The Auditor of the City and County of Denver is independently elected by the citizens of Denver. He is responsible for examining and evaluating the operations of City agencies for the purpose of ensuring the proper and efficient use of City resources and providing other audit services and information to City Council, the Mayor and the public to improve all aspects of Denver’s government. He also chairs the City’s Audit Committee.

The Audit Committee is chaired by the Auditor and consists of seven members. The Audit Committee assists the Auditor in his oversight responsibilities of the integrity of the City’s finances and operations, including the integrity of the City’s financial statements. The Audit Committee is structured in a manner that ensures the independent oversight of City operations, thereby enhancing citizen confidence and avoiding any appearance of a conflict of interest.

**Audit Committee**

- Dennis Gallagher, Chair
- Maurice Goodgaine
- Leslie Mitchell
- Rudolfo Payan
- Robert Bishop
- Jeffrey Hart
- Timothy O’Brien, Vice-Chair

**Audit Management**

- Kip Memmott, Director of Audit Services, MA, CGAP, CRMA
- John Carlson, Deputy Director, JD, MBA, CIA, CGAP, CRMA
- Audrey Donovan, Deputy Director, CIA, CGAP, CRMA

**Audit Staff**

- Chris Wedor, Internal Audit Supervisor, MBA
- Katja Freeman, Internal Auditor Supervisor, MA, MELP
- Manijeh Taherynia, Senior Internal Auditor, CPA, CFE, CRMA
- Torry J. van Slyke, Senior Internal Auditor

You can obtain copies of this report by contacting us at:

**Office of the Auditor**

201 West Colfax Avenue, Department 705 • Denver CO, 80202
(720) 913-5000 • Fax (720) 913-5247

Or download and view an electronic copy by visiting our website at:

[www.denvergov.org/auditor](http://www.denvergov.org/auditor)

*Report Number - A2014-18*
Jose Cornejo, Executive Director  
Department of Public Works  
City and County of Denver  

Dear Mr. Cornejo:

Attached is the Auditor’s Office Audit Services Division’s report of their audit of Stormwater Administration. The purpose of the audit was to determine whether activities carried out by the Department of Public Works (Public Works) satisfy water quality requirements of the City’s stormwater permit and applicable City policies and whether Public Works budgets and tracks activities related to the stormwater permit and other stormwater quality activities. Such tracking would enable Public Works to determine the true cost of these activities, improve financial planning, and increase transparency.

Overall, while the City and County of Denver does well in its pollution prevention program, we found that a lack of adequate data hinders Public Works from assessing the effectiveness of its efforts to decrease stormwater pollution. Further, we found that Public Works can improve management of the financial aspects of its stormwater quality programs and activities.

If you have any questions, please call Kip Memmott, Director of Audit Services, at 720-913-5000.

Sincerely,

Dennis J. Gallagher  
Auditor

cc: Honorable Michael Hancock, Mayor  
Honorable Members of City Council  
Members of Audit Committee  
Ms. Cary Kennedy, Deputy Mayor, Chief Financial Officer  
Ms. Janice Sinden, Chief of Staff  
Mr. David P. Edinger, Chief Performance Officer  
Ms. Beth Machann, Controller  
Mr. Scott Martinez, City Attorney  
Ms. Janna Young, City Council Executive Staff Director

To promote open, accountable, efficient and effective government by performing impartial reviews and other audit services that provide objective and useful information to improve decision making by management and the people.

We will monitor and report on recommendations and progress towards their implementation.
Mr. L. Michael Henry, Staff Director, Board of Ethics
Ms. Lesley Thomas, City Engineer
Mr. George Delaney, Chief Operating Officer
Mr. Reza Kazemian, Director of Wastewater Management Operations

To promote open, accountable, efficient and effective government by performing impartial reviews and other audit services that provide objective and useful information to improve decision making by management and the people.

We will monitor and report on recommendations and progress towards their implementation.
AUDITOR'S REPORT

We have completed an audit of Stormwater Administration as carried out by the Department of Public Works (Public Works) through the Wastewater Management Division (Wastewater). The purpose of the audit was to determine whether activities carried out by Public Works satisfy water quality requirements of the City's stormwater permit and applicable City policies and whether Public Works budgets and tracks activities related to the stormwater permit and other stormwater quality activities. Audit work was focused on regional and Citywide collaborative approaches to stormwater management that include identifying sources of water pollutants, assessing Wastewater's stormwater quality improvement actions from a compliance and best practices standpoint, the City's storm drainage fees, and water quality considerations in the design of City infrastructure projects.

This performance audit is authorized pursuant to the City and County of Denver Charter, Article V, Part 2, Section 1, General Powers and Duties of Auditor, and was conducted in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

The audit has two findings. First, we found that a lack of adequate data hinders Public Works from assessing the effectiveness of its efforts to decrease stormwater pollution. We believe that Public Works can improve its data collection and analysis with regard to stormwater pollution improvement programs to better analyze how much money is being spent on water quality related projects and whether those projects are sufficiently reducing water pollution levels. Second, we found that Public Works should improve its management of the financial aspects of its stormwater quality programs and activities.

We extend our appreciation to Public Works and Wastewater and the personnel who assisted and cooperated with us during the audit.

Audit Services Division

Kip Memmott, MA, CGAP, CRMA
Director of Audit Services

To promote open, accountable, efficient and effective government by performing impartial reviews and other audit services that provide objective and useful information to improve decision making by management and the people. We will monitor and report on recommendations and progress towards their implementation.
Background
The Wastewater Management Division (Wastewater) within the Department of Public Works (Public Works) was established in 1966 as an enterprise fund to provide storm and sanitary sewer services to the residents of Denver and charge for services provided. Wastewater maintains more than 1,500 miles of sanitary sewers and over 800 miles of storm drainage facilities. Wastewater plans, designs, constructs, operates, and maintains Denver's sanitary and storm sewer systems. Wastewater consists of three sections: Design Engineering, Operations, and Wastewater Administration. Wastewater employs 260 full-time equivalent staff and operates on a 2015 approved budget of $102 million.

Purpose
Audit work was focused on regional and Citywide collaborative approaches to stormwater management that include identifying sources of water pollutants, assessing Wastewater’s stormwater quality improvement actions from a compliance and best practices standpoint, reviewing the City’s storm drainage fees, and examining water quality considerations in the design of City infrastructure projects.

Highlights
The audit has two findings with regard to how the City approaches stormwater management.

Finding 1
Our first finding states that additional data analysis to assess effectiveness of BMPs is necessary to decrease stormwater pollution. We found that Wastewater has implemented best management practices (BMPs) to comply with the City’s National Pollutant Discharge Elimination System (NPDES) MS4 permit. Wastewater is now experimenting with additional BMPs to supplement the existing BMPs in an effort to reduce E. coli levels for certain priority water basins. Permit holders are required to routinely assess whether additional BMPs are necessary to stay in compliance or achieve compliance.

Finding 2
Our second finding determined that Public Works should improve management of the financial aspects of its stormwater quality programs and activities in four areas. First, using the Consumer Price Index for All Urban Consumers (CPI-U) as the basis for storm drainage rate increases is not aligned with the intention of storm drainage service charges. Second, expenditures of the MS4 program and water quality activities are not comprehensively tracked. Third, funding for stormwater quality related projects is limited. Fourth, Public Works lacks data supporting stormwater quality impacts of certain wastewater expenditures.
# TABLE OF CONTENTS

**INTRODUCTION & BACKGROUND**
- Stormwater and Storm Drainage Systems 1
- Denver Wastewater Management Division 2
- Storm Drainage Master Plan 4
- Regulatory Framework and the City’s MS4 Permit 4
- Other City and Outside Entities Impacting with Stormwater Management 6
- Benefits of Reducing Stormwater Pollution 8
- Storm Drainage Fees 12
- Storm Drainage System Funding Sources and Expenditures 14

**SCOPE**

**OBJECTIVE**

**METHODOLOGY**

**FINDING 1**
- Additional Data Analysis To Assess Effectiveness of BMPs is Necessary To Decrease Stormwater Pollution 18
  - City’s MS4 Permit Program 18
- Public Works Should Improve Its Data Collection, Monitoring, and Analysis 24

**RECOMMENDATIONS**

**FINDING 2**
- The Department of Public Works’ Management of the Financial Aspects of Its Stormwater Quality Programs and Activities Should Be Improved 28

**RECOMMENDATIONS**

**APPENDIX A**
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glossary</td>
<td>35</td>
</tr>
<tr>
<td>APPENDIX B</td>
<td>38</td>
</tr>
<tr>
<td>Examples of Stormwater Best Management Practices (BMPs)</td>
<td>38</td>
</tr>
<tr>
<td>APPENDIX C</td>
<td>40</td>
</tr>
<tr>
<td>Audit Stormwater Management Benchmarking Summary</td>
<td>40</td>
</tr>
<tr>
<td>AGENCY RESPONSE</td>
<td>41</td>
</tr>
</tbody>
</table>
INTRODUCTION & BACKGROUND

Stormwater and Storm Drainage Systems

Stormwater consists of surface waters derived from rain and snow melt. When a parcel of land is undeveloped, most stormwater soaks into the land’s soil and is naturally infiltrated before reaching streams and rivers. Land development creates impervious surfaces that cannot readily absorb stormwater, inducing a high volume of stormwater runoff and limiting stormwater infiltration. Examples of impervious surfaces are paved or concrete areas and rooftops. Stormwater drainage systems are built to carry stormwater runoff and prevent flooding; these systems may vary in design from a small residential dry well to a large municipal system.

Sanitary Sewer and Storm Drainage Systems

A sanitary sewer system is a system of underground pipes carrying sewage from bathrooms, sinks, kitchens, and other plumbing components to a wastewater treatment plant where the sewage is filtered, treated, and discharged. A storm drainage system is designed to carry rainfall runoff and other drainage through underground pipes or open ditches into local streams, rivers, and other surface water bodies. Approximately 772 cities in the United States have combined sewer systems (CSS) that collect and convey domestic sewage, stormwater runoff, and industrial wastewater in the same system. Most of the time, a CSS transports wastewater to a sewage treatment plant where it is treated before being discharged into a waterbody. However, during periods of heavy rainfall or snowmelt, the wastewater volume in a CSS might exceed the capacity of the system or the treatment plant causing combined sewer overflows (CSOs). CSOs that contain untreated human and industrial waste, toxic materials, and debris might mandate a discharge of excess untreated wastewater directly to nearby streams, rivers, and other water bodies, causing water pollution. The United States Environmental Protection Agency (EPA) has developed policies and guidance on how communities with CSOs can reach the water quality goals mandated by the federal Clean Water Act. As a result of the strict standards in the Clean Water Act, many cities with a CSS have started separating their sanitary and stormwater systems.

1 Infiltration is the process by which water on the ground surface enters the soil. Infiltration rate in soil science is a measure of the rate at which soil is able to absorb rainfall or irrigation.
2 A dry well is a small, excavated pit filled with stone or gravel that temporarily stores stormwater runoff until it soaks into the surrounding soil.
In other areas of the United States, including Colorado and the City and County of Denver, sanitary and stormwater sewers have been designed and built as separate systems. The main stormwater pollution risk associated with having separate systems arises from the fact that stormwater generally does not run through a treatment facility. Therefore, it is harder to keep the pollutants from getting into streams and other water bodies once they are part of the stormwater.

