

MAINTENANCE MANUAL FOR THE STORMWATER FACILITIES

FOR PROPOSED

HANGAR EXPANSION

PRINCETON AIRPORT

BLOCK 34001, LOT 57

*TOWNSHIP OF MONTGOMERY
SOMERSET COUNTY, NEW JERSEY*

To be maintained by:

Property Owner

*Project #2194-020
November 2021*

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Bioretention System Overview

Functionality

Bioretention systems are used to remove a wide range of pollutants, such as suspended solids, nutrients, metals, hydrocarbons, and bacteria from stormwater runoff. They can also be used to reduce peak runoff rates and increase stormwater infiltration when designed as a multi-stage, multi-function facility.

A bioretention system can be configured as either a bioretention basin or a longer, narrower bioretention swale. In general, a bioretention basin has a flat bottom while a bioretention swale may have a sloping bottom. Runoff storage depths above the soil bed surface are typically shallow. The TSS removal rate for bioretention systems is 80 or 90 percent, depending upon the thickness of the soil planting bed and the type of vegetation grown in the bed.

Type of BMP – Dry Basin / Infiltration

A bioretention system is a type of **dry** basin. Dry basins must fully drain within 72 hours of the most recent rainfall. Standing water in excess of 72 hours is a sign of basin failure. It may also contribute to mosquito breeding and other health and safety issues. The design drain time shall be closely monitored to ensure that potential failure is recognized early. A bioretention system designed for infiltration does not have an underdrain piping system. The runoff exits the system by infiltrating into the subsoil beneath the bioretention media with larger storms overflowing out a structure.

A bioretention system with infiltration can also be designed for extended detention, in which case it will attenuate peak flows from storms larger than the Water Quality Design Storm.

Proper care and attention in the long-term maintenance of the stormwater management measure is critically important to the safety and health of the public.

Basic Design Information

Hydrology Design Targets

1. The bioretention system is designed as an online system.
2. Basins must drain within 72 hours. See Stormwater Management Report for detailed soil testing results & drain time calculations.
3. Seasonal high water table elevations have been confirmed by soil testing (see Stormwater Management Report. Minimum separation from bottom of BMP to seasonal high water table is 2' for systems designed to infiltrate into the subsoil, and 1' for systems with underdrains.

Hydraulic Design Targets

Design parameters

	Water Quality Design Storm	2-year storm	10-year storm	100-year storm
Rainfall Depth (inches)	1.25 inches (in 2 hours)	3.3 inches (in 24 hours)	5.0 inches (in 24 hours)	8.2 inches (in 24 hours)
Runoff Volume (cubic feet)	1,669	6,348	10,887	20,020
Peak Flow Rate (cfs)	0.00 (entire WQ storm infiltrated)	0.47	1.61	4.67
Water Surface Elevation (feet)	120.14	120.44	120.67	120.84

The emergency spillway is at elevation 120.85 feet.

Basin Configuration Targets

1. Planting Soil Bed

- The depth of the soil planting bed is 1.5 ft
- Mixture of the planting soil consists of 85% to 95% sands (with no more than 25% of the sands as fine or very fine sands; no more than 15% silt and clay with 2% to 5% clay content). The organic matter shall be within 3% to 7%.
- The pH of the planting soil should be in the range of 5.5 and 6.5.
- Filter fabric is placed along the sides of the soil planting bed.
- The system is designed with planting soil permeability rates as noted above in “Hydrology Design Targets”.

2. Outlet Information:

Outlet Description	Outlet Type	Orifice Size / Weir Length	Invert Elevation
Weir	Weir	12”	120.15
Grate	Grate	2’ x 2’	120.60

3. Vegetation

- The vegetation type will be terrestrial forested community.

Critical Maintenance Features

1. No heavy equipment on the basin surface.
2. Remove vegetation strictly in accordance with the landscaping plan.
3. Grass clippings shall be collected from the basin and properly disposed.
4. Keep the appearance of the basin aesthetic.

