



**INFILTRATION BED (MRC) 51 (BMP 51)  
MANAGED RELEASE CONCEPT (MRC) DESIGN SUMMARY**

*Complete One Design Summary Sheet for Each BMP Designed for MRC*

**GENERAL INFORMATION**

Applicant Name: Kennett Township Project Name: Greenway Trail along Chandler Mill Road  
 Applicant Address: 801 Burrows Run Road Municipality: Kennett Township  
 City, State, Zip: Chadds Ford, PA 19317 County: Chester  
 Permit Type:  NPDES PAG-02  NPDES IP  ESCGP  ESP

	Pre-Development	Post-Development	Change
Impervious Area (acres):	0.032	0.045	0.013

**MRC BMP INFORMATION**

MRC BMP Type: Underground Chambers Stormwater BMP Manual Section: 6.4.3

Will the BMP Include Vegetation?  Yes  No

If Yes, Identify Proposed Vegetation: \_\_\_\_\_

For Non-Vegetated BMPs Will There Be Pre- or Post-Treatment?  Yes (Pre-)  Yes (Post-)  No

If Yes, Identify Proposed Pre- or Post-Treatment: Pre: Impervious runoff crosses vegetated buffer and verge area

Name of Surface Water to Receive MRC BMP Discharges: West Branch Red Clay Creek

Designated Use of Surface Water: TSF-MF Existing Use of Surface Water (if different): \_\_\_\_\_

Is the Surface Water Impaired?  Yes  No

If Yes, Identify Cause(s): Siltation from Agriculture

Will the BMP have an impermeable liner?  Yes  No

If Yes, explain why a liner is proposed: \_\_\_\_\_

BMP Media Description: Stone aggregate

Are Any Deviations from MRC Design Standards Proposed?  Yes  No

If Yes, Identify Deviations: \_\_\_\_\_

**MRC BMP DESIGN VALUES AND STANDARDS**

Parameter	Design Value	Design Standard
Actual Contributing Impervious Area to BMP (acres)	0.045	
Equivalent Contributing Impervious Area to BMP (acres)	0.058	
Total Drainage Area to BMP (acres)	0.060	
MRC BMP Release Rate (cfs)	0.00	No greater than 0.01 cfs / acre of equivalent contributing impervious
Underdrain Outflow Rate During 1.2-Inch/2-Hour Storm (cfs)	0.00	<= MRC BMP Release Rate (cfs)
Maximum Storm Event Routed to MRC BMP	100 yr	

**MRC BMP Design Summary**  
**Revised, August 25, 2020**

Parameter	Design Value	Design Standard
BMP Footprint Area (ft <sup>2</sup> )	<b>1005</b>	
Bottom BMP Elevation (Native Soils) (ft)	<b>237.25</b>	
2-Yr/24-Hr Storm Ponding Depth (ft)	<b>1.24</b>	1 ft (recommended) (2 ft max)
Maximum Ponding Depth (ft)	<b>1.86</b>	4 ft (max)
Overflow Bypass Elevation (ft)	<b>238.88</b>	
Media Depth (ft)	<b>2.67</b>	2 ft (min) – 4 ft (max)
Media Void Space (%)	<b>40</b>	
Internal Water Storage (IWS) Depth (ft)	<b>1.0</b>	1 ft recommended
Top of IWS Elevation (ft)	<b>238.75</b>	
Underdrain Pipe Diameter (in)	<b>6</b>	
Underdrain Orifice Diameter (in)	<b>0.25</b>	
Underdrain Outlet Elevation (ft)	<b>238.75</b>	
IWS Available for Routing (%)	<b>20</b>	50% max
Separation Distance (Groundwater) (ft)	<b>&gt;2</b>	1 ft (min) (2 ft recommended)
Infiltration Rate (in/hr)	<b>n/a</b>	
Volume of Overflow During 1.2-Inch/2-Hour Storm (cf)	<b>0</b>	0 (No overflow allowed)
1-Yr/24-Hr <b>Pre</b> -Development Peak Rate (cfs)	<b>0.202</b>	
2-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.000</b>	1-Yr/24-Hr Pre-Development Peak Rate (or per approved Act 167 Plan)
10-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.003</b>	10-Yr/24-Hr Pre-Development Peak Rate
50-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.194</b>	50-Yr/24-Hr Pre-Development Peak Rate
100-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.395</b>	100-Yr/24-Hr Pre-Development Peak Rate
Total 2-Yr/24-Hr Runoff Volume Managed by BMP (cf)	<b>546</b>	* - Disturbed Area Volume used on PCSM spreadsheets
Ponding Time @ 2-Yr/24-Hr Storm (hrs)	<b>28</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 10-Yr/24-Hr Storm (hrs)	<b>57</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 50-Yr/24-Hr Storm (hrs)	<b>57</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 100-Yr/24-Hr Storm (hrs)	<b>59</b>	72 hrs (surface), 7 days (underground)