**Flood Prevention**

Effective stormwater management offers the following benefits:

- Protection of wetlands and ecosystems
- Improved water quality of streams, rivers, and other water bodies
- Protection of water resources
- Protection of public health
- Flood control

As witnessed in 2013, the greater Denver area occasionally experiences flooding of streets and low-lying areas during large, infrequent storms, which require flood control detention. Stormwater treatment and flood prevention can both be achieved through a coordinated design approach, according to the City’s 2004 Water Quality Management Plan. For example, it states that in cases where an extended detention basin, retention pond, wetland basin, or sand filter basin is used to address stormwater quality, any of these basins can be modified to include flood control detention in the zone above the water quality capture volume.

**Denver Wastewater Management Division**

The City’s Wastewater Management Division (Wastewater) within the Department of Public Works (Public Works) was established in 1966 as an enterprise fund to provide storm and sanitary sewer services to the residents of Denver. Wastewater maintains more than 1,500 miles of sanitary sewers and over 800 miles of storm drainage

---


7 These terms are defined in the glossary in Appendix A.
facilities. Wastewater plans, designs, constructs, operates, and maintains Denver's sanitary and storm sewer systems. Wastewater consists of three sections: Design Engineering, Operations, and Wastewater Administration. Wastewater employs 260 full-time equivalent staff and operates on a 2015 approved budget of approximately $102 million.

**Design Engineering** - Wastewater's Design Engineering Section is responsible for the design of all sanitary sewer improvements and storm drainage facilities within the City’s public right-of-way. Specific section responsibilities include drainage problem investigation, design solutions, contract administration, and preparation of standard construction drawings and specifications.

**Operations** - The Wastewater Operations Section maintains and operates the City's sanitary and storm systems by monitoring, cleaning, repairing, rehabilitating, and reconstructing system components. The Operations Section includes the following groups that make up the broader Section:

- **Engineering Support and Water Quality** - This group, commonly referred to as the National Pollutant Discharge Elimination System (NPDES) program team, is primarily responsible for compliance with the City's stormwater permit, construction site compliance, and water quality within the City’s storm sewers. Additionally, the team performs operation engineering tasks and manages flood emergency cases.

- **Television and Quality Control** - This group is responsible for televising storm and sanitary sewers to identify deficiencies within City sewer mains. The group also televises all new construction for proper installations prior to public sewer acceptance. The quality control element of the group investigates issues such as cross connections or broken taps to reduce bacterial numbers in the storm sewer system and waterways.

- **System Maintenance** - This group is responsible for preventative maintenance of more than 1,500 miles of sanitary and 800 miles of storm sewers and all manholes and catch basins within the City and County of Denver.

- **Construction Operations** - The Construction Operations group is tasked with the repair of existing sewer lines and installation of new pipes as needed.

- **Laboratory and Sampling** - The Laboratory and Sampling group provides analysis needed to meet the regulatory requirements of the City's stormwater permit. The laboratory element of the group also provides analytical services for industrial waste customers, the Department of Environmental Health (DEH), and the Denver Zoo as well as consulting services to industries that may deposit industrial loadings into the sanitary sewer. Laboratory also conducts environmental studies to reduce bacterial numbers and detect illicit discharges within the storm sewer system. The Sampling element of the group

---

8 Drainage facilities are man-made structures or natural waterways for conveyance of storm runoff. Some examples of these facilities are storm sewers, detention and water quality ponds, channels, gulches, pipes, and ditches.
collects samples from outfalls in conjunction with the City stormwater permit requirements.

- **Wastewater Customer and Support Service** - The Wastewater Customer Service group is responsible for measuring the impervious surfaces of land parcels located within the City and County of Denver through aerial photography and field inspections and billing customers accordingly for annual storm drainage charges. The Customer Service group also responds to all sanitary and storm billing inquiries. The Wastewater Support Service group manages the Wastewater building, the motor pool, and the Central Platte Campus, which is shared by Wastewater and a few other divisions of Public Works.

**Administration** - Wastewater Administration encompasses multiple functions including agency purchasing, human resources and technology support, financial management, budgeting, and accounting services.

**Storm Drainage Master Plan**

In accordance with the provisions of the Denver Revised Municipal Code (D.R.M.C.), Public Works is required to develop a master drainage plan for the City. The purpose of the master plan, commonly referred to as the Denver Storm Drainage Master Plan, is to set forth the location and design of all storm drainage facilities within the City, including those which presently exist, and those which are planned to be constructed in the future. The plan, which according to the D.R.M.C. should be updated at least every five years, is intended to:

- Present the general data and information needed to understand the relationship between rainfall and storm runoff
- Form the basis for the development of construction priorities, budgets, and long-range plans for financing storm drainage system maintenance and operations
- Provide additional engineering bases to support financing the required new and expanded storm drainage facilities
- Furnish additional supportive data to establish fees and charges required to provide funding for system construction, operations, and maintenance needs

**Regulatory Framework and the City’s MS4 Permit**

Compliance with water quality standards, such as the federal Clean Water Act, is achieved through the MS4/NPDES stormwater permit, commonly referred to as the

---

9 Monthly sanitary bills are sent with water bills to Denver customers through monthly bills from Denver Water.
10 D.R.M.C. § 56-110.
11 Ibid.
12 Ibid.
MS4 permit. The EPA mandates that discharges from regulated municipal separate storm sewer systems (MS4s) must be addressed under the NPDES program, and delegate’s implementation authority to the State of Colorado.

The Colorado Department of Public Health and Environment’s (CDPHE’s) Water Quality Control Division enforces statewide stormwater regulations, to which all municipalities in Colorado are subject. These regulations require that specific MS4s obtain a Colorado Discharge Permit System (CDPS) permit. The City has a Phase 1 permit, which is issued for medium- and large-sized municipalities with populations greater than 100,000 inhabitants.

In 2011, the City’s MS4 consisted of 775 miles of main line pipe, 559 siphon sets, 21,316 catch basins, 32 detention ponds, and 134 miles of ditches and channels. The requirements under the City’s MS4 permit are implemented by Wastewater. Program Implementation requires coordination with other Public Works divisions such as Engineering, Capital Project Management, Street Maintenance, Fleet Management, and Solid Waste Management. Additionally, Wastewater management works together with other agencies such as DEH, CDPHE, the Urban Drainage and Flood Control District (UDFCD), the Denver Fire Department, and local hazmat teams.

To remain in compliance with the permit, a permittee is required to decrease the discharge of pollutants from its MS4 to the maximum extent practicable, to protect water quality standards, and to satisfy the applicable water quality requirements of the Colorado Water Quality Control Act and the Colorado Discharge Permit Regulations through the development and implementation of a CDPS Stormwater Management Program. When implementing the CDPS Stormwater Management Program, the permittee must utilize a range of Best Management Practices (BMPs) to reduce the discharge of pollutants from the MS4. The regulating agency, the CDPHE, issues the MS4 permit and monitors permittee compliance.

Remaining in compliance with the MS4 permit requires implementing a set of BMPs that aim to reduce E. coli levels. The City has implemented the EPA’s pollution standard for E. coli in its 2020 Sustainability Goals, emphasizing the City’s goal to implement the E. coli reduction requirements of the MS4 permit for the South Platte

---

13 MS4 stands for a conveyance or system that is owned by a state, city, town, village, or other public entity that discharges to U.S. waters. The system or conveyance must be used to collect stormwater (including storm drains, pipes, ditches etc.), is not a combined sewer and is not part of a sewage plant.

14 5 C.C.R. § 1002-61.

15 The Colorado Water Quality Control Act is located at C.R.S. § 25-8-101 et. seq.

16 E. coli, or Escherichia coli, is bacteria commonly found in the intestines of people and animals. Most E. coli strains are harmless but some can cause food poisoning.
River and provide a safe environment for recreational water activities for Denver’s citizens.17

The federal Clean Water Act states that MS4 discharge permits may be issued for a five-year period; however, the compliance period is ten years. The difference is the result of the EPA wanting to grant flexibility to permit holders when working to meet pollution thresholds. However, this longer compliance period also presents some challenges for addressing mitigation and compliance for specific permits.

The City’s MS4 permit expired on February 28, 2014, and CDPHE has not yet renewed the permit. Due to changes to MS4 permits for smaller jurisdictions, the agency is experiencing a backlog of permits for issuance. Successful renewal of the City’s permit is anticipated to take place by 2016; CDPHE has extended the City’s current permit until renewal is complete.

Other City and Outside Entities Impacting Stormwater Management

In addition to Wastewater’s involvement with stormwater, several other Public Works divisions, City departments, and outside entities perform activities that impact stormwater quality within the City. These entities include the UDFCD; the Public Works Policy, Planning and Sustainability Section; the Public Works Street Maintenance Division; the Public Works Solid Waste Division; DEH; the Department of Parks and Recreation (Parks); and the City Attorney’s Office.

Urban Drainage and Flood Control District – UDFCD was created as a special district by the Colorado legislature in 1969 to assist local governments within the Denver metropolitan area with drainage and flood control challenges and activities across multiple jurisdictions.18 UDFCD, funded through property taxes mill levies, encompasses an area of more than 1,600 square miles, including the City and County of Denver, parts of Denver’s six surrounding counties, and all or parts of thirty-two cities and towns. UDFCD activities are carried out by four programs:

- Master Planning
- Design, Construction and Maintenance
- Floodplain Management
- Information Services and Flood Warning

One of the focus areas of the UDFCD Master Planning program is to fund and oversee special projects pertaining to development of criteria and technical information for stormwater quality and quantity BMPs.19 Audit inquiries indicated that the City, along with a few other local jurisdictions, has worked with UDFCD on a number of these special projects that are fully or partially funded by UDFCD, with

---

18 For more information on UDFCD, see: http://www.udfcd.org/index.html.
remaining funds provided by local jurisdictions such as the City and occasionally by federal grants.

**Public Works Policy, Planning and Sustainability Section** - In 2013, in an effort to coordinate Citywide water quality efforts, Public Works created and filled a position entitled Project Manager for Water Quality within the existing Policy, Planning and Sustainability Section. This position spearheads the Water Quality Taskforce established by Public Works consisting of representatives from Public Works Capital Projects; the Department of Community Planning and Development, Development Services; DEH; and Parks. Additionally, the Project Manager for Water Quality coordinates the water quality efforts of the Wastewater NPDES team and manages Public Works' outside consultant who works on water quality related projects. Additionally, the Project Manager for Water Quality is currently jointly developing a green infrastructure manual with UDFCD. This manual is expected to serve as guidance for implementation of stormwater quality infrastructure, such as planters and tree trenches, in the highly urbanized areas of the City.

