March 22, 2021

Ref: 14500.00

Ms. Kathy Joubert, Town Planner
Town of Northborough
Northborough Town Offices
63 Main Street
Northborough, MA 01532

Re: Response to Peer Review Comment Letter
425 Whitney Street

Dear Kathy,

On behalf of Isomedix Operations Inc. (the "Applicant"), VHB is pleased to provide the following responses to the comments/questions raised in the peer review letter prepared by Environmental Partners (EP) dated February 25, 2021 regarding the proposed facility expansion located at 425 Whitney Street, Northborough (the "Project").

For ease of reference, VHB has provided a copy of each comment in italics followed by our response in bold text. Attachments to this letter include:

- Revised Site Plans
- Revised Stormwater Report
- Site Lighting Cut Sheets

Northborough Zoning Bylaw

Comment 1. *Section 7-07-010 D(3)(c)[4] allows industrial development on lots within the Groundwater Protection Overlay District Area 3 provided the post development net runoff volume does not exceed existing conditions by more than 15%. The submitted calculations demonstrate that the proposed project meets this requirement. However, we do have recommendations regarding the time span used for the hydrologic calculations as described below. This section also states that the proposed project will not cause a violation of Class B water quality standards and will not cause a violation of Class I groundwater quality standards. Class B standards as described in 314 CMR 4, address dissolved oxygen, temperature, pH, bacteria, solids, color and turbidity. Oil and grease, and taste and odor. The project generally meets the Massachusetts Stormwater Management Standards. However, many of the pollutant described in this section are not specifically addressed in the Stormwater Management Standards. In our opinion, the proposed project, under normal operations, will likely not cause a degradation of the Class B standards.*

Engineers | Scientists | Planners | Designers
120 Front Street, Suite 500, Worcester, MA 01608
P 508.752.1001 www.vhb.com

Response: The peak rates of runoff occur at the 12-hr mark therefore the peak rates would not be affected by a longer time span. We have updated the model to show a longer time span. VHB does not expect the Project to cause a degradation of the Class B standards.

Comment 2. *Section 7-09-010 D (5)(f) regarding land clearing and grading requires weekly inspections of all erosion and sedimentation control measures. This exceeds the requirements of the United States Environmental Protection Agency National Pollutant Discharge Elimination System Construction General Permit. We recommend that weekly inspections be included as part of the "Recommended Construction Period Pollution Prevention and Erosion and Sedimentation Controls" document submitted by the applicant and that copies of all weekly reports be submitted to Town.*

Response: The Maintenance/Evaluation Checklist provided within the "Recommended Construction Period Pollution Prevention and Erosion and Sedimentation Controls" document recommends inspection of all BMPs "weekly and after storm events of ½ inch or greater". The document has been updated to reflect this inspection frequency and require that records of the inspections will be maintained on site by the contractor and copies of all weekly reports submitted to the Town. See revised Stormwater Report attached hereto.

Comment 3. *Section 7-09-010 D (6)(b) requires four inches of loam and seed. We recommend a note be added to the landscape plan and Grading, Drainage, and Erosion Control Plan requiring a minimum of 4" of loam and seed be placed to stabilize the site.*

Response: VHB's General Notes, note 4 (sheet C-1) reads as follows "Areas disturbed during construction and not restored with impervious surfaces (buildings, pavements, walks, etc.) shall receive six (6) inches loam and seed."

Comment 4. *Section 7-09-010 E includes requirements for monitoring and inspections. We recommend that the project notes be updated for consistency with the requirements of this section.*

Response: The requirements of Section 7-09-010 E will be included in the project's Stormwater Pollution Prevention Plan (SWPPP) to be provided to the US EPA as part of the Construction General Permit (CGP) process at least 14 days prior to the start of construction.

Comment 5. *Section 7-09-020 C (1) requires projects to comply with Chapter 4-12 regarding illicit discharges. The proposed design does not appear to include any illegal discharges to the municipal storm drain system. The project plans includes a sewer ejector pump with a note that the design of the force main will be prepared following completion of survey. The plans do not include a detail for the pump station of the force main design. As described in the Stormwater Management section of this letter, the Illicit Discharge Statement has not been submitted consistent with the Massachusetts Stormwater Management Standards.*

Response: The sewer force main and ejector pump are shown for illustrative purposes only at this time. Once prepared, the design will be fully reviewed and coordinated with Northborough DPW for approval prior to construction. The illicit discharge statement has been added to the Stormwater Report, Appendix G.

Comment 6. *Section 7-09-020 C (2) requires details regarding site lighting. We recommend that details of the site lights be included on the site plans in conformance with the requirements of this section, including light pole heights.*

Response: Details regarding site lighting have been added to the site plans. All fixtures have house side shields that are reducing light spill and shielding the LEDs from abutters positioned behind the poles that run along the perimeter of the parking area. Pole heights are shown on the photometric plan and are called out as "MH: 20" or mounting height. Additional text has been added to the Luminaire Location Summary to provide clarification on pole heights. Fixtures are Dark Sky compliant.

Comment 7. *Section 7-09-020 C (5) (a) [2] requires a 50 foot area of open space for industrial projects abutting residential districts. We understand that the Zoning Board of Appeals issued a variance from this requirement on August 27, 2019.*

Response: As noted, the Zoning Board of Appeals granted a dimensional variance allowing a structure to be located within 20' of the westerly property boundary, making it impossible to provide a 50 foot buffer in that area. However, the project will maintain existing vegetation to the maximum extent practicable. It's also worth noting that a railroad parcel and an aqueduct parcel are situated between the project site and residential uses.

Comment 8. *Section 7-09-020 C (5) (d) requires exposed storage areas, truck loading areas, etc., to be screened by abutting properties. The proposed 'loading area' to the rear of the proposed parking lot does not include any additional landscaping. Based on review of aerial photography, there appears to be limited vegetation between 425 Whitney Street and the adjacent property.*

Response: The loading area to the rear of the property abuts a vegetated wetland system to the east and north. Additional screening seems unnecessary in this location.

Comment 9. *Section 7-09-030 B (2) provides parking ratios for different land uses. The applicant has provided required parking estimates using the industrial (office) and warehouse parking ratios. Based on these ratios, the applicant has estimated that 38 parking spaces are required by regulation. However, the parking requirements table shown on the Layout and Materials Plan indicates the proposed use only requires 20 parking spaces. We recommend the Board consider allowing the applicant to reduce the number of parking spaces to reduce impervious surfaces and stormwater management impacts.*

Response: No response necessary.

Comment 10. *Section 7-09-030 B (3) allows the Planning Board to authorize a 30% reduction in off-street parking spaces, subject to conditions described in the Bylaw.*

Response: No response necessary.

Comment 11. *Section 7-09-030 C (1) (a) requires the maximum driveway width to be 24 feet. The proposed driveway is 30 feet wide.*

Response: The width of the driveway matches the existing condition and is also preferred to better accommodate larger trucks.

Comment 12. *Section 7-09-030 C (4) (a) [1] requires parking areas with greater than five parking spaces to have a buffer of approximately 10 feet in width. EP was not asked to perform a comprehensive review of the landscape design. However, the proposed landscape plan includes the staggered planting of trees on the outside edge of the parking lot.*

Response: The landscape architect has reviewed the planting plan for compliance with the Bylaw requirements. With the low branching and widespread characteristics of the proposed plantings and the existing landscape, VHB believes to have provided the required buffer. If additional plantings are necessary, please provide recommendations.

Comment 13. *Section 7-09-030 F (1) requires bicycle parking facilities be incorporated into the site design unless waived by the issuing authority. It does not appear that bicycle facilities are included on the plans. This section requires one bicycle parking stall for every 10 vehicular parking spaces. We recommend bicycle facilities be added to the plans consistent with the requirements of the Bylaw.*

Response: A bicycle rack has been added to the plan in accordance with the requirements of the Bylaw. See revised Site Plans attached hereto.

Massachusetts Stormwater Management Standards

Comment 1. *Standard 1 – The project complies with this requirement. There are two direct discharges to wetlands. Prior to the discharge of stormwater to wetland resources, stormwater is treated and discharged over a rip-rap pad to reduce erosion impacts. Environmental Partners has comments regarding the riprap pad below.*

Response: No response necessary.

Comment 2. *Standard 2 – The project, as currently designed, complies with this requirement. The current design does not increase offsite peak flows to the wetlands.*

Response: No response necessary.

Comment 3. *Standard 3 – The project – as designed - provides groundwater recharge in excess of the amount required by the Standard.*

Response: No response necessary.

Comment 4. *Standard 4 – The project design provides adequate Total Suspended Solids removal, consistent with the Standards.*

Response: No response necessary.

Comment 5. *Standard 5 – The project is not considered a Land Use with Higher Potential Pollutant Loads, as described by the Standards.*

Response: No response necessary.

Comment 6. *Standard 6 – The project is located within the Groundwater Protection District and therefore the project is required to treat the 1-inch water quality volume. The project provides adequate treatment to meet the performance standards.*

Response: No response necessary.

Comment 7. *Standard 7 – The project is a mix of new development and redevelopment and meets the performance standards for a mix of new development and redevelopment.*

Response: No response necessary.

Comment 8. *Standard 8 – An erosion and sedimentation control plan has been provided and generally complies with the Standards. We do have the following comments regarding erosion and sedimentation.*

a. *A Stormwater Pollution Prevention Plan required by the United States Environmental Protection Agency's National Pollutant Discharge Elimination System (NPDES) Construction General Permit was not provided. This document, which is sometimes submitted as part of a Notice of Intent application, is required to be prepared two weeks prior to construction. We recommend this document be submitted to the Town of Northborough a minimum of two weeks prior to the start of construction for review and comment.*

Response: A SWPPP will be prepared and submitted to the Town of Northborough a minimum of two weeks prior to the start of construction for review and comment.

b. *We recommend that copies of all SWPPP inspection reports be submitted to the Town of Northborough.*

Response: Notes will be added to the SWPPP requiring all SWPPP inspection reports be submitted to the Town of Northborough.

c. *We recommend the Recommended Construction Period Pollution Prevention and Erosion and Sedimentation Controls document include information regarding protecting the bottom of all infiltration facilities during construction to prevent compaction. The bottom of all infiltration facilities should be protected from heavy machinery. In the event that heavy machinery is allowed on the bottom of the infiltration basins, the basins ability to infiltrate water could be impacted.*

Response: The Recommended Construction Period Pollution Prevention and Erosion and Sedimentation Controls document has been revised to include notes on protecting the bottom of all infiltration facilities, including protection from heavy machinery. The notes read as follows:

For the long-term function of the infiltration basins, care shall be taken in the areas of the infiltration basins during construction in accordance with the following:

- **The infiltration basins shall not be used as a construction sedimentation basin without the prior approval of the engineer.**
- **Stormwater runoff from exposed surfaces shall be directed away from the infiltration basins.**
- **Construction equipment, vehicular traffic, parking of vehicles, and stockpiling of construction materials shall be outside of the infiltration basin areas.**
- **Excavation for construction of the infiltration system shall ensure that the soil at the bottom of the excavation is not compacted or smeared.**

- **The perimeter of the infiltration basins shall be staked and flagged to prevent the use of the area for activities that might damage the infiltration ability of the system.**
- **If infiltrations areas are used as temporary sedimentation basins during construction, then the soils shall be excavated a minimum of 2' from the temporary basin bottom to remove clogged soils.**

d. *We also recommend the Recommended Construction Period Pollution Prevention and Erosion and Sedimentation Controls document include a section regarding the maintenance of the construction exit.*

Response: The Recommended Construction Period Pollution Prevention and Erosion and Sedimentation Controls document will include a section regarding the maintenance of the construction exit.

Comment 9. *Standard 9 – The long Term Operations and Maintenance Plan generally meets the Standards.*

Response: No response necessary.

Comment 10. *Standard 10 – A signed illicit discharge statement needs to be signed and submitted.*

Response: A signed illicit discharges statement is attached hereto and will be included in the revised Stormwater Management Report, Appendix G.

Town of Northborough Wetlands Protection Bylaw

Comment 1. *Section 4.2.3 states that no foundation, building, road, or sidewalk shall be places within 35 feet of any resource area. This section also states that there will be no construction activity within 25 feet of resource areas. The proposed warehouse expansion is approximately 33 feet from the wetlands at its closest point.*

Response: The application was filed prior to the enactment of the buffer distances listed in the Wetlands Bylaw amended through September 21, 2019. The dimensional requirements as per the Wetlands Bylaw amended through January 1, 2000 were as follows *"No foundation, building, road, sidewalk, or other permanent structure shall be placed within thirty (30) feet of any resource area. Furthermore, no grading, filling, excavation, removal of vegetation or other construction activity shall be allowed within fifteen (15) feet of said resource areas." As such, the project was designed in accordance with the requirements in affect at the time.*

Additional Stormwater Management Comments

Comment 1. *We recommend the applicant add a note to the Grading, Drainage, and Erosion Control Plan to limit heavy machinery in the bottom of the infiltration basin.*

Response: A note has been added to the grading, drainage, and erosion control plan to the effect of "Construction equipment, vehicular traffic, parking of vehicles, and stockpiling of construction materials shall be outside of the infiltration basin areas." See VHB's revised Site Plans attached hereto.

Comment 2. *We recommend stone for pipe ends, consistent with MassDOT standard specification, be installed at the rip-rap discharge pad.*

Response: Materials for stone for pipe ends at all rip rap pads will be specified in the Project Specifications as follows: "Stone for pipe ends and energy dissipaters shall be sound, durable rock, angular in shape. Rounded stones, boulders, sandstone, or similar stone or relatively thin slabs will not be acceptable. The majority of the larger stones shall weigh not less than 50 pounds nor be less than 1.4 ft. long, 0.5 ft. wide, and 0.5 ft. in height. Each larger stone shall weigh not more than 125 pounds nor be more than 2.0 ft. long, 0.8 ft. wide, and 0.8 ft. in height and at least 50 percent of the larger stone volume shall consist of stones weighing not less than 75 pounds nor be less than 1.6 ft. long, 0.6 ft. wide, and 0.6 ft. height. The remainder of the stones shall be so graded that when placed with the larger stones the entire mass will be compact."

Comment 3. *Drain manhole 1 may need to be oversized given the configuration of piping into the manhole.*

Response: Drain Manhole 1 (DMH-1) has been upsized to a 5' diameter manhole. This change has been reflected on VHB's revised site plans.

Comment 4. *The Project shows a small increase in total volume of runoff for the 10 and 100-year storms. This increase is below the 15% threshold required for industrial properties located in the Groundwater Protection Overlay District. However, the time span used in the hydrologic calculations is 5 to 20 hours. Using a longer time span, such as 0 to 48 hours, may show different changes in total volumes.*

Response: The peak rates of runoff occur at the 12-hr mark therefore the peak rates would not be affected by a longer time span, however the model has been updated to incorporate the longer time span suggested. See VHB's revised Stormwater Report attached hereto.

Comment 5. *The hydrologic drainage calculations show the french drain filling during the 10-year, 25 year, and 100-year storms. The100 year storm shows the peak elevation in the french drain approximately 5 feet*

higher than the top of the storage. The french drain is showing a higher outflow than inflow for the 25 and 100-year storms. We recommend the applicant verify and revise the modeling.

Response: VHB has upsized the perforated pipe in the French Drain from 12" to 18". The size of the stone bed has increased as a result of this change. These modifications have been reflected in the French Drain detail shown on C-6. By upsizing the perforated pipe and expanding the stone bed, the French Drain has sufficient storage for runoff in all storms and the inflow is now greater than the outflow.

Comment 6. *We recommend the construction entrance be added to Construction Period Pollution Prevention and Erosion and Sedimentation Controls document. We also recommend that language be included to protect of the infiltration basin from heavy machinery.*

Response: Acknowledged, see Stormwater Management and Erosion Control Response 8.

Comment 7. *We recommend the Stabilized Construction Exits detail be revised to include 2-3" stone and the depth be increased to 6 inches.*

Response: The construction exit has been revised to utilize the recommended larger 2" to 3" stone coarse aggregate and the depth of the stone will be increased to 6 inches.

Comment 8. *The plans show the ramp leading to the warehouse expansion building will create a low spot. The plans should be revised to remove the low spot or add a drainage structure to drain any water that may pond in this location.*

Response: Grading in this area will be refined on the construction drawings to be prepared after the project permit phase has been completed.

Comment 9. *Maintenance access to the infiltration basin will be limited. Vehicles will not be able to access the basin and all work will need to be performed by hand.*

Response: Acknowledged.

Comment 10. *We recommend a gate be provided to allow maintenance access to the flared end structure located on the north side of the site.*

Response: A gate has been added to allow maintenance access to the flared end structure located on the north side of the site. This change is reflected on VHB's revised site plans.

Additional Civil/Site Comments

Comment 1. *We recommend granite curb be installed at the site entrance along Whitney Street.*

Response: The plans have been updated to reflect this change, see revised Site Plans attached hereto.

Comment 2. *We recommend that cut sheets of the site lights be provided. We also recommend that the applicant verify that the proposed site lights are dark skies compliant.*

Response: Cut sheets are attached hereto. The proposed fixtures are Dark Sky compliant.

Comment 3. *We recommend the applicant verify plans for trash disposal. There does not appear to be any outside dumpsters or provisions for trash.*

Response: The facility doesn't generate a volume of trash significant enough to warrant an external dumpster.

Comment 4. *We recommend the applicant confirm the installation of sewer force main is allowed by Public Works. We are unclear regarding the status of the design. We recommend the applicant provide details of the sewer ejector pump and wet well. The pump and force main design shown on the plans are schematic in nature.*

Response: See response to Comment 5 in the *Northborough Zoning Bylaw* section of this letter. VHB is working through the design and coordination of this utility. All necessary documentation will be provided to the Town for approval prior to construction.

If you have any questions or need additional information in the interim please feel free to contact me at (508) 513-2719 or RWhitehouse@vhb.com.

Sincerely,

Rich Whitehouse, Jr., ENV SP
Project Manager

Site Plans

Issued for	Local Permitting
Date Issued	September 13, 2019
Latest Issue	March 22, 2021

Facility Expansion Project

425 Whitney Street
Northborough, Massachusetts

Owner
Isomedix Operations Inc.
C/O STERIS Corporation
5960 Heisley Road
Mentor, Ohio 44060
(508) 393-9323

Applicant
Isomedix Operations Inc.
425 Whitney Street
Northborough, MA 01532
(508) 393-9323

Assessor's Map: 15
Lot: 8

Sheet Index

No.	Drawing Title	Latest Issue
C 1	Legend and General Notes	September 13, 2019
C 2	Layout and Materials Plan	March 22, 2021
C 3	Grading, Drainage, and Erosion Control Plan	March 22, 2021
C 4	Utility Plan	September 13, 2019
C 5	Site Details 1	March 22, 2021
C 6	Site Details 2	March 22, 2021
L 1	Planting Plan	September 13, 2019
L 2	Planting Details	September 13, 2019

Reference Drawings

No.	Drawing Title	Latest Issue
	Existing Conditions Plan of Land	August 13, 2019
	Photometrics Plan	March 22, 2021
A201	Exterior Elevations	September 12, 2019

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(508) 791-8500

Wetland Scientist
EcoTec, Inc.
102 Grove Street
Worcester, Massachusetts 01605
(508) 752-9666

Site Lighting Designer
OMNI LITE, INC.
263 Winn Street
Burlington, MA 01803
(781) 272-0759

Land Surveyor
Odone Survey and Mapping
291 Main Street
Suite 5
Northborough, MA 01532
(508) 351-6022

VHB Project #: 14580.00 Facility Expansion Project

Legend

Exist. | Prop.

Abbreviations

General

Utility

General

Utilities

Layout and Materials

Demolition

Erosion Control

Existing Conditions Information

Document Use

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Facility Expansion Project

425 Whitney Street
Northborough, Massachusetts

Local Permitting — September 13, 2019

Not Approved for Construction

Legend and General Notes

C-1

1 — 8

14500.00

Zoning Summary Chart

Zoning District(s):	Industrial (I)		
Overlay District(s):	Groundwater District 3 (GW3)		

Zoning Regulation Requirements	Existing	Required	Provided
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

NOTES

[illegible]

Parking Summary Chart

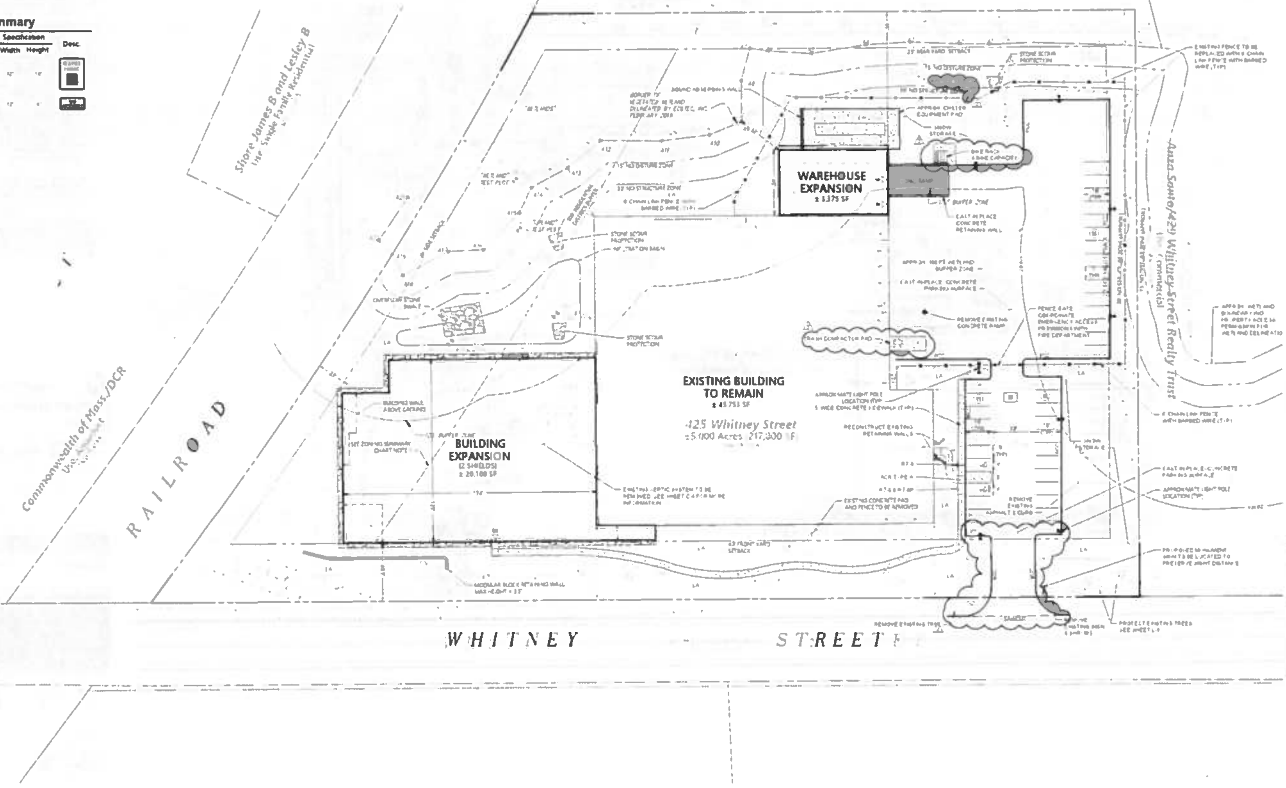
	Size		Spaces		
Description	Required	Provided	Existing	Required	Provided
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]	[illegible]	[illegible]

Parking Requirements:

[illegible]

Sign Summary

M.U.T.C.D. Number	Specification		Desc.
	Width	Height	
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]



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Facility Expansion Project

425 Whitney Street
Northborough, Massachusetts

Local Permitting September 13, 2019

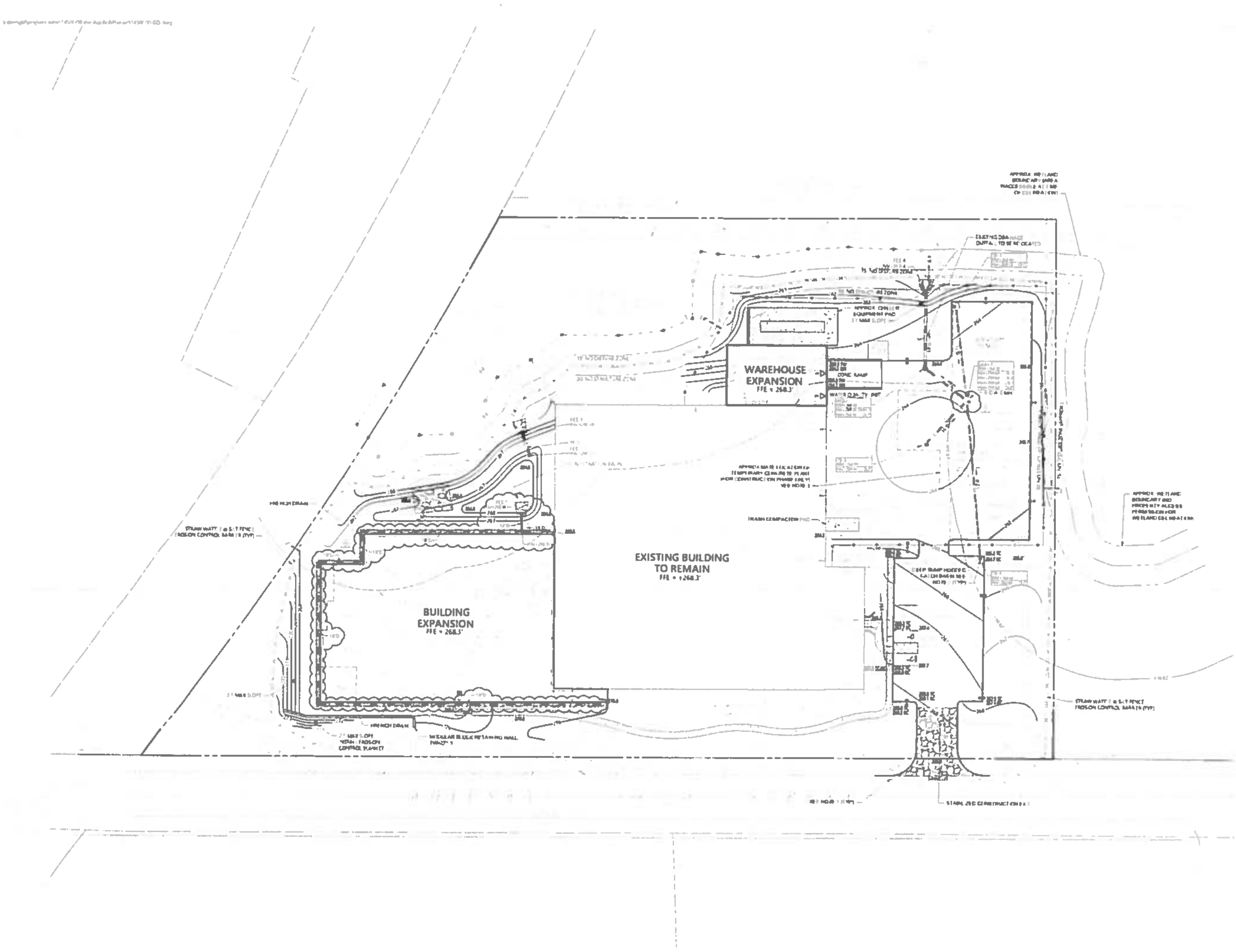
Not Approved for Construction

Layout and Materials Plan

C-2

2 6

14500.00



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Notes:

1. CONTRACTOR SHALL INSTALL AND MAINTAIN SILT SACKS IN ALL EXISTING AND PROPOSED CATCH BASINS AND LANDSCAPE DRAINS ON LINE DURING CONSTRUCTION.
2. FOR THE LONG TERM FUNCTION OF THE INFILTRATION BASIN(S)/STRUCTURE(S), CARE SHALL BE TAKEN IN THE INFILTRATION AREAS DURING CONSTRUCTION. THE CONTRACTOR SHALL EMPLOY THE FOLLOWING MINIMUM BEST MANAGEMENT PRACTICES (BMPs):
   - CONSTRUCTION EQUIPMENT, VEHICULAR TRAFFIC, PARKING OF VEHICLES AND STOCKPILING OF CONSTRUCTION MATERIALS SHALL BE OUTSIDE OF THE INFILTRATION BASIN AREAS.
   - INFILTRATION AREAS SHALL NOT BE USED AS TEMPORARY CONSTRUCTION SEDIMENTATION BASINS WITHOUT THE PRIOR APPROVAL OF THE ENGINEER. IF INFILTRATION AREAS ARE USED AS TEMPORARY SEDIMENTATION BASINS DURING CONSTRUCTION, THEN THE SOILS SHALL BE EXCAVATED A MINIMUM OF 2' FROM THE TEMPORARY BASIN BOTTOM TO REMOVE CLOGGED SOILS.
   - EXCAVATION FOR CONSTRUCTION OF THE INFILTRATION BASIN(S)/STRUCTURE(S) SHALL ENSURE THAT THE SOIL AT THE BOTTOM OF THE EXCAVATION IS NOT COMPACTED OR SMEARED.
3. CONTRACTOR SHALL COORDINATE WITH ENGINEER AND CONSERVATION COMMISSION FOR SEDIMENTATION/WASHOUT BASIN AND OTHER SEDIMENTATION PROTECTION MEASURES RELATED TO THE TEMPORARY CONCRETE PLANT.

0 15 30 60 Feet

Facility Expansion Project

425 Whitney Street
Northborough, Massachusetts

Local Permitting — September 13, 2019

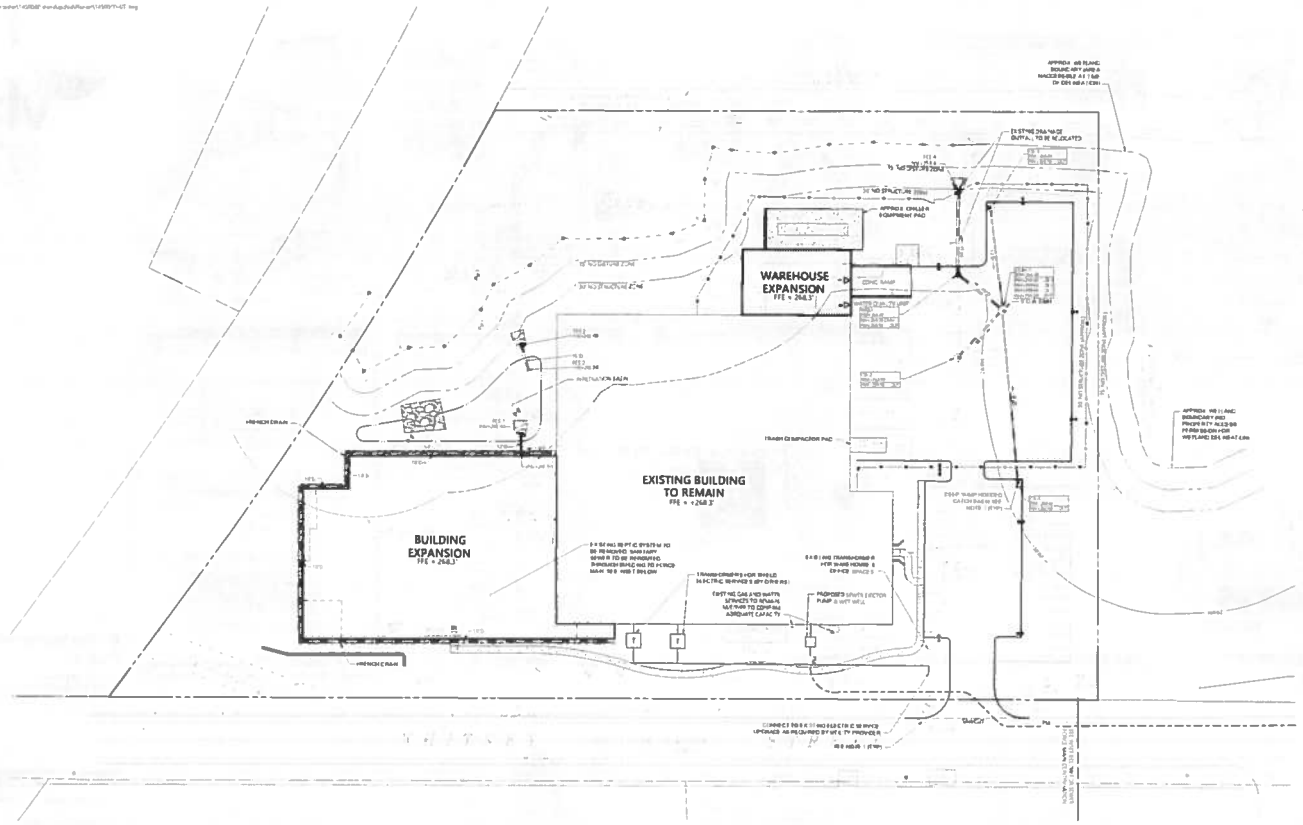
Not Approved for Construction

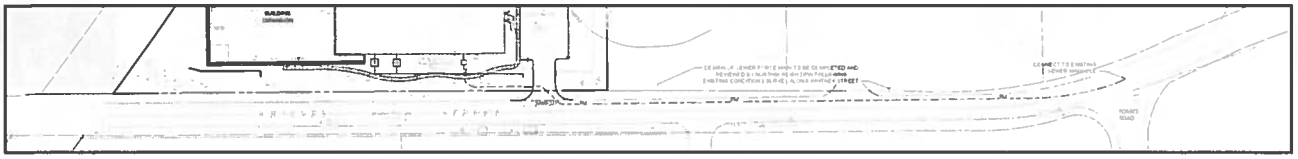
Grading, Drainage, and Erosion Control Plan

C-3

3 of 8

14508.00





INSET A - SEWER FORCE MAIN

SCALE 1" = 60'

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508.752.1001

Notes:

1. CONTRACTOR SHALL INSTALL AND MAINTAIN ALL SAFETY PRACTICES AND PROVIDE AND PROPOSED CATCH BASIN AND LANDSCAPE DRAINS ON THIS SHEET DURING CONSTRUCTION

0 15 30 60 Feet

Facility Expansion Project

425 Whitney Street
Northborough, Massachusetts

No.	Revision	Date	Init.

