ditch that extends from Mabry to the Ingram Dam.

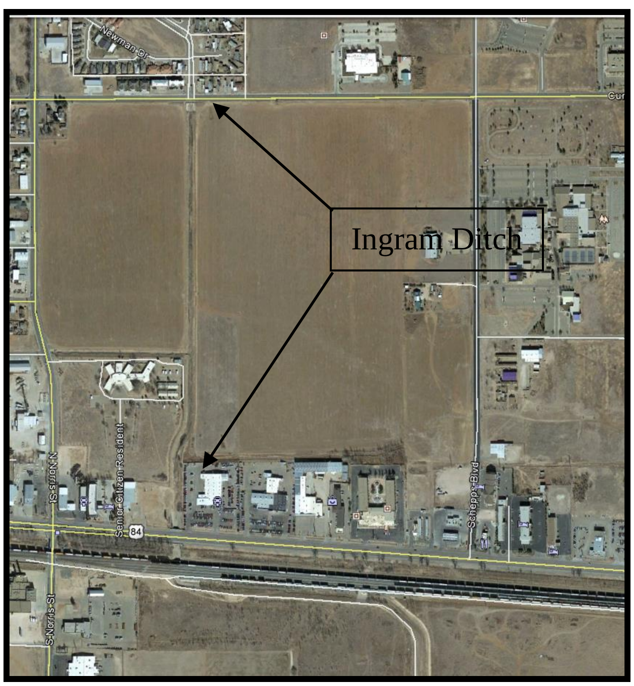

FIGURE 11-19
INGRAM DITCH

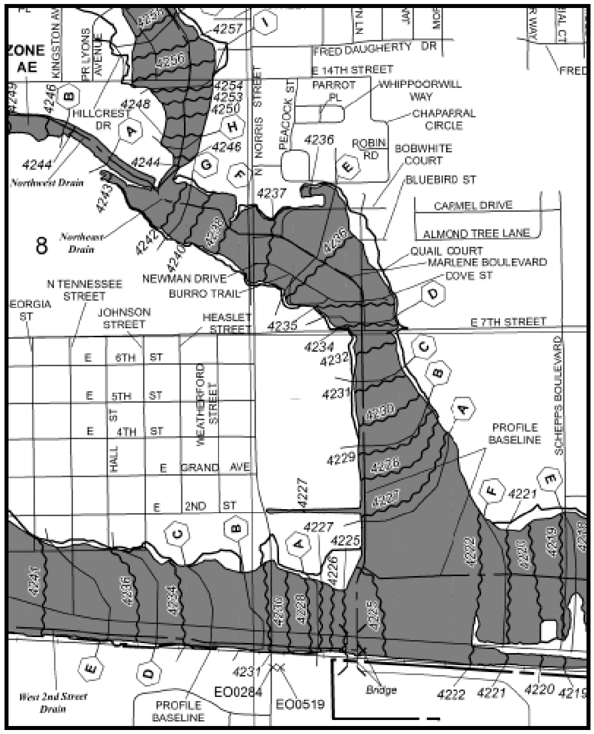

FIGURE 11-20
INGRAM DITCH AREA FLOOD PLAIN

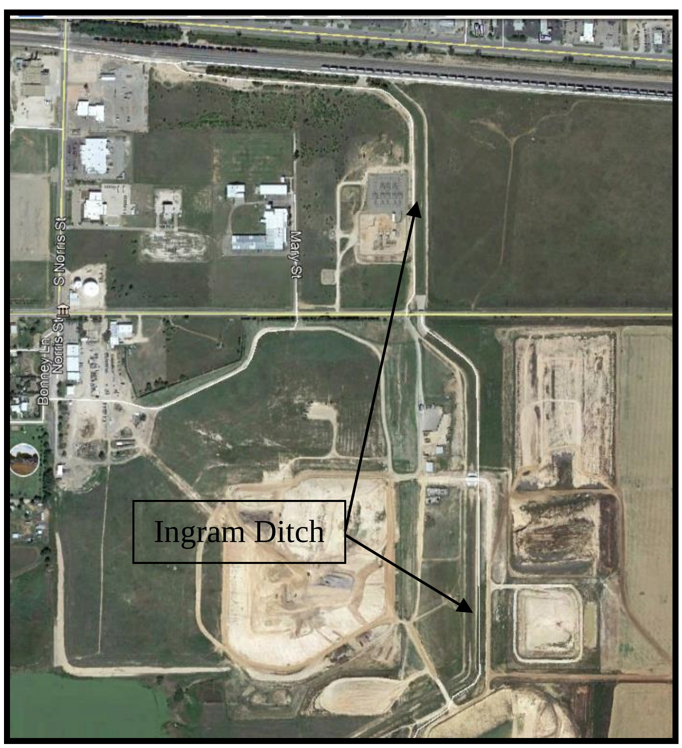

FIGURE 11-21
INGRAM DITCH AREA FLOOD PLAIN

Exhibits 17, 18, and 19 show a plan and profile of this channel, as well as the proposed typical section.

