Illinois Environmental Protection Agency

Bureau of Water • 1021 N. Grand Avenue E. • P.O. Box 19276 • Springfield • Illinois • 62794-9276

Division of Water Pollution Control
ANNUAL FACILITY INSPECTION REPORT
for NPDES Permit for Storm Water Discharges from Separate Storm Sewer Systems (MS4)

This fillable form may be completed online, a copy saved locally, printed and signed before it is submitted to the Compliance Assurance Section at the above address. Complete each section of this report.

Report Period: From March, 2022 To March, 2023

Permit No. ILR40 0736

MS4 OPERATOR INFORMATION: (As it appears on the current permit)

Name: Village of Tolono

Mailing Address 1: PO Box 667

Mailing Address 2: 507 W. Strong St.

County: Champaign

City: Tolono State: IL Zip: 61880-0667 Telephone: 217-485-5212

Contact Person: Connor Block
(Person responsible for Annual Report)

Email Address: connor.block@tolonoil.us

Name(s) of governmental entity(ies) in which MS4 is located: (As it appears on the current permit)

Village of Tolono

THE FOLLOWING ITEMS MUST BE ADDRESSED.

A. Changes to best management practices (check appropriate BMP change(s) and attach information regarding change(s) to BMP and measurable goals.)

1. Public Education and Outreach ☐
2. Public Participation/Involvement ☐
3. Illicit Discharge Detection & Elimination ☐
4. Construction Site Runoff Control ☐
5. Post-Construction Runoff Control ☐
6. Pollution Prevention/Good Housekeeping ☐

B. Attach the status of compliance with permit conditions, an assessment of the appropriateness of your identified best management practices and progress towards achieving the statutory goal of reducing the discharge of pollutants to the MEP, and your identified measurable goals for each of the minimum control measures.

C. Attach results of information collected and analyzed, including monitoring data, if any during the reporting period.

D. Attach a summary of the storm water activities you plan to undertake during the next reporting cycle (including an implementation schedule.)

E. Attach notice that you are relying on another government entity to satisfy some of your permit obligations (if applicable).

F. Attach a list of construction projects that your entity has paid for during the reporting period.

Any person who knowingly makes a false, fictitious, or fraudulent material statement, orally or in writing, to the Illinois EPA commits a Class 4 felony. A second or subsequent offense after conviction is a Class 3 felony. (415 ILCS 5/44(h))

Owner Signature:

5-26-23
Date:

Connor Block
Printed Name:

Public Works Supreintendent
Title:

EMAIL COMPLETED FORM TO: epa.ms4annualinsp@illinois.gov

or Mail to: ILLINOIS ENVIRONMENTAL PROTECTION AGENCY
WATER POLLUTION CONTROL
COMPLIANCE ASSURANCE SECTION #19
1021 NORTH GRAND AVENUE EAST
POST OFFICE BOX 19276
SPRINGFIELD, ILLINOIS 62794-9276

ATTACHMENT TO
IEPA - ANNUAL FACILITY INSPECTION FORM
TOLONO MS4 - ILR400736
VILLAGE OF TOLONO, ILLINOIS
May 23, 2023

A.	**CHANGES TO BEST MANAGEMENT PRACTICES (BMPs)**
	NONE
B.	**STATUS OF COMPLIANCE WITH PERMIT CONDITIONS [COMPLETED IN 2022/2023]**
1	**PUBLIC EDUCATION AND OUTREACH**
a)	***BMP # A.1 - Distributed Paper Materials***
	In 2022/2023, pamphlets were reprinted (as needed) and were made avaiable at the Tolono Village Hall
	Milestone completed.
2	**PUBLIC PARTICIPATION/INVOLVEMENT**
a)	***BMP # B.7 - Other Public Involvement [A.1.1]***
	Annual public information meeting regarding stormwater was held on May 16th, 2023. No public/developer comments regarding storm water facilities.
	Milestone completed.
3	**ILLICIT DISCHARGE DETECTION AND ELIMINATION**
a)	***BMP # C.1 - Storm Sewer Map Preparation [C.1.1]***
	The Village completed preparation of Storm Water Illicit Discharge Detection & Elimination (IDDE) Plan, which also included prepartion of an electronic copy of the Village's Storm Sewer Map; Copy of Village's IDDE Plan (d. February 2021) is attached herewith for information.
	Milestone completed.
4	**CONSTRUCTION SITE RUNOFF CONTROL**
a)	***BMP # D.2 - Erosion and Sediment Control BMPs [D.2.1]***
	In 2022/2023, no project requiring SWPPP completed.
	Milestone completed.
b)	***BMP # D.6 - Site Inspection/Enforcement Procedures [D.6.1]***
	In 2022/2023, no project requiring SWPPP completed.
	Milestone completed.
5	**POST-CONSTRUCTION RUNOFF CONTROL**
a)	***BMP # E.6 - Post-Construction Inspections [E.6]***
	In 2022/2023, no project requiring SWPPP completed.
	Milestone completed.
6	**POLLUTION PREVENTION/GOOD HOUSEKEEPING**
a)	***BMP # F.6 - Other Municipal Operations Controls [F.6.1]***
	Cleaning and replacement compIteded in 2022/2023:
	Manhole at Holden and Whitehead.
	307 E. Holden. 40' of 8" tile replaced.
	CR 800 N. ditchline catch basin installed.
	New catch basin at Main St. and Elizabeth.
	Replacement of 50' of tile at Main St. and 2nd St. running west to collector tile along Main St.
	Cleaning and root removal at Linden and Galloway manhole structure.
	300' of perorated tile installed at Third St. and Broadway , running East to catch basin.
	Cleaning and removal of debris from all catch basins within Village.
	Jetting of all sotrm sewers West of Route 45.
	Milestone completed.

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C.		**RESULTS OF INFORMATION COLLECTED AND ANALYZED**
		N/A
D.		**FUTURE STORMWATER ACTIVITIES [PLANNED FOR 2021/2022]**
	1	**PUBLIC EDUCATION AND OUTREACH**
	a)	***BMP # A.1 - Distributed Paper Materials***
		In 2023/2024, The Village will print current and new pamphlets (as needed), and make them avaiable at the Tolono Village Hall
	2	**PUBLIC PARTICIPATION/INVOLVEMENT**
	a)	***BMP # B.7 - Other Public Involvement [A.1.1]***
		In 2023/2024, the Village will hold an annual public information meeting regarding stormwater in person one a year, tentatevely scheduled around February or March, prior to submitting the IEPA Annual MS4 Facility Inspection Report to the Agency.
	3	**ILLICIT DISCHARGE DETECTION AND ELIMINATION**
	a)	***BMP # C.1 - Storm Sewer Map Preparation [C.1.1]***
		In 2022/2023, the Village staff will follow the IDDE Plan, and note any updates to the Storm Sewer Map.
	4	**CONSTRUCTION SITE RUNOFF CONTROL**
	a)	***BMP # D.2 - Erosion and Sediment Control BMPs [D.2.1]***
		In 2023/2024, the Village will require the Contractors for any construction projects in given year requiring SWPPP to provide the Erosion and Sediment control devices as per Village's MS4 permit.
	b)	***BMP # D.6 - Site Inspection/Enforcement Procedures [D.6.1]***
		In 2023/2024, the Village will inspect construction site any construction projects in given year requiring SWPPP and require the Contractors to comply with the provisions of Village's MS4 permit.
	5	**POST-CONSTRUCTION RUNOFF CONTROL**
	a)	***BMP # E.6 - Post-Construction Inspections [E.6]***
		In 2023/2024, the Village staff will perform post-construction site inspection of all projects in given year requiring SWPPP.
	6	**POLLUTION PREVENTION/GOOD HOUSEKEEPING**
	a)	***BMP # F.6 - Other Municipal Operations Controls [F.6.1]***
		In 2023/2024, the Village staff will continue to clean various stormsewer components ahead of the expected rain events.
E.		**RELIANCE ON ANOTHER GOVERNMENTAL ENTITY**
		N/A
F.		**CONSTRUCTION PROJECT LIST**
		NONE

VILLAGE OF TOLONO
BOARD OF TRUSTEES MEETING AGENDA
MAY 16, 2023 – 6:30 p.m. – POLICE STATION (205 E. Main St)

I. CALL MEETING TO ORDER; ROLL CALL
President: Rob Murphy _____ Clerk: Brandy Dalton _____
Trustees: Daniel Grady _____ Ann Jack Haluzak _____ Jared Robbins _____
Terrence Stuber _____ Vacant _____ Vacant _____

II. PLEDGE OF ALLEGIANCE & INVOCATION
III. PUBLIC COMMENTS – *limited to 5 minutes per person*
IV. PROCLAMATIONS, RECOGNITION, PRESENTATIONS

V. REPORTS, COMMENTS, ANNOUNCEMENTS
A. Engineers
1. Public Information Regarding the MS4 Stormwater Management Program
2. Public Information on Preparation of the Annual Facility Inspection Report
B. Public Works
C. Police Department
D. Clerk/Treasurer
E. Board Members
F. Planning & Zoning Board
G. Park Board

VI. CONSENT AGENDA
A. Motion to approve minutes of the May 2, 2023 Regular Session Board meeting
B. Motion to approve bills/warrants as presented
C. Motion to approve May 12, 2023 Payroll
D. Motion to approve water/sewer usage/billed report
E. Motion to approve budget vs actual report
F. Motion to approve April 2023 bank statements and reconciliations
G.

VII. OLD BUSINESS
A. Discussion/Approval of Cooperative Management Agreement with Tolono Park Board
B. Discussion/Approval of Replat for Waste Water Treatment Plant Site

VIII. NEW BUSINESS
A. Discussion/Approval of Rise Broadband Fiber Agreement
B. Discussion/Approval of Tolono Fun Days Beer Pavilion Special Event Permit
C. Consideration of an ordinance clarifying payment of administrative fee for tax collection
D. Consideration of an ordinance regulating storm water discharge
E. Consideration of an ordinance regulating right of way construction
F. Discussion/Approval to Budget $250,000 for MFT Program 2023

IX. MISCELLANEOUS
A. Nuisance File
B. Special Event Permits
C. Next Regular Meeting – June 6, 2023

X. EXECUTIVE SESSION *(if needed)* - Consideration of a motion to enter into Executive Session for the limited purpose of discussing the hiring, performance, compensation and/or employment of one or more Village employees (5 ILCS 120/2(c)(1)), possible litigation (5 ILCS 120/2(c)(11)), acquisition of land (5 ILCS 120/2(c)(5)), and sale of land (5 ILCS 120/2(c)(6))

XI. ADJOURNMENT

STORM WATER ILLICIT DISCHARGE DETECTION & ELIMINATION (IDDE) PLAN

Village Of Tolono

TOLONO, ILLINOIS

PREPARED FOR:

VILLAGE OF TOLONO ILLINOIS
510 WEST STRONG STREET
TOLONO ILLINOIS, 61883

PREPARED: FEBRUARY 2021

DONOHUE
Donohue & Associates, Inc.
1605 South State Street, Suite 1C
Champaign, IL 61820
Phone: 217.903.5088

www.donohue-associates.com

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1.0 Introduction

The Village of Tolono Illinois (the Village) a Location Map is provided as **Map 1** in the Appendix, is affected by the National Pollutant Discharge Elimination System (NPDES) Phase II rule, published as final on December 8, 1999. The rule requires regulated operators of municipal separate storm sewer systems (MS4s) to obtain a permit to discharge storm water runoff from their MS4 and establishes conditions they must meet to reduce the impacts of storm water discharges. One of these conditions requires regulated communities to develop an Illicit Discharge Detection and Elimination (IDDE) Program to investigate and eliminate illicit discharges to the MS4. Requirements for the program were outlined in the General NPDES Permit No. ILR40, issued February 10, 2016 for Discharges from Small Municipal Separation Storm Sewer Systems (MS4s), which expires on February 28, 2021, but remains in effect until a revised permit is issued.

A new General Permit was not issued before the preparation of this plan. This plan should be reviewed and updated as necessary to meet the requirements of the new final permit when it is released.

1.1 Purpose

The purpose of this plan is to outline a program to detect and eliminate illicit discharges to the Village of Tolono Illinois (MS4) and waterways to improve storm water quality and meet the Federal Phase II Storm Water requirements. A Catchment and Delineation Map is provided as **Map 2** in the Appendix.

1.2 Illicit Discharges

An illicit discharge is defined as any non-storm water discharge to the MS4 that is not composed entirely of storm water. Common illicit discharges include overflow from failed septic tanks or cesspools, floor drains where regulated contaminants are stored, vehicle wash wastewater, laundry wastewater, and improper disposal of automobile and household products. These illicit discharges may contribute high levels of pollutants, including heavy metals, toxic chemicals, oil and grease, nutrients, viruses, and bacteria to water bodies.

Illicit discharges can enter the municipal system either through direct connections (pipes connected directly to the storm drain) or through indirect routes (through cracked pipes, leaking tanks, overland runoff or dumped by hand into storm drains). Municipal storm water systems are not designed to accept, process, or discharge such illicit sources.

1.3 Exceptions

Non-storm water illicit discharge exceptions are listed below, and should only be addressed if they are identified as significant sources of pollutants:

- Water line flushing;
- Landscape irrigation;
- Diverted stream flows;
- Rising groundwater;
- Uncontaminated groundwater infiltration;
- Uncontaminated pumped groundwater;
- Discharges from potable water sources;
- Foundation drains;
- Air conditioning condensation;
- Irrigation water;
- Springs;
- Water from crawl space pumps;
- Footing drains;
- Lawn watering;
- Storm sewer cleaning water
- Individual residential car washing;
- Flows from riparian habitats and wetlands;
- De-chlorinated swimming pool water;
- Street wash water;
- Residential building wash waters without detergents;
- Flows or discharges from firefighting activities flows.
- De-chlorinated water reservoir discharges; and
- Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred

The above-referenced non-storm water discharges are not expected to be significant contributors of pollutants to the MS4, and are not expected to cause or contribute to water quality standard exceedances.

1.4 Illicit Discharge Detection and Elimination Plan

The Phase II Storm Water rule requires regulated operators of MS4s to develop and implement an illicit discharge detection and elimination program, as outlined below.

The United States Environmental Protection Agency (EPA) recommends the following steps in developing this Illicit Discharge Detection and Elimination (IDDE) Plan:

1. Identify priority problem areas suspected of having illicit discharges;
2. Locate illicit discharge sources;
3. Remove/correct illicit connections; and
4. Document actions taken and evaluate impacts.

This plan addresses these four steps and includes the following components:

1. Mapping and Outfall Inventory – Section 2.0
2. Identification of Illicit Discharges – Section 3.0
3. Elimination of Illicit Discharges – Section 4.0

The data components of this report were developed based on information obtained by the Village of Tolono and Donohue & Associates, Inc.

1.5 Program Responsibility

The IDDE Program shall be the responsibility of the Village Board. The Public Works Department shall be responsible for implementing storm water components. The Village Board shall be responsible for implementing and enforcing required ordinances.

Point of Contact for Illicit Discharges

Public Works Superintendent	Scott Arbuckle
Public Works Department	(217)485-5212

2.0 Mapping and Outfall Inventory

2.1 Mapping

As required under the Small MS4 General Permit, the Village performed storm water system mapping of outfalls during field efforts in 2020 focused on the regulated urbanized area (UA). Future mapping of additional structures will be mapped as they become located or newly installed.

The Village mapped the following conveyance system structures;

- Outfall manholes within the UA
- Outfall culverts within the UA
- System manholes
- Catch basins

These structures serve as key points for beginning illicit discharge detection and elimination activities. A Storm Water System Map is provided as **Map 3** in the Appendix.

As outlined in the MS4 General Permit 2016 the permittee must develop a detailed map that depicts the above information. Note that the Village does not have any interconnections with other MS4s, sanitary sewer or combined sewer. The Village does have Storm Water BMPs in place. Additionally, the Village delineated catchment areas to each outfall based on topography and localized drainage characteristics using “USGS StreamStats”.

(https://streamstats.usgs.gov/ss/)

Public Drinking Water Supply

Community water supplies in the Village are received from Illinois American Water Corporation. There are no active wells in the Village

2.2 Outfall Inventory

As outlined in Section 2.0, the Village has mapping and inventoried all known outfalls within the village limits. As part of the outfall inventory, the following information is provided.

- Unique identifier
- GPS location (latitude and longitude)
- Outlet structure type
- Outlet pipe diameter
- Outlet pipe material construction
- Outlet structure protection
- Surrounding land use and slope
- Receiving waterbody
- Most recent inspection results

Drainage outfalls will be identified with a unique ID to provide a consistent identification method for tracking future observations. Additionally, outfalls not previously mapped can be added according to the existing list of outfalls using the same labeling method. The location of each outfall was recorded with GPS equipment to record latitude and longitude for future location and follow-up.

Outfall pipe characteristics, include type of structure, pipe diameter, material construction (concrete, steel, etc.), and outlet structure protection (headwall, riprap, none, etc.) will also be recorded. Finally, outfall interconnections to nearby catch basins and manholes will also be recorded for mapping purposes.

The surrounding sub-water shed/catchment area was then assessed for the dominant land use, typically residential, and nearby slope. Mapping was then used to determine the receiving waterbody and associated watershed within the Village.

Finally, the outfall inventory documented the most recent inspection results as follows:

- Inspection date;
- Pipe condition (good, cracked, corroded, etc.);
- End-of-pipe deposits (sediment, brush, etc.);
- Depth of sediment, if applicable;
- Surrounding impacts to vegetation;
- Evidence of erosion;
- Maintenance needed or recommended; and

- Any additional comments or notes.

An **Outfall Inventory** spread sheet is provided in the Appendix.

3.0 Identification of Illicit Discharges

This section provides the procedures for the identification of non-storm water discharges entering the storm drain system in the Village. These procedures should be implemented beginning with the High Priority catchments and progress to Low Priority catchment areas.

3.1 Visual Field Inspection

The first step for detecting non-storm water connections in MS4s is to physically observe all discharge points in the field during periods of dry weather.

Inspection Conditions

Visual inspections for illicit discharges must occur during dry weather conditions. Dry weather conditions are defined as a minimum of 24 consecutive hours with less than 0.10 inches of rainfall, however 72 hours is recommended. MS4s are designed to only carry storm water runoff; therefore if a flow exists at a discharge point during the dry weather inspections, it is identified as a potential illicit discharge. Storm water discharges to culverted streams that cannot be easily accessed (i.e., underground discharge locations) should be inspected at the nearest upstream location (e.g., manhole). It may be possible for inspection to take place inside the culverted stream depending on the size of pipes and the inspection crew's safety qualifications for work in confined spaces.

Considerations

Dry weather flow can be continuous or intermittent. Therefore, it is important to accurately document outfall conditions and evaluate whether future inspections are needed based on known water quality problems or impaired water bodies. In cases where there is physical evidence of an intermittent flow or illicit discharge, follow-up inspections should be performed to identify the dry weather flow. Intermittent flows also present an opportunity to involve the public with outfall observations. Volunteer watchers in local areas can inspect outfalls on a more frequent basis and alert the appropriate department when flow is present.

Observations and Interpretation

During inspection of an outfall for the presence of dry weather flow, physical characteristics such as odor, color, sheen, floatables, turbidity, the condition of the outfalls, and surrounding land uses and activities will be observed for further identification and confirmation of illicit discharges. **Table 1** provides some possible sources of illicit discharges based on physical parameters collected during field observations. If an outfall is inaccessible or submerged, personnel should inspect the nearest accessible upstream catch basin or manhole. A sample

Outfall Inspection Checklist is provided in the Appendix to assist in maintaining consistent and detailed records of inspections.

It is possible that some illicit discharges may only occur in wet weather, such as an overflow event from a septic tank. It is sometimes possible to detect these illicit discharges at the storm water outfall, as evident from unusual debris (e.g. toilet paper), stressed vegetation, sheen, etc.

Table 1 – Interpretation of Physical Observation Parameters[1]

Parameter	Observations	What Could It Mean?
Odor	Sewage	Stale sanitary wastewater, especially in pools near fallout
	Sulfur (rotten eggs)	Industries that discharge sulfide compounds or organics (meat packers, canneries, dairies, etc.) Also could be petroleum related "high sulfur" fuels.
	Rancid Sour	Food preparation facilities (restaurants, hotels, etc.)
	Oil & Gas	Petroleum refineries or many facilities associated with vehicle maintenance or petroleum product storage.
Color	Yellow	Chemical plants, textile and tanning plants.
	Brown	Meat packers, printing plants, metal works, stone and concrete, fertilizers, and petroleum, refining facilities.
	Green	Chemical plants, textile facilities.
	Red	Meat packers, metal works.
	Gray	Dairies, sewage.
Turbidity	Cloudy	Sanitary wastewater, concrete or stone operations, fertilizer facilities, automotive dealers.
	Opaque	Food processors, lumber mills, metal operations, pigment plants.
Floatable Matter	Oil Sheen	Petroleum refineries or storage facilities and vehicle service facilities, restaurants.
	Grease	
	Sewage	Sanitary wastewater
Deposits and stains	Sediment	Construction site erosion
	Oily	Sanitary wastewater
Vegetation	Excessive Growth	Food products facilities, fertilizers, farming, agricultural use.
	Inhibited Growth, Stressed Vegetation	High storm water flows, beverage facilities, printing plants, metal product facilities, drug manufacturing, petroleum facilities, vehicle service facilities, and auto dealers.
Damage to Outfall Structures	Concrete Cracking or Spalling	Industrial flows, chemicals.
	Peeling Paint	
	Metal Corrosion	
Source: Pitt R. University of Alabama at Birmingham.		

1. Note that many of these sources may not apply to the Village, however are shown for reference.

3.2 Dry Weather Sampling

Although visual inspection will indicate the presence of dry weather flow, sampling and testing is needed to confirm whether these flows are illicit discharges that need further investigation. Some dry weather flows may be attributed to groundwater infiltration or other allowable non-storm water discharges as outlined in Section 1.2, which could be confirmed through sampling. These tests can help identify contributing pollutants and the extent of water quality impairment at the outfalls. Key chemical parameters that are helpful in identifying the sources of non-storm water discharges are shown in **Table 2**.