Local Permitting — September 13, 201

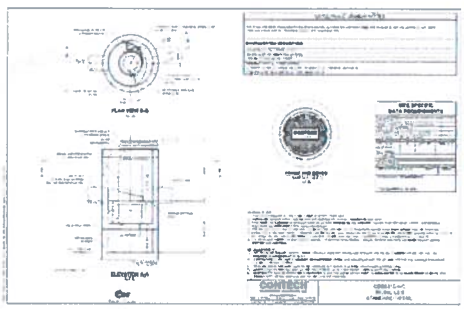
Not Approved for Construction

Utility Plan

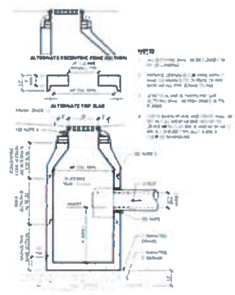
C-4

4 8

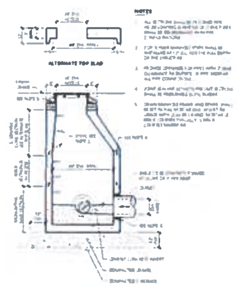
14508.00



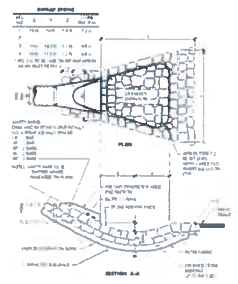
Water Quality Unit (WQU)



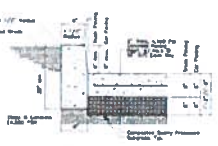
Catch Basin (CB) With Oil/Debris Trap



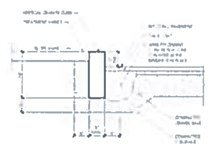
Drain Manhole (DMH)



Flared End Section (FES) with Stone Protection

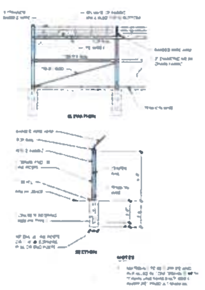


Concrete Curb & Concrete Pavement Section

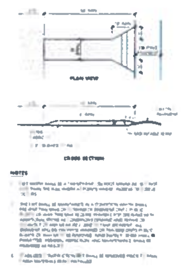


Vertical Granite Curb (VGC)

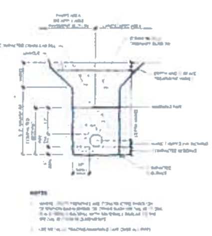
Accessible Parking Space



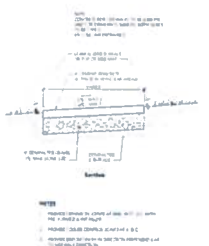
6' Chain Link Fence with Barbed Wire



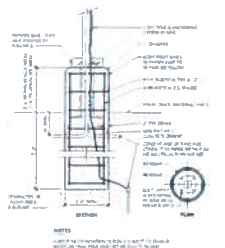
Stabilized Construction Exit



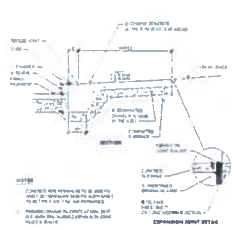
Utility Trench



Concrete Sidewalk in Landscape Area



Light Pole Foundation Detail (Up to 40' Pole)



Monolithic Concrete Curb (MCC) & Sidewalk

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vhb

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Suite 500
Worcester, MA 01608
508.752.1001

Facility Expansion Project

425 Whitney Street
Northborough, Massachusetts

Local Permitting — September 13, 2019

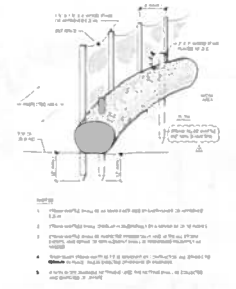
Not Approved for Construction

Site Details 1

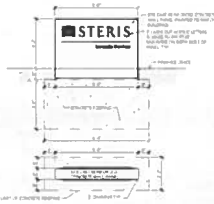
C-5

5 of 8

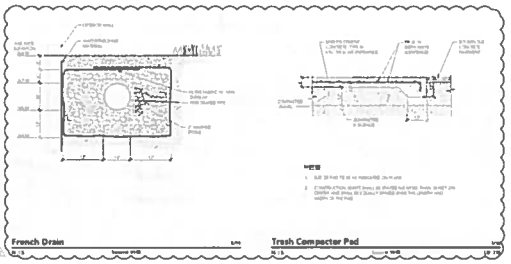
14508.00



Straw Wattle - Erosion Control Barrier

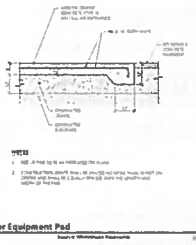


Monument Sign

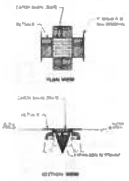


French Drain

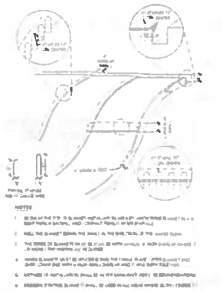
Trash Compactor Pad



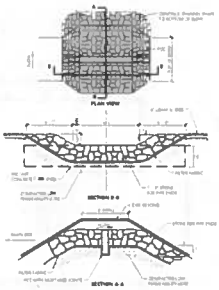
Chiller Equipment Pad



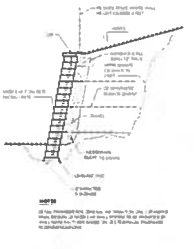
Siltsack Sediment Trap



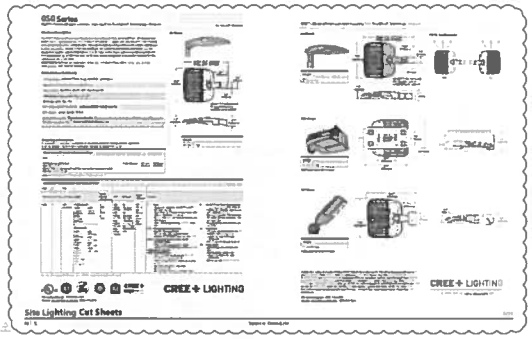
Erosion Control Blanket Slope Installation



Overflow Stone Swale



Modular Retaining Wall



Site Lighting Cut Sheets

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508.752.1001

Facility Expansion Project

425 Whitney Street
Northborough, Massachusetts

No.	Name	Date
1	Address per Site Revisions	10/22/2021
2	Address Post Review Comments	11/22/2021

Local Permitting — September 13, 20

Not Approved for Construction

Site Details 2

C-6

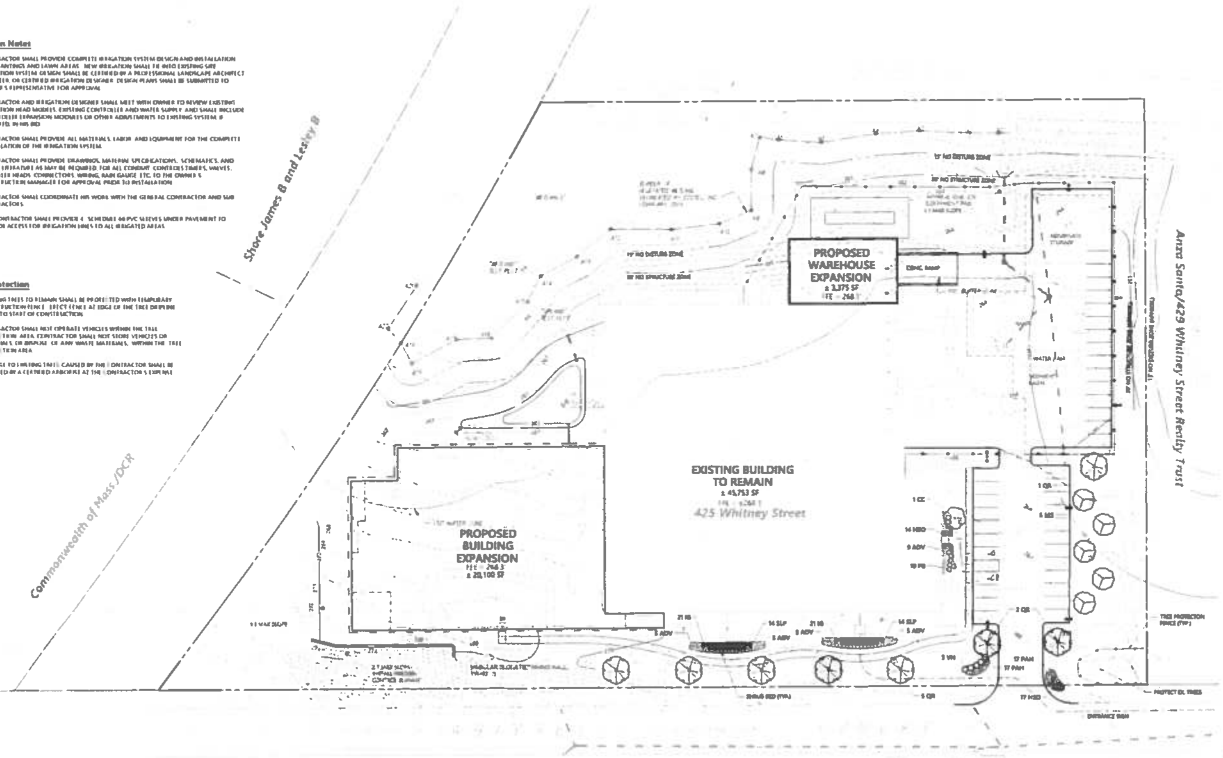
14500.00

Irrigation Notes

1. CONTRACTOR SHALL PROVIDE COMPLETE IRRIGATION SYSTEM DESIGN AND INSTALLATION FOR PLANTINGS AND LAWN AREAS. NEW IRRIGATION SHALL TIE INTO EXISTING SITE IRRIGATION SYSTEM. DESIGN SHALL BE CERTIFIED BY A PROFESSIONAL LANDSCAPE ARCHITECT, ENGINEER, OR CERTIFIED IRRIGATION DESIGNER. DESIGN PLANS SHALL BE SUBMITTED TO OWNER'S REPRESENTATIVE FOR APPROVAL.
2. CONTRACTOR AND IRRIGATION DESIGNER SHALL MEET WITH OWNER TO REVIEW EXISTING IRRIGATION HEAD MODELS, EXISTING CONTROLLER AND WATER SUPPLY, AND SHALL INCLUDE CONTROLLER EXPANSION MODULES OR OTHER ADJUSTMENTS TO EXISTING SYSTEM, IF REQUIRED, IN HIS BID.
3. CONTRACTOR SHALL PROVIDE ALL MATERIALS, LABOR, AND EQUIPMENT FOR THE COMPLETE INSTALLATION OF THE IRRIGATION SYSTEM.
4. CONTRACTOR SHALL PROVIDE DRAWINGS, MATERIAL SPECIFICATIONS, SCHEMATICS, AND OTHER LITERATURE AS MAY BE REQUIRED, FOR ALL CONDUIT, CONTROLS, TIMERS, VALVES, SPRINKLER HEADS, CONNECTORS, WIRING, RAIN GAUGE, ETC. TO THE OWNER'S CONSTRUCTION MANAGER FOR APPROVAL PRIOR TO INSTALLATION.
5. CONTRACTOR SHALL COORDINATE HIS WORK WITH THE GENERAL CONTRACTOR AND SUB CONTRACTORS.
6. SITE CONTRACTOR SHALL PROVIDE 4" SCHEDULE 40 PVC SLEEVES UNDER PAVEMENT TO PROVIDE ACCESS FOR IRRIGATION LINES TO ALL IRRIGATED AREAS.

Tree Protection

1. EXISTING TREES TO REMAIN SHALL BE PROTECTED WITH TEMPORARY CONSTRUCTION FENCE. ERECT FENCE AT EDGE OF THE TREE DRIPLINE PRIOR TO START OF CONSTRUCTION.
2. CONTRACTOR SHALL NOT OPERATE VEHICLES WITHIN THE TREE PROTECTION AREA. CONTRACTOR SHALL NOT STORE VEHICLES OR MATERIALS, OR DISPOSE OF ANY WASTE MATERIALS, WITHIN THE TREE PROTECTION AREA.
3. DAMAGE TO EXISTING TREES CAUSED BY THE CONTRACTOR SHALL BE REPAIRED BY A CERTIFIED ARBORIST AT THE CONTRACTOR'S EXPENSE.



Planting Notes

1. ALL PROPOSED PLANTING LOCATIONS SHALL BE STAKED AS SHOWN ON THE PLANS FOR FIELD REVIEW AND APPROVAL BY THE LANDSCAPE ARCHITECT PRIOR TO INSTALLATION.
2. CONTRACTOR SHALL VERIFY LOCATIONS OF ALL BELOW GRADE AND ABOVE GROUND UTILITIES AND NOTIFY OWNER'S REPRESENTATIVE OF CONFLICTS.
3. NO PLANT MATERIALS SHALL BE INSTALLED UNTIL ALL GRADING AND CONSTRUCTION HAS BEEN COMPLETED IN THE IMMEDIATE AREA. CONTRACTOR SHALL NOTIFY OWNER'S REPRESENTATIVE OF ANY CONFLICT.
4. A 3 INCH DEEP MULCH PER SPECIFICATION SHALL BE INSTALLED UNDER ALL TREES AND SHRUBS, AND IN ALL PLANTING BEDS, UNLESS OTHERWISE INDICATED ON THE PLANS, OR AS DIRECTED BY OWNER'S REPRESENTATIVE.
5. ALL TREES SHALL BE BALLED AND BURLAPPED, UNLESS OTHERWISE NOTED IN THE DRAWINGS OR SPECIFICATION, OR APPROVED BY THE OWNER'S REPRESENTATIVE.
6. FINAL QUANTITY FOR EACH PLANT TYPE SHALL BE AS GRAPHICALLY SHOWN ON THE PLAN. THIS NUMBER SHALL TAKE PRECEDENCE IN CASE OF ANY DISCREPANCY BETWEEN QUANTITIES SHOWN ON THE PLANT LIST AND ON THE PLAN. THE CONTRACTOR SHALL REPORT ANY DISCREPANCIES BETWEEN THE NUMBER OF PLANTS SHOWN ON THE PLANT LIST AND PLANT LABELS PRIOR TO BIDDING.
7. ANY PROPOSED PLANT SUBSTITUTIONS MUST BE REVIEWED BY LANDSCAPE ARCHITECT AND APPROVED IN WRITING BY THE OWNER'S REPRESENTATIVE.
8. ALL PLANT MATERIALS INSTALLED SHALL MEET THE SPECIFICATIONS OF THE "AMERICAN STANDARDS FOR NURSERY STOCK" BY THE AMERICAN ASSOCIATION OF NURSERYMEN AND CONTRACT DOCUMENTS.
9. ALL PLANT MATERIALS SHALL BE GUARANTEED FOR ONE YEAR FOLLOWING DATE OF FINAL ACCEPTANCE.
10. AREAS DESIGNATED "LOAM & SEED" SHALL RECEIVE MINIMUM 6" OF LOAM AND SPECIFIED SEED MIX. LAWNS OVER 2:1 SLOPE SHALL BE PROTECTED WITH EROSION CONTROL FABRIC.
11. ALL DISTURBED AREAS NOT OTHERWISE NOTED ON CONTRACT DOCUMENTS SHALL BE LOAM AND SEEDED OR MULCHED AS DIRECTED BY OWNER'S REPRESENTATIVE.
12. THIS PLAN IS INTENDED FOR PLANTING PURPOSES. REFER TO SITE / CIVIL DRAWINGS FOR ALL OTHER SITE CONSTRUCTION INFORMATION.

PLANT SCHEDULE

TREES	QTY	BOTANICAL NAME	COMMON NAME	SIZE	
CC	1	Cercis canadensis	Eastern Redbud	2 1/2 - 3" CAL.	
MS	5	Malus x 'Sugar Tyme' TM	Sugar Tyme Crab Apple	2 1/2 - 3" CAL.	
QR	6	Quercus rubra	Red Oak	2 1/2 - 3" CAL.	
SHRUBS	**QTY**	**BOTANICAL NAME**	**COMMON NAME**	**SIZE**	**SPACING**
ABV	29	Azalea x 'Delaware Valley White'	Delaware Valley White Azalea	18 - 24" HT.	
FG	9	Fothergilla gardenii	Dwarf Fothergilla	18 - 24" HT.	
IG	42	Ilex glabra 'Shamrock'	Shamrock Inkberry	3 - 5' HT.	
SLP	29	Spiraea japonica 'Little Princess'	Little Princess Japanese Spirea	15 - 18" SPR.	
VN	5	Viburnum nudum 'Winterthur'	Smooth Witherod	2 - 2 1/2' HT.	
PERENNIALS	**QTY**	**BOTANICAL NAME**	**COMMON NAME**	**SIZE**	**SPACING**
HSD	71	Hemerocallis x 'Stella de Oro'	Stella de Oro Daylily	#1 POT	18" o.c.
GRASSES	**QTY**	**BOTANICAL NAME**	**COMMON NAME**	**SIZE**	**SPACING**
PAH	34	Pennisetum alopecuroides Hameln	Hameln Dwarf Fountain Grass	#1 POT	24" o.c.

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0 15 30 60 Feet

Facility Expansion Project

425 Whitney Street
Northborough, Massachusetts

Local Permitting September 13, 2019

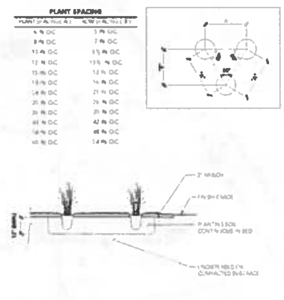
Not Approved for Construction

Planting Plan

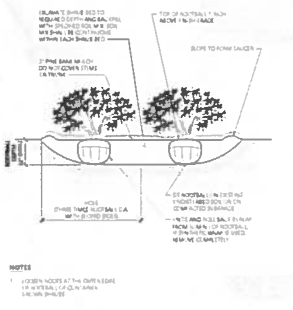
L-1

7 8

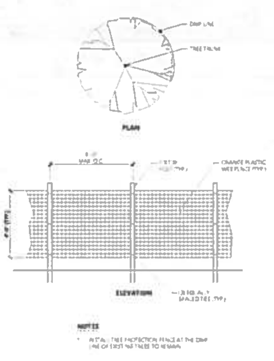
14508.00



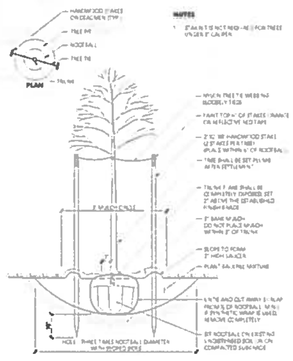
Perennial and Ornamental Grass Planting
NTS Source: VHB LD 610



Shrub Bed Planting
NTS Source: VHB LD 601



Tree Protection Fence
NTS Source: VHB LD 610



Tree Planting (For Trees Under 4" Caliper)
NTS Source: VHB LD 602

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Facility Expansion Project

425 Whitney Street
Northborough, Massachusetts

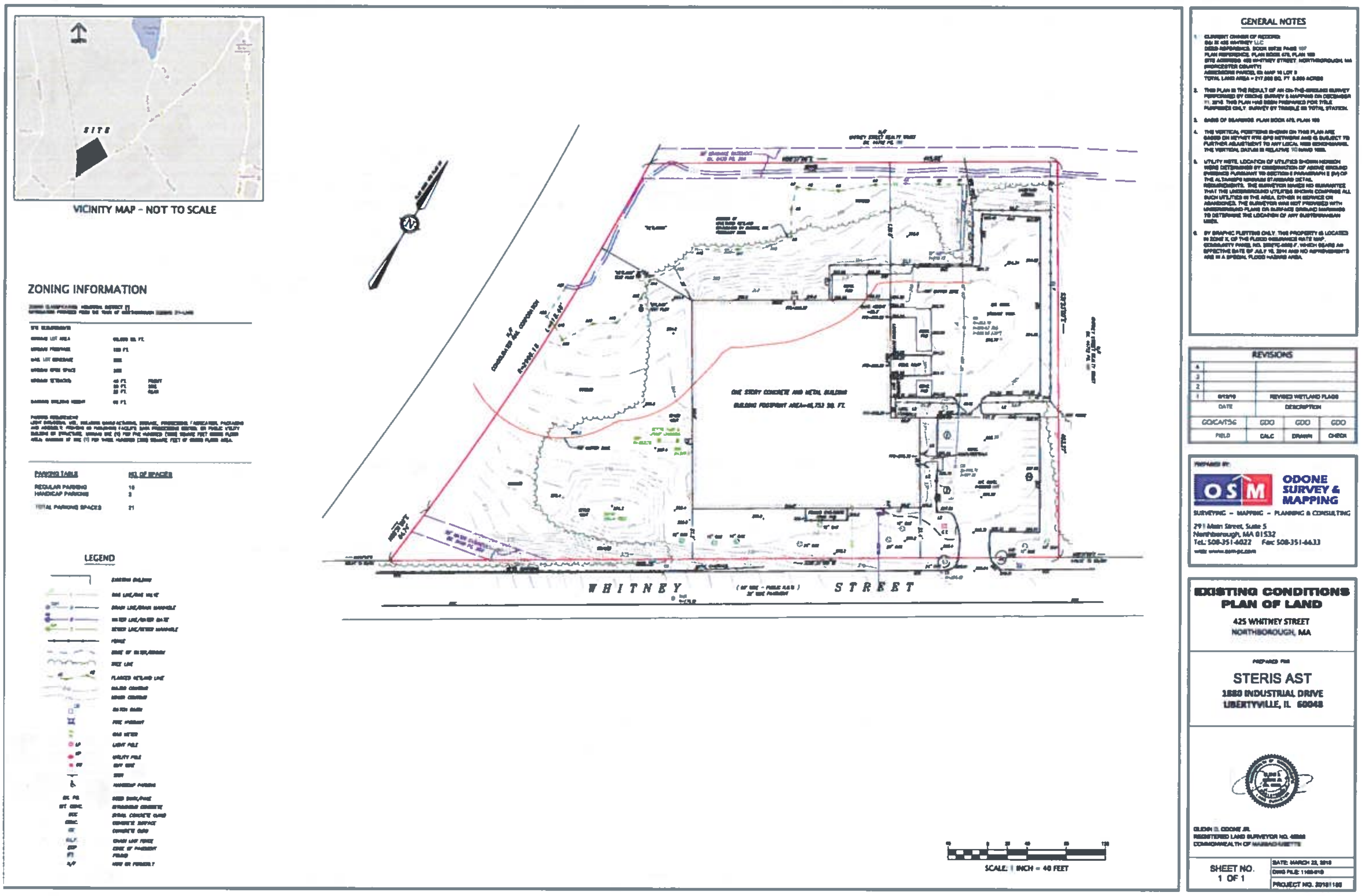
Local Permitting September 13, 20…

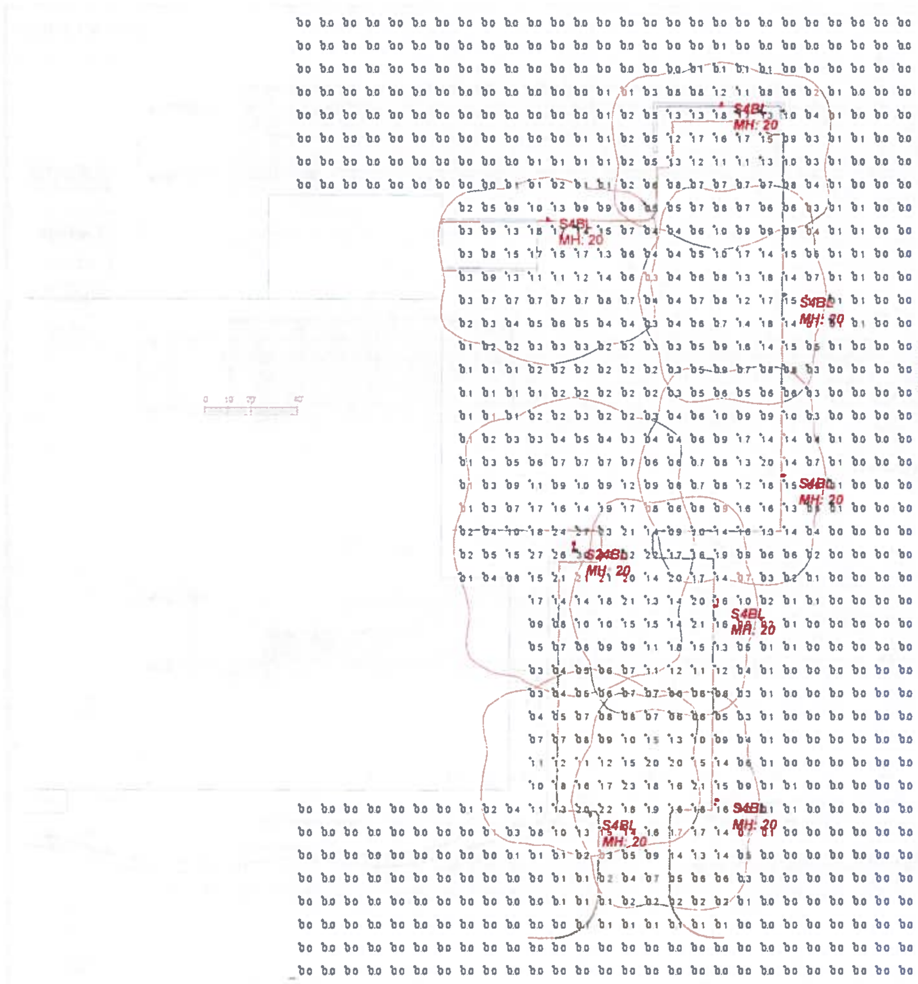
Not Approved for Construction

Planting Details

L-2

14508.00


VICINITY MAP - NOT TO SCALE
SITE
ZONING INFORMATION
PARKING TABLE
NO. OF SPACES
REGULAR PARKING
HANDICAP PARKING
TOTAL PARKING SPACES
LEGEND
GENERAL NOTES
WHITNEY STREET
ONE STORY CONCRETE AND METAL BUILDING
SCALE: 1 INCH = 40 FEET
REVISIONS
4
3
2
1
DATE
DESCRIPTION
REVISED WETLAND FLAGS
GDC/ATSG
GDO
GDO
GDO
FIELD
CALC
DRAWN
CHECK
ODONE SURVEY & MAPPING
SURVEYING - MAPPING - PLANNING & CONSULTING
291 Main Street, Suite 5
Northborough, MA 01532
Tel.: 508-351-6022 Fax: 508-351-6633
EXISTING CONDITIONS PLAN OF LAND
425 WHITNEY STREET
NORTHBOROUGH, MA
STERIS AST
1880 INDUSTRIAL DRIVE
LIBERTYVILLE, IL 60048
SHEET NO.
1 OF 1



Outdoor Luminaire Schedule

Symbol	Qty	Label	Description	Arrangement	Abs	Lum. Lumens	LLF	Filename
	7	S4BL	[illegible]	SINGLE	[illegible]	[illegible]	[illegible]	[illegible]
	1	S24BL	[illegible]	BACK-BACK	[illegible]	[illegible]	[illegible]	[illegible]

Luminaire Location Summary

LumNo	Label	X	Y	Z-MH*	Orient	Tilt
1	S4BL	218.375	222	20	270	0
2	S4BL	148	172.25	20	270	0
3	S4BL	246.875	130.125	20	180	0
4	S4BL	246.875	90.875	20	180	0
5	S24BL	184.125	36.125	20	270	0
6	S4BL	210.875	3.5	20	180	0
7	S4BL	217.375	-46.625	20	180	0
8	S4BL	161.125	-90.125	20	90	0

* Mounted Height

Calculation Summary

Label	Calc Type	Units	Avg	Max	Min	Avg/Min	Max/Min
CalcPts_1	Illuminance	Fc	[illegible]	[illegible]	0.0	N.A.	N.A.

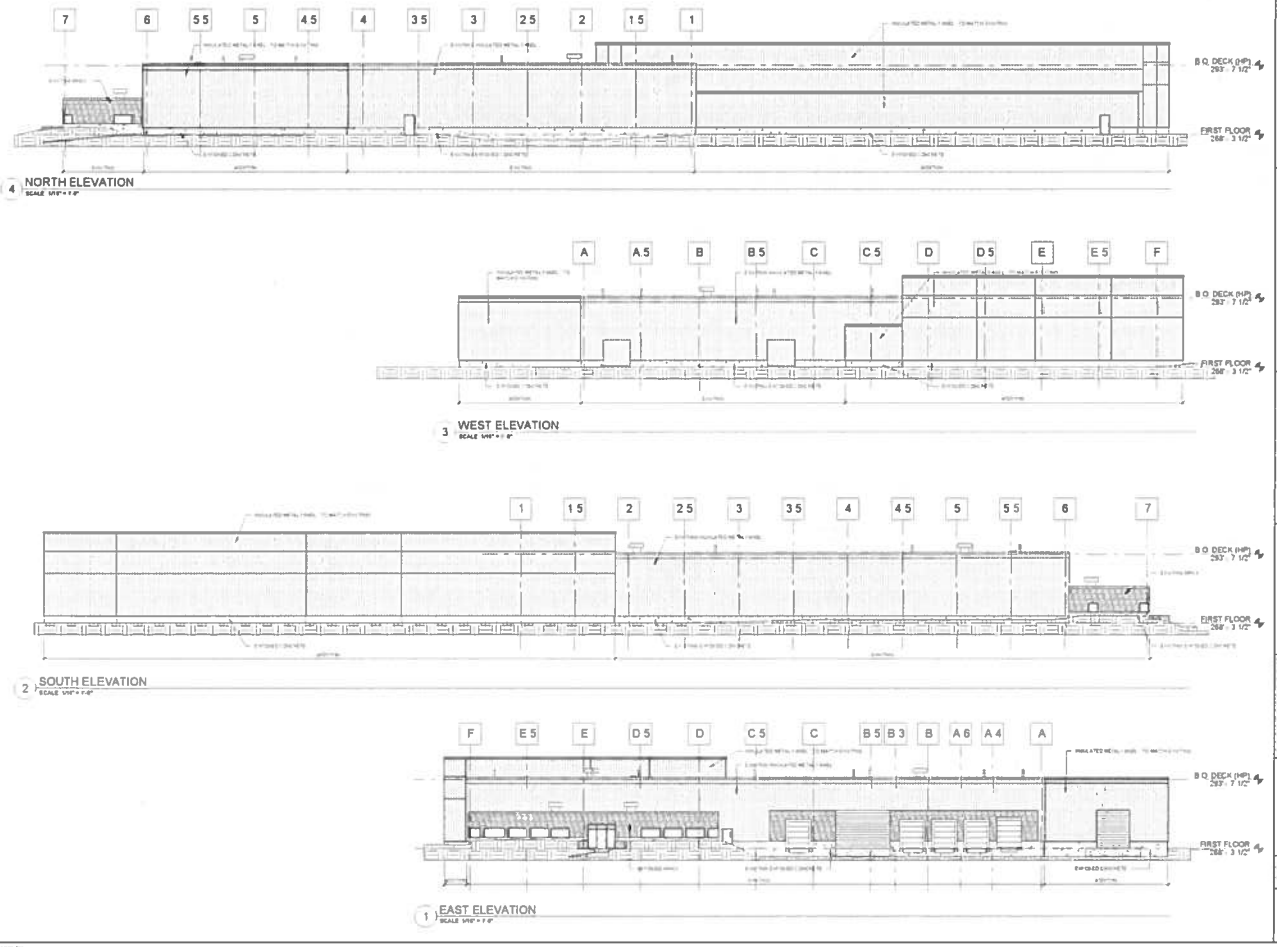
OMNI-LITE, INC.

Northborough Site

XXX

FEET

08/13/2019



4 NORTH ELEVATION
SCALE: 1/16" = 1'-0"

3 WEST ELEVATION
SCALE: 1/16" = 1'-0"

2 SOUTH ELEVATION
SCALE: 1/16" = 1'-0"

1 EAST ELEVATION
SCALE: 1/16" = 1'-0"

STERIS
Applied Purification Technologies

PROJECT NAME
425 WHITNEY STREET
NORTHBOROUGH, MA

Cutler
Design

41 Harvard Street
Worcester MA 01609

(508) 757-7500 PHONE
(508) 799-3000 FAX
www.cutlerassociates.com

Consultant Title
Consultant Address Line 1
Consultant Address Line 2

EXTERIOR ELEVATIONS

A201

STORMWATER REPORT

Facility Expansion Project

PREPARED FOR

Isomedix Operations Inc
425 Whitney Street
Northborough, MA 01532

PREPARED BY

vhb

120 Front Street, Suite 500
Worcester, MA 01608

September 2019
Revised October 2019
Revised March 2021

Table of Contents

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

---

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

Brittany Gesner September 13, 2019
Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): _____

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☒ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☒ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☒ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☒ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☒ Redevelopment portion of mix of new and redevelopment.

☒ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with the Massachusetts Stormwater Management Standards in accordance with the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00).

Project Description

The Applicant, Isomedix Operations Inc, is proposing to construct a building expansion to their existing facility (the Project). As proposed, the Project consists of a 24,700+/- square foot addition to an existing 45,753 square foot building, minor parking lot modifications, and stormwater management improvements. The Project is not considered a Land Use with Higher Potential Pollutant Loads (LUHPPL).

Site Description

The Project Site is a 5.0-acre parcel of land (the Site) located at 425 Whitney Street in Northborough, Massachusetts (see Figure 1). The Site lies within the Concord surface watershed and is bounded by wetland areas to the north, Whitney Street to the south, industrial uses to the east, and railroad tracks to the west. See Figure 1, Site Locus Map.

For information regarding the wetland resource areas present on the site see the Project Notice of Intent prepared by EcoTec, Inc. dated September 2019.

According to the National Resources Conservation Service (NRCS), surface soils on the Site primarily include Agawam fine sandy loam and Walpole sandy loam. On-site soils are classified as Hydrologic Soil Group (HSG) B. Based on the soil evaluation included in Appendix C, the Site is not considered to be within an area of rapid infiltration (soils with a saturated hydraulic conductivity greater than 2.4 inches per hour).

Existing Drainage Conditions

Under existing conditions, the Site is developed with one building and a parking and loading area. The remainder of the site includes and existing septic system and wooded and wetland areas. Site topography slopes from the south, away from

Whitney Street, towards to wetlands at the northern edge of the Site. Figure 2 illustrates the existing drainage patterns on the Site. Currently, the Site is divided into 1 drainage area from which stormwater runoff flows to 1 Design Point, which has been identified as the vegetated wetland at the northern limits of the Site. Table 2 below provides a summary of the existing conditions hydrologic data.

Table 1
Existing Conditions Hydrologic Data

Drainage Area	*Discharge Location*	*Design Point*	*Area (acres)*	*Curve Number*	*Time of Concentration (min)*
S-1	Vegetated Wetlands at Northern Limits of Site	DP-1	5.0	80	11.8

Total = 5.0 acres

Proposed Drainage Conditions

The Project proposes to expand upon the existing building and reduce the size of the existing parking and loading area. The proposed building expansion will occur in the location of the existing septic system. The existing septic system will be replaced by a connection to the municipal sewer system. No work is proposed within wetland areas. Figure 3 illustrates the proposed "post construction" drainage conditions for the project. As shown, the Site will be divided into 2 drainage areas that discharge treated stormwater to the 1 existing Design Point. Table 3 below provides a summary of the proposed conditions hydrologic data.

Table 2
Proposed Conditions Hydrologic Data

Drainage Area	*Discharge Location*	*Design Point*	*Area (acres)*	*Curve Number*	*Time of Concentration (min)*
S-1	Vegetated Wetlands at Northern Limits of Site	DP-1	3.8	86	11.8
S-2	Vegetated Wetlands at Northern Limits of Site	DP-1	1.2	74	8.4

Total = 5.0 acres

Integrated into the site design is a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook. Stormwater runoff from the existing parking area will be improved in the proposed conditions through the implementation of deep-sump, hooded catch basins and a water quality unit. The Project is located within the Town of Northborough Groundwater Protection Overlay District, and therefore the proposed stormwater management system has been designed to treat the one-inch Water Quality Volume.

Stormwater runoff from the proposed building expansion will be directed to a French drain and surface infiltration basin for peak rate attenuation and recharge.

Pipe Sizing

The structural components of the stormwater management system proposed as part of the Project have been designed to convey the storm event associated with the 25-year recurrence interval.

