Section 6

Control Technologies and Screening

6.1 Overview of Control Technologies and Screening

This section describes the potential Combined Sewer Overflow (CSO) control technologies to be considered by Capital Region Water (CRW). The technologies included are generally grouped into the following categories:

- Source Controls: Technologies, operating strategies, and policies that affect the quantity and quality of runoff that enters CRW's combined sewer system.
- Conveyance/Collection System Control: Modifications within the collection system that affect CSO flows and loads after the introduction of runoff.
- Storage Technologies: In-line and off-line storage for wet weather flows that are detained and released once treatment and conveyance capacity have been restored.
- Treatment Technologies: Technologies to reduce pollutant load to the receiving waters.
- Receiving Water Technologies: Methods for removing pollutants after they have been discharged to the receiving waters.

6.2 Identification of Feasible CSO Controls

6.2.1 Source Controls

Green Stormwater Infrastructure (GSI)*:* Specific sets of source controls that use natural processes such as infiltration, evapotranspiration, and filtration, storage, and controlled release to reduce the volume of stormwater entering the sewer system. Green stormwater infrastructure includes bioretention, subsurface infiltration, green roofs, porous pavement, rain gardens, and street trees, and is capable of providing significant levels of control over the course of a year through their performance in small- to moderate-sized storms.

Inflow Reduction: A variety of control measures can be utilized to reduce the inflow of stormwater and/or pollutants to the combined sewer. These include roof leader disconnections, sump pump disconnections, catch basin modifications and maintenance, street storage (catch basin inlet control), etc.

Construction-Phase Controls: The Dauphin County Conservation District (District) enforces construction-phase erosion and sediment (E&S) control within the CRW service area in accordance with PA-DEP requirements. These measures reduce the load of solids to the combined sewer and receiving waters. District staff review and approve E&S plans submitted by developers and conduct site inspections during construction, levying fines if necessary to ensure compliance.

Post-Construction Controls: CRW enforces stormwater management rules and regulations for new development and redevelopment. Post-construction controls are most effective for CSO control where they focus on restoring a more natural balance between stormwater runoff and infiltration, reducing pollutant loads, and controlling runoff rates at levels that minimize stream bank erosion. CRW has initiated a pilot green infrastructure program to better define design criteria and potential enhanced regulations that address impairment of a surface water body in Harrisburg. Site designers can provide the level of performance required using a variety of controls such as disconnection of impervious cover, bioretention, subsurface storage and infiltration, green roofs, swales, and tree canopy.

Pollution Prevention/Good Housekeeping: Several good housekeeping practices can reduce pollution in local waterways, such as proper handling of hazardous materials, spill prevention, and street sweeping. Additional means of preventing pollution include requirements for industrial pretreatment and stormwater management, septic system management, household hazardous waste collection, and litter and illegal dumping enforcement.

6.2.2 Conveyance/Collection System Controls

Sewer Separation: An inflow removal/source control method whereby a combined sewer system is divided into separate sewers/pipes for sanitary and stormwater flows. The scope of work could be limited to sewers within the public right-of-way or it could extend to private property. Sewer separation can be accomplished by providing new sanitary sewers, including private connections to existing structures and constructing a new separate sanitary collection system. The existing combined sewers will then serve as the new separate storm sewers. Sewer separation can also be accomplished by leaving the previously combined sewers as sanitary sewers and new storm sewers would be constructed. This is more commonly referred to "stormwater redirection." Complete separation involves both public and private inflow removal whereas partial separation involves only the public inflow sources, such as a catch basin in the public right-of-way.

Optimization of Existing System: Use of the collection system for storage has long been recognized as a potentially cost-effective means to mitigate the occurrence and impacts of CSOs. An approach that can be implemented to gain additional in-system storage is to raise the overflow elevation by physically modifying the overflow structure (e.g. raising an overflow weir). However, this approach must be implemented cautiously, since raising the overflow elevation also raises the hydraulic grade line in the combined trunk sewer during storm flows, and therefore increases the risk of basement and other structural flooding within the upstream sewer system due to backup or surcharge problems.

Real-Time Control: Real-time controls are controlled CSO outfall/regulator gate facilities that use level monitors to control the position of the connector pipe gate and tide gate at each location for maximizing the utilization of in-system storage in the combined sewer system. These computer controlled outfall facilities apply real-time control (RTC) mechanisms to maximize in-system storage. The use of RTC allows the capture and delivery to the treatment works of flow at the maximum rate at which it can be treated. This approach is attractive in terms of optimizing the use of the existing sewer system to capture combined wastewater and minimize CSOs.