Table 2 – Field Survey Parameters and Non-Storm Water Flow Sources[1]

Parameters	Natural Water	Potable Water	Sanitary Sewage	Septage Water	Industrial Water	Wash Water	Rinse Water	Irrigation Water
Fluoride	-	+	+	+	+ / -	+	+	+
Hardness Change	-	+ / -	+	+	+ / -	+	+	-
Surfactants	-	-	+	-	-	+	+	-
Fluorescence	-	-	+	+	-	+	+	-
Potassium	-	-	+	+	-	-	-	-
Ammonia	-	-	+	+	-	-	-	+ / -
Odor	-	-	+	+	+	-	-	-
Color	-	-	-	-	+	-	-	-
Clarity	-	-	+	+	+	+	+ / -	-
Conductivity	-	-	+	+	+	+ / -	+	+
Temperature Change	-	-	+ / -	-	+	+ / -	+ / -	-
pH	-	-	-	-	+	-	-	-

1. Note that many of these sources may not apply to the Village, however are shown for reference.
2. A minus (-) indicates that the parameter has a low value or low potential association with the flow source. A plus (+) indicates a high value or likely associated with the flow source. When both symbols are present (-/+) the parameter may be high or low depending on background readings.

EPA requires sampling fresh water at a minimum for ammonia, chlorine, conductivity, salinity, E.coli, surfactants, and temperature under General NPDES Permit No. ILR40. Additional water quality parameters such as dissolved oxygen (DO), pH, and turbidity may also be sampled to obtain additional representative data. Additional parameters may be used at the Village's discretion such as Volatile Organic Compound (VOC) analysis if non-storm water discharges have a solvent odor or oil and grease analysis if oil or oil sheen are present

The presence of any of these compounds in non-storm water discharges indicates an illicit discharge that needs to be investigated.

It is important to identify threshold concentrations or limits for key parameters to detect illicit connections. Standards and water quality criteria are developed by state and federal agencies for the acceptable limits based on the scientific understanding of the risk to human and ecological health. Acceptable limits of identified key parameters were developed through review of the IEPA water quality standards and EPA's water quality criteria. A list of reference concentrations for the Village's non-storm water discharges is provided in **Table 3**.

Table 3 – Reference Concentrations for Non-Storm Water Discharge

Sampling Parameters	**Reference Concentration for Tolono**	
	Class A Waters	**Class B Waters**
Ammonia[1]	>0.50 mg/L	
Chloride[2]	Acute Standard: 860 mg/L	
	Chronic Standard: 230 mg/L	
Dissolved Oxygen[3]	>6 mg/L	>5 mg/L
E.Coli[4]	<153 colonies/100mL in a single sample	<406 colonies/100mL in a single sample
Fluoride[5]	4 mg/L	
pH[3]	As natural occurs	Between 6.5 to 8.0 unless due to natural causes
Potassium[5]	35 mg/L	
Specific Conductivity[2]	Background Levels, Normal: 0-100 µS/cm	
Surfactants[1]	0.25 mg/L	
Temperature[3]	No numeric standard; as naturally occurs	
TNK	No numeric standard; as naturally occurs[3]	No numeric standard; as naturally occurring, shall contain no nitrogen in such concentrations that would impair any existing or designated uses
	Average: 0.26 - 0.40 mg/L[2]	Average: 0.26 - 0.40 mg/L[2]
Total Phosphorus[6]	0.40 mg/L	
Turbidity[3]	No Turbidity unless naturally occurring	Shall not exceed naturally occurring conditions by more than 10 NTU

These concentrations should be used as a guideline for detecting illicit discharges when field screening dry weather flows or evaluating laboratory data for samples that were collected. Background concentrations should also be considered. Once several outfalls have been sampled, background levels will become more evident with a range of common values. Results greater than the acceptable concentrations should flag a site for investigation; however, results that fall below these concentrations should not be ignored.

As outlined in General NPDES Permit No. ILR40, ammonia greater than or equal to 0.50 mg/L, surfactants greater than or equal to 0.25 mg/L, and either bacterial levels greater than applicable water quality criteria or detectable levels of chlorine shall be considered highly likely to contain illicit discharges. As such, these catchments shall be ranked at the top of High Priority Catchments category for investigation.

As data is collected for dry weather flows throughout town, the results that fall below the acceptable concentrations may be useful for gauging background water quality. The background concentrations can be used to evaluate sites for investigation based on the data statistics (e.g., range, average). For example, if dissolved oxygen results for dry weather flows throughout town show an average of 6.5 mg/L; sites that fall below 5.0 mg/L may warrant further investigation because the results are lower than the background level. This method of data evaluation may reveal potential sources of illicit discharges that may not be large contributors of pollution but create an opportunity to improve water quality if removed.

NPDES Permitted Facilities

Illicit discharge detection efforts in industrial areas of Village should always consider existing dry weather flows that have a NPDES Permit to discharge. These facilities are required to meet numeric effluent standards in accordance with the NPDES provisions and the Clean Water Act. Therefore, these flows do not require additional evaluation under the Village Illicit Discharge Detection and Elimination Plan unless it appears there is a large pollution problem.

The EPA currently has these facilities listed with the NPDES program located in the village limits, see **Table 4**.

Table 4 – Reference NPDES Permittees

NPDES Permittee	
Name	**Address**
Contractor's Concrete Inc.	1073 County RD 900 N Tolono, IL 61880-9747
Mayflower Contract Services	619 S Rte. 45 Tolono, IL 61880
Tolono STP, Village of	South Bourne Street Tolono, IL 61880

The EPA website should be periodically checked to identify new NPDES permittees.

- http://www.epa.gov/enviro/facts/pcs/search.html

3.3 Wet Weather Sampling

Wet weather screening and sampling may be needed for some outfalls where vulnerabilities are identified as discussed under Section 4.4. In these cases, wet weather screening and sampling shall proceed during or after a storm event of sufficient depth or intensity to produce a storm water discharge but only during the spring (March to June) when groundwater levels are relatively high. The purpose of wet weather screening and sampling is to identify illicit discharges that may activate or become evident during wet weather, therefore should be sampled under conditions where storm event intensities are likely to trigger a septic system failure (e.g., heavy rains or rains of long duration rather than first flush). Samples should be analyzed for the same parameters outlined in Section 4.2 for dry weather sampling.

3.4 Catchment Investigation Procedures

In addition to the outfall screening, EPA is expected to require investigation of all catchments to determine the potential for illicit connections. The following procedures shall be followed for catchment investigations and updated as necessary based on the requirements in the final MS4 permit.

1) Review Mapping and Historic Plans and Records – Review relevant mapping and historic plans and records to the extent available, including but not limited to plans related to the construction of the storm drains in the catchment, prior work performed on the storm drain system, municipal data on sanitary sewer system failures or required upgrades, and complaint records related to sanitary sewer system breakouts. This review shall be used to identify areas within the catchment with higher potential for illicit connections and system vulnerabilities that indicate a risk of sanitary sewer system

inputs to the MS4 under wet weather conditions. Identify and record the presence of any specific system vulnerabilities:

Include the results of this evaluation with this IDDE Plan. Where system vulnerabilities are present, the catchment area shall be inspected and sampled under wet weather conditions as outlined in Section 4.3.

2) Identify and Inspect Key Junction Manholes – Identify key junction manholes for dry and wet (where system vulnerabilities are present) weather inspection. A key junction manhole is one that can represent one or more junction manholes in evaluating the presence of potential illicit connections. Thus, a manhole can be excluded from investigation if the same information can be gathered through investigation of other nearby key junction manholes.

3) Isolation and Source Verification – Where manhole investigations or other physical evidence or screening has identified the potential presence of illicit discharges, more detailed investigations must be performed. Follow the procedures outlined in Section 4.5 for source investigation.

3.5 Source Investigation

Once an illicit discharge is identified at an outfall, further investigation is necessary to identify the specific point where the illicit discharge comes from (source). The objective of a source investigation is to trace the path of an illicit discharge from the outfall or manhole to the upstream source.

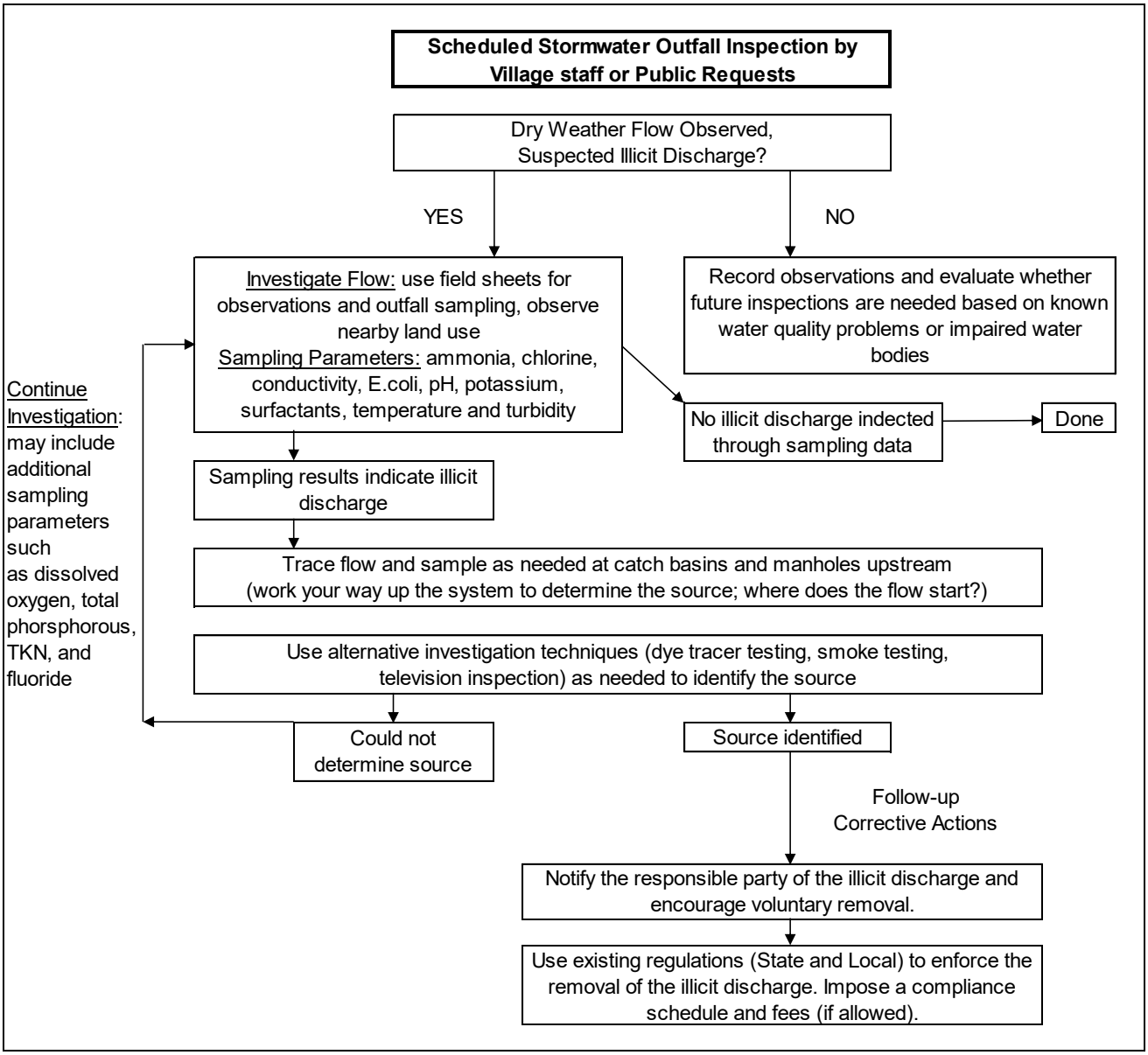
It is important to first identify the drainage network and catchment area contributing to an outfall before evaluating the source of an illicit discharge. The sampling results may give an indication of a possible source and help narrow the search. The procedures used for source investigation will vary depending on field conditions; however, typical procedures should at least begin with historic record evaluations and field surveys before progressing through additional tests or procedures, as outlined below:

- **Field Reviews** – surveying the drainage system and land area that contributes to an outfall is the first and perhaps the quickest and easiest method for identifying the sources of illicit discharges. It is important for field crews to remember to observe the land use and activities surrounding the outfall and the up gradient drainage system to determine if there are any obvious sources that could be causing the illicit discharge. Tracing the drainage system by inspecting manholes and connecting drainage pipes can often lead to the source. A quick survey of nearby land uses and activities may reveal the source immediately (for example a nearby car washing event). Also, field crews can simply follow the non-storm water discharge if it is flowing. However, some cases may require additional methods, as discussed below, if a flow cannot be traced due to blind connections or complicated drainage networks.

- **Dye Tracer Testing** – fluorometric dye can be used to trace flows from unknown pipes to identify illicit connections to the drainage system. Once the dye has been introduced into a drain (e.g., building floor drain) or other suspect pipe to the drainage system, the water in the collection system is monitored for the dye to determine whether an illicit connection is present. It is important to use a fluorometric dye that is non-toxic to humans and aquatic life.
- **Smoke Testing** – smoke testing is another method used to discover and investigate illicit connections. Non-toxic smoke can be injected into the drainage system or into individual unknown connections to the drainage system. In order for the smoke test to be effective, pipes must be plugged to prevent smoke from easily escaping through manholes, catch basins, or daylight areas. For example, a portion of a drainage system could be filled with smoke to determine if there are any sanitary sewer cross connections from nearby residential buildings. If a cross connection exists, smoke will appear from the building's sanitary sewer vent at the roof. The smoke should not affect residents since nearly all sanitary sewer systems have a trap that will prevent smoke from backing up into the house. In many cases smoke testing will only be used once an unknown pipe is identified. The individual pipe can be plugged and filled with smoke while workers look for signs of smoke at nearby buildings or facilities. It is important to notify the public prior to conducting smoke testing to inform them of when the activity will occur and that the smoke is non-toxic and will not affect their building. This notification presents a good opportunity to involve the public as observers during the smoke test and to educate local residents about storm water, allowable non-storm water discharges and illicit discharges. Providing the public with an opportunity to participate in the illicit discharge source investigation will promote IDDE efforts and awareness throughout town.
- **Television Inspection** – remotely guiding television cameras through the drainage system is another way to identify illicit connections. There may be blind connections (i.e., lateral connections to a pipe system with no manhole) to the drainage system that TV inspection can readily identify. Any connections identified during TV inspection that are not shown on the existing Village storm drain map need to be investigated to determine the source. The village can typically hire a company to perform TV inspection.

A comprehensive summary sheet for field crews is provide in **Diagram 1**.

Diagram 1 – Comprehensive Summary Sheet for Field Crews



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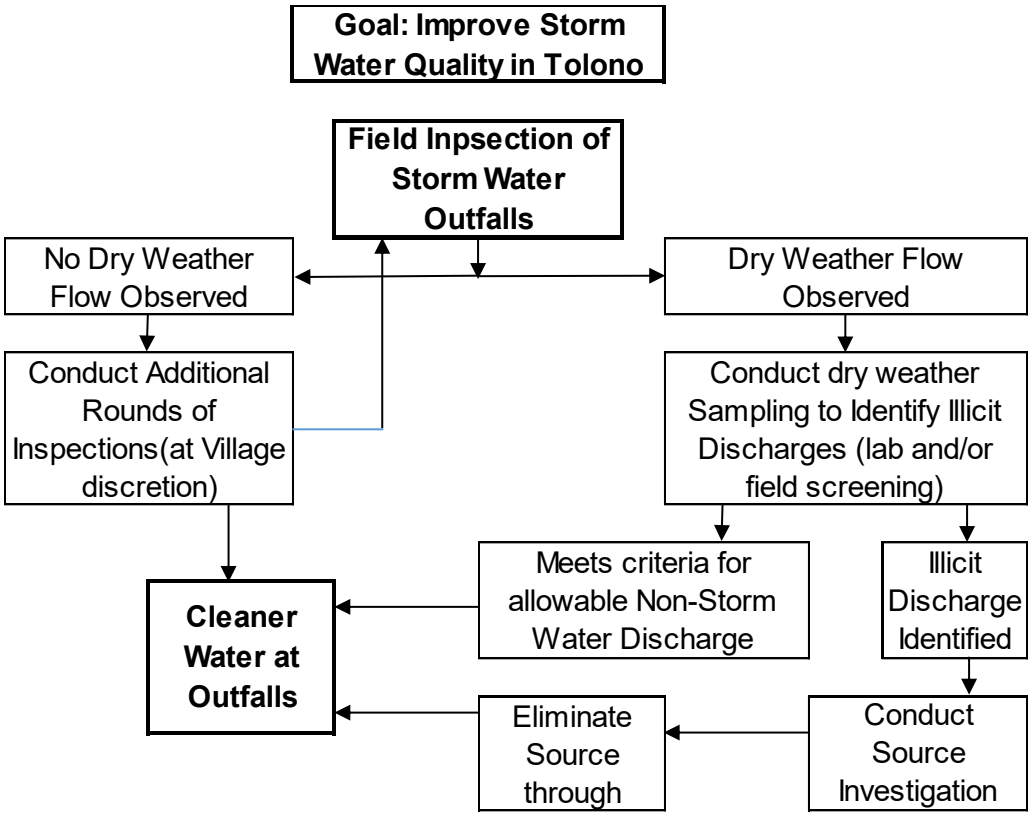
3.6 IDDE Approach

The approach for investigating and eliminating illicit discharges in the Village is summarized in the following Illicit Discharge Detection Elimination Flow Chart - **Diagram 2**.



Note: Recordkeeping is an essential tool for IDDE activities

3.7 Activities and Schedule

As outlined in the flow chart above, there is an ongoing pattern of activities for identifying and eliminating illicit discharges. The timing of some activities may appear obvious; however, a summary of the proposed activities and schedules are provided below to assist the Village in overall planning so that IDDE activities occur in a timely and cost-effective manner. **Table 5** provides a list of recommended IDDE activities and schedules.

Table 5 – Recommended IDDE Activities and Schedule

Activity	Schedule (from effective date of final permit
Dry weather screening and sampling of every MS4 outfall and interconnection (except Excluded and Problem Catchments)	Annual
Complete catchment investigation procedure in 80% of Problem Catchments	3 years
Complete catchment investigation procedure in 100% of Problem Catchments	5 years
Complete catchment investigation procedure in 100% of catchments where information indicates sewer input*	5 years
Complete catchment investigation procedure in 40% of all catchments	5 years
Complete catchment investigation procedure in 100% of all catchments	10 years
Source investigation	As soon as sampling results are obtained and evaluated
Source elimination	As soon as possible through enforcement procedures
Confirmatory outfall or interconnection screening	Within 1 year of removal of all identified illicit discharge and SSO sources
Follow-up screening upon completion of catchment investigation and illicit discharge removal and confirmation (if necessary)	5 years

*Includes outfall/interconnection screening that indicates sewer input based on olfactory/visual evidence or sampling results.

3.8 Recordkeeping

A field inspection log is provided in Appendix A for storm water outfall inspections. These logs begin the IDDE recordkeeping process and much more information will follow such as laboratory data, field notes for source investigations, and correspondence with property owners for source elimination and enforcement.

To ensure an effective and well-maintained IDDE program, the Village should update records annually to address the following topics:

- Summary of findings for field inspections & needs for subsequent rounds;
- Summary of dry weather sampling results & future needs;
- Identified sources & source elimination efforts;
- Illicit discharges eliminated;
- Status of IDDE activities by catchment; and
- Recommendations for future IDDE activities.

3.9 Activities Completed to Date

Storm water system mapping of the entire village is performed concurrently with IDDE inspections. Manholes, catch basins and outfalls were mapped separately in the field. All structure locations were recorded with a Global Positioning System (GPS) unit and incorporated into the GIS base map as shown on **Map 3** Storm Water System Map in the Appendix.

As new outfalls and other structure are located or installed, the base map is periodically updated approximately once a year to reflect changes.

4.0 Elimination of Illicit Discharges

The previous sections provide background information and a program for detecting illicit discharges to the MS4 in the Village. This section focuses on program effectiveness (i.e., elimination of illicit discharges), which is the ultimate result of a successful IDDE program. Program effectiveness or the elimination of illicit discharges can be broken down into two major categories: prevention (pre-occurrence) and removal of illicit discharges (post-occurrence), which are discussed below.

4.1 Prevention

Prevention of illicit discharges is achieved through education, outreach, and advocacy. Education and advocacy programs that are targeted towards identifying where and when possible illicit discharges and connections occur are good long-term prevention activities.

The following activities can be used in the Village to help prevent illicit discharges to the drainage system:

- Educate the public on illicit discharges and the impacts to ecological and human health using existing avenues such as water bill mailers, flyer handouts, newspaper articles, and posting a storm water display during Village events;
- Utilize the Village website by developing and maintaining a dedicated "Storm water Management" page to provide information on upcoming programs, proper waste disposal, and pollution reduction techniques;
- Hold periodic meetings with target audiences to encourage awareness and promote stewardship of the storm drain system, emphasizing the cause and effect relationship between non-storm water inputs to the drainage system and water quality impacts;
- Host periodic public events such as roadside cleanups to allow interested residents the opportunity to participate in the Villages storm water program;
- Establish a storm drain marking program to educate and potentially involve the community to promote illicit discharge prevention;
- Hold bi-annual household hazardous waste collections days to give residents the opportunity to properly dispose of wastes;
- Provide information on spill response and prevention procedures, including identifying and containing spills, reporting procedures, and documentation;
- Utilize the annual IDDE program evaluation results to promote and support the program in the Village;
- Educate the public about the consequences of violations; and/or
- Direct citizens to voice concerns or information regarding illicit discharges to the village officials

4.2 Removing Illicit Discharges

Once an illicit discharge or connection is identified and confirmed, the village will document the following information for its records:

- Location of the discharge and its source;
- Description of the discharge;
- Method of discovery;
- Date of discovery;
- Date of elimination;
- Mitigation or enforcement action (see below); and
- Estimate of the volume of flow removed.