**Public Works Street Maintenance Division** - A number of activities carried out by the Public Works Street Maintenance Division impact stormwater quality. These activities include street sweeping, snow removal, and alley improvements. As discussed in more detail later in this report, based on the presumed impacts on stormwater quality, the Wastewater Enterprise Fund regularly reimburses certain percentages of the costs associated with these activities to the City's general fund.20

**Public Works Solid Waste Management Division** - Under the requirements of the MS4 permit, the Public Works Solid Waste Management Division is responsible for removing illegal dumping, collecting household hazardous waste, and enforcing compliance with the permit requirements related to illegal dumping and illicit discharges.21

**Department of Environmental Health** - The Water Quality Program within DEH's Environmental Quality Division regularly monitors the quality of water in Denver's streams and lakes. These activities involve year-round monitoring of streams and annual sampling of water from lakes to measure the amount of E. coli and other water pollutants. The results of the monitoring are published in the reports generated for compliance purposes and public information and awareness. Additionally, an individual from the Water Quality Program participates in the City's Water Quality Taskforce and contributes to the Engineering, Regulatory, and Analytics (ERA) group by reviewing for water quality-related matters in City capital projects.22 Furthermore,

---

20 These reimbursements were established based on a 2005 memorandum from the Manager of Public Works to the Mayor. For more information, see “Wastewater Enterprise Fund Performance Audit,” City and County of Denver Auditor’s Office, March 2010, www.denvergov.org/auditor/DenverAuditor/AuditReports/tabid/443012/Default.aspx.

21 Illegal dumping refers to the disposal of certain items in solid waste bins for regular pick-up that cannot be handled by Public Works' fleet of waste disposal trucks. These items are typically large and must be removed by a special truck, arranged through a large-item pick-up. Examples include furniture, televisions, and construction materials. Hazardous waste includes, but is not limited to, latex paint, antifreeze, motor oil, car batteries, CFL bulbs, expired medications, and household batteries.

22 ERA is responsible for performing regulatory plan review and approvals for all proposed design and construction activities that are planned to occur in the City's right-of-way. For example, when a Department of Parks and Recreation or a Public Works project is in the design phase, it is placed on a City shared information systems drive and an email notice is
this individual provides expert feedback to Public Works regarding the water quality management plan, and to the City as a whole for any City policy affecting water quality.

**Department of Parks and Recreation** - Parks is responsible for maintaining nearly 20,000 acres of urban parks and mountain parkland with approximately 6,000 acres of traditional parks, parkways, and urban natural areas located within the boundaries of the City. Parks implements water quality BMPs based on available funding sources. Parks’ Natural Area and Open Space Planner participates in the Water Quality Task Force and the ERA group. Parks also implements water quality projects in partnership with Wastewater in City parks mainly using Wastewater funds or occasionally grants.

**City Attorney’s Office** - The City Attorney’s Office (CAO) handles all legal aspects of the City’s regulatory requirements pertaining to the MS4 permit, including interactions and negotiations with regulatory bodies such as CDPHE. Additionally, CAO is involved in drafting any changes to the stormwater provisions of the D.R.M.C.

**Benefits of Reducing Stormwater Pollution**

Colorado’s climate, water shortage in the West, increasing urbanization of the Denver metropolitan area, and general public health concerns make stormwater pollution prevention an especially important policy area for the City. BMPs in stormwater pollution management have shifted to reducing volumes of stormwater rather than only focusing on treating stormwater.

**Colorado’s Climate** - The greater Denver metropolitan area is characterized as a semi-arid continental climate with cold, dry winters and cool, relatively dry summers. Low levels of precipitation and humidity in the region create particular challenges to stormwater pollutant reduction. Annual precipitation averages approximately sixteen inches with more than two-thirds of the precipitation taking place between April and September. On average, seventy-five storm events take place in Denver every year. Of those, typically seven storm events are considered large events with precipitation levels greater than 0.5 inches. These larger events are characterized by short-duration, high intensity rain showers that have the potential to overwhelm the existing stormwater drainage infrastructure for several hours.

---

Infrequent rainfalls allow the accumulation of pollutants on streets, which are then washed in high concentrations into water streams along with rainfall. Initial surface run-off from a rain storm contains higher concentrations of pollution than the remainder of the storm event. This so-called “first-flush phenomenon” poses additional challenges to increasing the quality of stormwater in the Denver area. In many parts of Colorado, the incidents of run-off events have increased due to the decrease in permeable surface area caused by rapidly evolving urbanization. As a result, areas that virtually never experienced run-off events are now being affected.24

**Water Shortage in the West** - Certain areas in Colorado experience water shortages, primarily affecting the agricultural sector. For example, the Draft Colorado Water Plan, which was prepared by the Colorado Water Conservation Board for the State of Colorado, addresses a supply gap in the South Platte River and encourages studies on additional municipal water conservation of water available for reuse, additional municipal water reuse in relation to water available for exchanges and reuse, and successive uses of water downstream including effects on agricultural water shortages.25 The plan further recommends conservation efforts, reuse, and drought management plans to include environmental and recreational aspects.

Colorado’s semi-arid climate, tendency towards water shortage, increasing urbanization, and general public health concerns heighten the importance of stormwater policy in the Denver area.

**Increasing Urbanization** - As communicated in the Draft Colorado Water Plan, the State of Colorado will experience many changes over the next thirty years with potential consequences for regional and state water management.26 As the population and economy increase and affect land use, water quantity will decrease due to amplified demand and water quality will experience even more stressors such as increased urban and industrial run-off.

The 2004 Water Quality Management Plan mentions the effects of urbanization on volumes of run-off. Before an area is developed, most of the rain that falls on the ground is absorbed into the soil or captured by vegetation. However, once an area is developed, rain that falls onto roofs or pavement mostly runs off. As a result, peaks and volumes of run-off are much greater after development, which can cause erosion in stream systems, increased sedimentation, decreased native wildlife, increased flooding, and generate greater pollutant loads downstream.

**Stormwater Prevention** - In wastewater management, a shift has taken place from diluting stormwater and moving it as quickly and as far as possible from the sources to...
the next waterbody.\textsuperscript{27} Currently, BMPs recommend reducing stormwater before it travels to the next water stream.\textsuperscript{28} Once pollutants are present in a waterbody affecting the physical makeup and habitat of a watershed, it is more difficult and expensive to repair the damage and restore the system. Reducing volumes of urban run-off to the maximum extent possible to more closely match natural conditions is considered one of the most effective stormwater quality BMPs. The Water Quality Plan mentions the following techniques for reducing the amount of stormwater:\textsuperscript{29}

- Instead of routing stormwater run-off from pavement to inlets to storm sewers to offsite pipes or concrete channels, BMPs recommend directing run-off to contact landscape areas, which will slow down the movement of stormwater and promote infiltration.
- BMPs recommend breaking up areas of imperviousness and directing run-offs from roofs and paved areas to grass buffers, swales, and other landscape areas prior to being conveyed off the site.\textsuperscript{30}
- The less impervious area that exists on a site, the less run-off from a site will occur, resulting in a smaller required water quality capture volume. For example, smaller street sections or porous pavement in fire access lanes, parking lanes, and driveways will reduce the total site imperviousness.
- Porous landscape detention, porous pavement detention, and sand filter detention promote greater volume reduction than extended detention basins, since run-off tends to be absorbed into the filter media or infiltrate into underlying soils.

\textbf{E. coli Contamination of Denver Streams} – According to literature in the field, the main sources of contamination of water bodies with E. coli are as follows:

- Sanitary sources
- Urban wildlife and domesticated animals
- Environmental sources

The 2013 Water Quality Update created by DEH includes information about supported uses of the greater Denver metropolitan area’s streams.\textsuperscript{31} Table 1 shows

\begin{itemize}
\item Best Management Practices, or BMPs, in this context describe types of water pollution control. BMPs for stormwater management are techniques, measures, or structural controls that are intended to manage the quantity of stormwater pollution and increase the quality of stormwater run-off.
\item See Appendix A for a glossary of terms.
\end{itemize}
major streams in the area and what types of uses are and are not supported based on levels of E. coli and other potential contaminants.

**Table 1**

<table>
<thead>
<tr>
<th>Stream</th>
<th>Aquatic Life</th>
<th>Recreation</th>
<th>Water Supply</th>
<th>Crops &amp; Livestock</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Platte River</td>
<td>Yes</td>
<td>No (E. coli)</td>
<td>No (Arsenic)</td>
<td>Yes</td>
</tr>
<tr>
<td>South Platte Tributaries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bear Creek</td>
<td>No (Habitat)</td>
<td>No (E. coli)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lakewood, Weir, Sanderson, Harvard West, and Harvard Gulches and Westerly</td>
<td>No (Selenium)</td>
<td>No (E. coli)</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Cherry Creek</td>
<td>No (Selenium and Iron)</td>
<td>No (E. coli)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Cherry Creek Tributaries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goldsmith Gulch</td>
<td>No (Selenium)</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Sand Creek</td>
<td>Not Sampled</td>
<td>Not Sampled</td>
<td>N/A</td>
<td>Not Sampled</td>
</tr>
</tbody>
</table>

**Source:** City and County of Denver, Department of Environmental Health, Water Quality Update, 2013.

According to the Centers for Disease Control and Prevention (CDC), *Escherichia coli* (E. coli) bacteria normally live in the intestines of people and animals. Most E. coli are harmless and actually are an important part of a healthy human intestinal tract. However, some E. coli are pathogenic, meaning they can cause illness; some strains of E. coli can cause diarrhea, while others cause urinary tract infections, respiratory

---

illness and pneumonia, and other illnesses. The types of E. coli that can cause diarrhea can be transmitted through contaminated water or food, or through contact with animals or persons.\(^{32}\)

Public health officials have used E. coli levels as markers for some time to measure levels of fecal contamination of recreational water bodies. The federal Clean Water Act directs the EPA to establish criteria for water quality and promulgate a threshold for E. coli and other pollutants that can be discharged into water bodies.\(^{33}\) Those levels are then imposed by states as water quality standards and must be approved by the EPA. When pollutants such as E. coli surpass levels as specified in an MS4 permit, the stream or lake is considered impaired. As a result, this status requires a series of clean-up actions as determined by the applicable MS4 permit.

The EPA uses fecal indicator bacteria (FIB), such as E. coli, enterococci, or fecal coliform, rather than pathogens to measure water quality because FIB are easier to detect and measure in water quality samples than a large variety of pathogens in human and animal feces.\(^{34}\) However, levels of E. coli alone do not indicate whether swimming, wading, or boating in a waterbody will make an individual sick. It is the existence of pathogens such as norovirus, cryptosporidium, or a pathogenic strain of E. coli that will result in illness, especially in young children, the elderly, and people with compromised immune systems.

E. coli levels are used as an approximation since they indicate that a waterbody is contaminated with other pollutants. E. coli can survive in environments for a long period of time and can therefore give the false impression that a water stream only recently was contaminated. The EPA updated its Recreational Water Quality Criteria in 2012 and conducted several epidemiological studies to analyze new health and water quality data. The studies helped the EPA to reaffirm that enterococcus and E. coli are associated with gastrointestinal diseases and that E. coli should be used as a measure of recreational water quality due the absence of a better indicator.

**Storm Drainage Fees**

In accordance with the D.R.M.C., storm drainage service charges are due and collected based on impervious surface area on every lot or parcel of land within the City.\(^{35}\) The annual charges, first collected in 1981, are to be spent on the operation, maintenance, replacement, and improvement of the existing and future City storm

---


\(^{33}\) 33 U.S.C. § 304 (a) (1).


