

# CHAPTER 11

## KEY CONCEPTS

### 1. Emphasis on Collaboration

This plan emphasizes collaboration and education among and between key audiences including policy-makers, developers, agricultural interests, the business community, and a “general public.” Additionally, this plan emphasizes demonstration, broad engagement in research and interpretation, and ongoing idea and information exchanges.

### 2. Key Messages

Key messages include paths to successful projects (financial resources and technical assistance), the importance of maintaining healthy top soil as the watershed develops, the impact of construction sites, the need for transparency and monitoring, the overall value of flood plain protection (in urban and rural areas) and the cost-benefit information of current BMPs.

### 3. Individual Responsibility

The general public needs information to connect to their personal responsibility and specific tactics they can take as homeowners and/or consumers of waters, soils and natural resources.

### 4. Education About WMAs

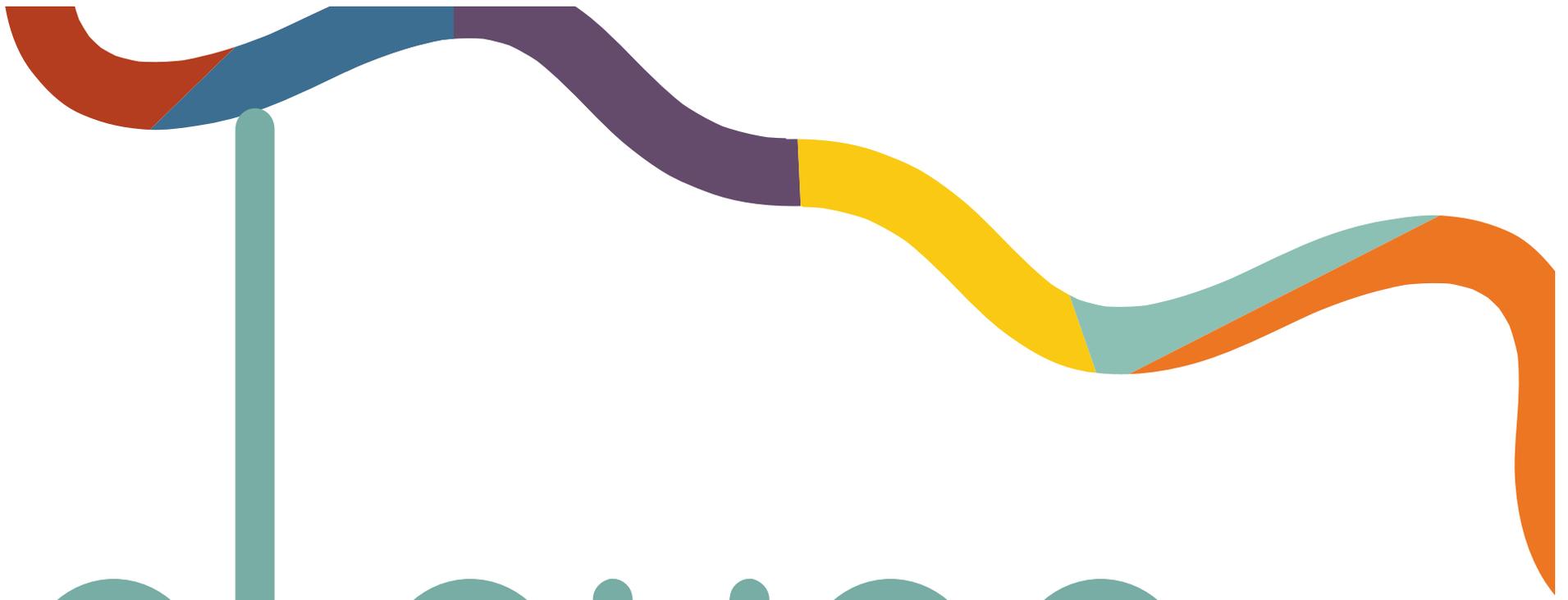
Ongoing education about Watershed Management Authorities and their role in sparking watershed results is also referenced here.

### 5. Ongoing Information Sharing

Specific ongoing mechanisms for communication should be established.

## HOW DO THESE CONCEPTS INFLUENCE DEVELOPMENT OF THE PLAN?

The plan proposes wide-ranging tools for exchange of information, depending on the audience(s) involved. Considering the variation in audiences, learning styles and the need for information, employing many of these tools simultaneously and on an ongoing basis is recommended.



# elevation

Education and Collaboration Plan



## Walnut Creek WMA Watershed Plan

The following education and collaboration plan looks at five audiences with farmers, business/developers, staff and policy-makers (primarily council members, county supervisors, and SWCD commissioners) as the priority audiences. The “general public” is a catch-all for Walnut Creek watershed residents and students. Due to recent flooding, increasing erosion and news accounts of water quality problems in Iowa, a subset of residents will likely be particularly responsive to learning more about their role in the Walnut Creek watershed.

At the time of this plan development, a collaboration is forming among the metro area Watershed Management Authorities which will likely translate into some level of staff support for the various WMAs forming in the region. The specifics have been in discussion and a confirmed/documented collaboration has just recently transpired. This portion of the plan assumes staff time of a “watershed coordinator” will be available to the Walnut Creek WMA in partnership with other WMAs to support education/collaboration tactics such as:

1. Work Sessions
2. Field Days
3. “Speed Dating” Sessions with Farmers, Elected Officials, Developers, etc.
4. Developing Support from/through Current Staff
5. Incentives to Try Practices on Their Own
6. Engagement of Local Television/Media
7. Panel of Experts
8. Increased Engagement around Science and Research
9. Connection through Social Media

More general communications methods, and more specific “plan launch tactics” are described below for the primary audiences.

## Landowners/Agricultural Sector

This chapter has been labeled an “education and collaboration” plan for a reason. Too many planning efforts have assumed that one sector of this planning group needs to “educate” another. That can be a patronizing and inaccurate way of addressing

what needs to occur. Here, we propose that education is, in fact, an ongoing sharing of research, experience and ideas among all parties/stakeholders connected through the watershed.

### *Tactics and key messages include:*

1. **Resources**—Extensive existing informational and teaching resources exist to ensure that practices are implemented correctly. There are also financial resources that can be used to address cost concerns. Those resources may also be on an upward trajectory. At the time of this report, new funding sources have been identified: grants through a multi-partner Regional Conservation Partnership Program (RCP) and a grant awarded to Polk SWCD for specific practices. *Continue to improve connections between resources and on-the-ground actions/practices.*
2. **Concerns with Land**—The strategies targeted in this watershed management plan are intended to keep soil and nutrients in the upper watershed. This supports sustainable land use practices and agricultural yield potentials in the near term and for the following generations. *Share strategies, practices and associated benefits, particularly focusing on landowners/operators, where shifts in practice achieve the greatest overall benefit-to-cost ratio with respect to water management.*
3. **Partnerships & Collaboration**—Partnerships with other producers or land owners allow cost sharing and efficiency for the implementation of certain practices. Additionally, *landowners in this watershed have asked for bus tours/information exchanges (urban/rural) and a seat at the research development and analysis table.*
4. **Range of Solutions**—There are a range of solutions available to mitigate certain concerns. While there may be room for some basic practices to be applied broadly (due to some level of guaranteed benefit), many practices are best established by each landowner/operator based on their particular situation and comfort level for implementation. *Information currently “buried” in the nutrient reduction strategy that pairs BMPs and their anticipated N/P reductions should be delivered to each landowner in the watershed. (See Tactics, next page).*
5. **Why Care?**—What is the *legacy we are leaving for the future generation of producers?* This message is best developed and understood as a collective understanding from all stakeholders in the watershed.

- 6. Opportunities for Partnership Using Existing Entities**—Agencies, non-profits and trade groups, such as the NRCS, Polk Soil and Water Conservation District or the Iowa Soybean Association, already have the infrastructure for *building partnerships with individuals or groups of producers*.

### Plan Launch Tactics

Early tactics for information distribution and primary information sources:

- A follow-up meeting at the Heartland Co-op to share the preliminary results of the plan and the early strategies for increased monitoring to get direct input into that aspect of the plan (thus providing an early “seat at the table”). Execute this in partnership with ISA, Heartland Co-op, Polk/Dallas SWCD. Begin with sharing “emerging themes” from the landowner meeting. (Note: At the time of publication of this report, this has been accomplished.)
- Through ISA/Co-op or other means, directly distribute highlighted pages of the Nutrient Reduction Strategy that feature BMPs and associated N/P reductions. Secure permission and post on-line. Distribute directly, by mail or other method as recommended by commodity group partners.
- Secure slot on Farm Bureau county meeting agenda(s) to present plan results.
- In partnership with ISA, Dallas/Polk SWCDs and the Heartland Co-op, identify a communications “task force” to develop (minimally) an annual bus tour.
- Identify (minimally) 3-5 area conservation farmers/landowners with best practices in place, and encourage their participation as watershed-educators through presentations, field days, and dialogue in their commodity group organizations. Research the viability of contracting with landowner-educators to secure ongoing participation.
- Additionally research the practicality of partnership through Iowa Flood Center, ISU and other entities to bring researchers to the watershed for interactive presentations about research methods and encourage mutual exchange.
- Work in partnership with the Greater Des Moines Partnership’s Soil and Water Future Task Force ongoing dialogues to bring the Walnut Creek farm community to that table.
- Proactively connect to landowners-operators to share the benefits and achieve access to the new funding/granting opportunities as they arise.

### Additional methods of ongoing communication include:

- Direct Mail
- Informational Meetings
- Focus Groups
- Outreach via Agricultural Retail—USDA, SWCD, etc.
- Field Days
- Surveys
- Website/Social Media
- Workshops
- Speaker Series
- On-Farm Learning Network

### Developers and Business Community

Brief descriptions of the collaboration elements applicable to this group are presented below. In this instance, these elements present a mix of key messages and long-term strategies. These elements will assist in establishing greater consistency in the ordinances/guidelines throughout the WMA jurisdictions.

#### Tactics and key messages include:

- 1. Resources**—There are extensive informational and teaching resources to ensure that practices are implemented correctly. Additionally, *once consistency in implementation throughout the watershed is achieved, developers will enjoy an increased efficiency when navigating standards and requirements.*
- 2. Potential to Streamline the Review Process**—*Consistent standards* will assist with streamlining the review process.
- 3. Review of Current Policies**—*Reviewing current policies while getting the business community involved* will connect and inform this group, as well as give ownership and involvement to the overall process.
- 4. Public Health**—*Making a connection between the health of the waterways and overall public health* will help make a connection to the public, which builds advocacy. The developer and business community will have this information to take into consideration as they move forward with developments.
- 5. Why Regulations Exist**—*Provide information regarding the negative effects that would result if regulations did not exist.*

6. **Demonstration Opportunities**—If practices are implemented within the property, it allows the owner to *demonstrate their practice and get recognition throughout the community.*
7. **Previous Studies**—*Educate regarding the positive outcomes of previous studies performed with certain practices.*
8. **Partnership Opportunities and Outreach to Clients**—This will allow *partnerships between businesses for shared costs* and provide another avenue to connect with potential clients and customers.
9. **Triple Bottom Line**—The triple bottom line consists of three P's: profit, people and planet. Sharing ideas for effective watershed management practices aims to demonstrate that the *financial, social and environmental performance of the corporation can improve over a period of time.*

### Plan Launch Tactics

Early tactics for information distribution and primary information sources:

- In partnership with other jurisdiction(s)/organizations, or as a stand-alone task force, convene Walnut Creek area developers for a special interactive presentation on the existing-conditions findings and results of the Walnut Creek Watershed Plan. As part of this presentation/summit or short-term education series:
  - Include data on development growth and degradation in water management over time. Emphasize the need for new developments to achieve new results in stormwater management for prevention of additional flood damages and water quality degradation.
  - Place emphasis on the implications of topsoil loss and the engineering and water management impacts of failure to replace that topsoil.
  - Provide education on strengths and challenges of developing and applying Storm Water Pollution Prevention Plans (SWPPPs) and provide case studies of successful SWPPP applications and where SWPPPs have commonly “gone wrong.” Acknowledge the ongoing concerns that have surfaced as part of this planning process related to potentially compliant, but perhaps ineffective, SWPPPs.
  - Present the vision of a healthy Walnut Creek watershed and the resulting growth in property values and desirability for residential and business/commercial interests.
  - Establish a dialogue about the necessity of low-impact development principles and associated ordinance/guidance options for implementation.

Present local and regional case study examples, allowing for a healthy, collaborative assessment of same.

- Jointly identify methods for government/community to support “new ways of doing business” on the part of the developers with the understanding that business-as-usual future development will fail the watershed and all those downstream.
- Encourage developer participation in bus tour and other landowner/farmer/policy maker interactions (see above).
- Establish ongoing and healthy means for dialogue/exchange on stormwater management and soil health issues within the region. Consider working with the Greater Des Moines Partnership’s Soil and Water Future Task Force to potentially place greater emphasis on urban strategies and thereby maintain strong business-developer and urban-rural connections for ongoing strengthening of this plan.
- Additional methods of ongoing communication parallel those listed above under landowner/agricultural sector.

### Decision- and Policy-Makers—City and County Officials

This group consists of city council members, county board members, and other civic and/or agency officials with a particular emphasis on elected officials.

Brief descriptions of the education messages for delivery to this group are presented below.

1. **Cost Savings with Potential Return on Investment**—If policy changes, or even dollar investments on certain practices, are made now, the *cost of future losses, maintenance, and repairs can be mitigated.*
2. **Impacts on Other Community Systems**—Recognition and mitigation of flood and water quality issues can reduce the resource commitment required to *address impacts to utility systems, transportation systems and public health.*
3. **Community Collaboration Opportunities**—*Some practices provide opportunities for collaboration among different departments within a jurisdiction to ensure the most benefit for the community and its residents. There is also the possibility for talent collaboration with other jurisdictions on joint projects.*
4. **What is in the Water = Public Health**—If the concentrations of contaminants entering Walnut Creek are reduced, the *public health of users of the creek and greenway system will be improved.*

- 5. **Cost Sharing and Grants**—Projects that may span *multiple jurisdictions* or are located at the border of more than one jurisdiction, *provide opportunities for cost sharing* and to implement a practice that may not otherwise be executed.
- 6. **WMA Education**—Despite the advent of Watershed Management Authorities within the state and region, *WMAs are still a new way for agencies to work together*. Provide information for elected officials and other decision-makers on the true workings and potential of WMAs. Ultimately, help leaders recognize the substantial benefits that can result through WMA efforts.

### **Plan Launch Tactics**

The planning team has connected with decision-makers throughout the planning process (via WMA meetings, executive meetings, stakeholder meetings, public events and direct presentations to councils, boards of supervisors and SWCDs). This over-arching strategy of ongoing communication needs to continue. Specifically, a presentation on this plan as a work-in-progress was developed and delivered to each participating WMA jurisdiction.

Moving forward, plan implementation will also rely on gaining approval of the final plan from each of those jurisdictions. The following steps are proposed:

- After final changes are incorporated into the plan’s final draft, craft a council/board resolution for plan approval and update an accompanying presentation and talking points as required. Urge WMA members to take the update/changes summary and resolution to their various jurisdictions for approval. The planning team will support these communications as much as possible.
- Publicize and post executive summary, final plan, and a checklist of early implementation steps including responsible parties and timelines as much as is practical.

Upon plan approval, the ongoing involvement of decision-makers requires ongoing communications similar to those listed above, but including:

- Quarterly updates via email newsletter with emphasis on:
  - Potential resources for plan implementation
  - Plan progress by partners, including measurable results
  - Project highlights and succinct success stories (from within and without the region)
- Quarterly updates at council/supervisor/SWCD meetings by WMA members
- Succinct, well-visualized annual “Reports to the WMA Communities” of plan progress and next steps

### **Government/Agency Staff—Day-to-day plan implementers**

Primary messaging for this key audience focuses on understanding:

1. Cost-benefit of specific measures/practices
2. Impacts of traditional vs. low-impact development
3. Potential challenges and opportunities of various policies/ordinances
4. Technical requirements of successful projects and potential technical pitfalls
5. How to implement successful projects, including achieving positive impacts from guidelines and ordinances in play
6. How to measure success and achieve adaptive management
7. How to access/partner for resources

### **Plan Launch Tactics**

- Convene a technical workshop (or workshops) for key implementers within agency staffs to address the priorities of the Walnut Creek Watershed Plan.
  - Partner with Fourmile Creek and Spring/Mud/Camp Creek Watershed plans, due to the overlap of key personnel involved.
  - Focus the workshop on identified outcomes, priority projects, enhanced technical understanding and purpose behind recommendations—why new methods of stormwater management are important.
  - Highlight stormwater management training including use of SWPPPs, the Iowa Stormwater Management Manual, low-impact design principles and strengths/challenges of proposed ordinances.
- Build awareness of other successful strategies/projects through case studies and partnerships.

Tools for this work parallel those identified in the Landowners/Agricultural Sector plus ongoing technical trainings and references/conferences related to updating available resources and securing grants.