The removal of the illicit discharge can be accomplished through voluntary elimination or legal enforcement, as discussed below.

Voluntary Elimination

The voluntary elimination of illicit discharges is strongly encouraged. Through voluntary elimination, the responsible party of an illicit discharge can be contacted and informed about the incident by telephone. A responsible village official should make this contact after an illicit discharge has been identified and verified. When a responsible party is contacted, the following information should be provided:

- Details on the identification and verification process;
- Information on the actions or types of BMPs that should be implemented to correct the problem; and
- Potential support and incentives that the Village can offer as a result of the voluntary approach.

This approach is the quickest and provides an opportunity for the responsible party to correct the problem in a cost-effective manner, versus a legal enforcement obligation, which is discussed below.

Legal Enforcement

Legal enforcement action is often necessary to completely eliminate illicit discharges in the village, particularly those that have significant cost implications. The Village will drafted an illicit discharge ordinance governing discharges to the municipal storm drain system for prohibition and removal. This ordinance will allow the Village to enforce and effectively remove illicit discharges to comply with the Storm Water Regulations. Generally, enforcement of illicit discharges can be implemented through the following methods which will be incorporated into the ordinance:

- ***Written Order*** – When proof of a discharge and the responsible party are identified, the village may issue a written order outlining the requirements for compliance with local ordinances. If the enforcing person determines that abatement or remediation is required, the order shall establish a deadline that abatement or remediation activities must be completed.
- ***Reimbursement*** – If remediation is not completed by the time outlined in the written order, the village may complete the necessary work and seek reimbursement by the offending party. The violator will then have thirty days to reimburse the village for work incurred, or have a lien placed on the property.
- ***Penalties or Fines*** – Penalties and fines can be issued to the responsible party if the problem has not been corrected as outlined in the written order.
  For example, if remediation is not completed within the timetable established by the written order, the village may assess penalties to accrue for each day the violation continues. The village can use penalties and fines to recover the cost of enforcement, and may establish other appropriate corrective measures.

- ***Civil and/or Criminal Court Actions*** – As a final effort, the village may use civil and/or criminal court actions under the local, state, and federal laws and regulations such as the Clean Water Act, which may result in significant fines levied upon the noncompliant responsible parties.

4.3 Confirmatory Sampling

Within one year of removal, confirmatory sampling will be conducted during dry weather to verify that the illicit discharge has been removed. If confirmatory screening indicates evidence of an additional illicit discharge, the catchment shall be reinvestigated as documented previously.

TOLONO ILLINOIS - STORM WATER ILLICIT DISCHARGE DETECTION & ELIMINATION (IDDE) PLAN

OUTFALL INSPECTION CHECKLIST

OUTFALL ID# _____ **LOCATION AID#** _____

DATE:_____ **TIME:**_____ **WEATHER TODAY:**_____

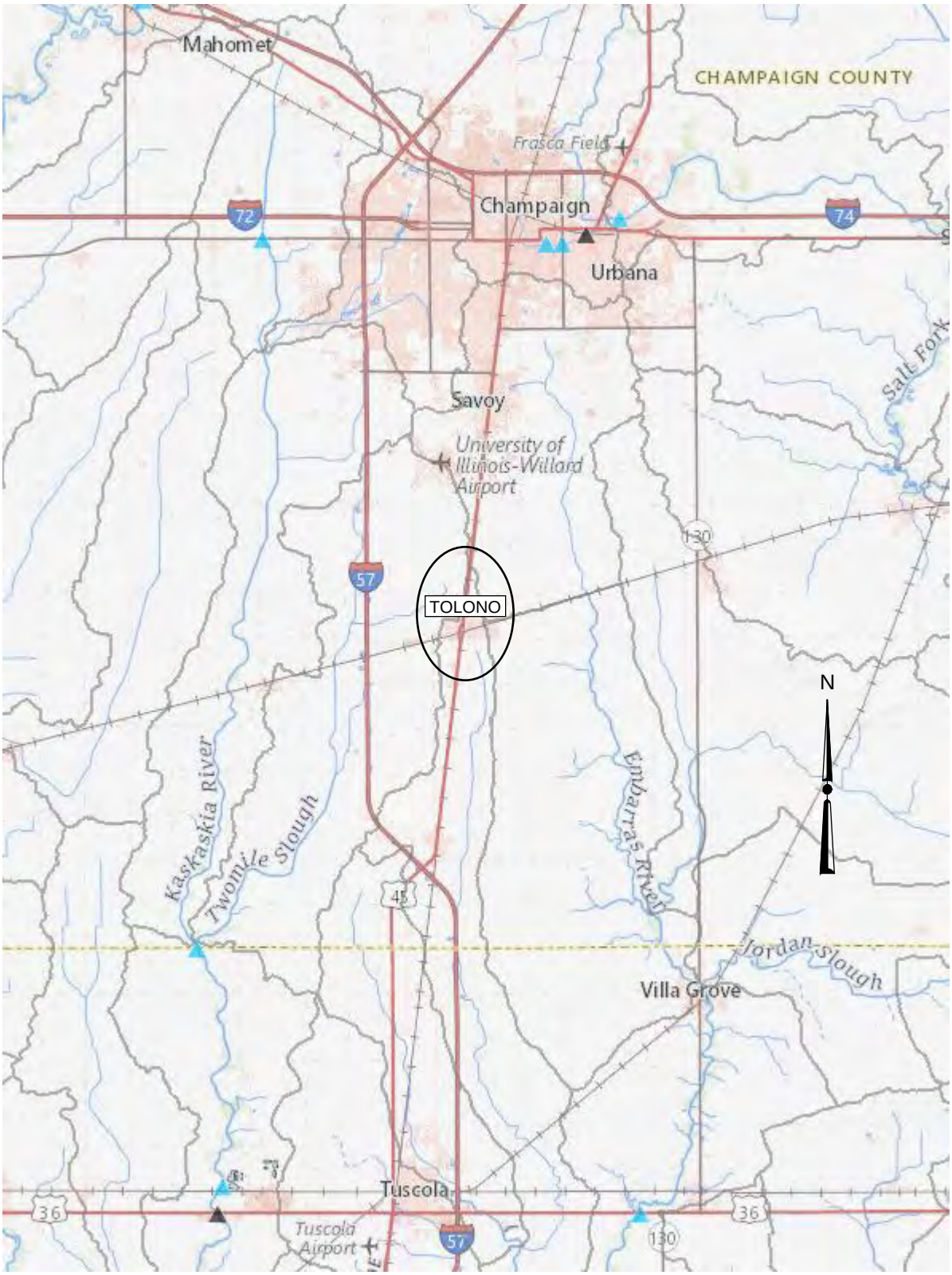
OBSERVER(S):_____ **WEATHER OVER PAST 72 HOURS:**_____

FLOW OBSERVED (CIRCLE): YES NO

1.) FLOW OBSERVATIONS(FILL OUT THIS SECTION ONLY IF FLOW IS OBSERVED	**PIPE FLOW DEPTH (INCHES) NOTE: MEASURE FROM PIPE INVERT**	**CHANNEL, DITCH,OR SWALE FLOW DEPTH (INCHES) NOTE: MEASURE FROM CENTER OF CONVEYANCE**	**FLOW APPEARANCE / COLOR**	**FLOW ODOR**	**FIELD MONITORING DATA (NOTE: FILL IN UNITS FOR EACH PARAMETER)**				
					TURBUDITY	**TEMPERATURE**	**pH**	**CONDUCTIVITY**	**COMMENTS**
	 — DEPTH	 — DEPTH	— CLEAR — CLOUDY/MILKY — DARK (TEA) — SHEEN — SUSPENDED SEDIMENT (OPAQUE) — OTHER *	— NONE — CHEMICAL — PETROLEUM — SEWAGE — OTHER *					
2.) STRUCTURE DETAILS (PIPE OR OTHER CONVEYEANCE INFO.)	**PIPE MATERIAL**	**PIPE CONDITION**	**CHANNEL, DITCH OR SWALE CONDITION**	**DIAMETER OR WIDTH (SPECIFY DISTANCE UNITS)**	**SLOPE DEGREES**	**OUTLET STRUCTURE**	**GPS COORDINATES**	**DISCHARGE DIRECTLY TO SURFACE WATER**	**COMMENTS**
	— CLAY — CONCRETE — CORRUGATED STEEL — PVC — CAST IRON — HDPE — STEEL (DI)	— GOOD — CRACKED — EXPOSED STEEL — CORRODED — OTHER *	— GOOD — CLOGGED — DEBRIS — SCOURED OR ERODED — OTHER *		— FLAT — MODERATE — STEEP	— HEADWALL — RIPRAP — FLARED END — NO OUTLET PROTECTION — OTHER *	LAT._____ LON._____	— YES — NO IF YES, PROVIDE RECEIVING WATER NAME	
3.) OUTFALL OBSERVATIONS (GENERAL CONDITIONS AT OUTFALL)	**DEPOSITS**	**SURROUNDING VEGATATION**	**ERODIBILITY**	**LAND USE AT OUTFALL**	**LAND USE UPSTREAM OF OUTFALL**	**APPEARANCE / COLOR**	**ODOR**	**SEDIMENT DEPTH (INCHES) (IF PRESENT)**	**COMMENTS**
	— NONE — GREASE/OIL — PAPER/TRASH — FOAM — HEAVY SEDIMENT DEPOSITS — OTHER *	— LITTLE OR NO DISTRESS — MODERATE DISTRESS — HIGH DISTRESS	— LITTLE OR NO EROSION — SMALL AREAS OF EROSION — MANY ERODED AREAS	— FOREST — AGRICULTURE — RESIDENTIAL — COMMERCIAL — INDUSTRIAL — WATERBODY — DETENTION POND/BASIN	— FOREST — AGRICULTURE — RESIDENTIAL — COMMERCIAL — INDUSTRIAL	— CLEAR — CLOUDY/MILKY — DARK (TEA) — SHEEN — SUSPENDED SEDIMENT (OPAQUE) — OTHER *	— NONE — CHEMICAL — PETROLEUM — SEWAGE — OTHER *		
4.) LABORATORY ANALYSIS (CHECK IF SUBMITTED	**SURFACTANT**	**AMMONIA CONCENTRATION**	**E. COLI**	**OIL & GREASE (IF OIL OR SHEEN IS OBSERVED)**	**VOCs (IF SOLVENT ODOR IS PRESENT)**	**ADDITIONAL FIELD COMMENTS AND NOTES**			

NOTES:
* PROVIDE ADDITIONAL COMMENTS TO DESCRIBE THE OBSERVATIONS MADE FOR THE CATEGORY.
** DISCHARGES DIRECTLY TO SURFACE WATERS ARE DIFINED AS: ANY CONVEYANCE OR DISCERNABLE CONCENTRATED FLOW (I.E., PIPE, SWALE, DITCH) OTHER THAN OVERLAND SHEET FLOW THAT ENTERS A BODY OF WATER

MAP 1



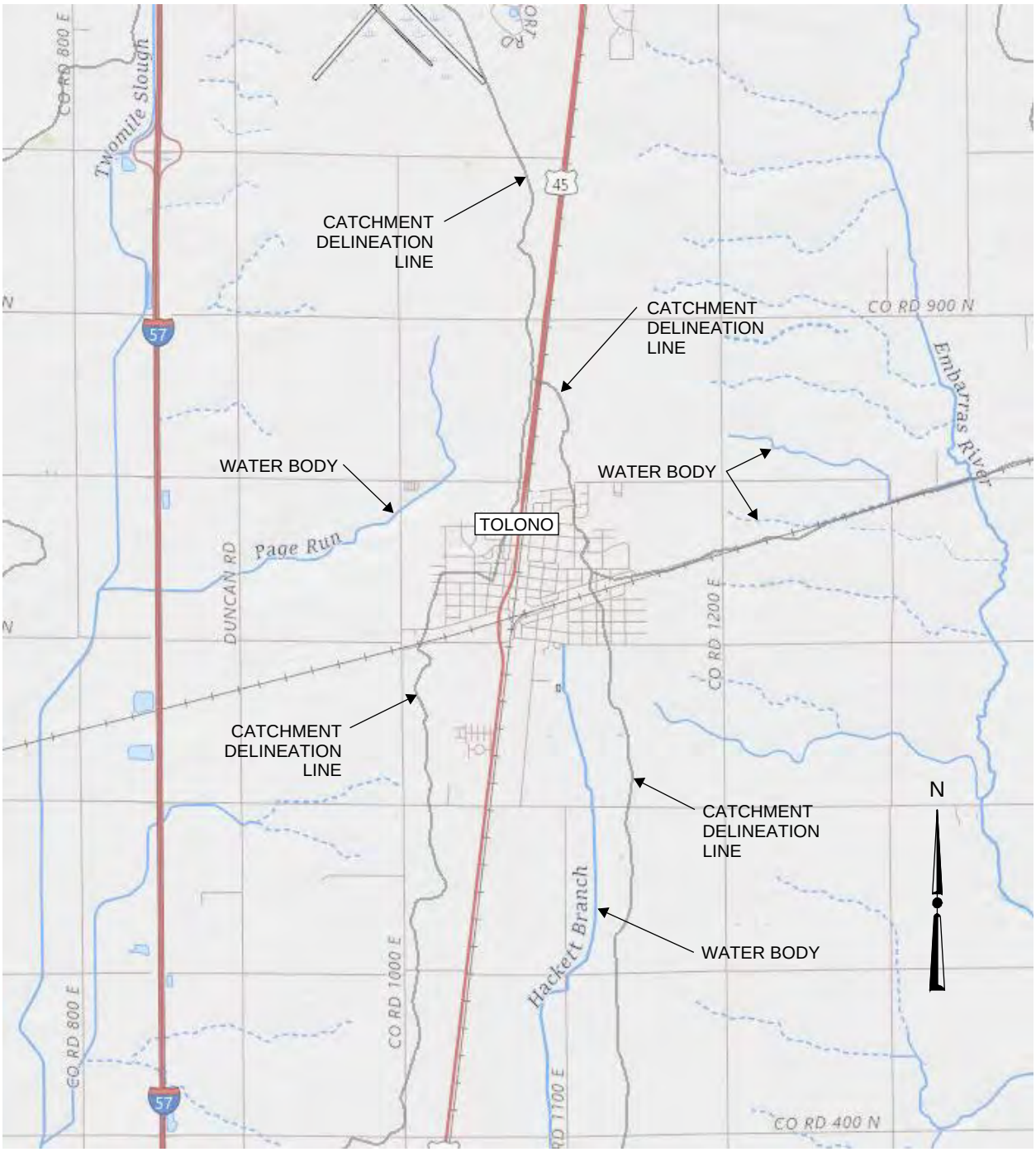
TOLONO ILLINOIS

LOCATION MAP

NOT TO SCALE

Source: USGS Stream Stats

MAP 2

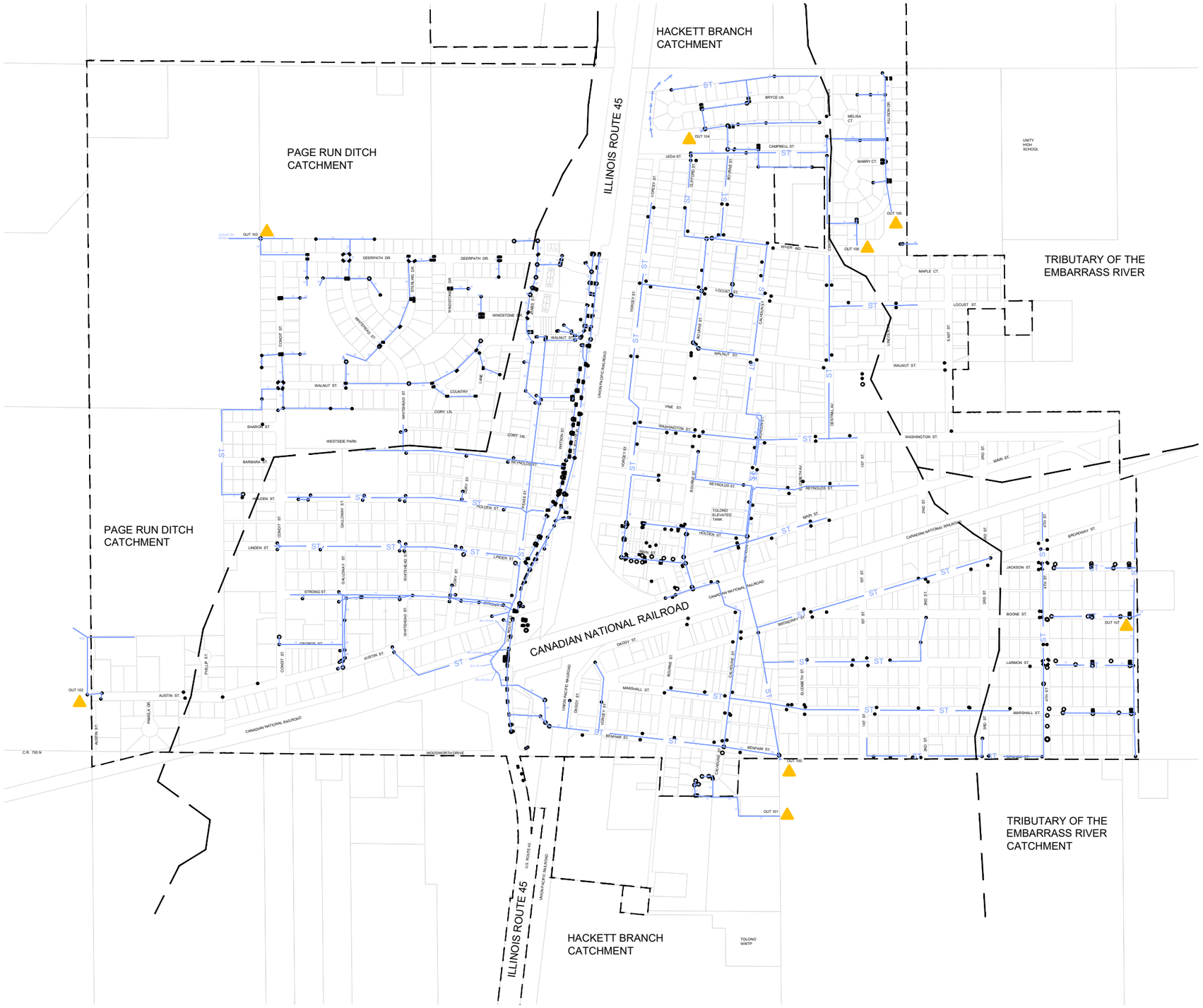


TOLONO ILLINOIS

CATCHMENT AND DELINEATION MAP

NOT TO SCALE

Source: USGS StreamStats



NTS

LEGEND

- CORPORATE LIMIT LINE
- CATCHMENT DELINEATION LINE
- STORM SEWER AND SIZE
- STORM MANHOLE
- STORM INLET
- STORM CURB INLET
- OUTFALL LOCATION AND IDENTIFIER

Revision Number	Revision Description	Drawn By	Checked By	Date
1	REVISED WATER SYSTEM WITH GPS LOCATING OF STRUCTURES	JAB		JULY 30, 2020

Designed By	JAB
Drawn By	JAB
Checked By	
Approved By	
Filename	STRM 002CK-1.DWG
Project No.	13531
Project Date	FEB 2021

VILLAGE OF TOLONO
STORM WATER SYSTEM MAP
ILLICIT DISCHARGE DETECTION ELIMINATION PLAN
STORM WATER SYSTEM MAP URBANIZED AREA (UA)

DONOHUE

Sheet No.

Drawing No.

MAP 3

U.S. EPA Stormwater Educational Videos

Reduce Runoff: Slow It Down, Spread It Out, Soak It In

Building Green: A Success Story in Philadelphia

RiverSmart Homes: Getting Smart about Runoff in Washington, DC

EPA United States Environmental Protection Agency

Office of Wetlands, Oceans, and Watersheds

http://water.epa.gov/aboutow/owow/

EPA-840-F-10-004

EPA United States Environmental Protection Agency

1200 Pennsylvania Ave, NW

4501T

Washington, DC 20012

What is LID (Low Impact Development) ?

Low Impact Development (LID), also known as Green Infrastructure, helps mimic the natural way water moves through an area before development by using design techniques that infiltrate, evapotranspirate, and reuse runoff close to its source. LID helps protect and restore water quality. Using vegetated areas that capture runoff also improves air quality, mitigates the effects of urban heat islands, and reduces a community's overall carbon footprint.

For more information, visit:

Low Impact Development
www.epa.gov/nps/lid

Green Infrastructure
www.epa.gov/greeninfrastructure

Watch the videos and download them for free!

http://www.epa.gov/nps/lid/video.html

Reduce Runoff: Slow It Down, Spread It Out, Soak It In

This 9-minute video by the U.S. EPA and the U.S. Botanic Garden highlights green techniques such as rain gardens, green roofs and rain barrels to help manage stormwater runoff. The film showcases green techniques that are being used in urban areas to reduce the effects of stormwater runoff on the quality of downstream receiving waters. The techniques are innovative stormwater management practices that manage urban stormwater runoff at its source, reduce the volume of stormwater runoff, and capture harmful pollutants. Using vegetated areas to capture runoff improves air quality, mitigates the effects of urban heat islands, and reduces a community's carbon footprint. The video is also available with Spanish subtitles.

Building Green: A Success Story in Philadelphia

In 2010, EPA's Office of Water produced this 11-minute video which highlights innovative efforts by green builders in Philadelphia who are helping protect and restore environmental quality and beautify the city. By installing cisterns, green roofs, porous pavers, solar panels, and Energy Star appliances, builders are capturing rainwater, reducing stormwater runoff, and saving energy. The exciting news is that the units are selling even in a depressed market, thanks to many of the amenities, including the attractive green roofs, reduced utility bills and proximity to public transit. The city is now offering incentives to builders and developers like Onion Flats to use green techniques to help meet clean water and other environmental goals.

