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STORMWATER QUALITY ANALYSIS OF HOLLAND ROAD EXPANSION AND EXTENSION

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STORMWATER QUALITY ANALYSIS OF HOLLAND ROAD EXPANSION AND EXTENSION

by

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I could not have gotten where I am today without the loving support of my parents. Thank you for always supporting my decisions and helping me out through rough times. I would also like to thank my friends for standing by my side, giving me memories that will last a life time. I would also like to thank my girlfriend for motivating me to complete my honors degree. I would not have written this without you pushing me. Thank you to God as well, for my faith in him gave me the strength to complete this project. Finally, I would like to thank all my professors, because without their knowledge and guidance, I could not be graduating.

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ABSTRACT

STORM WATER QUALITY ANALYSIS OF HOLLAND
ROAD EXPANSION AND EXTENSION

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Before many construction projects, there is no human influence on the land. There is more vegetation in pre-developed land that acts like a filter, absorbing many chemicals in stormwater runoffs. Vegetation cover also leads to lower flows for stormwater runoff. The development of land decreases the vegetation cover by introducing impervious layer, such as concrete. The increase in impervious layers decreases the amount of runoff that can be absorbed naturally by the ecosystem, leading to more stormwater runoff. Furthermore, development leads to an increase in exposure to manmade chemicals. Thus, development leads to more intense exposure to harmful chemicals that the ecosystem cannot handle.

My honors project will address the problem of contaminated stormwater runoff by analyzing the effectiveness of different water quality management techniques and practices. My honors project will also include a discussion of the governing design criteria for water quality management. Furthermore, my honors project will include a discussion

of several hydraulic structures and systems that aid in improving the water quality of stormwater runoff. Finally, recommendations for a water quality management system will be made for the site of my senior project.

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CHAPTER 1

INTRODUCTION

1.1 Senior Project Description

The location of my Senior Project is in the south eastern portion of the City of Mansfield, just west of Joe Pool Lake. Mansfield currently has a population of around 67,000 people and occupies a total area of 36.49 mi^2. Due to an increase in urbanization in the city limits, the City of Mansfield is in constant need of improvements to its transportation system. Based on the observed increase and projected future growth, the City has developed a masterplan for the ideal roadway system for its citizens that can be seen in Figure 1.1.