11.15 Casillas Ponds

One continual problem area, despite all the planned improvements is the area south of Grand and from Cameo to Meriwether. Even the NMDOT project on US 60 cannot accommodate many of the flows from this area. As a result, the NMDOT project conceived a ponding area now in a City park area, and is known as the Casillas Ponds. Detention of runoff in this area assists the proposed US 60 drainage system. Figures 11-22 and 11-23 show the pond locations and the current flood plain limits. Exhibit 20 shows additional detail on the Casillas Ponds.

FIGURE 11- 22
CASILLAS PONDS

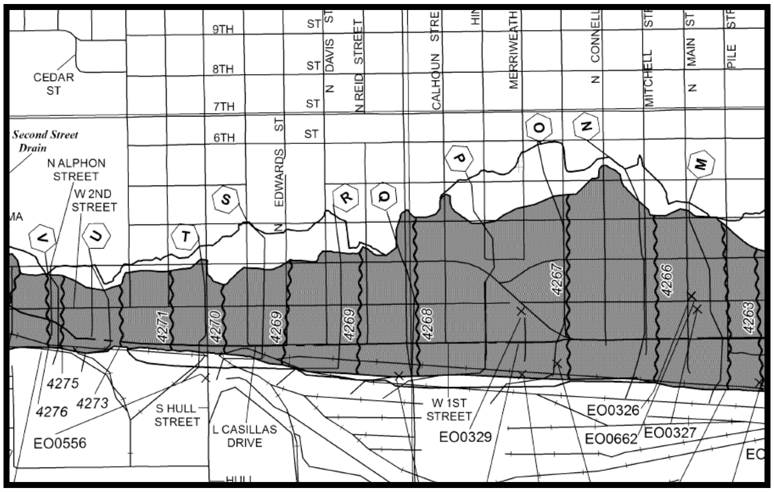

FIGURE 11-23
CASILLAS PONDS FLOOD PLAIN

The projects listed in Table 11-3 are not necessarily prioritized. Priority rankings can take several forms. Priority might mean project order based upon need. However, the size or cost of a project might also indicate a priority order or priority change. For example, a $500,000 project might rank somewhat low on the priority listing but may in any given year, fit the budget properly so that it can be done in advance. Priority rankings can also be influenced by downstream to upstream sequence, as it is necessary for drainage to improve capacity in this direction. Priority can also be influenced by area of the City or City Council District, in order to make sure citizens realize that improvements are included in their neighborhood in an equitable fashion.

11.16 Liebelt Channel

Another project which should be considered is the lining of the existing open channel from MLK to Greene Acres Lake. This project would increase capacity and should lower maintenance concerns in the channel area. The project is depicted in Exhibit 21 and the flood plain in this area is shown in Figure 11-24 below.

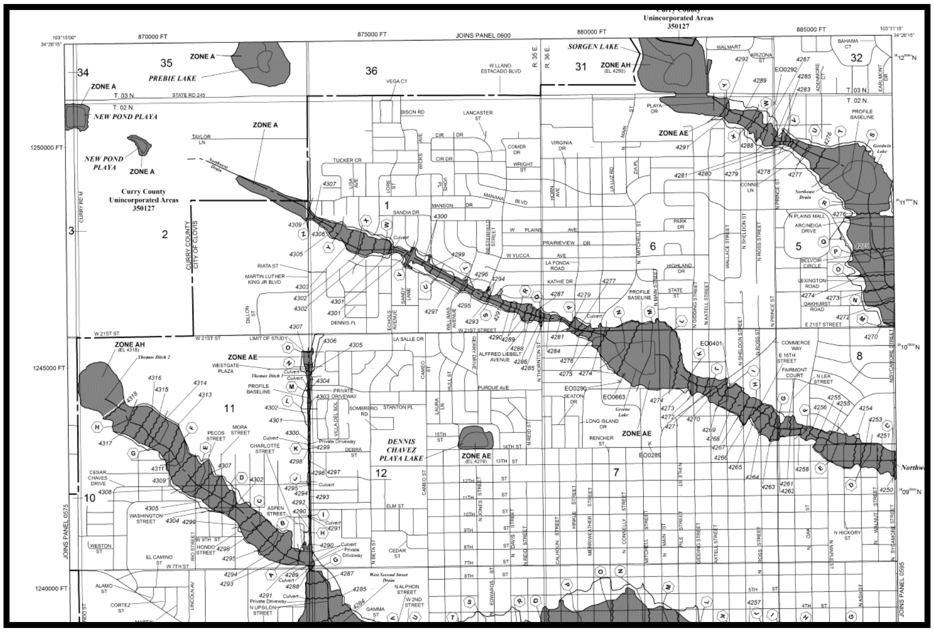

FIGURE 11-24
LIEBELT CHANNEL FLOOD PLAIN

Caution should be considered as there are other projects in this master plan that inlcude low water crossings on Sandy Lane and Thornton. If the Liebelt Channel lining will not be completed soon, then the low water crossings should be considered for a lesser event, for example a 10-year event. However, if the Liebelt Channel project is to be funded in the near future, then the low water crossings should be designed as trapezoidal sections that match the channel cross sections and not as low water crossings.