RiverSmart Homes: Getting Smart about Runoff in Washington, DC

This 12-minute video produced in 2010 highlights RiverSmart Homes, a program that was launched in 2006 by the District Department of the Environment as a way to combat Washington, DC's serious stormwater problems and to actively involve the community. Residential properties are the single largest land use in the nation's capital, and the program actively engages the community in restoring the rivers. Thanks to this unique urban waters project, homeowners in diverse city neighborhoods are enthusiastically adopting environmentally friendly landscaping practices to reduce the effects of stormwater runoff and help bring back the Anacostia and Potomac Rivers, as well as lesser known Rock Creek and Oxon Run.

After the Storm

For more information contact:

or visit
www.epa.gov/npdes/stormwater
www.epa.gov/nps

EPA 833-B-03-002

January 2003

A Citizen's Guide to Understanding Stormwater

What is stormwater runoff?

Stormwater runoff occurs when precipitation from rain or snowmelt flows over the ground. Impervious surfaces like driveways, sidewalks, and streets prevent stormwater from naturally soaking into the ground.

Why is stormwater runoff a problem?

Stormwater can pick up debris, chemicals, dirt, and other pollutants and flow into a storm sewer system or directly to a lake, stream, river, wetland, or coastal water. Anything that enters a storm sewer system is discharged untreated into the waterbodies we use for swimming, fishing, and providing drinking water.

The effects of pollution

Polluted stormwater runoff can have many adverse effects on plants, fish, animals, and people.

- Sediment can cloud the water and make it difficult or impossible for aquatic plants to grow. Sediment also can destroy aquatic habitats.

- Excess nutrients can cause algae blooms. When algae die, they sink to the bottom and decompose in a process that removes oxygen from the water. Fish and other aquatic organisms can't exist in water with low dissolved oxygen levels.

- Bacteria and other pathogens can wash into swimming areas and create health hazards, often making beach closures necessary.
- Debris—plastic bags, six-pack rings, bottles, and cigarette butts—washed into waterbodies can choke, suffocate, or disable aquatic life like ducks, fish, turtles, and birds.
- Household hazardous wastes like insecticides, pesticides, paint, solvents, used motor oil, and other auto fluids can poison aquatic life. Land animals and people can become sick or die from eating diseased fish and shellfish or ingesting polluted water.
- Polluted stormwater often affects drinking water sources. This, in turn, can affect human health and increase drinking water treatment costs.

Stormwater Pollution Solutions

Education is essential to changing people's behavior. Signs and markers near storm drains warn residents that pollutants entering the drains will be carried untreated into a local waterbody.

Residential

Recycle or properly dispose of household products that contain chemicals, such as insecticides, pesticides, paint, solvents, and used motor oil and other auto fluids. Don't pour them onto the ground or into storm drains.

Auto care

Washing your car and degreasing auto parts at home can send detergents and other contaminants through the storm sewer system. Dumping automotive fluids into storm drains has the same result as dumping the materials directly into a waterbody.

- Use a commercial car wash that treats or recycles its wastewater, or wash your car on your yard so the water infiltrates into the ground.
- Repair leaks and dispose of used auto fluids and batteries at designated drop-off or recycling locations.

Lawn care

Excess fertilizers and pesticides applied to lawns and gardens wash off and pollute streams. In addition, yard clippings and leaves can wash into storm drains and contribute nutrients and organic matter to streams.

- Don't overwater your lawn. Consider using a soaker hose instead of a sprinkler.
- Use pesticides and fertilizers sparingly. When use is necessary, use these chemicals in the recommended amounts. Use organic mulch or safer pest control methods whenever possible.
- Compost or mulch yard waste. Don't leave it in the street or sweep it into storm drains or streams.
- Cover piles of dirt or mulch being used in landscaping projects.

Septic systems

Leaking and poorly maintained septic systems release nutrients and pathogens (bacteria and viruses) that can be picked up by stormwater and discharged into nearby waterbodies. Pathogens can cause public health problems and environmental concerns.

- Inspect your system every 3 years and pump your tank as necessary (every 3 to 5 years).
- Don't dispose of household hazardous waste in sinks or toilets.

Pet waste

Pet waste can be a major source of bacteria and excess nutrients in local waters.

- When walking your pet, remember to pick up the waste and dispose of it properly. Flushing pet waste is the best disposal method. Leaving pet waste on the ground increases public health risks by allowing harmful bacteria and nutrients to wash into the storm drain and eventually into local waterbodies.

Residential landscaping

Permeable Pavement—Traditional concrete and asphalt don't allow water to soak into the ground. Instead these surfaces rely on storm drains to divert unwanted water. Permeable pavement systems allow rain and snowmelt to soak through, decreasing stormwater runoff.

Rain Barrels—You can collect rainwater from rooftops in mosquito-proof containers. The water can be used later on lawn or garden areas.

Rain Gardens and Grassy Swales—Specially designed areas planted with native plants can provide natural places for rainwater to collect and soak into the ground. Rain from rooftop areas or paved areas can be diverted into these areas rather than into storm drains.

Vegetated Filter Strips—Filter strips are areas of native grass or plants created along roadways or streams. They trap the pollutants stormwater picks up as it flows across driveways and streets.

Commercial

Dirt, oil, and debris that collect in parking lots and paved areas can be washed into the storm sewer system and eventually enter local waterbodies.

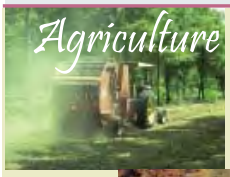
- Sweep up litter and debris from sidewalks, driveways and parking lots, especially around storm drains.
- Cover grease storage and dumpsters and keep them clean to avoid leaks.
- Report any chemical spill to the local hazardous waste cleanup team. They'll know the best way to keep spills from harming the environment.

Construction

Erosion controls that aren't maintained can cause excessive amounts of sediment and debris to be carried into the stormwater system. Construction vehicles can leak fuel, oil, and other harmful fluids that can be picked up by stormwater and deposited into local waterbodies.

- Divert stormwater away from disturbed or exposed areas of the construction site.
- Install silt fences, vehicle mud removal areas, vegetative cover, and other sediment and erosion controls and properly maintain them, especially after rainstorms.
- Prevent soil erosion by minimizing disturbed areas during construction projects, and seed and mulch bare areas as soon as possible.

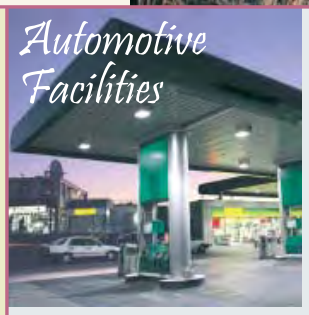
Agriculture



Lack of vegetation on streambanks can lead to erosion. Overgrazed pastures can also contribute excessive amounts of sediment to local waterbodies. Excess fertilizers and pesticides can poison aquatic animals and lead to destructive algae blooms. Livestock in streams can contaminate waterways with bacteria, making them unsafe for human contact.

- Keep livestock away from streambanks and provide them a water source away from waterbodies.
- Store and apply manure away from waterbodies and in accordance with a nutrient management plan.
- Vegetate riparian areas along waterways.
- Rotate animal grazing to prevent soil erosion in fields.
- Apply fertilizers and pesticides according to label instructions to save money and minimize pollution.

Automotive Facilities



Uncovered fueling stations allow spills to be washed into storm drains. Cars waiting to be repaired can leak fuel, oil, and other harmful fluids that can be picked up by stormwater.

- Clean up spills immediately and properly dispose of cleanup materials.
- Provide cover over fueling stations and design or retrofit facilities for spill containment.
- Properly maintain fleet vehicles to prevent oil, gas, and other discharges from being washed into local waterbodies.
- Install and maintain oil/water separators.

Forestry

Improperly managed logging operations can result in erosion and sedimentation.

- Conduct preharvest planning to prevent erosion and lower costs.
- Use logging methods and equipment that minimize soil disturbance.
- Plan and design skid trails, yard areas, and truck access roads to minimize stream crossings and avoid disturbing the forest floor.
- Construct stream crossings so that they minimize erosion and physical changes to streams.
- Expedite revegetation of cleared areas.

Clean Water

Everybody's Business

10 Things You Can Do to Prevent Stormwater Runoff Pollution

- Use fertilizers sparingly and sweep up driveways, sidewalks, and roads
- Never dump anything down storm drains
- Vegetate bare spots in your yard
- Compost your yard waste
- Avoid pesticides; learn about Integrated Pest Management (IPM)
- Direct downspouts away from paved surfaces
- Take your car to the car wash instead of washing it in the driveway
- Check car for leaks, and recycle motor oil
- Pick up after your pet
- Inspect and pump your septic tank regularly

EPA United States Environmental Protection Agency

For more information, visit www.epa.gov/nps or www.epa.gov/npdes/stormwater

Stormwater and the Construction Industry

Protect Natural Features

- Minimize clearing.
- Minimize the amount of exposed soil.
- Identify and protect areas where existing vegetation, such as trees, will not be disturbed by construction activity.
- Protect streams, stream buffers, wild woodlands, wetlands, or other sensitive areas from any disturbance or construction activity by fencing or otherwise clearly marking these areas.

Construction Phasing

- Sequence construction activities so that the soil is not exposed for long periods of time.
- Schedule or limit grading to small areas.
- Install key sediment control practices before site grading begins.
- Schedule site stabilization activities, such as landscaping, to be completed immediately after the land has been graded to its final contour.

Vegetative Buffers

- Protect and install vegetative buffers along waterbodies to slow and filter stormwater runoff.
- Maintain buffers by mowing or replanting periodically to ensure their effectiveness.

Silt Fencing

- Inspect and maintain silt fences after each rainstorm.
- Make sure the bottom of the silt fence is buried in the ground.
- Securely attach the material to the stakes.
- Don't place silt fences in the middle of a waterway or use them as a check dam.
- Make sure stormwater is not flowing around the silt fence.

Maintain your BMPs!

www.epa.gov/npdes/menuofbmps

Site Stabilization

- Vegetate, mulch, or otherwise stabilize all exposed areas as soon as land alterations have been completed.

Construction Entrances

- Remove mud and dirt from the tires of construction vehicles before they enter a paved roadway.
- Properly size entrance BMPs for all anticipated vehicles.
- Make sure that the construction entrance does not become buried in soil.

Slopes

- Rough grade or terrace slopes.
- Break up long slopes with sediment barriers, or under drain, or divert stormwater away from slopes.

Dirt Stockpiles

- Cover or seed all dirt stockpiles.

Storm Drain Inlet Protection

- Use rock or other appropriate material to cover the storm drain inlet to filter out trash and debris.
- Make sure the rock size is appropriate (usually 1 to 2 inches in diameter).
- If you use inlet filters, maintain them regularly.

Stormwater and the Construction Industry

Planning and Implementing Erosion and Sediment Control Practices

The construction industry is a critical participant in the nation's efforts to protect streams, rivers, lakes, wetlands, and oceans. Through the use of best management practices (BMPs), construction site operators are the key defense against erosion and sedimentation.

As stormwater flows over a construction site, it picks up pollutants like sediment, debris, and chemicals. High volumes of stormwater can also cause stream bank erosion, and destroy downstream aquatic habitat. Preventing soil erosion and sedimentation is an important responsibility at all construction sites.

In addition to the environmental impact, uncontrolled erosion can have a significant financial impact on a construction project. It costs money and time to repair gullies, replace vegetation, clean sediment-clogged storm drains, replace poorly installed BMPs, and mitigate damage to other people's property or to natural resources.

Best Management Practice (BMP)
A BMP is a method used to prevent or control stormwater runoff and the discharge of pollutants, including sediment, into local waterbodies. Silt fences, inlet protection, and site-stabilization techniques are typical BMPs on a construction site.

Operator
An operator is someone who has control over and the ability to modify construction plans and specifications (e.g. owner, general contractor)

or

Someone who has control over the day-to-day operations at a site (e.g., owner, general contractor) that are necessary to ensure compliance with the permit requirements. It is the responsibility of a construction site owner or operator to contain stormwater runoff and prevent erosion during **all** stages of a project.

There may be more than one person at a site who meets these definitions and must apply for permit coverage. (States may have different definitions of the term "operator.")

So what's being done about polluted runoff?

The Clean Water Act includes the National Pollutant Discharge Elimination System (NPDES) permitting program. As of January 2003, 44 states and territories are authorized to issue NPDES stormwater permits. If your state isn't authorized to operate the NPDES stormwater permit program, EPA issues the permits. Permits vary from state to state, so contact your state or EPA for specific information. Your permitting authority has specific information on your state's NPDES stormwater permit program. In general, construction permits require construction operators to do all of the following:

- Develop and implement a stormwater pollution prevention plan
- Submit a permit application or notice of intent (NOI)
- Comply with the permit, including maintaining BMPs and inspecting the site

Under the NPDES program, construction activities that disturb 1 or more acres are required to obtain stormwater permit coverage. States have different names for the plans that construction operators must develop, such as

- Stormwater pollution prevention plan
- Erosion and sediment control plan
- Erosion control and stormwater management plan
- Stormwater management plan
- Water pollution control plan
- Pollution prevention plan

This document uses the term "*Plan*."

I think I need a permit... Where do I start?

All land-disturbing activities, including clearing, grading, and excavation, that disturb **1 or more acres** are required to be covered under a state or EPA-issued NPDES construction stormwater permit **prior to land disturbance**. Permit requirements vary by state. Begin by researching the specific requirements in your state. You might already be subject to local erosion and sediment control requirements, but that doesn't release you from the requirements of the NPDES program at the state or EPA level. Although you must comply with both sets of requirements, in most cases they have been designed to be complementary. Contact your permitting authority to find out exactly what you need to do. A good place to start your search is the Construction Industry Compliance Assistance web site at http://www.envcap.org/cica.

The NPDES permit requirements include small construction activities that are part of a larger common plan of development or sale, such as a single lot within a larger subdivision. For developments with multiple operators, all operators must have permit coverage for their individual parts of the larger development, no matter how large or small each operation happens to be. When there are multiple operators at one site, they're encouraged to develop and share one comprehensive Plan and obtain permit coverage as co-permitees.

The **owner or operator** of the construction site is responsible for complying with the requirements of the permit. Responsibilities include developing a Plan, obtaining permit coverage, implementing BMPs, and stabilizing the site at the end of the construction activity.

Construction sites that discharge unpermitted stormwater are in violation of the Clean Water Act and may be subject to fines of up to $27,500 a day per violation.

Determine your eligibility

All construction activity that disturbs 1 or more acres of land, as well as activity that disturbs less than 1 acre but is part of a larger common plan of development, must obtain permit coverage.

Read and understand your stormwater permit requirements

Get a copy of the permit for construction activities and a permit application (or notice of intent form) from your state or EPA permitting authority.

Develop a Plan

Most states do not require you to submit your Plan. However, you do need to keep the Plan on site. If that's impractical, you may post a notice that tells where the Plan is kept so it can be accessed by the permitting authority and other interested parties.

You'll need to post a copy of your completed application on site. Put it in a place where the public can see it so they'll know your site is covered by an NPDES permit!

Apply for permit coverage

Once you understand your permit requirements and have developed a Plan, you can submit a stormwater permit application (or notice of intent) to your permitting authority. This must be done before beginning any land disturbance on the site. Some states require a few days of lead time, so check with your permitting authority. Once you've submitted the application, you must satisfy the conditions of the permit.

Implement the Plan

Be prepared to implement the BMPs in your Plan before construction begins. Ensure that BMPs are properly maintained, and upgrade and repair them as necessary.

Developing and Implementing a Plan

You must have a Plan that includes erosion and sediment control and pollution prevention BMPs. These Plans require

- Advance planning and training to ensure proper implementation of the BMPs
- Erosion and sediment control BMPs in place until the area is permanently stabilized
- Pollution prevention BMPs to keep the construction site "clean"
- Regular inspection of the construction site to ensure proper installation and maintenance of BMPs

Fortunately, the practices and measures that must be included in your Plan are already part of the standard operating procedures at many construction sites.

Six steps are associated with developing and implementing a stormwater Plan. There's a wealth of information available on developing pollution prevention plans. Please contact your permitting authority for help in finding additional guidance materials, or visit www.epa.gov/npdes/stormwater. A sample construction plan is available at www.epa.gov/npdes/pubs/sample_swppp.pdf.

1. Site Evaluation and Design Development

- **Collect site information**
- **Develop site plan design**
- **Prepare pollution prevention site map**

The first step in preparing a Plan is to define the characteristics of the site and the type of construction that will occur. This involves collecting site information, identifying natural features that should be protected, developing a site plan design, describing the nature of the construction activity, and preparing a pollution prevention site map.

2. Assessment

- **Measure the site area**
- **Determine the drainage areas**
- **Calculate the runoff coefficient**

The next step is assessing the impact the project will have on stormwater runoff. Determine the drainage areas and estimate the runoff amounts and velocities. For more information on calculating the runoff coefficient, go to www.epa.gov/npdes/pubs/chap02_conguide.pdf, page 11.

3. Control Selection and Plan Design

- **Review and incorporate state or local requirements**
- **Select erosion and sediment controls**
- **Select other controls**
- **Select stormwater management controls**
- **Indicate the location of controls on the site map**
- **Prepare an inspection and maintenance plan**
- **Coordinate controls with construction activity**
- **Prepare sequence of major activities**

In the third step you'll actually document your procedures to prevent and control polluted stormwater runoff. You must delineate areas that will not be disturbed, including critical natural areas like streamside areas, floodplains, and trees. You must also identify the measures (or BMPs) you'll use to protect these areas.

Phasing your project to minimize the amount of exposed soil at any given time is a highly effective way to prevent erosion. Erosion control measures designed to prevent soil from being mobilized include diversions to route stormwater away from exposed soils and stabilization with vegetation, mulch, and geotextiles. Sedimentation control measures designed to remove sediment from stormwater or prevent it from leaving the site include silt fences, sediment traps, and diversions.

You'll need to select erosion and sediment controls—including stabilization measures for protecting disturbed areas and structural controls for diverting run-off and removing sediment—that are appropriate for your particular site. The appropriateness of the control measures will depend on several factors, but will be influenced most directly by the site characteristics. Some stabilization measures you might consider are temporary seeding, permanent seeding, and mulching. Structural control measures include earth dikes, silt fences, and sediment traps. No single BMP will meet all of the erosion and sedimentation control needs of a construction site. A combination of BMPs is necessary. For more information on the types of BMPs appropriate for your construction site, see the BMP fact sheet series available at www.epa.gov/npdes/menuofbmps.

Soil erosion control tips...

- Design the site to infiltrate stormwater into the ground and to keep it out of storm drains. Eliminate or minimize the use of stormwater collection and conveyance systems while maximizing the use of stormwater infiltration and bioretention techniques.
- Minimize the amount of exposed soil on site.
  - To the extent possible, plan the project in stages to minimize the amount of area that is bare and subject to erosion. The less soil exposed, the easier and cheaper it will be to control erosion.
  - Vegetate disturbed areas with permanent or temporary seeding immediately upon reaching final grade.
  - Vegetate or cover stockpiles that will not be used immediately.
- Reduce the velocity of stormwater both onto and away from the project area.
  - Interceptors, diversions, vegetated buffers, and check dams are a few of the BMPs that can be used to slow down stormwater as it travels across and away from the project site.
  - Diversion measures can also be used to direct flow away from exposed areas toward stable portions of the site.
  - Silt fences and other types of perimeter filters should never be used to reduce the velocity of runoff.
- Protect defined channels immediately with measures adequate to handle the storm flows expected.
  - Sod, geotextile, natural fiber, riprap, or other stabilization measures should be used to allow the channels to carry water without causing erosion. Use softer measures like geotextile or vegetation where possible to prevent downstream impacts.
- Keep sediment on site.
  - Place aggregate or stone at construction site vehicle exits to accommodate at least two tire revolutions of large construction vehicles. Much of the dirt on the tires will fall off before the vehicle gets to the street.
  - Regular street sweeping at the construction entrance will prevent dirt from entering storm drains. Do not hose paved areas.
  - Sediment traps and basins are temporary structures and should be used in conjunction with other measures to reduce the amount of erosion.
- Maintaining all BMPs is critical to ensure their effectiveness during the life of the project.
  - Regularly remove collected sediment from silt fences, berms, traps, and other BMPs.
  - Ensure that geotextiles and mulch remain in place until vegetation is well established.
  - Maintain fences that protect sensitive areas, silt fences, diversion structures, and other BMPs.

Other BMPs and Activities to Control Polluted Runoff

You'll need to select other controls to address potential pollutant sources on your site. Construction materials, debris, trash, fuel, paint, and stockpiles become pollution sources when it rains. Basic pollution prevention practices can significantly reduce the amount of pollution leaving construction sites. The following are some simple practices that should be included in the Plan and implemented on site:

- Keep potential sources of pollution out of the rain as practicable (e.g., inside a building, covered with plastic or tarps, or sealed tightly in a leak-proof container).
- Clearly identify a protected, lined area for concrete truck washouts. This area should be located away from streams, storm drain inlets, or ditches and should be cleaned out periodically.
- Park, refuel, and maintain vehicles and equipment in one area of the site to minimize the area exposed to possible spills and fuel storage. This area should be well away from streams, storm drain inlets, or ditches. Keep spill kits close by and clean up any spills or leaks immediately, including spills on pavement or earthen surfaces.
- Practice good housekeeping. Keep the construction site free of litter, construction debris, and leaking containers. Keep all waste in one area to minimize cleaning.
- Never hose down paved surfaces to clean dust, debris, or trash. This water could wash directly into storm drains or streams. Sweep up materials and dispose of them in the trash. Never bury trash or debris!
- Dispose of hazardous materials properly.

4. Certification and Notification

- **Certify the Plan**
- **Submit permit application or notice of intent**

Once the Plan has been developed, an authorized representative must sign it. Now is the time to submit the permit application or notice of intent. Your permit might require that the Plan be kept on site, so be sure to keep it available for the staff implementing the Plan.

Erosion and sedimentation control practices are only as good as their installation and maintenance.