Rainfall frequency rates used for this analysis were based on NOAA Atlas 14, Volume 10, Version 3 precipitation data for Northborough, Massachusetts, as follows for the 25-year recurrence storm:

- 5-minute duration: 8.54 inches/hour
- 10-minute duration: 6.05 inches/hour
- 15-minute duration: 4.75 inches/hour
- 30-minute duration: 3.22 inches/hour
- 60-minute duration: 2.04 inches/hour

Computations and supporting information regarding the hydraulic modeling are included in Appendix F.

Groundwater Protection Overlay District

The Site is located in Area 3 of the Groundwater Protection Overlay District as defined by the Town of Northborough Municipal Code. The Project has been designed to comply with the development restrictions identified for industrial developments located within Area 3 of the Groundwater Protection Overlay Distict.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2-, 10-, 25-, and 100-years. The results of the analysis, as summarized in Table 3 below, indicate that the post-development net runoff volume does not exceed existing conditions by more than fifteen percent (15%) for the 2-, 10-, 25-, and 100-year storm events.

Table 3
Net Runoff Volumes (acre-feet)

Design Point	*2-year*	*10-year*	*25-year*	*100-year*
Design Point: DP-1				
Existing	0.6	1.1	1.5	2.1
Proposed	0.6	1.2	1.5	2.2
Net Change	-	9%	-	5%

Rainfall volumes used for this analysis were based on NOAA Atlas 14, Volume 10, Version 3 precipitation data for Northborough, Massachusetts, as follows:

- 2-year storm: 3.30 inches
- 10-year storm: 5.04 inches
- 25-year storm: 6.14 inches
- 100-year storm: 7.82 inches

Runoff coefficients for the existing and proposed conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.

Table 4 below demonstrates that the Project has been designed such that the post-development impervious cover of the lot is not increased over the existing conditions by more than forty percent (40%).

Table 4
Impervious Cover Areas (acres)

	Total Impervious Cover
Existing Conditions	1.9
Proposed Conditions	2.4
Net Change	26%

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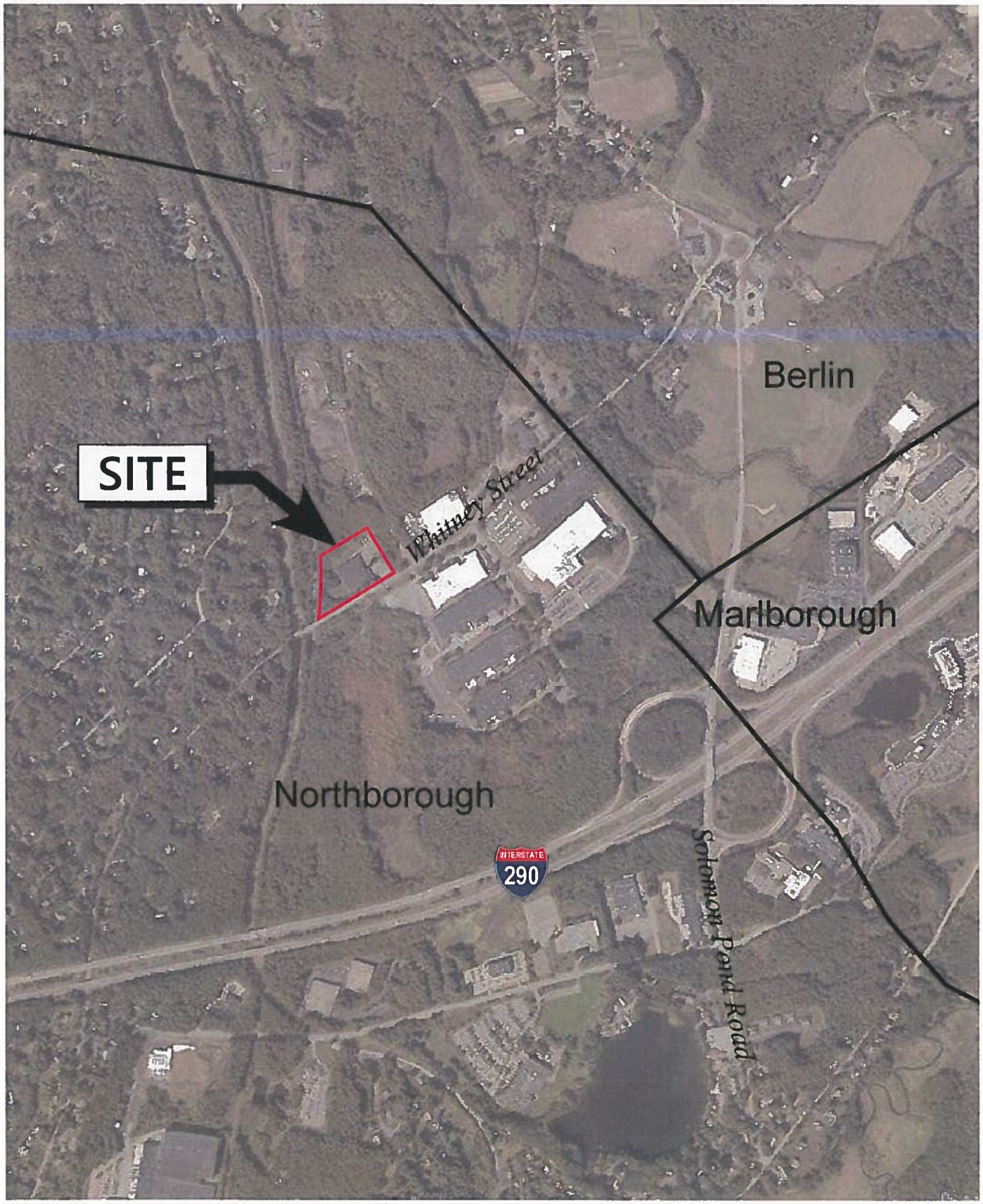

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Project Area

vhb

Site Locus Map
Facility Expansion Project
425 Whitney Street
Northborough, MA

Figure 1

August 2019

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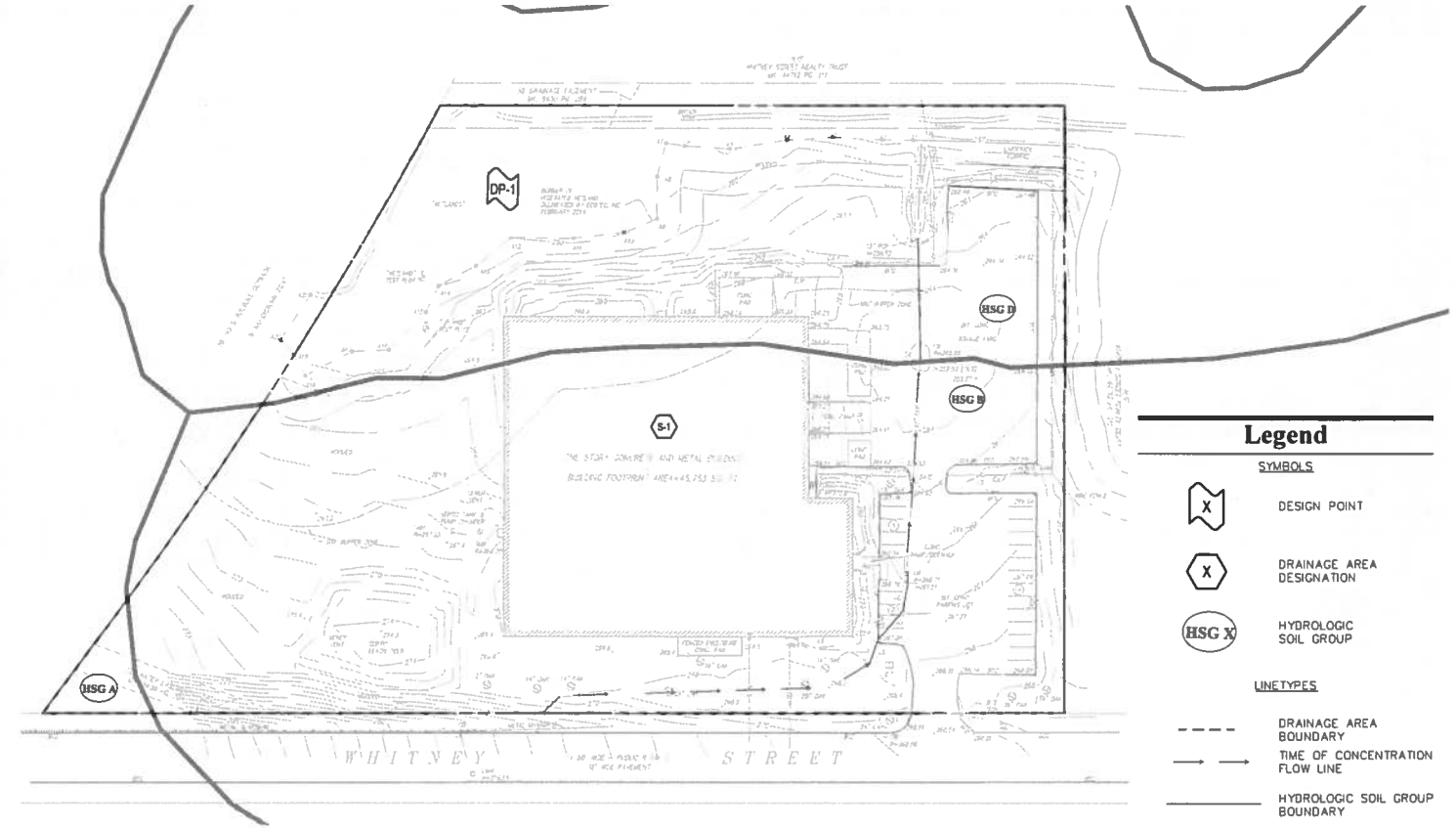

Legend

SYMBOLS

- DESIGN POINT
- DRAINAGE AREA DESIGNATION
- HSG X — HYDROLOGIC SOIL GROUP

LINETYPES

- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- HYDROLOGIC SOIL GROUP BOUNDARY

0 30 60 Feet

vhb

Facility Expansion Project
Existing Conditions Drainage Figure
425 Whitney Street
Northborough, MA

Figure 2

September 201
Rev. Oct. 7, 201

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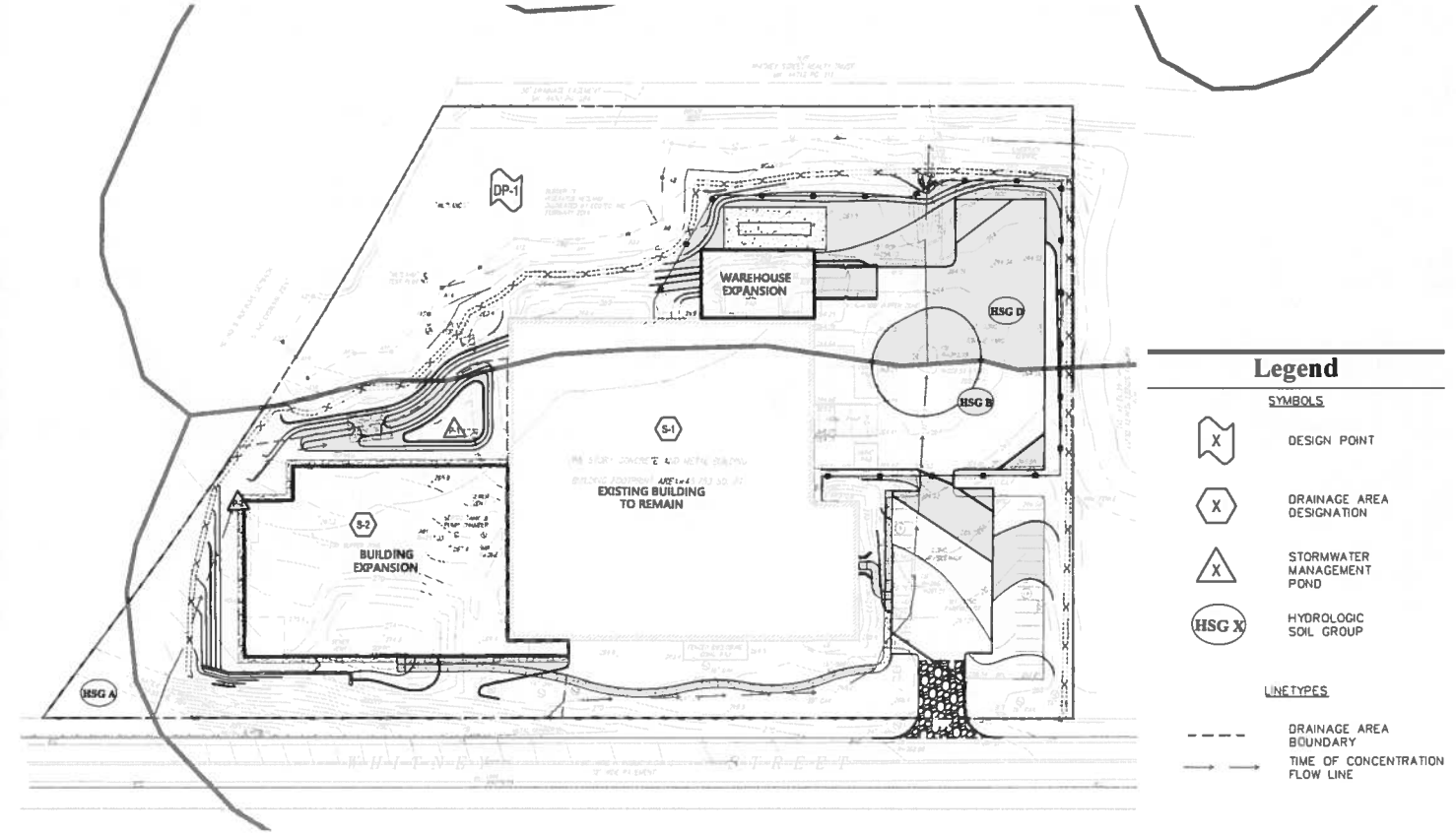

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Facility Expansion Project
Proposed Conditions Drainage Figure
425 Whitney Street
Northborough, MA

Figure 3

September 201
Rev Oct 7, 201

Regulatory Compliance

Massachusetts Department of Environmental Protection (DEP) - Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards.

Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project stormwater outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters. Outlets from closed drainage systems have been designed with flared end sections and stone protection to dissipate discharge velocities. Overflows from BMP's that impound stormwater have been designed with stone to protect down gradient areas from erosion.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix A.

Standard 2: Peak Rate Attenuation

The Project has been designed to comply with Standard 2.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2-, 10-, 25-, and 100-years. The results of the analysis, as summarized in Table 3 below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions for the 2-, 10-, 25-, and 100-year storm events.

Table 5
Peak Discharge Rates (cfs*)

Design Point	*2-year*	*10-year*	*25-year*	*100-year*
Design Point: DP-1				
Existing	10.1	20.2	26.7	37.3
Proposed	10.0	18.6	25.6	36.0

Rainfall volumes used for this analysis were based on NOAA Atlas 14, Volume 10, Version 3 precipitation data for Northborough, Massachusetts, as follows:

- 2-year storm: 3.30 inches
- 10-year storm: 5.04 inches
- 25-year storm: 6.14 inches
- 100-year storm: 7.82 inches

Runoff coefficients for the existing and proposed conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.

Standard 3: Stormwater Recharge

The Project has been designed to comply with Standard 3 for the net new impervious area proposed by the Project.

In accordance with the Stormwater Handbook, the Required Recharge Volume for the Project is 635 cubic feet.

Recharge of stormwater has been provided through the use of a French drain along the proposed building expansion and a surface infiltration basin, which has been sized using the Static method. The surface infiltration BMP has been designed to drain completely within 72 hours. Table 4 below provides a summary of the proposed infiltration BMPs utilized for the Project.

Table 6
Summary of Recharge Calculations

Infiltration BMP	*Provided Recharge Volume (cubic feet)*
P-1	673
P-2	600
Total Provided Recharge	1,273
Total Required Recharge	635

Subsurface soils in the location of the proposed surface infiltration basin were observed by VHB on September 5, 2019. Sandy loam was observed as the most predominant (and most restrictive) subsurface soil. Therefore, the analyses summarized herein assume a Rawls Infiltration Rate of 1.02 inches/hour. The probable high groundwater elevation at the proposed surface infiltration basin is at approximately elevation 260, greater than 2' below the bottom of the proposed infiltration BMPs.

Soil evaluation, computations, and supporting information are included in Appendix C.

Standard 4: Water Quality

The Project has been designed to comply with Standard 4.

Although the Project will result in a net add of impervious area due to the building expansion, the Project will result in a net decrease of paved vehicular and loading area. Additionally, the Project proposes to reconstruct the existing paving area to remain to include new deep-sump, hooded catch basins and a water quality unit, resulting in an improvement to the quality of the stormwater runoff from the site. The Project is located within the Town of Northborough Groundwater Protection Overlay District. Therefore, the proposed stormwater management system has been designed to treat the one-inch Water Quality Volume. The proposed stormwater management system implements a treatment train of BMPs that has been designed to provide 80% TSS removal of stormwater runoff from all proposed vehicular areas.

Computations and supporting information, including the Long-Term Pollution Prevention Plan, are included in Appendix D.

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

The Project is not considered a LUHPPL.

Standard 6: Critical Areas

The Project is located within the Town of Northborough Groundwater Protection Overlay District and therefore has been designed with suitable BMPs sized to treat the 1-inch Water Quality Volume. Proposed source controls and pollution prevention measures have been identified in the Long-Term Pollution Prevention Plan included in Appendix D.

For computations and supporting information regarding the sizing of BMPs suitable for treatment of runoff near or to critical areas, see Appendix D.

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable

The Project is a partial redevelopment and has been designed to comply with Stormwater Management Standards 2-6 to the maximum extent practicable. Standards 8-10 have been met completely.

Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The Project will disturb more than 1.0 acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit. As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) will be developed and submitted before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls to be finalized in the SWPPP are included in Appendix F.

Standard 9: Operation and Maintenance Plan

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan has been developed for the Project. The O&M Plan is included in Appendix D as part of the Long Term Pollution Prevention Plan.

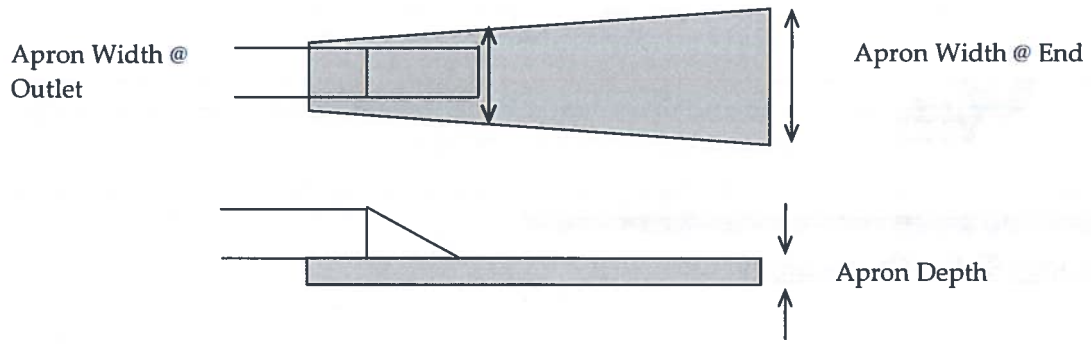
Standard 10: Prohibition of Illicit Discharges

Sanitary sewer and storm drainage structures remaining from previous development which are part of the redevelopment area will be removed or will be incorporated into updated sanitary sewer and separate stormwater sewer systems. The design plans submitted with this report have been designed so that the components included therein are in full compliance with current standards. No statement is made with regard to the drainage system in portions of the site not included in the redevelopment project area. The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges. A signed Illicit Discharges Statement is included in Appendix G.

Appendix A
Standard 1 Computations and Supporting Information
Supporting Information

- Apron & Riprap Sizing Calculations

Apron & Riprap Sizing Calculations



Apron Width at Outlet ($3D_o$): Width = 3 x pipe dia. (or width of channel)

Apron Length (La): Length = From Virginia DCR Handbook - Plate 3.18-3 if Tw depth is < 1/2 dia.
Length = From Virginia DCR Handbook - Plate 3.18-4 if Tw dwpth is >= 1/2 dia.

Apron Width at End (W): Width = dia. + apron length if Tw depth is < 1/2 dia.
Width = dia. + 0.4 x apron length if Tw dwpth is >= 1/2 dia.
or apron width = channel width if a well defined channel exists

Rock Riprap: Median Diameter (d_{50}) = From Virginia DCR Handbook - Plate 3.18-3 or 4
Largest stone dia = 1.5 x d_{50}

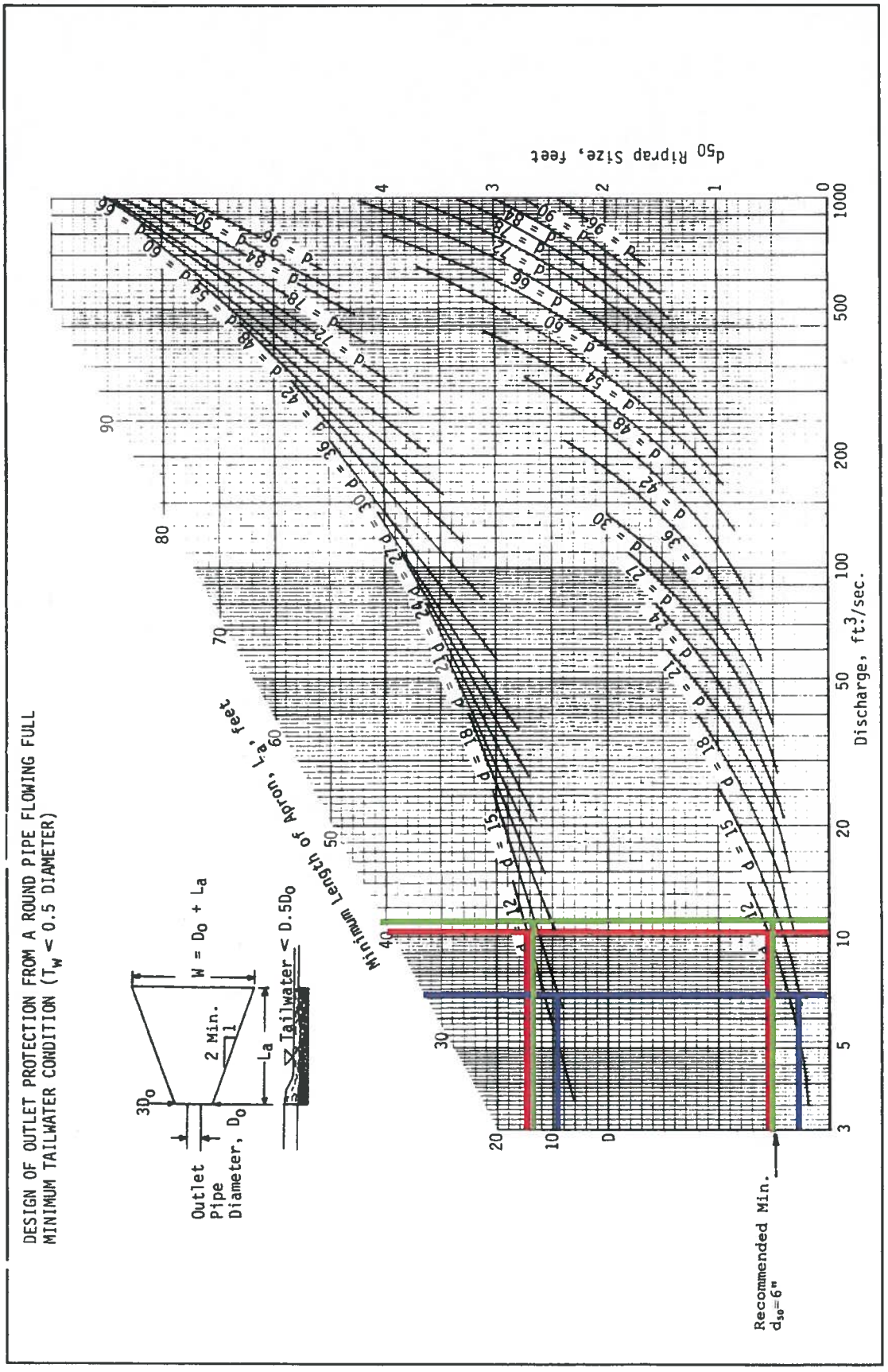
Apron Depth: 6" or 1.5 x largest stone dia

Design Element	Outlet Description		
	FES 1[1]	FES 3[1]	FES 4[2]
Design Storm (yr):	100	100	100
Defined Channel (yes/no)	no	no	no
Pipe Dia (D_o), in	12.0	15.0	18.0
Tail Water (Tw), ft	0.00	0.00	0.00
Flow (Q), cfs	10.2	6.9	11.0
Median Stone Dia. (d_{50}), ft	0.6	0.5	0.5
Apron Length (La), ft	15.0	9.0	10.0
Apron Width ($3D_o$) (outlet), ft	**3.0**	**3.8**	**4.5**
Apron Width (W) (end), ft	**16.0**	**10.3**	**11.5**
Median Stone Dia. (d_{50}), in	7.2	6.0	6.0
Largest Stone Dia., ft	0.90	0.75	0.75
Largest Stone Dia., in	10.8	9.0	9.0
Apron Depth, ft	1.35	1.13	1.13
Apron Depth, in	16.2	13.5	13.5

[1] Flows calculated using 100- year design storm in HydroCAD.

[2] Flows calculated using 100- year design storm in StormCAD

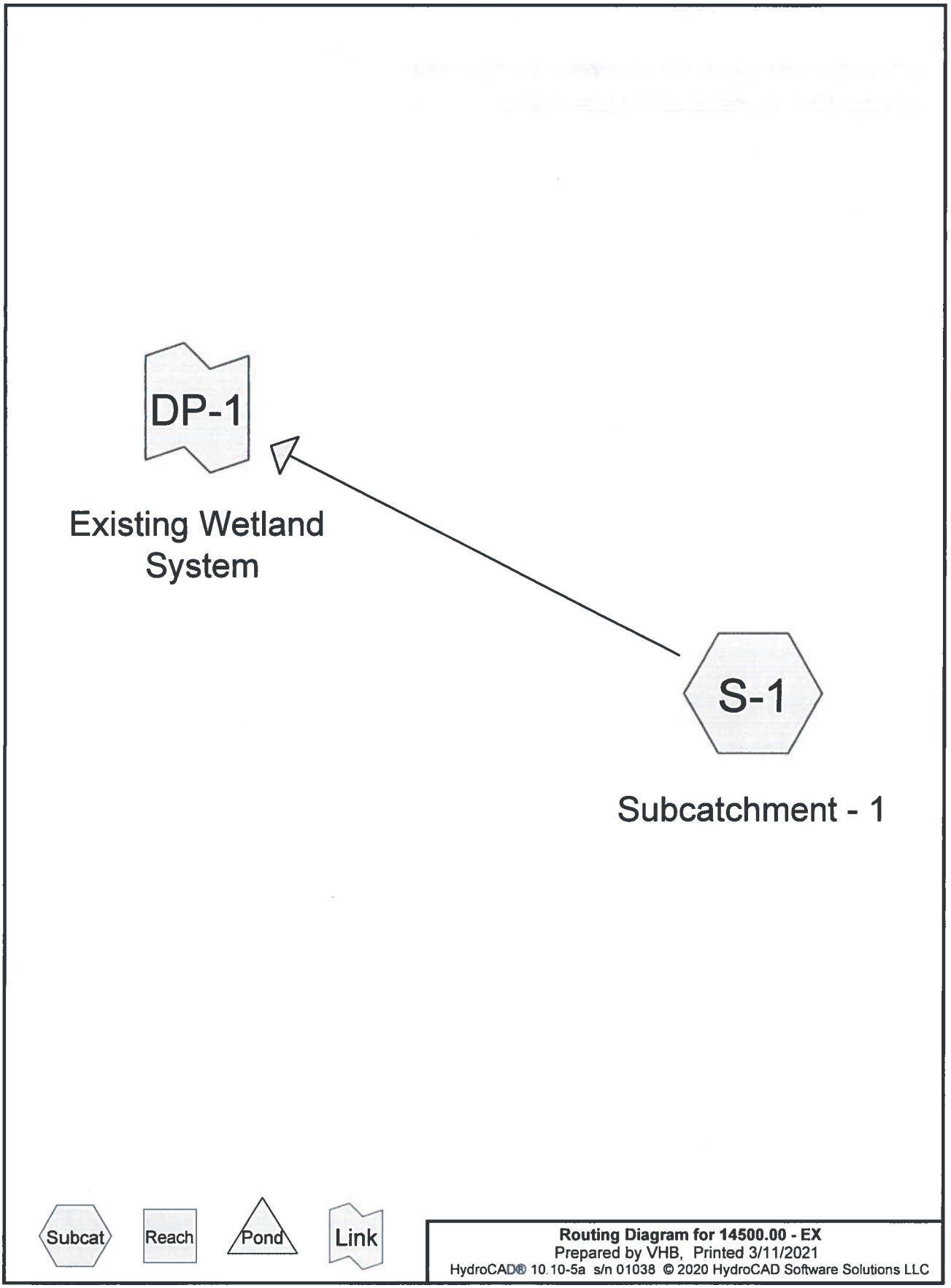
FES 1 FES 3 FES 4



Source: USDA-SCS Plate 3.18-3

Appendix B
Standard 2 Computations and Supporting Information

HydroCAD Analysis: Existing Conditions


DP-1
Existing Wetland System
S-1
Subcatchment - 1
Subcat
Reach
Pond
Link
Routing Diagram for 14500.00 - EX
Prepared by VHB, Printed 3/11/2021
HydroCAD® 10.10-5a s/n 01038 © 2020 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.1	61	>75% Grass cover, Good, HSG B (S-1)
0.6	80	>75% Grass cover, Good, HSG D (S-1)
0.5	98	Paved parking, HSG B (S-1)
0.3	98	Paved parking, HSG D (S-1)
1.0	98	Unconnected roofs, HSG B (S-1)
0.1	98	Unconnected roofs, HSG D (S-1)
0.1	30	Woods, Good, HSG A (S-1)
0.5	55	Woods, Good, HSG B (S-1)
0.8	77	Woods, Good, HSG D (S-1)
5.0	**79**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.1	HSG A	S-1
3.1	HSG B	S-1
0.0	HSG C	
1.8	HSG D	S-1
0.0	Other	
5.0		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.0	1.1	0.0	0.6	0.0	1.7	>75% Grass cover, Good	S-1
0.0	0.5	0.0	0.3	0.0	0.8	Paved parking	S-1
0.0	1.0	0.0	0.1	0.0	1.1	Unconnected roofs	S-1
0.1	0.5	0.0	0.8	0.0	1.4	Woods, Good	S-1
0.1	**3.1**	**0.0**	**1.8**	**0.0**	**5.0**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentS-1: Subcatchment- 1 Runoff Area=5.0 ac 38% Impervious Runoff Depth=1.4"
Flow Length=595' Tc=11.8 min CN=79 Runoff=10.1 cfs 0.6 af

Link DP-1: Existing Wetland System Inflow=10.1 cfs 0.6 af
Primary=10.1 cfs 0.6 af

Total Runoff Area = 5.0 ac Runoff Volume = 0.6 af Average Runoff Depth = 1.4"
62% Pervious = 3.1 ac 38% Impervious = 1.9 ac

Summary for Subcatchment S-1: Subcatchment - 1

Runoff = 10.1 cfs @ 12.04 hrs, Volume= 0.6 af, Depth= 1.4"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-year Rainfall=3.3"

Area (ac)	CN	Description
0.1	30	Woods, Good, HSG A
0.5	55	Woods, Good, HSG B
0.8	77	Woods, Good, HSG D
1.1	61	>75% Grass cover, Good, HSG B
0.6	80	>75% Grass cover, Good, HSG D
0.5	98	Paved parking, HSG B
0.3	98	Paved parking, HSG D
1.0	98	Unconnected roofs, HSG B
0.1	98	Unconnected roofs, HSG D
5.0	79	Weighted Average
3.1		62% Pervious Area
1.9		38% Impervious Area
1.1		58% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0800	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.2"
7.0	207	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	49	0.1220	7.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	142	0.0140	7.36	9.03	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.2	82	0.0120	6.81	8.36	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
1.0	65	0.0460	1.07		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.8	595	Total			

Summary for Link DP-1: Existing Wetland System

Inflow Area = 5.0 ac, 38% Impervious, Inflow Depth = 1.4" for 2-year event
Inflow = 10.1 cfs @ 12.04 hrs, Volume= 0.6 af
Primary = 10.1 cfs @ 12.04 hrs, Volume= 0.6 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentS-1: Subcatchment- 1 Runoff Area=5.0 ac 38% Impervious Runoff Depth=2.8"
Flow Length=595' Tc=11.8 min CN=79 Runoff=20.2 cfs 1.2 af

Link DP-1: Existing Wetland System Inflow=20.2 cfs 1.2 af
Primary=20.2 cfs 1.2 af

Total Runoff Area = 5.0 ac Runoff Volume = 1.2 af Average Runoff Depth = 2.8"
62% Pervious = 3.1 ac 38% Impervious = 1.9 ac

Summary for Subcatchment S-1: Subcatchment - 1

Runoff = 20.2 cfs @ 12.04 hrs, Volume= 1.2 af, Depth= 2.8"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-year Rainfall=5.0"

Area (ac)	CN	Description
0.1	30	Woods, Good, HSG A
0.5	55	Woods, Good, HSG B
0.8	77	Woods, Good, HSG D
1.1	61	>75% Grass cover, Good, HSG B
0.6	80	>75% Grass cover, Good, HSG D
0.5	98	Paved parking, HSG B
0.3	98	Paved parking, HSG D
1.0	98	Unconnected roofs, HSG B
0.1	98	Unconnected roofs, HSG D
5.0	79	Weighted Average
3.1		62% Pervious Area
1.9		38% Impervious Area
1.1		58% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0800	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.2"
7.0	207	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	49	0.1220	7.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	142	0.0140	7.36	9.03	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.2	82	0.0120	6.81	8.36	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
1.0	65	0.0460	1.07		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.8	595	Total			

Summary for Link DP-1: Existing Wetland System

Inflow Area = 5.0 ac, 38% Impervious, Inflow Depth = 2.8" for 10-year event
Inflow = 20.2 cfs @ 12.04 hrs, Volume= 1.2 af
Primary = 20.2 cfs @ 12.04 hrs, Volume= 1.2 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentS-1: Subcatchment- 1 Runoff Area=5.0 ac 38% Impervious Runoff Depth=3.8"
Flow Length=595' Tc=11.8 min CN=79 Runoff=26.7 cfs 1.6 af

Link DP-1: Existing Wetland System Inflow=26.7 cfs 1.6 af
Primary=26.7 cfs 1.6 af

Total Runoff Area = 5.0 ac Runoff Volume = 1.6 af Average Runoff Depth = 3.8"
62% Pervious = 3.1 ac 38% Impervious = 1.9 ac

Summary for Subcatchment S-1: Subcatchment - 1

Runoff = 26.7 cfs @ 12.03 hrs, Volume= 1.6 af, Depth= 3.8"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year Rainfall=6.1"

