

STORMWATER SYSTEM MAPPING USING  
GIS SOFTWARE FOR THE CITY OF STILLWATER

By

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STORMWATER SYSTEM MAPPING USING GIS  
SOFTWARE FOR CITY OF STILLWATER

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अज्ञानतिमिरान्धस्य ज्ञानांजनशलाकया |  
चश्रुर्न्मीलितं ययेन तस्मै श्रीगुरवे नमः ||  
- (Subhashitmala)

*Salutation to the precipitator, who with a stick of collyrium of knowledge opens the eye of the ones who had been blind because of darkness in the form of ignorance.*

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माता पिता गुरुः च इति त्रयः नृणाम् सदा वन्द्यः |  
तदाशिषा आयुः विद्या बलम् च इति त्रिणी आप्नोति ||  
- (Subhashitmala)

*Mother, Father, and Teacher are always respected by human being. Life, knowledge and strength can be obtained only with their blessing.*

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# CHAPTER 1

## INTRODUCTION

### 1.1 Overview

EPA defines stormwater as “*storm water runoff, snow melt runoff, and surface runoff and drainage*” (Dodson, 1999). Urbanization has been recognized as responsible for the increase in both peak flow and total volume of surface runoff because of the decrease in infiltration as compared to pre-developed conditions. Urban stormwater has also been identified as a major contributor to the pollution of water courses, as it typically contains high suspended solid and bacteria levels (Marsalek, 1986).

Storm water is carried by a sewer system called Municipal Separate Storm Sewer Systems (MS4s). An MS4 is a conveyance or system of conveyances that is:

- Owned by a state, city, town, village, or other public entity that discharges to waters of the U.S.;
- Designed or used to collect convey stormwater (including storm drains, pipes, ditches etc.)
- Not a combined sewer; and
- Not part of a Publicly Owned Treatment Works (sewage treatment plant) (EPA, 2009a).

## 1.2 Background of Stormwater regulations

The National Storm Water Program (NSWP) provides regulations for

1. Discharges associated with industrial activity (including construction sites)
2. Discharges from large and medium municipal separate storm sewer systems
3. Discharges which the director of NPDES program designates as contributing to a violation of a water quality standard or as a significant contributor of pollutant to the waters of United States (Dodson, 1999).

Polluted stormwater runoff is commonly transported through Municipal Separate Storm Sewer Systems (MS4s), from which it is often discharged untreated into local water bodies. To prevent harmful pollutants from being washed or dumped into an MS4, operators must obtain a NPDES permit and develop a stormwater management program.

The State of Oklahoma has its own state body, Oklahoma Department of Environmental Quality (ODEQ), which does the compliance monitoring on behalf of EPA. The standards may be same as the EPA or more stringent depending on the state body. ODEQ follows the same standards as set by EPA. EPA implemented stormwater regulation in phases as follows:

- Phase I, issued in 1990, and requires *medium* and *large* cities or certain counties with populations of 100,000 or more to obtain NPDES permit coverage for their stormwater discharges.
- Phase II, issued in 1999, requires regulated small MS4s in urbanized areas, as well as small MS4s outside the urbanized areas that are designated by the

permitting authority, to obtain NPDES permit coverage for their stormwater discharges.

Generally, Phase I MS4s are covered by individual permits and Phase II MS4s are covered by a general permit. Each regulated MS4 is required to develop and implement a stormwater management program (SWMP) to reduce the contamination of stormwater runoff and prohibit illicit discharges (EPA, 2009a). ODEQ granted the Phase II permit to Stillwater in 2005. Stillwater is classified as a small MS4 discharge, which requires it to follow the *General Permit OKR04 – Phase II Small Municipal Separate Sewer System Discharges within the State of Oklahoma*.

### **1.3 Concern for Pollution**

Stormwater pollution has two different types of sources, namely *point source pollution* and *non-point source pollution*. EPA defines point source pollution in section 502(14) as follows –

*'The term "point source" means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged. This term does not include agricultural storm water discharges and return flows from irrigated agriculture'* (EPA, 2010).

Sewage and industrial discharges into the rivers are mainly considered as point source pollution.

Whereas non-point source is defined as –

*'The "nonpoint source" is defined to mean any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.'*

It consists of land runoff, precipitation, atmospheric decomposition, drainage seepage or hydraulic modifications.

Non point source pollution can include

- Pesticides, herbicides from agricultural land,
- Sediment runoff from construction site or eroded banks,
- Bacteria and nutrients from livestock farming, and
- Oil, grease and other chemicals from urban runoff

These pollutants are difficult to control and the track of the main source is indistinct. It is hence difficult to control the outlet into the rivers, creeks and lakes. These pollutants are harmful to aquatic life, and wildlife population. They can kill vegetation, cause foul smells in drinking water, and make the recreational areas unpleasant and insecure (EPA 2010).

#### **1.4 Components and Methods for Mapping a Storm Sewer System**

The main components of the stormwater network are as follows:

1. Open Channels – These include channels, trickle channels, flumes, grassy swales and streams.
2. Closed Channels – These consist of culverts and underground pipes.
3. Storage – These include detentions basins, diversion chambers and retention basins.

4. Inlets – These are the point where stormwater runoff enters the MS4. These include curb openings, hoods and grates, standpipes and drop inlets.
5. Outlets – These are the points where the stormwater runoff after travelling through the MS4 finally connects to a stream, lake or river.

Mapping the stormwater system is beneficial because it provides with general information about the layout of the system and the area. Unlike pollution from industry or sewage treatment facilities, which is caused by a discrete number of sources, stormwater pollution is caused by the daily activities of people everywhere. Rainwater and snowmelt run off streets, lawns, farms, and construction and industrial sites, and pick up fertilizers, dirt, pesticides, oil and grease, and many other pollutants on the way to our rivers, lakes, and coastal waters. Stormwater runoff was found to be our most common cause of water pollution (EPA, 2009b). Because stormwater pollution is caused by so many different activities, traditional regulatory controls are not enough. Education and outreach are key components to any successful stormwater program (EPA, 2009b). If the system is mapped, a pollution source and source tracking is possible. Proper control and preventive measures then can be taken. The mapping will also help in keeping tabs on the infrastructure of the system, and repairs can be done at the appropriate time.

The methods that can be used to map the stormwater system are:

- GPS mapping – Using a global positioning system (GPS) to map the manholes, inlets and outlets

- Aerial orthophotography review – This part of the geographic information system (GIS) software uses an aerial view of the land, from which the MS4s elements on the surface can be used to mark the inlets and open channels.
- Site/drainage plan reviews – Every construction project has a drainage plan for that particular site. These plans can be used to map the underground storm sewers as well as other storm sewer components
- Field verification–Field verification is done when there is ambiguity about a certain portion of the MS4.

## **1.5 Objective**

The requirements of ODEQ permit makes it imperative for the city of Stillwater to have a stormwater system and all outfall locations in place. GIS is a very helpful tool as it records data in accord with their geographical position. The location of various stormwater system elements and outfalls can thus be determined with help of GIS.

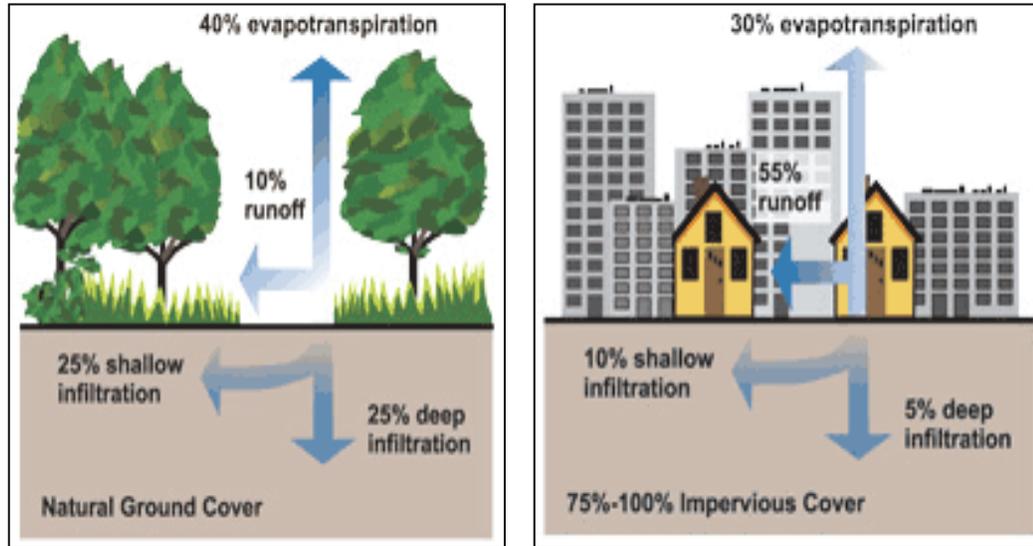
To comply with the ODEQ permit and have first-hand knowledge of stormwater system of the city, the MS4 map was decided to put up in GIS. The goal was to have a complete stormwater system for the city of Stillwater.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

Before urbanization, stormwater runoff was not a significant problem because the natural landscape allowed the stormwater to filtrate into the ground. The figure 2.1 below shows how urbanization has affected stormwater runoff. On natural ground cover stormwater runoff is low and has almost no pollutants. Infiltration takes up to 50% of the runoff which is absorbed by the pervious ground. Evapotranspiration removes another 40%, and there is only 10% of actual runoff on the surface. This compares to the urbanized area which has about 75-100% impervious surface. The infiltration rate is reduced to 15%, whereas the runoff is increased to 55%. The increased runoff is then able to carry more pollutants and thus more pollution in the receiving streams, rivers, lakes and ponds. The difference in the quantity of stormwater runoff shows the need to monitor stormwater runoff (EPA, 2003).



**Figure 2.1: Relation between impervious cover and surface runoff. (Photo Courtesy of EPA)** This figure gives the information of how development is affecting the stormwater runoff in terms of quantity. The increase in the quantity thus allows the runoff to carry large amount of pollutants.

Stormwater runoff has increased over the past years as a result of urbanization. The natural land becomes covered with pavement, and buildings which hinder the natural flow of the stormwater runoff. This raised the need for the building of stormwater drainage systems which help carry the water from rooves and pavements without causing floods and other damage. The main concern with stormwater runoff is that it gathers pollutants like oil, sediment, chemicals, fertilizers and bacteria while flowing over the urban surfaces. These pollutants are in turn carried to the streams receiving the runoff. Hence the need arises to monitor the quality and quantity of the stormwater runoff (EPA, 2003).

## 2.2 History of Stormwater Regulations

The 1972 Amendments to Federal Water Pollution Control Act, also known as the Clean Water Act, prohibited the discharge of any pollutants to the waters of United States from a point source unless it was authorized by the National Pollutant Discharge Elimination

System (NPDES). The past efforts to regulate stormwater were limited to industrial and municipal discharges. Efforts to improve the water quality were made under the NPDES program. According to the 1996 survey by National Water Quality Inventory, a biennial summary of state surveys of water quality, found that 40% of the water bodies were still impaired with pollutants and did not meet water quality standards (Bernard, 2002). The main culprit found was polluted runoff. From the survey it was found that 13% of impaired rivers, 21% impaired lakes, and 45% of impaired estuaries were affected solely due to urban stormwater runoff, whereas, 6% of impaired rivers, 11% of impaired lakes and estuaries were affected by construction site runoff (Bernard, 2002). Recognizing the importance of non-point sources, the Congress revised the 1987 Clean Water Act (CWA) on November 16, 1990, issuing regulations to stormwater discharges. The revisions established requirements for municipal separate storm sewers (MS4) and for stormwater discharges associated with industrial activities. It included those cities serving population of 100,000 or more. This was the Phase I Permit that covered for large or medium MS4. On December 8, 1999, EPA promulgated regulations for Phase II Permitting. This rule now included NPDES stormwater program for small MS4s (Bernard, 2002).

The Oklahoma Department of Environmental Quality (ODEQ) incorporated the Phase II of Stormwater Program in February 8, 2005, and released the regulations OKR04 (ODEQ, 2005).

The requirements of Phase II are given in Table 2.1. This table shows the various requirements as given in OKR04 of the ODEQ manual for stormwater management.

**Table 2.1: Requirements of the ODEQ General Permit, OKR04, Phase II Small MS4 Discharges within the state of Oklahoma**

Minimum Control Measures (MCMs)		Requirements
1	Public Education and Outreach Program	Develop public education and outreach program.
		Conduct outreach activities for education of stormwater impact.
		Involvement by the public to reduce pollutants.
2	Public Participation and Involvement	Develop and implement a plan to encourage public involvement and participation.
		Develop and implement a process by which public can comment on the Stormwater Management Program (SWMP).
		Comply with State and local public notice requirements while implementing this program.
3	Illicit Discharge Detection and Elimination	Develop, implement and enforce a program to detect and eliminate illicit discharges into your SMS4.
		Develop, a storm sewer system map, showing the location of all outfalls in the city's waterbodies.
		Implement appropriate enforcement procedures and actions for non-stormwater discharges.
		Develop and implement a plan to detect and address non-storm water discharges.
		Inform public employees, businesses, and the general public of hazards associated with illegal discharges.
4	Construction Site Storm Water Runoff Control	An ordinance or other regulatory mechanism to require erosion and sediment controls.
		Procedures for site plan review which incorporate consideration of potential water quality impacts
		Procedures for site inspection and enforcement of control measures
5	Post-Construction Management in New Development and Redevelopment	Develop, implement, and enforce a program to address storm water runoff from new development and redevelopment projects
		Develop and implement strategies which include a combination of structural and/or non-structural best management practices (BMPs)
		Use an ordinance or other regulatory mechanism to address post-construction runoff from new development and redevelopment projects
		Ensure adequate long-term operation and maintenance of BMPs
6	Pollution Prevention/Good Housekeeping For MS4 Operations	Develop and implement an operation and maintenance program
		Program must include employee training to prevent and reduce storm water pollution from activities

### **2.3 Background of City of Stillwater**

Stillwater is a city in and the county seat of Payne County, Oklahoma, United States. The population was 39,065 at the 2000 census (US Census Bureau, 2000). Founded on December 12, 1884, it was the first settlement in the Unassigned Lands. According to the United States Census Bureau, the city has a total area of 28.3 square miles (73.3 km<sup>2</sup>), of which, 27.9 square miles (72.1 km<sup>2</sup>) of it is land and 0.5 square miles (1.2 km<sup>2</sup>) of it (1.62%) is water.

The mapping of the MS4 is a requirement of the permit program. It is a better way to keep records and is a handy tool while trying to find a pollutant source or to keep a tab on which structure needs repairs or replacement. This will help in better stormwater management.

### **2.4 Importance of GIS in MS4 Mapping**

A Geographic Information System (GIS) is a computer system that manages data identified by their locations (geographically referenced)

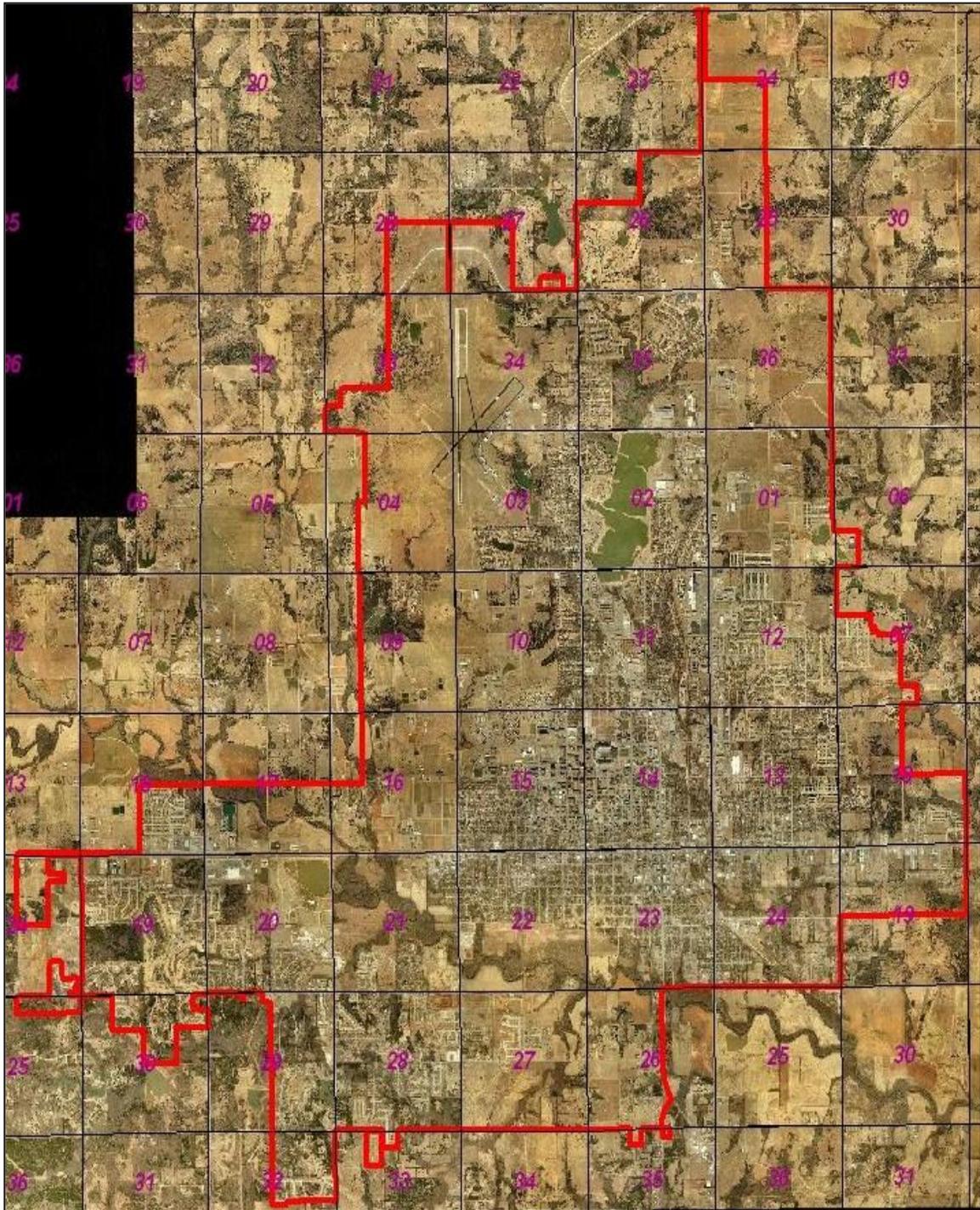
GIS technology can be used for scientific investigations, natural resource management, and development planning. For example, a GIS system could:

1. Allow emergency planners to easily calculate emergency response times in the event of a natural disaster.
2. Use water quality and land use data to identify wetlands that need protection from pollution.
3. Create presentation-quality maps (EPA, 2009c).

The GIS has the capacity to put on layer over layer on a particular area.

The Figure 2.2 shows the city's aerial view, with red colored lines showing the city limits. This is the latest aerial view taken on March 2009. This feature in GIS shows all the buildings, streams, lakes and ponds. The magenta colored numbers are the sections in which the city is divided. It can also zoom to a particular area, street name, or address.

The big green patch at the center of the map is the Boomer Lake which falls in section 02 of the city. The brown wavy line that runs from southwest to southeast of the city is the Stillwater creek.



**Figure 2.2: Aerial View of City of Stillwater in GIS. (Photo Courtesy of City of Stillwater)**  
 This aerial view shows all the buildings, streams, and pond inside the city limit as on March, 2009. The magenta colored numbers on the map are the sections in which the city is divided in squares of a mile.

According to the NPDES permit it is required to inspect and maintain the stormwater systems. The Municipality is required to maintain a record-keeping system for the same. Previously, this was achieved by system inventory completed during the stormwater master planning process or subdivision record keeping. This process can take years before the Municipality is in compliance with the NPDES permit. For these reasons Florida started to use GIS for the stormwater system (Mack, Dean, Kura, 1999).

The following are the main uses of a GIS mapping process

#### **2.4.1 General Reference**

The map gives a wide-ranging reference of the stormwater system throughout the city. It helps in locating the major creeks, rivers, lakes at a glance. Also the general terrain, contours and easements are readily available. It has the feature to load one layer over another which helps in analyzing things simultaneously. It saves time as all the required information is available at one click of a button.

#### **2.4.2 Pollution Prevention**

This map can help in pollution prevention as it will allow a better stormwater planning and management. It will aid in better planning of stormwater as the existing system is available, along with other major factors like topography, easements, and subdivisions in the area.

#### **2.4.3. Source Tracking**

The most important use of a GIS map will be in tracking the sources of pollution. The map not only provides the system elements present but as a whole it conveys

the way in which the runoffs flows and meet creeks, rivers or lakes. A pollutant found in a lake or river can be traced back using this route, and proper control measures can be taken to prevent it from happening in the future.

#### **2.4.4 Hydrologic and Hydraulic Studies**

The topography, pipe system and easement can be used for future hydrologic or hydraulic studies pertaining to an area. Channel, pipe dimensions can help in calculating the flow values, during a rainfall. This will help in better management of stormwater runoff.