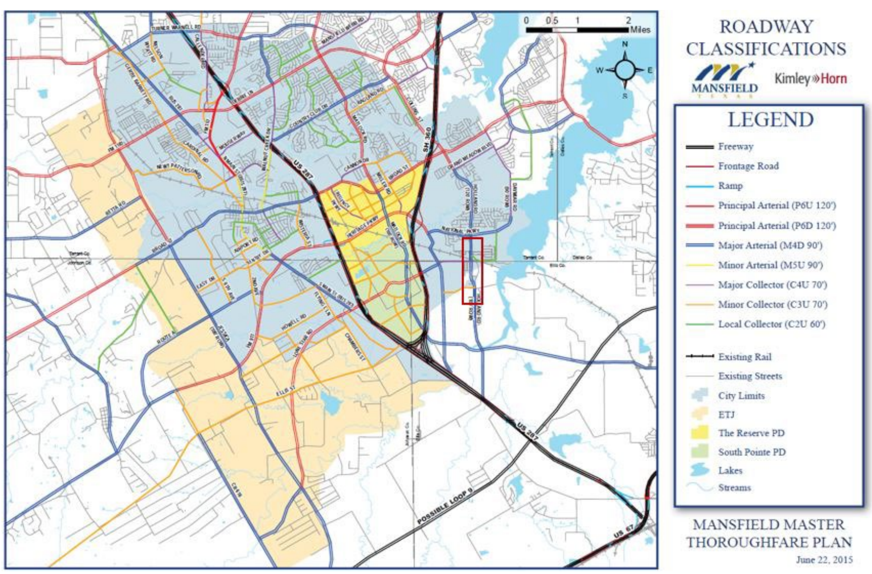

Figure 1.1: City of Mansfield Thoroughfare Masterplan

The red box found in Figure 1.1 indicates the project location for my Senior Project Group. Our group was tasked with designing the roadway expansion and extension for the section of Holland Road enclosed in the red box. Currently, this section of Holland Road is a two-lane undivided roadway that dead-ends at Britton Road. Our group was tasked with designing Holland Road to be a four-lane divided major arterial that extends past Britton Road to FM 661, north of Gifco Road. This includes 3,900 feet of roadway, and one creek crossing. A new railroad crossing design was also developed. A traffic analysis was performed accounting for suburban development in the southwest sector of Briton Road. The specific location and extent of the project can be seen in Figure 1.2. The proposed roadway in red crosses through Tarrant and Ellis counties; however, the project is solely under City of Mansfield's jurisdiction.

Figure 1.2: Tentative Route for Holland Road

1.1.1 Team Member Responsibilities

For my Senior Project Group there were five members working together to complete the design of the roadway expansion and extension. The five members of the team were myself, Maria Frias, Justin Macke, Max Lantano, and Palash Kachhy. I had the responsibility of designing the storm water management structures north of the railroad on the site. Justin Macke was in charge of developing the hydrologic and hydraulic models for the bridge crossing south of the railroad. Max Lantano was in charge of the vertical and horizontal alignment of the road. While, Maria Frias was in charge of the traffic analysis, signage along the road, and the railroad crossing.

1.2 The Problems of Storm Water Runoff

Development creates more homes, apartments, and businesses for citizens, which generally improves the standard of living for the citizens in the surrounding area. However, land development also leads to an increase in the amount of impervious layers (roads, driveways, sidewalks, roofs, esc.). Increasing the amount of impervious layers decreases the available space that can absorb stormwater runoff leading to an increase in the stormwater runoff. Increased impervious layers also decrease the time of concentration for a drainage area. The time of concentration is the time it takes the water to reach the outlet from the furthest hydraulic point within the drainage area. The time of concentration is decreased due to the increased flow velocities over the impervious layers. The decreased time of concentration leads to an increase in the rainfall-runoff response for the site, leading to quicker peak flows.

Due to the higher and quicker peak flows, storm water runoff management is a major priority for land developers. If the storm water runoff is not routed properly, then roads, yards, and even homes on the site could be flooded. The effects of developing a site and increasing the flow can also effect downstream development. If downstream hydraulic structures are not checked to ensure the increased flows can be handled, then downstream structures could be compromised.

Stormwater runoff routing has been the primary concern for engineers, but stormwater runoff can also be a huge environmental risk to surrounding ecosystems. Studies have shown that stormwater runoff from developed lands leads to increased pollutants. A preliminary report from the EPA shows that in some water quality measures, stormwater runoff from urban areas is comparable to untreated domestic wastewater. Urban stormwater runoff shows comparable ranges of concentrations to untreated domestic wastewater for total suspended solids, dissolved lead, dissolved copper, and dissolved zinc. Lead, copper, and zinc pollutants can lead to major problems to ecosystems if not handled properly. Thus, developers and engineers have become more concerned with the water quality management of stormwater runoff.

CHAPTER 2

WATER QUALITY MANAGEMENT REGULATIONS

2.1 Regulation Hierarchy

In all civil engineering projects there are three main governmental entities that create rules and regulations for civil engineers to follow. The most important regulations are the federal regulations created by the United States government. Once compliance with federal regulations are met, state regulations must be met. In some cases, states have stricter regulations than the federal government to ensure the safety of its citizens. Finally, engineers must meet the requirements set forth by the regional and local governments. If an engineer does not follow all the regulations set forth by all governmental entities, then they are liable to lose their license or face lawsuits and jail time if there is a catastrophic failure.

