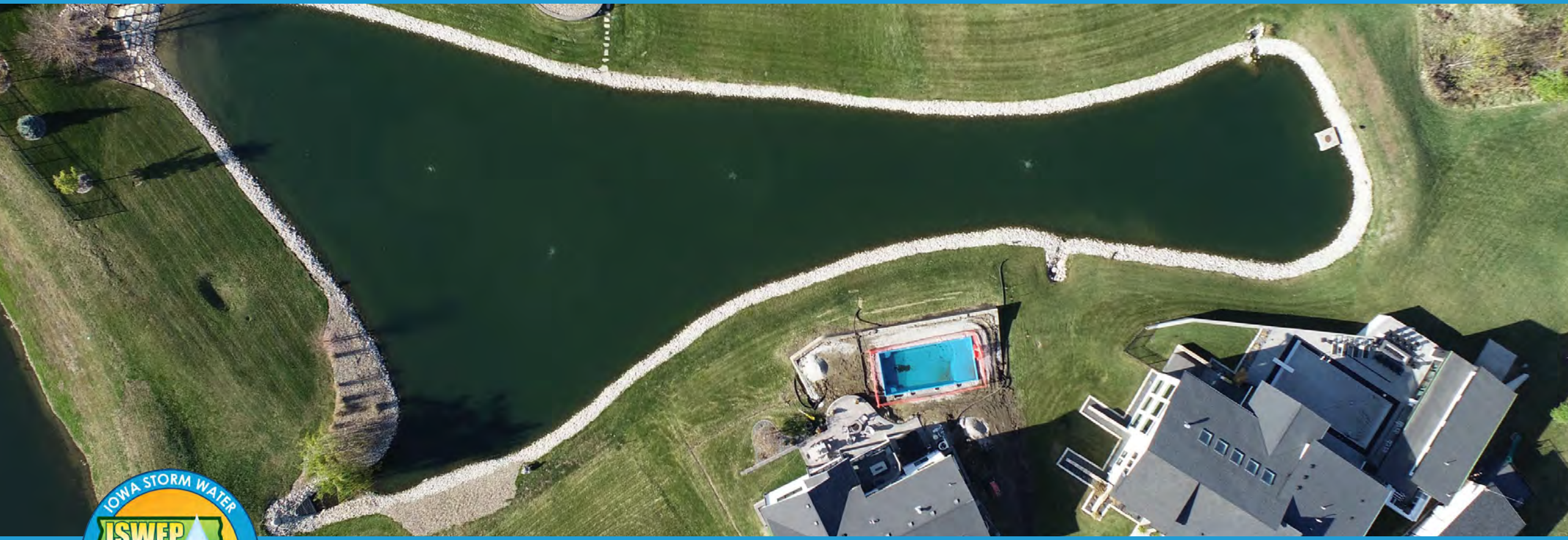
How to Manage Your Pond

Stormwater Basin Basics for Homeowners

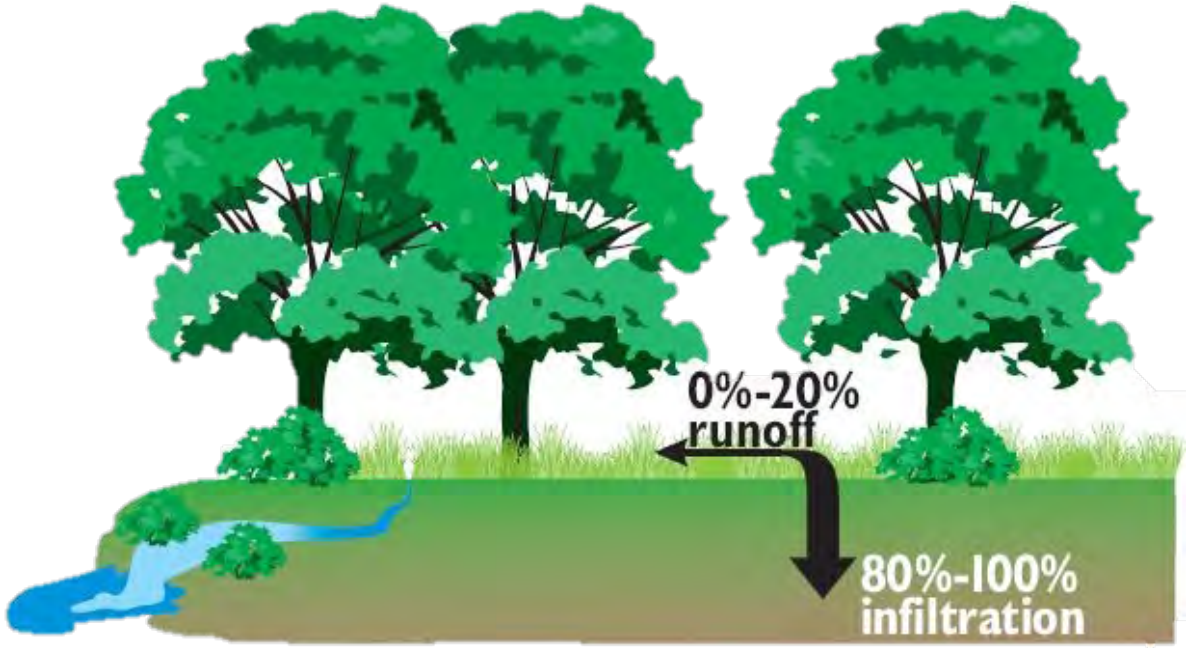


City of Waukee, IA
Iowa Stormwater Education Partnership

Waukee

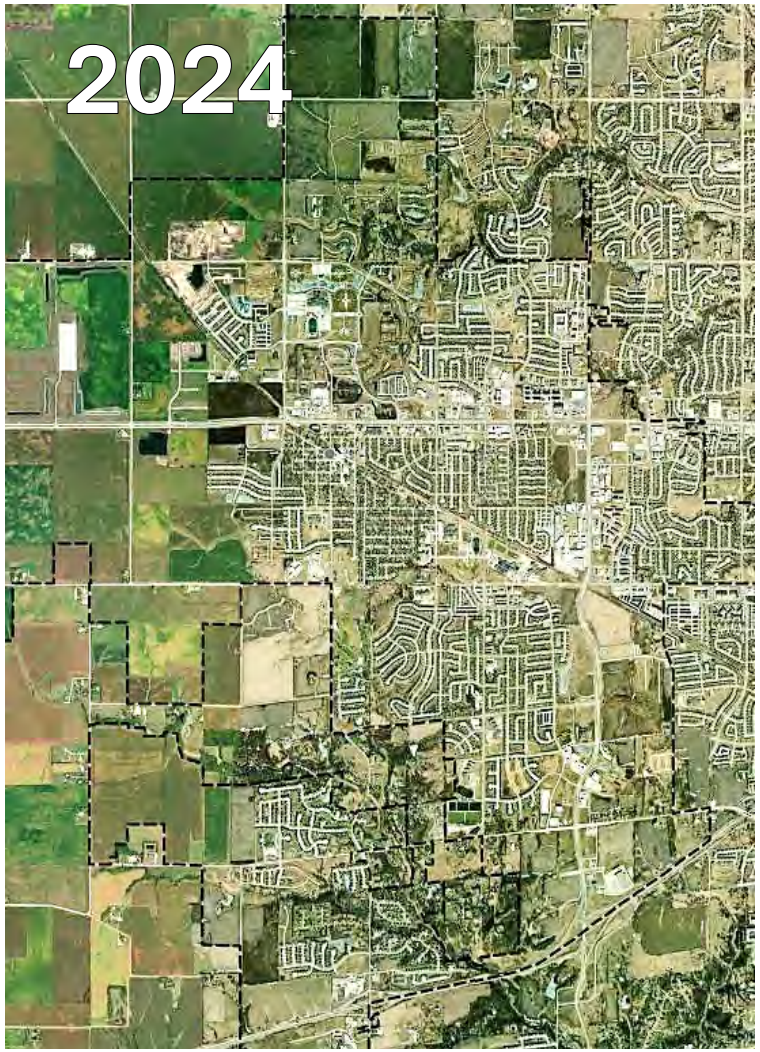
First, some background...

Urbanization disrupts the natural water cycle



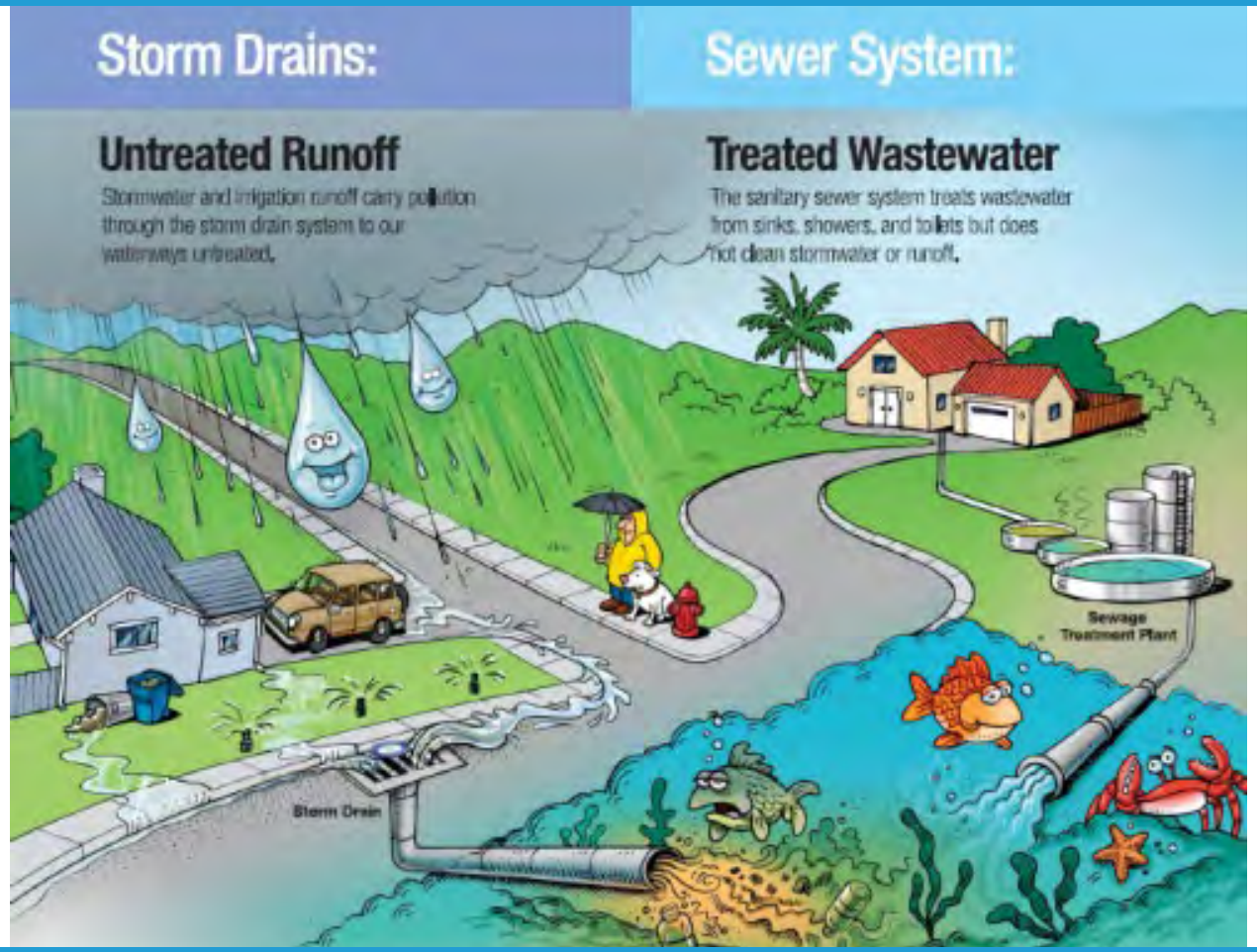
Source: City of Lincoln, Nebraska

Urbanization disrupts the natural water cycle



Source: Iowa Geographic Map Server

Unlike wastewater, stormwater runoff flows to our streams untreated



Stormwater runoff creates community-wide problems

Sources: Buddha Dog Flickr, Pike County Conservation District, Neponset River Watershed Association

More water

Colby Park flooding from Walnut Creek in Windsor Heights, Iowa, after heavy rain Sunday, July 1, 2018.

Rodney White And Michael Zamora/The Register

Steve Lucas of Waukee, right, helps sort through the wood he, brother Eric Bauer, left, and BauerÕs son Austin, 7, center, tore out of their parents basement on Sunday, July 1, 2018, in Clive. They said there was about eight inches of water in the basement and everything needed to go.

Brian Powers/The Register

Moving faster

Source: RDG – Sugar Creek Watershed Assessment

Little Walnut Creek Sewer, Streambank Stabilization, Trail, and Habitat Restoration

5152236220

littlewalnutcreek@cityofclive.com

In 2023, the City of Waukee started construction on a new sanitary sewer near the north bank of Little Walnut Creek, running from Warrior Lane East to NW 156th Street (see map below). The project will affect neighborhoods, trails, and natural areas near the creek in Waukee, Clive, and Urbandale. All three cities are working together to lessen disruptions caused by the construction and prepare for future improvements, including streambank stabilization, vegetation restoration, trail expansion, and widening Alices Road.