11.17 West Grand Channel

A project which had been considered in the NMDOT project for the US improvements but was later removed, was a channel on the south side of Grand from Industrial Park Road to the Worthington Ditch at MLK Boulevard. The NMDOT project has been scaled back to not include any drainage improvements west of MLK. This project was most likely considered to evacuate runoff from Grand Avenue before it could cross the road and continue east. Figure 11-25 shows the flood plain area. Additional detail is shown in Exhibit 22.

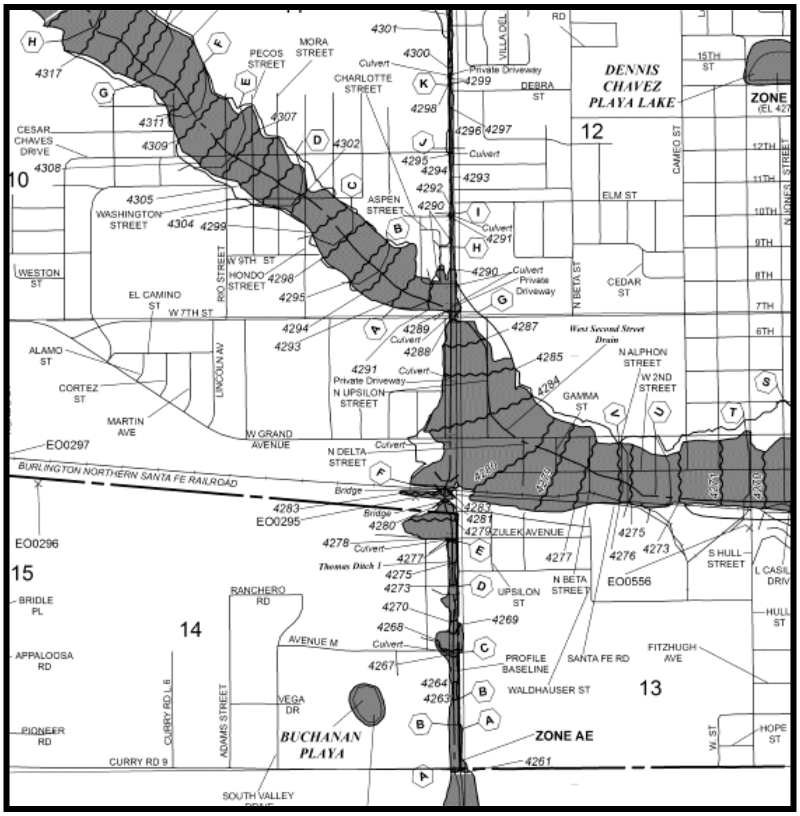

FIGURE 11-25
WEST GRAND CHANNEL AREA FLOOD PLAIN

The reason for this project, according to the NMDOT drainage report was to provide additional capacity to the 18" storm drain now in West Grand between El Camino/Grand to MLK and the Worthington Ditch. According to the NMDOT report, some 50 cfs would enter this channel on the west end of this channel and that discharge would increase to some 500 cfs at the Worthington Ditch. This is more than the storm drain in Grand can handle. In addition, the FEMA FIS states that these flows cross MLK and travel east to Grand and eventually First Street to Prince, adding to the flood plain mapping problem.

Having this ditch would accommodate the overflow from the storm drain, and then discharge to the Worthington Ditch, thence travelling south and not entering the severe flood plain areas along First Street.

Exhibit 22 shows additional details for this project.

11.18 Pump Stations

This project suggests the addition of various pump stations that the City desires to install on various playa lakes throughout the City to pump some stormwater volumes from the playa to the sanitary sewer system. This would increase water re-use potential and show that the City has a mechanism to drain the playas so that the 25% full FEMA requirement in flood modelling can be waived.

The individual projects vary on a project by project basis. An estimation tool has been provided in Appendix D of this report to help analyze pump capacity, time to drain, and cost for each playa lake pump station being considered.

11.19 FEMA Map Revisions

These are, in fact, capital project improvements. As each project for storm drainage is completed, a flood plain revision should be considered. One good example of this is the completion of Mabry Drive from Prince to Tennessee, which is now complete, and the pending construction of the 7th Street System. Both of these will make significant reductions in the flood plain areas along Mabry and along the Ingram ditch from Mabry to 7th Street. Once completed, the City should attempt to revise the flood plain mapping in order to save the adjacent neighbors with their flood insurance premiums.