Area (ac)	CN	Description
0.1	30	Woods, Good, HSG A
0.5	55	Woods, Good, HSG B
0.8	77	Woods, Good, HSG D
1.1	61	>75% Grass cover, Good, HSG B
0.6	80	>75% Grass cover, Good, HSG D
0.5	98	Paved parking, HSG B
0.3	98	Paved parking, HSG D
1.0	98	Unconnected roofs, HSG B
0.1	98	Unconnected roofs, HSG D
5.0	79	Weighted Average
3.1		62% Pervious Area
1.9		38% Impervious Area
1.1		58% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0800	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.2"
7.0	207	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	49	0.1220	7.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	142	0.0140	7.36	9.03	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.2	82	0.0120	6.81	8.36	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
1.0	65	0.0460	1.07		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.8	595	Total			

Summary for Link DP-1: Existing Wetland System

Inflow Area = 5.0 ac, 38% Impervious, Inflow Depth = 3.8" for 25-year event
Inflow = 26.7 cfs @ 12.03 hrs, Volume= 1.6 af
Primary = 26.7 cfs @ 12.03 hrs, Volume= 1.6 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentS-1: Subcatchment- 1 Runoff Area=5.0 ac 38% Impervious Runoff Depth=5.3"
Flow Length=595' Tc=11.8 min CN=79 Runoff=37.3 cfs 2.2 af

Link DP-1: Existing Wetland System Inflow=37.3 cfs 2.2 af
Primary=37.3 cfs 2.2 af

Total Runoff Area = 5.0 ac Runoff Volume = 2.2 af Average Runoff Depth = 5.3"
62% Pervious = 3.1 ac 38% Impervious = 1.9 ac

Summary for Subcatchment S-1: Subcatchment - 1

Runoff = 37.3 cfs @ 12.03 hrs, Volume= 2.2 af, Depth= 5.3"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-year Rainfall=7.8"

Area (ac)	CN	Description
0.1	30	Woods, Good, HSG A
0.5	55	Woods, Good, HSG B
0.8	77	Woods, Good, HSG D
1.1	61	>75% Grass cover, Good, HSG B
0.6	80	>75% Grass cover, Good, HSG D
0.5	98	Paved parking, HSG B
0.3	98	Paved parking, HSG D
1.0	98	Unconnected roofs, HSG B
0.1	98	Unconnected roofs, HSG D
5.0	79	Weighted Average
3.1		62% Pervious Area
1.9		38% Impervious Area
1.1		58% Unconnected

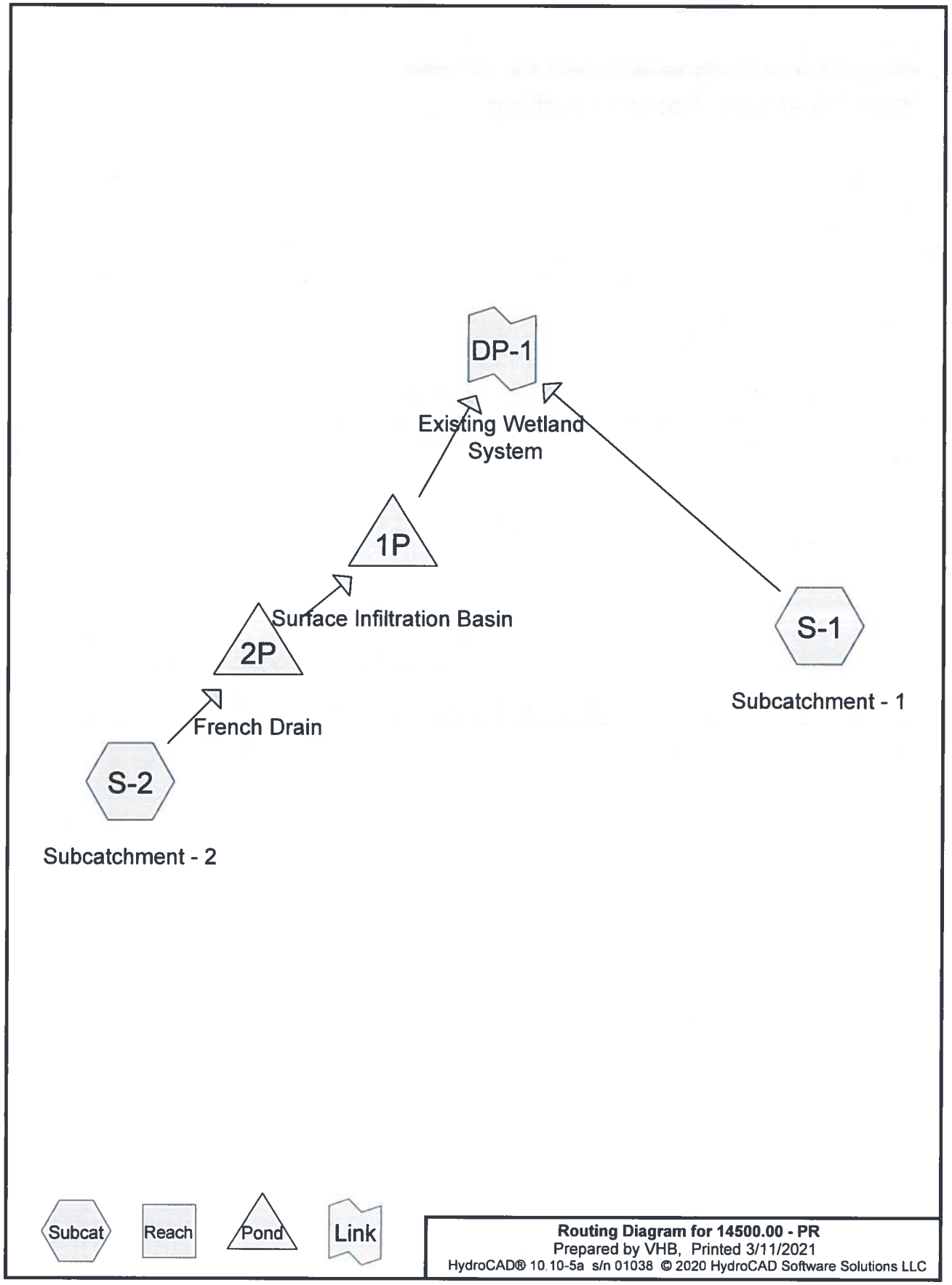
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0800	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.2"
7.0	207	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	49	0.1220	7.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	142	0.0140	7.36	9.03	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.2	82	0.0120	6.81	8.36	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
1.0	65	0.0460	1.07		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.8	595	Total			

Summary for Link DP-1: Existing Wetland System

Inflow Area = 5.0 ac, 38% Impervious, Inflow Depth = 5.3" for 100-year event
Inflow = 37.3 cfs @ 12.03 hrs, Volume= 2.2 af
Primary = 37.3 cfs @ 12.03 hrs, Volume= 2.2 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

HydroCAD Analysis: Proposed Conditions


DP-1
Existing Wetland System
1P
Surface Infiltration Basin
2P
French Drain
S-2
Subcatchment - 2
S-1
Subcatchment - 1
Subcat
Reach
Pond
Link
Routing Diagram for 14500.00 - PR
Prepared by VHB, Printed 3/11/2021
HydroCAD® 10.10-5a s/n 01038 © 2020 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.2	61	>75% Grass cover, Good, HSG B (S-1, S-2)
0.5	80	>75% Grass cover, Good, HSG D (S-1)
0.5	98	Paved parking, HSG B (S-1)
0.3	98	Paved parking, HSG D (S-1)
1.4	98	Unconnected roofs, HSG B (S-1, S-2)
0.2	98	Unconnected roofs, HSG D (S-1)
0.1	30	Woods, Good, HSG A (S-2)
0.8	77	Woods, Good, HSG D (S-1)
5.0	**83**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.1	HSG A	S-2
3.1	HSG B	S-1, S-2
0.0	HSG C	
1.8	HSG D	S-1
0.0	Other	
5.0		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.0	1.2	0.0	0.5	0.0	1.7	>75% Grass cover, Good	S-1, S-2
0.0	0.5	0.0	0.3	0.0	0.8	Paved parking	S-1
0.0	1.4	0.0	0.2	0.0	1.6	Unconnected roofs	S-1, S-2
0.1	0.0	0.0	0.8	0.0	0.9	Woods, Good	S-1, S-2
0.1	**3.1**	**0.0**	**1.8**	**0.0**	**5.0**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentS-1: Subcatchment- 1 Runoff Area=3.8 ac 50% Impervious Runoff Depth=1.8"
Flow Length=595' Tc=11.8 min CN=85 Runoff=10.0 cfs 0.6 af

SubcatchmentS-2: Subcatchment- 2 Runoff Area=1.2 ac 42% Impervious Runoff Depth=1.1"
Flow Length=220' Tc=8.4 min CN=74 Runoff=2.1 cfs 0.1 af

Pond 1P: Surface Infiltration Basin Peak Elev=265.68' Storage=1,178 cf Inflow=1.2 cfs 0.1 af
Discarded=0.0 cfs 0.0 af Primary=0.2 cfs 0.0 af Outflow=0.2 cfs 0.1 af

Pond 2P: French Drain Peak Elev=266.07' Storage=1,279 cf Inflow=2.1 cfs 0.1 af
Discarded=0.0 cfs 0.1 af Primary=1.2 cfs 0.1 af Outflow=1.2 cfs 0.1 af

Link DP-1: Existing Wetland System Inflow=10.0 cfs 0.6 af
Primary=10.0 cfs 0.6 af

Total Runoff Area = 5.0 ac Runoff Volume = 0.7 af Average Runoff Depth = 1.7"
52% Pervious = 2.6 ac 48% Impervious = 2.4 ac

Summary for Subcatchment S-1: Subcatchment - 1

Runoff = 10.0 cfs @ 12.04 hrs, Volume= 0.6 af, Depth= 1.8"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-year Rainfall=3.3"

Area (ac)	CN	Description
0.8	77	Woods, Good, HSG D
0.6	61	>75% Grass cover, Good, HSG B
0.5	80	>75% Grass cover, Good, HSG D
0.5	98	Paved parking, HSG B
0.3	98	Paved parking, HSG D
0.9	98	Unconnected roofs, HSG B
0.2	98	Unconnected roofs, HSG D
3.8	85	Weighted Average
1.9		50% Pervious Area
1.9		50% Impervious Area
1.1		58% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0800	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.2"
7.0	207	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	49	0.1220	7.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	142	0.0140	7.36	9.03	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.2	82	0.0120	6.81	8.36	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
1.0	65	0.0460	1.07		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.8	595	Total			

Summary for Subcatchment S-2: Subcatchment - 2

Runoff = 2.1 cfs @ 12.01 hrs, Volume= 0.1 af, Depth= 1.1"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-year Rainfall=3.3"

Area (ac)	CN	Description
0.1	30	Woods, Good, HSG A
0.6	61	>75% Grass cover, Good, HSG B
0.5	98	Unconnected roofs, HSG B
1.2	74	Weighted Average
0.7		58% Pervious Area
0.5		42% Impervious Area
0.5		100% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	30	0.4000	0.20		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.2"
4.1	20	0.0500	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.2"
1.8	170	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.4	220	Total			

Summary for Pond 1P: Surface Infiltration Basin

Inflow Area = 1.2 ac, 42% Impervious, Inflow Depth = 0.5" for 2-year event
Inflow = 1.2 cfs @ 12.11 hrs, Volume= 0.1 af
Outflow = 0.2 cfs @ 12.71 hrs, Volume= 0.1 af, Atten= 83%, Lag= 36.2 min
Discarded = 0.0 cfs @ 12.71 hrs, Volume= 0.0 af
Primary = 0.2 cfs @ 12.71 hrs, Volume= 0.0 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 265.68' @ 12.71 hrs Surf.Area= 1,664 sf Storage= 1,178 cf

Plug-Flow detention time= 216.8 min calculated for 0.1 af (100% of inflow)
Center-of-Mass det. time= 216.9 min (1,001.3 - 784.4)

Volume	Invert	Avail.Storage	Storage Description
#1	264.80'	8,096 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
264.80	1,000	0	0
265.00	1,160	216	216
266.00	1,900	1,530	1,746
267.00	2,900	2,400	4,146
268.00	5,000	3,950	8,096

Device	Routing	Invert	Outlet Devices
#1	Primary	266.80'	**20.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	265.50'	**15.0" Round Culvert** L= 18.0' Ke= 0.500

Inlet / Outlet Invert= 265.50' / 265.00' S= 0.0278 '/' Cc= 0.900
n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#3 Discarded 264.80' **1.020 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.0 cfs @ 12.71 hrs HW=265.68' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=0.2 cfs @ 12.71 hrs HW=265.68' (Free Discharge)
├**1=Broad-Crested Rectangular Weir**(Controls 0.0 cfs)
└**2=Culvert** (Inlet Controls 0.2 cfs @ 1.45 fps)

Summary for Pond 2P: French Drain

Inflow Area = 1.2 ac, 42% Impervious, Inflow Depth = 1.1" for 2-year event
Inflow = 2.1 cfs @ 12.01 hrs, Volume= 0.1 af
Outflow = 1.2 cfs @ 12.11 hrs, Volume= 0.1 af, Atten= 43%, Lag= 6.3 min
Discarded = 0.0 cfs @ 11.65 hrs, Volume= 0.1 af
Primary = 1.2 cfs @ 12.11 hrs, Volume= 0.1 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 266.07' @ 12.11 hrs Surf.Area= 1,750 sf Storage= 1,279 cf

Plug-Flow detention time= 126.6 min calculated for 0.1 af (100% of inflow)
Center-of-Mass det. time= 126.7 min (985.7 - 859.0)

Volume	Invert	Avail.Storage	Storage Description
#1	264.50'	2,097 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc) 6,125 cf Overall - 884 cf Embedded = 5,241 cf x 40.0% Voids
#2	265.50'	884 cf	**18.0" Round Pipe Storage** Inside #1 L= 500.0'
		2,980 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
264.50	1,750	0	0
268.00	1,750	6,125	6,125

Device	Routing	Invert	Outlet Devices
#1	Primary	265.50'	**18.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 265.50' / 265.40' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf
#2	Discarded	264.50'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.0 cfs @ 11.65 hrs HW=264.55' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=1.1 cfs @ 12.11 hrs HW=266.06' (Free Discharge)
└**1=Culvert** (Barrel Controls 1.1 cfs @ 2.80 fps)

Summary for Link DP-1: Existing Wetland System

Inflow Area = 5.0 ac, 48% Impervious, Inflow Depth = 1.4" for 2-year event
Inflow = 10.0 cfs @ 12.04 hrs, Volume= 0.6 af
Primary = 10.0 cfs @ 12.04 hrs, Volume= 0.6 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentS-1: Subcatchment- 1 Runoff Area=3.8 ac 50% Impervious Runoff Depth=3.4"
Flow Length=595' Tc=11.8 min CN=85 Runoff=18.1 cfs 1.1 af

SubcatchmentS-2: Subcatchment- 2 Runoff Area=1.2 ac 42% Impervious Runoff Depth=2.4"
Flow Length=220' Tc=8.4 min CN=74 Runoff=4.6 cfs 0.2 af

Pond 1P: Surface Infiltration Basin Peak Elev=266.23' Storage=2,208 cf Inflow=3.9 cfs 0.2 af
Discarded=0.1 cfs 0.1 af Primary=2.2 cfs 0.1 af Outflow=2.2 cfs 0.2 af

Pond 2P: French Drain Peak Elev=266.64' Storage=1,931 cf Inflow=4.6 cfs 0.2 af
Discarded=0.0 cfs 0.1 af Primary=3.9 cfs 0.2 af Outflow=4.0 cfs 0.2 af

Link DP-1: Existing Wetland System Inflow=18.6 cfs 1.2 af
Primary=18.6 cfs 1.2 af

Total Runoff Area = 5.0 ac Runoff Volume = 1.3 af Average Runoff Depth = 3.2"
52% Pervious = 2.6 ac 48% Impervious = 2.4 ac

Summary for Subcatchment S-1: Subcatchment - 1

Runoff = 18.1 cfs @ 12.03 hrs, Volume= 1.1 af, Depth= 3.4"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-year Rainfall=5.0"

Area (ac)	CN	Description
0.8	77	Woods, Good, HSG D
0.6	61	>75% Grass cover, Good, HSG B
0.5	80	>75% Grass cover, Good, HSG D
0.5	98	Paved parking, HSG B
0.3	98	Paved parking, HSG D
0.9	98	Unconnected roofs, HSG B
0.2	98	Unconnected roofs, HSG D
3.8	85	Weighted Average
1.9		50% Pervious Area
1.9		50% Impervious Area
1.1		58% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0800	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.2"
7.0	207	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	49	0.1220	7.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	142	0.0140	7.36	9.03	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.2	82	0.0120	6.81	8.36	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
1.0	65	0.0460	1.07		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.8	595	Total			

Summary for Subcatchment S-2: Subcatchment - 2

Runoff = 4.6 cfs @ 12.00 hrs, Volume= 0.2 af, Depth= 2.4"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-year Rainfall=5.0"

Area (ac)	CN	Description
0.1	30	Woods, Good, HSG A
0.6	61	>75% Grass cover, Good, HSG B
0.5	98	Unconnected roofs, HSG B
1.2	74	Weighted Average
0.7		58% Pervious Area
0.5		42% Impervious Area
0.5		100% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	30	0.4000	0.20		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.2"
4.1	20	0.0500	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.2"
1.8	170	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.4	220	Total			

Summary for Pond 1P: Surface Infiltration Basin

Inflow Area = 1.2 ac, 42% Impervious, Inflow Depth = 1.7" for 10-year event
Inflow = 3.9 cfs @ 12.05 hrs, Volume= 0.2 af
Outflow = 2.2 cfs @ 12.18 hrs, Volume= 0.2 af, Atten= 44%, Lag= 7.7 min
Discarded = 0.1 cfs @ 12.18 hrs, Volume= 0.1 af
Primary = 2.2 cfs @ 12.18 hrs, Volume= 0.1 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 266.23' @ 12.18 hrs Surf.Area= 2,129 sf Storage= 2,208 cf

Plug-Flow detention time= 113.7 min calculated for 0.2 af (100% of inflow)
Center-of-Mass det. time= 113.9 min (921.9 - 808.0)

Volume	Invert	Avail.Storage	Storage Description
#1	264.80'	8,096 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
264.80	1,000	0	0
265.00	1,160	216	216
266.00	1,900	1,530	1,746
267.00	2,900	2,400	4,146
268.00	5,000	3,950	8,096

Device	Routing	Invert	Outlet Devices
#1	Primary	266.80'	**20.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	265.50'	**15.0" Round Culvert** L= 18.0' Ke= 0.500

Inlet / Outlet Invert= 265.50' / 265.00' S= 0.0278 '/' Cc= 0.900
n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#3 Discarded 264.80' **1.020 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.1 cfs @ 12.18 hrs HW=266.22' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=2.1 cfs @ 12.18 hrs HW=266.22' (Free Discharge)
├**1=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)
└**2=Culvert** (Inlet Controls 2.1 cfs @ 2.90 fps)

Summary for Pond 2P: French Drain

Inflow Area = 1.2 ac, 42% Impervious, Inflow Depth = 2.4" for 10-year event
Inflow = 4.6 cfs @ 12.00 hrs, Volume= 0.2 af
Outflow = 4.0 cfs @ 12.05 hrs, Volume= 0.2 af, Atten= 14%, Lag= 3.1 min
Discarded = 0.0 cfs @ 10.65 hrs, Volume= 0.1 af
Primary = 3.9 cfs @ 12.05 hrs, Volume= 0.2 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 266.64' @ 12.05 hrs Surf.Area= 1,750 sf Storage= 1,931 cf

Plug-Flow detention time= 71.3 min calculated for 0.2 af (100% of inflow)
Center-of-Mass det. time= 71.5 min (907.5 - 836.0)

Volume	Invert	Avail.Storage	Storage Description
#1	264.50'	2,097 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 6,125 cf Overall - 884 cf Embedded = 5,241 cf x 40.0% Voids
#2	265.50'	884 cf	**18.0" Round Pipe Storage** Inside #1 L= 500.0'
		2,980 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
264.50	1,750	0	0
268.00	1,750	6,125	6,125

Device	Routing	Invert	Outlet Devices
#1	Primary	265.50'	**18.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 265.50' / 265.40' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf
#2	Discarded	264.50'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.0 cfs @ 10.65 hrs HW=264.54' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=3.9 cfs @ 12.05 hrs HW=266.64' (Free Discharge)
└**1=Culvert** (Barrel Controls 3.9 cfs @ 3.78 fps)

Summary for Link DP-1: Existing Wetland System

Inflow Area = 5.0 ac, 48% Impervious, Inflow Depth = 2.9" for 10-year event
Inflow = 18.6 cfs @ 12.04 hrs, Volume= 1.2 af
Primary = 18.6 cfs @ 12.04 hrs, Volume= 1.2 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentS-1: Subcatchment- 1 Runoff Area=3.8 ac 50% Impervious Runoff Depth=4.4"
Flow Length=595' Tc=11.8 min CN=85 Runoff=23.1 cfs 1.4 af

SubcatchmentS-2: Subcatchment- 2 Runoff Area=1.2 ac 42% Impervious Runoff Depth=3.3"
Flow Length=220' Tc=8.4 min CN=74 Runoff=6.3 cfs 0.3 af

Pond 1P: Surface Infiltration Basin Peak Elev=266.52' Storage=2,873 cf Inflow=5.6 cfs 0.3 af
Discarded=0.1 cfs 0.1 af Primary=3.7 cfs 0.2 af Outflow=3.8 cfs 0.3 af

Pond 2P: French Drain Peak Elev=266.93' Storage=2,221 cf Inflow=6.3 cfs 0.3 af
Discarded=0.0 cfs 0.1 af Primary=5.6 cfs 0.3 af Outflow=5.7 cfs 0.3 af

Link DP-1: Existing Wetland System Inflow=25.6 cfs 1.6 af
Primary=25.6 cfs 1.6 af

Total Runoff Area = 5.0 ac Runoff Volume = 1.7 af Average Runoff Depth = 4.1"
52% Pervious = 2.6 ac 48% Impervious = 2.4 ac

Summary for Subcatchment S-1: Subcatchment - 1

Runoff = 23.1 cfs @ 12.03 hrs, Volume= 1.4 af, Depth= 4.4"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year Rainfall=6.1"

Area (ac)	CN	Description
0.8	77	Woods, Good, HSG D
0.6	61	>75% Grass cover, Good, HSG B
0.5	80	>75% Grass cover, Good, HSG D
0.5	98	Paved parking, HSG B
0.3	98	Paved parking, HSG D
0.9	98	Unconnected roofs, HSG B
0.2	98	Unconnected roofs, HSG D
3.8	85	Weighted Average
1.9		50% Pervious Area
1.9		50% Impervious Area
1.1		58% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0800	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.2"
7.0	207	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	49	0.1220	7.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	142	0.0140	7.36	9.03	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.2	82	0.0120	6.81	8.36	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
1.0	65	0.0460	1.07		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.8	595	Total			

Summary for Subcatchment S-2: Subcatchment - 2

Runoff = 6.3 cfs @ 12.00 hrs, Volume= 0.3 af, Depth= 3.3"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 25-year Rainfall=6.1"

Area (ac)	CN	Description
0.1	30	Woods, Good, HSG A
0.6	61	>75% Grass cover, Good, HSG B
0.5	98	Unconnected roofs, HSG B
1.2	74	Weighted Average
0.7		58% Pervious Area
0.5		42% Impervious Area
0.5		100% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	30	0.4000	0.20		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.2"
4.1	20	0.0500	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.2"
1.8	170	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.4	220	Total			

Summary for Pond 1P: Surface Infiltration Basin

Inflow Area = 1.2 ac, 42% Impervious, Inflow Depth = 2.6" for 25-year event
Inflow = 5.6 cfs @ 12.04 hrs, Volume= 0.3 af
Outflow = 3.8 cfs @ 12.14 hrs, Volume= 0.3 af, Atten= 33%, Lag= 6.0 min
Discarded = 0.1 cfs @ 12.14 hrs, Volume= 0.1 af
Primary = 3.7 cfs @ 12.14 hrs, Volume= 0.2 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 266.52' @ 12.14 hrs Surf.Area= 2,421 sf Storage= 2,873 cf

Plug-Flow detention time= 91.1 min calculated for 0.3 af (100% of inflow)
Center-of-Mass det. time= 90.9 min (902.8 - 811.9)

Volume	Invert	Avail.Storage	Storage Description
#1	264.80'	8,096 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
264.80	1,000	0	0
265.00	1,160	216	216
266.00	1,900	1,530	1,746
267.00	2,900	2,400	4,146
268.00	5,000	3,950	8,096

Device	Routing	Invert	Outlet Devices
#1	Primary	266.80'	**20.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	265.50'	**15.0" Round Culvert** L= 18.0' Ke= 0.500

Inlet / Outlet Invert= 265.50' / 265.00' S= 0.0278 '/' Cc= 0.900
n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#3 Discarded 264.80' **1.020 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.1 cfs @ 12.14 hrs HW=266.52' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=3.7 cfs @ 12.14 hrs HW=266.52' (Free Discharge)
├**1=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)
└**2=Culvert** (Inlet Controls 3.7 cfs @ 3.43 fps)

Summary for Pond 2P: French Drain

Inflow Area =	1.2 ac, 42% Impervious,	Inflow Depth =	3.3"	for 25-year event
Inflow =	6.3 cfs @	12.00 hrs, Volume=	0.3 af	
Outflow =	5.7 cfs @	12.04 hrs, Volume=	0.3 af,	Atten= 10%, Lag= 2.6 min
Discarded =	0.0 cfs @	9.95 hrs, Volume=	0.1 af	
Primary =	5.6 cfs @	12.04 hrs, Volume=	0.3 af	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 266.93' @ 12.04 hrs Surf.Area= 1,750 sf Storage= 2,221 cf

Plug-Flow detention time= 55.7 min calculated for 0.3 af (100% of inflow)
Center-of-Mass det. time= 55.9 min (883.0 - 827.1)

Volume	Invert	Avail.Storage	Storage Description
#1	264.50'	2,097 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 6,125 cf Overall - 884 cf Embedded = 5,241 cf x 40.0% Voids
#2	265.50'	884 cf	**18.0" Round Pipe Storage** Inside #1 L= 500.0'
		2,980 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
264.50	1,750	0	0
268.00	1,750	6,125	6,125

Device	Routing	Invert	Outlet Devices
#1	Primary	265.50'	**18.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 265.50' / 265.40' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf
#2	Discarded	264.50'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.0 cfs @ 9.95 hrs HW=264.54' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=5.5 cfs @ 12.04 hrs HW=266.91' (Free Discharge)
└**1=Culvert** (Barrel Controls 5.5 cfs @ 4.13 fps)

Summary for Link DP-1: Existing Wetland System

Inflow Area = 5.0 ac, 48% Impervious, Inflow Depth = 3.8" for 25-year event
Inflow = 25.6 cfs @ 12.04 hrs, Volume= 1.6 af
Primary = 25.6 cfs @ 12.04 hrs, Volume= 1.6 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

SubcatchmentS-1: Subcatchment- 1 Runoff Area=3.8 ac 50% Impervious Runoff Depth=6.0"
Flow Length=595' Tc=11.8 min CN=85 Runoff=31.2 cfs 1.9 af

SubcatchmentS-2: Subcatchment- 2 Runoff Area=1.2 ac 42% Impervious Runoff Depth=4.8"
Flow Length=220' Tc=8.4 min CN=74 Runoff=9.1 cfs 0.5 af

Pond 1P: Surface Infiltration Basin Peak Elev=266.91' Storage=3,889 cf Inflow=8.3 cfs 0.4 af
Discarded=0.1 cfs 0.1 af Primary=7.0 cfs 0.3 af Outflow=7.1 cfs 0.4 af

Pond 2P: French Drain Peak Elev=267.46' Storage=2,605 cf Inflow=9.1 cfs 0.5 af
Discarded=0.0 cfs 0.1 af Primary=8.3 cfs 0.4 af Outflow=8.4 cfs 0.5 af

Link DP-1: Existing Wetland System Inflow=36.0 cfs 2.3 af
Primary=36.0 cfs 2.3 af

Total Runoff Area = 5.0 ac Runoff Volume = 2.4 af Average Runoff Depth = 5.7"
52% Pervious = 2.6 ac 48% Impervious = 2.4 ac

Summary for Subcatchment S-1: Subcatchment - 1

Runoff = 31.2 cfs @ 12.03 hrs, Volume= 1.9 af, Depth= 6.0"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-year Rainfall=7.8"

Area (ac)	CN	Description
0.8	77	Woods, Good, HSG D
0.6	61	>75% Grass cover, Good, HSG B
0.5	80	>75% Grass cover, Good, HSG D
0.5	98	Paved parking, HSG B
0.3	98	Paved parking, HSG D
0.9	98	Unconnected roofs, HSG B
0.2	98	Unconnected roofs, HSG D
3.8	85	Weighted Average
1.9		50% Pervious Area
1.9		50% Impervious Area
1.1		58% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.2	50	0.0800	0.26		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.2"
7.0	207	0.0050	0.49		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	49	0.1220	7.09		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	142	0.0140	7.36	9.03	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
0.2	82	0.0120	6.81	8.36	**Pipe Channel,** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
1.0	65	0.0460	1.07		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.8	595	Total			

Summary for Subcatchment S-2: Subcatchment - 2

Runoff = 9.1 cfs @ 12.00 hrs, Volume= 0.5 af, Depth= 4.8"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-year Rainfall=7.8"

Area (ac)	CN	Description
0.1	30	Woods, Good, HSG A
0.6	61	>75% Grass cover, Good, HSG B
0.5	98	Unconnected roofs, HSG B
1.2	74	Weighted Average
0.7		58% Pervious Area
0.5		42% Impervious Area
0.5		100% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.5	30	0.4000	0.20		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.2"
4.1	20	0.0500	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.2"
1.8	170	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
8.4	220	Total			

Summary for Pond 1P: Surface Infiltration Basin

Inflow Area = 1.2 ac, 42% Impervious, Inflow Depth = 4.0" for 100-year event
Inflow = 8.3 cfs @ 12.03 hrs, Volume= 0.4 af
Outflow = 7.1 cfs @ 12.10 hrs, Volume= 0.4 af, Atten= 15%, Lag= 4.4 min
Discarded = 0.1 cfs @ 12.11 hrs, Volume= 0.1 af
Primary = 7.0 cfs @ 12.10 hrs, Volume= 0.3 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 266.91' @ 12.11 hrs Surf.Area= 2,810 sf Storage= 3,889 cf

Plug-Flow detention time= 65.6 min calculated for 0.4 af (100% of inflow)
Center-of-Mass det. time= 65.9 min (877.8 - 811.9)

Volume	Invert	Avail.Storage	Storage Description
#1	264.80'	8,096 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
264.80	1,000	0	0
265.00	1,160	216	216
266.00	1,900	1,530	1,746
267.00	2,900	2,400	4,146
268.00	5,000	3,950	8,096

Device	Routing	Invert	Outlet Devices
#1	Primary	266.80'	**20.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	265.50'	**15.0" Round Culvert** L= 18.0' Ke= 0.500

Inlet / Outlet Invert= 265.50' / 265.00' S= 0.0278 '/' Cc= 0.900
n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.23 sf
#3 Discarded 264.80' **1.020 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.1 cfs @ 12.11 hrs HW=266.90' (Free Discharge)
└**3=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=6.9 cfs @ 12.10 hrs HW=266.90' (Free Discharge)
├**1=Broad-Crested Rectangular Weir** (Weir Controls 1.6 cfs @ 0.79 fps)
└**2=Culvert** (Inlet Controls 5.2 cfs @ 4.25 fps)

Summary for Pond 2P: French Drain

Inflow Area = 1.2 ac, 42% Impervious, Inflow Depth = 4.8" for 100-year event
Inflow = 9.1 cfs @ 12.00 hrs, Volume= 0.5 af
Outflow = 8.4 cfs @ 12.03 hrs, Volume= 0.5 af, Atten= 8%, Lag= 2.1 min
Discarded = 0.0 cfs @ 8.80 hrs, Volume= 0.1 af
Primary = 8.3 cfs @ 12.03 hrs, Volume= 0.4 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 267.46' @ 12.03 hrs Surf.Area= 1,750 sf Storage= 2,605 cf

Plug-Flow detention time= 42.4 min calculated for 0.5 af (100% of inflow)
Center-of-Mass det. time= 42.3 min (858.7 - 816.4)

Volume	Invert	Avail.Storage	Storage Description
#1	264.50'	2,097 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 6,125 cf Overall - 884 cf Embedded = 5,241 cf x 40.0% Voids
#2	265.50'	884 cf	**18.0" Round Pipe Storage** Inside #1 L= 500.0'
		2,980 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
264.50	1,750	0	0
268.00	1,750	6,125	6,125

Device	Routing	Invert	Outlet Devices
#1	Primary	265.50'	**18.0" Round Culvert** L= 20.0' Ke= 0.500 Inlet / Outlet Invert= 265.50' / 265.40' S= 0.0050 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf
#2	Discarded	264.50'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.0 cfs @ 8.80 hrs HW=264.54' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=8.1 cfs @ 12.03 hrs HW=267.42' (Free Discharge)
└**1=Culvert** (Barrel Controls 8.1 cfs @ 4.66 fps)

Summary for Link DP-1: Existing Wetland System

Inflow Area =	5.0 ac,	48% Impervious,	Inflow Depth =	5.4"	for 100-year event
Inflow =	36.0 cfs @	12.04 hrs,	Volume=	2.3 af	
Primary =	36.0 cfs @	12.04 hrs,	Volume=	2.3 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Rainfall Depths

