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# Stakeholder Outreach
Notes from all stakeholder interviews and public meetings

## Stakeholder Interviews & Public Meetings

| Name | Title | Date | Topic Covered |
|---|---|---|---|
| Keith Wood | Suez Project Manager | 13-Jun-18 | water sampling, testing & monitoring by Suez for Boonton Reservoir |
| Judeth Yeany | NJDEP Legal Services and Stewardship Bureau Chief | 3-Aug-18 | Potential trail project, review of 2001 plan |
| Sue Seyboldt | NJDEP Green Acres Project Manager | 3-Aug-18 | |
| Neil Henry | Town of Boonton Administrator | 22-Jan-19 | Project overview and public comment |
| Cy Wekilsky | Town of Boonton Alderman | 22-Jan-19 | |
| Matthew DiLauri | Town of Boonton Mayor | 22-Jan-19 | |
| Andrew Miller | Parsippany Troy-Hills Police Chief | 22-Jan-19 | |
| Michael Eoga | Town of Boonton Alderman | 22-Jan-19 | |
| Dr. Edina Renfro-Michel | Town of Boonton Alderwman | 22-Jan-19 | |
| Edward Robillard | Town of Boonton Fire Chief | 22-Jan-19 | |
| | NJ Fireman's Home Caretaker | 22-Jan-19 | |
| David Mayhood | Town of Boonton Police Chief | 22-Jan-19 | |
| Elliot Ruga | Boonton Resident | 22-Jan-19 | |
| Mark Herzog | Boonton Resident | 22-Jan-19 | |
| Patrick Owens | Morris County Prosecutor's Office, Critical Infrastructure | 22-Feb-19 | Public access trail safety concerns, specifically the dam |
| Nick Kormash | Hudson County | 22-Feb-19 | |
| Scott DiGiralomo | Director of Morris County Department of Law and Public Safety (OEM) | 8-Mar-19 | Emergency response on the trail and dam concerns |
| Greg Kierce | OEM Director & Homeland Security Officer | 27-Mar-19 | Emergency response on the trail, patrols, resources, dam safety |
| Joe Coviello | JCMUA Director of Public Affairs | 27-Mar-19 | |
| Michael Kelly | Chief of Police Jersey City | 27-Mar-19 | |
| Edward Robillard | Fire Department Chief Boonton Town | 9-Apr-19 | Public safety: emergency access points, emergency response needs, water contamination issues, county responsibilities for maintenance |
| Neil Henry | Boonton Town Administrator | 9-Apr-19 | |
| David Mayhood | Boonton Town Chief of Police | 9-Apr-19 | |
| Stephen Jones | Boonton Town Police Lieutenant | 9-Apr-19 | |
| Scott Bednar | Boonton Town Fire Department | 9-Apr-19 | |
| Mike Petonak | Boonton Town DPW | 9-Apr-19 | |
| Dr. Edina Renfro-Michel Ward | Boonton Town Alderwoman | 9-Apr-19 | |
| Kathy Clark | NJ Division of Fish and Wildlife Biologist | 23-Apr-19 | Bald and Gold Eagle Protection Act and trail access |
| Andrew Miller | Parsippany-Troy Hills Police Chief | 7-May-19 | Safety issues, emergency response, access issues |
| Jay Weiners | Parsippany-Troy Hills Police Captain | 7-May-19 | Safety issues, emergency response, access issues |
| Alison Cucco | Jersey City Environmental Commission Chairwoman | 11-May-19 | Boonton Reservoir site walk and public access concerns |
| Matt Trump | JCEC | 11-May-19 | |
| Ashley Metius | JCEC | 11-May-19 | |
| Michelle Luebke | JCEC | 11-May-19 | |
| Mario Verdibello | JCEC | 11-May-19 | |
| Alison Cucco | JCEC | 12-Jun-19 | Jersey City Environmental Commission public meeting preparations |
| Kate Lawrence | Office of Sustainability | 12-Jun-19 | |
| Sally Rubin | Great Swamp Watershed Association Executive Director | 12-Jun-19 | |
| Sandra Lavigne | Great Swamp Watershed Association Director of Water Quality Programs | 12-Jun-19 | |
| Keith Donath | Jersey City Mayor's Office | 12-Jun-19 | |
| Matthew DiLauri | Mayor of Boonton | 17-Jun-19 | Parking, access points, patrol plans |
| Neil Henry | Boonton Administrator | 17-Jun-19 | |
| Dr. Edina Renfro-Michel | Boonton Alderwoman | 17-Jun-19 | |
| Geoffrey Gersten | Deputy Attorney General for the Division of Law, Watershed Property Review Board Member | 18-Jun-19 | Overview of review process by WRB |
| Jessica Patterson | Green Acres Program, Watershed Property Review Board Member | 18-Jun-19 | |
| Megan Lupo | Board of Public Utilities Division of Water, Watershed Property Review Board Member | 18-Jun-19 | |
| Alison Cucco | Jersey City Environmental Commission Chairwoman | 18-Jun-19 | Jersey City Environmental Commission public meeting |
| Michelle Luebke | JC Environmental Commissioner | 18-Jun-19 | |
| Ashley Metius | JC Environmental Commissioner | 18-Jun-19 | |

