CHAPTER 1

Introduction to Water Quality and Resiliency in the Texas Coastal Zone

- √ **Stormwater Runoff Basics**
- √ **Importance and Status of Surface Water Quality in the Coastal Zone**
- √ **Sustainable and Resilient Site Design**
- √ **Why Stormwater Management Matters?**

Citizens and communities of the Texas coast are proud of the diverse ecosystems, natural beauty, cultural bounty, and way of life they experience living along the Gulf of Mexico. The economy, cultural heritage, and environmental quality of the communities and rural areas throughout the Texas coastal counties are inextricably linked to the health of tidal streams, bays, and estuaries along the Gulf Coast. Texas coastal waters sustain freshwater and marine water habitats that, in turn, support an abundance of fish and wildlife, tourism, and recreation. Threats to water quality, coastal habitats, fish and wildlife populations, and public safety are direct threats to the Gulf Coast economy.

1.1 STORMWATER RUNOFF BASICS

When a drop of rain falls during a storm, it may land on a tree and evaporate; it may land on a farm field and soak into the soil; or it may land on a rooftop, driveway, road or other hard, impermeable surface where it cannot be absorbed. Precipitation that does not evaporate or soak into the ground, but instead runs across the land and into the nearest waterway, is considered stormwater runoff. When stormwater travels across a surface, moving downhill towards rivers, arroyos, and bays, it picks up pollutants along the way. These pollutants can include bacteria, oil, grease, metals, organic material, or litter and all eventually end up in the receiving water body.

Stormwater runoff from parking lots, roads, and rooftops may flow to the street and into a storm drain, where it is conveyed through a pipe to a river or other body of water. Piping runoff in this way reduces the amount of water than can soak into the ground and eliminates the pollutant removal that occurs in natural systems. Over time, this can reduce the water quality in the receiving waterbody.

Given the interconnectedness of ecosystem/water quality health and coastal community economies, it is critical to understand how land development directly affects watershed functions. When development occurs in previously undeveloped areas, the resulting alterations to the land can dramatically change the conveyance and storage of stormwater runoff and can generate downstream flooding. Land development causes soil compaction and creates roadways, parking lots, buildings, and other surfaces that prevent infiltration of runoff into the ground. Any man-made surface which inhibits natural filtration of rainwater through soil and increases surface runoff is typically called impervious cover.

As illustrated in Figure 1.1, new development, and the associated increase in hard, impervious surfaces often has the unintended consequence of increasing the volume as well as decreasing the quality of stormwater runoff that makes its way into rivers and bays. However, when new developments are designed following guidance outlined in this document, it is possible to both reduce the amount of stormwater exiting a site and improve its quality.

Sustainable and resilient development strategies are designed to reduce the impact of development on the environment, are compatible with the coastal landscape, and can be implemented at three scales: 1) the region or large watershed area, 2) the community or neighborhood, and 3) the site or block. Different stormwater approaches are used at different scales to afford the greatest degree of protection to waterbodies. At the regional or watershed scale, decisions about where and how to develop are the first, and perhaps most important, decisions related to water quality and resiliency. At the site and block scale, combining multiple strategies to address stormwater volumes can have significant beneficial effects on both water quality and flood control. These issues are discussed in more detail in Chapter 2.

