



Memorandum

To: Sudbury Board of Appeals
c/o Jody Kablack
Town of Sudbury
278 Old Sudbury Road
Sudbury, MA 01776

Date: June 20, 2016

cc:

Janet Carter Bernardo, P.E.
Senior Project Manager
Horsley Witten Group, Inc.

Project #: 13125.00

From: Karen F Staffier, PE

Re: Response to Comments – Initial Review of Avalon Sudbury Multi-Family Housing Development Site

The following responses are offered with respect to the comments received by VHB from the Horsley Witten Group Inc. (HW) in a letter dated June 6, 2016 Re: Peer Review for Avalon Sudbury related to their review of the May 2016 dated drainage report and supporting grading and drainage plan prepared by VHB in support of the Project. In support of this letter VHB is providing revised site plans dated June 20, 2016 ("Revised Site Plans") incorporating the changes noted herein.

Comment 1: *Standard 1: No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.*

The Applicant has stated that all stormwater will be discharged to existing closed drainage systems and does not propose any new outfalls to wetlands. To verify that the Avalon Sudbury redevelopment project is in compliance with Standard 1, HW recommends that the Applicant clarify which existing pipes associated with the various wetland resources areas will remain. It appears that the proposed development will be discharging into the large existing stormwater basin via two existing drain pipes. The existing drain pipes are discharging into recently refurbished forebays which should alleviate potential erosion into this wetland resource area.

HW recommends that the Applicant confirm that these are the only two outfalls impacted by the proposed development and clarify which existing drain lines within the limit of work are to be maintained. For instance it is not clear if the existing outlet from the wetland (WF6) along the southwest property line is being maintained as it is located beneath proposed Bio-retention Basin P-A. Furthermore it is not clear if the existing drain lines associated with the wetland (WF5) located near the north property line will remain.

Response: The existing pipe outlet from the southwest wetland area (WF6) – including the portion which crosses below Bio-retention Basin P-A (Note that the naming convention of the bioretention basins has been changed for clarity; Basin P-A is now Basin 1, Basin P-B: Basin 2), and the corresponding downstream outfall to the existing retention basin (Wetland 3) will be retained. Due to the location of proposed buildings, segments of pipe between these two outfalls will be relocated as shown on the Revised Site Plans. Additionally, the existing drain lines associated with the northern wetland area (WF5) will also remain. Notes have been added to the plans to clarify the segments of drain pipe within the Avalon Area are being retained.

Comment 2: *Standard 2: Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates...The Applicant appears to be in compliance with Standard 2.*

Response: No response needed.

Comment 3: *Standard 3 requires that the annual recharge from post-development shall approximate annual recharge from pre-development conditions.*

- a. *The Applicant has noted that the impervious area of the entire site will be reduced under the proposed layout and therefore the recharge criteria are met. To provide additional recharge the Applicant is proposing infiltration trenches around the perimeter of each building to infiltrate the roof runoff and a subsurface infiltration system as well as two bioretention areas to infiltrate portions of the access drive, walkways, and driveways. These methods of infiltrating are considered acceptable best management practices (BMPs) per the MSH. It appears that the Applicant is in compliance with Standard 3.*

Response: No response needed.

- b. *Three soil test pits have been performed to verify soils and separation to groundwater at the two bioretention areas (Pond P-A and P-B) as well as the subsurface infiltration system (Pond P-C). In accordance with Volume 2, Chapter 2, page 104 of the MSH, a second test pit should be conducted within the infiltration system. Mounding calculations may be required if the vertical separation from the bottom of the infiltration practices to the estimated seasonal high groundwater is less than four feet and the systems will infiltrate the 10-year storm event. HW recommends that the Applicant confirm whether a mounding analysis is required and provide the same if applicable. HW further recommends that additional test pits are conducted prior to construction in accordance with the MSH.*

Response: A note has been added to provide a second test pit at each infiltration BMP prior to construction to confirm soil and groundwater conditions. The systems are not designed to attenuate peak flow rates nor meet groundwater recharge requirements. They are solely designed to infiltrate the 1" Water Quality Volume, therefore a mounding analysis is not required.

- c. *HW recommends that a detail of the subsurface infiltration system including DMH 303 and OCS 302 be provided as part of the plan set. The HydroCAD modeling calculations for Pond P-C are difficult to follow without further detail, specifically in regards to the primary outlet. The HydroCAD modeling includes an 18 inch culvert at 145.40; however HW was not able to confirm this culvert on the plan.*

Response: Details of the subsurface infiltration system including DMH303 and OCS 302 are included on the Revised Site Plans and the HydroCAD model has been clarified.

Comment 4: *Standard 4 requires that the stormwater system be designed to remove 80% Total Suspended Solids (TSS) and to treat 1.0-inch of volume from the impervious area for water quality.*

- a. *The Applicant has stated that the stormwater management system is designed to remove a minimum of 80% of the Total Suspended Solids (TSS) from all proposed impervious surfaces as well as 44% pretreatment prior to infiltration BMPs. In order to meet the 80% TSS removal rate, the Applicant has proposed deep sump catch basins and water quality units or an infiltration system, or bioretention basins. The Applicant appears to have met the 80% TSS removal criteria.*

Response: No response required.