NOAA Atlas 14, Volume 10, Version 3
Location name: Northborough, Massachusetts, USA*
Latitude: 42.3521°, Longitude: -71.6308°
Elevation: 263.05 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.347 (0.266-0.443)	0.409 (0.313-0.523)	0.511 (0.390-0.655)	0.595 (0.451-0.767)	0.711 (0.523-0.956)	0.799 (0.577-1.10)	0.889 (0.625-1.26)	0.987 (0.662-1.44)	1.13 (0.728-1.70)	1.24 (0.782-1.91)
10-min	0.492 (0.377-0.628)	0.580 (0.444-0.741)	0.724 (0.553-0.929)	0.843 (0.640-1.09)	1.01 (0.741-1.35)	1.13 (0.818-1.55)	1.26 (0.885-1.79)	1.40 (0.939-2.05)	1.59 (1.03-2.41)	1.75 (1.11-2.71)
15-min	0.578 (0.443-0.739)	0.682 (0.522-0.872)	0.851 (0.649-1.09)	0.991 (0.752-1.28)	1.18 (0.872-1.59)	1.33 (0.961-1.83)	1.48 (1.04-2.11)	1.65 (1.10-2.41)	1.88 (1.21-2.84)	2.06 (1.30-3.18)
30-min	0.781 (0.599-0.998)	0.922 (0.706-1.18)	1.15 (0.879-1.48)	1.34 (1.02-1.73)	1.61 (1.18-2.16)	1.80 (1.30-2.48)	2.01 (1.41-2.86)	2.23 (1.50-3.27)	2.55 (1.65-3.86)	2.80 (1.77-4.32)
60-min	0.984 (0.754-1.26)	1.16 (0.890-1.49)	1.45 (1.11-1.86)	1.69 (1.29-2.18)	2.03 (1.49-2.73)	2.28 (1.65-3.13)	2.54 (1.78-3.61)	2.82 (1.89-4.12)	3.22 (2.08-4.87)	3.53 (2.24-5.46)
2-hr	1.23 (0.946-1.56)	1.47 (1.13-1.87)	1.87 (1.44-2.39)	2.20 (1.69-2.83)	2.66 (1.98-3.57)	3.01 (2.19-4.12)	3.37 (2.39-4.80)	3.79 (2.55-5.50)	4.40 (2.86-6.62)	4.91 (3.12-7.54)
3-hr	1.40 (1.09-1.77)	1.69 (1.31-2.14)	2.17 (1.68-2.76)	2.57 (1.97-3.28)	3.11 (2.32-4.16)	3.52 (2.58-4.82)	3.95 (2.82-5.63)	4.46 (3.01-6.46)	5.22 (3.39-7.83)	5.86 (3.73-8.96)
6-hr	1.79 (1.40-2.25)	2.17 (1.69-2.73)	2.79 (2.17-3.53)	3.31 (2.56-4.20)	4.02 (3.02-5.35)	4.55 (3.36-6.20)	5.12 (3.68-7.26)	5.79 (3.92-8.33)	6.81 (4.44-10.1)	7.67 (4.89-11.6)
12-hr	2.28 (1.80-2.85)	2.76 (2.17-3.45)	3.54 (2.78-4.45)	4.19 (3.27-5.29)	5.09 (3.85-6.73)	5.75 (4.27-7.78)	6.47 (4.68-9.10)	7.31 (4.97-10.4)	8.57 (5.61-12.7)	9.64 (6.17-14.5)
24-hr	2.71 (2.15-3.36)	3.30 (2.61-4.09)	4.25 (3.36-5.30)	5.04 (3.96-6.32)	6.14 (4.67-8.06)	6.95 (5.19-9.34)	7.82 (5.69-10.9)	8.86 (6.05-12.6)	10.4 (6.86-15.3)	11.8 (7.56-17.6)
2-day	2.99 (2.39-3.69)	3.68 (2.94-4.55)	4.81 (3.83-5.96)	5.75 (4.54-7.16)	7.04 (5.40-9.21)	7.98 (6.02-10.7)	9.02 (6.63-12.6)	10.3 (7.06-14.5)	12.3 (8.08-17.9)	14.0 (9.00-20.8)
3-day	3.24 (2.60-3.97)	3.98 (3.19-4.89)	5.19 (4.14-6.40)	6.20 (4.92-7.69)	7.58 (5.84-9.89)	8.60 (6.50-11.5)	9.72 (7.17-13.5)	11.1 (7.62-15.6)	13.2 (8.74-19.2)	15.1 (9.72-22.3)
4-day	3.47 (2.80-4.25)	4.25 (3.42-5.21)	5.52 (4.42-6.79)	6.57 (5.23-8.12)	8.02 (6.19-10.4)	9.08 (6.88-12.1)	10.2 (7.57-14.2)	11.7 (8.04-16.3)	13.9 (9.18-20.1)	15.8 (10.2-23.3)
7-day	4.16 (3.37-5.07)	5.00 (4.04-6.10)	6.36 (5.13-7.79)	7.49 (6.00-9.22)	9.05 (7.02-11.7)	10.2 (7.76-13.5)	11.5 (8.46-15.7)	13.0 (8.96-18.0)	15.2 (10.1-21.9)	17.1 (11.1-25.1)
10-day	4.84 (3.94-5.88)	5.71 (4.64-6.94)	7.13 (5.77-8.70)	8.31 (6.69-10.2)	9.94 (7.73-12.7)	11.1 (8.48-14.6)	12.4 (9.18-16.9)	13.9 (9.67-19.3)	16.2 (10.8-23.1)	18.0 (11.7-26.3)
20-day	6.90 (5.66-8.32)	7.83 (6.41-9.46)	9.36 (7.63-11.3)	10.6 (8.61-12.9)	12.4 (9.66-15.6)	13.7 (10.4-17.7)	15.0 (11.1-20.1)	16.5 (11.5-22.6)	18.5 (12.4-26.3)	20.1 (13.1-29.1)
30-day	8.61 (7.09-10.4)	9.59 (7.89-11.5)	11.2 (9.16-13.5)	12.5 (10.2-15.2)	14.3 (11.2-18.0)	15.7 (12.0-20.1)	17.1 (12.6-22.5)	18.5 (13.0-25.2)	20.3 (13.6-28.7)	21.7 (14.1-31.3)
45-day	10.7 (8.88-12.9)	11.8 (9.71-14.1)	13.4 (11.0-16.1)	14.8 (12.1-17.9)	16.7 (13.1-20.8)	18.2 (13.9-23.1)	19.6 (14.4-25.6)	21.0 (14.7-28.5)	22.6 (15.2-31.7)	23.7 (15.5-34.1)
60-day	12.5 (10.4-14.9)	13.6 (11.2-16.2)	15.3 (12.6-18.3)	16.7 (13.7-20.2)	18.7 (14.7-23.2)	20.3 (15.5-25.6)	21.7 (15.9-28.2)	23.0 (16.2-31.1)	24.5 (16.6-34.4)	25.5 (16.7-36.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

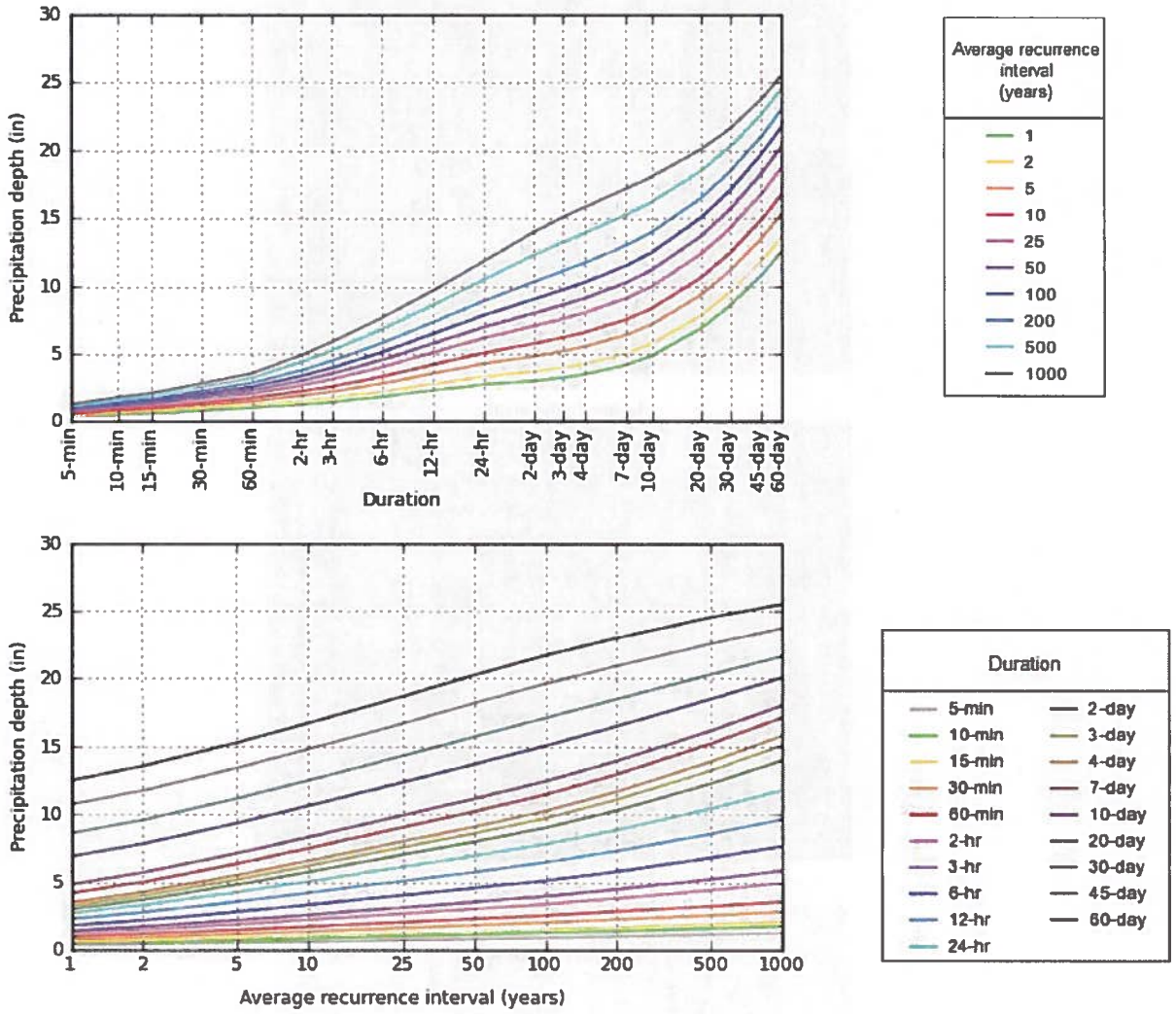
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 42.3521°, Longitude: -71.6308°



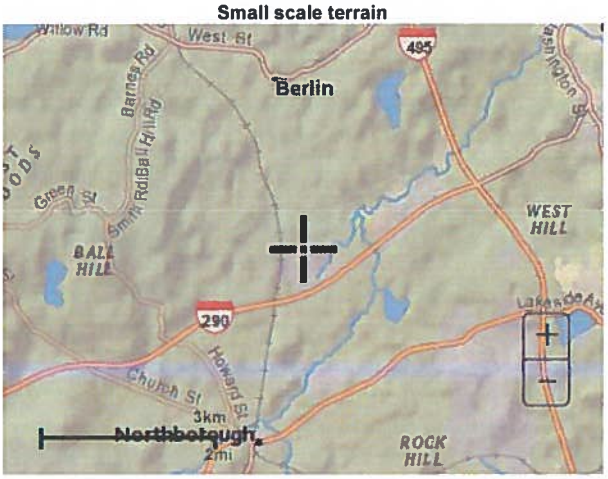
NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Tue Sep 3 13:10:10 2019

Back to Top

Maps & aerials

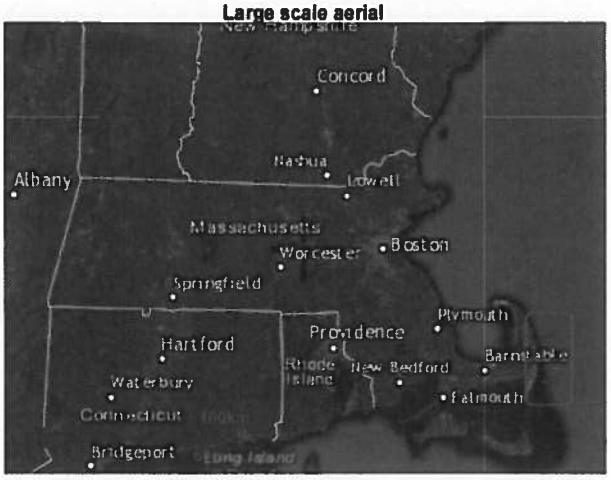
Small scale terrain



Large scale terrain

Large scale map

Large scale aerial



Back to Top

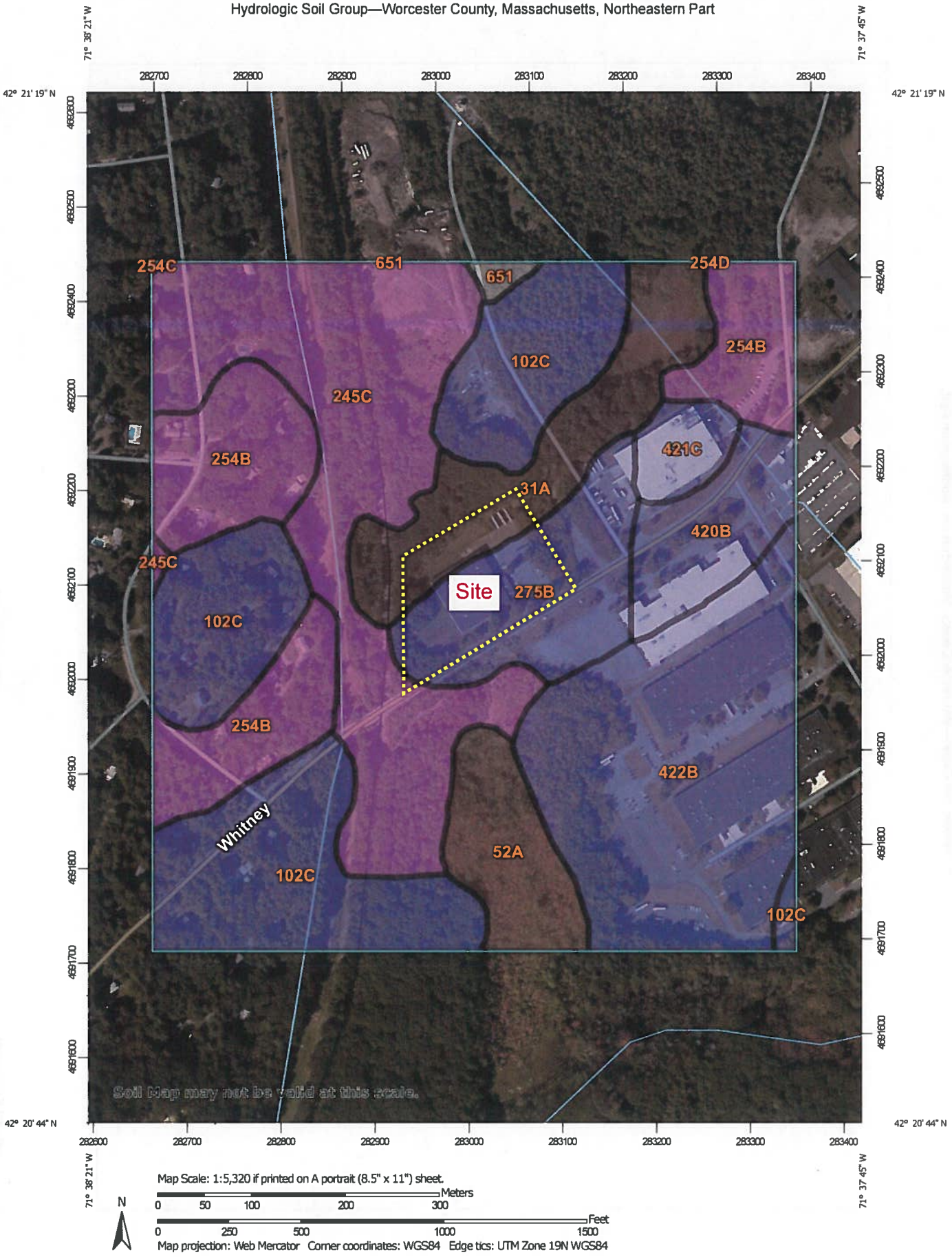
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix C
Standard 3 Computations and Supporting Information

- NRCS Soils Map
- Soil Evaluation and Analysis
- Required and Provided Recharge Volumes with 72-hour Drawdown Analysis

NRCS Soils Map


71° 38' 21" W
71° 37' 45" W
42° 21' 19" N
42° 20' 44" N
282700
282800
282900
283000
283100
283200
283300
283400
4692600
4692500
4692400
4692300
4692200
4692100
4692000
4691900
4691800
4691700
4691600
254C
651
651
254D
254B
102C
245C
254B
421C
31A
420B
245C
Site
275B
102C
254B
422B
Whitney
52A
102C
102C
Soil Map may not be valid at this scale.
Map Scale: 1:5,320 if printed on A portrait (8.5" x 11") sheet.
Meters
0 50 100 200 300
N
Feet
0 250 500 1000 1500
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Worcester County, Massachusetts, Northeastern Part
Survey Area Data: Version 13, Sep 11, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
31A	Walpole sandy loam, 0 to 3 percent slopes	B/D	10.1	8.1%
52A	Freetown muck, 0 to 1 percent slopes	B/D	5.8	4.7%
102C	Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes	B	26.3	21.2%
245C	Hinckley loamy sand, 8 to 15 percent slopes	A	25.1	20.2%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	16.1	13.0%
254C	Merrimac fine sandy loam, 8 to 15 percent slopes	A		
254D	Merrimac fine sandy loam, 15 to 25 percent slopes	A	0.0	0.0%
275B	Agawam fine sandy loam, 3 to 8 percent slopes	B	9.5	7.6%
420B	Canton fine sandy loam, 3 to 8 percent slopes	B	5.7	4.6%
421C	Canton fine sandy loam, 8 to 15 percent slopes, very stony	B	2.3	1.9%
422B	Canton fine sandy loam, 0 to 8 percent slopes, extremely stony	B	22.8	18.3%
651	Udorthents, smoothed		0.5	0.4%
Totals for Area of Interest			**124.2**	**100.0%**

Soil Groups

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Soil Evaluation and Analysis

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: 1 (Hole #) 09/09/19 (Date) _____ (Time) Partly Cloudy (Weather) _____ (Latitude) _____ Longitude:

1. Land Use: _____ (e.g., woodland, agricultural field, vacant lot, etc.) _____ Vegetation _____ Surface Stones (e.g., cobbles, stones, boulders, etc.) _____ Slope (%)

   Description of Location: _____

2. Soil Parent Material: _____ Landform _____ Position on Landscape (SU, SH, BS, FS, TS)

3. Distances from: Open Water Body _____ feet; Drainage Way _____ feet; Wetlands _____ feet; Property Line _____ feet; Drinking Water Well _____ feet; Other _____ feet

4. Unsuitable Materials Present: ☐ Yes ☐ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☑ Yes ☐ No If yes: 7 Depth Weeping from Pit 8.5 Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
2"-0"	O										
0"-14"	Ap										
14"-30"	Bw	Loamy Sand	2.5Y 5/4				5%	0	Granular	V. Friable	Strayations of 7.5 YR 5/8
30"-10'	C	Sandy Loam	2.5Y 5/4				0	0	Blocky	Friable	Strayations of 7.5 YR 5/8

Additional Notes: Smearing in silty layer. Very Moist @ 7' Depth Hole caved in @ that elevation. Standing water in Hole @ 8.5' depth after ~60min.

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: 2 (Hole #) ____ (Date) ____ (Time) ____ (Weather) ____ (Latitude) ____ (Longitude:)

1. Land Use: ____ (e.g., woodland, agricultural field, vacant lot, etc.) ____ Vegetation ____ Surface Stones (e.g., cobbles, stones, boulders, etc.) ____ Slope (%)

   Description of Location: ____

2. Soil Parent Material: ____ Landform ____ Position on Landscape (SU, SH, BS, FS, TS)

3. Distances from: Open Water Body ____ feet; Drainage Way ____ feet; Wetlands ____ feet; Property Line ____ feet; Drinking Water Well ____ feet; Other ____ feet

4. Unsuitable Materials Present: ☐ Yes ☐ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☑ Yes ☐ No If yes: 7.5 Depth Weeping from Pit 9 Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
2"-0"	A										
0"-15"	A										
15"-45"	B	Sandy loam	10YR 5/4				0	0	Granular	V. Friable	Many roots
45"-126"	C	Sandy loam	2.5Y 5/1				0	0	Blocky	Friable	Stayations of 7.5YR 5/8

Additional Notes: Very moist soil layer @ 7.5', Hole caving in at that point water appearing gradually in bottom of Hole. 9' to standing @ ~40 min.

101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

Frimpter Method Calculation
High Ground-Water Levels in Massachusetts

Name: Steris
425 Whitney Street
Location: Northborough, MA

Proj. No.: **14500.00**
Date: **9/5/2019**
Computed by: **DJM**
Checked by: **VHB**

USGS Well Location:	**Boylston, MA**
USGS Well ID:	MA-WSW 26
Land Surface Elevation:	485 ft
Well Depth:	16.8 ft
Topographic Setting:	Hillside
Lithology:	Sand
Data:	Start of Record, 1995
Date:	Data taken Sep 04, 2019

Sh=Sc - (Sr/OWr)(OWc - OWmax)

	Sh	Estimated depth to probable high groundwater at the site
(see below)	**Sc**	Measured depth to water at the site
8.62	**OWc**	Measured depth to water level in observation well used to correlate with the water levels at the site
1.19	**OWmax**	Depth to recorded maximum water level at the observation well which is used to correlate with the water levels at the site.
95th % 2.5	**Sr**	Range of water level where the site is located
10.18	**OWr**	Recorded upper limit of annual range of water level at the observation well used to correlate with the water levels at the site.

	Measured			Estimated		
Test Pit	**Ground Elevation**	**(Sc) Depth of Water from Ground Surface* (ft)**	**Water Elevation**	**Groundwater Correction Factor (ft)**	**Depth to Probable High Groundwater (ft)**	**Probable High Groundwater Elevation**
Surface Basin #1						
TP-1	265	7	258.0	1.82	5.18	259.8
TP-2	265.3	7.5	257.8	1.82	5.68	259.6

Required and Provided Recharge Volumes with 72-hour Drawdown Analysis

Recharge Calculations

Project Name: Facility Expansion
Proj. No.: 14500.00
Date: September 2019
Project Location: Northborough, MA
Calculated by: BMG

Proposed Impervious Surface Summary

Net New Proposed Impervious Areas by Hydrologic Soil Group (HSG) in acres

Subcatchment	HSG A	HSG B	HSG C	HSG D	Total Area
S-2		0.50			0.50
TOTAL	**0.00**	**0.50**	**0.00**	**0.00**	**0.50**

Required Recharge Volume (Cubic Feet)

HSG	Area (acres)	Recharge Depth* (in.)	Volume (c.f.)
A	0.0	0.60	0
B	0.5	0.35	635
C	0.0	0.25	0
D	0.0	0.10	0
TOTAL			**635**

Assumptions:

* Massachusetts DEP Infiltration requirement: HSG A = 0.60 in; HSG B = 0.35 in; HSG C = 0.25 in; HSG D = 0.10 in.

Capture Area Adjustment

Required Recharge Volume	635	c.f.
Total Site Net New Impervious Area	0.50	acres
Total Site Net New Impervious Area Draining to Recharge Facilities	0.50	acres
Capture Area Adjustment Factor	1.00	-
Adjusted Required Recharge Volume:	**635**	**c.f.**

Provided Recharge Volume (Cubic Feet) and Drawdown Times

POND P-1

Pond P-1 (Recharge Volume and Drawdown Time)
Infiltration Volumes Provided in Basin below Outlet Pipe at invert elevation 265.5

Basin Volume Below Overflow Weir

Elevation	Area (s.f.)	Incremental Volume (c.f.)	Cumulative Volume (c.f.)	Drawdown (hours)
265.00	1,160	0	0	-
265.50	1,530	673	673	7
TOTAL			**673**	**7**

Assumptions:
Recharge Rate: 1.02 in/hr 99 cf/hr

Total Drawdown Time: **7 hours**

Total Recharge Volume: **673 c.f.**

POND P-2

Pond P-2 (Recharge Volume and Drawdown Time)
Infiltration Volumes Provided in French Drain below Overflow Pipe at elevation 266.0

Basin Volume Below Overflow Weir

Elevation	Area (s.f.)	Incremental Volume (c.f.)	Cumulative Volume (c.f.)	Drawdown (hours)
265.00	1,500	0	0	-
266.00	1,500	1,500	1500	15
TOTAL			1,500	**15**
Cumulative Volume within Stone @ 40% Void Ratio:			**600**	

Assumptions:
Recharge Rate: 1.02 in/hr 128 cf/hr

Total Drawdown Time: **15 hours**

Total Recharge Volume: **600 c.f.**

Recharge Volume Summary

Basin	Volume
Pond P-1 Recharge Provided:	673 c.f.
Pond P-2 Recharge Provided:	600 c.f.
Total Recharge Volume Provided:	**1,273 c.f.**

Adjusted Required Recharge Volume: **635 c.f.**

Appendix D
Standard 4 Computations and Supporting Information

- Long-Term Pollution Prevention Plan
- Proprietary Water Quality Unit Sizing Calculations
- Proprietary Water Quality Unit TSS Removal Data
- Proprietary Water Quality Unit Systems Evaluation
- TSS Removal Worksheets

Long –Term Pollution Prevention Plan

Long-Term Pollution Prevention Plan

This Long-Term Pollution Prevention Plan has been developed to establish site management practices that improve the quality of stormwater discharges from the Project.

Description of Pollutant Sources

Potential pollutant sources for the Project include the employee vehicle parking area, the loading dock area, and the dumpster pad.

Pollutant Control Approach

Maintenance of Pavement Systems

Standard Asphalt Pavement

Regular maintenance of pavement surfaces will prevent pollutants such as oil and grease, trash, and sediments from entering the stormwater management system. The following practices should be performed:

- Sweep or vacuum asphalt pavement areas quarterly with a commercial cleaning unit and dispose of removed material.
- Check loading docks and dumpster areas frequently for spillage and/or pavement staining and clean as necessary
- Routinely pick up and remove litter from the parking areas, islands, and perimeter landscaping.

Maintenance of Vegetated Areas

Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

- Inspect planted areas on a semi-annual basis and remove any litter.
- Maintain planted areas adjacent to pavement to prevent soil washout.
- Immediately clean any soil deposited on pavement.

- Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming. Maintain a vegetation cover of at least 75%.
- Plant alternative mixture of grass species in the event of unsuccessful establishment.
- The grass vegetation should be cut to a height between three and four inches.
- Pesticide/Herbicide Usage – No pesticides are to be used unless a single spot treatment is required for a specific control application.
- Fertilizer usage should be avoided. If deemed necessary, slow release fertilizer should be used in accordance with all manufacturer's instructions. Fertilizer may be used to begin the establishment of vegetation in bare or damaged areas, but should not be applied on a regular basis unless necessary.

Management of Snow and Ice

Storage and Disposal

Snow shall be stockpiled on standard pavement surfaces so sand and salt may be swept in the spring or removed as snow melts and drains through the stormwater management system. Key practices for the safe storage and disposal of snow include:

- Under no circumstances shall snow be disposed or stored within 25' of any wetland resource areas.
- Under no circumstances shall snow be disposed or stored in stormwater basins, swales, or bioretention areas.
- Abrasives such as sand or grit shall be applied only as necessary.

Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site-specific conditions.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials

Spill Prevention and Response Plan

Spill prevention Response Plan will be provided by the owner.

Stormwater Operation and Maintenance Plan

Project Information

Owner

STERIS A.S.T.
425 Whitney Street
Northborough, MA 01532

Site Supervisor

Name: _____

Telephone: _____

Cell phone: _____

Email: _____

Description of Stormwater Maintenance Measures

The following Operation and Maintenance (O&M) program is proposed to ensure the continued effectiveness of the stormwater management system. Attached to this plan is a Stormwater Best Management Practices Checklist for use during the long term operation and maintenance of the stormwater management system.

Catch Basins

- All catch basins shall be inspected quarterly and cleaned a minimum of at least once per year.
- Sediment (if more than six inches deep) and/or floatable pollutants shall be pumped from the basin and disposed of at an approved offsite facility in accordance with all applicable regulations.
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary
- During colder periods, the catch basin grates must be kept free of snow and ice.
- During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

Structural Water Quality Devices

- Inspect devices monthly for the first three months after construction.
- After initial three month period, all water quality units are to be inspected at least four times per year and cleaned a minimum of at least once per year or when sediment reaches 75% of storage capacity in the isolated sump or when hydrocarbons and trash have accumulated (per manufacturer recommendations).
- Follow manufacturer instructions for inspection and cleaning and contact manufacturer if system is malfunctioning. Specifications and instructions for cleaning the CDS 2015-4 device are provided as an attachment to this section.

Stormwater Outfalls

- Inspect outfall locations monthly for the first three months after construction to ensure proper functioning and correct any areas that have settled or experienced washouts.
- Inspect outfalls annually after initial three month period.
- Annual inspections should be supplemented after large storms, when washouts may occur.
- Maintain vegetation around outfalls to prevent blockages at the outfall.
- Maintain rip rap pad below each outfall and replace any washouts.

- Remove and dispose of any trash or debris at the outfall.

Roof Drain Leaders

- Perform routine roof inspections quarterly.
- Keep roofs clean and free of debris.
- Keep roof drainage systems clear.
- Keep roof access limited to authorized personnel.

Infiltration Basins

- Basins should be inspected after every major storm for the first few months to ensure proper stabilization and function.
- The grass on the side slopes and in the buffer areas should be mowed, and grass clippings, organic matter, and accumulated trash and debris removed, at least twice during the growing season.
- Eroded or barren spots should be reseeded immediately after inspection to prevent additional erosion and accumulation of sediment.
- Sediment should be removed from the basin as necessary. Removal procedures should not take place until the floor of the basin is thoroughly dry.

Inspections and Cleaning

- Basins should be inspected at least twice a year to ensure proper stabilization and function.
- Light equipment which will not compact the underlying soils should be used to remove accumulated sediment and debris.
- The inflow location should be inspected annually for clogging.
- The outlet control structure and overflow swale should be inspected annually to ensure that they are functioning.
- Side slopes should be inspected annually for erosion of the side slopes.

French Drain

- Inspect and remove debris every six months and after ever major storm.
- Remove sediment accumulation every six months and after every major storm.

Facility Expansion Project, Northborough, Massachusetts
Long Term Best Management Practices – Maintenance/ Evaluation Checklist

Best Management Practice	Inspection Frequency (unless otherwise stated in Order of Conditions)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐yes ☐no (List Items)	Date of Cleaning/Repair	Performed by
Street Sweeping	N/A			• Complete four times per year			
Deep Sump and Hooded Catch basins	Quarterly			• Inspect for and remove accumulated sand, sediment & floatables • Clean at least once per year • Inlets free of debris, snow and ice	☐yes ☐no		
CDS 2015-4 Water Quality Device	Every month (for first 3 months) & Quarterly			• Clean at a minimum of once per year or when sediment reaches 75% of storage capacity in the isolated sump or when hydrocarbons and trash have accumulated (per manufacturer recommendations)	☐yes ☐no		
Stormwater Outfalls	Every month (for first 3 months) & Annually			• Ensure proper functioning and correct any areas that have settled or experienced washouts • Remove vegetation around outfalls to prevent blockages • Maintain rip rap pad below each outfall and replace any washouts • Remove and dispose of any trash or debris at the outfall	☐yes ☐no		
Roof Drain Leaders	Quarterly			• Keep roofs clean and free of debris • Keep roof drainage systems clear	☐yes ☐no		
Infiltration Basin	After every major storm (for first 3 months) & Twice Annually			• Inspect for and remove accumulated sediment • Erosion of side slopes • Inlets/Outlets free of debris	☐yes ☐no		
French Drain	After every major storm & Twice Annually			• Inspect for and remove debris • Remove accumulated sediment	☐yes ☐no		

Notes on Stormwater / Drainage Issues:

____

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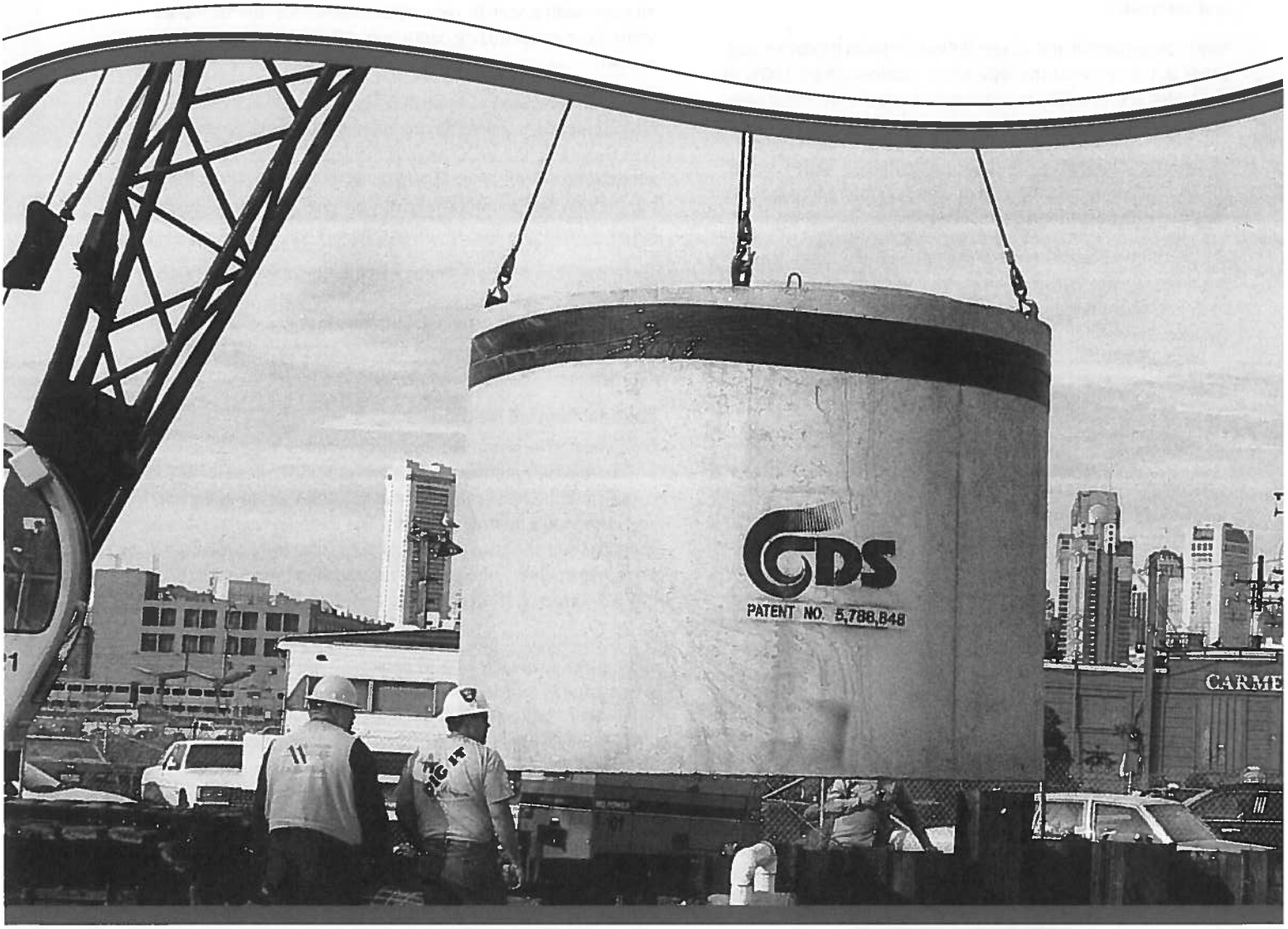
____

____

Stormwater Control Manager ______________________________

CONTECH®
ENGINEERED SOLUTIONS

CDS Guide
Operation, Design, Performance and Maintenance



CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

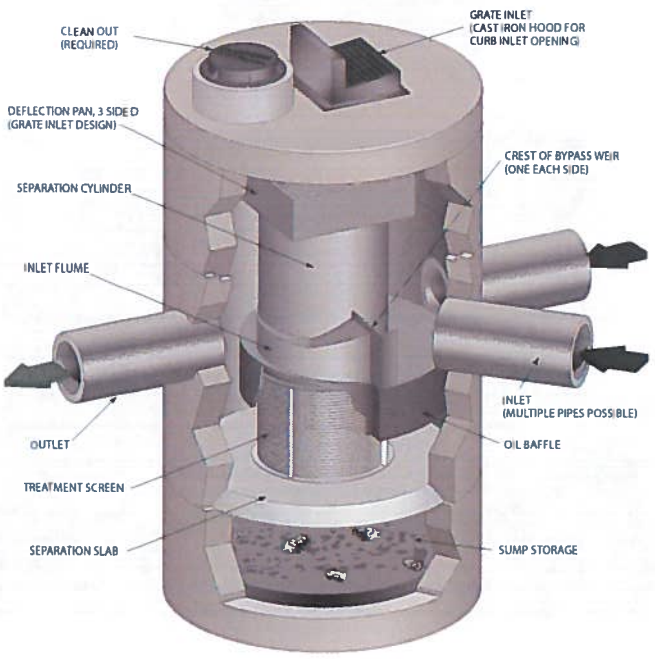
Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.



Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are

determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

Performance

Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 μm) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 μm) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

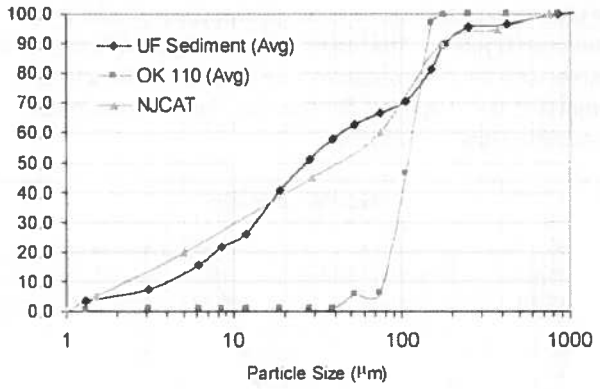


Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect

to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

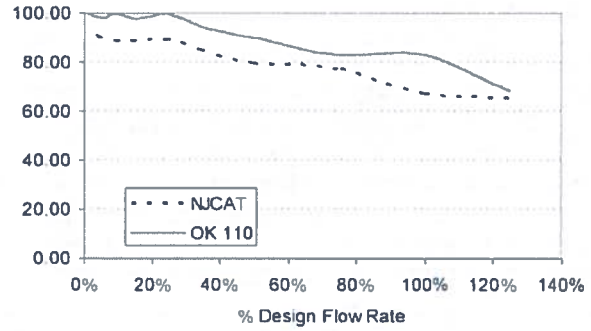


Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 μm).

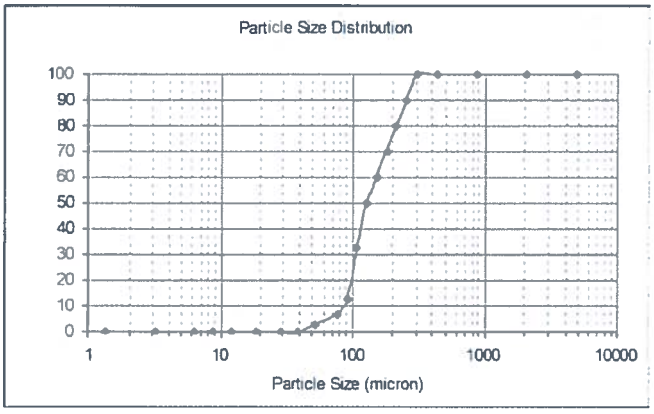


Figure 3. WASDOE PSD

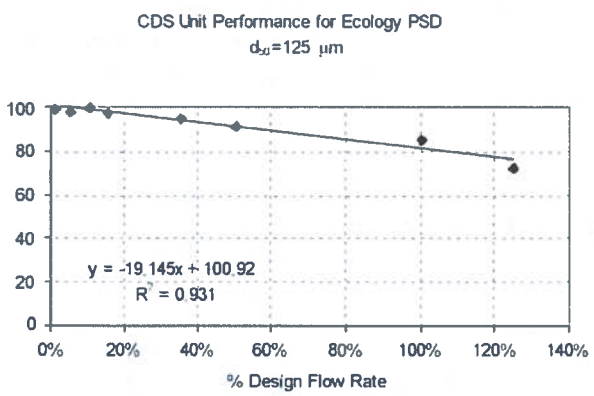


Figure 4. Modeled performance for WASDOE PSD.

Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified

during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

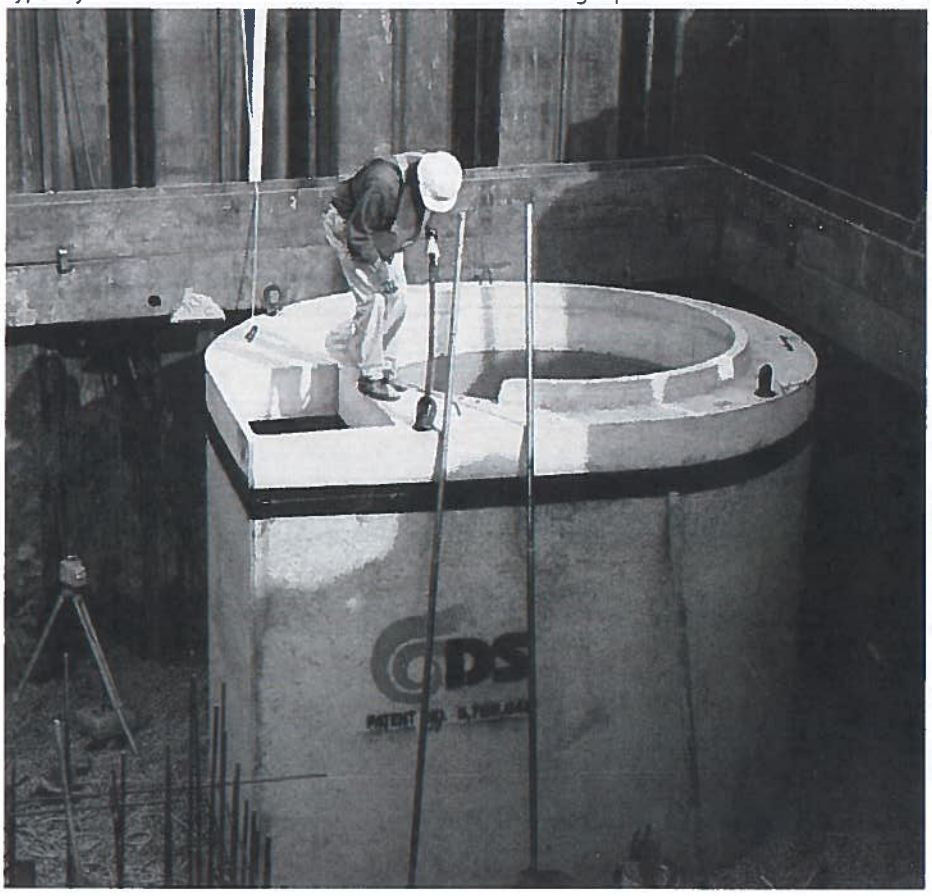
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

CDS Model	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y^3	m^3
CDS1515	3	0.9	3.0	0.9	0.5	0.4
CDS2015	4	1.2	3.0	0.9	0.9	0.7
CDS2015	5	1.5	3.0	0.9	1.3	1.0
CDS2020	5	1.5	3.5	1.1	1.3	1.0
CDS2025	5	1.5	4.0	1.2	1.3	1.0
CDS3020	6	1.8	4.0	1.2	2.1	1.6
CDS3025	6	1.8	4.0	1.2	2.1	1.6
CDS3030	6	1.8	4.6	1.4	2.1	1.6
CDS3035	6	1.8	5.0	1.5	2.1	1.6
CDS4030	8	2.4	4.6	1.4	5.6	4.3
CDS4040	8	2.4	5.7	1.7	5.6	4.3
CDS4045	8	2.4	6.2	1.9	5.6	4.3
CDS5640	10	3.0	6.3	1.9	8.7	6.7
CDS5653	10	3.0	7.7	2.3	8.7	6.7
CDS5668	10	3.0	9.3	2.8	8.7	6.7
CDS5678	10	3.0	10.3	3.1	8.7	6.7

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



CDS Inspection & Maintenance Log

CDS Model: _____ Location: _____

Date	Water depth to sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.**

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.

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800-338-1122
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Contech Engineered Solutions provides site solutions for the civil engineering industry. Contech's portfolio includes bridges, drainage, sanitary sewer, earth stabilization and stormwater treatment products. For information on other Contech division offerings, visit www.ContechES.com or call 800.338.1122

The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266; related foreign patents or other patents pending.

cds_manual 3/17 PDF

RECYCLED PAPER

Proprietary Water Quality Unit Sizing Calculations

Project:	**Facility Expansion**
Location:	**Northborough, MA**
Prepared For:	**VHB / Brittany Gesner**

CONTECH ENGINEERED SOLUTIONS

Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Procedure: Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

Compute Q Rate using the following equation:

$$Q = (qu)\ (A)\ (WQV)$$

where:

Q = flow rate associated with first 1" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1" in this case)

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
WQU #1	1.00	0.0015625	5.0	0.083	1.00	795.00	1.24

Proprietary Water Quality Unit TSS Removal Data

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION BASED ON THE RATIONAL RAINFALL METHOD

FACILITY EXPANSION
NORTHBOROUGH, MA

Area	1.00 ac	Unit Site Designation	WQU #1
Weighted C	0.9	Rainfall Station #	70
t_c	5 min		
CDS Model	2015-4	CDS Treatment Capacity	1.4 cfs

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.04	15.1%	15.1%	0.04	0.04	14.5
0.08	24.6%	39.7%	0.07	0.07	23.0
0.12	13.7%	53.4%	0.11	0.11	12.6
0.16	9.4%	62.8%	0.14	0.14	8.5
0.20	6.6%	69.5%	0.18	0.18	5.9
0.24	5.2%	74.7%	0.22	0.22	4.5
0.28	4.8%	79.5%	0.25	0.25	4.1
0.32	3.1%	82.6%	0.29	0.29	2.6
0.36	2.7%	85.3%	0.32	0.32	2.2
0.40	2.1%	87.4%	0.36	0.36	1.7
0.48	2.5%	89.9%	0.43	0.43	1.9
0.56	2.0%	91.9%	0.50	0.50	1.5
0.64	1.4%	93.3%	0.58	0.58	1.0
0.72	1.0%	94.3%	0.65	0.65	0.7
0.80	1.1%	95.4%	0.72	0.72	0.7
1.00	1.6%	97.1%	0.90	0.90	0.9
1.20	0.9%	98.0%	1.08	1.08	0.4
1.40	0.6%	98.6%	1.26	1.26	0.2
1.60	0.5%	99.1%	1.44	1.40	0.1
1.80	0.5%	99.6%	1.62	1.40	0.1
0.00	0.0%	99.6%	0.00	0.00	0.0
					87.0
				Removal Efficiency Adjustment[2] =	0.0%
				Predicted % Annual Rainfall Treated =	99.5%
				Predicted Net Annual Load Removal Efficiency =	**87.0%**

1 - Based on 14 years of 15-minute rainfall data from NCDC Station 2107, East Brimfield Lake, Worcester County, M
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Proprietary Water Quality Unit Systems Evaluation

NJCAT TECHNOLOGY VERIFICATION

ADDENDUM REPORT

HIGH EFFICIENCY CONTINUOUS DEFLECTIVE SEPARATORS

CDS TECHNOLOGIES INC.

DECEMBER 2004

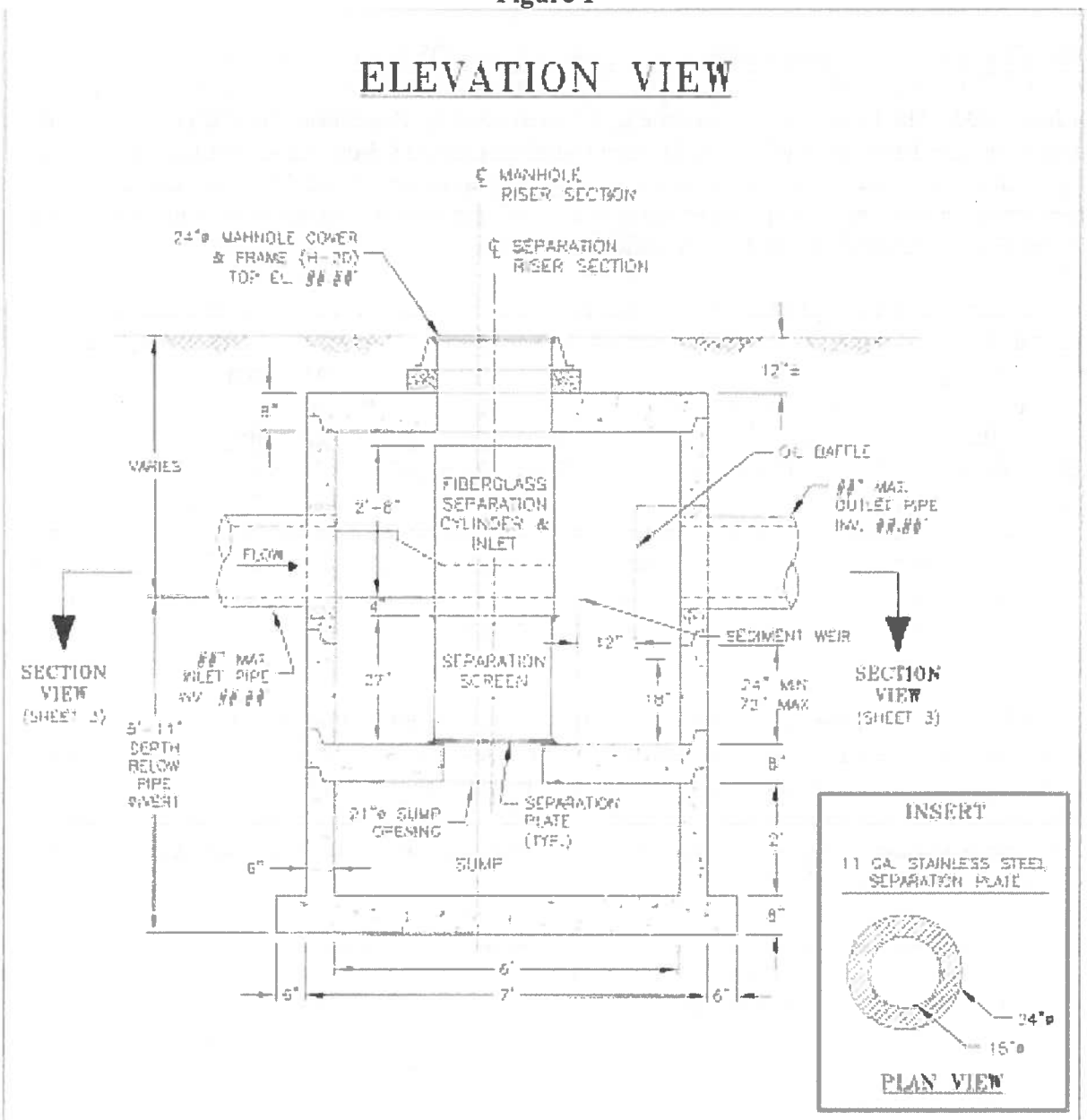
1. Introduction

NJCAT published a Technology Verification Report on CDS Technologies Inc. (CDS Technologies) stormwater treatment technology using the mechanism of continuous deflective separation (CDS) in June 2003. The New Jersey Department of Environmental Protection (NJDEP) considered the sediment particle size distribution (PSD) and influent total suspended solids (TSS) loadings used in the laboratory studies to develop the TSS removal efficiency claims (Claims 3 and 4) not to be relevant to New Jersey stormwater particulate loading conditions and decided that they would not grant interim certification to CDS Technologies based on the NJCAT Verification Report[1].

CDS continues to make product improvements to achieve greater capture of particulates. When the CDS separator maintains good tangential velocity on the screen very little solids of any size get through. It is only when the tangential velocity decreases, or the flow velocity through the screen is substantially higher than the average velocity across the whole screen, that excessive loss of solids occurs. Increasing the ratio of the diameter of the manhole, to that of the screen, prevents short-circuiting from the area of the screen nearest the outlet. This minimizes excessive flow through the screen. Excessive screen velocities are especially detrimental to solids loss when they occur down in the lower part of the screen, where the tangential velocity has deteriorated. Consequently, the oil containment baffle was hurting particle capture efficiency because it forced all of the flow to enter the outlet area at an elevation in the lower third of the screen. Hence baffling to force the flow into the outlet at a higher elevation on the screen helps removal efficiency, because more flow goes through the screen in the upper regions where the tangential velocity is higher.

CDS wishes to retain their oil baffling capability, so they modified their original design to use a double baffle. It looks like a U, with the outer baffle (oil baffle), where the water enters, at an elevation 1/3 down on the screen, and the inner baffle (sediment weir) extending over the height of the separation screen. The diameter of the manhole has also been increased by 1 foot so that there is more separation between the screen and the inlet to the double baffle. CDS units employing this new design are designated High Efficiency Continuous Deflective Separators. CDS, recognizing that New Jersey is developing into a market that requires protection of its water resources through the verified removal of a very fine gradation of particles, will only provide its high efficiency particle removal efficiency CDS screening product in this market. All stormwater units sold in New Jersey will be one of these high efficiency units configured with a sediment weir. A New Jersey specific CDS Technical Manual having plan and profile drawings of commercial high efficiency particle removal CDS units with sedimentation weirs has been developed. Figure 1 shows the double baffle system for CDS Model PMSU20_20_6 (1.1 cfs, 493 gpm).

Figure 1


ELEVATION VIEW
℄ MANHOLE RISER SECTION
24"ø MANHOLE COVER & FRAME (H-20) TOP EL. ##.##
℄ SEPARATION RISER SECTION
12"±
8"
VARIES
OIL BAFFLE
FIBERGLASS SEPARATION CYLINDER & INLET
2'-6"
##" MAX. OUTLET PIPE INV. ##.##
FLOW
SEDIMENT WEIR
SECTION VIEW (SHEET 3)
##" MAX. INLET PIPE INV. ##.##
SEPARATION SCREEN
27"
12"
18"
24" MIN 72" MAX
SECTION VIEW (SHEET 3)
5'-11" DEPTH BELOW PIPE INVERT
8"
21"ø SUMP OPENING
SEPARATION PLATE (TYP.)
SUMP
6"
2'
8"
6'
5"
7'
6"
INSERT
11 GA. STAINLESS STEEL SEPARATION PLATE
34"ø
15"ø
PLAN VIEW
CDS MODEL PMSU20_20_6, 1.1 CFS TREATMENT CAPACITY
STORM WATER TREATMENT UNIT
(RIGHT-HANDED CONFIGURATION)
CDS TECHNOLOGIES
PROJECT NAME
CITY, STATE
JOB# XX-##-###
DATE ##/##/##
DRAWN INITIALS
APPROV
SCALE 1" = 2.5'
SHEET 2
307 N. Bridge Street, Suite 3, Elkton, Maryland 21921 (410) 620-8933 www.cdstech.com

CDS Technologies has submitted a new performance claim for a high efficiency CDS unit based on previously submitted data[2] to NJCAT that more closely matches the PSD and influent loadings contained in the NJDEP Total Suspended Solids Laboratory Testing Procedures[3]. The objective of this Addendum Report is to evaluate this new performance claim based on this previously submitted data.

2. Technical Performance Claim

Claim – A 500 GPM unit (Model PMSU20_20_5) with a 2400 micron screen opening and a reconfigured outlet for best sediment control, operating with an average influent TSS concentration of 184 mg/L and zero initial sediment loading, has been shown to have a total mass TSS removal efficiency of 73.7% (per NJDEP treatment efficiency calculation methodology) for silica sand particles < 100 microns (d_{50} particle size of 63 microns) in laboratory studies using simulated stormwater.

3. Technical System Performance

3.1 Laboratory Study

Background

Portland State University (PSU), in its continuing evaluation of the CDS performance for sediment control, performed extensive testing that was aimed at determining the ability to control sub-100 micron particles[2].

Producing a suitable material to represent the fine particle gradation that needed evaluation was the first challenge. The source of the parent material is the Sil-Co-Sil 106 silica sand produced by the US Silica Company. The material originated at the Ottowa, IL plant. It is specified as a product suitable for BMP testing by the State of Washington, Department of Ecology. The base material used in the PSU testing was developed by repeated washing and decanting of the fines from the parent material to achieve the ultimate test gradation. The resulting sub-100 micron particle size distribution is shown in Table 1. The d_{50} particle size is 63 microns.

Table 1 – Sub-100 Micron Particle Size Distribution

Particle Size Micron (μm)	Percent (%)	Cumulative (%)
< 10	1.5	1.5
10-45	5.25	6.75
45-53	13.3	20.05
53-75	56.55	76.6
75-100	22.4	99.0

The second issue that needed to be managed was to reconfigure the laboratory to facilitate feed rate control, eliminate the need to re-circulate the test water during a discrete test, and reconfigure the CDS outlet for best sediment control. Feed control was achieved through using constant feed peristaltic pumps manufactured by Anko Products, Inc. and a slurry tank that was equipped with a high energy variable speed mixer Model #850 manufactured by Arrow Engineering Company and re-circulating peristaltic pumps to assure the larger (>50-μm) particles would not separate from the mixed solution.

Eliminating the need to re-circulate the water was accomplished by adding five (5) 550-gallon (gal) tanks. This, along with the existing storage in the laboratory created 1650-gal of source water and 1650-gal capacity to hold the CDS effluent (Figure 2). The CDS oil baffle was flipped over to behave as a sediment weir.

Slurry was prepared for each test run. This was done by utilizing the constant feed rate of the peristaltic pumps, coupled with the CDS run flow rate, and batched to hit a 200 milligram per liter (mg/L) sediment loading. The actual feed rate was determined after each run, when the actual CDS flow rate was determined.

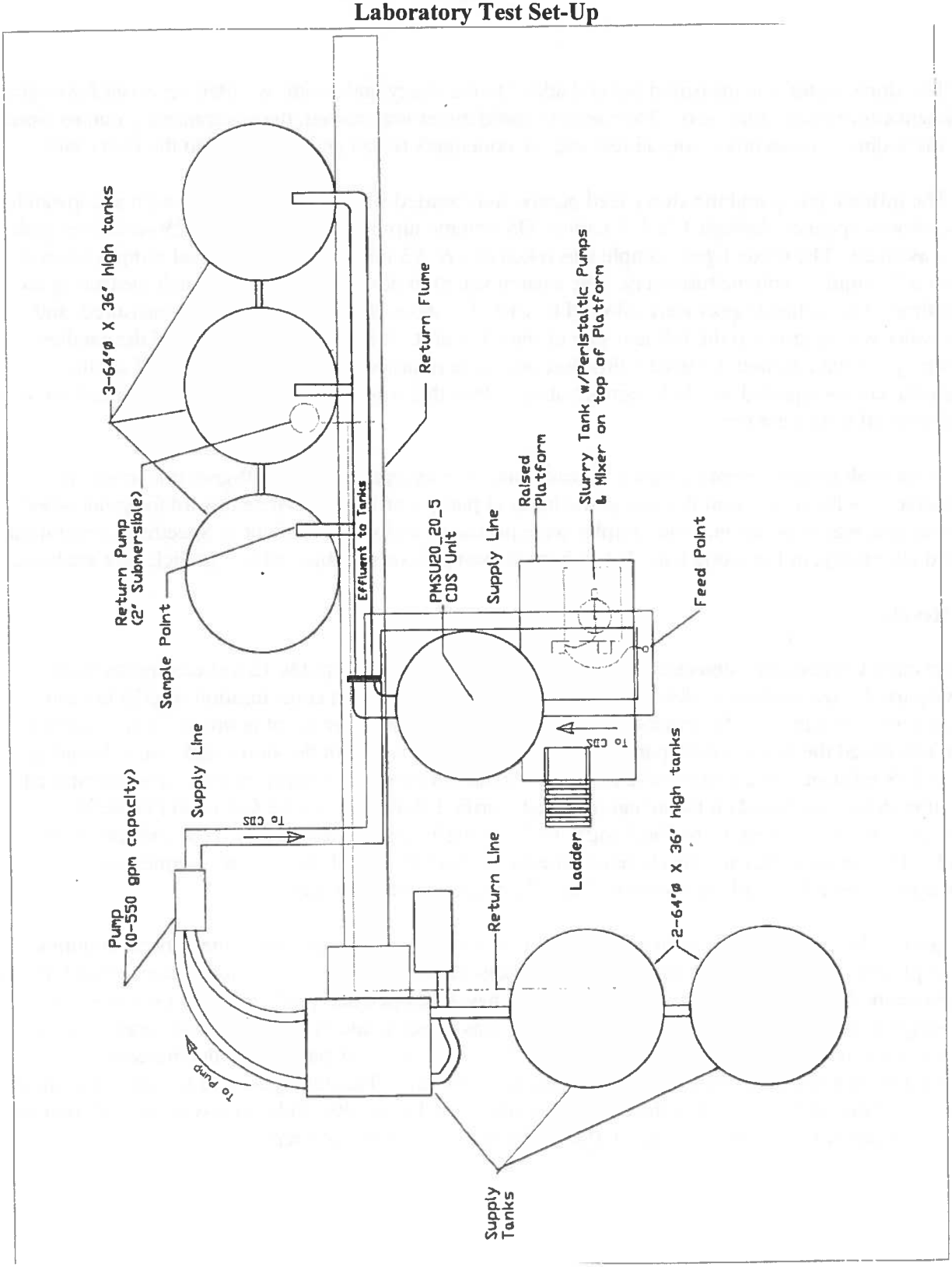
The volume of water and solids required for each run was determined and measured on a triple beam laboratory scale. The dry material was mixed with approximately two liters of water, in two one-liter sample bottles. These were shaken thoroughly and allowed to hydrate until they were used.

Test Procedure

Tests were run for incremental flow rates of about 25 gallon per minute (gpm) or 5% of the CDS unit's capacity to 250-gpm, or 50% of the unit's capacity. In addition, runs were carried out at flow rates of approximately 340-gpm and 500-gpm to establish TSS removal efficiencies at or near the unit's treatment operating capacity.

For each flow rate, the pump was set to the approximate flow using a digital magnetic flow meter. Once this was set, the pump was switched off. Water in the effluent side of the CDS unit was pumped to influent storage using a 75-gpm submersible pump. The depth in the effluent tanks was measured and was used later in the volumetric calculations to determine precise flow rates for each test run.

Figure 2
Laboratory Test Set-Up



The slurry water was measured out and added to the slurry tank, with two liters reserved for rinsing the sediment concentrate containers. The variable speed mixer was started, the re-circulating pumps were started, the sediment concentrate was added, and the containers rinsed and emptied into the slurry tank.

The influent pump and the slurry feed pumps were started simultaneously, along with a stopwatch. The system was operated through 1 & 1/3 active CDS volume turnover before the first 250-milliliter grab sample was taken. The second grab sample was taken at 1 & 2/3 turnover, with the final sample taken at just beyond 2 complete volume turnovers. The system was shut down, with the stopwatch measuring the total run time. The effluent tanks were allowed to settle for about 20-minutes, the depth measured, and then the water was returned to the influent side of the CDS unit. It is possible that some of the smallest particles may not have settled out during this time and were returned to the influent tanks. If so, the removal efficiencies reported would be conservative. Once this was done, the procedure set out above was repeated until all tests were run.

Three grab samples were collected for each run, with exception of the 500-gpm run, where it was only possible to achieve two samples due to the influent pump starting to cavitate toward the point when the third sample was to be taken. The samples were packaged and sent overnight to Spectrex Corporation, a certified laboratory, in Redwood City, CA. where the samples were subjected to a particle size analysis.

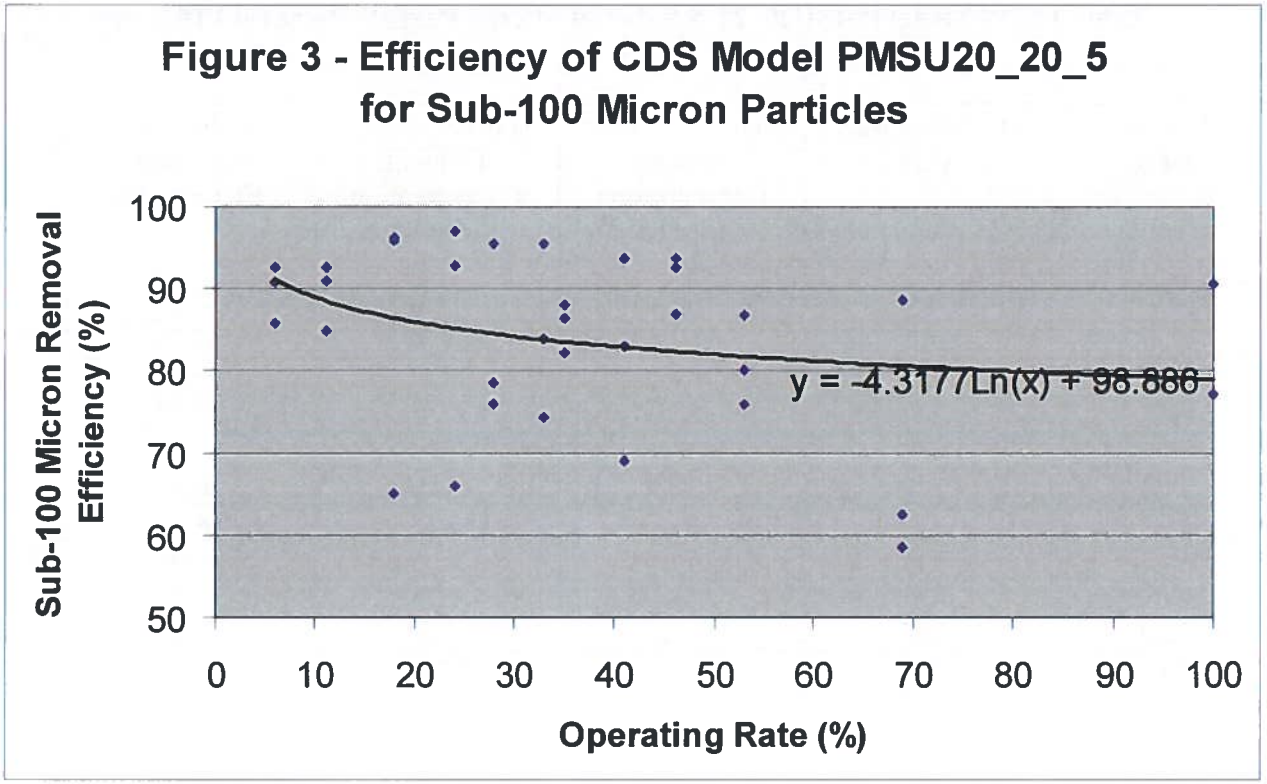
4. Results

Spectrex Corporation subjected the 35 grab samples collected from the 12 test conditions to an extensive particle size analysis to determine the sub-100 micron effluent concentration (mg/L) in each sample as shown in Table 2. (Spectrex first performed a particle number count in one micron increments and then calculated the mass in each particle size range.). The loading in the slurry tank was selected to achieve a TSS influent concentration of 200 mg/L. Actual influent TSS concentrations were determined at the end of each test run based on the actual recorded, verified flow rate into the CDS unit (Table 2). Influent concentrations varied from 160.4 mg/L to 202.9 mg/L, with an average influent concentration of 184 mg/L. The sub-100 micron particle removal efficiencies for each of the 35 grab samples was calculated from these data and are shown in Table 2 and graphically in Figure 3.

Figure 3 shows a wide scatter in the data. This is possibly a consequence of the particle counting method deployed especially for the resulting low effluent concentrations. This is not a science that follows a standard method and each provider of this technique has developed and perfected their processes for determining the results. The method is expensive, but was selected due to its ability to accurately discern the particle sizes in the samples in a timely manner. Moreover, as expected, the results indicate a decreasing TSS removal efficiency with increasing operating rate. The deployment of a sediment control baffle in lieu of the oil baffle used in the earlier Portland State University study improved the TSS removal efficiency substantially over that verified in the earlier NJCAT verification report[1].

Table 2 CDS Model PMSU20_20_5 Sub-100 Micron Particle Removal Efficiency

Flowrate (gpm)	Operating Rate (%)	Sub-100 micron Influent Concentration (mg/L)	Sub-100 micron Effluent Concentration (mg/L)	Sub-100 micron Removal Efficiency (%)
30.7	6	160.4	12.0	92.5
30.7	6	160.4	14.97	90.7
30.7	6	160.4	22.55	85.9
53.7	11	182.9	13.46	92.6
53.7	11	182.9	27.67	84.9
53.7	11	182.9	16.51	91.0
89.6	18	164.7	6.25	96.2
89.6	18	164.7	57.5	65.1
89.6	18	164.7	6.73	95.9
116.9	24	168.4	57.33	66.0
116.9	24	168.4	12.12	92.8
116.9	24	168.4	5.19	96.9
136.8	28	179.9	42.99	76.1
136.8	28	179.9	38.45	78.6
136.8	28	179.9	8.35	95.4
162.1	33	182	8.17	95.5
162.1	33	182	29.41	83.8
162.1	33	182	46.33	74.5
172	35	200	27.27	86.4
172	35	200	35.45	82.3
172	35	200	24.0	88.0
203.8	41	193.1	59.69	69.1
203.8	41	193.1	32.92	83.0
203.8	41	193.1	12.4	93.6
228.4	46	193.8	14.31	92.6
228.4	46	193.8	12.21	93.7
228.4	46	193.8	25.23	87.0
259.1	53	190	25.32	86.7
259.1	53	190	45.72	75.9
259.1	53	190	37.78	80.1
339	69	202.9	84.24	58.5
339	69	202.9	76.14	62.5
339	69	202.9	23.31	88.5
493	100	199.9	19.07	90.5
493	100	199.9	45.82	77.1



The weighting factors contained in the NJDEP Total Suspended Solids Laboratory Procedures[3] document were applied to the test results to generate the weighted average removal efficiency as shown in Table 3. Since no tests were run at flow rates higher than the treatment operating rate, it was decided to give no credit for TSS removal at 125% of the operating rate. This was deemed the most conservative approach.

Table 3 NJDEP Weighted TSS Removal Efficiency for CDS Model PMSU20_20_5

Treatment Operating Rate (%)	NJDEP Weight Factor	CDS TSS Removal Efficiency[1] (%)	NJDEP Weighted Average Removal Efficiency (%)
25	0.25	85.0	21.2
50	0.30	82.0	24.6
75	0.20	80.2	16.0
100	0.15	79.0	11.9
125	0.10	NA	-
Total			**73.7**

[1]Removal Efficiency = -4.3177ln (operating rate) + 98.886

5. Technical Evaluation Analysis

5.1 Verification of Performance Claim

Based on the evaluation of the results from the Portland State University sub-100 micron particle testing studies, sufficient data is available to support the CDS Technologies Claim: A 500 GPM unit (Model PMSU20_20_5) with a 2400 micron screen opening and a reconfigured outlet for best sediment control, operating with an average influent TSS concentration of 184 mg/L and zero initial sediment loading, has been shown to have a total mass TSS removal efficiency of 73.7% (per NJDEP treatment efficiency calculation methodology) for silica sand particles < 100 microns (d_{50} particle size of 63 microns) in laboratory studies using simulated stormwater.

5.2 Limitations

CDS Technologies Inc. offers a range of stormwater treatment systems designed to treat stormwater runoff. Treatment performance requirements vary throughout the country. New Jersey requires protection of its water resources through the verified removal of a fine gradation of particles. CDS Technologies has developed high efficiency continuous deflective separators configured with a sediment weir. These are the only CDS units which are capable of meeting or exceeding the verified performance claim. Since the high efficiency CDS units contain a double baffle and an increased manhole diameter, the commercial high efficiency particle removal CDS units' performance should exceed the performance demonstrated in the reconfigured unit tested at Portland State University. Only high efficiency CDS units should be approved in New Jersey. A New Jersey specific CDS Technical Manual having plan and profile drawings of commercial high efficiency CDS units with sedimentation weirs has been developed exclusively for use in New Jersey.

