Redeveloping Stormwater Management in Maricopa County, Arizona: Exploring the Establishment of a Regional Authority

by

Matt Nymeyer

A Thesis Presented in Partial Fulfillment
of the Requirements for the Degree
Master of Science in Technology

Approved April 2011 by the
Graduate Supervisory Committee:

Larry Olson, Chair
Nicholas Hild
David Edwards

ARIZONA STATE UNIVERSITY

May 2011

ABSTRACT

The current practice of municipal stormwater management in the United States has failed to effectively reduce the amount of pollutants discharged into surface waters. Water impairment as a result of polluted stormwater runoff from urbanized areas remains a significant concern despite federally mandated efforts to reduce the impact of these discharges. To begin addressing these shortfalls the Environmental Protection Agency contracted the National Research Council to investigate the extent of the stormwater program and to identify areas that require improvement in order to more effectively implement the program. Their findings indicated widespread, foundational flaws with the stormwater regulatory structure and proposed new permitting guidelines.

The purpose of this study was to explore the specific shortcomings of stormwater management in the Maricopa County region and to suggest the establishment of a regional authority. Doing so would require an alternative permitting regime to replace the current approach of population based municipal permitting with a permit that considered the entire urbanized region. The organizational structure, legality concerns and intergovernmental partnerships needed to properly establish such a regional authority were part of this study. The effect of this approach suggested a more effective, efficient and economical model of municipal stormwater management that better addressed certain Integrated Urban Stormwater Management strategies and began to address the program weaknesses identified by the National Research Council.

TABLE OF CONTENTS

CHAPTER Page

APPENDIX Page

LIST OF TABLES

LIST OF ACRONYMS AND DEFINITIONS

AAC…………………………………………………Arizona Administrative Code

ADEQ ……………………………Arizona Department of Environmental Quality

ARS…………………………………………………...Arizona Revised Statutes

AZPDES………………………..Arizona Pollution Discharge Elimination System

BAT……………………….Best Available Technology Economically Achievable

BCT…………………………….Best Conventional Pollutant Control Technology

BMP……………………………………………………Best Management Practice

CAFO…………………………………..Concentrated Animal Feeding Operations

CFR……………………………………………...Code of Federal Regulations

CGP……………………………………………..Construction General Permit

CWA……………………………………………………………...Clean Water Act

DOT……………………………………………………Department of Transportation

EPA…………………………………………Environmental Protection Agency

IDDE…………………………………Illicit Discharge Detection and Elimination

IGA……………………………………………………Intergovernmental Agreement

ILA……………………………………………………………...Interlocal Agreement

IUSM…………………………………Integrated Urban Stormwater Management

MCM……………………………………………..Minimum Control Measure

MCRSP……………………The Maricopa County Regional Stormwater Program

MDEQ…………………………..Michigan Department of Environmental Quality

MEP……………………………………………………Maximum Extent Practicable

MOA……………………………………………………Memorandum of Agreement

MS4……………………………………..Municipal Separate Storm Sewer System

MSGP……………………………………………...Multi Sector General Permit

NCTCOG…………………………..North Central Texas Council of Governments

NOI…………………………………………………………………...Notice of Intent

NOT…………………………………………………………Notice of Termination

NPDES…………………………National Pollution Discharge Elimination System

NRC…………………………………………………National Research Council

PAH…………………………………………Polycyclic Aromatic Hydrocarbon

PSA……………………………………………Public Service Announcement

SQMC………………………………Stormwater Quality Management Committee

STORM………………………..Stormwater Outreach for Regional Municipalities

SWMP……………………………………….....Stormwater Management Plan

SWPPP……………………………………..Stormwater Pollution Prevention Plan

TMDL……………………………………………...Total Maximum Daily Load

Best management practices (BMP): means schedules of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of "waters of the United States." BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage (Protection of Environment, 1998).

Impaired Water: means a waterbody (i.e., stream reaches, lakes, waterbody segments) with chronic or recurring monitored violations of the applicable numeric and/or narrative water quality criteria (Environmental Protection Agency, 2011a).

Maximum Extent Practicable (MEP): means a standard that establishes the level of pollutant reductions that MS4 operators must achieve through implementation of a stormwater management program. The strategies used to reduce pollutants to the MEP may be different for each small MS4 because of unique local hydrologic, geologic, and water quality concerns in different areas. EPA envisions that permittees will determine what the MEP is on a location-by-location basis and consider such factors as conditions of receiving waters, specific local concerns, and other aspects of a comprehensive watershed plan (Environmental Protection Agency, 2011b).

Outfall: means a point source as defined by 40 CFR 122.2 at the point where a municipal separate storm sewer discharges to waters of the United States and does not include open conveyances connecting two municipal separate storm sewers, or pipes, tunnels or other conveyances which connect segments of the same stream or other waters of the United States and are used to convey waters of the United States (Protection of Environment, 1998).

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, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff (Protection of Environment, 1998).

Stormwater: means stormwater runoff, snow melt runoff, and surface runoff and drainage (Protection of Environment, 1998).

Chapter 1

INTRODUCTION

The population-based approach to municipal stormwater permitting has resulted in the establishment of 24 unique Municipal Separate Storm Sewer Systems (MS4) in the Maricopa County region. The consequence of this required the enactment of ordinances within each municipality to regulate stormwater discharges. Stormwater runoff is created when rain or snowmelt flows over land or impervious surfaces and does not percolate into the ground. As the runoff comes into contact with paved streets, parking lots, construction sites, industrial sites, etc., it accumulates many pollutants that can negatively impact water quality if the stormwater is left untreated (Environmental Protection Agency, 2011). This crowded regulatory framework produces redundant management practices, increased costs and jurisdictional confusion among citizens, regulators and industrial stakeholders in the region.

Overview

In an effort to improve surface water quality under the Clean Water Act Amendments of 1972 (CWAA of 1972), the Environmental Protection Agency (EPA) set out to control point source discharges to Waters of the U.S. under the National Pollution Discharge Elimination System (NPDES). Throughout the 1970's and early 1980's NPDES permits were issued to industrial facilities and municipal sewage treatment plants that required wastewater discharges to meet technology based effluent limits and/or water quality based effluent limits so as to not cause a negative environmental impact on receiving waters. Despite this heightened level of control surface water discharges have not yet been eliminated—according to the CWAA of 1972, pollutants were to be eliminated by 1985. Thousands of water bodies in the U.S. remained classified as “Impaired”, meaning they contained pollutant levels higher than what the EPA considered safe for the water’s intended use. The interim goal of the CWA was to restore Waters of the U.S. to “fishable” and “swimmable” conditions, a task not yet achieved by regulating only point source discharges from industrial and wastewater discharges. Clearly, there were other sources contributing to water pollution. Stormwater was strongly considered as the leading culprit (National Research Council, 2007). In fact, polluted runoff was found to be the major cause of impairment in approximately 40% of U.S. water bodies surveyed that did not meet water quality standards (Environmental Protection Agency, 2007).

To begin regulating polluted runoff originating from non-point sources, the NPDES program was expanded to include stormwater discharges from industrial runoff and municipal separate storm sewer systems (MS4). The Stormwater program was initiated in two phases. Beginning in 1990, Phase I permits were issued to municipalities with populations greater than 100,000 persons, and to industrial dischargers and construction sites disturbing five acres or more of earth located within that municipal jurisdiction. Phase I permitting set standards requiring best management practices (BMP) to be implemented before any stormwater discharges were allowed. In 1999, Phase II permits were issued to municipalities with populations greater than 50,000 people, and to industrial dischargers and construction sites disturbing one acre or more of earth located within that municipal jurisdiction. Additionally, select non-traditional MS4s were required to be permitted as well, including large universities, hospitals and military bases. To date, there are approximately 1,059 Phase I communities and 5000-6000 Phase II communities operating stormwater programs under the NPDES umbrella (The Center for Watershed Protection and Robert Pitt, 2004).

With the creation of such a broad, national program encompassing at a minimum 6,000 communities and the subsequent regulation of hundreds of thousands of non-point sources thereof, the EPA did not have the resources to implement the program themselves. Most states were delegated authority to implement their own NPDES programs, allowing them to grant permits (with federal guidance) to municipalities, industrial sources and construction operations within their region (Environmental Protection Agency, 2011b). The resulting programs, once implemented, established a crowded regulatory framework where stakeholders and permittees are left to manage compliance at multiple levels of government. To demonstrate the redundancies of this program, this research focused on the legal stormwater infrastructure implemented in the Maricopa County, AZ region.

Maricopa County is a major urbanized region in southern Arizona with a population exceeding 4 million people (the fourth most populated county in the nation). Under the current stormwater permitting program, there are 24 unique

MS4s located within Maricopa County, with the unincorporated urbanized areas of Maricopa County itself regarded as a Phase II MS4. Because the County is so large, totaling 9,226 square miles in size, of which only 15.6 percent is actually incorporated, the holes in annexation result in numerous "County Islands" dispersed throughout its jurisdiction (Maricopa County Board of Supervisors, 2010). From a stormwater management standpoint, this creates a nearly insurmountable challenge. Unlike a traditional city, like Phoenix or Mesa, where municipal jurisdictions are clearly defined and regionalized and the MS4 is conceptually developed, County Islands don't share the same structure. In Maricopa County, specifically, this results in the management of 32 separate "micro-MS4s" spread across a region of significant land mass (refer to Appendix A).

Table 1. Stormwater Permittees in the Maricopa County Region
(Arizona Department of Environmental Quality, 2010)

Phase I MS4	Phase II MS4	
ADOT (partially)	Apache Junction (partially)	Litchfield Park
Glendale	Avondale	Luke Air Force Base
Mesa	Arizona State University	Maricopa County
Phoenix	Chandler	Paradise Valley
Scottsdale	El Mirage	Peoria
Tempe	Fountain Hills	Surprise
	Gilbert	Tolleson
	Goodyear	Veteran Hospital, Phoenix
	Guadalupe	Youngtown

This is a phenomenon that is unique to states with large county boundaries and has simply not been considered in the general permitting process implemented by the EPA — which was developed based on the municipal boundaries of eastern states that are generally smaller in land mass and develop more numerous, smaller sized county boundaries. The resultant framework creates undue burden on regulators and stakeholders alike. Success of the program is dependent upon communication between the permittees that ideally should be sharing effective management strategies, pollutant load reduction inventories, industrial inventories as well as developing similar enforcement and/or compliance mechanisms. But in reality, intergovernmental communication is poor and the end result is that operators have no understanding of the effect their stormwater prevention programs have on surface water quality.

Additionally, each MS4 has enacted separate and unique regulations or ordinances that require best management practices be implemented by industrial and construction operations. Since these regulations differ in each municipal jurisdiction regulated entities are tasked with knowing the compliance requirements of each MS4. Therefore, an environmental manager for a construction firm operating in Maricopa County alone would be required to have an operational understanding of as many as 24 separate rules to ensure compliance. Since many stormwater regulatory programs include plan review and permitting fees, it is conceivable that a construction project spanning multiple municipalities would be liable for multiple permits. Given that the Phase I and Phase II stormwater program is in and of itself a dual permitting program, construction operators face triple and quadruple permitting (more for some linear projects). This requires an exaggerated investment of resources and leads to confused compliance efforts as each municipality governs the program differently. And despite all of this regulatory effort, the impact on the watershed is still unknown since discharge inventories, at least in Arizona, have not been fully developed.

In general, each Phase II MS4 is required to implement a set of six Minimum Control Measures (MCM) that include: public education and outreach, public participation and involvement, illicit discharge detection and elimination (which includes extensive outfall and storm sewer mapping), construction site runoff control, post-construction runoff control and pollution prevention/good housekeeping for municipal operations. In the Maricopa County region, many municipalities have joined together to form a regional organization known as STORM (Stormwater Outreach for Regional Municipalities) to help promote public education, outreach and participation. The organization is involved in numerous public events each year to help educate the general public on stormwater pollution concerns. As a group, STORM also sponsors radio and television Public Service Announcements (PSA) and other educational materials. This allows each member of STORM to meet their public education permit requirements while simultaneously benefitting from the cost-sharing of expensive PSAs. This also helps to eliminate a duplication of education efforts (Stormwater Outreach for Regional Municipalities, 2010).

Unfortunately, not all permit requirements are shared in such a way. Each individual MS4 in the Maricopa County region has implemented its own method of regulating illicit discharges from construction and industrial activities. In general, this has manifested into the development of city code and/or regulation. Although each municipality has the same obligation to prevent and/or minimize discharges to their MS4s from sources operating within their jurisdiction, they have each, individually, passed regulations to ensure (and sometimes to enforce) compliance. In fact, the Arizona Pollution Discharge Elimination System (AZPDES) MS4 General Permit requires the municipality to do so. The cost of implementing such a program is explored as part of this study.

Despite all of this extended oversight, the success of the program nationally remains in question and the realization of surface water quality improvement has thus far been elusive (National Research Council, 2007). To begin addressing this troublesome reality, the EPA requested that the National Research Council (NRC) review the current stormwater permitting program and begin developing proposals for improvement. To briefly summarize the results of the survey, the NRC found extensive, foundational deficiencies in the NPDES stormwater program ranging from watershed monitoring and analysis to regulatory oversight and permitting. Particularly, federal and state permitting programs don't have, nor will they ever have, the resources to effectively regulate the thousands upon thousands of active sources contributing to stormwater pollution in a given region. The NRC states, "A better structure would be one where the NPDES permitting authority empowers the MS4 permittees to act as the first tier of entities exercising control on stormwater discharges to the MS4 to protect water quality" (National Research Council, 2007, p. 10). The NRC recommends using the EPA's National Pretreatment Program as a successful model of implementation. The study goes on to suggest a watershed-based permitting approach rather than the current municipal (Phase I and Phase II) population based approach. Such a proposal entails the abandonment of political boundaries regarding stormwater and other wastewater discharges and places the focus on maintaining watershed integrity, regardless of which municipal jurisdiction it may fall under. The foundation of such a program would consider the impact of discharges on the maintenance and/or improvement of the watershed system, cooperation among jurisdictions sharing a watershed and the coordinated regulation and management of all discharges having the potential to modify the hydrology and water quality of the watershed's receiving waters (National Research Council, 2007).

Given that watershed permitting will almost certainly require cross-jurisdictional support, the NRC (2007) suggests that the issuance of watershed-based permits should take a centralized approach. This would consist of a municipal lead permittee working in partnership with other municipalities in the watershed as co-permittees. The permit would set a minimum water quality goal in each watershed to prevent impairment or set goals to improve water quality so that the watershed may recover from "impaired" designation. It is the NRC's opinion that this approach will provide permittees with the responsibility, authority and funding needed to manage all discharges into municipally owned conveyances or to other waterbodies that make up the given watershed (National Research Council, 2007). While the NRC's suggestion of implementing a watershed-based permitting program is certainly a step in the right direction, the practice of municipal co-permittees may still impose jurisdictional difficulties that may prove prohibitive. For example, several municipal regions, such as the Stormwater Quality Management Committee in Clark County, NV and the Stormwater Management Joint Task Force in Harris County, TX have implemented co-permitted programs (though not under watershed-based permitting) where each co-permittee is still left to manage many program elements individually (North Central Texas Council of Governments Department of Environment & Development, 2009). This fails to eliminate the inconsistencies and redundancies that currently plague the program. Using the concept of watershed-based permitting as a baseline, a better solution might be to implement the stormwater program on an urbanized regional basis. Doing so would provide MS4 permittees with the authority and empowerment they need to develop more consistent and efficient strategies for stormwater management.

The intended purpose of this study is one that will explore the possible mechanisms for improving the stormwater program in the Maricopa County region. The program would likely benefit by abandoning the municipal structure of regulatory authority and adopting a more regional framework, such as delegating overall authority to the County government. It is anticipated that doing so will not only streamline the implementation of stormwater management, but would also spread the cost of the program over a larger population, which would result in cost savings to both the taxpayer and the regulated community by reducing redundant practices. Moreover, this type of model is not unfounded in environmental permitting. Under the Clean Air Act, for example, states develop state implementation plans that are delegated to local entities for implementation. The Maricopa County Air Quality Department operates under this authority. According to the NRC, for a similar arrangement to be practicable for the NPDES Stormwater program, states would have to be confident that municipalities would be able to employ the granted authority. In general, the NRC concluded the following: "The committee's opinion is that municipalities generally do have the capability working together as co-permittees with a large-jurisdiction lead permittee and with guidance and support from states" (National Research Council, 2007, p. 394).

Problem Statement

The population-based approach to municipal stormwater permitting has resulted in the establishment of 24 unique MS4s in the Maricopa County region. The consequence of which required the enactment of ordinances within each municipality to regulate stormwater discharges. This crowded regulatory framework produces redundant management practices and jurisdictional confusion among citizens, regulators and industrial stakeholders.

Specific Objectives

Under the guidance of the NRC's assessment, this study focused on the following objectives:

- Research in detail the redundancies of the current system in the Maricopa County region;
- Provide an exploration of stormwater programs throughout the nation to assess if any regions have begun to implement practices based on urbanized regions rather than strict municipal jurisdictions;
- This research resulted in the development of a blueprint proposal detailing the structure of an urbanized regional stormwater program for the Maricopa County region.

The overall intent of this study is to make it clear that some regions, i.e. Maricopa County and other heavily populated, large land mass regions, may benefit from an alternative method of stormwater management. It is not this study's intention to suggest that the NPDES stormwater program requires national overhaul, but rather, to suggest that states with primacy may find it beneficial to delegate authority in some instances. The study outlines a blueprint for what that delegated authority might resemble and will specifically focus on Arizona and the Maricopa County region, utilizing specific knowledge of the local municipal structure and state laws. The study addresses potential legal concerns in an attempt to determine if the current legal structure allows for such a program to be developed or if new law will need to be proposed. The expectations of the newly delegated authority, as well as the municipalities falling under their control, are considered, including certain reporting structures, cooperation, staffing needs and coordinated analysis. The new authority will also require a new departmental organizational hierarchy including divisions for inspection and compliance, planning and analysis, permitting and engineering and enforcement. Overall, the resulting blueprint outlines a stormwater program that is more consistent, productive and economical than the program currently in place. Adhering to this blueprint as guidance may supply the state permitting authority with the confidence they need, as suggested by the NRC, to effectively delegate authority.

Limitations and Assumptions

For the purposes of reviewing municipal stormwater ordinances and program budgets, analysis was limited to traditional MS4s. Non-traditional MS4s, such as Arizona State University and Luke Air Force Base, were not considered. Additionally, budget research will not include Capital Improvement data when reviewing stormwater management program costs because Capital Improvement expenditures are typically for stormwater infrastructure projects undertaken by the specific municipality and not necessarily for stormwater quality improvement. The regional authority considered in this study is concerned about the costs of managing discharges to that infrastructure after it has been developed. Finally, when budget data for municipal stormwater management costs are unknown, the implementation costs are assumed to be $9.16 per household in that municipality. This figure is based on the analysis conducted in EPA's *Economic*

Analysis of the Final Phase II Storm Water Rule (Environmental Protection Agency, 1999).

Chapter 2

LITERATURE REVIEW

Stormwater Pollution

The issue at hand is the effect that urbanization has had on natural drainage and stormwater infiltration. In natural environments, precipitation generally soaks into the ground, filtering through the soil and recharging groundwater. Urban environments, however, consist of large areas of impervious surfaces, preventing stormwater infiltration. To avoid flooding in these urbanized regions, rain and snowmelt are directed to drains or other conveyance channels that carry runoff from these impervious areas into streams or lakes or other receiving water bodies. In most cases, storm drainage is not treated at local wastewater treatment plants before being discharged into receiving waters. The effluent, therefore, remains untreated and as it is conveyed over urban surfaces (roofs, sidewalks, roads, parking lots, etc.) it takes on a number of contaminants, including: metals, chemicals, nutrients, sediment, pathogens, debris, trash and other floatables (Natural Resources Defense Council, 2005). These stormwater contaminants degrade water quality and impair a waterbody's capacity for maintaining healthy populations of aquatic life. Additionally, these negative impacts affect a substantial number of Americans by contaminating drinking water sources, recreational waters, commercial fisheries, and increasing floods. Appendix B lists the commonly encountered surface water contaminants in the state of Arizona and provides criteria for their regulated concentrations. While the list is in no way exhaustive of the types of contaminants found in stormwater throughout the nation it is representative of the pollutant loads commonly experienced. The source and overall impact of these contaminants are varied and place a burden on not only the aquatic ecosystem and human health but also imposes lasting economic impacts (Waterkeeper Alliance, 2009).

