Columbia Wastewater and Stormwater IMP

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Our Columbia Waters
Integrated Management Plan
Wastewater & Stormwater

Technical Memorandum 7 *Stormwater System Alternatives*

Columbia Wastewater and Stormwater Integrated Management Plan

Columbia, Missouri
January 5, 2018

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Table of Contents

List of Tables

List of Attachments

Section 1. Introduction and Objectives

The City of Columbia, Missouri (City) is working to develop an Integrated Management Plan (IMP) for the City's wastewater and stormwater utilities. The goal of the IMP is to develop an adaptable and affordable long-term plan that addresses the City's wastewater and stormwater management needs and meets Clean Water Act requirements. The IMP will be developed based on guidance presented in US Environmental Protection Agency's (EPA) *Integrated Municipal Stormwater and Wastewater Planning Approach Framework*[1].

Early in the IMP process, the City and their project team worked to evaluate the City's environmental resources and infrastructure assets to better define the existing condition, performance, and needs of its systems. Results from these efforts were documented in the following technical memoranda:

- Technical Memorandum 1 – Surface Water Quality and Biological Conditions
- Technical Memorandum 2 – Wastewater Collection System Assessment
- Technical Memorandum 3 – Wastewater Treatment System Assessment
- Technical Memorandum 4 – Stormwater System Assessment

These needs assessments were useful in guiding initial prioritization of potential wastewater and stormwater improvements. Priorities were further refined during a series of community outreach meetings. Information developed from these activities formed the basis for identifying potential capital and programmatic alternatives that should be evaluated as part of the IMP. Outcomes from these efforts have been documented in the following technical memoranda:

- Technical Memorandum 5 – Wastewater Collection System Alternatives
- Technical Memorandum 6 – Wastewater Treatment System Alternatives
- Technical Memorandum 7 – Stormwater System Alternatives
- Technical Memorandum 8 – Community Outreach Results

The purpose of this memorandum is to describe the assumptions and methods used to develop potential IMP alternatives for addressing stormwater system needs. Capital and programmatic needs were identified in Technical Memorandum 4 (TM4) . Most critically, the evaluation highlighted the fact that the current level of asset management investment is not sufficient to address existing needs. Currently, approximately 15% of pipes in the system are beyond their physical effective life (PEL). This number is expected to grow to nearly 60% over the next 20 years at the current renewal rate. The assessment findings also indicated that only 1% of the pipes and 7% of the structures have been inspected and assigned a condition rating. Continued underfunding and deferment of system replacement, renewal, and assessment activities will reduce system function and reliability.

These asset renewal issues contribute to public health, safety, and water quality concerns. Flooding is a critical health and safety issue in the City; the City's historical customer complaint

[1] Stoner, N. and C. Giles. 2012. Integrated Municipal Stormwater and Wastewater Planning Approach Framework. June 5, 2012. Washington D.C.

database includes nearly 2,700 reports of street, house, and yard flooding. The City has addressed many of these issues but several areas with a relatively high concentration of flooding reports remain. Approximately 60% of the City's annual stormwater budget is spent resolving flooding issues, as well as making emergency repairs to address dangerous pipe collapses and roadway failures. Improving and maintaining water quality in area streams and lakes is also a significant concern for the Utility and City residents. The Missouri Department of Natural Resources (MDNR) has identified seven water quality impairments in the City that are caused by urban and other nonpoint source runoff.

Alternatives to address these capital and programmatic needs were developed by HDR Engineering, Inc. (HDR), and Geosyntec Consultants, Inc. (Geosyntec), based on information gathered regarding current system performance, Utility staff goals, estimated implementation costs, and community priorities. Representatives from HDR and Geosyntec then met with City staff on January 27 and March 8, 2017 to review and confirm information and assumptions used to formulate the alternatives presented in this memorandum.

Given the uncertainties and data gaps identified during the stormwater system assessment, the alternatives outlined in this memorandum are only intended to serve as planning level estimates. These alternatives and associated costs should be refined as additional information is developed during future phases of the IMP. Results from the stormwater system alternatives assessment are documented in the sections that follow.

Section 2. Stormwater System Goals

In 2008, the City funded a study to evaluate the stormwater program with respect to applicable regulations, current and future program goals, and potential funding options (CH2MHill 2008). Goals were identified and prioritized through a workshop approach with stakeholders from the community. The final 2008 prioritized goals were as follows:

1. Provide Public Safety
2. Maintain the Stormwater Conveyance System
3. Adequately Fund, Staff, and Organize the Stormwater Utility
4. Provide Environmental Protection without Unreasonable Economic Burdens
5. Improve Environmental Integrity and Reduce Flooding
6. Regulatory Compliance

As part of the IMP alternative development process, HDR and Geosyntec reviewed these goals with City staff and confirmed that they still generally reflect the overall goals and objectives of the Stormwater Utility. However, the group decided that the original six goals could logically be re-categorized and reduced to four goals which still capture the priorities outlined in the 2008 study. The four goals are:

1. Provide Public Safety
2. Improve Environmental Integrity
3. Renew and Maintain the Stormwater Conveyance System
4. Adequately Fund and Staff the Stormwater Utility

The City believes that developing and implementing their stormwater program to achieve these four goals will help ensure that public health protections are maintained, level of service (LOS) goals are achieved, and environmental protections are economically sensible. In addition to redefining the goals, key performance indicators (KPIs) that could aid in evaluating how effectively the City achieves the goals were also discussed. These KPIs will be evaluated and refined through future iterations of the IMP. Brief descriptions of each goal, along with suggested KPIs, are included in the sections that follow.

2.1 Provide Public Safety

The City's highest stormwater priority is to provide services that maintain public health, welfare, and safety. From a stormwater perspective, the greatest threats to public safety include infrastructure failures such as street collapses and flooding. The City is currently focused on providing services to address these two specific issues but current funding levels do not address the overall needs. For example, the City has identified over $30 million worth of stormwater projects to reduce flooding, increase capacity, and make other system improvements. However, funding for these projects has averaged only $316,000 per year over the last three years. Improving system renewal and assessment management activities will aid in addressing public safety and flood reduction, but at the current level of funding public safety-related projects will continue to be deferred.