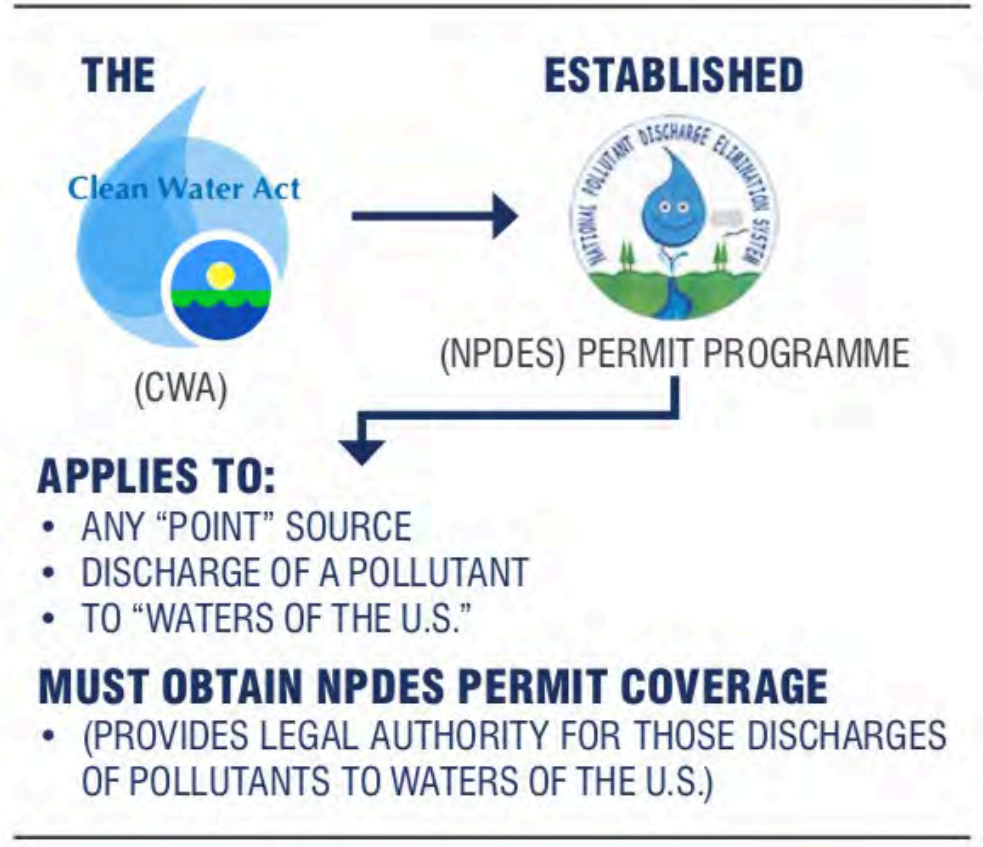
Carrying pollutants

Source: City of Weston, MA

Source: RPBC Watershed District

Stormwater is regulated under the Clean Water Act

Source: The Cleaveland Press Collection



Source: Uniteam Marine

Waukee's Municipal Separate Storm Sewer System (MS4) has an NPDES permit issued by the IA DNR

Source: City of Braintree, MA

IOWA DEPARTMENT OF NATURAL RESOURCES

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT

PERMITTEE

City of Waukee
230 Highway 6
Waukee, Iowa 50263

IDENTITY AND LOCATION OF FACILITY

City of Waukee

IOWA NPDES PERMIT NUMBER: 25-73-0-02

RECEIVING WATERCOURSES
Sugar Creek and other, undesignated waterbodies

EPA NUMBER – IA0078875

This permit is issued pursuant to the authority of section 402(b) of the Clean Water Act (33 U.S.C. 1342(b)), Iowa Code section 455B.174, and rule 567–64.13, Iowa Administrative Code. You are authorized to operate the disposal system and to discharge the pollutants specified in this permit in accordance with the monitoring requirements and other terms set forth in this permit.

Facility Name: City of Waukee Municipal Separate Storm Sewer System
Permit Number: 25-73-0-02 Final permit

IA DNR and US EPA conduct audits/inspections to ensure compliance

Fines can be issued for non-compliance

6 Minimum Control Measures are required in this permit

MCM 5: Post-construction stormwater management is most relevant to today's discussion

CHAPTER 103

POST-CONSTRUCTION STORMWATER MANAGEMENT

103.01 PURPOSE.

1. MS4 Permit Obtained By City. The U.S. EPA's National Pollutant Discharge Elimination System (NPDES) permit program (program) administered by the Iowa Department of Natural Resources (IDNR) requires that cities meeting certain demographic and environmental impact criteria obtain from the IDNR an NPDES permit for the discharge of stormwater from a municipal separate storm sewer system (MS4). The City's MS4 permit is on file at the office of the City Clerk and is available for public inspection during regular office hours.

2. Enforcement of Program; Requirements and Restrictions. As a condition of the City's MS4 permit, the City is obliged to develop, implement, and enforce a program to address stormwater runoff from new construction and reconstruction projects for which State NPDES General Permit No. 2 stormwater permit coverage is required by adopting a post-construction stormwater management ordinance designed to:

A. Require water quality and quantity components be considered in the design of new construction and implemented when practical; and

B. Promote the use of stormwater detention and retention, grass swales, buffer strips, and proper operation and maintenance of these facilities; and

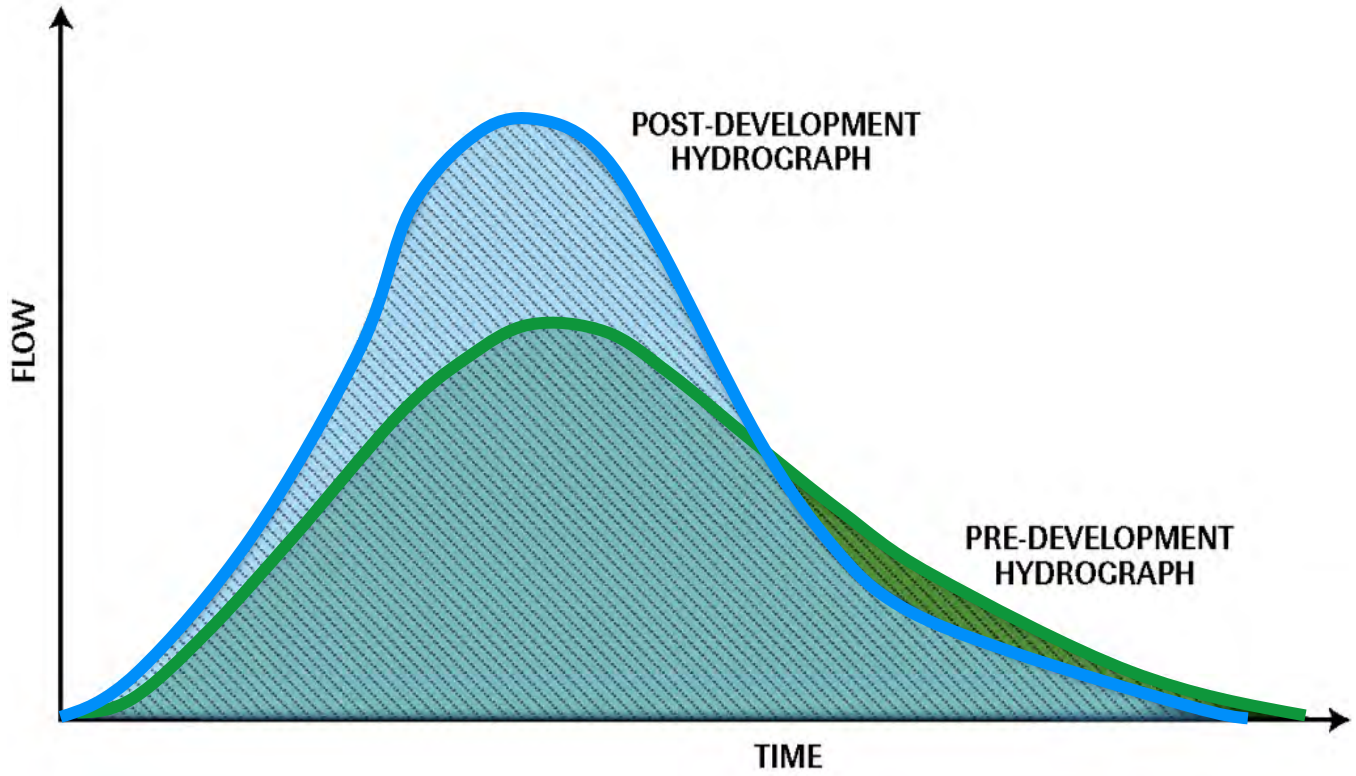
C. Allow use of bio-retention swales and riparian buffers where practical and the soils and topography are suitable to ensure such measures will be effective in accomplishing the purpose of this chapter; and

D. Prohibit construction activities from commencing until the plans for post-construction runoff controls have been submitted to the City; and

E. Allow the City to have the ability to access private property for the purpose of enforcement procedures to promote compliance with the State NPDES General Permits No. 2 which require post-construction compliance by applicants.

Source: LGROW

The goal of post-construction stormwater management is to mimic natural conditions