Regulator/Pump Station Inspection/Maintenance/Repairs*:* In order to keep the regulators and pumping stations optimized it is necessary to have routine site inspections and maintenance performed. It is not uncommon for debris and grit to interfere with regulator and pump operations and therefore, expansion and continuation of the current regulator and pumping station inspection and maintenance programs will allow for efficient detection of malfunctioning regulator and/or pumping stations. Presently, the maintenance and repair program relies on site inspections to identify faulty mechanisms, grit or debris build-up and/or damage to the regulator or pumping structure itself. The observations are documented and updated in a database to track repairs.

Outfall and Regulator Consolidation: Where several outfalls are near each other, CRW can investigate whether to consolidate them to a single location for storage and/or treatment. Consolidation can provide more cost-effective control of CSOs, minimizing the number of sites necessary for abatement facilities, and reducing the number of permitted outfalls. In waterfront areas where redevelopment is taking place and new public amenities are being created, elimination of outfalls can remove an impediment to public use and enjoyment of the waterfront.

Outfall Maintenance Program: Because of the debris normally present in combined sewage, regulators are particularly susceptible to the accumulation of materials that cause clogging and blockages. Trash blockages at the entrance to the orifice of the interceptor increase head loss through the orifice and cause the majority of unnecessary overflows in passive regulators. Other causes of unnecessary diversions at regulators include weir plates or dams that are improperly set, damaged, or broken off. Similarly, tide gate failure can often be attributed to trash or debris becoming lodged in the gate, or corrosion of the gate or deterioration of the gate gaskets. Tide gate failure allows the receiving water to enter the combined sewer system (CSS), reducing the storage and flow capacity.

Sewer System Inspection and Cleaning: Maintenance of sewers includes activities required to keep the system functioning as it was originally designed and constructed. Any reinvestment in the system, including routine maintenance, capital improvements for repair or rehabilitation, inspection activities, and monitoring activities are generally classified as maintenance.

An inspection program is vital to proper maintenance of a wastewater collection system. Without inspections, a maintenance program is difficult to design, since problems cannot be solved if they are not identified. Sewer inspections identify problems such as blocked, broken, or cracked pipes; tree roots growing into the sewer; sections of pipe that settle or shift so that pipe joints no longer match; and sediment and other material building up and causing pipes to break or collapse. The elements of an inspection program include flow monitoring, manhole inspections, smoke/dye testing, closed circuit television inspection, and private sector inspections. Private sector building inspection activities include inspection of area drains, downspouts, cleanouts, sump discharges, and other private sector inflow sources into the system.

In addition to inspection, routine maintenance must also include sewer cleaning, root removal/treatment, cleaning of mainline stoppages, cleaning of house service stoppages, and inspections and servicing of pump stations.

Parallel Interceptors: Parallel interceptors provide increased transmission capacity to bring flows to the Advanced Wastewater Treatment Facility (AWTF).

Remove Flow Bottlenecks: CRW's collection system includes some localized instances where infrastructure does not have the capacity to convey the full flow from upstream. Examples include siphons and pipes of smaller diameter than upstream pipes. In these cases, localized replacement may be a cost-effective way to increase transmission capacity to the AWTF.

Combined Sewer Rehabilitation: An inspection program may identify sections of sewer that are in poor condition and in need of major repair or replacement. Under the traditional method of sewer relief, a replacement or additional parallel sewer line is constructed by digging along the entire length of the existing pipeline. While these traditional methods of sewer rehabilitation require unearthing and replacing the deficient pipe (the dig-and-replace method), trenchless methods of rehabilitation use the existing pipe as a host for a new pipe or liner. Trenchless sewer rehabilitation techniques offer a method of correcting pipe deficiencies that requires less restoration and causes less disturbance and environmental degradation than the traditional dig and-replace method.

Diversion of Trunk Flow Directly to AWTF: For a limited number of small catchment areas close to the AWTF, it may be possible to divert all trunk flow to the AWTF without regulation.