## The General Public

Among the general public, some residents have experienced direct effects of flood, silt or erosion damage. Others recognize they are at some risk for those impacts. A broader public has general interest in improved water quality and recreation and many value a broad range of education messages about water and natural resources reaching their school-age children. Some of the priority messages for the general public include:

1. Understanding flood mapping, flood insurance and associated risks and impacts
2. Creating a clearer understanding of source water, river/stream and drinking water standards and hazards
3. Knowing what clear, clean water in Iowa could/should look like
4. Effects of urbanization on soil erosion, water quality and flooding
5. Potential for low-impact development to shift impacts of urbanization
6. Agricultural impacts and potential for improvements through BMPs and other forms of stewardship
7. Recognizing homeowner responsibilities for water quality and flooding, along with homeowner actions (e.g., recognizing/appreciating green infrastructure; installing rain barrels, rain gardens, gray water systems). To this end, develop educational materials for residents that answer the question, "what can I do to help?"
8. The value of direct involvement of residents through volunteerism and citizen science
9. Ongoing education about the value of green spaces/greenways, habitat corridors, wetlands, fens and other natural features on overall quality of life, flood mitigation and water quality
10. Understanding of indicator species and basics of biological connections
11. Knowing the watershed in which they live, its associated partnerships and upstream/downstream implications
12. Celebrating/knowing the fun that can be had in clean water nearby

## Plan Launch Tactics

- With homeowners in new flood zones and others needing to be aware of pending risks, the priority tactic here is getting information including maps, FAQs and public meeting notices to those affected homeowners. As of this writing, that work is in progress.
- Partner with the Walnut Creek Watershed Coalition for ongoing participation in this volunteer organization's many effective events that have included rain barrel making, public cleanups and celebrations. Consider supporting the work of this coalition to assist in expanding membership, the organization's physical reach within the watershed and ongoing education opportunities.
- Leverage the work of the Metropolitan Planning Organization's Water Trails Plan.
- Similarly, leverage the work of the Clive Greenbelt Master Planning efforts and associated expansion of education opportunities, facilities and associated programming.
- Support the water/watershed education work of the County Conservation naturalists, the Blank Park Zoo, the Science Center of Iowa and the many additional education arms (e.g., community naturalists, scouting groups, 4H and FFA) to enhance/expand watershed education within Polk and Dallas Counties.
- Employ education strategies of Soil and Water Conservation Districts, the Urban Conservationists, and/or the Iowa Stormwater Education Partnership (ISWEP).
- In partnership with the business community, launch improved realtor education and associated materials for distribution to potential home buyers.
- Through the schools, support the re-invigoration of the Project WET curriculum (an Iowa School curriculum, once more widely used than today, that offered broad-based, interactive learning about the science and uses of water).
- Develop public information, interpretation and signage components for bridges, benches, trails, trailheads and additional access points/gateways in/near Walnut Creek, North Walnut Creek and other streams/tributaries of the watershed.

Additional methods of ongoing communication parallel those listed above under the landowner/agricultural sector.

# CHAPTER 12

## KEY CONCEPTS

### 1. Measures and Milestones

This chapter sets forth a timeline for implementing and meeting the objectives of this plan, which can be used to annually evaluate if progress is “on target.”

### 2. Urban Policy Adoption

As over 400 acres are projected to be developed each year, it is important to make ordinance and policy updates a priority for adoption. To see watershed scale results, communities are urged to complete these updates and amendments by the end of calendar year 2017.

### 3. Monitoring

An effective monitoring program is necessary to better evaluate current conditions and to observe what changes occur as improvements are made and policies are adopted. This plan needs to be implemented as soon as possible so that data collection can begin. Monitoring should be coordinated with parallel efforts being completed by Polk County Conservation, IOWATER and the Iowa Soybean Association / Agriculture's Clean Water Alliance.

### 4. Projects

Recommended timelines for completion of key projects are included within this chapter.

### 5. Reporting Progress

An annual report should be presented to the members of the Walnut Creek WMA, which outlines collected water quality monitoring data and documents progress toward achieving expected outcomes of the plan.

## HOW DO THESE CONCEPTS INFLUENCE DEVELOPMENT OF THE PLAN?

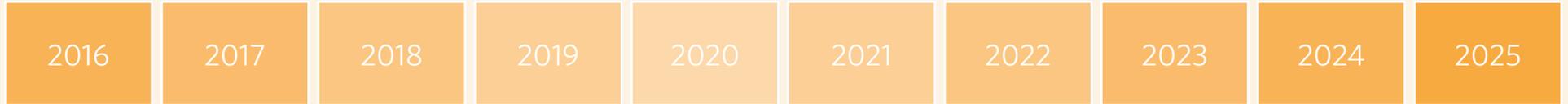
An effective plan addresses the questions: “Who, what, when, where and why?” Previous chapters are focused on answering the what, where and “why.” This chapter focuses on the remaining questions. This chapter also outlines a means of evaluating and reporting progress. Such progress reports will be vital in determining how the plan needs to adapt in a changing environment. This plan needs to be a “living document,” which may need to be changed based on what is learned through annual reports as well as the financial, technical and staffing resources that are available to carry out this plan.



Measures and Milestones

# Timeline

(Year)



Local Policy Adoption



Education & Outreach



Project Implementation



Monitoring



Evaluate Progress



Report Results



Plan Update



Evaluate/Extend Plan to New Areas

★ Key Benchmark

## Schedule

The following is a plan for the first ten years of implementation of policies, improvements within case study subwatersheds and other key improvements throughout the watershed.

## Urban Policy Adoption

Changes in local ordinances and policies often requires extended interaction with the general public, local stakeholders and elected officials. Such changes often have an impact on costs at various stages of development and how private land can be altered for more intense uses. These factors often result in a resistance to change.

This plan has documented how aspects of erosion and sediment control, stormwater management and development within the flood plain have had a negative influence on water quality and stream corridor stability. It cannot be expected to see improved watershed conditions without alterations to the way policies are enacted and enforced. The potential impacts and benefits of these policies was outlined in previous chapters.

The timeline at right may be seen by some to be too rapid of a pace to make these changes. However, this study has identified that in an average year more than 400 acres are developed into urban land uses. As time passes, significant opportunities to reduce impacts related to stormwater runoff increases and pollutant loads will be lost. Also, uniform adoption of such policies will assure more widespread benefits throughout the watershed and reduce the perceptions that one community or municipality has standards which are more adverse towards development than the others. Such coordination and collaboration to set consistent policies across borders within the watershed has to be one of the key purposes of the existence of the Walnut Creek Watershed Management Authority.

## Project Implementation

Chapter 10 contains lists for priority projects targeted within each of the case study watersheds as well as projects to be implemented throughout the entirety of the Walnut Creek watershed. Those projects identify larger-scale efforts to address currently observed conditions. The tables in Chapter 10 divide these projects into three categories:

- Short-term (within the next five years)
- Medium-term (within the next ten years)
- Long-term (likely to occur beyond the next ten years)

Implementation of Recommended Policies		
Policy	Community	Adopt by End of Year
Review existing construction site erosion control ordinances. Implement changes in enforcement to achieve the desired results as outlined in Chapter 9 of this plan. Amend ordinances as required to support such enforcement. Coordinate with IDNR storm water coordinator as necessary prior to amending ordinances. Use the local Council of WMAs as a means to reconcile any conflicts in recommended policy changes.	All communities	2016
Adopt or amend flood plain protection ordinances which include outlined recommendations as described in Chapter 9 of this plan.	All communities	2016
Adopt or amend stormwater management ordinances which reference ISWMM Unified Sizing Criteria as described in Chapter 9 of this plan.	All communities	2017
Adopt ordinances related to soil quality management and restoration or amend other ordinances to include requirements as described in Chapter 9 of this plan.	All communities	2017
Adopt or amend stream buffer protection ordinances which include outlined recommendations as described in Chapter 9 of this plan.	All communities	2017

Over time, conditions may change and priorities may shift based on new implementation opportunities. This list should be annually re-evaluated to review which practices have been completed and any need to move projects from one category to another.

These lists also do not identify the numerous opportunities to implement smaller-scale practices at the individual homeowner or development site scale. Also, they do not identify all of the stormwater management practices that will need to be implemented to manage runoff from new developments (regardless of whether they are proposed to be implemented on a site-by-site or regional basis).

## Monitoring Plan

An expanded, ongoing **monitoring program** is required to better understand existing water quality conditions, better identify pollutant sources and evaluate the impact on installed practices on water quality. To more accurately define **pollutant loadings**, data needs to be collected more consistently from a broad number of locations and at dates spread throughout the year.

### Data to be Collected

For each monitoring location that is maintained by the Walnut Creek WMA and its membership and partners, data should be collected on at least these key chemical or environmental parameters:

- Air temperature
- pH
- Dissolved Oxygen
- Water Temperature
- Level of Flow
- Recent precipitation (from NWS records)
- Nitrate
- Phosphate
- E. coli (lab)
- Transparency, Turbidity or TSS
- Nitrite
- Chloride
- Conductance (lab)

At least once annually, at each location collect information on the following physical site characteristics:

- Stream width (at toe and top of bank)
- Local biological assessment
- Local stream stability
- Stream depth (from baseflow)

## Recommended Implementation Strategies

### Strategy #1—Coordinate and Build upon Existing Monitoring Efforts

- There are several ongoing programs that are collecting water quality information within the Walnut Creek watershed. The purpose of this plan is to support these efforts, rather than supplanting or competing with them.
- Iowa Soybean Association / Agriculture's Clean Water Alliance  
These organizations continue to collect data at two separate locations along the main channel of Walnut Creek. Their data collection has occurred every other week, typically from April through late August or early September. We would recommend that they expand upon this work, to include year round sampling. Late season spikes in nutrient levels have been reported at the Des Moines Water Works intake site on the Raccoon River. Such a spike has also been observed at some IOWATER testing sites within the Walnut Creek watershed. Year round testing could determine if such a spike commonly occurs within this watershed and could provide a more accurate measurement of annual loadings of the pollutants of concern.
- Polk County Conservation  
This organization has just initiated a program to monitor select sites within the Fourmile, Beaver and Walnut Creek watersheds inside Polk County. They have selected four collection sites within the watershed (three on Walnut Creek and one on North Walnut Creek). They plan to collect data during the first and third calendar weeks of each month, on a given day between the hours of 10am and 2pm. During each sample they will assess chemical and physical conditions. IOWATER test kits will be used to evaluate the following parameters:
  - Transparency
  - pH
  - Dissolved Oxygen
  - Nitrate
  - Nitrite
  - Phosphate
  - Chloride
- *IOWATER volunteer monitoring*  
Volunteer monitoring data has been recorded from a total of 32 sites throughout the Walnut Creek watershed since 2004. Of these sites, data has been actively collected at 22 sites since 2012. At these ten sites, data has been collected twice each year (in May and October). Data has been collected both through the use of IOWATER test kits and by collection of samples for lab testing (lab testing completed at 10 of these sites since 2012). It is recommended that these volunteer efforts be continued and coordinated, so that data for the key parameters (noted under the heading "Data to be Collected" above) is collected at each site, either through IOWATER test kits or lab testing.

Recommended Real-Time Monitoring Station Locations		
Station #	Microwatershed	Location Description
	Section-Township-Range	
	Jurisdiction	
1	101.01	Downstream of railroad bridge, accessible by trail. Just upstream of mouth of Walnut Creek.
	13-78-25	
	Des Moines	
2	213.01	Just upstream of mouth of South Walnut Creek, accessible by trail.  (Urban case study subwatershed monitoring station)
	31-79-25	
	Clive	
3	411.01	Upstream side of crossing at W Avenue along tributary to Walnut Creek.  (Rural case study subwatershed monitoring station)
	3-79-26	
	Dallas County	
4	601.01	Upstream side of trail bridge, just upstream of mouth of Little Walnut Creek.  (Developing case study subwatershed monitoring station)
	24-79-26	
	Urbandale	
5	501.01	Upstream side of trail bridge, just upstream of mouth of North Walnut Creek.
	3-78-25	
	Clive	
6	201.01	Station on Walnut Creek, just west of trail bridge over North Walnut Creek. Location nearby priority station 5.
	3-78-25	
	Clive	
7	301.02	Upstream side of bridge at 260th Street along Walnut Creek.  (Monitor near current interface between rural and urban areas, downstream of where the three major headwater tributary streams converge)
	11-79-26	
	Urbandale	

**Strategy #2—Establish a Network of Real-Time Monitoring Stations within the Watershed**

This plan has noted how different pollutants originate from different sources. Some of these sources are less frequently occurring and some are larger sources during storm events. There are some questions that cannot be answered without constant collection of data. Real time data collection allows more rarely occurring sources of pollution to be identified (a one-time fertilizer application prior to a storm event, for example).

Ongoing data collection also makes it possible to understand how pollutant concentrations and loads are changing through the entire duration of a storm event. Higher concentrations are often observed during the “first flush” of storm events. It is challenging to grab samples during this period, as it would require collection of samples on random dates as rainfall occurs, samples would need to be collected within a short window after rainfall begins (often while it is still raining) and high flows could create dangerous conditions for sample collection.

For these reasons, a network of real-time monitoring stations is recommended as a key part of implementation of water quality improvements. As such stations come at an expense to install and maintain, this plan must be selective in the recommended initial locations for these stations. Over time, additional stations may be added to the network as dictated by the location of proposed improvements, changes in land use and available funding.

It is recommended that the initial network consist of seven stations located throughout the watershed. These locations have been selected to (1) help better define overall watershed pollutant loading rates, (2) differentiate pollutant concentrations and loadings within Walnut Creek and its principal tributaries, and (3) evaluate changes in conditions over time near the outlets of the case-study subwatershed areas.

The approximate cost for each station is expected to be \$25,000 for the initial purchase of equipment and installation and average costs of \$8,000 per year for ongoing operation and maintenance.

**Strategy #3—Establish Grab Sample Monitoring at Key Locations within the Case Study Subwatersheds**

To determine the effects of water quality improvements within each case study area, a more frequent and distributed pattern of monitoring is required. Monitoring sites should be located so that changes in outcomes over time can be evaluated. These sites should be established as soon as possible, so that a time record of water quality conditions prior to any improvements can be established. Over time, this monitoring should determine if measurable changes in water quality parameters can be observed. Trends in data can be reviewed to determine if the proposed implementation program is working as expected or if the plan needs to be reviewed and amended to improve results.

It is recommended that sampling be conducted using a similar collection schedule as that which has been developed by Polk County Conservation (year round, 1st and 3rd week of each month, collection between 10am and 2pm). This will improve the quality of collected data by collecting it under more uniform conditions. IOWATER test kits could be used for an initial site screening, however it is recommended that samples be collected during each site visit for lab analysis of key pollutants and lab analysis will be necessary to evaluate levels of indicator bacteria present.

Recommended Grab Sample Monitoring Sites in the Developing Case Study Subwatershed (601)		
Station #	Microwatershed	Location Description
	Section-Township-Range	
	Jurisdiction	
D1	601.02	Upstream of crossing at NW 156th Street along Little Walnut Creek.
	23-79-26	
	Urbandale	
D2	601.02	Upstream of crossing of NW 170th Street (Alice's Road) along Little Walnut Creek.
	22-79-26	
	Clive	
D3	601.03	Upstream of crossing of Warrior Lane along Little Walnut Creek.
	21-79-26	
	Waukee	

\* As development occurs, it is recommend to establish a sampling site at the inflow and outfall of each constructed detention facility.

**Quality Control for Data Collection, Recording**

The broad number of sites will likely require more than one person or party to complete the recommended sampling. Data needs to be collected in a consistent manner, to prevent results being influenced by how samples are collected or test kit results are interpreted at each site. The collected data needs to be collected and frequently uploaded into a database that is accessible to interested parties. For these reasons, the following methods are recommended by this plan:

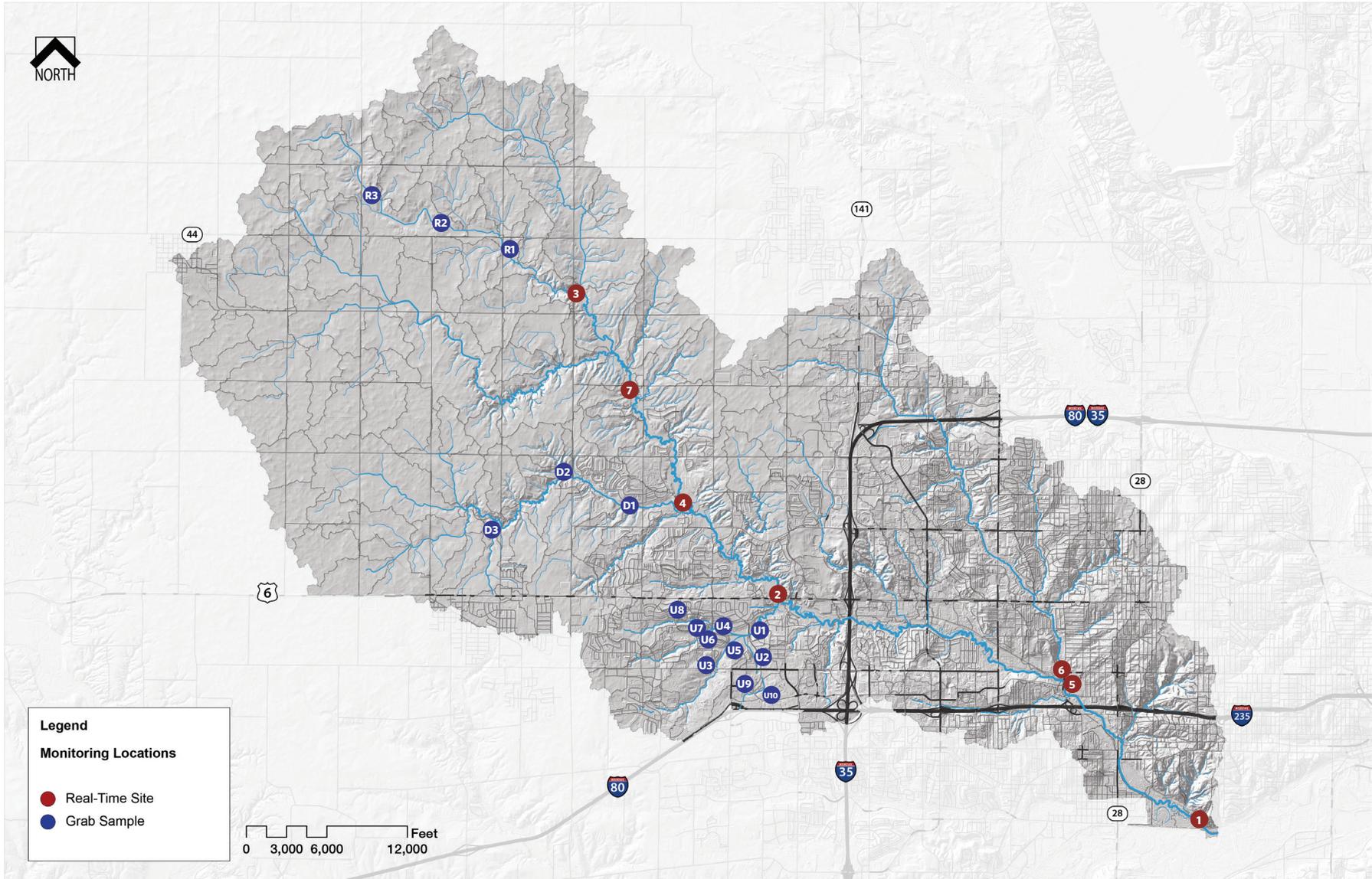
1. Create a **Quality Assurance Project Plan (QAPP)** for all water quality monitoring activities. This document should be reviewed and approved by the Iowa Department of Natural Resources.
2. Maintain at least two databases of collected water quality data. Each database should be kept current with recorded results.
3. Collaborate with the ISA/ACWA, Polk County Conservation and IOWATER at the end of each quarter year, to share all collected water quality data within the Walnut Creek watershed.
4. Pursue means to use online resources to make collected water quality data available for public review.