Source: PACE Water Engineering

Stormwater management practices can reduce, slow down, and clean up runoff

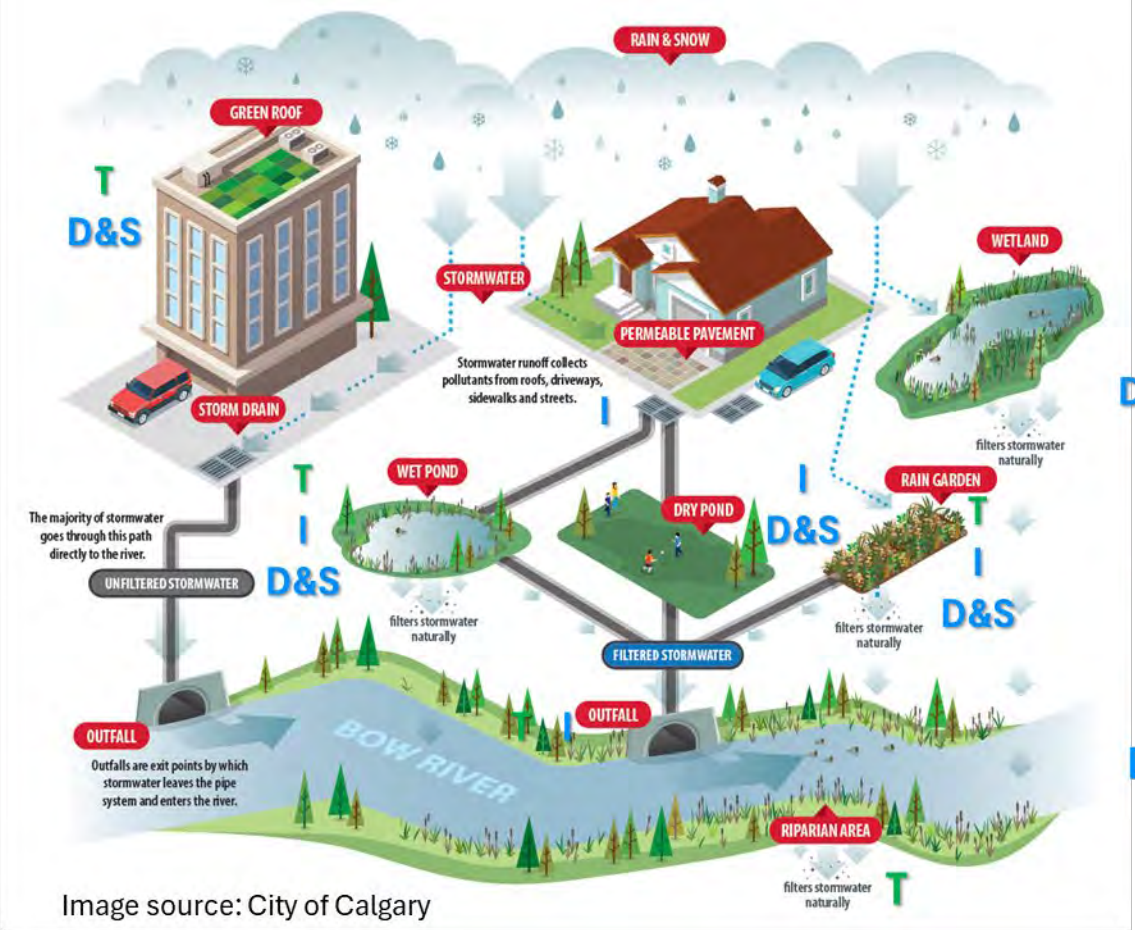


Image source: City of Calgary

T: Treatment — Clean up

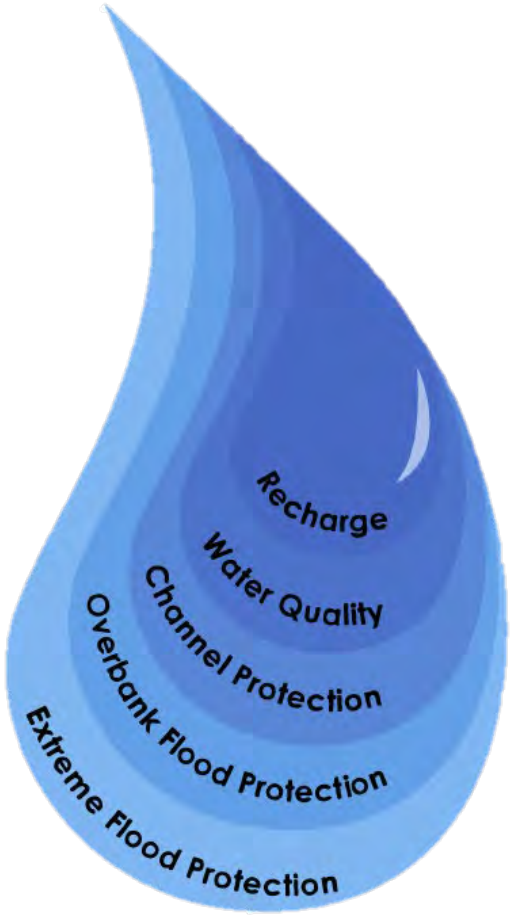
I: Infiltration

D&S: Detention & storage — Slow down & reduce

Different storms require different management approaches

CRITERIA	OBJECTIVE
SMALL STORM	
Recharge Volume (Rev)	Runoff volume reduction, groundwater recharge.
Water Quality Volume (WQv)	Provide water quality treatment, reduce total pollutant load.
Channel Protection Volume (CPv)	Protect downstream channels from increased flow rates, extended duration of high flows and erosive flow velocities.
LARGE STORM	
Overbank Flood Protection (Qp)	Reduce potential for downstream storm sewer network surcharge and overbank flooding in local urban watersheds.
Extreme Flood Protection (Qf)	Protect adjacent and downstream properties and infrastructure. Prevent increases in flood high water elevations downstream. Manage impacts of extreme storm events through detention controls and floodplain management.

Source: Iowa Stormwater Management Manual

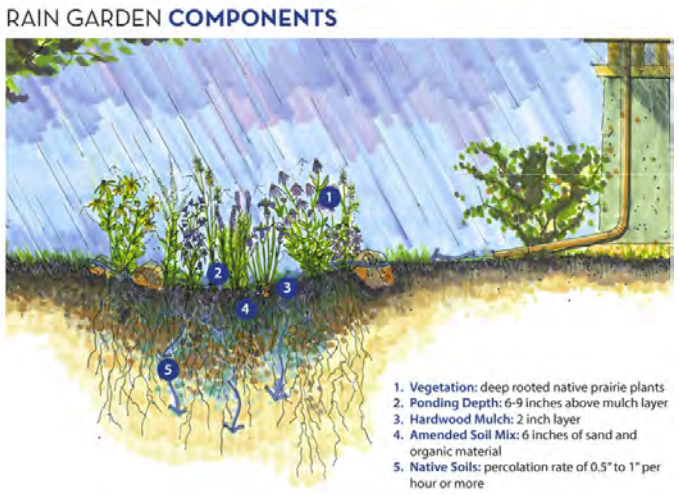


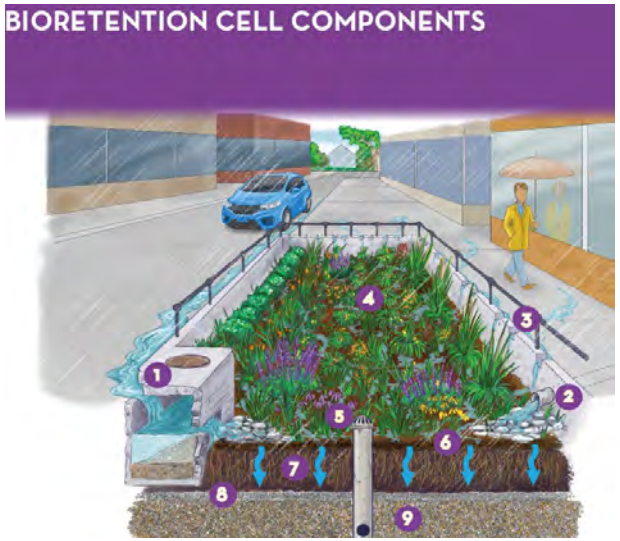
Treating small storms (≥1 yr return frequency) can capture “first flush” pollutants

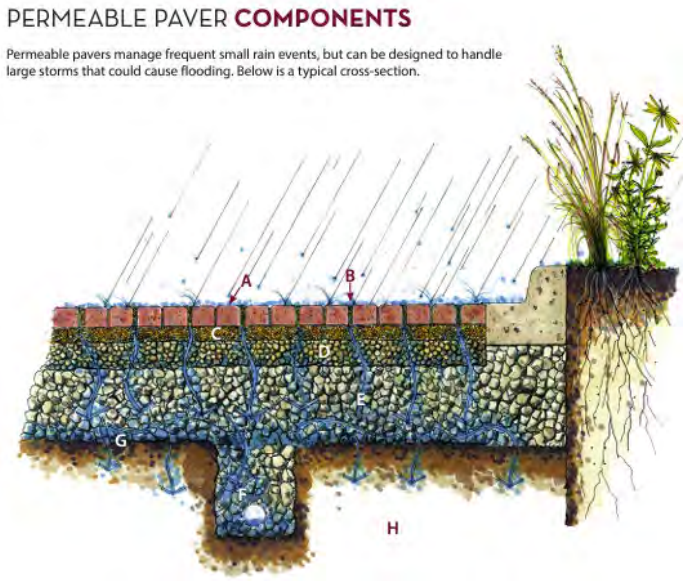
2. *Water Quality Volume (WQv)*

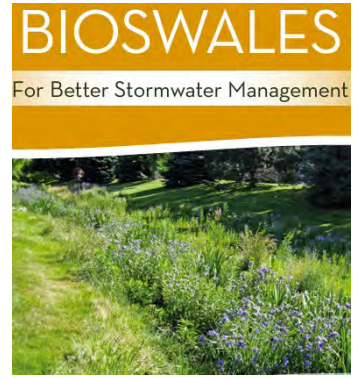
The WQv criteria is focused on the capture and treatment of runoff from the most commonly occurring storm events. Statewide, approximately 90% of rainfall events on an annual basis are less than or equal a depth of 1.25 inches. The vast majority of runoff from a site will be captured and treated through installation of BMPs that are sized to address these most common, small storms. A 80% reduction in TSS can typically be expected from practices that address 90% of annual rainfall events.

Small storms are managed by maximizing infiltration and facilitating biogeochemical processes









Controlling flow rates from medium storms (5 yr return frequency) prevents stream erosion

Figure 3.01-2.4: City staff noted that the small urban stream in this area was 2 feet wide and 1 feet deep when the area was platted about 30 years before this photo was taken. In this photo, the stream had a top width of around 40 feet and a depth of 15 feet.

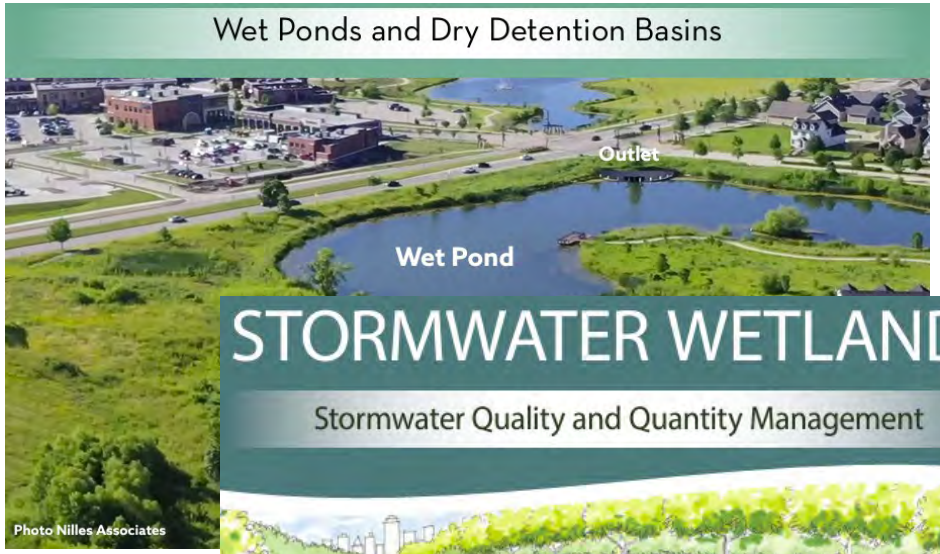
Source: Iowa Stormwater Management Manual

Source: Iowa PBS

Detaining flow from large storms (5+ yr return frequency) helps with flood control

Source: Des Moines Register

Basins are among several detention and storage practices

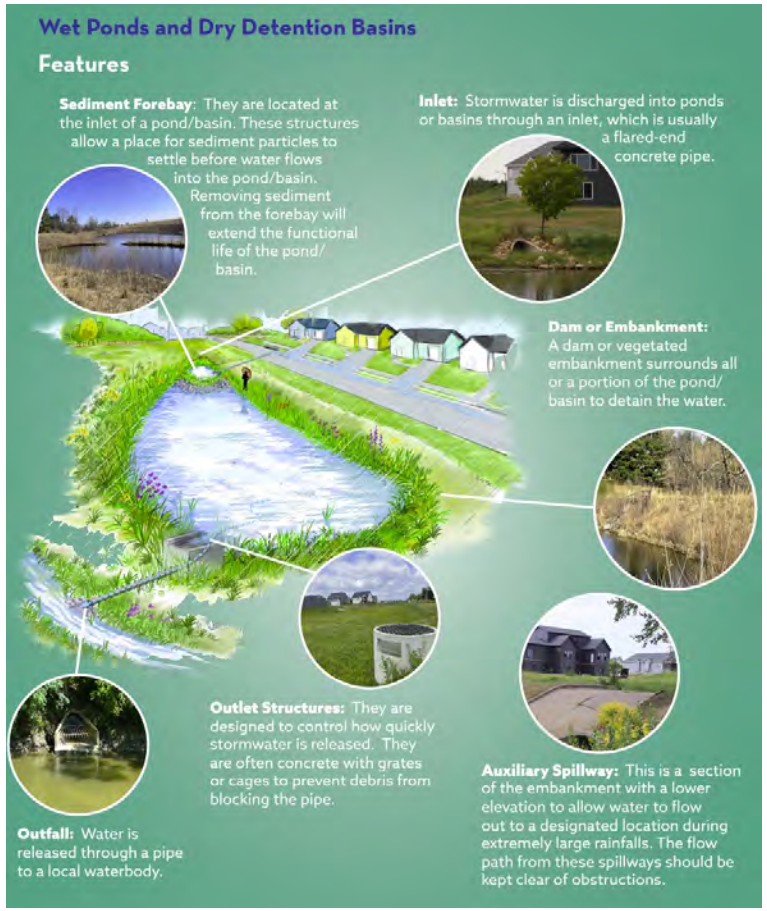


Source: Urban Water Atlas

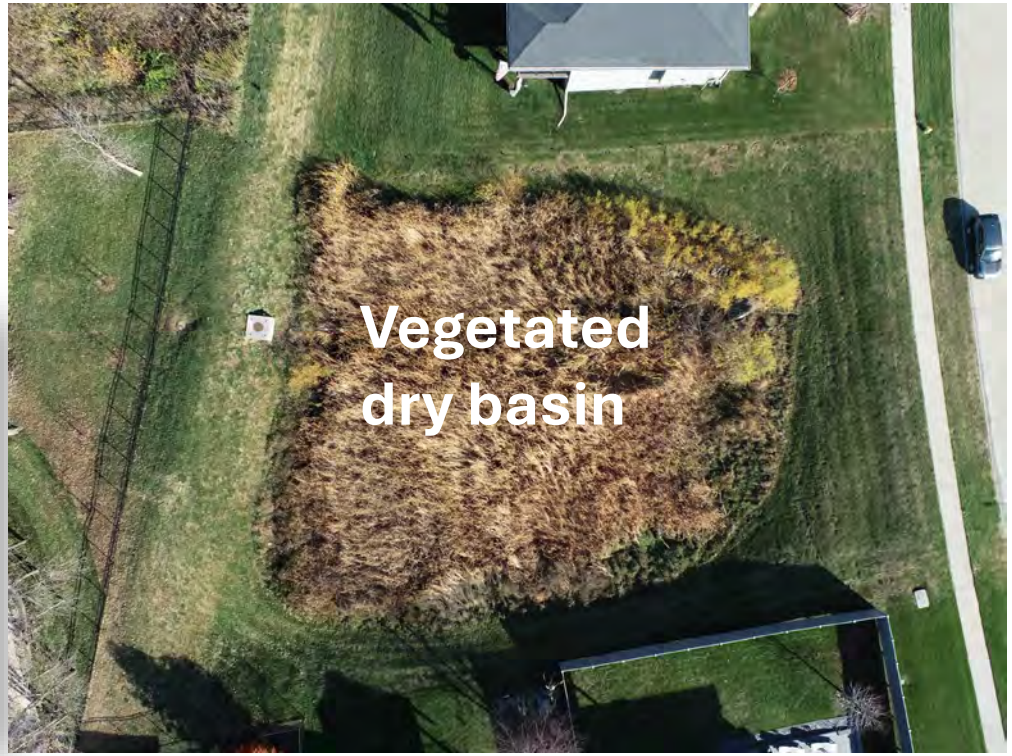
Source: VERTEX

Basin and pond basics...