5. Implementing and Maintaining a Plan

- **Implement controls**
- **Inspect and maintain controls**
- **Update/change the Plan**
- **Report releases of hazardous materials**

A Plan describes the practices and activities you'll use to prevent stormwater contamination and meet the NPDES permit requirements. Make sure that the Plan is implemented and that the Plan is updated as necessary to reflect changes on the site.

Erosion and sedimentation control practices are only as good as their installation and maintenance. Train the contractors that will install the BMPs and inspect immediately to ensure that the BMPs have been installed correctly.

Regularly inspect the BMPs (especially before and after rain events) and perform any necessary repairs or maintenance immediately. Many BMPs are designed to handle a limited amount of sediment. If not maintained, they'll become ineffective and a source of sediment pollution.

It's also important to keep records of BMP installation, implementation, and maintenance. Keep track of major grading activities that occur on the site, when construction activities cease (temporarily or permanently), and when a site is temporarily or permanently stabilized.

If construction plans change at any time, or if more appropriate BMPs are chosen for the site, update the Plan accordingly.

6. Completing the Project: Final Stabilization and Termination of the Permit

- **Final stabilization**
- **Notice of Termination**
- **Record retention**

Many states and EPA require a Notice of Termination (NOT) or other notification signifying that the construction activity is completed. An NOT is required when

- Final stabilization has been achieved on all portions of the site for which the permittee is responsible.
- Another operator has assumed control over all areas of the site that have not been finally stabilized. That operator would need to submit a new permit application to the permitting authority.
- For residential construction only, temporary stabilization of a lot has been completed prior to transference of ownership to the homeowner, with the homeowner being made aware of the need to perform final stabilization.

Permittees must keep a copy of their permit application and their Plan for at least 3 years following final stabilization. This period may be longer depending on state and local requirements.

Preconstruction Checklist

- A site description, including
  - Nature of the activity
  - Intended sequence of major construction activities
  - Total area of the site
  - Existing soil type and rainfall runoff data
  - A site map with:
    - Drainage patterns
    - Approximate slopes after major grading
    - Area of soil disturbance
    - Outline of areas which will not be disturbed
    - Location of major structural and nonstructural soil erosion controls
    - Areas where stabilization practices are expected to occur
    - Surface waters
    - Stormwater discharge locations
  - Name of the receiving water(s)
- A description of controls:
  - Erosion and sediment controls, including
    - Stabilization practices for all areas disturbed by construction
    - Structural practices for all drainage/discharge locations
  - Stormwater management controls, including
    - Measures used to control pollutants occurring in stormwater discharges after construction activities are complete
    - Velocity dissipation devices to provide nonerosive flow conditions from the discharge point along the length of any outfall channel
  - Other controls, including
    - Waste disposal practices that prevent discharge of solid materials
    - Measures to minimize offset tracking of sediments by construction vehicles
    - Measures to ensure compliance with state or local waste disposal, sanitary sewer, or septic system regulations
  - Description of the timing during the construction when measures will be implemented
- State or local requirements incorporated into the Plan
- Inspection and maintenance procedures for control measures identified in the Plan
- Contractor certification and Plan certification

Implementation Checklist

- Maintain records of construction activities, including
  - Dates when major grading activities occur
  - Dates when construction activities temporarily cease on the site or a portion of the site
  - Dates when construction activities permanently cease on the site or a portion of the site
  - Dates when stabilization measures are completed on the site
- Prepare inspection reports summarizing
  - Name of person conducting BMP inspections
  - Qualifications of person conducting BMP inspections
  - BMPs/areas inspected
  - Observed conditions
  - Necessary changes to the Plan
- Report releases of reportable quantities of oil or hazardous materials
  - Notify the National Response Center at 800-424-8802 immediately
  - Report releases to your permitting authority immediately, or as specified in your permit. You must also provide a written report within 14 days.
  - Modify the Plan to include
    - The date of release
    - Circumstances leading to the release
    - Steps taken to prevent reoccurrence of the release
- Modify Plan as necessary
  - Incorporate requests of the permitting authority to bring the Plan into compliance
  - Address changes in design, construction operation, or maintenance that affect the potential for discharge of pollutants

An ounce of prevention is worth a pound of cure! It's far more efficient and cost-effective to prevent pollution than it is to try to correct problems later. Installing and maintaining simple BMPs and pollution prevention techniques on site can greatly reduce the potential for stormwater pollution and can also save you money!

Visit www.epa.gov/npdes/stormwater for more information.

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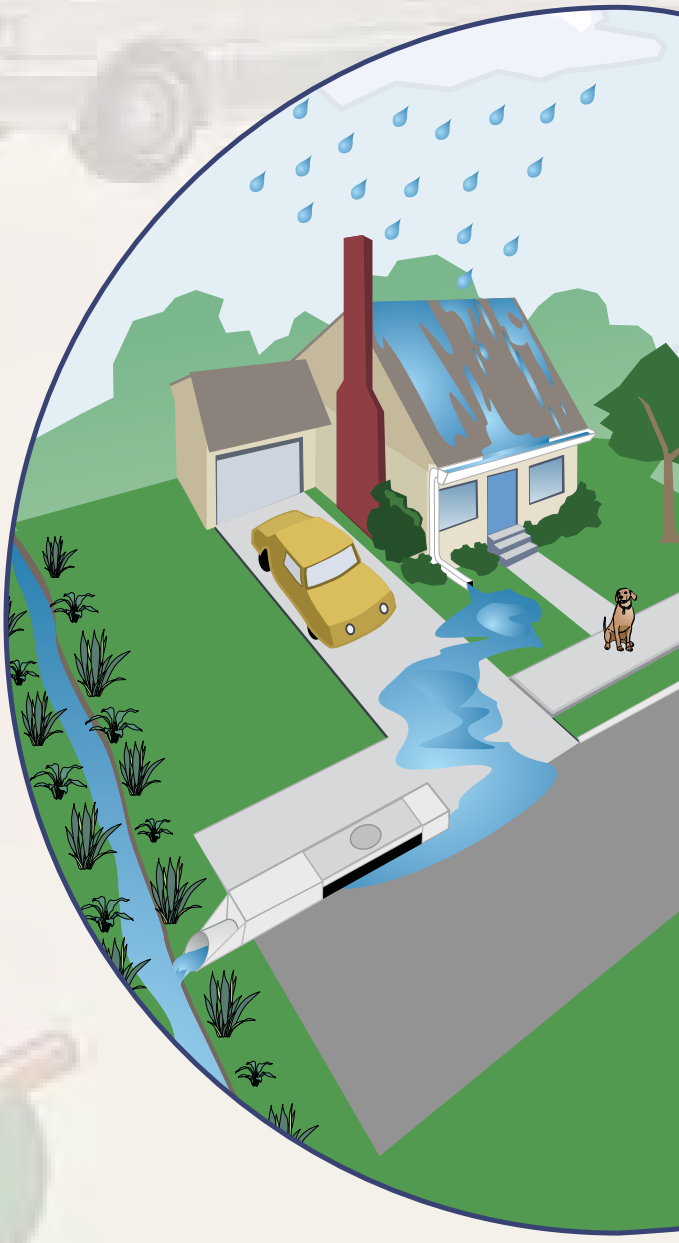
THE YEAR OF CLEAN WATER
Celebrating a Century

Make your home

The

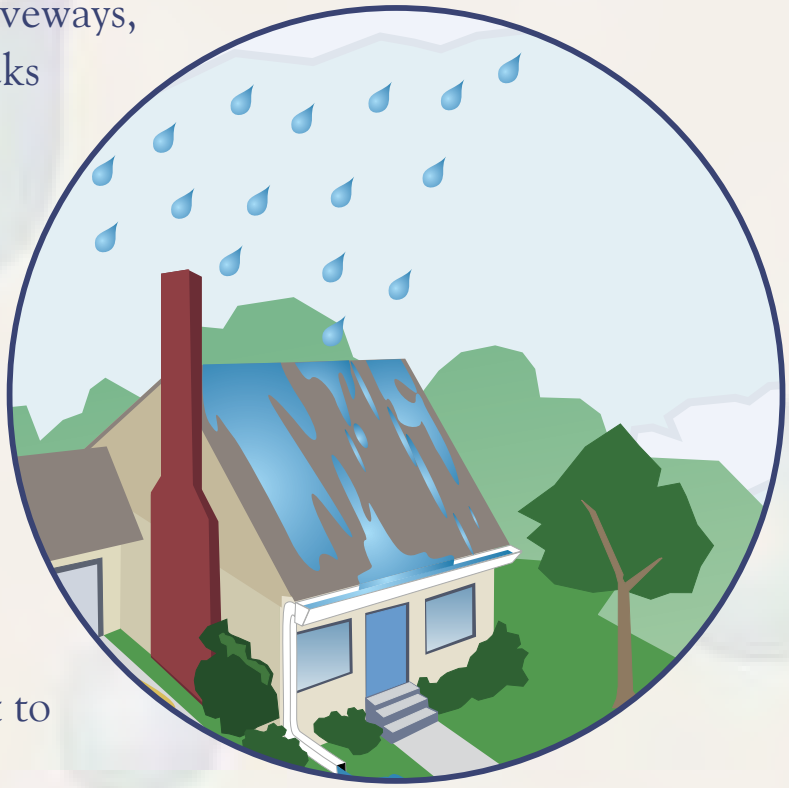
SOLUTION TO STORMWATER POLLUTION!

A homeowner's guide to healthy habits for clean water



EPA United States Environmental Protection Agency

As stormwater flows over driveways, lawns, and sidewalks, it picks up debris, chemicals, dirt, and other pollutants. Stormwater can flow into a storm sewer system or directly to a lake, stream, river, wetland, or coastal water. Anything that enters a storm sewer system is discharged untreated into the waterbodies we use for swimming, fishing, and providing drinking water. Polluted runoff is the nation's greatest threat to clean water.

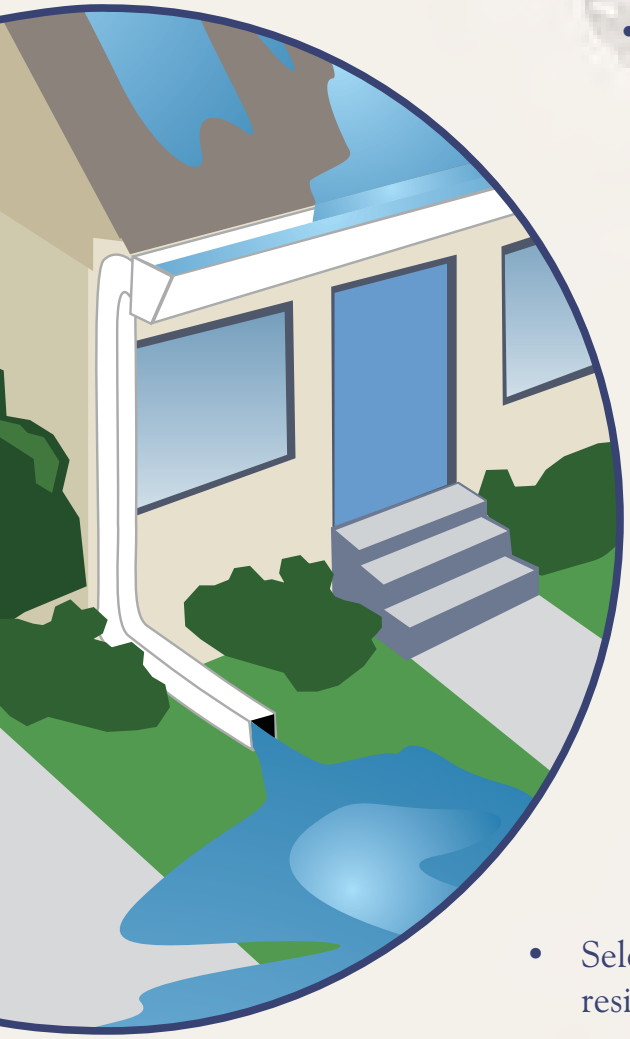


By practicing healthy household habits, homeowners can keep common pollutants like pesticides, pet waste, grass clippings, and automotive fluids off the ground and out of stormwater. Adopt these healthy household habits and help protect lakes, streams, rivers, wetlands, and coastal waters. Remember to share the habits with your neighbors!

Healthy Household Habits for Clean Water

Vehicle and Garage

- Use a commercial car wash or wash your car on a lawn or other unpaved surface to **minimize** the amount of dirty, soapy water flowing into the storm drain and eventually into your local waterbody.



- Check your car, boat, motorcycle, and other machinery and equipment for leaks and spills. Make repairs as soon as possible. Clean up **spilled fluids** with an absorbent material like kitty litter or sand, and don't rinse the spills into a nearby storm drain. Remember to properly dispose of the absorbent material.

- **Recycle** used oil and other automotive fluids at participating service stations. Don't dump these chemicals down the storm drain or dispose of them in your trash.

Lawn and Garden

- Use pesticides and fertilizers **sparingly**. When use is necessary, use these chemicals in the recommended amounts. Avoid application if the forecast calls for rain; otherwise, chemicals will be washed into your local stream.

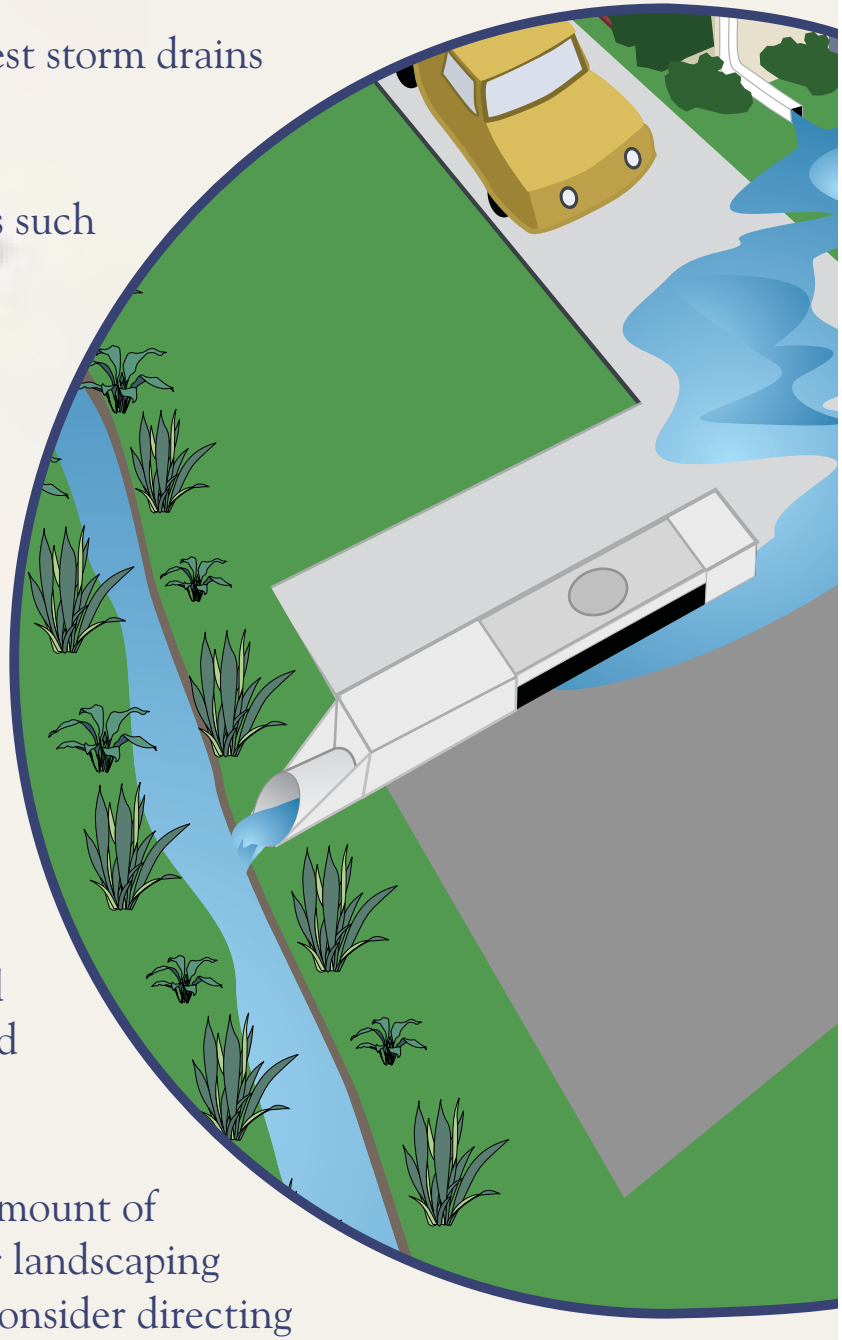
- Select **native** plants and grasses that are drought- and pest-resistant. Native plants require less water, fertilizer, and pesticides.

- **Sweep up** yard debris, rather than hosing down areas. Compost or recycle yard waste when possible.

- Don't overwater your lawn. Water during the **cool** times of the day, and don't let water run off into the storm drain.

- Cover piles of dirt and mulch being used in landscaping projects to prevent these pollutants from blowing or washing off your yard and into local waterbodies. **Vegetate** bare spots in your yard to prevent soil erosion.

Home Repair and Improvement



- Before beginning an outdoor project, locate the nearest storm drains and **protect** them from debris and other materials.

- **Sweep up** and properly dispose of construction debris such as concrete and mortar.

- Use hazardous substances like paints, solvents, and cleaners in the **smallest amounts possible**, and follow the directions on the label. Clean up spills **immediately**, and dispose of the waste safely. Store substances properly to avoid leaks and spills.

- Purchase and use **nontoxic**, **biodegradable**, **recycled**, and **recyclable** products whenever possible.

- **Clean** paint brushes in a sink, not outdoors. Filter and reuse paint thinner when using oil-based paints. Properly dispose of excess paints through a household hazardous waste collection program, or donate unused paint to local organizations.

- **Reduce** the amount of paved area and increase the amount of vegetated area in your yard. Use native plants in your landscaping to reduce the need for watering during dry periods. Consider directing downspouts away from paved surfaces onto lawns and other measures to increase infiltration and reduce polluted runoff.

Pet Care

- When walking your pet, remember to **pick up** the waste and dispose of it properly. Flushing pet waste is the best disposal method. Leaving pet waste on the ground increases public health risks by allowing harmful bacteria and nutrients to wash into the storm drain and eventually into local waterbodies.

Swimming Pool and Spa

- **Drain** your swimming pool only when a test kit does not detect chlorine levels.
- Whenever possible, drain your pool or spa into the **sanitary** sewer system.
- Properly store pool and spa chemicals to **prevent** leaks and spills, preferably in a covered area to avoid exposure to stormwater.

Septic System Use and Maintenance

- Have your septic system **inspected** by a professional at least every 3 years, and have the septic tank **pumped** as necessary (usually every 3 to 5 years).
- Care for the septic system drainfield by **not** driving or parking vehicles on it. Plant only grass over and near the drainfield to avoid damage from roots.
- Flush responsibly. Flushing household chemicals like paint, pesticides, oil, and antifreeze can **destroy** the biological treatment taking place in the system. Other items, such as diapers, paper towels, and cat litter, can **clog** the septic system and potentially damage components.

Storm drains connect to waterbodies!

Remember: Only rain down the drain!

For more information, visit
www.epa.gov/npdes/stormwater
or
www.epa.gov/nps

EPA United States Environmental Protection Agency

EPA 833-B-03-003

January 2003

THE YEAR OF CLEAN WATER
Celebration & Recommitment

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Water-Smart Landscapes

Start With WaterSense®

Cover photographs from Gino Piscelli, Mississauga, Ontario; Joy Stewart, Bristol, Tennessee; Linda Andrews, Olympia, Washington; and John Galbraith, Grants Pass, Oregon

Overview

Having a beautiful yard doesn't have to mean using a lot of water or spending a lot of money.

The U.S. Environmental Protection Agency's (EPA's) WaterSense program can help you take some of the guesswork out of keeping a healthy yard while using less water.

Outdoor water use stresses existing water supplies by contributing to peak demand during summer months. During these hot, dry times, utilities must increase capacity to meet water needs, sometimes as much as three to four times the amount used during the winter.

This brochure provides a holistic approach to developing a water-smart landscape for your home or property. From thoughts on landscape design to daily maintenance, it includes a step-by-step process for any homeowner and examples of beautiful, water-saving landscapes from across the country.

WaterSense and this brochure make it easy to find products and information to ensure you have a water-smart landscape that you can be proud of—for both its natural beauty and its low impact on the environment.

WATERSENSE'S KEY STEPS FOR SAVING WATER OUTSIDE

- **Timing is everything.** Know how much water your landscape actually needs before you set your sprinkler. Your local water utility can offer recommendations and best times to water.
- **Look for the label.** WaterSense labeled irrigation controllers use local weather data to water only when needed. If your system uses a clock timer, consider upgrading to this smart technology.
- **Go with a pro.** Contractors certified through a WaterSense labeled program can audit, install, or maintain your system to ensure water isn't wasted. Ask for credentials!

look for WaterSense Meets EPA Criteria

What Is Water-Smart Landscaping?

Water-smart landscaping produces attractive landscapes because it uses designs and plants that are well suited to local conditions.

Water is our most precious natural resource; without it, there is no life. Yet judging by our water use and consumption practices, many Americans take it for granted.

The average American uses 100 gallons of water per day—that's 320 gallons used every day by the average family. More and more Americans are demonstrating their water smarts indoors by retrofitting their homes with WaterSense labeled products. But outdoors, especially in the summer, the amount of water used by a household can exceed the amount used for all other purposes in the entire year. This is especially true in hot, dry climates.