6. References

1. CDS Technologies, Inc. – NJCAT Technology Verification Report, June 2003.

2. Howard, R. (2003), under the direction of Wells, S.A. and Slominski, S., Continuous Deflective Separation Fine Sediment Control – Study Update, Department of Civil Engineering, Portland State University, Portland, Oregon.

4. Patel, M. (2004) Total Suspended Solids Laboratory Testing Procedures, dated December 23, 2003, New Jersey Department of Environmental Protection, Office of Innovative Technology and Market Development.

TSS Removal Worksheets

TSS Removal Calculation Worksheet

VHB, Inc.,
101 Walnut Street
Post Office Box 9151
Watertown, MA 02471
P 617.924.1770

Project Name:	**Facility Expansion**	Sheet:	**1 of 1**
Project Number:	**14500.00**	Date:	**1-Sep-2019**
Location:	**Northborough, MA**	Computed by:	**BMG**
Discharge Point:	**DP-1**	Checked by:	**REW**
Drainage Area(s):	**S-1**		

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**25%**	**1.00**	**0.25**	**0.75**
Water Quality Unit	**80%**	**0.75**	**0.60**	**0.15**
	0%	**0.15**	**0.00**	**0.15**
	0%	**0.15**	**0.00**	**0.15**
	0%	**0.15**	**0.00**	**0.15**

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1. Removal rates for proprietary devices are from approved studies and/or manufacturer data.

** Equals remaining load from previous BMP (E)

Treatment Train TSS Removal = **85%**

Appendix E
Standard 8 Supporting Information

- List of recommended Construction Period BMPs
- Recommended construction period maintenance checklist

Recommended Construction Period Pollution Prevention and Erosion and Sedimentation Controls

The following erosion and sedimentation controls are for use during the earthwork and construction phases of the project. The following controls are provided as recommendations for the site contractor and do not constitute or replace the final Stormwater Pollution Prevention Plan that must be fully implemented by the Contractor and owner in Compliance with EPA NPDES regulations.

Erosion Control Barriers

Erosion control barriers shall be installed at the downstream edge of the proposed limit of work prior to any on site earth disturbance work and shall be placed in accordance with the Order of Conditions. Erosion control barriers will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. Barriers will be set at least four inches into the existing ground to minimize undercutting by runoff. In areas where high runoff velocities or high sediment loads are expected, erosion control barriers will be backed up with silt fencing. This semi permeable barrier made of a synthetic porous fabric will provide additional protection. The silt fences and erosion control barrier will be replaced as determined by periodic field inspections. No equipment, vehicles, or activity shall be allowed on the wetlands resource side of the barrier.

Catch Basin Protection

Newly constructed catch basins and existing catch basins to remain will be protected with silt sacks throughout construction. During construction catch basins shall be cleaned on an as-needed basis, but in no case less frequently than every six months.

Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

Temporary Sediment Basins

Temporary sediment basins will be designed either as excavations or bermed stormwater detention structures (depending on grading) that will retain runoff for a sufficient period of time to allow suspended soil particles to settle out prior to discharge. These temporary basins will be located based on construction needs as determined by the contractor and outlet devices will be designed to control velocity and sediment. Points of discharge from sediment basins will be stabilized to minimize erosion.

Infiltration Basins

For the long-term function of the infiltration basins, care shall be taken in the areas of the infiltration basins during construction in accordance with the following:

- The infiltration basins shall not be used as a construction sedimentation basin without the prior approval of the engineer.
- Stormwater runoff from exposed surfaces shall be directed away from the infiltration basins.
- Construction equipment, vehicular traffic, parking of vehicles, and stockpiling of construction materials shall be outside of the infiltration basin areas.
- Excavation for construction of the infiltration system shall ensure that the soil at the bottom of the excavation is not compacted or smeared.
- The perimeter of the infiltration basins shall be staked and flagged to prevent the use of the area for activities that might damage the infiltration ability of the system.
- If infiltrations areas are used as temporary sedimentation basins during construction, then the soils shall be excavated a minimum of 2' from the temporary basin bottom to remove clogged soils.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 3:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro seeding or sodding. A suitable topsoil, good seedbed preparation, and adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil to absorb water.

Maintenance

Maintenance of construction period pollution prevention and erosion and sedimentation controls will be detailed in the Stormwater Pollution Prevention Plan (SWPPP) which shall be prepared and submitted to the EPA a minimum of two weeks prior to construction. VHB recommends, at a minimum, that the following maintenance procedures are incorporated into the SWPPP:

- The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan (to be prepared as part of the SWPPP). In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.
- The on-site contractor will inspect all sediment and erosion control structures weekly and after each rainfall event of ½ inch or greater. Records of the inspections will be prepared and maintained on site by the contractor and copies of all weekly reports will be submitted to the Town of Northborough.

- Silt shall be removed from behind barriers if greater than 6 inches deep or as needed.
- Damaged or deteriorated items will be repaired immediately after identification.
- The underside of erosion control barriers bales should be kept in close contact with the earth and reset as necessary.
- Sediment that is collected in structures shall be disposed of properly and covered if stored on site.
- Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be regraded and stabilized as necessary.
- Maintain the construction exit in a condition which will prevent tracking and washing of sediments onto paved surfaces. Maintenance may include turning the material in the exit or adding additional rock.

INSPECTION ITEM	CONDITION	MAINTENANCE ACTIVITY
CONSTRUCTION ACCESS ROUTES ADJACENT TO THE DISTRUBANCE AREA	Sediment present on vehicle travel surfaces	Sweep, shovel, or vacuum sediment from the surface, dispose of properly
CONSTRUCTION ENTRANCE CONDITION	Muddy or sediment-laden	Add a top-dressing of stone or gravel

Temporary erosion and sedimentation control measures, not limited to those previously described, may be required to be implemented to protect discharge areas throughout the construction process.

Construction Best Management Practices – Maintenance/Evaluation Checklist

A reduced version of the Erosion Control Maintenance measures as described above is included in the following checklist for quick reference:

Facility Expansion, Northborough, Massachusetts
Construction Best Management Practices – Maintenance/ Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐yes ☐no (List Items)	Date of Cleaning/Repair	Performed by:
Erosion Control Barrier	Weekly and after storm events of ½ inch or greater			• Accumulated sediment • Separation of straw wattles with the earth and each other • Damaged or broken straw wattles/silt fence	☐yes ☐no		
Catch Basin Protection	Weekly and after storm events of ½ inch or greater			• Accumulated sediment within silt sacks • Rips or torn silt sacks	☐yes ☐no		
Diversion Channels	Weekly and after storm events of ½ inch or greater			• Cracking, • Erosion, • Leakage in the embankments	☐yes ☐no		
Temporary Sedimentation Basins	Weekly and after storm events of ½ inch or greater			• Cracking, • Erosion, • Leakage in the embankments • Accumulation of sediment	☐yes ☐no		
Vegetated Slope Stabilization	Weekly and after storm events of ½ inch or greater			• Cracking, • Erosion	☐yes ☐no		

Stormwater Control Manager _____

Appendix F
Pipe Sizing Computations and Supporting Information

StormCAD Analysis: 25-Year Storm - Proposed

Project:	Facility Expansion Project	Project #:	14500.00
Location:	Northborough, MA	Sheet:	1 of 1
Calculated By:	BMG	Date:	9/13/2019
Title:	25-Year Storm Drain Calculations per Stormcad Model		

Start Node	Stop Node	Upstream Invert (ft)	Downstream Invert (ft)	Slope (ft/ft)	Manning's n	Diameter (in)	Length (ft)	Flow (cfs)	Capacity (cfs)	**Flow/ Capacity (%)**	Average Velocity (ft/s)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
CB-1	DMH-1	260.4	259.6	0.01	0.01	12	119.8	3.6	3.8	94	5.5	261.2	261.0
CB-2	DMH-1	259.9	259.6	0.01	0.01	15	43.3	4.5	7.0	63	6.1	260.8	260.9
CB-3	DMH-1	260.1	259.6	0.01	0.01	12	71.3	0.9	3.9	23	4.0	260.6	260.7
DMH-1	WQU	259.5	259.2	0.01	0.01	18	39.7	8.7	11.8	74	7.3	260.6	261.0
WQU	FES-4	258.9	258.4	0.01	0.01	18	58.3	8.7	12.7	68	7.7	260.0	260.2

Rainfall Intensities

NOAA Atlas 14, Volume 10, Version 3
Location name: Northborough, Massachusetts, USA*
Latitude: 42.3106°, Longitude: -71.655°
Elevation: 327.82 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	4.14 (3.17-5.34)	4.90 (3.74-6.31)	6.13 (4.67-7.94)	7.14 (5.42-9.30)	8.54 (6.29-11.6)	9.60 (6.94-13.3)	10.7 (7.52-15.4)	11.9 (7.98-17.5)	13.6 (8.80-20.7)	14.9 (9.46-23.3)
10-min	2.93 (2.25-3.78)	3.47 (2.65-4.48)	4.34 (3.31-5.62)	5.06 (3.84-6.59)	6.05 (4.46-8.21)	6.80 (4.92-9.44)	7.58 (5.33-10.9)	8.44 (5.66-12.4)	9.62 (6.23-14.7)	10.6 (6.70-16.5)
15-min	2.30 (1.76-2.97)	2.72 (2.08-3.51)	3.40 (2.60-4.40)	3.97 (3.01-5.16)	4.75 (3.50-6.44)	5.34 (3.86-7.39)	5.95 (4.18-8.54)	6.62 (4.44-9.75)	7.55 (4.89-11.5)	8.30 (5.26-12.9)
30-min	1.56 (1.19-2.01)	1.84 (1.41-2.38)	2.31 (1.76-2.99)	2.69 (2.04-3.50)	3.22 (2.37-4.38)	3.63 (2.62-5.03)	4.04 (2.84-5.81)	4.50 (3.02-6.63)	5.14 (3.33-7.85)	5.66 (3.58-8.82)
60-min	0.981 (0.752-1.26)	1.16 (0.889-1.50)	1.46 (1.11-1.89)	1.70 (1.29-2.22)	2.04 (1.50-2.77)	2.29 (1.66-3.18)	2.56 (1.80-3.67)	2.85 (1.91-4.20)	3.26 (2.11-4.97)	3.59 (2.27-5.59)
2-hr	0.610 (0.470-0.782)	0.733 (0.564-0.941)	0.935 (0.718-1.20)	1.10 (0.842-1.43)	1.33 (0.990-1.81)	1.51 (1.10-2.09)	1.69 (1.20-2.43)	1.90 (1.28-2.79)	2.22 (1.44-3.36)	2.48 (1.57-3.84)
3-hr	0.464 (0.358-0.592)	0.561 (0.433-0.718)	0.721 (0.555-0.925)	0.853 (0.653-1.10)	1.03 (0.771-1.40)	1.17 (0.857-1.62)	1.32 (0.941-1.90)	1.49 (1.00-2.17)	1.75 (1.14-2.64)	1.96 (1.25-3.03)
6-hr	0.296 (0.230-0.377)	0.360 (0.280-0.458)	0.464 (0.359-0.592)	0.550 (0.424-0.706)	0.669 (0.501-0.900)	0.757 (0.557-1.04)	0.852 (0.612-1.22)	0.965 (0.653-1.40)	1.14 (0.741-1.71)	1.28 (0.817-1.96)
12-hr	0.188 (0.147-0.237)	0.227 (0.178-0.288)	0.292 (0.228-0.371)	0.346 (0.268-0.442)	0.420 (0.316-0.561)	0.475 (0.351-0.649)	0.534 (0.385-0.759)	0.603 (0.410-0.871)	0.708 (0.463-1.06)	0.797 (0.510-1.21)
24-hr	0.112 (0.088-0.141)	0.136 (0.107-0.172)	0.176 (0.138-0.222)	0.209 (0.163-0.265)	0.254 (0.192-0.338)	0.287 (0.213-0.391)	0.323 (0.234-0.458)	0.366 (0.250-0.526)	0.431 (0.283-0.640)	0.486 (0.312-0.735)
2-day	0.062 (0.049-0.078)	0.076 (0.060-0.096)	0.100 (0.079-0.125)	0.119 (0.093-0.150)	0.145 (0.111-0.193)	0.165 (0.124-0.224)	0.186 (0.136-0.264)	0.212 (0.145-0.303)	0.253 (0.166-0.373)	0.287 (0.185-0.432)
3-day	0.045 (0.036-0.056)	0.055 (0.044-0.069)	0.072 (0.057-0.090)	0.085 (0.067-0.108)	0.104 (0.080-0.138)	0.119 (0.089-0.160)	0.134 (0.098-0.189)	0.153 (0.105-0.217)	0.182 (0.120-0.267)	0.207 (0.133-0.309)
4-day	0.036 (0.029-0.045)	0.044 (0.035-0.055)	0.057 (0.045-0.071)	0.068 (0.054-0.085)	0.083 (0.063-0.109)	0.094 (0.071-0.127)	0.106 (0.078-0.149)	0.121 (0.083-0.171)	0.143 (0.095-0.210)	0.162 (0.105-0.242)
7-day	0.025 (0.020-0.031)	0.030 (0.024-0.037)	0.038 (0.030-0.047)	0.044 (0.035-0.055)	0.054 (0.041-0.070)	0.060 (0.045-0.081)	0.068 (0.050-0.094)	0.076 (0.053-0.108)	0.090 (0.059-0.131)	0.101 (0.065-0.150)
10-day	0.020 (0.016-0.025)	0.024 (0.019-0.029)	0.030 (0.024-0.037)	0.034 (0.027-0.043)	0.041 (0.032-0.054)	0.046 (0.035-0.061)	0.051 (0.038-0.071)	0.058 (0.040-0.081)	0.067 (0.044-0.097)	0.074 (0.048-0.110)
20-day	0.014 (0.012-0.018)	0.016 (0.013-0.020)	0.019 (0.016-0.024)	0.022 (0.018-0.027)	0.026 (0.020-0.033)	0.028 (0.021-0.037)	0.031 (0.023-0.042)	0.034 (0.024-0.047)	0.038 (0.025-0.055)	0.041 (0.027-0.061)
30-day	0.012 (0.010-0.015)	0.013 (0.011-0.016)	0.015 (0.012-0.019)	0.017 (0.014-0.021)	0.020 (0.015-0.025)	0.022 (0.016-0.028)	0.024 (0.017-0.031)	0.025 (0.018-0.035)	0.028 (0.019-0.040)	0.030 (0.019-0.043)
45-day	0.010 (0.008-0.012)	0.011 (0.009-0.013)	0.012 (0.010-0.015)	0.014 (0.011-0.017)	0.015 (0.012-0.019)	0.017 (0.013-0.022)	0.018 (0.013-0.024)	0.019 (0.013-0.026)	0.021 (0.014-0.029)	0.022 (0.014-0.032)
60-day	0.009 (0.007-0.011)	0.009 (0.008-0.011)	0.011 (0.009-0.013)	0.012 (0.009-0.014)	0.013 (0.010-0.016)	0.014 (0.011-0.018)	0.015 (0.011-0.020)	0.016 (0.011-0.022)	0.017 (0.011-0.024)	0.018 (0.011-0.025)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

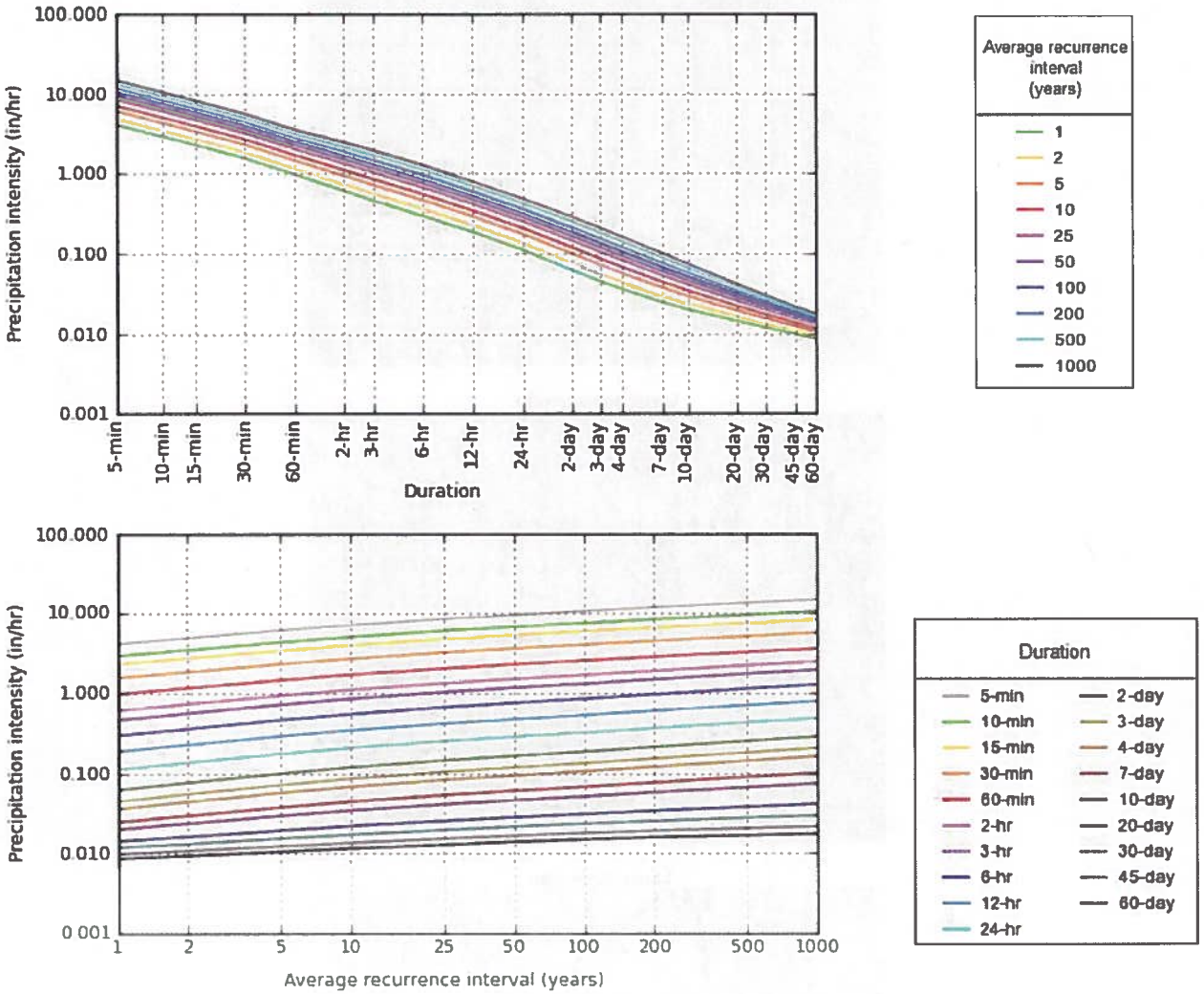
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

PDS-based intensity-duration-frequency (IDF) curves
Latitude: 42.3106°, Longitude: -71.6550°



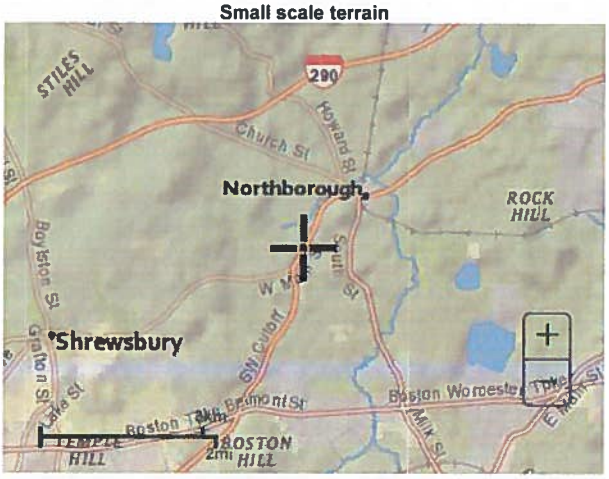
NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Fri Sep 13 17:05:45 2019

Back to Top

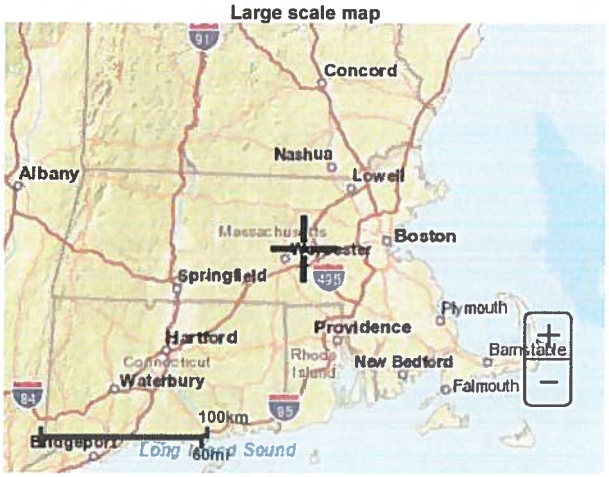
Maps & aerials

Small scale terrain



Large scale terrain

Large scale map



Large scale aerial

Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix G
Computations and Supporting Information

Illicit Discharge Compliance Statement

I, Michael C. Carelli, as representative for the Applicant, Isomedix Operations Inc., certify the following as they pertain to the proposed facility expansion project located at 425 Whitney Street, Northborough:

Sanitary sewer and storm drainage structures remaining from previous development which are part of the redevelopment area will be removed or will be incorporated into updated sanitary sewer and separate stormwater sewer systems. The design plans submitted with this report have been designed in full compliance with current standards, including proposing separate sanitary sewer and storm drain systems. The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges.

Applicant

Name: Michael C. Carelli 16MAR2021

Company: STERIS AST

Signature: Michael C Carelli

OSQ Series

OSQ™ LED Area/Flood Luminaire featuring Cree TrueWhite® Technology – Medium

Rev. Date: V27 10/21/2020

Product Description

The OSQ™ Area/Flood luminaire blends extreme optical control, advanced thermal management and modern, clean aesthetics. Built to last, the housing is rugged cast aluminum with an integral, weathertight LED driver compartment. Versatile mounting configurations offer simple installation. Its slim, low-profile design minimizes wind load requirements and blends seamlessly into the site providing even, quality illumination. The 'B' Input power designator is a suitable upgrade for HID applications up to 250 Watt, and the 'K' Input power designator is a suitable upgrade for HID applications up to 400 Watt.

Applications: Parking lots, walkways, campuses, car dealerships, office complexes, tunnels, underpasses, and internal roadways

Performance Summary

Utilizes Cree TrueWhite® Technology on 5000K Luminaires

NanoOptic® Precision Delivery Grid™ optic

Assembled in the U.S.A. of U.S. and imported parts

Initial Delivered Lumens: Up to 17,291

Efficacy: Up to 136 LPW

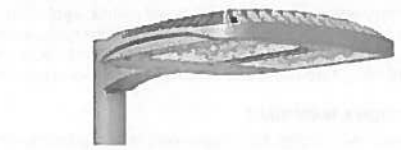
CRI: Minimum 70 CRI (3000K, 4000K & 5700K); 90 CRI (5000K)

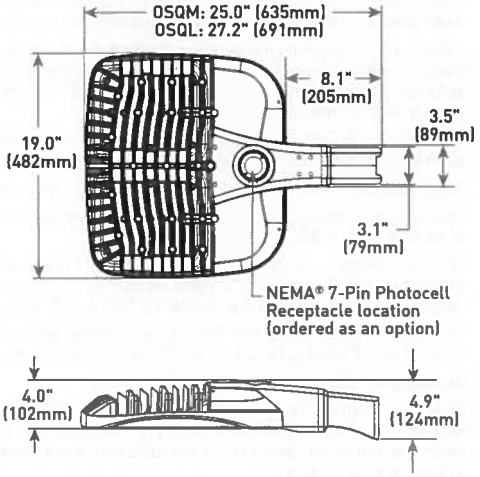
CCT: 3000K, 4000K, 5000K, 5700K

Limited Warranty[1]: 10 years on luminaire; 10 years on Colorfast DeltaGuard® finish; up to 5 years for Synapse® accessories; 1 year on luminaire accessories

[1] See http://creelighting.com/warranty for warranty terms. For Synapse accessories, consult Synapse spec sheets for details on warranty terms.

DA Mount





Weight
28.9 lbs. (13.1kg)

Ordering Information

Fully assembled luminaire is composed of two components that must be ordered separately:
Example: **Mount:** OSQ-B-AASV + **Luminaire:** OSQ-A-NM-2ME-B-40K-UL-SV

Mount (Luminaire must be ordered separately)*	
OSQ-	
OSQ-B-AA Adjustable Arm **OSQ-DA** Direct Arm **OSQ-M-TSP** Transportation Mount (stainless steel; do not specify color) **OSQ-TM** Trunnion Mount	**Color Options:** **SV** Silver **BZ** Bronze **BK** Black **WH** White

* Reference EPA and pole configuration suitability data beginning on page 10

Luminaire (Mount must be ordered separately)								
OSQ	**A**	**NM**						
Product	**Version**	**Mounting**	**Optic**	**Input Power Designator**	**CCT**	**Voltage**	**Color Options**	**Options**
OSQ	**A**	**NM** No Mount	**Asymmetric** **2ME*** Type II Medium **3ME*** Type III Medium **4ME*** Type IV Medium **Symmetric** **5ME** Type V Medium **5SH** Type V Short **5SQ** Type V Square **WSN** Wide Sign **15D** 15° Flood **25D** 25° Flood **40D** 40° Flood **60D** 60° Flood **120D** 120° Flood	**B** 86W **K** 130W **Z** 53W	**30K** 3000K, 70 CRI **40K** 4000K, 70 CRI **50K** 5000K, 90 CRI **57K** 5700K, 70 CRI	**UL** Universal 120-277V **UH** Universal 347-480V - Available with B & K Input Power Designators only	**BK** Black **BZ** Bronze **SV** Silver **WH** White	**F Fuse** - Compatible only with 120V, 277V or 347V (phase to neutral) - Consult factory if fusing is required for 208V, 240V or 480V (phase to phase) - Refer to PML spec sheet for availability with PML options - When code dictates fusing, use time delay fuse **PML Programmable Multi-Level, up to 40' Mounting Height** - Refer to PML spec sheet for details - Intended for downlight applications at 0° tilt **PML2 Programmable Multi-Level, 10-30' Mounting Height** - Refer to PML spec sheet for details - Intended for downlight applications at 0° tilt **Q9/Q6/Q5/Q4/Q3/Q2/Q1 Field Adjustable Output** - Must select Q9, Q6, Q5, Q4, Q3, Q2, or Q1 - Offers full range adjustability - Refer to pages 12-13 for power and lumen values - Available with B & K Input Power Designators only - Not available with PML or PML2 options **R NEMA® 7-Pin Photocell Receptacle** - 7-pin receptacle per ANSI C136.41 - Intended for downlight applications with maximum 45° tilt - Factory connected 0-10V dim leads - 18" (457mm) seven-conductor cord exits luminaire - Requires photocell or shorting cap by others **RL Rotate Left** - LED and optic are rotated to the left - Refer to RR/RL configuration diagram on page 14 for optic directionality - Not for use with symmetric optics **RR Rotate Right** - LED and optic are rotated to the right - Refer to RR/RL configuration diagram on page 14 for optic directionality - Not for use with symmetric optics

* Available with Backlight Shield when ordered with field-installed accessory (see table above)

US: creelighting.com (800) 236-6800
Canada: creelighting-canada.com (800) 473-1234

CREE LIGHTING

Product Specifications

CREE TRUEWHITE® TECHNOLOGY

A revolutionary way to generate high-quality white light, Cree TrueWhite® Technology is a patented approach that delivers an exclusive combination of 90+ CRI, beautiful light characteristics and lifelong color consistency, all while maintaining high luminous efficacy – a true no compromise solution.

CONSTRUCTION & MATERIALS

- Slim, low profile design minimizes wind load requirements
- Luminaire housing is rugged die cast aluminum with an integral, weathertight LED driver compartment and high-performance heat sink
- Convenient interlocking mounting method on direct arm mount. Mounting adaptor is rugged die cast aluminum and mounts to 3" (76mm) or larger square or round pole, secured by two 5/16-18 UNC bolts spaced on 2" (51mm) centers
- Mounting for the adjustable arm mount adaptor is rugged die cast aluminum and mounts to 2" (51mm) IP, 2.375" (60mm) O.D. tenon
- Adjustable arm mount can be adjusted 180° in 2.5° increments
- Transportation mount is constructed of 316 stainless steel and mounts to surface with (4) 3/8" fasteners by others
- Trunnion mount is constructed of A500 and A1011 steel and is adjustable from 0-180° in 15° degree increments. Trunnion mount secures to surface with (1) 3/4" bolt or (2) 1/2" or 3/8" bolts
- Includes 18" (340mm) 18/5 or 16/5 cord exiting the luminaire. When ordered with R option, 18" (340mm) 18/7 or 16/7 cord is provided
- Designed for uplight and downlight applications
- Exclusive Colorfast DeltaGuard® finish features an E-Coat epoxy primer with an ultra-durable powder topcoat, providing excellent resistance to corrosion, ultraviolet degradation and abrasion. Silver, bronze, black, and white are available
- **Weight:** OSQ-DA: 28.9 lbs. (13.1kg); OSQ-B-AA: 28.4 lbs. (12.9kg); OSQ-M-TSP: 42 lbs. (19.1kg); OSQ-TM: 32.6 lbs. (14.8kg)

ELECTRICAL SYSTEM

- **Input Voltage:** 120-277V or 347-480V, 50/60Hz, Class 1 drivers
- **Power Factor:** > 0.9 at full load
- **Total Harmonic Distortion:** < 20% at full load
- Integral 10kV surge suppression protection standard
- When code dictates fusing, a slow blow fuse or type C/D breaker should be used to address inrush current
- Designed with 0-10V dimming capabilities. Controls by others
- Refer to Dimming spec sheet for details
- **Maximum 10V Source Current:** 1.0mA
- **Operating Temperature Range:** -40°C - +40°C (-40°F - +104°F)

REGULATORY & VOLUNTARY QUALIFICATIONS

- cULus Listed
- Suitable for wet locations
- Enclosure rated IP66 per IEC 60529 when ordered without R option
- Consult factory for CE Certified products
- Certified to ANSI C136.31-2001, 3G bridge and overpass vibration standards with AA, DA, TM, and TSP mounts
- ANSI C136.2 10kV surge protection, tested in accordance with IEEE/ANSI C62.41.2
- Meets FCC Part 15, Subpart B, Class A limits for conducted and radiated emissions
- Luminaire and finish endurance tested to withstand 5,000 hours of elevated ambient salt fog conditions as defined in ASTM Standard B 117
- Meets Buy American requirements within ARRA
- DLC and DLC Premium qualified versions available. Some exceptions apply. Please refer to https://www.designlights.org/search/ for most current information
- RoHS compliant. Consult factory for additional details
- Dark Sky Friendly, IDA Approved when ordered with 30K CCT and direct or transportation mounts only. Please refer to https://www.darksky.org/our-work/lighting/lighting-for-industry/fsa/fsa-products/ for most current information
- ⚠ **CA RESIDENTS WARNING:** Cancer and Reproductive Harm – www.p65warnings.ca.gov

Product Specifications

SYNAPSE® SIMPLYSNAP INTELLIGENT CONTROL

The Synapse SimplySNAP platform is a highly intuitive connected lighting solution featuring zone dimming, motion sensing, and daylight harvesting with utility-grade power monitoring and support of up to 1000 nodes per gateway. The system features a reliable and robust self-healing mesh network with a browser-based interface that runs on smartphones, tablets, and PCs. The Twist-Lock Lighting Controller (TL7-B2) and Site Controller (SS450-002) take the OSQ Series to a new performance plateau, providing extreme energy productivity, code compliance and a better light experience.

Electrical Data*

Input Power Designator	System Watts 120-480V	Total Current (A)					
		120V	208V	240V	277V	347V	480V
B	86	0.73	0.43	0.37	0.32	0.25	0.19
K	130	1.09	0.65	0.56	0.49	0.38	0.28
Z	53**	0.46	0.26	0.22	0.19	N/A	N/A

* Electrical data at 25°C (77°F). Actual wattage may differ by +/- 10% when operating between 120-277V or 347-480V+/-10%
** Available with UL voltage only

OSQ Series Ambient Adjusted Lumen Maintenance[1]

Ambient	Optic	Initial LMF	25K hr Reported[2] LMF	50K hr Reported[2] LMF	75K hr Reported[2]/ Estimated[3] LMF	100K hr Reported[2]/ Estimated[3] LMF
5°C (41°F)	Asymmetric	1.04	1.03	1.01	0.99[2]	0.97[2]
	Symmetric	1.05	1.05	1.05	1.05[3]	1.05[3]
10°C (50°F)	Asymmetric	1.03	1.02	1.00	0.98[2]	0.96[2]
	Symmetric	1.04	1.03	1.03	1.03[3]	1.03[3]
15°C (59°F)	Asymmetric	1.02	1.01	0.99	0.97[2]	0.95[2]
	Symmetric	1.02	1.02	1.02	1.02[3]	1.02[3]
20°C (68°F)	Asymmetric	1.01	1.00	0.98	0.96[2]	0.94[2]
	Symmetric	1.01	1.01	1.01	1.01[3]	1.01[3]
25°C (77°F)	Asymmetric	1.00	0.99	0.97	0.95[2]	0.93[2]
	Symmetric	1.00	1.00	1.00	1.00[3]	1.00[3]

[1] Lumen maintenance values at 25°C (77°F) are calculated per IES TM-21 based on IES LM-80 report data for the LED package and in-situ luminaire testing. Luminaire ambient temperature factors (LATF) have been applied to all lumen maintenance factors. Please refer to the Temperature Zone Reference Document for outdoor average nighttime ambient conditions.
[2] In accordance with IES TM-21, Reported values represent interpolated values based on time durations that are up to 6x the tested duration in the IES LM-80 report for the LED.
[3] Estimated values are calculated and represent time durations that exceed the 6x test duration of the LED.