Sources of Stormwater Pollution

In urbanized regions, the sources of stormwater contaminants are vast, ranging from atmospheric deposition to pollutants originating from residential activities. Air pollutants, such as fossil fuel emissions from automobiles or industrial activities and agricultural emissions from dust, pesticides, and fertilizers can be scrubbed from the air during rain events or from morning dew. The result is the deposition of ammonia, fine particulates, metals, nitrates, pesticides, petroleum products, phosphorus and other toxic organics onto impervious surface areas that are then washed away by stormwater into the storm drain system and eventually discharged into the receiving water body (Minton, 2005).

Public infrastructure is another leading source of stormwater contaminants. Stormwater runoff traveling over roads, driveways, and sidewalks collects gasoline, motor oil, hydraulic fluids, salt and other deicing agents, polycyclic aromatic hydrocarbons (PAHs), trash, debris, and heavy metals such as cadmium, chromium, copper, iron, manganese, nickel, lead, and zinc. Asphaltic and concrete structures have the ability to alter the temperature of stormwater discharges, which can have a direct effect on the aquatic ecosystem of the receiving water. Conveyance devices, such as untreated galvanized culverts and drain pipes can leach zinc over time and can also introduce harmful pathogens due to cross-contamination and/or illegal connection from the sanitary sewer system. Of particular concern in colder climates across the United States is the introduction of pollutants from the use of deicing agents. The materials typically used for deicing include rock salt, magnesium chloride, calcium chloride, calcium-magnesium acetate, and sand. Acetates are known to cause an increase in biological oxygen demand and the chloride in deicing salts can dissolve metals into solution. Deicers also commonly use cyanide agents to prevent caking. Vehicle driving is another major contributor of stormwater contaminants including leaking automotive fluids, gasoline, and PAH's. Brake drum and tire wear can contribute fine particulates and metals, including cadmium, chromium, copper, lead, and zinc to roadway surfaces that get carried away by stormwater (Minton, 2005).

Commercial activities result in the deposition of many stormwater contaminants, mostly as a result of poor storage practices. Items such as waste, tires, or chemicals are often improperly stored at warehouses, consumer outlets, or other businesses and may leach or leak. Without proper containment or cleanup procedures these contaminants get carried into the storm drainage system. Illegal connections at restaurants are also common and may result in discharges of fats, oils and greases into the storm system. Over time, building exteriors can become corroded contributing eroded paints and galvanized metals into runoff. Construction and site development activities can contribute organics, paints, sediment, petroleum products, nutrients and high pH from alkaline building materials such as cement into the storm system (Minton, 2005).

Residential activities are a major source of stormwater contamination. There is an estimated 46.5 million acres of turf and lawn in the United States (The Lawn Institute, 2007). Residential and roadside landscape maintenance can contribute dissolved organics, herbicides, nitrogen, pesticides, phosphorus as well as sediment and debris into the storm system. And given the large scale at which these activities take place its contribution to stormwater pollutant loads is significant. Additionally, every residential property has the capacity to deliver pollutants to stormwater including pesticides, fertilizers, yard debris, pet waste, trash and pathogens. Rooftops, patios, sidewalks, driveways and other exposed building exterior surfaces have the potential to discharge aluminum and zinc from galvanized rain gutters or lead from plastic gutters. Rock and tar shingle, wood shingle, and composition shingle roofs have been known to leach zinc (Minton, 2005).

Effects of Stormwater Pollution

Metals and Toxics.

Heavy metals and toxics including cadmium, chromium, copper, iron, manganese, nickel, lead, zinc, pesticides, petroleum products, and compounds such as PAHs can have a profound impact on aquatic life. Since many aquatic organisms are sensitive to these types of pollutants they can have a destructive effect in small quantities. These chemicals have been known to hinder immune function and even delay or halt early development in aquatic organisms. And given the careful balance observed in aquatic ecosystems a negative impact on one species can have a ripple effect throughout the entire food web. Of paramount concern are the bioaccumulative properties of such toxins as mercury or pesticides. These toxins are stored in fatty tissues and can enter the food chain at a low trophic level. As small organisms are consumed by predators, the toxin is transferred up the food chain in ever increasing concentrations. This phenomenon of bioaccumulation, or biomagnification, can affect generations of species and poison nearly every trophic level in the ecosystem. Not even humans are immune, as top predator fish like bass, tuna or swordfish are frequently consumed by humans and can deliver significant pollutant loads (Aryal, Vigneswaran, Kandasamy, & Ravi, 2010). As of 2003, 44 states had issued mercury-contamination advisories urging people to reduce or avoid consumption of at least one fish species found in local waterways. In total, 13.1 million acres of lakes, 767,000 miles of river and 70% of coastal waters in the contiguous 48 states are under mercury contamination advisory (Corrigan, 2004).

Nutrients.

While nutrients are essential to fertilize and maintain healthy lawns and crop fields, excess macronutrients like nitrogen and phosphorous can be picked up by stormwater and deposited into water bodies. At this point, a chain of events occur that has the potential to kill an entire aquatic ecosystem. This is known as eutrophication. Even though eutrophication is a natural process, anthropogenic nutrient pollution is a leading cause of "dead zones" and impaired waters. The introduction of large amounts of nutrients into a lake or stream can cause explosive algal blooms. The algae then cover the water, preventing sunlight from penetrating the surface. Aquatic organisms that depend on photosynthesis or on light to catch prey begin to die. The algae too begin to die. And as bacteria start to decompose the dead organisms the oxygen levels in the water decline, resulting in hypoxic conditions. The oxygen level becomes so low that the water can no longer support aquatic plants or fish and the ecosystem crashes. These so-called "dead zones" are present in major water bodies like the Gulf of Mexico and the Chesapeake Bay. Additionally, excessive nitrogen levels in drinking water poses health concerns for humans, notably methemoglobinemia or "blue baby syndrome" as well as livestock populations (Aryal, et al., 2010).

Temperature.

As stormwater contacts pavement, sidewalks and other impervious areas it absorbs the heat radiating from these surfaces. As a result, stormwater can be as much as 6 to 7˚C warmer than natural flows (Natural Resources Defense Council, 1999). And since many aquatic organisms require narrow temperature ranges to survive, thermal stormwater pollution can create an inhospitable environment for sensitive species. Additionally, warm water carries less oxygen. As a result, thermal pollution may cause dissolved oxygen levels in the water body to plummet, asphyxiating the aquatic inhabitants (Waterkeeper Alliance, 2009 and Minton, 2005).

Sediment.

The introduction of excess sediments, defined as particulate matter that can be carried by water and deposited in receiving water bodies as a layer of solids, can have profound impacts on both natural and commercial uses of aquatic habitat. As stormwater travels over urban environments it picks up sediment from impervious surfaces and construction that is then carried into the receiving waterway. Impervious surfaces also have the effect of increasing the velocity and volume of stormwater, which can scour streambeds and deposit increased sediment loads downstream. In slower moving portions of the stream, the sediment begins to settle and fill in the bed. This can destroy the habitat of rockfish, shad, flounder, crab, oyster, and other commercial and recreational fisheries. Sedimentation can also alter the elevation of navigable waters, requiring the need for dredging and spoils treatment to prevent boats from running aground (Aryal, et al., 2010).

Increase sedimentation also increases the turbidity of water, otherwise known as the “cloudiness” of water. Turbid water scatters sunlight, preventing it from reaching aquatic vegetation. This decreases the rate of photosynthesis that occurs in the aquatic habitat and therefore reduces the amount of dissolved oxygen available in the water. As oxygen levels continue to fall, the water becomes unable to support life and the ecosystem begins to die. Additionally, high turbidity levels can reduce visibility of predator fish, preventing them from being able to see and catch their food. Suspended solids can also clog fish gills, injure fish eggs and depress the immune systems of aquatic fauna (Minton, 2005). High turbidity is also considered to be a major contributor to the amount of impaired U.S. waterways (United States Environmental Protection Agency, 2004). Suspended solids in recreational waters provide a binding site for pathogens and other toxins, like metals, that can seriously harm those people utilizing the water (Waterkeeper Alliance, 2009).

Trash.

Trash is a major eye sore in U.S. waterways. Stormwater often conveys debris such as cigarettes, cans, yard waste, plastic bags and other trash into the storm sewer system and eventually into the receiving water. These types of floatables not only impact the aesthetic value of the water body, but it can hinder navigation and recreation, increase oxygen demand and provide surface area for bacterial growth. Not to mention that trash is often consumed by wildlife causing death or illness. Other debris, such as six ring plastic can holders, can entangle and kill wildlife (Allison, Chiew and McMahon, 1997).

Pathogens.

Stormwater often contains bacteria, viruses, protozoa, and parasites after coming in contact with fecal matter from wildlife, livestock, and pets. Human waste is also a common stormwater contaminant, originating from failing septic systems or combined sewer overflows. Water with high pathogen loads can contaminate shellfish beds, shutting down commercial shellfishing operations.

Pathogens in water can also impact human health, causing upper respiratory and gastrointestinal illness, skin rashes and eye and ear infections (Hathaway and Hunt, 2008). For example, in Santa Monica Bay, epidemiological researchers found that people who swam near stormwater outfalls experienced a significant increase in episodes of fevers, chills, ear discharge and vomiting over swimmers further away from the outlets (Santa Monica Bay Restoration Project, 1996).

Flooding.

The result of urban sprawl and increased impervious surface area has changed the way by which stormwater naturally behaves. In natural conditions forests and wetlands act like a sponge, absorbing stormwater. But in urban areas with vast amounts of pavement and rooftops, the stormwater has nowhere to absorb and runoff increases in both volume and velocity. This increases the risk of flash floods and overbank flooding, placing life and property in harm's way. The increased speed and volume can also carve rills and gullies into hillsides, increasing the chance of mudslides (Chester County Water Resources Authority, 2004).

Another major concern is that increases in impervious surface areas result in less surface area for groundwater recharge. As a result, streams and rivers that depend on groundwater base flow may completely dry up in periods of low precipitation. This can also affect private wells and drinking water reservoirs, exacerbating the water shortages we are already experiencing (Waterkeeper Alliance, 2009 and Minton, 2005).

The Clean Water Act and Stormwater Regulation (NPDES)

The Clean Water Act of 1972 sought to prohibit the discharge of any pollutant to waters of the United States from a point source unless authorized by a NPDES permit. Traditionally, this program was targeted toward industrial dischargers and required that technology based and/or water quality based controls be implemented to reduce or eliminate pollution entering waterways. The NPDES program affected 60,000 industrial dischargers across all 50 states and U.S. territories. For the first 15 years, the program focused on controlling pollution from drains, pipes, and other features common to the discharging industry. While effluent limitation guidelines were set for stormwater discharges from those eligible industries, stormwater was not a specific concern of the program at the time. In fact, the EPA attempted to exempt stormwater discharges from the NPDES program. This decision was rejected by the D.C. Circuit Court of Appeals in 1977 in NRDC v. Costle, 568 F.2d 1369. Following this ruling, the EPA began developing regulations to reduce pollutant loads in stormwater runoff. These rules, however, produced no significant reductions in stormwater pollution (Waterkeeper Alliance, 2009).

Despite the growing regulatory arm over point source discharges into U.S. waterways, water quality monitoring studies showed that diffuse, or non-point, sources of pollution, including drainage from urban areas and construction site runoff, were the leading causes of water body contamination. To address these concerns Congress passed the Water Quality Act in 1987, which amended the

Clean Water Act section 402(p) to include provisions that addressed stormwater discharges. Specifically, this language required municipal separate storm sewer systems (MS4s), to obtain NPDES permits. Just as in permitting industrial sources, municipal storm sewers would be required to meet technology based effluent limits, or when insufficient, implement more stringent controls to protect water quality (Waterkeeper Alliance, 2009). The specific language adopted by Congress stated that MS4 discharges shall be controlled in such a way to "reduce the discharge of pollutants to the maximum extent practicable," (Clean Water Act §402(p)(3)(B)(iii)).

The definition of "maximum extent practicable," or MEP, remained ambiguously defined by Congress. Unlike the implementation of other control technology language, such as best available technology economically achievable (BAT) and best conventional pollutant control technology (BCT) that define reachable standards, MEP was left vague. As a result, the standard has resulted in unreliable and inconsistent control practices leading to negligible water quality improvement (Waterkeeper Alliance, 2009). This concern will be looked at later when addressing the findings of the National Research Council regarding urban stormwater management.

In order to implement these new stormwater requirements for municipalities, section 402(p) set forth a two-phase permitting and regulation program that would incrementally cover MS4s based on municipal population. The Phase I and Phase II components of the 402(p) stormwater requirements came online to cover the varied sources of stormwater pollution through the establishment of five-year permit terms.

The Phase I regulations went into effect on November 16, 1990 and required large and medium municipalities (those with populations exceeding 100,000) to begin implementing a stormwater management program. Also coming under the Phase I umbrella were state departments of transportation and 11 specific industrial categories identified in paragraphs (b)(14) (i) through (x) in 40 CFR 122.26. This includes hazardous waste treatment, storage and disposal facilities, landfills, recyclers, steam electric power generating facilities, transportation facilities, treatment works for domestic sewage, sludge or other wastewater. Other eligible industrial facilities are identified by Standard Industrial Classification (40 CFR 122.26).

Phase I of the NPDES stormwater program required the EPA to develop stormwater permitting regulations for MS4 discharges, including the conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) that discharge urban runoff into waters of the U.S. Phase I permitting was rolled out in two parts, allowing municipalities two years to submit their permit application. Large MS4s (those serving a population of 250,000 or more) were required to complete the application process by November 1992 and medium MS4s (those serving a population of 100,000 – 249,999) were given until May 1993. In the first part of the application the municipality was required to identify the source of pollutants entering their storm sewers. Additionally, they were required to identify known outfalls, to outline current structural controls, identify areas of expected population growth, and identify prioritized areas with a greater potential to discharge, such as industrially zoned properties (Waterkeeper Alliance, 2009).

Within a year of completing part one of the application, the MS4 was required to complete the second part of the application. Part two consisted of a more detailed discharge characterization and source identification report and a Stormwater Management Program (SWMP). In short, the purpose of the SWMP was to describe the BMPs the municipality would engage in to reduce the discharge of pollutants from its MS4 to the maximum extent practicable. This included such efforts as, but not limited to, implementing public education and participation programs, intergovernmental agreements, training and outreach programs, control and treatment practices, and new drainage design and engineering standards. Part two of the application also required a self-evaluation plan outlining the MS4's efforts to review and adjust, when needed, the success of its control practices (Waterkeeper Alliance, 2009).

On December 8, 1999, the EPA published its Phase II stormwater rules, broadening the permitting approach to apply to construction sites disturbing one acre or greater of earth and MS4s serving populations of at least 50,000 but not more than 100,000 with a population density of 1,000 people per square mile. Additionally, the Phase II rules allowed the EPA or the state NPDES permitting agency to authorize the designation of smaller MS4s if they discharge to impaired waters or may otherwise cause water quality impairments. This broader scope of stormwater permitting came to affect smaller local governments, military bases, smaller transportation departments, and large hospitals, prisons, and universities. Phase II rules also required construction sites disturbing one acre or greater of earth (or less if part of a larger plan of development) to implement BMPs under coverage of a Construction General Permit (Environmental Protection Agency, 2000).

Phase II permitting required the MS4 to develop a SWMP containing six MCMs meant to reduce stormwater pollution to the maximum extent practicable. These MCMs required the MS4 to develop provisions for the following:

1. Public education and outreach,
2. Public participation and involvement,
3. Illicit discharge detection and elimination,
4. Construction site runoff control,
5. Post-construction runoff control, and
6. Pollution prevention / good housekeeping.

Unlike Phase I permitting, the Phase II program was meant to be established using a general permit system. Essentially, the permitting agency (either EPA or state agency) would develop a general permit that outlined the mandatory Phase II requirements. The MS4 would then apply for coverage by filing a Notice of

Intent (NOI) with the permitting authority agreeing to comply with the terms and requirements of the general permit (Environmental Protection Agency, 2000).

While the general permitting process can save considerable time and resources for the permitting authority, it has created significant frustration among some permittees, environmental advocates and other concerned citizens. The reason being is that under a general permit process, the public has only limited opportunity to participate in SWMP development and permit issuance. As a result, specific concerns within a particular MS4 are often ignored or only partially addressed and therefore don't respond to the unique water quality issues within a given region (Waterkeeper Alliance, 2009). Though a 30-day public notice is typically posted for MS4 NOI submittals, the general permit remains resistant to comment incorporation. It is simply impractical to expect a national or statewide general permit to be capable of addressing unique discharges throughout diverse regional watersheds and climate patterns. Despite the fact that stormwater management needs vary drastically given the region (i.e. the Pacific Northwest vs. the arid Southwest), individual Phase II permitting remains elusive.

In addition to permitting small MS4s, Phase II rules also acted to permit small construction site activities—those disturbing one acre or greater of earth or less if part of a larger plan of development, such as individual residential lots in a subdivision. Similar to the MS4 General Permit, the EPA or the state permitting agency was required to draft a Construction General Permit (CGP) to permit stormwater discharges from construction operations. The permit outlines requirements for developing a Stormwater Pollution Prevention Plan (SWPPP) and for implementing best management practices to prevent or reduce stormwater pollutants. Prior to construction, qualifying construction operations are required to put together a SWPPP and apply for an NOI from the permitting authority. Once the construction activity has been completed, the operator must certify that soil disturbing activities have ceased and that permanent stabilization has been established by submitting a Notice of Termination (NOT), thereby terminating coverage under the CGP (Arizona Department of Environmental Quality, 2010).

The MS4 General Permit and the CGP are closely related in that construction site regulation is part of the minimum control measures, MCM #4 and MCM #5, required as part of Phase II MS4 permit requirements. While it is the job of the permitting authority to issue general permits for construction and industrial activities, and to maintain a database tracking NOI and NOT submittals, agencies typically have limited resources for compliance enforcement. Permitting authorities generally rely on the local MS4 to enforce the compliance requirements of the stormwater program. The MS4 is required then to establish a regulatory program as outlined in its Stormwater Management Plan, including authoring necessary regulations, codes or ordinances granting the MS4 regulatory authority and jurisdiction (Arizona Department of Environmental Quality, 2010).

Under the NPDES program, general permits expire and require reissuance every five years. Currently, many municipalities and permitting agencies are on their second or third cycle of stormwater permitting. It is common for permit conditions to become more stringent in each subsequent cycle, requiring municipalities to analyze the efficacy of their stormwater monitoring strategies. A major criticism of the program to this point is its reliance on BMPs to reduce stormwater pollution rather than numeric effluent limits. It is likely that as the NPDES program continues to evolve that stormwater discharges will have to meet numeric effluent limits based on water body waste load allocations, also known as the Total Maximum Daily Load (TMDL). This is a trend already witnessed in more progressive jurisdictions (Waterkeeper Alliance, 2009).

History of the AZPDES Stormwater Program

As of the year 2000 the state of Arizona did not have primacy to administer the NPDES permit program. At the time, it was one of only six states in the country to not have primacy, meaning the EPA assumed statewide control of NPDES, controlling the affected entities within the state at the federal level. In order for Arizona to assume control of the program at the state level, it had to secure program approval from the EPA by demonstrating it had the appropriate statutory authority to proctor the program. Once the state of Arizona could demonstrate such authority it could enter in to a Memorandum of Agreement (MOA) with the EPA outlining how the program will be managed (Greenway, 2004).

In February 2000, the Arizona Department of Environmental Quality (ADEQ) established a NPDES Rules Subcommittee, forming seven working groups to review and discuss the federal rules in place regarding stormwater from municipal, industrial and construction discharges, pretreatment, sewage sludge/biosolids and general and individual permitting. In October 2000, ADEQ initiated a NPDES steering committee consisting of various stakeholder groups to begin developing the components of their program submittal package. In December 2000, EPA Region 9 reviewed the existing statutory authority in the state and found that it did not currently contain the components necessary to effectively implement the NPDES program. To address these deficiencies, ADEQ, with insight from the NPDES steering committee and rules subcommittee, collaborated to develop House Bill (HB) 2426. The bill passed in the 2001 legislative session, becoming effective August 9, 2001, and thereby creating the Arizona Pollutant Discharge Elimination System (AZPDES) program—Article 3.1, Title 49 in the Arizona Revised Statues. With sufficient statutory authority established, ADEQ and EPA Region 9 drafted an MOA with provisions for permit transference, application review, enforcement and MOA modification (Greenway, 2004).

On December 5, 2002, the AZPDES administrative rules became effective for stormwater discharges and facility point source discharges into navigable waters. This excludes discharges on tribal lands, which remain the jurisdiction of the EPA (Arizona Department of Environmental Quality, 2010). Essentially, the rules adopted by reference language from the Code of Federal Regulations (CFR) regarding NPDES program standards and permitting authority. Based on 40 CFR 122 and 40 CFR 124, ADEQ could exercise AZPDES authority to grant individual and general permits to address water quality issues throughout the state of Arizona (Greenway, 2004).