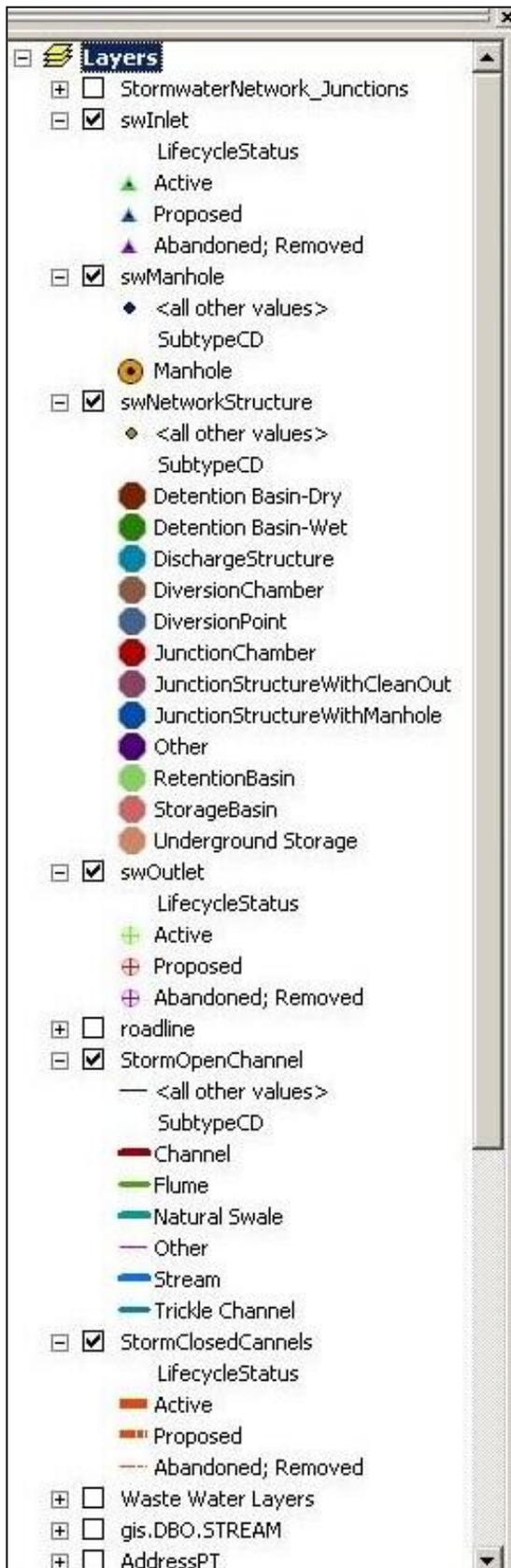
## **CHAPTER 3**

### **METHODOLOGY**

#### **3.1 Mapping MS4 in GIS**

GIS has the capacity of adding layers to the original map. This method was used to map the MS4s. The layers are added in the GIS through ArcCatalogue whereas the editing is done with the help of ArcEditor. Once the layers are added, the required element can be selected to map the components of MS4.

Figure 3.1 shown below represents all the layers added for mapping MS4 for the city of Stillwater. These layers are distinguished from each other by using different colors and shapes.



**Figure 3.1: The layers used to map MS4 for the city of Stillwater. (Photo Courtesy of City of Stillwater)**

**This is how the layers look in GIS ArcViewer or ArcEditor. A particular layer on the map can be seen by checking the box on the left-hand side. From the photo it can be seen that the inlets are marked by a triangle. The different color triangles represent the lifecycle status of inlet namely, active, proposed, and abandoned. The stormwater outlets and closed channels follow the same categories of lifecycle status. Whereas, stormwater structures, manholes and open channels are marked which are active at present.**

### 3.2 Layers in the GIS software

The layers are added in the ArcCatalogue. It provides us with the liberty to add as many layers as possible, with subtypes. Layers added to the GIS for the mapping of the GIS system are:

- Inlets – They are further classified as:
  - Curb openings
  - Hood inlet
  - Grate Inlet
  - Combination of Hood/Grate
  - Drop inlet
  - Standpipe
  - Headwall
  - Overflow

These are represented by a solid triangle with a black point in the center. The structures can be distinguished based on their status (active, proposed, inactive/abandoned, and removed). All these features are marked by different colors for proper differentiation. The active status is green colored triangle, proposed is blue triangle and abandoned or removed is purple triangle.

Figures 3.2, 3.3 and 3.4 show the combination of grate and hood, grate inlet, and curb opening respectively. These are the places through which stormwater enters the MS4.



**Figure 3.2: Inlet type – Combination of grate and hood**



**Figure 3.3: Inlet type – Grate inlet**



**Figure 3.4: Inlet type – Curb opening**

➤ Manhole

A manhole is represented by a solid orange circle with black point at the center.

➤ Structures – These are further classified as:

- Discharge chambers
- Discharge structures
- Storage basins
- Retention Basins
- Detention basins – dry
- Detention basins – wet
- Other

A structure is represented by a solid octagon shape. These are also distinguished based on the color of the representation. For example the detention basin – dry is given brown color and the detention basin – wet is given the green color. These are not sub-classified based on their life status.

➤ Storm open channels – These include

- Streams
- Grassy Swales
- Channels
- Flumes
- Trickle channel
- Other

Open channels are represented by a single line. The different colors are given to identify the above mentioned subtypes. The streams are represented with a dark blue color, the grassy swales with greenish blue color, channels with maroon color, flumes with green color, and trickle channels with light blue color. Open channels marked on the map are all active hence not differentiated based on life status.

Figures 3.5, 3.6, 3.7, and 3.8 show streams, grassy swale, channel and flume respectively as seen on site.



**Figure 3.5: Open channel – Stream**



**Figure 3.6: Open channel – Grassy swale**



**Figure 3.7: Open channel - Channel**



**Figure 3.8: Open channel - Flume**

➤ Storm Closed channels – There are two types of closed channels

- Sewer
- Culvert

The sewers and culverts can be of different materials like concrete, ductile iron, reinforced concrete pipe, polyvinyl chloride pipe (PVC), corrugated metal pipe, reinforced concrete box, galvanized corrugated metal pipe, or cast iron. These attributes can be added to the channels while mapping them on the GIS. They can be differentiated based on life status.

➤ Outlets – These are classified as

- Pipe-concrete
- Pipe-metal
- Pipe-plastic
- Weir-structure
- Open Channel outfall
- Curb opening
- Endwall
- Other

These are represented by colored circles with plus signs in them. These are classified based on their life status. The active outlet is represented by green color, the abandoned with purple, and magenta for proposed outlets.

Figure 3.9 and 3.10 show pipe-concrete and curb opening outlets respectively.

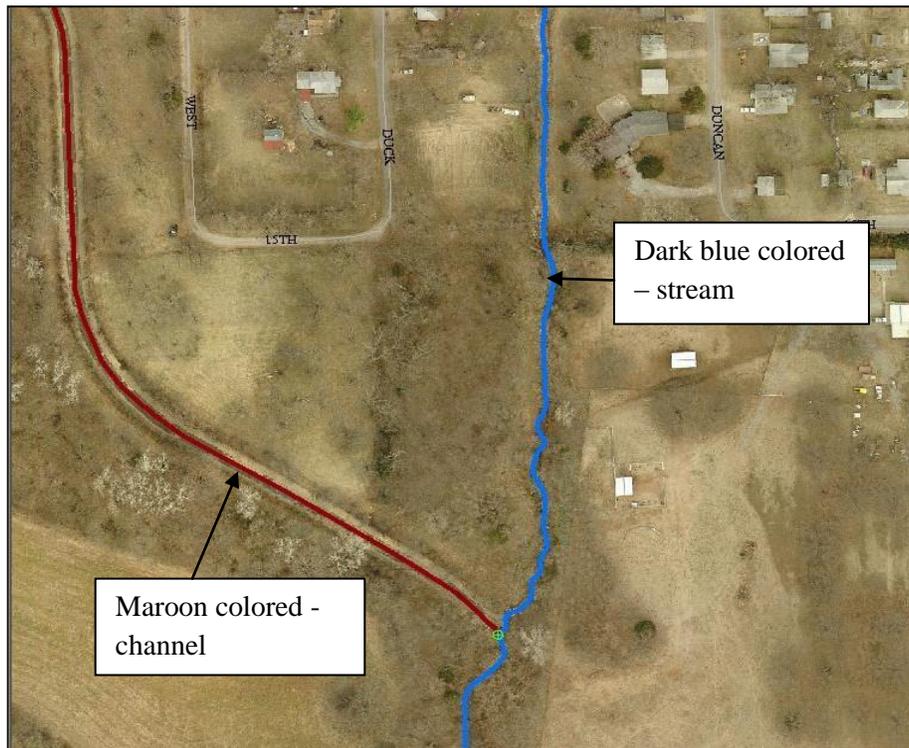


**Figure 3.9: Outlet type – Pipe-concrete**



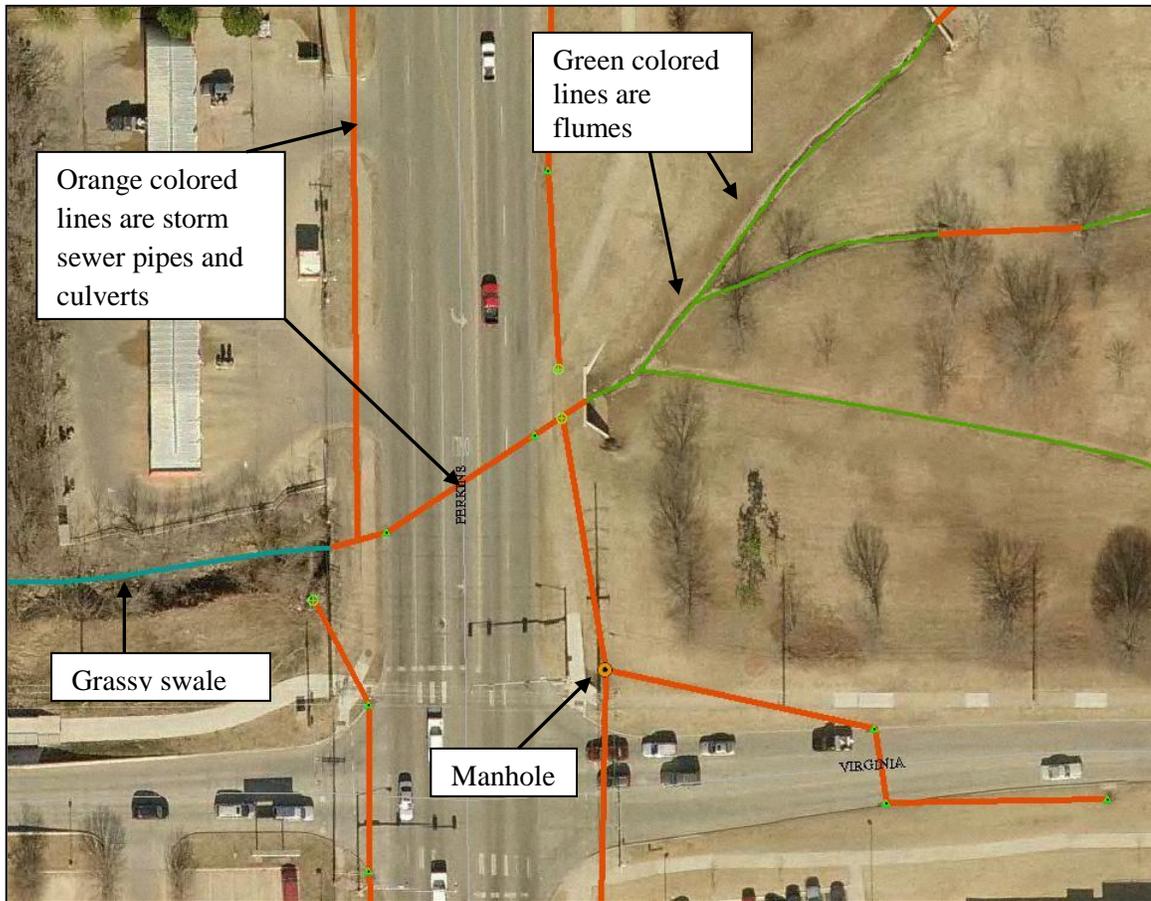
**Figure 3.10: Outlet type – Curb opening**

Figure 3.11 shows how the open channels will be seen on the MS4 map in GIS. The maroon colored marked line represents the channel and the dark blue colored line represents the stream.



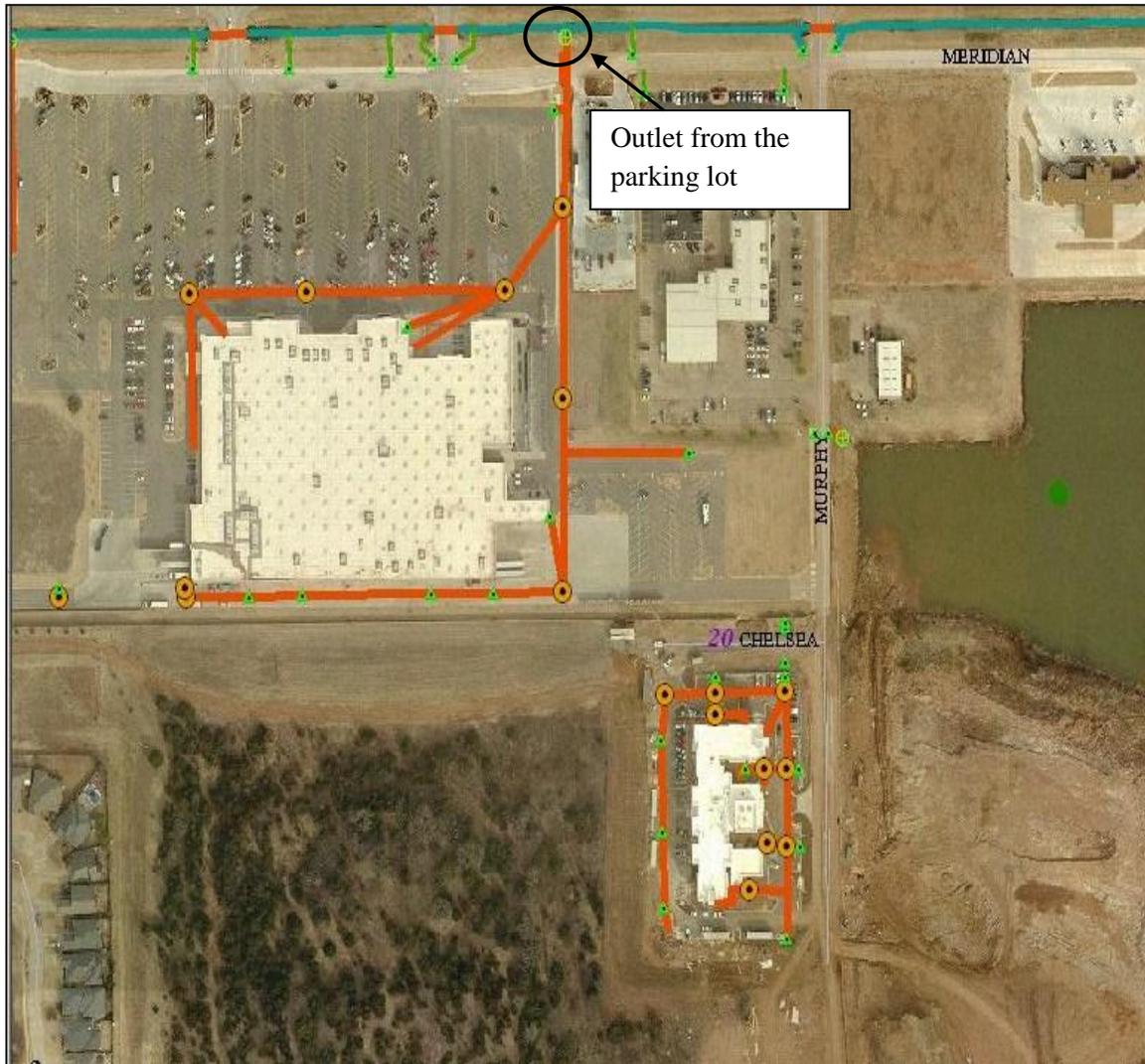
**Figure 3.11: Open channels marked on GIS. (Photo Courtesy of City of Stillwater)**

Figure 3.12 shows the various features of MS4. The orange line indicates the culverts and pipes, bluish green line is a grassy swale, the green lines are flumes, and the orange circle is a manhole.



**Figure 3.12: Culvert, pipes, flumes and grassy swale marked on GIS (Photo Courtesy of City of Stillwater)**

Figure 3.13 explains the underground MS4 for Wal-Mart on the 6<sup>th</sup> Avenue. From the system we can make out that the stormwater from the parking lot is carried by the pipes and let out on the other side of Meridian road (marked with a circle).



**Figure 3.13: Underground system of storm sewer for the Wal-Mart on the 6<sup>th</sup> Ave (Photo Courtesy of City of Stillwater). The orange lines represents the pipes through which stormwater is conveyed and is let out at Meridian Road**



### 3.3 Methods used for Developing MS4

There are four methods which can be used to develop the map of the stormwater system. Most of the time, all the methods need to be applied to have the correct and accurate location and complete knowledge of the storm sewer.

#### 3.3.1 GPS mapping

Global Positioning System (GPS) can be used to map points such as the manholes, inlets and outlets. For this task, a GPS handheld device is used to mark the exact point of inlets, outlets and manholes.

Figure 3.16 is a photo taken while mapping of a pipe-concrete outfall along the Duck creek.



**Figure 3.16: Mapping of outfall using GPS.**

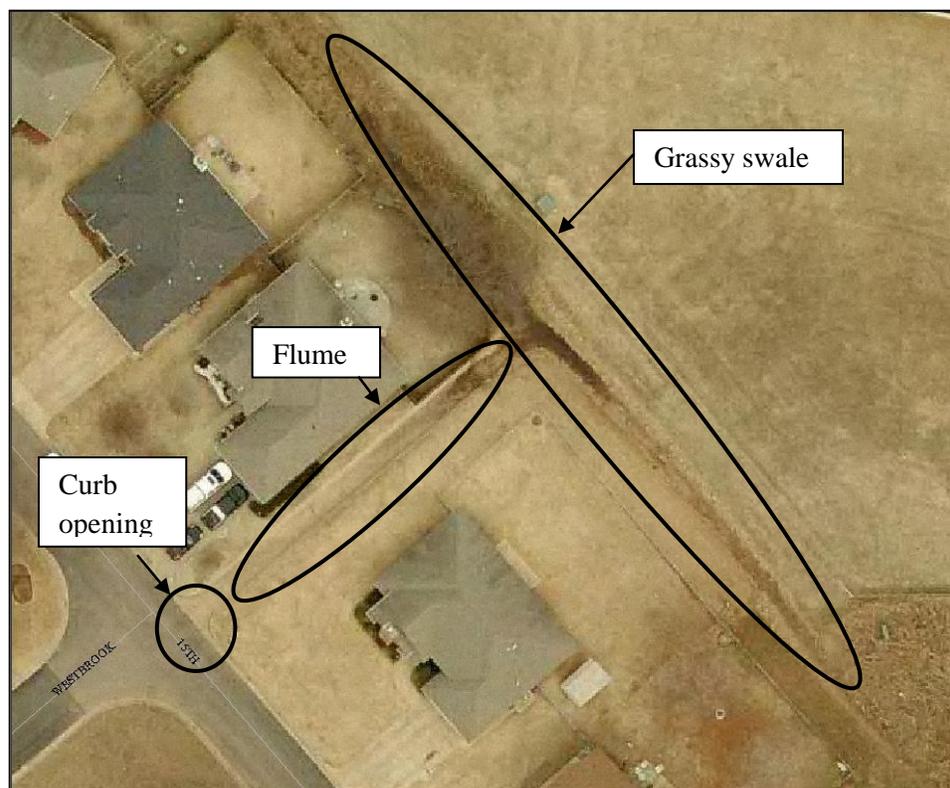
**The device is very small and marks the exact location of the outlet using satellite locator. Since these are geographically referenced, the file just needs to be imported into GIS.**

Mapping of all the outfalls was done using the GPS and walking along the major creeks of Stillwater.

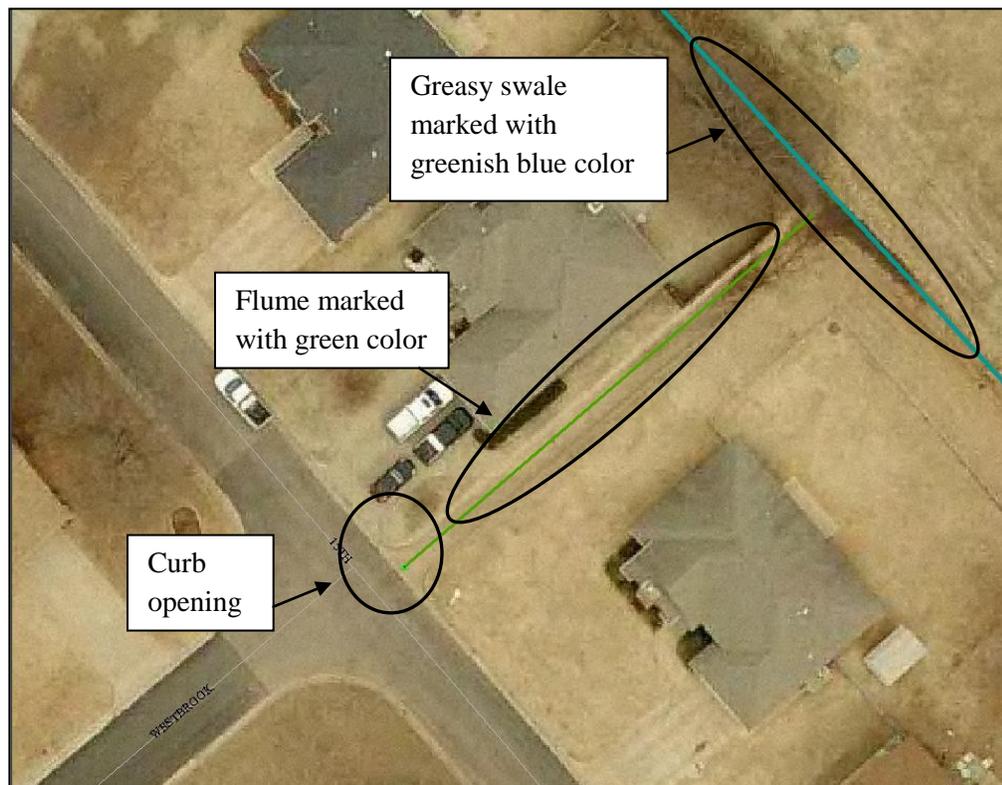
### 3.3.2 Aerial Orthophotography review

This part of the GIS software allows view of the land from which we can make out the MS4s which are on the surface can be used to mark the inlets and open channels.

Figure 3.17 and 3.18 show how an area looks before marking and after marking the stormwater components.



**Figure 3.17: Aerial view showing the stormwater components before marking the curb opening, flume, and grassy swale. (Photo Courtesy of City of Stillwater)**



**Figure 3.18: Aerial view showing the stormwater components after they are marked in GIS. (Photo Courtesy of City of Stillwater)**

### **3.3.3 Site/Drainage plan review**

Every construction project has a drainage plan for that particular site. These plans can be used to map the underground storm sewers as well as other storm sewer components.

