Section 5

City Beautiful H_2O Program Planning Process

This section summarizes the governing principals, objectives, approach, and planning process for developing CRW's *City Beautiful H_2O Program Plan* (Program Plan). The Program Plan, is a long-term, integrated strategy to address the hydraulic and structural deficiencies of CRW's wastewater / stormwater assets, improve in-stream water quality, and protect public health. The planning process is outlined in **Figure 5-1**, illustrating how previous data collection and analyses have been incorporated to develop CSO control strategies for further evaluation. This process is consistent with both the US-EPA CSO Policy[1], and the US-EPA Integrated Municipal Stormwater and Wastewater Planning Approach Framework[2].

5.1 Overview of the Planning Process

CRW utilized three governing principals and objectives to guide the City Beautiful H_2O Program planning process:

- Be affordable and cost-effective
- Balance control of CSOs, SSOs, "unauthorized discharges", and MS4 discharges
- Optimize multi-objective opportunities to control stormwater, rehabilitate CRW assets, and enhance service area communities

The four-step planning process illustrated in **Figure 5-1** is summarized here and described in more detail in the subsequent subsections of this section.

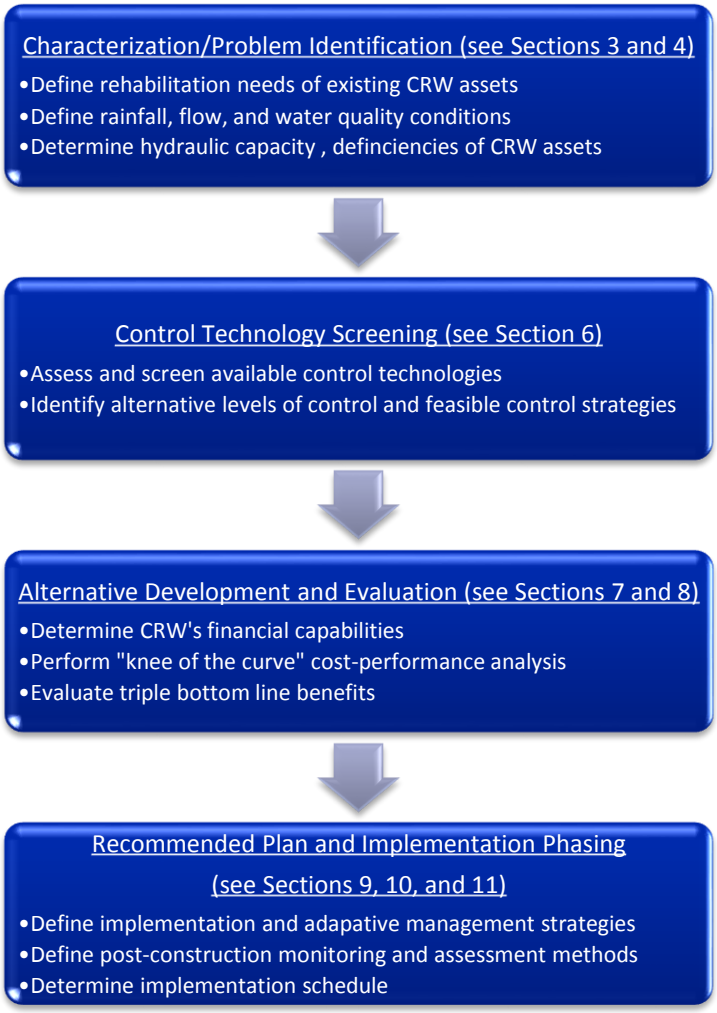

Figure 5-1: Summary of Integrated Wet Weather Control Plan Process

[1] Federal Register, *Combined Sewer Overflow (CSO) Control Policy: Notice; Part VII Environmental Protection Agency,* Vol. 59, No. 75, April 19, 1994, pp 18688 through 18698, Washington, DC.

[2] Stoner, Nancy, Memorandum: *Integrated Municipal Stormwater and Wastewater Planning Approach Framework,* June 5, 2012, U.S. Environmental Protection Agency, Washington, DC.

Characterization/Problem Identification involves the activities and processes used to characterize the CRW service area, including:

- The configuration and rehabilitation needs of CRW's treatment, conveyance, and collection assets,
- The characteristics of rainfall over CRW's service area, the wastewater/stormwater flows within CRW's sewer systems, and quality and condition of surface waters that receive discharges for CSW's systems, and
- The hydraulic performance of CRW's combined sewer system and separate sanitary sewer system, including the quantity and quality of discharges from this system.