With delegated authority, ADEQ was authorized to begin issuing individual and general permits as part of the AZPDES program. It is important to note that discharges other than stormwater also fall under AZPDES including, de minimus discharges and Concentrated Animal Feeding Operations (CAFO). Those permits regarding stormwater specifically and issued by ADEQ include the small MS4 General Permit, the Multi Sector General Permit (MSGP) and the CGP. The Arizona MSGP, which regulates stormwater discharges from industrial sources, has been administratively continued from the EPA MSGP issued in the year 2000. ADEQ has yet to reissue the MSGP, though plans to publish a mining and non-mining MSGP sometime in 2010 (Arizona Department of Environmental Quality, 2010).

The National Research Council

The full effect of Phase I and Phase II Stormwater permitting and subsequent regulation expanded the NPDES program significantly. The EPA estimates that the number of permittees covered by the stormwater program exceeds 500,000 entities. Managing such a volume of sources in addition to ensuring that each maintains regulatory compliance is a time and resource intensive process. Given the often lack of said resources, stormwater compliance is largely dependent on self-reporting. In general, permittees file for coverage under a general permit and develop a set of BMPs (referred to in the report as stormwater control measures or SCMs) as part of either a SWPPP or a SWMP. In cases where oversight is limited, the permittee is expected to monitor the performance of their BMPs to ensure they are properly maintained and functioning to reduce and/or prevent stormwater pollution. If the permittee should find that their chosen BMPs are not sufficient to adequately control stormwater discharges, they are required to implement more stringent controls (National Research Council, 2007).

Despite this massive effort to clean up stormwater in the United States, water body impairment remains high (National Research Council, 2007). An impaired water is one that fails to reach the water quality standards described in section 303(d) of the CWA (Environmental Protection Agency, 2011a). Recognizing that stormwater is a major contributor to water quality impairment and that increases in population and urbanization are inevitable (and consequently the leading contributors to stormwater pollution) the EPA requested that the NRC evaluate its current stormwater permitting program and provide suggestions for improvement. The basic logic being: if the program isn't working now, it is not going to work as urbanization expands. Addressing the program's shortcomings sooner rather than later is the only logical strategy for improvement (National Research Council, 2007). Refer to Table 2 for the number of impaired waters per state or US territory. Refer to Table 3 for a list of the main causes of impairment in US waterbodies.

Table 2. Impaired waters by State (Environmental Protection Agency, 2010).

State Name	Number of Waters on 303(d) List	State Name	Number of Waters on 303(d) List
Alabama	200	Florida	827
Alaska	32	Georgia	281
American Samoa	44	Guam	54
Arizona	84	Hawaii	311
Arkansas	224	Idaho	1,057
California	691	Illinois	1,058
Colorado	198	Indiana	1,836
Connecticut	408	Iowa	278
Delaware	101	Kansas	1,333
District Of Columbia	27	Kentucky	1,089
Louisiana	250	Ohio	267
Maine	206	Oklahoma	743
Maryland	501	Oregon	1,397
Massachusetts	837	Pennsylvania	6,957
Michigan	2,352	Puerto Rico	166
Minnesota	1,144	Rhode Island	141
Mississippi	197	South Carolina	1,060
Missouri	204	South Dakota	168
Montana	665	Tennessee	900
N. Mariana Islands	71	Texas	651
Nebraska	177	Utah	118
Nevada	181	Vermont	131
New Hampshire	1,089	Virgin Islands	77
New Jersey	745	Virginia	2,534
New Mexico	187	Washington	2,419
New York	491	West Virginia	981
North Carolina	902	Wisconsin	593
North Dakota	247	Wyoming	106
			Total: 39,988 impaired waters

Table 3. Causes of Impairment (Environmental Protection Agency, 2010).

Cause of Impairment Group Name	Number of Causes of Impairment Reported
Pathogens	10,767
Metals (other than Mercury)	7,450
Nutrients	6,841
Organic Enrichment/Oxygen Depletion	6,511
Sediment	6,251
Polychlorinated Biphenyls (PCBs)	6,178
Mercury	3,771
pH/Acidity/Caustic Conditions	3,714
Cause Unknown - Impaired Biota	3,332
Turbidity	3,064
Temperature	3,038
Pesticides	1,798
Salinity/Total Dissolved Solids/Chlorides/Sulfates	1,750
Cause Unknown	1,238
Noxious Aquatic Plants	981
Habitat Alterations	699
Dioxins	549
Toxic Organics	459
Algal Growth	449
Ammonia	356
Toxic Inorganics	350
Total Toxics	318
Other Cause	222
Oil and Grease	155
Taste, Color and Odor	115
Flow Alteration(s)	109
Trash	57
Fish Consumption Advisory	56
Biotoxins	53
Radiation	44
Chlorine	34
Nuisance Exotic Species	29
Cause Unknown - Fish Kills	12
Nuisance Native Species	3

Upon its evaluation, the NRC found multiple issues with the implementation of the current stormwater program. The NRC describes them as follows:

> First, there is limited information available on the effectiveness and longevity of many SCMs, thereby contributing to uncertainty in their performance. Second, the requirements for monitoring vary depending on the regulating entity and the type of activity. For example, a subset of industrial facilities must conduct "benchmark monitoring" and the results often exceed the values established by EPA or the states, but it is unclear whether these exceedances provide useful indicators of potential water quality problems. Finally, state and local stormwater programs are plagued by a lack of resources to review stormwater pollution prevention plans and conduct regular compliance inspections. For all these reasons, the stormwater program has suffered from poor accountability and uncertain effectiveness at improving the quality of the nation's waters (National Research Council, 2007, pp. 1-2).

Perhaps one of the biggest challenges to overcome is the overall infrastructure of stormwater management. Stormwater quality regulations have only been in place for roughly 20 years, which is relatively late in the overall development of urban areas. Up to this point, the laws regarding stormwater control have been geared towards flood management and that of directing water away from structures and cities as quickly as possible. As such, the laws in place that are meant to better improve stormwater quality are often in conflict with the state and local rules, which are primarily written for flood control. The result is an entire urban infrastructure built to move stormwater into receiving waters at high velocities and high volumes with little regard for stormwater quality treatment. The NRC and many prior investigations found that stormwater discharges are best regulated through land use restrictions and limitations on both the quantity and quality of stormwater runoff distributed into surface waters. This finding is certainly in contradiction to the current methods of control and lends to the not so surprising fact that polluted stormwater remains a major contributor to water body impairment. Compounding the problem further is that in many local governments land use planning and stormwater management programs are separate agencies with limited partnership (National Research Council, 2007).

As a means to begin remedying the old and ineffectual practices of stormwater management the NRC suggests an overall change to the regulatory permitting requirements. The new permitting approach would manage all stormwater and wastewater discharges on the basis of watershed boundaries rather than municipal jurisdiction. This watershed-based permit would be issued to a municipal lead permittee that would work in partnership with the other municipalities in the watershed as co-permittees. The NRC believes that this approach will help to centralize authority over stormwater management while providing co-permittees with more responsibility and funding to manage discharging activities (National Research Council, 2007).

Stormwater Management in the Maricopa County Region

Stormwater management in the Maricopa County region faces many of the challenges described in NRC's nationwide assessment of urban stormwater management. Additionally, it is climate, geography and county designations supply additional impediments to effective stormwater management. The state of Arizona has six of the largest twenty-five counties by landmass in the U.S., eclipsed in frequency only by Alaska. Maricopa County ranks 21st on that list with a land area of 9,203.14 square miles. Maricopa County is the fourth most populated county in the U.S. with a population of 4,023,132 (U.S. Census Bureau, 2010). The density of this population has resulted in the establishment 24 unique MS4s, four of which are classified as non-traditional MS4s. The resultant stormwater permitting infrastructure requires twenty municipal MS4s to develop and maintain stormwater management programs is the region.

Maricopa County, acting as a municipality, is required to manage stormwater in those urbanized regions not yet annexed by a city or town, resulting in "County Islands" present throughout the entire 9,203 square mile landmass of the County (refer to Appendix A). The burden that this type of approach has placed on municipalities, stakeholders and private citizens was briefly discussed in Chapter One. Of specific concern is the redundant duplication of efforts the current implementation strategy encourages. For example, each municipality was required to develop an enforceable ordinance to regulate stormwater within their jurisdiction. Table 4 lists these ordinances.

There are 19 ordinances regulating stormwater in the

Table 4. Stormwater Ordinances by Municipality in Maricopa County

Apache Junction	Apache Junction City Code: Chapter 5, Articles 1 and 2, Floodplain and Stormwater Standards.
Arizona State University	Erosion and Sediment Control/Grading Policy
Avondale	Avondale, Arizona, Code of Ordinances: Chapter 8, Article II, Stormwater Quality Protection.
Chandler	Chandler, Arizona, Code of Ordinances: Part VII, Chapter 45, Storm Drainage Requirements.
El Mirage	Storm Water Ordinance No. O06-07-12
Fountain Hills	Town of Fountain Hills Ordinance 03-13
Gilbert	Town of Gilbert Code of Ordinances: Article III, Pollution Prevention.
Glendale	Glendale, Arizona, Code of Ordinances: Part II, Chapter 18.5, Article II, Grading and Drainage and Part II, Chapter 31, Article II, Subdivisions.
Goodyear	City of Goodyear Storm Water Pollution Elimination Ordinance Article 16-7.
Litchfield Park	Illegal Dumping/Illicit Discharge Ordinance 05-104, Chapter 9 Construction Runoff Control Ordinance, Chapter 14.
Maricopa County	Maricopa County Stormwater Quality Management and Discharge Control Regulation.
Mesa	Stormwater Pollution Control Ordinance (Title 8, Chapter 5 of the Mesa City Code).
Paradise Valley	Paradise Valley Town Code: Subdivision Articles 6-3, Safety, Health, Sanitation & Nuisance Articles 8-3 and Sanitary Sewers Articles 15-1 and 15-2.
Peoria	Peoria City Code: Chapter 20, Planning and Development and Chapter 25, Water, Sewers and Sewage Disposal.
Phoenix	Phoenix, Arizona, Code of Ordinances: Part II, Chapter 32C, Stormwater Quality Protection.
Scottsdale	Scottsdale, Arizona, Code of Ordinances: Volume II, Chapter 37, Floodplain and Stormwater Regulation and Article III, Division I, Stormwater Quality Protection.
Surprise	Surprise Code of Ordinances: Chapter 117, Stormwater Management.
Tempe	Tempe City Code: Chapter 12 Article IV, Storm Water Retention, §§ 12-56—12-100, Article V, Storm Water System Extension Policy, §§ 12-101—12-105 Article VI, Storm Water Pollution Control, §§ 12-115—12-152.
Tolleson	Tolleson Municipal Code: Chapter 7, Building Article 7-13 Storm Water Pollution Prevention.

Maricopa County region. And given that they are all authored by different cities and lawyers, with minimal (if any) collaboration with neighboring MS4s, the requirements of each ordinance differ despite the overall goals being the same. Stakeholders and other parties subject to these regulations operating throughout the Maricopa County region must be familiar with the specific municipal codes in order to be compliant. This is a significant burden for operators of linear projects (such as utilities or DOTs) whose projects may extend through multiple municipal boundaries. Stormwater compliance would have to meet State requirements as well as the requirements of each eligible MS4, which may include additional fees, permitting and plan review (see Table 5).

As will be described later, the Maricopa County urbanized region is essentially one large MS4 and the establishment of 19 ordinances is not only expensive and duplicative, but unneeded. A single entity, given proper statutory authority, could regulate the region with equal effectiveness operating under a single ordinance. This will drastically reduce the aforementioned redundancies.

Table 5. Utilities and Fees of MS4s in the Maricopa County Region.

MS4	Phase	Utility	Total Fees
Avondale	II	No	Plan review: $375/sheet
Chandler	II	No	Plan review: $440/sheet Inspection fee: $50/hr: 1hr minimum
Gilbert	II	No	Plan review: $295/sheet up to 20 sheets, $150/sheet for 21+ sheets.
Glendale	I	No	Plan review: $315.57/sheet/review

MS4	Phase	Utility	Total Fees
Goodyear	II	No	Plan review: $150/sheet/review (3 sheets minimum) Permit fee: $490 + $50 + 5% of BMP costs = $540 +
Maricopa County	II	No	Pre-Construction Plan Review: $1050.00 Pre-Construction Site Inspection: $325.00 Post-Construction Plan Review: $1050.00 Post-Construction Site Inspection: $325.00
Mesa	I	$3/month (environmental fee—not specific to stormwater).	Plan review: $710/sheet
Peoria	II	$1/month	Plan review: $1000 (Master res)/$500 (Residential-Commercial Subdivision)/$350 (single commercial lot) Permit fee: 3.5% of contract price
Phoenix	I	$0.70/month	Plan review: $405/project Permit fee: $240/project
Scottsdale	I	3.667% of total water base and usage fees	Unknown
Surprise	II	$1/month	Plan review: $140 processing fee + $380/sheet Permit fee: $140 processing fee + 3% of cost
Tempe	I	Included in Water/Sewer rates	Storm drains per linear foot $2.75 Rip rap (square foot) $0.90 Storm water retention pipes per linear foot $1.15

This redundancy is experienced throughout the region, as each MS4 designs, develops and implements its Stormwater Management Program. Another example is the storm sewer system mapping requirements for each municipality. The intention of this program element is to have a complete GIS map of the storm sewer system so that discharges or spills can be accurately tracked. While these maps are being developed for each individual MS4, they have not yet been compiled to represent the urbanized region. If a discharge or spill should cross the municipal boundary, response teams would have to consult the neighboring jurisdiction to obtain flow pattern data. This is an example of each municipality following the State and Federal requirements, but failing to meet the overall intentions of the program. A regional authority, with its broader jurisdiction, would be better able to achieve the intended product of this requirement.

Chapter 3

METHODS

Research Design

The first step to developing a blueprint proposal for an urbanized regional stormwater authority in Maricopa County was to determine if it was legal to do so. To accomplish this, a thorough legal review was conducted of both federal and State language. This included 40 CFR 122, the Arizona Administrative Code (AAC) Title 18 Chapter 9, and the Arizona Revised Statutes (ARS) Title 49. Intergovernmental Agreements were also considered and a review of ARS Title 11 and the North Central Texas Council of Government's *Storm Water Cooperative Agreement Handbook* was used as guidance.

In order to get an understanding of the costs associated with implementing a Stormwater Management Program at the municipal level a review of municipal budgeting was required. The city and town budgets were reviewed for the following municipalities: City of Apache Junction, City of Avondale, City of Chandler, City of El Mirage, City of Glendale, City of Goodyear, City of Litchfield Park, City of Mesa, City of Peoria, City of Phoenix, City of Scottsdale, City of Surprise, City of Tempe, City of Tolleson, Maricopa County, Town of Fountain Hills, Town of Gilbert, Town of Guadalupe, Town of Paradise Valley, Town of Youngtown. A review of EPA's *Economic Analysis of the Final Phase II Storm Water Rule* was also conducted to supplement cost data.

The development of a regional stormwater program is rooted in Integrated Urban Stormwater Management (IUSM) strategies. Therefore, IUSM concepts were reviewed and applied to the proposal of an urbanized regional stormwater program in the Maricopa County region. To learn the benefits and shortcomings of regional stormwater management, a nationwide assessment was performed to analyze regional stormwater programs already in existence. This included: The Stormwater Management Joint Task Force, The Stormwater Quality Management Committee, The Northeast Ohio Regional Sewer District, The Truckee Meadows Watershed Committee, Wake County, North Carolina, The Rouge River National Wet Weather Demonstration Project, The South County Storm Water Quality Coalition in Texas, The Northern Kentucky Regional Storm Water Program, The Regional Management Program, The Western New York Stormwater Coalition, The North Central Texas Council of Governments Regional Storm Water Management Program, Yakima County, Washington, and Stormwater Outreach for Regional Municipalities of Arizona. Program elements were reviewed and considered for implementation—including an analysis of potential cost savings—into the design of a regional stormwater program in Maricopa County.

To gain a better understanding of the municipal structure and MS4 design in Maricopa County a geographical review was conducted. This included a mapping analysis of Arizona watersheds, Maricopa County municipal jurisdictions, the Maricopa County street grid, and the Maricopa County storm sewer system.

The proposal of a functioning regional stormwater program required a clearly defined organization hierarchy. To develop a hierarchy consistent with other County programs, the organizational structure of the Maricopa County Air Quality Department, the Maricopa County Planning and Development Department and the Maricopa County Environmental Services Department was reviewed.

Chapter 4

RESULTS AND DISCUSSION

Legal Review

The first step in considering an urbanized regional stormwater authority in Maricopa County was to determine if it was legal to do so. 40 CFR 122.26 outlines the specific permitting requirements relative to stormwater discharges. The following passage was taken from 40 CFR 122.26 and discusses the possibility of issuing system-wide discharge permits—a concept that is vital to implementing an urbanized regional stormwater program. Portions of the code below have been underlined to illustrate the language that is supportive of a regional stormwater permitting infrastructure.

> The Director may designate discharges from municipal separate storm sewers on a system-wide or jurisdiction-wide basis. In making this determination the Director may consider the following factors:
>
> (A) The location of the discharge with respect to waters of the United States as defined at 40 CFR 122.2.
>
> (B) The size of the discharge;
>
> (C) The quantity and nature of the pollutants discharged to waters of the United States; and
>
> (D) Other relevant factors.
>
> (2) The Director may not require a permit for discharges of storm

water runoff from the following:

(i) Mining operations composed entirely of flows which are from conveyances or systems of conveyances (including but not limited to pipes, conduits, ditches, and channels) used for collecting and conveying precipitation runoff and which are not contaminated by contact with or that have not come into contact with, any overburden, raw material, intermediate products, finished product, byproduct, or waste products located on the site of such operations, except in accordance with paragraph (c)(1)(iv) of this section.

(ii) All field activities or operations associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities, including activities necessary to prepare a site for drilling and for the movement and placement of drilling equipment, whether or not such field activities or operations may be considered to be construction activities, except in accordance with paragraph (c)(1)(iii) of this section. Discharges of sediment from construction activities associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities are not subject to the provisions of paragraph (c)(1)(iii)(C) of this section.

(3) *Large and medium municipal separate storm sewer systems.* (i) Permits must be obtained for all discharges from large and medium

municipal separate storm sewer systems.

(ii) The Director may either issue one system-wide permit covering all discharges from municipal separate storm sewers within a large or medium municipal storm sewer system or issue distinct permits for appropriate categories of discharges within a large or medium municipal separate storm sewer system including, but not limited to: all discharges owned or operated by the same municipality; located within the same jurisdiction; all discharges within a system that discharge to the same watershed; discharges within a system that are similar in nature; or for individual discharges from municipal separate storm sewers within the system.

(iii) The operator of a discharge from a municipal separate storm sewer which is part of a large or medium municipal separate storm sewer system must either:

(A) Participate in a permit application (to be a permittee or a co-permittee) with one or more other operators of discharges from the large or medium municipal storm sewer system which covers all, or a portion of all, discharges from the municipal separate storm sewer system;

(B) Submit a distinct permit application which only covers discharges from the municipal separate storm sewers for which the operator is responsible; or

(C) A regional authority may be responsible for submitting a permit application under the following guidelines:

(*1*) The regional authority together with co-applicants shall have authority over a storm water management program that is in existence, or shall be in existence at the time part 1 of the application is due;

(*2*) The permit applicant or co-applicants shall establish their ability to make a timely submission of part 1 and part 2 of the municipal application;

(*3*) Each of the operators of municipal separate storm sewers within the systems described in paragraphs (b)(4) (i), (ii), and (iii) or (b)(7) (i), (ii), and (iii) of this section, that are under the purview of the designated regional authority, shall comply with the application requirements of paragraph (d) of this section.

(iv) One permit application may be submitted for all or a portion of all municipal separate storm sewers within adjacent or interconnected large or medium municipal separate storm sewer systems. The Director may issue one system-wide permit covering all, or a portion of all municipal separate storm sewers in adjacent or interconnected large or medium municipal separate storm sewer systems.

(v) Permits for all or a portion of all discharges from large or medium municipal separate storm sewer systems that are issued on a system-wide, jurisdiction-wide, watershed or other basis may specify different conditions relating to different discharges covered by the permit, including different management programs for different drainage areas which contribute storm water to the system. (vi) Co-permittees need only comply with permit conditions relating to discharges from the municipal separate storm sewers for which they are operators.