The existing plans of the City were divided into street paving and subdivisions. The full list of names of street and subdivision can be seen in Appendices A and B respectively. Table 3.1 shows the number of plans and number of field verifications required to conduct the MS4 survey.

**Table 3.1: Total number of plans available and field verifications required. The field verification numbers are approximate**

	<b>Number</b>
Number of Street Paving plans	706
Number of Subdivision plans	480
Number of Field Verifications Required	225

Figures 3.19 and 3.20 are scanned copies of a road and a subdivision plan, respectively, showing the underground stormwater system. Figure 3.20 of the road map, shows the elements of MS4 along the road. The line diagram below shows the stormwater pipe profile, its slope, and direction of flow. These plans show exactly where the inlets, pipes and outlet are located in an area.

Figure 3.21 is how the storm sewer system of the subdivision shown in figure 3.21 will look in GIS after mapping all the components of MS4.

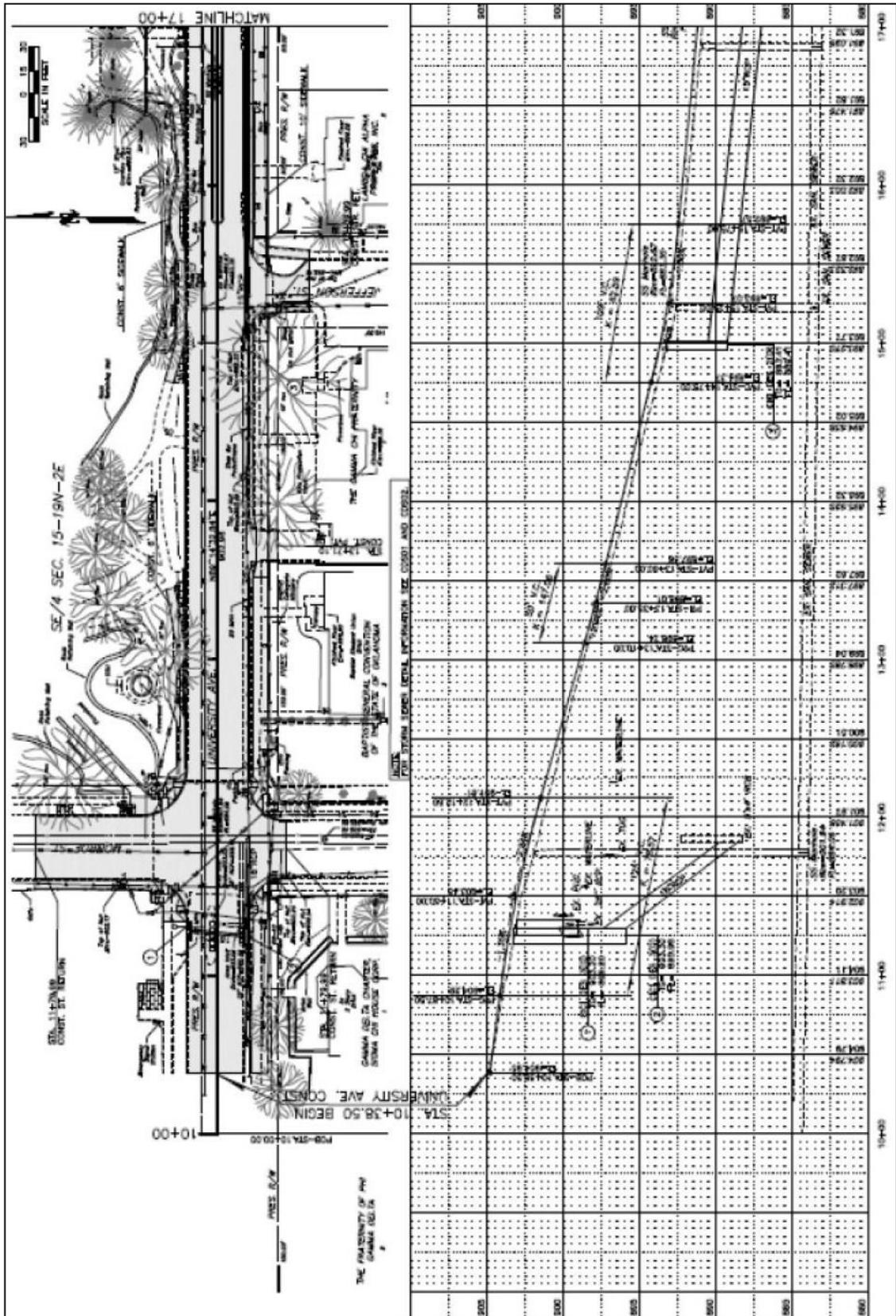
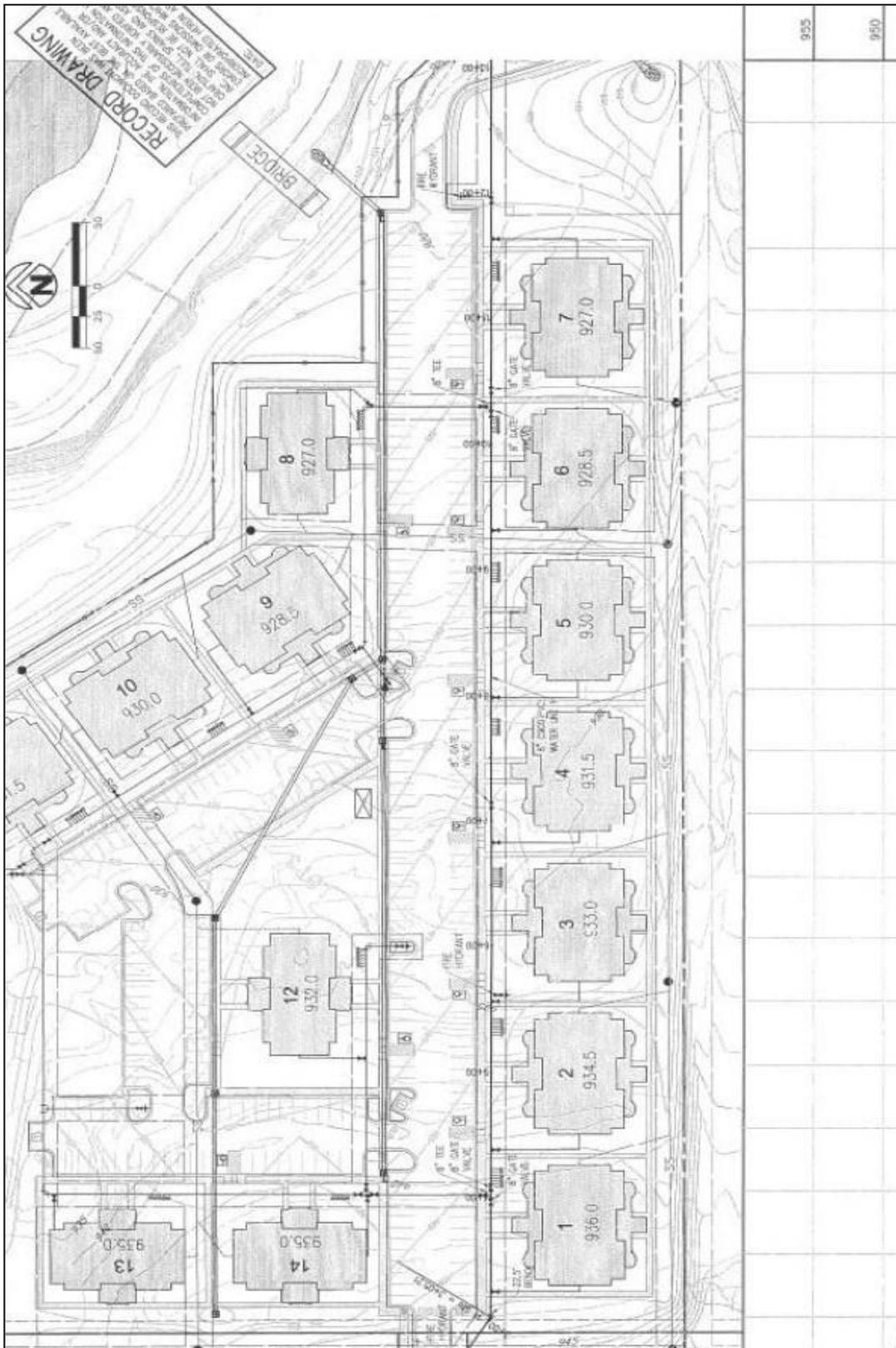


Figure 3.19: Drainage plan of road showing underground storm sewer system  
 (Courtesy: City of Stillwater)



**Figure 3.20: Drainage plan of a subdivision showing underground storm sewer system  
(Courtesy: City of Stillwater)**



Figure 3.21: Subdivision marked in GIS after referring the plan shown in Figure 3.20. (Courtesy: City of Stillwater)

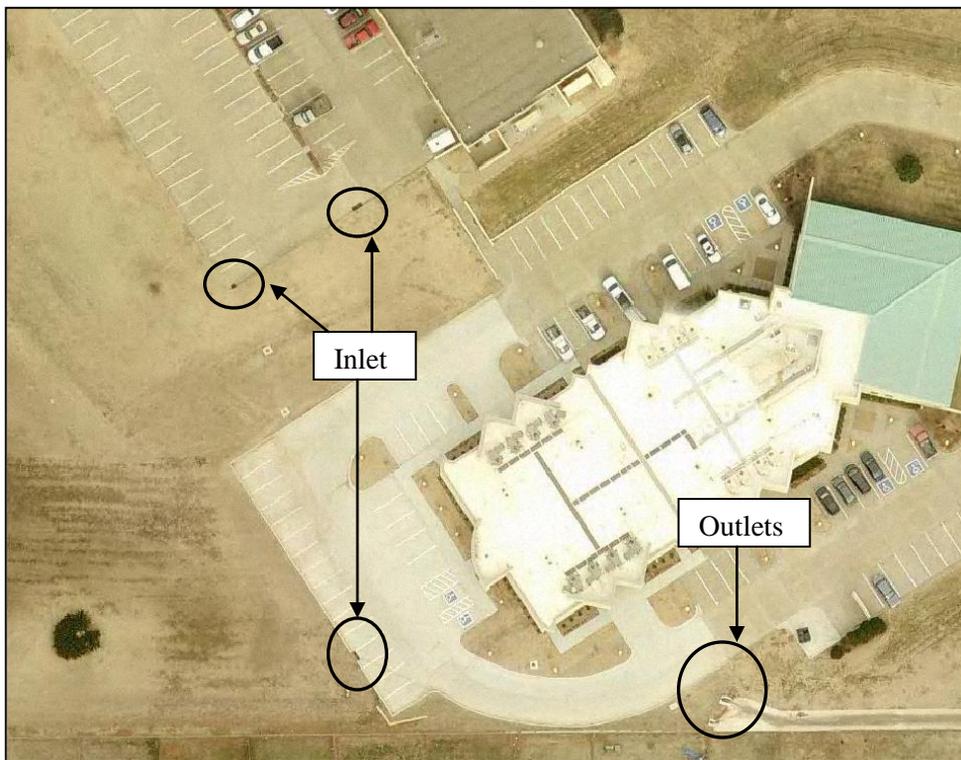
### 3.3.4 Field Verification

The aerial views and site plans are not always clear, and there can be confusion created in an area that is being re-developed. Under such situations, the area may have an old drainage system, and during re-development additional drainage features might have been added. Hence for clarification and to accurately present the information to be put into the GIS, it is preferable to get field data on the as-built of drainage system of the area.

The following steps are followed in this method:

1. Field verification is done when a drainage plan is not found of an area, but by looking at the aerial we can confirm that there is an existing system.

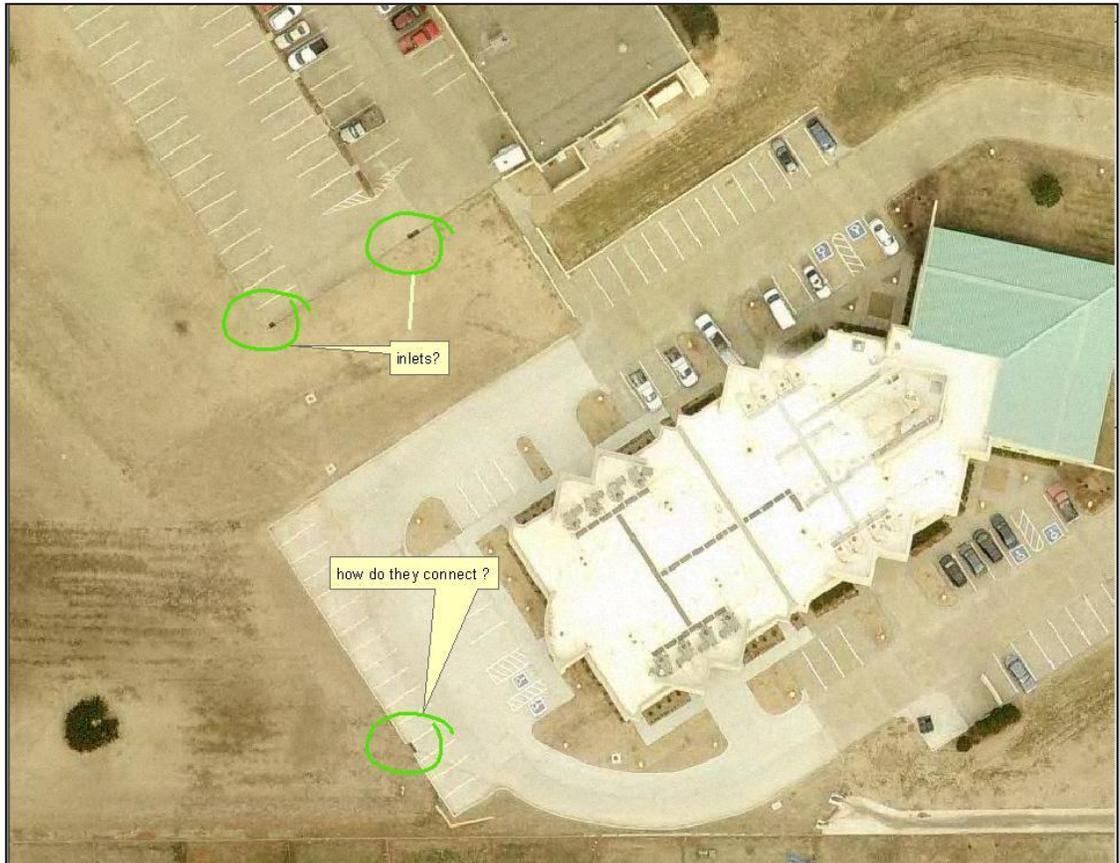
Figure 3.22 shows the parking lot of a commercial site, whose drainage plans were not available. From the photo we can say for sure that there are inlets, and outlets, hence there should be an existing system.



**Figure 3.22: Aerial view of parking lot of a Commercial site. From this we can be certain that there are inlets in the parking lots. (Courtesy: City of Stillwater)**

2. The questions are marked on the GIS itself and printed out. The GIS has a feature to make a note on the map.

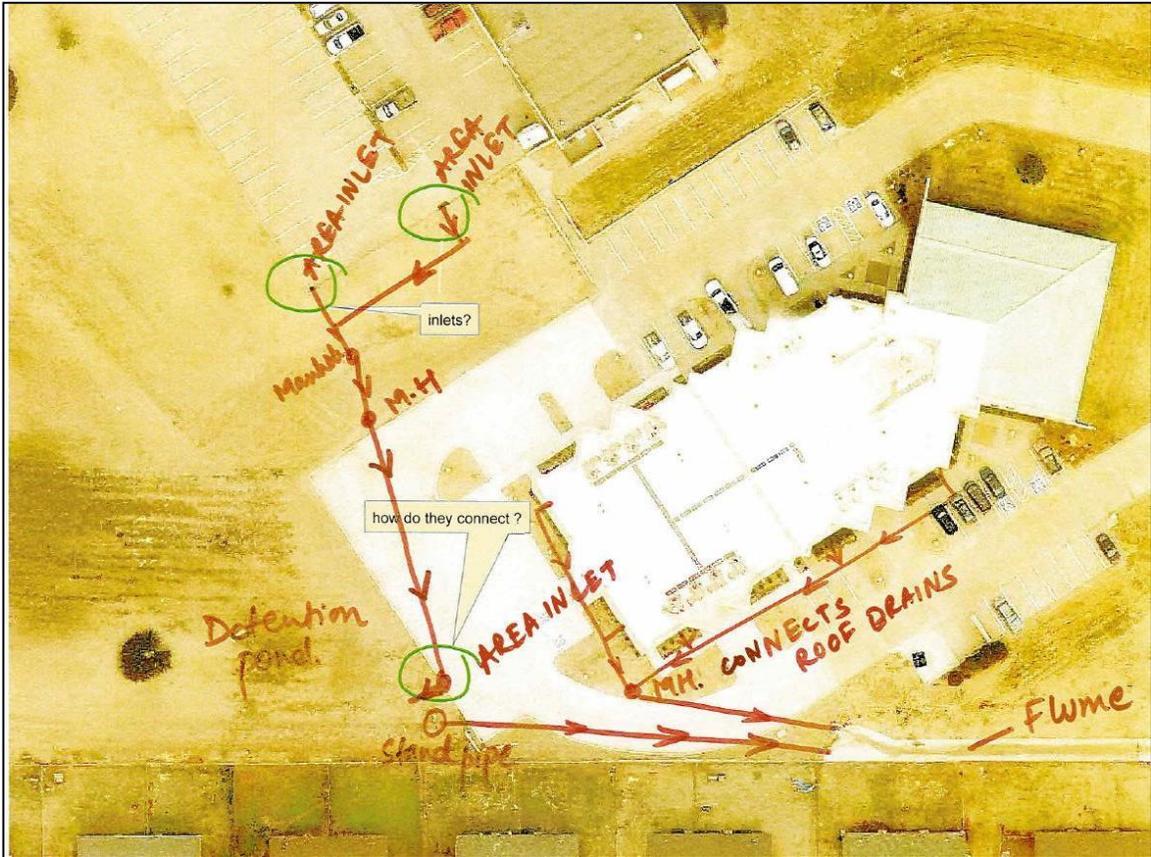
Figure 3.23 shows how questions are marked in GIS and taken for field verification



**Figure 3.23: Questions marked in GIS (Courtesy: City of Stillwater)**  
Printout of the area is taken to the site, to find out how they system is connected.

3. The printout is taken to the site and the directions of the pipes, inlets, manholes and outlet are marked on it. This marked printout is now the drainage plan for that area. In this particular situation, it was found that there are manholes and a detention pond present.

Figure 3.24 shows how the inlets, pipes, detention pond and manholes are marked and taken back as a confirmation of all the stormwater structure for that area.



**Figure 3.24: Field Verification done for the commercial site (Courtesy: City of Stillwater)** As shown in the photo the pipes, inlets are marked and put in to GIS. For this case, we did not know that there was a detention pond near the parking lot. Doing field verification is very helpful, as can confirm all the elements of MS4 for a site.

Figure 3.25 shows how the end result will look in GIS once all the data is fed into GIS.



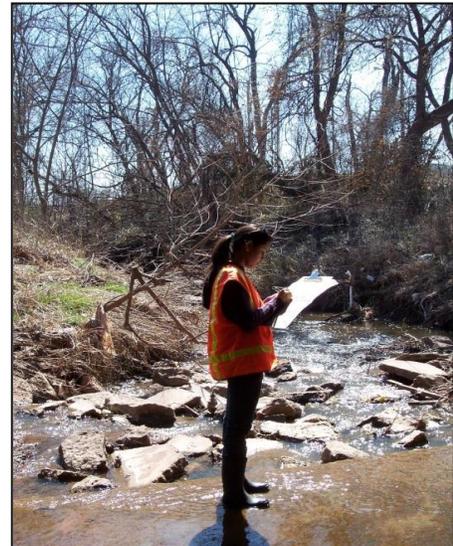
**Figure 3.25: Aerial view in GIS after input of all the data collected during field verification. The orange lines are the underground pipes; the orange circles are manholes; the brown circle (looks like circle but is an octagon) is the dry-detention pond and green lines are flumes present on the site. (Photo Courtesy of City of Stillwater)**

### **3.4 Mapping of Outfalls on the Creeks of Stillwater**

The Phase II General Permit requires the City to map all the outfalls on the main Creeks of Stillwater (ODEQ, 2005). The major creeks of Stillwater are

1. East Boomer Creek
2. West Boomer Creek
3. Stillwater Creek
4. Duck Creek

The mapping of the outfalls is done using GPS mapping, obtaining site/drainage plans, and performing field verifications. Every drainage plan of roads or subdivision essentially has an outlet or a way to divert the runoff of the property without doing any harm. This outlet can be into a creek or a structure that will eventually join in to a creek. The field verification and GPS mapping are done simultaneously. The outlet is marked using the GPS device and it is also marked on the printouts taken for field verification, as shown in the Figure 3.26 below.



**Figure 3.26: Mapping of outfall on the Boomer Creek**

### **3.5 Problems encountered during the Mapping of System**

The main problem encountered during the mapping was the absence of site/drainage plans for many areas of the City of Stillwater. The old roads and subdivisions no longer have copies of As-Built. They either were not provided or were lost along the way. This is typical for the old plans in most municipalities. All of the new roads and sub-divisions built had provided the City with a copy of the storm sewer system As-Built plans. For

those sites without adequate plans, field verification was performed and the system was mapped based on field data. Also, the field verification sometimes was a challenge as

In addition, the aerial view in the GIS was quite helpful. Most of the surface structures could be seen on these views. However, the photo quality is often poor, hence zooming in the view did not help. Also there can be confusion on the components like grate inlets and water meters. In the aerial view they appear almost same and one can be confused for the other, thus, creating a possibility for an inaccuracy in the map of the system. These doubts were clarified by doing field verification.