Sections 3 and 4 of this Program Plan summarize the findings of CRW's characterization and problem identification process. Planning procedures for performing these tasks are included in these sections. CRW's characterization and problem identification process revealed substantial asset rehabilitation needs attributable to years of deferred maintenance throughout the treatment, conveyance, and collection systems. Hydraulic evaluation revealed frequent, short-duration overflows at each of CRW's regulated CSO outfalls, coupled with localized collection system flooding and potential basement backups. Evaluation of water quality data indicated that CRW's CSO and municipal separate stormwater sewer system (MS4) discharges, coupled with significant hydromodification of Paxton Creek, contribute to water quality degradation.

Control Technology Screening involves the initial planning processes by which decentralized and multi-objective control opportunities were identified for CRW's treatment and conveyance systems, along with designated planning areas within CRW's collection system. It explains how the planning areas were selected and delineated. It goes on to describe the screening analyses used to evaluate and pare down the alternative control opportunities, and defines baseline alternatives. Section 5.3 summarizes the screening processes used to define feasible technologies and develop alternative control strategies for CRW's assets. Complete findings of the technology screening process are found in Section 6.

Alternative Development and Evaluation, defines appropriate control technologies for each control strategy, determines the "knee-of-the-curve" cost performance, and evaluates the benefits of each strategy using triple bottom line (TBL) evaluation criteria. The process is explained in Section 5.4.

- Formulating baseline, systemwide, and local control strategies, composed of specific feasible control technologies that meet the identified planning objectives and the opportunities to further enhance wet weather control,
- Using a "knee-of the curve" cost evaluation process to size alternative control technologies to achieve each alternative level of control being evaluated, i.e., an affordable, cost-effective, and water quality compliant level of control.
- Employing a "triple bottom line" decision making process to select a preferred control strategy (or combination of strategies) for CRW's treatment, conveyance, and collection assets.

- Performing a financial capabilities analysis according to US-EPA protocol and using it to establish realistic investment strategies and phasing of priority system rehabilitation and wet weather controls.

The CRW Program Plan has adopted a triple bottom line (TBL) accounting framework that incorporates three dimensions of performance: social, environmental and financial. TBL is a concept which seeks to broaden the focus on the financial bottom line by including social and environmental responsibilities and Program benefits. The CRW planning process included preparing and considering three different (and quite separate) bottom lines. One was the traditional measure of cost versus benefit, the bottom line. The second was the bottom line of the Plan's "people account", a measure in some shape or form of how socially responsible the Plan is in improving the quality of life for CRW's customers. The third was the bottom line of the Plan's "planet" account, a measure of how environmentally responsible it is.

Recommended Plan and Implementation Phasing employs a financial capability assessment (FCA) to determine an affordable, balanced level of investment in CRW's assets, and uses this evaluation to establish appropriate program phasing and limits on program financing. In addition, an adaptive management process is defined that sets program milestones, establishes a long-term monitoring and implementation tracking system to measure progress, and establishes decision-making metrics for future adjustments to the implementation schedule under an evolving adaptive management process. This process is explained in Section 5.5.

5.2 Characterization and Problem Identification

The first major phase of the Program Plan development process was to implement the activities and processes required to fully understand the existing system; how it is configured, its current condition and defects, and how it performs hydraulically. Characterization and problem identification were addressed in Sections 3 and 4 of this Program Plan. This section summarizes the key elements of the planning process used to develop this portion of the Program Plan.

5.2.1 Evaluation of Collected System Data and Monitoring Results

A brief summary of the data collection process is provided in Section 3.2. In addition, flow/precipitation/stream depth monitoring data and system condition data were processed and analyzed to understand the existing system and characterize existing hydraulic conditions.

5.2.2 Hydrologic and Hydraulic Model Development

After collecting the required data, a hydrologic and hydraulic (H&H) model was developed and used as a tool to simulate existing conditions and evaluate alternative control strategies and levels of control. The H&H model was developed from the collected data, and was calibrated and subsequently used to quantify and characterize sewer system flows and the frequency, duration and volume of CSO discharges into receiving water bodies. Refer to Section 3.4. The calibrated model was then used to characterize the changes in hydraulic flow through the conveyance system and the changes to CSO discharges to receiving waters under a range of selected alternative improvements/ controls.