It is important to note that this description of stormwater permitting applies to designated small MS4s as well, as outlined in 40 CFR 122.32. Regarding the development of an urbanized regional stormwater program, the code language makes two clear distinctions that favor such a concept: 1) permits may be issued on a system-wide basis; and 2) it is possible to have multiple permittees working together as co-permittees to comply with the conditions of a given permit. The next step is to determine if a given urbanized region (in this case Maricopa County) can be looked at as one system. To do so, it is important to consider the following definitions:

> 40 CFR 122.26 (b)(8): *Municipal separate storm sewer* means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):
>
> 40 CFR 122.26 (b)(18) *Municipal separate storm sewer system*

> means all separate storm sewers that are defined as "large" or "medium" or "small" municipal separate storm sewer systems pursuant to paragraphs (b)(4), (b)(7), and (b)(16) of this section, or designated under paragraph (a)(1)(v) of this section.

Based on these definitions it is clear that the designation of a storm sewer is much more ambiguous than that of a sanitary sewer. A storm sewer is not confined to a system of underground pipes or conveyances. It is much broader, including roads, municipal streets, ditches and gutters. In the broadest sense, any area that drains, directs and or captures stormwater can be considered part of the MS4. Therefore, to determine if the entire urbanized region of Maricopa County can be considered as a system-wide MS4, it would have to be determined that the MS4 in each municipal jurisdiction within the region is somehow interconnected. Basic mapping can help with this determination.

Appendix C displays the location of each of the designated municipal MS4s in the Maricopa County region, including those portions of the urbanized unincorporated areas of Maricopa County that have been permitted to discharge stormwater under the AZPDES program. Municipalities that have not yet been required to obtain stormwater permitting are also displayed as an attempt to demonstrate the density of urbanization located throughout the region.

Additionally, Appendix E displays the general street grid of the region, showing the interconnectivity of all the municipalities. This demonstration is key to considering a system-wide designation for stormwater permitting, as a municipal separate storm sewer includes roads and municipal streets.

Appendix D is a preliminary storm sewer map of the urbanized areas of Maricopa County and shows the major flood control structures that intersect the region. Again, it is clear that the overall system is interconnected and does not sever given its crossing of jurisdictional boundaries. Drainage is continuous.

Appendices F and G are critical to the consideration of issuing a permit based on watershed—a concept championed by the NRC but beyond the scope of this proposal. It should be noted that the Maricopa County urbanized region resides in the Middle Gila Watershed. Hypothetically, a stormwater discharge permit issued for the watershed would very much resemble one issued for the Maricopa County urbanized region.

While it seems clear that the Maricopa County urbanized region might be considered a system-wide storm sewer based on federal law, it is also necessary to determine if the same is true under Arizona State Law. The Arizona Administrative Code defines a municipal separate storm sewer system as follows:

> R18-9-A901 (A)(23). "Municipal separate storm sewer system" means all separate storm sewers defined as "large," "medium," or "small" municipal separate storm sewer systems or <u>any municipal separate storm sewers on a system-wide or jurisdiction-wide basis as determined by the Director under R18-9-C902(A)(1)(g)(i) through (iv).</u>

Based on this definition, it is still the Director's discretion to determine municipal separate storm sewers on a system-wide basis. One way to do so is to consider an individual permit, as stated below:

> R18-9-C902. Required and Requested Coverage Under an Individual Permit
>
> **A.** Individual permit requirements.
>
> 1. The Director may require a person authorized by a general permit to apply for and obtain an individual permit for any of the following cases:
>
> a. A discharger or treatment works treating domestic sewage is not in compliance with the conditions of the general permit;
>
> b. A change occurs in the availability of demonstrated technology or practices for the control or abatement of pollutants applicable to the point source or treatment works treating domestic sewage;
>
> c. Effluent limitation guidelines are promulgated for point sources covered by the general permit;
>
> d. An Arizona Water Quality Management Plan containing requirements applicable to the point sources is approved;
>
> e. Circumstances change after the time of the request to be covered so that the discharger is no longer appropriately controlled under

the general permit, or either a temporary or permanent reduction or elimination of the authorized discharge is necessary;

f. Standards for sewage sludge use or disposal are promulgated for the sludge use and disposal practices covered by the general permit; or

g. If the Director determines that the discharge is a significant contributor of pollutants. When making this determination, the Director shall consider:

i. The location of the discharge with respect to navigable waters,

ii. The size of the discharge,

iii. The quantity and nature of the pollutants discharged to navigable waters, and

iv. Any other relevant factor.

The Arizona Administrative Code refers to the Code of Federal Regulations for individual permit requirements. Specifically, R18-9-B901 refers to the individual permit requirements outlined in 40 CFR 122.26, 40 CFR 122.33 and 40 CFR 122.34.

R18-9-B901. Individual Permit Application

A. Time to apply.

1. Any person who owns or operates a facility covered by R18-9-A902(B) or R18-9-A902(C), shall apply for an AZPDES

individual permit at least 180 days before the date of the discharge or a later date if granted by the Director, unless the person:

a. Is exempt under R18-9-A902(G);

b. Is covered by a general permit under Article 9, Part C of this Chapter; or

c. Is a user of a privately owned treatment works, unless the Director requires a permit under 40 CFR 122.44(m).

2. Construction. Any person who proposes a construction activity under R18-9-A902(B)(9)(c) or R18-9-A902(B)(9)(d) and wishes coverage under an individual permit, shall apply for the individual permit at least 90 days before the date on which construction is to commence.

3. Waivers.

a. Unless the Director grants a waiver under 40 CFR 122.32, a person operating a small MS4 is regulated under the AZPDES program.

b. The Director shall review any waiver granted under subsection (A)(3)(a) at least every five years to determine whether any of the information required for granting the waiver has changed.

B. Application. An individual permit applicant shall submit the following information on an application obtained from the Department. The Director may require more than one application from a facility depending on the number and types of discharges or outfalls.

1. Discharges, other than stormwater.

a. The information required under 40 CFR 122.21(f) through (l);

b. The signature of the certifying official required under 40 CFR 122.22;

c. The name and telephone number of the operator, if the operator is not the applicant; and

d. Whether the facility is located in the border area, and, if so:

i. A description of the area into which the effluent discharges from the facility may flow, and

ii. A statement explaining whether the effluent discharged is expected to cross the Arizona-Sonora, Mexico border.

2. Stormwater. In addition to the information required in subsection (B)(1)(c) and (B)(1)(d):

a. For stormwater discharges associated with industrial activity, the application requirements under 40 CFR 122.26(c)(1);

b. For large and medium MS4s, the application requirements under 40 CFR 122.26(d);

c. For small MS4s:

i. A stormwater management program under 40 CFR 122.34, and

ii. The application requirements under 40 CFR 122.33.

C. Consolidation of permit applications.

1. The Director may consolidate two or more permit applications for any facility or activity that requires a permit under Articles 9 and 10 of this Chapter.

2. Whenever a facility or activity requires an additional permit under Articles 9 and 10 of this Chapter, the Director may coordinate the expiration date of the new permit with the expiration date of an existing permit so that all permits expire simultaneously. The Department may then consolidate the processing of the subsequent applications for renewal permits

Finally, the code allows the director to consolidate permit applications, making it conceivable that stormwater management programs in the Maricopa County region do not necessitate strict jurisdictional coverage. Based on this legal review of Federal and State regulatory language, system-wide permits may be issued, permit applications may be consolidated and multiple permittees can gain coverage for stormwater discharges under a single discharge permit. Together, these tools are sufficient to design a blueprint for the establishment of an urbanized regional stormwater discharge program for the Maricopa County region.

Integrated Urban Stormwater Management

The inadequacies of stormwater management are not specific to the United States. Many countries, such as Australia, New Zealand, Ireland and Columbia have recognized the inability of the current methods for stormwater management to effectively prevent receiving water impairment. Consequently, many have begun to investigate alternative and more efficient strategies. One such idea is that of Integrated Urban Stormwater Management (IUSM) discussed in CEPA, 1993 and Sharpin, 1996. Paramount to the concept is that of recognizing urban stormwater as a resource and not as a nuisance requiring rapid conveyance and removal. Thus, the goals of IUSM are that of sustainable management focusing on flood reduction, pollution minimization, stormwater retention, urban landscape improvement and an overall reduction of drainage investments. These goals are not dissimilar to the current stormwater ideology except perhaps the placement of emphasis on harvesting and reusing rainwater and stormwater runoff locally (Brown, 2005). Just as the goals are similar, so too are the impediments. The major obstructions to implementing IUSM exist mainly at the organizational level of government oversight and regulatory control. These include the current administrative arrangements, inadequate funding for stormwater management at all levels of government, fragmented organizational responsibilities and an overall lack of legal accountability (*CEPA 1993,* Sharpin 1996).

Regional Stormwater Programs

As a means of implementing IUSM strategies in the United States, several regulated MS4s have formed coalitions to establish regionally based stormwater management programs. By no means is the following list exhaustive, however, it is meant to demonstrate the existence and precedent of real time strategies for regional stormwater management—similar to that which is being proposed here for the Maricopa County region. For example, the Stormwater Management Joint Task Force represents a cooperative effort to comply with stormwater permit requirements in the Harris County (Texas) region. To satisfy Phase I NPDES Stormwater permitting, the entities in the region including City of Houston, Harris County, Harris County Flood Control District (HCFCD) and Texas Department of Transportation (TxDOT) filed a joint permit application. On October 1, 1998, EPA Region 6 issued the permit. Though the permit expired on September 30, 2003, it remains under administrative continuance pending issuance of a renewal permit by the Texas Commission on Environmental Quality, who has since been granted NPDES primacy (Clean Water Clear Choice, 2007).

The permit requires each co-permittee to develop and implement structural and non-structural best management practices to reduce the introduction of stormwater pollutants to the MS4 from residential properties, commercial and industrial facilities and construction sites. Additionally, the co-permittees are required to prohibit illegal dumping, regulate hazardous waste disposal, promote proper pesticide, herbicide and fertilizer usage as well as monitor and analyze stormwater quality at designated outfalls. While each permittee is responsible for implementing its own program, the Joint Task Force has been successful in providing consistency, efficiency and economy in overall permit implementation and program development. In fact, the Joint Task Force has been commended by the EPA for its partnership (Clean Water Clear Choice, 2007).

Another similar coalition is the Stormwater Quality Management Committee (SQMC) in Clark County, Nevada—a community partnership that along with the Clark County Regional Flood Control District has worked to establish stormwater pollution monitoring, control and outreach programs in the Las Vegas Valley. The SQMC was issued a State NPDES permit to authorize municipal stormwater discharges to the Las Vegas Wash from the cities of Las Vegas, North Las Vegas, Henderson and Clark County. The permit has allowed a cooperative effort of stormwater monitoring involving several local agencies, including: U.S. Bureau of Reclamation, US Geological Survey, Nevada Division of Environmental Protection, City of Henderson, City of Las Vegas, Clark County Sanitation District, Southern Nevada Water Authority and Las Vegas Wash Coordination Committee. This level of coordination has streamlined resource and data sharing among permittees, thereby improving efficiency and reducing the overall costs of the monitoring program. However, the whole program is not similarly coordinated. The Illegal/Illicit Connection Detection and Elimination Program and Wet Weather and Dry Weather sampling programs are implemented individually by the local municipalities (Stormwater Quality Management Committee, 2007).

The Northeast Ohio Regional Sewer District operates a regional stormwater management program for the Cleveland Metropolitan Area, including the City of Cleveland and all or portions of 60 suburban municipalities in Cuyahoga, Summit and Lorain Counties. The District provides stormwater management services for the region by conducting pipe, culvert and stream inventories and assessments, developing Stormwater Master Plans for watersheds, conducting inspection and maintenance activities, initiating construction projects to solve flooding and erosion issues, providing NPDES Phase II compliance assistance to permitted MS4s in the regions, and developing education and technical programs (Northeast Ohio Regional Sewer District, 2010).

The Truckee Meadows Watershed Committee, a cooperative regional stormwater quality management program encompassing the City of Reno, City of Sparks, Washoe County and the Nevada Department of Transportation. This committee was initially formed in 1990 to manage the regional stormwater discharge permit issued to the region by the Nevada Division of Environmental Protection. Management authority has been obtained from the parties through an interlocal agreement (City of Reno, 2010).

Another semi-regional stormwater management program can be found in Wake County, North Carolina. Wake County administers stormwater regulations for all unincorporated areas in the region as well as for the Town of Wendell, Town of Rolesville and the Town of Zebulon through interlocal agreements. Wake County's role in administering the program includes plan review, permit issuance, construction inspections, enforcement, post construction inspections and permanent BMP maintenance (Wake County North Carolina, 2009).

The Rouge River National Wet Weather Demonstration Project in Michigan is a good example of a watershed cooperative that has been organized locally to focus on restoring the urban river system. This type of collaboration is made possible by the Michigan General Storm Water Permit. The Michigan Department of Environmental Quality (MDEQ), the Rouge Project, and Rouge communities got together and developed a watershed-based general permit for municipal storm water discharges. To encourage similar cooperation throughout the state, MDEQ subsequently developed two general permits for discharges of storm water. The Jurisdictional Storm Water General Permit outlines specific stormwater best management practices to be implemented within the jurisdiction of the permittee. The Watershed-based Storm Water General Permit addresses the same basic requirements as the Jurisdictional Storm Water General Permit but provides greater flexibility in how those requirements are selected and implemented. It also requires cooperative interaction among entities outside of the permittees jurisdiction. This cooperative approach is designed to accomplish storm water quality improvements in an entire watershed and provide benefits of cost sharing among entities (North Central Texas Council of Governments Department of Environment & Development, 2009).

The South County Storm Water Quality Coalition in Texas involves the Cities of Port Neches, Nederland, Groves, Port Arthur as well as Jefferson County and the Jefferson County Drainage District No. 7. Each of these participants submitted their Storm Water Management Programs (SWMP) together and are working cooperatively to implement the Phase II MS4 permit. In 2008, the Coalition drafted an interlocal agreement for the implementation of a regional stormwater management program. To assist with the development of the program, the Coalition contracted with a consulting firm to conduct the necessary implementation tasks outlined in the permit, including developing public education materials, facilitating public meetings to discuss program status and ordinances, performing field work such as dry weather field screening at outfalls, updating outfall inventory maps, developing a construction/post construction guidance manual, conducting municipal employee training and preparing annual reports. The costs of the program are split equally among the Coalition participants (North Central Texas Council of Governments Department of Environment & Development, 2009).

The Northern Kentucky Regional Storm Water Program is managed by the existing wastewater management agency, Sanitation District No. 1. The Program was developed to assist its 37 co-permittees (33 cities, 3 counties, and the Kentucky Transportation Cabinet) with compliance of the Kentucky Pollution Discharge Elimination System (KPDES) Phase II MS4 permit. The communities within Northern Kentucky decided that the most cost-effective and efficient approach for addressing local stormwater management requirements was to develop and implement a regional approach. This was done through the adoption of an interlocal agreement that allowed the Sanitation District No. 1 to submit a Storm Water Management Program (SWMP) to the permitting authority on behalf of its 37 co-permittees. The Program is funded by a storm water surcharge as well as plan review and inspection fees. Additionally, the interlocal agreement provided the Sanitation District No. 1 with the legal authority to prohibit illicit discharges within the region, meaning that the individual cities and counties would not have to adopt separate ordinances of their own (North Central Texas Council of Governments Department of Environment & Development, 2009).

Another regional stormwater program in Texas is the Regional Management Program encompassing the City of San Antonio, Bexar County and the San Antonio River Authority. This partnership was established through an interlocal agreement that outlined the responsibilities of each participating party. This led to the authorship of a Watershed Master Plan that set the goals, objectives, performance standards and best management practices to be implemented by the Regional Management Program. The plan also stressed the need to coordinate with existing local ordinances, state and federal laws to ensure consistency. The benefits experienced by the Program as a result of its municipal partnerships are a reduction in duplicate efforts among public entities, effective resource coordination, standardization of design, operations, and maintenance of flood control and water quality projects, a better coordinated public outreach program, integrated compliance activities and a more unified approach for seeking state and federal funding (North Central Texas Council of Governments Department of Environment & Development, 2009).

Another robust regional program is the Western New York Stormwater Coalition, consisting of 43 municipalities. The Coalition works to utilize regional collaboration to effectively and efficiently manage stormwater pollution and to maximize the use of existing resources (Erie County Department of Environment and Planning, 2010).

Yakima County, Washington has developed a Regional Stormwater Management Program to manage Phase II permit compliance efforts for the cities of Yakima, Sunnyside, Union Gap, and urbanized Yakima County. The municipalities formed an ILA under findings that a regional approach to stormwater management would reduce program costs and confusion regarding implementation practices (Regional Stormwater Management Program, 2011).

The regional concept is not an entirely new one in the Maricopa County region. STORM is a regional organization founded to promote stormwater quality education throughout the metropolitan areas of Maricopa County. Collectively, the members of STORM are able to meet their public education and outreach permit requirements by targeting audiences through radio, television and various special events. They also work together to provide permit information to the general public and the regulated community. The group is able to unify its stormwater message and by sharing costs is able to simultaneously save money while reaching a larger audience. Members include: Apache Junction, Arizona Department of Transportation, Avondale, Chandler, El Mirage, Flood Control District of Maricopa County, Fountain Hills, Gilbert, Glendale, Goodyear, Guadalupe, Luke Air Force Base, Maricopa County, Mesa, Paradise Valley, Peoria, Phoenix, Salt River Pima-Maricopa Indian Community, Scottsdale, Surprise, Tempe, Tolleson, and Youngtown. Compliance, enforcement, monitoring and inspection activities are not shared by members of the organization (Stormwater Outreach for Regional Municipalities, 2010).

Perhaps the most comprehensive regional stormwater management program reviewed is the North Central Texas Council of Governments (NCTCOG) Regional Storm Water Management Program. The NCTCOG represents a 16-county region in North Central Texas based around the metropolitan areas of Dallas and Fort Worth. In total, NCTCOG is made up of 230 member governments including 16 counties, 171 cities, and various school districts and special districts. It should be noted that not all of these members are required to implement the NPDES Stormwater program. The role of NCTCOG is to work with local governments and stakeholders to develop and implement regional strategies for addressing stormwater quality issues in the region. To facilitate this The Regional Policy Position on Managing Urban Storm Water Quality was created in 1999, providing guidance for the regional strategy by outlining the key elements for a cooperative and comprehensive regional approach to stormwater management (North Central Texas Council of Governments, 2010b). This level of cooperation is made easier by the Interlocal Cooperation Act, passed by the Texas Legislature in 1971. Section 791.001 of the Act states: “The purpose of this chapter is to increase the efficiency and effectiveness of local governments by authorizing them to contract, to the greatest possible extent, with one another and with agencies of the state.” While this Act does not grant additional government powers it does set forth the guidelines and mechanisms for successful interlocal contracting.

Despite this affinity for cooperative effort, the NCTCOG Regional Storm Water Management Program is not a true regional authority. They act in the interest of local government participation and oversight while pursuing regional strategies and development initiatives for stormwater management. While this helps to focus overall regional objectives and to act as a liaison between regulators, stakeholders and the State regulating authority, it does not eliminate duplicative efforts among municipalities. Each eligible municipality, regardless of their membership to the NCTCOG Regional Storm Water Management Program, is still required to implement their own stormwater management program following Phase I or Phase II requirements. Eliminating these redundancies is the true value of a regional authority and is the focus of the proposed Maricopa County Regional Stormwater Program (MCRSP).

The Maricopa County Regional Stormwater Program

It would be impossible for a single regional entity to oversee all aspects of stormwater management. The program is simply too robust. Crossover elements of the program such as street sweeping and household hazardous waste disposal are best handled at the individual municipal level. This is because the needed facilities, equipment (i.e. street sweepers) and infrastructure are already in place. But IDDE, mapping, construction site and industrial compliance programs should be implemented uniformly throughout the region. This is where the regional authority can be most beneficial. With this understanding it is possible to begin addressing the third objective of this study—that of developing a blueprint proposal for the establishment of a regional stormwater authority in Maricopa County. Utilizing existing AZPDES requirements as well as the program elements and management techniques of the existing regional stormwater programs reviewed as part of this study for guidance, the blueprint will outline the basic requirements of a regional permit and the overall structure of the intergovernmental agreements needed between the regional lead permittee and the affiliated co-permittees.

Permit requirements

The first requirement is that MCRSP would need to develop and apply for an individual permit from ADEQ. The permit requirements would not differ greatly from the permitting structure already in place except that it would account for multiple permittees rather than a single jurisdictional entity. It is conceivable that ADEQ could draft a regional general permit, similar to that developed by the Michigan Department of Environmental Quality. MCRSP would then apply for coverage under that general permit. A regional general permit would be of value if ADEQ found it likely that other urbanized regions throughout the state would collaborate to develop regional stormwater management programs similar to the one being proposed in the Maricopa County urbanized region. Otherwise, the individual permit is probably the best option.