Stephen C. Giampaolo, P.E.  
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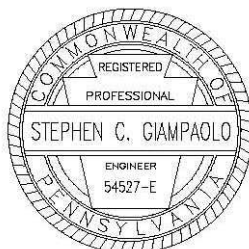
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**Date**





**INFILTRATION BED (MRC) 52 (BMP 52)  
MANAGED RELEASE CONCEPT (MRC) DESIGN SUMMARY**

*Complete One Design Summary Sheet for Each BMP Designed for MRC*

**GENERAL INFORMATION**

Applicant Name: Kennett Township Project Name: Greenway Trail along Chandler Mill Road  
 Applicant Address: 801 Burrows Run Road Municipality: Kennett Township  
 City, State, Zip: Chadds Ford, PA 19317 County: Chester  
 Permit Type:  NPDES PAG-02  NPDES IP  ESCGP  ESP

	Pre-Development	Post-Development	Change
Impervious Area (acres):	0.011	0.016	0.005

**MRC BMP INFORMATION**

MRC BMP Type: Underground Chambers Stormwater BMP Manual Section: 6.4.3

Will the BMP Include Vegetation?  Yes  No

If Yes, Identify Proposed Vegetation: \_\_\_\_\_

For Non-Vegetated BMPs Will There Be Pre- or Post-Treatment?  Yes (Pre-)  Yes (Post-)  No

If Yes, Identify Proposed Pre- or Post-Treatment: Pre: Impervious runoff crosses vegetated buffer and verge area

Name of Surface Water to Receive MRC BMP Discharges: West Branch Red Clay Creek

Designated Use of Surface Water: TSF-MF Existing Use of Surface Water (if different): \_\_\_\_\_

Is the Surface Water Impaired?  Yes  No

If Yes, Identify Cause(s): Siltation from Agriculture

Will the BMP have an impermeable liner?  Yes  No

If Yes, explain why a liner is proposed: \_\_\_\_\_

BMP Media Description: Stone aggregate

Are Any Deviations from MRC Design Standards Proposed?  Yes  No

If Yes, Identify Deviations: \_\_\_\_\_

**MRC BMP DESIGN VALUES AND STANDARDS**

Parameter	Design Value	Design Standard
Actual Contributing Impervious Area to BMP (acres)	0.016	
Equivalent Contributing Impervious Area to BMP (acres)	0.014	
Total Drainage Area to BMP (acres)	0.021	
MRC BMP Release Rate (cfs)	0.00	No greater than 0.01 cfs / acre of equivalent contributing impervious
Underdrain Outflow Rate During 1.2-Inch/2-Hour Storm (cfs)	0.00	<= MRC BMP Release Rate (cfs)
Maximum Storm Event Routed to MRC BMP	100 yr	

**MRC BMP Design Summary**  
**Revised, August 25, 2020**

Parameter	Design Value	Design Standard
BMP Footprint Area (ft <sup>2</sup> )	<b>385</b>	
Bottom BMP Elevation (Native Soils) (ft)	<b>239.00</b>	
2-Yr/24-Hr Storm Ponding Depth (ft)	<b>1.17</b>	1 ft (recommended) (2 ft max)
Maximum Ponding Depth (ft)	<b>2.87</b>	4 ft (max)
Overflow Bypass Elevation (ft)	<b>241.25</b>	
Media Depth (ft)	<b>2.96</b>	2 ft (min) – 4 ft (max)
Media Void Space (%)	<b>40</b>	
Internal Water Storage (IWS) Depth (ft)	<b>1</b>	1 ft recommended
Top of IWS Elevation (ft)	<b>240.50</b>	
Underdrain Pipe Diameter (in)	<b>6</b>	
Underdrain Orifice Diameter (in)	<b>0.25</b>	
Underdrain Outlet Elevation (ft)	<b>240.50</b>	
IWS Available for Routing (%)	<b>20</b>	50% max
Separation Distance (Groundwater) (ft)	<b>&gt;2</b>	1 ft (min) (2 ft recommended)
Infiltration Rate (in/hr)	<b>n/a</b>	
Volume of Overflow During 1.2-Inch/2-Hour Storm (cf)	<b>0</b>	0 (No overflow allowed)
1-Yr/24-Hr <b>Pre</b> -Development Peak Rate (cfs)	<b>0.070</b>	
2-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.000</b>	1-Yr/24-Hr Pre-Development Peak Rate (or per approved Act 167 Plan)
10-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.000</b>	10-Yr/24-Hr Pre-Development Peak Rate
50-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.001</b>	50-Yr/24-Hr Pre-Development Peak Rate
100-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.002</b>	100-Yr/24-Hr Pre-Development Peak Rate
Total 2-Yr/24-Hr Runoff Volume Managed by BMP (cf)	<b>188</b>	* - Disturbed Area Volume used on PCSM spreadsheets
Ponding Time @ 2-Yr/24-Hr Storm (hrs)	<b>32</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 10-Yr/24-Hr Storm (hrs)	<b>32</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 50-Yr/24-Hr Storm (hrs)	<b>58</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 100-Yr/24-Hr Storm (hrs)	<b>67</b>	72 hrs (surface), 7 days (underground)