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| Alexander Mirescu | JC Environmental Commissioner | 18-Jun-19 | |
| Scott Mittman | JC Environmental Commissioner | 18-Jun-19 | |
| Allison Solowsky | JC Environmental Commissioner | 18-Jun-19 | |
| Matthew Trump | JC Environmental Commissioner | 18-Jun-19 | |
| Mario Verdibello | JC Environmental Commissioner | 18-Jun-19 | |
| Kate Lawrence | JC Environmental Commissioner, Office of Sustainability | 18-Jun-19 | |
| Michael Soriano | Mayor of Parsippany-Troy Hills | 20-Jun-19 | Parking, access points, patrol plans |
| Andrew Miller | Chief of Police Parsippany- Troy Hills | 20-Jun-19 | |
| Matthew Clarkin | Mayor's Chief of Staff for Parsippany-Troy Hills | 20-Jun-19 | |
| John Kale | NJDEP Dam Safety | 3-Jul-19 | Suggests all parties involved with security meet together |
| David Mayhood | Boonton Chief of Police | 11-Jul-19 | Local police patrol, emergency response |
| Andrew Miller | Parsippany Chief of Police | 11-Jul-19 | |
| Gabe DiPietro | MCPC Chief of Police | 11-Jul-19 | |
| Michael Soriano | Mayor of Parsippany-Troy Hills | 11-Jul-19 | |
| Edward Conti | JCMUA | 31-Jul-19 | Security Roundtable. |
| Joe Coviello | JCMUA | 31-Jul-19 | |
| Rajiv Prakash | JCMUA | 31-Jul-19 | |
| Greg Kierce | Jersey City OEM | 31-Jul-19 | |
| Keith Donath | Jersey City Mayor's Office | 31-Jul-19 | |
| Jay Wieners | Parsippany Troy-Hills OEM | 31-Jul-19 | |
| Andrew Miller | Parsippany Troy-Hills Police Chief | 31-Jul-19 | |
| Nick Kormash | Hudson County Prosecutor's Office | 31-Jul-19 | |
| Patrick Owens | Morris County Prosecutor's Office | 31-Jul-19 | |
| Gabriele DiPeitro | Morris County Park Commission | 31-Jul-19 | |
| Dave Helmer | Morris County Park Commission | 31-Jul-19 | |
| Sean Gorman | NJ Office of Homeland Security | 31-Jul-19 | |
| Michael Hlavaty | Suez | 31-Jul-19 | |
| Peter Kania | Suez | 31-Jul-19 | |
| John Hroncich | Suez | 31-Jul-19 | |
| Clint Oman | NJDEP Dam Safety | 31-Jul-19 | |
| Sarah Hatala | NJDEP Dam Safety | 31-Jul-19 | |
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Stormwater Management Review

Prepared by Rippled Waters Engineering, LLC

# STORMWATER MANAGEMENT REVIEW OF BOONTON RESERVOIR TRAIL & ENHANCEMENT PROJECT
## August 2019

Prepared by: Rippled Waters Engineering, LLC for Amy S. Greene Environmental Consultants, Inc.

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As part of the design process for the trail project at Boonton Reservoir, Rippled Waters Engineering (RWE) conducted a site assessment of each of the stormwater outfalls entering the Boonton Reservoir for potential improvements. The outfalls are detailed below in Phase order together with potential improvement recommendations for each outfall structure in the future.

**Stormwater Overview**

Runoff into Boonton Reservoir comes from the areas immediately surrounding the reservoir and includes several unnamed tributaries to the Rockaway River. Multiple stormwater outfalls discharge into the wooded areas surrounding the reservoir on the north and west and include runoff from Interstate 287 as well as residential, commercial, and industrial land uses in Parsippany-Troy Hills and Boonton. In general, stormwater runoff from urban areas such as the contributory watershed to the reservoir is laden with pollutants resulting from a variety of nonpoint sources including fertilized lawns, septic systems, and runoff from impervious surfaces.

In New Jersey, fecal coliform, bacteria, phosphorus, nitrogen, and total suspended solids loads (TSS) can cause problems and are regulated for many watercourses in the State. Specifically, phosphorus, nitrogen, and TSS are regulated and stormwater management measures are required for new development and redevelopment projects of a certain size to ensure that pollutants are treated. With the increase in rainfall experienced in 2018 – nearly 40% more than a typical year, pollutant runoff is at an all-time high. In the summer of 2019, several large bodies of water in the state, most notably Lake Hopatcong, were impacted by Harmful Algae Blooms (HABs). HABs have the potential to disrupt water supply as contact with the water can lead to infections and illness. To that end, it is important to consider mitigation measures for water quality treatment. The existing stormwater conditions around the reservoir are evaluated in greater detail throughout this report together with mitigation measures to address nutrient loading.

