

6 LAND-BASED CONTROL MEASURES (SOURCE CONTROLS)

6.1 IDENTIFICATION AND DESCRIPTION OF CONTROL MEASURES

PWD is committed to a balanced “land-water-infrastructure” approach to achieve its watershed management and CSO control goals. This method includes infrastructure-based approaches where appropriate, but relies on a range of land-based stormwater management techniques and physical reconstruction of aquatic habitats where appropriate. The ultimate goal of PWD’s approach is to achieve full regulatory compliance in a cost-effective manner while regaining the resources in and around streams that have been lost due to urbanization, both within the City of Philadelphia and in the surrounding counties. Land-based measures are a key part of this approach because they provide benefits to the community beyond water quality improvement. These benefits include recreational opportunities, improved aesthetics, and increased home values.

Philadelphia is making a substantial commitment to reducing the burden on combined sewer infrastructure by controlling stormwater at the source. Development and redevelopment projects are taking place throughout the City under the stormwater requirements enacted in 2006. A number of demonstration projects are complete, in design, or in construction on public lands, including PWD properties, parks and recreation facilities, and schools. PWD will be revising its stormwater rate structure based on impervious cover.

Land-based management measures provide a number of additional long-term benefits. They help to protect the City’s investment in stream channel and habitat restoration. They will help reduce sediment loads from runoff and streambank erosion. They help protect infrastructure along stream corridors that can be damaged by high stream flows and velocities. They provide source water protection benefits. By reducing the burden on combined sewers, they help reduce the frequency and severity of basement flooding in some locations. Outside the combined sewered areas, land-based stormwater management is helping Philadelphia to meet requirements of total maximum daily loads (TMDLs) and its Non-Point Discharge Elimination System (NPDES) Phase 1 MS4 permit. The measures also help Philadelphia and the region meeting requirements of Pennsylvania’s Act 167 Stormwater Management Program, which requires stormwater management on a watershed basis in developing areas.

Table 6.1 lists the land-based options (source controls) that are being considered for implementation in the initial screening stage and identifies the goals that each option is designed to meet.

Descriptions of these options are described in this section. Details on Table 6.1’s headers are:

- Required: required under CSO permits
- IWMP: commented to in an Integrated Watershed Management Plan (IWMP)
- Dry Weather WQ: addresses dry weather water quality (WQ)
- Solids / Floatables: addresses solids and floatables
- Recreation: addresses recreation
- Tributary Habitat: addresses tributary habitat
- Water Balance: addresses water balance

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Table 6.1 Land-Based Options (Source Controls)

Number	Category	Option	Goals Addressed										
			Required	IWMP	Dry Weather WQ	Solids/ Floatables	Recreation	Tributary Habitat	Tidal Habitat	Water Balance	Wet Weather WQ	Stewardship	
L.1	Flow reduction	Catch Basin Modifications				X						X	
L.2	Flow reduction	Sump Pump Disconnect										X	
L.3	Flow reduction	Catch Basin and Storm Inlet Maintenance	X	X		X						X	
L.4	Flow reduction	Illicit Connection Control	X	X	X							X	
L.5	Flow reduction	Roof Leader Disconnect Program		X								X	
L.6	Flow reduction	Street Storage (catch basin inlet control)										X	
L.7	Flow reduction	Offload Groundwater Pumpage										X	
L.8	Flow reduction	Stream Diversion		X								X	
L.9	Flow reduction	Groundwater Infiltration Reduction		X								X	
L.10	Flow reduction	Reduction of Contractual Flow										X	
L.11	Low impact development/ redevelopment/retrofit	Require Existing Resources Inventory, Sketch Plan, Initial Meeting		X								X	X
L.12	Low impact development/ redevelopment/retrofit	Require Integrated Site Design		X								X	X
L.13	Low impact development/ redevelopment/retrofit	Require Post-construction Stormwater Management	X	X								X	X
L.14	Low impact development/ redevelopment/retrofit	Post-construction Inspection and Enforcement		X								X	X