As the City continues to develop and implement their program over time, several KPIs could be used to better track progress in achieving public safety goals. These KPIs include:

- Identifying and tracking the number of street closures due to flooding or infrastructure failures.
- Identifying and tracking the number of flooding complaints organized by storm size.

2.2 Improve Environmental Integrity

In addition to providing for the public health, welfare, and safety of the community, another important goal for the Stormwater Utility is to provide a minimum level of environmental protection and improve environmental integrity in areas that have already been impacted. These goals include compliance with the City's municipal separate storm sewer system (MS4) permit and implementation of existing (Hinkson Creek Collaborative Adaptive Management) or future total maximum daily loads (TMDLs) to address water quality impairments.

Since 2008, the City has made progress towards achieving these goals by refining the Stormwater Management & Water Quality Manual (Columbia 2009), implementing a stream buffer ordinance, and coordinating installation of more than 400 water quality best management practices (BMPs). However, there are areas across the City that have historically been impacted by flooding and erosion that should be addressed to improve attainment of this goal.

Existing regulatory requirements are outlined in the City's MS4 permit. The City, Boone County, and University of Missouri jointly hold the permit and are collectively responsible for compliance with permit conditions through implementation of a stormwater management program. Although the co-permittees are in compliance with their permit, some programmatic elements of the current stormwater management program could be refined to improve program effectiveness and water quality conditions in the City. These elements include pursuing a more strategic and proactive visual inspection program to identify illicit discharges, refining standards and BMP design requirements, improving data management, and improving construction site runoff inspection procedures.

New and evolving requirements and regulations targeted to improve water quality will strain the Utility's already limited resources. As outlined in Technical Memorandum 1, there are a number of potential future regulatory requirements that will impact stormwater management activities in the City. For example, future water quality criteria changes and regulations governing how permit requirements should be expressed will impact the City's MS4 permit and program. Many new regulatory requirements will also be related to the implementation of existing and future TMDLs aimed at addressing aquatic life and bacteria impairments. These TMDLs could drive stream stabilization and runoff treatment improvements to address water quality conditions.

Potential KPIs for measuring progress towards attaining environmental integrity goals include tracking:

- Stream miles evaluated per year,
- Number of outfalls and frequency of inspections,
- Detention cell and BMP inspections,

- Construction site inspections,
- Length of unstable stream banks in the City, and
- Number of water quality impairments attributed to storm water runoff by MDNR in the City and MS4 area.

2.3 Renew and Maintain the Stormwater Conveyance System

As noted in Section 1, the City currently spends significant time and resources making emergency repairs to the stormwater conveyance system. As a result, there is a significant backlog (approximately 23 miles) of structurally deficient pipes in need of rehabilitation or replacement. Improving maintenance and assessment activities will enable effective and efficient project planning and facilitate attainment of the other system goals.

Currently the City uses closed-circuit television (CCTV) primarily for the sanitary collection system. However, opportunities exist to expand CCTV use for the stormwater system. For example, specifications have recently been revised to require that all new stormwatwer facilities be inspected using CCTV prior to acceptance by the City. By integrating stormwater CCTV observations with the City's information management system, the City can more efficiently make decisions at the asset level. This allows for data driven forecasting of short- and long-term renewal needs for management of the stormwater system and aids in prioritizing future CCTV and system renewal efforts. As the City continues to move forward with the inspection and rehabilitation of the stormwater system, using the data to inform an asset management based process for prioritization of inspection and renewal activities will help ensure the City focuses their resources where they provide the most benefit.

To fully assess the stormwater conveyance system, a stormwater master plan should be developed to aid in identifying and prioritizing improvement locations. Computer models provide much of the data needed to assess the capacity of the stormwater conveyance system. Currently, the City has a hydraulic analysis model for the regulatory floodplain which includes the open channel portions of the drainage system. However, conveyance system models have not been completed for critical areas of concern. Resources are required to build models, collect data for calibrating the models, and for applying the models to generate the necessary information for decision-making.

Potential KPIs for measuring progress towards attaining conveyance system maintenance goals include tracking:

- Annual system renewal,
- Inspection progress,
- Number and cost of emergency repairs, and
- Pipe and structure ages.

2.4 Adequately Fund and Staff the Stormwater Utility

Without sufficient funding, the City cannot fully meet the aforementioned goals or provide the level of service expected by the community. In 2015, voters approved a measure to increase

stormwater charges by approximately 25% per year through 2020, but investment needs still exceed the available funding.

The Utility's 2017 budget of $2.2 million is intended to address aging infrastructure, flood reduction, and water quality improvements across the City. However, this budget is insufficient to address existing needs in any one, let alone all three, of these areas. For example, current backlog of stormwater infrastructure beyond its PEL is approximately $50 million. Even if the entire existing budget were devoted to addressing this backlog, renewal needs will continue to increase over the next 20 years due to the age and material of many pipes and structures in the system. With the resources currently available, necessary system renewal, flood reduction, and water quality improvement activities must be deferred. This deferment will make the system less reliable, less safe, and will increase the number and cost of emergency repairs going forward.

In the future, the Utility may want to develop specific financial and management KPIs to measure progress towards meeting this goal. In the interim however, progress can be measured with the same KPIs that will be tracked for the public safety, environmental integrity, and conveyance system maintenance goals described previously. Consistent progress as measured by those KPIs would suggest that the Utility is adequately funding and staffing program activities, whereas a lack of progress could suggest that additional funding and staffing may be needed.

Section 3. Funding Scenario Development

As mentioned previously, uncertainties and data gaps in the stormwater system preclude the development of specific project recommendations or alternatives. Instead, planning level estimates were identified to characterize the expected additional level of investment required to address system needs, anticipated regulatory drivers, and City goals over the next 20 years. These estimates represent the investments and activities needed **in addition to** resources the Stormwater Utility currently manages.