One of the most important projects relating to FEMA mapping is the Ingram Channel. The current flood plain maps, as they always do, follow jurisdictional boundaries. The mapped flood plain appears to disappear at the City limits.

In Clovis, this appears at the most important location of runoff conveyance and the municipal boundaries. In particular this location is the crossing of the Ingram Ditch at the US 70 (Mabry) crossing.

The current flood plain limits are shown in Figure 11-26.

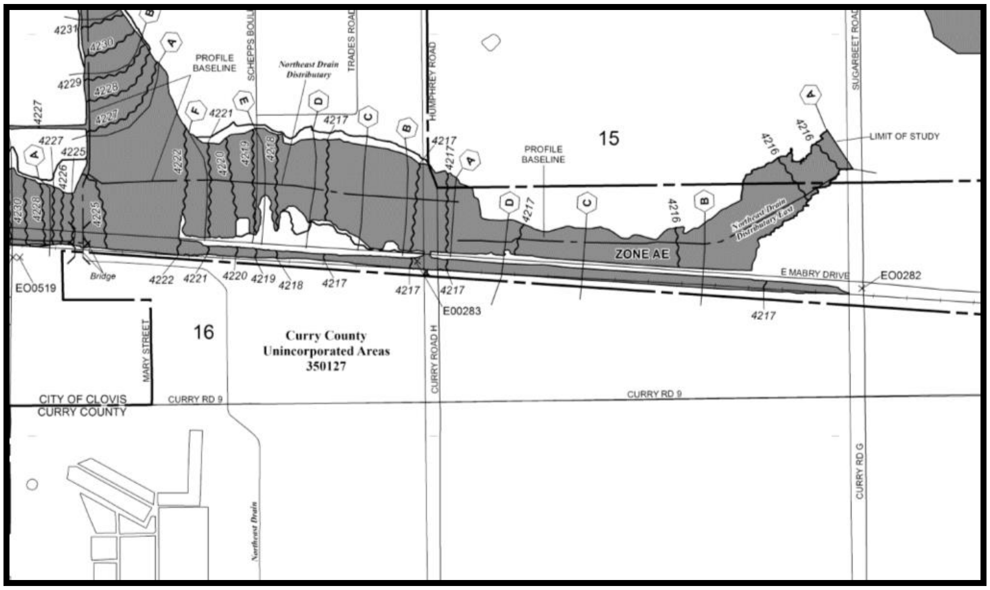

FIGURE 11-26
MABRY/INGRAM CHANNEL FLOOD PLAIN LIMITS

From this figure, it appears that jurisdictional boundaries, not hydrologic modelling controlled the flood plain mapping limits. It is the belief of this drainage master plan that flows do indeed pass through the Mabry Bridge, via the Ingram Channel, to the south. However, with the jurisdictional limits on the south side of Mabry, it appears that flows were forced eastward as shown and some backwater conditions may have resulted in the Ingram Channel north of Mabry.

Current modelling shows flooded areas south of Mabry as shown in Figure 11-27 below.

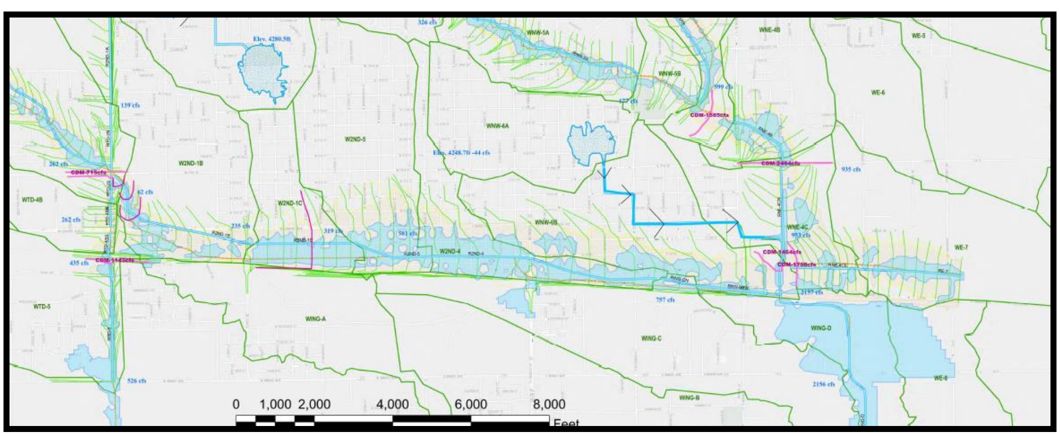

FIGURE 11-27
MABRY/IGRAM CHANNEL FLOOD PLAIN LIMITS

Figure 11-27 shows some flood plain encroachment to the east of the Ingram Channel and south of Mabry. This was due to lack of survey data east of the Ingram Channel. However, models show that the channel itself, especially when concrete lined, has ample capacity to convey the flows within the confines of the improved channel and flood plain limits reduce greatly. See Exhibit 6.