## **CHAPTER 4**

### **APPLICATION OF MS4 MAP AND RESULTS**

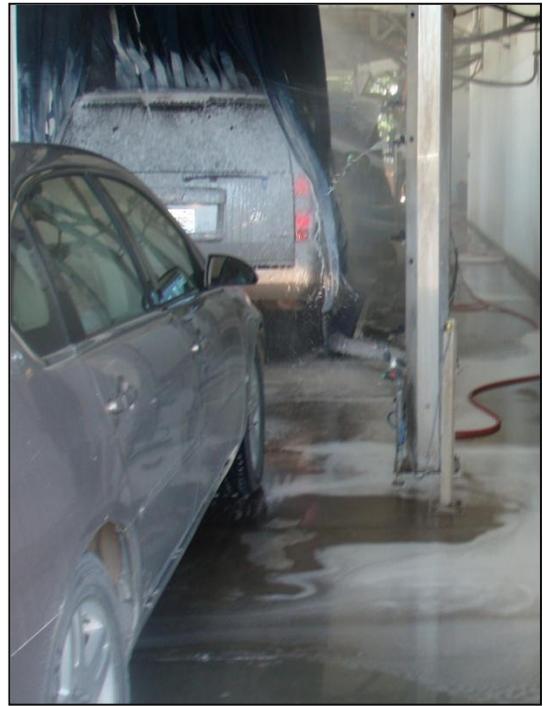
#### **4.1 GIS Mapping used for Source tracking**

The GIS mapping will be of greatest assistance for tracking the sources of pollution that are found in the downstream of a river, lake or stream. The system shows a continuous path of water flow over the impervious surfaces, thus making it easier to back-track the source. While mapping the outfalls along the creeks we came across the following three pollution problems.

1. In the first instance, we came across soap water in a grassy swale. The amount itself was very high, and it could be seen that it was not from any residential area (Refer Figure 4.1). The grassy swale was flowing into a grate inlet and finally had an outlet into Boomer Creek. On further exploration it was found that there was a car wash nearby, as shown in Figure 4.2. When investigated, it was found that one of the outlet pipes at the base of the floor, where cars were washed, was not connected to the sanitary sewer, but was directly let out into the grassy swale.



**Figure 4.1: Soap solution from car wash that was going into the grassy swale**



**Figure 4.2: Cars being washed in shed of a car wash.  
All the soap water was draining into the grate seen on the left-hand side photo.**

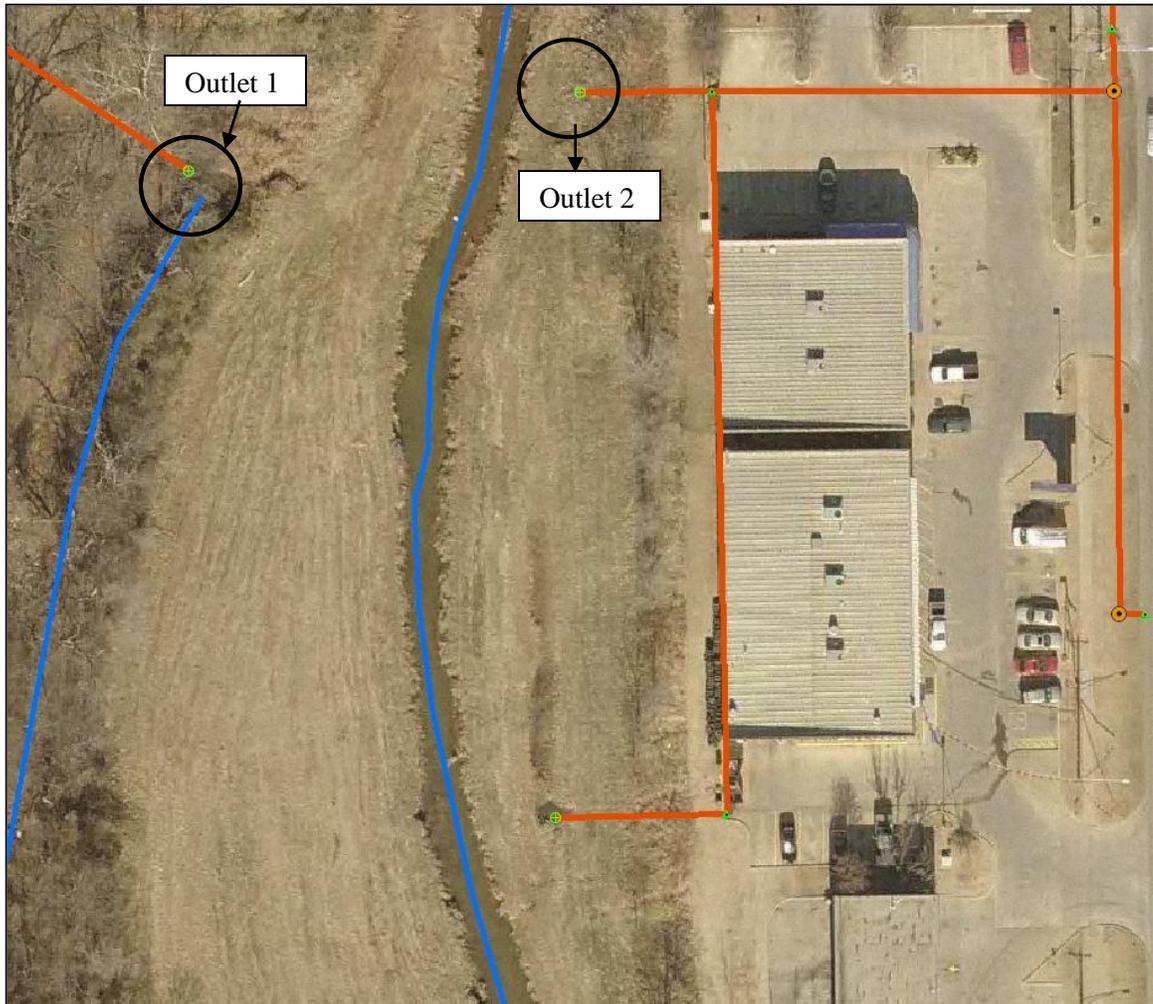
The soap solution was being dumped from the left side of the picture. The cars were washed in a shed and the soapy wastewater was draining into the grate inlets shown on the left-hand side in first picture of Figure 4.2. The floor was sloped towards the left- right hand side so that all the soap water could drain towards the grate.

2. While mapping the outfalls along the creek a small area had collected water with grease floating on top it was found, as shown in Figure 4.3. There was a PVC pipe outlet right above it. This outlet was directly leading into the creek. The pipe had a grate inlet at the top for a parking lot. The parking lot was located at an auto repair and mechanics shop. Thus the parking can be the source of the grease downstream.



**Figure 4.3: Stagnant water with grease on floating on top**

3. Consider a hypothetical situation when the grease was found downstream of creek and not at the outlet itself. When referred to the GIS map we can see that there are three outlets into the creek that could have caused the problem.



**Figure 4.4: GIS map showing three outlets into the Creek. (Photo Courtesy of City of Stillwater)**

Considering that the grease washed off at the south side of the stream, the above shown three outlets could be the cause. The outlet 1, at the top corner, carries runoff from the adjacent road which was found by looking at the storm sewer system in GIS. Outlet 2 and

3, carry the runoff from the roads as well as the parking lots. The building on the top was found to be a book store from where outlet 2 is discharging the stormwater. The bottom building was an auto repair shop which had outlet 3 discharging its runoff. From this we can conclude, from the amount of grease found that the most likely culprit would be the auto repair shop rather than the other two.

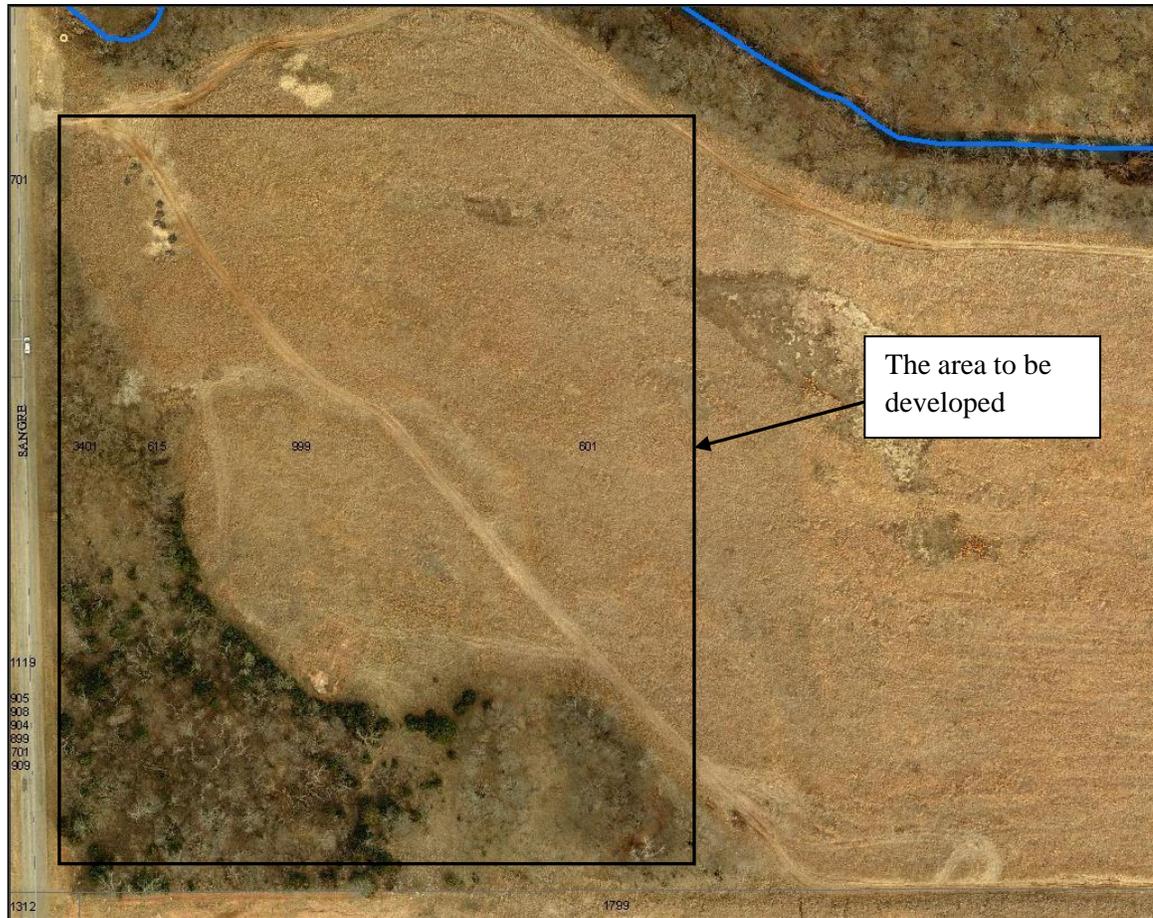
#### **4.2 GIS Mapping used for General Reference**

When the map of MS4 system is looked at as a whole, it gives us the general trend of the runoff, and the flow direction. These things can be very useful while planning a structure, developing a subdivision, and for pollution control. If we know there is going to be a sediment problem, the areas that are going to be affected can be found and proper measures can be taken to prevent or minimize those effects.

#### **4.3 GIS mapping used for Pollution Prevention and Planning**

The map can also be used for pollution prevention. If a pollutant is found to be in a swale or on a pavement proper measures can be taken before it enters a river, creek or pond. The pollution can be contained and removed using standard methods. Similarly, in case of a flood calamity, proper planning for storm runoff can be done using this map and the worst damage can possibly be prevented. The flooding of previously affected area can possibly be overcome by taking proper measures.

Consider a scenario of developing a subdivision. Figure 4.5 shows the area to be developed. It is approximately, 410 sq ft.



**Figure 4.5: Area to be developed. (Photo Courtesy of City of Stillwater)**

From figure 4.5 we can see that a stream is running behind the area to be developed. Hence care should be taken during the construction, to stop sediments entering the stream. Proper measure should be taken in case of rain which will result in sediment runoff directly into the stream. The best option is to create a sediment detention basin behind the area to be developed. This detention basin can also be used later to store the runoff after the building is built.

GIS can be used to find the topography of the area, the area available for a detention basin. The average rainfall in Stillwater is 7.31 inches (ASTRO, 2010).

Considering this, the volume of runoff can be calculated as follows:

Rainfall = 7.31 inches = 0.18 m

Runoff volume = 0.18m x 410 sq ft x 0.09 sq m/sq ft  
= 6.63 m<sup>3</sup>

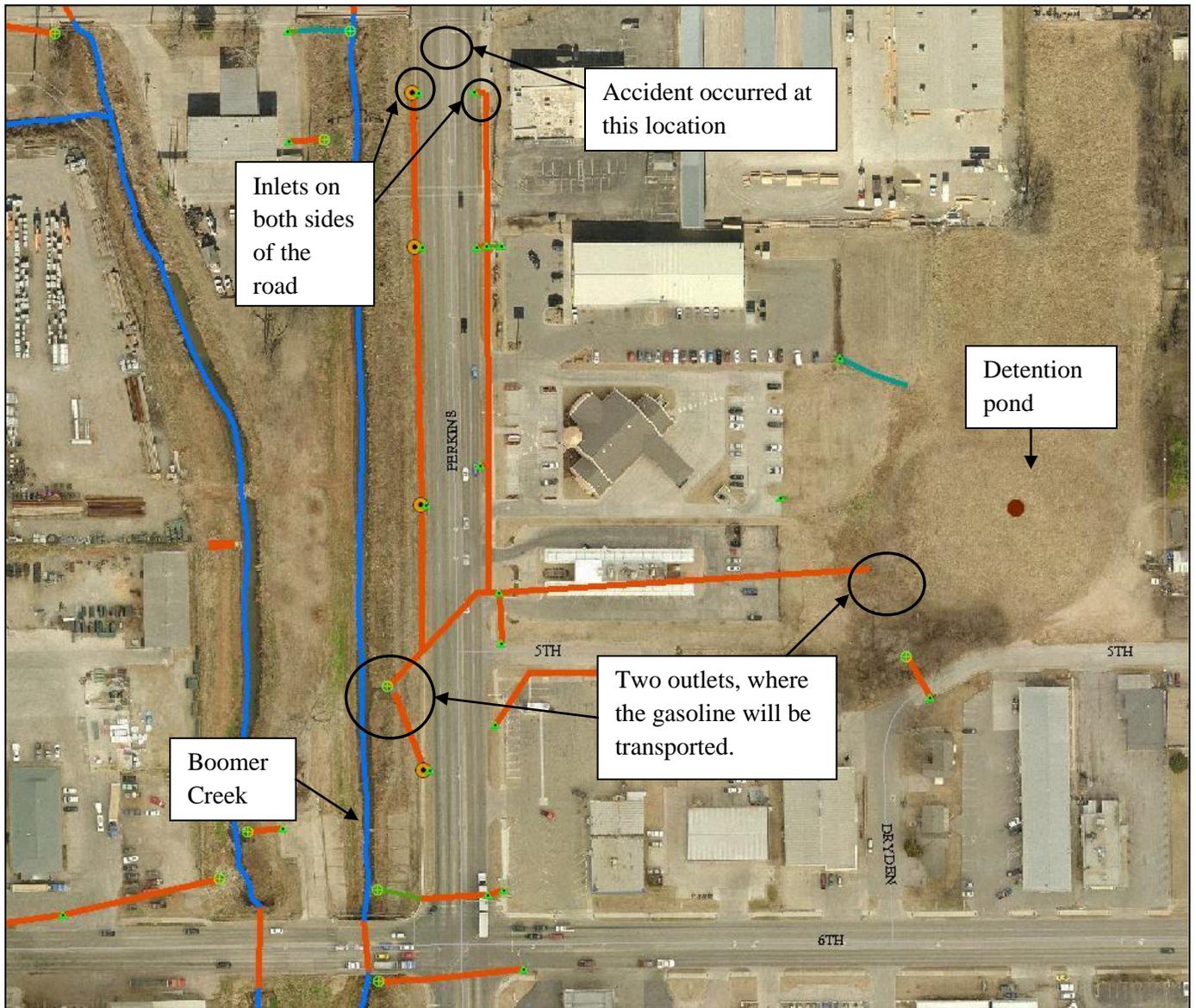
Runoff in liters = 6630 liters

This is the volume of stormwater runoff resulting from the average rainfall over 24 hours.

The detention basin's dimension can be calculated for the given volume after adding a safety factor. The dimension of the basin will depend on the area available.

#### **4.4 GIS mapping used for Emergency management**

Figure 4.6 shows the MS4 for area near Perkins Rd. Consider, there has been an accident involving a tank truck carrying gasoline, at the circled area in Figure 4.5. Gasoline is a very harmful pollutant for rivers, lakes and creeks.



**Figure 4.6: Accident scenario on Perkins Rd. (Photo Courtesy of City of Stillwater)**

The road has inlets on both sides, but the spill has mostly been on the left lane. From the GIS map we can see that the inlet on left goes and meet the creek and the inlet on right goes into a detention pond behind the building. The other factor that will affect the flow of the gasoline is the rainfall that will help in washing off the spilled gasoline before it is

contained. The following steps can be taken by the fire department to minimize the effect of spill and methods that can be used to contain it before major harm is done.

1. From the GIS map, we can conclude that gasoline will enter the MS4 at two locations. Tracking these storm sewers we can see the two outlets, one in the creek and other in the detention pond (refer figure 4.6).
2. Taking the average velocity of water flow in the creek and time required for the fire department to get to the site, the distance travelled by the spill can be calculated.

For e.g. assuming the average flow of stream = 2 m/s

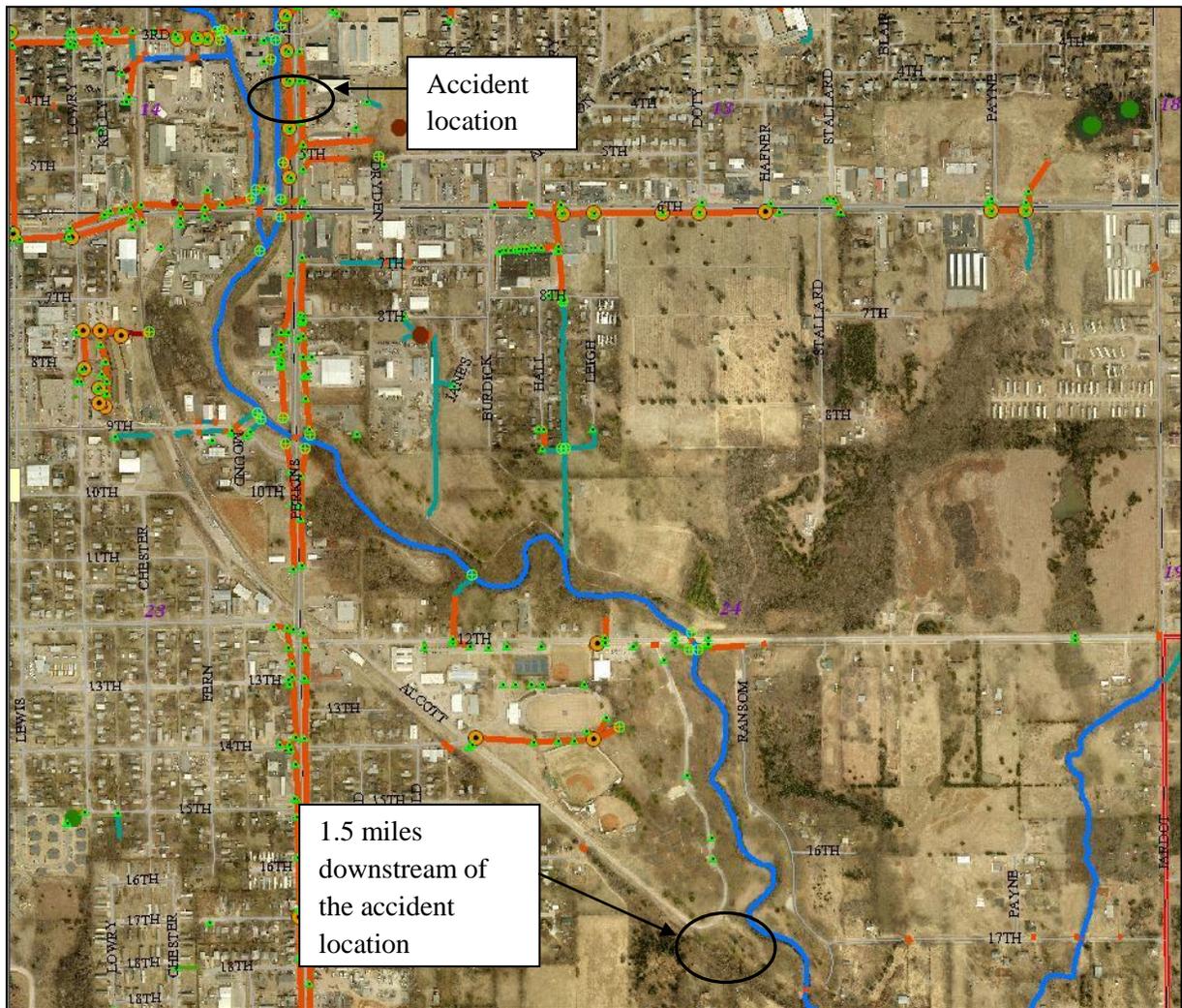
Fire department took about 20 minutes to get to the site.

The approximate distance travelled by gasoline during this time is,

$$= 2 \text{ m/s} \times 20 \text{ minutes} \times 60 \text{ s} = 2400 \text{ m}$$

3. Converting the meters to miles,  $2400 \text{ m} = 2400 \times 0.0006 \text{ miles} = 1.44 \text{ miles}$ .
4. Hence, we can safely assume that it travelled approximately 1.5 miles from the point of origin.
5. Going back to GIS map, we can measure the distance along the creek and find the approximate distance, where the pollutant is at the present moment. Also from the map we find an intersection where the fire department can set up a perimeter to contain the pollutant.

Figure 4.7 show the location where the gasoline will end downstream of the Boomer Creek.