- b. *The Applicant has indicated on the design plans that forebays are proposed at the inlet to the bioretention basins. HW recommends that forebay sizing calculations be provided for review in accordance with Volume 2, Chapter 1, page 15 of the MSH.*

Response: Sediment forebay sizing calculations are attached hereto.

- c. *The HydroCAD calculations provided for Bio-retention Basin, P-B, include a 15 inch culvert with an invert at 150.50 as a primary outlet. On the plan this outlet appears to be a 12 inch culvert with an invert at 150.00. HW recommends that the Applicant revise the plans or the calculations for consistency. It also appears that during larger storm events Basin P-B may overtop the 154.5 berm proposed. HW further recommends an emergency overflow be proposed to protect the bank from potential erosion.*

Response: The HydroCAD model has been modified to reflect the correct outlet (Changed to an 18-inch) for consistency with the plans. The outlets are sized to minimize the likelihood that the basin will overtop, however a rip rap spillway has been added to the Revised Site Plans for use in rare circumstances.

Comment 5: *Standard 5 is related to projects with a Land Use of Higher Potential Pollutant Loads (LUHPPL)... The project is not considered a LUHPPL, therefore no further comment is needed.*

Response: No response needed.

Comment 6: *Standard 6 is related to projects with stormwater discharging into a critical area, a Zone II or an Interim Wellhead Protection Area of a public water supply. The Applicant appears to be in compliance with Standard 6.*

Response: No response needed.

Comment 7: *Standard 7 is related to projects considered Redevelopment...The Applicant appears to be in compliance with Standard 7.*

Response: No response needed.

Comment 8: *Standard 8 requires a plan to control construction related impacts including erosion, sedimentation or other pollutant sources.*

- a. *The Applicant has noted that a Stormwater Pollution Prevention Plan (SWPPP) will be developed and submitted to the Town prior to land disturbance in accordance with the EPA National Pollutant Discharge Elimination System (NPDES) Construction General Permit. In the event that various phases are constructed simultaneously the Applicant should verify that the proposed erosion control methods function in harmony. For instance it may be reasonable to utilize the same construction entrance for various phases and verify that the location of the erosion control barriers (e.g. straw bale or silt sock) for one phase are not in conflict with the vehicle access to a separate phase.*
- b. *The plans reviewed by HW did not include extensive erosion controls or details. HW recommends that the Applicant provide full erosion control plans with typical construction practices including the location of stock piles and construction access for review and approval by the Town of Sudbury.*

Response: The erosion controls proposed and the related details are included on the Revised Site Plan.

Comment 9: *Standard 9 requires a Long Term Operation and Maintenance (O & M) Plan to be provided.*

The Applicant has included a Long Term Operation and Maintenance (O&M) Plan in the submission that includes checklists for maintenance. It appears that Sudbury Avalon, Inc. will be responsible for all maintenance and inspections of the stormwater system for the Avalon Sudbury development. HW recommends that the Applicant confirm who the responsible party will be.

The Maintenance of Stormwater Management Systems narrative includes a statement on checking dumpster areas. It does not appear that dumpsters have been located on the plan set. HW recommends that the Applicant clarify how solid waste will be typically managed at Avalon Sudbury.

Response: The responsible party for stormwater maintenance will be Sudbury Avalon, Inc. The Avalon Sudbury project will be professionally managed by Avalon staff who are present on site on a daily basis. Trash and recycling will be handled within the trash building. The area around the trash building will be inspected daily by Avalon's maintenance team and regular private trash pickups will be scheduled to assure a clean and safe operation.

Comment 10: *Standard 10 requires an Illicit Discharge Compliance Statement be provided.*

The Applicant has stated that the stormwater components included in the design plans submitted for this portion of the Master redevelopment project are in full compliance with current standards. HW recommends that as stated in Volume 1, Chapter 1, page 25 of the Massachusetts Stormwater Handbook, a Certificate of Compliance should not be issued by the Sudbury Conservation Commission until it has been determined that the Illicit Discharge Compliance Statement has been submitted for the Avalon Sudbury development and that it has been verified that there are no illicit discharges occurring on this portion of the 50 acre site.

Response: No response needed.

Comment 11: Plan Details

- a. *HW recommends that a detail for the bioretention basins be provided including the inlets, forebays, berms, materials, and planting plan.*

Response: A detail of the bioretention basins has been provided. Plantings proposed within the basins will be based on the palette of bioretention area plantings indicated on the Planting Plan.

- b. *The inlets to Basin P-B should be clarified. There appear to be two however only one has been labeled.*
- c. *HW recommends that additional spot grades be added within the parking area to verify that runoff will flow towards the catch basins and not pond in corners.*

Response: At the time construction plans are developed, it is anticipated that spot grading will be added throughout the site to clarify the intended drainage patterns as well as required accessible routes for the contractor to confirm the intent of the design will be ultimately built.