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Number	Category	Option	Goals Addressed										
			Required	IWMP	Dry Weather WQ	Solids/ Floatables	Recreation	Tributary Habitat	Tidal Habitat	Water Balance	Wet Weather WQ	Stewardship	
L.15	Low impact development/ redevelopment/retrofit	Demonstration Projects on Public Lands		X							X	X	X
L.16	Low impact development/ redevelopment/retrofit	Large-Scale Implementation on Public Lands		X							X	X	X
L.17	Low impact development/ redevelopment/retrofit	Street Trees and Street Greening		X							X	X	X
L.18	Low impact development/ redevelopment/retrofit	Revise Stormwater Rate Structure		X							X	X	
L.19	Low impact development/ redevelopment/retrofit	Stormwater Management Incentives for Retrofit		X							X	X	
L.20	Public education	Water Efficiency										X	
L.21	Public education	Catch Basin Stenciling		X								X	X
L.22	Public education	Community Cleanup and Volunteer Programs		X	X	X							X
L.23	Public education	Pet Waste Education		X								X	X
L.24	Public education	Public Notification and Signage	X	X	X		X					X	X
L.25	Public education	Litter and Dumping Education		X	X	X						X	X
L.26	Public education	School-Based Education		X	X	X	X					X	X
L.27	Good housekeeping	Loading, Unloading, and Storage of Materials	X	X								X	
L.28	Good housekeeping	Spill Prevention and Response	X	X	X							X	
L.29	Good housekeeping	Street Sweeping Programs		X		X						X	
L.30	Good housekeeping	Vehicle & Equipment Management	X	X								X	
L.31	Good housekeeping	Private Scrapyard Inspection and Enforcement		X								X	

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Number	Category	Option	Goals Addressed										
			Required	IWMP	Dry Weather QQ	Solids/Floatables	Recreation	Tributary/Habitat	Tidal Habitat	Water Balance	Wet Weather WQ	Stewardship	
L.32	Good housekeeping	Employee Training	X	X								X	
L.33	Good housekeeping	Record Keeping and Reporting	X	X								X	
L.34	Good housekeeping	Flow Diversion and Exposure Minimization Structures		X								X	
L.35	Good housekeeping	Responsible Bridge and Roadway Maintenance		X								X	
L.36	Pollution prevention	Require Industrial Pretreatment	X	X								X	
L.37	Pollution prevention	On-lot Disposal (septic system) Management		X	X							X	
L.38	Pollution prevention	Household Hazardous Waste Collection			X							X	
L.39	Pollution prevention	Oil/water Separator/WQ Inlets										X	
L.40	Pollution prevention	Industrial Stormwater Pollution Prevention	X	X								X	
L.41	Pollution prevention	Litter and Illegal Dumping Enforcement		X	X	X							
L.42	Pollution prevention	Require Construction-phase Stormwater/E&S controls	X	X		X						X	

The distribution of roof sizes suggests that it may be efficient to focus on larger buildings. The smallest half of buildings represents only 10% of total roof area, while the largest 10% represents nearly 50% of total roof area (Table 6.6).

Interstate Highways and Waterfront Land

Properties located close to the Delaware and Schuylkill waterfronts present opportunities for sewer separation, appropriate pretreatment of stormwater, and direction of stormwater to public or private permitted outfalls. It is important to note that the same land-based stormwater management techniques being considered for the combined sewer system can function as pretreatment for runoff entering a separate storm sewer system. This runoff would no longer be included in PWD’s CSO management program but would continue to be managed through PWD’s larger stormwater and watershed management programs.

Table 6.7 lists the “waterfront” drainage area currently draining to combined sewers. Waterfront can be defined in one of two ways. Defined as all land between interstate highways and rivers, it comprises approximately 4% of combined drainage area. This percentage is highest in the southeast drainage district at 7%. Defined more narrowly as the area between combined sewer regulator structures and the river, the waterfront area comprises approximately 2% of drainage area. There is also a long-term potential to disconnect the interstate highways themselves from the combined sewer system.