5.2.3 Characterization of Existing Combined Sewer Systems

The next step in planning process is to utilize the calibrated H&H model to quantify and characterize the hydraulic performance of the combined sewer system and identify specific areas of surface flooding or potential basement flooding or backups. Refer to Section 4.4. Concurrently, the system inspection data and subsequent condition assessment analyses were used to characterize the condition of the existing conveyance and collection systems, and to identify critical defects that need to be corrected as part of the Plan. Many system rehabilitation projects, to be included and scheduled in the Plan, have already been identified from the inspection information gathered.

As continuing CCTV inspections are completed, the list of rehabilitation projects will be updated and re-prioritized as needed. The reality is that there will likely be more identified significant problem areas than there is available budget to repair, as demonstrated in Section 7. Rehabilitation projects may be deferred until budget becomes available. Imminent defects requiring immediate rehabilitation may require reallocating budget from green infrastructure or CSO control budgets, and may ultimately result in a worst-case scenario, reducing the level of CSO/SSO/MS4/unauthorized release control provided by the Program Plan.

5.2.4 Characterization of Existing Separate Sanitary Sewer Systems

A thorough understanding of CRW's separate sanitary sewer systems was developed. The Program Plan must address both CSO and SSO discharges as well as MS4 stormwater discharges and unauthorized releases (sewage surface flooding, dry weather overflows, and basement backups) from the combined system. The calibrated H&H model was used to quantify and characterize the hydraulic performance of the separate sewer system and identify locations for potential SSO discharges and basement flooding. Refer to Section 4.5. Concurrently, the system inspection data and subsequent analyses were used to characterize the condition of the existing conveyance and collection systems, and to identify critical defects and hydraulic bottlenecks that need to be corrected as part of the Program Plan.

5.3 Control Technology Screening

The second major phase of the Program Plan development process consists of evaluating available stormwater/wet weather control technologies, categorizing them to fit the baseline, systemwide, and local control strategies, and eliminating from consideration technologies that are not feasible or relevant to implement within CRW's system. Section 6 presents the full evaluation and screening of available control technologies.

5.3.1 Describe, Evaluate Feasibility of Available Control Technologies

CRW established a list of technologies that are commonly used for stormwater/wet weather control, sewer rehabilitation, and hydraulic enhancements. Refer to Section 6 for these technologies. Each of these control technologies is further assessed and categorized to fit into the various control strategies under this Program Plan (identified in Section 5.3.2 below) to identify feasible and cost-effective technologies to be further refined, and those that will not be considered. The identified technologies were screened based upon construction feasibility, siting feasibility, cost effectiveness, and other criteria. Technologies that were clearly not constructible, would not fit within the available space, are not cost-effective, or are not applicable to the CRW

service area were ruled out. Technologies that were feasible, cost-effective and applicable were retained for further evaluation in Section 8.

5.3.2 Define Alternative Levels of Control

CRW's partial Consent Decree requires performance of a "knee-of-the-curve" cost performance evaluation. The findings of this evaluation are presented throughout Section 8. This "knee-of-the-curve" evaluation, in turn, is used to define four distinct levels of control:

- ***Level 1: Baseline Level of Control.*** The level of control provided by the multi-objective projects that optimize the existing sewer system, which include relatively low-cost operating changes, repairs, and small-scale capital projects.
- ***Level 2: Affordable Level of Control.*** The level of control that would lie within the maximum financial capabilities of CRW's ratepayers without severe economic hardship, as defined in Section 7.
- ***Level 3: Cost-Effective Level of Control.*** The level of control provided at the inflection point of the "knee of the curve", where the ratio of the control benefits to the associated control cost is maximized, based on analyses described in Section 8.
- ***Level 4: Presumptive Level of Control.*** The level of control provided by implementing sufficient wet weather controls to capture and treat 85 percent of the systemwide combined sewage during the typical year.