Three potential funding level scenarios were used to guide the analysis. They are broadly defined as follows:

- **Level 1 Funding (Level 1) –** Funding needed to **provide the minimum** LOS that meets both community-wide expectations and **existing** regulatory requirements over the 20-year IMP planning period.
- **Level 2 Funding (Level 2) –** Funding needed to **exceed the minimum** LOS that meets community-wide expectations and **more proactively** meets existing regulatory requirements over the 20-year IMP planning period.
- **Level 3 Funding (Level 3) –** Funding needed to **address all** forecasted infrastructure needs and proactively meet **both** existing and forecasted regulatory requirements over the 20-year IMP planning period.

The estimates include potential capital costs, operation and maintenance costs, and costs associated with necessary planning or data collection activities needed over the IMP planning period. The resulting total and annual spending differences between each funding level presented above are the product of assumptions related to total project implementation cost, project scheduling, and the timing of known regulatory drivers. Because the 2015 voter-approved rate increase is scheduled to continue through 2020, the City cannot plan to dedicate additional funds to stormwater projects until at least 2021. Therefore, the IMP assumes that no new funding would be dedicated to any of the three levels described above until 2021, assuming future rate increases are approved by voters. Further, it is important to note that annual expenditures for each category outlined below should be considered “average annual” costs over the planning period, as actual annual costs may vary to accommodate future stormwater rate calculations.

Funding level estimates were developed for six major project categories focused on improving infrastructure and water quality. These categories are:

- Stormwater planning,
- System assessment and cleaning,
- System renewal,
- Flood control,
- Stream erosion,
- Runoff treatment to improve water quality, and
- Stormwater management program.

Brief descriptions of these project categories and the assumptions used to develop funding level estimates are described in the sections that follow. Detailed costs forecasts for each funding level are presented in **Attachment A**.

3.1 Stormwater Planning and Program Support

It has been approximately 20 years since comprehensive stormwater management, planning, and modeling tools have been evaluated for the City[2]. Changing development patterns and densities, increasing population growth, expanding City boundaries, and evolving regulatory requirements over that time have significantly changed the conditions and assumptions on which those plans were based. As a result, the City has been operating the Stormwater Utility without the benefit of a functional stormwater master plan or conveyance system model for some time. These tools, as well as improved data management processes, should be developed to enhance project planning, prioritization, and identification of improvement locations to more fully meet conveyance system assessment goals. Results of these efforts will be used to refine funding needs and identify a long term improvement plan to address the conveyance issues present within the system.

As discussed in TM4, improving the quality of stormwater system data and GIS mapping information is a priority for the City. The most significant needs at this time include improving the consistency of existing data management and storage. As the stormwater program grows and additional asset information such as cleaning records, maintenance activities, and overall condition is collected, more robust data management tools will be needed to support necessary planning and analysis efforts. These tools will help the City efficiently maintain existing stormwater assets and proactively address problematic areas or conditions. They will also help facilitate coordination with Boone County and the University of Missouri.

Estimated costs for data management (program support), master planning, and modeling were developed based on similar efforts in other Midwest communities. These estimates were used as the basis for estimating funding needs for the first steps in evaluating the conveyance system. Planned resources may be needed or may need to be reallocated to manage future program activities based on the results of the master planning and modeling efforts. For initial planning purposes, the funding scenarios assume that external consultants will be retained to assist with program support. As the program develops over time, these estimates can be refined to incorporate the appropriate mix of internal and external resources.

Assumptions used to develop funding scenarios according to the three IMP levels included in this evaluation are as follows:

- **Level 1 – Stormwater Master Planning and Low Level Program Support**
  - $650,000 total over five years to develop master plan and modeling.
  - On average, $50,000 annually throughout planning period for program and data management support.

[2] Black and Veatch. 1983. Stormwater Management Plan for Columbia, Missouri. Kansas City, Missouri.
Burns and McDonnell. 1996. Phase 1 Stormwater Management Plan. Kansas City, Missouri.
Burns and McDonnell. 1998. Phase 2 Stormwater Management Plan. Kansas City, Missouri.

- **Level 2 – Stormwater Master Planning and Medium Level Program Support**
  - $650,000 total over five years to develop master plan and modeling.
  - On average, $100,000 annually for program and data management support.
- **Level 3 – Stormwater Master Planning and High Level Program Support**
  - $650,000 total over five years to develop master plan and modeling.
  - On average, $150,000 annually for program and data management support.

3.2 System Condition Assessment and Cleaning Program

To help meet the goal of assessing and maintaining the stormwater conveyance system, a more systematic approach is recommended to decrease unanticipated costs through system evaluation and maintenance. Assumptions used to develop system condition assessment and cleaning funding scenarios according to the three IMP funding levels included in this evaluation are outlined below. These estimates are based on existing data and information and should be refined as stormwater planning activities outlined in Section 3.1 are completed.

- **Level 1 – Establish the Condition Assessment and Dedicated Cleaning Program**
  - Add 1 dedicated CCTV truck to be replaced every 10 years beginning in 2021.
  - Add two new CCTV staff.
- **Level 2 – Establish the Programs and Assess the CMPs within Three Years**
  - Add 1 dedicated CCTV truck to be replaced every 10 years beginning in 2021.
  - Add two new CCTV staff.
  - Beginning in 2021, $250,000 over three years to enhance the assessment program by using a subcontractor to assess half of the CMP (approximately 30 miles) within 3 years
  - 1 additional staff engineer to oversee the enhanced assessment.
- **Level 3 – Same as Level 2**

3.3 System Renewal

To meet the goal of maintaining the stormwater conveyance system, a more proactive approach is recommended to decrease emergency repairs and unanticipated costs. This includes additional resources to repair and rehabilitate the system and additional staff to provide necessary support for the increased system renewal efforts. The funding levels for system renewal were determined by using the current GIS database which includes system ages for 70% of the pipes and structures. Ages for the remaining 30% of the system were assigned as described in TM4 Ages were used to determine the current backlog based upon the assumed PEL. According to the analysis, CMP is the most common pipe used in the system and 33% of the CMP is currently beyond its PEL. Failing CMP is the most significant threat to public health, safety, and water quality.