Maintenance Log

Person responsible for maintaining the bioretention basin will keep a detailed Maintenance Log of all preventative and corrective maintenance performed, including all maintenance-related work orders. The maintenance log of this manual, which lists the maintenance tasks for the bioretention basin, shall submitted to the Township Engineer by April 1 of each year.

Cost Estimate of Maintenance Tasks

	Description	Frequency (per year)	Cost	Total
1	Trash/Debris removal from site	2	\$200	\$400
2	Trash/Debris removal from inlets	2	\$100	\$200
3	Sediment removal from Basin	2	\$2,000	\$2,000
4	Lawn/Vegetation maintenance	12	\$100	\$1,200
5	Revegetate bare surfaces	4	\$100	\$400
Annual Maintenance Cost:				\$4,200
Additional Cost:				
1	Bioretention media removal and replacement.	Every 5-10 yrs.	\$5,000	\$5,000
2	Structure Repair – If required (basin outlet structures)	Every 10 yrs.+	\$3,000	\$3,000

Safety Measures and Procedures

Maintenance and corrective measures to be in accordance with applicable OSHA regulations to protect the safety of the inspection and maintenance personnel.

Proper safety equipment shall be worn and used during inspection and maintenance activities including hardhats, safety glasses, protective gloves, steel-toed boots, and hearing protection.

Any individual operating machinery that requires special training shall have complete required training. During operation, the proper safety precautions shall be taken to ensure the safety of the operator and those in the immediate vicinity.

Training Plan and Records

Prior to performing inspections, all inspection personnel are required to be properly trained in accordance with NJDEP Best Management Practices Manual. Each individual is required to be trained for the usage of the NJDEP Field Manuals as well as Stormwater Management Basic Training. All inspection personnel shall be trained for occupational safety.

1. Stormwater Management Basic Training: Inspection and maintenance personnel shall be familiar with the general purposes and functions of BMPs. Personnel shall also be trained in specialized inspection and maintenance tasks and/or the specialized maintenance equipment. Training shall also be provided for the need and use of all required safety equipment and procedures. Training material can be found in the NJDEP Stormwater BMP Manual, Chapters 9.1 Bioretention Systems. More information on training is available at NJStormwater.org (nj.gov/dep/stormwater/training.htm).
2. Vegetation Care: All Inspection and maintenance personnel shall be familiar with the general purpose and functions of the vegetation and landscaping used in conjunction with the BMPs. Training material is available in NJDEP Stormwater BMP Manual, Chapter Seven: Landscaping. The NJDEP Stormwater BMP Manual provided information on vegetation and landscaping for stormwater management measures.
3. Occupational Safety Training: Inspection and maintenance personnel shall be properly trained and certified through OSHA. Training attendance sheets and certification for inspection and maintenance personnel shall be attached by the responsible party after each training.

Tools and Equipment

The following is a list of required inspection equipment for routine operation and maintenance procedures and inspections.

1. A clipboard, a pencil and the inspection checklist – the inspection checklist is included in this manual.
2. A standard 6-foot collapsible ruler.
3. A camera – photographs or observed portions of the basin will provide a measure of performance when comparing past and present maintenance practices or conditions.
4. A probe – any stiff light sticks or rod with a blunt tip of sufficient strength to penetrate soil. The probe can provide information on conditions below the surface of the basin, such as the depth and softness of a saturated area.
5. A weed whacker – can be used to clear non-visible areas to perform routine maintenance.
6. A flashlight – a flashlight can be used to observe the inside of inlet pipes and structural components.

Maintenance of the basins may include heavy equipment including the following:

1. Lawn Mower
2. Wheelbarrow
3. Backhoe
4. Dump truck

Sources of the following materials should be identified for immediate use if warranted by the inspection.