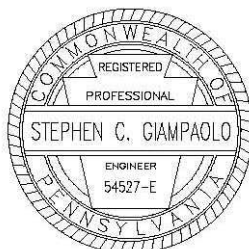
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**INFILTRATION BED (MRC) 53 (BMP 53)  
MANAGED RELEASE CONCEPT (MRC) DESIGN SUMMARY**

*Complete One Design Summary Sheet for Each BMP Designed for MRC*

**GENERAL INFORMATION**

Applicant Name: Kennett Township Project Name: Greenway Trail along Chandler Mill Road  
 Applicant Address: 801 Burrows Run Road Municipality: Kennett Township  
 City, State, Zip: Chadds Ford, PA 19317 County: Chester  
 Permit Type:  NPDES PAG-02  NPDES IP  ESCGP  ESP

	Pre-Development	Post-Development	Change
Impervious Area (acres):	0.038	0.050	0.012

**MRC BMP INFORMATION**

MRC BMP Type: Underground Chambers Stormwater BMP Manual Section: 6.4.3

Will the BMP Include Vegetation?  Yes  No

If Yes, Identify Proposed Vegetation: \_\_\_\_\_

For Non-Vegetated BMPs Will There Be Pre- or Post-Treatment?  Yes (Pre-)  Yes (Post-)  No

If Yes, Identify Proposed Pre- or Post-Treatment: Pre: Impervious runoff crosses vegetated buffer and verge area

Name of Surface Water to Receive MRC BMP Discharges: West Branch Red Clay Creek

Designated Use of Surface Water: TSF-MF Existing Use of Surface Water (if different): \_\_\_\_\_

Is the Surface Water Impaired?  Yes  No

If Yes, Identify Cause(s): Siltation from Agriculture

Will the BMP have an impermeable liner?  Yes  No

If Yes, explain why a liner is proposed: \_\_\_\_\_

BMP Media Description: Stone aggregate

Are Any Deviations from MRC Design Standards Proposed?  Yes  No

If Yes, Identify Deviations: \_\_\_\_\_

**MRC BMP DESIGN VALUES AND STANDARDS**

Parameter	Design Value	Design Standard
Actual Contributing Impervious Area to BMP (acres)	0.050	
Equivalent Contributing Impervious Area to BMP (acres)	0.038	
Total Drainage Area to BMP (acres)	0.062	
MRC BMP Release Rate (cfs)	0.00	No greater than 0.01 cfs / acre of equivalent contributing impervious
Underdrain Outflow Rate During 1.2-Inch/2-Hour Storm (cfs)	0.00	<= MRC BMP Release Rate (cfs)
Maximum Storm Event Routed to MRC BMP	100 yr	