**Figure 4.7: View in GIS showing the accident location and the calculated location of the pollutant. From the photo we can also make out the street names and intersection where perimeter can be set up to contain gasoline from moving further downstream. (Photo Courtesy of City of Stillwater)**

6. The best way to control it to put sand bags, or built temporary dams or put in grease trap on the creek and stop the flow of water. Once the pollutant is stopped from flowing downstream, it can be removed using vacuums to suck the gasoline from the top layer and disposing it properly. Also, the detention pond must be cleaned to remove gasoline from it. Thus, having a ready GIS map will not only save time but will be more efficient in handling situations that need immediate response and action.



Table 4.1 shows the number of inlets, outlets, manholes and structures mapped and miles of streams and pipes mapped. The inlets, outlets and pipes are classified based on their lifecycle status (active, proposed, and removed) and the source used to map them. Then they are classified according to the subtypes. Manholes and structures all are active.

**Table 4.1: Number/miles of MS4 elements mapped in GIS**  
**The inlet, manholes, outlets and structures are in total numbers. The open and closed channels are measured in the number of miles mapped**

		Subtypes	Number/Miles Mapped	Total number/miles mapped (Active ASBUILT and AERIAL)
<b>Inlet</b>	Active - ASBUILT/GPS	Curb Openings	513	
		Grate	651	
		Hood	149	
		Combination hood/Grate	663	
		Drop inlet	21	
		Standpipe	-	
		Headwall	6	
		Overflow	-	
	Active - AERIAL	Curb Openings	45	
		Grate	-	
		Hood	-	
		Combination hood/Grate	-	
		Drop inlet	-	
		Standpipe	-	
		Headwall	-	<b>2050</b>
		Overflow	-	
	Active - BASEMAP/STORM	Curb Openings	-	
		Grate	-	
		Hood	-	
		Combination hood/Grate	-	
		Drop inlet	-	
		Standpipe	-	
		Headwall	-	
Overflow		-		
Proposed - ASBUILT		-		
Proposed - AERIAL		-		
Proposed - BASEMAP/STORM PLAN		-		
Abandoned - ASBUILT		2		
Abandoned - AERIAL		-		
Abandoned - BASEMAP/STORM PLAN		-		
<b>Manhole</b>	Active - ASBUILT/GPS		400	
	Active - BASEMAP/STORM PLAN		-	<b>400</b>
	Proposed - ASBUILT/GPS		-	
	Abandoned - ASBUILT/GPS		-	

<b>Structures</b>	Active - ASBUILT/GPS	Detention Basin - dry	63	<b>384</b>
		Detention Basin - wet	80	
		Discharge Structure	-	
		Diversions Chamber	-	
		Diversions point	-	
		Junction chamber	-	
		Junction structure w/clean out	-	
		Junction structure w/manhole	-	
		Other	-	
		Retention Basin	15	
		Storage Basin	-	
		Underground storage	5	
	Active - AERIAL	Detention Basin - dry	23	
		Detention Basin - wet	198	
		Discharge Structure	-	
		Diversions Chamber	-	
		Diversions point	-	
		Junction chamber	-	
		Junction structure w/clean out	-	
		Junction structure w/manhole	-	
Other		-		
Retention Basin		-		
Storage Basin	-			
Underground storage	-			
Active - BASEMAP/STORM PLAN		-		
Proposed - ASBUILT		-		
Proposed - AERIAL		-		
Proposed - BASEMAP/STORM PLAN		-		
Abandoned - ASBUILT		-		
Abandoned - AERIAL		-		
Abandoned - BASEMAP/STORM PLAN		-		
<b>Outlet</b>	Active - ASBUILT/GPS	Pipe - concrete	84	
		Pipe - metal	32	
		Pipe - plastic	4	
		Weir Structure	9	
		Open channel outfall	152	
		Curb opening	31	
		Endwall	1	
		Other	24	
	Active - AERIAL	Pipe - concrete	23	
		Pipe - metal	2	
		Pipe - plastic	-	
		Weir Structure	-	
		Open channel outfall	24	
		Curb opening	-	
Endwall	-			
Other	1			

<b>Outlet</b>	Active - BASEMAP/STORM	-	-	<b>382</b>
	Proposed - ASBUILT	-	-	
	Proposed - AERIAL	-	-	
	Proposed - BASEMAP/STORM PLAN	-	-	
	Abandoned - ASBUILT	-	-	
	Abandoned - AERIAL	-	-	
	Abandoned - BASEMAP/STORM PLAN	-	-	
<b>Open channels</b>	Active - ASBUILT/GPS	Stream	3.32	<b>138.83 miles</b>
		Grassy Swale	10.7	
		Channels	2.13	
		Flume	5.99	
		Trickle channel	2.67	
		Other	0.07	
	Active - AERIAL	Stream	77.45	
		Grassy Swale	32.37	
		Channels	1.79	
		Flume	1.4	
		Trickle channel	0.94	
		Other	-	
	Active - BASEMAP/STORM	Stream	-	
		Grassy Swale	-	
		Channels	-	
		Flume	-	
		Trickle channel	-	
		Other	-	
	Proposed - ASBUILT	-	-	
	Proposed - AERIAL	-	-	
	Proposed - BASEMAP/STORM PLAN	-	-	
	Abandoned - ASBUILT	-	-	
	Abandoned - AERIAL	-	-	
Abandoned - BASEMAP/STORM PLAN	-	-		

<b>Closed Channels</b>	Active - ASBUILT/GPS	Culvert	2.87	<b>51.53 miles</b>
		Storm Sewer	44.55	
	Active - AERIAL	Culvert	4.03	
		Storm Sewer	0.08	
	Active - BASEMAP/STORM	Culvert	-	
		Storm Sewer	-	
	Proposed - ASBUILT	Culvert	-	
		Storm Sewer	-	
	Proposed - AERIAL	Culvert	-	
		Storm Sewer	-	
	Proposed - BASEMAP/STORM PLAN	Culvert	-	
		Storm Sewer	-	
	Abandoned - ASBUILT	Culvert	-	
		Storm Sewer	-	
	Abandoned - AERIAL	Culvert	-	
		Storm Sewer	-	
	Abandoned - BASEMAP/STORM PLAN	Culvert	-	
	Storm Sewer	-		

## **CHAPTER 5**

### **RECOMMENDATION AND CONCLUSION**

#### **5.1 Recommendations**

In future, whenever a new pipe or storm sewer system is put in place, the same should be entered into the GIS city system to make sure that the map is always current. It will be helpful to input the size of the pipes and structure which are needed for flow calculations while designing or re-developing a structure. Along with sizes, the date of the structures build can also be entered which will help in maintenance and repairs of the structures. Also, the demolished or abandoned pipes or inlets should be updated in the GIS. This map can be used by any Department that deals storm sewer systems.

## **5.2 Conclusion**

The City of Stillwater has MS4 in place, which will meet the criteria for the ODEQ Phase II Permit for Small Municipals. The city of Stillwater has the stormwater system in place. It can be used for future reference for source tracking, planning and emergency management. Also locations of the outfalls into the creeks of Stillwater are mapped. Further improvements in the map can be done as and when there are new developments are done.

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## APPENDICES

## Appendix A: Paving Drainage plans referred

	<b>Names of paved streets</b>
111	1st Avenue-Dist. #137 (Park Terrace to Brentwood)
111	2nd Avenue-Dist. #137 (Windsor to Brentwood)
111	2nd Court-Dist. #137 (2nd to South)
112	3rd Avenue-Box Culvert (3rd & Boomer Creek)
112	3rd Avenue-Brush Creek Meadows-2nd Section
112	3rd Avenue-Dist. #137 (Park Terrace to Brentwood)
112	3rd Avenue-Dist. #4 (Burdick to Benjamin)
112	3rd Avenue-Dist. #91 (Brush Creek to Colby Lance)
112	3rd Avenue-Drainage (Brown-Moore Blk 2, Willis to 3rd)
112	3rd Avenue-Drainage (Eastern Ave)
112	3rd Avenue-Improvements (Main to Perkins Rd)
113	3rd Avenue-Improvements 3-84 (Duck to Lewis)
113	3rd Avenue-Pavement Reconstruction (Hester to West)
113	3rd Avenue-Street Intersection (Main)
113	3rd Avenue-Signalization (3rd & Duck)
113	3rd Avenue-Signalization (3rd & Perkins)
113	3rd Avenue-Signalization (3rd & Perkins)
114	3rd Place-Dist. #137 (Windsor to Brentwood)
115	4th Avenue-Alley Paving
115	4th Avenue-Dist. #116 (Oakdale to Windsor)
115	4th Avenue-Dist. #125 (Villa to 387' East)
115	4th Avenue-Dist. #136 (Doty to Stallard)
115	4th Avenue-Dist. #38 (Villa to 400' West)
115	4th Avenue-Dist. #91 (Brush Creek to East)
116	4th Avenue-Sidewalk & Parking (4th & Washington)
116	5th Avenue-Dist. #116 (Charles to Oakdale)
116	5th Avenue-Dist. #136 (Willis to McFarland)
116	5th Avenue-Dist. #38 (Villa to 500' West)
117	5th Avenue-Dist. #48 (Perkins to 150' East)
117	5th Avenue-Intersection of Main & 5th
117	5th Avenue-SID #178 (Country Club Rd)
118	5th Avenue-Sidewalk (5th & Main Street)
118	6th Avenue-(Jardot)
118	6th Avenue-(Holiday Inn Entrance at Devon)
118	6th Avenue-(Washington to Husband)
118	6th Avenue-Bridge Plans (Cow Creek & Stillwater Creek)
120	6th Avenue-Drainage Structure & Pipe Layout (6th & McDonald)
121	6th Avenue-Entrance Improvements (6th & Main)
121	6th Avenue-Federal Aid Proj.#F-198(43)(45) (Range to Cow Creek)
121	6th Avenue-Federal Aid Proj.#F-198(71) (Jardot to 1345' E. of Fairgrounds)
121	6th Avenue-Federal Aid Proj.#F-U-198(16) (Husband to Western)
121	6th Avenue-Federal Aid Proj.#SU-6018(100)C (12th to HOF)(6th & Western)
121	6th Avenue-Federal Aid Proj.#U-F-198(18) (Husband to Jardot)
122	6th Avenue-Guardrails (Cow Creek & Stillwater Creek)
122	6th Avenue-Sidewalk
122	6th Avenue-Sidewalk (Western to Ridge)
122	6th Avenue-Sidewalk Perkins, SMC, Elm & West, 5th & Main
122	6th Avenue-Signalization (6th & Burdick, 6th & Perkins)
122	6th Avenue-Signalization (6th & Railroad Tracks)
123	6th Avenue-Signalization (Monroe to Perkins, 6th & Perkins)

123	6th Avenue-Signalization (Monroe to Perkins, 6th & Perkins)
123	6th Avenue-Signalization (Western to Burdick)
123	6th Avenue-Storm Sewer (6th & Washington)
123	6th Avenue-Turn Lane & RCB at Country Club
124	6th Avenue-Under drains
125	7th Avenue-Country Club Basin (Oak Ridge to Basin Ridge)
125	7th Avenue-Dist. #132 (Crosswinds to Greystone)
126	7th Avenue-Dist. #136 (Western to Ridge)
126	7th Avenue-Dist. #139 (Pine to Adams)
126	7th Avenue-Dist. #54 (Walnut to Pine)
126	7th Avenue-Storm Sewer-Project #65-1-65-292 (7th & Ramsey)
126	8th Avenue-(Country Club Basin)
126	8th Avenue-Box Culvert(Hall to Leigh)
126	8th Avenue-Dist. #132 (Stoneybrook to Greystone)
127	8th Avenue-Dist. #139 (Burdick to Leigh)
127	8th Avenue-Dist. #140 (Perkins to Burdick)
127	8th Avenue-Dist. #158 (McDonald to Orchard)
128	8th Avenue-Off Street Parking at Husband & 8th
129	8th Avenue-Storm Sewer (Hester to Ramsey)
129	9th Avenue-Dist. #107 (Country Club to 1608' West)
129	9th Avenue-Dist. #11 (Lewis to Lowry)
129	9th Avenue-Dist. #139 (Burdick to Hall)
129	9th Avenue-Dist. #27 (Husband to Lewis)
130	9th Avenue-Improvements (Perkins to Railroad Tracks)
131	9th Avenue-RCB- (Duck Creek & 9th)
131	9th Avenue-Sidewalk (Western to Duck)
131	10th Avenue to 11th Ave-Drainage Flume
132	10th Avenue-(Adams to Jefferson St)-CDBG
132	10th Avenue-(Lowry St to Chester St)
132	10th Avenue-(15th, Pennsylvania St & Husband Pl)
133	10th Avenue-Dist. #1 (Western to Ridge)
134	10th Avenue-Dist. #101 (Western to 567' West)
135	10th Avenue-Dist. #107 (Springdale to Blueridge)
136	10th Avenue-Improvements ( Duck to Ramsey)
136	10th Avenue-SID 166 (Stanley to Adams)
136	11th Avenue-(Adams to Washington)-CDBG
137	11th Avenue-Dist. #107 (Woodcrest to Edgemoor)
138	11th Avenue-Improvements #6-82 (Husband to Fern)
138	11th Avenue-Improvements (Duck to West)
139	11th Avenue-Improvements (Duncan to Husband, Hester to West)
139	12th Avenue-1966 Bond Issue (Duck to Main)
139	12th Avenue-Bridge & Paving-Project #BRF-60C(268)UR
139	12th Avenue-Dist. #146 (Western to Ridge)
139	12th Avenue-Dist. #1-80 (Perkins to Boomer Creek)
140	12th Avenue-Dist. #84 (Ramsey to Adams)
140	12th Avenue-Ditch Liner
140	12th Avenue-Drainage Structure (McDonal & 12th)
141	12th Avenue-Improvements (Duck to Hester)
141	12th Avenue-Improvements (Hester to Ramsey)
141	12th Avenue-Intersection (At Main St)
141	12th Avenue -ODOT

141	12th Avenue-Project #SU-6018(100)C (Western to Duck)
142	12th Avenue-(Ransom St to Jardot Rd)
142	13th Avenue-Dist. #142 (Lewis to Lowry)
142	13th Avenue-Improvements #4-82 (Lewis to Husband)
142	13th Avenue-(Duck to Duncan)-CDBG
143	13th Avenue-(Lowry to Fern St)-CDBG
145	13th Avenue-(West to Duck St)-CDBG
145	14th Avenue-(At Hartford)
145	14th Avenue-Dist. #139 (Perkins to Railroad)
146	14th Avenue-Improvements #4-82 (Main to Duck)
147	14th Avenue-Intersection (at Main & 14th)
147	15th Avenue-Dist. #119 (Dublin to Woodland)
147	15th Avenue-Dist. #136 (Sangre to Shalamar)
148	15th Avenue-Dist. #152 (Lowry to Chester)
148	15th Avenue-Drainage (Shalamar Addition)
148	15th Avenue-(120' West of Husband)-CDBG
150	15th Place-Dist. #60
150	16th Avenue-Dist. #122 (Yorkshire to Shalamar)
151	16th Avenue-Dist. #139 (Perkins to Pennsylvania)
151	16th Avenue-Dist. #140 (Pennsylvania to Alcott)
151	16th Avenue-Dist. #83 (Country Club to Fairfield)
152	16th Avenue-Retaining Wall (16th & Shalamar)
152	17th Avenue-Dist. #157 (Surrey to East)
152	17th Avenue-(2 Blocks West of Perkins Rd)-CDBG
152	17th Avenue-(Pennsylvania & Aetna St)-CDBG
153	18th Avenue-Dist. #119 (Berkshire to 100' East)
153	18th Avenue-Dist. #122 (Shalamar to East)
153	18th Avenue-Dist. #157 (Surrey to East)
153	18th Avenue-Dist. #29 (Surrey to East)
153	18th Avenue-Dist. #64 (Westbrook Addition)
154	18th Avenue-Dist. #83 (Westridge to Fairfield)
154	18th Court-Dist. #60
154	19th & Sangre-Signalization
154	19th Avenue-(Country Club to Range Rd)
154	19th Avenue-(Country Club to Sangre)
155	19th Avenue-(Pioneer Trail to Country Club Dr)
155	19th Avenue-Dist. #3-80 (1214' West of Sangre)
155	19th Avenue-Intersection Improvements (19th & Western)
155	19th Avenue-Sidewalk (Sangre to Hillside)
155	19th Avenue-Sidewalk-Improvements #7-83
156	19th Avenue-Signal & Paving Improvements (19th & Sangre)
156	23rd Avenue-Dist. #146 (Western to Willis)
157	24th Avenue-Dist. #139 (Western to Willis)
158	26th Avenue-Bridge (1/2 mile West of Washington)
158	26th Avenue-Drainage Ditch & Detention Pond
159	27th Avenue-Dist. #44 (Pioneer to August)
160	27th Avenue-Dist. #49 (Quail Ridge to August)
160	27th Court-Dist. #96
160	28th Court-Dist. #96 (Quailridge to Mar Vista)
160	29th Avenue-Dist. #56 (Husband to 628' West)

161	29th Avenue-Dist. #73 (Husband to Knoblock)
162	29th Court-Dist. #111 (Black Oak to East)
162	30th Avenue-Dist. #111 (Saddle Rock to Black Oak)
162	31st Avenue-Dist. #111 (Saddle Rock to West)
163	Adams Street-SID 166 (9th to 11th)
163	Admiral Avenue-Dist. #002 (Western to Willis)
163	Admiral Avenue-Drainage Duck Creek (Admiral to University)
163	Airport Access Road
163	Airport Drive-(Airport Rd to 700' North)
164	Airport Industrial/Office Park
165	Airport Lane-Dist. #141(Airport Rd to 700' N)
165	Airport Parking Area-(Delta & Exec. Air Offices)
166	Airport Road-(Perkins to Marine)
166	Airport Road-(Marine to Jardot)
166	Airport Road-Bridge over Boomer Lake
167	Airport Road-Dist. #92(Perkins Rd to 2800' W)
168	Airport Road-Drainage (800 Block West Airport)
168	Airport Road-Project #35-92-13-6409 (Washington)
168	Airport Road-Railroad Tracks to Boomer Bridge
169	Airport Road-Signalization (Airport & Washington)
170	Airport Road-Signalization at Washington
170	Airport-Layout Plan
171	Airport-Overlay of tie-down and ramp area
171	American Appliance-Grading & Drainage Plan
172	Andrew Hills Addition- 1st Section-Dist. #17
172	Andrew Hills Addition- 1st Western Section-Dist. #37
172	Andrew Hills Addition-2nd Western Section-Dist. #128
172	Andrew Hills Addition-3rd Western Section-Dist. #63
173	Andrew Hills Addition-4th Section-Dist. #52
173	Andrew Hills Addition-5th Western Section-Missing Sheets
173	Andrew Hills Addition-6th Western Section-Dist. #88
173	Arapaho Avenue-Preliminary Assessments
173	Arapaho Ave-SID #177(Ramsey to Knoblock)
174	Arrington Court-Dist. #88 (Redbud to North)
175	Arrington Drive-Dist. #142 (Maple to Elm)
175	Arrington Street-Dist. #88 (Redbud to Knapp)
176	Arrowhead Drive-Dist. #136 (Western to Willis)
176	Audene Drive East-Dist. #124 (North Rogers to East)
177	Audene Drive East-Dist. #97 (Marie to North Rogers)
178	August Drive-Dist. #49 (26th to 27th)
178	August Drive-Dist. #60
179	August Drive, 5th, Knoblock, 25th-SID #174 Alley
179	Babcock Park-Paving
179	Basin Ridge Drive-Country Club Basin (6th to 7th)
180	Bellis Street-Dist. #137 (Eskridge to S 310')
180	Bellis Street-Dist. #145 (McElroy to Connell)
180	Bellis Street-Dist. #162 (McElroy to Tyler)
181	Bellis Street-Dist. #8 (McElroy to Tyler)
181	Benjamin Street-Concrete Rehab
181	Benjamin Street-Dist. #109 (Franklin to Krayler)

181	Benjamin Street-Dist. #143 (Lakeview to Dell)
181	Benjamin Street-Dist. #147 (3rd to Maple)
181	Benjamin Street-Dist. #168 (3rd to 400' South)
182	Benjamin Street-Dist. #33 (McElroy to Tyler)
182	Benjamin Street-Dist. #4 (3rd to Maple)
183	Benjamin Street-Dist. #88 (Redbud to North)
183	Bennett Hall-Storm Sewer(Hall of Fame, Hester, Scott, Duck)
183	Berkshire Drive-Dist. #119 (15th to 18th)
183	Berry Court-Dist. #88 (Redbud to North)
184	Berry Street-Drainage (Virginia to Burdick)
185	Berry's Addition-Dist. #121 (Alley 8th to 9th between Walnut & Pine)
185	Black Oak Drive-Dist. #111 (32nd to Country Side)
185	Blue Sky Way-Dist. #39
185	Blueridge Drive-Dist. #107 (9th to Springdale)
186	Boomer Creek-Bridge (9th & Perkins)
186	Boomer Creek-Channelization & Drop Structure
187	Boomer Creek-Channelization & Drop Structure (3rd & Virginia)
187	Boomer Creek-Channelization (6th & Perkins)
187	Boomer Drive-Federal Proj.#U-319(25) (Elm to 579' North Lakeview)
188	Boomer Drive-Signalization(Boomer, Husband & Tyler)
190	Boomer Drive-U.S. Works Program #WPMH 231 (Elm to Lakeview)
190	Boomer Lake Bridge-(Airport Rd. & Boomer Lake)
191	Boomer Lake Park-Paving Improvements
191	Boomer Lake Park-Paving Improvements (North Husband St.)
193	Boomer Lake-Boat Ramp & Parking Lot
193	Boomer Lake-Contours
193	Boomer Road-Intersection of Boomer & Duck
193	Boomer Road-Intersection of Boomer & Washington
194	Boomer Road-Sidewalks (24th, 6th, Kings, Manning)
194	Boomer Road-Storm Sewer (Boomer & Tyler)
194	Brentwood Drive-Dist. #137 (1st to 3rd)
194	Briarwood Drive-Dist. #109 (Manning to Krayler)
194	Briggs's Addition-Dist. #13
195	Brighton Addition-Detention Pond
196	Brighton Addition-Street, Water & Sewer
196	Brighton-Detention Ponds
197	Britton Drive and Court-Dist. #124 (North Rogers to East)
197	Britton Drive and Court-Dist. #97 (Marie to North Rogers)
198	Britton Drive(North)-Dist. #69 (North Rogers to 178' North)
198	Britton Drive(North)-Dist. #74 (Marie to North Rogers)
198	Brooke Avenue-Box Culvert (Brooke to Moore)
198	Brooke Avenue-Dist. #109 (Benjamin to Manning)
199	Brooke Avenue-Dist. #162 (Washington to Boomer)
199	Brooke Avenue-Storm Sewer (Alley Boomer Dr. to Boomer Creek)
199	Brooke Hollow
199	Brooke Hollow Drive
199	Brookhart Addition-(Block 6 Drainage Ditch)
200	Brookhart Addition-1st Section-Dist. #51
201	Brookhart Addition-2nd Section-Dist. #95
202	Brookhart Addition-Dist. #24
202	Brookhart Addition-Drainage Improvement