6.2.3 Storage Technologies

In-Line Storage in Interceptor or Trunk Sewer: In-line storage can be developed in two ways: (1) construction of new tanks or oversized conduits to provide storage capacity or (2) construction of a flow regulator to optimize storage capacity in existing conduits. The new tanks or oversized conduits are designed to allow dry weather flow to pass through, while flows above design peaks are restricted, causing the tank or oversized conduit to fill. A flow regulator on an existing conduit functions under the same principle, with the existing conduit providing the storage volume. Developing in-line storage in existing conduits is typically less costly than other, more capital-intensive technologies, such as offline storage/sedimentation, and is attractive because it provides the most effective utilization of existing facilities. The applicability of in-line storage, particularly the use of existing conduits for storage, is very site-specific, depending on existing conduit sizes and the risk of flooding due to an elevated hydraulic grade line.

Earthen Basins: Generally, there are three types of earthen basins used in stormwater management design: Detention, Wet Weather Retention, and Infiltration. All basins are supplemented with some form of underdrain and emergency overflow structure to manage flow into the combined system. Detention basins are large areas of depression within a pervious location that remains dry except during wet weather events. The detention basins capture wet weather runoff during storm events and detain the runoff to attenuate peak flows into the combined system. Wet weather retention basins always have a small pond of water and generally are vegetated. The retention pond allows for greater nutrient and solids removal than that of the detention basin. Infiltration basins are constructed with a more intricate underdrain system to facilitate nutrient and solids removal as well as infiltration and groundwater recharge of captured stormwater.

Earthen basins, as described above, may be implemented in a variety of sizes and locations to help meet stormwater management needs for large or small drainage areas. The flexibility of earthen basins allow for them to be used in conjunction with other stormwater management practices to reduce CSOs into receiving waters.

Offline Above or Below Grade Closed Storage Tanks: Off-line or tank storage control technologies are designed to capture a prescribed volume of overflow, with no provisions for flow-through operation. Volumes exceeding the design capacity bypass the tank storage. The volume stored is sufficient to allow capture of all smaller storms and some fraction of larger storms. The tanks have influent screening and automatic flushing systems to assist in the post-event tank cleaning. Dewatering pumps are provided to transport the contents of the tank and the collected solids to the interceptor system following the overflow event.

Tunnel Storage: A system used to capture, store, and convey large volumes of CSO or SSO discharge. The pumped effluent is transported and treated either at the AWTF or through another technology before being discharged to the receiving waters. Tunnels can accommodate large overflow volumes with little or no disruption to the surrounding land surface area and capture all smaller storms and some fraction of larger storms.

Instream Storage: The instream storage method involves using floating pontoons and flexible curtains to create a storage facility within the receiving water. CSO flows fill the facility by displacing the receiving water that normally occupies the storage facility. The CSO flows are then pumped to the collection system following a storm. The technology has been used for CSO control in Brooklyn, New York. This alternative involves permanently installing the floating pontoons in the receiving water near the CSO outlets. The feasibility of this technology, therefore, depends in part on whether the structure would be a hindrance to navigation.

6.2.4 Treatment Technologies

Screening: Screens and trash racks consist of a series of vertical and horizontal bars or wires that trap floatables while allowing water to pass through the openings between the bars or wires. Screens can be installed at select points within a CSS to capture floatables and prevent their discharge in CSOs. Screens used for CSO control include mechanically cleaned permanent screens, static screens, traveling screens, or drum screens. Screens can also be divided into three categories according to the size of floatable material they are designed to capture. These are:

- Bar screens (> 2.5 centimeter [1 inch] openings)
- Coarse screens (0.5 to 2.5 centimeter [0.19 to 1 inch] openings)
- Fine screens (0.01 to 0.5 centimeter [0.004 to 0.19 inch] openings)

The screens most commonly used to control CSOs are trash racks (a type of bar screen primarily used as an end-of-pipe control) and coarse screens.

Netting: Two types of netting systems can be used to collect floatables in a CSS: in-line netting and floating units. In-line netting can be installed at strategic locations throughout the CSS. The nets would be installed in underground concrete vaults containing one or more nylon mesh bags and a metal frame and guide system to support the nets. The mesh netting is sized according to the volume and types of floatables targeted for capture. The CSO flow carries the floatables into the nets for capture. Bags are replaced after every storm event. Floating units consist of an in-water containment area that funnels CSO flow through a series of large nylon mesh nets. Mesh size depends on the volume and type of floatables expected at the site. This system is passive and relies on the energy of the overflow to carry the floatables to the nets. However, nets must be located some distance from the outfall (often 15 meters [50 feet] or more) to allow floatables entrained in the turbulent CSO flow to rise to the flow surface and be captured. The nets are single use, and after an overflow, the nets are typically removed and taken to a disposal area.