\(^{35}\) D.R.M.C. § 56-112.
36 Drainage facilities. Wastewater Customer Service bills and collects these service charges, which are based on the relative impact of each property on the storm drainage, determined by the size of impervious surfaces on the property. For instance, a parking lot will direct more storm runoff to the storm system than a grassy area of the same size. Impervious surfaces on each property are primarily captured using GIS (aerial) images followed by Wastewater site inspections. The square footage of these surfaces is measured using Wastewater GIS tools and applications. Once the impervious surface area in a City property or on a City lot is measured, storm drainage charges are calculated using the following steps:

1. The ratio of the impervious surface area in the property or on the lot to the total property or parcel area is calculated, which can be any number between zero and one.
2. Based upon the calculated ratio, the property or lot is assigned to a ratio group and each ratio group is assigned a base rate per one-hundred square feet of impervious surface area.
3. The total number of one-hundred square feet of impervious surface areas in the property or on the lot is multiplied by the base rate to arrive at the storm drainage charges due and billed annually to the property or lot owner.

The current City storm drainage base rates for each 100 square feet of impervious surface area in or on a City property or lot for the different ratio groups are shown in Table 2. For example, in a property measuring a total of 7,500 square feet with impervious surface area of 2,750 square feet, the ratio of the impervious surface area to the total property area will be 36.6 percent. Storm drainage base rate for this property will be $3.31 and annual storm drainage fees for the property will amount to $91.03.
Table 2
Denver Storm Drainage Base Rate Schedule

<table>
<thead>
<tr>
<th>Ratio Group *</th>
<th>Rate of Charge (per 100 Square Feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7/1/2014 - 6/30/2015</td>
</tr>
<tr>
<td>0-.10</td>
<td>$1.85</td>
</tr>
<tr>
<td>.11-.20</td>
<td>$2.31</td>
</tr>
<tr>
<td>.21-.30</td>
<td>$2.80</td>
</tr>
<tr>
<td>.31-.40</td>
<td>$3.31</td>
</tr>
<tr>
<td>.41-.50</td>
<td>$3.78</td>
</tr>
<tr>
<td>.51-.60</td>
<td>$4.04</td>
</tr>
<tr>
<td>.61-.70</td>
<td>$4.29</td>
</tr>
<tr>
<td>.71-.80</td>
<td>$4.77</td>
</tr>
<tr>
<td>.81-.90</td>
<td>$5.25</td>
</tr>
<tr>
<td>.91-1.00</td>
<td>$5.76</td>
</tr>
<tr>
<td>Minimum Annual Charge (All Ratio Groups)</td>
<td>$13.17</td>
</tr>
</tbody>
</table>

Source: Table was constructed by audit team using data from Wastewater Website. *Ratio = Total Impervious Area/Parcel Area

Storm Drainage System Funding Sources and Expenditures

Wastewater is responsible for billing over 160,000 customers for monthly sanitary sewer and annual storm drainage charges. Revenues generated from storm drainage and sanitary sewer charges are accounted for separately in the sanitary sewer fund and the storm drainage fund, collectively making up the Wastewater Management Enterprise Fund. However, the D.R.M.C. allows monies derived from sanitary sewer charges to be used to fund a portion of the operation and maintenance costs of the storm drainage system. Likewise, a portion of the proceeds from storm drainage fees can be used to pay for the sanitary sewer system’s operating and maintenance costs. The D.R.M.C. provisions justify this cross spending based on the beneficial impacts of the operations and maintenance of each system on the other. Table 3 illustrates revenues generated by the storm drainage fees for the years 2010 through 2013.

---

Table 3
Storm Drainage Charges Revenue

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Revenue</th>
<th>Percent Revenue Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>$29,806,256</td>
<td>N/A</td>
</tr>
<tr>
<td>2011</td>
<td>$31,464,231</td>
<td>5.6%</td>
</tr>
<tr>
<td>2012</td>
<td>$36,596,860</td>
<td>16.3%</td>
</tr>
<tr>
<td>2013</td>
<td>$37,871,321</td>
<td>3.5%</td>
</tr>
</tbody>
</table>

**Source:** Wastewater Management Enterprise Fund Financial Statements and Independent Auditor's Report, December 31, 2013, 2012, 2011, and 2010. Percent increases were calculated by the audit team.

In addition to the storm drainage service charges, Wastewater periodically issues revenue bonds secured by the revenues generated from sanitary sewer and storm drainage charges. A portion of the proceeds from the latest series of bonds issued in 2012 were dedicated to rehabilitation, maintenance, and construction projects of the City’s storm drainage system, as shown in Table 4.

Table 4
Wastewater 2012 Series Revenue Bonds Dedicated to Storm Drainage System

<table>
<thead>
<tr>
<th>Period Ending</th>
<th>Remaining Bond Proceeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/31/2012</td>
<td>$32,500,000</td>
</tr>
<tr>
<td>12/31/2012</td>
<td>$28,816,760</td>
</tr>
<tr>
<td>12/31/2013</td>
<td>$18,283,337</td>
</tr>
<tr>
<td>11/30/2014</td>
<td>$4,592,010</td>
</tr>
</tbody>
</table>

**Source:** Information obtained by audit team from the City’s shared P-drive.

Table 5 shows expenditures for the City’s storm drainage system for the years 2011 through 2013. Since the D.R.M.C. allows for cross spending of the sanitary sewer and the storm drainage funds, the operating and maintenance expenditures shown in Table 5 reflect some of the expenditures reallocated from the sanitary sewer fund to the storm drainage fund using estimates. Capital expenditures are partially funded by revenue bonds.

---

39 All Wastewater personnel and utility expenses are paid by the sanitary sewer fund. For internal cost tracking purposes, an estimated portion of these expenditures are annually reallocated to the storm drainage fund.
<table>
<thead>
<tr>
<th>Expenditures</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating and Maintenance</td>
<td>$28,466,949</td>
<td>$29,161,864</td>
<td>$32,904,525</td>
</tr>
<tr>
<td>Capital</td>
<td>$27,555,103</td>
<td>$13,286,323</td>
<td>$18,415,624</td>
</tr>
<tr>
<td>Totals</td>
<td>$56,022,052</td>
<td>$42,448,187</td>
<td>$51,320,149</td>
</tr>
</tbody>
</table>

Source: Department of Public Works.
SCOPE

The audit was focused on assessing the regional and Citywide collaborative approaches to stormwater management that included: Identifying sources of water pollutants, assessing Wastewater stormwater quality improvement actions from compliance and best practices standpoint, reviewing storm drainage fees, and examining water quality in the design of City projects.

OBJECTIVE

The objective of the audit was to determine:

- Whether Public Works’ activities satisfy water quality requirements of the City’s MS4 permit and applicable City policies
- Whether Public Works budgets and tracks MS4 permit and other stormwater quality activities to determine the costs of these activities for the City to improve financial planning and increase transparency

METHODOLOGY

To achieve the audit objectives, the audit team utilized several methodologies including but not limited to:

- Reviewing applicable City, state, and federal rules and regulations and internal policies and procedures
- Reviewing applicable contracts and plans, including an analysis of how Public Works incorporates and translates goals from the 2004 Water Quality Management Plan into actual projects
- Reviewing applicable stormwater permits and pertinent requirements
- Reviewing relevant internal and external audits and reviews
- Interviewing staff and personnel at Public Works, other relevant City agencies, and relevant external entities as well as experts in the field as necessary
- Reviewing the City’s stormwater fee structure
- Analyzing reports of revenue and expenditure accounts for trends regarding stormwater quality-related activities
- Analyzing current and past capital projects to determine criteria used with regard to stormwater quality
- Contacting comparable jurisdictions for information regarding stormwater fees, water quality best management practices, and funding allocated for stormwater pollution improvement programs
- Researching how the water quality goals from the City’s 2020 Sustainability Goals are translated into Public Works projects
FINDING 1

Additional Data Analysis to Assess Effectiveness of BMPs is Necessary to Decrease Stormwater Pollution

Our audit found that the City’s Wastewater Management Division (Wastewater) within the Department of Public Works (Public Works) has implemented best management practices (BMPs) to comply with the City’s National Pollutant Discharge Elimination System (NPDES) MS4 permit.40 Wastewater is now experimenting with additional BMPs to supplement the existing BMPs in an effort to reduce E. coli levels for certain priority basins.41 The MS4 permit mandates the assessment of the effectiveness of BMPs used to remain in compliance, and permit holders are required to assess whether additional BMPs are necessary to stay in compliance or achieve compliance. Moreover, the City and Public Works have demonstrated their commitment to reducing E. coli levels and providing a safe recreational environment for users of Denver’s streams. Therefore, we believe that Wastewater would benefit from assessing the effectiveness of all BMPs currently in use to assist with the management of Denver’s stormwater. Such an assessment would require better data collection and analysis to determine where specifically its resources are being spent on water-quality-related initiatives and what kinds of returns those resources are yielding.

City’s MS4 Permit Program

Remaining in compliance with the City’s MS4 permit requires a wide range of efforts that serve to reduce the volume of stormwater and decrease pollutants in stormwater that makes its way into the City’s water bodies. Wastewater conducts dry weather monitoring to collect data on E. coli levels in accordance with the E. coli monitoring plan.42 This monitoring plan is part of Segment 14 of the South Platte River in the MS4 permit.43 Additional requirements for the South Platte River include the implementation of best management practices with regard to the system maintenance program, storm sewer markers and education and outreach. Part I.D. of the MS4 permit demands the continuation of a wet weather monitoring program to assess wet weather conditions, particularly the effects of urban stormwater on state waters.44 Denver, Aurora, Lakewood, and the Urban Drainage and Flood Control District have partnered to fund five metro-area monitoring stations in the

40 “MS4” refers to a municipal separate storm sewer system, which is regulated by the federal Environmental Protection Agency.
41 E. coli, or Escherichia coli, is bacteria commonly found in the intestines of people and animals. Most E. coli strains are harmless but some can cause food poisoning.
42 Dry weather means that flow is largely composed of non-storm water. Dry weather flows may contain oil and other fluids from cars, detergent, and dirt from car washing, litter, fertilizer and pesticides.
43 Segment 14 of the South Platte River is the mainstream of the South Platte River from Bowles Avenue in Arapahoe County to the Burlington Ditch in Diversion in the City and County of Denver.
44 Wet weather discharges primarily occur as the direct result of precipitation events.
South Platte River that collect data during storm events. A private consulting firm collects and analyzes the data.

The City’s MS4 program includes the following areas and associated responsibilities:

- Commercial/Residential Management Program
  - Maintenance of structural controls such as periodic sediment, trash, and debris removal from detention facilities and major drainage ways
  - New development planning procedures to address stormwater runoff from new developments or redevelopments of one acre or greater
  - Assessment of the impacts of flood management programs and associated projects on water quality

- Illicit Discharge Detection and Elimination Program\(^45\)
  - On-going field screenings
  - Prevention of illicit discharges and improper disposal
  - Investigation of suspected illicit discharges
  - Procedures to prevent, contain, and respond to spills
  - Educational activities to promote public reporting of illicit discharges and improper disposal
  - Public education activities to promote proper management and disposal of toxic materials
  - Household chemical waste collection programs
  - Control of sanitary sewer seepage into the municipal storm sewer system

- Construction Sites Run-Off Control Program

- Post-Construction Stormwater Management in New Development and Redevelopment

- Pollution Prevention/Good Housekeeping for Municipal Operations

- Stormwater monitoring requirements specifically applying to Segment 14 of the South Platte River
  - Dry weather monitoring E. coli Control Plan\(^46\)
  - System Maintenance Program
  - Storm sewer markers
  - Education and outreach

\(^{45}\) The City has the authority to eliminate illicit discharges within its MS4 system through the Denver Revised Municipal Code, sections 56-102, 56-107, 49-555, and 49-558.