Costs were calculated for pipe lining or renewal. Lining costs were calculated for non-concrete pipes with diameters of 8 to 48 inches. Renewal costs were also calculated for the various structures present in the system, including area inlets, curb inlets, inlet lids, junction structures, and end structures. Costs also included surface restoration (non-lined), contingency, and engineering. Estimates are based on existing information and should be refined as stormwater

planning and assessment activities outlined in Sections 3.1 and 3.2 are completed. The general assumptions used to develop system renewal funding scenarios according to the three IMP funding levels included in this evaluation are included below.

- **Level 1 – Repair or Replace 50% of the CMP and Replace 50% of Structures that will be beyond PEL during the 20-Year Planning Period**
  Within the 20-year planning period, approximately 38 miles of CMP and 13,300 structures will age beyond their PEL. Level 1 assumes that 50% of the CMP (approximately 19 miles) and 50% of the structures (approximately 6,660) will be repaired or replaced over the 20-year planning period.
  - Approximately $800,000 annually to rehabilitate approximately 19 miles of CMP (line 75% and replace 25%).
  - Approximately $2.6 million annually to replace 50% of the structures (6,600 structures).
  - Add three operators, one staff engineer, one engineering technician, and one inspector to help manage and execute the program. Costs for these additional staff were not considered, as they are already accounted for in the Utility's existing budget projections based on the planned rate increases through 2020.

- **Level 2 – Repair or Replace 100% of the CMP and Replace 50% of Structures that will be beyond PEL during the 20-Year Planning Period**
  Within the 20-year planning period, approximately 38 miles of CMP and 13,300 structures will age beyond their PEL. Level 2 assumes that 100% of the CMP (approximately 38 miles) and 50% of the structures (approximately 6,660) will be repaired or replaced.
  - Approximately $1.6 million annually to rehabilitate approximately 38 miles of CMP (line 75% and replace 25%).
  - Approximately $2.6 million annually to replace 50% of the structures (6,600 structures).
  - Add three operators, one staff engineer, one engineering technician, and one inspector to help manage and execute the program. Costs for these additional staff were not considered, as they are already accounted for in the Utility's existing budget projections based on the planned rate increases through 2020.

- **Level 3 – Repair or Replace 100% of the System that will be beyond PEL within First 10 Years of the IMP Planning Period**
  Within the 20-year planning period, approximately 63 miles of pipe (of various materials) and 13,300 structures will age beyond their PEL. Replacing all of these assets is cost prohibitive. Therefore, Level 3 only includes costs for pipes and structures that will age beyond their PEL during the first 10 years, but assumes that they will be repaired or replaced over a 20-year period.

  Approximately 35 of miles of pipe will age beyond their PEL during the first 10 years of the planning period. A significant portion of this 35 miles is CMP, but includes other pipe

materials as well. Level 3 assumes that 100% of the 35 miles will be repaired or replaced over a 20-year period.

Approximately 9,400 of the 13,300 structures will age beyond their PEL duirng the first 10 years of the planning period. Level 3 assumes that 100% of the 9,400 structures will be replaced over a 20-year period.

- Approximately $3.9 million annually to rehabilitate approximately 35 miles of all pipe types (line 75% and replace 25%).
- Approximately $3.4 million annually to replace 100% of the structures (9,400 structures).
- Add three operators, one staff engineer, one engineering technician, and one inspector to help manage and execute the program. Costs for these additional staff were not considered, as they are already accounted for in the Utility's existing budget projections based on the planned rate increases through 2020.

3.4 Flood Reduction

The City has identified approximately $23 million of immediate flood reduction needs. As the City works to develop stormwater master planning efforts over time, new flood reduction projects will be identified and existing projects and estimates may be refined. Assumptions used to develop IMP cost estimates are as follows:

- **Level 1 – Low Level Investment in Flood Reduction**
  - After 2020, approximately $1.4 million annually ($23 million total) to complete identified projects.
  - One engineer, one inspector, and one technician to help manage and execute the program.
  - Two field trucks to be replaced every 10 years.
- **Level 2 – Medium Level Investment in Flood Reduction**
  - After 2020, approximately $1.4 million annually ($23 million total) to complete identified projects.
  - After 2020, approximately $440,000 annually ($7 million total) to complete unidentfied projects.
  - One engineer, one inspector, and one technician to help manage and execute the program.
  - Two field trucks to be replaced every 10 years.
- **Level 3 – High Level Investment in Flood Reduction**
  - After 2020, approximately $1.4 million annually ($23 million total) to complete identified projects.
  - After 2020, approximately $875,000 annually ($14 million total) to complete unidentfied projects.
  - One engineer, one inspector, and one technician to help manage and execute the program.
  - Two field trucks to be replaced every 10 years.

3.5 Stream Erosion

Erosion contributes to water quality and habitat degradation issues in stream channels. Erosion also causes private and public property damage, impacts infrastructure such as roads, sanitary sewers and other utilities, and can exacerbate downstream flooding concerns. In addition, City staff has indicated that there are growing expectations from the community that the City should be responsible for addressing these problems.

Stream erosion restoration cost estimates were developed from complaints in the database provided by the City and engineering judgment. Only the complaints related to either "yard" or "severe" erosion in the database were considered. For purposes of this analysis, it was assumed that complaints located within 250 feet of high resolution (1:24,000) USGS national hydrography dataset flowlines were related to stream erosion.

Each complaint was assumed to impact approximately 200 feet of streambank based on expected lot sizes. Past project experience indicated that a cost of $300 per linear foot of stream restoration was an appropriate estimate. Therefore, each complaint was associated with a cost of $60,000 for restoration. The cost for restoration was developed based on the number of complaints grouped by watershed.