**Reporting Progress toward Water Quality Standards**

An annual monitoring report should be prepared and presented to the Walnut Creek WMA board, then made available for public review. The report should include the following information:

1. An overall map of the watershed showing monitoring locations, including those maintained by the Walnut Creek WMA (and its membership), ISA/ACWA, Polk County Conservation and IOWATER.
2. The average, maximum and minimum levels of each parameter at each monitoring location for the given year. Note the date when maximum and minimum levels were observed.
3. For each parameter, review changes in levels for each parameter on a month by month basis throughout the given calendar year.
4. Review data related to items #2 and #3 above for prior years, and provide a cumulative analysis for each that includes data collected for all calendar years to date.
5. Provide a brief review data from items #2-#4 above and determine if trends support that appropriate progress is being made toward the loading reduction goals at the end of Chapter 6 of this plan.





Monitoring Site Locations

## Milestones—Criteria for Measuring Success

At the end of each year, progress towards meeting the goals of this plan need to be evaluated. These key milestones represent ways to measure if implementation of this plan is on schedule and that the expected results are being observed.

1. Document when communities adopt and begin enforcement of the various recommended policies.
  - Goal: A review of ordinances and adoption of recommended amendments or new ordinances by the dates listed earlier in this chapter (staggered adoption in 2016 and 2017).
  - If not achieved by the desired dates, what are the obstacles to adoption?
2. Document improved compliance with erosion and sediment control recommendations through photographs, reductions in enforcement actions or other annual reports. The report should provide the following information:
  - Are the concerns listed in Chapter 9 being addressed?
  - What are some areas that remain in need of improvement?
  - Coordinate with IDNR Field Office #5 to determine what are the most common local violations to address related to construction site pollution prevention. Ask field office staff the following questions:
    - In their view, have conditions throughout the watershed improved?
    - How many notices of violation were issued within the watershed during the past year?
3. Document when the recommended improvements are completed. Document any modifications to the implementation plan or additional practices which are constructed.
  - Review the schedule within this chapter and verify that this plan is on schedule.
  - If implementation is not on schedule, remark on expected changes to complete the overall project list by 2025.
  - Are there new challenges that have been identified that impede full completion of this list?
4. For the rural case study watershed, validate that desired pollutant loading reductions are being achieved by observing average annual (and seasonal) concentration reductions of 41% for nitrate + nitrite, 29% for phosphorus and 29% for TSS by the end of 2025.
5. For the urban case study watershed, validate that desired pollutant loading reductions are being achieved by observing average annual (and seasonal) concentration reductions of 2% for nitrate + nitrite, 17% for phosphorus and 43% for TSS by the end of 2025.
6. For the developing case study watershed, document the number and size of each management facility constructed in urbanizing areas. Validate that each basin is designed and constructed to meet ISWMM's Unified Sizing Criteria.

# CHAPTER 13

## KEY CONCEPTS

### 1. Financial Resources

Significant funds will be required to implement the first ten years of this effort. This chapter outlines the costs associated with this plan.

### 2. Staffing

Personnel will be required in order to coordinate ongoing projects, review ongoing monitoring, prepare or support grant applications and monitor overall execution of the plan.

### 3. Improvements

Total costs related to projects listed in Chapter 10 are summarized in this chapter.

### 4. Monitoring

The monitoring program outlined in Chapter 12 will require resources to install and maintain the system. Additional time will be required to complete grab sample monitoring, pay for lab testing and staff or consultant time to compile and analyze results.

### 5. Maintenance

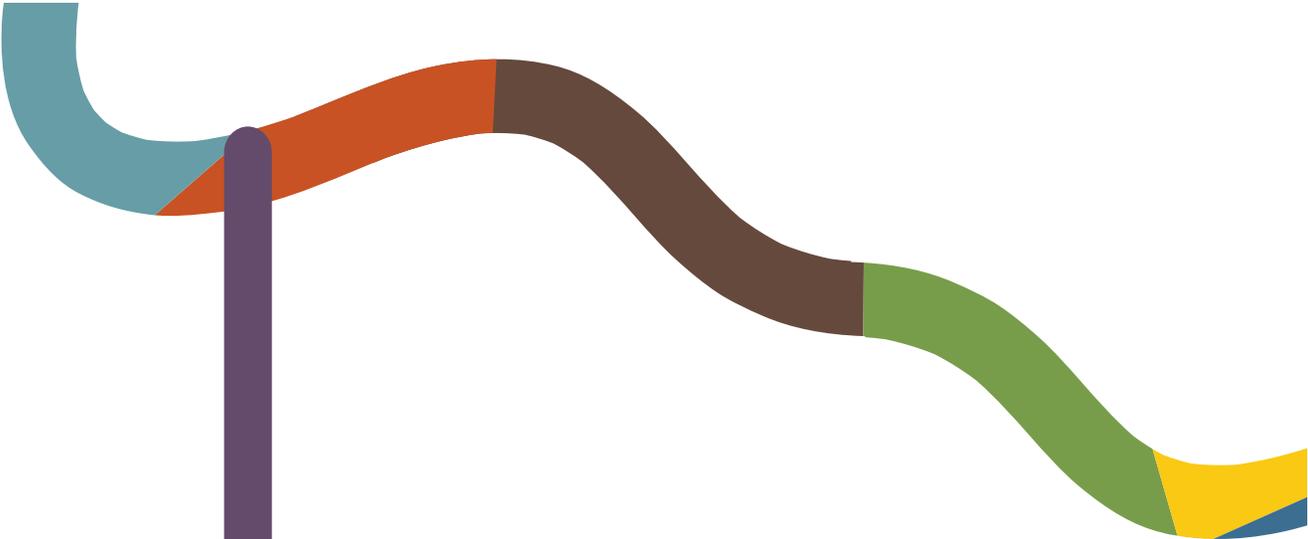
Any physical improvement requires maintenance. But maintenance often fails to be completed if it is not properly accounted for in the budgeting process. It is important that local jurisdictions consider including such costs in their ongoing budgets.

### 6. Sources of financial support

A variety of grant sources are available at multiple scales of government as well as through not-for-profits and other private concerns. A general consensus across Iowa remains, however, that expanded resources will be needed to effectively address water quality and flood mitigation in this watershed and in most watersheds in the state.

## HOW DO THESE CONCEPTS INFLUENCE DEVELOPMENT OF THE PLAN?

This plan will fail to be completed if appropriate funds are not set aside for implementation, or if qualified, motivated personnel are not used to coordinate efforts, evaluate progress and advise when amendments to the plan are necessary.



thirteen

Resource Requirements

## Costs

Financial support will be key to successful implementation of this plan. Staff support activities, construction of improvements, monitoring water quality and maintenance activities cannot be completed without dedicated funding.

## Staffing

Staff time will be required to monitor execution of the plan, review monitoring data, coordinate or complete grant applications, work with consultants and report results to the Walnut Creek WMA board and public. This can be achieved by using existing staff time from the various member communities or hiring a project coordinator (or additional staff) to be dedicated to directing execution of this plan on behalf of the WMA.

At the time of this writing, area WMAs intend to collaborate in securing support through Polk SWCD through a dedicated coordinator. This coordinator should fulfill at least the following duties:

### *Administrative*

- Coordinate meetings, perform administrative duties, provide leadership and support

### *Monitoring*

- Oversee the monitoring program and support collecting results
- Report and share data with other groups conducting monitoring within this watershed

### *Education and Outreach*

- Provide resources and technical assistance to stakeholders
- Work with rural landowners and producers to identify candidate locations for practices and implement them
- Communicate with city and county officials regarding completion of watershed goals and objectives

### *Implementation*

- Assist or coordinate during the design, layout and construction oversight of practices

### *Ordinance Changes*

- Review draft ordinance changes prepared by local communities or regional entities to develop more consistent language across multiple jurisdictions
- Support ordinance adoption

## *Funding acquisition*

- Pursue funding opportunities to execute this plan as well as other practices as deemed beneficial

## *Report Progress*

- Prepare annual reports on plan achievements, ordinance adoption and monitoring results
- Make recommendations on any required changes based on available data

The initial cost of this coordinator position is expected to be \$145,000/year. The cost for these services may be shared with other local WMAs.

## Improvements

This plan has detailed dozens of priority projects within the watershed that are intended to achieve a set of short-term water quality goals. The table on the next page provides a summary of the overall infrastructure investments that have been recommended by this plan. For more specific information regarding these projects, refer to Chapter 10 of this plan.

## Monitoring

Water quality monitoring will require resources to apply for grants and financial support, install monitoring stations, compensate for staff time and resources to collect samples and record results and pay for laboratory testing.

## Maintenance

Several types of maintenance activities will be required to execute this plan and keep constructed improvements in good working order. Forested areas within stream buffers may need selective clearing of underbrush and invasive species to encourage establishment of more erosion resistant surface vegetation. Where new areas of native vegetation are established, short-term maintenance activities may include minor erosion repair and re-seeding, spot spraying of weeds. Long-term maintenance includes re-seeding, mowing and controlled burns. Streambank stabilization projects may require some repairs after major flood events. Other stormwater best management practices require removal of collected sediments, other debris and repairs to keep them operating as intended. These needed maintenance activities will likely not occur, if its cost is not identified and included in local budgets.

Category	Projected Cost (2016)
Rural Case Study Subwatershed	\$2,595,000
Urban Case Study Subwatershed	\$5,775,000
Developing Case Study Subwatershed	\$3,250,000
Other Watershed Level Projects	\$15,555,000
Current Capital Improvements Projects	\$2,485,000

Year	Real-time Monitoring	Grab Sample Monitoring
2016	\$ 5,000	\$15,000
2017	\$ 125,000	\$15,000
2018	\$ 90,000	\$15,000
2019	\$ 56,000	\$15,000
2020	\$ 56,000	\$15,000
2021	\$ 56,000	\$15,000
2022	\$ 56,000	\$15,000
2023	\$ 56,000	\$15,000
2024	\$ 56,000	\$15,000
2025	\$ 56,000	\$15,000

Expected Cost of Maintenance (Urban Areas)	
Practice	Cost (in 2015 \$)
Selective Clearing	\$14,000 / acre
Re-seeding (native vegetation)	\$6,000 / acre
Controlled Burns	\$1,500-\$2,000 / each
Repairs (restored streambank areas)	\$12,000 / year / restored stream mile
Debris Removal	\$10,000 / year / stream mile

## Local Jurisdictions and Staff

To successfully implement this plan, city and county staff will need to cooperate. Key staff will need to review local ordinances and policies to identify current procedures that are in conflict with the recommendations of this plan. These staff should work with the project coordinator to draft language for ordinances and policy changes. They will also need to identify the financial needs expected for their jurisdiction based on this plan and determine how each area will be funded (capital improvement program, storm water utility, grant, etc.).

Any staff responsible for the review of storm water management plans and calculations should become familiar with the design and calculation methods set forth in the Iowa Stormwater Management Manual. The Iowa Stormwater Education Partnership has also developed other tools such as model ordinances and checklists which may be helpful to review staff when implementing the changes recommended in this plan.

## Citizens and Businesses

Private organizations and individual citizens can make a difference. It is most effective to address stormwater as close to its sources as possible. Private homeowners can install rain barrels, rain gardens and direct downspouts away from driveways and other paved areas. Local businesses and agencies can use stormwater retrofits to address the quality and quantity of stormwater runoff from their properties. Refer to Chapter 11 for more information on how to engage these groups through educational efforts.

## Sources of Financial Support

### *Stormwater Utility Funds*

Many communities have established these funds. They collect fees from “users” of the utility (any property which generates runoff) which are usually added to City water bills. The fees are usually related to the amount of impervious area on a given property. These are funds which can be directly collected by the individual communities, but must be used to fund stormwater-related items.

### **Grant Opportunities**

#### *Sponsored Projects Program via State Revolving Fund*

Municipalities that borrow funds to complete sanitary collection or treatment projects can piggyback a stormwater project through the Sponsored Projects Program. The state adjusts the interest rate on the project loan, allowing an extra 10% to be borrowed, but the repayment amount remains the same. Essentially, for every \$1 million spent on a sanitary project, \$100,000 can be borrowed toward construction of a stormwater quality project, at no additional cost to the municipality receiving the loan.

#### *IDALS Urban Water Quality Initiative (WQI)*

A program which takes annual requests to fund water quality improvement projects, with a maximum grant amount of \$100,000.

#### *Watershed Improvement Review Board*

This program used to be a significant source of funding for stormwater improvement projects in both rural and urban areas. Projects were eligible for grants up to \$500,000. However, in recent years the program has not been adequately funded at the State level. Watershed Management Authorities could work together to lobby for restored funding for this important program.

#### *Polk County SWCD REAP funding for urban stormwater practices*

Small amounts of funding (\$10,000 / year) are available for small-scale stormwater (rainscaping) practices on private lands.

#### *Environmental Quality Incentives Program (EQIP)*

Funding from this program is available from county SWCD offices through IDALS and NRCS for conservation practices on private agricultural lands.

### *Resource Enhancement and Protection (REAP)*

State of Iowa investments in the enhancement and protection of the state’s natural and cultural resources. Funding is allocated to a variety of programs which may relate to projects included within this plan:

- City Parks and Open Space
- County Conservation
- Private / Public Open Space Acquisition
- Conservation Education
- Roadside Vegetation
- Soil and Water Enhancement



# CHAPTER 14

## KEY CONCEPTS

### 1. Continued WMA Structure

This chapter offers recommendations on how the WMA should continue to operate and coordinate with other Central Iowa WMAs.

### 2. Evaluation Framework

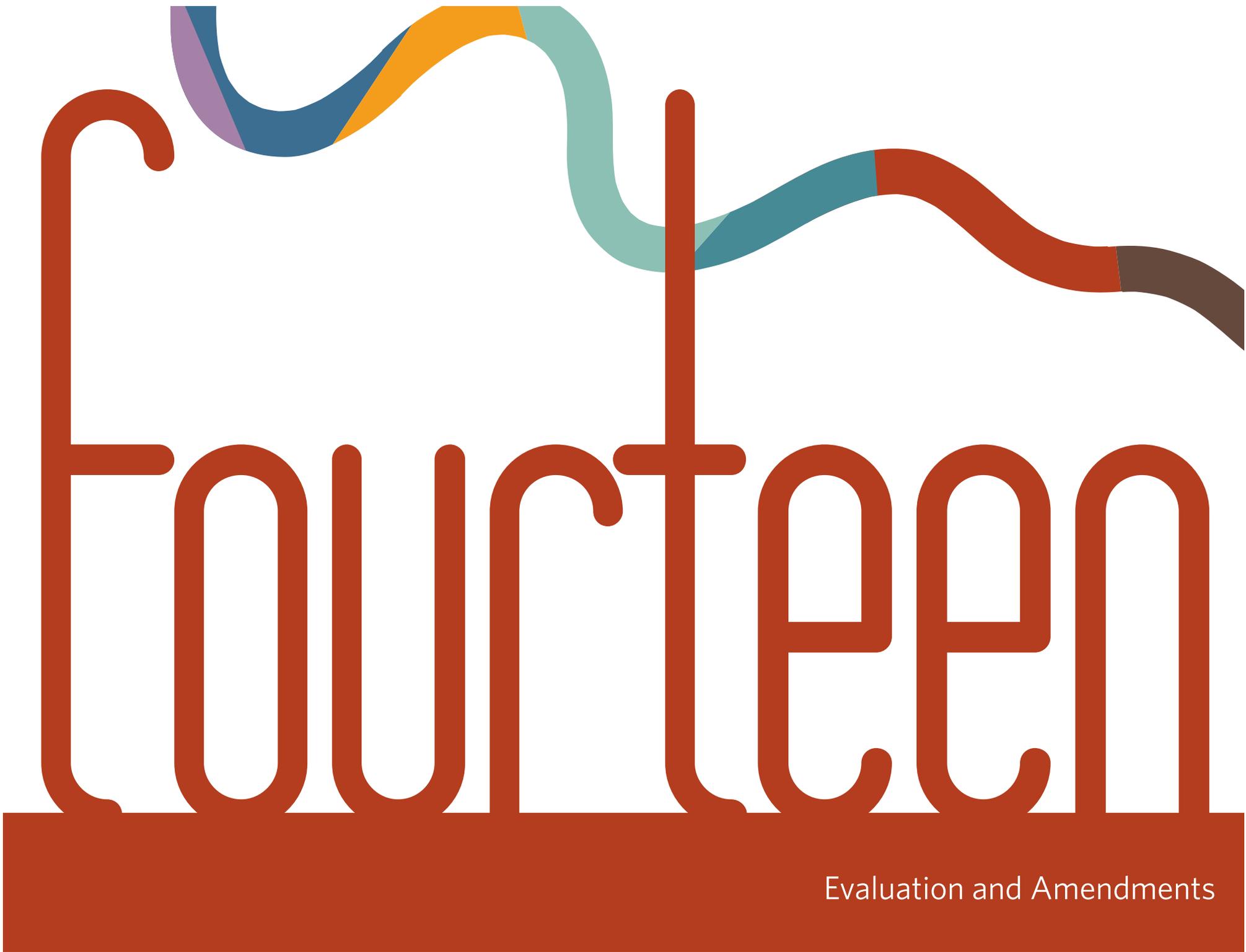
This plan needs to be evaluated at least annually, with more in-depth evaluations after year five.

### 3. Amendment Timeline

After a ten-year period, the entire plan should be re-evaluated with the goal of developing a new ten-year implementation strategy.