202	Brookhart Addition-Storm Sewer
202	Brown Drive-Dist. #13 (Blakely to Washington)
203	Brown-Moore Addition-Drainage (Willis to 3rd)
203	Brush Creek Meadows-1st Section
203	Brush Creek Meadows-2nd Section
204	Brush Creek-Low Water Bridge
204	Burdick Street-Dist. #137 (6th to 7th)
204	Burdick Street-Dist. #139 (5th to 6th)
204	Burdick Street-Dist. #139 (8th to 850' North)
204	Burdick Street-Dist. #140 (8th to 9th)
205	Burdick Street-Dist. #154 (3rd to Maple)
205	Burdick Street-Dist. #4 (3rd to Maple)
205	Burdick Street-Dist. #66 (McElroy to 596' North)
205	Burdick Street-Drainage
205	Burdick Street-Drainage (Burdick to Virginia)
205	Burdick Street-Drainage Ditch (McElroy to 950' North)
206	Burdick Street-Storm Sewer System
206	Cantwell Avenue-Concrete Rehab
206	Cantwell Avenue-Dist. #150 (Husband to Duck)
207	Cantwell Avenue-Dist. #5 (Washington to Knoblock)
207	Canyon Rim Drive-Dist. #46 (Sunrise to 177' South)
208	Canyon Rim Place-Dist. #17 (Skyline to Sunrise)
208	Carmike Cinema Theater-Drainage Plan
208	Carpenter's Addition-Dist. #3
208	Cedar Drive-Dist. #34 (Manning to Stallard)
208	Cedar Drive-Drainage
208	Cedar Oaks Estates-Dist. #57
208	Celia Lane-Dist. #60
209	Celia Street-Dist. #29 (Now Surrey Drive)
209	Centennial Plaza
211	Charles Drive-Dist. #116 (4th to 6th)
211	Charles Drive-Dist. #118 (6th to 600' North)
212	Cherokee Avenue-Dist. #140 (Washington to Knoblock)
213	Cherokee Avenue-Dist. #146 (Ramsey to Knoblock)
213	Chester Street-Improvements #14-82 (12th to 14th)
213	Chester Street-(10th to 11th Ave)
213	Chester Street-(11th to 12th)
214	Chester Street-(14th Ave to 15th Ave)-CDBG
214	Childress Industrial Park
214	Chiquita Court-Dist. #81
214	Cimarron Drive-Dist. #32 (Skyline to Willham)
215	Cimarron Estates
215	Cimarron Turnpike Spur-U.S. 177-(Lakeview to Turnpike)
216	Classen Court(North)-Dist. #74 (East Rogers to North)
216	Colby Lance Street-Dist. #91 (3rd to 4th)
216	College Addition-Alley Paving
216	College Campus Addition-Grading & Drainage
216	College Heights Addition-Block 2 & 5-Storm Sewer
216	College Heights Addition-Block 5-Storm Sewer Drain Box

216	Collins Addition-Dist. #91
217	Connell Avenue-Dist. #10 (Washington to Knoblock)
218	Connell Avenue-Dist. #15 (Manning to Donaldson)
219	Connell Avenue-Dist. #137 (Washington to Knoblock)
220	Connell Avenue-Dist. #150 (Duncan to Husband)
221	Copperfield Addition
221	Couch Park-Paving Improvements
221	Country Club Basin
221	Country Club Drive-(Fairfield to Williamsfield)
221	Country Club Drive-Dist. #130 (Country Club to Shumard)
221	Country Club Drive-Dist. #167
221	Country Club Drive-The Meadows
221	Country Club Road-(6th to Stillwater Creek)
221	Country Side Addition-3rd & 4th Section
222	Country Side Drive-Dist. #39
223	Crescent Circle-Dist. #11 (Crescent to Swim)
224	Crescent Drive-Dist. #68 (Lakehurst to Mohawk)
224	Crescent Drive-Dist. #140 (Husband to Dell's)
224	Crescent Drive-Dist. #150 (Dell's to Lakeview)
224	Crosswinds Addition- 1st Section-Dist. #132
225	Crosswinds Street-Dist. #132 (S.H. 51 to 7th)
226	Dairy Queen-Grading & Drainage Plan
227	Davis Court-Dist. #117 (North Rogers to North)
227	Dell's Avenue-Box Culvert (Main to Wildwood)
228	Dell's Avenue-Dist. #81 (Glenwood to Wildwood)
228	Dell's Avenue-Dist. #143 (Benjamin to Grandview)
229	Denver Court-Dist. #135 (Sunrise to South)
229	Devon Street (At 7th Avenue)
229	Devon Street-(S.H. 51 to 641' South)
229	Dizzyland Skate Center-Grading & Drainage Plan
229	Donaldson & Manning Eastern Hills-Drainage
230	Donaldson & Manning Estates-2nd Section-Dist. #32
230	Donaldson & Manning Estates-3rd Section-Dist. #65
230	Donaldson Drive-Dist. #15 (Connell to 581' South)
230	Donaldson Street-(Virginia to Cedar)
230	Donaldson Street-Dist. #16 (McElroy to South of Scott)
232	Doty Street-Dist. #6 (3rd to 5th)
233	Doty Street-Dist. #141(3rd to Maple)
234	Doty Street-Drainage (to Marshall St)
234	Doty Street-SID 166 (5th to 3rd)
235	Drop Structures Repairs - Concrete Apron
235	Dryden Addition-Dist. #48
236	Dryden Circle-Dist. #51 (Dryden St.)
236	Dryden Circle-Dist. #95 (Dryden St.)
238	Dryden Street-Dist. #24 (McElroy to 556' North)
238	Dryden Street-Dist. #35 (McElroy to 800' North)
238	Dryden Street-Dist. #37 (Redbud to 450' North)
238	Dryden Street-Dist. #51 (McElroy to 1100' North)
239	Dryden Street-Dist. #88 (Redbud to South)
239	Dryden Street-Dist. #147 (3rd to Maple)

239	Dublin Drive-Dist. #119 (Berkshire to 15th)
239	Duck Creek & Trib
239	Duck Creek-RCB at 12th
239	Duck Creek-RCB at 9th
239	Duck Creek-Storm Drain Improvements (University to Admiral)
239	Duck Creek-Storm Drain Improvements-HUD Project
240	Duck Street-(12th to Boomer)
240	Duck Street-1966 Bond Issue (12th to Elm)
240	Duck Street-Drainage Ditch (N. of McElroy btw Duck & West)
240	Duck Street-Improvements (12th to 14th)
240	Duck Street-Intersection (12th to Boomer)
241	Duck Street-Intersection (Duck & Miller)
241	Duck Street-Intersection at Duck & Matthews
241	Duck Street-Intersection Boomer & Eskridge
241	Duck Street-Intersection Hall of Fame
241	Duck Street-Replacement of South Return at 6th Avenue
241	Duck Street-Sidewalk Improvement Bond Issue
241	Duck Street-Signalization (3rd & Duck)
241	Duck Street-Signalization (Miller)
241	Duck Street-Storm Sewer (Hall of Fame & Hester to Scott)
241	Duck Street-Storm Sewer (Hall of Fame to Hester, Knoblock, Duck)
241	Duck Street-Turn lanes at Matthew & Duck
242	Duncan Street-Dist. #150 (Connell to McElroy)
243	Duncan Street-Dist. #150 (Miller to 140' South)
243	Duncan Street-Dist. #154 (McElroy to North)
243	Duncan Street-Dist. #162 (McElroy to Connell)
243	Duncan Street-Improvements #4-82 (13th to 14th)
243	Duncan Street-Improvements (12th to 13th)
243	Duncan's Mobile Home Park-Dist. #125
244	Eastern Avenue-Dist. #61 (Payne to Jardot)
245	Eastern Hills Addition-Dist. #102
246	Eastern Villa Estates-Dist. #38
246	Eastgate Shopping Area-Dist. #78
247	Eastgate Street-Dist. #78 (S.H. 51 to 960' South)
247	Eastridge Addition-2nd Section
247	Eastridge Addition-Dist. #109
248	Eastridge Addition-Dist. #143
248	Eastridge Residential Park
248	Edgemoor Drive-Dist. #107 (9th to 11th)
248	Electric Utilities Building-Site Plan
248	Elmwood Drive-(Elm) 1950
248	Elvin Avenue-Dist. # 39 (Meadow Park Addition)
249	Eskridge Avenue-Dist. #2 (Washington to Knoblock)
249	Eskridge Avenue-Dist. #20 (Lincoln to Jefferson)
249	Eskridge Avenue-Storm Sewer & Boomer Creek Channel
250	Eskridge Avenue-Washington to Knoblock
251	Eskridge Place-Dist. #20 (Lincoln to Washington)
251	Eskridge Street-High Water Area (Knoblock & Eskridge)
251	Eskridge Street-Intersection Paving (Duck to Eskridge)
251	Eunice Street-Dist. #47 (24th to South)

251	Fairfield Drive-Dist. #83 (16th to 18th)
251	Fairfield Drive-Dist. #130 (12th to 14th)
252	Fern Street-Improvements #1-82 (11th to 15th)
253	Fire Station No. 4
254	Fox Ledge Drive-Dist. #156 (32nd to Yellow Brick)
254	Frances Avenue-Dist. #6 (Monroe to Lincoln)
254	Franklin Avenue-Dist. #89 (Boomer to Husband)
254	Franklin Avenue-Dist. #109 (Benjamin to Briarwood)
255	Franklin Avenue-Under drains
256	Friedeman's Addition-Dist. #101
256	Frontier Drive-Dist. #12 (Skyline to Willard)
256	Garden Estates Addition-1st Section-Dist. #135
256	Garfield Street-SID 166 (4th to 3rd)
257	Georgia Avenue-Dist. #137 (Husband to Glenwood)
258	Glenwood Addition-Drainage Improvements
258	Glenwood Addition-Storm Sewer Alley (Connell & Main)
258	Glenwood Drive-Dist. #68 (Husband to 360' East)
259	Glenwood Drive-Dist. #138 (South of Lakeview to Georgia)
259	Glenwood Drive-Dist. #150 (Lakeview to Dells)
260	Glenwood/Railroad Drainage Channel
260	Golf Street-Ditch Liner
261	Graham Drive-Dist. #8 (Washington to Lincoln)
261	Grandview Addition East-Dist. #41
261	Grandview Court-Dist. #46 (Sunrise to 125' South)
261	Grandview Street-Dist. #10 (Maple to Virginia)
261	Grandview Street-Dist. #16 (McElroy to Connell)
262	Grandview Street-Dist. #41 (Virginia to 292' North)
262	Grandview Street-Dist. #42 (4th to North)
262	Grandview Street-Dist. #109 (Sunrise to 1320' North)
263	Grandview-Detention Pond & Drain Pipe
264	Gray Street-Dist. #165 (12th to 9th)
264	Greystone Street-Dist. #132 (7th to 1100' South)
264	Hafner Street-Dist. #103 (4th to 305' South)
264	Hafner Street-Dist. #141 (400' North of S.H. 51 to 148.7' North)
264	Hafner Street-Dist. #165 (6th to 557' North)
264	Hall of Fame-(Main to Perkins) Job #05858(4)
265	Hall of Fame-Dist. #85 (Duck to Perkins)
265	Hall of Fame-Intersection Duck & Hall of Fame
265	Hall of Fame-Project #SU-6018(100)C (Western to Main)
265	Hall of Fame-Signalization (Washington & Hester)
266	Hall of Fame-Signalizations at Monroe
266	Hall of Fame-Storm Sewer (Hester, Knoblock, Duck)
266	Hall of Fame-Storm Sewer (Hester, Knoblock, Duck)
266	Hall of Fame-Survey
266	Hall Street-Dist. #139 (8th to 9th)
267	Hall Street-Drainage Ditch (8th to Boomer Creek)
267	Hanson Addition-Dist. #31
268	Hanson Circle-Dist. #31
268	Hanson-Duncan Addition-Dist. #10
269	Harned Avenue-Dist. #26 (Lincoln to Monroe)

269	Harned Avenue-Dist. #80 (Perkins to Park)
269	Harned Avenue-Dist. #134 (Washington N 1391' to East)
269	Hartford Street-Dist. #72 (Lakeview to Knotts)
269	Hartford Street-Dist. #128 (Redbud to 165' North)
269	Hartford Street-Dist. #139 (14th to 17th)
269	Hartford Street-Dist. #147 (3rd to Maple)
269	Hartford Street-Improvements (14th& Hartford) (sewer)
269	Hartman Avenue-Dist. #99 (Husband to Main)
270	Harvey Avenue-Dist. #39
271	Hester Street-Dist. #139 (McElroy to Eskridge)
271	Hester Street-Improvements (9th to 12th)
271	Hester Street-Storm Sewer (Hall of Fame to Hester, Knoblock, Duck)
271	Hester Street-Storm Sewer (Hall of Fame to Hester, Knoblock, Duck)
271	Hickory Court-(Mansfield to east in The Meadows)
271	Hidden Oaks-1st Section
271	High View Drive-Dist. #19 (Star to Perkins)
271	Hillcrest Avenue-Dist. #43 (Blakely to Monroe) 1969
271	Hillside Court-Dist. #83 (16th to South)
272	Hillside Manor Addition-Dist. #83
272	Hillside Manor Addition-Dist. #94
272	Hillside Manor Addition-Drainage Channel (Hillside to Fairfield)
272	Hillside Street-Dist. #83 (16th to 19th)
272	Hoke Estates-4th Section
273	Hoke Estates-5th Section-Dist. #133
274	Hoke Estates-6th Section
275	Hoke Estates-Dist. #68
276	Hoke Street-Dist. #165 (Hall of Fame to 248' North)
283	Hughes Lumber-Detention Facility
286	Husband & Duncan-Alley Paving (7th to 8th)
288	Husband Court-Dist. #134 (Husband to West)
288	Husband Court-Dist. #134 (Lakeview to 2641' North)
289	Husband Place-(12th to 13th)
289	Husband Street-(6th to 9th)
289	Husband Street-(14th to 15th)-CDBG
289	Husband Street-(Airport Road South 1/2 Mile)
291	Husband Street-Concrete Rehab
292	Husband Street-Dist. #3 (McElroy to Lakeview)
293	Husband Street-Dist. #30 (Lakeview to 2641' North)
295	Husband Street-Dist. #134 (Golf to North)
298	Husband Street-Dist. #145 (Lakeview to Swim)
299	Husband Street-Dist. #145 (McElroy to Boomer)
299	Husband Street-Dist. #160 (Franklin to Lakeview)
300	Husband Street-Improvements #4-82 (13th to 14th)
300	Husband Street-Improvements (10th to 12th)
301	Husband Street-Improvements (12th to 13th)
301	Husband Street-Off Street Parking at 8th & Husband
302	Husband Street-Topo for Library Parking (6th St. to 150' North)
302	Jardot Road & Lakeview Road
302	Jefferson Street-Dist. #20 (Eskridge)
303	Jefferson Street-Dist. #108 (Preston to 470' South)

304	Jefferson Street-Pavement Rehab
305	Juniper Drive-Dist. #57 (19th to Black Wolf)
305	Keller Drive-Dist. #133 (Mohawk to Lakehurst)
307	Kerntke's Grandview Addition-1st Section-Dist. #34
307	Kerntke's Grandview Addition-2nd Section-Dist. #51
308	Kerntke's Grandview Addition-4th Section
309	Kids Under Construction-New Addition
309	Kings Street-Dist. #134 (6th to 9th)
309	Kings Street-Dist. #136 (9th to 12th)
309	Kings Street-Storm Sewer (Kings to McFarland)
309	Knapp Avenue-Dist. #03 (Lincoln to Washington)
309	Knapp Avenue-Dist. #88 (Benjamin to Arrington)
310	Knoblock Street-Dist. #36 (Miller to Matthews)
310	Knoblock Street-Dist. #137 (7th to 8th)
310	Knoblock Street-Dist. #162 (Cherokee to 300' South)
310	Knoblock Street-High Water Area (Knoblock & Eskridge)
310	Knoblock Street-Improvements (8th to 12th)
310	Knoblock Street-Intersection of University
311	Knoblock Street-SID 166 (Airport to Arapaho)
312	Knoblock Street-Storm Sewer (Scott to Knoblock)
312	Knoblock Street-Wheelchair Ramps (University to 3rd)
313	Knoblock-Storm Sewer (Hall of Fame to Hester, Knoblock, Duck)
315	Knott's Avenue-Dist. #72 (Perkins to East)
315	Krayler Avenue-Dist. #109 (Briarwood to Benjamin)
315	Krayler Avenue-Dist. #113 (Perkins to East)
315	Krayler Avenue-(Grandview to Skyline St)
315	Kwik Kar Lube-Grading Plan
316	Lackey Addition-Dist. #42
316	Lake McMurtry Road-Improvements #10-82
317	Lakehurst Drive-Dist. #68 (Husband to Keller)
318	Lakehurst Drive-Dist. #133 (Keller to East)
319	Lakeridge Drive-Pavement Rehab
320	Lakeridge-Dist. #7
321	Lakeshore Estates-1st Section-Dist. #28
322	Lakeshore Estates-2nd Section-Dist. #53
323	Lakeshore Estates-3rd Section-Dist. #70 (sewer)
324	Lakeshore Estate-3rd Section-Dist. #129
325	Lakeview Addition-2nd Section-Dist. #108
326	Lakeview Cottage Gardens-Improvements
326	Lakeview Drive-Dist. #45 (State Street West)
328	Lakeview Road & Jardot Road
329	Lakeview Road-(Western to 3/4 mile west)
330	Lakeview Road-Dist. #140 (Husband to Perkins)
330	Lakeview Road-Pedestrian Tunnel
332	Lakeview Rd-Sidewalk (North Side)
333	Lakeview Road-Traffic Signals at Lakeview & Perkins
334	Land Run Rd/Wright Dr
335	Landfill Contours and Baseline
335	Landfill Excavation Plans
335	Landfill Terraces
336	Leigh Addition-Drainage Ditch (8th to Boomer Creek)

336	Leigh Street-Dist. #140 (8th to 9th)
337	Lewis Street-(9th to 10th)
337	Lewis Street-Dist. #142 (9th to 14th)
338	Lewis Street-Dist. #161 (McElroy to Tyler)
339	Lewis Street-Dist. #2-80 (8th to 9th)
340	Liberty Avenue-Dist. #53 (Park to N. Star)
340	Liberty Avenue-Dist. #62 (State to 1191' East)
341	Liberty Avenue-Dist. #82 (Woodcrest Addition)
341	Liberty Avenue-Dist. #108 (Monroe to Washington)
342	Liberty Avenue-Pavement Rehab
342	Liberty Circle-Dist. #18 (State)
345	Library-Drainage
345	Lincoln Street-Dist. #5 (Will Rogers to Graham)
346	Lincoln Street-Dist. #6 (Frances to Thomas)
347	Lincoln Street-Dist. #7 (Monroe to Lakeridge)
347	Lincoln Street-Dist. #20 (Eskridge to Will Rogers)
349	Lincoln Street-Dist. #26 (Thomas to Logan)
350	Lincoln Street-Drainage (to Osage Ave)
350	Lincoln Street-Intersection at McElroy & Lincoln
351	Linda Avenue-Dist. #139 (Skyline to Jardot)
351	Logan Heights Addition-Dist. #26
352	Lowry Street-Dist. #142 (12th to 13th)
352	Lowry Street-Dist. #145 (9th to 12th)
353	Lowry Street-Dist. #149 (14th to 15th)
354	Lowry Street-Drainage
354	Lowry Street-Drainage & Alignment Intersection (Miller to Lowry)
355	Lowry Street-Improvements #3-82 (13th to 14th)
355	Lowry Street-Storm Sewer-Dist. #4-81 (6th to 9th)
356	Main Street-Concrete Rehab
357	Main Street-Dist. #1 (5th to 11th)
357	Main Street-Dist. #150 (McElroy to Redbud)
358	Main Street-Dist. #87 (6th to 12th)
358	Main Street-Federal Proj.#U-319(25) (Elm to 573' N. of Lakeview)
358	Main Street-Intersection of 14th & Main
359	Main Street-Intersection of 5th & Main
359	Main Street-Intersection of Maple & Main
360	Main Street-Intersection of Miller & Main
360	Main Street-Overlay (5th to 11th)
361	Main Street-Resurface & Striping (5th to 11th)
361	Main Street-Sidewalk
363	Main Street-Sidewalk (5th and Main)
364	Main Street-Sidewalk (14th to 18th) -CDBG
364	Main Street-Sidewalk (Virginia to Franklin)
365	Main Street-Storm Sewer, Lighting, Paving (6th to 11th)
367	Main Street-U.S. Works Program #WPMH 231 (Elm to Lakeview)
368	Manning Street-Concrete Rehab
369	Manning Street-Dist. #16 (McElroy to Connell)
370	Manning Street-Dist. #34 (Cedar to Scott)
371	Manning Street-Dist. #59 (Sunnybrook to Will Rogers)
373	Manning Street-Dist. #65 (Willham to Sunnybrook)