**Phase 1 –Southern and Eastern Side of Reservoir (south of the existing dam):**

This portion of the trail is primarily along an existing roadway access to the dike located along US Route 46 to the south. No existing stormwater outfalls were identified in the vicinity of the trail in Phase 1, which is proposed to follow the existing roadway access through this area.

*Trail Washouts:*

The existing roadway floods out approximately 800 feet west of the western to southern bend in Knoll Road as indicated in Photo 1 below.

*Photo 1. Image of roadway flooding.*

Runoff along the access road through this portion of the proposed trail concentrates as it moves downslope towards the reservoir as indicated in Photo 2 below.

*Photo 2. Concentrated runoff along the access road.*

Given the localized flooding and erosion that may occur in this portion of the trail, it is anticipated that minor re-grading of the roadway may be necessary. Typically, erosion occurs on trails with grades that exceed five percent and the use of drainage measures may be required to reduce erosion and long-term maintenance of the trail. Re-grading should be completed to ensure a proper crown on the trail is maintained and that drainage is directed into the low-lying areas adjacent to the trail.

Areas of concentrated runoff may require strategic placement of rolling grade dips or rock waterbars (refer to Figure 1 below) to direct stormwater runoff across the trail without creating erosion. Rolling grade dips are used on steeper sections of trail to drain water off trails and require minimal maintenance. Rock waterbars are structures that have the potential to clog, so care will be taken to ensure they are placed in locations that are least likely to clog. In areas where the runoff is concentrated to a point that a waterbar may not be sufficient, a culvert installation may be necessary.

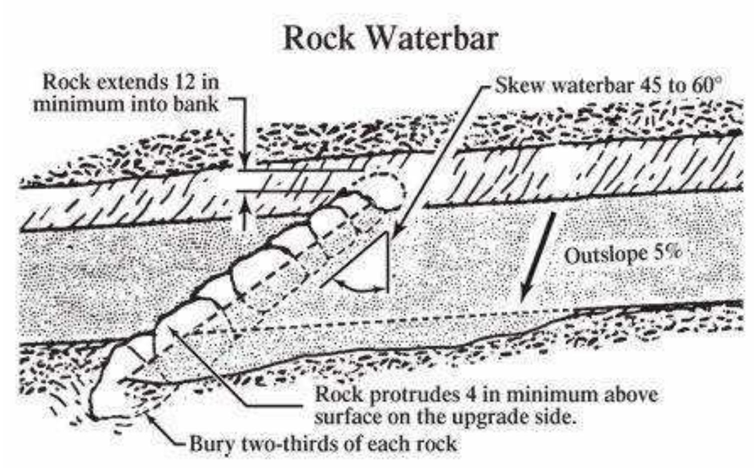


*Figure 1. Typical Rock Waterbar Drainage Feature (obtained from the USDA Forest Service Trail Construction and Maintenance Notebook).*

Costs for waterbar installation is nominal (<$500 per structure) while the cost for installation of culverts along the trail can be anticipated to range from $500 to $5,000.

**Phase 2 – Northern Side of Reservoir (Town of Boonton):**

In general, stormwater runoff in this area has been managed using culverts and other engineered crossings of the existing sewer line that exists along the trail in this area.

*Existing Culverts:*

Working in a westerly direction from the Phase 2 limit at the existing dam, there is a culvert located approximately 160 feet from the eastern edge of the dam embankment. There is a connection to an unnamed tributary to the Rockaway River to the north of this existing culvert crossing. There is localized scour at the downstream end of the culvert and its hydraulic capacity should be further evaluated to ensure that erosion downslope from the culvert will be limited in the future. The area around the trail is heavily mowed, which likely contributes to the erosion at this location.

Continuing to move west there are a series of culverts with masonry end walls that serve to pass several "blue line" tributaries [1]to the reservoir beneath the existing sewer lines. An example of one of the masonry walls and culverts is shown in Photo 3 below.

[1] "Blue line" tributaries refer to watercourses that are mapped on United States Geologic Survey maps as stream channels.

*Photo 3. Image of existing culvert along sewer line in the vicinity of the proposed trail.*

At this location, there are two culverts (approximately 36 inches in diameter). Upstream and downstream of the crossings the channels are heavily rock lined (refer to Photo 4 below) and there is evidence of significant vegetative debris and garbage accumulated both upstream and downstream of the crossings. In the case of the crossing depicted above, the culverts are virtually buried beneath the debris and boulders in the channel, which severely limits the hydraulic capacity of the pipes. It is recommended that the existing culvert crossings be cleared of all debris and large boulders when the trail is constructed and that the crossings be maintained on a regular basis as part of the ongoing trail maintenance in the future.