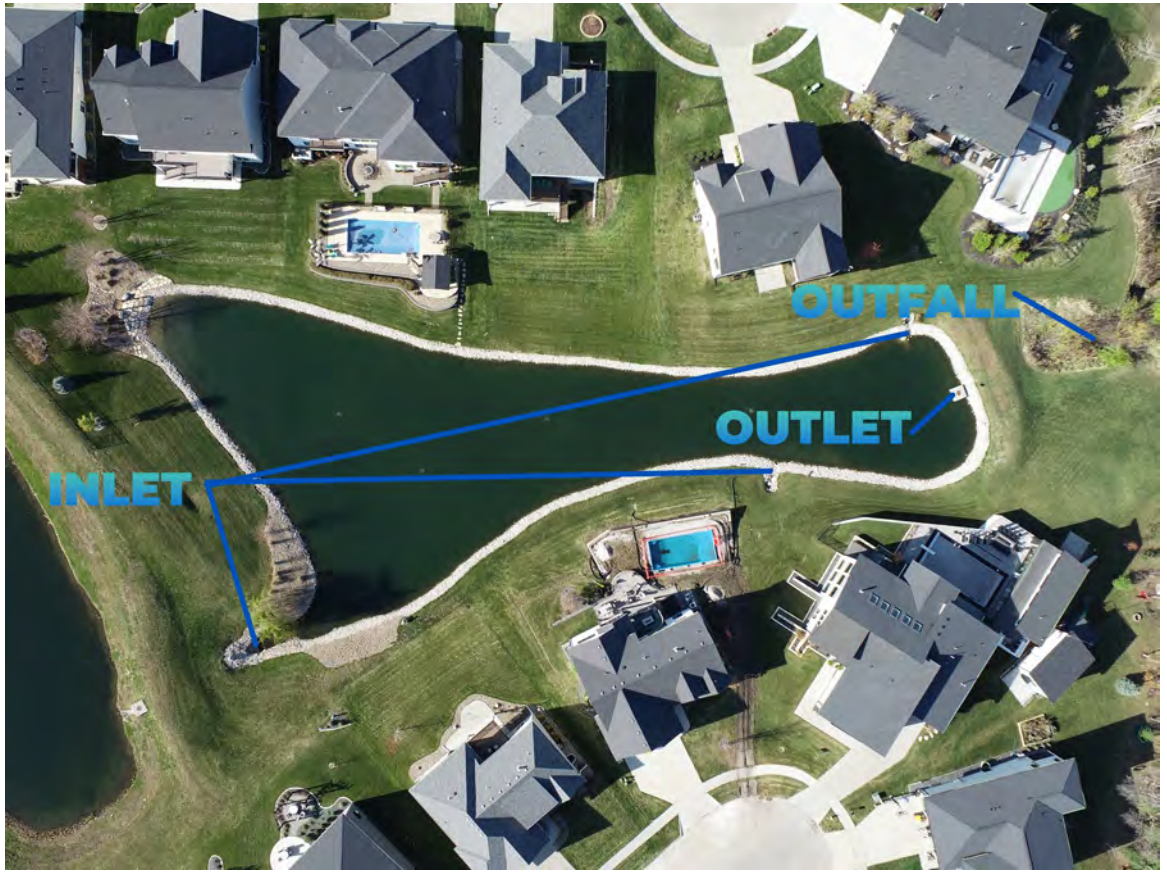
Basins manage medium and large storms by providing a safe place to hold back water



In dry detention basins, water is temporarily held back



In wet ponds, water is detained and sometimes stored



Basins can also provide water quality benefits

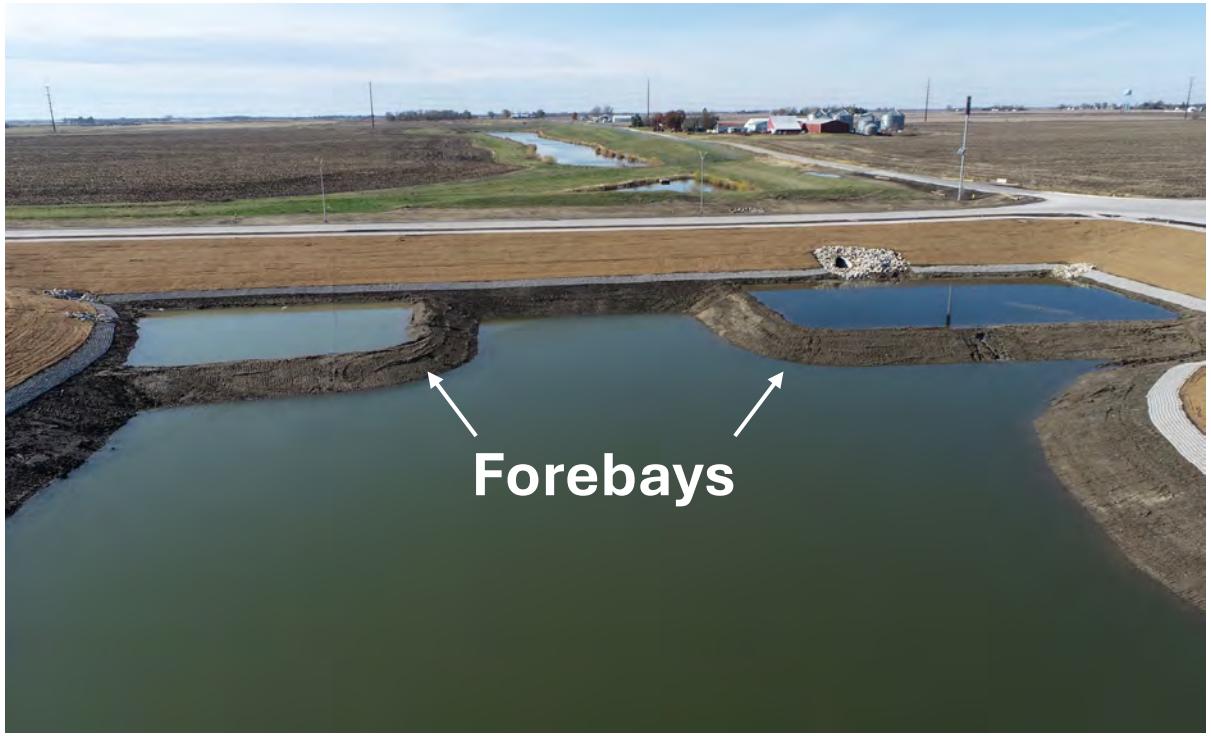
Median pollutant load capture rate

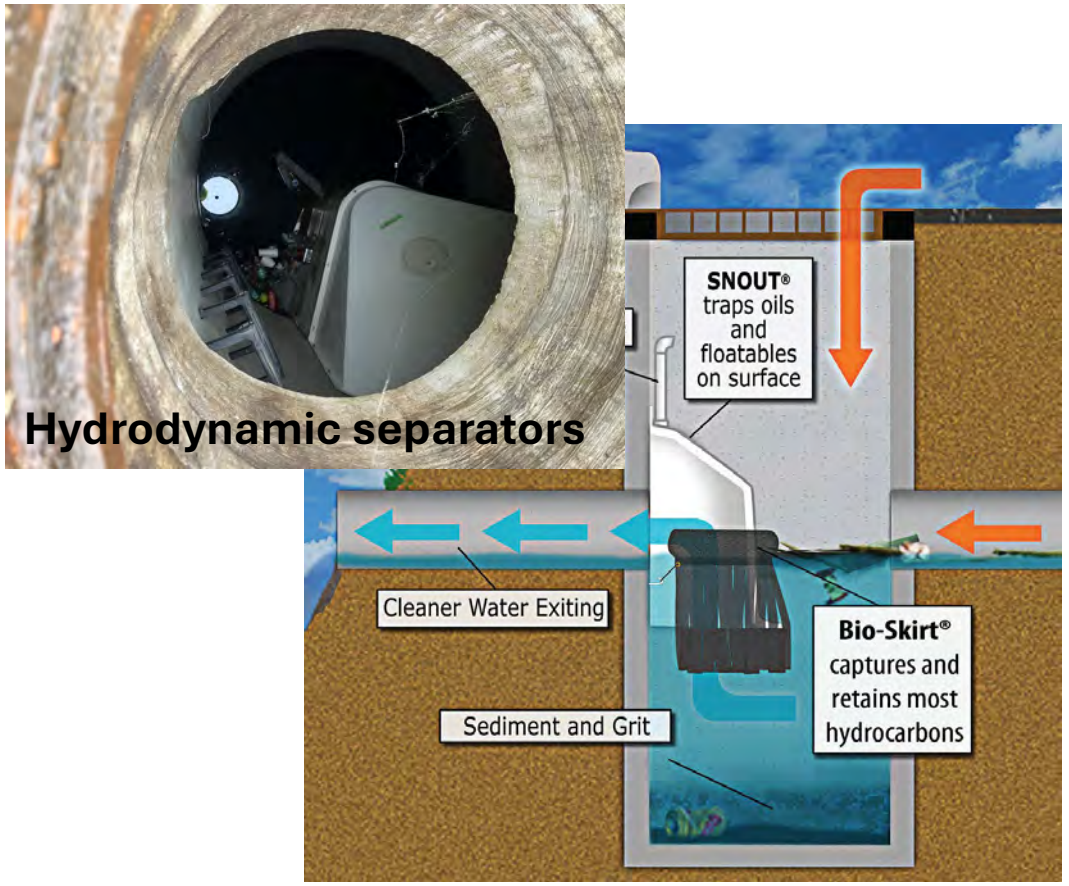
	TSS Total Suspended Solids	15 P Phosphorus 30.973762	7 N Nitrogen 14.00674	24 Cr Chromium 51.9961	82 Pb Lead 207.2	48 Cd Cadmium 112.411	29 Cu Copper 63.546	30 Zn Zinc 65.39
 Wet ponds	76%	51%	26%	50%	67%	50%	49%	57%
 Dry basins	66%	26%	2%	25%	67%	26%	48%	67%

Source: ISBD. 2022. International stormwater BMP database. Retrieved from https://bmpdatabase.org/

Basic features of basins

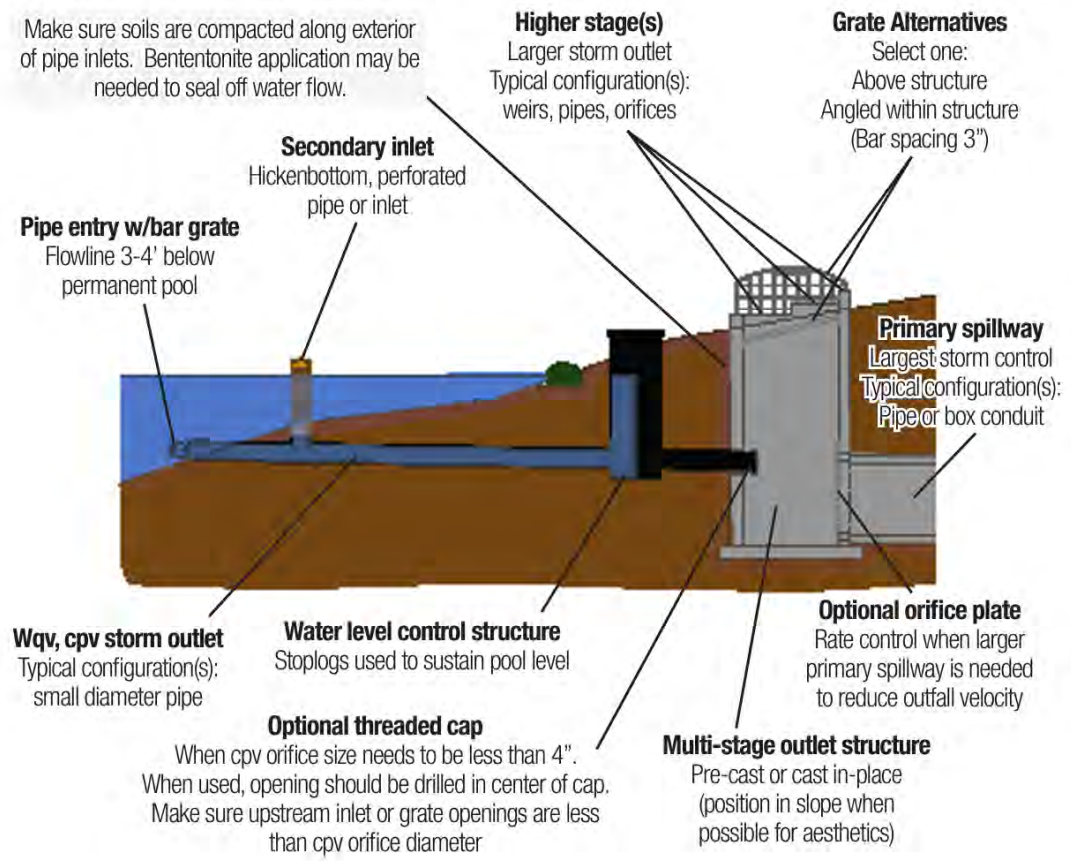
Pre-treatment mechanisms capture trash and sediment