2.1.1 Federal Regulations and State Regulations

The Environmental Protection Agency (EPA) is the federal entity responsible for regulating stormwater runoff management. The first major law in the United Stated to address water pollution was the Federal Water Pollution Control Act of 1948. The Fedeal Water Pollution Control Act of 1948 was created in order to provide a comprehensive program for preventing, abating, and controlling water pollution. This law gave the power of controlling water pollution to state governments. Even though this law had good intentions, it did not contain regulations that prohibited polluting water sources, limit new sources of pollution, or set water quality standards that states must meet.

The Clean Water Act was passed in 1972 to amend the Federal Water Pollution Control Act of 1948 by correcting some of its glaring problems. The Clean Water Act addresses the three regulations the Federal Control Act of 1948 lacked. For example, the Clean Water Act made it illegal for any person to discharge any pollutant from a point source into navigable water, unless with a permit. The Clean Water Act also set water quality standards for all contaminants in surface waters, and created the basic structure for regulating pollutant discharges into United States water.

One program created from the Clean Water to regulate the pollutant discharges was the National Pollutant Discharge Elimination System (NPDES). NPDES is a permit program to address water pollution from point systems. Within NPDES, there are several sub-programs, including a stormwater program. The stormwater program regulates stormwater discharges from municipal separate storm sewer systems, construction activities, and industrial activities. Without proper permits from the NPDES stormwater program, a project contain any of three systems or activities is not allowed to discharge stormwater.

The Clean Water Act has provisions to allow states to create their own NPDES program. Texas' NPDES state program is the Texas Commission on Environmental Quality (TCEQ). Unlike other NPDES state programs, TCEQ is a partial NPDES program. TCEQ is not allowed to issue permits for activities related to oil and gas. The Environmental Protection Agency is the permitting authority for oil and gas activities within Texas. TCEQ can issue permits for all other NPDES programs, including stormwater programs.

2.1.2 Local Regulations

Obtaining proper permits from federal and state officials is not the only requirements that must be met by engineers and land owners, knowing local regulations is just as important for engineers. For many large metropolises, there is a regional council of governments to foster communication between all the cities in the area. In most cases, these regional governments create design regulations and standards that can be adopted and amended by city government. Adopted regulation and standards must be met by engineers working in the governing city or jurisdiction. The regulations created by the council of governments give smaller cities in the region a baseline for acceptable practices. Overall these regional recommendation help create better infrastructure for its citizens and visitors.

My senior project site falls in the North Central Texas Council of Governments' (NCTCOG) jurisdiction. NCTCOG's jurisdiction includes Wise, Denton, Collin, Hunt, Kaufman, Rockwall, Dallas, Tarrant, Parker, Palo Pinto, Erath, Hood, Somervell, Johnson, Ellis, and Navarro Counties. NCTCOG has developed a stormwater management plan for the entire region. The stormwater plan created by NCTCOG is called the Integrated Stormwater Management Plan (iSWM). This plan gives steps, formulas, and examples for many structures to route stormwater downstream of the site. iSWM also gives typical construction practices for certain project criteria.

iSWM is used for any general construction project. However, within iSWM there is also the Transportation Integrated Stormwater Management Plan (TriSWM). TriSWM is used for projects involving roadways. Since my senior project is a roadway extension and expansion, TriSWM will contain the recommended management practices for the project.

City regulations must also be accounted for when developing a site. If a city regulation is present, it will be stricter than the existing federal, and state regulation, or regional recommendation. Cities make stricter regulations to ensure its citizens are not harmed by the negative impacts of urban development. The City of Mansfield does not have any regulations governing the water quality measures for a development beyond the adopted recommendations from iSWM.