1. Clean sand or gravel for filling erosion rills and gullies.
2. Topsoil mixture, fertilizer and seed.
3. Large stone riprap for emergency repairs caused by erosion.
4. Synthetic geo-fabric netting and stakes to prevent seed and top soil from blowing away.

Visual Aid for Dry Type Stormwater Basin Inspection

<p>Issue:</p> <p>Corrective Action:</p> <p>Preventative Action:</p>	 <p>The inlet is not properly drained, assuming it has not rained within 72 hours.</p> <p>Clear and remove sediment. Check whether the water table is at or above the bottom of the forebay. Also check the permeability of the underlying soil, if necessary.</p> <p>Routine inspections and removal of sediment from the forebay.</p>
<p>Issue:</p> <p>Corrective Action:</p> <p>Preventative Action:</p>	 <p>The Inflow path under the sidewalk is clogged by sediment and vegetation.</p> <p>Clear and remove sediment and unwanted vegetation.</p> <p>Routine inspection and removal of sediment and unwanted vegetation.</p>

<p>Issue:</p> <p>Corrective Action:</p> <p>Preventative Action:</p>	 <p>The Inflow path under the sidewalk is entirely clogged by sediment and trees.</p> <p>Clear and remove sediment and trees.</p> <p>Routine inspection & removal of sediment and unwanted vegetation.</p>
<p>Issue:</p> <p>Corrective Action:</p> <p>Preventative Action:</p>	 <p>The excessive sediment in inflow pipe might be caused by a blockage of flow to the basin due to excessive vegetation and overgrown trees.</p> <p>Clear and remove trees and vegetation. If necessary, re-grade the bottom slope to ensure the flow properly spreads over the basin bottom.</p> <p>Routine inspection and removal of sediment and unwanted vegetation.</p>
	

<p>Issue:</p> <p>Corrective Action:</p> <p>Preventative Action:</p>	<p>Eroded inflow apron.</p> <p>Repair apron.</p> <p>Routine inspection and rehabilitation, if necessary.</p>
<p>Issue:</p> <p>Corrective Action:</p> <p>Preventative Action:</p>	 <p>The vegetation loss and the blackish soil may indicate frequent inundation.</p> <p>Check the permeability rate of the soil and the water table elevation. Replace the soil if necessary.</p> <p>Routine inspection and tilling/aeration, if necessary.</p>
<p>Issue:</p> <p>Corrective Action:</p> <p>Preventative Action:</p>	 <p>Outlet is damaged.</p> <p>Repair the outlet.</p> <p>Routine inspection, especially after large storm events. Tighten any loose bolts and repair structural flaws.</p>

Inspection Checklist / Maintenance Actions

Bioretention System

Checklist (circle one): Monthly / Quarterly / Semiannual / Annual / Special Event Inspection

Checklist No. _____ **Inspection Date:** _____

Date of most recent rain event: _____

Rain Condition (circle one):

Drizzle / Shower / Downpour / Other _____

Ground Condition (circle one):

Dry / Moist / Ponding / Submerged / Snow accumulation

Bioretention Basin

Frequency listed reflects minimum inspection frequency.

		For Maintenance Crew			
Component No. Component Name	Inspection Item and Inspection Item No.	Result	Preventative / Corrective Maintenance Actions	Frequency	
A Basin Bed	1	Standing water is present after the design drain time The observed drain time is approximately _____ hours.	Y__ N__	Recheck to determine if there is standing water after 72 hours If standing water is present longer than 5 days, report to mosquito commission. Remove any sediment buildup Check the soil permeability Till the soil bed with rotary tiller or disc harrow Replace the planting soil, if necessary. Work Order #	Semiannual
	2	Excessive sediment, silt, or trash accumulation on basin bed	Y__ N__	Clean pretreatment system Remove silt, sediment, and trash	Semiannual
	3	Erosion or channelization is present	Y__ N__	Check whether the flow bypass or diversion device is clogged Re-grade the infiltration bed Work Order # _____	Semiannual
	4	Animal burrows/rodents are present	Y__ N__	Pest control Work Order # _____	Semiannual