Nevertheless, a solution to this area is to initiate a project which captures all the survey data needed along the Ingram Channel from Mabry to the Ingram Dam to accurately model this area. Once the correct survey data is collected, it is the belief of this master plan, that the choke point, i.e., the Ingram crossing of Mabry, can be removed without construction, but by better data, and the flood plain in this area along the Ingram Channel from Seventh Street to the Ingram Dam can be eliminated.

11.20 Playa Lakes

11.20.1 Greene Acres Lake

This master plan envisions no improvements to Greene Acres Lake. It lies in the heart of the City of Clovis. It has a gated outlet and can be drained before a storm event is anticipated.

11.20.2 Dennis Chavez Lake

This lake is in a residential neighborhood. It has no outlet structure and is prone to flooding. Flooding exists in 14th Street and residential neighborhoods just south of the lake. When floods occur, the City installs temporary pumps that discharge to a pipe that runs south on Jones Street to 10th, where, at that point the flow can drain along the curb by gravity to Grand, then east on Grand to the split between Grand and 1st, near the Roy S. Walker Recreational Center. The flows go into a drop inlet at that point and flow down 1st to the ultimate discharge.

Improvements to Dennis Chavez Lake at this time include a pump station at the lake to discharge to a force main and ultimately discharge to a proposed new pond at Cameo/7th. Currently, the

City has installed a pump to discharge this flow to the sanitary sewer system to help alleviate flooding in the areas south of Dennis Chavez. It would be preferable to pump this water to a new pond at Cameo, rather than into the sanitary sewer system.

11.20.3 Circle of Trees

No improvements are planned for the Circle of Trees. It is believed that the Circle of Trees Playa contains all flows from upstream areas and this playa does not overflow. This is an important piece of the FEMA puzzle in Clovis. Current flood plain maps indicate that this playa does overflow and contributes to flooding in downtown Clovis, particularly near 1st and Main near the railroad yard headquarters. This Master Plan indicates that this playa does not overflow and field verification solidifies that opinion.

11.20.4 Priebe Playa

Priebe Playa is located on the north side of Llano Estacado and just east of Martin Luther King Boulevard. This playa is almost always dry. While it may contain runoff occasionally, it evaporates or infiltrates rather rapidly. This report did not recommend any specific improvements to this playa due to the dry nature of this playa. It has a large capacity and provides significant protection to the City of Clovis as it lies on the the upstream area of the watershed. Sediment removal and excavation are recommended as a maintenance measure and to increase the holding capacity of the ponding area.

Were a pumping station needed for this facility in order to drain the last 25% of storage, it could be accomplished by pumping via a force main to New Pond to the west. An alternative would be a pump station and short force main down Martin Luther King Boulevard to the Lieibelt channel where it crosses Martin Luther King Boulevard.

11.20.5 Sorgen Playa

Sorgen Playa is a very large playa located on the north side of Llano Estacado just west of Arizona Street, near the Wal-Mart. This playa is normally dry and after storm events dries rather quickly.

11.20.6 New Pond

No recommendations have been given in this report for New Pond. New Pond is located east and west of Wheaton Drive. It has a gated outlet and can be controlled by the City to release all waters stored during dry conditions so that New Pond is dry before a storm event.

11.20.7 Goodwin Playa

Goodwin Playa is located strategically in the heart of the City. It has been somewhat improved as a dual use facility with hiking trails and picnic areas. Goodwin Playa is a good candidate for sediment removal and excavation for addition capacity as it receives runoff from many parts of the city.

11.20.8 Senior Citizens Playa

The Senior Citizens Playa is also strategically situated in the heart of Clovis. Currently, the City is pursuing a project on 7th Street to reconstruct the roadway and install a new storm drain. This project intends to expand the Senior Citizens Pond and utilize this area for storm drain surcharge and retention of runoff. Therefore, this drainage master plan has no further recommendations for improvements at this facility. However, the drainage master plan did include these improvements in order to better convey runoff through this area of the City.

11.20.9 Ingram Dam

Ingram Dam is the final outfall for most of the runoff in the City. While the pond itself appears to be of adequate size for the intended use, it does not require immediate or long term improvements. Rather, the conveyance facilities upstream are in need of further analysis and possible improvement to improve the flood plain especially to the east of the channel and south of US 70.

11.20.10 Cameo Pond

The drainage master plan did consider the vacant areas north of Grand and east of Cameo Street as a possible location for a future retention/detention pond. This pond would collect flows from north of 7th Street in order to intercept flows before entering Grand and the US 60/84 Corridor being designed by the NMDOT. This pond would also accept flows from south of Grand from Delta to Cameo. Along with this pond, a storm drain easement or earth channel should be made available from 7th Street to the Cameo Pond on the north side.