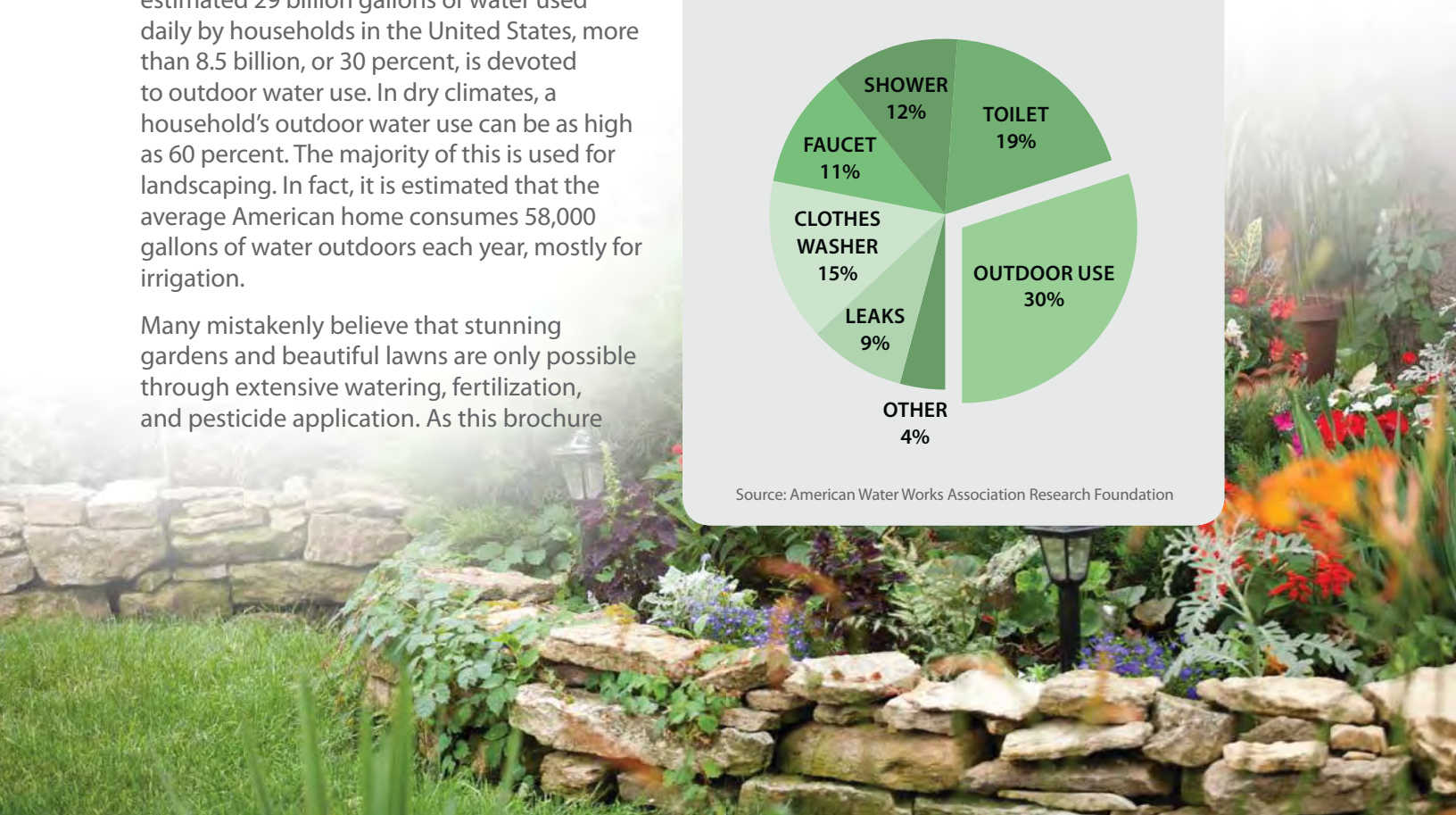
Gardening and lawn care account for the majority of this seasonal increase. Of the estimated 29 billion gallons of water used daily by households in the United States, more than 8.5 billion, or 30 percent, is devoted to outdoor water use. In dry climates, a household's outdoor water use can be as high as 60 percent. The majority of this is used for landscaping. In fact, it is estimated that the average American home consumes 58,000 gallons of water outdoors each year, mostly for irrigation.

Many mistakenly believe that stunning gardens and beautiful lawns are only possible through extensive watering, fertilization, and pesticide application. As this brochure demonstrates, eye-catching gardens and landscapes that save water and protect the environment are, in fact, easily achieved by employing water-smart landscaping.

For specific information about how to best apply water-smart landscaping principles in your geographical area, consult with your county extension service and local garden and nursery centers. Local governments and water utilities also possess a wealth of information, suggestions, and sometimes incentives for using water more efficiently in all aspects of your life, including landscaping.

HOW MUCH WATER DO WE USE OUTDOORS?

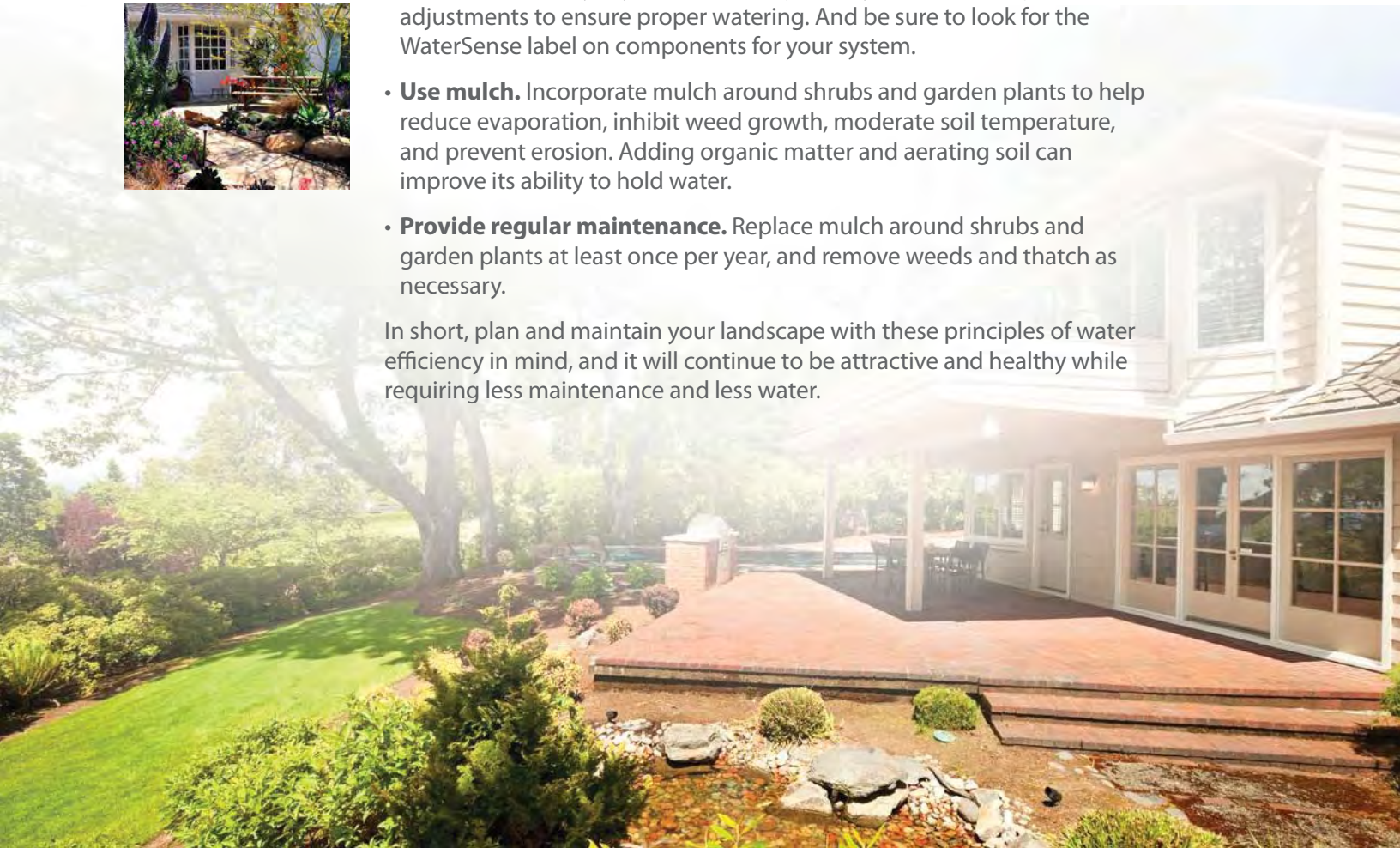
Source: American Water Works Association Research Foundation



KEY TIPS TO REMEMBER WHEN IT COMES TO WATER-SMART LANDSCAPING:

- **Go native or choose plants that need less water.** Once established, native and low water-using plants require little water beyond normal rainfall. If you're designing a new landscape or just sprucing up your current landscape, be sure to consider the water needs of the plants you choose.
- **Group plants according to their water needs.** Grouping vegetation with similar watering needs into specific "hydrozones" reduces water use by allowing you to water to each zone's specific needs. Turf areas and shrub areas should always be separated into different hydrozones because of their differing water needs.
- **Maintain healthy soils.** Healthy soils are the basis for a water-smart landscape; they effectively cycle nutrients, minimize runoff, retain water, and absorb excess nutrients, sediments, and pollutants.
- **Be selective when adding turf areas.** Turfgrass receives the highest percentage of irrigation water in traditional landscaping. To improve the aesthetics of your landscape and better manage outdoor water use, plant turfgrass only where it has a practical function.
- **Water wisely.** Know your plant's water needs and avoid watering during the heat of the day. If you have an irrigation system, make regular adjustments to ensure proper watering. And be sure to look for the WaterSense label on components for your system.
- **Use mulch.** Incorporate mulch around shrubs and garden plants to help reduce evaporation, inhibit weed growth, moderate soil temperature, and prevent erosion. Adding organic matter and aerating soil can improve its ability to hold water.
- **Provide regular maintenance.** Replace mulch around shrubs and garden plants at least once per year, and remove weeds and thatch as necessary.

In short, plan and maintain your landscape with these principles of water efficiency in mind, and it will continue to be attractive and healthy while requiring less maintenance and less water.



Why Use Water-Smart Landscaping?

Proper landscaping techniques not only create beautiful landscapes, but also benefit the environment and save water.

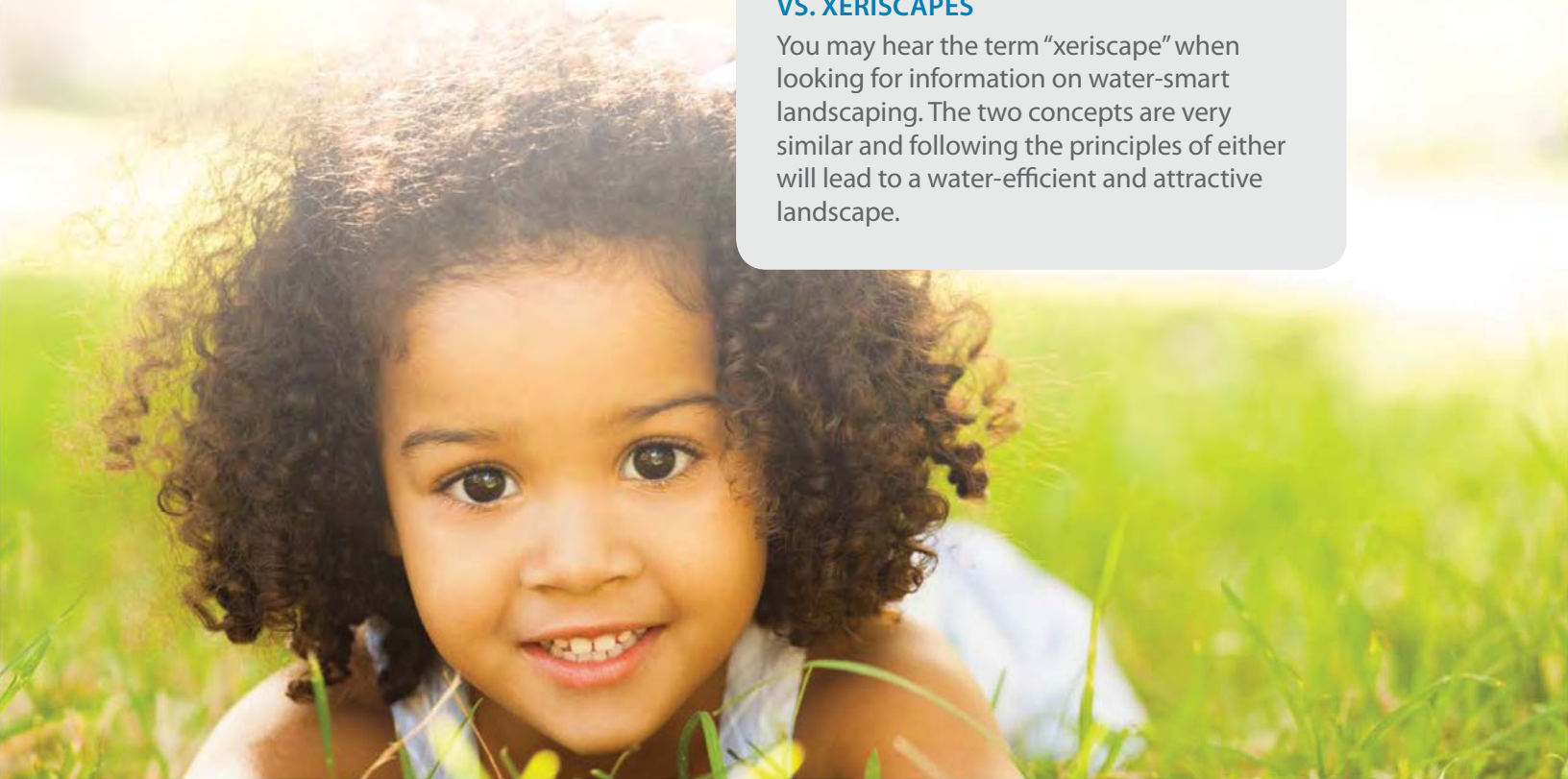
Water-smart yards often have increased curb appeal, which can lead to higher home values. In addition to requiring less water, fertilizer, pesticides, and usually less maintenance, water-smart landscapes offer many other benefits:

- Lower water bills from reduced water use.
- Conservation of natural resources and preservation of habitat for plants and wildlife, such as fish, birds, and waterfowl.
- Decreased energy use (and air pollution associated with its generation) because less pumping and treatment of water is required.
- Reduced home or office heating and cooling costs through the careful placement of shade trees and shrubs.
- Reduced runoff of stormwater and irrigation water that carries top soils, fertilizers, and pesticides into lakes, rivers, and streams.
- Fewer yard trimmings to be managed or landfilled.
- Reduced landscaping labor and maintenance costs.
- Extended life for water resource infrastructure (e.g., reservoirs, treatment plants, groundwater aquifers), thus reduced taxpayer costs.

If you've designed a water-smart landscape, you might be able to get all the water you need from rainfall alone. But sometimes, that might not be enough. Whether you water with a hose or use an irrigation system, smart watering habits can keep your lawn and landscape healthy and beautiful without wasting water or money.

WATER-SMART LANDSCAPES VS. XERISCAPES

You may hear the term "xeriscape" when looking for information on water-smart landscaping. The two concepts are very similar and following the principles of either will lead to a water-efficient and attractive landscape.



How Is Water-Smart Landscaping Applied?

Through careful planning, landscapes can be designed to be both pleasing to the senses and kind to the environment.

GO NATIVE OR CHOOSE PLANTS THAT NEED LESS WATER

Your landscape design should take into account your local climate as well as soil conditions. Focus on preserving as many existing trees and shrubs as possible, because established plants usually require less water and maintenance. Choose plants native to your region. Native plants, once established, require very little to no additional water beyond normal rainfall. Also, because they are adapted to local soils and climatic conditions, native plants commonly do not require the addition of fertilizers and are more resistant to pests and disease.

When selecting plants, avoid those labeled "hard to establish," "susceptible to disease," or "needs frequent attention," as these types of plants frequently require large amounts of supplemental water, fertilizers, and pesticides. Be careful when selecting non-indigenous or exotic species, as some of them can become invasive. An invasive plant might be a water guzzler and will surely choke out native species. Your state or county extension service or local nursery can help you select appropriate plants for your area.

PLAN BEFORE YOU PLANT

Developing a landscape plan is the first and most important step in creating a water-smart landscape. Your plan should take into account the regional and microclimatic conditions of the site, existing vegetation, topography, intended uses of the property, and most importantly, the grouping of plants by their water needs. Also consider the plants' sun or shade requirements and preferred soil conditions. A well-thought-out landscape plan can serve as your roadmap in creating beautiful, water-smart landscapes and allow you to continually improve your landscape over time.

MAINTAIN HEALTHY SOILS

Because soils vary from site to site, test your soil before beginning your landscape improvements. Check with your local garden center for soil test kits and proper amendments. Alternatively, your county extension service can likely:

- Analyze the pH levels; nutrient levels (e.g., nitrogen, phosphorus, potassium); and the sand, silt, clay, and organic matter content of your soil.
- Suggest ways to improve your soil's ability to support plants and retain water (e.g., by aeration or the addition of soil amendments).

BE SELECTIVE WHEN ADDING TURF AREAS

How and where turf is placed in the landscape can significantly reduce the amount of irrigation water needed to support the landscape. Lawns require a large amount of supplemental water and generally greater maintenance than other vegetation. Use turf where it has a practical function, such as in play or recreation areas. Grouping turf areas can increase watering efficiency and significantly reduce evaporative and runoff losses. Select a type of grass that can withstand drought periods and become dormant during hot, dry seasons. Reducing or eliminating turf areas altogether further reduces water use.

WATER WISELY

Proper irrigation is an important part of using water efficiently outdoors, and applies in any landscape. For this reason, an entire section of this brochure addresses efficient irrigation; it can be found on page 7.

USE OF MULCHES

Mulches aid in greater retention of water by minimizing evaporation, reducing weed growth, moderating soil temperatures, and preventing erosion. Organic mulches also improve the condition of your soil as they decompose. Mulches are typically composed of wood bark chips, wood grindings, pine straws, nut shells, small gravel, and/or shredded landscape clippings. Avoid using rock mulches in sunny areas or around non-arid climate plants, as they radiate large amounts of heat and promote water loss that can lead to scorching. Avoid using too much mulch, as excessive amounts can restrict water flow to plant roots.

APPROPRIATE MAINTENANCE

Water and fertilize plants only as needed. Too much water promotes weak growth and increases pruning and mowing requirements. Like any landscape, a water-smart yard can require regular pruning, weeding, pest control, and possibly irrigation.

As your landscape matures, it will require less maintenance and less water. Cutting turfgrass only when it reaches 2 to 3 inches promotes deeper root growth and a more drought-resistant lawn. As a rule of thumb, mow your turfgrass before it requires more than 1 inch to be removed. The proper cutting height varies, however, with the type of grass, so you should contact your county extension service or local nursery to find out the ideal cutting height for your lawn. Avoid shearing plants or giving them high-nitrogen fertilizers during dry periods because these practices encourage water-demanding new growth.

Water-Smart Landscape Irrigation Methods

Don't let your yard control your water bill.

The information included in this section applies to every yard, whether it is designed specifically with water efficiency in mind or not.

With today's common watering practices, up to 50 percent of the water applied to lawns and gardens is not absorbed by the plants. It is lost through evaporation, runoff, or being pushed beyond the root zone because it is applied too quickly or in excess of the plants' needs. The goal of efficient irrigation is to reduce these losses by applying only as much water as is needed to keep your plants healthy, whether you have a water-smart or a conventional landscape.

To promote the strong root growth that supports a plant during drought, water deeply and water only when the plant needs it. For clay soils, it is recommended to water less deeply, and in multiple cycles. Irrigating with consideration to soil type, the condition of your plants, the season, and weather conditions—rather than on a fixed schedule—significantly improves your watering efficiency and results in healthier plants. Grouping plants according to similar water needs also makes watering easier and more efficient.

Lawns, gardens, and landscapes can be irrigated manually or with an automatic irrigation system. Manual watering with a handheld hose tends to be the most water-efficient method. According to the American Water Works Association (AWWA) Research Foundation's *Residential End Uses of Water* study, households that manually water with a hose typically use 33 percent less water outdoors than the average household. The study also showed that households with in-ground sprinkler systems used 35 percent more water; those with automatic timers used 47 percent more water; and those with drip irrigation systems used 16 percent more water than households without these types of systems. These results show that in-ground sprinkler and drip irrigation systems must be operated properly to be water-efficient.

YARDS WITHOUT AUTOMATIC IRRIGATION SYSTEMS

You can use a handheld hose or a sprinkler for manual irrigation. To reduce water losses from evaporation and wind, avoid sprinklers that produce a fine mist or spray high into the air. Soaker hoses can also be very efficient and effective when used properly. Also, consider using a handheld soil moisture probe to determine when irrigation is needed.

GET THE MOST OUT OF YOUR IRRIGATION SYSTEM

- **Set sprinklers to water the lawn or garden only**—not the street or sidewalk, because they don't grow!
- **Play "zone" defense.** Schedule each individual zone in your irrigation system to account for the type of sprinkler, sun or shade exposure, and the soil type for the specific area. The same watering schedule rarely applies to all zones in the system.
- **Consult a professional.** A certified irrigation professional can design, install, maintain, and/or audit your system to ensure optimal efficiency and that you are using the proper amount of water to maintain a healthy landscape.

YARDS WITH AUTOMATIC IRRIGATION SYSTEMS

To make automatic irrigation systems more efficient, consider upgrading your standard clock timer to a WaterSense labeled irrigation controller. And rain sensors or soil moisture sensors will also help prevent waste by ensuring that the sprinkler does not turn on during and immediately after rainfall or when soil moisture levels are above preprogrammed levels. Drip-type irrigation systems are considered the most efficient of the automated irrigation methods because they deliver water directly to the plants' roots.

With automatic systems, overwatering is most common during the fall when summer irrigation schedules have not been adjusted to the cooler temperatures. Irrigation system schedules should always be adjusted down in the fall to prevent overwatering in the colder months.

EPA's WaterSense program also recognizes professional certification programs that advance water-efficient irrigation techniques and practices. Whether you're upgrading your system, having it audited, or checking it at the beginning or end of the season, be sure to consult a professional who is certified by a WaterSense labeled program. Always ask for credentials to ensure that your contractor is knowledgeable about your plants' water needs and your irrigation system.