Since the regional program will be made up of municipalities of varying population and required to satisfy the AZPDES program requirements for both

Phase I and Phase II MS4s, the individual permit will likely need to encompass the requirements of both phases. The exact application requirements are given in 40 C.F.R. 122.26(d) and 40 C.F.R. 122.34(b). Given that the stormwater program has already been implemented in various degrees by the eligible MS4s in the Maricopa County region, many of these requirements will have already been completed. To address this progress and to begin considering the changes in direction of stormwater management in relation to upcoming EPA rulemaking, the permit should attempt to incorporate those elements described in EPA's 2010 MS4 Permit Improvement Guide. State permit writers should already be familiar with this language. The permit must outline, at a minimum, the following conditions to be upheld by MCRSP:

1. Develop an outfall monitoring program
2. Storm sewer system mapping
3. Develop an industrial site inventory
4. Develop an industrial site inspection and compliance program,
5. Develop a public education and outreach program
6. Develop methods for public participation and involvement,
7. Develop an illicit discharge detection and elimination program
8. Develop a construction site runoff control program
9. Develop a post-construction runoff control program
10. Develop and implement strategies for pollution prevention and good housekeeping at municipal operations

The operational integrity of MCRSP will rely on its ability to regulate the region such that potential dischargers (industrial, construction, commercial, etc.) are held to the standards outlined in the regional permit. This will require the development of an ordinance or regulation and general oversight powers in order to effectively delegate responsibility among itself and its co-permittees. Understanding this needed level of authority, MCRSP and ADEQ may wish to discuss the possibility of a delegation agreement. Arizona Revised Statutes states the following regarding delegation:

> ARS 49-107. Local delegation of state authority
>
> A. The director may delegate to a local environmental agency, county health department, public health services district or municipality any functions, powers or duties which the director believes can be competently, efficiently and properly performed by the local agency if the local agency accepts the delegation and agrees to perform the delegated functions, powers and duties according to the standards of performance required by law and prescribed by the director.
>
> B. Monies appropriated or otherwise made available to the department for distribution to local agencies may be allocated or reallocated in a manner designed to assure that the recognized local activities and the delegated functions, powers and duties are

> accomplished according to the applicable standards of performance.
>
> C. The director may terminate, for cause, all or part of the delegation and reallocate all or part of any monies that may have been conditioned on the further performance of the delegated functions, powers and duties.

Delegation agreements are standard practice in the state of Arizona and the Maricopa County Environmental Services Department and the Maricopa County Air Quality Department currently hold active agreements with ADEQ. The argument at hand here is whether a delegation agreement is actually needed between the parties of MCRSP and ADEQ. While ADEQ will make the final determination regarding the necessity of entering into an agreement, one is not likely needed. Since the ARS does not prohibit government entities from entering into contracts with other parties or from passing regulation, MCRSP has the legal powers it needs to pursue its interests of regional stormwater management. Additionally, the permit should provide adequate coverage for both ADEQ and MCRSP to fulfill their respective requirements under the Clean Water Act. Given these elements, State powers do not need to be delegated.

Interlocal agreements

The Interlocal Agreement (ILA) is a commonly used contract among co-permittees under a regional stormwater management program. The ILA outlines specific services to be provided or carried out by the given jurisdiction.

Typically, the ILA is constructed in such a way as to take advantage of the resources and powers specific to the municipality and in partnership with the needs of the overall region. The ILA operates as a contract following the principles of contract law and any subsequent failures to complete the services defined in the Agreement constitutes a breach of contract (North Central Texas Council of Governments, 2009). The elements of an ILA in Arizona must consist, at a minimum, of the following:

> Intergovernmental agreements and contracts:
>
> Arizona Code § 11-952 (B). Any such contract or agreement shall specify the following:
>
> 1. Its duration;
>
> 2. Its purpose or purposes;
>
> 3. The manner of financing the joint or cooperative undertaking and of establishing and maintaining a budget therefor;
>
> 4. The permissible method or methods to be employed in accomplishing the partial or complete termination of the agreement and for disposing of property upon such partial or complete termination;
>
> 5. Any other necessary or proper matters.

The ILA is also important for identifying the day-to-day activities to be carried out by the municipality. The major provisions include: identification of parties and purposes; description of work to be performed; explanation of contract limitations; financing; administration; fiscal procedures; personnel matters; property arrangements; duration, termination and amendment; and miscellaneous provisions such as a severability clause and an indemnity or hold harmless clause (North Central Texas Council of Governments, 2009).

Co-Permittees

Ideally, all eligible MS4s in the region would agree to become co-permittees under the leadership of MCRSP. Full participation provides the best overall coverage and cost savings. Considering only the traditional MS4s in the region the co-permittees will be: Glendale, Mesa, Phoenix, Scottsdale, Tempe, Apache Junction, Avondale, Chandler, El Mirage, Fountain Hills, Gilbert, Goodyear, Guadalupe, Litchfield Park, Paradise Valley, Peoria, Surprise, Tolleson and Youngtown. The next step is to determine their responsibilities. Table 6 outlines the needed compliance elements and the primary and secondary entities responsible for their implementation.

Organization hierarchy

The general infrastructure of an urbanized regional stormwater program closely resembles the implementation of IUSM, as previously explored. The fact remains that the current practice of implementing stormwater programs nationwide provides many impediments to IUSM strategies. Therefore, it is reasonable to assume that these same impediments will need to be addressed in order to effectively design an urbanized regional stormwater program for the Maricopa County region. The dominant hindrances are varied and exist in multiple levels of organizational administration. These include areas of Structure and Jurisdiction, Leadership, and Technical Expertise (Brown, 2005). Table 7

Table 6. Responsible Parties For Regional Permit Implementation.

Compliance elements	Responsible for Implementation
Outfall monitoring	Primary: MCRSP, Secondary: co-permittees agree to allow access to monitoring sites or to assist in lease agreements if monitors must be placed on private property within the permittee's jurisdiction.
Storm sewer system mapping	Primary: MCRSP Secondary: co-permittees agree to share available mapping data and municipal infrastructure plans.
Industrial site inventory	Primary: MCRSP Secondary: co-permittees agree to provide assistance by supplying zoning data and any existing industrial inventories.
Industrial site inspection and compliance	MCRSP
Public education and outreach	Primary: MCRSP Secondary: co-permittees agree to coordinate with MCRSP for education events, such as the use of city libraries or parks. Co-permittees will also work to label storm drains: "No Dumping."
Public participation and involvement,	Primary: MCRSP Secondary: co-permittees agree to assist in participation events, such as poster contests at local schools.
Illicit discharge detection and elimination	Primary: MCRSP Secondary: co-permittees agree to handle illicit discharges through their existing environmental code compliance programs. Otherwise, it should be referred to MCRSP.
Construction site runoff control	Primary: MCRSP Secondary: co-permittees agree to provide notification to MCRSP of new building projects as they apply for building permits in the given jurisdiction.
Post-construction runoff control	MCRSP
Pollution prevention and good housekeeping at municipal operations	Each permittee will be responsible for implementing good housekeeping practices at all municipal operations.

provides a specific explanation of the impediments most commonly recognized.

Table 7. Impediments to Stormwater Management Programs (Brown, 2005).

Administrative Category	Impediments
Structure and Jurisdiction	State departments and Local agencies often operate in isolation, reinforcing jurisdictional attitudes.
	Intragovernmental departments and intergovernmental agencies have unclear responsibilities.
	Top-down intergovernmental relationships between State and Local agencies.
	Political boundaries supersede ecological boundaries.
Leadership	Stormwater remains a low political priority.
	Stormwater remains underfunded.
	Stormwater is often a subsidiary program implemented piecemeal across multiple departments.
Technical Expertise	Policy is often developed in the absence of technical experts.
	Technical experts are typically removed from working with communities.
	Urban water issues are often complex and difficult to simplify.

With this in mind, it is possible to develop an organizational hierarchy to address the varied needs of a comprehensive stormwater management program. Moreover, there isn't a need to reinvent the general layout of such a hierarchy, as there are many programs within Maricopa County that provide similar services and would subsequently operate under a similar organizational structure. Such departments include the Maricopa County Air Quality Department, the Maricopa County Planning and Development Department and the Maricopa County

Environmental Services Department. Each of these departments contains programs for planning and analysis, engineering, permitting, inspection and compliance, enforcement, finance, and public education. These programs will be essential to a fully functioning regional stormwater program. Unique to the regional stormwater program will be a liaison position to manage and facilitate intergovernmental agreements among the co-permittees operating in conjunction with the program. Appendices I and J illustrate the general organizational hierarchy and subsequent responsibilities of MCRSP. The design of the organizational hierarchy is set up to encompass both a separate department or as a program within an already existing department. The major difference between the two is that a separate department will require a director and possibly a deputy director whereas a program will require the appointment of a program manager. Throughout the nation, it is not uncommon to find stormwater programs harbored in Environmental Services Departments, Flood Control Departments or even Departments of Transportation.

Intergovernmental liaison

This is the most important office in the program and is responsible for evaluating the functions of all the divisions below it to ensure that the program as a whole is in compliance with its permit. This will include coordinating with all the other co-permitted municipalities to ensure they are continually engaged in their agreed upon activities for stormwater management and overall pollution prevention. This office will also be responsible for developing the annual report and communicating with ADEQ any comments or concerns the regional authority may have as it progresses with its Stormwater Management Plan.

Monitoring

The impact and development of the monitoring division influences the entire stormwater program by addressing managerial, regulatory and research goals. Monitoring is essential to setting water quality objectives and the determination of the effectiveness of BMPs. Monitoring allows the program to know whether it is attaining certain standards and will help allow for the assessment and remediation of deficiencies. The Monitoring Division will work to determine the following:

- performance of BMPs under normal conditions;
- pollutant control efficacy for various pollutants;
- Total Maximum Daily Load (TMDL)
- large storm event efficiency;
- small storm event efficiency;
- design variables and their impact on efficiency;
- operation and maintenance schedules to ensure efficiency over time;
- comparison studies to determine which BMPs perform best under given conditions (Environmental Protection Agency, 2002).

Additionally, Monitoring will be responsible for the maintenance of sampling equipment, such as automatic samplers, and laboratory analysis. Given the perceived number of outfall sampling required in addition to discharge samples gathered by compliance staff, it may be cost effective to develop an in house laboratory capable of testing for metals, organics, turbidity, pH, coliform, and nutrients. Additional testing may be contracted.

Engineering

The Engineering Division performs a wide variety of duties, including: review of site development plans and final property plats, technical support, stormwater planning, review of subdivision designs to ensure that construction will conform to requirements for street design, drainage, stormwater detention, grading, and erosion control, permitting for the issuance of permanent BMP permits, industrial site plan review, waivers, operation and maintenance agreements, and planning and analysis for rule writing. Additionally, engineering staff will be involved in the development of technical manuals that describe the specifications and indicated uses of specific BMP installation as well as land development tools to help developers design and construct projects that reduce the impacts of stormwater pollution.

Compliance

The Compliance Division will be responsible for conducting stormwater compliance inspections at construction sites, industrial sites and municipal operations. Staff will also take citizen complaints to investigate potential stormwater pollution concerns as well as actively participate in IDDE practices throughout the region. The role of the Compliance Division is to prevent the discharge of pollutants into storm drainage systems, eliminate, or significantly reduce outdoor pollutant sources that are likely to be washed into the storm drain system upon contact with rainfall and to eliminate illegal connections to storm drainage systems. Compliance staff will be responsible for issuing violations to those entities found to be operating outside of the prevailing regulation governing stormwater pollution control practices.

Enforcement

The Enforcement Division will be responsible for addressing CWA violations discovered by Compliance staff. To do so, they will utilize three basic enforcement actions: administrative orders, civil actions and criminal prosecutions. For those entities found to be in continual and/or significant non-compliance, Enforcement will pursue various strategies to gain compliance including: Consent Orders, Cease and Desist Orders, Orders of Abatement, Fines, Property Liens, Injunctive Relief, Permit Suspension or Revocation and/or Criminal Charges. The Enforcement Division may also participate in Alternative Dispute Resolution (ADR).

Public education

Because stormwater pollution comes from so many different activities, including those commonly performed at private residences (i.e. car washing), traditional regulatory controls will only go so far. The Public Education Division will be responsible for developing outreach materials that address the critical components of any successful stormwater program. This Division will develop a campaign to prioritize stormwater pollution concerns as they pertain to the general public, homeowners, children, construction site operators, industrial and commercial activities, and other affected entities. Part of this campaign will be to develop training opportunities for inspectors, consultants, construction workers, industrial operators and certain commercial businesses. The Division will also promote public involvement activities such as poster or mascot contests at local schools and Adopt-a-Storm Drain. It may also promote volunteer activities to help clean up the many illegal dumpsites present near the river ways in the Maricopa County region.

Mapping

Critical to any stormwater program is the mapping element. The storm sewer system map is meant to demonstrate a basic awareness of the intake and discharge areas of the system. It is needed to help determine the extent of discharged dry weather flows, the possible sources of the dry weather flows, and the particular water bodies these flows may be affecting. Topographical data will also help determine which direction water flows in a given area and can be utilized in the event of a catastrophic spill or release to determine the most advantageous area to focus cleanup efforts. The Mapping Division will also utilize GPS and GIS technologies to identify stormwater outfalls and the locations of permanent stormwater BMPs. It will be the intent of the Division to develop and maintain a comprehensive, layered stormwater map that will be available to view by all online.

To conclude, by implementing an organizational hierarchy as described, MCRSP will avoid many of the administrative impediments previously discussed. By keeping all major elements of the hierarchy within a single program or department a greater level of technical expertise is available to specifically address stormwater quality issues, rather than being parsed out among multiple agencies. Additionally, developing this organizational structure provides a clear understanding of specific leadership roles within the Program and as such, helps to demonstrate regional priorities for stormwater quality. Finally, the Intergovernmental Liaison will help to soothe the many political and jurisdictional issues that often impede upon successful stormwater management programs. This office will allow the overall program/department to operate with a collaborative and unified voice to satisfy compliance requirements and to functionally address more efficient stormwater management strategies.

Costs

The effect of stormwater regulation in the US has exacted many costs upon stakeholders, including federal, state and local agencies, construction operators, various industrial sectors and even residential and commercial property owners. Of paramount concern for the development of a proposal for a regional stormwater management program is to determine if it is cost effective to do so. To make this comparison, it is necessary to focus on the expenses of the NPDES stormwater permit requirements as they are currently implemented at municipal agencies. It is then possible to address the regional model to assess where cost savings may be realized.

Because the stormwater program is often implemented across multiple departments within a given agency, ranging from large cost operations such as program development to small incidental (and subsequently difficult to track) administrative costs, budget data is often estimated. The budget also varies significantly between municipalities. Obviously, the stormwater budgets for large municipalities such as Phoenix or Mesa is going to be greater than that of smaller municipalities like Litchfield Park or Surprise. Additionally, large municipalities often have more effective cost recovery strategies in place (such as utilities and fees) as a result of it servicing a larger population. Municipalities also frequently pair stormwater compliance practices with various other departments and divisions, including Transportation Departments, Engineering Divisions (often in multiple departments), Water and Waste Departments, Public Works Departments, Planning and Development Departments as part of building permit requirements and/or grading and drainage policies, Environmental Services Departments and Flood Control Districts.

This type of organization makes it very difficult to track accurately the cost of those activities specifically related to NPDES stormwater compliance. This is yet another example of the benefits a regional program would provide. A focused initiative and a clear understanding of actual program costs will actually promote more cost effective compliance strategies. If overall expenditures are unclear, so too are the methods that may be employed to minimize those expenditures. Appendix H outlines the stormwater budgets for many of the municipal MS4s in the Maricopa County region. Each of these MS4s would be eligible co-permittees under the proposed formation of MCRSP.

For those municipalities where budget data is unknown, the EPA estimates the annual costs of implementing the Phase II Stormwater program requirements to be $9.16 (1998 dollars) per household located within that municipality (Environmental Protection Agency, 1999). This data is displayed in Table 8.

Table 8. Estimated Expenditures For Municipal Stormwater Compliance Activities

Municipality*	Number of Households**	Estimated Costs***
City of Apache Junction	15,574	$142,657.84
City of Chandler	86,924	$796,223.84
City of El Mirage	9,416	$86,250.56
City of Litchfield Park	2,263	$20,729.08
City of Tempe (Phase I)	66,000	$604,560.00
City of Tolleson	1,959	$17,944.44
Town of Gilbert	69,372	$635,447.52
Town of Guadalupe	1,292	$11,834.72
Town of Paradise Valley	4,860	$44,517.60
Town of Youngtown	2,470	$22,625.20

*Housing information obtained from the U.S. Census Bureau (U.S. Census Bureau, 2010).

**For the purposes of this estimation, a household shall constitute an occupied housing unit.

***Costs calculated by multiplying the number of households by $9.16

Cost Savings

Capital improvements will remain the responsibility of the jurisdiction, which includes storm drain installation and improvement, infrastructure maintenance, and grading and drainage. The effect of the regional authority on the stormwater costs currently borne by permitted MS4s will be to divert the costs of compliance away from the municipality and onto the regional authority. This will save cities considerable monies by avoiding the costs associated with developing and maintaining a compliance program, including ordinance development and the hiring of specialized staff. As co-permittees, the necessary costs associated with coverage will be an equal split of the permit fees imposed by the State as well as those costs required to maintain those activities outlined in the ILA. The remaining costs of the overall program will be assumed under the regional authority, utilizing fees for service and utility user fees to enable effective cost recovery.

NCTCOG has published a brochure outlining some of the cost benefits it has experienced as a result of its regional stormwater management program. Similar cost savings can be expected with MCRSP. For example, cooperative purchasing for public education and outreach materials helps to realize the cost benefits of bulk purchasing. Purchasing a large quantity of a given item and distributing it to all regional entities helps to drive down the unit price. This avoids individual purchasing and helps to streamline the message of outreach materials. NCTCOG cites the distribution of a pet waste stormwater awareness bookmark having an individual unit price of $0.55. Cooperative pricing reduced the unit price to $0.05, providing a savings of $0.50 (North Central Texas Council of Governments, 2010a). This is significant when considering a bulk purchase of this item to be distributed regionally. Advertising efforts are also a source of cost savings when considering cooperative purchasing. For example, a particular internet banner ad cost $3,250. But through the members of NCTCOG and cooperative purchasing, the price was reduced to $250, resulting in a savings of $3,000 or 90% (North Central Texas Council of Governments, 2010a). These kinds of savings are similar to those realized locally through the members of STORM. But cooperative purchasing within STORM is limited only to public education and outreach campaigns. This is where a regional authority with broader compliance responsibilities can assert more significant cost savings throughout the entire scope of stormwater management practices.

Training is another area where savings can be experienced. By utilizing the combined expertise of member agencies, NCTCOG cites that training costs can be reduced by as much as 70%. The regional program also provides training products that can be distributed in-house for virtually no additional costs. Perhaps the greatest savings demonstrated by NCTCOG are those associated with their wet weather monitoring program. The average permittee cost for their sampling program (based on six sites with four samples per year for five years) was $821,000. As a functioning collaborative, which managed to effectively petition the permitting authority to reduce the number of required sample sites per regional participant, sampling costs were reduced to $158,000. This provided each regional participant with a savings of $663,000 (North Central Texas Council of Governments, 2010a).

Yakima County, Washington has also developed a regional stormwater program with the overall goals of reducing costs, facilitating public acceptance of

BMPs, utilizing a regionally appropriate program and streamlining the efficiency of the program through effective partnerships. By addressing these goals, the regional approach was able to realize a three-year cost savings of $800,500 and a total five-year cost savings of $5.16M over the original draft budget (Leita, 2008).

Overall cost savings are very difficult to determine given the often used ambiguous budgeting practices for stormwater management. Stormwater management is more than just NPDES compliance and is often budgeted under Capital Improvement Plans and Flood Control Districts. Understanding the exact costs associated with permit compliance activities will remain diffuse for as long as those activities remain piecemealed throughout municipal departments. One of the advantages of a regional stormwater management program is to begin streamlining compliance costs toward the measurable and successful implementation of best management practices.