The funding scenarios outlined below were structured to address watersheds with the most critical erosion issues first. Assumptions used to develop the scenarios according to the three IMP funding levels included in this evaluation were as follows:

- **Level 1 – Address Critical Erosion Areas**
  - Approximately $173,000 annually after 2020 to address stream erosion in watersheds with a high frequency of erosion complaints (>5 complaints per mile). These watersheds include the Mill Creek and County House Branch watersheds.
- **Level 2 – Address Erosion in the Hinkson Creek Watershed**
  - Approximately $485,000 annually after 2020 to address the Level 1 watersheds, remaining Hinkson Creek mainstem, and Hinkson Creek tributary watersheds.
  - Add one engineer to coordinate and manage projects, one inspector, and one field truck to be replaced every 10 years.
- **Level 3 – Address Erosion in all Watersheds**
  - Approximately $700,000 annually after 2020 to address all watershed areas in the City.
  - Add one engineer to coordinate and manage projects, one inspector, and one field truck to be replaced every 10 years.

3.6 Runoff Treatment for Water Quality

Similar to erosion, stormwater runoff impacts downstream water quality. Pollutants such as sediment, debris, phosphorus, nitrogen, oil and grease, pesticides, and pathogens can be carried by stormwater into local waterways and impact aquatic health, recreation, and aesthetics. Runoff treatment with structural BMPs will reduce the volume of stormwater runoff, thereby reducing flooding, and will retain pollutants, including sediment, to prevent transport to local waterways.

Runoff treatment alternatives were focused on addressing stormwater runoff from impervious areas only within the road right-of-way (ROW) owned by the City. The City has approximately 16 square miles of impervious surface, including 5 square miles within the road ROW. The analysis assumed that 100% of the impervious area within the City's ROW would be treated through structural BMPs. Based on discussions with the City, the two BMPs selected for implementation in the runoff treatment analysis were bioretention basins and permeable pavers. It is important to note that this combination was chosen to simplify the analyses. Prior to implementation, a site-specific evaluation would be needed to identify the appropriate suite of BMPs that would be appropriate for each project.

Costs for runoff treatment were based on unit cost information developed for the EPA National Stormwater Calculator. A regionalization factor for St. Louis was applied using the Bureau of Labor Statistics Consumer Price Index and Producer Price Index. Cost estimates do not include engineering or other soft costs associated with BMP implementation. Assumptions used to develop BMP costs used for the evaluation include the following:

- BMP is sited on an existing development or is a substantial retrofit of existing infrastructure that is likely to have moderate to very constrained space;
- Areas for outflow and overflow discharge are likely constrained and may require significant grading or pipe infrastructure for safe discharge;
- Placement location of the BMP has difficult access for equipment and material delivery;
- Placement location is controlled by steep slopes (i.e. greater than 7%); or
- Soil infiltration rates of the existing subgrade beneath the BMP are representative of Hydrologic Soil Group C and D soils.

For planning purposes, implementation was assumed to be 50% bioretention and 50% permeable pavers based on discussions with City staff. The costs were estimated and applied on a watershed basis. Assumptions used to develop runoff treatment scenarios according to the three IMP funding levels included in this evaluation are as follows:

- **Level 1 – Re-evaluate Existing Redevelopment Ordinance and Opportunistic BMP Implementation**
  - No additional costs.
- **Level 2– Address Runoff in Tributary Watersheds of Hinkson Creek**
  - Approximately $2.7 million annually after 2020 to treat runoff in all Hinkson Creek tributary watersheds. This estimate does not include treating runoff in the mainstem Hinkson Creek watershed. Addressing runoff quality in tributary watersheds is also expected to benefit the mainstem of Hinkson Creek.
  - Add one engineer to coordinate and manage projects.
- **Level 3 – Address Runoff in All Watersheds**
  - Approximately $7.5 million annually after 2020 to treat runoff in all watershed areas in the City.
  - Add one engineer and one technician to coordinate and manage projects.
  - One field truck to be replaced every 10 years.

3.7 Stormwater Management Program

Enhancing the City's stormwater management program, specifically Minimum Control Measures (MCMs) #1, #3, and #4, to address water quality issues would consist of expanding the education and outreach, illicit discharge detection elimination (IDDE), and construction site stormwater runoff control programs, respectively. In conjunction with the IDDE program, streams in the City could be inspected for erosion problems to better identify and characterize the extent of stream erosion in the City.

MCM #1: Public Education and Outreach

Current funding (excluding staffing costs) for the City's education and outreach program is $27,000 per year. In general, City staff has developed and is implementing a program that provides a wide array of education and outreach opportunities with limited funds. The US EPA often directs other communities to contact the City staff to learn about ways to cost-effectively develop a successful stormwater education and outreach program.

City staff places a heavy emphasis on "people pollution," meaning individual behaviors are a large source of stormwater pollution within the City. Significant amounts of litter following sporting events and residential fertilizer application are provided as examples of "people pollution." To provide effective education and outreach opportunities to address and positively change these individual behaviors, the City staff needs to have a significant amount of close interaction with the residents of the City. These interactions include providing education and outreach at schools, community and religious organizations, and public events. However, the City's ability to deliver education and outreach at more of these settings is limited by current staffing levels. As such, the City has identified that the addition of up to three part-time employees, such as university students, would allow for increased education and outreach delivery to City residents.

MCM #3: Illicit Discharge Detection and Elimination Program

There are approximately 150 stream miles in the City. Costs for implementing an enhanced IDDE and stream erosion assessment program were developed by estimating the amount of time necessary to conduct stream walks and associated administrative tracking and coordination. Since extended dry periods are necessary for IDDE inspections, the number of available dry days per year for inspection was calculated based on the average number of days measured flows in Hinkson Creek (at USGS gage station 06910230) were below the long-term median flow value since 2008. Additional days per year for other IDDE tasks include the following:

1) 10 days: field testing and tracing detected illicit discharges;
2) 5 days: removing the source of discharge and post-monitoring;
3) 20 days: development of a public IDDE reporting program; and
4) 20 days: IDDE public outreach and education.

Based on these data, one full-time employee would be needed to conduct one assessment of the 150-mile system during every 5-year MS4 permit cycle.