5.3.3 Define a Baseline Level of Control

A baseline level of control involves multi-objective projects to first rehabilitate, then provide routine renewal of CRW's assets, including its AWTF, its major pumping stations, its interceptors, and its various CSO regulator structures. Included are asset rehabilitation projects that include hydraulic/treatment enhancements feasible to incorporate into the existing AWTF, pump station, and/or CSO regulator structures. Defining the baseline level of control involves:

- Define "baseline" technologies that are low-cost, simple changes, including minimum control measures, operational changes, and simple structural refinements that optimize or enhance the existing system.
- Provide an ongoing program of rehabilitation and renewal of CRW assets to recognize and address critical risks, enhance system resiliency, and restore/enhance the hydraulic capacity of existing assets where cost-effective (i.e., no new or replacement assets).
- Determine the associated level of control. This will provide a starting point for establishing feasible systemwide and local control strategies.
- Phase the implementation of baseline controls using risk-based prioritization criteria and cost-effectiveness considerations, defined based on financial capabilities analysis presented in Section 7.

Program Plan Section 4.2 provides descriptions of the high risk/high priority projects at the AWTF and along the conveyance system that are included in the baseline level of control.

5.3.4 Delineate Program Planning Areas

CRW's service area was divided into program planning areas, a standard procedure for the development of all LTCPs. Fifteen planning areas were delineated, some largely separate and some largely combined. This delineation was based on receiving water, interceptor sewershed, recognized neighborhoods, and logical groupings of catchments to support satellite control strategies. A map of the delineated planning areas is found in **Figure 5-2**.

5.3.5 Establish Feasible Systemwide and Local Control Strategies

The next step in the planning process is to formulate feasible control strategies. First, the following two *systemwide control strategies* start with the baseline strategy and progressively integrate appropriate control technologies into CRW's AWTF and conveyance system:

- ***Systemwide Strategy 1*:** achieve the full hydraulic conveyance capacity of CRW's interceptors (approximately 120 MGD) by increasing the AWTF hydraulic/primary treatment capacity, adding additional pumping capacity, and replacing restrictive connector pipes at CRW regulators.
- ***Systemwide Strategy 2*:** install deep tunnels parallel to CRW's conveyance system, including consolidation sewers from CSO regulators to tunnel drop shafts and new dewatering pump stations, increasing overall conveyance and storage within CRW's conveyance system.

Next, the following three *local control strategies* start with the baseline strategy within each of the program planning areas, and progressively integrate appropriate control technologies into CRW's collection system:

- ***Local Strategy 1:*** A *decentralized control strategy* that focuses controls (a) within catchments where the baseline strategy does not achieve the desired CRW level of control and (b) to achieve multi-objective benefits (e.g., reduce CSOs/SSOs/unauthorized discharges, and MS4 discharges; maximize triple bottom line benefits, leverage non-traditional funding sources).
- ***Local Strategy 2:*** A *satellite control strategy* that employs storage/treatment/conveyance facilities focused on CSO control within catchments where the baseline strategy does not achieve the desired CRW level of control.
- ***Local Strategy 3:*** A *sewer separation strategy* within catchment areas where the baseline strategy does not achieve the desired CRW level of control, defining various percentages and areas of the collection system to separate to achieve desired control levels.