Swirl Concentrator: Swirl concentrators provide flow regulation and solids separation by inducing a swirling motion within a vessel. Solids are concentrated and removed through an underdrain, while clarified effluent passes over a weir at the top of the vessel. Types of swirl devices include the US-EPA swirl concentrator. Conceptually, the US-EPA swirl concentrator is designed to act as an in-line regulator device. In addition to flow routing or diversion, it removes heavy solids and floatables from the overflow. Each type of swirl unit has a different configuration of depth/diameter ratio, baffles, pipe arrangements, and other details designed to maximize performance.

Vortex Separation: The commercial vortex separators are based on the same general concept as the US-EPA swirl concentrator, but include a number of design modifications intended to improve solids separation. The commercial designs have been applied as offline treatment units. Vortex separators placed at discharge points are intended for inorganic solids separation and removal prior to discharging. Separation is facilitated by a swirling motion similar to a centrifuge and the solids are settled out at the bottom of the unit. Vortex Separators are available for both in-line and offline treatment, are available in varying sizes and designs, which are based on the peak flow design event and on-site configuration requirements.

High Rate Clarification: High rate clarification (HRC) processes have surface overflow rates greater than 20 gallons per minute per square foot (gpm/ft^2). Several proprietary technologies exist.

- *DensaDeg® Ballasted Flocculation* recirculates settled sludge as the ballast to achieve total suspended solids (TSS) removal at a standard design surface overflow rate of 40 gpm/ft^2 for wet weather flow. The process consists of a rapid mix zone, reactor zone, and a clarifier/thickening zone. Polymer is added as a flocculating agent as the wastewater flows to the reactor zone, which is equipped with an axial flow impeller/ draft tube arrangement. The water and flocculated sludge enter the clarification zone where most of the solids settle. Suspended solids removal in excess of 90 percent of influent concentrations can be achieved consistently by Actiflo® Ballasted Flocculation

- *Actiflo® Ballasted Flocculation* utilizes microsand as the ballast to achieve TSS removal at a standard design surface overflow rate of 60 gpm/ft^2 for wet weather flow. The process consists of a coagulation zone, injection zone, maturation zone, and clarification zone. Wastewater enters the coagulation chamber along with a coagulant for flash mixing. Microsand interacts with the destabilized particles and the polymer. The polymer promotes the formation of strong flocs around the microsand. The Actiflo® process provides high removal efficiencies and is stable at variable influent flows and loads.

- *Biologically and chemically enhanced clarification (Bio CEC)* is a relatively new process that incorporates a short duration biological contact tank upstream of chemically enhanced clarification (CEC) to achieve rapid uptake of soluble organic matter that would not be removed by only CEC. In this process, activated sludge from a plant's secondary process (RAS or WAS) is routed to a short-duration (5-10 minutes) contact basin where it blends with excess wet weather flows to achieve rapid uptake of soluble organic matter into the biomass. This mixture of biomass and influent wastewater is then treated through chemically enhanced primary treatment (CEPT) or HRC. The nonproprietary technology is Bio CEPT, and the current proprietary technology is BioActiflo®.

High Rate Filtration: High rate filtration systems utilize proprietary filter media for CSO treatment with high filtration rates of around 20 to 40 gpm/ft^2. These systems occupy less space than standard filtration systems or sedimentation tanks. Examples of high rate filtration technologies include the Metawater® pinwheel filter medium and Schreiber LLC® Fuzzy Filter compressible synthetic medium.

Disinfection: This process destroys or inactivates microorganisms in overflows, most commonly through contact with forms of chlorine. Various disinfection technologies are available both with and without chlorine compounds. Some of the more common technologies include gaseous chlorine, liquid sodium hypochlorite, chlorine dioxide, ultraviolet radiation, and ozone. For disinfection of CSOs, liquid sodium hypochlorite is the most common of the above technologies.

Dechlorination: A major disadvantage of chlorine-based disinfection systems is that the residual chlorine concentration can have a toxic effect on the receiving waters, due either to the free chlorine residual itself or to the reaction of the chlorine with organic compounds present in the effluent. With the relatively short contact times available at many CSO control facilities, disinfection residuals can be of particular concern and can require consideration of dechlorination alternatives. Two of the more common means for dechlorinating treated effluent are application of gaseous sulfur dioxide or liquid sodium bisulfite solution.