374	Manning Street-Dist. #88 (Redbud to 841' North)
375	Manning Street-Dist. #102 (Scott to 365' South)
376	Manning Street-Dist. #109 (Sunrise to Krayler)
378	Manning Street-Dist. #110 (McElroy to 258' South)
379	Manning Street-Drainage
381	Manning Street-Drainage
382	Manning Street-Drainage (Will Rogers & Sunnybrook)
383	Manning Street-The Meadows (1300' N of 19th to 2600' N of 19th)
384	Mansfield Street-Dist. #94 (19th to 1300' North)
384	Maple Avenue Bridge-Dist. #8-82 (Maple to Park)
385	Maple Avenue-Dist. #4 (Burdick to Benjamin)
386	Maple Avenue-Dist. #141 (Doty to Grandview)
387	Maple Avenue-Dist. #147 (Hartford to Burdick)
388	Maple Avenue-Intersection of Maple & Main
389	Mar Vista-Dist. #96 (27th to 28th)
390	Marie Drive-Dist. #97 (North Rogers to Britton)
391	Marie Drive-Dist. #124 (North Rogers to East)
394	Marshall Street-Dist. #142 (3rd to Arrington)
395	Matthews Avenue-Dist. #36 (Knoblock to Duck)
395	Matthews Avenue-Dist. #120 (Duck to Duncan)
395	Matthews Avenue-Turn Lanes (Duck & Matthews)
396	McDonald Street-Assessment Plat (6th to 8th)
397	McDonald Street-Dist. #170
397	McDonald Street-Drainage (6th & McDonald)
399	McDonald Street-Drainage Structure (12th & McDonald)
399	McElroy Road-Dist. #90 (Western to Orchard)
399	McElroy Road-Dist. #144 (Perkins to Jardot)
399	McElroy Road-Federal Proj.#MG-6420(15) (Lewis to Dryden)
400	McElroy Road-Federal Proj.#MG-6420(15)(19) (Main to Benjamin)
400	McElroy Road-Intersection at McElroy & Lincoln
400	McElroy Road-Intersection at McElroy & Western
400	McElroy Road-Traffic Signalization (McElroy & Washington)
401	McElroy-Sidewalk
401	McElroy-(Washington to Duck)
402	McFarland Acres-Storm Sewer (Kings to McFarland)
402	McFarland Street-Dist. #21 (Admiral to Connell)
403	McFarland Street-Dist. #136 (6th to 9th)
403	McPheeter's Addition-Dist. #4
403	Meadow Park Addition-Dist. #39
404	Meadows-1st Section-Flume
404	Miller Avenue-Drainage & Alignment Intersection (Miller to Lowry)
405	Miller Avenue-Intersection of Duck & Miller
405	Miller Avenue-Intersection of Main & Miller
406	Mohawk Avenue-Dist. #133 (Crescent to East)
407	Monroe & Lakeview-RCB & Street Paving
408	Monroe Street-Dist. #6 (Francis to Thomas)
408	Monroe Street-Dist. #13 (Hillcrest to Harned)
409	Monroe Street-Dist. #21 (McElroy to Matthews)
409	Monroe Street-Dist. #26 (Thomas to Harned)

410	Monroe Street-Dist. #86 (University to 6th)
411	Monroe Street-Dist. #100 (Preston to Osage)
412	Monroe Street-Dist. #108 (Preston to Liberty)
412	Monroe Street-Dist. #112 (Lakeview to South)
413	Monroe Street-Dist. #114 (Airport to 593' North)
413	Monroe Street-Dist. #115 (Hillcrest to 500' North)
414	Monroe Street-Dist. #146 (Lakeview to North)
414	Monroe Street-Dist. #146 (McElroy to Tyler)
415	Monroe Street-Pavement Rehab
416	Monroe Street-Storm Sewer (North of University)
417	Monroe Street-Storm Sewer (University South on Monroe)
418	Monroe-Traffic Signals at Hall of Fame
418	Moore Avenue-Box Culvert (Moore & Brooke)
419	Moore Avenue-Dist. #109 (Benjamin to Manning)
419	Mungers Addition-Drainage Ditch (N. of McElroy, Duck to West)
420	Multigraphic Parking Lot Extension
421	Municipal Building-(7th & Lewis)
422	Municipal Building-Parking Garage
422	Myer's Addition-Dist. #1
423	New Covenant Church-Grading Plan
423	Newman Avenue-Dist. #71 (Park to Star)
424	Newman Addition-Dist. #115
425	Newman Avenue-Dist. #115 (Monroe to 400' West)
426	North Britton Drive-Dist. #74 (Marie to Rogers)
426	North Britton Drive-Dist. #97 (Marie to North Rogers)
427	North Classen Court-Dist. #74 (East Rogers to East)
427	North Gate Addition 2nd Section-Dist. #134
427	North Park Circle-Dist. #129
428	North Park Circle-Dist. #70
429	North Park Drive-Dist. #70 (Park Circle to Perkins)
429	North Park Drive-Dist. #71 (Airport to Newman)
429	North Park Drive-Dist. #80 (Harned to Park)
430	North Park Drive-Dist. #129
431	North Park Drive-Repair (Lots 2-5 O'Haver)
432	North Star Drive-Dist. #19 (McElroy to Scenic)
433	North Star Drive-Dist. #28 (Lakeview to Preston)
433	North Star Drive-Dist. #71 (Newman to Airport)
434	Northern Pines Addition-Dist. #114 (sewer)
435	Northgate Addition 1st Section-Dist. #93
436	Northgate Addition 2nd Section-Dist. #93
436	Northgate Commercial Area 1st Section-Dist. #79
437	Oak Ridge Drive-Country Club Basin (7th to 8th)
438	Oak Trail Addition 1st Section
439	Oak Trail Addition 6th Section
440	Oakdale Drive-Dist. #116 (4th to 5th)
440	O'Haver Industrial Park 1st Section-Dist. #71
441	O'Haver Industrial Park 2nd Section-Dist. #80
441	Oklahoma Avenue-(Western to Jardot)
442	Oklahoma Technology & Research Park-Nomadic-Phase 1
443	Oklahoma Technology & Research Park-Phase 1

443	Orchard Lane-Dist. #145 (6th to 8th)
443	Osage Drive-Dist. #7 (Monroe to Washington)
443	Osage Drive-Dist. #127 (Lincoln to 500' West)
443	Osage Drive-Pavement Rehab
444	OSU-Storm Sewer Improvements
445	OSU-Traffic Signals (Knoblock, Walnut on Hall Of Fame)
445	Owen Thomas-Detention Facility
446	Owen Thomas-RCP Plans
446	Park Circle(North)-Dist. #70 (North Park to Perkins)
446	Park Circle(North)-Dist. #129
446	Park Drive-Dist. #53 (Lakeview to Liberty)
447	Park Drive-Dist. #70 (Park Circle to Perkins)
448	Park Drive-Dist. #71 (Airport to Newman)
448	Park Drive-Dist. #80 (Harned to Park Drive)
448	Park Drive-Dist. #129 (Perkins to Liberty)
448	Park Terrace-Dist. #137 (1st to 3rd)
449	Park View Estates 1st Section-Dist. #69
450	Park View Estates 2nd Section Dist. #74
450	Park View Estates 3rd Section-Dist. #97
451	Park View Estates 4th Section-Dist. #117
452	Park View Estates 5th Section-Dist. #124
452	Park View Estates 6th Section
453	Park View Estates 7th Section
455	Parkersville Addition-Dist. #103
456	Payne Street-Dist. #139 (Linda to Sunrise)
457	Peachtree Avenue-Dist. #106
458	Pecan Drive-Dist. #154 (Redbud to Wildwood)
458	Perkins Family Restaurant-Detention
459	Perkins Road-5th Lane (6th to McElroy)
459	Perkins Road-Bridge over Boomer Creek (9th & Perkins)
459	Perkins Road-Federal Proj.#319(85) (6th to U.S. 177)
459	Perkins Road-Federal Proj.#RS-S-6012(105) (Richmond to Yost)
459	Perkins Road-Federal Proj.#S-SU-1109(13)(15) (6th to U.S. 177)
459	Perkins Road-Intersection (Perkins & Richmond) (ROW change)
461	Perkins Road-Intersection Virginia & Perkins
464	Perkins Road-Roadway Improvements
466	Perkins Road-Sidewalk
467	Perkins Road-Traffic Signalization (3rd & Perkins)
467	Perkins Road-Traffic Signalization (3rd & Perkins)
468	Perkins Road-Traffic Signalization (3rd & Perkins)
468	Perkins Road-Traffic Signalization (6th & Perkins)
469	Perkins Road-Traffic Signalization (12th Ave.)
469	Perkins Road-Traffic Signalization (12th Ave) ODOT
469	Perkins Road-Traffic Signalization (19th to S.H. 51)
472	Perkins Road-Traffic Signalization (Lakeview & Perkins)
473	Perkins Road-Traffic Signalization (Virginia & Perkins)
474	Perkins Road-Utility Relocation-Federal Aid #319(85) (6th to 36th)
474	Pioneer Trail-Water Improvements (19th Ave. South)
476	Preston Avenue-Pavement Rehab

476	Preston Circle-Dist. #18 (State)
477	Preston Drive-Dist. #108 (Monroe to Washington)
478	Preston Lane-Dist. #18 (State to 385' East)
479	Quail Ridge Court-Dist. #49 (27th to 280' North)
479	Quail Ridge East-1st Section-Dist. #44
480	Quail Ridge East-2nd Section-Dist. #49
481	Quail Ridge East-3rd Section-Dist. #96
482	Quail Ridge South-1st Section-Dist. #111
483	Quail Ridge Street-Dist. #96 (27th to 785' South)
484	Raintree Drive-Dist. #106
485	Ramsey Street
485	Ramsey Street-Dist. #7 (Scott to McElroy)
487	Ramsey Street-Dist. #151 (Connell to McElroy)
489	Ramsey Street-Dist. #155 (6th to 7th)
490	Ramsey Street-Dist. #159 (McElroy to Eskridge)
492	Ramsey Street-Improvements #3-82 (7th to 9th)
493	Ramsey Street-Improvements (9th to 12th)
495	Ramsey Street-Storm Sewer Extension
496	Ramsey Street-Storm Sewer Part B (15th & Duck to Ramsey)
496	Ranch Drive-SID 166 (Washington to Knoblock)
497	Redbud Drive-Dist. #88 (Benjamin to Manning)
498	Redbud Drive-Dist. #154 (Main to Wildwood)
499	Richmond Hills Commercial Park
500	Richmond Road-Intersection (Perkins & Richmond)
500	Ridge Road-Dist. #1 (9th to 11th)
501	Ridgecrest Addition-Dist. #19
501	Ridgecrest Avenue-Dist. #109 (Benjamin to Manning)
503	Ridgelea Addition-Dist. #72
503	Rogers Drive-Concrete Box
503	Rogers Drive(East)-Dist. #69 (Perkins to 873' West)
503	Rogers Drive(East)-Dist. #74 (Britton to East)
503	Rogers Drive-Dist. #117 (Classen to West)
503	S.H. 160-Federal Proj.#319(85) (6th to U.S. 177)
503	S.H. 160-Federal Proj.#S-SU-1109(13)(15) (6th to U.S. 177)
503	S.H. 51-(Holiday Inn Entrance at Devon)
504	S.H. 51-(Washington to Husband)
504	S.H. 51-Federal Aid Project #F-198(43)(45) (Range to Cow Creek)
505	S.H. 51-Federal Aid Project #F-198(71) (Jardot to 1345' E. of Fairgrounds)
507	S.H. 51-Federal Proj.#U-F198(16) (Husband to Western)
508	S.H. 51-Railroad Crossing Improvements
509	S.H. 51-State Proj.#1045 (Western)
511	Saddle Rock Lane-Dist. #111 (27th to South)
512	Sanborn Drive-Improvements 3-83 (Airport Road to 430' South)
513	Sangre Ridge Addition-Dist. #156
517	Sangre Ridge-Cedar Isle Lake Dam and Profile
518	Sangre Road
518	Sangre Road-(Yellow Brick to 32nd)
519	Sangre Road-Core Samples
520	Sangre Road-Dist. #47 (32nd to Yellow Brick Drive)
521	Sangre Road-RCB Improvements 11-83 (North of 19th on Sangre)
522	Scenic Drive-Dist. #19 (Perkins to N. Star)

522	Scott Avenue-Dist. #9 (Ramsey to Knoblock)
523	Scott Avenue-Dist. #146 (Hester to Knoblock)
524	Scott Avenue-Dist. #165 (Duncan to Husband)
524	Scott Avenue-Storm Sewer (Scott to Knoblock)
525	Seven Oaks Addition- 1st Section
526	Shalamar Drive-Dist. #122 (19th to North)
527	Shalamar Drive-Retaining Wall (16th & Shalamar)
528	Sheraton Drive-Dist. #131 (S.H. 51 to 900' North)
529	Sherwood Avenue-Dist. #136 (Western to 628' East)
530	Shumard Oaks Addition-(Country Club to Fairfield)
531	Shumard Oaks Addition-(Country Club to Fairfield)
532	Shumard Oaks Addition-Dist. #130
533	Site "F" Detention Pond-Drainage Improvements
534	Skyline Street-Dist. #12 (McElroy to Linda)
534	Skyline Street-Dist. #17 (Will Rogers to Sunrise)
535	Skyline Street-Dist. #148 (Sunrise to 1/4 mile North)
536	Skyline-Sidewalk
537	Small Cities-Phase 1-Dist. #139
539	Small Cities-Phase 2-Dist. #140
540	Springdale Drive-Dist. #107 (9th to 1322' South)
541	Springfield Street-Dist. #139 (14th to 16th)
542	Stallard Street-Dist. #137 (6th to Maple)
543	Stallard Street-Drainage Ditch (Raymond Kay's Property)
544	Stallard Street-Pavement Reconstruction (McElroy to Summit Circle)
546	Stallard Street-Sidewalk
547	Stallard Street-Under drains (6th to 3rd)
548	Stallard-Sidewalk
549	Stanley Street-Dist. #145 (9th to 12th)
550	Star Drive North-Dist. #19 (McElroy to Scenic)
551	Star Drive North-Dist. #71 (Newman to Airport)
551	Star Drive-Dist. #28 (Lakeview to Preston)
552	State Lane-Dist. #45 (State Street to 477' West)
553	State Street-Dist. #18 (Lakeview to Liberty)
554	Sterling House-Grading
555	Stillwater Bypass-(6th to Main)
556	Stillwater Community Center-Parking Lot Replacement
557	Stillwater Creek Bridge-(Western)
559	Stillwater Creek Watershed
560	Stillwater Elderly Housing
562	Stillwater Golf and Country Club-2nd Section-Dist. #107
563	Stillwater High School-Drainage (East side of Parking)
564	Stillwater Municipal Parking Facility
565	Stonegate Avenue-Dist. #106
566	Stonegate Estates-2nd Section
567	Stonegate Estates-Phase 1-Dist. #106
568	Stoneybrook Street-Dist. #132 (7th to 8th)
569	Strickland Park
570	Strickland Park-Ball fields
571	Summit Circle-Dist. #140
572	Sunnybrook Court-Dist. #65
572	Sunnybrook Drive-Dist. #59
572	Sunnybrook Estates

573	Sunnybrook Estates-Dist. #59
574	Sunnybrook Estates-Drainage Improvements
575	Sunrise Avenue-Concrete Rehab
576	Sunrise Avenue-Dist. #46 (Skyline to Grandview)
577	Sunrise Avenue-Dist. #109 (Manning to Grandview)
578	Sunrise Avenue-SID 166 (Jardot to Hightower)
579	Sunset Drive-Dist. #134 (Ridge to McFarland)
580	Sunset Drive-Dist. #136 (Western to Ridge)
581	Surrey Drive-Dist. #29 (16th to 18th)
582	Surrey Drive-Dist. #29 (18th to 19th)
583	Surrey Drive-Dist. #157 (16th to 19th)
584	Surrey Hills Estates-1st Section-Dist. #29
586	Surrey Hills Estates-2nd Section-Dist. #60
590	Surrey Hills Estates-3rd Section-Dist. #76
591	Surrey Place-Dist. #76 (16th to North)
592	Swim Avenue-Dist. #145 (Husband to Crescent)
593	Terrace South Addition-Dist. #73
594	Terrill Brothers Addition-Dist. #56
595	Thomas Addition-Dist. #6
595	Thomas Addition-Dist. #6 (Lincoln to Monroe)
596	Thomas Avenue-Dist. #67 (Lincoln to Monroe)
597	Thomas Avenue-Pavement Rehab
598	Trib 3 - Site F
599	Trib 3 to East Boomer Creek
600	Tyler Avenue-Dist. #40 (Benjamin to Burdick)
601	Tyler Avenue-Dist. #161 (Lewis to Main)
601	Tyler St to Will Rogers Ave - Drainage
603	Tyler Avenue-SID 166 (Boomer to Main)
604	Tyler Avenue-Storm Sewer (Boomer & Tyler)
605	U.S. 160-Federal Proj.#RS-S-6012(105) (Richmond to Yost)
606	U.S. 177-Cimmarron Turnpike Spur-(Lakeview to Turnpike)
606	U.S. 177-Dist. #1 (5th to 11th)
607	U.S. 177-Federal Aid Project #E231 E&F (Airport to County Line)
608	U.S. 177-Federal Aid Project #F-319 (15) (S.H. 33 to 36th)
609	U.S. 177-Federal Proj.#U-319(25) (Elm t 573' N. of Lakeview)
609	U.S. 177-ROW Plans-Oklahoma State Highway 40 (36th to Burris)
610	U.S. 177-ROW Plans-Oklahoma State Highway 40 (36th to Burris)
610	U.S. 177-U.S. Works Program #WPMH 231 (Elm to Lakeview)
611	University Avenue-Drainage (Washington & University)
612	University Avenue-Drainage Duck Creek (University to Admiral)
612	University Avenue-Intersection of University & Knoblock
613	University Avenue-Intersection of Washington
613	University Avenue-Signalization (University & Monroe)
613	University Estates-Dist. #18
613	University Estates-Dist. #45
613	University Estates-Dist. #62
613	University Square
613	Ute Avenue-Dist. #165 (Washington to Knoblock)

614	Villa Drive-Dist. #38 (4th to 6th)
615	Virginia Avenue
616	Virginia Avenue-Alignment (West Boomer Creek to Perkins Rd)
616	Virginia Avenue-Assessments SID 172
617	Virginia Avenue-Bridge (East Boomer Creek)
617	Virginia Avenue-Bridge (Virginia to Miller)
618	Virginia Avenue-Dist. #10 (Grandview & Virginia)
618	Virginia Avenue-Dist. #123 (Jardot to 1336' East)
619	Virginia Avenue-Dist. #151 (Grandview to Arrington)
619	Virginia Avenue-Drainage (Berry Street, Virginia to Burdick)
619	Virginia Avenue-Improvements (Lowry to East Boomer Creek)
619	Virginia Avenue-Intersection at Virginia & Perkins
619	Virginia Avenue-Resurfacing
620	Wal-Mart
621	Wal-Mart-Expansion
622	Walnut Street-Storm Sewer (University to 4th West of Walnut)
623	Ware-Storm Sewer (Alley Brooke Ave, Boomer Dr. to Boomer Creek)
624	Washington and Airport Road-Project #35-92-13-6409
625	Washington Heights-1st Section-Dist. #5
626	Washington Heights-2nd Section-Dist. #20
627	Washington Street-(Airport to County Line)
628	Washington Street-(Hall of Fame to Boomer Rd)
628	Washington Street-(McElroy to Boomer)
629	Washington Street-Dist. #149 (9th to 12th)
632	Washington Street-Drainage
635	Washington Street-Drainage (University & Washington)
650	Washington Street-Intersection of Boomer & Washington
651	Washington Street-Sidewalk & Parking (4th & Washington)
652	Washington Street-Storm Sewer (6th to Washington)
653	Washington Street-Storm Sewer (University to 8th)
654	Washington Street-University
655	Washington-Sidewalk
656	Washington-Sidewalk (Knapp to Brooke Ave)
657	Washington-Signalization (Airport)
658	Washington-Signalization (McElroy)
659	Washington-Signalization (McElroy)
660	Washington-Topo (Wyatt Building, 400 Blk.)
661	Wedgewood-2nd Section
662	Wedgewood-3rd Section
663	Wedgewood-Drainage
664	West Hazen Hills Addition-Dist. #7
665	West Hazen Hills Addition-Dist. #127
666	West Street-(12th to 13th Ave)-CDBG
667	West Street-Drainage Ditch (Duck & West, North of McElroy)
668	West Street-Improvements (9th to 12th)
669	Westbrook Court-Dist. #119 (15th to South)
670	Westbrook Drive-Blocks 1-5-Dist. #64 (19th to 1835' East)
671	Westbrook Estates-2nd Section-Dist. #119
672	Westbrook Estates-3rd Section-Dist. #122
673	Westbrook Estates-4th Section-Dist. #136
674	Westbrook-Drainage 230' West of 19th & Sangre

675	Western Road-(19th to 32nd)
676	Western Road-Intersection of McElroy
677	Western Road-Intersection of McElroy Rd
678	Western Road-Left turn lanes at 6th
679	Western Road-Project #SU-6018(100)C (12th to Hall of Fame)
680	Western Road-Sidewalk
681	Westpark-1st Section-Dist. #116
682	Westpark-1st Section-Dist. #126
683	Westpark-2nd Section-Dist. #137
684	Westridge Street-Dist. #83 (16th to 18th)
685	Wicklow Street-Dist. #50 (6th to 469' South)
686	Wildwood Addition-Dist. #81
686	Wildwood Addition-Drainage Ditch
687	Wildwood Drive-Dist. #81 (Pecan to Dell's)
688	Wildwood Drive-Dist. #154 (Redbud to Pecan)
689	Will Park Estates-Dist. #47
690	Will Rogers Avenue-Dist. #52 (Manning to East)
691	Will Rogers Avenue-Dist. #63 (Manning to Benjamin)
692	Will Rogers Drive-Dist. #5 (Lincoln to Washington)
692	Will Rogers Drive-Dist. #17 (Skyline to 310' West)
693	Willham Avenue-Dist. #59
694	Willham Drive-Dist. #12 (Skyline to Frontier)
695	Willham Drive-Dist. #32 (Cimarron to 100' East)
696	Willham Drive-Dist. #65 (Manning to 428' East)
696	Willham Drive-Dist. #65 (Sunnybrook Court to 523' East)
696	Willham Drive-Inlets
697	William Court-Dist. #74 (North Britton to South)
698	Willis Street-Dist. #165 (11th to 12th)
699	Willis Street-Drainage (Brown-Moore Blk 2, Willis to 3rd)
699	Willis Street-Drainage (Ridge St)
700	Willow Park Circle-Dist. #47 (Sangre)
700	Willow Park Estates-Dist. #47
700	Willow Park Lane-Dist. #47 (Willow Park Circle to East)
700	Willow Run-(Mansfield to N.E. 187'
700	Windsor Drive-Dist. #116 (N & S 1/2 Blk from 4th)
701	Windsor Drive-Dist. #126
702	Windsor Drive-Dist. #137 (1st to 3rd)
703	Windsor Drive-Dist. #138 (S.H. 51 to 600' North)
704	Woodcrest Addition-Dist. #82
705	Woodcrest Drive-Dist. #107 (9th to 1410' South)
705	Woodland Drive-Dist. #64 (Westbrook Addition)
705	Yellow Brick Drive-Dist. #156 (Sangre to Foxledge)
705	Yorkshire Drive-Dist. #64 (Westbrook Addition)