**MRC BMP Design Summary**  
**Revised, August 25, 2020**

Parameter	Design Value	Design Standard
BMP Footprint Area (ft <sup>2</sup> )	<b>512</b>	
Bottom BMP Elevation (Native Soils) (ft)	<b>238.75</b>	
2-Yr/24-Hr Storm Ponding Depth (ft)	<b>2.31</b>	1 ft (recommended) (2 ft max)
Maximum Ponding Depth (ft)	<b>2.87</b>	4 ft (max)
Overflow Bypass Elevation (ft)	<b>241.0</b>	
Media Depth (ft)	<b>3.03</b>	2 ft (min) – 4 ft (max)
Media Void Space (%)	<b>40</b>	
Internal Water Storage (IWS) Depth (ft)	<b>1.25</b>	1 ft recommended
Top of IWS Elevation (ft)	<b>240.50</b>	
Underdrain Pipe Diameter (in)	<b>6</b>	
Underdrain Orifice Diameter (in)	<b>0.25</b>	
Underdrain Outlet Elevation (ft)	<b>240.50</b>	
IWS Available for Routing (%)	<b>20</b>	50% max
Separation Distance (Groundwater) (ft)	<b>1.40 (Bedrock)</b>	1 ft (min) (2 ft recommended)
Infiltration Rate (in/hr)	<b>n/a</b>	
Volume of Overflow During 1.2-Inch/2-Hour Storm (cf)	<b>0</b>	0 (No overflow allowed)
1-Yr/24-Hr <b>Pre</b> -Development Peak Rate (cfs)	<b>0.202</b>	
2-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.003</b>	1-Yr/24-Hr Pre-Development Peak Rate (or per approved Act 167 Plan)
10-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.079</b>	10-Yr/24-Hr Pre-Development Peak Rate
50-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.471</b>	50-Yr/24-Hr Pre-Development Peak Rate
100-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.573</b>	100-Yr/24-Hr Pre-Development Peak Rate
Total 2-Yr/24-Hr Runoff Volume Managed by BMP (cf)	<b>569</b>	* - Disturbed Area Volume used on PCSM spreadsheets
Ponding Time @ 2-Yr/24-Hr Storm (hrs)	<b>31</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 10-Yr/24-Hr Storm (hrs)	<b>49</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 50-Yr/24-Hr Storm (hrs)	<b>52</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 100-Yr/24-Hr Storm (hrs)	<b>53</b>	72 hrs (surface), 7 days (underground)

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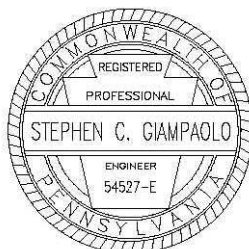
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**INFILTRATION BED (MRC) 54 (BMP 54)  
MANAGED RELEASE CONCEPT (MRC) DESIGN SUMMARY**

*Complete One Design Summary Sheet for Each BMP Designed for MRC*

**GENERAL INFORMATION**

Applicant Name: Kennett Township Project Name: Greenway Trail along Chandler Mill Road  
 Applicant Address: 801 Burrows Run Road Municipality: Kennett Township  
 City, State, Zip: Chadds Ford, PA 19317 County: Chester  
 Permit Type:  NPDES PAG-02  NPDES IP  ESCGP  ESP

	Pre-Development	Post-Development	Change
Impervious Area (acres):	0.033	0.051	0.018

**MRC BMP INFORMATION**

MRC BMP Type: Underground Chambers Stormwater BMP Manual Section: 6.4.3

Will the BMP Include Vegetation?  Yes  No

If Yes, Identify Proposed Vegetation: \_\_\_\_\_

For Non-Vegetated BMPs Will There Be Pre- or Post-Treatment?  Yes (Pre-)  Yes (Post-)  No

If Yes, Identify Proposed Pre- or Post-Treatment: Pre: Impervious runoff crosses vegetated buffer and verge area

Name of Surface Water to Receive MRC BMP Discharges: West Branch Red Clay Creek

Designated Use of Surface Water: TSF-MF Existing Use of Surface Water (if different): \_\_\_\_\_

Is the Surface Water Impaired?  Yes  No

If Yes, Identify Cause(s): Siltation from Agriculture

Will the BMP have an impermeable liner?  Yes  No

If Yes, explain why a liner is proposed: \_\_\_\_\_

BMP Media Description: Stone aggregate

Are Any Deviations from MRC Design Standards Proposed?  Yes  No

If Yes, Identify Deviations: \_\_\_\_\_

**MRC BMP DESIGN VALUES AND STANDARDS**

Parameter	Design Value	Design Standard
Actual Contributing Impervious Area to BMP (acres)	0.051	
Equivalent Contributing Impervious Area to BMP (acres)	0.040	
Total Drainage Area to BMP (acres)	0.069	
MRC BMP Release Rate (cfs)	0.00	No greater than 0.01 cfs / acre of equivalent contributing impervious
Underdrain Outflow Rate During 1.2-Inch/2-Hour Storm (cfs)	0.00	<= MRC BMP Release Rate (cfs)
Maximum Storm Event Routed to MRC BMP	100 yr	