\(^{46}\) This plan has been approved by the State of Colorado to monitor E. coli levels for discharges along the South Platte River, Segment 14, which has a designated Total Maximum Daily Load (TMDL). The City has identified “outfalls of concern” as part of the monitoring effort, which are monitored four times per year. The geometric mean for E. coli levels within discharges should not exceed waste allocations of 126 colony forming units per 100 milliliters (126 cfu/100 ml).
The goal of the MS4 permit is to reduce the discharge of pollutants from municipal separate storm sewer systems to the maximum extent practicable under the Colorado Water Quality Control Act. MEP is the standard used to determine the level of pollutant reductions that the MS4 permit holder must achieve through implementing BMPs. The Colorado Department of Public Health and Environment (CDPHE), which issues the MS4 permit in Colorado, has purposefully not further specified what MEP means to leave maximum flexibility in MS4 permitting. According to MS4 permit language, implementation of BMPs consistent with the provisions of the Colorado Discharge Permit System (CDPS) Stormwater Management Program and the other requirements in the permit constitutes compliance with the standard of reducing pollutants to the maximum extent practicable. However, if it becomes apparent that existing BMPs are not sufficient to protect water quality standards, Wastewater may request modification of the program requirements to reduce E. coli and receive approval from CDPHE.

Several City employees praised Wastewater for its efforts in maintaining the existing stormwater infrastructure, and a third-party audit from 2013 noted network cleaning rates exceeding current industry best practices. Such efforts contribute to low overflow rates, which positively affects Denver’s wastewater customers. The third-party audit further observed a significant improvement of Wastewater’s activities over the last ten years related to cleaning and rehabilitating a wastewater and stormwater system that had historically been neglected. The operational review by a third party determined that both the wastewater and stormwater networks are in excellent condition and free of major sediment build-up or blockage.

The goal of the MS4 permit is for the permittee to reduce the discharge of pollutants from their municipal separate storm sewer system, or MS4, to the maximum extent practicable (MEP) to protect water quality standards and to satisfy the appropriate water quality requirements of the Colorado Water Quality Control Act. MEP is the standard used to determine the level of pollutant reductions that the MS4 permit holder must achieve through implementing BMPs. The Colorado Department of Public Health and Environment (CDPHE), which issues the MS4 permit in Colorado, has purposefully not further specified what MEP means to leave maximum flexibility in MS4 permitting. According to MS4 permit language, implementation of BMPs consistent with the provisions of the Colorado Discharge Permit System (CDPS) Stormwater Management Program and the other requirements in the permit constitutes compliance with the standard of reducing pollutants to the maximum extent practicable. However, if it becomes apparent that existing BMPs are not sufficient to protect water quality standards, Wastewater may request modification of the program requirements to reduce E. coli and receive approval from CDPHE.

Several City employees praised Wastewater for its efforts in maintaining the existing stormwater infrastructure, and a third-party audit from 2013 noted network cleaning rates exceeding current industry best practices. Such efforts contribute to low overflow rates, which positively affects Denver’s wastewater customers. The third-party audit further observed a significant improvement of Wastewater’s activities over the last ten years related to cleaning and rehabilitating a wastewater and stormwater system that had historically been neglected. The operational review by a third party determined that both the wastewater and stormwater networks are in excellent condition and free of major sediment build-up or blockage.

According to a third-party expert, the City’s wastewater and stormwater networks are both in excellent condition and free of major sediment build-up or blockage.

---

47 The Colorado Water Quality Control Act is located at § 25-8-101 et seq., C.R.S. For further information on the rationale on stormwater discharges associated with municipal separate storm sewer systems (MS4s), see General Permit in Colorado, Colorado Discharge Permit Number COR-090000, III.A
48 City and County of Denver MS4 permit, “Authorization to Discharge Under the Colorado Discharge Permit System,” Permit No. COS-000001.
49 Part I.B.1. f (5) of the permit requires the permittee to develop new programs as necessary so that dry weather discharges from the MS4 permit do not contribute to an exceedance of the E. coli standard. An annual analysis is required as mentioned in Part I.B.1(f)(1)(b) to assess the success of programs and BMPs being implemented to control sources of E. coli, and determine the need for additional programs and/or BMPs.
50 Veolia Water, Operations Review, November 2013. The objective of the operations review was to examine core operational activities of the Denver Wastewater Management Division, such as to identify areas of strengths and areas for improvement.
**Current Structural BMPs** - Wastewater utilizes the following structural BMP types, which are promoted by the Urban Drainage and Flood Control District (UDFCD) Manual Volume 3 as BMPs:51

- Grass buffer
- Grass swale
- Bioretention (rain garden or porous landscape detention)
- Green roof
- Extended detention basin
- Sand filter
- Retention pond
- Constructed wetland pond
- Constructed wetland channel
- Permeable pavements

Photos of the BMPs implemented by Wastewater can be found in Appendix B.

**Current Non-Structural BMPs** - In addition to structural BMPs, Wastewater has employed some non-structural BMPs to remain in compliance with the City’s MS4 permit. Specifically, the Division organized an education and outreach program for more than 900 school children titled “Keep It Clean Neighborhood Environmental Trios” (KIC-NET), which is a joint effort with the Environmental Protection Agency’s (EPA’s) Region 8 and a non-profit organization. The program is designed to teach children about water pollution and how to identify and possibly even solve water quality issues in their communities, and was named Best New Program by the Colorado Alliance for Environmental Education.

Another example of a non-structural BMP is the City’s street sweeping operations, which are 50-percent funded through Wastewater and stormwater policies and regulations.52

**Future Compliance Efforts** - The City’s current MS4 permit has been active for six years, and Wastewater is currently working on the following efforts to further improve the City’s stormwater management:

- Wastewater will soon implement a three-year strategic action plan for E. coli that incorporates alternative E. coli clean-up strategies. A draft of this action plan will likely have been released by the middle of January 2015 and should

---

51 For definitions of these BMPs, see Appendix A.
receive final approval by Public Works senior management in March 2015. Part of the strategic plan will be to evaluate whether BMPs have been effective in reducing E. coli levels in area streams and in the South Platte River.

- The Water Quality Manager will update the Denver 2004 Water Quality Management Plan, likely by August 2015. The updated plan will propose approaches that will help to reduce levels of E. coli and other pollutants such as phosphorous and nitrogen.
- The City’s Water Quality Manager in partnership with UDFCD is working on a final version of a “Green Infrastructure Manual.”
- An external consultant will develop a tool box of remedial strategies for dry weather E. coli flows. The consultant will analyze what has been done on the national level and internally and will create, together with Wastewater personnel, a catalogue of BMPs and associated costs for implementation for use by Wastewater.
- Wastewater has recently started pilot studies on alternative methods of infiltrating dry weather water. Such pilot studies might include constructing an infiltration green structure at a basin that discharges into the South Platte River after the dry weather water is put through a newly built infiltration structure. The infrastructure consists of filtering-sand that not only filters based on physical aspects but also has the capability to break E. coli cell membranes and sanitize water without the use of chemicals. The findings from the pilot studies will help to determine whether Wastewater should build small models like those at the basins of other outfalls. The technical as well as the economic aspects of the pilot studies will be analyzed for feasibility on a broader scale.

In Comparison: E. coli Pollution in Swimming Pools and Swim Beaches - When trying to understand what contamination with a pathogen in E. coli from a recreational waterbody means for public health, a comparison with swimming pools, swim beaches, and drinking water standards may provide some perspective.

A study published by the Centers for Disease Control found that 70 percent of public pools contained evidence of E. coli bacteria, which is commonly found in stool. 49 percent of pools in private clubs were contaminated with E. coli, as were 66 percent of water parks. The State of Colorado considers water quality at swim beaches to be safe for swimming when E. coli levels are less than 235 colonies/100 ml. Pollutants

53 The manual is meant to provide guidance to public and private developers on incorporating green infrastructure into their projects.
54 A dry weather E. coli flow is a measurement of E. coli at least forty-eight hours after a rain event.
such as selenium, iron, and arsenic are not considered to be a health risk for swimmers, waders, or boaters. However, arsenic can pose a risk when detected in drinking water. As a comparison, drinking water should not exceed more than 5 percent of samples that test coliform positive. Denver Water has tested for Giardia, Cryptosporidium, and E. coli in its water for more than twenty years but has not found those microorganisms in its treated water. Occasionally, these microorganisms are found in source waters but are effectively eradicated in treatment plants.

**Current E. coli Levels in Denver’s Stormwater** - The City’s MS4 permit sets the standard for E. coli pollution in the South Platte River in Denver at 126 cfu/100 ml based on water standards as promulgated by the EPA. We reviewed a report that Wastewater released using data from July through October 2014, generated by measuring E. coli pollutants during dry weather periods at twelve outfall measurement stations. Of the measured outfalls in the report, seven are considered major. Six of the major outfalls hold priority status, meaning that these outfalls are treated with urgency and that Wastewater is implementing additional BMPs to reduce pollution based on the measured E. coli levels. Additional or alternative BMPs in this context mean that the agency is implementing additional measures like using natural filtration methods or using specific sand for filtration that is capable of lowering E. coli levels.

The City as the permit holder is required to conduct an annual analysis of available data on E. coli densities in the MS4 and Segment 14 of the South Platte River, and review the implementation of permit requirements. The annual analysis will assess the permittee’s process towards reducing E. coli densities in dry weather discharges from the MS4 to 126 cfu per 100ml or less. Moreover, the analysis will also analyze the need for implementation of additional programs and BMPs in accordance with Part I.B.1.f (5) of the permit. With regard to the system maintenance program, the storm sewer markers, and education and outreach requirements, the City has until November 2018 to implement additional BMPs and programs to reduce end-of-pipe dry weather discharges of E. coli, to the extent necessary, so that, by the end of the compliance period, results from all monitoring conducted in accordance with the permit do not exceed an E. coli density of 126 cfu/100 ml for a geometric mean of all samples collected at a specific outfall in a thirty-day period.

---


59 An outfall is every point where a conveyance of the City’s stormwater system discharges into a stream, lake, or river.

60 This means that the pipes of these outfalls are larger than thirty-six inches and the basin is larger than fifty acres.

61 According to the report, during the measured time period, outfalls with priority status have seen spikes in E. coli pollution that can range up to 3,800 cfu/100 ml during an average period, and a geometric mean of up to 1,042 cfu/100 ml. Cfu/100 ml stands for colony forming units per 100 ml and is the measurement for a bacterial unit.

62 Colorado Discharge Permit, Part I.B.1.f (1) (b). Dry weather discharge refers to discharge taking place at least 48 hours after a rain event.

63 Colorado Discharge Permit, Part I.B.f (5).
Public Works Should Improve Its Data Collection, Monitoring, and Analysis

Overall, Wastewater does a great deal to protect the water quality of the City’s streams and rivers through its MS4 permit compliance efforts and is effective at maintaining the City's stormwater infrastructure. Wastewater also has plans to do even more to improve the City's stormwater management, much of which relates to managing E. coli levels. However, E. coli poses a unique set of challenges compared to other pollutants because removing the source of E. coli does not necessarily remove the pollutant quickly. Due to the challenge of removing E. coli, it is important that Wastewater improve its data collection, monitoring, and analysis activities to determine which BMPs yield higher success rates in terms of effectiveness and economy compared to others. Moreover, Wastewater should consider exploring BMPs that reduce both E. coli and other pollutants such as phosphorus and nitrogen.