Once the NMDOT project is constructed, the pond at Cameo would be both for retention and detention. While some of the water in the proposed Cameo pond could be drained through an outfall to a storm drain in Grand, some of the runoff stored in this pond would lie below the pipe outfall and would be considered retention and would drain by evaporation and infiltration.

11.20.11 Ridley Pond (E-1)

Ridley Pond is located east of Highway 209 (Prince Street) and north of Wilhite. This playa has a large storage capacity and should be protected. Currently, a significant amount of flow along 209 is diverted in culverts to this playa lake so that flows do not enter the City. Development in this area and northeast of this area also appear to drain to this playa and this system appears to be working appropriately. No recommendations are being given for infrastructure to this location in this master plan. However, this playa should be protected for future development on the north side of the City.

11.20.12 Country Meadows Playa (E-2 or 801)

Country Meadows is now the outfall for the Wilhite drainage system. Wilhite was recently reconstructed to include additional lanes for traffic and a new storm drain which accepts flows from Wilhite/Prince and conveys these flows eastward to the Country Meadows Playa. Ultimately, the Country Meadows Playa would outflow to the Gouker Pond to the south and east.

Development in this area is including an open channel from Country Meadows to Gouker, for flow transfer. From Gouker, outfall would be to the east along ditches on the side of Llano Estacado or CR 12 to the east to areas unknown. Both of these ponds and the outfall ditches are outside of the City of Clovis limits.

<u>11.20.13 Gouker Pond</u>

Gouker Pond will eventually receive flows from the Country Meadows Playa as mentioned above. This playa, as well as the Country Meadows Playa are outside of the City limits and are outside of the mapped flood plain for the City of Clovis. Development in Clovis now centers around this area and good design standards should be applied and the City should control development to maintain the integrity of the Country Meadows Playa and Gouker Pond.

Ultimately, the outfall for Gouker is to the east, along Llano Estacado or CR 12 to other playas outside of the City limits. The storage volumes in Country Meadows and Gouker should be able to accommodate 100-year flows.

No infrastructure improvements are being recommended in this master plan for either of these playas.

<u>11.20.14 Van Solen and Bomer Playas</u>

One of these two playa lake areas have been purchased by the City of Clovis. The storage volumes of these two playas are of very significant capacity. This is critical to the overall system as development pressure seems to be in the northeast side or the east side of the City at this point in time. This playa provides an adequate outfall for most of this development.

11.20.15 Zoo (Golf Course)

The Zoo (Golf Course) Playa is in the center of the City. Many previous improvements have been made in the storm drain system in and around the Zoo Playa. This Master Plan makes no recommendations regarding infrastructure improvements to this Playa.

11.20.16 Conestoga Lake

This playa provides a significant outfall for much of the runoff flows from the western side of the City. The land is not owned by the City. However, significant drainage conveyance structures do direct runoff to this playa. The playa has sufficient storage capacity. However, conveyance to this playa is needed.

Most noteworthy is the Worthington Ditch which extends along Martin Luther King Boulevard from 21^{st} Street to Brady, and then to Conestoga Lake. While this channel is improved from 21^{st} to the railroad tracks and even to Brady, the channel downstream of Brady needs to be improved to get runoff to the playa.

11.20.17 Goodwin Lake Outlet

The Goodwin Lake Playa lies just north of Arcineiga Drive and east of Prince Street. It would be desirable and possible to construct a controlled outlet to this playa. The Sycamore Storm Drain is a project that was completed in 1998. The upstream end of this system is located at Marvin Haas Blvd. and Concord Street. The storm drain is a 53" X 41" aluminized steel pipe-arch with two drop inlets in Marvin Haas, one on each side of the street, south of Concord. The downstream outfall for this system is the Zoo Playa. A controlled outlet and storm drain could be constructed from Goodwin Playa to the Marvin Haas/Concord intersection whereby it would connect with the Sycamore storm drain system. Considering that the Sycamore storm drain ended at Marvin Haas/Concord with a 53" X 41" pipe arch, one would assume that the intent of this system was to eventually extend it northward in the future, probably to the Goodwin Playa.