**MRC BMP Design Summary**  
**Revised, August 25, 2020**

Parameter	Design Value	Design Standard
BMP Footprint Area (ft <sup>2</sup> )	<b>810</b>	
Bottom BMP Elevation (Native Soils) (ft)	<b>248.25</b>	
2-Yr/24-Hr Storm Ponding Depth (ft)	<b>1.82</b>	1 ft (recommended) (2 ft max)
Maximum Ponding Depth (ft)	<b>2.75</b>	4 ft (max)
Overflow Bypass Elevation (ft)	<b>250.50</b>	
Media Depth (ft)	<b>2.98</b>	2 ft (min) – 4 ft (max)
Media Void Space (%)	<b>40</b>	
Internal Water Storage (IWS) Depth (ft)	<b>1.50</b>	1 ft recommended
Top of IWS Elevation (ft)	<b>250.25</b>	
Underdrain Pipe Diameter (in)	<b>6</b>	
Underdrain Orifice Diameter (in)	<b>0.25</b>	
Underdrain Outlet Elevation (ft)	<b>250.25</b>	
IWS Available for Routing (%)	<b>20</b>	50% max
Separation Distance (Groundwater) (ft)	<b>1.96</b>	1 ft (min) (2 ft recommended)
Infiltration Rate (in/hr)	<b>n/a</b>	
Volume of Overflow During 1.2-Inch/2-Hour Storm (cf)	<b>0</b>	0 (No overflow allowed)
1-Yr/24-Hr <b>Pre</b> -Development Peak Rate (cfs)	<b>0.227</b>	
2-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.00</b>	1-Yr/24-Hr Pre-Development Peak Rate (or per approved Act 167 Plan)
10-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.010</b>	10-Yr/24-Hr Pre-Development Peak Rate
50-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.228</b>	50-Yr/24-Hr Pre-Development Peak Rate
100-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.469</b>	100-Yr/24-Hr Pre-Development Peak Rate
Total 2-Yr/24-Hr Runoff Volume Managed by BMP (cf)	<b>616</b>	* - Disturbed Area Volume used on PCSM spreadsheets
Ponding Time @ 2-Yr/24-Hr Storm (hrs)	<b>67</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 10-Yr/24-Hr Storm (hrs)	<b>67</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 50-Yr/24-Hr Storm (hrs)	<b>85</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 100-Yr/24-Hr Storm (hrs)	<b>86</b>	72 hrs (surface), 7 days (underground)

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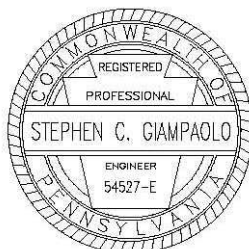
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9/9/2022

**Date**







**INFILTRATION BED (MRC) 55 (BMP 55)  
MANAGED RELEASE CONCEPT (MRC) DESIGN SUMMARY**

*Complete One Design Summary Sheet for Each BMP Designed for MRC*

**GENERAL INFORMATION**

Applicant Name: **Kennett Township** Project Name: **Greenway Trail along Chandler Mill Road**  
 Applicant Address: **801 Burrows Run Road** Municipality: **Kennett Township**  
 City, State, Zip: **Chadds Ford, PA 19317** County: **Chester**  
 Permit Type:  NPDES PAG-02  NPDES IP  ESCGP  ESP

	Pre-Development	Post-Development	Change
Impervious Area (acres):	0.044	0.059	0.015

**MRC BMP INFORMATION**

MRC BMP Type: **Underground Chambers** Stormwater BMP Manual Section: **6.4.3**

Will the BMP Include Vegetation?  Yes  No

If Yes, Identify Proposed Vegetation: \_\_\_\_\_

For Non-Vegetated BMPs Will There Be Pre- or Post-Treatment?  Yes (Pre-)  Yes (Post-)  No

If Yes, Identify Proposed Pre- or Post-Treatment: **Pre: Impervious runoff crosses vegetated buffer and verge area**

Name of Surface Water to Receive MRC BMP Discharges: **West Branch Red Clay Creek**

Designated Use of Surface Water: **TSF-MF** Existing Use of Surface Water (if different): \_\_\_\_\_