Generally, if the source of a pollutant is taken away, the pollutant will disappear as well. However, with E. coli, when the source of a microorganism is taken away, it may take considerable time to see the positive impact of the reduction or removal of the microorganism. Currently, Wastewater is monitoring the effectiveness of an additional E. coli-related BMP at one of the City’s larger outfalls. To know how well its efforts are or are not working, Wastewater should monitor the effectiveness and efficiency of all BMPs that are implemented to reach compliance for priority outfalls.

According to Part I.C of the MS4 permit, Wastewater has to conduct an annual review of the current programs in addition to the annual review that is required for Segment 14, Part I.B.(f)(5). For that, an assessment of the effectiveness of controls established by the program has to be developed and an assessment of any program modifications needed.

With regard to BMPs that are part of the E. coli monitoring plan, Wastewater cannot explain which BMPs are more successful than others due to the size of the data sets, in particular, before the implementation of the BMPs took place. Moreover, some cleaning efforts have taken place in the priority basins prior to the City tracking maintenance data. In addition, BMP implementation is ongoing and may therefore affect the analysis.

Due to limited data collection and analysis, Wastewater has not been able to identify the main sources of E. coli responsible for spikes in Denver’s streams. When asked why this type of monitoring is not occurring, a Wastewater representative explained that the agency does not have the resources to monitor and track exact sources of E. coli and other pathogens.

Wastewater has closely monitored maintenance and other activities associated with its stormwater infrastructure. Further, for compliance purposes, the Division must show...
that their efforts have reduced pollutants to the “maximum extent practicable.” That means for compliance with the MS4 permit, they have to show the program they have designed meets the written requirements in the permit.

We believe that increased monitoring and analyzing activities would help Wastewater to pursue more effective and economically feasible BMPs and discontinue the usage of those that are less effective and economical feasible. Moreover, data analysis should help Wastewater determine whether a BMP is helpful in reducing pollutants at a specific site. The International Stormwater BMP Database analysis protocols used for conventional water chemistry analysis pay specific attention to effluent concentrations achieved by different BMPs and recommends asking questions such as: Is the BMP helping to protect water quality? How is the BMP performing on this specific site? What factors are different in comparison to another site? Due to the unique challenges that E. coli poses, it is possible that a BMP works in one area but not another. Without tracking and analyzing relevant data, it is difficult for Wastewater to make informed decisions about which BMPs are successful and which are not and possibly need replacement or supplementation.

Increased data collection, monitoring, and analysis will also help Wastewater pursue one of the strategies laid out in the Mayor’s 2014 Budget: “to define and carry out excellent water quality practices as put forth by various water quality initiatives and best management practices to provide a safe living environment.”

In addition, the Public Works Strategic Action Plan, SMART Denver, provides a framework of goals, objectives, and actions for Public Works. It also outlines outcomes the Department expects to accomplish during 2014 and 2015. The plan mentions three goals pertaining to water quality, air quality, and waste. The goal affecting water quality pursues a citywide water quality program to promote sustainability.

One of the objectives explaining how the goal is to be reached specifically addresses reducing E. coli levels in dry weather discharges in eight priority outfalls through investigation and development of innovative BMPs. The strategy specified in the 2014 budget, SMART Denver, and the City’s 2020 Sustainability Goals that apply to providing a safe swimming and recreational environment in the South Platte River collectively demonstrate the City’s commitment to water quality improvement.

---


66 The City confirms its support of E. coli standards as mandated in the MS4 permit, which can be seen its water quality related 2020 Sustainability Goals. Available at: https://www.denvergov.org/sustainability/OfficeofSustainability/2020SustainabilityGoals/tabid/445247/Default.aspx.
In accordance with the City’s MS4 permit, Wastewater has until November 2018 to implement additional BMPs if the existing BMPs fail to reduce E. coli levels as mandated in the MS4 permit according to federal Clean Water Act requirements. For Wastewater to determine what additional BMPs need to be implemented to achieve compliance for specific priority outfalls, it is necessary for the Division to assess whether currently used BMPs help or fail to achieve sufficient pollutant level reductions.

Non-compliance with mandated MS4 permit requirements can lead to consent decrees with substantial fines as witnessed in the case of Baltimore. A more recent case example is Los Angeles. These examples provide further incentives to strive for the exploration of innovative BMPs to continue the positive performance of the City.

With regard to a possible future inclusion of other pollutants in the MS4 permit, the Water Quality Control Commission of CDPHE adopted a new section for surface water to regulate nutrients such as phosphorus, nitrogen, and chlorophyll a in 2013. The Commission has not determined yet if these values should be implemented for any specific waterbodies. It is unknown at this point how these new standards for phosphorous, nitrogen, and chlorophyll a will affect the City. However, Wastewater should consider taking a pro-active stance towards monitoring levels of additional pollutants in Denver’s water bodies.

---


68 Natural Resources Defense Council v. County of Los Angeles, Los Angeles County Flood Control District, 725 F.3d 1194.

RECOMMENDATIONS

1.1 **Best Management Practices** - Public Works should monitor and assess the effectiveness and economy of its current and additional best management practices in reducing levels of E. coli and possibly other pollutants to improve stormwater quality and assess the need for additional funding.
FINDING 2

The Department of Public Works’ Management of the Financial Aspects of Its Stormwater Quality Programs and Activities Should Be Improved

We found that the Department of Public Works’ (Public Works’) management of the financial aspects of its stormwater quality programs and activities should be improved in four areas. First, the adoption of the Consumer Price Index for All Urban Consumers (CPI-U) as the basis for storm drainage rate increases is not aligned with the intention of storm drainage service charges.70 Second, expenditures of the MS4 program and water quality activities are not comprehensively tracked.71 Third, funding for stormwater quality related projects is limited. Fourth, Public Works lacks data supporting stormwater quality impacts of certain wastewater expenditures.

Using the Consumer Price Index as the Basis for Storm Drainage Rate Increases Is Not Aligned with the Intention of Storm Drainage Service Charges

The Denver Revised Municipal Code (D.R.M.C.) stipulates that storm drainage service charges are to fund the operation, maintenance, replacement, and improvement of existing and future City storm drainage facilities.72 However, the most recent storm drainage rate increase, which took effect July 1, 2014, is based on changes in the CPI-U, rather than the analysis of the cost of Wastewater Management Division (Wastewater) activities.

Rate Calculations and Historical Rate Increases

Impervious surface area in a property or on a lot is the primary determinant of the property or lot’s impact on the City’s storm drainage system and a main factor in calculating storm drainage fees due from the property or lot owner. Based on the ratio of the square footage of these surfaces to a property’s total square footage, the property is assigned to one of ten ratio groups with a pre-set storm drainage base rate (base rate) per each one-hundred square feet of impervious surface area. Table 2 in the Introduction and Background of this report shows the current base rates charged to the City’s storm drainage customers based on their ratio group.

Since 1989, storm drainage base rates have increased sporadically, ranging from annually to every five years until July 1, 2011. The rate increases during that period

---


71 “MS4” refers to a municipal separate storm sewer system, which is regulated by the federal Environmental Protection Agency.

72 D.R.M.C. § 56-112.
ranged from 6.6 percent to 38 percent. Table 6 depicts the historical trend of base rate increases. Beginning July 1, 2011, rate increases occurred annually at 20 percent in 2011 and 2 percent in both 2012 and 2013. Beginning July 1, 2014, the annual rate increase was based on the changes from the previous year in the CPI-U, amounting to a 3-percent increase effective July 1, 2014, as shown in Table 6. In accordance with D.R.M.C. provisions, the annual CPI-U-based changes of storm drainage rates will continue annually.

Table 6
Historical Increases of Storm Drainage Base Rates

<table>
<thead>
<tr>
<th>Effective date</th>
<th>Percent Increase</th>
<th>Lowest rate / 100 sq. ft</th>
<th>Highest rate / 100 sq. ft</th>
<th>Minimum Annual Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/1981</td>
<td>n/a</td>
<td>$0.37</td>
<td>$1.17</td>
<td>$3.70</td>
</tr>
<tr>
<td>1/1/1989</td>
<td>6.6%</td>
<td>$0.56</td>
<td>$1.76</td>
<td>$3.70</td>
</tr>
<tr>
<td>1/1/1992</td>
<td>19%</td>
<td>$0.56</td>
<td>$1.76</td>
<td>$3.70</td>
</tr>
<tr>
<td>1/1/1997</td>
<td>7%</td>
<td>$0.60</td>
<td>$1.88</td>
<td>$3.96</td>
</tr>
<tr>
<td>1/1/2002</td>
<td>38%</td>
<td>$0.83</td>
<td>$2.59</td>
<td>$10.26</td>
</tr>
<tr>
<td>1/1/2003</td>
<td>20%</td>
<td>$1.00</td>
<td>$3.11</td>
<td>$10.26</td>
</tr>
<tr>
<td>1/1/2004</td>
<td>20%</td>
<td>$1.20</td>
<td>$3.73</td>
<td>$10.26</td>
</tr>
<tr>
<td>1/1/2006</td>
<td>20%</td>
<td>$1.44</td>
<td>$4.48</td>
<td>$10.26</td>
</tr>
<tr>
<td>7/1/2011</td>
<td>20%</td>
<td>$1.73</td>
<td>$5.38</td>
<td>$12.31</td>
</tr>
<tr>
<td>7/1/2012</td>
<td>2%</td>
<td>$1.76</td>
<td>$5.49</td>
<td>$12.56</td>
</tr>
<tr>
<td>7/1/2013</td>
<td>2%</td>
<td>$1.80</td>
<td>$5.60</td>
<td>$12.81</td>
</tr>
<tr>
<td>7/1/2014</td>
<td>3%</td>
<td>$1.85</td>
<td>$5.76</td>
<td>$13.17</td>
</tr>
</tbody>
</table>

Source: Wastewater Management Division.

Our benchmarking showed that the Denver storm drainage fees are lower than similar charges in three other similar municipalities, including the City of Fort Collins, the City of Portland, and the City of Minneapolis. Two of these cities, Minneapolis and Portland, provide some discount in their charges as an incentive to customers who reduce volume and improve quality of stormwater discharged from their property. The complete results of our benchmarking contacts and study are shown in Appendix C. All three of these benchmark municipalities use projected stormwater management expenditures as the basis for any storm drainage fee increases in contrast to Denver, which uses the CPI-U.73

Public Works and the City’s Budget and Management Office (BMO) have engaged an outside consultant to study Wastewater’s capital and operating needs and

---

develop a financial plan to address these needs. According to BMO, the financial plan will include the review of another potential sanitary and/or storm drainage rate increase. However, as of the date of the issuance of this report, the audit team has not received any additional information about the outcome of this study. We recommend that Public Works ensure that any rate increases are supported by the operational, maintenance, and capital needs of the storm drainage system.