- d. *There are a number of locations around the perimeter of the proposed development where the proposed contours do not tie back in to the exiting contours. It appears that the grading can be designed appropriately however the Applicant should verify the proposed contours are added so that the proposed stormwater will be runoff as designed. There are a number of contours missing near the Beltran Building as well as in the vicinity of the wastewater treatment plan, both of which are labeled to remain.*

Response: The Revised Site Plans include proposed contours in these areas where this detail was previously not provided.

- e. *HW has only reviewed the Grading, Drainage, and Erosion Control Plan for this*

Comment 12: Drainage Calculations

The Applicant has provided storm drain calculations for the 25-year design storm. HW offers the following comments:

- a. *It appears that the 18-inch pipe at CB-308 only has only one foot of cover. HW recommends that the Applicant verify that the pipe can physically be installed in this catch basin.*

Response: The plan previously provided was a simplification of the anticipated landscape drainage system that will ultimately be implemented within the open space amenity area around the clubhouse. To provide some clarification at this level of design, the 18-inch pipe at CB308 has been changed to a 12-inch pipe, and a landscape drain (LD308B) has been added to the area near the pool to intercept some runoff originally indicated as contributing to CB308.

- b. *It is not clear what material is proposed for the drain pipes. HW recommends that the material be listed on the plan set or on a detail sheet.*

Response: At this time pipe materials are anticipated to be High Density Polyethylene, with the potential for PVC among the smaller diameter pipes like roof drain header pipes. Reinforced Concrete pipe will be used in areas where cover is less than 2ft in vehicular areas.

Attachments:

- ***Site Plans dated June 20, 2016***
- ***Revised HydroCAD bioretention & subsurface sizing analysis***
- ***Forebay sizing calculations***

13125-Avalon Bioretention Sizing

Type III 24-hr 25-Year Rainfall=6.0"

Prepared by WATSCCM2012

Printed 6/16/2016

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Summary for Pond B-1: Bio-retention Basin 1

Inflow Area = 0.9 ac, 32.34% Impervious, Inflow Depth = 3.6" for 25-Year event
 Inflow = 3.9 cfs @ 12.07 hrs, Volume= 0.3 af
 Outflow = 2.8 cfs @ 12.15 hrs, Volume= 0.3 af, Atten= 29%, Lag= 4.4 min
 Discarded = 0.7 cfs @ 12.15 hrs, Volume= 0.2 af
 Primary = 2.1 cfs @ 12.15 hrs, Volume= 0.0 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 154.64' @ 12.15 hrs Surf.Area= 3,399 sf Storage= 1,898 cf
 Flood Elev= 155.00' Surf.Area= 3,882 sf Storage= 3,214 cf

Plug-Flow detention time= 12.8 min calculated for 0.3 af (100% of inflow)
 Center-of-Mass det. time= 12.8 min (831.0 - 818.2)

Volume	Invert	Avail.Storage	Storage Description
#1	154.00'	3,214 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
154.00	2,545	0	0
155.00	3,882	3,214	3,214

Device	Routing	Invert	Outlet Devices
#1	Primary	151.00'	12.0" Round Culvert L= 16.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 151.00' / 150.50' S= 0.0313 '/' Cc= 0.900
#2	Device 1	154.50'	24.0" Horiz. Orifice/Grate X 2.00 C= 0.600 Limited to weir flow at low heads
#3	Discarded	154.00'	8.270 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.7 cfs @ 12.15 hrs HW=154.64' (Free Discharge)
 ↑**3=Exfiltration** (Exfiltration Controls 0.7 cfs)

Primary OutFlow Max=2.1 cfs @ 12.15 hrs HW=154.64' (Free Discharge)
 ↑**1=Culvert** (Passes 2.1 cfs of 6.7 cfs potential flow)
 ↑**2=Orifice/Grate** (Weir Controls 2.1 cfs @ 1.22 fps)

13125-Avalon Bioretention Sizing

Type III 24-hr 25-Year Rainfall=6.0"

Prepared by WATSCCM2012

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Hydrograph for Pond B-1: Bio-retention Basin 1