Retention Treatment Basins: Retention treatment basins (RTBs) are satellite high rate treatment facilities designed to provide screening, settling, skimming (with a fixed baffle), and disinfection of combined sewer flows before discharge to a receiving water. Since RTBs are empty between wet weather events, they also provide storage, which can completely capture combined sewer flows from small wet weather events for later dewatering and conveyance to the AWTF for treatment. RTBs can be designed with a variety of screen types, disinfection methods and basin geometries. The surface loading rates can also vary but are typically higher than rates used for design of primary clarifiers. RTBs can be constructed above or below grade but typically require at least an above grade process/control building. If pumping of the combined sewer flow is required, the pump station may be integral to the RTB facility or constructed as a separate structure. An advantage of RTBs is that they are relatively simple to operate and maintain. A disadvantage is that the large footprint of the structure occupies waterfront land that could otherwise provide public amenities.

Satellite Sewage Treatment (SST): A method whereby satellite facilities provide biological treatment for excess wet weather flows, in separate sanitary sewer portions of the system. Examples of satellite sewage treatment include conventional activated sludge process, sequencing batch reactor process, and trickling filter process. SST facilities can be considered where sufficient average daily flow is available to sustain a biological treatment facility. Therefore, intermittent operation of an SST facility only during wet weather is not feasible. When evaluating a potential SST site, it is necessary to identify the existing base flow that can be diverted on a continuous basis to the SST.

Satellite Advanced Treatment: A higher level of satellite sewage treatment for use on smaller tributary streams where treatment beyond the secondary level is required due to a TMDL or other water quality factors.

Expansion of Primary Treatment Capacity: Expansion of the primary treatment capacity of the AWTF must take into account the average daily flow, the peak instantaneous flow and the maximum daily average flow that could potentially be delivered to each plant. Using this information, the feasibility of expanding the plant to apply primary treatment to all flow being delivered must be evaluated with regard to spatial limitations of the plant expansion footprint, costing, and a list of design options.

6.2.5 Receiving Water Technologies

Side Stream Aeration: This option consists of adding air directly to a receiving waterway in order to increase dissolved oxygen concentration. Side stream aeration is when flow is diverted to an offline aeration facility and re-diverted back to the stream or river.

Instream Aeration: Instream aeration is a technology developed to add oxygen to the water column in areas where slow, stagnant conditions occur in streams. Air can be added directly to stream or river flow using a diffusion system to increase dissolved oxygen levels for the improvement of fish habitat and water quality.

Stream Cleanup and Maintenance: Keeping streams free of trash is a continuous activity. Cleanup and maintenance crew can be deployed to periodically remove trash and large debris from the receiving waters.

Plunge Pool Removal: When stormwater and combined sewer outfalls discharge directly to the stream channel, they may create deep, poorly mixed pools. Because these pools are typically near the bank and not in the main flow, they can become poorly mixed during low flow. These pools often have increased odors and reduce the aesthetic quality of the stream. Biological activity in the sediment and water column can reduce dissolved oxygen (DO) to low levels, and this low-DO water can be flushed out and affect downstream areas during wet weather. The depression of DO is a function of both pollutant loads from the outfalls and in stream baseflow, and the physical condition of the channel. When DO is in an acceptable range in the well-mixed portion of the channel but not in nearby plunge pools, elimination of the plunge pools can be expected to eliminate the water quality condition that might affect the aquatic ecosystem.

Constructed Wetlands Along Stream Corridors: Because stream relocation and realignment typically involve extensive grading and replanting, new runoff patterns and hydrology can be created that are more similar to original riparian conditions, whereby the riparian corridor receives storm runoff sheet flow from the adjacent landscape. In addition, wetland habitats can be created that allow more diverse habitat. Wetlands are rich habitats that rely on saturated soils and vegetation adapted to these conditions. They could be recreated concurrently with channel realignment, bank restoration, and planting of more diverse native vegetation, including hydrophytic species adapted to saturated soil conditions.

Invasive Species Management: A plan to control invasive plant species is necessary when restoring or enhancing wetlands and riparian forests. Invasive species provide little value to native animals that depend on native species for habitat and food. Maintaining a healthy riparian plant community will retain biodiversity and support a healthy stream ecosystem.