2.1.2.1 Discussion of the Differences in iSWM and TriSWM

Even though TriSWM is a section of the iSWM criteria manual, TriSWM has different steps for water quality management than outlined by iSWM. TriSWM and iSWM do have the same hydraulic structures (this topic is discussed in depth in Chapter 3); however, they have different steps to implement them. In TriSWM a treatment level must be determined in order to select the proper hydraulic structure to manage the water quality of the site. There are three treatment levels within TriSWM: Level I, Level II, and Level III. The treatment levels are determined based on two factors. The first factor is the volume of traffic that is carried by the roadway. This is an important factor because the more vehicles traveling the road equates to larger amounts of chemicals deposited on the road from rubber and oil leakages. Two levels of the volume of traffic are outlined in TriSWM: high volume and low volume. The Federal Highway Administration (FHWA) has done extensive studies on its roadways in order to classify the volume. The FHWA outlines that any road with greater than 30,000 average daily trips (ADT) is classified as a road carrying a high volume of traffic. While anything below this threshold is considered a low volume of traffic. Average daily trips is a common measure used by transportation engineers to assign grades to the level of service of the roadway and is the reason why TriSWM uses ADT to distinguish between a high volume of traffic and a low volume of traffic.

The other factor used to determine the treatment level of the site is the susceptibility of the downstream receiving waters to the impact of pollutants. TriSWM outlines three levels of susceptibility: high, moderate, and minimal. Highly susceptible waters are any body of water classified as an Exceptional Quality Aquatic Habitat, an Endangered or Protected Species Habitat, and/or a close proximity to a water supply reservoir. Exceptional Quality Aquatic habitats are determined and listed by TCEQ. Endangered and Protected Species Habitats are determined and listed by the Texas Parks and Wildlife Department. Water supply reservoirs are determined by local water treatment facilities, and a list of water supply reservoirs is only available by contacting the local water treatment facilities. Moderately susceptible waters are waters that have three or more designated uses on the Texas Water Quality Standards, a perennial stream not classified by the Texas Water Quality Standards, and/or a wetland where the project contributes at least ten percent of the flow to the wetland. Waters with minimal susceptibility are any waters not listed in high or moderate susceptibility.

Once a volume level and a susceptibility level are determined for the site the table below provided in TriSWM is used to determine the treatment level:

Table 2.1: TriSWM Treatment Level

Traffic Volume	Receiving Water Susceptibility		
	Minimal	Moderate	High
Low	Level I	Level I	Level II
High	Level I	Level II	Level III

While TriSWM has a clear process to determine the hydraulic structures that should be implemented to manage water quality, iSWM is vaguer on how to manage the water quality of the site. In iSWM there are three management options that the developer can use. The three options the developer can use are an integrated site design practices and credits checklist (option 1), treatment of the water quality protection volume (option 2), and/or assisting with off-site pollution prevention programs and activities (option 3). iSWM requires an integrated site design practices and credits checklist and either of the other two options. Option 1 is required by the iSWM manual; however, it does not specifically say which structures should be used. This option creates a point system that rewards points to certain management practices, which most are not hydraulic structures. Certain development incentives are provided if the development receives ten more points than the minimum number of points required by the site. Table 2.1 outlines the minimum number of points required by sites.

Table 2.2: Integrated Stormwater Management Point Requirements

Percentage of Site with Natural Features Prior to Proposed Development	Minimum Required Points for Water Quality Protection
>50%	50
20-50%	30
<20%	20

Option 2 only states that any hydraulic structure implemented for water quality management must treat the water quality protection volume, which is the runoff volume from the first 1.5 inches of rainfall. Option 3 is the vaguest of all three by only requiring a developer to assist in off-site management plans. Option 3 requires no hydraulic structures for water quality management of the site.

Even though there are certain levels of requirements for iSWM and TriSWM, the developer does not have to implement any further management practices beyond the minimum requirements. This could be problematic in areas requiring very little water quality protection points. Not only does the point system not outline what structures should be used, there is no standard for water quality that must be met by the discharged stormwater. Furthermore, with TriSWM the treatment level does not stop a developer from choosing the least effective treatment structure. These management practices are not ideal, but are better than the alternative: no requirements. Different hydraulic structures and their treatment capabilities are discussed in Chapter 3.