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
8.00	0.0	1	154.00	0.0	0.0	0.0
8.50	0.0	1	154.00	0.0	0.0	0.0
9.00	0.0	2	154.00	0.0	0.0	0.0
9.50	0.1	3	154.00	0.1	0.1	0.0
10.00	0.1	4	154.00	0.1	0.1	0.0
10.50	0.1	6	154.00	0.1	0.1	0.0
11.00	0.2	9	154.00	0.2	0.2	0.0
11.50	0.3	16	154.01	0.3	0.3	0.0
12.00	2.5	826	154.30	0.6	0.6	0.0
12.50	0.8	1,591	154.55	1.0	0.6	0.4
13.00	0.4	1,241	154.44	0.6	0.6	0.0
13.50	0.3	761	154.28	0.6	0.6	0.0
14.00	0.2	262	154.10	0.5	0.5	0.0
14.50	0.2	11	154.00	0.2	0.2	0.0
15.00	0.2	9	154.00	0.2	0.2	0.0
15.50	0.2	8	154.00	0.2	0.2	0.0
16.00	0.1	7	154.00	0.1	0.1	0.0
16.50	0.1	6	154.00	0.1	0.1	0.0
17.00	0.1	5	154.00	0.1	0.1	0.0
17.50	0.1	5	154.00	0.1	0.1	0.0
18.00	0.1	4	154.00	0.1	0.1	0.0
18.50	0.1	4	154.00	0.1	0.1	0.0
19.00	0.1	4	154.00	0.1	0.1	0.0
19.50	0.1	3	154.00	0.1	0.1	0.0
20.00	0.1	3	154.00	0.1	0.1	0.0
20.50	0.1	3	154.00	0.1	0.1	0.0
21.00	0.1	3	154.00	0.1	0.1	0.0
21.50	0.1	3	154.00	0.1	0.1	0.0
22.00	0.1	3	154.00	0.1	0.1	0.0
22.50	0.0	3	154.00	0.0	0.0	0.0
23.00	0.0	2	154.00	0.0	0.0	0.0
23.50	0.0	2	154.00	0.0	0.0	0.0
24.00	0.0	2	154.00	0.0	0.0	0.0
24.50	0.0	0	154.00	0.0	0.0	0.0
25.00	0.0	0	154.00	0.0	0.0	0.0
25.50	0.0	0	154.00	0.0	0.0	0.0
26.00	0.0	0	154.00	0.0	0.0	0.0
26.50	0.0	0	154.00	0.0	0.0	0.0
27.00	0.0	0	154.00	0.0	0.0	0.0
27.50	0.0	0	154.00	0.0	0.0	0.0
28.00	0.0	0	154.00	0.0	0.0	0.0

13125-Avalon Bioretention Sizing

Type III 24-hr WQV-DYN-A Rainfall=2.8"

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Summary for Pond B-1: Bio-retention Basin 1

Inflow Area = 0.9 ac, 32.34% Impervious, Inflow Depth = 1.0" for WQV-DYN-A event
 Inflow = 1.0 cfs @ 12.08 hrs, Volume= 0.1 af
 Outflow = 0.5 cfs @ 12.26 hrs, Volume= 0.1 af, Atten= 51%, Lag= 10.6 min
 Discarded = 0.5 cfs @ 12.26 hrs, Volume= 0.1 af
 Primary = 0.0 cfs @ 0.00 hrs, Volume= 0.0 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
 Peak Elev= 154.11' @ 12.26 hrs Surf.Area= 2,687 sf Storage= 277 cf
 Flood Elev= 155.00' Surf.Area= 3,882 sf Storage= 3,214 cf

Plug-Flow detention time= 2.9 min calculated for 0.1 af (100% of inflow)
 Center-of-Mass det. time= 2.8 min (858.7 - 855.9)

Volume	Invert	Avail.Storage	Storage Description
#1	154.00'	3,214 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
154.00	2,545	0	0
155.00	3,882	3,214	3,214

Device	Routing	Invert	Outlet Devices
#1	Primary	151.00'	12.0" Round Culvert L= 16.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 151.00' / 150.50' S= 0.0313 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	154.50'	24.0" Horiz. Orifice/Grate X 2.00 C= 0.600 Limited to weir flow at low heads
#3	Discarded	154.00'	8.270 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.5 cfs @ 12.26 hrs HW=154.11' (Free Discharge)
 ↑**3=Exfiltration** (Exfiltration Controls 0.5 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=154.00' (Free Discharge)
 ↑**1=Culvert** (Passes 0.0 cfs of 6.0 cfs potential flow)
 ↑**2=Orifice/Grate** (Controls 0.0 cfs)

13125-Avalon Bioretention Sizing

Type III 24-hr WQV-DYN-A Rainfall=2.8"

Prepared by WATSCCM2012

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Hydrograph for Pond B-1: Bio-retention Basin 1