		For Maintenance Crew			
Component No. Component Name	Inspection Item and Inspection Item No.	Result	Preventative / Corrective Maintenance Actions	Frequency	
	5	Uneven bed	Y__ N__	Use light equipment to resurface the bed Work Order # _____	Semiannual
	6	Evidence of sinkholes or subsidence	Y__ N__	Monitor for sinkhole development	Semiannual
B Vegetation	1	Large spot(s) showing bare soil	Y__ N__	Vegetative cover must be maintained at 85%. Revegetate the entire basin if 50% or more vegetation has been lost Work Order # _____	Quarterly
	2	Invasive plants are present	Y__ N__	Remove the invasive plants and restore the vegetation in accordance with the landscaping plan Work Order # _____	Quarterly
	3	The vegetation in the basin has been mowed or removed	Y__ N__	Revegetate the system in accordance with the vegetation plan Work Order # _____ Note: The vegetation in a bioretention system should not be mowed or removed	Quarterly
Note:					

		For Maintenance Crew			
Component No. Component Name	Inspection Item and Inspection Item No.	Result	Preventative / Corrective Maintenance Actions	Frequency	
C Bioretention System Embankment and Side Slopes	1 Signs of erosion, soil slide or bulges, seeps and wet spots, loss of vegetation, or erosion on the basin slope	Y__ N__	Check for excessive overland runoff flow through the embankment. Check for any sink hole development Restabilize the bank Work Order # _____	Quarterly	
	2 Overgrown perimeter vegetation	Y__ N__	Mow the vegetation on the perimeter of the embankment Work Order # _____ Note: Mowing of vegetation should only take place in the area outside the basin. Dense vegetation must be maintained in the basin.	Monthly or as needed	
D Outlet	1 Trash or debris accumulation more than 20%	Y__ N__	Clean and remove Determine source of trash and address to reduce future maintenance costs or basin failure	Monthly	
	2 Trash rack is damaged or rusted greater than 50% Trash rack is bent, loose, or missing parts	Y__ N__	Repair or replace trash rack Work Order # _____	Semiannual	
	3 Outlet components (e.g., orifice plates or weir plate) skewed, misaligned, or missing	Y__ N__	Repair or replace component Work Order # _____	Semiannual	
	4 Discharge pipe apron is eroded or scoured	Y__ N__	Restabilize the discharge riprap apron Work Order # _____	Semiannual	

For Maintenance Crew					
Component No. Component Name	Inspection Item and Inspection Item No.		Result	Preventative / Corrective Maintenance Actions	Frequency
F Miscellaneous	1	Excessive or overgrown vegetation blocking access to the basin	Y__ N__	Clear, trim, or prune the vegetation to allow access for inspection and maintenance Work Order # _____	Quarterly

Note:

Follow Up Items (Component No. / Inspection Item No.):

Associated Work Orders: # _____, # _____, # _____, # _____, # _____

Inspector Name **Signature** **Date**

Report issues to the local authority and mosquito commission as required by local ordinances and regulatory authorities.

File this checklist in the Maintenance Log after performing maintenance.

Disposal Plan

Remove accumulated sediment and debris twice a year from the basin. Removal shall occur when the basin is dry. Collected trash and debris shall be disposed at the Monmouth County Landfill or another NJDEP approved offsite facility in compliance with all applicable local, state, and federal waste disposal regulations. Sediment shall be disposed of at the Middlesex County Landfill or another offsite location approved by the New Jersey Department of Environmental Protection.

Dewatering Plan

The performance level of the bioretention system shall be determined six months after its installation and semiannual thereafter. This may be done by recording length of time it takes to drain the design storm runoff volume as determined by the design engineer. If significantly different, an evaluation must be made of the system's groundwater and/or tailwater levels. Appropriate measures shall then be taken to bring the basin into compliance with the drain time requirements. Dewatering shall be performed with wet pump and discharged through a sediment bag to the nearby inlets.