*Photo 4. Rock lined channel upstream of sewer line crossings.*

Traveling west from the crossings, there are low lying areas of the trail to the southwest of the masonry culvert crossing that may require boardwalk or bridge sections during wetter periods, clean up and regrading.

*Trail Washouts:*

An example of the types of washouts that are evident in this area is shown in Photo 5 below. This image includes accumulated concrete debris from past attempts at stabilization. Debris accumulation and erosion are directly linked to pollutant concentration in the stormwater runoff. Phosphorus and nitrogen tend to bind with soil particles as they travel in sediment laden stormwater runoff. Turbidity is also a good indication of overall water quality as the suspended sediment load is directly linked to nutrient concentration and can also increase temperature resulting in bacteria and fecal coliform loads increasing as well.

Areas like these will be further evaluated during future phases of the project, however, it is assumed that a combination of drainage features may be necessary to address potential washouts. These features may include waterbars, boardwalk crossings of stormwater swales, or other means necessary to control runoff across the trail in these locations and to aid in drainage in and around the trail.

*Photo 5. Erosion and washout of soil along trail.*

The cost to repair trail washout sections is highly variable, however, it can be assumed that costs may be on the order of $1,000 to $5,000 per location.

*Stormwater Outfalls:*

An existing stormwater outfall is located approximately 170 feet southwest of the intersection of Sherman Street and Reservoir Drive. Runoff from this discharge gradually meanders downslope until it enters Boonton Reservoir (refer to Photo 6).

*Photo 6. Stormwater outfall pipe and discharge channel.*

The discharge appears to be mostly stable with well-established vegetation downgradient. The pipe discharge has limited scour immediately beneath it, however, given the amount of wetland vegetation in the discharge area (refer to Photo 7) as runoff travels downslope to the reservoir it is not recommended that any stormwater mitigation measures be employed in this location. The downgradient area is stable and no erosion was noted.

*Photo 7. Wetland vegetation downstream of stormwater discharge.*

Continuing westward there are two stormwater discharges that enter the reservoir property from Reservoir Drive to the south and west of the stormwater outfall described above. Photo 8 below shows one of the asphalt swales as it leaves Reservoir Drive discharging towards the reservoir.

*Photo 8. Asphalt stormwater swale from Reservoir Drive.*

These asphalt swales terminate within the reservoir property where the runoff has created minor erosion. Photo 9 below shows the runoff channel that has been formed as a result of this runoff with heavy vegetative debris. No significant erosion was noted with these discharges.