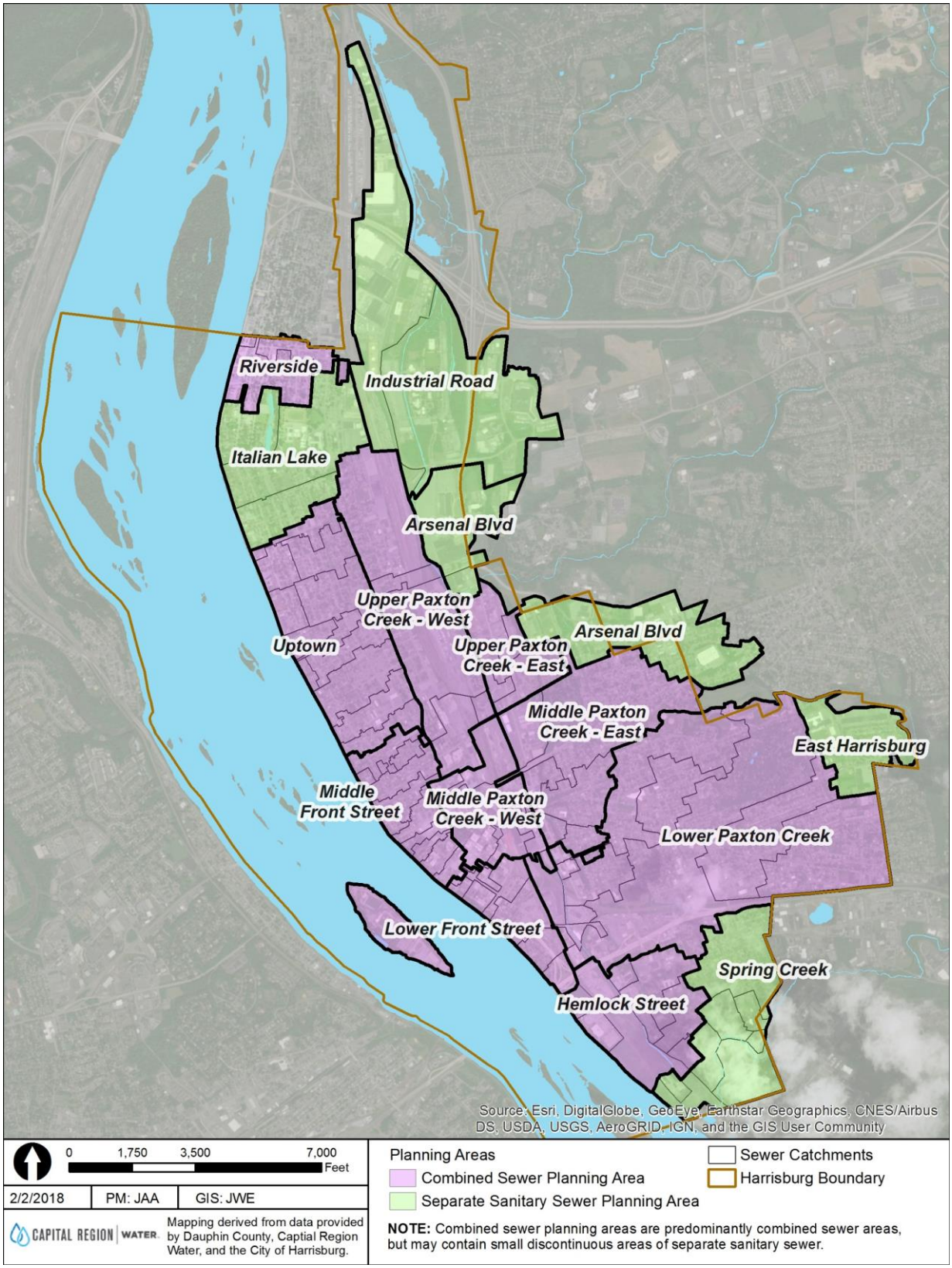

Figure 5-2: Designated Planning Areas within the CRW Service Area

Within each of the program planning areas, control strategies are developed to best balance the following three priorities.

- Reduce CSO discharge volumes and frequencies to mitigate water quality impairment.
- Mitigate hydraulic pinch-points and their associated risks of unauthorized releases and SSOs.
- Improve the structural integrity and resilience of priority sewer assets.

Alternative controls to consider may include a combination of further modifications to CSO regulator structures and connector pipes, required rehabilitation for grade 4 (poor condition) and 5 (very poor condition) pipe defects, solutions for localized flooding and basement backup areas, and green stormwater infrastructure opportunities. As required sewer rehabilitation projects come up on the series of 5-year schedules, opportunities for additional levels of stormwater/CSO control will be identified and assessed for potential project elements such as oversizing the damaged pipe reach to provide additional storage, adding supplemental green stormwater infrastructure to the project for stormwater runoff control, etc.

5.4 Alternative Development and Evaluation

The third major phase of the Program Plan development process is to evaluate and select appropriate control technologies for each control strategy, conduct the "knee-of-the-curve" cost performance analyses (including limitations on the level of control achievable within each strategy), and evaluate the benefits of each strategy using triple bottom line evaluation criteria.

5.4.1 Define Alternatives to Enhance Wet Weather Control

Specific control technologies were selected for each control strategy, as well as feasible levels of implementation based upon an evaluation of the opportunities and barriers to implementing these controls within CRW's system across the range of sizes necessary to define the "knee-of-the-curve" as defined in the Partial Consent Decree (PCD). The PCD requires CRW to evaluate system-wide sewer separation and system-wide tunnel storage alternatives regardless of financial/implementation feasibility or cost effectiveness.

CRW has developed and assessed a series of decentralized approaches that implement various combinations of the grey control technologies and the green control technologies that were selected through the previously completed control technology screening process. Specific decentralized strategies have been developed for each of the designated planning areas within the CRW service area. The series of evaluated strategies provided a range of levels of CSO discharge control. Each level of control has an associated cost and resulting benefits.