Annual Evaluation of the Effectiveness of the Plan

The party responsible for the maintenance and repair of the stormwater management facilities onsite is the property owner. Evaluate the effectiveness of this maintenance plan at least once per year and adjust the plan as needed. The items to evaluate may include the following:

- The inspections have been performed as scheduled.
- The preventive maintenance has been performed as scheduled.
- The frequency of preventative maintenance needs to increase or decrease.
- The planned resources were enough to perform the maintenance.
- The repairs were completed on time.
- The actual cost was consistent with the estimated cost.
- The inspection, maintenance, and repair records have been kept.

If actual performance of those items has been deviated from the maintenance plan, the responsible party should find the causes and implement solutions in a revised maintenance plan.

Annual Evaluation Records

Evaluator(s)	Date of Evaluation	Decision
		<p><u> </u> Maintain current version OR</p> <p><u> </u> Revise current version Revision date _____ (also update the last revision date on the cover page)</p> <p><u> </u> Requires a new deed recording (also update the last recording information on the cover page)</p>
		<p><u> </u> Maintain current version OR</p> <p><u> </u> Revise current version Revision date _____ (also update the last revision date on the cover page)</p> <p><u> </u> Requires a new deed recording (also update the last recording information on the cover page)</p>
		<p><u> </u> Maintain current version OR</p> <p><u> </u> Revise current version Revision date _____ (also update the last revision date on the cover page)</p> <p><u> </u> Requires a new deed recording (also update the last recording information on the cover page)</p>

Preventative Maintenance Record – Bioretention System

Corresponding Checklist No. _____
 Component No. _____, Inspection Item No. _____

Work Logs

Activities	Components	Date Completed
Sediment/debris removal Sediment removal should take place when the basin is thoroughly dry.	A – Basin Bed	
	C – Bioretention System Embankment and Side Slopes	
	D – Outlet	
Vegetation removal	A – Basin Bed	
	C – Basin Embankment and Side Slopes	
	D – Outlet	

Vegetation is removed by _____ (type of equipment) with minimum disruption to the remaining vegetation.

All use of fertilizers, pesticides, mechanical treatments, and other means to ensure optimum vegetation health must not compromise the intended purpose of the stormwater management measure. The fertilizer applied is _____ (type), and _____ (quantity per usage) is applied _____ (frequency of use).

Debris, sediment, and trash are handled (onsite / by _____ (contractor name) to disposal site _____). (See Part I: Maintenance Plan – Disposal Plan Section)

Crew member: _____ / _____ **Date:** _____
 (name/ signature)

Supervisor: _____ / _____ **Date:** _____
 (name/ signature)

File this Preventative Maintenance Record in the Maintenance Log after performing maintenance