Reforestation: Reforestation that occurs adjacent to the channel will provide wetland habitat and other associated benefits. Although priority reforestation areas consist of floodplains, steep slopes, and wetlands, smaller areas such as public rights-of-way, parks, schools, and neighborhoods also provide reforestation opportunities. Benefits of reforestation are numerous: cooler temperatures, rainfall interception, reduced runoff, reduced sediment load, reduced discharge velocities, increased groundwater recharge, increased species diversity and habitat, and improved air quality and aesthetics.

6.3 Alternative Control Strategies

CRW has developed a range of alternative control strategies that will be further defined and evaluated in Section 8 of this Program Plan. This section provides the basic framework of these strategies, and indicates the control technologies best aligned with each strategy.

6.3.1 Minimum Control Requirements

The minimum control strategy (MC) represents those controls that must be implemented to meet the technology requirements of the Clean Water Act (CWA). The minimal control strategy is defined by CRW's Nine Minimum Control (NMC) Plan[1], which defines CRW's approach to meeting the technology-based minimum controls of the CSO Control Policy, as well as the six minimum control measures (MCMs) required for municipal separate storm sewer system (MS4) permits.

6.3.2 Baseline Level of Control

A baseline level of control is developed in Section 8 from the control technologies described in this section. The 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" controls that are low-cost, simple changes, including operational changes, that optimize or enhance the existing system.
- Determine the associated level of CSO control. This will provide a starting point for establishing feasible control strategies.

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[1] CRW *Nine Minimum Control Plan, Version 3.0*, August 2017, available at **https://capitalregionwater.com/cbh2o/**

Table 6-1 lists alternative technologies, which are screened for application within the baseline, systemwide, and local control strategies. Some technologies are minimum controls satisfying the technology-based requirements of the CWA, and satisfying the requirements of CRW's Nine Minimum Control (NMC) Plan and the minimum control measures (MCMs) under PA-DEP MS4 permitting regulations.

6.3.3 Establish Feasible Control Strategies

The next step in the planning process is to formulate feasible control strategies. First, the following two ***systemwide control strategies*** (SW) start with the baseline level of control and add enhanced levels of control for 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 a deep tunnel parallel to CRW's conveyance system, including consolidation sewers from CSO regulators to tunnel drop shafts and a new dewatering pump station, increasing overall conveyance and storage within CRW's conveyance system.

Next, the following three ***local control strategies*** start with the baseline level of control within each of the designated program planning areas, and add enhanced levels of control within CRW's collection system:

- ***Local Strategy 1:*** A *decentralized control strategy* (DC) involving green/grey infrastructure 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* (SC) 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* (SP) within catchments where the baseline strategy does not achieve the desired CRW level of control, defining various percentages of the collection system to separate to achieve desired control levels.

Within each of the program planning areas, these alternative controls may solve existing problems regarding CSOs, SSOs, unauthorized releases, MS4 discharges, and significant structural deterioration. Alternative controls to consider may include a combination of further modifications to CSO regulator structures and connector pipes, required rehabilitation for grade 4 and 5 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

Table 6-1: Feasible Wet Weather Control Alternatives for CRW's Service Area

Source Controls	Type
Green Stormwater Infrastructure	
▪ Bioretention / rain gardens	DC
▪ Dry wells	DC
▪ Grassed swales	DC
▪ Rain barrels	NA
▪ Infiltration trenches	DC
▪ Green roofs	DC
▪ Permeable pavement	DC
Inflow Reduction	
▪ Catch basin modifications	DC
▪ Sump pump disconnect	DC
▪ Catch basin and storm inlet maintenance	MC
▪ Illicit connection control	MC
▪ Roof leader disconnect program	DC
▪ Street storage (catch basin inlet control)	DC
▪ Offload groundwater pumpage	DC
▪ Stream diversion	NA
▪ Groundwater infiltration reduction	DC
▪ Reduction of contractual flow	DC
Construction-Phase Controls	
▪ Construction-phase E&S controls	MC
Post-Construction Controls	
▪ Post-construction stormwater control	DC
▪ Post-construction inspection/enforcement	MC
Pollution Prevention/Good Housekeeping	
▪ Loading, unloading, and storage of materials	MC
▪ Spill prevention and response	MC
▪ Street sweeping programs	MC
▪ Vehicle and equipment management	MC
▪ Private scrapyard inspection/enforcement	MC
▪ Employee training	MC
▪ Record keeping and reporting	MC
▪ Flow diversion/exposure minimization	MC
▪ Responsible landscaping practices	MC
▪ Responsible bridge/roadway maintenance	MC
▪ Require industrial pretreatment	MC
▪ On-lot disposal (septic system) management	MC
▪ Household hazardous waste collection	MC
▪ Oil/water separator/water quality inlets	MC
▪ Industrial stormwater pollution prevention	MC
▪ Litter and illegal dumping enforcement	MC