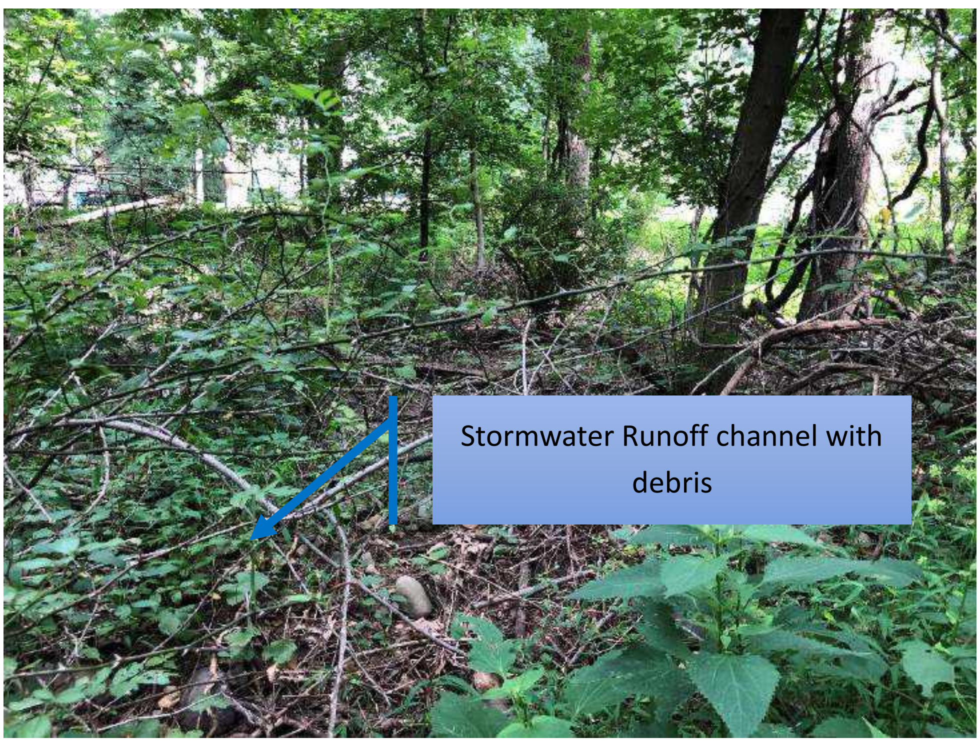


*Photo 9. Discharge from asphalt swales on Reservoir Drive.*

It is recommended that stormwater mitigation for the swales be limited to that which is necessary to ensure that the trail does not wash out. Use of a swale with bio-logs may be necessary to ensure proper drainage and to improve water quality. A typical layout for the bio-log swale is shown in Figure 2 below. This concept design involves the placement of bio-logs perpendicular to flow in the channel area that are staked into the ground to a minimum depth of 12 inches. The logs can be planted and serve to retain water behind them slowing flow and reducing erosive potential and allowing suspended sediment to settle out before it discharges into the reservoir. Slowing the water also allows time for uptake by the vegetation communities and reduction of nutrient load in the system. The swale is planted with native species and the logs themselves can also be planted. Sediment will settle out behind each of the bio-logs as flow travels downstream. A retrofit like this one can be assumed to cost on the order of $50/linear foot of swale depending on the vegetation and the diameter of biolog necessary to stabilize the swale.

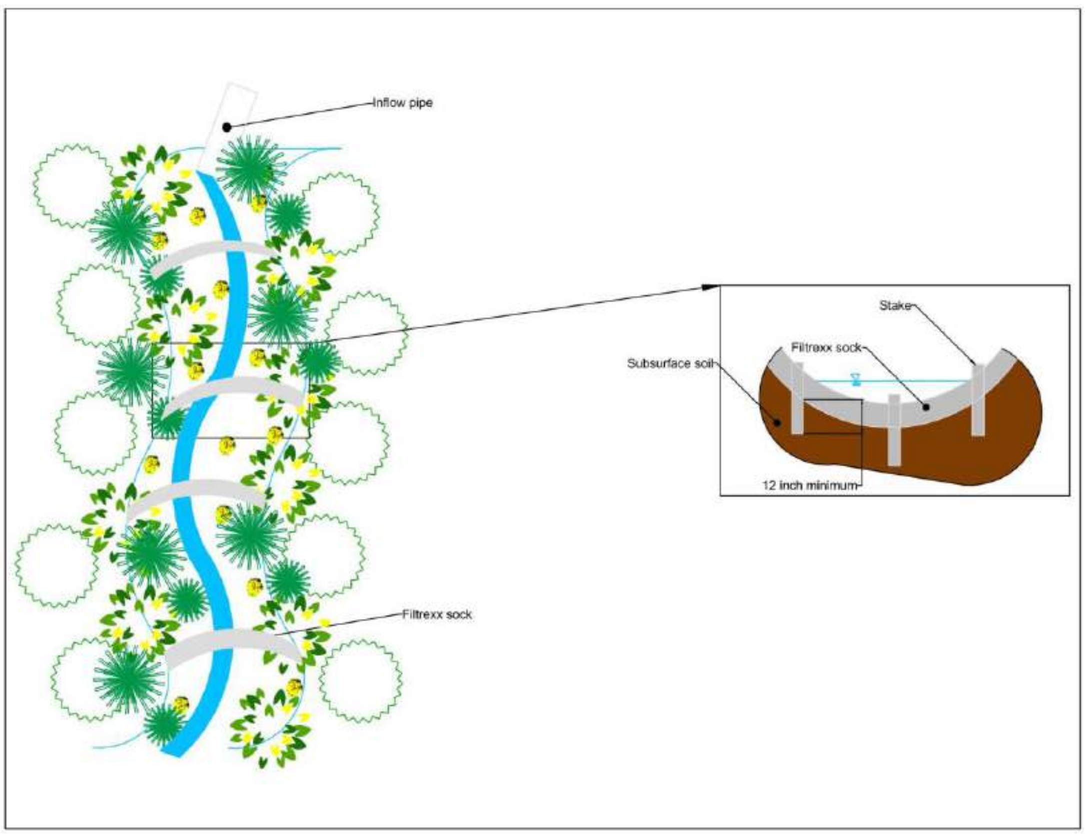


*Figure 2. Bio-log swale feature*

In this area of the trail, there are two more asphalt swales located south of the intersection of Boyd Street and Reservoir Drive as shown in Photo 10 below. The asphalt swales are located off the reservoir property, but the discharge from the swales at the confluence is on the reservoir property itself.

*Photo 10. Asphalt swales discharge southeast of the intersection of Reservoir Drive and Boyd Street.*

Downstream of the asphalt swales confluence is an existing vegetated swale that discharges downslope into the reservoir. The swale is dry except during rain events and has a lot of vegetative debris as shown in Photo 11 below.

*Photo 11. Vegetated dry swale.*

No erosion or debris was noted in the vegetated swale so no improvements are anticipated at this location for stormwater mitigation.

Immediately southeast of the existing pedestrian bridge across the Boonton Reservoir, there is a stormwater outlet into the reservoir which collects runoff from County Route 511. This area is susceptible to a heightened sediment and debris load given its proximity to businesses and the busier roadway. As such, it may be a candidate for retrofit, however, space at this location is limited. Use of the bio-log swale as described above may be an option at this location or alternatively, use of a biofilter cell may be more appropriate depending on the frequency of debris loads. The design concept for the biofilter cell is shown in Figure 3 below.