CHAPTER 3

HYDRAULIC STRUCTURES AND TREATMENT CAPABILITIES

There are many hydraulic structures that can be designed to handle and manage stormwater runoff. Hydraulic structures can be classified as a primary stormwater conveyance measure, a primary water quality protection measure, or a combination of both. Hydraulic structures can also be classified as a secondary stormwater conveyance measure, a secondary water quality protection measure, or a combination of both. The iSWM manual contains a list of different hydraulic structures and their classifications for water quality protection and flood control that can be seen in Table 3.1. In Table 3.1, P stands for primary structure and S stands for secondary structure. For each structure in Table 3.1, a brief discription and how well they treat stormwater runoff can be seen in Section 3.2.

3.1 Stormwater Treatment with Hydraulic Structures

Treatment of stormwater runoff is not as simple as it sounds. Treatment processes in general are very complex. For example, wastewater treatment plants have a relatively know amount of flow and contaminants that enter its system daily. Treatment processes are designed to treat these specific flows and have relatively routine processes from day to day, with fine tuning when needed. Even with these relatively known daily contaminants and routine treatment processes, trained professionals must be monitoring all operations to ensure they are running properly. This monitoring is necessary because small changes in the physical and chemical makeup of untreated wastewater could cause water quality measures of the treated water to exceed maximums set by governing regulations.

Table 3.1: List of Hydraulic Structures and Their Purpose

Category	*Integrated* Stormwater Controls	Water Quality Protection	Flood Control
Channels	Enhanced Swales	S	P
	Channels, Grass	S	P
	Channels, Open	-	P
Chemical Treatment	Alum Treatment System	P	-
Bioretention Areas	Bioretention Areas	P	S
Conveyance System Components	Culverts	-	P
	Energy Dissipation	-	S
	Inlets/Street Gutters	-	P
	Pipe Systems	-	P
Detention	Detention, Dry	S	P
	Detention, Extended Dry	S	P
	Detention, Multi-purpose Areas	-	P
	Detention, Underground	-	P
Filtration	Filter Strips	S	-
	Organic Filters	P	-
	Planter Boxes	P	-
	Sand Filters, Surface/Perimeter	P	-
	Sand Filters, Underground	P	-
Hydrodynamic Devices	Gravity (Oil-Grit) Separator	S	-
Infiltration	Downspout Drywell	P	-
	Infiltration Trenches	P	-
	Soakage Trenches	P	-
Pools	Wet Pool	P	P
	Wet ED Pool	P	P
	Micropool Porous Pond	P	P
	Multiple Ponds	P	P
Porous Surfaces	Green Roof	P	-
	Modular Porous Paver Systems	S	-
	Porous Concrete	S	-
Proprietary Systems	Proprietary Systems	S/P	S
Re-Use	Rain Barrels	P	-
Wetlands	Wetlands, Stormwater	P	P
	Wetlands, Submerged Gravel	P	-

In the case of stormwater runoff, there is more uncertainty that adds another level of complexity to treating water. The frequency and magnitude of stormwater runoff is unknown because it is directly related to the weather. Also, the chemical contaminants from a site could be drastically different from storm event to storm event. One storm event could have large levels of fecal bacteria from fertilizer, while another could have high levels of lead from oil leaks. Knowing the exact chemical composition to treat specific chemicals from stromwater runoff is virtually impossible and impractical. Furthermore, drainage areas can drastically change from year to year, through extensive urban development. For example, according to census data the Dallas, Fort Worth area has grown 79 percent from 1980 to 2011. This has led to a drastic change in the drainage area of the Dallas, Fort Worth area.

In order to simplify how well stormwater runoff is treated, the level of total dissolved solid treatment is measured for hydraulic structures. Total suspended solids are directly related to many water quality parameters. More total suspended solids lead to decreased dissolved oxygen levels, decreased light transmission to photosynthetic organisms, and increased chemical contaminants. Total suspended solids are also one of the easier water quality measures to record and evaluate. The treatment levels of various hydraulic structures for suspended solids as outlined by the iSWM manual can be seen in Table 3.2.