MCM #4: Construction Site Stormwater Runoff Control

Expanding the construction site stormwater runoff control program would consist of adding dedicated full-time equivalent (FTE) employees to perform inspections. The current construction inspection program includes building and site inspectors from the City's Community Development Department performing stormwater inspections weekly at each construction site. The weekly inspection frequency is required by existing permits but is intended to apply only to the permit holder, not to the City who should be acting in an oversight role. It is generally recommended that the City perform less frequent, but more intense, audits of construction sites. This approach would require that the City have dedicated staff trained to conduct audits, rather than building inspectors. The required number of FTEs was calculated based on 2016 construction inspection data provided by the City, and included the following assumptions:

1) 3 hours/inspection: Travel time and site visit;
2) 1 hour/inspection: In-office reporting;
3) 3 inspections/month: Notice of Violation (NOV) discovery; and
4) 4 hours/NOV: In-office reporting and follow-up.

Stormwater Management Program Funding Scenarios

Funding scenarios targeted at enhancing MCMs #1, #3, and #4 described above will improve the City's ability to conduct outreach, enhance existing IDDE capabilities, and make construction site stormwater runoff control programs more effective. Assumptions used to develop program funding scenarios according to the three IMP levels included in this evaluation are as follows:

- **Level 1 – Enhance Outreach and Education, Implement Stream Walks, and Conduct Monthly Erosion Control Inspections**
    - Additional $73,000 annually after 2020 to conduct additional outreach and education (MCM #1).
    - One technician to perform stream walks (1/permit cycle) and stream erosion inspections (MCM #3).
    - Three technicians to perform monthly construction site erosion control inspections (MCM #4).
    - Four new trucks to be replaced every 10 years. It is assumed that these trucks will also be used to support work conducted under the Stream Erosion and Runoff Treatment project categories.
- **Level 2 – Enhance Outreach and Education, Implement Enhanced Stream Walks, and Conduct Monthly Erosion Control Inspections**
    - Additional $73,000 annually after 2020 to conduct additional outreach and education (MCM #1).
    - 1 Field Technician to perform stream walks (1/permit cycle) and stream erosion inspections (MCM #3).
    - 4 Field Technicians to perform monthly erosion control inspections (MCM #4).

  - Five new trucks to be replaced every 10 years. It is assumed that these trucks will also be used to support work conducted under the Stream Erosion and Runoff Treatment project categories.
- **Level 3 – Enhance Outreach and Education, Implement Enhanced Stream Walks, and Conduct Bi-Monthly Erosion Control Inspections**
  - Additional $73,000 annually after 2020 to conduct additional outreach and education (MCM #1).
  - 1 Field Technician to perform stream walks (1/permit cycle) and stream erosion inspections (MCM #3).
  - 5 Field Technicians to perform bi-monthly erosion control inspections (MCM #4).
  - Six new trucks to be replaced every 10 years. It is assumed that these trucks will also be used to support work conducted under the Stream Erosion and Runoff Treatment project categories.

Section 4. Summary

HDR and Geosyntec worked with the City to review existing stormwater system goals and develop alternatives to address system and program needs identified in TM4. Most importantly, TM4 highlighted the fact that the current level of asset management investment is not sufficient to address existing renewal or assessment needs. Continued underfunding and deferment of system replacement, renewal, and assessment activities will reduce system function and reliability and contribute to public health, safety, and water quality issues.

In 2008, the City sponsored a stakeholder process to identify and prioritize program goals (CH2MHill 2008). As part of the alternative development process for the IMP, HDR and Geosyntec reviewed these goals with City staff and confirmed that they still generally reflect the overall goals and objectives of the current Utility. However, the group decided that the original six goals could logically be re-categorized and reduced to the following four goals which still capture the Utility's priorities:

1. Provide Public Safety
2. Improve Environmental Integrity
3. Renew and Maintain the Stormwater Conveyance System
4. Adequately Fund and Staff the Stormwater Utility

Developing and implementing the stormwater program to achieve these four goals will help ensure that public health protections are maintained, LOS goals are achieved, and environmental protections are economically sensible. Appropriate KPIs to help the City track performance and achievement of these goals will be developed over time as the IMP is implemented and more data become available.

Potential capital and programmatic alternatives and planning level costs were identified to characterize the expected additional level of investment required to address stormwater system needs, anticipated regulatory drivers, and City goals over the 20-year IMP planning period. Cost estimates include potential additional capital, operation and maintenance, and necessary planning or data collection costs. Estimates were developed for three potential funding level scenarios and six project categories. The three funding levels represent increasingly proactive investments that the City could pursue to make infrastructure upgrades and water quality improvements through the IMP.

Results of the alternatives evaluation indicate that between $93 million and $306 million of **additional** investment will be needed to address stormwater system needs over the IMP planning period (Table 1). In subsequent analyses, these cost estimates will be combined with estimates for the wastewater treatment and collection system and evaluated to identify the level of investment that appropriately balances overall costs with anticipated community benefits. These subsequent evaluations will also consider impacts on future residential utility bills and community-wide affordability.

Table 1.Summary of Stormwater System Capital and Programmatic Costs, in 2017 Dollars.

Project Categories	20-Year Funding Scenario		
	Level 1	**Level 2**	**Level 3**
Stormwater Planning	$1,450,000	$2,250,000	$3,050,000
System Assessment and Cleaning	$2,080,000	$2,330,000	$2,330,000
System Renewal	$54,241,000	$67,477,000	$116,379,000
Flood Reduction	$26,570,000	$33,620,000	$40,620,000
Stream Erosion	$2,760,000	$10,270,000	$13,810,000
Runoff Treatment for Water Quality	$0	$44,145,00	$122,396,000
Stormwater Management Program	$5,544,000	$6,634,000	$7,724,000
Total Additional Cost	**$92,645,00**	**$166,726,000**	**$306,309,000**
Additional Staff*	**Engineer (1) Technician** (8)**	**Engineer (4) Technician (10)**	**Engineer (4) Technician (12)**
Additional Equipment	**CCTV Truck (1) Field Truck (6)**	**CCTV Truck (1) Field Truck (8)**	**CCTV Truck (1) Field Truck (9)**

*Additional staff estimates include only those staff for which the Utility would incur additional costs. The estimates do not include the seven existing staff members or eight additional staff members that the Utility plans to add over the next four years. These staffing estimates (and associated costs) were developed for initial IMP planning purposes. Future staffing levels, as well as specific positions, should be reevaluated as the IMP progresses over time.