Table 6.7 Distribution of Waterfront Land

Land Location	Combined-Sewered Impervious Area (ac)				Combined-Sewered Impervious Area (% of total)			
	City-Wide	SEDD	NEDD	SWDD	City-Wide	SEDD	NEDD	SWDD
Non-waterfront	43,414	8,700	20,060	14,654	95.8	91.5	98.4	94.9
Between regulator structures and rivers	681	157	245	279	1.6	1.8	1.2	1.9
Between major highways and rivers	1,507	578	234	695	3.5	6.6	1.2	4.7
Highway	315	165	94	56	1.1	1.9	0.5	0.4
Waterfront + hghway	1,822	743	327	752	4.2	8.5	1.6	5.1

6.3 SCREENING RESULTS

The following criteria are proposed for initial screening of options:

- Options that are required by NPDES permit or other regulation are recommended for inclusion in all management alternatives.
- Options recommended for implementation in one of PWD’s Integrated Watershed Management Plans are recommended for inclusion in all management alternatives.
- Other options must meet at least one stated goal of the LTCPU to be considered for inclusion in management alternatives. Options also must be technically feasible to implement and maintain.

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Table 6.8 Recommendations for Land-Based Options

Number	Category	Option	Include in All Alternatives	Consider Including in Alternatives	Do Not Include in Alternatives
L.1	Flow Reduction	Catch Basin Modifications		X	
L.2	Flow Reduction	Sump Pump Disconnect	X		
L.3	Flow Reduction	Catch Basin and Storm Inlet Maintenance	X		
L.4	Flow Reduction	Illicit Connection Control	X		
L.5	Flow Reduction	Roof Leader Disconnect Program	X		
L.6	Flow Reduction	Street Storage (catch basin inlet control)		X	
L.7	Flow Reduction	Offload Groundwater Pumpage	X		
L.8	Flow Reduction	Stream Diversion	X		
L.9	Flow Reduction	Groundwater Infiltration Reduction	X		
L.10	Flow Reduction	Reduction of Contractual Flow	X		
L.11	Low Impact Development/Redevelopment/Retrofit	Require Existing Resources Inventory, Sketch Plan, Initial Meeting		X	
L.12	Low Impact Development/Redevelopment/Retrofit	Require Integrated Site Design		X	
L.13	Low Impact Development/Redevelopment/Retrofit	Require Post-construction Stormwater Management		X	
L.14	Low Impact Development/Redevelopment/Retrofit	Post-construction Inspection and Enforcement		X	
L.15	Low Impact Development/Redevelopment/Retrofit	Demonstration Projects on Public Lands		X	
L.16	Low Impact Development/Redevelopment/Retrofit	Large-scale Implementation on Public Lands		X	
L.17	Low Impact Development/Redevelopment/Retrofit	Street Trees and Street Greening		X	
L.18	Low Impact Development/Redevelopment/Retrofit	Revise Stormwater Rate Structure		X	
L.19	Low Impact Development/Redevelopment/Retrofit	Stormwater Management Incentives for Retrofit		X	
L.20	Public Education	Water Efficiency		X	
L.21	Public Education	Catch Basin Stenciling	X		
L.22	Public Education	Community Cleanup and Volunteer Programs	X		
L.23	Public Education	Pet Waste Education	X		
L.24	Public Education	Public Notification and Signage	X		
L.25	Public Education	Litter and Dumping Education	X		
L.26	Public Education	School-based Education	X		
L.27	Good Housekeeping	Loading, Unloading, and Storage of Materials	X		