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
8.00	0.0	0	154.00	0.0	0.0	0.0
8.50	0.0	0	154.00	0.0	0.0	0.0
9.00	0.0	0	154.00	0.0	0.0	0.0
9.50	0.0	0	154.00	0.0	0.0	0.0
10.00	0.0	0	154.00	0.0	0.0	0.0
10.50	0.0	0	154.00	0.0	0.0	0.0
11.00	0.0	1	154.00	0.0	0.0	0.0
11.50	0.0	2	154.00	0.0	0.0	0.0
12.00	0.6	27	154.01	0.5	0.5	0.0
12.50	0.3	172	154.07	0.5	0.5	0.0
13.00	0.1	6	154.00	0.1	0.1	0.0
13.50	0.1	5	154.00	0.1	0.1	0.0
14.00	0.1	4	154.00	0.1	0.1	0.0
14.50	0.1	4	154.00	0.1	0.1	0.0
15.00	0.1	3	154.00	0.1	0.1	0.0
15.50	0.1	3	154.00	0.1	0.1	0.0
16.00	0.0	2	154.00	0.0	0.0	0.0
16.50	0.0	2	154.00	0.0	0.0	0.0
17.00	0.0	2	154.00	0.0	0.0	0.0
17.50	0.0	2	154.00	0.0	0.0	0.0
18.00	0.0	1	154.00	0.0	0.0	0.0
18.50	0.0	1	154.00	0.0	0.0	0.0
19.00	0.0	1	154.00	0.0	0.0	0.0
19.50	0.0	1	154.00	0.0	0.0	0.0
20.00	0.0	1	154.00	0.0	0.0	0.0
20.50	0.0	1	154.00	0.0	0.0	0.0
21.00	0.0	1	154.00	0.0	0.0	0.0
21.50	0.0	1	154.00	0.0	0.0	0.0
22.00	0.0	1	154.00	0.0	0.0	0.0
22.50	0.0	1	154.00	0.0	0.0	0.0
23.00	0.0	1	154.00	0.0	0.0	0.0
23.50	0.0	1	154.00	0.0	0.0	0.0
24.00	0.0	1	154.00	0.0	0.0	0.0
24.50	0.0	0	154.00	0.0	0.0	0.0
25.00	0.0	0	154.00	0.0	0.0	0.0
25.50	0.0	0	154.00	0.0	0.0	0.0
26.00	0.0	0	154.00	0.0	0.0	0.0
26.50	0.0	0	154.00	0.0	0.0	0.0
27.00	0.0	0	154.00	0.0	0.0	0.0
27.50	0.0	0	154.00	0.0	0.0	0.0
28.00	0.0	0	154.00	0.0	0.0	0.0

13125-Avalon Bioretention Sizing

Type III 24-hr 25-Year Rainfall=6.0"

Prepared by WATSCCM2012

Printed 6/16/2016

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Page 1

Summary for Pond B-2: Bio-retention Basin 2

Inflow Area = 2.2 ac, 52.26% Impervious, Inflow Depth = 4.2" for 25-Year event
 Inflow = 11.2 cfs @ 12.07 hrs, Volume= 0.8 af
 Outflow = 10.2 cfs @ 12.11 hrs, Volume= 0.8 af, Atten= 9%, Lag= 2.1 min
 Discarded = 0.9 cfs @ 12.11 hrs, Volume= 0.5 af
 Primary = 9.3 cfs @ 12.11 hrs, Volume= 0.3 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 2
 Peak Elev= 154.37' @ 12.11 hrs Surf.Area= 4,770 sf Storage= 6,266 cf
 Flood Elev= 155.00' Surf.Area= 5,206 sf Storage= 6,908 cf

Plug-Flow detention time= 50.0 min calculated for 0.8 af (100% of inflow)
 Center-of-Mass det. time= 50.0 min (852.6 - 802.6)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	6,908 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	1,364	0	0
153.00	2,290	1,827	1,827
154.00	3,513	2,902	4,729
154.50	5,206	2,180	6,908

Device	Routing	Invert	Outlet Devices
#1	Primary	150.00'	18.0" Round Culvert L= 11.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 150.00' / 149.30' S= 0.0636 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	154.00'	24.0" Horiz. Orifice/Grate X 2.00 C= 0.600 Limited to weir flow at low heads
#3	Discarded	152.00'	8.270 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.9 cfs @ 12.11 hrs HW=154.37' (Free Discharge)
 ↑ **3=Exfiltration** (Exfiltration Controls 0.9 cfs)

Primary OutFlow Max=9.3 cfs @ 12.11 hrs HW=154.37' (Free Discharge)
 ↑ **1=Culvert** (Passes 9.3 cfs of 16.2 cfs potential flow)
 ↑ **2=Orifice/Grate** (Weir Controls 9.3 cfs @ 1.99 fps)

13125-Avalon Bioretention Sizing

Type III 24-hr 25-Year Rainfall=6.0"

Prepared by WATSCCM2012

Printed 6/16/2016

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Hydrograph for Pond B-2: Bio-retention Basin 2