## HOW DO THESE CONCEPTS INFLUENCE DEVELOPMENT OF THE PLAN?

This plan needs to be a “living document,” which may need to be changed based on what is learned through annual reports as well as the financial, technical and staffing resources that are available to carry out this plan. Effective collaboration and communication between the various jurisdictions within this watershed will be vital to successful implementation of this plan.



Evaluation and Amendments

## Continued WMA Structure

The Walnut Creek WMA currently coordinates through an executive committee panel and a larger board with representatives from all the jurisdictions located within the Walnut Creek watershed. Other stakeholders and consultants frequently attend the WMA board meetings. It is recommended that both the executive committee and board continue to meet on at least a quarterly basis, to discuss plan progress and to coordinate implementation of the plan. Should a project coordinator be designated (refer to Chapter 13), this person would help to schedule meetings, develop agendas and minutes and prepare information for review by the board and committee.

## Evaluation Framework

Implementing a ten-year plan requires regular review periods to determine if implementation is following the schedule set forth. It is also critical to review monitoring and other forms of measurement to ensure that the plan is achieving the desired results. By the end of June 2017, a status report should be prepared by the project coordinator (or other party designated by the board). This report should be repeated annually and contain the following information:

- Document which communities have enacted new ordinances related to the recommendations listed in Chapter 9.
- Include a brief update from each community related to erosion and sediment control enforcement and compliance.
- Itemize completed improvement projects related to water quality within each community.
- Summarize of monitoring results, including average, minimum and maximum pollutant concentrations and comparison of those values to those observed during Year 1 of the monitoring program.
- Detail progress on rural plan implementation including an update on the rural case study area and other conservation or storm water management practices applied throughout the watershed.

After Year 5 of monitoring, the annual report should include a more detailed review of monitoring results and determine if progress towards water quality goals (pollutant concentration reduction) is on pace, based on the level of improvements that have been implemented. If it is not, the implementation plan should be reviewed and adjustments considered, informed by local observations and updated study related to management practices.

## Process / Timeline to Amend the Plan

This study has detailed how rapidly conditions within this watershed are changing. Based on past growth rates, it could be expected that within the next ten years an additional six to eight square miles of the watershed may be developed. At that point, urban development may cover between 50 and 55% of the overall land area. Over a similar period of time, it would be expected that stream conditions may be much different and the need for improvements could shift.

Over a decade, the other improvements within the case study areas and throughout the watershed should be implemented. Following Year 10 of the monitoring program, it is recommended to review and update many of the findings within this plan, and develop a new implementation and monitoring plan from those findings. New strategies should extend the plan for an additional 10 years.



# CHAPTER 15

## KEY CONCEPTS

### 1. Rural Best Management Practices (BMPs)

Various practices to reduce runoff and pollution from rural landscapes are generally described in this chapter. A brief description of the practice is provided as well as a source for additional information.

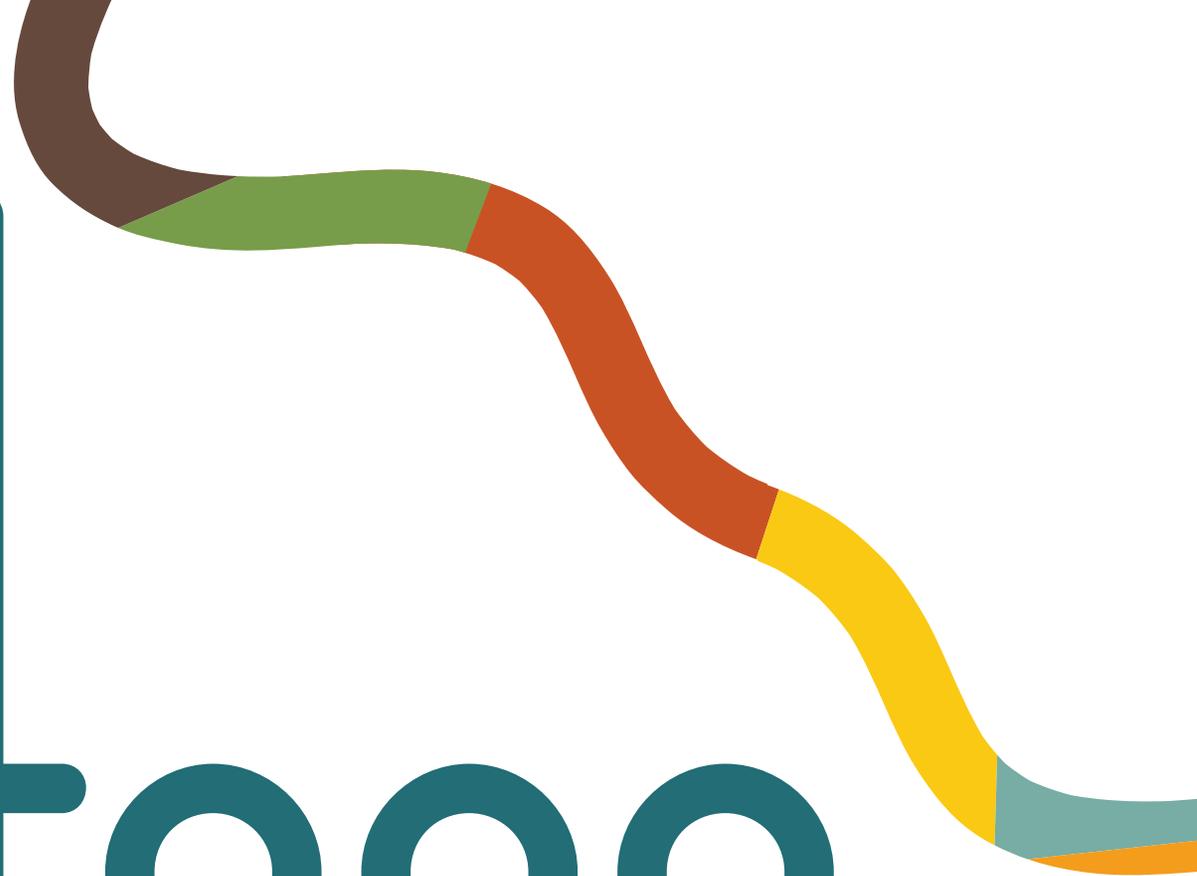
### 2. Urban Best Management Practices

Various practices to manage stormwater from developing and redeveloping urban areas are generally described in this chapter. Each practice listed is briefly described and includes a source for additional information.

## HOW DO THESE CONCEPTS INFLUENCE DEVELOPMENT OF THE PLAN?

Land owners, farmers, suppliers, planners, designers and policy-makers need to understand the types of “tools” there are in the “toolbox” to address the water quality issues identified in this plan. Many people may not be familiar with these practices. This chapter is not intended to be a detailed design guide for such practices. It is intended as a resource to help people understand what each practice is, what it is intended to do, where they are most likely to be located and where to go for additional information.

fitteen



Rural Best Management Practices *		
Practice	Description	
<b>Nitrogen Management Practices</b>		
<b>N</b>	<b>Timing</b>	<p>There are estimates that indicate over 3 million acres of cropland in Iowa have fertilizer applied in the fall. Research indicates that there could be an average reduction in nitrate-N concentrations in tile drainage water of 6% by moving fall applications of nitrogen fertilizer to spring, assuming the same application rate is used.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 4 and 24-25</i></p>
<b>N</b>	<b>Sidedress</b>	<p>There are different techniques to apply fertilizer after corn emergence. The practice applies nitrogen during plant uptake, timing applications to reduce the risk of nutrient loss due to early spring rainfall / leaching events. Research indicates that there could be an average reduction in nitrate-N concentrations in tile drainage water of 5% by moving fall applications to spring/split-applications and 4-7% reduction with sidedress compared to spring pre-plant; considering the same application rate is used.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 4-5 and 28</i></p>
<b>N</b>	<b>Source</b>	<p>Research indicates that a 4% reduction in nitrate-N concentrations may be expected when substituting liquid swine manure to fertilizer nitrogen, considering the same crop available application rate. Some manure sources high in solids content may also have a positive impact on soil organic carbon, soil structure and runoff.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 5</i></p>

\* Information adapted from the 2013 version of Iowa's Nutrient Reduction Strategy or other sources listed.

- N Nitrogen-Targeted Practice
- P Phosphorus-Targeted Practice
- NP Nitrogen- and Phosphorus-Targeted Practice



Fertilizer Application

Source: USDA

<b>N</b>	<b>Application Rate</b>	<p>Nitrogen rate varies based on a variety of factors including crop rotations and prices. The rate of application does have a predictable impact on nitrate-N concentrations leaving the root zone and entering tile flow. The online Corn Nitrogen Rate Calculator (Iowa State University Agronomy Extension) can be used to determine the Maximum Return to Nitrogen (MRTN) for corn or corn rotated with soybean acres. This practice involves reducing application rates to these values. The estimated load reductions from this practice range from 4-15%, depending on the MRTN value selected.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 5 and 27. and the Corn Nitrogen Rate Calculator—Iowa State University Agronomy Extension website</i></p>
<b>N</b>	<b>Nitrification Inhibitor</b>	<p>Inhibitors slow the rate which microbes convert ammonium-nitrogen into nitrates. This allows more ammonium to remain present for crop use. This practice specifically uses Nitrapyrin applied with fall anhydrous ammonia, when soil temperatures were 50°F and cooling. An average nitrate-N loading reduction of 9% is expected from this practice, with average crop yield increases of 6% currently observed in Iowa.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 5 and 28-30</i></p>

## Phosphorus Management Practices

<b>P</b>	<b>Soil Test P Level</b>	<p>A large portion of phosphorus loss is associated with erosion, as phosphorus often binds to soil particles or becomes dissolved in surface runoff with suspended sediments. Phosphorus loss can be reduced by decreasing total soil P concentrations by limiting or stopping applications to soils when testing shows that the soil test levels are lowered to optimum conditions. This practice does not reduce erosion directly, but reduces the P loading that is within the eroded soil. On average, a 17% reduction in loading would be expected where this practice is implemented.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.3—page 5 and 21-22</i></p>
<b>P</b>	<b>Source</b>	<p>Research has provided little evidence of short-term reductions in P loading related to changing the source of this nutrient. However, long-term reductions have been observed when using manure (when compared to commercial fertilizers) by increasing soil organic carbon and improving soil structure. In addition, significantly less P loss has been observed on fields where beef or poultry manure was used as a source when runoff producing rainfall events occur immediately after P application. Research has indicated that long-term average loading reductions of 46% may be expected where manure is used in place of inorganic fertilizer sources.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.3—page 6</i></p>
<b>P</b>	<b>Placement</b>	<p>Subsurface banding of phosphorus or incorporation of surface-applied fertilizer or manure on sloping ground reduces P loss (when compared with traditional surface application) when runoff producing events occur within a few weeks of the application. Average loading reductions are expected to range between 24-36%, depending on the placement method used.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.3—page 6 and 24-25</i></p>



Cover Crops

Source: USDA

## Land Use

<b>NP</b>	<b>Cover Crops</b>	<p>The intent of this practice is to reduce soil erosion and limit leaching of nitrate-N from the system. They can be seeded in the fall by a variety of methods. Research indicates that an average loading reduction of 31% of nitrate-N and 29% of P would be expected with use of a winter rye cover crop.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 6 and 30-32 and Section 2.3—page 6 and 27-29</i></p>
<b>N</b>	<b>Living Mulches</b>	<p>These are permanent land cover that are grown within a primary row crop. This practice may have a steeper learning curve and can require a year or two to establish the living mulch before the desired row crop can be planted. However, the potential nitrate reduction is expected to be 41%. Reduced soil erosion and enhanced soil structure are other benefits of this practice.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 6</i></p>
<b>NP</b>	<b>Perennial (Energy) Crops</b>	<p>These crops are grown for the use of biomass as fuel. As of 2014, there were few markets for these products. If these markets develop, the potential for nutrient reduction is high, with 72% N loading and 34% P loading reductions expected where row crop acres are converted to this practice. Increased habitat, reduced soil erosion and enhanced soil structure are expected additional benefits.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 6 and 37-38 and Section 2.3—page 7 and 30-31</i></p>



Perennial (Energy) Crops

Source: USDA

NP	<b>Perennial Cover (CRP)</b>	<p>The Conservation Reserve Program has already been used by many landowners to set aside land for long periods of time (10-15 years) into conservation plots similar to native prairie landscapes. Improved habitat and soil structure are expected in these areas. Research has indicated that an average reduction of 85% of nitrate and 75% of phosphorus loading is expected where row crop production is converted to CRP. Similar reductions are expected where permanent conservation easements are established as an alternative to CRP.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 7 and 36-37 and Section 2.3—page 7 and 31-33</i></p>
NP	<b>Extended Rotations</b>	<p>This practice includes a primary row crop being rotated with at least two years of a forage legume crop such as alfalfa. Within the Nutrient Reduction Strategy, a corn-soybean-alfalfa-alfalfa rotation was assumed. Due to nitrogen fixing, very little if any nitrogen would typically need to be applied during the corn rotation. Improvements in soil structure and organic matter are expected benefits of this practice. This practice reduces P losses by reducing the potential for erosion of soils. Research indicates that an average nitrate loading reduction of 42% is expected in tile drainage water, with annual corn yields improved by 10%. Although significant phosphorus loading reductions are anticipated to be caused by this practice, there is little data available to evaluate what the specific load reductions would be.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 7 and 39-40 and Section 2.3—page 7 and 33-34</i></p>
NP	<b>Grazed Pastures</b>	<p>No pertinent data is available for nitrogen leaching from pastureland systems in Iowa. Within the Nutrient Reduction Strategy, these systems are assumed to perform similar to the perennial crop (CRP) practice. Phosphorus loading reductions from this practice are expected to be 59% on average where row crop systems are converted to grazed pastures (assuming that the conversion is done in a way that provides no new direct animal access to streams).</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 7 and 36-37 and Section 2.3—page 7</i></p>
P	<b>Tillage</b>	<p>Reduced tillage increases the ground cover provided by crop residue and exposes less soil to erosion. Research shows that both conservation tillage and no-till have substantial ability to reduce phosphorus losses, with expected average reductions ranging from 33-90% depending on which method is used.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.3—page 6 and 26</i></p>



**Extended Rotations**

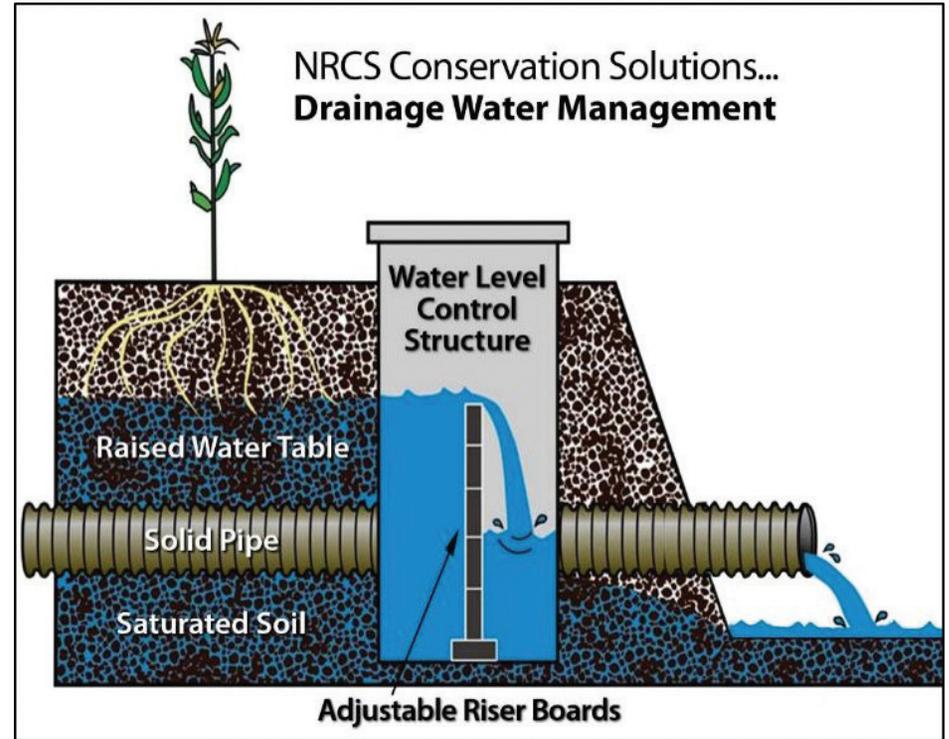
Source: USDA



**Reduced Tillage**

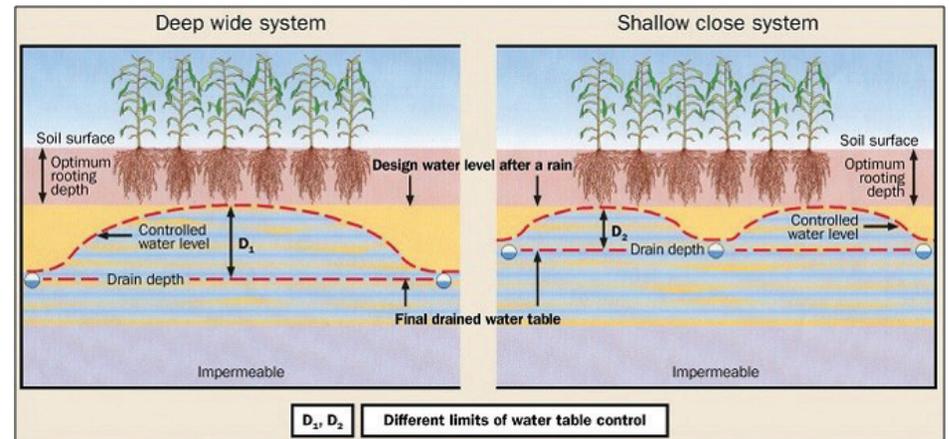
Source: USDA

Edge of Field		
P	<b>Drainage Water Mgmt.</b>	<p>This practice involves installing control structures near tile outlets that allow the water table in a field to be raised or lowered. These systems reduce nitrate loadings by reducing the volume of tile drainage water by an average of 33%. Water is usually released before planting and harvest to allow for equipment traffic within the field.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 7 and 34-35</i></p>
P	<b>Shallow Drainage</b>	<p>Tile drains can be installed more shallow (2.5 feet) and at closer spacing than traditional tile systems. Research has shown that tile drainage water volume is reduced by an average of 32%, which reduces nitrate loadings. This practice is most applicable where new tile drainage systems are being proposed or old systems need to be replaced.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 7 and 34-35</i></p>
NP	<b>Water Quality Wetlands</b>	<p>The Conservation Reserve Enhancement Program (CREP) is the primary nitrate reduction wetland program in Iowa. These practices are designed to be installed where they can receive nitrates and they've been shown to reduce nitrate concentrations by 52% on average. Additional load reductions can be observed due to cropland being taken out of production. Wetlands can also help to trap sediments, reduce phosphorus loading and provide valuable habitat. The Nutrient Reduction Strategy does not project the expected phosphorus loading reduction due to wetlands.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 7-8 and 32 and Section 2.3—page 7</i></p>