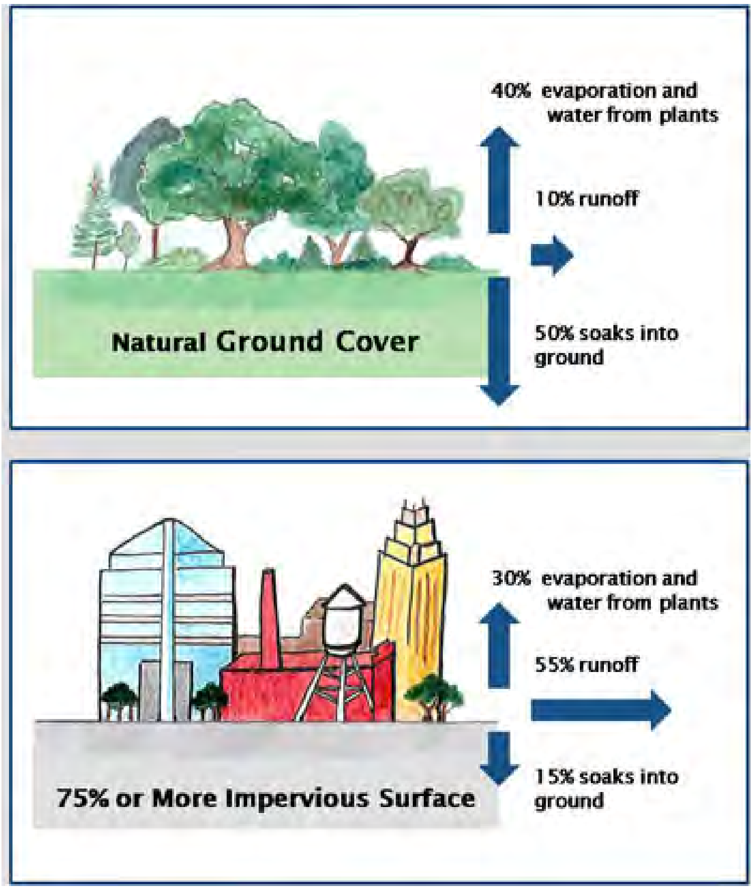


Figure 1-1: Influence of impervious cover on infiltration. (Graphic courtesy of City of Durham, North Carolina)

1.2 SURFACE WATER QUALITY IN THE COASTAL ZONE

Water quality in the State's tidal streams, bays, and estuaries is influenced by the quality and volume of freshwater inflow, which is critical for maintaining the fragile balance of water chemistry that marine species and coastal ecosystems depend on (TPWD 2014). Freshwater inflow to our coastal waters is provided by streams, rivers, groundwater, and stormwater runoff.

Water quality throughout the Texas coastal zone management boundary (CZMB) varies widely from pristine, high quality waters to those that do not meet water quality standards established by the Texas Commission on Environmental Quality (TCEQ). These water quality problems stem from a wide array of pollutants associated with "point sources" and "nonpoint sources" of pollution within coastal watersheds. Point sources of pollution originate from a single point or a discrete pipe such as a municipal wastewater treatment plant. Nonpoint sources of pollution (NPS) originate from diffuse sources primarily associated with stormwater runoff. Protecting water quality will require ongoing commitments from developers, businesses, homeowners, landowners, drainage districts, as well as municipal, county, and regional governments. NPS associated with stormwater runoff from new development is the sole focus of the recommendations and strategies described in this guidance document.

Texas has approximately 2,400 square miles of estuaries, and approximately 3,900 square miles of the Gulf of Mexico are within the jurisdiction of the State of Texas (TCEQ 2000). There are approximately 2,400 miles of tidally influenced streams along the Texas coastline, which stretches 624 miles from the Sabine River to the Rio Grande.

Waterbodies in Texas have specific water quality standards, set by TCEQ and approved by the U.S. Environmental Protection Agency (USEPA), which must be met. These standards serve as goals to protect water quality for a wide variety of uses, including drinking water, industrial use, agriculture irrigation, swimming, and protection of aquatic species.

Waterbodies that do not meet water quality standards are included on a list of impaired waterbodies, in accordance with Section 303(d) of the Clean Water Act. This list provides information about management activities, such as total maximum daily load (TMDL), on that waterbody to address an impairment and lists the pollutant(s) of concern.

Typical pollutants transported in stormwater runoff from new development include metals, bacteria, sediment, organic matter, and nutrients. Design solutions used to mitigate pollutants and manage volumes of stormwater runoff are called Best Management Practices (BMPs). Best management practices are further described in Chapter 4.

Figure 1-2: Texas coastal wetlands. (Photo courtesy of TPWD)

1.3 STORMWATER CONTROLS AND TREATMENT FUNCTIONS

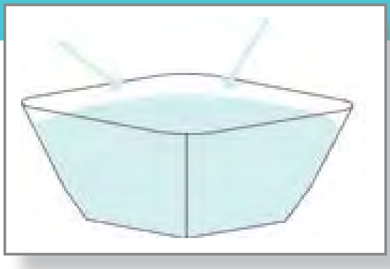
The following sections use several of the terms below as they define the practice and approaches to sustainable stormwater management strategies in more detail.

DETENTION

The temporary storage of stormwater runoff (in ponds, underground systems, or depressed areas) to allow for controlled discharge at a later time. The outlet structure restricts outflow to pre-development rates.