Chapter 5

CONCLUSION

Summary

As evidenced by the findings of NRC's nationwide report on urban stormwater management, current control programs are failing to meet the standards outlined in the CWA. Despite large scale increases in stormwater regulation, water impairment remains high and continues to rise. This is a testament not only to the significant impact that urbanization places on water quality but also to the challenges involved in trying to minimize contaminant loading from non-point sources of pollution. To begin addressing these issues, the NRC recommends a watershed based permitting approach as opposed to the current practice of population based municipal permitting. In response, the EPA has initiated new rulemaking to begin incorporating many of NRC's suggestions into future stormwater legislation. The overall intent of these changes is to steer the program toward more effective stormwater management strategies similar to those outlined in IUSM. Rather than wait for these rule changes to take effect, many municipal regions across the country have taken it upon themselves to begin voluntarily pursuing these strategies by forming regional stormwater management coalitions. Groups and regions such as the Stormwater Management Joint Task Force, Stormwater Quality Management Committee, Northeast Ohio Regional Sewer District, Truckee Meadows Watershed Committee, Rouge River National Wet Weather Demonstration Project, South County Storm Water Quality

Coalition, NCTCOG, Northern Kentucky Regional Storm Water Program, Wake County, Yakima County and others found that this approach provided a greater level of interlocal cooperation, compliance partnerships, streamlined efficiency and reporting as well as cost savings. By coordinating with State permitting authorities, developing interlocal agreements and establishing co-permitting partnerships these groups were able to pursue alternative stormwater management strategies within the existing legal framework.

With this precedent, it is possible to consider a similar implementation plan for the Maricopa County region. Stormwater management in the Maricopa County region offers some unique challenges, particularly that of being a densely populated urban area. The resultant stormwater permitting matrix requires stormwater programs for 24 individual MS4s. Maricopa County, regarded in this case as a municipality, must manage the remaining unincorporated urbanized areas, known as "County Islands." This creates a situation where Maricopa County must manage stormwater from 32 "micro-MS4s" spread throughout a County that exceeds 9,000 square miles in size. Considering that each municipality is part of an interconnected urban region, sharing streets and drainage ways, it makes sense to manage stormwater on a regional rather than individual basis. As demonstrated throughout this study, the development of a regional authority for stormwater management in the Maricopa County region can provide many benefits to the compliance efforts of those designated MS4s. Moreover, the regional program can be developed under existing law, utilizing individual permitting procedures and referencing the practices employed by similar coalitions already established in other parts of the country.

The proposed development of MCRSP relies on addressing three major components: legal clarification, organizational hierarchy and intergovernmental agreement. After reviewing the language of 40 CFR 122.26 as well as Arizona Administrative Code R18-9-A901 (A)(23), R18-9-C902 and R18-9-B901, it is clear that system-wide permits may be issued, permit applications may be consolidated and multiple permittees can gain coverage for stormwater discharges under a single discharge permit. This determination is critical to establishing a regional authority. Next, a strong organizational structure will be needed if MCRSP is to avoid many of the common impediments to effective IUSM practices. These impediments are typically experienced when the organization hierarchy fails to properly outline program structures and jurisdictions, define leadership responsibilities, and incorporate sound technical expertise throughout program implementation. To address these potential concerns, MCRSP will operate under an organizational hierarchy that includes the following departments/divisions: Director/Program Manager, Intergovernmental Liason, Monitoring, Engineering, Compliance, Enforcement, Public Education and Mapping. Finally, strong IGAs will need to be developed to effectively manage and communicate the responsibilities of the regional authority and its co-permitted partners. Considering only the traditional MS4s in the region as co-permittees, IGAs will need to be developed between MCRSP and the following cities and towns: Glendale, Mesa, Phoenix, Scottsdale, Tempe, Apache Junction, Avondale, Chandler, El Mirage, Fountain Hills, Gilbert, Goodyear, Guadalupe, Litchfield Park, Paradise Valley, Peoria, Surprise, Tolleson and Youngtown. The IGA will assign responsibility for compliance with the following elements:

1. Outfall monitoring
2. Storm sewer system mapping
3. Industrial site inventory
4. Industrial site inspection and compliance
5. Public education and outreach
6. Public participation and involvement
7. Illicit discharge detection and elimination
8. Construction site runoff control
9. Post-construction runoff control
10. Pollution prevention and good housekeeping at municipal operations

By developing a regional authority for stormwater management in Maricopa County, the duplicative practices currently engaged will no longer be necessary. The result of which will reduce redundant compliance efforts, such as code development, and relieve stakeholders from multiple permitting and plan reviews when operating cross-jurisdictionally. By establishing a single source of control in the region, eligible MS4s and affected stakeholders will benefit from a more consistent approach to BMP implementation and regulator expectations toward compliance. Additionally, this improved level of collaboration will harbor more effective communication and provide for more efficient service. And, as evidenced by the case studies performed by NCTCOG and Yakima County, help the region to realize significant cost savings when implementing NPDES compliance mechanisms.

By utilizing the program elements implemented by various regional stormwater programs throughout the nation, it was possible to develop a foundation for a regional authority in the Maricopa County region. By learning from the limitations of those programs reviewed, the establishment of MCRSP was designed to avoid those shortcomings while simultaneously addressing the legal requirements of stormwater permitting. Overall, the authority, organizational hierarchy and implementation of MCRSP represents a unique approach to managing stormwater on a system-wide basis.

Future Research

Opportunities for further study include a continued review of regional stormwater programs throughout the nation in order to gain an even greater understanding of any existing compliance and enforcement partnerships. As stormwater management is not solely limited to the United States, this study could be broadened to include an analysis of regional stormwater management programs internationally. Greater review will also help uncover potential cost saving opportunities. Moving forward with the implementation of MCRSP would require an in depth discussion with ADEQ to address any comments and concerns they may have in permitting such a program. Commissioning their input would be the next logical in realizing a regional authority for stormwater management in the Maricopa County region.

REFERENCES

Allison, Robin, Chiew, Francis & McMahon, Tom. (1997). *Stormwater Gross Pollutants*. Retrieved from Cooperative Research Centre for Catchment Hydrology website: http://www.catchment.crc.org.au/pdfs/industry199711.pdf

Arizona Department of Environmental Quality. 2009. *2006/2008 Status of Ambient Surface Water Quality in Arizona: Arizona's Integrated 305(b) Assessment and 303(d) Listing Report*. Retrieved September 27, 2010, from http://www.azdeq.gov/environ/water/assessment/assess.html

Arizona Department of Environmental Quality. 2010. *Water Quality: Permits: Stormwater*. Retrieved August 29, 2010, from http://www.azdeq.gov/environ/water/permits/stormwater.html

Aryal, Rupak, Vigneswaran, Sarvanamuthu, Kandasamy, Jaya, & Naidu, Ravi. (2010). Urban stormwater quality and treatment. *The Korean Journal of Chemical Engineering*, 27(5), 1343-1359. DOI: 10.1007/s11814-010-0387-0

Brown, Rebekah R. 2005. Impediments to Integrated Urban Stormwater Management: The Need for Institutional Reform. *Environmental Management*, 36(3), 455-468. doi: 10.1007/s00267-004-0217-4

CEPA (1993) Urban stormwater a resource too valuable to waste. Commonwealth Environment Protection Agency, Canberra, Australia.

Chester County Water Resources Authority. 2004. *Reducing Stormwater and Flooding*. Retrieved March 22, 2011 from http://dsf.chesco.org/water/lib/water/pdf/brochures/stormwater.pdf

City of Apache Junction. 2008. *City of Apache Junction, Arizona Annual Budget: Fiscal Year 2008-2009*. Retrieved from City of Apache Junction website: http://www.ajcity.net/DocumentView.aspx?DID=1018

City of Glendale. 2006. *POTW Pretreatment Annual Report*. Retrieved from City of Glendale website: http://www.glendaleaz.com/utilities/pretreatment/documents.cfm

City of Glendale. 2007. *POTW Pretreatment Annual Report*. Retrieved from City of Glendale website: http://www.glendaleaz.com/utilities/pretreatment/documents.cfm

City of Goodyear. 2006. *City of Goodyear, Arizona Amended Stormwater Management Plan*. Goodyear, AZ: City of Goodyear.

City of Mesa. 2007. *City of Mesa Storm Water Annual Report: July 2006 – June 2007*. Mesa, AZ: City of Mesa.

City of Peoria. 2010. *City of Peoria Annual Program Budget Fiscal Year 2011*. Retrieved from City of Peoria: http://www.peoriaaz.gov/uploadedFiles/Peoriaaz/Departments/Budget/FY2011CouncilBudgetWorkbook.pdf

City of Phoenix. 2009. *City of Phoenix Municipal Separate Storm Sewer System Annual Report*. Phoenix, AZ: Prepared by URS.

City of Reno. 2010. *Regional Stormwater Quality Management Program: Truckee Meadows Watershed Committee*. Retrieved October 3, 2010, from http://www.reno.gov/Index.aspx?page=366

City of Scottsdale. 2010. *City of Scottsdale, Arizona Adopted FY 2010/11 Budget: Program Operating Budget - Volume Two*. Retrieved from City of Scottsdale website: http://www.scottsdaleaz.gov/Assets/Public+Website/finance/Archive/FY+2010-11/FY_2010-11_Volume_2.pdf

City of Surprise. 2009. *City of Surprise Adopted Budget Fiscal Year 2010.* Retrieved from City of Surprise website: http://www.surpriseaz.gov/files/FY2010%20Budget%20Book.pdf

City of Tempe. 2010. *City of Tempe Annual Budget Fiscal Year 2010-2011*. Retrieved from City of Tempe website: http://www.tempe.gov/budget/FY%2010-11/COT_2010_11_Annual_Budget.pdf

Clean Water Clear Choice. 2007. *Regional Watershed Protection Program*. Retrieved September 4, 2010, from http://www.cleanwaterways.org/

Corrigan, Zachary. 2004. *Fishing for Trouble*. U.S. PIRG Education Fund. Retrieved August 7, 2010, from http://www.cleanair.org/FishingForTrouble.pdf

Environmental Protection Agency. 1999. *Economic Analysis of the Final Phase II Storm Water Rule*. Washington DC, Office of Wastewater Management US Environmental Protection Agency.

Environmental Protection Agency. 2000. *Stormwater Phase II Final Rule: An Overview*. Retrieved March 22, 2011 from http://www.epa.gov/npdes/pubs/fact1-0.pdf

Environmental Protection Agency. 2002. *Urban Stormwater BMP Performance Monitoring: A Guidance Manual for Meeting the National Stormwater*

BMP Database Requirements. Washington DC, Office of Water (4303T) US Environmental Protection Agency.

Environmental Protection Agency. 2007. *Stormwater: Frequently Asked Questions*. Retrieved September 17, 2010, from http://cfpub.epa.gov/npdes/faqs.cfm?program_id=6

Environmental Protection Agency. 2010. *Watershed Assessment, Tracking & Environmental Results.* Retrieved September 4, 2010, from http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T

Environmental Protection Agency. 2011a. *Impaired Waters and Total Maximum Daily Loads*. Retrieved March 20, 2011 from http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/index.cfm

Environmental Protection Agency. 2011b. *Stormwater Program*. Retrieved March 20, 2011 from http://cfpub.epa.gov/npdes/home.cfm?program_id=6

Environmental Quality, A.A.C. Title 18, Chapter 9 (2005). Arizona Administrative Code.

Erie County Department of Environment and Planning. 2010. *Municipal Phase II Stormwater Program*. Retrieved October 10, 2010, from http://www.erie.gov/environment/compliance/pollution_sw2.asp

Greenway, Roger, A. (2004). *How to Obtain Water Quality Permits* (pp. 121). McGraw-Hill Companies, New York, NY.

Hathaway, Jon M. & Hunt, William F. (2008). *Urban Waterways: Removal of Pathogens in Stormwater*. Retrieved from North Carolina State University College of Agriculture and Life Sciences website: http://www.bae.ncsu.edu/stormwater/PublicationFiles/PathogensSW.2008.pdf

Intergovernmental Agreements and Contracts, A.R.S. 11-952 (2007).

Interlocal Cooperation Act. 1971. Texas Legislature.

Leita, Michael D. 2008. *A Regional Stormwater Program in Yakima County: Building Partnership and Public Acceptance*. Powerpoint presentation. Yakima County Commissioner.

Maricopa County Assessor's Office. 2010. *GIS Interactive Maps*. Retrieved September 27, 2010, from http://www.maricopa.gov/Assessor/GIS/javamap.htm

Maricopa County Board of Supervisors. 2010. *Maricopa County Structure, History & Info*. Retrieved September 17, 2010, from http://www.maricopa.gov/bos/size.aspx

Maricopa County Environmental Services Department. 2010. *Stormwater Program*. Retrieved September 17, 2010, from http://www.maricopa.gov/EnvSvc/WaterWaste/StormWater/Stormwater.aspx

Maricopa County Flood Control District. 2005. *Comprehensive Plan 2005*. Retrieved September 17, 2010 from http://www.fcd.maricopa.gov/About/downloads/FCDCOMPPlan2005.pdf

Minton, G. (2005). *Stormwater Treatment: Biological, Chemical, & Engineering Principles*. Sheridan Books, Inc. Ann Arbor, Michigan.

National Research Council. (2007). *Urban Stormwater Management In the United States*. Washington DC: The National Academies Press.

Natural Resources Defense Council. 2005. *Testing the Waters 2005: A Guide to Water Quality at Vacation Beaches*. Retrieved July 31, 2010, from http://www.nrdc.org/water/oceans/ttw/ttw2005.pdf

North Central Texas Council of Governments Department of Environment & Development. 2009. *Storm Water Cooperative Agreement Handbook.* Arlington, TX. North Central Texas Council of Governments.

North Central Texas Council of Governments. 2010a. *Program Benefits: Regional Storm Water Management Program*. Retrieved October 13, 2010, from http://www.nctcog.org/envir/SEEclean/stormwater/cost_shares/benefits_brochure_final_091310.pdf

North Central Texas Council of Governments. 2010b. *Regional Storm Water Management Program*. Retrieved October 16, 2010, from http://www.nctcog.org/envir/SEEclean/stormwater/index.asp#

Northeast Ohio Regional Sewer District. 2010. *Regional Stormwater Management*. Retrieved October 3, 2010, from http://www.neorsd.org/I_Library.php?a=download_file&LIBRARY_RECORD_ID=4282

Protection of Environment, 40 C.F.R. 122 (1998).

Reese, Andrew J. (2003). *Funding Phase II Storm Water Programs*. Nashville, TN: AMEC Earth & Environmental, Inc.

Sharpin, M. (1996). *Managing urban stormwater: Strategic framework (draft)*. State Stormwater Coordinating Committee, NSW Environment Protection Authority, Sydney.

Stormwater Outreach for Regional Municipalities. 2010. *Stormwater Outreach for Regional Municipalities.* Retrieved March 26, 2011 from http://www.azstorm.org

Stormwater Quality Management Committee. 2007. Retrieved September 7, 2010, from http://www.lvstormwater.com/index.htm

The Center for Watershed Protection and Robert Pitt. (2004). *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments*. EPA Cooperative Agreement, Washington DC.

The Lawn Institute (2007). *Interesting Facts About Turf Grass*. Retrieved August 1, 2010, from http://www.thelawninstitute.org/faqs/?c=183313

The Environment, A.R.S 49-107 (2007).

Town of Fountain Hills. 2009. *Town of Fountain Hills, Arizona Fiscal Year 2010 – 2011 Adopted Budget*. Retrieved from Town of Fountain Hills website: http://www.fh.az.gov/Data/Sites/2/media/finance/budget/fy10_11_budget.pdf

Town of Gilbert. 2009. *Town of Gilbert, Arizona Annual Budget 2009 – 2010*. Retrieved from Town of Gilbert website: http://www.gilbertaz.gov/budget/pdf/operating/budget09_10b.pdf

U.S. Census Bureau. 2010. *American Fact Finder*. Retrieved March 20, 2011 from http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t

Wake County North Carolina. 2009. *Stormwater Management*. Retrieved October 10, 2010, from http://www.wakegov.com/water/stormwater/management/default.htm

Waterkeeper Alliance. (2009). *A manual for reading, understanding, and advocating for effective municipal stormwater permits in the United States*. Author, Irvington, New York.

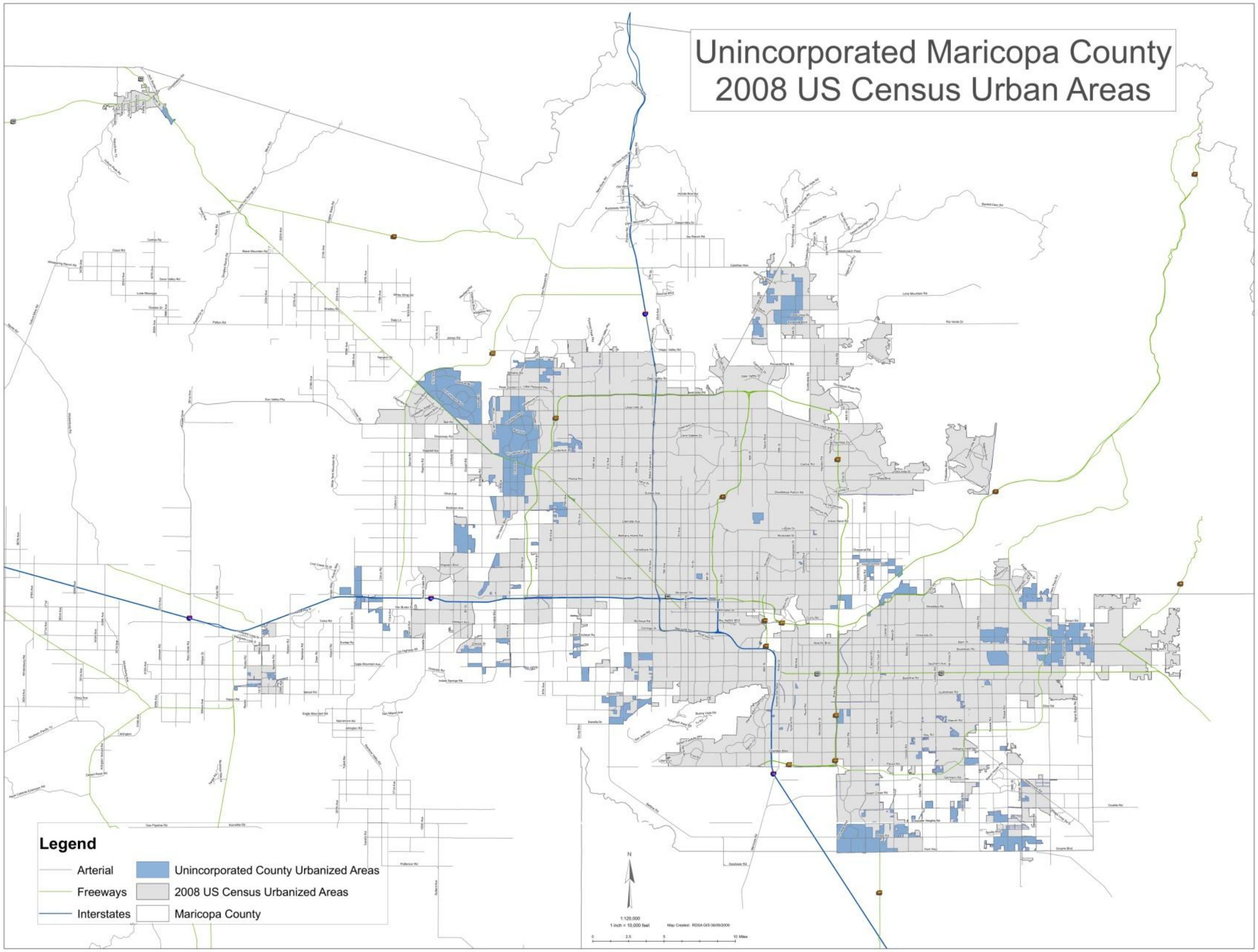
White, Stacey Swearingen and Boswell, Michael R. (2007). Stormwater Quality and Local Government Innovation. *Journal of the American Planning Association*, Vol. 73(2) 185-193.

Yakima County. 2010. *Yakima County Regional Stormwater Manual*. Retrieved from Yakima County website: http://www.yakimacounty.us/stormwater/documents/ManagementManual/Yakima%20Stormwater%20Manual.pdf

APPENDIX A

UNINCORPORATED MARICOPA COUNTY

(Maricopa County Environmental Services Departement, 2010)


Unincorporated Maricopa County
2008 US Census Urban Areas
Legend
Arterial
Freeways
Interstates
Unincorporated County Urbanized Areas
2008 US Census Urbanized Areas
Maricopa County

APPENDIX B

SURFACE WATER QUALITY STANDARDS IN THE STATE OF ARIZONA

(Arizona Department of Environmental Quality, 2009).