**Drainage Water Management System**

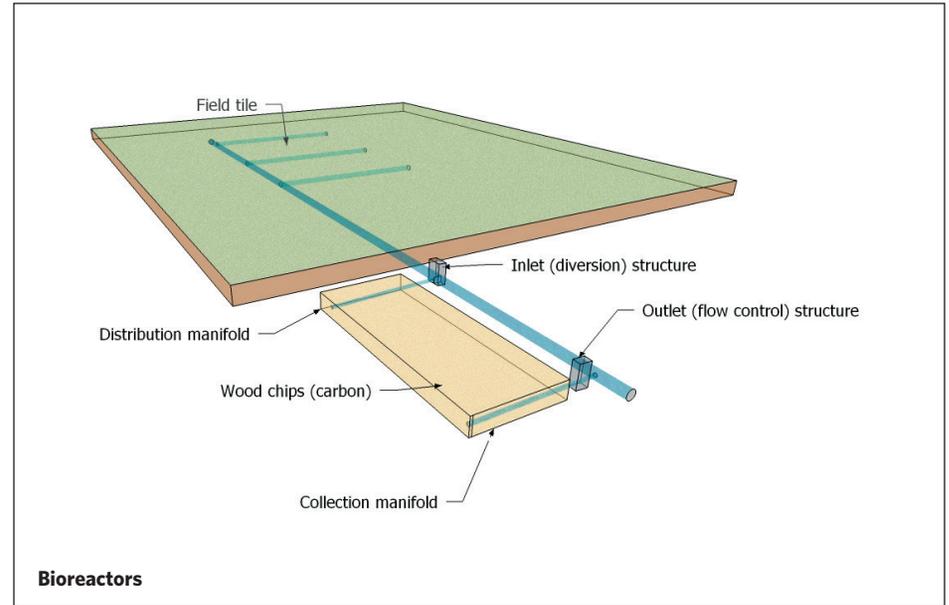
Source: USDA-NRCS



**Shallow Drainage**

Source: Ontario Ministry of Agriculture, Food and Rural Affairs

<b>N</b>	<b>Bioreactors</b>	<p>These are excavated pits, filled with woodchips. Control structures are placed on tile drainage lines to divert water into these systems. These control structures allow larger flows to bypass the system and flow directly to the stream. Bacteria growing within the woodchip media convert nitrate into nitrogen gas. These practices can treat tile systems which receive runoff from up to 100 acres of land. Research indicates that these systems can reduce nitrate loading by 43%.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 8 and 33</i></p>
<b>NP</b>	<b>Buffers</b>	<p>Located along streams, buffers offer the opportunity to remove nitrates in water flowing across the buffer or through its root zone. They also provide habitat, reduce sediment transport and help to stabilize streambanks. Their benefits for nitrate removal may be limited where drainage is diverted around or under the buffer by tile drainage. However, the nitrate concentrations in water contacting the root zone in the buffer is expected to be reduced by 91%. Nitrate removals have been shown to be high for a variety of buffer conditions. Average phosphorus reductions of 58% are expected from the area tributary to the buffer.</p> <p><i>More info: Iowa Nutrient Reduction Strategy, Section 2.2—page 8 and 34 and Section 2.3,—page 8 and 29-30</i></p>
<b>NP</b>	<b>Saturated Buffers</b>	<p>Tiles running toward a stream are intercepted into tiles running parallel to a stream and diverted to a control structure. This forces tile water to percolate through the soils under a buffer where it can be used by the roots of the native plants planted above.</p>



Source: Iowa Soybean Association



Source: Minnesota Department of Agriculture

<b>P</b>	<b>Terraces</b>	Terraces have been used for many years as a method to prevent gully erosion within fields with steeper grades. They level steeper fields out using a set of stepped plateaus and/or dams. Runoff is captured at each level and drained through a system of subsurface tiles. As this is a well-established practice, little additional information is included in the Nutrient Reduction Strategy. Where applied, average phosphorus reductions of 77% are expected from the area served.
<b>P</b>	<b>Sediment Basins</b>	Basins can be constructed to capture sediment from fields prior to its entry into a stream or wetland. Where applied, average phosphorus loading reductions of 85% are expected from the area tributary to the practice. These basins could provide additional flood reduction and water quality benefits by being constructed with multi-stage outlets to provide extended detention of small storm events by slowly releasing runoff from a 1-year return period storm (2.67" in 24-hours) over a period of one to two days. <i>More info: Iowa Nutrient Reduction Strategy, Section 2.3,—page 7</i>



**Terraces**

Source: USDA



**Sediment Basins**

Source: USDA

Other Practices		
NP	<b>Grass Waterways</b>	<p>These are common practices used to prevent erosion through fields along paths of concentrated surface flow. The drainage path is shaped into a trapezoidal, triangular or parabolic cross-section and stabilized with perennial vegetation. Deeper rooted, native plants may be a good choice for vegetation of these areas, as their deeper root structures are more resistant to erosion and enhance the ability of the soil to absorb surface runoff. These structures do require maintenance, as sediment often builds up near the edges of the waterway, which may block runoff from entering the practice, leading to erosion as runoff follows a path parallel to the waterway.</p> <p><i>More info: Part 650, Engineering Field Handbook—Chapter 7 (USDA / NRCS)</i></p>
NP	<b>Two-Stage Ditches</b>	<p>Recently these practices have been implemented across several Midwestern states. They are most commonly used where an existing ditch is widened to include two bottom stages: (1) a narrow lower channel to convey baseflow and (2) a wider secondary flood-plain bench. This system offers many benefits over traditional narrow trapezoidal channels. Runoff has more area to spread out leading to slower flows, reducing peak flow rates downstream and less erosive force within the channel. Sediment is transported more effectively, leading to less long-term maintenance. The section also allows for improved habitat, by providing a more natural connection between the stream and the adjacent flood-plain. The flood plain bench also allows for better development of vegetation, leading to improved filtration potential of nutrients. These systems have been shown to reduce nitrogen, phosphorus and sediment loadings by significant amounts in various studies.</p> <p><i>More info: Part 654, National Engineering Handbook—Chapter 10 (USDA / NRCS)</i></p>
P	<b>Culvert Modifications</b>	<p>Entrances to existing culverts can be amended to include multi-stage outlet features. These modifications would allow runoff from small storms (those of a 1-year return period or less) to be captured and slowly released over a period of one to two days. These systems would reduce runoff rates from 98% of the rainfall events in Iowa to more natural rates. Such systems would also reduce flows during larger storms by capturing and holding a significant portion of the runoff volume. This offers multiple benefits including sediment capture and phosphorus load reduction from the served area, downstream flood peak flow reduction and reduced streambank erosion. These systems might be best located where crop losses due to excessive moisture are present, or where there is room for a constructed wetland or sediment basin immediately upstream of the candidate location. A system of these facilities distributed through a subwatershed could make a significant impact in reducing local flood risk by reducing both rates and volumes of flow during all rainfall events.</p>



Source: RDG



Source: RDG

NP	<b>Cattle Stream Access</b>	When cattle, sheep or other farm animals are allowed direct access to streams the direct manure input to the stream can have significant impacts. When given access, animals may spend around 90 minutes each day in the water (about 6% of the time). Direct access often leads to streambank instability and erosion due to overgrazing or soil exposure due to tracking up and down the steep slopes adjacent to the stream. Animal manure contains high levels of nitrogen, phosphorus and pathogens. Where feasible, direct access to the stream should be restricted by fencing or other means and other methods provided to get water from the stream (or other sources) to the animals for drinking. The Water Quality Improvement Plan for the Raccoon River (TMDL) identified this a key practice for both nitrate and bacteria load reductions. (That study did not analyze phosphorus reduction practices).
NP	<b>Streambank Stabilization</b>	Eroding streambanks and gullies have been shown to be significant sources of most of the key pollutants identified within this plan. Stabilization methods should be prioritized by the severity of erosion, potential impacts to property and infrastructure and available access to complete and maintain repairs. Stabilization techniques should include comprehensive techniques which use soils, plants and rock structures to secure the toes of slopes along outer bends, deflect the path of low flow toward the center of the stream and make the bank of the stream more resistant to erosion. These "bio-engineering" techniques should be employed in lieu of use of only stone or concrete materials to armor the surface of the streambank. Such traditional methods have been shown to offer more limited benefits and often have remained less stable over time. Widened cross-sections with better connection between the stream and flood plain should be created where feasible. Such sections would reduce flow velocities, lower erosion shear forces and provide for additional flood plain storage.



Source: USDA



Source: Greg Pierce

## Urban Best Management Practices

Practice	Description
<b>Better Site Design and Source Reduction</b>	<p>Far too often stormwater issues are first addressed late in the site design process, when many site layout decisions have already been made. At this point, there is often limited space to install the most effective management techniques. A better approach is to incorporate stormwater management very early in the planning process. Important features such as wetlands, streams, floodplains and high quality soils can be identified and protected. Alternative site layouts can be reviewed to orient site features in ways that reduce the amount of grading needed and the area to be covered by impervious surfaces (buildings, paving, etc.). Stormwater management features can be designed at multiple locations across sites, attempting to treat runoff as close to the source as possible. Preliminary estimates of required treatment volumes can be used to properly set aside space for the most efficient and cost effective water quality practices.</p> <p><i>More info: Iowa Stormwater Management Manual, Section—"Planning and Design Principles"</i></p>
<b>Construction Site Pollution Prevention—Erosion Controls</b>	<p>Erosion controls are measures that protect the surface of the soil from the erosive force of raindrops or running water. Mulches, compost blankets, seeding, sodding, rolled erosion control products (RECPs), turf reinforcement mats (TRMs) and flow diversions are all methods to reduce soil erosion. These measures are often overlooked, but it is more effective to prevent erosion than it is to try to trap sediment materials once they have been moved by water or wind.</p> <p><i>More info: Iowa SUDAS Design Manual, Chapter—"Erosion and Sediment Control"</i> <i>Iowa Construction Site Erosion Control Manual (Iowa Department of Natural Resources)</i></p>
<b>Construction Site Pollution Prevention—Sediment Controls</b>	<p>Sediment controls are practices that are intended to keep soil materials from being carried off site by running water or tracked by construction equipment. Stabilized construction entrances, silt fences, filter socks, wattles and sediment basins are examples of practices which serve these functions. Each of these practices have limitations that designers and installers should be familiar with. These practices must be properly located, sized, installed and maintained to work effectively.</p> <p><i>More info: Iowa SUDAS Design Manual, Chapter—"Erosion and Sediment Control"</i> <i>Iowa Construction Site Erosion Control Manual (Iowa Department of Natural Resources)</i></p>
<b>Construction Site Pollution Prevention—Other Features</b>	<p>Other forms of pollution prevention such as trash collection, concrete washout collection and spill prevention are also important to protecting downstream water quality. These features are also required to be identified and included in Storm Water Pollution Prevention Plans.</p> <p><i>More info: Iowa SUDAS Design Manual, Chapter—"Erosion and Sediment Control"</i> <i>Iowa Construction Site Erosion Control Manual (Iowa Department of Natural Resources)</i></p>



Source: Greg Pierce

### Soil Quality Management and Restoration (SQM / SQR)

Preserving and restoring quality topsoil layers is the first line of defense in post-construction stormwater management. Open spaces that have healthy, porous surface are able to absorb and store more water. Organic material within these soils allows desired vegetation to be supported and provides habitat to worms, insects and burrowing animals which further increases soil water retention. Healthy soils are necessary to support desired landscaping and reduce the need for irrigation. A soil management plan (SMP) identifies the methods used at a given site to preserve or restore topsoil layers for open spaces.

*More info: Iowa Stormwater Management Manual, Section—"Soil Quality Management and Restoration"*

### Pretreatment Practices

Many different management practices can fail when they experience heavy sediment loads. Ponds can silt in, losing their storage volume and affecting fish habitat. Infiltration practices will not work if their surface layers become plugged with deposited sediment. There are several alternatives to intercept heavier sediment loads before they can impact downstream water quality management practices:

- Concentrated flows can be directed through grass swales to filter runoff.
- Where flow can be spread more evenly, it can be directed through vegetated filter strips.
- Sediment forebays are depressions used to trap sediment at pipe outlets, curb cuts or other places where flow is near entry to a practice. These areas usually are a shallow pond or trap that can be cleaned out by a backhoe, skid loader or vacuum system.
- Hydrodynamic devices are engineered systems installed underground that intercept runoff from storm sewer networks and divert it through a chamber where water is forced to swirl. This creates a low velocity zone in the center of the structure where sediments and debris can settle out and be removed.
- Gravity separators and sumps are engineered systems within storm pipe networks which feature low sections or separator walls which force different pollutants or trash to fall out of suspension.
- Catch basin sumps and inserts are methods to screen trash and debris or force sediment to settle in sections of storm sewer intakes that are set below the pipes that they are connected to.

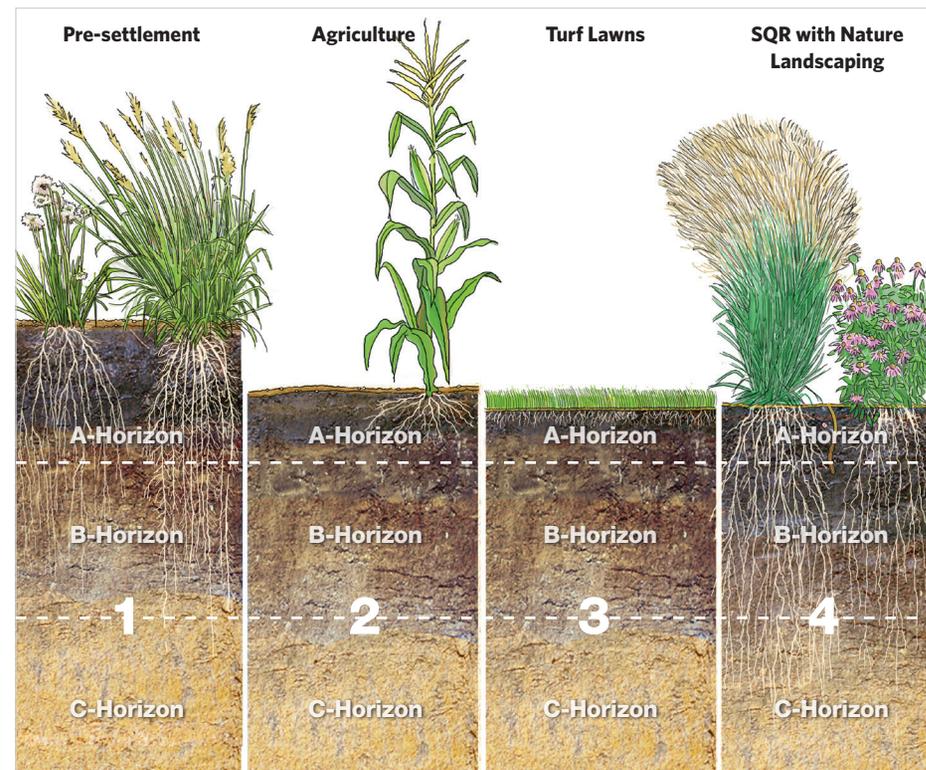
If these features are working properly, they will collect sediment and other debris which will need to be removed over time. It is essential that such maintenance is properly scheduled and budgeted for. Failure to do so may lead to more expensive repairs or sediment removal efforts downstream.

*More info: Various sections within the Iowa Stormwater Management Manual*

### Rainfall Collection and Reuse—Green Roofs

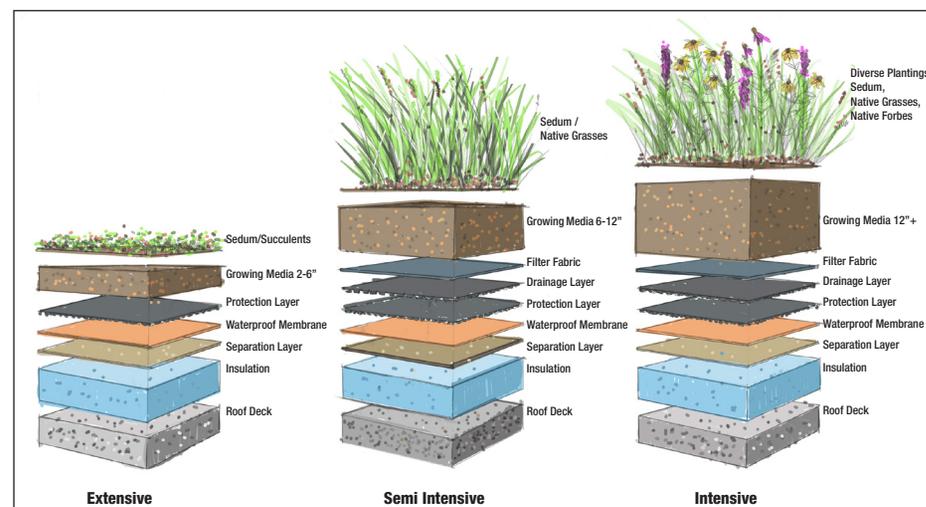
Green roof systems are beginning to be used more frequently in Iowa. They feature vegetation grown in layers of media or soil. Green roofs are an excellent way to address runoff at its source. Buildings featuring green roof systems will have runoff properties that are more similar to open spaces. In addition to addressing water quality, use of these systems can allow downstream water management practices to be downsized (refer to ISWMM for more details).