Conveyance/Collection System Controls	Type
▪ Sewer separation	SP
▪ Optimization of existing system	BL
▪ Real-time control	SW
▪ Regulator/pump station inspection/maintenance/repairs	MC
▪ Outfall and regulator consolidation	SC
▪ Outfall maintenance program	MC
▪ Sewer system inspection and cleaning	MC
▪ Parallel interceptors	SW
▪ Remove flow bottlenecks	SW DC
▪ Combined sewer rehabilitation	BL
▪ Diversion of trunk flow directly to AWTF	SW
Storage Technologies	**Type**
▪ In-line storage	SC
▪ Earthen basins	SC
▪ Offline above/below grade storage tanks	SC
▪ Tunnel storage	SW
▪ Instream storage	SC
Treatment Technologies	**Type**
▪ Screening	SC
▪ Netting	SC
▪ Swirl concentrator	SC
▪ Vortex separation	SC
▪ High rate clarification	SC
▪ High rate filtration	SC
▪ Disinfection	SC
▪ Dechlorination	SC
▪ Retention treatment basins	SC
▪ Satellite sewage treatment	SC
▪ Satellite advanced treatment	SC
▪ Expansion of primary treatment capacity	SC
Receiving Water Technologies	**Type**
▪ Side stream aeration	SC
▪ Instream aeration	SC
▪ Stream cleanup and maintenance	MC
▪ Plunge pool removal	SC
▪ Constructed wetlands along stream corridors	SC
▪ Invasive species management	MC
▪ Reforestation	MC

Alternative Control Strategies

MC - Minimum Control (e.g., CSO NMC, MS4 MCM)

BL - Baseline

SW - Systemwide

DC – Decentralized Control (i.e., implement within collection system)

SC – Satellite Control

SP – Separation

NA - Not Applicable / Not Feasible

reach to provide additional storage, adding supplemental green stormwater infrastructure to the project for stormwater runoff control, etc.

6.4 Screening Results

The available control technologies described in Section 6.2 were categorized according to their alignment with the alternative control strategies in Section 6.3. Control technologies deemed infeasible or not applicable to the control strategies suitable for CRW's system are marked "NA". Previously presented, **Table 6-1** indicates the specific control strategies considered suitable for one or more of the defined control strategies, A rationale for this selection follows.

6.4.1 Source Controls

The Partial Consent Decree (PCD) defines Source Controls as "*measures that reduce the volume, peak flow, or pollutant load of runoff, either before it enters the combined Collection System or is re-directed to an MS4, including measures that mimic natural hydrologic processes. Source Controls shall include, inter alia, Green Infrastructure, as defined in this Consent Decree*". They typically consist of minimum controls per NMCs, MCMs and decentralized controls. Source controls are fundamental elements of the minimum level of control (MC) baseline control strategy and the decentralized control strategy.

6.4.2 Collection System Controls

The PCD defines Collection System Controls as "*measures that reduce the volume, peak flow, or pollutant load of flows within the combined Collection System.*" Some Collection System Controls are aligned with the minimum level of control (MC), while others are best aligned with the baseline level of control (BL), the systemwide control strategy (SW), the decentralized control strategy (DC), or the satellite control strategy (SC) conveyance enhancements. In general, they are supporting elements of each control strategy.

6.4.3 Storage Technologies

The PCD defines Storage Technologies as "*structural measures that detain flows within the Conveyance System and reduce peak flows prior to treatment at the AWTF*". They are typically implemented as part of a satellite control strategy (SC), but also include deep tunnels and other technologies that align with the systemwide control strategy (SW).

6.4.4 Treatment Technologies

The PCD defines Treatment Technologies as "*structural measures that reduce the pollutant load in a CSO to its Receiving Water*." Treatment Technologies are commonly incorporated into satellite control strategies (SC). Some may also enhance the wet weather treatment capacity of the AWTF.

6.4.5 Receiving Water Technologies

Receiving Water Technologies are not defined in the PCD. They may align with the satellite control strategy (SC), or represent a minimum level of control (MC) that enhances the physical, biological, or chemical conditions within a receiving water.