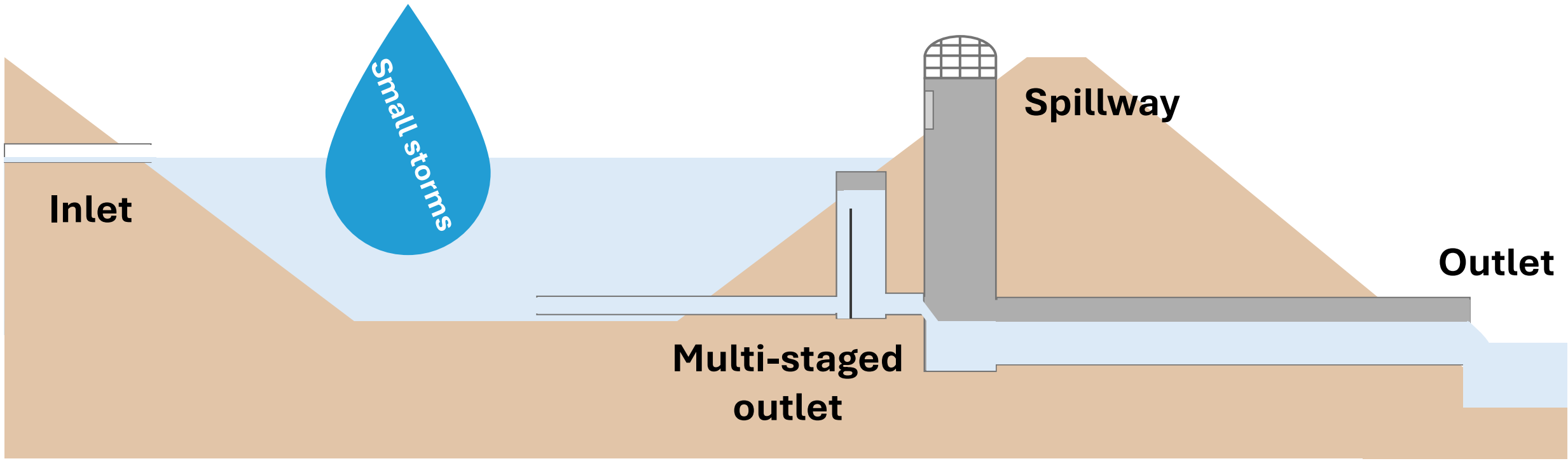


Inlet and outlet structures control water movement through the basin

Figure 9.04-5.1: Multi-stage outlet example



Multi-staged outlets allow wet ponds to manage a range of storms



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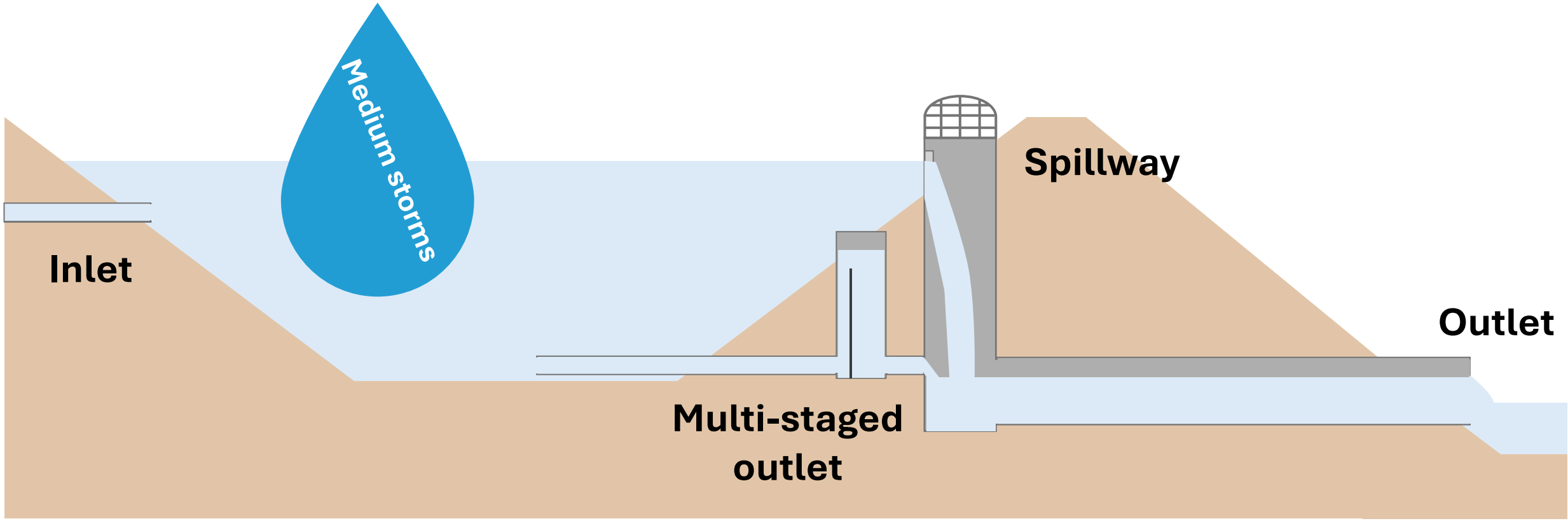
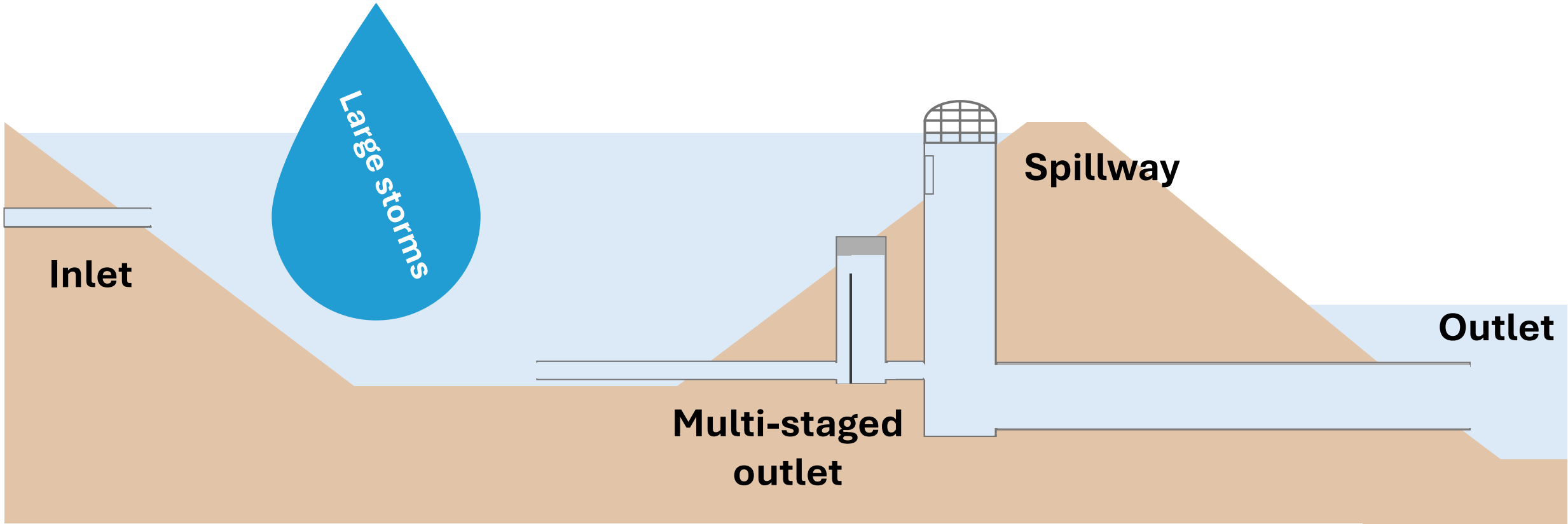
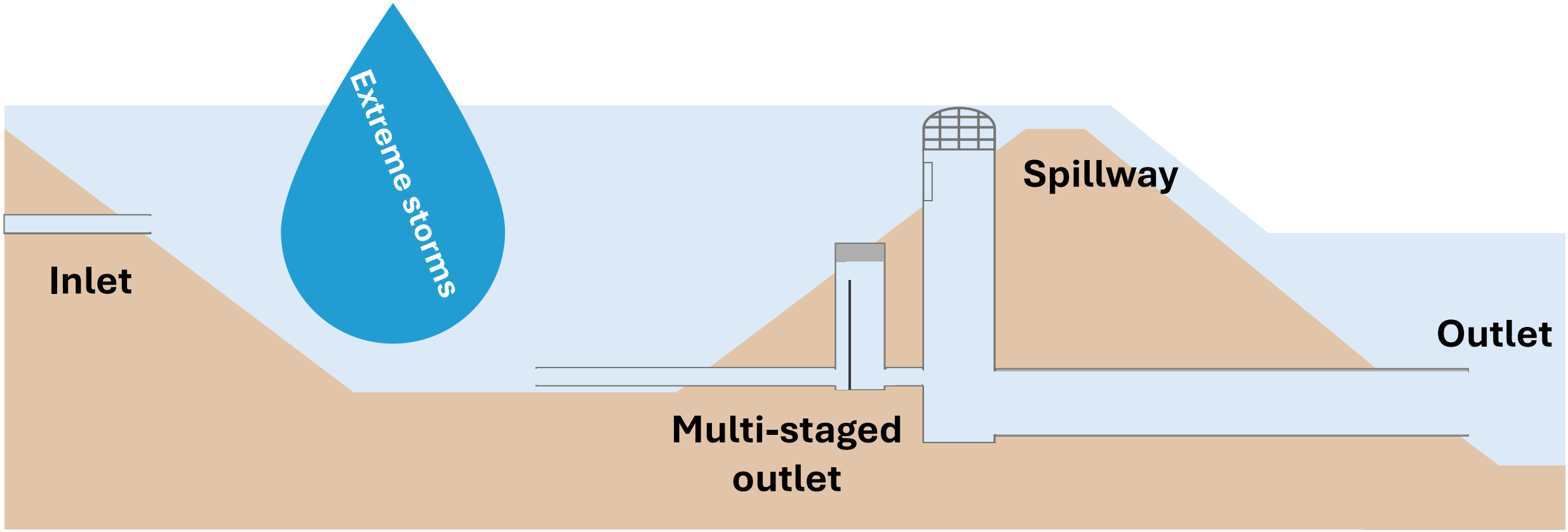


Multi-staged outlets allow wet ponds to manage a range of storms



During very extreme events, the emergency spillway can provide a safe exit path for water



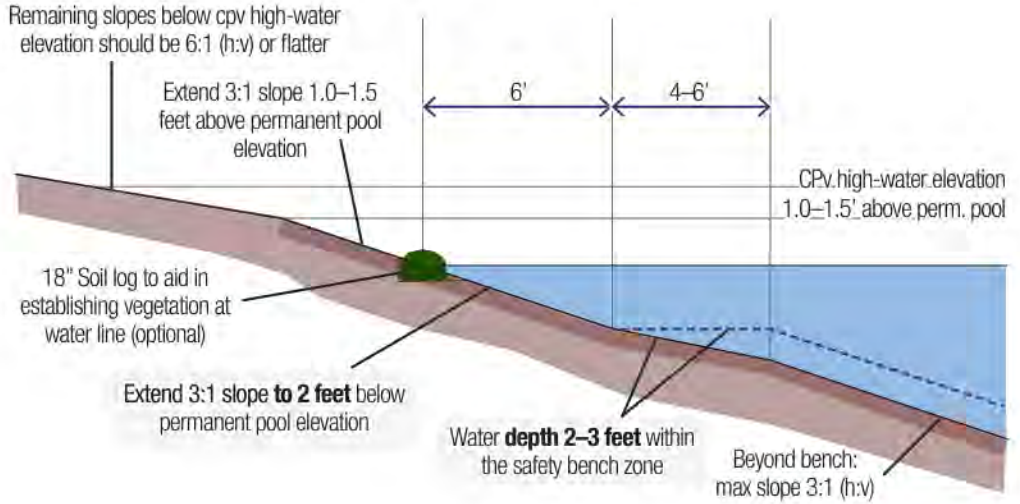
Basins typically have safety features

SAFETY BENCH/POND EDGE

Along the edge of the pond, a safety bench should be provided to reduce the potential of someone falling into deep water, and also to promote growth of aquatic vegetation to aid in water quality improvement. This safety bench also reduces the potential of shoreline erosion. There are two types of safety benches that may be provided: ESSENTIAL

Narrow bench (fishing option): A smaller bench can be provided to make it easier for fishing, with lines cast across the bench. For this option the bench should be 4–6 feet wide, measured from toe of the steeper slope along the shoreline. Water depth above the bench should be 2–3 feet deep.