Corrective Maintenance Record

1. **Work Order #** _____ **Date Issued** _____

2. **Issue to be resolved:**

3. The issue was from **Corresponding Checklist** _____, **Component No.** _____, **Inspection Item No.** _____.

1. Required Actions

Actions	Planned Date	Date Completed

2. **Responsible person(s):**

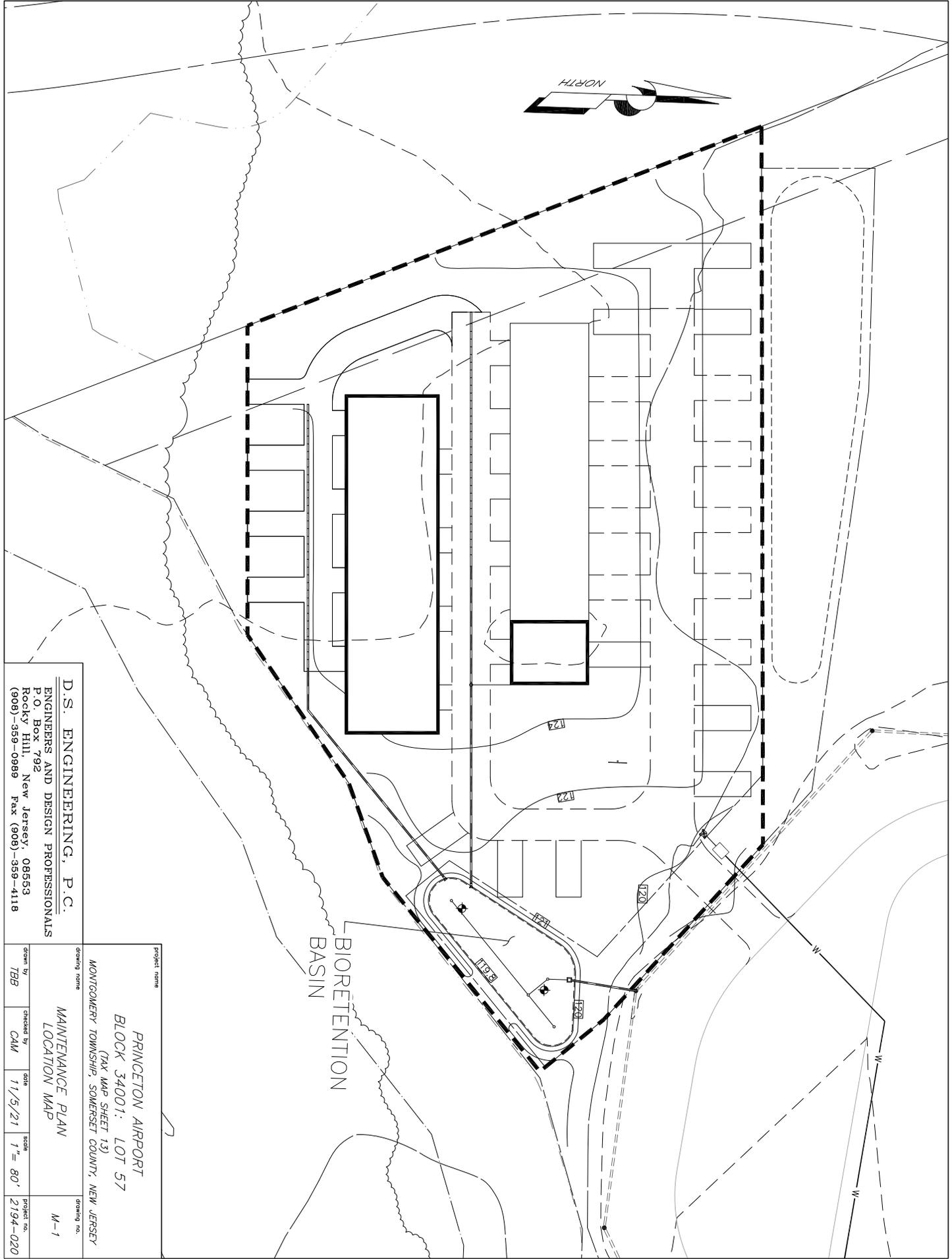
3. **Special requirements**

- Time of the season or weather condition: _____
- Tools/equipment: _____
- Subcontractor (name or specific type): _____

Approved by _____ / _____ **Date** _____
(name/signature)

Verification of completion by _____ / _____ **Date** _____
(name/signature)

File this Corrective Maintenance Record in the Maintenance Log after performing maintenance.



BIORETENTION
BASIN

project name
PRINCETON AIRPORT
BLOCK 34001: LOT 57
 (TAX MAP SHEET 13)
 MONTGOMERY TOWNSHIP, SOMERSET COUNTY, NEW JERSEY

D.S. ENGINEERING, P.C.
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drawing name	drawing no.
MAINTENANCE PLAN LOCATION MAP	M-1
drawn by TBB	checked by CAM
date 11/5/21	scale 1" = 80'
project no. 2194-020	