TABLE 11-3
PROJECT MATRIX

#	Name	Description	Notes	Estimated Cost
0	Drainage Utility Funding			
	Ad Valorem Tax	Currently Exists	$400K per year +/-	Exists now
	Drainage Utility	Utility Billing	Provides perhaps $1M/Yr. or more. Needs State Legislative Approval	Administrative
	Flood Commissioner	Establish a Flood Commissioner. Levy $1.5/$1,000 of property value	Statutory Authority Exists. Could fund $815K/yr.	Administrative
	Flood Control District		Statutory Authority Exists. May require vote. Bonds can be issued for O&M	Administrative
	Special Assessment District (SAD)	Per project. Assess property owners for improvements	Per project area. Liens on property.	Paid by SAD
1	Playa Lakes Water Rights	Purchase Water Rights for Playa Volume	Ownership by City	Case by Case. $10K to $20K
	Playa Lakes Land Purchase	Land Acquisition	Ownership by City	Market Value
	Effluent Reuse	Put Storm Drainage into SAS	Can cause problems with Plant	Per Project. Approximately $500K per project for lift station and other
2	Echols Area	SD Echols to Dennis Chavez	Flooding relief for the neighborhood.	$ 884,280
3	Grand Avenue	SD Prince to Norris	Flooding relief esp. on Prince	$1,440,411
4	Dennis Chavez Lake	SD & Lift Sta. to Cameo Pond	Flooding relief for areas south of Dennis Chavez.	$2,000,000
5	Wilhite Area	SD Prince to Norris	Flooding relief for Wilhite	Completed
6	Mabry Drive	SD Prince to Ingram Ditch	Reduced flood plain limits. NMDOT Project	Completed

#	Name	Description	Notes	Estimated Cost
7	US 60/84 Grand to Prince	MLK to Prince Roadway and SD	Improved conveyance to Prince	Under Design
8	SW Channel	US 60/84To Conestoga	Relieve on US 60 Corridor	$7,912,409
9	Low Water Crossings	Liebelt Channel/Thornton and Sandy Lane	Small storm relief and access	$ 461,000 Each
10	Seventh St. Reid to Main	Continue Existing 7th Street SD project to the west	Intercept flows before they get to Grand/1st	$1,422,842
11	Worthington Ditch Lining	Concrete Channel Lining	Reduce maintenance, improve conveyance to south and relieve Grand/1st from upstream flows	$2,934,266
12	Worthington Ditch Crossings	Culvert and roadway reconstruction	Consistency in crossing capacity	$450,000 Each
13	Norris Llano Estacado to Hillcrest	Street Reconstruction and new Storm Drain	Provide one lane dry each direction for access	$2,367,990
14	Ingram Ditch	Concrete Channel Lining	Improve capacity, less maintenance, alleviate flood plain	I. $3,173,175 II. $3,855,587 III. $5,078,401
15	Casillas Ponds	Convert park to ponding	Needed for US 60/84 project	$760,000
16	Liebelt Channel	Concrete Lining	Improve conveyance, less maintenance	$6,577,000
17	Worthington Ditch Crossings	Culvert and roadway reconstruction	Consistent flow conveyance. Maybe with Ditch concrete lining	$450,000/Each
18	Playa Pump Stations	Individual	Eliminate the 25% full rule	Project Dependent, $250,000 to $5,000,000 each
19	FEMA Map Revisions	Individual	Project dependent	$50,000 each
20	Far NE Playas	Connect Playas via SD or Channel	Country Meadows and Gouker	Private Funding

#	Name	Description	Notes	Estimated Cost
21	Cameo Pond	Construct New Playa for US 60/84 and North Areas		TBD
22	Goodwin Outfall	Connect to Sycamore Storm Drain	Down Marvin Haas Blvd.	$1,899,680

APPENDIX A
FLOOD ZONES

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

<u>Moderate to low risk areas:</u>

Zone B and Zone X (shaded)

Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floods. B Zones are also used to designate base floodplains of lesser hazards, such as areas protected by levees from 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than one square mile (sq. mi.).

Zone C and Zone X (unshaded)

Area of minimal flood hazard, usually depicted on FIRM's as above the 500-year flood level. Zone C may have ponding and local drainage problems that don't warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood and protected by levee from 100-year flood.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2 percent annual chance flood plain, areas within the 0.2 percent annual chance flood plain, areas of 1 percent annual chance flooding where average depths are less than one foot, areas of 1 percent annual chance flooding where the contributing drainage area is less than one sq. mi., and areas protected from the base flood by levees. No Base Flood Elevations (BFEs) or depths are shown within this zone.

High Risk Areas:

Zone A

Areas subject to inundation by the 1 percent annual chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no BFE's of flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone AE and Zone A1-30

Areas subject to inundation by the 1 percent annual chance flood event determined by detailed methods. BFE's are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone AH

Areas subject to inundation by 1 percent annual chance shallow flooding (usually areas of ponding) where average depths are between one and three feet. BFE's derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone AO

Areas subject to inundations by one percent annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between one and three feet. Average flood depths derived from detailed hydraulic analyses are shown in this zone. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone AR

Areas that result from the decertification of a previously accredited flood protection system that is determined to be in the process of being restored to provide base flood protection. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone A99

Areas subject to inundation by the 1 percent annual chance flood event, but which will ultimately be protected upon completion of an under-construction federal flood protection system. These are areas of special flood hazard where enough progress has been made on the construction of a protection system, such as dikes, dams, and levees to consider it complete for insurance rating purposes. Zone A99 may only be used when the flood protection system has reached specified statutory progress toward completion. No BFE's or depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Coastal Zones:

Zone V

Areas along coasts subject to inundations by the 1 percent annual chance flood event with additional hazards associated with storm induced waves. Because detailed hydraulic analyses have not been performed, no BFE's or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Zone VE and Zone V1-30

Areas along coasts subject to inundations by the 1 percent chance flood event with additional hazards due to storm induced velocity wave action. BFE's derived from detailed hydraulic analyses are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

Undetermined Risk Areas:

Zone D

Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk.