PARAMETER	FRACTION	DESIGNATED USE (Or Site-Specific Standard)	ACUTE OR SINGLE SAMPLE MAXIMUM CRITERIA	CHRONIC CRITERIA
Ammonia (NH_3)	Total	A&Wc/A&Ww	Varies by pH., see published standards	Varies by temperature and pH, see published standards
Arsenic (As)	Dissolved	A&Wc/A&Ww/A&Wedw A&We	360 µg/L 440 µg/L	190 µg/L NA
	Total	DWS/FBC AGL PBC FC AGI People's Canyon Creek	50 µg/L 200 µg/L 420 µg/L 1450 µg/L 2,000 µg/L 20 µg/L	NA NA NA NA NA NA
Chlorine (total residual) (Cl)	Total	A&Wc/A&Ww/A&Wedw DWS FBC/PBC	11 µg/L 700 µg/L 140,000 µg/L	5 µg/L NA NA
Copper (Cu)	Dissolved	A&Ww/A&Wc/A&We/A&Wedw	Varies by hardness*, see published standards.	Varies by hardness*, see published standards.
		Rio de Flag below WWTP outfall	36 µg/L	
	Total	AgL DWS/FBC/PBC AgI	500 µg/L 1,300 µg/L 5,000 µg/L	NA NA NA
Cyanide (Cn)	Total	A&Wc A&Ww/A&Wedw A&We AgL, DWS FBC/PBC FC	22 µg/L 41 µg/L 84 µg/L 200 µg/L 28,000 µg/L 215,000 µg/L	5.2 µg/L 9.7 µg/L NA NA NA NA
Dissolved Oxygen (DO)	Total	A&Ww A&Wc A&Wedw (In compliance is percent saturation is > 90%)	>6.0 mg/L >7.0 mg/L >3.0 mg/L (3 hours after sunrise) >1.0 mg/L (at sunset)	NA NA NA
	Total	West Fork Little Colorado Peoples Canyon Creek Cienega Creek & Bonita Creek	no decrease due to discharge	

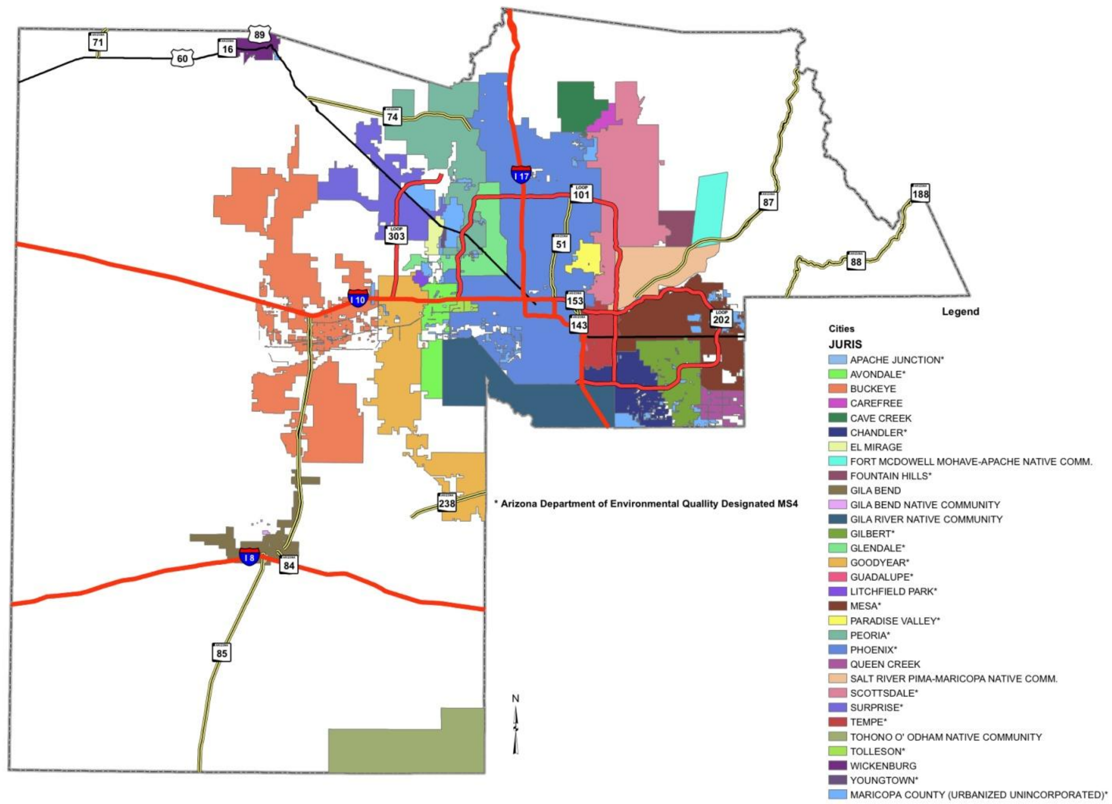
PARAMETER	FRACTION	DESIGNATED USE (Or Site-Specific Standard)	ACUTE OR SINGLE SAMPLE MAXIMUM CRITERIA	CHRONIC CRITERIA
DDE (metabolite of DDT)	Total	AgI, AgL, FC DWS A&Wc A&Ww, A&Wedw A&We FBC/PBC	0.001 0.1 1.1 µg/L 1.1 µg/L 1.1 µg/L 4.1	NA NA 0.001 0.02 NA NA
Escherichia coli	Total	FBC PBC	235 CFU/100ml 576 CFU/100ml	Geometric mean standard, using 4 consecutive samples: FBC = 126 CFU/100 ml PBC = 126 CFU/100 ml
Fluoride (F)	Total	DWS FBC/PBC	4,000 µg/L(4 mg/L) 84,000 µg/L(84 mg/L)	NA NA
Lead (Pb)	Dissolved	A&Ww/A&Wc/A&We/A&Wedw	Standard varies by water hardness*, see published standards	Standard varies by hardness*, see published standards.
	Total	DWS/ FBC/PBC AgL AgI	15 µg/L 100 µg/L 10,000 µg/L	NA NA NA
Mercury (Hg)	Dissolved	A&Wc/A&Ww A&Wedw A&We	2.4 µg/L 2.6 µg/L 5.0 µg/L	0.01 µg/L 0.2 µg/L NA
	Total	FC DWS AgL FBC/PBC	0.6 µg/L 2 µg/L 10 µg/L 420 µg/L	NA NA NA NA
Nitrate (as nitrogen) (NO3)	Total	DWS San Pedro (Curtiss-Benson) FBC/PBC	10 mg/L 10 mg/L 2,240 mg/L	NA NA NA
Nitrite/Nitrate (as nitrogen) (NO_2/NO_2)	Total	DWS	10 mg/L	NA

PARAMETER	FRACTION	DESIGNATED USE (Or Site-Specific Standard)	ACUTE OR SINGLE SAMPLE MAXIMUM CRITERIA	CHRONIC CRITERIA
Nitrite (as nitrogen)	Total	DWS FBC/PBC	1 mg/L 140 mg/L	NA NA
pH			6.5 - 9.0 5.0 - 9.0 4.5 - 9.0 Maximum change due to discharge = 0.5 No change due to discharge	
Suspended Sediment Concentration	Total		Geometric mean (4 sample minimum) 80 mg/L	
Sulfides (S2)	Total	A&W	100 µg/L(0.1 mg/L) applies only in upper layer in a lake	NA
Total Dissolved Solids (TDS)	Total	Colorado River below Hoover Dam below Parker Dam at Imperial Dam		Flow-weighted average annual 723 mg/L 747 mg/L 879g/L

APPENDIX C

MARICOPA COUNTY MUNICIPAL JURISDICTIONS

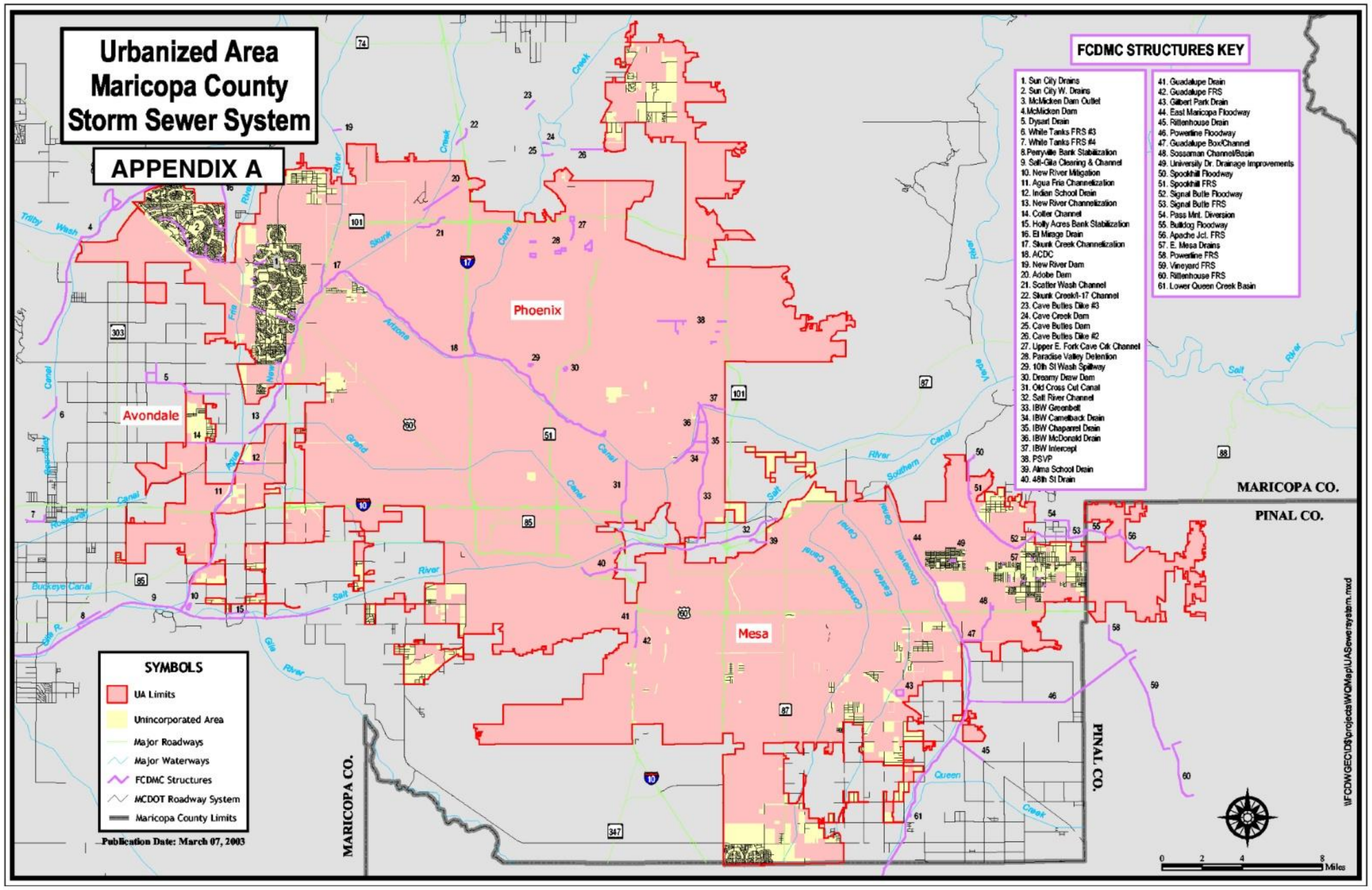
Maricopa County Municipal Jurisdictions



APPENDIX D

MARICOPA COUNTY STORM SEWER SYSTEM

(Maricopa County Flood Control District, 2005).

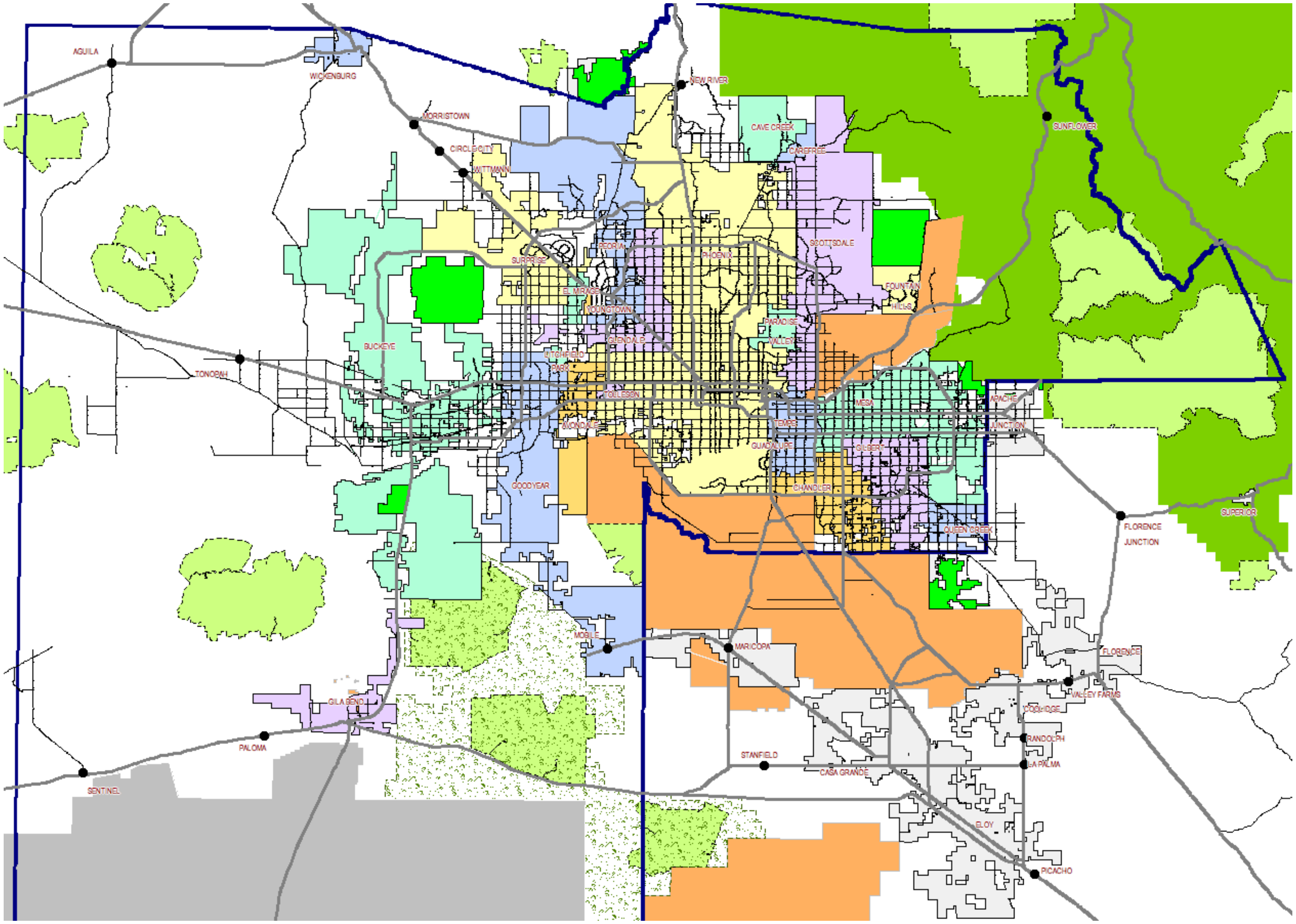


Urbanized Area
Maricopa County
Storm Sewer System
APPENDIX A
FCDMC STRUCTURES KEY
1. Sun City Drains
2. Sun City W. Drains
3. McMicken Dam Outlet
4.McMicken Dam
5. Dysart Drain
6. White Tanks FRS #3
7. White Tanks FRS #4
8.Perryville Bank Stabilization
9. Salt-Gila Clearing & Channel
10. New River Mitigation
11. Agua Fria Channelization
12. Indian School Drain
13. New River Channelization
14. Colter Channel
15. Holly Acres Bank Stabilization
16. El Mirage Drain
17. Skunk Creek Channelization
18. ACDC
19. New River Dam
20. Adobe Dam
21. Scatter Wash Channel
22. Skunk Creek/I-17 Channel
23. Cave Buttes Dike #3
24. Cave Creek Dam
25. Cave Buttes Dam
26. Cave Buttes Dike #2
27. Upper E. Fork Cave Crk Channel
28. Paradise Valley Detention
29. 10th St Wash Spillway
30. Dreamy Draw Dam
31. Old Cross Cut Canal
32. Salt River Channel
33. IBW Greenbelt
34. IBW Camelback Drain
35. IBW Chaparrel Drain
36. IBW McDonald Drain
37. IBW Intercept
38. PSVP
39. Alma School Drain
40. 48th St Drain
41. Guadalupe Drain
42. Guadalupe FRS
43. Gilbert Park Drain
44. East Maricopa Floodway
45. Rittenhouse Drain
46. Powerline Floodway
47. Guadalupe Box/Channel
48. Sossaman Channel/Basin
49. University Dr. Drainage Improvements
50. Spookhill Floodway
51. Spookhill FRS
52. Signal Butte Floodway
53. Signal Butte FRS
54. Pass Mnt. Diversion
55. Bulldog Floodway
56. Apache Jct. FRS
57. E. Mesa Drains
58. Powerline FRS
59. Vineyard FRS
60. Rittenhouse FRS
61. Lower Queen Creek Basin
Phoenix
Avondale
Mesa
MARICOPA CO.
PINAL CO.
SYMBOLS
UA Limits
Unincorporated Area
Major Roadways
Major Waterways
FCDMC Structures
MCDOT Roadway System
Maricopa County Limits
Publication Date: March 07, 2003
Miles

APPENDIX E

MARICOPA COUNTY MAJOR STREETS GRID

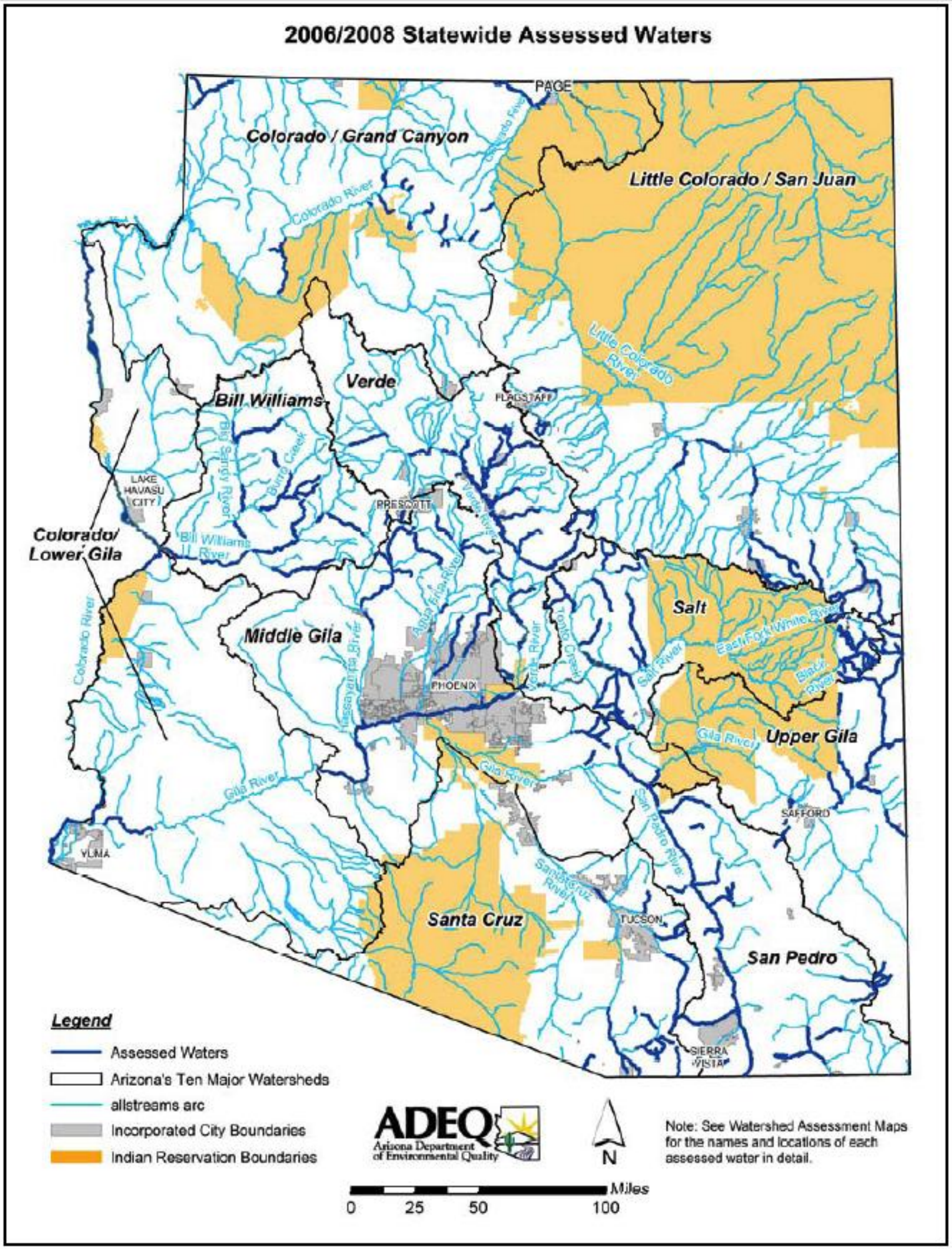
(Maricopa County Assessor’s Office, 2010).