Expenditures of the MS4 Program and Water Quality Activities Are Not Comprehensively Tracked By Public Works

Audit work determined that Public Works does not centrally track the cost of the overall City MS4 program and stormwater quality activities. The funding and expenditures related to these activities are spread across several Public Works and Wastewater sections. Expenditures by section are not labeled and tracked as the funding and costs associated with the MS4 program and/or stormwater quality.

Within the Wastewater Operations Section, the Engineering Support and Water Quality team, or the National Pollutant Discharge Elimination System (NPDES) team, have the primary responsibility for the MS4 program and related stormwater quality improvement activities. However, other units within Wastewater also perform activities that directly impact stormwater quality, and consequently MS4 permit compliance. Specifically, the Wastewater units other than the NPDES team and their activities directly impacting stormwater quality include:

- The System Maintenance group, which performs routine cleaning and preventive maintenance of storm sewers
- The Construction Crew, which builds pilot best management practice (BMP) structures for the MS4 program and stormwater quality
- The Wastewater Laboratory, which performs water quality sampling analysis

Wastewater NPDES management personnel indicated that there is some limited tracking of personnel resources spent on the stormwater quality activities carried out by the System Maintenance and the Construction groups.

Public Works' Manager for Water Quality within the Policy, Planning and Sustainability Section separately tracks funding and expenditures for that position's activities, which are funded through several sources such as the Wastewater Enterprise Fund, the City Capital Improvement Program, and grants. Additionally, the Wastewater Enterprise Fund partially reimburses the costs of certain activities performed by Public Works Street Maintenance based on the ground that these activities improve stormwater quality.

---

Multiple units within Wastewater perform activities that directly impact stormwater quality, however, the cost for these activities are not tracked.

---

74 Other units within the Wastewater Operations Section with activities indirectly impacting stormwater quality are not included in this discussion. An example of these units is the Television and Quality Control group that uses televised, live data to repair sanitary leakage.
quality, among other benefits to the City’s storm drainage systems. Moreover, Wastewater reimburses the Solid Waste Management Division for the cost of collection of hazardous material because of its impact on stormwater quality.

Since each of the units described have an internal budget and perform expenditure tracking for the unit, it cannot be readily determined whether adequate funding and resources are being dedicated to the City’s MS4 program. During an Environmental Protection Agency (EPA) inspection of the City’s Phase I of MS4 permit compliance in November 2012, Public Works was unable to readily provide the documentation of estimated budget and funding for the City MS4 program upon the EPA inspector’s request. Rather, this information was provided later in Public Works’ response to the EPA inspection report.

Therefore, it is critical that Public Works comprehensively track the costs of all the activities with a direct impact on the MS4 program and stormwater quality activities to ensure timeliness and adequacy of the dedicated funding and resources to the program and its activities.

Funding for Stormwater Quality Related Projects Is Limited

Our review showed that Public Works does not have a dedicated source of funding for the pilot BMPs for improving stormwater quality. According to Wastewater NPDES personnel, these projects are funded through ad hoc sources such as a small amount of funding set aside by Wastewater Operations for research and development, funding available through savings in the other Wastewater Operations units, or grants when available. Additionally, these personnel noted that with the increase in the number of the BMPs, the need for maintenance of these structures and costs of such maintenance will increase, requiring additional dedicated funding.

Furthermore, audit work determined that stormwater quality projects performed by the Public Works Manager for Water Quality, under Public Works Policy, Planning and Sustainability, do not have a dedicated budget and so far have been funded through the City’s Capital Improvement funding, sources outside of Public Works, and grants. These water quality improvement projects are important because they not only help the City prepare for potentially more stringent MS4 requirements related to water quality, but they are also consistent with the Public Works Strategic Plan, referred to as SMART Denver. Further, our benchmarking showed that Fort Collins and Portland have dedicated funding for their stormwater quality initiatives. Therefore, it is important that Public Works ensures stormwater quality projects receive the necessary funding.

75 These reimbursements were established based on a 2005 memorandum from the Manager of Public Works to the Mayor. For more information, see “Wastewater Enterprise Fund Performance Audit,” City and County of Denver Auditor’s Office, November 2010, www.denvergov.org/auditor/DenverAuditor/AuditServices/AuditReports/tabid/443012/Default.aspx.


77 Specifically, auditors found that there is no dedicated funding source for additional BMPs that would be used to further reduce E. coli levels.

78 Wastewater is exploring additional BMPs to further reduce E. Coli levels according to MS4 permit requirements.
Public Works Lacks Data Supporting Stormwater Quality Impacts of Certain Wastewater Expenditures

The Wastewater Enterprise Fund partially reimburses the Public Works' Street Maintenance Division (SMD) for certain activities. The reimbursements and their associated percentages were established in a memo from the Manager of Public Works to the Mayor in October 2005. The memo specified that the costs of three SMD activities, including street sweeping, snow removal and paving unimproved alleys, should be partially reimbursed by the Storm Drainage Fund based on the beneficial impact of these activities on the City's storm drainage system, including but not limited to the improvement of stormwater quality. Percentages of reimbursement by Wastewater set forth in the memo were street sweeping at 50 percent, alley improvements at 50 percent, and snow removal at 25 percent.

In addition to the SMD activities included in the 2005 memo, Wastewater reimburses SMD for 15 percent of the costs of hauling construction debris and 24 percent of the hauling equipment costs, again on the basis of benefits to the storm drainage system. Table 7 shows the SMD activity costs from 2011 through 2013 charged to and reimbursed by Wastewater.

---

79 The Auditor’s Office’s 2010 performance audit of the Wastewater Enterprise Fund recommended that Public Works compile more documentation supporting the costs allocated to Wastewater based on the 2005 memo if such documents are lawfully requested. See "Wastewater Enterprise Fund Performance Audit," City and County of Denver Auditor’s Office, November 2010, www.denvergov.org/auditor/DenverAuditor/AuditServices/AuditReports/tabid/443012/Default.aspx. While Public Works executive management at the time agreed with audit recommendation, subsequent audit follow-up determined that Public Works did not implement the audit recommendation.
### Table 7
Street Maintenance Division Costs Reimbursed by Wastewater

<table>
<thead>
<tr>
<th>Street Maintenance Activity</th>
<th>Percent Charged to Wastewater</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alley Paving/Grading</td>
<td>50%</td>
<td>$528,062</td>
<td>$490,515</td>
<td>$136,767</td>
</tr>
<tr>
<td>Street Sweeping</td>
<td>50%</td>
<td>$2,361,626</td>
<td>$2,594,627</td>
<td>$2,559,944</td>
</tr>
<tr>
<td>Snow Removal</td>
<td>25%</td>
<td>$1,359,149</td>
<td>$1,216,888</td>
<td>$1,528,955</td>
</tr>
<tr>
<td>Concrete Work</td>
<td>(Maintenance of Curb and Gutters) *</td>
<td>50%</td>
<td>$-(1,530)</td>
<td>$-</td>
</tr>
<tr>
<td>Hauling of Construction Debris and Equipment</td>
<td>15% and 24%</td>
<td>$143,173</td>
<td>$83,951</td>
<td>$-(122,748)</td>
</tr>
<tr>
<td>Totals</td>
<td>n/a</td>
<td>$4,390,480</td>
<td>$4,385,981</td>
<td>$4,102,918</td>
</tr>
</tbody>
</table>

**As Percent of Storm Drainage Operating and Maintenance Expenditures**

<table>
<thead>
<tr>
<th></th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Charged to Wastewater</td>
<td>15%</td>
<td>15%</td>
<td>12%</td>
</tr>
</tbody>
</table>

**Source:** Department of Public Works.

* SMD did not perform any concrete work during the periods shown in the table. Concrete work does not have any known benefit related to stormwater quality. Rather, curbs and gutters contribute to the conveyance of stormwater. The table shows the concrete work charges to capture their net effects on Wastewater payments for the other activities.

**Operating and Maintenance costs shown on Table 5 of this report were used to calculate percentages.**

Our review determined that SMD has not provided any data showing how and to what extent current Street Maintenance activities justify the stormwater quality costs to the Wastewater Enterprise Fund. Some national and local studies outside of Denver have confirmed the beneficial impact of street sweeping on stormwater quality. However, to improve transparency of the Wastewater expenditures, it is important to gather data that will demonstrate water quality improvements that have resulted from street sweeping and other activities to justify the costs to Denver storm drainage customers.80

---

RECOMMENDATIONS

To improve financial efficiency and transparency of regulatory compliance and best management practice activities related to stormwater, we offer the following recommendations to the Department of Public Works (Public Works):

2.1 **Storm Drainage Fee Increases** - Public Works should ensure that any storm drainage fee increases are substantiated based on the cost of maintaining, replacing, and improving the City's storm drainage facilities rather than unrelated factors such as the Consumer Price Index for All Urban Consumers (CPI-U).

2.2 **Cost Tracking** - Public Works should track the cost of all stormwater quality activities to ensure adequate and timely funding for these activities.

2.3 **Dedicated Funding** - Public Works should have a dedicated funding source in its annual budget for all its stormwater quality projects.

2.4 **Data Collection** - Public Works should collect data showing that stormwater quality improvement has resulted from the Street Maintenance Division activities that are partially reimbursed by the Wastewater Enterprise Fund.
Glossary

Definitions of technical terms were adopted from the UDFCD Volume 3 Criteria Manual.

**Bioretention (rain garden or porous landscape detention):** A best management practice (BMP) that utilizes bioretention is an engineered, depressed landscape area designed to capture and filter or infiltrate the water quality capture volume (WQCV). BMPs that utilize bioretention are frequently referred to as rain gardens or porous landscape detention areas (PLDs). The term PLD is common in the Denver metropolitan area as this manual first published the BMP by this name in 1999. In an effort to be consistent with terms most prevalent in the stormwater industry, this document generally refers to the treatment process as bioretention and to the best management practice as a rain garden.81

**Constructed Wetland Pond:** A constructed wetlands pond (also sometimes called wetland basin) is a shallow retention pond designed to permit the growth of wetland plants such as rushes, willows, and cattails. Constructed wetlands slow runoff and allow time for sedimentation, filtering, and biological uptake. Constructed wetlands ponds differ from natural wetlands, as they are artificial and are built to enhance stormwater quality.82

**Constructed Wetland Channel:** A constructed wetland channel is a conveyance best management practice that is built, in part, to enhance stormwater quality. Constructed wetland channels use dense vegetation to slow down runoff and allow time for both biological uptake and settling of sediment. Constructed wetlands differ from natural wetlands, as they are artificial and are built to enhance stormwater quality.83

**Extended Detention Basin (EDB):** An EDB is a sedimentation basin that was adapted from a detention basin used for flood control. They are designed to intercept and slowly release stormwater runoff to improve water quality and reduce peak runoff rates. The primary difference between an EDB and a flood control detention basin is the design of the outlet: the extended detention basin uses a much smaller outlet that extends the emptying time of more frequently occurring runoff events to facilitate pollutant removal. UDFCD recommends a forty-hour drain time for the water quality capture volume (WQCV) to remove a significant portion of suspended pollutants found in urban stormwater runoff. Many EDBs are also called “dry ponds” because they are designed to drain most of the water between storm runoff events. In Colorado, a detention pond is supposed to release water after twelve hours.84