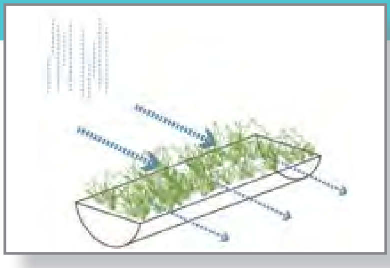
RETENTION

The storage of stormwater runoff on site and not released at a later time.



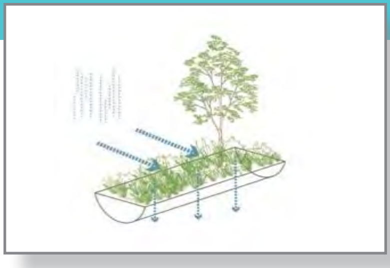
FILTRATION

The removal of sediment and other pollutants from stormwater runoff by the movement of runoff across a vegetated area and through media.



INFILTRATION

The vertical movement of stormwater through plants and soil. In systems without an under drain or liner, infiltration recharges groundwater.



EVAPOTRANSPIRATION

The combined amount of evaporation and plant transpiration from the soil surface or from the plant's vascular system to the atmosphere.

1.4 BENEFITS OF SUSTAINABLE AND RESILIENT DRAINAGE DESIGN

More than 6 million people live in the 18 Texas coastal counties; by 2050 the population in these counties is expected to reach 8.5 million (TWDB 2014a). Future land development in urbanized and rural areas will continue to create challenges for maintaining and restoring water quality in Texas' coastal watersheds. Sustainable stormwater management approaches can alleviate some of the challenges posed by development. The following section provides a brief discussion of some of the benefits of sustainable drainage practices.

1.4.1 ENVIRONMENTAL BENEFITS AND HYDROMODIFICATION AVOIDANCE

POLLUTION ABATEMENT

The key to successful sustainable development practices is the reduction of both the volume of runoff and the amount of pollutants discharged into receiving waters. Sustainable development practices result in pollutant removal by using multiple strategies to mimic natural processes such as settling, filtration, adsorption, and biological uptake. The International BMP Database (www.bmpdatabase.org) is a good resource for examining pollutant removal data derived from multiple monitoring sites across the country. Reductions in stormwater pollutant discharges to receiving waters improve habitat for aquatic and terrestrial wildlife and enhance recreational uses.

PROTECTION OF DOWNSTREAM WATER RESOURCES AND RIPARIAN AREAS

Sustainable development practices can be used to protect water resources that are downstream. These practices can help to prevent or reduce hydrologic impacts on receiving waters, reduce stream channel degradation from erosion and sedimentation, improve water quality, increase water supply, and enhance the recreational and aesthetic value of the natural resources.

GROUNDWATER RECHARGE

Sustainable development practices can be used to infiltrate runoff and recharge groundwater. Growing water shortages throughout Texas increasingly indicate the need for water resource management strategies designed to integrate stormwater, drinking water, and wastewater programs to maximize benefits and minimize costs. Development pressures typically result in increases in the amount of impervious surface and volume of runoff. Infiltration practices can be used to replenish groundwater and increase stream flow during dry periods. Adequate flow to streams during dry weather is important because low groundwater levels can lead to greater fluctuations in stream depth, flows, and temperatures, all of which can be detrimental to aquatic life.

HABITAT IMPROVEMENTS

Innovative stormwater management techniques like sustainable development or conservation design can be used to improve natural resources and wildlife habitat or avoid expensive mitigation costs. Aquatic habitat improvements can be seen from sustainable development practices as the quality, volume, rate, and temperature of stormwater runoff entering receiving water bodies is more closely associated with pre-development conditions.

HYDROMODIFICATION AVOIDANCE

Sustainable development practices such as stream and shoreline buffer zones that significantly limit disturbance of natural streams and wetlands protect water quality, slow and absorb flood flows, reduce stream velocities, and protect wildlife and aquatic habitats. Sustainable planning that encourages the design of development and roads beyond the floodplain and/or with limited stream crossings also preserves natural water body function and allows natural process to manage water quality and floods. At the same time, this preservation of natural resources to manage stormwater can reduce development costs and help mitigate long-term maintenance costs since infrastructure and other constructed measures are located outside of "harms way".