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
8.00	0.1	13	152.01	0.1	0.1	0.0
8.50	0.1	19	152.01	0.1	0.1	0.0
9.00	0.2	27	152.02	0.2	0.2	0.0
9.50	0.2	36	152.03	0.2	0.2	0.0
10.00	0.3	64	152.05	0.3	0.3	0.0
10.50	0.4	222	152.15	0.3	0.3	0.0
11.00	0.6	567	152.37	0.3	0.3	0.0
11.50	1.0	1,290	152.75	0.4	0.4	0.0
12.00	7.3	5,311	154.15	3.3	0.8	2.5
12.50	2.2	5,218	154.13	2.7	0.8	2.0
13.00	1.0	4,877	154.04	1.0	0.7	0.3
13.50	0.8	4,791	154.02	0.8	0.7	0.1
14.00	0.6	4,730	154.00	0.7	0.7	0.0
14.50	0.5	4,573	153.96	0.7	0.7	0.0
15.00	0.5	4,315	153.88	0.6	0.6	0.0
15.50	0.4	3,969	153.78	0.6	0.6	0.0
16.00	0.3	3,547	153.64	0.6	0.6	0.0
16.50	0.3	3,086	153.49	0.6	0.6	0.0
17.00	0.3	2,634	153.32	0.5	0.5	0.0
17.50	0.2	2,197	153.16	0.5	0.5	0.0
18.00	0.2	1,777	152.98	0.4	0.4	0.0
18.50	0.2	1,380	152.80	0.4	0.4	0.0
19.00	0.2	1,023	152.62	0.4	0.4	0.0
19.50	0.2	705	152.45	0.3	0.3	0.0
20.00	0.2	423	152.28	0.3	0.3	0.0
20.50	0.2	179	152.13	0.3	0.3	0.0
21.00	0.2	24	152.02	0.2	0.2	0.0
21.50	0.1	22	152.02	0.1	0.1	0.0
22.00	0.1	21	152.02	0.1	0.1	0.0
22.50	0.1	20	152.01	0.1	0.1	0.0
23.00	0.1	19	152.01	0.1	0.1	0.0
23.50	0.1	18	152.01	0.1	0.1	0.0
24.00	0.1	17	152.01	0.1	0.1	0.0
24.50	0.0	0	152.00	0.0	0.0	0.0
25.00	0.0	0	152.00	0.0	0.0	0.0
25.50	0.0	0	152.00	0.0	0.0	0.0
26.00	0.0	0	152.00	0.0	0.0	0.0
26.50	0.0	0	152.00	0.0	0.0	0.0
27.00	0.0	0	152.00	0.0	0.0	0.0
27.50	0.0	0	152.00	0.0	0.0	0.0
28.00	0.0	0	152.00	0.0	0.0	0.0

13125-Avalon Bioretention Sizing

Type III 24-hr WQV-DYN-B Rainfall=2.4"

Prepared by WATSCCM2012

Printed 6/16/2016

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Summary for Pond B-2: Bio-retention Basin 2

Inflow Area = 2.2 ac, 52.26% Impervious, Inflow Depth = 1.0" for WQV-DYN-B event
 Inflow = 2.8 cfs @ 12.08 hrs, Volume= 0.2 af
 Outflow = 0.5 cfs @ 12.55 hrs, Volume= 0.2 af, Atten= 82%, Lag= 28.3 min
 Discarded = 0.5 cfs @ 12.55 hrs, Volume= 0.2 af
 Primary = 0.0 cfs @ 0.00 hrs, Volume= 0.0 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 2
 Peak Elev= 153.29' @ 12.55 hrs Surf.Area= 2,650 sf Storage= 2,553 cf
 Flood Elev= 155.00' Surf.Area= 5,206 sf Storage= 6,908 cf

Plug-Flow detention time= 42.0 min calculated for 0.2 af (100% of inflow)
 Center-of-Mass det. time= 42.0 min (884.7 - 842.7)

Volume	Invert	Avail.Storage	Storage Description
#1	152.00'	6,908 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
152.00	1,364	0	0
153.00	2,290	1,827	1,827
154.00	3,513	2,902	4,729
154.50	5,206	2,180	6,908

Device	Routing	Invert	Outlet Devices
#1	Primary	150.00'	18.0" Round Culvert L= 11.0' RCP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 150.00' / 149.30' S= 0.0636 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	154.00'	24.0" Horiz. Orifice/Grate X 2.00 C= 0.600 Limited to weir flow at low heads
#3	Discarded	152.00'	8.270 in/hr Exfiltration over Surface area

Discarded OutFlow Max=0.5 cfs @ 12.55 hrs HW=153.29' (Free Discharge)
 ↑**3=Exfiltration** (Exfiltration Controls 0.5 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=152.00' (Free Discharge)
 ↑**1=Culvert** (Passes 0.0 cfs of 9.5 cfs potential flow)
 ↑**2=Orifice/Grate** (Controls 0.0 cfs)

13125-Avalon Bioretention Sizing

Type III 24-hr WQV-DYN-B Rainfall=2.4"

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Hydrograph for Pond B-2: Bio-retention Basin 2