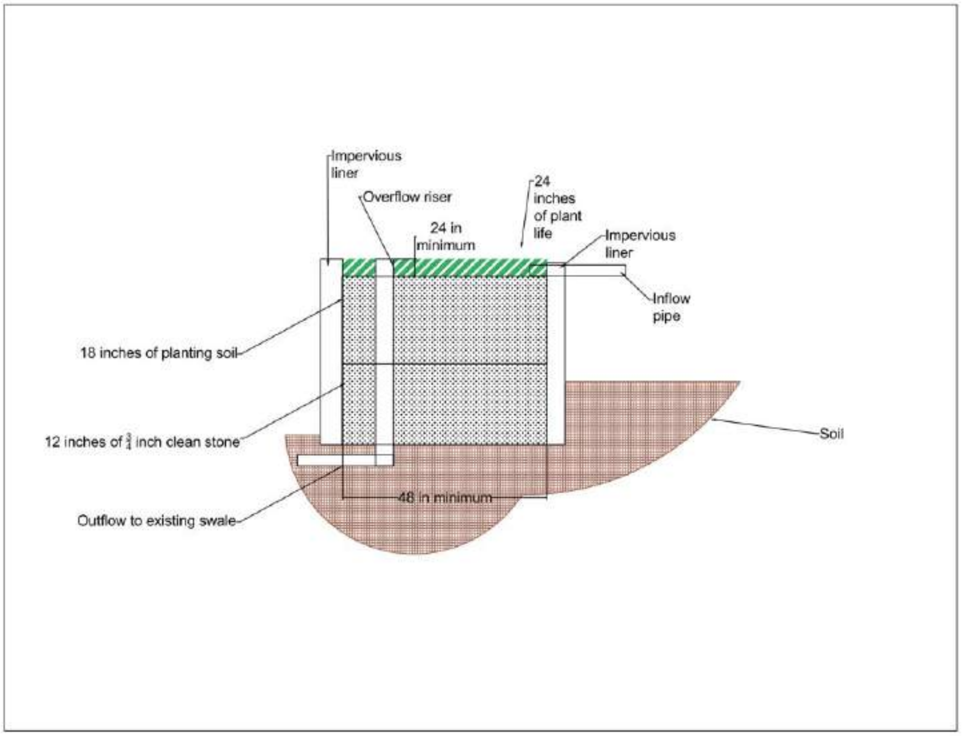


*Figure 3. BIofilter cell cross-section view.*

The biofilter cell consists of a mulch bed over a combination of planting soil and clean stone that serves as a filter over the native soils. If the native soils are such that they can infiltrate than no underdrain is necessary. Alternatively, the system is lined and use of a perforated pipe that serves as an underdrain for the cell is used. The biofilter cell system filters pollutants from the runoff before discharge into the reservoir and also serves to collect floatable and vegetative debris at the surface and would serve to improve water quality. Runoff from large rain events (greater than a 2-year recurrence interval) overflows from the cell and discharges At the southern terminus of Phase 2, there is an existing stormwater gully that will require a trail crossing in the form of a boardwalk or bridge, however, no erosion was noted at this location so no stormwater mitigation measures are proposed.

A biofilter cell can be assumed to cost on the order of $1,500 to $10,000 depending on size of the cell. The construction of these cells can be completed with hand tools and maintenance tends to be limited to removal of accumulated debris on the surface and tilling of the planting soil as needed to ensure drainage.

**Phase 3 –Northeastern portion of the reservoir (including the dam structure):**

Given the fact that the dam is regulated by the New Jersey Department of Environmental Protection Division of Dam Safety & Flood Control and they regulate the structure in this area of the trail, no stormwater improvements are anticipated in this phase.

**Phase 4 –Western edge of the reservoir (including areas adjacent to I-287):**

For this discussion, the trail and stormwater features will be described commencing at the southern terminus of Phase 2 traveling westward. The first feature encountered in this area is a small stream from Parsippany Boulevard. A bridge will be necessary to cross the stream in this location.

*Stormwater Outfalls:*

Stormwater discharges from I-287 in this area of the trail are the largest and have the most erosion and debris associated with the runoff entering the reservoir. It is our opinion that these outfalls should be prioritized for stormwater mitigation over others in the project area.

Traveling south from the Phase 2 terminus, there are two outfalls from I-287 that discharge into a cove at the western boundary of Boonton Reservoir. These discharges are large with many pipes at the outlets and are in generally poor condition. Both features will require bridge crossings and significant sediment and debris loads were observed at the outfalls. Photo 12 below indicates the level of erosion and existing condition of the existing outlet structures.