**Grass Buffer:** Grass buffers are densely vegetated strips of grass designed to accept sheet flow from up-gradient development. Properly designed grass buffers play a key role in Low Impact Development, enabling infiltration and slowing runoff. Grass buffers provide filtration

---

(straining) of sediment. Buffers differ from swales in that they are designed to accommodate overland sheet flow rather than concentrated or channelized flow.\textsuperscript{85}

**Grass Swale:** Grass swales are densely vegetated trapezoidal or triangular channels with low-pitched side slopes designed to convey runoff slowly. Grass swales have low longitudinal slopes and broad cross-sections that convey flow in a slow and shallow manner, thereby facilitating sedimentation and filtering (straining) while limiting erosion. Berms or check dams may be incorporated into grass swales to reduce velocities and encourage settling and infiltration. When using berms, an under-drain system should be provided. Grass swales are an integral part of the Low Impact Development concept and may be used as an alternative to a curb and gutter system.\textsuperscript{86}

**Green Roof:** Green roofs could be defined as contained living systems on top of human-made structures. This green space can be below, at, or above grade involving systems where plants are not planted in the ground.\textsuperscript{87}

**Permeable Pavements:** The term Permeable Pavement System, as used in this appendix, is a general term to describe any one of several pavements that allow movement of water into the layers below the pavement surface. Depending on the design, permeable pavements can be used to promote volume reduction, provide treatment and slow release of the water quality capture volume (WQCV), and reduce effective imperviousness. Use of permeable pavements is a common Low Impact Development practice and is often used in combination with other best management practices to provide full treatment and slow release of the WQCV.\textsuperscript{88}

**Porous Landscape Detention:** See Bioretention

**Porous Pavement Detention:** Porous pavement detention (PPD) consist of an installation of modular block pavement that is flat and provided with a two inch deep surcharge zone to temporarily store the Water Quality Capture Volume (WQCV) draining from an adjacent drainage area. Runoff will infiltrate into the void spaces of the grave base course through the sand filter media and sandy loom turf. The latter is not used for the PPD facility to ensure more rapid drainage of the parking surface and easy maintenance when the media needs to be replaced to maintain rapid drainage of the ponding areas. The ponded and filtered water slowly exits through an under-drain. The application of modular block pavement without the flat slope and surcharge zone functions to reduce imperviousness of pavement areas. However, with the detention features this best management practice has the potential to satisfy the WQCV requirement for a site.\textsuperscript{89}

\textsuperscript{85} http://www.udfcd.org/downloads/pdf/critmanual/Volume%203%20PDFs/chapter%204%20fact%20sheets/T-01%20Grass%20Buffer.pdf.
\textsuperscript{86} http://www.udfcd.org/downloads/pdf/critmanual/Volume%203%20PDFs/chapter%204%20fact%20sheets/T-02%20Grass%20Swale.pdf.
\textsuperscript{87} http://www.udfcd.org/downloads/pdf/critmanual/Volume%203%20PDFs/chapter%204%20fact%20sheets/T-04%20Green%20Roof.pdf.
Retention Pond: A retention pond, sometimes called a wet pond, has a permanent pool of water with capacity above the permanent pool designed to capture and slowly release the water quality capture volume (WQCV) over twelve hours. The permanent pool is replaced, in part, with stormwater during each runoff event so stormwater runoff mixes with the permanent pool water. This allows for a reduced residence time compared to that of the extended detention basin (EDB). The twelve-hour drain time helps to both better replicate pre-development flows for frequent events and reduce the potential for short circuiting treatment in smaller ponds. Retention ponds can be very effective removing suspended solids, organic matter, and metal through sedimentation, as well as removing soluble pollutants like dissolved metals and nutrients through biological processes.\(^\text{90}\)

Sand Filter: A sand filter is a filtering or infiltrating best management practice (BMP) that consists of a surcharge zone underlain by a sand bed with an under-drain system (when necessary). During a storm, accumulated runoff collects in the surcharge zone and gradually infiltrates into the underlying sand bed, filling the void spaces of the sand. The under-drain gradually dewater the sand bed and discharges the runoff to a nearby channel, swale, or storm sewer. It is similar to a BMP designed for bioretention in that it utilizes filtering, but differs in that it is not specifically designed for vegetative growth. For this reason, it can have a greater depth and be designed for a larger contributing area. A sand filter is also similar to an extended detention basin (EDB) in that it is a dry basin, which can be easily designed to include the flood control volume above the WQCV or EURV. However, a sand filter does not require a fore-bay or micro-pool because the solids that would be deposited in these components in an EDB will be retained on the surface of the sand bed in a sand filter.\(^\text{91}\)


APPENDIX B

Examples of Stormwater Best Management Practices (BMPs)

Forebay Pictures of Aqua Golf Railing

Before Rainfall

Source: Wastewater Management Division.
After Rainfall

Source: Wastewater Management Division.
## APPENDIX C

Audit Stormwater Management Benchmarking Summary

<table>
<thead>
<tr>
<th>Does the city have separate or combined sewer system?</th>
<th>Denver</th>
<th>Fort Collins</th>
<th>Minneapolis</th>
<th>Portland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate/Combined/Hybrid(1)</td>
<td>Separate</td>
<td>Separate</td>
<td>Hybrid</td>
<td>Hybrid</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are storm drainage fees structured based on impervious surface ratio?</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes/No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is any portion of storm drainage fees dedicated to water quality activities?</th>
<th>No</th>
<th>Yes</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes/No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Is storm drainage fee increase based on actual/projected system maintenance and capital costs?</th>
<th>No</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes/No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stormwater fee credits available as incentive for implementation of stormwater BMPs?</th>
<th>No</th>
<th>No</th>
<th>Yes (2)</th>
<th>Yes (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes/No</td>
<td>No</td>
<td>No</td>
<td>Yes (2)</td>
<td>Yes (3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2014 Storm drainage fee comparison (4)</th>
<th>$91</th>
<th>$149</th>
<th>$179</th>
<th>$309</th>
</tr>
</thead>
</table>

**Source:** Audit team.
(1) Hybrid means that both systems exist.
(4) Among the four cities, only Denver storm drainage fees are collected on annual basis. Therefore, annual fees for all four cities were calculated for a hypothetical residential property with 7,500 sq. ft. parcel and 2750 sq. ft. of impervious surface area. For Portland, the applicable rate for single family and duplexes was used.
February 11, 2015

Mr. Kip R. Memmott, MA, CGAP, CRMA
Director of Audit Services
Office of the Auditor
City and County of Denver
201 West Colfax Avenue, Dept. 705
Denver, Colorado 80202

Dear Mr. Memmott:

The Office of the Auditor has conducted a performance audit of Stormwater Administration.

This memorandum provides a written response for each reportable condition noted in the Auditor’s Report final draft that was sent to us on January 23, 2015. This response complies with Section 20-276 (c) of the Denver Revised Municipal Code (D.R.M.C.).

AUDIT FINDING 1
Additional data analysis to assess effectiveness of BMPs is necessary to decrease stormwater pollution.

RECOMMENDATION 1.1

Best Management Practices – Public Works should monitor and assess the effectiveness and economy of its current and additional best management practices in reducing levels of E. coli and possibly other pollutants to improve stormwater quality and assess the need for additional funding.

<table>
<thead>
<tr>
<th>Agree or Disagree with Recommendation</th>
<th>Target date to complete implementation activities (Generally expected within 60 to 90 days)</th>
<th>Name and phone number of specific point of contact for implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td>12/31/2015</td>
<td>Reza Kazemian 303.446.3433</td>
</tr>
</tbody>
</table>

Narrative for Recommendation 1.1
PW/WMD is currently in compliance with all program commitments under the MS4 permit and has been transitioning into more advanced outfall remediation methods. PW/WMD has been and continues to monitor and assess the effectiveness of both Dry Weather and Wet Weather BMPs. WMD currently is monitoring and assessing multiple new BMPs which mitigate not only E-coli, but other pollutants from both Dry Weather and Wet Weather discharges. PW/WMD agrees that additional data should be gathered for technical, financial, and regulatory decision making purposes. PW/WMD will complete a Water Quality Data Gap Analysis to identify and mitigate any deficiencies.
AUDIT FINDING 2
The Department of Public Works’ Management of the Financial Aspects of Its Stormwater Quality Programs and Activities Should Be Improved

RECOMMENDATION 2.1
Storm Drainage Fee Increases - Public Works should ensure that any storm drainage fee increases are substantiated based on the cost of maintaining, replacing, and improving the City’s storm drainage facilities rather than unrelated factors such as the Consumer Price Index for All Urban Consumers (CPI-U).

<table>
<thead>
<tr>
<th>Agree or Disagree with Recommendation</th>
<th>Target date to complete implementation activities (Generally expected within 60 to 90 days)</th>
<th>Name and phone number of specific point of contact for implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td>120 Days</td>
<td>George Delaney 720.913.1776</td>
</tr>
</tbody>
</table>

Narrative for Recommendation 2.1
Public Works will review the costs of the storm drainage system annually and compare those cost increases to the certified annual Denver-Boulder Consumer Price Index factor. CPI increases are authorized by ordinances for both Storm and Sanitary rates effective July 1 of each year. Any increase in rates above CPI would require Mayor and Council approval.

RECOMMENDATION 2.2
Cost Tracking - Public Works should track the cost of all stormwater quality activities to ensure adequate and timely funding for these activities.

<table>
<thead>
<tr>
<th>Agree or Disagree with Recommendation</th>
<th>Target date to complete implementation activities (Generally expected within 60 to 90 days)</th>
<th>Name and phone number of specific point of contact for implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td>90 Days</td>
<td>Reza Kazemian 303.446.3433</td>
</tr>
</tbody>
</table>

Narrative for Recommendation 2.2
PW/WMD will define, categorize, and accumulate all related stormwater quality activities costs for future reporting.

RECOMMENDATION 2.3
Dedicated Funding - Public Works should have a dedicated funding source in its annual budget for all its stormwater quality projects.

<table>
<thead>
<tr>
<th>Agree or Disagree with Recommendation</th>
<th>Target date to complete implementation activities (Generally expected within 60 to 90 days)</th>
<th>Name and phone number of specific point of contact for implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td>May 2015</td>
<td>Reza Kazemian 303.446.3433</td>
</tr>
</tbody>
</table>
Narrative for Recommendation 2.3
PW/WMD will evaluate capital and operating costs and assess the merit and level of funding for the budget line item for 2016.

<table>
<thead>
<tr>
<th>RECOMMENDATION 2.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Collection - Public Works should collect data showing that stormwater quality improvement has resulted from the Street Maintenance Division activities that are partially reimbursed by the Wastewater Enterprise Fund.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Agree or Disagree with Recommendation</th>
<th>Target date to complete implementation activities (Generally expected within 60 to 90 days)</th>
<th>Name and phone number of specific point of contact for implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td>12/31/15</td>
<td>Jose Cornejo 720.913.8712</td>
</tr>
</tbody>
</table>

Narrative for Recommendation 2.4
PW will assess the qualitative effects of Street Maintenance activities on improving Stormwater quality.

Please contact Reza Kazemian at 303-446-3433 with any questions.

Sincerely,

Reza Kazemian, P.E.
Director, Wastewater Operations

cc: Jose Cornejo, Executive Director
    George Delaney, Chief Operations Officer
    Sarah Anderson
    Paul Sobiech