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Number	Category	Option	Include in All Alternatives	Consider Including in Alternatives	Do Not Include in Alternatives
L.28	Good Housekeeping	Spill Prevention and Response	X		
L.29	Good Housekeeping	Street Sweeping Programs	X		
L.30	Good Housekeeping	Vehicle & Equipment Management	X		
L.31	Good Housekeeping	Private Scrapyard Inspection and Enforcement	X		
L.32	Good Housekeeping	Employee Training	X		
L.33	Good Housekeeping	Record Keeping and Reporting	X		
L.34	Good Housekeeping	Flow Diversion and Exposure Minimization Structures	X		
L.35	Good Housekeeping	Responsible Bridge and Roadway maintenance	X		
L.36	Pollution Prevention	Require Industrial Pretreatment	X		
L.37	Pollution Prevention	On-lot Disposal (septic system) Management	X		
L.38	Pollution Prevention	Household Hazardous Waste Collection	X		
L.39	Pollution Prevention	Oil/water Separator/WQ inlets			X
L.40	Pollution Prevention	Industrial Stormwater Pollution Prevention	X		
L.41	Pollution Prevention	Litter and Illegal Dumping Enforcement	X		
L.42	Pollution Prevention	Require Construction-phase Stormwater/E&S controls	X		

8.0 INFRASTRUCTURE-BASED CONTROL MEASURES

8.1 IDENTIFICATION AND DESCRIPTION OF CONTROL MEASURES

Table 8-1 lists the infrastructure-based options being considered for implementation in the initial screening stage. Descriptions of these options follow.

Table 8-1 Infrastructure-Based Options

Number	Category	Option	Required	IWMP	Goals Addressed								
					Dry Weather WQ	Solids/Floatables	Recreation	Tributary Habitat	Tidal Habitat	Water Balance	Wet Weather WQ	Stewardship	
I.1	Nine Minimum Controls	Nine Minimum Controls	X	X	X	X						X	X
I.2	Operation and Maintenance	Inspection and Cleaning of Combined Sewers	X	X	X	X						X	
I.3	Operation and Maintenance	Combined Sewer Interceptor Rehabilitation		X	X								
I.4	Operation and Maintenance	Regulator/Pump Station Inspection/Maintenance/Repairs	X									X	
I.5	Operation and Maintenance	Outfall Maintenance Program				X						X	
I.6	Operation and Maintenance	House Lateral Repairs											X
I.7	Sewer Separation	Permitted Discharge to Receiving Water for Waterfront Properties				X						X	
I.8	Sewer Separation	Separation of Sanitary Sewage and Stormwater on Development Sites				X						X	
I.9	Sewer Separation	Separate Street Runoff from Combined System				X						X	
I.10	Sewer Separation	Complete Separation into Sanitary and Storm Sewer Systems				X						X	
I.11	Sewer Separation	Permitted Discharge to Receiving Water for Waterfront Interstate Highways				X						X	
I.12	Outfall Consolidation/Elimination	Outfall and Regulator Consolidation				X						X	
I.13	Storage	Instream Storage Technologies				X						X	
I.14	Storage	In-Line Storage in Interceptor or Trunk Sewer				X						X	
I.15	Storage	Earthen Basins				X						X	
I.16	Storage	Offline Covered Storage Basins				X						X	
I.17	Storage	Offline Open Storage Basins				X						X	
I.18	Storage/Transmission	Deep Tunnels				X						X	
I.19	Storage/Transmission	Real Time Control		X		X						X	
I.20	Transmission	Parallel Interceptors				X						X	
I.21	Transmission	Remove Flow Bottlenecks				X						X	
I.22	Transmission	Diversion of Trunk Flow Directly to WPCP				X						X	
I.23	Treatment at Discharge Point	Swirl Concentrators				X						X	
I.24	Treatment at Discharge Point	Vortex Separators				X						X	