*Photo 12. Existing Outfall from I-287 along significant watercourse at the northern end.*

There are structural improvements necessary to stabilize the existing headwall and concrete aprons, however, the downstream channel and discharge into the reservoir is also in need of retrofit to curtail scour, erosion, and control debris as noted in Photo 13 below.

*Photo 13.  View of scour and erosion at outfall from I-287*

For these outfalls, the contributory watersheds are of such a size that significant volumes of water must be managed within the exit channels.  The channels are regulated watercourses given their size and it is recommended that the use of stormwater bioretention cells be employed to create a series of pools at the outfall pipe locations to address the erosion and debris loads exiting the outfall pipes.  Figure 4 below depicts the plan view and profile view of the potential stormwater mitigation system.

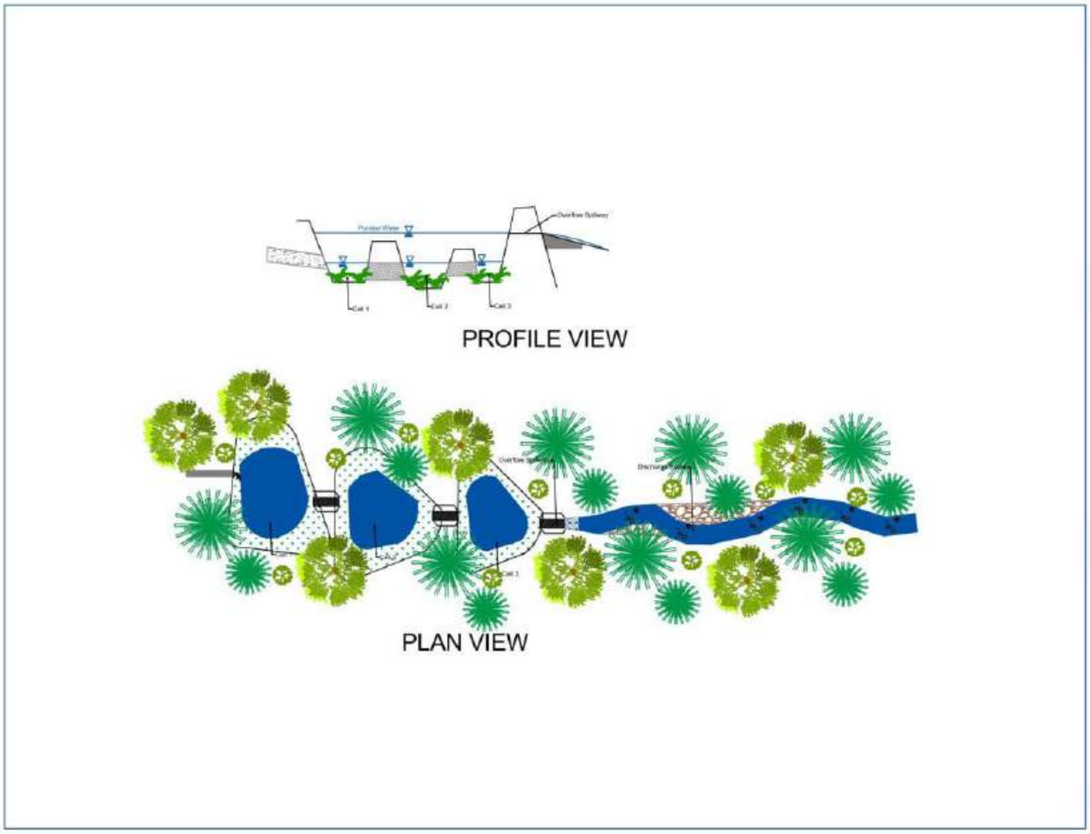


*Figure 4. Bioretention cells and swale system*

The bioretention cells serve as collection points for sediment and debris and allow for easier cleanout of accumulated materials as they exit the pipes and provide water quality treatment for stormwater runoff. The cells also serve to control stormwater runoff discharge rate and volume and promote infiltration and vegetation uptake of stormwater removing pollutants from the system. Further, these cells serve to slow the water down and dissipate energy as it flows downgradient. Up to three cells may be necessary to dissipate the energy and collect the debris prior to discharge into a vegetated swale conveyance downstream. The system will serve to provide filtration of water associated with small rain events (less than a 2-year recurrence interval) and retention of rain events up to the 10-year recurrence interval with runoff from larger events discharging via an overflow spillway into the downstream swale. The entire system will be planted with native vegetation.

Costs for bioretention swale systems can be assumed to range from $5,000 to $75,000 depending on the size and scale of the work being completed. These systems are more complex as they involve larger discharges and as such require structural work and care to construct. Once installed maintenance is fairly straightforward with sediment and debris being removed from the cells and removal of any invasive species by hand.

Continuing southward, another outfall from I-287 discharges into the forested area and discharges eastward into the reservoir. This outfall is in fair condition as evidenced in Photo 14 below, however, there is a significant amount of debris at this outfall and significant scour exists at the discharge point which has eroded away a portion of the soil beneath the existing fence line.