Figure 9.11-1-7: Narrow bench cross section



Additionally, proper signage and maintenance protect public safety and reduce liability

What are your responsibilities and how do you maintain your basin?

Waukee requires annual inspections of privately owned basins

WHY?

- Waukee's MS4 permit requirements, HOA maintenance covenants
- Catch and repair minor issues early
- Ensure proper functioning
- Prevent catastrophic failures and expenses

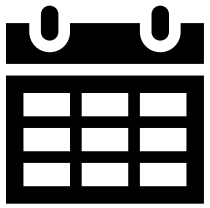
Responsible parties

Property owner/HOA is responsible for inspection and maintenance

A qualified individual should conduct the inspection; professional companies may be hired

Contact Waukee Public Works (515-978-7920, stormwater@waukee.org) if major dam or outlet structure repairs are required

Inspection frequency & timing

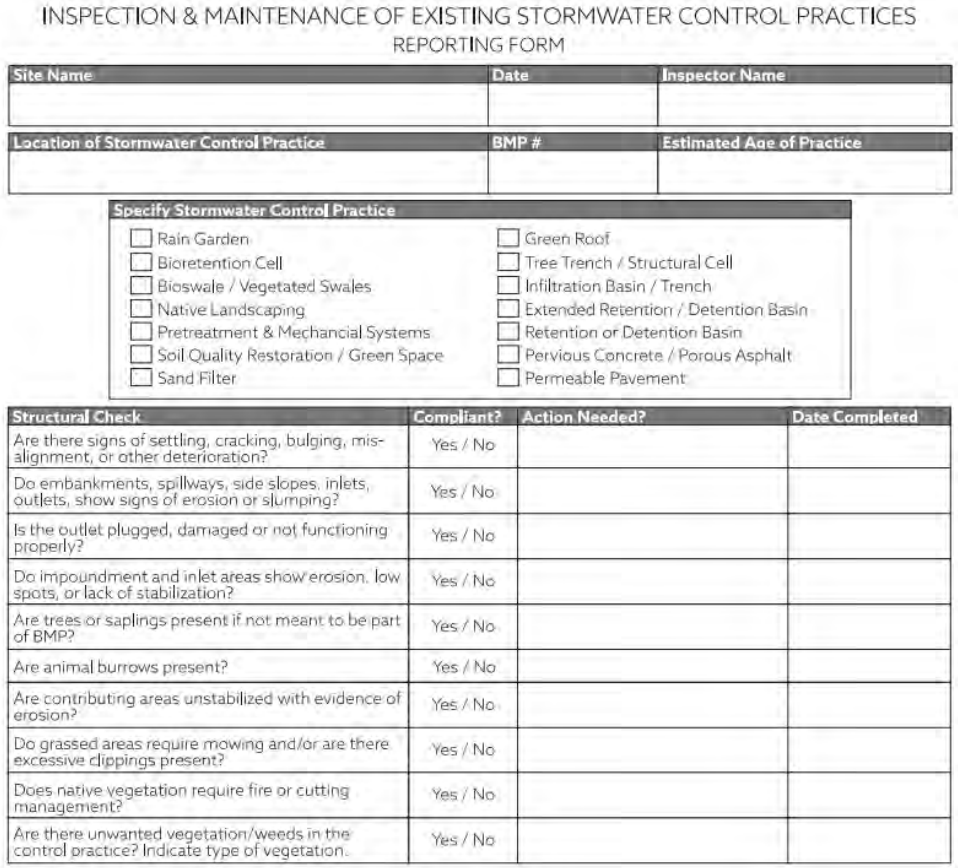


At least once a year

Best practice to conduct within 24 hours after storms of 1 inch or greater

Ideally conduct monthly inspection of inlet pipes, outflow barrel, and outlet structure weirs/orifices

Inspection procedure



INSPECTION & MAINTENANCE OF EXISTING STORMWATER CONTROL PRACTICES
REPORTING FORM

Site Name	Date	Inspector Name

Location of Stormwater Control Practice	BMP #	Estimated Age of Practice

Specify Stormwater Control Practice

- ☐ Rain Garden
- ☐ Bioretention Cell
- ☐ Bioswale / Vegetated Swales
- ☐ Native Landscaping
- ☐ Pretreatment & Mechanical Systems
- ☐ Soil Quality Restoration / Green Space
- ☐ Sand Filter
- ☐ Green Roof
- ☐ Tree Trench / Structural Cell
- ☐ Infiltration Basin / Trench
- ☐ Extended Retention / Detention Basin
- ☐ Retention or Detention Basin
- ☐ Pervious Concrete / Porous Asphalt
- ☐ Permeable Pavement

Structural Check	Compliant?	Action Needed?	Date Completed
Are there signs of settling, cracking, bulging, mis-alignment, or other deterioration?	Yes / No		
Do embankments, spillways, side slopes, inlets, outlets, show signs of erosion or slumping?	Yes / No		
Is the outlet plugged, damaged or not functioning properly?	Yes / No		
Do impoundment and inlet areas show erosion, low spots, or lack of stabilization?	Yes / No		
Are trees or saplings present if not meant to be part of BMP?	Yes / No		
Are animal burrows present?	Yes / No		
Are contributing areas unstabilized with evidence of erosion?	Yes / No		
Do grassed areas require mowing and/or are there excessive clippings present?	Yes / No		
Does native vegetation require fire or cutting management?	Yes / No		
Are there unwanted vegetation/weeds in the control practice? Indicate type of vegetation.	Yes / No		

1. Complete inspection form
2. Inspect each inlet and note sediment accumulation
3. Measure sediment depths in inlet pipes
4. Check outfall pipe area for erosion/debris/damage
5. Site walk to note erosion/pollution discharge
6. Documentation: Include photos, sign, date, file original

Plan for required maintenance

ACTIVITY	SCHEDULE
Inspect storm inlets, outlets for debris. Look for signs of sediment accumulation, flow channelization, erosion damage, local streambank instability. Check the outfall for signs of surface erosion, seepage or tunneling along outfall pipe.	At least annually AND after rain events of 1.25" or larger
Inspect forebays and other pretreatment areas.	At least twice annually
Remove accumulated sediment from forebay.	When forebay is 1/2 full OR at least once every 5 years
Clean and remove debris from inlet and outlet structure.	At least three times annually
Monitor vegetation and perform replacement planting as necessary.	Annually (after short-term establishment period)
• Examine stability of the safety bench and shoreline edge. • Inspect for invasive vegetation and remove where possible. • Inspect for damage to the embankment and inlet/outlet structures; repair as necessary. • Note any signs of hydrocarbon build-up and remove accordingly.	Annual Inspection
Repair undercut or eroded areas.	When observed
Harvest wetland plants that have been "choked out" by sediment accumulation.	Annually
Remove sediment when total pool volume has become reduced significantly (~25%), when plants along pond edge are "choked" with sediment or the pond becomes eutrophic. (Estimated time: every 10–20 years)	As needed; when approximately 25% of the total pool volume has been lost, or as noted

Plan for required maintenance

Outlets and drainage

- ✓ Maintain flow channels
- ✓ Repair eroded outfall channels with riprap
- ✓ Check for proper drainage (excess or standing water >3 days indicates issues)
- ✓ Check for signs of frequent spillway overtopping (erosion, settlement)
- ✓ Familiarize yourself with normal water levels and note significant changes

Plan for required maintenance

Sediment and debris

- ✓ Pick up trash prior to mowing
- ✓ Clean out debris at least three times a year
- ✓ Clean inlets when sediment deeper than 2 inches
- ✓ Clean forebay/pretreatment structures regularly or as needed based on accumulation
- ✓ Dredge when sediment accumulation compromises pond storage capacity
- ✓ Dispose of cleanout materials properly
- ✓ Observe outfall to ensure that no sediment, debris, or other pollutants are discharging

Plan for required maintenance

Structural components

- ✓ Inspect grates for accumulated debris or damage
- ✓ Repair visible leaks
- ✓ Seal cracks with epoxy low-shrink grout
- ✓ Repair surface damage to concrete structures
- ✓ Replace severely deteriorated structures
- ✓ Check for settling, animal burrows, structural cracks
- ✓ Repair areas with undercutting, scouring, and/or erosion
- ✓ Inspect/repair retaining wall for cracks/bowing

Plan for required maintenance

Vegetation management

- ✓ Familiarize yourself with vegetation plan to distinguish between plants and weeds
- ✓ Clear trees within 5x principal spillway pipe diameter
- ✓ Remove nuisance vegetation as needed
- ✓ Check for and address excessive algae
- ✓ Only approved aquatic-safe herbicides should be applied near pond or inlets
- ✓ No pesticides or fertilizers should be applied near pond or inlets
- ✓ Check for bare areas and re-vegetate to ensure stability

Be sure to document I&M activities and complete repairs in a timely manner

- ✓ Maintain a complete inspection and maintenance log
- ✓ Use standardized inspection forms for all inspections
- ✓ Keep records (including as-builts) for a minimum of 5 years in a designated, accessible location (e.g., HOA digital files, property management office, or other agreed-upon location)
- ✓ Share copies with relevant parties (HOA board, property manager, city)
- ✓ Document and date any repairs needed and completed
- ✓ Complete repairs within 30 days or make arrangements with city

What's wrong with this inlet?

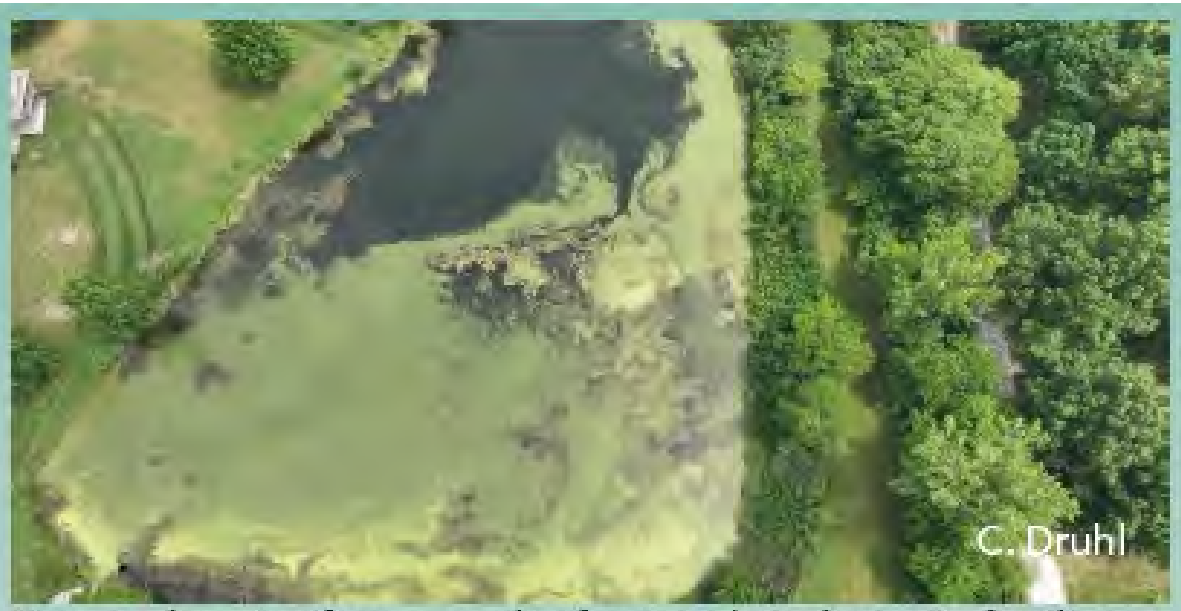
Can you spot the problems with this basin?

What is the issue here?

What is the problem here?

Check upstream if experiencing excessive sedimentation (dirt, silt, etc.)

Prevent algae blooms by reducing upstream nutrients



Excess algae is often a result of using phosphorus in fertilizers on yards that drain into ponds. Hire a contractor when extensive algal issues occur.

Use phosphorus-free fertilizers (On a bag label, the middle number should be 0) on lawns, and apply properly. Don't use fertilizers near the shoreline.

Discourage nuisance wildlife with native plants

Geese like turf grass areas around ponds and leave behind a lot of waste. This causes aesthetic issues and contributes excess bacteria and nutrients into the pond, polluting the water and contributing to algal blooms.