*More info: Iowa Stormwater Management Manual, Section—"Green Roof Systems"*



**Soil Quality Management and Restoration (SQM / SQR)**

Source: RDG



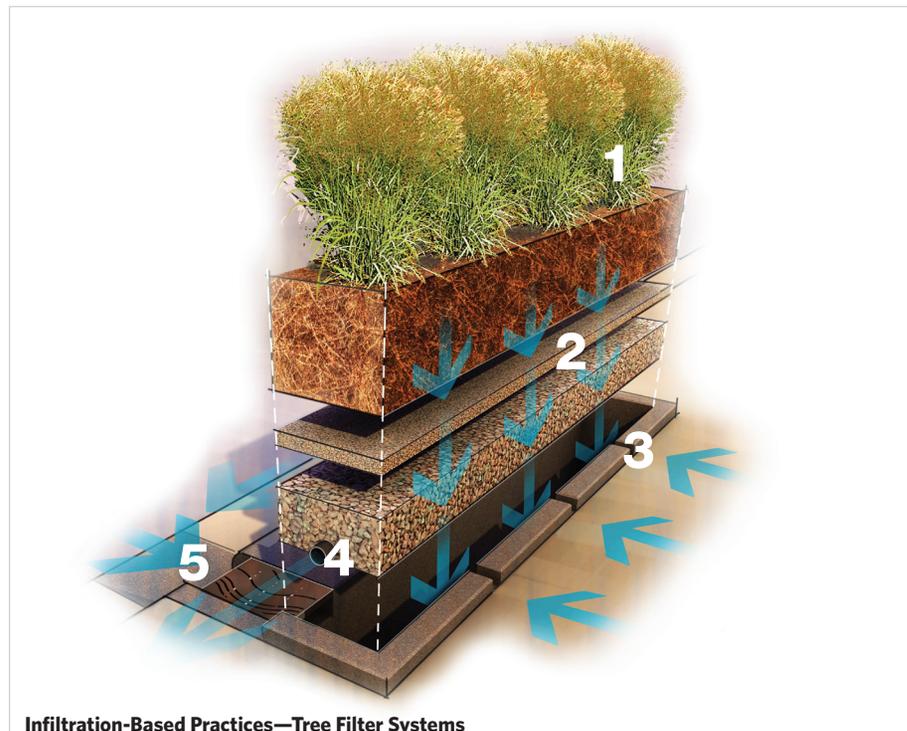
**Rainfall Collection and Reuse—Green Roofs**

Source: RDG

<b>Rainfall Collection and Reuse—Rainwater Harvesting</b>	<p>Storm water can also be captured and reused for irrigation and non-potable uses (i.e. toilet flushing). This can be done by directing roof drains or other pipes to rain barrels, storage tanks or cisterns. This provides a double benefit of reducing both storm water runoff and the use of drinking water for irrigation and other uses.</p>
<b>Native Landscaping</b>	<p>Prior to pioneer settlement, Iowa’s landscape was dominated by tall grass prairies and savannas. Native plants that lived within these systems are naturally tuned to our climate. Most of these plants can survive and thrive without becoming invasive or having other unanticipated negative effects on the environment. They also provide important habitat for pollinators (bees, butterflies), many of which have seen massive population losses. These systems developed deep root systems which extended many feet into the soil. Their root action combined with other biological activity to create the deep, rich topsoil which is the foundation for Iowa’s agricultural economy. These roots also made these plant systems much more resistant to erosion than turf grass lawns. Using native landscaping in open spaces has great potential to reduce runoff volumes. It can also be incorporated within streambank restoration projects to create surfaces that are more resistant to streambank movement.</p> <p><i>More info: Iowa Stormwater Management Manual, Section—“Native Landscaping”</i></p>
<b>Infiltration-Based Practices—Tree Filter Systems</b>	<p>Tree filter systems are most often constructed within parking areas and along urban streetscapes. Planter boxes are created by building walls or fabricated vaults from concrete or other materials. These vaults are usually filled with an aggregate (small rock material free of small particles) layer set below engineered soils. Stormwater enters from adjacent streets, walks and other impervious areas through curb cuts, pipes or intakes. The runoff is used to support trees, shrubs or other landscape material that are planted on the surface of filter system. Sometimes a series of these systems can be connected by subsurface soil and aggregate layers to expand tree root growth zones and provide additional stormwater storage volume.</p>
<b>Infiltration-Based Practices—Infiltration Trenches</b>	<p>These systems are constructed by excavating an area and filling it with aggregate materials. The open space between the rocks allows water to infiltrate through the surface and be stored within the rock chamber. Stormwater can percolate out through subsoil layers or be drained out much more slowly by a subsurface drain system. Any water entering the drain system has been cooled and filtered, removing pollutant loads.</p> <p><i>More info: Iowa Stormwater Management Manual, Section—“Infiltration Trenches”</i></p>

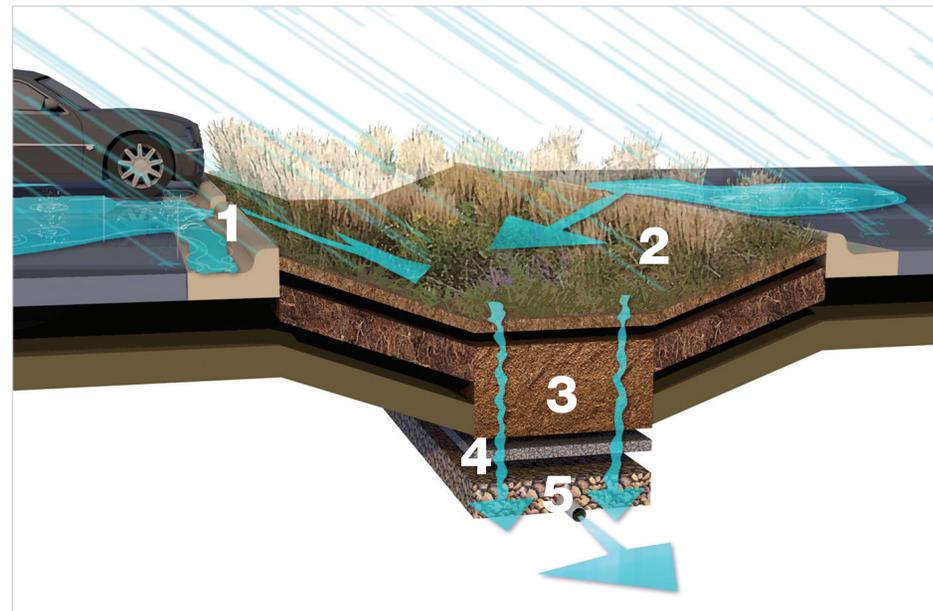


Source: Greg Pierce



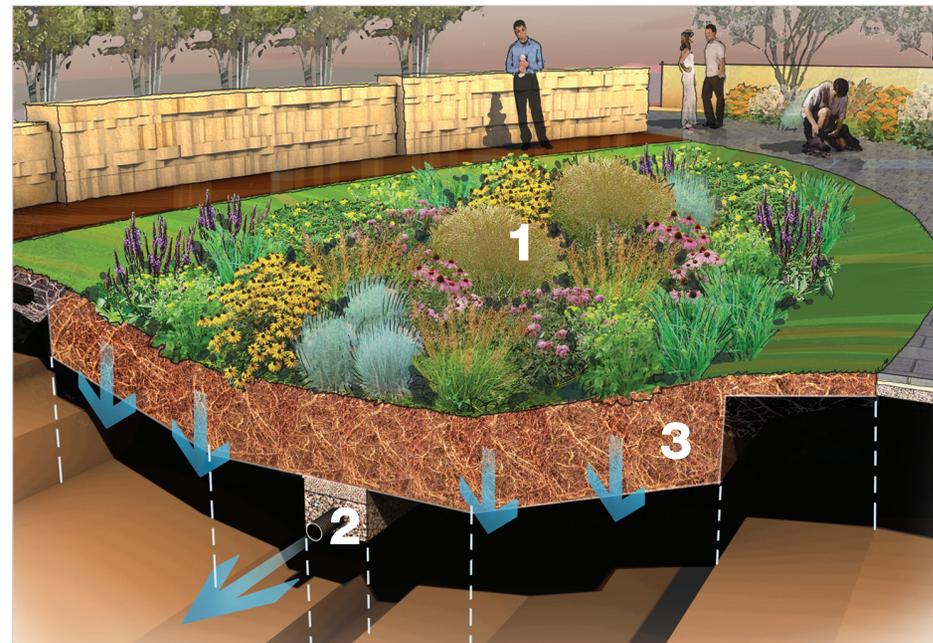
Source: RDG

<p><b>Infiltration-Based Practices—Bioretention Systems</b></p>	<p>These features are constructed shallow depressions used to capture and filter runoff. An excavation is made and filled with a base layer of aggregate material, an engineered soil layer (a prescribed mix of compost, sand and topsoil) above and a mulch layer at the surface. The system is designed to have a surface that is level from end to end and side to side. The lowest surface drain outlet within the cell is set 6-9" above the level surface. Stormwater spreads across the level surface and, because of the elevated inlet, is forced to infiltrate into the soil. From there it will percolate through the soil and aggregate layers into subsoils. If water can't move quickly enough into the subsoils, it is able to be drained out through a subdrain system. The surface outlet is used to allow an overflow so that larger events don't overload the system. The outlet can be sized to control the rate of surface outflow to more natural levels.</p> <p><i>More info: Iowa Stormwater Management Manual, Section—"Bioretention Systems"</i></p>
<p><b>Infiltration-Based Practices—Bioswales</b></p>	<p>Bioswales are similar in construction to bioretention cells. The main difference between the two is that while bioretention cells are constructed level, bioswales are constructed with a slight grade from one end to the other. Water passes through the bioswales at low speeds, allowing pollutants to settle out, be filtered or absorbed by the native plant material within the swales. Check dams are also used to control runoff rates, and water ponded behind each dam is able to infiltrate into the soil layers below. Bioswales can treat runoff from larger drainage areas than bioretention cells. However, they need to have enough length to give water enough travel time to be treated.</p> <p><i>More info: Iowa Stormwater Management Manual, Section—"Bioswales"</i></p>
<p><b>Infiltration-Based Practices—Infiltration Basins</b></p>	<p>These large, flat basins use natural soil profiles to infiltrate runoff, so their application is usually limited to areas with soils with high percolation rates. They rely on creating a basin with a relatively flat bottom which allows captured runoff to be infiltrated into soils over a larger area. It can be difficult construct large basins with a level bottom (low areas tend to be created) or without compacting soils during construction (which reduces infiltration and percolation rates). For these reasons, bioretention systems or bioswales may be a more reliable option at many locations. Use of native landscaping in these areas can maintain or increase their ongoing ability to absorb runoff.</p> <p><i>More info: Iowa Stormwater Management Manual, Section—"Infiltration Basins"</i></p>
<p><b>Infiltration-Based Practices—Rain Gardens</b></p>	<p>These features are similar in shape to a bioretention cell. However, they do not include subsurface layers of engineered soils and aggregate and do not include a subdrain. They are most applicable on individual home or commercial sites where they serve small drainage areas. Subsoils must not have been disturbed extensively by construction and have adequate percolation rates for them to be able to absorb the water that they intercept.</p> <p><i>More info: Iowa Rain Garden Design and Installation Manual</i></p>



**Infiltration-Based Practices—Bioretention Systems**

Source: RDG



**Infiltration-Based Practices—Rain Gardens**

Source: RDG

### Permeable Pavement Systems

Pavement systems are now available which allow water to pass through the surface. Runoff can be stored in a subsurface rock layer where it can be allowed to percolate through subsoil layers or released through a subdrain system at more modest rates. Permeable concrete, asphalt and pavers are available to be used for the surface of the pavement system. What makes these surfaces different from standard paving is that sands and other fine grained materials have either been left out of their mix design (concrete and asphalt) or not used as filler material between paver units. This allows water to flow more freely through the surface material into the rock storage below. Some of these systems have unique installation methods that installation contractors should be familiar with. These systems require routine maintenance by a vacuum truck or other methods to avoid clogging of the surface openings. It is very important that runoff from unprotected active construction sites or material storage areas not be allowed onto the pavement surface (this will quickly clog the pavement's ability to infiltrate water).

*More info: Iowa Stormwater Management Manual, Sections—"General Information for Pavement Systems," "Pervious Concrete Pavement," "Porous Asphalt Pavement" and "Permeable Pavers"*

### Stormwater Detention—Constructed Wetlands

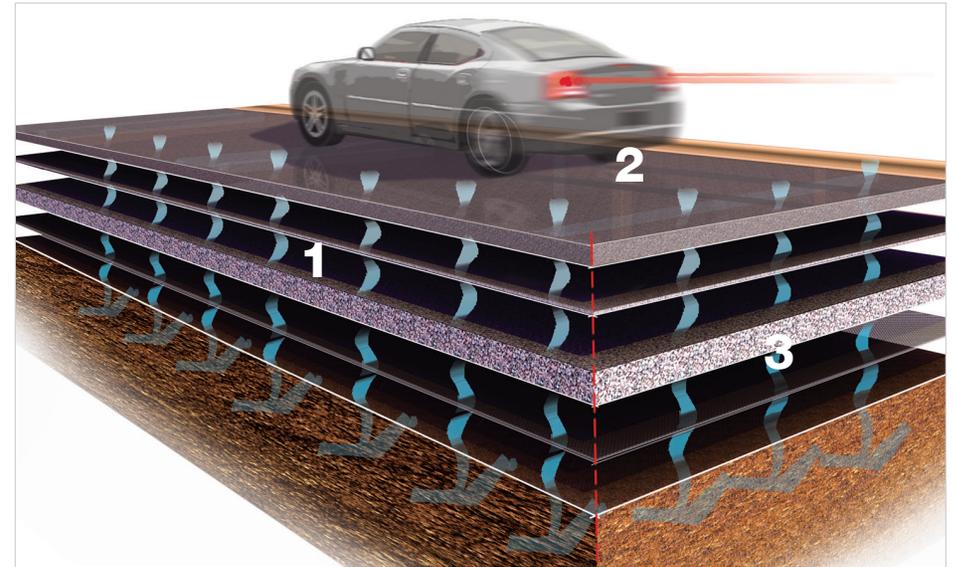
Stormwater wetlands have been shown to be very effective at removal of bacteria, nutrients and sediments from storm water. A constructed wetland is basically a stormwater maze, forcing runoff to take a much longer path through a series of shallow depressions and pools of various depths. They can be used to address management needs for both small and large storm events. The proportion of shallow and deep water zones are set by different "recipes" for wetland designs set forth in ISWMM. These areas provide important habitat for many species including ducks, frogs, dragonflies and fish.

*More info: Iowa Stormwater Management Manual, Sections—"General Information for Stormwater Wetlands" and "Design of Stormwater Wetlands"*

### Stormwater Detention—Standard Dry Detention

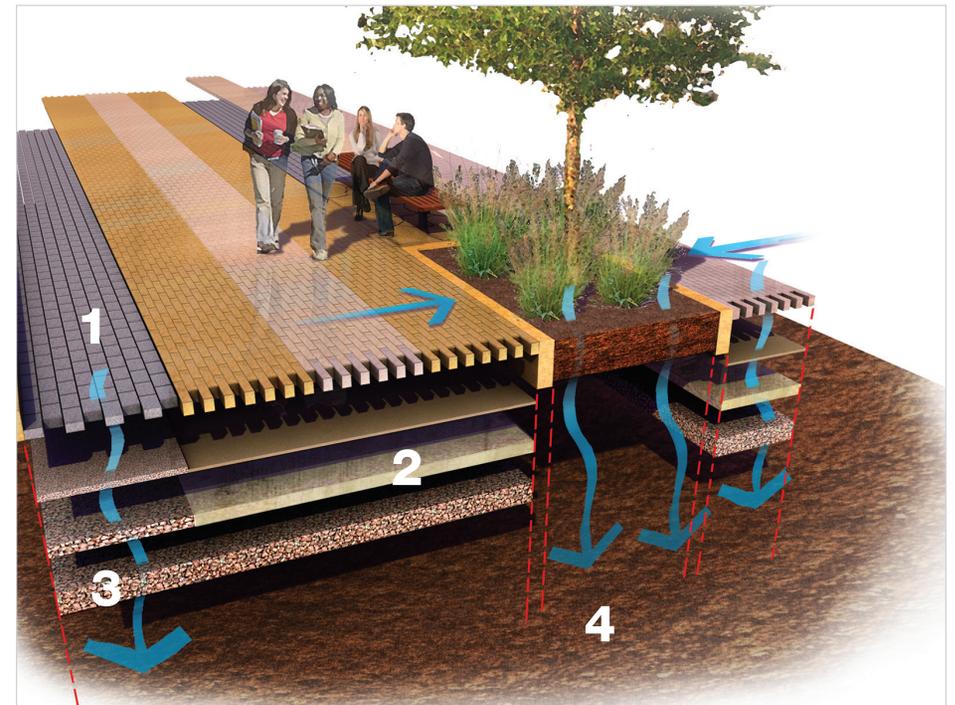
Dry detention basins have historically been the most common form of stormwater management employed in Central Iowa. These areas are intended to be dry between rainfall events. Outlets are designed to limit the rate at which runoff can leave the basin. When larger storms occur, the rate of inflow is larger than the rate that water can get out of the basin. This causes water to back up within the basin or be "detained." Dry detention basins lack adequate methods such as infiltration, ponding or plant uptake to provide significant water quality benefits. For this reason, *standard dry basins are not usually considered water quality practices*. They need to be paired with other management practices located upstream to address water quality.

*More info: Iowa Stormwater Management Manual, Sections—"General Information for Detention Practices" and "Dry Detention"*



**Permeable Pavement Systems**

Source: RDG



**Stormwater Detention—Constructed Wetlands**

Source: RDG

### Stormwater Detention—Extended Dry Detention

Dry detention basins can be designed or modified to provide for extended detention of small storm events. This involves designing outlets which are staged to release runoff during small storms much more slowly than was done in the past. Most standard dry detention basins release the runoff they receive in minutes or a few hours after a rain event. Extended detention basins capture and hold runoff longer, releasing it over a period of no less than 24 hours. Extended dry detention basins can be used to address the Channel Protection Volume (runoff caused by a 1-year, 24-hour event—2.67" in Central Iowa). Since water will be present more often in these basins, native plants chosen for wetter soil conditions are better suited than traditional turf grass lawns to provide permanent vegetation.