RAINWATER HARVESTING

Saving water from storms with rain barrels or cisterns is a great way to further reduce your water consumption. Homes with access to alternative sources of irrigation can reduce their water bills and the runoff that would otherwise go into the street. Commercial rooftop collection systems are available, but simply diverting your downspout into a covered barrel is an easy, low-cost approach. When collecting rainwater, cover all collection vessels to prevent animals and children from entering and to prevent mosquito breeding. Some states might have laws which do not allow collection of rainwater, so be sure to check with your state's water resource agency before implementing a rainwater collection system. Check with your local water utility or county government to see if there are rebate programs available in your area.

WATERSENSE LABELED IRRIGATION CONTROLLERS—TAKING THE GUESSWORK OUT OF WATERING

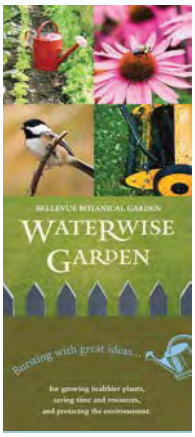
WaterSense labels irrigation controllers, a type of "smart" irrigation control technology that uses local weather data to determine whether your sprinkler system needs to turn on.

With proper installation, programming, and adjustments, WaterSense labeled irrigation controllers can help consumers save water, time, and money when compared to use of a conventional controller.

Water-Smart Landscape Examples

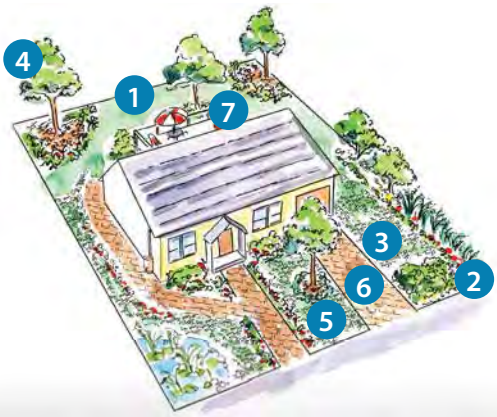
Designing a water-smart landscape can help you save money and water and doesn't have to mean piles of rocks and prickly cacti—in fact, it's just the opposite. Today's yards that incorporate hardy native plants, proper soil amendments, mulch, and smart irrigation systems (where needed), are beautiful, colorful, creative spaces that can add curb appeal and convenience.

Communities and local water utilities around the country support demonstration gardens that can provide information and inspiration to get you started. County cooperative extension offices, master gardeners, and local nurseries can also be great sources of information on native and adaptive plants that can thrive in your local climate.



For a climate that gets a moderate amount of rain with a typically wet summer and a long winter (e.g., some mid-Atlantic areas, such as Pittsburgh, Pennsylvania), this landscape design could be appropriate.

1. Low to medium water-using trees
2. Low to medium water-using groundcover
3. Mulched beds
4. Medium water-using turf
5. Low water-using shrubs



For a dry climate that gets minimal rain like Austin, Texas, a beautiful, water-smart yard includes a low water-using turf only where it is functional. A good alternative to turf is one of the many drought-tolerant groundcovers, such as *Phyla nodiflora*.

1. Low water-using turf
2. Low water-using shrubs
3. Low water-using groundcover
4. Low water-using trees
5. Mulched beds
6. Permeable pavers
7. Deck

MISSISSAUGA, ONTARIO

Photo credit: Gino Piscelli

This landscape design creates the aesthetics of a traditional garden with modern, low water-using plants, flowers, colors, and textures. In this sunny yard, placing the right plant in the right place was the key to creating a water-smart landscape. The owners installed a number of drought-tolerant plants that thrive in direct sunlight. Mulch was used to help reduce evaporation, inhibit weed growth, moderate soil temperature, and prevent erosion. The landscape requires little to no supplemental water, even during the peak summer months.

BRISTOL, TENNESSEE

This landscape was transformed from turfgrass plagued by stormwater runoff problems into a water-smart paradise. Nearly 75 percent of the lawn was replaced with native wildflowers, trees, shrubs, and grasses that are appropriate for local water conditions. To help reduce runoff, the property also features a 1,400-gallon pond, four rain gardens, a vegetated green roof, and a dry stream bed that collects and routes stormwater into the rain gardens.

Photo credit: Joy Stewart

OLYMPIA, WASHINGTON

Photo credit: Linda Andrews

This compact, no-turf landscape features both edible and drought-tolerant plants. A unique patio of permeable crushed rock and cobalt recycled glass aggregate adds eye-catching interest to the landscape. The plants are efficiently watered by a drip irrigation system, which irrigates slowly to minimize evaporation and runoff. The landscape also features a rain garden that captures rainwater from roofs, driveways, and sidewalks which reduces runoff by allowing stormwater to slowly soak into the ground.

GRANTS PASS, OREGON

Photo credit: John Galbraith

The owners of this home wanted to replace their turfgrass with a fun, low-maintenance landscape cover that was both beautiful and efficient. In keeping with the home's simple, modern features, the new landscape consists of low water-using shrubs, perennials, and ornamental grasses that sweep across the front of the house. The planting areas are dressed with aged bark mulch throughout to reduce evaporation and minimize erosion. An irrigation system utilizing rotary spray heads provides water, when needed, to the plantings.

DEL MAR, CALIFORNIA

This drought-tolerant, regionally appropriate garden turns heads with its year-round color and texture. The owners transformed a high water-using landscape into a water-smart oasis by choosing drought-tolerant plants that require little water beyond normal rainfall. To get the most out of their irrigation system, the owners make use of water-efficient technologies such as rotary spray heads and a weather-based irrigation controller. When needed, the rotary spray heads deliver water in a thick stream, ensuring more water reaches plants and less is lost to evaporation and wind.

Photo credit: Chris Roesink

JUNCTION, TEXAS

Photo credit: Scott Richardson; designed by Billy Kniffen

Junction Middle School's water-savvy landscape features rain gardens and a large palette of native perennials. Five rain gardens capture rainwater from the school's roof, reducing stormwater runoff and increasing infiltration. Nearly 300 native grasses, shrubs, and trees cover the landscape, which needs minimal supplemental water. Mulch covers the soil around the plants, reducing water loss from evaporation. An efficient, drip irrigation system irrigates plants only during the driest months. Volunteer students and adults donated their time to create this conservation landscape, dedicated to the memory of Opal B. Roberts, an exceptional teacher.

FOR MORE INFORMATION

The following list of organizations can provide more information on water-efficient landscaping. This is not an exhaustive list; it is intended to help you locate local information sources and possible technical assistance.

Your local water management district can often provide information on water conservation, including water-efficient landscaping practices. Your state or county extension service is also an excellent source of information. Many extension services provide free publications and advice on home landscaping issues, including tips on plant selection and soil improvement. Some also offer a soil analysis service for a nominal fee. A directory of Cooperative Extension System Offices can be found on the USDA's website (**www.csrees.usda.gov/Extension**).

A directory of Master Gardener programs can be found on the American Horticultural Society's website, (**www.ahs.org/master_gardeners**).

The WaterSense website (**www.epa.gov/watersense**) can link you to a number of additional resources, including information on how to choose the right plants for your landscape (**www.epa.gov/watersense/outdoor/what_to_plant.html**).

To contact WaterSense by phone, call toll-free (866) WTR-SENS (987-7367).

RESOURCES AND ACKNOWLEDGEMENTS

The brochure updates a 2002 brochure on water-efficient landscaping which included technical advice from Alice Darilek, Elizabeth Gardner, and David Winger.

The following is a partial list of publications on resource-efficient landscaping. For more information, particularly on plants suited to your locale, consult your local library, county extension service, nursery, garden clubs, or water utility.

Ball, Ken and American Water Works Association (AWWA) Water Conservation Committee. *Xeriscape Programs for Water Utilities*. Denver: AWWA, 1990.

Bennett, Jennifer. *Dry-Land Gardening: A Xeriscaping Guide for Dry-Summer, Cold-Winter Climates*. Buffalo: Firefly, 1998.

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Weinstein, Gayle. *Xeriscape Handbook : A How-To Guide to Natural, Resource-Wise Gardening*. Golden: Fulcrum Publishing, 1998.

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Winger, David, ed. *Xeriscape Plant Guide: 100 Water-Wise Plants for Gardens and Landscapes*. Golden: Fulcrum Publishing, 1998.

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Cover photographs from Gino Piscelli, Joy Stewart, Linda Andrews, and John Galbraith.

Illustrations by Mindy Mitchell.

U. S. Environmental Protection Agency
(4204M)

(866) WTR-SENS (987-7367)

EPA WaterSense Program

EPA 832-K-12-2002
July 2013

Water-Efficient Landscaping:

Preventing Pollution & Using Resources Wisely

A Message from the Administrator

Christine Todd Whitman

I believe water is the biggest environmental issue we face in the 21st Century in terms of both quality and quantity. In the 30 years since its passage, the Clean Water Act has dramatically increased the number of waterways that are once again safe for fishing and swimming. Despite this great progress in reducing water pollution, many of the nation's waters still do not meet water quality goals. I challenge you to join with me to finish the business of restoring and protecting our nation's waters for present and future generations.

United States Environmental Protection Agency
Office of Water (4204M)
EPA832-F-02-002
September 2002
www.epa.gov/owm/water-efficiency/index.htm

Contents

What is Water-efficient Landscaping?

Water, many agree, is our most precious natural resource; without it, life ceases. Yet judging by our water use and consumption practices, many of us in the United States seem to take it for granted. A typical household uses approximately 260 gallons of water per day. "Water conscious" individuals often install high-efficiency shower heads and toilets and wash only full loads of clothes and dishes to reduce consumption. But in the summer, the amount of water used outdoors by a household can exceed the amount used for all other purposes in the entire year. This is especially true in hot, dry climates.

Gardening and lawn care account for the majority of this seasonal increase, but other outdoor activities, such as washing cars and filling swimming pools, also contribute. According to the U.S. Geological Survey, of the 26 billion gallons of water consumed daily in the United States[1], approximately 7.8 billion gallons, or 30 percent[2], is devoted to outdoor uses. The majority of this is used for landscaping. In fact, it is estimated that the typical suburban lawn consumes 10,000 gallons of water above and beyond rainwater each year (Vickers, p 140).

Many mistakenly believe that stunning gardens and beautiful lawns are only possible through extensive watering, fertilization, and pesticide application. As this booklet will demonstrate, eye-catching gardens and landscapes that save water, prevent pollution, and protect the environment are, in fact, easily achieved by employing water-efficient landscaping. Water-efficient landscaping produces attractive landscapes because it utilizes designs and plants suited to local conditions.

This booklet describes the benefits of water-efficient landscaping. It includes several examples of successful projects and programs, as well as contacts, references, and a short bibliography. For specific information about how to best apply water-efficient landscaping principles to your geographical area, consult with your county extension service and local garden and nursery centers. Local governments and water utilities also possess a wealth of information and suggestions for using water more efficiently in all aspects of your life, including landscaping.

Xeriscape garden at Denver Water

1 W.B. Solley, R.R. Pierce, and H.A. Perlman. 1998. *Estimated Use of Water in the United States in 1995* (USGS Circular 1200). USGS. Reston, VA. p.27.

2 Amy Vickers. 2001. *Handbook of Water Use and Conservation*. WaterPlow Press. Amherst, MA. p. 140.

Xeriscaped front yard in Colorado Springs

Many terms and schools of thought have been used to describe approaches to water-efficient landscaping. Some examples include "water-wise," "water-smart," "low-water," and "natural landscaping." While each of these terms varies in philosophy and approach, they are all based on the same principles and are commonly used interchangeably. One of the first conceptual approaches developed to formalize these principles is known as "Xeriscape[3] landscaping." Xeriscape landscaping is defined as "quality landscaping that conserves water and protects the environment." The word "Xeriscape" was coined and copyrighted by Denver Water Department in 1981 to help make water conserving landscaping an easily recognized concept. The word is a combination of the Greek word "*xeros*," which means "dry," and "landscape."

The seven principles upon which Xeriscape landscaping is based are:

- Proper planning and design
- Soil analysis and improvement
- Appropriate plant selection
- Practical turf areas
- Efficient irrigation
- Use of mulches
- Appropriate maintenance

The eight fundamentals of water-wise landscaping, below, illustrate the similarities in the underlaying concepts and principles of Xeriscape landscaping and other water-efficient approaches.

- Group plants according to their water needs.
- Use native and low-water-use plants.
- Limit turf areas to those needed for practical uses.
- Use efficient irrigation systems.
- Schedule irrigation wisely.
- Make sure soil is healthy.
- Remember to mulch.
- Provide regular maintenance.

In short, plan and maintain your landscape with these principles of water efficiency in mind and it will continue to conserve water and be attractive.

3 Denver Water welcomes the use of the term Xeriscape in books, articles, and speeches promoting water conserving landscape. EPA is using this term with permission from Denver Water. For permission to use "Xeriscape" in your publications, call Denver Water at 303 628-6330.

Why Use Water-efficient Landscaping?

Proper landscaping techniques not only create beautiful landscapes, but also benefit the environment and save water. In addition, attractive, water-efficient, low-maintenance landscapes can increase home values.

Water-efficient landscaping offers many economic and environmental benefits, including:

- Lower water bills from reduced water use.
- Conservation of natural resources and preservation of habitat for plants and wildlife such as fish and waterfowl.
- Decreased energy use (and air pollution associated with its generation) because less pumping and treatment of water is required.
- Reduced home or office heating and cooling costs through the careful placement of trees and plants.
- Reduced runoff of stormwater and irrigation water that carries top soils, fertilizers, and pesticides into lakes, rivers, and streams.
- Fewer yard trimmings to be managed or landfilled.
- Reduced landscaping labor and maintenance costs.
- Extended life for water resources infrastructure (e.g., reservoirs, treatment plants, groundwater aquifers), thus reduced taxpayer costs.

Meadow Sage (Salvia pratensis) *is the background for New Mexico Evening Primrose* (Oenothera berlandieri 'siskiyou')

How is Water-efficient Landscaping Applied?

Landscaping that conserves water and protects the environment is not limited to arid landscapes with only rocks and cacti. Through careful planning, landscapes can be designed to be both pleasing to the senses and kind to the environment. One simple approach to achieving this is applying and adopting the basic principles of water-efficient landscaping to suit your climatic region. The seven principles of Xeriscape landscaping are used below to describe these basic concepts in greater detail.

Dragon's Blood Sedum (Sedum spurium) *under Honeylocust Trees* (Gleditsia triaconthos)

Proper planning and design

Developing a landscape plan is the first and most important step in creating a water-efficient landscape. Your plan should take into account the regional and microclimatic conditions of the site, existing vegetation, topography, intended uses of the property, and most importantly, the grouping of plants by their water needs. Also consider the plants' sun or shade requirements and preferred soil conditions. A well-thought-out landscape plan can serve as your roadmap in creating beautiful, water-efficient landscapes and allow you to continually improve your landscape over time.

Soil analysis and improvements

Because soils vary from site to site, test your soil before beginning your landscape improvements. Your county extension service can analyze the pH levels; nutrient levels (e.g., nitrogen, phosphorus, potassium); and the sand, silt, clay, and organic matter content of your soil. It can also suggest ways to improve your soil's ability to support plants and retain water (e.g., through aeration or the addition of soil amendments or fertilizers).

Appropriate plant selection

Your landscape design should take into account your local climate as well as soil conditions. Focus on preserving as many existing trees and shrubs as possible because established plants usually require less water and maintenance. Choose plants native to your region. Native plants, once established, require very little to no additional water beyond normal rainfall. Also, because they are adapted to local soils and climatic conditions, native plants commonly do not require the addition of fertilizers and are more resistant to pests and disease.

When selecting plants, avoid those labeled "hard to establish," "susceptible to disease," or "needs frequent attention," as these types of plants frequently require large amounts of supplemental water, fertilizers, and pesticides. Be careful when selecting non-indigenous species as some of them may become invasive. An invasive plant might be a water guzzler and will surely choke out native species. Your state or county extension service or local nursery can help you select appropriate plants for your area.

The key to successful planting and transplanting is getting the roots to grow into the surrounding soil as quickly as possible. Knowing when and where to plant is crucial to speeding the establishment of new plants. The best time to plant will vary from species to species. Some plants will thrive when planted in a dormant or inactive state. Others succeed when planted during the season when root generation is highest and sufficient moisture is available to support new growth (generally, spring is the best season, but check plant tags or consult with your local nursery for specific species).

Wine Cup (Callirhoe involucrata) *and Sunset Hyssop* (Agastache rupestris) *in the Denver Water Xeriscape Garden*

Practical turf areas

How and where turf is placed in the landscape can significantly reduce the amount of irrigation water needed to support the landscape. Lawns require a large amount of supplemental water and generally greater maintenance than other vegetation. Use turf where it aesthetically highlights the house or buildings and where it has practical function, such as in play or recreation areas. Grouping turf areas can increase watering efficiency and significantly reduce evaporative and runoff losses. Select a type of grass that can withstand drought periods and become dormant during hot, dry seasons. Reducing or eliminating turf areas altogether further reduces water use.

Efficient irrigation

Efficient irrigation is a very important part of using water efficiently outdoors, and applies in any landscape—whether Xeriscape or conventional. For this reason, an entire section of this booklet addresses efficient irrigation; it can be found on page 6.

Use of mulches

Mulches aid in greater retention of water by minimizing evaporation, reducing weed growth, moderating soil temperatures, and preventing erosion. Organic mulches also improve the condition of your soil as they decompose. Mulches are typically composed of wood bark chips, wood grindings, pine straws, nut shells, small gravel, or shredded landscape clippings. Avoid using rock mulches in sunny areas or around non-arid climate plants, as they radiate large amounts of heat and promote water loss that can lead to scorching. Too much mulch can restrict water flow to plant roots and should be avoided.

Appropriate maintenance

Water and fertilize plants only as needed. Too much water promotes weak growth and increases pruning and mowing requirements. Like any landscape, a water-efficient yard will require regular pruning, weeding, fertilization, pest control, and irrigation. As your water-efficient landscape matures, however, it will require less maintenance and less water. Cutting turf grass only when it reaches two to three inches promotes deeper root growth and a more drought-resistant lawn. As a rule of thumb, mow your turf grass before it requires more than one inch to be removed. The proper cutting height varies, however, with the type of grass, so you should contact your county extension service or local nursery to find out the ideal cutting height for your lawn. Avoid shearing plants or giving them high nitrogen fertilizers during dry periods because these practices encourage water-demanding new growth.

Water-efficient Landscape Irrigation Methods

With common watering practices, a large portion of the water applied to lawns and gardens is not absorbed by the plants. It is lost through evaporation, runoff, or being pushed beyond the root zone because it is applied too quickly or in excess of the plants' needs. The goal of efficient irrigation is to reduce these losses by applying only as much water as is needed to keep your plants healthy. This goal is applicable whether you have a Xeriscape or a conventional landscape.

To promote the strong root growth that supports a plant during drought, water deeply and only when the plant needs water. For clay soils, watering less deeply and more often is recommended. Irrigating with consideration to soil type, the condition of your plants, the season, and weather conditions—rather than on a fixed schedule—significantly increases your watering efficiency. Grouping plants according to similar water needs also makes watering easier and more efficient.

Purple Fountain Grass (Pennisetum setaceum "Rubrum") *and Marigolds* (Calendula officinalis) *in planter bed*

Irrigating lawns, gardens, and landscapes can be accomplished either manually or with an automatic irrigation system. Manual watering with a hand-held hose tends to be the most water-efficient method. According to the AWWA Research Foundation's outdoor end use study, households that manually water with a hose typically use 33 percent less water outdoors than the average household. The study also showed that households with in-ground sprinkler systems used 35 percent more water, those with automatic timers used 47 percent more water, and those with drip irrigation systems used 16 percent more water than households without these types of systems. These results show that in-ground sprinkler and drip irrigation systems must be operated properly to be water-efficient.

You can use a hand-held hose or a sprinkler for manual irrigation. To reduce water losses from evaporation and wind, avoid sprinklers that produce a fine mist or spray high into the air. Soaker hoses can also be very efficient and effective when used properly. Use a hand-held soil moisture probe to determine when irrigation is needed.