Number	Category	Option	Required	IWMP	Goals Addressed							
					Dry Weather WQ	Solids/Floatables	Recreation	Tributary Habitat	Tidal Habitat	Water Balance	Wet Weather WQ	Stewardship
I.25	Treatment at Discharge Point	Disinfection				X					X	
I.26	Treatment at Discharge Point	High Rate Treatment				X					X	
I.27	Treatment at Discharge Point	Screens				X						
I.28	Treatment at Discharge Point	Netting				X						
I.29	Treatment at Discharge Point	Booms				X						
I.30	Treatment at Discharge Point	Baffles				X						
I.31	Treatment in Receiving Water	Debris Skimming Vessels		X		X						
I.32	Treatment at Existing WPCP	Expand Primary Treatment Capacity				X					X	
I.33	Treatment at Existing WPCP	Expand Secondary Treatment and Disinfection Capacity				X					X	
I.34	Treatment at Existing WPCP	Flow Equalization				X					X	
I.35	Treatment at Existing WPCP	Expansion of Wet Weather Treatment Capacity				X					X	

I.1 Nine Minimum Controls

In the first phase of the PWD’s CSO strategy, and in compliance with its NPDES permits, the PWD submitted CSO Documentation: Implementation of Nine Minimum Controls to the Pennsylvania Department of Environmental Protection on September 27, 1995. The nine minimum controls are low-cost actions or measures that can reduce CSO discharges and their effect on receiving waters, do not require significant engineering studies or major construction, and can be implemented in a relatively short time frame. To provide information needed for the development of the Nine Minimum Controls (NMC) program, the PWD instituted a \$6.5 million project to upgrade its comprehensive system flow monitoring network. This program provides information necessary to identify and eliminate dry weather overflows, monitor system performance and operation, and configure and calibrate computer hydraulic models needed to develop the NMCs and long-term CSO control plans. This information provided the basis for the System Hydraulic Characterization Report that was submitted to the PADEP in June 1995 and provided the technical basis for the development of the NMC plan.

Extensive data from the PWD’s Geographic Information System (GIS), flow monitoring system, the U.S. Army Corps of Engineer’s Storage, Treatment, Overflow, Runoff Model (STORM), and the EXTRAN and RUNOFF blocks of the EPA Stormwater Management Model (SWMM) were used to support each phase of the CSO program. These tools were developed to support concept engineering through implementation and post-construction monitoring. The monitoring system, models, and GIS will serve as the basis for planning improvements and enhancing operation of the sewerage system over the long-term.

Table 8-17 Ratings Assigned to Infrastructure-Based Options

Number	Category	Option	Include in All Alternatives	Consider Including in Alternatives	Do Not Include in Alternatives
I.1	Nine Minimum Controls	Nine Minimum Controls	X		
I.2	Operation and Maintenance	Inspection and Cleaning of Combined Sewers	X		
I.3	Operation and Maintenance	Combined Sewer Interceptor Rehabilitation	X		
I.4	Operation and Maintenance	Regulator/Pump Station Inspection/Maintenance/Repairs	X		
I.5	Operation and Maintenance	Outfall Maintenance Program	X		
I.6	Operation and Maintenance	House Lateral Repairs		X	
I.7	Sewer Separation	Permitted Discharge to Receiving Water for Waterfront Properties		X	
I.8	Sewer Separation	Separation of Sanitary Sewage and Stormwater on Development Sites	X		
I.9	Sewer Separation	Separate Street Runoff from Combined System		X	
I.10	Sewer Separation	Complete Separation into Sanitary and Storm Sewer Systems		X	
I.11	Sewer Separation	Permitted Discharge to Receiving Water for Waterfront Interstate Highways		X	
I.12	Outfall Consolidation/Elimination	Outfall and Regulator Consolidation		X	
I.13	Storage	Instream Storage Technologies		X	
I.14	Storage	In-Line Storage in Interceptor or Trunk Sewer		X	
I.15	Storage	Earthen Basins		X	
I.16	Storage	OffLine Covered Storage Basins		X	
I.17	Storage	OffLine Open Storage Basins		X	
I.18	Storage/Transmission	Deep Tunnels		X	
I.19	Storage/Transmission	Real Time Control	X		
I.20	Transmission	Parallel Interceptors		X	
I.21	Transmission	Remove Flow Bottlenecks		X	
I.22	Transmission	Diversion of Trunk Flow Directly to WPCP		X	
I.23	Treatment at Discharge Point	Swirl Concentrators		X	
I.24	Treatment at Discharge Point	Vortex Separators		X	
I.25	Treatment at Discharge Point	Disinfection		X	
I.26	Treatment at Discharge Point	High Rate Treatment		X	
I.27	Treatment at Discharge Point	Screens		X	
I.28	Treatment at Discharge Point	Netting		X	
I.29	Treatment at Discharge Point	Booms		X	
I.30	Treatment at Discharge Point	Baffles		X	
I.31	Treatment in Receiving Water	Debris Skimming Vessels	X		
I.32	Treatment at Existing WPCP	Expand Primary Treatment Capacity		X	
I.33	Treatment at Existing WPCP	Expand Secondary Treatment and Disinfection Capacity		X	
I.34	Treatment at Existing WPCP	Flow Equalization		X	
I.35	Treatment at Existing WPCP	Expansion of Wet Weather Treatment Capacity		X	