5.4.2 Perform Knee-of-the-Curve Cost Performance Analyses

A knee-of-the curve cost performance evaluation was performed for the entire control range for each selected decentralized alternative within each of the designated planning basin areas. A knee-of-the curve cost performance evaluation was also performed for the entire range of PCD-required system-wide sewer separation and system-wide tunnel storage alternatives. The process, illustrated in **Figure 5-3**, is intended to identify whether a systemwide or

decentralized/local control strategy is best for the CRW service area under each level of control, as well as identify potential implementation and feasibility issues, including economic feasibility constraints.

5.4.3 Determine Benefits and Costs of each Control Strategy

The CRW Program Plan has adopted a triple bottom line (TBL) framework for evaluating the alternative control strategies that incorporates three dimensions of performance: social, environmental and financial. TBL is a concept which seeks to broaden the focus on the financial bottom line by including social and environmental responsibilities and Program Plan benefits. CRW prepared a strategic plan for the entire organization, setting strategic goals and objectives for measuring performance. Those strategic objectives associated with CRW's stormwater / wastewater system were incorporated into the TBL framework for alternatives evaluation, as illustrated in **Table 5-1**. In addition, specific criteria are noted for each TBL objective, which were taken into consideration during the evaluation.

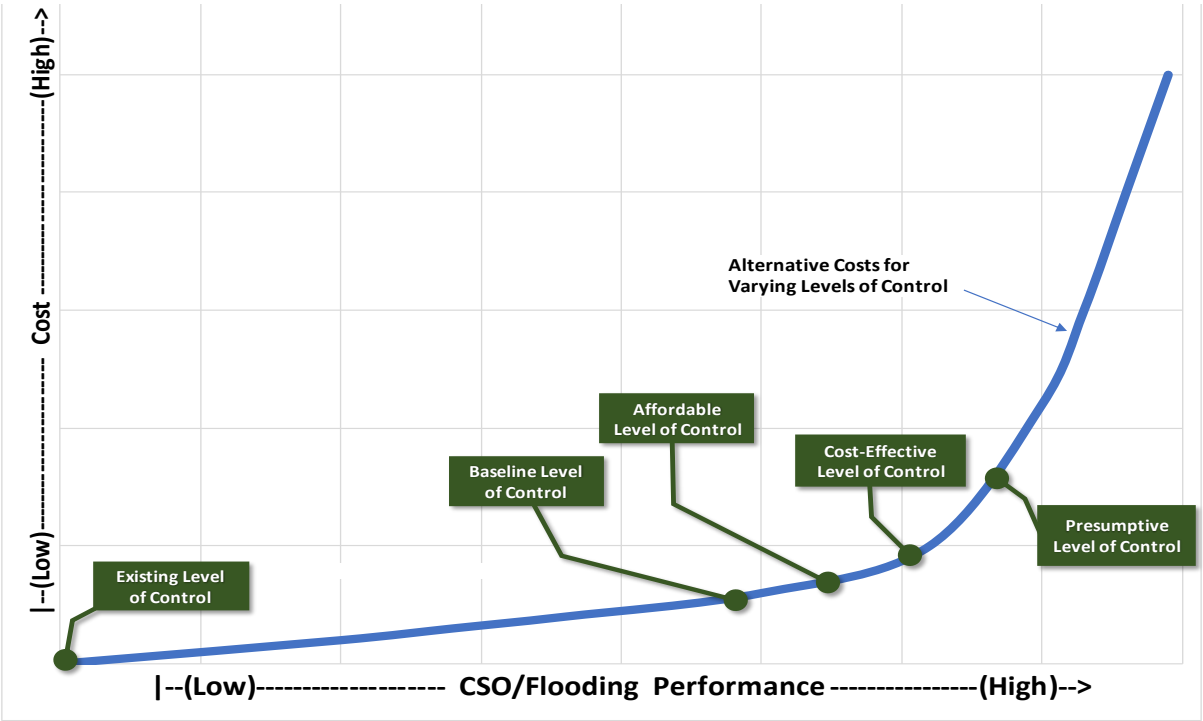

Figure 5-3: Example Cost Performance Curve with Differing Endpoints

The CRW planning process included preparing and considering three different (and quite separate) bottom lines. One is ***financial***, the traditional measure of profit, the bottom line of the cost and benefit analysis. The second is ***social/community***, the bottom line of the Plan's "people account", a measure in some shape or form of how socially responsible the Plan is in improving the quality of life for CRW's customers. The third is ***environmental,*** the bottom line of the Plan's "planet" account, a measure of how environmentally responsible it is.