*More info: Iowa Stormwater Management Manual, Sections—"General Information for Detention Practices" and "Dry Detention"*

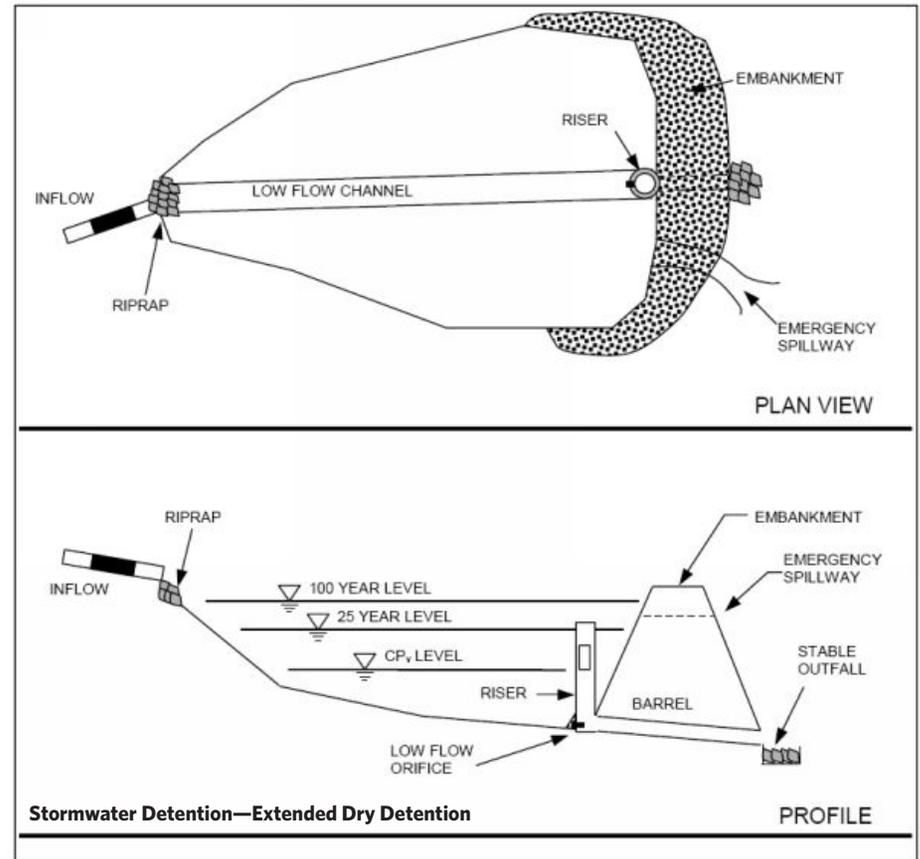
### Stormwater Detention—Wet Detention Ponds

Wet ponds are a feature that can provide aesthetic benefits, recreational opportunities, and improved habitat while meeting stormwater management goals. These systems retain a permanent pool of water which allows pollutants to drop out of solution, be absorbed by shoreline vegetation or broken down by other natural processes. Outlets can be designed to draw water out a few feet below the surface to keep the more oxygen rich water in the pond. Ponds can be designed to address water quality, provide extended detention and limit runoff for larger events to pre-settlement levels. Safety shelves along the shoreline reduce drowning risk while provided better habitat for wetland vegetation. Maintenance access and pretreatment methods are important to consider in the design process. Outlets should feature a multi-stage design, to effectively manage runoff from both small and large storm events.

*More info: Iowa Stormwater Management Manual, Sections—"General Information for Detention Practices" and "Wet Detention"*

### Increase Flood Plain Storage

Grading can be completed along major streams to excavate collected sediments or other earth materials from within flood prone areas. This can increase the cross-sectional area of the stream or adjacent flood plain, which can reduce flow velocities. It also provides greater volume available for storage during larger flood events. These effects reduce flood hazard elevations and slow the downstream movement of flood waves. Such grading can often improve habitat by providing a more natural connection between the stream and the adjacent flood plain (often this connection is an abrupt slope due to years of downcutting or streambank erosion). There is a potential to reduce flow velocities to a level that would actually lead to higher levels of deposition, or create flow patterns that could be more erosive. Planning and design of such removals should be done by professionals familiar with patterns of stream movement (fluvial geomorphology). Environmental and flood plain construction permitting is usually required.



Source: ISWMM manual



Source: Greg Pierce

<b>Water Quality Outlet Modifications</b>	<p>Larger ponds or detention facilities may offer opportunities to modify outlets to improve their capacity for extended detention. In some cases this could be as simple as changing the width or elevation of water entry points at the top of the outlet structure or adding a low flow pipe outlet. More detailed analysis of each basin could determine if such a modification could be made without significant additional risk to surrounding properties or structures during large storm events. Such modifications can usually be made with a smaller investment, yet could provide a measurable improvement in pollutant removal and downstream channel protection.</p>
<b>Stream Corridor Restorations</b>	<p>This plan has identified that very few urban small stream corridors are considered stable. Ongoing erosion can directly impact public infrastructure and private property. Streambank materials displaced by erosion is estimated to be the largest contributor of sediment to Walnut Creek. Stream corridor restorations can make streams able to withstand flow rates with less erosion. Rock riffles can be used to slow downcutting and mimic natural pool systems. Toe protection can reduce the potential for erosion along outer stream bends. Native vegetation improves aesthetics and provides more erosion resistant permanent vegetation. In addition to reduced channel erosion, stream corridor restoration improves water quality through filtration and deposition of pollutants. Habitat for a variety of wildlife is greatly improved. The final product is a stream system which is much healthier and accessible to the public.</p>

**Stream restoration techniques can be used to repair and restore eroded stream corridors.**

### Before



Source: Greg Pierce

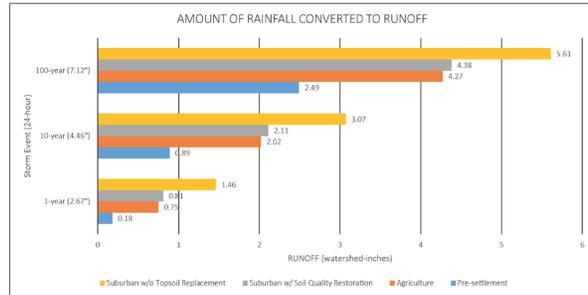
### After



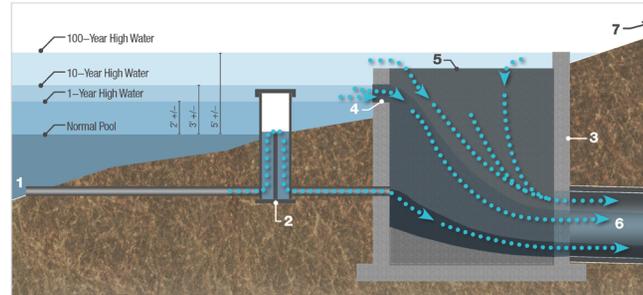
Source: Greg Pierce

# Draft Recommendations—Best Practices

## Preserve topsoil



## Modify existing detention basins to manage 98% of all storm events



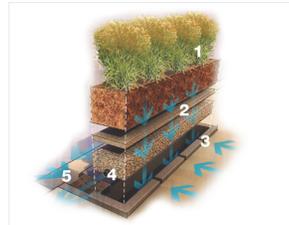
### Staged Outlet

1. 1st Stage: Small Diameter Inlet - Low Flow Control (Below Surface)
2. Water Level Control Structure
3. Main Outlet Structure
4. 2nd Stage: Notch Weir or Medium Size Opening (Controls 2-25 Year Storms)
5. 3rd Stage: Longer Overflow Weir (50-100 Year Storms)
6. Pipe Outlet (Likely Controls 50-100 Year Storms)
7. 4th Stage: Emergency Spillway (For Storms Larger Than 100-Year)

## Manage the water quality volume using green infrastructure

### Storm Water Planters

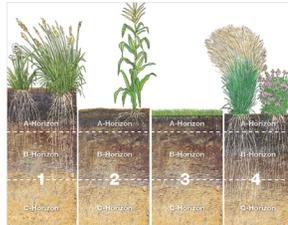
Stormwater planters capture the street's stormwater runoff before it enters into the city's storm sewer. By promoting stormwater infiltration, the planters remove pollutants and debris that would otherwise be released directly into our waterways.



1. Salt tolerant native plants stabilize the soils and provide habitat for native organisms.
2. Plant growth and stormwater infiltration are enhanced by amended soil and layers of open graded washed rock.
3. Stormwater that collects on the sidewalk is directed to the planters through a series of curb cuts.
4. To help remove excess water from the stormwater planter, the underdrain ensures water will not pond on the surface for extended periods of time, creating an unhealthy soil for plants.
5. During times of heavy rain, water flows into the curb inlets and flows into the stormwater planter.

### Soil Health

By supplementing existing urban soils with organic matter, soil health can be restored by increasing the pore space and water holding capacity.



1. Pre-Settlement Soil: Distinct A and B horizons; deep roots; well aerated soil; and up to 6% organic matter.
2. Agricultural Soil: Minimal A and B horizons; highly erodible B soils; and less than 2% organic matter.
3. Urban Soil: No A horizon; highly compacted soils; shallow roots and minimal aeration; and less than 1% organic matter.
4. Restored Soil: Increasing A horizon; increasing pore space; return of soil organisms; and more than 3% organic matter.

### Permeable Pavers

Permeable pavers promote infiltration of stormwater through a series of small openings within the pavement surface. This reduces the amount of runoff that causes flooding and helps remove pollutants from stormwater.



1. Spaces between permeable pavers direct water to a series of layers below pavement subbase.
2. Layers of uniformly graded washed rock allows water to be temporarily stored below pavement surface before it infiltrates into existing soils.
3. Pollutants are removed from the stormwater by small beneficial bacteria that "digest" and breakdown complex metals and chemicals.
4. Sandy subsoil has a high infiltration rate allowing water to move through the soil at rates greater than 3" per hour.

### Rain Garden

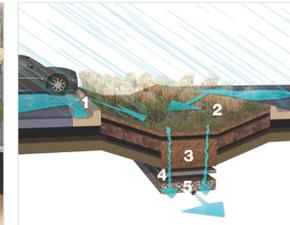
Rain gardens are an infiltration based stormwater management practice that work to clean water, reduce flooding and recharge the groundwater.



1. Native plants help manage stormwater runoff from buildings, landscapes and the surrounding watershed. Deep rooted native plants and grasses help build soil structure and allow water to infiltrate the ground better than traditional turf grass. Native plants also are low maintenance, adapt to the surrounding region, resist pests and diseases as well as provide habitat for local birds and butterflies.
2. To help remove excess water from the stormwater planter, the underdrain ensures that water will not pond on the surface for extended periods of time.
3. To support plant growth and promote infiltration, rain gardens are often supplemented with organic compost and sand. This amended soil removes pollutants from contributing waters and helps restore life within the soil.

### Bioswale

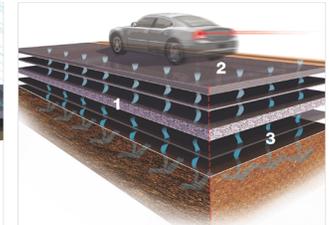
Bioswales remove over 95% of the pollutants found within urban stormwater run off, including heavy metals, oil, leaking fuel and deicers.



1. A curb cut allows water to enter into the swale.
2. Water is infiltrated through the native plants and hardwood mulch. Native plants help aerate the ground, build soil structure and clean water as it moves into the subsoil. The hardwood mulch is an important system component, breaking down pollutants such as heavy metals, oils, leaking fuel and deicers.
3. Amended soil is used to promote infiltration and support plant diversity. The soils are a mixture of blended sand and compost.
4. Layers of washed rock help increase the soil's infiltration rate and remove harmful pollutants.
5. A subdrain is installed to help remove excess ponded water during times of heavy rain. Some bioswales do not need a subdrain if the soil contains a high percentage of sand.

### Porous Asphalt

Porous asphalt is a flexible pavement that promotes the infiltration of stormwater through the pavement surface. Stormwater filters its way through a sequence of subbase layers filtering pollutants, heavy metals and other harmful chemicals.



1. Stormwater that moves through the pavement surface is captured and held in the pavement subbase and base course layers. Up to a 40% void space allows for water to be temporarily held before infiltrating into the ground, unlike traditional pavements where stormwater runs off.
2. Porous asphalt is composed of a highly permeable surface that does not have any fine sand or other small aggregates in the pavement. By using an evenly sized aggregate blend, a pavement surface with a void ratio of up to 16% significantly reduces the amount of stormwater runoff from vehicular service drives.
3. To prevent migration of the aggregates and stabilize the subbase layers, a geotextile (or permeable fabric) is placed between the rock and subsoil.

WALNUT CREEK WATERSHED

RDg...  
PLANNING • DESIGN

DES MOINES AREA  
MPO  
METROPOLITAN PLANNING ORGANIZATION

S  
SNYDER & ASSOCIATES  
Engineers and Planners

Polk Soil & Water  
CONSERVATION DISTRICT



glossary



## Glossary

Abbreviation	
ACWA	Agriculture's Clean Water Alliance
BMP	Best Management Practice
CAFO	Confined Animal Feeding Operation
CWA	Clean Water Act
DMWW	Des Moines Water Works
FEMA	Federal Emergency Management Agency
FIB	Fecal Indicator Bacteria
FIRM	Flood Rate Insurance Map
GIS	Geographic Information Systems
IDALS	Iowa Department of Agriculture and Land Stewardship
IDNR	Iowa Department of Natural Resources
ISA	Iowa Soybean Association
ISWMM	Iowa Stormwater Management Manual
LiDAR	Light Detection and Ranging
MCL	Maximum Contaminate Level
MPN	Most Probable Number of organisms
NOAA	National Oceanic and Atmospheric Administration
NOD	Notice of Discontinuation
NRCS	National Resources Conservation Service
POTW	Publicly Owned Treatment Works
QAPP	Quality Assurance Project Plan
RC&D	Resource Conservation and Development
RECPs	Rolled Erosion Control Products
SMP	Soil Management Plan
SQR	Soil Quality Restoration
SUDAS	Statewide Urban Design standards And Specifications
SWPPPs	Storm Water Pollution Prevention Plans
TMDL	Total Maximum Daily Load
TRMs	Turf Reinforcement Mats
USGS	United States Geological Survey
WRCC	Water Resources Coordinating Council

Term	Definition as related to the context of this plan
<b>absentee landlord</b>	<i>A property owner who rents land for farming, but gives little or no oversight to the methods of farming or conservation practices used within their property.</i>
<b>agronomist</b>	<i>A person who studies properties of soils and/or plants and uses them to improve agricultural production.</i>
<b>algae</b>	<i>There are many types of algae, but those most common to this watershed are microorganisms that grow on the surface of freshwater ponds and streams.</i>
<b>algal blooms</b>	<i>When nutrient levels are high, growth of algae can be accelerated leading to algal blooms. These are large groups of algae which collect in a common area.</i>
<b>annual</b>	<i>The total or average value of something over a calendar year.</i>
<b>annual exceedance probability</b>	<i>The chance a storm event or flood of a certain depth will be equaled or exceeded in any given year.</i>
<b>bioreactors</b>	<i>Refer to Chapter 15 for details on rural best management practices.</i>
<b>bioretention</b>	<i>Refer to Chapter 15 for details on urban best management practices.</i>
<b>bioswales</b>	<i>Refer to Chapter 15 for details on urban best management practices.</i>
<b>buffers</b>	<i>A separation between a stream and adjacent land uses (either urban or agricultural) which feature grasses, forbs, trees and shrubs which filter and clean runoff before it can enter a stream. These areas usually provide important habitat to a variety of species.</i>
<b>canopy</b>	<i>An area under the expanse of branches and leaves from a tree or tree group.</i>
<b>channel protection volume</b>	<i>One element of the Unified Sizing Criteria within the Iowa Stormwater Management Manual. Practices designed to address this element will capture runoff from a 1-year storm (2.67" in 24-hours) and slowly release it over a period of 24-48 hours. Peak flows from such an event are typically reduced by more than 95% by these practices.</i>
<b>Clean Water Act</b>	<i>A federal law originally passed in 1972 which was intended to reduce surface water pollution. Most current federal regulations related to surface water quality are based on this law.</i>
<b>common plan of development</b>	<i>A term used in Iowa's NPDES General Permit No. 2 which governs pollution prevention and water quality protection from construction sites. It is usually a parcel or adjacent parcels of land which are planned to be developed in phases over a period of time. Permit coverage is required for common plans of development which will disturb more than one acre of land. This term is used in the permit requirements to prevent land from being developed in many smaller phases to avoid the requirement of a permit.</i>
<b>complementary benefits</b>	<i>Not the primary intended benefit of an improvement or practice, but a secondary benefit of value.</i>
<b>concentrated flow</b>	<i>Where runoff is funneled to flow more rapidly in a narrow path.</i>
<b>conservation tillage</b>	<i>Practices that reduce that reduce disturbance of the soil or leave additional crop residue in fields to resist erosion.</i>
<b>constructed wetlands</b>	<i>Refer to Chapter 15 for details on best management practices. There are varieties of these to treat runoff from both urban and rural land uses.</i>
<b>contour planting</b>	<i>Planting crops so that rows are placed "on contour" or across the slope. Runoff is forced to run perpendicular to the rows, reducing flow velocities and reducing erosion.</i>
<b>cover crops</b>	<i>Refer to Chapter 15 for details on rural best management practices.</i>
<b>Des Moines Lobe</b>	<i>A section of the Wisconsin Glacier which pushed into what is Central Iowa today.</i>
<b>designated uses</b>	<i>An official category of public uses of a stream, as defined by the State. These may include items such as public recreation, fishing and water supply.</i>