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
8.00	0.0	0	152.00	0.0	0.0	0.0
8.50	0.0	0	152.00	0.0	0.0	0.0
9.00	0.0	0	152.00	0.0	0.0	0.0
9.50	0.0	0	152.00	0.0	0.0	0.0
10.00	0.0	2	152.00	0.0	0.0	0.0
10.50	0.0	6	152.00	0.0	0.0	0.0
11.00	0.1	11	152.01	0.1	0.1	0.0
11.50	0.2	23	152.02	0.1	0.1	0.0
12.00	1.7	578	152.38	0.3	0.3	0.0
12.50	0.6	2,541	153.29	0.5	0.5	0.0
13.00	0.3	2,335	153.21	0.5	0.5	0.0
13.50	0.2	1,947	153.05	0.5	0.5	0.0
14.00	0.2	1,550	152.88	0.4	0.4	0.0
14.50	0.2	1,152	152.69	0.4	0.4	0.0
15.00	0.1	780	152.49	0.3	0.3	0.0
15.50	0.1	433	152.29	0.3	0.3	0.0
16.00	0.1	114	152.08	0.3	0.3	0.0
16.50	0.1	15	152.01	0.1	0.1	0.0
17.00	0.1	13	152.01	0.1	0.1	0.0
17.50	0.1	12	152.01	0.1	0.1	0.0
18.00	0.1	10	152.01	0.1	0.1	0.0
18.50	0.1	10	152.01	0.1	0.1	0.0
19.00	0.1	9	152.01	0.1	0.1	0.0
19.50	0.1	9	152.01	0.1	0.1	0.0
20.00	0.1	8	152.01	0.1	0.1	0.0
20.50	0.1	8	152.01	0.1	0.1	0.0
21.00	0.0	8	152.01	0.0	0.0	0.0
21.50	0.0	7	152.01	0.0	0.0	0.0
22.00	0.0	7	152.01	0.0	0.0	0.0
22.50	0.0	7	152.00	0.0	0.0	0.0
23.00	0.0	6	152.00	0.0	0.0	0.0
23.50	0.0	6	152.00	0.0	0.0	0.0
24.00	0.0	6	152.00	0.0	0.0	0.0
24.50	0.0	0	152.00	0.0	0.0	0.0
25.00	0.0	0	152.00	0.0	0.0	0.0
25.50	0.0	0	152.00	0.0	0.0	0.0
26.00	0.0	0	152.00	0.0	0.0	0.0
26.50	0.0	0	152.00	0.0	0.0	0.0
27.00	0.0	0	152.00	0.0	0.0	0.0
27.50	0.0	0	152.00	0.0	0.0	0.0
28.00	0.0	0	152.00	0.0	0.0	0.0

13125-Avalon Infiltration Sizing

Type III 24-hr WQV-DYN Rainfall=1.2"

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Summary for Pond P-C: Subsurface Infiltration System

Inflow Area = 2.6 ac, 100.00% Impervious, Inflow Depth = 1.0" for WQV-DYN event
Inflow = 2.9 cfs @ 12.07 hrs, Volume= 0.2 af
Outflow = 0.1 cfs @ 9.20 hrs, Volume= 0.2 af, Atten= 98%, Lag= 0.0 min
Discarded = 0.1 cfs @ 9.20 hrs, Volume= 0.2 af
Primary = 0.0 cfs @ 0.00 hrs, Volume= 0.0 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 155.49' @ 16.68 hrs Surf.Area= 2,921 sf Storage= 5,732 cf
Flood Elev= 155.50' Surf.Area= 2,921 sf Storage= 5,747 cf

Plug-Flow detention time= 760.2 min calculated for 0.2 af (100% of inflow)
Center-of-Mass det. time= 760.2 min (1,541.3 - 781.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	152.50'	2,593 cf	39.50'W x 73.64'L x 3.50'H Field A 10,180 cf Overall - 3,698 cf Embedded = 6,483 cf x 40.0% Voids
#2A	153.00'	3,698 cf	ADS_StormTech SC-740 x 80 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap Row Length Adjustment= +0.44' x 6.45 sf x 8 rows
#3	152.50'	63 cf	4.00'D x 5.00'H Vertical Cone/Cylinder
		6,354 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	152.50'	1.020 in/hr Exfiltration over Surface area
#2	Primary	148.70'	30.0" Round Culvert out of OCS302 L= 125.0' Ke= 0.500 Inlet / Outlet Invert= 148.70' / 147.80' S= 0.0072 '/' Cc= 0.900 n= 0.011 Concrete pipe, straight & clean, Flow Area= 4.91 sf
#3	Device 2	155.50'	4.0' long x 2.50' rise Sharp-Crested Rectangular Weir 0 End Contraction(s) 3.5' Crest Height

Discarded OutFlow Max=0.1 cfs @ 9.20 hrs HW=152.56' (Free Discharge)

↑**1=Exfiltration** (Exfiltration Controls 0.1 cfs)

Primary OutFlow Max=0.0 cfs @ 0.00 hrs HW=152.50' (Free Discharge)

↑**2=Culvert out of OCS302** (Passes 0.0 cfs of 37.7 cfs potential flow)

↑**3=Sharp-Crested Rectangular Weir** (Controls 0.0 cfs)

13125-Avalon Infiltration Sizing

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Type III 24-hr WQV-DYN Rainfall=1.2"

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Pond P-C: Subsurface Infiltration System - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 (ADS StormTech®SC-740)

Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf

Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

Row Length Adjustment= +0.44' x 6.45 sf x 8 rows

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

10 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 71.64' Row Length +12.0" End Stone x 2 = 73.64' Base Length

8 Rows x 51.0" Wide + 6.0" Spacing x 7 + 12.0" Side Stone x 2 = 39.50' Base Width

6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

80 Chambers x 45.9 cf +0.44' Row Adjustment x 6.45 sf x 8 Rows = 3,697.8 cf Chamber Storage

10,180.5 cf Field - 3,697.8 cf Chambers = 6,482.7 cf Stone x 40.0% Voids = 2,593.1 cf Stone Storage