Table 5-1: Triple Bottom Line Evaluation Criteria and Relationship to CRW Strategic Goals and Objectives

Triple Bottom Line Category	CRW Strategic Planning Goals	CRW Strategic Planning Objectives	Evaluation Criteria to Consider
Financial	Efficient Use of Resources	Use Financial Resources Efficiently	▪ Capital cost-effectiveness ▪ O&M cost-effectiveness ▪ Potential operational/resource impacts
		Use Energy Efficiently	▪ Anticipated energy use
		Integrate Infrastructure/Operations to Achieve Multiple Objectives	▪ Strategy addresses multiple objectives ▪ Strategy achieves operational efficiencies ▪ Strategy integrates programs/facilities
	Infrastructure Stability	Ensure Reliable Operations	▪ Technologies are feasible and reliable ▪ Strategy is acceptable to regulators
		Minimize Construction Difficulty/Risk	▪ Anticipated construction difficulty, risk
		Ensure Flexibility, Adaptability, and Expandability of New Infrastructure	▪ Flexibility to address multiple risks ▪ Public-private partnership opportunities ▪ Adaptive management opportunities
Social/ community	Customers and Stakeholders	Increase Customer and Stakeholder Satisfaction	▪ Is affordable to ratepayers ▪ Has stakeholder support ▪ Integrates with community objectives ▪ Environmental justice population impacts
	Workforce	Create Employment Opportunities at CRW and in the Community	▪ Employment opportunities at CRW ▪ Employment opportunities in City
Environmental	Public Health and the Environment	Improve Water Quality	▪ CSO volume/frequency reduction ▪ Pollutant load reduction ▪ Addresses pollutants of concern ▪ Addresses sensitive/priority areas ▪ Regulatory compliance considerations
		Support Long-term Community Health	▪ Reduced risk of SSOs ▪ Reduced risk of unauthorized releases ▪ Increases green space/vegetation/trees

5.5 Recommended Control Plan and Implementation Phasing

The final phase of the Program Plan development process is to use the findings of the screening activities and the selected control strategy/technology combinations to consider a range of facility sizes and associated control ranges, and to conduct cost-effectiveness analyses to identify the optimal control range and implementation duration. A control plan is selected that minimizes CSO discharges, improves water receiving quality, addresses stormwater management and local flooding, and meets affordable guideline constraints for rate payers.

5.5.1 Determine Affordability of Alternative Control Levels

From a triple bottom line perspective, based upon the knee-of-the curve cost performance results, the affordability limits, and the identified optimal solutions for each of the program planning areas, select the preferred control strategy (or combination of control strategies) for the affordable level of control.

5.5.2 Prioritize and Phase Implementation of Controls

The selected plan, as identified and defined in the Program Plan, will evolve over time under an adaptive management implementation approach. To facilitate an adaptive management approach, required sewer rehabilitation projects (for pipe reaches with grade 4 or 5 defects) will be

identified on the series of 5-year schedules. These 5-year schedules and the associated selected projects and costs, will evolve as new CCTV information becomes available and implementation priorities adjust accordingly. It must be understood that strongly desired projects and/or control facility elements may need to be ruled out because their costs are obviously outside the range of affordability, even though the component may be "needed" or provide significant desired benefits. Unless an unmet/unaffordable need is critical with significant and unacceptable consequences, many desirable projects or project elements will not be included in the Program Plan because of affordability constraints. Under the adaptive management approach, opportunities for additional levels of stormwater/CSO control will be identified and assessed as each individual prioritized rehabilitation project is scheduled for implementation. The design process will include identifying potential grey/green project elements that would provide additional stormwater runoff control and reduce demands on sewer infrastructure.

5.5.3 Prepare Integrated Wet Weather Control Plan

The *City Beautiful H_2O Program Plan* was prepared to address all required elements of the PCD, the CSO Control Policy, the CSO LTCP Guidance, and US-EPA's integrated stormwater/wastewater planning strategy. PCD requirements and other PCD compliance documents were summarized and/or incorporated into the Program Plan by reference.

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