**In this table, the term “technician” refers to all operators, inspectors, and technicians.

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Technical Memorandum 7
Attachments

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Attachment A. Detailed Cost Forecasts

Table A.1. Level 1 Stormwater System Capital and Programmatic Cost Forecast, in 2017 Dollars. Estimates include potential additional capital, operation and maintenance, and planning costs over the IMP planning period. Because the 2015 voter-approved rate increase is scheduled to continue through 2020, the IMP assumes that no additional funding would be dedicated to any of the three levels described above until 2021.

Columbia Stormwater System
Capital and Programmatic Cost Estimates - Level 1 Service

Project Category	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Stormwater Planning	$ -	$ -	$ -	$ -	$ 180,000	$ 180,000	$ 180,000	$ 180,000	$ 180,000	$ 50,000
Condition Assessment and Cleaning	$ -	$ -	$ -	$ -	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000
System Renewal Program	$ -	$ -	$ -	$ -	$ 3,390,051	$ 3,390,051	$ 3,390,051	$ 3,390,051	$ 3,390,051	$ 3,390,051
Flood Reduction	$ -	$ -	$ -	$ -	$ 1,657,500	$ 1,657,500	$ 1,657,500	$ 1,657,500	$ 1,657,500	$ 1,657,500
Stream Erosion	$ -	$ -	$ -	$ -	$ 172,500	$ 172,500	$ 172,500	$ 172,500	$ 172,500	$ 172,500
Runoff Treatment	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Stormwater Management Program	$ -	$ -	$ -	$ -	$ 434,000	$ 334,000	$ 334,000	$ 334,000	$ 334,000	$ 334,000
Annual Total	**$ -**	**$ -**	**$ -**	**$ -**	**$ 5,964,051**	**$ 5,864,051**	**$ 5,864,051**	**$ 5,864,051**	**$ 5,864,051**	**$ 5,734,051**
Cumulative Total	**$ -**	**$ -**	**$ -**	**$ -**	**$ 5,964,051**	**$ 11,828,101**	**$ 17,692,152**	**$ 23,556,202**	**$ 29,420,253**	**$ 35,154,303**

Columbia Stormwater System
Capital and Programmatic Cost Estimates - Level 1 Service

Project Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Stormwater Planning	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000
Condition Assessment and Cleaning	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000
System Renewal Program	$ 3,390,051	$ 3,390,051	$ 3,390,051	$ 3,390,051	$ 3,390,051	$ 3,390,051	$ 3,390,051	$ 3,390,051	$ 3,390,051	$ 3,390,051
Flood Reduction	$ 1,657,500	$ 1,707,500	$ 1,657,500	$ 1,657,500	$ 1,657,500	$ 1,657,500	$ 1,657,500	$ 1,657,500	$ 1,657,500	$ 1,657,500
Stream Erosion	$ 172,500	$ 172,500	$ 172,500	$ 172,500	$ 172,500	$ 172,500	$ 172,500	$ 172,500	$ 172,500	$ 172,500
Runoff Treatment	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Stormwater Management Program	$ 334,000	$ 334,000	$ 334,000	$ 334,000	$ 434,000	$ 334,000	$ 334,000	$ 334,000	$ 334,000	$ 334,000
Annual Total	**$ 5,734,051**	**$ 5,784,051**	**$ 5,734,051**	**$ 5,734,051**	**$ 5,834,051**	**$ 5,734,051**	**$ 5,734,051**	**$ 5,734,051**	**$ 5,734,051**	**$ 5,734,051**
Cumulative Total	**$ 40,888,354**	**$ 46,672,404**	**$ 52,406,455**	**$ 58,140,505**	**$ 63,974,556**	**$ 69,708,606**	**$ 75,442,657**	**$ 81,176,707**	**$ 86,910,758**	**$ 92,644,808**

Table A.2. Level 2 Stormwater System Capital and Programmatic Cost Forecast, in 2017 Dollars. Estimates include potential additional capital, operation and maintenance, and planning costs over the IMP planning period. Because the 2015 voter-approved rate increase is scheduled to continue through 2020, the IMP assumes that no additional funding would be dedicated to any of the three levels described above until 2021.

Columbia Stormwater System
Capital and Programmatic Cost Estimates - Level 2 Service

Project Category	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Stormwater Planning	$ -	$ -	$ -	$ -	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 230,000	$ 100,000
Condition Assessment and Cleaning	$ -	$ -	$ -	$ -	$ 213,468	$ 213,468	$ 213,468	$ 130,000	$ 130,000	$ 130,000
System Renewal Program	$ -	$ -	$ -	$ -	$ 4,217,341	$ 4,217,341	$ 4,217,341	$ 4,217,341	$ 4,217,341	$ 4,217,341
Flood Reduction	$ -	$ -	$ -	$ -	$ 2,145,000	$ 2,095,000	$ 2,095,000	$ 2,095,000	$ 2,095,000	$ 2,095,000
Stream Erosion	$ -	$ -	$ -	$ -	$ 663,750	$ 638,750	$ 638,750	$ 638,750	$ 638,750	$ 638,750
Runoff Treatment	$ -	$ -	$ -	$ -	$ 2,759,081	$ 2,759,081	$ 2,759,081	$ 2,759,081	$ 2,759,081	$ 2,759,081
Stormwater Management Program	$ -	$ -	$ -	$ -	$ 524,000	$ 399,000	$ 399,000	$ 399,000	$ 399,000	$ 399,000
Annual Total	**$ -**	**$ -**	**$ -**	**$ -**	**$ 10,752,639**	**$ 10,552,639**	**$ 10,552,639**	**$ 10,469,171**	**$ 10,469,171**	**$ 10,339,171**
Cumulative Total	**$ -**	**$ -**	**$ -**	**$ -**	**$ 10,752,639**	**$ 21,305,279**	**$ 31,857,918**	**$ 42,327,089**	**$ 52,796,261**	**$ 63,135,432**