Table 3.2: List of Hydraulic Structures and Treatment Levels

Category	*integrated* Stormwater Controls	Total Suspended Solids Treatment Level
Channels	Enhanced Swales	80%
	Channels, Grass	50%
	Channels, Open	-
Chemical Treatment	Alum Treatment System	90%
Bioretention Areas	Bioretention Areas	80%
Conveyance System Components	Culverts	-
	Energy Dissipation	-
	Inlets/Street Gutters	-
	Pipe Systems	-
Detention	Detention, Dry	65%
	Detention, Extended Dry	65%
	Detention, Multi-purpose Areas	-
	Detention, Underground	-
Filtration	Filter Strips	50%
	Organic Filters	80%
	Planter Boxes	80%
	Sand Filters, Surface/Perimeter	80%
	Sand Filters, Underground	80%
Hydrodynamic Devices	Gravity (Oil-Grit) Separator	40%
Infiltration	Downspout Drywell	80%
	Infiltration Trenches	80%
	Soakage Trenches	80%
Pools	Wet Pool	80%
	Wet ED Pool	80%
	Micropool Porous Pond	80%
	Multiple Ponds	80%
Porous Surfaces	Green Roof	85%
	Modular Porous Paver Systems	Decreases Impervious Layers
	Porous Concrete	Decreases Impervious Layers
Proprietary Systems	Proprietary Systems	Must be Provided by Manufacturer
Re-Use	Rain Barrels	-
Wetlands	Wetlands, Stormwater	80%
	Wetlands, Submerged Gravel	80%

3.2 Hydraulic Structure Descriptions

3.2.1 Channels

iSWM classifies three engineered structures as channels. These three structures are enhanced swales, vegetation lined channels, and open channels. Open channels and vegetation lined channels are basically the same structure. Both are structures that are designed to convey stormwater with a free surface exposed to the atmosphere. iSWM distinguishes between these structures by classifying open channels as structures lined with rigid linings like concrete. Whereas, vegetation lined channels are channels that with natural linings like grass or shrubs. Vegetation lined channels can also be lined with energy dissipaters such as riprap in certain areas where stream protection is needed. Enhanced swales are vegetated open channels that are designed and constructed to capture stormwater in cells dammed by walls or other hydraulic structures.

3.2.2 Chemical Treatment

Chemical treatments are used most commonly in water or wastewater treatment plants. The most common form of chemical treatment is alum treatment. Alum can also be used for stormwater runoff. Alum treatment is based on a flow-weighted basis during rain events by injecting alum into a storm sewer that drains into a collection pond. The alum is allowed to react and coagulate in the storm sewer pipe, creating floc that can settle in the pond. This system is the most effective in treating stormwater runoff, but is the most complex and one of the most expensive options.

3.2.3 Bioretention Areas

Bioretention areas are any shallow stormwater basin or landscaped area that uses engineered soils and vegetation to capture and treat runoff. These structures route stormwater to a grass buffer strip, a ponding area, or a porous soil. The routed water passes through these structures and is slowed, allowing sediments to settle (grass buffer strip, or ponding area). If porous soil is used, the soil acts like a filter as the stormwater infiltrates through the soil. Bioretention areas are only effective for very small drainage areas, because they are designed to slow down flow.

3.2.4 Conveyance System Components

Stormwater conveyance systems consist of a combination of culverts, inlets, pipe systems, and energy dissipaters. None of these structures treat stormwater runoff; however, they provide excellent flood control management. Culverts are a short closed conduit that conveys stormwater under a roadway. Inlets are used to collect surface runoff into culverts or pipe systems. Pipe systems are long closed conduits that transport collected water to other stormwater control structures or to downstream receiving waters. Energy dissipaters are structures used to decrease the energy in the system, decreasing flow velocities, and mitigating erosion of natural banks.