**Appendix B: Subdivision drainage plans referred**

	<b>Name of Subdivision</b>
1	ACRE HEIGHTS ADD
2	AIRPORT IND OFF PARK
3	ALBERT PIKE ADDITION
4	ALBERT PIKE ADDITION
5	AND HILLS 2ND SEC
6	AND HILLS 2ND WEST
7	AND HILLS 3RD SEC
8	AND HILLS 3RD WEST
9	AND HILLS 4TH SEC
10	AND HILLS 5TH WEST
11	AND HILLS 6TH WEST
12	AND HILLS WEST SEC
13	ANDREW HILLS ADD
14	ANNS ADDITION
15	ARN HEIGHTS 2ND SEC
16	ARN SUB PARKERVILLE
17	ARNOLD HEIGHTS ADD
18	BARNES ADD
19	BELLIS ADD
20	BERRY ADD
21	BERRY ADD REPL BLK15
22	BERRY BLOCK
23	BERRY BLOCK
24	BERRY BLOCK
25	BEVERLY HILL ADD
26	BLACKJACK ESTATES
27	BOOMER CREEK COM PRK
28	BOOMER CRK COMM PK 2
29	BOOMER PARK
30	BRADFORD RIDGE ADD
31	BRIGG'S SUB REPLAT
32	BRIGHTON REPLAT OF
33	BRKHRT REPL BL 1,4&5
34	BROOKE HOLLOW 2ND
35	BROOKE HOLLOW ADD
36	BROOKHART
37	BROOKHART 2ND SEC
38	BROWN MOORE 1ST ADD
39	BROWN MOORE 2ND ADD
40	BRUSH CK MEADOW 1ST

41	BUCKMAN MOUDY EST
42	BURDICK' ADD
43	BURDICK' ADD
44	BURR'S SUBURBAN ADD
45	CAMDEN POND
46	CAMPUS VIEW ADD
47	CARLISLE'S ADD
48	CARPENTER ADD
49	CEDAR GROVE ADD
50	CEDAR OAKS EST.
51	CEDAR RIDGE ESTATES
52	CEDAR VALLEY
53	CENTRAL ADD
54	CHATEAU LAKES 1ST SE
55	CHATEAU LAKES, SECOND SECTION
56	CHERMAR ADD
57	CHILDRESS IND PARK
58	CIMARRON EST
59	CIMARRON EST 3RD
60	CIMARRON EST 2ND
61	CIMARRON PLAZA
62	CLASSEN HEIGHTS ADD
63	COLLEGE ADD
64	COLLEGE CAMPUS ADD
65	COLLEGE CIRCLE ADD
66	COLLEGE GARDENS ADD
67	COLLEGE GDNS 2ND SEC
68	COLLEGE GDNS 3RD SEC
69	COLLEGE GDNS 4TH SEC
70	COLLEGE HEIGHTS ADD
71	COLLEGE HOME ACRES
72	COLLEGE HOMES ADD
73	COLLINS 51-EAST ADD
74	COPPERFIELD ADD 1ST
75	COPPERFIELD ADD 2ND
76	CORYCROFT ADD
77	COUNTRY CLUB EST
78	COUNTRY CLUB VILLAGE
79	COUNTRYSIDE ADD 1ST
80	COUNTRYSIDE ADD 2ND

81	COUNTRYSIDE ADD 3RD
82	COUNTRYSIDE ADD 4TH
83	COUNTRYSIDE ADD 5TH
84	COUNTRYSIDE ADD 6TH
85	CRESCENT HILLS
86	CRESTVIEW ESTATES
87	CRESTWOOD EST
88	CROSSWINDS ADD
89	CROSSWINDS THE HIGH
90	CROSWDS, THE COURTS
91	CROSWDS, THE GARDENS
92	CROSWDS, THE VILLAGE
93	CTRY CLUB BASIN
94	CTRY CLUB DISTRICT
95	D&M ADD
96	D&M EAST HILLS ADD
97	D&M EST 1ST SEC
98	D&M EST 2ND SEC
99	D&M EST 3RD SEC
100	D&M SUB WATSON HTS 2
101	DEER CROSSING ESTATE
102	DEER CROSSING ESTATE SEC 2
103	DOUGLAS ADD
104	DOUGLAS ADD 2ND ADD
105	DRYDEN ADD
106	DRYDEN ADD
107	DUCK ADD
108	DUNCAN ADD
109	E VIRG SUB PKERVLE
110	EAST BROOK ADD
111	EAST COLLEGE ADD
112	EAST COLLEGE ADD, SUB OF BLK 1, LOTS 3, 4
113	EASTERN VILLA EST
114	EASTGATE SHOP AREA
115	EASTRIDGE 2ND SEC
116	EASTRIDGE ADD
117	EASTRIDGE RES PARK
118	ELMWOOD ADD
119	EVERGREEN EST
120	FAIRLAWN HTS ADD SUB

121	FOCHT ADD
122	FOCHT ADD REP BL 3&4
123	FOREST HILLS
124	FRANKLIN ADD
125	FRIEDEMANN'S ADD
126	GARDEN EST 2ND SEC
127	GARDEN EST ADD
128	GENE'S SUB
129	GLENWOOD ADD
130	GLOVERS ADD
131	GOLF LAKE EST
132	GRAHAM ADD
133	GRANDVIEW ADD EAST
134	GRANDVIEW EAST 2ND
135	GREEN ACRES
136	GREENWOOD ADD
137	HALL'S SUB
138	HAMILTON ADD
139	HAMILTON ADDITION 2ND
140	HAMILTON ADDITION 3RD
141	HAMILTON ADDITION 4TH
142	HANSON ADD
143	HANSON DUNCAN ADD
144	HARNED ADD
145	HARRISON ADD
146	HARTENBOWER HTS ADD
147	HAZEN HILLS ADD
148	HERT SUBDIVISION
149	HERTS SUB COL HMS AD
150	HIDDEN OAKS 1ST SEC
151	HIGH POINT ADD
152	HIGH SCHOOL ADD
153	HIGHLAND PARK ADD
154	HILLCREST HEIGHTS
155	HILLSIDE MANOR 2ND
156	HILLSIDE MANOR ADD
157	HOEL'S SUB MCFAR HTS
158	HOKE EST 2ND REPLAT
159	HOKE EST ADD 10TH
160	HOKE EST ADD 2ND

161	HOKE EST ADD 3RD
162	HOKE EST ADD 4TH
163	HOKE EST ADD 5TH
164	HOKE EST ADD 6TH
165	HOKE EST ADD 7TH
166	HOKE EST ADD 8TH
167	HOKE EST ADD 9TH
168	HOKE ESTATES ADD
169	HOKE'S SUB W COL ADD
170	HOOPER SUB
171	HOUCK ADD
172	HOYT'S BLOCK
173	HUDIBERG SUBDIVISION
174	HUMAN ADDITION
175	HUNTERS RIDGE
176	HUNTINGTON HILLS 1ST SEC
177	HUNTINGTON HILLS 2ND SEC
178	INDUSTRIAL ADD
179	INGHAM ADDITION
180	J T GRAY'S ADD SUB
181	J T GRAY'S ADD SUB
182	J T GRAY'S ADD SUB
183	JACOB HEIGHTS ADD
184	JONES ADDITION
185	KAD COMMERCIAL PARK
186	KARSTEN CREEK ESTATES
187	KARSTEN CREEK ESTATES
188	KELOWNA PARK
189	KERNTKE'S GRANDVIEW ADD
190	KERNTKE'S GRANDVIEW ADD 2ND
191	KERNTKE'S GRANDVIEW ADD 3RD
192	KERNTKE'S GRANDVIEW ADD 4TH
193	KINGS BLOCK
194	KINGS HIGHWAY ADD
195	KINNEBREW ADDITION
196	LACKEY ADDITION
197	LAKESHORE ADDITION
198	LAKESHORE EST 2ND
199	LAKESHORE EST 3RD
200	LAKESHORE ESTATES

201	LAKESIDE ADD NORTH
202	LAKESIDE ADDITION
203	LAKEVIEW ADD 2ND SEC
204	LAKEVIEW ADD 3RD SEC
205	LAKEVIEW ADD 4TH SEC
206	LAKEVIEW ADDITION
207	LAKEVIEW COTTAGE GDN
208	LAKEVIEW PLAZA
209	LAKEVIEW VILLAGE
210	LEIGH ADDITION BLK 1
211	LESSERT ADDITION
212	LEWIS ADDITION
213	LOGAN HEIGHTS ADD
214	LOWRY ADDITION 1ST
215	LOWRY ADDITION 2ND
216	LYNN ADDITION
217	MCFAR HT SUB BL11-12
218	MCFARLAND ACRES ADD
219	MCFARLAND ACRES SBU, LOTS 7-9
220	MCFARLAND ACRES SUB, LOTS 1-4
221	MCFARLAND HTS ADD
222	MCNEFF ACRES
223	MCPHEETERS ADDITION
224	MEADOW PARK SUB
225	MEADOWS ADDITION
226	MEADOW BROOK EST
227	MILLER'S ADDITION
228	MILLER'S BLOCK
229	MORNINGSIDE ADDITION
230	MUNGER ADDITION
231	MYER'S SUBDIVISION
232	MYRICK'S SUBDIVISION
233	N COLLEGE HOMES ADD
234	NEFF ADD 2ND SEC
235	NEFF ADDITION
236	NEWMAN ADDITION
237	NORRISTOWN ESTATES
238	NORTH CENTRAL ADD
239	NORTH SLOPE ADDITION
240	NORTH STILLWATER ADD

241	NORTH TOWER PARK 1ST
242	NORTH TOWER PARK 2ND
243	NORTH TOWER PARK 3RD
244	NORTHEAST TERRACE
245	NORTHERN PINES ADD
246	NORTHGATE ADD 2ND
247	NORTHGATE ADDITION
248	NORTHGATE COMM 1ST
249	NORTHWEST TERRITORY COMMERCIA
250	NORTHWEST TERRITORY COM RPLT 6&7
251	NORWOOD ADDITION
252	NOTTINGHAM SUB
253	NOTTINGHAM SUB 2ND SEC
254	OAK RIDGE EST
255	OAK TRAIL ADD 6TH
256	OAK TRAIL ADDN 1ST
257	OAK TRAIL ADDN 2ND
258	OAK TRAIL ADDN 3RD
259	OAK TRAIL ADDN 4TH
260	OAK TRAIL ADDN 5TH
261	OAKWOOD ADD
262	O'HAVER ADDITION
263	O'HAVER INDUS PARK
264	O'HAVER INDUS PARK 2
265	ORIG TOWN STILLWATER
266	OTEY TRACTS
267	P & B SUNNYBROOK EST
268	PARK ADDITION
269	PARK MEADOWS 2ND RP
270	PARK MEADOWS GDN HMS
271	PARK MEADOWS, THIRD SECTION
272	PARKERVILLE ADDITION
273	PARKERVILLE ADDITION
274	PARKERVILLE ADDITION
275	PARKERVILLE REPL L 1
276	PARKERVILLE SUB BL 2
277	PARKVIEW ESTATES
278	PARKVIEW ESTATES 2ND
279	PARKVIEW ESTATES 3RD
280	PARKVIEW ESTATES 4TH

281	PARKVIEW ESTATES 5TH
282	PARKVIEW ESTATES 6TH
283	PARKVIEW ESTATES 7TH
284	PARKVIEW ESTATES 8ND
285	PARKVIEW ESTATES 9TH
286	PARKVIEW GDN HMS REP
287	PARTNER PROP GROUP
288	PAYNE'S SUB BURR'S
289	PECAN GROVE ADD
290	PECAN HILL ADD
291	PERKINS ADDITION
292	QUAIL RIDGE DEV
293	QUAIL RIDGE E 1ST
294	QUAIL RIDGE E 2ND
295	QUAIL RIDGE E 3RD
296	QUAIL RIDGE SOUTH
297	RANDOLPH COURT
298	RANSOM'S SUBDIVISION
299	REDBUD ADDITION
300	REPLAT OF LOTS 6 & 7, NW TERR COMM PARK
301	RICHMOND HILLS COMM
302	RIDGECREST 1ST SEC
303	RIDGECREST 1ST SEC RPL BLK 3
304	RIDGECREST 2ND SEC
305	RIDGELEA ADDITION
306	RIDGEVIEW ADDITION
307	RIGG'S SUBDIVISION
308	RODERICK INDUS PARK
309	ROGER'S BLOCK
310	ROKA RIDGE
311	ROMSHE ADDITION
312	S E CHANEY'S SUB
313	S HAZEN HILLS ADD
314	S U DEV 2ND WILDWOOD
315	S U DEV 3RD WILDWOOD
316	S U DEV 4TH WILDWOOD
317	S U DEV WILDWOOD ADD
318	SADDLE ROCK RDG
319	SADDKE ROCK RDG AMMENDED
320	SADDLE ROCK SOUTH ADDITION

321	SANGRE RIDGE ADD
322	SANGRE RIDGE ADD
323	SANGRE RIDGE ADD 2ND SEC
324	SCHOLARSHIP PLACE
325	SELPH ADD
326	SHADOW OAKS SUB
327	SHUMARD OAKS ADD
328	SKYLINE ADDITION
329	SKYLINE E ADD SEC 1
330	SMALLEY'S ADD
331	SMITH'S SUB OF BLK 10 COLLEGE ADD
332	SORELL-BAKER ADDITION, 1ST SEC
333	SOUTH COLLEGE ADD
334	SOUTH WINDS
335	SOUTHERN HEIGHTS ADD
336	SOUTHERN HILLS ADD
337	STAFFEN ADDITION
338	STILLWATER MEDICAL PROFESSIONAL BUILDING
339	STONE POINTE ADDITION
340	STONEGATE EST PH 1
341	STONERIDGE ESTATES
342	STW GOLF & C C ADD
343	STW GOLF & CC ADD 2N
344	SUD 4TH WILDWOOD 2ND
345	SUMMIT ADD
346	SUNNY BROOK ADD
347	SUNNYSIDE ADD
348	SUNRISE ADD 1ST
349	SUNSET HEIGHTS ADD
350	SUNSET MEMORIAL GRD
351	SUNSET TERRACE
352	SURREY HILLS EST
353	SURREY HILLS EST 2ND
354	SURREY HILLS EST 3RD
355	SURREY HILLS EST 4TH
356	SUTTON ADD
357	SWANK'S 1ST ADD
358	TEAL RIDGE ADD 1ST
359	TEAL RIDGE ADDITION, SECOND SE
360	TERRACE SOUTH ADD

361	TERRILL BROTHERS ADD
362	THOMAS ADDITION
363	THOMPSON ADDITION
364	THOMPSON SUB MCF HT
365	THORN-RICKER SUB PKV
366	TIMBERLINE WEST SUB
367	TINKERS SUB W COLL
368	TUCKER ADD
369	TUCKER TRACTS
370	TWIN CREEK ADD
371	UNIV EST REP BLK 6-7
372	UNIV EST REP L35 BL2
373	UNIVERSITY EST
374	VALLEY VIEW SUB 1ST
375	VILLA ESTATES
376	WARD'S SUB PKVILLE
377	WASHINGTON HTS
378	WASHINGTON HTS 2ND
379	WATSON ADDITION
380	WATSON HEIGHTS
381	WATSON HTS 2ND
382	WEAVER ADDITION
383	WEDGEWOOD ADDITION
384	WEDGEWOOD SEC 2
385	WEDGEWOOD SEC 3
386	WEDGEWOOD SEC 4
387	WEDGEWOOD SEC 5
388	WEST COLLEGE ADD
389	WEST COLLEGE ADD
390	WEST COLLEGE HEIGHTS
391	WEST HAZEN HILLS ADD
392	WEST OAK PK COMM 1ST
393	WEST PARK ADD 1ST
394	WEST PARK ADD 2ND
395	WEST PARK ADD 3RD
396	WEST SUNSET HTS
397	WESTBROOK EST 2ND
398	WESTBROOK EST 3RD
399	WESTBROOK EST 4TH
400	WESTBROOK EST, REPLAT PART OF BLK 4,5

401	WESTBROOK ESTATES
402	WESTERN HEIGHTS
403	WESTVIEW ACRES
404	WHITEHURST ADDITION
405	WILDWOOD ACRES
406	WILLOW PARK ESTATES
407	WILLSON'S SUB
408	WILMSMEYER ADDITION
409	WINDMILL HEIGHTS ADD
410	WINDMILL HEIGHTS ADD, REPLAT OF BLK 1, 2
411	WINDRUSH ADDITION
412	WITTUM ADDITION
413	WITTUM ADDITION 2ND
414	WOOD CREST ADDITION
415	WOOD LAKE VILLAS
416	WOODLAKE 1ST ADDN
417	WOODLAKE 2ND ADDN
418	WOODLAND PARK
419	YOUNG'S SUBDIVISION
420	CAMDEN PLACE AT 19TH
421	CAMDEN POND
422	COUNTRYSIDE ADDITION, 5TH
423	COUNTRYSIDE ADDITION, 6TH
424	SADDLE ROCK REPLAT
425	SORRELL-BAKER ADDITION
426	SUMMERLIN ADDITION, 2ND.
427	TEAL RIDGE ADDITION, 3RD
428	THE FALLS
429	BOULDER CREEK SPRING HILL
430	BOULDER CREEK THE ESTATES
431	WESTPARK 1st SECTION, PHASE 1 REPLAT
432	CAMDEN POND REPLAT
433	BERRY CREEK FIRST SECTION
434	TEAL RIDGE ADDITION, 4TH
435	WOODLAND TRAILS, 1ST SECTION
436	LAKEVIEW RIDGE FIRST SECTION
437	BERRY CREEK SECOND SECTION
438	WINDRIDGE
439	LAKEVIEW RIDGE SECOND SECTION
440	WOODLAND TRAILS, 2ND SECTION

441	WESTPARK 1ST SECTION PHASE 2 REPLAT
442	LAKEVIEW RIDGE THIRD SECTION
443	TYCON PLAZA
444	WOODLAND TRAILS, 3RD SECTION
445	DEVIN PLACE
446	JAMES CREEK
447	BERRY CREEK THE GARDENS
448	THE LINKS, PHASE I
449	WEDGEWOOD SECTION 6
450	EAST BROOKE ESTATES
451	BOULDER CREEK GARDEN POINTE
452	WHITE BARN ADDITION, BLKS 1 & 2
453	LAKEVIEW POINTE
454	LAKEVIEW RIDGE 4TH SECTION
455	SURREY HILLS ESTATES FIFTH
456	BERRY CREEK, OFFICE COMPLEX
457	WHITE BARN ADDITION, BLKS 3, 4, & 5
458	THE CANYONS, 1ST SECTION
459	WEDGEWOOD, SECTION 7
460	BERRY CREEK, 3RD SECTION
461	EAGLE SUMMIT
462	PLEASANT OAKS
463	NORTH TOWER PARK, 4TH SECTION
464	SORRELL-BAKER, 2ND ADDITION
465	WESTLANDS
466	OAKDALE PARK, 1ST SECTION
467	SAWGRASS
468	HEATHERWOOD, 1st Section
469	WEDGEWOOD SECTION SIX REPLAT
470	QUAIL MEADOWS
471	PARKVIEW ESTATES SECTION 8
472	TEAL RIDGE 5TH
473	THE LINKS, SECTION 2
474	BARRETT PLACE
475	HEATHERWOOD, 2ND SECTION
476	BOULDER CREEK, OLD POND
477	BOULDER CREEK, HIGHLANDS
478	THE CANYONS, 2ND SECTION
479	TRADAN HEIGHTS, 1ST SECTION
480	COPPER CREEK

VITA

Gauri S Gajewar

Candidate for the Degree of

Master of Science

Thesis: STORMWATER SYSTEM MAPPING USING GIS SOFTWARE FOR THE CITY OF STILLWATER

Major Field: Environmental Engineering

Biographical:

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Education: Earned the Bachelor of Engineering Degree in Civil Engineering from V.J.T.I., University of Mumbai, India in May 2005.  
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Experience: Design and Detailing Engineer in Intech Designs Pvt (India) Ltd., Mumbai (Feb 2006 - June 2008)  
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Name: Gauri Gajewar

Date of Degree: May, 2010

Institution: Oklahoma State University

Location: Stillwater, Oklahoma

Title of Study: STORMWATER SYSTEM MAPPING USING GIS SOFTWARE FOR  
THE CITY OF STILLWATER.

Pages in Study: 94

Candidate for the Degree of Master of Science/Arts

Major Field: Environmental Engineering

Scope and Method of Study:

The scope of this study was to develop Stormwater system for the City of Stillwater using GIS software and show the application of the same.

Findings and Conclusions:

The GIS map was successfully created which completes one of the necessary criteria for the Oklahoma Department of Environmental Quality Phase II Permit. It has stormwater system for the city for future reference and the outfalls along the creeks of Stillwater. This map can be used for source tracking, pollution prevention; planning during develop or re-development, and emergency management. The map will need to be keep updated as and when there are new developments in the city of Stillwater.

ADVISER'S APPROVAL: Dr. Dee Ann Sanders

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