*Photo 14. Outfall from I-287 (east).*

The discharge area has evidence of significant ponding and floatable debris along the fence line from I-287 as shown in Photo 15 below.

*Photo 15. Debris and rack line from outfall*

Significant sedimentation and vegetated growth exist downstream of the outfall, however, runoff from the outfall is current uncontrolled as it enters the reservoir and the amount of debris and garbage is a concern for water quality. To address runoff in this location, it is anticipated that the bioretention cell stormwater mitigation measures could be employed as described for the northernmost outfalls in this area. It is not anticipated that three cells will be necessary for this location and instead perhaps a single cell may achieve the desired water quality treatment and collection point for debris.

Continuing southward, another stormwater outfall exists from I-287 runoff discharging to the southeast. There is no defined swale at this location and the outfall appears to be in good condition as shown in Photo 16 below.

*Photo 16. Outfall from I-287 (southeast discharge)*

The discharge apron is fairly stable, however, there is no visible riprap or other conduit outlet protection visible at this location. There is a debris/rack line noted in the foreground of Photo 15, however, no erosion or defined channel exists downstream as runoff from the pipe spreads out and sheet flows across to the reservoir.

Stormwater mitigation for this outfall would be in the form of a bio-log swale as described elsewhere in this memorandum. The discharge is stable, however, there is no defined channel downstream and clearing of some existing vegetation may be necessary to construct the bio-log swale. Use of the bio-log swale will allow for more controlled management of the sediment and debris load exiting this outfall and ultimately discharging into the reservoir.

The last outfall at the southern end of I-287 within Phase 4 of the project, is in very poor condition with significant scour and erosion noted in Photo 17 below.

*Photo 17. Outfall from I-287 (southernmost discharge).*

The bottom of the existing headwall and apron have completely separated and the surrounding fence area has eroded to a depth of more than three feet completely exposing the footings for the chainlink fence and exposing roots of sizable trees in the forest. It can be assumed that significant sediment loads and poor water quality exists in the discharge into the reservoir from this location and that stormwater management measures will improve conditions and curtail the erosion and scour.

This outfall is one of the worst along the proposed trail and mitigation for the stormwater should be prioritized. It is anticipated that use of the bioretention cells as detailed earlier in this memorandum would be the most likely solution for this outfall. The heavy sediment load and debris load from this outfall currently is uncontrolled as runoff travels downgradient into the reservoir.

Photo 18 below provides a snapshot of the conditions downgradient from the outfall.

*Photo 18.  Downgradient erosion from I-287 southernmost outfall.*

The stream should be stabilized using bioengineering techniques and use of large woody debris and engineered rock structures may be necessary depending on the shear stresses in the channel.  The channel itself does not appear to have been constructed and instead was formed from years of uncontrolled runoff discharging from the outfall.  Typical construction details for large woody debris and engineered rock structures are shown in Figure 5 below.

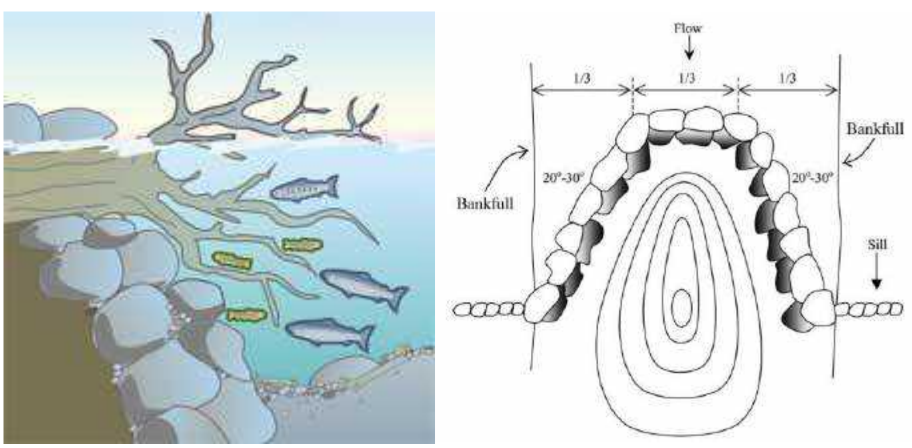


*Figure 5.  Large Woody Debris detail (from King County website) and Rock Vane detail (Rosgen).*

Costs for addressing the scour and installation of woody debris and vane structures in the downstream discharge for a system like this would be on the order of $5,000 to $30,000 to install.

**Summary**

Existing stormwater runoff in the area of the proposed trail is being managed in some locations and in others there is little to no management employed. There are a series of existing outfalls into the reservoir property that are in various states of repair and some will require significant efforts to mitigate. Other areas can be addressed with mitigation measures that require a much lighter touch. All stormwater mitigation for the area will serve to reduce erosion and improve water quality for the reservoir for years to come.