3.2.5 Detention Areas

Detention areas are large excavated areas that contain stormwater runoff allowing water to collect. Detention areas are excellent at managing flows and bringing them close to the preexisting conditions. Dry extended and extended dry detention ponds are very common in urban development projects. Both structures are large excavated areas open to the atmosphere that are designed for stormwater management and water quality protection purposes. A multi-purpose detention area is a detention area that is designed primarily for another use beside stormwater management. For example, parking lots could be designed to contain and store some level of stormwater runoff before routing it downstream.

Detention areas can also be placed under ground, connecting to pipe systems. Underground detention areas are typically smaller than dry extended detention ponds because of the large excavation costs. Multi-purpose and underground detention areas are not able to provide water quality protection because they are made of concrete which does not treat or filter water.

3.2.6 Filtration Structures

iSWM classifies five structures as filtration structures: filter strips, organic filters, planter boxes, sand filters and underground sand filters. Filter strips are uniformly graded and densely vegetated sections of land engineered and designed to treat runoff and remove pollutants through vegetative filtering. Organic filters are similar to sand filters, but contain organic materials in the filter media. Organic materials include leaf compost or a peat/sand mixture as the filter media. The organic materials allow for higher pollutant treatment than sand filters. Sand filters are multi-chamber structures using a sediment forebay, a sand bed as its primary filter media, and an underdrain collection system. Planter boxes are large pots filled with soil and plants. These planter boxes filter small amounts of rain, and provides aesthetic enhancements to the site. Underground sand filters are sand filters that are in an underground vault instead of a surface contained system.

3.2.7 Hydrodynamic Devices

Gravity (oil grit) separators are classified as hydrodynamic devices. These structures are designed to contain stormwater runoff in pools that allow particles within the water to settle. A typical gravity separator can be seen in Figure 3.1.

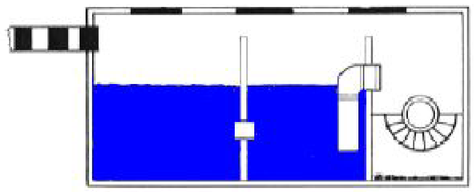

Figure 3.1: Gravity Separator

Gravity separators are not economical for large projects because of their frequent maintenance requirements and poor performance with large flows.

3.2.8 Infiltration Structures

Infiltration structures include downspout drywells, infiltration trenches, and soakage tranches. Downspout drywells are perforated manholes. Perforations in the manhole structures allow surcharged water to pass through the slits and infiltrate through the soil. Infiltration trenches are excavated trenches filled with stone aggregate used to capture and facilitate infiltration of stormwater runoff. Soakage trenches are a variation of infiltration trenches that have perforated pipe imbedded in the ground to convey stormwater runoff.

3.2.9 Pools

Pools are engineered stormwater ponds that are designed to retain water under normal climate conditions. These structures include wet ponds, wet extended detention ponds, micropool extended detention ponds, and multiple pond systems. Wet ponds are designed to permanently hold water quality control volumes. Wet extended ponds are designed to split the water quality control volume between a permanent pool and a dry detention area. Micropool extended detention ponds are the same as wet extended detention ponds, except they have smaller pooled areas. Multiple pond systems contain the water quality control volume in multiple cells. All these structures can treat relatively large drainage areas.

3.2.10 Porous Surfaces

Porous surfaces include green roofs, modular porous paver systems, and porous concrete surfaces. Green roofs are vegetated roofs that are intended to handle small storms by retaining the water until the end of the peak flows. Green roofs also slow down runoff, decreasing overall flows from larger storm events. Modular porous paver systems are structural units such as concrete blocks with regularly spaced voids. These structures are placed on top of gravel surfaces that allow water passing through the voids infiltrate through the gravel. Porous concrete is made of very coarse aggregate and Portland cement. The coarse aggregate allows rapid infiltration of water through the concrete surface.