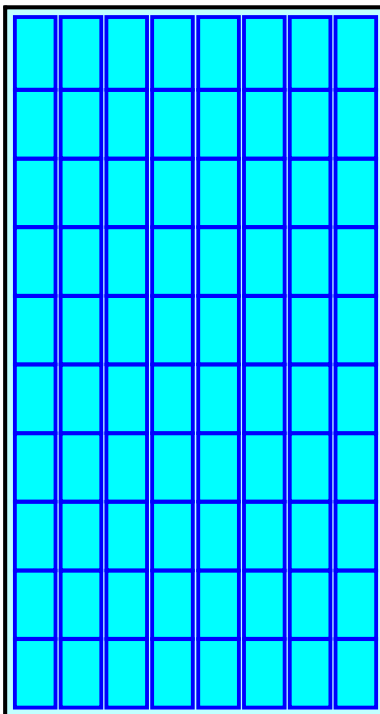
Chamber Storage + Stone Storage = 6,290.9 cf = 0.1 af

Overall Storage Efficiency = 61.8%

80 Chambers

377.1 cy Field

240.1 cy Stone



13125-Avalon Infiltration Sizing

Type III 24-hr WQV-DYN Rainfall=1.2"

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Hydrograph for Pond P-C: Subsurface Infiltration System

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.0	0	152.50	0.0	0.0	0.0
2.00	0.0	0	152.50	0.0	0.0	0.0
4.00	0.0	2	152.50	0.0	0.0	0.0
6.00	0.0	13	152.51	0.0	0.0	0.0
8.00	0.0	36	152.53	0.0	0.0	0.0
10.00	0.1	132	152.61	0.1	0.1	0.0
12.00	1.9	1,946	153.56	0.1	0.1	0.0
14.00	0.2	5,388	155.22	0.1	0.1	0.0
16.00	0.1	5,719	155.48	0.1	0.1	0.0
18.00	0.0	5,685	155.45	0.1	0.1	0.0
20.00	0.0	5,505	155.31	0.1	0.1	0.0
22.00	0.0	5,268	155.15	0.1	0.1	0.0
24.00	0.0	4,982	154.98	0.1	0.1	0.0
26.00	0.0	4,493	154.72	0.1	0.1	0.0
28.00	0.0	3,996	154.47	0.1	0.1	0.0
30.00	0.0	3,500	154.24	0.1	0.1	0.0
32.00	0.0	3,003	154.02	0.1	0.1	0.0
34.00	0.0	2,506	153.80	0.1	0.1	0.0
36.00	0.0	2,010	153.59	0.1	0.1	0.0
38.00	0.0	1,513	153.38	0.1	0.1	0.0
40.00	0.0	1,017	153.17	0.1	0.1	0.0
42.00	0.0	520	152.94	0.1	0.1	0.0
44.00	0.0	34	152.53	0.0	0.0	0.0
46.00	0.0	0	152.50	0.0	0.0	0.0
48.00	0.0	0	152.50	0.0	0.0	0.0
50.00	0.0	0	152.50	0.0	0.0	0.0
52.00	0.0	0	152.50	0.0	0.0	0.0
54.00	0.0	0	152.50	0.0	0.0	0.0
56.00	0.0	0	152.50	0.0	0.0	0.0
58.00	0.0	0	152.50	0.0	0.0	0.0
60.00	0.0	0	152.50	0.0	0.0	0.0
62.00	0.0	0	152.50	0.0	0.0	0.0
64.00	0.0	0	152.50	0.0	0.0	0.0
66.00	0.0	0	152.50	0.0	0.0	0.0
68.00	0.0	0	152.50	0.0	0.0	0.0
70.00	0.0	0	152.50	0.0	0.0	0.0
72.00	0.0	0	152.50	0.0	0.0	0.0



Sediment Forebay Sizing Calculations

Project Name: Avalon Sudbury **Proj. No.:** 13125.00
Project Location: Sudbury, MA **Date:** 5/18/2016
Calculated by: BMG

Bio-Retention Basin 1

Total Contributing Impervious Area (sq.ft.) = **12,651**

Sediment Forebay WQV:

Required:

Runoff Depth to be Treated (in.)	Required Volume (cu.ft.)
0.10	105

Provided:

Elevation	Area (s.f.)	Cumulative Volume (c.f.)
154	352	0
154.5	183	134



Sediment Forebay Sizing Calculations

Project Name: Avalon Sudbury

Proj. No.: 13125.00

Date: 5/18/2016

Project Location: Sudbury, MA

Calculated by: BMG

Bio-Retention Basin 2

Total Contributing Impervious Area (sq.ft.) = **50,831**

Sediment Forebay 1 WQV:

Required:

Runoff Depth to be Treated (in.)	Required Volume (cu.ft.)
0.10	212

Provided:

Elevation	Area (s.f.)	Cumulative Volume (c.f.)
153	146	0
154	315	231

Sediment Forebay 2 WQV:

Required:

Runoff Depth to be Treated (in.)	Required Volume (cu.ft.)
0.10	212

Provided:

Elevation	Area (s.f.)	Cumulative Volume (c.f.)
153	111	0
154	340	226