AGUILA
WICKENBURG
MORRISTOWN
CIRCLE CITY
WITTMANN
NEW RIVER
CAVE CREEK
CAREFREE
SUNFLOWER
SURPRISE
PEORIA
PHOENIX
SCOTTSDALE
EL MIRAGE
YOUNGTOWN
FOUNTAIN
HILLS
PARADISE
VALLEY
GLENDALE
BUCKEYE
TONOPAH
LITCHFIELD
PARK
TOLLESON
MESA
APACHE
JUNCTION
AVONDALE
TEMPE
GUADALUPE
GILBERT
GOODYEAR
CHANDLER
QUEEN CREEK
SUPERIOR
FLORENCE
JUNCTION
MOBILE
MARICOPA
FLORENCE
VALLEY FARMS
COOLIDGE
GILA BEND
RANDOLPH
PALOMA
STANFIELD
LA PALMA
CASA GRANDE
SENTINEL
ELOY
PICACHO

APPENDIX F

ARIZONA WATERSHEDS

(Arizona Department of Environmental Quality, 2009).

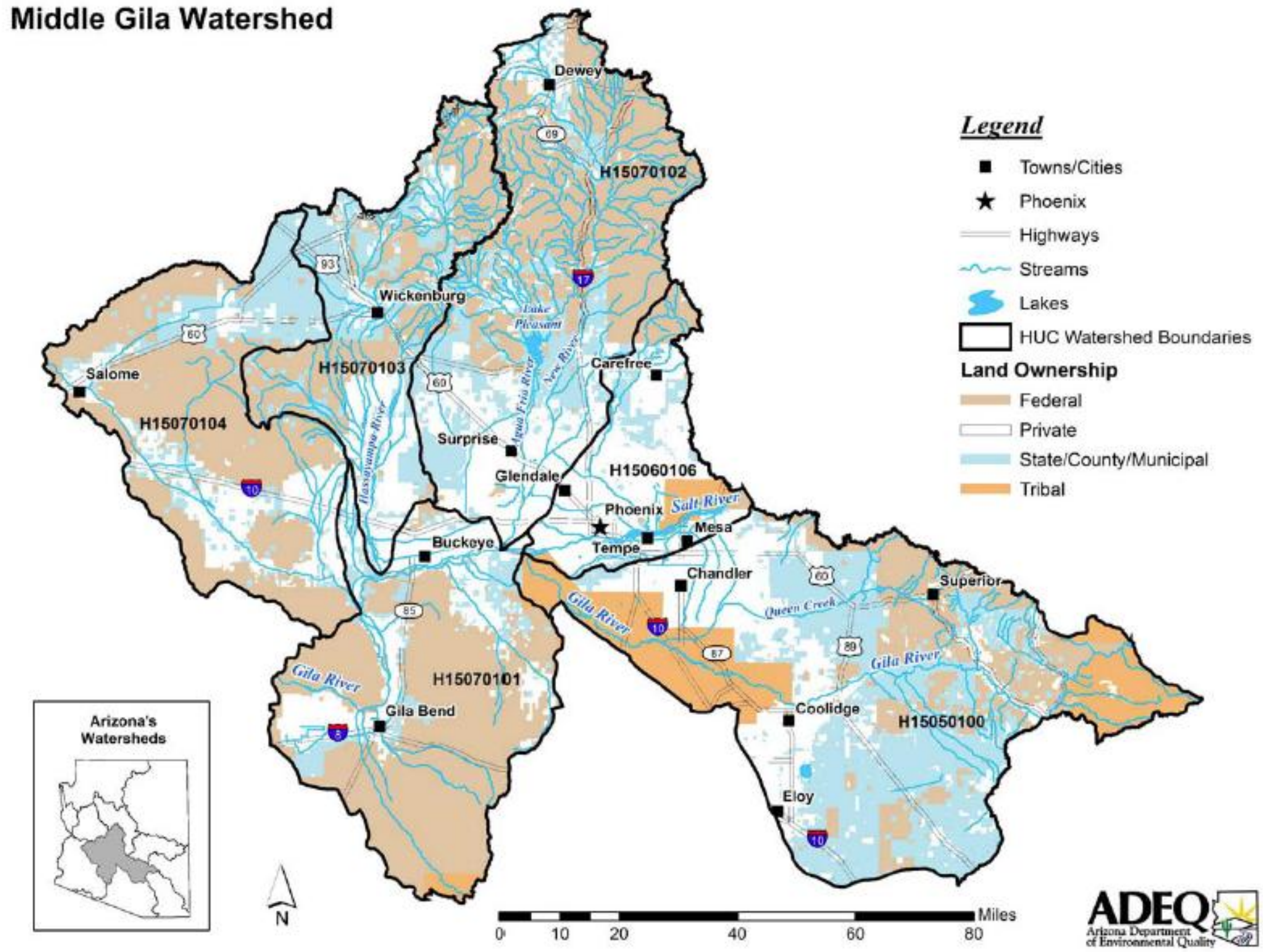


2006/2008 Statewide Assessed Waters
Colorado / Grand Canyon
Little Colorado / San Juan
Verde
Bill Williams
Colorado/
Lower Gila
Middle Gila
Salt
Upper Gila
Santa Cruz
San Pedro
PAGE
FLAGSTAFF
PRESCOTT
LAKE
HAVASU
CITY
PHOENIX
SAFFORD
YUMA
TUCSON
SIERRA
VISTA
Legend
Assessed Waters
Arizona's Ten Major Watersheds
allstreams arc
Incorporated City Boundaries
Indian Reservation Boundaries
ADEQ
Arizona Department
of Environmental Quality
N
Note: See Watershed Assessment Maps
for the names and locations of each
assessed water in detail.
Miles
0
25
50
100

APPENDIX G

MIDDLE GILA WATERSHED

(Arizona Department of Environmental Quality, 2009).


Middle Gila Watershed
Legend
Towns/Cities
Phoenix
Highways
Streams
Lakes
HUC Watershed Boundaries
Land Ownership
Federal
Private
State/County/Municipal
Tribal
Dewey
H15070102
Wickenburg
H15070103
Salome
H15070104
Lake Pleasant
Carefree
Surprise
Glendale
H15060106
Phoenix
Salt River
Mesa
Tempe
Buckeye
Chandler
Superior
Queen Creek
Gila River
H15070101
Gila Bend
Coolidge
H15050100
Eloy
Arizona's Watersheds
N
Miles
0 10 20 40 60 80
ADEQ
Arizona Department of Environmental Quality

APPENDIX H

MUNICIPAL EXPENDITURES FOR STORMWATER COMPLIANCE ACTIVITIES

<table>
<tr><td>Municipality</td><td>Stormwater Budget Data</td></tr>
<tr><td>City of Apache Junction (City of Apache Junction, 2008).</td><td>NPDES compliance is carried out by the Public Works Department. Specific stormwater information is not available.</td></tr>
<tr><td>City of Avondale (Paul Lopez. Personal Communication August 25, 2010).</td><td>The city estimates its annual stormwater expenditures for stormwater compliance is $200,000.</td></tr>
<tr><td>City of Chandler</td><td>Unknown</td></tr>
<tr><td>City of El Mirage</td><td>Unknown</td></tr>
<tr><td>City of Glendale (City of Glendale, 2006, 2007).</td><td>Stormwater compliance activities are bundled with the pretreatment program. Budget data does not indicate specific stormwater expenditures.
<table>
<tr><td>Expenditure Category</td><td>Fiscal Year 2006</td><td>Fiscal Year 2007</td></tr>
<tr><td>Computer Upgrades & Equipment</td><td>$10,905</td><td>$119,659</td></tr>
<tr><td>Chemicals, Sampling Supplies</td><td>$26,992</td><td>$30,306</td></tr>
<tr><td>Office Supplies</td><td>$2,868</td><td>$2,669</td></tr>
<tr><td>Laboratory Analysis</td><td>$49,769</td><td>$69,671</td></tr>
<tr><td>Maintenance</td><td>$15,871</td><td>$16,763</td></tr>
<tr><td>Personnel Expenses</td><td>$364,773</td><td>$411,572</td></tr>
<tr><td>Total</td><td>$471,178</td><td>$665,518</td></tr>
</table></td></tr>
<tr><td>City of Goodyear (City of Goodyear, 2006).</td><td>The city estimates its annual stormwater expenditures for stormwater compliance is $100,000.</td></tr>
<tr><td>City of Litchfield Park</td><td>Unknown</td></tr>
</table>

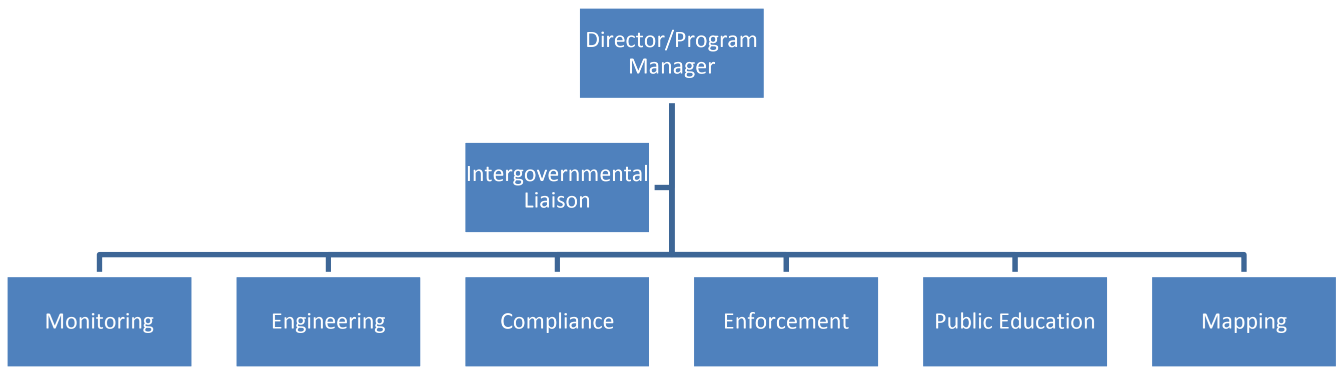
<table>
<tr><th>Municipality</th><th>Stormwater Budget Data</th></tr>
<tr><td>City of Mesa (City of Mesa, 2007).</td><td>
<table>
<tr><th>Expenditure Category</th><th>Fiscal Year 06/07</th><th>Fiscal Year 07/08</th></tr>
<tr><td>Monitoring Program</td><td>$47,635</td><td>$89,241</td></tr>
<tr><td>Storm Drain Maintenance</td><td>$606,164</td><td>$1,264,222</td></tr>
<tr><td>Retention Basin Maintenance</td><td>$1,563,680</td><td>$1,606,307</td></tr>
<tr><td>Street Cleaning</td><td>$1,266,406</td><td>$2,072,424</td></tr>
<tr><td>Emergency Response</td><td>$4,568</td><td>$40,777</td></tr>
<tr><td>Household Hazardous Waste Program</td><td>$257,742</td><td>$287,267</td></tr>
<tr><td>Administration, Inspection and Enforcement</td><td>$124,763</td><td>$383,860</td></tr>
<tr><td>Total</td><td>$3,870,958</td><td>$5,744,098</td></tr>
</table>
</td></tr>
<tr><td>City of Peoria (City of Peoria, 2010).</td><td>
<table>
<tr><th>Expenditure Category</th><th>Fiscal Year 08</th><th>Fiscal Year 09</th><th>Fiscal Year 10 (estimated)</th><th>Fiscal Year 11 (budget)</th></tr>
<tr><td>Personal Services</td><td>$284,599</td><td>$259,689</td><td>$359,074</td><td>$266,545</td></tr>
<tr><td>Contractual Services</td><td>$148,042</td><td>$219,535</td><td>$235,971</td><td>$357,150</td></tr>
<tr><td>Commodities</td><td>$33,101</td><td>$11,079</td><td>$14,694</td><td>$4,387</td></tr>
<tr><td>Capital Outlay</td><td>$6,173</td><td>$2,000</td><td>$0</td><td>$0</td></tr>
<tr><td>Total</td><td>$471,915</td><td>$492,303</td><td>$609,739</td><td>$628,082</td></tr>
</table>
</td></tr>
<tr><td>City of Phoenix (City of Phoenix, 2009).</td><td>
<table>
<tr><th>Expenditure Category</th><th>Fiscal Year 08/09</th><th>Fiscal Year 09/10</th></tr>
<tr><td>Street Transportation Department</td><td>$590,494</td><td>*Services transferred</td></tr>
<tr><td>Water Services Department</td><td>*Services transferred</td><td>$671,989</td></tr>
<tr><td>Engineering & Architectural Services</td><td>$521,520</td><td>$500,433</td></tr>
<tr><td>Development Services</td><td>$529,893</td><td>$315,000</td></tr>
<tr><td>Totals</td><td>$1,641,907</td><td>$1,487,422</td></tr>
</table>
</td></tr>
<tr><td>City of Scottsdale (City of Scottsdale, 2010).</td><td>
Stormwater compliance activities are bundled with the Development Services program. Budget data does not indicate specific stormwater expenditures.
<table>
<tr><th>Expenditure Category</th><th>Fiscal Year 08/09</th><th>Fiscal Year 09/10</th><th>Fiscal Year 10/11</th></tr>
<tr><td>Personnel Services</td><td>$8,645,431</td><td>$5,922,577</td><td>$5,677,885</td></tr>
<tr><td>Contractual Services</td><td>$829,169</td><td>$1,798,822</td><td>$1,153,228</td></tr>
<tr><td>Commodities</td><td>$58,138</td><td>$146,958</td><td>$147,409</td></tr>
<tr><td>Capital Outlays</td><td>$1,507</td><td>$5,000</td><td>$5,000</td></tr>
<tr><td>Total</td><td>$9,534,246</td><td>$7,873,357</td><td>$6,983,522</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Municipality</th><th>Stormwater Budget Data</th></tr>
<tr><td>City of Surprise (City of Surprise, 2009).</td><td><table><tr><th></th><th>Fiscal Year 2007</th><th>Fiscal Year 2008</th><th>Fiscal Year 2009 (budgeted)</th><th>Fiscal Year 2010 (budgeted)</th></tr><tr><td>Total</td><td>$75,540</td><td>$77,225</td><td>$105,200</td><td>$95,300</td></tr></table></td></tr>
<tr><td>City of Tempe (City of Tempe, 2010).</td><td>Only capital improvements data available. Not relevant to this study.</td></tr>
<tr><td>City of Tolleson</td><td>Unknown</td></tr>
<tr><td>Maricopa County (Lene Pope. Personal Communication October 28, 2010).</td><td><table><tr><th></th><th>Fiscal Year 2005</th><th>Fiscal Year 2006</th><th>Fiscal Year 2007</th><th>Fiscal Year 2008</th><th>Fiscal Year 2009</th></tr><tr><td>Total</td><td>$326,188</td><td>$292,807</td><td>$119,174</td><td>$171,174</td><td>$219,630</td></tr></table></td></tr>
<tr><td>Town of Fountain Hills (Town of Fountain Hills, 2009).</td><td><table><tr><th></th><th>Fiscal Year 10/11</th></tr><tr><td>Total</td><td>$46,940</td></tr></table></td></tr>
<tr><td>Town of Gilbert (Town of Gilbert, 2009).</td><td>Only capital improvements data available. Not relevant to this study.</td></tr>
<tr><td>Town of Guadalupe</td><td>Unknown</td></tr>
<tr><td>Town of Paradise Valley</td><td>Unknown</td></tr>
<tr><td>Town of Youngtown</td><td>Unknown</td></tr>
</table>

APPENDIX I

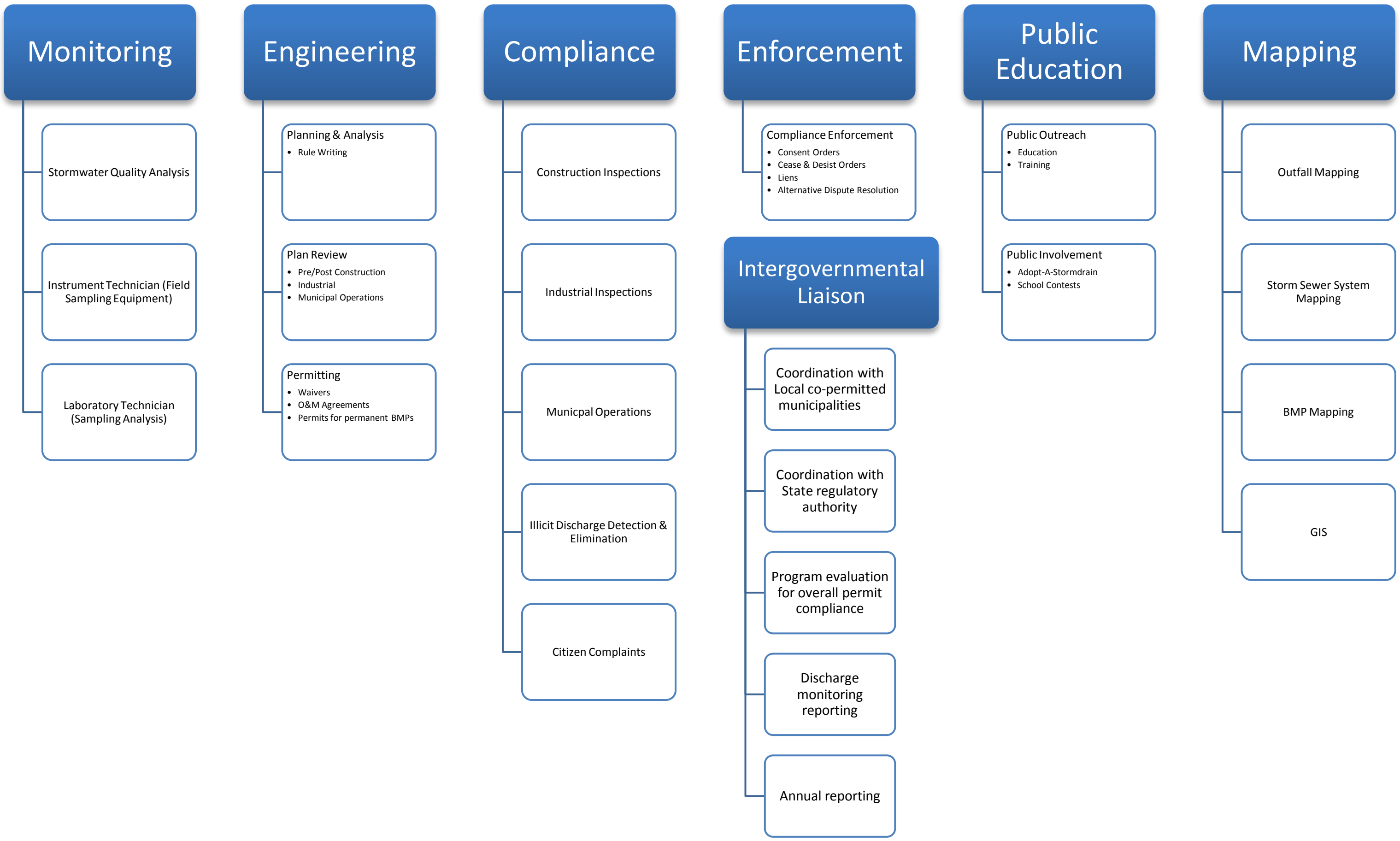
MARICOPA COUNTY REGIONAL STORMWATER PROGRAM

ORGANIZATIONAL HIERARCHY


Director/Program Manager
Intergovernmental Liaison
Monitoring
Engineering
Compliance
Enforcement
Public Education
Mapping

APPENDIX J

ORGANIZATIONAL RESPONSIBILITIES



Monitoring
Stormwater Quality Analysis
Instrument Technician (Field Sampling Equipment)
Laboratory Technician (Sampling Analysis)
Engineering
Planning & Analysis
• Rule Writing
Plan Review
• Pre/Post Construction
• Industrial
• Municipal Operations
Permitting
• Waivers
• O&M Agreements
• Permits for permanent BMPs
Compliance
Construction Inspections
Industrial Inspections
Municpal Operations
Illicit Discharge Detection & Elimination
Citizen Complaints
Enforcement
Compliance Enforcement
• Consent Orders
• Cease & Desist Orders
• Liens
• Alternative Dispute Resolution
Intergovernmental Liaison
Coordination with Local co-permitted municipalities
Coordination with State regulatory authority
Program evaluation for overall permit compliance
Discharge monitoring reporting
Annual reporting
Public Education
Public Outreach
• Education
• Training
Public Involvement
• Adopt-A-Stormdrain
• School Contests
Mapping
Outfall Mapping
Storm Sewer System Mapping
BMP Mapping
GIS