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controls are assumed to have only an administrative cost to PWD, although their cost to the private sector is tracked and accounted for.

- Measures to increase water pollution control plant capacity by taking full advantage of the hydraulic capacity of the existing facilities, including appropriate bypass of secondary treatment in wet weather.
- Continuation of partnerships and stakeholder processes in all watersheds, and coordination with upstream municipalities to reduce pollutant loads from other sources and wet weather flows.

Table 9-1 Options Included in All Alternatives other than Full Sewer Separation

L.2	Sump Pump Disconnect	L.37	On-Lot Disposal (Septic System) Management
L.3	Catch Basin and Storm Inlet Maintenance	L.38	Household Hazardous Waste Collection
L.4	Illicit Connection Control	L.40	Industrial Stormwater Pollution Prevention
L.5	Roof Leader Disconnect Program	L.41	Litter and Illegal Dumping Enforcement
L.7	Offload Ground Water Pumpage	L.42	Require Construction-Phase Stormwater/E&S Controls
L.8	Stream Diversion	W.1	Dam Modification/Removal
L.9	Groundwater Infiltration Reduction	W.2	Daylight Orphaned Storm Sewers
L.10	Reduction of Contractual Flow	W.3	Stream Cleanup and Maintenance
L.20	Water Efficiency	W.4	Channel Stabilization and Habitat Restoration
L.21	Catch Basin Stenciling	W.5	Channel Realignment and Relocation
L.22	Community Cleanup and Volunteer Programs	W.6	Plunge Pool Removal
L.23	Pet Waste Education	W.7	Improvement of Fish Passage
L.24	Public Notification and Signage	W.10	Constructed Wetlands along Stream Corridors
L.25	Litter and Dumping Education	W.11	Wetland Restoration Along Tidal Rivers
L.26	School-Based Education	W.12	Enhance Stream Corridor Recreational and Cultural Resources
L.27	Loading, Unloading, and Storage of Materials	W.13	Wetland Improvement
L.28	Spill Prevention and Response	W.14	Invasive Species Management
L.29	Street Sweeping Programs	W.15	Reforestation
L.30	Vehicle & Equipment Management	I.1	Nine Minimum Controls
L.31	Private Scrapyard Inspection and Enforcement	I.2	Inspection and Cleaning of Combined Sewers
L.32	Employee Training	I.3	Combined Sewer Interceptor Rehabilitation
L.33	Record Keeping and Reporting	I.4	Regulator/Pump Station Inspection/Maintenance/Repairs
L.34	Flow Diversion and Exposure Minimization Structures	I.5	Outfall Maintenance Program
L.35	Responsible Bridge and Roadway Maintenance	I.8	Separation of Sanitary Sewage and Stormwater on Development Sites
L.36	Require Industrial Pretreatment	I.19	Real Time Control
		I.31	Debris Skimming Vessels