<b>detention basins</b>	An urban BMP which reduces downstream runoff rates by having outlet controls which restrict flows to a certain level. The limited outflow rate forces water to build up within a depression or pond upstream, being stored or "detained" and released more slowly over an extended period of time.
<b>dewatering</b>	Removing water from a trench or other depression during construction, usually by pumping.
<b>dioxins</b>	A variety of highly toxic chemicals which is able to be absorbed by fatty tissue, able to remain present within the body of animals and humans for a long period of time.
<b>direct surface runoff</b>	Water that runs off the surface of the landscape without infiltrating into or percolating through soil or aggregate layers.
<b>discharge</b>	Stormwater that leaves a site and enters a pipe or surface water.
<b>disturbed areas</b>	An area of land where vegetation or other surface coverings are removed to accommodate grading or other construction related to urban land development.
<b>E.coli</b>	A species of bacteria that is commonly originates in the intestines of warm blooded animals. They may grow aggressively for a period of time in fecal matter, food or other media in the external environment. It is a fecal indicator bacteria currently used by the State to measure growth factors in the environment that would likely foster survival or growth of other pathogens (viruses and bacteria) which could pose risks to human health.
<b>easements</b>	A restriction placed on a piece of property which limits its use in favor of another purpose. For example, a drainage easement may restrict construction of structures, fences or other items which could prevent the safe flow of water through a drainage channel.
<b>edge of field</b>	A set of BMPs which are usually located along the boundaries between a field and a stream or other drainage outlet.
<b>ephemeral flow</b>	Channels or streams which only flow for hours or a few days after rainfall events or snowmelt.
<b>erodibility</b>	A soil property which indicates how likely a soil is to be eroded. Different soils have a coefficient assigned for this property that is used in the Revised Universal Soil Loss Equation to predict annual rates of soil erosion.
<b>erosion controls</b>	BMPs that are used to protect soil particles from being loosened from the surface of the ground by rainfall or concentrated flows.
<b>extended crop rotations OR extended rotations</b>	Adding alfalfa or other crops into a rotation of crops to rebuild organic matter in topsoil. Refer to Chapter 15 for rural best management practices.
<b>fecal coliform</b>	A species of bacteria that is commonly originates in the intestines of warm blooded animals. It is a fecal indicator bacteria which was formerly used by the State to measure growth factors in the environment that would likely foster survival or growth of other pathogens (viruses and bacteria) which could pose risks to human health.
<b>flood event</b>	A measure of stream flow related to a given level of rainfall, or a precipitation event which causes flow in a stream to exceed its banks and spread across into the adjacent low lying areas.
<b>flood protection elevations</b>	An established level where building structures must be placed above or have other protections in place to prevent damage from flooding.
<b>flood storage</b>	The volume available within a flood plain to temporarily store water.
<b>flow</b>	Water moving in a concentrated path.
<b>fluvial geomorphology</b>	The study of how stream conditions change over time.
<b>full establishment of vegetation</b>	A term used in Iowa's NPDES General Permit No. 2. When the desired permanent vegetation grows densely across all areas which were disturbed by construction, other than those areas covered by paving, structures or some other permanent stabilization technique.
<b>gage height</b>	The measured depth of flow above a set datum (base level) at a gaging station. At each station, the gage height at which flooding occurs is known.

<b>GIS databases</b>	Sets of information which include the location and properties of a variety of features which can be mapped using a given coordination system.
<b>GIS layers</b>	Groups of features of a similar type which can be mapped over each other on a similar coordinate system. Layers can be used to set how features such as parcels, land uses, utilities, roads, streams, etc. are displayed on maps.
<b>growing season</b>	The length of time where plants can grow, measured by consecutive frost-free days.
<b>headwaters</b>	The places where streams originate, or the furthest points from the mouth of the stream.
<b>high quality resource</b>	Waterbodies which have substantial recreational or ecological significance, requiring special protection.
<b>historic channel locations</b>	Places where streams used to flow, but have moved over time to flow along a parallel path.
<b>hydraulic</b>	Studies of the direction and velocity of moving water.
<b>hydric</b>	A soil that was historically saturated by water (either permanently or seasonally). These soils are used to determine where wetlands were most likely located in the past.
<b>hydrologic</b>	The study of the properties and movement of water across the surface of the earth.
<b>hydrologic soil group</b>	Soils are often grouped into four categories which measure the soils ability to infiltrate and percolate. Group A soils allow more free movement of water, while Group D soils offer more resistance to water movement.
<b>hypoxia</b>	A state of low dissolved oxygen levels in water, which can lead to the death of fish and other aquatic species.
<b>impaired waterway</b>	A waterbody which has poor water quality or other conditions which limits its ability to support its designated uses.
<b>impermeable</b>	A layer or feature that does not allow water to easily pass through it.
<b>impervious surface</b>	Buildings, pavement or other surface conditions which virtually eliminate water's ability to infiltrate into subsoil layers.
<b>individual development scale</b>	A stormwater BMP which is employed at a individual site or land development, usually having a smaller watershed area.
<b>in-field</b>	Rural BMPs which are applied within agricultural fields.
<b>infiltration</b>	Water entering the surface of the soil.
<b>inlet protection devices</b>	A BMP which is placed at the entrance to a culvert or storm sewer system to reduce the amount of sediment that is able to enter the pipe network.
<b>intermittent flow</b>	Streams which often have little or no flow for weeks or months at a time.
<b>inundation map</b>	A map that shows the area of land which will be covered by floodwaters for a given flood event.
<b>invasive species</b>	An animal or plant species with limited predators or other conditions that limit its reproduction. The species has the ability to grow rapidly to levels which negatively impact biodiversity by reducing habitat for other desirable species. Usually, invasive species are not native to the local environment.
<b>j-hooks</b>	Where sediment controls such as silt fences and wattles are turned upslope at the ends to increase the volume for water storage upstream of the control.
<b>key sources</b>	The primary land uses or areas where a type of pollution is expected to originate from.
<b>land subdivisions</b>	Areas of urban growth where larger parcels are subdivided into smaller parcels, usually involving the installation of streets and utilities to support construction of new buildings on the new parcels.
<b>living mulches</b>	Refer to Chapter 15 for details on rural best management practices.

<b>local design standards</b>	Requirements set by cities and counties to govern design of new developments.
<b>long term maintenance</b>	Maintenance requirements which are expected to occur at regular intervals for an indefinite period of time.
<b>low to medium density residential</b>	Single family homes or townhomes developments, usually less than 6 units per acre.
<b>manure management</b>	Plans required by the state to be developed for CAFOs for the storage, disposal or use of the manure wastes collected.
<b>maximum contaminate levels</b>	The highest concentration allowed of a certain pollutant to allow for a waterbody to support its designated uses.
<b>mean</b>	The average or the calculated middle value of a series of numbers.
<b>micro-watersheds</b>	The smallest divisions of drainage areas used by this plan, ranging from a few acres to about 250 acres in size.
<b>mitigate</b>	To offset the impact or effect of something. For example, wetland mitigation is done by creating additional new wetlands when others are lost.
<b>monitor OR monitoring</b>	Testing for water quality conditions by using test kits or by collecting samples for laboratory testing.
<b>monitoring program</b>	An detailed program to collect water quality data through monitoring and analyze the results. The program usually follows a QAPP to insure that data is collected accurately using consistent methods.
<b>neurological</b>	Related to the nervous system, including the brain, spine and the connecting nerves.
<b>nitrification inhibitors</b>	Chemicals that slow the conversion of fertilizer into nitrate.
<b>NOAA Atlas 14</b>	Updated tables of rainfall data that has been developed for most of the United States which was issued in 2013. Atlas 14, Volume 8 Version 2.0 includes data relevant to the State of Iowa.
<b>non-point source</b>	Pollutant sources that are distributed throughout the landscape, such as construction sites, most agricultural operations and urban developed areas.
<b>normal</b>	An average value over a more recent, defined period of time. For example, normal high temperatures are based on the average value for a given date or month over the most recent 30 years on record. Unless noted otherwise, the term normal used in this report refers to average values over the most recent 30-year period, ending in either 2014 or 2015.
<b>nutrient management plans</b>	A plan that defines how nutrient fertilizers are applied for agricultural operations. They include the location, schedule, application rate, chemical form and method of application.
<b>off-site tracking</b>	When sediments or other debris are carried by vehicle or equipment out of construction sites and are deposited on adjacent roadways or properties.
<b>outlot</b>	An open parcel of land that is not currently buildable, either reserved for future development or set aside as open space. Outlots are commonly used when a water feature or open space is held by either a public or private group to be used for the benefit of multiple land owners.
<b>pathogen indicator bacteria</b>	See FIB (fecal indicator bacteria).
<b>pathogens</b>	Items which can produce disease or infections such as various forms of viruses, bacteria, parasites and fungi.
<b>peer-reviewed</b>	Articles or studies which have been evaluated by experts in related fields for accuracy in the methods and procedures used to complete the work.
<b>percolation</b>	Water moving through void spaces in soils or other media.
<b>perennial flow</b>	Streams or rivers which will have continuous flow year round during periods of normal rainfall.

<b>perennial vegetation</b>	For the purposes of stormwater permitting, this refers to a desired mix of plant species which will grow back year after year. Temporary vegetation are grasses or other plants used for surface cover which typically only last one growing season.
<b>perimeter site controls</b>	Erosion or sediment controls placed near the boundaries of a construction site to prevent sediment from being washed or tracked onto adjacent properties or roadways.
<b>photosynthesis</b>	The process that plants use light to convert carbon dioxide and water into carbohydrates which they use to fuel their growth.
<b>point source</b>	A specific, individually regulated potential source of pollution, such as a wastewater treatment plant or confined animal feeding operation.
<b>pollutant concentration</b>	A measure of the amount of any pollutant present at any given time. Most chemical pollutants are measured by the weight present within a certain volume, such as milligrams per liter (mg/L). Biological concentrations may be in the most probable number of organisms (MPN) present in a certain volume, such as 100 milliliters (MPN / 100 mL).
<b>pollutant loading</b>	A total amount of a pollutant present in a stream over a set period of time, usually measured in units of weight (pounds, tons, etc.) Pollutant loading in streams is generally equal to pollutant concentration multiplied by the flow volume.
<b>pollutants of concern</b>	Chemicals, biological organisms, sediments or other factors that are known to be present at concentrations or volumes where they have a significant impact on stream functions, habitat, human health or the safety of people, private property or public infrastructure. Elements of this plan are specifically designed to address the pollutants of concern.
<b>pothole</b>	Shallow depressions located in flat areas below what was once covered by glaciers. These areas were most likely wetlands before they were drained by systems of tiles and ditches to improve agricultural production.
<b>precipitation</b>	Water falling from the sky in forms such as rain, snow, sleet or hail.
<b>pre-settlement</b>	Conditions that would have been expected prior to pioneer settlement which occurred in Iowa in the mid-1800s.
<b>priority impairments</b>	Impairments related to the largest sources of the key pollutants of concern identified within this study.
<b>publicly owned treatment works</b>	A facility owned by a city or other municipality for the treatment of wastewater (i.e. Dallas Center's Wastewater Treatment Plant).
<b>quality</b>	Managing for water quality means putting in place practices that reduce the presence of pollutants in any water discharged from a given site or area.
<b>quantity</b>	Managing for water quantity means using practices to reduce the volume or rate of flow being discharged from a given site or area.
<b>rate of runoff</b>	A measure of flow leaving a certain area, by volume over a certain period of time (such as cubic feet per second, or cfs).
<b>regional stormwater management</b>	Using larger scale practices to manage stormwater runoff for multiple properties or developments.
<b>regulatory 100-year flood plain</b>	Areas expected to be covered by floodwater during a 100-year flood (or a flood with 1% annual exceedance probability) as defined by flood rate insurance maps that are issued by FEMA.
<b>respiratory</b>	The system of organs in animals related to breathing.
<b>routed</b>	The method of passing larger flows through practices that have storage volume, such as ponds or detention basins. In analysis, comparison graphs are computed showing the inflow rate, outflow rate and the volume or depth of ponded (stored) water.
<b>row crop</b>	Agricultural products such as corn and soybean which are grown in rows.
<b>runoff volume</b>	The amount of runoff leaving a certain area measured in units of volume, such as cubic feet or acre-feet.
<b>sampling</b>	The process of testing for water quality by use of kits or collecting small volumes of water for laboratory testing.

<b>savanna</b>	An area where trees are present, but are spaced sufficiently so that light passes through the canopy to support grassland vegetation below.
<b>sediment basins</b>	In urban areas sediment basins are created by temporary excavations or dams which collect runoff from construction sites, allowing heavier suspended sediments to settle out of solution before the water is discharged. For rural settings, refer to Chapter 15 for details on rural best management practices.
<b>sediment controls</b>	BMPs that are used to capture soil particles which are suspended in stormwater runoff.
<b>setback</b>	A specified distance where structures or private property must be separated from a certain feature, such as a stream, utility, roadway or property line.
<b>short term maintenance</b>	Maintenance requirements which are expected to occur at regular or irregular intervals in the first few years after construction or establishment.
<b>silt fences</b>	A sediment control BMP which is an impermeable, synthetic fence stretched between metal posts used to capture runoff from construction sites so that sediment can settle out of solution upstream of the fence, preventing most of it from being washed off-site.
<b>single-family land development</b>	A subdivision of property into multiple parcels, each having only one dwelling unit which are not directly connected to any other dwelling unit.
<b>snapshot</b>	Water quality sampling events which are conducted only once or twice a year.
<b>soil logs</b>	A sediment control BMP which is a tube created by a netting or other synthetic material typically filled with compost, aggregate and seed. They are often installed along slopes to reduce the potential for erosion or with "J-hooks" to capture runoff and allow sediment to settle out on the upstream side. They can also be used along shoreline or edges of streams to establish vegetation and prevent erosion.
<b>source</b>	The area or land use where a key pollutant is expected to originate from.
<b>stabilized construction entrances</b>	A perimeter control where rock or gravel materials are used to remove sediment from the wheels of vehicles or equipment before they leave a construction site.
<b>stage-storage</b>	A graph, table or other relationship that shows the relationship between the water elevation in a practice and the volume of water that is being stored. These relationships are used in "routing" calculations.
<b>stop work orders</b>	A notice issued by a city or other enforcement agency used to stop any work on a construction site until proper pollution prevention best management practices are in place and in good working order.
<b>Strahler method</b>	A method of stream classification used to classify streams where headwater perennial stream are classified as first order. The confluence of two first order streams yields a second order stream. Where two second order streams meet, a third order stream is formed. Refer to Chapter 2 for more information.
<b>stream migration</b>	Patterns of stream movement over time.
<b>stream order</b>	A classification of streams into orders such as first, second, third, etc. based on the Strahler method. For this plan, significant paths of flow that were noted that have not been classified by the IDNR as first order or larger streams are referred to as "zero order" streams.
<b>subsurface tile drainage</b>	A system of perforated drains used to more rapidly drain groundwater from landscapes. Tile drainage systems have been used extensively in agricultural areas within the Walnut Creek Watershed as early as the late 1800s.
<b>subsurface water control</b>	Installing control structures that allow tile drainage flows to be stopped, released or diverted to another pipe.
<b>subwatersheds</b>	Larger divisions of drainage areas used by this plan. These areas vary greatly in size, but their average size is approximately 2.5 square miles (1600 acres).
<b>temporary sanitary facilities</b>	Portable restroom facilities used at construction sites or where more permanent restroom facilities are not available.

<b>temporary seeding and mulches</b>	An erosion control BMP where a fast growing temporary cover crop (such as rye or oats) or a mulch is used to reduce the potential for surface erosion.
<b>terracing</b>	Refer to Chapter 15 for details on rural best management practices.
<b>time of concentration</b>	The longest time it takes for runoff from a given area to travel from all the most distant points to the outlet (or another point of interest).
<b>topography</b>	The shape of the surface of the earth.
<b>TR-55</b>	A software program developed by the NRCS (originally as the Soil Conservation Service) that calculates the runoff volumes and rates of flow from small urban and rural watersheds.
<b>traditional stormwater management</b>	For the purpose of comparisons within this report, this term means management systems designed to capture runoff from a 100-year storm event and release it at peak rates that would be similar to those expected from a 5-year event under agricultural conditions. This assumes that such systems would be designed using techniques such as TR-55 and stage-storage routing.
<b>transpiration</b>	The process where water is moved from the roots, up through plants and evaporated into the air.
<b>travel times</b>	The time it takes surface runoff to pass from one point of interest to another.
<b>tributary</b>	A smaller stream which ultimately drains into a larger stream.
<b>typical flow curve</b>	For the purpose of this report, this term is defined as a graph of the normal stream flow expected for a given date, which has been calculated by finding the average flow for a 30-day period centered on a given date. For example, the average flow for January 15 is calculated by averaging flow observations that have been measured between January 1 and January 30. These values were calculated from flow observations at a USGS gaging station from October 1971 to August 2015.
<b>understory</b>	Smaller trees or shrubs which sometimes grow below the canopy of taller trees.
<b>water quality event</b>	A storm event of certain depth, where 90% of all events observed have been equal to or smaller. In Iowa, a water quality event has been established to be 1.25" in depth.
<b>water quality impairment</b>	When a pollutant is found to be in sufficient concentration through monitoring or other observations to have a significant negative effect on the designated uses of a waterbody.
<b>water quality modeling</b>	Computer calculations completed using software programs to predict pollutant loads and their sources.
<b>water quality standards</b>	Levels established by state or federal agencies that are allowed to be present in surface waters before the designated uses of waterbodies are negatively impacted.
<b>water quality volume</b>	One element of the Unified Sizing Criteria within the Iowa Stormwater Management Manual. Practices designed to address this element will capture runoff from a water quality event and use BMPs to treat this volume.
<b>watershed</b>	An area of land that drains to a common point of interest.
<b>watershed scale</b>	Practices that are applied across a broad area, or that are to be applied more broadly across all areas draining to Walnut Creek.
<b>wattles</b>	A sediment control BMP which is a tube created by a netting or other synthetic material filled with straw or mulch. They are typically installed along slopes to reduce the potential for erosion.
<b>wet detention ponds</b>	A pond which holds a permanent pool of water, which has space above to temporarily detain runoff after rainfall events.
<b>wetlands</b>	An area with hydric soils, which is permanently or seasonably saturated with water allowing the establishment of certain aquatic plants. Existing wetlands are protected by various environmental laws. Refer also to the definition of constructed wetlands.
<b>Wisconsin Glacier</b>	One of the most recent glaciers which extended across large parts of the upper Midwestern United States.