Columbia Stormwater System
Capital and Programmatic Cost Estimates - Level 2 Service

Project Category	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036
Stormwater Planning	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000
Condition Assessment and Cleaning	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000
System Renewal Program	$ 4,217,341	$ 4,217,341	$ 4,217,341	$ 4,217,341	$ 4,217,341	$ 4,217,341	$ 4,217,341	$ 4,217,341	$ 4,217,341	$ 4,217,341
Flood Reduction	$ 2,095,000	$ 2,095,000	$ 2,095,000	$ 2,095,000	$ 2,145,000	$ 2,095,000	$ 2,095,000	$ 2,095,000	$ 2,095,000	$ 2,095,000
Stream Erosion	$ 638,750	$ 638,750	$ 638,750	$ 638,750	$ 663,750	$ 638,750	$ 638,750	$ 638,750	$ 638,750	$ 638,750
Runoff Treatment	$ 2,759,081	$ 2,759,081	$ 2,759,081	$ 2,759,081	$ 2,759,081	$ 2,759,081	$ 2,759,081	$ 2,759,081	$ 2,759,081	$ 2,759,081
Stormwater Management Program	$ 399,000	$ 399,000	$ 399,000	$ 399,000	$ 524,000	$ 399,000	$ 399,000	$ 399,000	$ 399,000	$ 399,000
Annual Total	**$ 10,339,171**	**$ 10,339,171**	**$ 10,339,171**	**$ 10,339,171**	**$ 10,539,171**	**$ 10,339,171**	**$ 10,339,171**	**$ 10,339,171**	**$ 10,339,171**	**$ 10,339,171**
Cumulative Total	**$ 73,474,603**	**$ 83,813,775**	**$ 94,152,946**	**$ 104,492,117**	**$ 115,031,289**	**$ 125,370,460**	**$ 135,709,631**	**$ 146,048,803**	**$ 156,387,974**	**$ 166,727,145**

Table A.3. Level 3 Stormwater System Capital and Programmatic Cost Forecast, in 2017 Dollars. Estimates include potential additional capital, operation and maintenance, and planning costs over the IMP planning period. Because the 2015 voter-approved rate increase is scheduled to continue through 2020, the IMP assumes that no additional funding would be dedicated to any of the three levels described above until 2021.

Columbia Stormwater System Capital and Programmatic Cost Estimates - Level 2 Service										
Project Category	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Stormwater Planning	$ -	$ -	$ -	$ -	$ 280,000	$ 280,000	$ 280,000	$ 280,000	$ 280,000	$ 150,000
Condition Assessment and Cleaning	$ -	$ -	$ -	$ -	$ 213,468	$ 213,468	$ 213,468	$ 130,000	$ 130,000	$ 130,000
System Renewal Program	$ -	$ -	$ -	$ -	$ 7,273,668	$ 7,273,668	$ 7,273,668	$ 7,273,668	$ 7,273,668	$ 7,273,668
Flood Reduction	$ -	$ -	$ -	$ -	$ 2,582,500	$ 2,532,500	$ 2,532,500	$ 2,532,500	$ 2,532,500	$ 2,532,500
Stream Erosion	$ -	$ -	$ -	$ -	$ 885,000	$ 860,000	$ 860,000	$ 860,000	$ 860,000	$ 860,000
Runoff Treatment	$ -	$ -	$ -	$ -	$ 7,649,774	$ 7,649,774	$ 7,649,774	$ 7,649,774	$ 7,649,774	$ 7,649,774
Stormwater Management Program	$ -	$ -	$ -	$ -	$ 614,000	$ 464,000	$ 464,000	$ 464,000	$ 464,000	$ 464,000
Annual Total	**$ -**	**$ -**	**$ -**	**$ -**	**$ 19,498,410**	**$ 19,273,410**	**$ 19,273,410**	**$ 19,189,942**	**$ 19,189,942**	**$ 19,059,942**
Cumulative Total	**$ -**	**$ -**	**$ -**	**$ -**	**$ 19,498,410**	**$ 38,771,820**	**$ 58,045,229**	**$ 77,235,171**	**$ 96,425,113**	**$ 115,485,055**

Columbia Stormwater System Capital and Programmatic Cost Estimates - Level 2 Service										
Project Category	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**
Stormwater Planning	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000	$ 150,000
Condition Assessment and Cleaning	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000	$ 130,000
System Renewal Program	$ 7,273,668	$ 7,273,668	$ 7,273,668	$ 7,273,668	$ 7,273,668	$ 7,273,668	$ 7,273,668	$ 7,273,668	$ 7,273,668	$ 7,273,668
Flood Reduction	$ 2,532,500	$ 2,532,500	$ 2,532,500	$ 2,532,500	$ 2,582,500	$ 2,532,500	$ 2,532,500	$ 2,532,500	$ 2,532,500	$ 2,532,500
Stream Erosion	$ 860,000	$ 860,000	$ 860,000	$ 860,000	$ 885,000	$ 860,000	$ 860,000	$ 860,000	$ 860,000	$ 860,000
Runoff Treatment	$ 7,649,774	$ 7,649,774	$ 7,649,774	$ 7,649,774	$ 7,649,774	$ 7,649,774	$ 7,649,774	$ 7,649,774	$ 7,649,774	$ 7,649,774
Stormwater Management Program	$ 464,000	$ 464,000	$ 464,000	$ 464,000	$ 614,000	$ 464,000	$ 464,000	$ 464,000	$ 464,000	$ 464,000
Annual Total	**$ 19,059,942**	**$ 19,059,942**	**$ 19,059,942**	**$ 19,059,942**	**$ 19,284,942**	**$ 19,059,942**	**$ 19,059,942**	**$ 19,059,942**	**$ 19,059,942**	**$ 19,059,942**
Cumulative Total	**$ 134,544,997**	**$ 153,604,939**	**$ 172,664,880**	**$ 191,724,822**	**$ 211,009,764**	**$ 230,069,706**	**$ 249,129,648**	**$ 268,189,590**	**$ 287,249,531**	**$ 306,309,473**

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