Table 9-2 Additional Options Included in Green Stormwater Infrastructure with Targeted Traditional Infrastructure Alternative

L.11	Require Existing Resources Inventory, Sketch Plan, Initial Meeting
L.12	Require Integrated Site Design
L.13	Require Post-Construction Stormwater Management
L.14	Post-Construction Inspection and Enforcement
L.15	Demonstration Projects on Public Lands
L.16	Large-Scale Implementation on Public Lands
L.17	Street Trees and Street Greening
L.18	Revise Stormwater Rate Structure
L.19	Stormwater Management Incentives for Retrofit
I.35	Expansion of Wet Weather Treatment Capacity

9.1.3 Green Stormwater Infrastructure with Increased Transmission and Treatment Capacity

This alternative includes the same options as the previous alternative to address dry weather goals, restore living resources, and improve recreational opportunities. However, the alternative combines the large-scale green stormwater infrastructure approach with increased interceptor transmission capacity and increased wet weather wastewater treatment capacity. For a given combined sewer system percent capture level, a lower implementation level of green stormwater infrastructure is required compared to the Green Stormwater Infrastructure with Targeted Traditional Infrastructure alternative.

This alternative includes the options discussed below. Options are listed in Tables 9-1 and 9-3 and described in more detail in Sections 6 through 8.

- The full range of options recommended in the Cobbs and Tookany/Tacony-Frankford Integrated Watershed Management Plans.
- Measures to improve water quality in dry weather, including rehabilitation of interceptor sewers to reduce leakage in dry and wet weather.
- Restoration of the riparian corridor: stream channels, streambanks, floodplain connection, wetlands, recreational access and trails.
- Tidal wetland restoration along the Delaware and Schuylkill Rivers.
- Measures to manage stormwater runoff from directly connected impervious surfaces on a large scale on both public and private land. Examples are discussed in detail in Section 6 and include street trees, sidewalk planters, rain gardens, porous pavement, and many more technologies. As the program progresses, PWD will monitor emerging technologies that have the potential to improve performance or decrease cost. Additionally, there is potential for the creation of wetlands and opportunities to consolidate adjacent outfalls.
- Stormwater management measures following redevelopment are assumed to mitigate 20% of directly connected impervious surfaces over the course of the planning period. These controls are assumed to have no cost to PWD, although their cost to the private sector is tracked and accounted for.
- Proposed expansion of water pollution control plants to include a secondary treatment bypass where appropriate and, depending on the peak capacity needed, additional high rate treatment.

- New interceptors would provide additional transmission capacity along the same routes taken by existing interceptors. In the TTF and Cobbs Creek Watersheds, construction would be completed in conjunction with stream and stream corridor restoration.
- Continuation of partnerships and stakeholder processes in all watersheds, and coordination with upstream municipalities to reduce pollutant loads and wet weather flows entering the watershed.

Table 9-3 Additional Options Included in Green Stormwater Infrastructure with Increased Transmission and Treatment Alternative

L.11	Require Existing Resources Inventory, Sketch Plan, Initial Meeting
L.12	Require Integrated Site Design
L.13	Require Post-Construction Stormwater Management
L.14	Post-Construction Inspection and Enforcement
L.15	Demonstration Projects on Public Lands
L.16	Large-Scale Implementation on Public Lands
L.17	Street Trees and Street Greening
L.18	Revise Stormwater Rate Structure
L.19	Stormwater Management Incentives for Retrofit
I.20	Parallel Interceptors
I.35	Expansion of Wet Weather Treatment Capacity

9.1.4 Large-Scale Centralized Storage Alternative

This alternative seeks to reduce CSO volume, frequency, and duration using a traditional tunnel storage system. Combined sewage is stored temporarily and dewatered to the existing water pollution control plants. This alternative includes options to address dry weather goals, restoration of living resources, and improved recreational opportunities. However, if this alternative is selected it may be necessary to reassess the cost, affordability, and benefits of these programs in combination with a tunnel. This alternative does not include a significant amount of Green Stormwater Infrastructure for stormwater management.