To make automatic irrigation systems more efficient, install system controllers such as rain sensors that prevent sprinkler systems from turning on during and immediately after rainfall, or soil moisture sensors that activate sprinklers only when soil moisture levels drop below pre-programmed levels. You can also use a weather-

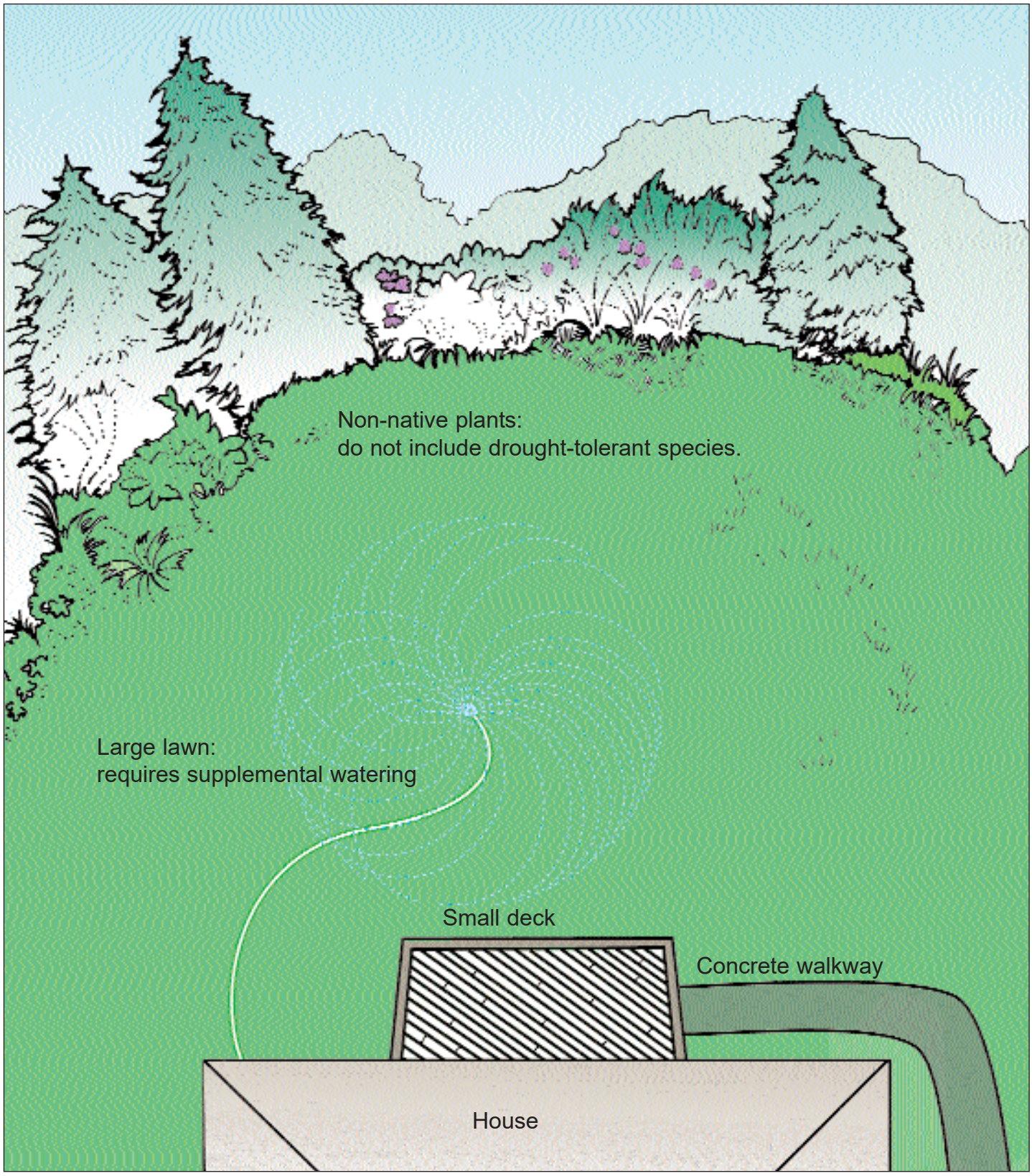
driven programming system. Drip-type irrigation systems are considered the most efficient of the automated irrigation methods because they deliver water directly to the plants' roots. It is also important to revise your watering schedule as the seasons change. Over-watering is most common during the fall when summer irrigation schedules have not been adjusted to the cooler temperatures.

To further reduce your water consumption, consider using alternative sources of irrigation water, such as gray water, reclaimed water, and collected rainwater. According to the AWWA Research Foundation, homes with access to alternative sources of irrigation reduce their water bills by as much as 25 percent.[4] Graywater is untreated household waste water from bathroom sinks, showers, bathtubs, and clothes washing machines. Graywater systems pipe this used water to a storage tank for later outdoor watering use. State and local graywater laws and policies vary, so you should investigate what qualifies as gray water and if any limitations or restrictions apply. Reclaimed water is waste water that has been treated to levels suitable for nonpotable uses. Check with local water officials to determine if it is available in your area. Collected rainwater is rainwater collected in cisterns, barrels, or storage tanks. Commercial rooftop collection systems are available, but simply diverting your downspout into a covered barrel is an easy, low-cost approach. When collecting rainwater, cover all collection vessels to prevent animals and children from entering and to prevent mosquito breeding. Some states might have laws which do not allow collection of rainwater, so be sure to check with your state's water resource agency before implementing a rainwater collection system.

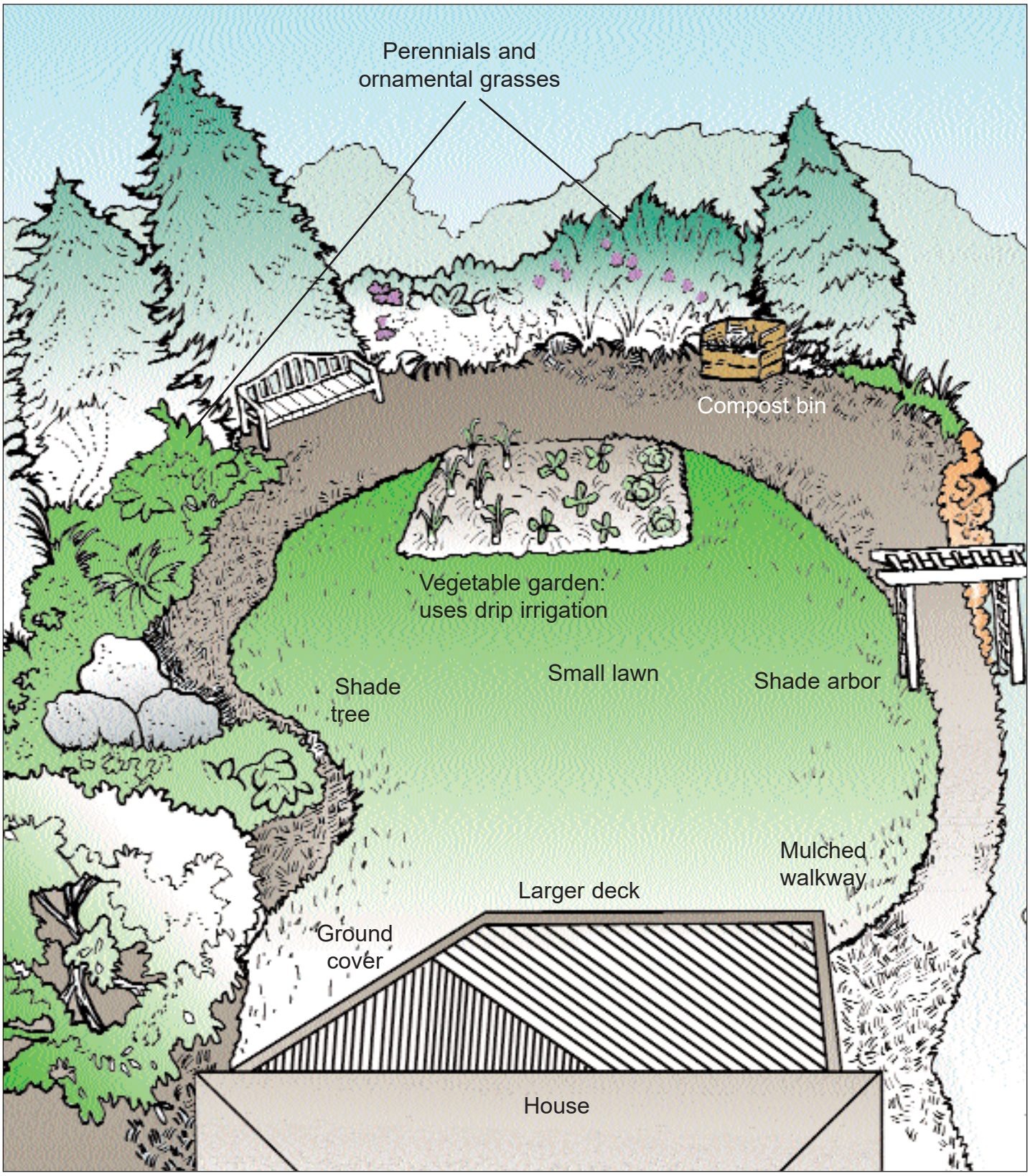
Red Valerian (Centranthus ruber)

4 AWWA Research Foundation. 1999. *Residential End Uses of Water*. <www.waterwiser.org>

Non-xeriscaping



Xeriscaping



Examples of Successful Water-efficient Landscaping Projects

Water-efficient landscaping techniques can be used by individuals, companies, state, tribal, and local governments, and businesses to physically enhance their properties, reduce long-term maintenance costs, and create environmentally conscious landscapes. The following examples illustrate how water-efficient landscapes can be used in various situations.

Oriental Poppies (Paparer orientale)

Homeowner–public/private partnership

- The South Florida Water Management District, the Florida Nurserymen and Growers Association, the Florida Irrigation Society, and local businesses worked together to produce a television video called "Plant It Smart with Xeriscape." The video shows how a typical Florida residential yard can be retrofitted with Xeriscape landscaping to save energy, time, and money. The showcase yard (selected from 70 applicants) had a history of heavy water use—more than 90,000 gallons per month. After the retrofit, the yard's aesthetic value was enhanced; plus it now uses 75 percent less water and relies on yard trimmings for mulch and compost.
- The Southwest Florida Water Management District (SWFWMD), the City of St. Petersburg, and Pinellas County, Florida, produced a video called "Xeriscape It!" It shows a landscape being installed using the seven Xeriscape principles. The SWFWMD also funded several Xeriscape demonstration sites and maintains a Xeriscape demonstration garden at its Brooksville, Florida, headquarters. The garden features a variety of native and non-native plants and is available for public viewing, along with a landscape plant identification guide.
- Residents of Glendale, Arizona, can receive a $100 cash rebate for installing or converting more than half of their landscapable area to non-grass vegetation. The Glendale Water Conservation Office conducts an inspection of the converted lawn to ensure compliance with rebate requirements and then issues a rebate check to the homeowner. The purpose of the Landscape Rebate Program is to permanently reduce the amount of water used to irrigate grass throughout Glendale.

State government

- Although perceived as a water-rich state, Florida became the first to enact a statewide Xeriscape law. Florida's legislature recognized that its growing population and vulnerable environment necessitated legal safeguards for its water resources. The Xeriscape law requires Florida's Departments of Management Ser-

vices and Transportation to use Xeriscape landscaping on all new public properties and to develop a 5-year program to phase in Xeriscape on properties constructed before July 1992. All local governments must also consider requiring the use of Xeriscape and offering incentives to install Xeriscaping.

- Texas also developed legislation requiring Xeriscape landscaping on new construction projects on state property beginning on or after January 1994. Additional legislation, enacted in 1995, requires the Department of Transportation to use Xeriscape practices in the construction and maintenance of roadside parks. All municipalities may consider enacting ordinances requiring Xeriscape to conserve water.

City government

In Las Vegas, Nevada, homeowners can receive up to $1,000 for converting their lawn to Xeriscape, while commercial landowners can receive up to a $50,000 credit on their water bill. The city and several other surrounding communities hope these eye-catching figures will help Las Vegas meet its goal of saving 25 percent of the water it would otherwise have used by the year 2010; to date, it has saved 17 percent. Local officials plan to reach the target with the assistance of incentive programs encouraging Xeriscape, a city ordinance limiting turf to no more than 50 percent of new landscapes, grassroots information programs, and a landscape awards program specifically for Xeriscaped properties. Preliminary results of a five-year study show that residents who converted a portion of their lawns to Xeriscape reduced total water consumption by an average of 33 percent. The xeric vegetation required less than a quarter of the water typically used and one-third the maintenance (both in labor and expenditures) compared to traditional turf.

Yellow Ice Plant (Delosperma nubigenum) *close-up*

Developers

Howard Hughes Properties (HHP), a developer and manager of more than 25,000 acres of residential, commercial, and office development property, has enthusiastically used drought tolerant landscaping on all of its properties since 1990. Most of the company's properties are located in Las Vegas, one of the country's fastest growing metropolitan areas. To conserve resources, the city and county have implemented regulations requiring developers to employ certain Xeriscape principles in new projects. Specifically, a limited percentage of grass can be used on projects, and it must be kept away from streets. As the area's first large-scale developer to recognize the need and value in incorporating drought tolerant landscaping in parks, streetscapes, and open spaces, HHP uses native and desert-adaptive plants that survive and thrive in the Las Vegas climate with minimal to moderate amounts of water.

Drip system irrigation controllers are linked to weather stations that monitor the evapotranspiration rate. This allows HHP to determine the correct amount of water to be applied to plants at any given time. HHP tests the irrigation systems regularly and adds appropriate soil amendments to promote healthy plant growth. The maintenance program also includes pest management, the use of mulching mowers, and the use of rock mulch top dressing on all non-turf planting areas. These measures combine to ensure a beautiful, healthy, and responsible landscape.

Public/private partnerships

Even the most water-conscious homeowners in Southern California are over-watering by 50 to 70 gallons per day. The excess water washes away fertilizers and pesticides, which pollute natural waterways. The quantity of water wasted (and the dollars that pay for it) are even more substantial for large-scale commercial properties and developments.

An innovative partnership in Orange County links landscape water management, green material management, and non-point source pollution prevention goals into one program—the Landscape Performance Certification Program. This program emphasizes efficient landscape irrigation and features a "landscape irrigation budget" based on a property's landscape area, type, and the daily weather. The Municipal Water District monitors actual water use through a system of 12,000 dedicated water meters installed by participating landscape managers.

Participants, including landscapers, property managers, and homeowner associations, can compare the actual cost of water used on their property with the calculated budget. Those staying within budget are awarded certification, a proven marketing tool. This new voluntary program is implemented by the Municipal Water District with input from the California Landscape Contractors' Association, the Orange County Integrated Management Department, the Metropolitan Water District of Southern California, and local nurseries and has the support of 32 retailing water suppliers. The program is already credited with increasing the use of arid-climate shrubs and landscaping to accommodate drip irrigation, and has resulted in cost savings to water customers.

Miscanthus sinensis (Miscanthus grass, also called Maiden grass) *variety with leaves turning yellow for fall.*

For More Information

The following list of organizations can provide more information on water-efficient landscaping. This is not meant to be an exhaustive list, rather it is intended to help you locate local information sources and possible technical assistance.

Turkish Speedwell (Veronica liwanensis) *in background and tulips in foreground.*

Water Management Districts or Utilities

Your local water management district often can provide information on water conservation, including water efficient landscaping practices. Your city, town, or county water management district can be found in the Blue Pages section of your local phone book or through your city, town, or county's Web site if it has one. If you do not know your city, town, or county's Web site, check for a link on your state's Web site. URLs for state Web sites typically follow this format: <www.state.(two letter state abbreviation).us>.

State/County Extension Services

Your state or county extension service is also an excellent source of information. Many extension services provide free publications and advice on home landscaping issues including tips on plant selection and soil improvement. Some also offer a soil analysis service for a nominal fee. Your county extension service can be found in the Blue Pages section of your local phone book under the county government section or through your county's Web site if it has one. The U.S. Department of Agriculture's Cooperative State Research, Education, and Extension Service (www.reeusda.gov/statepartners/usa.htm) provides an online directory of land-grant universities which can help you locate your state extension service. Government Guide (www.governmentguide.com) is yet another online resource that might prove helpful in locating state or local agencies.

Organizations

The following is a partial list of organizations located across the United States that provide helpful information on water-efficient landscaping.

American Water Works Association (AWWA)
6666 West Quincy Avenue
Denver, CO 80235
Telephone: 303 794-7711
and
1401 New York Avenue, NW, Suite 640
Washington, DC 20005
Telephone: 202 628-8303
Web: <www.awwa.org>

Arizona Municipal Water Users Association (AMWUA)
Web: <www.amwua.org/program-xeriscape.htm>

BASIN
City of Boulder Environmental Affairs
P.O. Box 791
Boulder, CO 80306
Phone: 303 441-1964
E-mail: basin@bcn.boulder.co. us
Web: <bcn.boulder.co.us/basin/local/seven.html>

Denver Water
1600 West 12th Avenue
Denver, CO 80204
Phone: 303 628-6000
Fax: 303 628-6199
TDDY: 303 534-4116
Office of Water Conservation hotline:
303 628-6343
E-mail: jane.earle@denverwater.org
Web: <www.water.denver.co.gov/conservation/conservframe.html>

New Mexico Water Conservation Program/Water Conservation Clearinghouse
P. O. Box 25102
Santa Fe, NM 87504
Phone: 800 WATER-NM
E-mail: waternm@ose.state.nm.us
Fax: 505 827-3813
Web: <www.ose.state.nm.us/water-info/conservation/index.html>

Project WET - Water Education for Teachers
201 Culbertson Hall
Montana State University
Bozeman, MT 59717
Phone: 406 994-5392
Web: <www.montana.edu/wwwwet>

Rocky Mountain Institute
1739 Snowmass Creek Road
Snowmass, CO 81654-9199
Phone: 970 927-3851
Web: <www.rmi.org>

Southern Nevada Water Authority
1001 S. Valley View Boulevard, Mailstop #440
Las Vegas, NV 89153
Phone: 702 258-3930
Web: <www.snwa.com>

Southwest Florida Water Management District
2379 Broad Street
Brooksville, FL 34604-6899
Phone: 352 796-7211 or 800 423-1476 (Florida only)
Web: <www.swfwmd.state.fl.us/watercon/xeris/swfxeris.html>

Sustainable Sources Green Building Program: Sustainable Building Source Book
E-mail: info@greenbuilder.com
Web: <www.greenbuilder.com/sourcebook/xeriscape.html>

Water Conservation Garden – San Diego County
12122 Cuyamaca College Drive West
El Cajon, CA 92019
Phone: 619 660-0614
Fax: 619 660-1687
E-mail: info@thegarden.org
Web: <www.thegarden.org/garden/xeriscape/index.html> and <www.sdcwa.org/manage/conservation-xeriscape.phtml>\

WaterWiser: The Water Efficiency Clearing House
(Operated by AWWA in cooperation with the U.S. Bureau of Reclamation)
6666 West Quincy Avenue
Denver, CO 80235
Phone: 800 559-9855
Fax: 303 794-6303
E-mail: bewiser@waterwiser.org
Web: <www.waterwiser.org>

Xeriscape Colorado!, Inc.
P.O. Box 40202
Denver, CO 80204-0202
Web: <www.xeriscape.org>

Resources

The following is a partial list of publications on resource efficient landscaping. For even more information, particularly on plants suited to your locale, consult your local library, county extension service, nursery, garden clubs, or water utility.

Ball, Ken and American Water Works Association Water Conservation Committee. *Xeriscape Programs for Water Utilities*. Denver: American Water Works Association, 1990.

Bennett, Jennifer. *Dry-Land Gardening: A Xeriscaping Guide for Dry-Summer, Cold-Winter Climates*. Buffalo: Firefly, 1998.

Bennett, Richard E. and Michael S. Hazinski. *Water-Efficient Landscape Guidelines*. Denver: American Water Works Association, 1993.

Brenzel, Kathleen N., ed. *Western Garden Book*, 2001 Edition. Menlo Park: Sunset Publishing Corporation, 2001.

City of Aurora, Colorado Utilities Department. *Landscaping for Water Conservation: Xeriscape!* Aurora: Colorado Utilities Department, 1989.

Johnson, Eric and Scott Millard. *The Low-Water Flower Gardener: 270 Unthirsty Plants for Color, Including Perennials, Ground Covers, Grasses & Shrubs*. Tucson: Ironwood Press, 1993.

Knopf, James M. *The Xeriscape Flower Gardener*. Boulder: Johnson Books, 1991.

Knopf, James M., ed. *Waterwise Landscaping with Trees, Shrubs, and Vines: A Xeriscape Guide for the Rocky Mountain Region, California, and the Desert Southwest*. Boulder: Chamisa Books, 1999.

Knox, Kim, ed. *Landscaping for Water Conservation: Xeriscape*. Denver: City of Aurora and Denver Water, 1989.

Nellis, David W. *Seashore Plants of South Florida and the Caribbean: A Guide to Identification and Propagation of Xeriscape Plants*. Sarasota: Pineapple Press, Inc., 1994.

Perry, Bob. *Landscape Plants for Western Regions: An Illustrated Guide to Plants for Water Conservation*. Claremont: Land Design Publishing, 1992.

Phillips, Judith. *Natural by Design: Beauty and Balance in Southwest Gardens*. Santa Fe: Museum of New Mexico Press, 1995.

Phillips, Judith. *Plants for Natural Gardens: Southwestern Native & Adaptive Trees, Shrubs, Wildflowers & Grasses*. Santa Fe: Museum of New Mexico Press, 1995.

Robinette, Gary O. *Water Conservation in Landscape Design and Maintenance*. New York: Nostrand Reinhold, 1984.

Rumary, Mark. *The Dry Garden*. New York: Sterling Publishing Co., Inc., 1995.

Springer, Lauren. *The Undaunted Garden: Planting for Weather-Resilient Beauty*. Golden: Fulcrum Publishing, 1994.

Springer, Lauren. *Waterwise Gardening*. New York: Prentice Hall Gardening, 1994.

Stephens, Tom, Doug Welsh, and Connie Ellefson. *Xeriscape Gardening, Water Conservation for the American Landscape*. New York: Macmillan Publishing, 1992.

Sunset Books, eds. *Waterwise Gardening: Beautiful Gardens with Less Water*. Menlo Park: Lane Publishing Company, 1989.

Vickers, Amy. *Handbook of Water Use and Conservation*. Amherst, MA: WaterPlow Press, 2001.

Weinstein, Gayle. *Xeriscape Handbook : A How-To Guide to Natural, Resource-Wise Gardening*. Golden: Fulcrum Publishing, 1998.

Williams, Sara. *Creating the Prairie Xeriscape*. Saskatchewan: University Extension Press, 1997.

Winger, David, ed. *Xeriscape Plant Guide: 100 Water-Wise Plants for Gardens and Landscapes*. Golden: Fulcrum Publishing, 1998.

Winger, David, ed. *Xeriscape Color Guide*. Golden: Fulcrum Publishing, 1998.

Winger, David, ed. *Evidence of Care: The Xeriscape Maintenance Journal, 2002, Vol. 1*, Colorado WaterWise Council, 2001.

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For copies of this publication contact:
EPA Water Resources Center (RC-4100)
U.S. Environmental Protection Agency
Ariel Rios Building, 1200 Pennsylvania Avenue, NW.
Washington, DC 20460

For more information regarding water efficiency, please contact:
Water Efficiency Program (4204M)
U.S. Environmental Protection Agency
Ariel Rios Building, 1200 Pennsylvania Avenue, NW.
Washington, DC 20460
<www.epa.gov/OWM/water-efficiency/index.htm>

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