1.4.2 LAND VALUE AND PUBLIC SAFETY BENEFITS

Many direct and indirect benefits of sustainable development derive from improved land value through improved aesthetics, additional lot yield, or property protection, and quality of life benefits. When used correctly, sustainable development techniques can enhance the quality of life within a community in many ways, from providing multiple amenities to creating improved landscapes with a strong sense of place.

REDUCED DOWNSTREAM FLOODING AND PROPERTY DAMAGE

Sustainable development practices can be used to reduce downstream flooding through the reduction of peak flows and the total amount or volume of runoff. Flood prevention reduces property damage and can reduce the initial capital costs, long-term operation and maintenance costs of stormwater infrastructure. As a result, costs for cleanups and stream bank restoration can be reduced or avoided altogether. The use of sustainable development techniques at a regional and neighborhood scale can help protect or restore floodplains, which can then be used as park space or wildlife habitat (Trust for Public Land 2007).

LOT YIELD

Strategies designed to manage runoff on-site or as close as possible to its point of generation can reduce the need for large detention areas and easements for stormwater conveyance infrastructure. In cases where sustainable development practices are incorporated on individual house lots and along roadsides as part of the landscaping, land that would normally be dedicated for a stormwater pond or other large structural control can be developed with additional housing lots. The BMPs listed in Chapter 4 illustrate the various measures that can be used to reduce the stormwater footprint as in the case of pervious pavement where runoff can be stored below the surface and negate the requirement for a stormwater basin.

AESTHETIC VALUE

Sustainable development techniques can be attractive features when using landscaping as an integral part of the designs. Designs that enhance a property's aesthetics using trees, shrubs, and flowering plants that complement other landscaping features can be selected.

PUBLIC SPACES/QUALITY OF LIFE/PUBLIC PARTICIPATION

Placing water quality practices on individual lots provides opportunities to involve homeowners in stormwater management and enhances public awareness of water quality issues. An American Lives, Inc. real estate study found that 77.7% of potential homeowners rated natural open space as "essential" or "very important" in planned communities (National Park Service 1995).

1.4.3 OTHER ECONOMIC BENEFITS

In addition to economic benefits from sustainable stormwater management such as erosion control, flood mitigation, or water quality improvements that reduce the cost of treating drinking water, there are a variety of economic benefits that are directly dependent on the quality and quantity of the water resources in the coastal zone. Examples of activities critical to the Texas economy and that are tied to the health of its bays and estuaries include:

- Coastal tourism provides $5.4 billion in Texas economic activity annually. Nature lovers from all over the world visit the Texas coast to see rare species. Numerous activities contribute to making tourism the third largest industry in Texas, after oil and gas production and agriculture. Tourism for the whooping crane alone results in over $6 million to Texas' coastal economy.
- Texas estuaries annually produce over 100 million pounds of seafood valued at $150-to-$250 million per year.
- Saltwater recreational fishing generates an estimated $2 billion (TPWD 2014). Sport fishing is popular among both residents and nonresidents in Texas, producing significant economic benefits for many individuals and businesses. Because fishing dollars are often spent in rural or sparsely populated areas, the economic contributions of these activities can be especially important to the rural economic base (Southwick Associates 2013).

Economic benefits are derived from preserving and restoring natural features and open space. Public and private investments in natural systems—through environmental conservation and sustainable development actions—have a stimulating effect on economic output and employment. Restoration efforts offer localized benefits that can be attributed to the tendency for projects to employ local labor and materials. Restoration investments have economic and employment stimulus effects as a result of the ripple or multiplier effect on suppliers and related industries. These can be direct economic effects from the initial investment; indirect effects from increased demand in other industries for goods and services; and induced effects from changes in household spending by workers. While there is considerable variability, one study found that restoration investments have beneficial effects on state or local economies comparable to those from investments in other industries (BenDor et al. 2014).

In addition, environmental conservation and sustainable development practices provide economic benefits by avoiding the costs of construction and maintenance associated with conventional infrastructure. Sustainable stormwater management can provide long-term benefits to property owners and businesses, increase tourism and recreation activity, increase yields for fisheries, and provide cost savings for local governments and State and Federal agencies.

Figure 1-3: Whooping cranes in Aransas County. (Photo courtesy of TPWD)