3.2.11 Proprietary Systems

Proprietary systems are any system manufactured that are not listed in the iSWM manual. If these systems are used, they must be extensively tested and designed to perform as described by the manufacturer.

3.2.12 Re-Use

Rain harvesting tanks and barrels can be used to re-use stormwater runoff. These structures collect stormwater runoff from roofs. The collected water helps decrease the stormwater runoff volume slightly. Rain harvesting tanks are not viable for large urban development because of their small capacity. Typically, rain harvesting systems only store 50-500 gallons of water. Furthermore, certain roof materials can cause contamination of runoff collected in the rain barrels.

3.2.13 Wetlands

Stormwater wetlands and submerged gravel wetlands are human made wetlands that route and store stormwater runoff so it can be treated. Engineered wetlands require large land areas to handle flows. These systems need constant base flows to be viable but can serve as a wildlife habitat. Furthermore, engineered wetlands can remove significant amounts of nutrients from stormwater runoff because of the plant life present in the system.

CHAPTER 4

RECOMMENDATIONS FOR SITE

As mentioned in Chapter 2, this project falls within the City of Mansfield's jurisdiction, which adopts and requires the recommendations outlined by NCTCOG. The iSWM or TriSWM manual should be used for making recommendations for water quality management structures for my senior project. Since my senior project is strictly transportation related, the TriSWM method of water quality management should be implemented. TriSWM first requires the treatment level of the site to be determined. This requires the ADT of the road and the susceptibility of the receiving waters to the pollutants. The projected ADT for the site is 29,658. This was provided from the traffic analysis conducted by Maria, one of my team members. This value means the site is classified as having a low traffic volume. Joe Pool Lake is the receiving waters for the flow from the site. This lake is planned to be a raw water reservoir for Dallas Water Utilities. This makes the receiving waters highly susceptible to stormwater pollutants. From Table 2.1, a low traffic volume and a high susceptibility to stormwater pollutants requires water quality management structures from treatment level II.

There are three hydraulic structures that can be used for treatment level II. Treatment level II prescribes that a bioretention area, extended dry detention pond, or an enhanced swale be used to treat the stormwater runoff. Since this site is a transportation project, there is limited space for further development. This eliminates the use of an extended dry detention pond. Bioretention areas could be placed in the median to help reduce some runoff and treat small amounts of runoff. Even though bioretention areas are primary sturctures for water quality protection, they will only be able to treat the runoff from the roadway. Treatment of existing stormwater runoff from the site would require the use of enhanced swales. This will work well because a vegetation lined channel will be used to route the flow of the site.

Two hydraulic strucutres should be implemented in order to treat the stormwater runoff from the site to protect the highly susceptible waters of Joe Pool Lake. Bioretetnion areas should be constructed in the median of the road to help treat runoff from the expansion from the road. Also, enhanced swales are recommended to treat the water from the existing stormwater runoff from adjacent suburbs.

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BIOGRAPHICAL INFORMATION

Trevor Stull graduated with an Honors Bachelor of Science in Civil Engineering at the University of Texas at Arlington. Trevor has research interests in Environmental and Water Resource Engineering. He has worked with Dr. Andrew Kruzic, Dr. Nick Fang, and Dr. Stephen Mattingly during his undergraduate career. With Dr. Kruzic, he aided graduate students with the detection and analysis of chloramines in treated water. He also worked with the effects of copper treatment on biofilm growth. With Dr. Fang, he worked on multiple hydrologic and engineering-related projects, including a flood prediction project with the City of Grand Prairie, and the Regional Housing Study for the Dallas/Fort Worth Area. The Regional Housing study for the Dallas/Fort Worth Area was a joint project with Dr. Stephen Mattingly.

After graduation, Trevor Stull plans to work with Garver Engineering and Consultants as a member of the Hydraulic Modeling Team. Here, he will be analyzing and designing water distribution systems for clients. He also plans on pursuing a Master in Civil Engineering at the University of Texas at Austin.