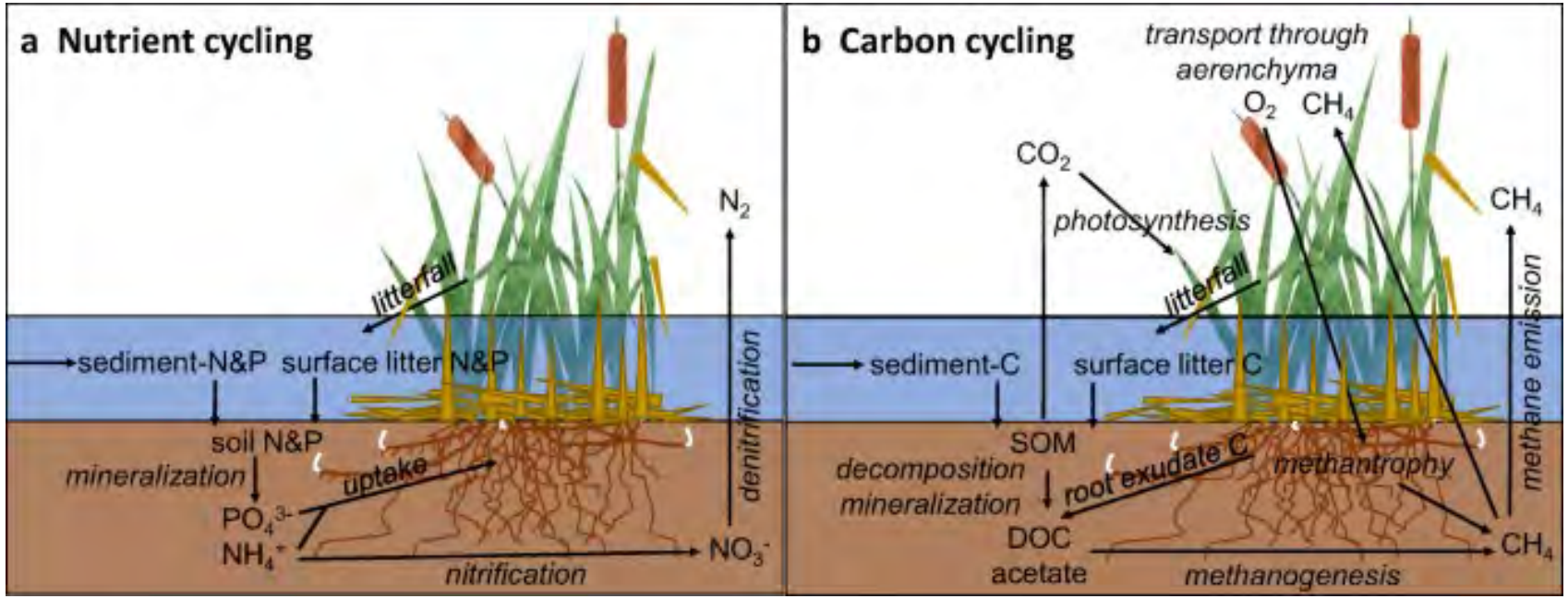
Buffer the shoreline with native plantings that will discourage geese from gathering and nesting in the pond because they don't like being in areas where they can't easily see predators. Access areas can still be made for the public.

Check for signs of burrowing animals to prevent costly dam and embankment failures

Source: Lakeshore Guys

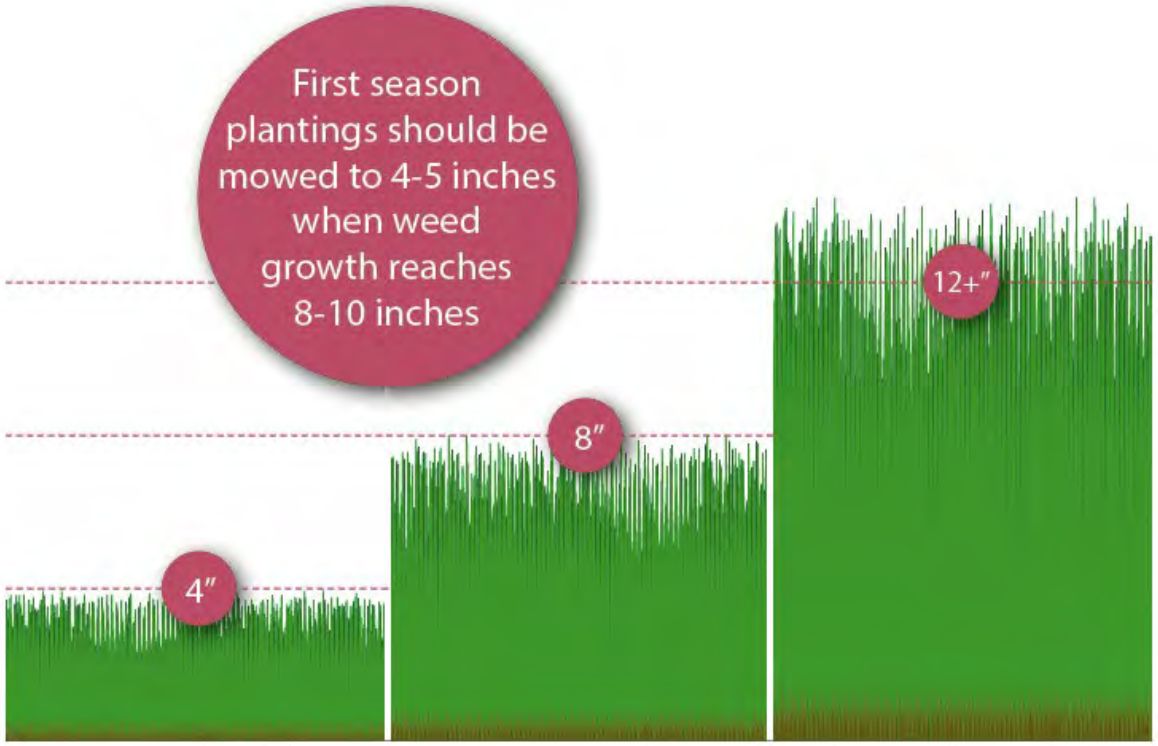
Manage vegetation to maintain basin function and appearance

Cattails are common in basins, there are pros and cons



Source: Bansal, S., Lishawa, S.C., Newman, S. et al. Typha (Cattail) Invasion in North American Wetlands: Biology, Regional Problems, Impacts, Ecosystem Services, and Management. *Wetlands* 39, 645–684 (2019). https://doi.org/10.1007/s13157-019-01174-7

Native plants may need extra attention, particularly during establishment



Source: Prairie Moon Nursery

Source: City of Johnston, IA

Be a good neighbor - keep pollutants out of shared stormwater ponds

Remember, stormwater basins function as living ecosystems

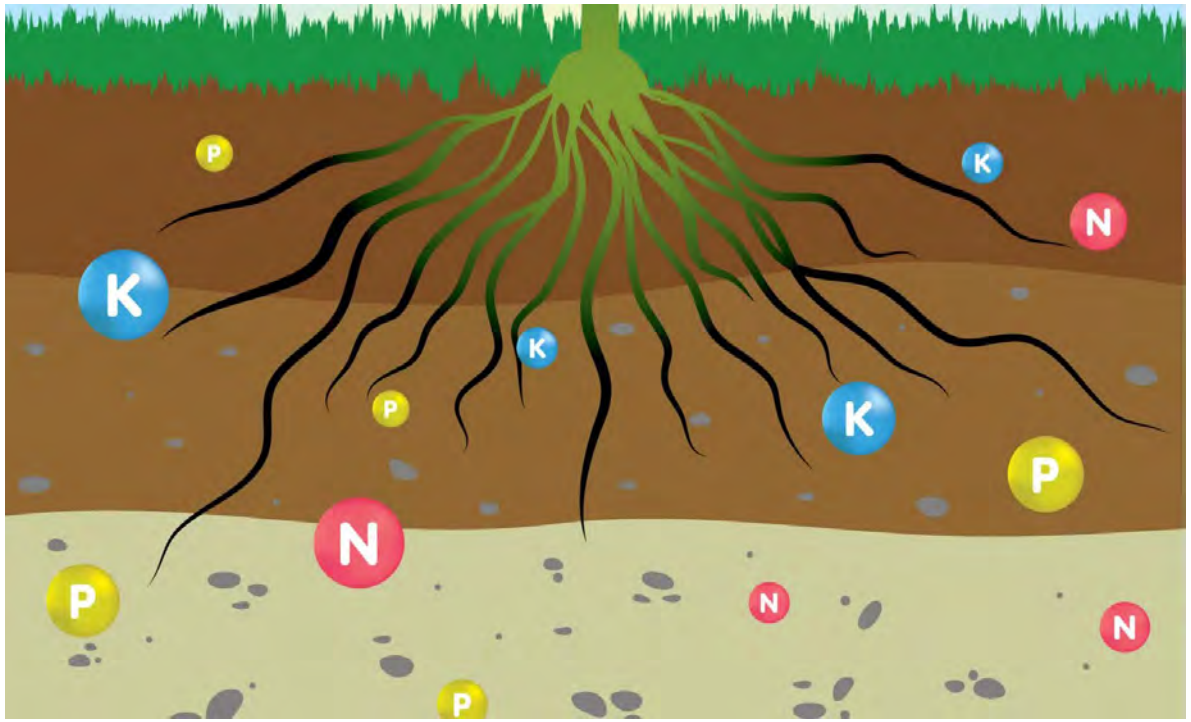
Pond Stocking

Years of experimentation have shown three fish species are best suited for Iowa ponds. Largemouth Bass and Bluegill are the primary species stocked in ponds, and must be stocked in combination to provide a good fishery. Bluegills are an excellent panfish and serve as prey for largemouth bass. Channel Catfish can also be stocked as a "bonus fish." All three species are available from many private hatcheries in Iowa.

- Stocking and Managing Iowa Ponds PDF
- Licensed Iowa Hatcheries that Stock According to DNR Guidelines PDF

Healthy soils upstream can help manage inflow and improve water quality in the basin

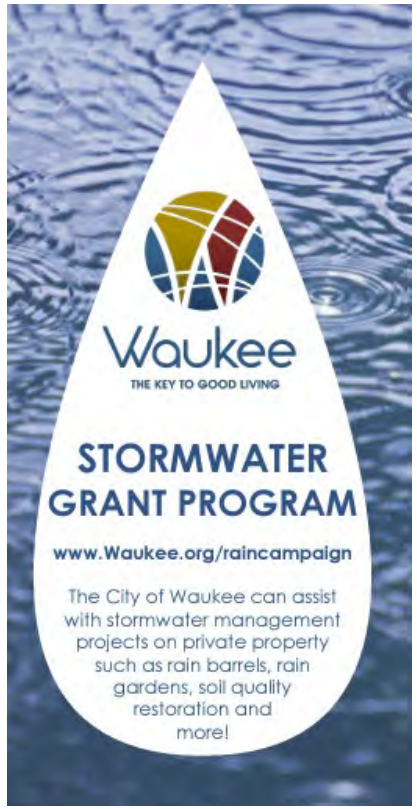
Source: Integrity Hardscape



Source: Green Planet

City of Waukee Stormwater Grant Program

Soil quality restoration (SQR) decreases runoff and fertilizer requirements



Poor quality residential lawn prior to soil quality restoration.

Residential lawn one year after soil quality restoration.

BMP cost share program

Native plantings reduce maintenance needs and solve common basin problems

BMP cost share program

Bank stabilization and other basin projects may also qualify for City funding

HOAs are eligible for up to $20,000 in funding to implement these practices

Individual properties up to $5,000

Eligible Stormwater Management Projects

Waukee residents can be a part of local water quality improvements by implementing 'rainscaping' practices and other stormwater projects at home.

RAIN GARDENS

Rain gardens are landscaped depressions that capture stormwater runoff from roofs, driveways/sidewalks, streets or compacted yards. The rainfall runoff captured in a rain garden is temporarily ponded, before infiltrating percolating down through the soil. The installation of a rain garden helps with sustainability by allowing rainfall to be absorbed through the soil to recharge groundwater and minimize runoff.

BIO-RETENTION CELLS

Bio-retention cells may be needed if the selected site does not allow for adequate soil percolation for the installation of a rain garden. An engineered subgrade ensures adequate percolation of captured runoff by using a perforated drain pipe in a rock bed covered by a sandy soil mixture.

SOIL QUALITY RESTORATION

Soil quality restoration (SQR) is one of the most popular Rainscaping practices in the Des Moines area. Compacted and high clay content soils with little to no topsoil or organic matter can lead to: ponding/ drainage issues, brown/patchy lawns, 'squishy' lawn after a rain and/ or constant need for watering. SQR uses tillage, aeration and compost to increase infiltration and organic matter content. The process naturally improves lawns by increasing soil health and ability to manage water.

NATIVE LANDSCAPING

Native landscaping is planting Iowa native plants and grasses with deep root systems, which are adapted to the state climate and weather extremes. Strategically placing native plants (minimum area of 100 square feet required for reimbursement) enhances the landscape's ability to infiltrate and manage water. In residential settings, this may consist of dense bands of prairie or woodland plants on the downslope side of the property.

RAIN BARRELS

Rain barrels collect and store rainwater from rooftops by capturing water from a property's downspout. The water collected may be used later for watering plants, lawns and gardens. Rain barrels help reduce runoff and conserve water needed for outdoor purposes.