Accessories

Field-Installed

Backlight Shield
OSQ-BLSMF
- Front facing optics
OSQ-BLSMR
- Rotated optics

Hand-Held Remote
XA-SENSREM
- For successful implementation of the programmable multi-level option, a minimum of one hand-held remote is required

Bird Spikes
OSQ-MED-BRDSPK

Shorting Cap
XA-XSLSHRT

Synapse Wireless Control Accessories

Twist-Lock Lighting Controller
TL7-B2
- Suitable for 120-277V (UL) voltage only
- Requires NEMA/ANSI C136.41 7-Pin Dimming Receptacle
- Not for use with PML or Q options
- Provides On/Off switching, dimming, power metering, digital sensor input, and status monitoring of luminaires
- Refer to TL7-B2 spec sheet for details

SimplySNAP Central Base Station
CBSSW-450-002
- Includes On-Site Controller (SS450-002) and 5-button switch
- Indoor and Outdoor rated
- Refer to CBSSW-450-002 spec sheet for details

Synapse Wireless Sensor
WSN-DPM
- Motion and light sensor
- Control multiple zones
- Refer to WSN-DPM spec sheet for details

SimplySNAP On-Site Controller
SS450-002
- Verizon® LTE-enabled
- Designed for indoor applications
- Refer to SS450-002 spec sheet for details

Building Management System (BMS) Gateway
BMS-GW-002
- Required for BACnet integration
- Refer to BMS-GW-002 spec sheet for details

Outdoor Antennas (Optional, for increased range, 8dB gain)
KIT-ANT420SM
- Kit includes antenna, 20' cable and bracket

KIT-ANT360
- Kit includes antenna, 30' cable and bracket

KIT-ANT600
- Kit includes antenna, 50' cable and bracket
- Refer to Outdoor antenna spec sheet for details

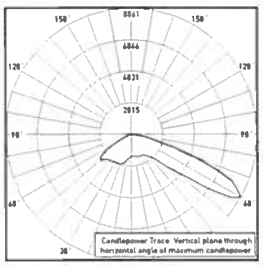
US: creelighting.com (800) 236-6800
Canada: creelighting-canada.com (800) 473-1234

CREE LIGHTING

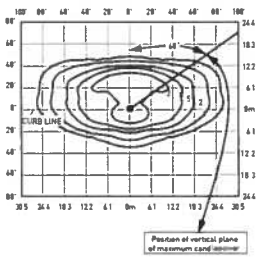
Photometry

All published luminaire photometric testing performed to IES LM-79-08 standards. To obtain an IES file specific to your project consult: https://creelighting.com/products/outdoor/area/osq-series

2ME



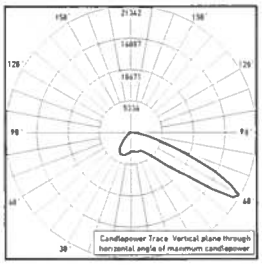
RESTL Test Report #: PL08877-001A
OSQ-A-**-2ME-B-30K-UL
Initial Delivered Lumens: 10,381



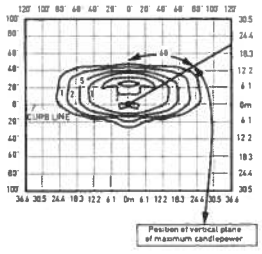
OSQ-A-**-2ME-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 11,424
Initial FC at grade

Type II Medium Distribution								
Input Power Designator	3000K (70 CRI)		4000K (70 CRI)		5000K (90 CRI)		5700K (70 CRI)	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
B	10,738	B2 U0 G2	11,424	B2 U0 G2	9,350	B2 U0 G2	11,648	B2 U0 G2
K	16,022	B3 U0 G3	16,959	B3 U0 G3	14,000	B3 U0 G2	17,291	B3 U0 G3
Z	6,481	B2 U0 G1	6,896	B2 U0 G1	5,750	B1 U0 G1	7,031	B2 U0 G1

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt



CESTL Test Report #: PL07700-001A
OSQ-A-**-2ME-U-57K-UL w/OSQ-BLSLF
Initial Delivered Lumens: 22,822



OSQ-A-**-2ME-B-40K-UL w/OSQ-BLSMF
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 8,779
Initial FC at grade

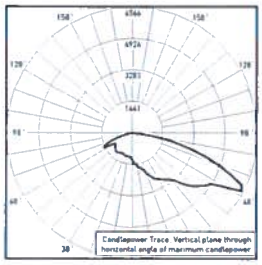
Type II Medium w/BLS Distribution								
Input Power Designator	3000K (70 CRI)		4000K (70 CRI)		5000K (90 CRI)		5700K (70 CRI)	
	Initial Delivered Lumens*	BUG Ratings** Per TM 15 11	Initial Delivered Lumens*	BUG Ratings** Per TM 15 11	Initial Delivered Lumens*	BUG Ratings** Per TM 15 11	Initial Delivered Lumens*	BUG Ratings** Per TM 15 11
B	8,251	B2 U0 G2	8,779	B2 U0 G2	7,200	B1 U0 G1	8,950	B2 U0 G2
K	12,312	B2 U0 G2	13,032	B2 U0 G2	10,750	B2 U0 G2	13,286	B2 U0 G2
Z	4,980	B1 U0 G1	5,299	B1 U0 G1	4,420	B1 U0 G1	5,402	B1 U0 G1

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit, https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

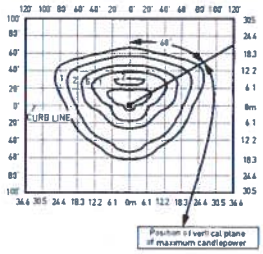
Photometry

All published luminaire photometric testing performed to IES LM-79-08 standards. To obtain an IES file specific to your project consult: https://creelighting.com/products/outdoor/area/osq-series

3ME



RESTL Test Report #: PL08876-001A
OSQ-A-**-3ME-B-30K-UL
Initial Delivered Lumens: 10,421

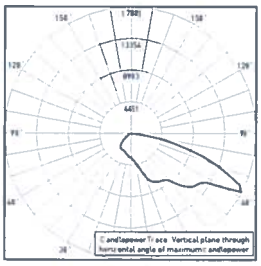


OSQ-A-**-3ME-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 11,424
Initial FC at grade

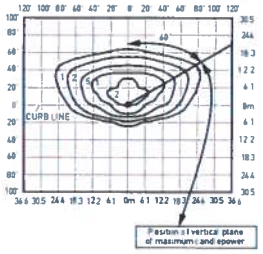
Type III Medium Distribution

Input Power Designator	3000K (70 CRI)		4000K (70 CRI)		5000K (90 CRI)		5700K (70 CRI)	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
B	10,738	B3 U0 G3	11,424	B3 U0 G3	9,350	B2 U0 G2	11,648	B3 U0 G3
K	16,022	B3 U0 G3	16,959	B3 U0 G3	14,000	B3 U0 G3	17,291	B3 U0 G3
Z	6,481	B2 U0 G2	6,896	B2 U0 G2	5,750	B2 U0 G2	7,031	B2 U0 G2

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt



CESTL Test Report #: PL07699-001A
OSQ-A-**-3ME-U-57K-UL w/OSQ-BLSLF
Initial Delivered Lumens: 23,601



OSQ-A-**-3ME-B-40K-UL w/OSQ-BLSMF
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 9,019
Initial FC at grade

Type III Medium w/BLS Distribution

Input Power Designator	3000K (70 CRI)		4000K (70 CRI)		5000K (90 CRI)		5700K (70 CRI)	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
B	8,477	B1 U0 G2	9,019	B1 U0 G2	7,400	B1 U0 G2	9,196	B1 U0 G2
K	12,649	B2 U0 G2	13,389	B2 U0 G2	11,050	B2 U0 G2	13,650	B2 U0 G2
Z	5,117	B1 U0 G1	5,444	B1 U0 G1	4,540	B1 U0 G1	5,551	B1 U0 G1

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

Photometry

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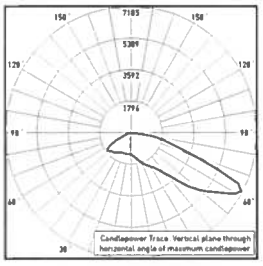
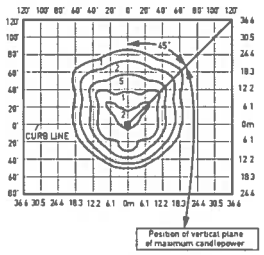
4ME



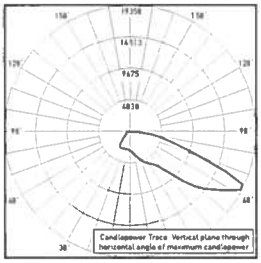
RESTL Test Report #: PL08878-001A
OSQ-A-**-4ME-B-30K-UL
Initial Delivered Lumens: 10,230



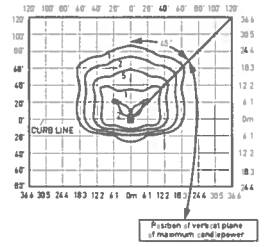
OSQ-A-**-4ME-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 11,424
Initial FC at grade

Type IV Medium Distribution								
Input Power Designator	3000K (70 CRI)		4000K (70 CRI)		5000K (90 CRI)		5700K (70 CRI)	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
B	10,738	B2 U0 G2	11,424	B2 U0 G2	9,350	B2 U0 G2	11,648	B2 U0 G2
K	16,022	B3 U0 G3	16,959	B3 U0 G3	14,000	B3 U0 G3	17,291	B3 U0 G3
Z	6,481	B2 U0 G2	6,896	B2 U0 G2	5,750	B2 U0 G1	7,031	B2 U0 G2

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt



CESTL Test Report #: PL07692-001A
OSQ-A-**-4ME-U-57K-UL w/OSQ-BLSLF
Initial Delivered Lumens: 22,793



OSQ-A-**-4ME-B-40K-UL w/OSQ-BLSMF
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 8,779
Initial FC at grade

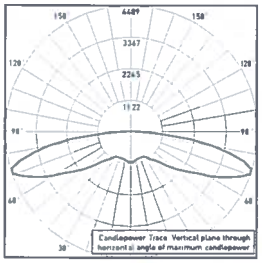
Type IV Medium w/BLS Distribution								
Input Power Designator	3000K (70 CRI)		4000K (70 CRI)		5000K (90 CRI)		5700K (70 CRI)	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
B	8,251	B1 U0 G2	8,779	B1 U0 G2	7,200	B1 U0 G2	8,950	B1 U0 G2
K	12,312	B2 U0 G2	13,032	B2 U0 G2	10,750	B2 U0 G2	13,286	B2 U0 G2
Z	4,980	B1 U0 G1	5,299	B1 U0 G1	4,420	B1 U0 G1	5,402	B1 U0 G1

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

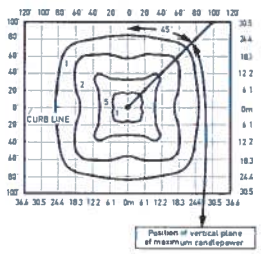
Photometry

All published luminaire photometric testing performed to IES LM-79-08 standards. To obtain an IES file specific to your project consult: https://creelighting.com/products/outdoor/area/osq-series

5ME



RESTL Test Report #: PL08534-001B
OSQ-A-**-5ME-B-40K-UL
Initial Delivered Lumens: 10,519

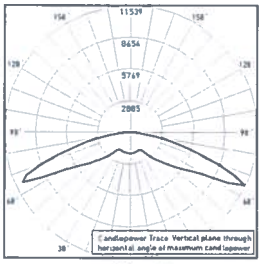


OSQ-A-**-5ME-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 10,867
Initial FC at grade

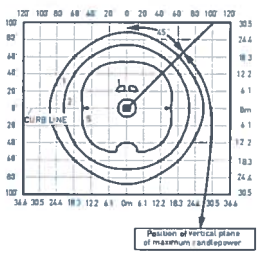
Type V Medium Distribution								
Input Power Designator	3000K (70 CRI)		4000K (70 CRI)		5000K (90 CRI)		5700K (70 CRI)	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
B	10,232	B4 U0 G3	10,867	B4 U0 G3	10,000	B4 U0 G3	11,056	B4 U0 G3
K	15,063	B4 U0 G4	15,999	B4 U0 G4	14,925	B4 U0 G4	16,277	B4 U0 G4
Z	5,257	B3 U0 G3	6,086	B3 U0 G3	6,175	B3 U0 G3	6,192	B3 U0 G3

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

5SH



CESTL Test Report #: PL10754-001A
OSQ-A-**-5SH-U-40K-UL
Initial Delivered Lumens: 25,679



OSQ-A-**-5SH-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 11,478
Initial FC at grade

Type V Short Distribution								
Input Power Designator	3000K (70 CRI)		4000K (70 CRI)		5000K (90 CRI)		5700K (70 CRI)	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
B	10,806	B4 U0 G2	11,478	B4 U0 G2	10,575	B4 U0 G2	11,678	B4 U0 G2
K	15,909	B4 U0 G3	16,897	B4 U0 G3	15,800	B4 U0 G3	17,191	B4 U0 G3
Z	5,552	B3 U0 G1	6,428	B3 U0 G2	6,525	B3 U0 G2	6,539	B3 U0 G2

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

Photometry

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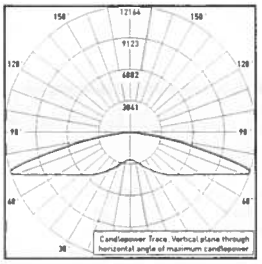
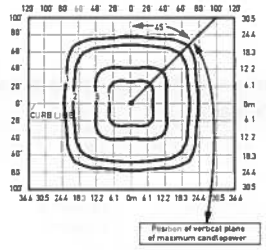
5SQ



RESTL Test Report #: PL14561-001B
OSQ-A-**-5SQ-U-57K-UL
Initial Delivered Lumens: 28,716



OSQ-A-NM-5SQ-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G.
Initial Delivered Lumens: 11,478
Initial FC at grade

Type V Square Distribution

Input Power Designator	3000K (70 CRI)		4000K (70 CRI)		5000K (90 CRI)		5700K (70 CRI)	
	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11	Initial Delivered Lumens*	BUG Ratings** Per TM-15-11
B	10,806	B3 U0 G2	11,478	B4 U0 G2	10,575	B3 U0 G2	11,678	B4 U0 G2
K	15,909	B4 U0 G2	16,897	B4 U0 G2	15,800	B4 U0 G2	17,191	B4 U0 G2
Z	5,552	B3 U0 G1	6,428	B3 U0 G1	6,525	B3 U0 G1	6,539	B3 U0 G1

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

Photometry

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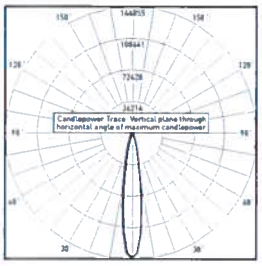
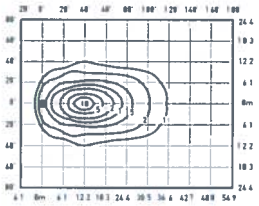
15D



CESTL Test Report #: PL07689-001A
OSQ-A-**-15D-U-30K-UL
Initial Delivered Lumens: 23,254

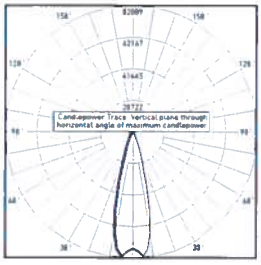


OSQ-A-**-15D-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G., 60° Tilt
Initial Delivered Lumens: 11,478
Initial FC at grade

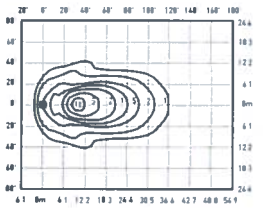
15° Flood Distribution				
Input Power Designator	3000K (70 CRI)	4000K (70 CRI)	5000K (90CRI)	5700K (70 CRI)
	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*
B	10,806	11,478	10,575	11,678
K	15,909	16,897	15,800	17,191
Z	5,552	6,428	6,525	6,539

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

25D



CESTL Test Report #: PL07696-001A
OSQ-A-**-25D-U-30K-UL
Initial Delivered Lumens: 23,265

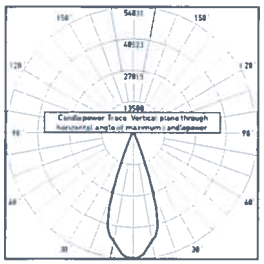


OSQ-A-**-25D-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G., 60° Tilt
Initial Delivered Lumens: 11,478
Initial FC at grade

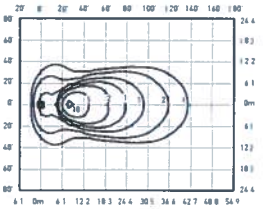
25° Flood Distribution				
Input Power Designator	3000K (70 CRI)	4000K (70 CRI)	5000K (90CRI)	5700K (70 CRI)
	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*
B	10,806	11,478	10,575	11,678
K	15,909	16,897	15,800	17,191
Z	5,552	6,428	6,525	6,539

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

40D



CESTL Test Report #: PL07697-001A
OSQ-A-**-40D-U-30K-UL
Initial Delivered Lumens: 22,943



OSQ-A-**-40D-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G., 60° Tilt
Initial Delivered Lumens: 11,478
Initial FC at grade

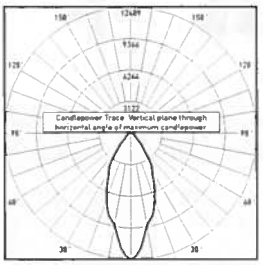
40° Flood Distribution				
Input Power Designator	3000K (70 CRI)	4000K (70 CRI)	5000K (90 CRI)	5700K (70 CRI)
	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*
B	10,806	11,478	10,575	11,678
K	15,909	16,897	15,800	17,191
Z	5,552	6,428	6,525	6,539

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

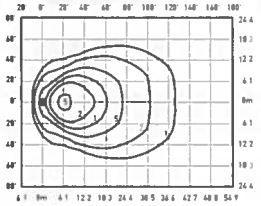
Photometry

All published luminaire photometric testing performed to IES LM-79-08 standards. To obtain an IES file specific to your project consult: https://creelighting.com/products/outdoor/area/osq-series

60D



CESTL Test Report #: PL08100-001B
OSQ-A-**-60D-B-30K-UL
Initial Delivered Lumens: 10,079

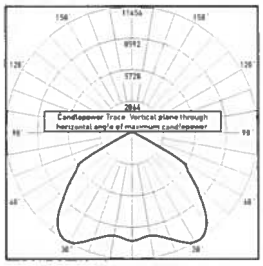


OSQ-A-**-60D-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G., 60° Tilt
Initial Delivered Lumens: 11,478
Initial FC at grade

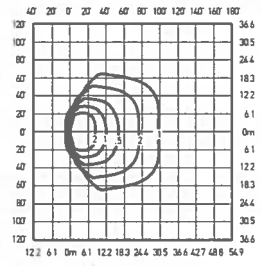
60° Flood Distribution				
Input Power Designator	3000K (70 CRI)	4000K (70 CRI)	5000K (90 CRI)	5700K (70 CRI)
	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*
B	10,806	11,478	10,575	11,678
K	15,909	16,897	15,800	17,191
Z	5,552	6,428	6,525	6,539

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

120D



RESTL Test Report #: PL15731-001A
OSQ-A-**-120D-U-40K-UL
Initial Delivered Lumens: 25,501

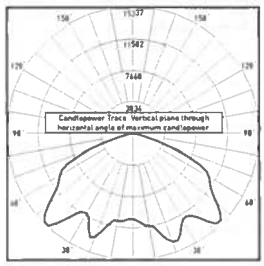


OSQ-A-**-120D-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G., 60° Tilt
Initial Delivered Lumens: 11,478
Initial FC at grade

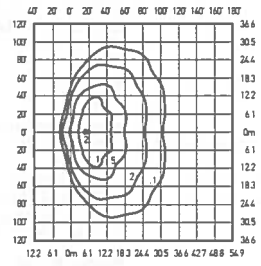
Type 120° Flood Distribution				
Input Power Designator	3000K (70 CRI)	4000K (70 CRI)	5000K (90 CRI)	5700K (70 CRI)
	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*
B	10,806	11,478	10,575	11,678
K	15,909	16,897	15,800	17,191
Z	5,552	6,428	6,525	6,539

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

WSN



CESTL Test Report #: PL07695-001A
OSQ-A-**-WSN-U-30K-UL
Initial Delivered Lumens: 23,116



OSQ-A-**-WSN-B-40K-UL
Mounting Height: 25' (7.6m) A.F.G., 60° Tilt
Initial Delivered Lumens: 11,478
Initial FC at grade

Wide Sign Distribution				
Input Power Designator	3000K (70 CRI)	4000K (70 CRI)	5000K (90 CRI)	5700K (70 CRI)
	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*	Initial Delivered Lumens*
B	10,806	11,478	10,575	11,678
K	15,909	16,897	15,800	17,191
Z	5,552	6,428	6,525	6,539

* Initial delivered lumens at 25°C (77°F). Actual production yield may vary between -10 and +10% of initial delivered lumens
** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit: https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf. Valid with no tilt

OSQ™ LED Area/Flood Luminaire featuring Cree TrueWhite® Technology – Medium

Luminaire EPA

Adjustable Arm Mount – OSQ-B-AA Weight: 28.4 lbs. (12.9kg)							
Single	2 @ 180°	2 @ 90°	3 @ 90°	3 @ 120°	3 @ 180°	4 @ 180°	4 @ 90°
Tenon Configuration (0°-80° Tilt); If used with Cree Lighting tenons, please add tenon EPA with Luminaire EPA							
 PB-1A*; PT-1; PW-1A3**	 PB-2A*; PB-2R2.375; PD-2A4(180); PT-2(180); PW-2A3**	 PB-2A*; PD-2A4(90); PT-2(90)	 PB-3A*; PD-3A4(90); PT-3(90)	 PB-3A*; PT-3(120)	 PB-3A*; PB-3R2.375	 PB-4A*(180)	 PB-4A*(90); PB-4R2.375; PD-4A4(90); PT-4(90)
0° Tilt							
0.74	1.48	1.19	1.93	1.63	3.33	4.66	2.38
10° Tilt							
0.75	1.48	1.49	2.23	2.15	4.22	5.84	2.98
20° Tilt							
1.12	1.48	1.86	2.60	2.85	5.31	7.32	3.72
30° Tilt							
1.46	1.48	2.20	2.94	3.56	6.34	8.68	4.40
45° Tilt							
1.96	1.96	2.69	3.43	4.54	7.83	10.68	5.38
60° Tilt							
2.33	2.33	3.07	3.81	5.11	8.94	12.16	6.14
70° Tilt							
2.49	2.49	3.23	3.97	5.11	9.43	12.80	6.46
80° Tilt							
2.58	2.58	3.32	4.06	5.11	9.71	13.16	6.64
Tenon Configuration (90° Tilt); If used with Cree Lighting tenons, please add tenon EPA with Luminaire EPA							
PB-1A*; PT-1; PW-1A3**	PB-2A*; PB-2R2.375; PD-2A4(180); PT-2(180); PW-2A3**	PB-2A*	PB-3A*	PB-3A*; PT-3(120)	PB-3A*; PB-3R2.375	PB-4A*(180)	PB-4A*(90); PB-4R2.375
90° Tilt							
2.61	2.61	4.44	6.05	5.11	9.79	13.28	10.39

* Specify pole size: 3 (3"), 4 (4"), 5 (5"), or 6 (6") for single, double or triple luminaire orientation or 4 (4"), 5 (5"), or 6 (6") for quad luminaire orientation
** These EPA values must be multiplied by the following ratio: Fixture Mounting Height/Total Pole Height. Specify pole size: 3 (3"), 4 (4"), 5 (5"), or 6 (6")

Tenon EPA

Part Number	EPA
PB-1A*	None
PB-2A*	0.82
PB-3A*	1.52
PB-4A*(180)	2.22
PB-4A*(90)	1.11
PB-2R2.375	0.92
PB-3R2.375	1.62
PB-4R2.375	2.32
PD Series Tenons	0.09
PT Series Tenons	0.10
PW-1A3**	0.47
PW-2A3**	0.94
WM-2	0.08
WM-4	0.25
WM-DM	None

* Specify pole size: 3 (3"), 4 (4"), 5 (5"), or 6 (6") for single, double or triple luminaire orientation or 4 (4"), 5 (5"), or 6 (6") for quad luminaire orientation
** These EPA values must be multiplied by the following ratio: Fixture Mounting Height/Total Pole Height. Specify pole size: 3 (3"), 4 (4"), 5 (5"), or 6 (6")

Tenons and Brackets‡ (must specify color)

Square Internal Mount Vertical Tenons (Steel)
- Mounts to 3-6" (76-152mm) square aluminum or steel poles

PB-1A* – Single
PB-2A* – 180° Twin
PB-3A* – 180° Triple
PB-4A*(90) – 90° Quad
PB-4A*(180) – 180° Quad

Square Internal Mount Horizontal Tenons (Aluminum)
- Mounts to 4" (102mm) square aluminum or steel poles

PD-2A4(90) – 90° Twin
PD-2A4(180) – 180° Twin
PD-3A4(90) – 90° Triple
PD-4A4(90) – 90° Quad

Wall Mount Brackets
- Mounts to wall or roof

WM-2 – Horizontal for OSQ-B-AA mount
WM-4 – L-Shape for OSQ-B-AA mount
WM-DM – Plate for OSQ-DA mount

Round External Mount Vertical Tenons (Steel)
- Mounts to 2.375" (60mm) O.D. round aluminum or steel poles or tenons

PB-2R2.375 – Twin
PB-3R2.375 – Triple
PB-4R2.375 – Quad

Round External Mount Horizontal Tenons (Aluminum)
- Mounts to 2.375" (60mm) O.D. round aluminum or steel poles or tenons
- Mounts to square pole with PB-1A* tenon

PT-1 – Single (Vertical)
PT-2(90) – 90° Twin
PT-2(180) – 180° Twin
PT-3(90) – 90° Triple
PT-3(120) – 120° Triple
PT-4(90) – 90° Quad

Mid-Pole Bracket
- Mounts to square pole

PW-1A3** – Single
PW-2A3** – Double

Ground Mount Post
- For ground-mounted flood luminaires

PGM-1 - for OSQ-B-AA mount

‡ Refer to the Bracket and Tenons spec sheet for more details

US: creelighting.com (800) 236-6800
Canada: creelighting-canada.com (800) 473-1234

CREE LIGHTING

Luminaire EPA

Direct Arm Mount – OSQ-DA Weight: 28.9 lbs. (13.1kg)					
Single	2 @ 180°	2 @ 90°	3 @ 90°	3 @ 120°	4 @ 90°
					
0.74	1.48	1.19	1.93	1.63	2.38

Direct Mount Configurations

Compatibility with OSQ-DA Direct Mount Bracket					
Input Power Designator	2 @ 90°	2 @ 180°	3 @ 90°	3 @ 120°	4 @ 90°
3" Square					
B, K & Z	N/A	✓	N/A	N/A	N/A
3" Round					
B, K & Z	N/A	✓	N/A	N/A	N/A
4" Square					
B, K & Z	✓	✓	✓	N/A	✓
4" Round					
B, K & Z	✓	✓	✓	✓	✓
5" Square					
B, K & Z	✓	✓	✓	N/A	✓
5" Round					
B, K & Z	✓	✓	✓	✓	✓
6" + Square					
B, K & Z	✓	✓	✓	N/A	✓
6" + Round					
B, K & Z	✓	✓	✓	✓	✓

Luminaire EPA

Trunnion Mount – OSQ-TM Weight: 32.6 lbs. (14.8kg)
Single
0° Tilt
0.75
15° Tilt
0.99
30° Tilt
1.57
45° Tilt
2.07
60° Tilt
2.46
75° Tilt
2.67
90° Tilt
2.33

Field Adjustable Output (Q9/Q6/Q5/Q4/Q3/Q2/Q1) Option Description:

The Field Adjustable Output option enables the OSQ area luminaires to be tuned to the exact needs of a particular application through multiple levels of adjustment. When ordered with the Q option, the luminaire will be shipped from the factory at the selected Q setting and will be fully adjustable between the nine settings.

Q Option Power & Lumen Data – Designator B

Q Option Setting	CCT/CRI	System Watts	Lumen Values						Optics Qualified on DLC QPL	
		120-480V	Asymmetric	5ME	5SH, 5SQ & Floods	2ME w/ BLS	3ME w/ BLS	4ME w/BLS	Standard	Premium
Q9 (Full Power)	30K (70 CRI)	86	10,738	10,232	10,806	8,251	8,477	8,251	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		11,424	10,867	11,478	8,779	9,019	8,779	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		9,350	10,000	10,575	7,200	7,400	7,200	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		11,648	11,056	11,678	8,950	9,196	8,950	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q6	30K (70 CRI)	77	9,449	9,004	9,509	7,261	7,460	7,261	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		10,053	9,563	10,101	7,726	7,937	7,726	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		8,350	8,950	9,450	6,425	6,600	6,425	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		10,250	9,729	10,277	7,876	8,092	7,876	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q5	30K (70 CRI)	72	8,913	8,492	8,969	6,848	7,036	6,848	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		9,482	9,020	9,527	7,287	7,486	7,287	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		7,525	8,050	8,525	5,775	5,950	5,775	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		9,668	9,176	9,693	7,429	7,633	7,429	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q4	30K (70 CRI)	62	7,731	7,367	7,780	5,941	6,103	5,941	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		8,225	7,824	8,264	6,321	6,494	6,321	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		6,575	7,025	7,425	5,050	5,175	5,050	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		8,387	7,960	8,408	6,444	6,621	6,444	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q3	30K (70 CRI)	53	6,550	6,241	6,592	5,033	5,171	5,033	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		6,969	6,629	7,002	5,355	5,502	5,355	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		5,575	5,975	6,325	4,290	4,410	4,290	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		7,105	6,744	7,124	5,460	5,610	5,460	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q2	30K (70 CRI)	45	5,476	5,218	5,511	4,208	4,323	4,208	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		5,826	5,542	5,854	4,477	4,600	4,477	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		4,550	4,890	5,175	3,500	3,590	3,500	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		5,940	5,639	5,956	4,565	4,690	4,565	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q1	30K (70 CRI)	34	4,188	3,990	4,214	3,218	3,306	3,218	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		4,455	4,238	4,476	3,424	3,517	3,424	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		3,500	3,770	3,980	2,690	2,760	2,690	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		4,543	4,312	4,554	3,491	3,586	3,491	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN

Field Adjustable Output (Q9/Q6/Q5/Q4/Q3/Q2/Q1) Option Description:

The Field Adjustable Output option enables the OSQ area luminaires to be tuned to the exact needs of a particular application through multiple levels of adjustment. When ordered with the Q option, the luminaire will be shipped from the factory at the selected Q setting and will be fully adjustable between the nine settings.

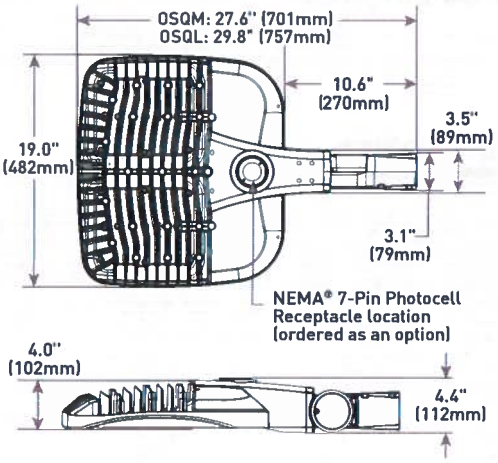
Q Option Power & Lumen Data – Designator K

Q Option Setting	CCT/CRI	System Watts	Lumen Values						Optics Qualified on DLC QPL	
		120-480V	Asymmetric	5ME	5SH, 5SQ & Floods	2ME w/BLS	3ME w/BLS	4ME w/BLS	Standard	Premium
Q9 (Full Power)	30K (70 CRI)	130	16,022	15,063	15,909	12,312	12,649	12,312	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		16,959	15,999	16,897	13,032	13,389	13,032	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		14,000	14,925	15,800	10,750	11,050	10,750	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		17,291	16,277	17,191	13,286	13,650	13,286	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q6	30K (70 CRI)	117	14,099	13,255	14,000	10,835	11,131	10,835	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		14,924	14,079	14,869	11,468	11,782	11,468	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		12,500	13,350	14,100	9,600	9,875	9,600	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		15,216	14,324	15,128	11,692	12,012	11,692	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q5	30K (70 CRI)	110	13,298	12,502	13,204	10,219	10,499	10,219	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		14,076	13,279	14,025	10,817	11,113	10,817	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		11,250	12,050	12,725	8,650	8,900	8,650	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		14,352	13,510	14,269	11,027	11,330	11,027	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q4	30K (70 CRI)	93	11,536	10,845	11,454	8,865	9,107	8,865	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		12,210	11,519	12,166	9,383	9,640	9,383	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		9,825	10,525	11,100	7,550	7,750	7,550	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		12,450	11,719	12,378	9,566	9,828	9,566	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q3	30K (70 CRI)	80	9,773	9,188	9,704	7,510	7,716	7,510	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		10,345	9,759	10,307	7,950	8,167	7,950	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		8,350	8,950	9,475	6,425	6,600	6,425	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		10,548	9,929	10,487	8,104	8,327	8,104	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q2	30K (70 CRI)	67	8,171	7,682	8,114	6,279	6,451	6,279	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		8,649	8,159	8,617	6,646	6,828	6,646	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		6,825	7,325	7,725	5,250	5,375	5,250	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		8,818	8,301	8,767	6,776	6,962	6,776	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
Q1	30K (70 CRI)	51	6,249	5,875	6,205	4,802	4,933	4,802	5ME	2ME, 3ME, 4ME, 5SH, 15D, 25D, 40D, 60D, WSN
	40K (70 CRI)		6,614	6,240	6,590	5,082	5,222	5,082	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	50K (90 CRI)		5,250	5,650	5,975	4,030	4,150	4,030	2ME, 3ME, 4ME	5ME, 5SH, 15D, 25D, 40D, 60D, WSN
	57K (70 CRI)		6,743	6,348	6,704	5,182	5,324	5,182	N/A	2ME, 3ME, 4ME, 5ME, 5SH, 15D, 25D, 40D, 60D, WSN

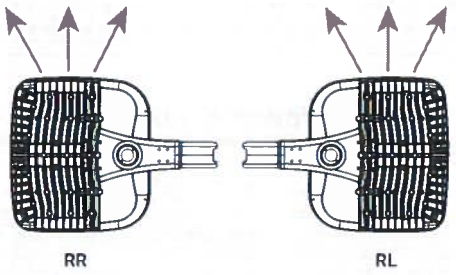
OSQ™ LED Area/Flood Luminaire featuring Cree TrueWhite® Technology – Medium

AA Mount

Weight
28.4 lbs. (12.9kg)



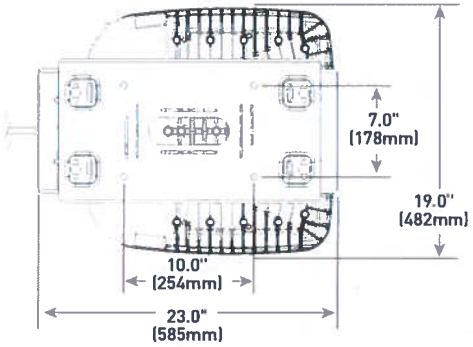
RR/RL Configuration

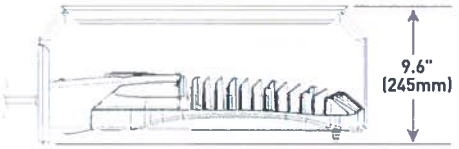


TSP Mount

Weight
42.0 lbs. (19.1kg)

OSQ Large luminaire shown.

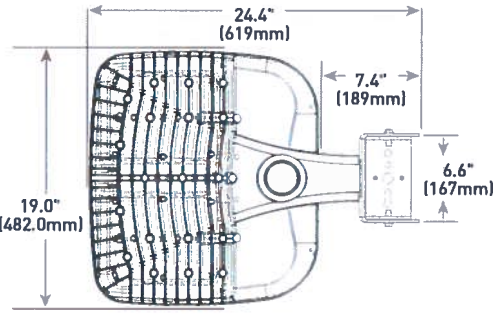


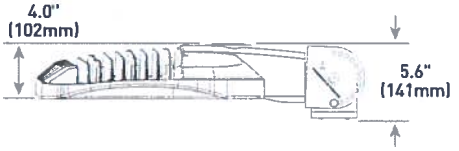


TM Mount

Weight
32.6 lbs. (14.8kg)

OSQ Large luminaire shown.





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