The Large-Scale Centralized Storage alternative includes the options discussed below.

- The full range of options recommended in the TTF and Cobbs Creek Integrated Watershed Management Plans.
- Measures to improve water quality in dry weather, including rehabilitation of interceptor sewers to reduce leakage in dry and wet weather.
- Restoration of the riparian corridor in the TTF and Cobbs Creek Watersheds: stream channels, streambanks, floodplain connection, wetlands, recreational access and trails.
- Tidal wetland restoration along the Delaware and Schuylkill Rivers.
- Storage tunnels and associated infrastructure approximately parallel to existing interceptor sewers and perpendicular to existing trunk sewers. A minimum length for each tunnel is fixed by the location of trunk sewers it would intercept. Tunnel inner diameters studied include a range from the approximate minimum feasibly constructible (about 15 feet) to the maximum feasibly constructible (about 35 feet). Additionally, there is potential to consolidate adjacent outfalls.
- Continuation of partnerships and stakeholder processes in all watersheds, and coordination with upstream municipalities to reduce pollutant loads and wet weather flows entering the watershed.

9.1.5 Large-Scale Satellite Treatment Alternative

The Large-Scale Satellite Treatment alternative seeks to reduce CSO volume, frequency, and duration using satellite treatment facilities. Combined sewage is conveyed to a treatment facility using new consolidation sewers, treated, disinfected, and discharged to the creek. This alternative includes options to address dry weather goals, restoration of living resources, and improved recreational opportunities. However, if this alternative is selected it may be necessary to reassess the cost, affordability, and benefits of these programs in combination with large-scale satellite treatment. This alternative does not include green infrastructure for stormwater management.

Large-Scale Satellite Treatment alternative includes the options discussed below. Options are listed in Tables 9-1 and 9-4 and described in more detail in Sections 6 through 8.

- The full range of options recommended in the TTF Integrated Watershed Management Plan.
- Measures to improve water quality in dry weather, including rehabilitation of interceptor sewers to reduce leakage in dry and wet weather.
- Restoration of the riparian corridor in the TTF and Cobbs Creek Watersheds: stream channels, streambanks, floodplain connection, wetlands, recreational access and trails.
- Tidal wetland restoration along the Delaware and Schuylkill Rivers.
- Satellite treatment facilities and associated infrastructure. These facilities would be sited to take advantage of existing regulator structure geography and collection system capacity, subject to site constraints. Three technologies are considered: retention treatment basins, ballasted flocculation, and swirl/vortex systems.
- New conveyance conduits to transmit more flow to the treatment facilities.
- Continuation of partnerships and stakeholder processes in all watersheds, and coordination with upstream municipalities to reduce pollutant loads and wet weather flows entering the watershed.

Table 9-4 Additional Options Included in the Large-Scale Satellite Treatment Alternative

I.20	Parallel Interceptors
I.25	Disinfection
I.26	High Rate Treatment
I.35	Expansion of Wet Weather Treatment Capacity

9.2 BENEFITS AND EXTERNAL COSTS OF ALTERNATIVE APPROACHES

A key goal of PWD’s *Green City, Clean Waters* program is to maximize the sustainability of the urban water resources system and to maximize benefits to the public of the money spent on reducing combined sewer overflows. A traditional engineering analysis of sewer system performance, capital costs, and operations and maintenance costs forms the core of the alternatives analysis and selection process, and will be presented later in this document. However, traditional analyses do not guarantee that benefits will be maximized because they leave out key variables that affect urban quality of life and long-term sustainability of the urban system.

PWD’s *Green City, Clean Waters* program is designed to provide many benefits beyond the reduction of combined sewer overflows, so that every dollar spent provides a maximum return in benefits to