OTHER PROJECTS

- Installation of a drain tile in a wet yard.
- Erosion prevention, including contractor expenses to place bank reinforcement.
- Professional engineering services for project design.

Visit
www.Waukee.org/raincampaign
for more information or to apply for a Waukee Stormwater Grant.

BMP cost share program

Simple application steps help you access funding for basin improvements

Qualifications for Funding

City staff will review the grant submittal to verify the project meets the intent of the program. The property owner is highly encouraged to discuss the project's eligibility with City staff prior to the official submittal of the application.

A project that is started before the grant is approved will be ineligible for funding.

Grant Application Information Required

1. Use attached template, and attach additional information as needed.
2. Contact information for applicant(s) to include, name, address, phone number, and email address. If multiple properties are involved, the main contact person is to be designated.
3. Detailed project description including location and sketch of the project.
4. Construction schedule.
5. Estimated project cost, including a breakdown of qualifying expenses and the grant amount being requested.

Let’s recap the major takeaways..

Owners are responsible for funding routine maintenance and long-term improvements

Elite

HOMEOWNERS ASSOCIATION BUDGET SAMPLE TEMPLATE

NAME OF HOMEOWNERS ASSOCIATION FISCAL YEAR 20__ - 20__		
INCOME	**ANNUAL BUDGET**	
Annual Assessments	30,000	
Interest Charges	500	
Late Fees	150	
Bank Interests	20	
Miscellaneous Income	0	
TOTAL INCOME		**30,670**
EXPENSES		
Administrative		
Accounting Audit	700	
Legal Services	500	
Management Fees	1,000	
Newsletter	100	
Office Supplies	500	
Property Insurance	2,500	
Reserve Study	850	
Taxes, Licenses, and Permits	900	
Miscellaneous	50	
TOTAL		7,100
Utilities		
Electric	900	
Garbage	700	
Telephone	300	
Sewage	300	
Water	850	
TOTAL		3,050
Services		
Cleaning Supplies	450	
General Maintenance and Repairs	2,500	
Landscaping	800	
Roof Maintenance	500	
Fire, Safety, Security	1,500	
Miscellaneous	300	
TOTAL		6,050
RESERVES CONTRIBUTION		12,000
TOTAL EXPENSES		**28,200**

Expenses will vary, depending on:

- Basin size, design, features
- Accessibility
- Deferred maintenance

Key takeaways: why basins matter

- ✓ **Basins control stormwater** to prevent downstream flooding and channel erosion
- ✓ **Basins provide water quality** benefits by removing pollutants
- ✓ **Basins are part of the local ecosystem**: plants, aquatic life, watersheds!
- ✓ **Maintain intended function and storage capability to** protect local residents and infrastructure

Key takeaways: steps you can take

- ✓ **Familiarize yourself with your pond**'s design and function, so you can spot problems early
- ✓ **Do an annual inspection:** sediment, debris, structures, plants (helps you stay on top of maintenance and meets City requirements)
- ✓ **Plan and budget for regular maintenance**
  Talk to your property manager or fellow HOA board members
- ✓ **Consider implementing control measures** to improve water quality
  Waukee's Stormwater Grant may be able to help, so review the requirements and coverage at Waukee.org/StormwaterGrant
- ✓ **Implement safety measures** like signs and educating neighbors
- ✓ **Keep good records** of inspections, maintenance activities, repairs

Help is available

Waukee Stormwater Program
Waukee.org/Stormwater
Waukee.org/StormwaterGrant
Sara Kappos, Jenny Corkrean
stormwater@waukee.org
(515) 978-7920
Email or call if you have questions or concerns about your basin/pond

Waukee Plats, Covenants, As-builts
https://www.waukee.org/173/Plats-Covenants

Iowa Stormwater Education Partnership
www.iowastormwater.org
Loulou Dickey
ldickey@iowastormwater.org
(319) 671-0338

Iowa Stormwater Management Manual
https://www.iowadnr.gov/Environmental-Protection/Water-Quality/NPDES-Storm-Water/Storm-Water-Manual

Dredging Example 1: Grant Park

2017

2020

$37,000

November 2017

Dredging Example 2: Legacy Pointe

2017

2021

$51,000

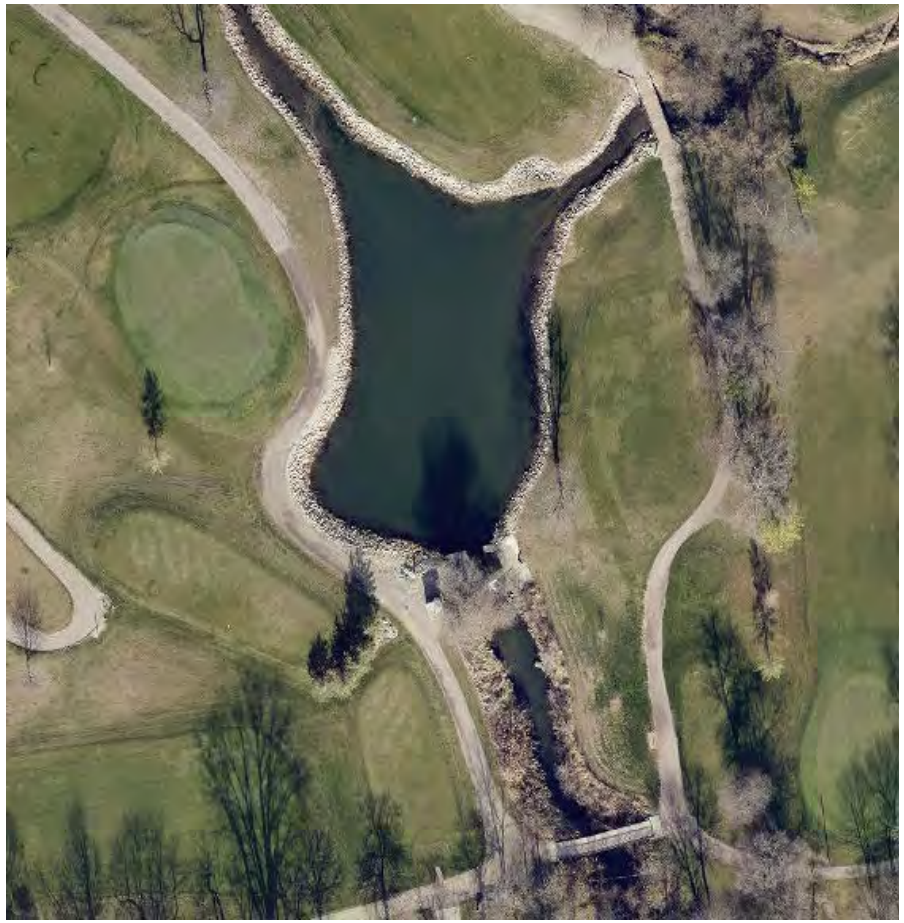
August 2020

- Dredging
- Sediment removal

Dredging Example 3: Sugar Creek Golf Course

2017

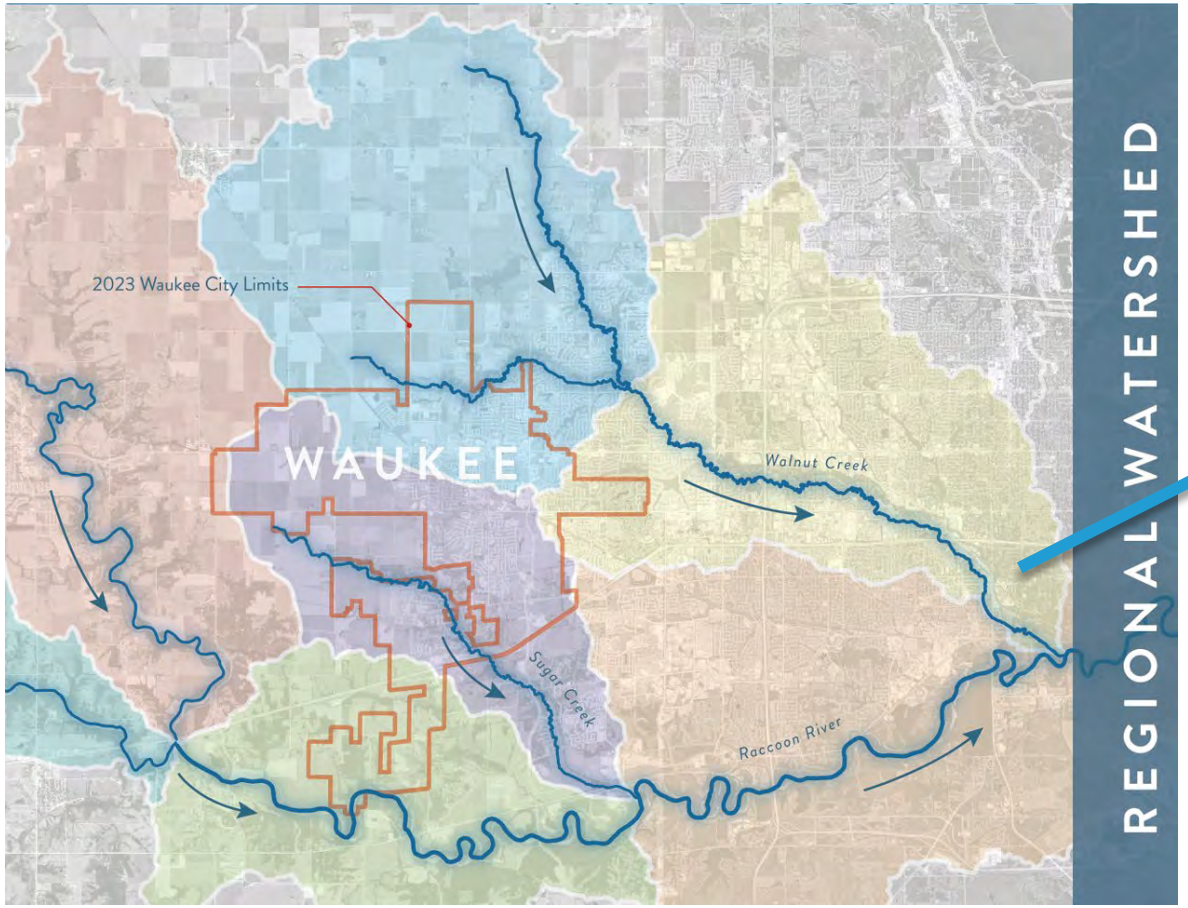
2024



$22,000
March 2017

- Clean out pond
- Built silt trap
- Haul in rock
- Remove tree/stumps
- Regrade slopes
- Haul in rock
- Rework crossing

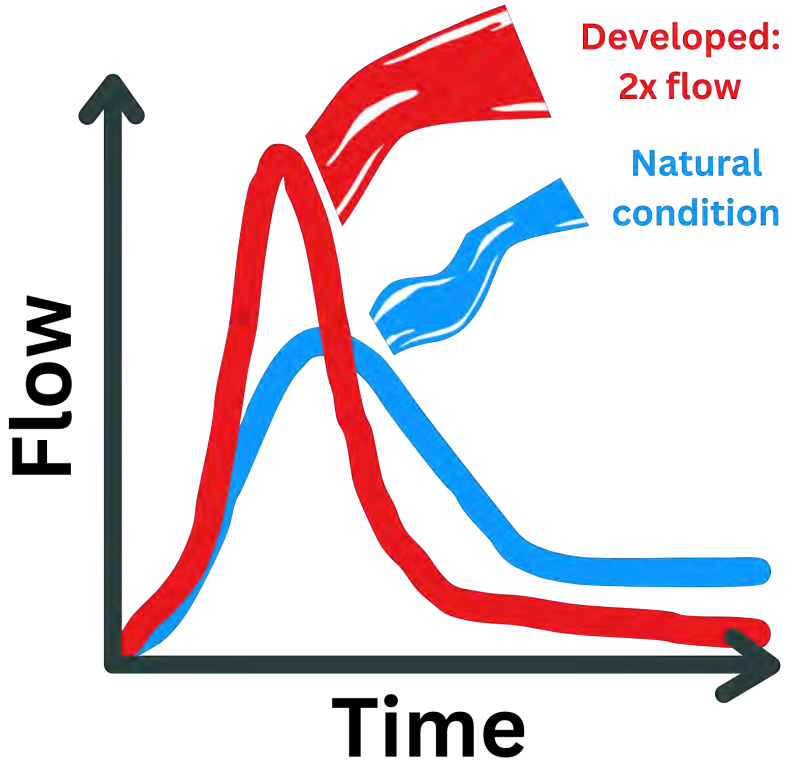
Carrying pollutants



Pollutant Sources by Land Use			
	N	P	Sediment
Urban	14%	26%	7%
Cropland	81%	49%	10%
Pastureland	2%	2%	0%
Forest	0%	1%	0%
Grasslands	0%	0%	0%
Gully	1%	5%	19%
Streambank	2%	10%	38%
Construction Site	1%	8%	25%

Construction sites, making up less than 0.1% of the overall watershed area are likely large contributors of sediment to Walnut Creek.

Channel erosion and flooding are prevented by slowing down and holding back water



Source: Practical Engineering YouTube