APPENDIX B
COMMUNITY RATING SYSTEM

FEMA has a Community Rating System (CRS) which enables a community to assist residents in reducing their flood insurance premium costs. There are ten levels of community best practices that the City of Clovis can do, which will result in lower flood plain insurance premiums in the community to save individual property owners on their premiums. These are listed below in Table B-1.

TABLE B-1
CRS LEVELS

Rate Class	SFHA	Non-SFHA	Credit Points Required
1	45%	10%	4500+
2	40%	10%	4000-4499
3	35%	10%	3500-3999
4	30%	10%	3,000 – 3,499
5	25%	10%	2,500 – 2,999
6	20%	10%	2,000 – 2,499
7	15%	5%	1,500 – 1,999
8	10%	5%	1,000 – 1,499
9	5%	5%	500 – 999
10	0%	0%	0 – 499

SFHA means Special Flood Hazard Area as designated on maps. Non-SFHA means areas not shown of Special Flood Hazard Area Maps. The percentages mean the reduced cost for a resident paying premiums.

How communities get CRS points are shown in Table B-2.

TABLE B-2
CRS CREDITS

Level	Description	Max Points	Average Points
310	**Elevation Certificates** Maintain FEMA elevation certificates for new construction in the floodplain. (At a minimum, a community must maintain certificates for buildings built after the date of its CRS application.)	116	46
320	**Map Information Service** Provide Flood Insurance Rate Map (FIRM) information to people who inquire and publicize this service.	90	63
330	**Higher Regulatory Standards** Require freeboard, soil tests or engineered foundations, and compensatory storage. Zone the floodplain for minimum lot sizes of one acre or larger. Require coastal construction standards in AE Zones. Have regulations tailored to protect critical facilities or areas subject to special flood hazards (for example, alluvial fans, ice jams, subsidence, or coastal erosion).	90	63
340	**Hazard Disclosure** Real estate agents advise potential purchasers of flood-prone property about the flood hazard. Regulations require notice of the hazard.		
350	**Flood Protection Information** The public library and/or community's website maintains references on flood insurance and flood protection.	125	33
360	**Flood Protection Assistance** Give inquiring property owners technical advice on how to protect their buildings from flooding and publicize this service.	110	49
370	**Flood Insurance Promotion**. This series credits programs that provide increased protection to new developments.	110	0
410	**Floodplain Mapping** Develop new flood elevations, floodway delineations, wave heights, or other regulatory flood hazard data for an area not mapped in detail by the flood insurance study. Have a more restrictive mapping standard.		
420	**Open Space Preservation** Guarantee that currently vacant floodplain parcels will be kept free from development.	2020	474

Level	Description	Max Points	Average Points
430	**Higher Regulatory Standards** Require freeboard, soil tests or engineered foundations, and compensatory storage. Zone the floodplain for minimum lot sizes of one acre or larger. Require coastal construction standards in AE Zones. Have regulations tailored to protect critical facilities or areas subject to special flood hazards (for example, alluvial fans, ice jams, subsidence, or coastal erosion).	2042	214
440	**Flood Data Maintenance** Keep flood and property data on computer records. Use better base maps. Maintain elevation reference marks.	222	54
450	**Stormwater Management** Regulate new development throughout the watershed to ensure that post-development runoff is no worse than pre-development runoff. Regulate new construction to minimize soil erosion and protect or improve water quality.	755	119
510	**Floodplain Management Planning** Prepare, adopt, implement, and update a comprehensive flood hazard mitigation plan using a standard planning process. (This is a minimum requirement for all repetitive loss communities.)	622	123
520	**Acquisition and Relocation** Acquire and/or relocate flood-prone buildings so that they are out of the floodplain.	1900	136
530	**Flood Protection** Protection of existing floodplain development by floodproofing, elevation, or minor structural projects.	1600	136
540	**Drainage System Maintenance** Conduct periodic inspections of all channels and retention basins, and remove debris as needed.	570	214
	Total	4692	609

The City of Clovis should continually work using Table B-2 in order to bring the CRS rating up as high as possible. The higher the CRS score, the more citizens will save on their FEMA Insurance premiums.

APPENDIX C
PLAYA LAKE DATA