Is the Surface Water Impaired?  Yes  No

If Yes, Identify Cause(s): **Siltation from Agriculture**

Will the BMP have an impermeable liner?  Yes  No

If Yes, explain why a liner is proposed: \_\_\_\_\_

BMP Media Description: **Stone aggregate**

Are Any Deviations from MRC Design Standards Proposed?  Yes  No

If Yes, Identify Deviations: \_\_\_\_\_

**MRC BMP DESIGN VALUES AND STANDARDS**

Parameter	Design Value	Design Standard
Actual Contributing Impervious Area to BMP (acres)	<b>0.059</b>	
Equivalent Contributing Impervious Area to BMP (acres)	<b>0.050</b>	
Total Drainage Area to BMP (acres)	<b>0.075</b>	
MRC BMP Release Rate (cfs)	<b>0.00</b>	<i>No greater than 0.01 cfs / acre of equivalent contributing impervious</i>
Underdrain Outflow Rate During 1.2-Inch/2-Hour Storm (cfs)	<b>0.00</b>	<i>&lt;= MRC BMP Release Rate (cfs)</i>
Maximum Storm Event Routed to MRC BMP	<b>100 yr</b>	

**MRC BMP Design Summary**  
**Revised, August 25, 2020**

Parameter	Design Value	Design Standard
BMP Footprint Area (ft <sup>2</sup> )	<b>708</b>	
Bottom BMP Elevation (Native Soils) (ft)	<b>247.50</b>	
2-Yr/24-Hr Storm Ponding Depth (ft)	<b>2.50</b>	1 ft (recommended) (2 ft max)
Maximum Ponding Depth (ft)	<b>3.52</b>	4 ft (max)
Overflow Bypass Elevation (ft)	<b>250.00</b>	
Media Depth (ft)	<b>3.40</b>	2 ft (min) – 4 ft (max)
Media Void Space (%)	<b>40</b>	
Internal Water Storage (IWS) Depth (ft)	<b>1.50</b>	1 ft recommended
Top of IWS Elevation (ft)	<b>249.50</b>	
Underdrain Pipe Diameter (in)	<b>6</b>	
Underdrain Orifice Diameter (in)	<b>0.25</b>	
Underdrain Outlet Elevation (ft)	<b>249.50</b>	
IWS Available for Routing (%)	<b>20</b>	50% max
Separation Distance (Groundwater) (ft)	<b>&gt;2</b>	1 ft (min) (2 ft recommended)
Infiltration Rate (in/hr)	<b>n/a</b>	
Volume of Overflow During 1.2-Inch/2-Hour Storm (cf)	<b>0</b>	0 (No overflow allowed)
1-Yr/24-Hr <b>Pre</b> -Development Peak Rate (cfs)	<b>0.269</b>	
2-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.00</b>	1-Yr/24-Hr Pre-Development Peak Rate (or per approved Act 167 Plan)
10-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.030</b>	10-Yr/24-Hr Pre-Development Peak Rate
50-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.337</b>	50-Yr/24-Hr Pre-Development Peak Rate
100-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.531</b>	100-Yr/24-Hr Pre-Development Peak Rate
Total 2-Yr/24-Hr Runoff Volume Managed by BMP (cf)	<b>689</b>	* - Disturbed Area Volume used on PCSM spreadsheets
Ponding Time @ 2-Yr/24-Hr Storm (hrs)	<b>43</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 10-Yr/24-Hr Storm (hrs)	<b>62</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 50-Yr/24-Hr Storm (hrs)	<b>64</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 100-Yr/24-Hr Storm (hrs)	<b>66</b>	72 hrs (surface), 7 days (underground)

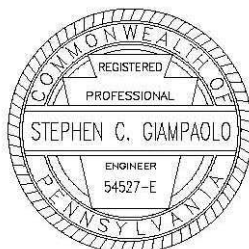
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**Date**





**INFILTRATION BED (MRC) 56 (BMP 56)  
MANAGED RELEASE CONCEPT (MRC) DESIGN SUMMARY**

*Complete One Design Summary Sheet for Each BMP Designed for MRC*

**GENERAL INFORMATION**

Applicant Name: Kennett Township Project Name: Greenway Trail along Chandler Mill Road  
 Applicant Address: 801 Burrows Run Road Municipality: Kennett Township  
 City, State, Zip: Chadds Ford, PA 19317 County: Chester  
 Permit Type:  NPDES PAG-02  NPDES IP  ESCGP  ESP

	Pre-Development	Post-Development	Change
Impervious Area (acres):	0.068	0.091	0.023

**MRC BMP INFORMATION**

MRC BMP Type: Underground Chambers Stormwater BMP Manual Section: 6.4.3

Will the BMP Include Vegetation?  Yes  No

If Yes, Identify Proposed Vegetation: \_\_\_\_\_

For Non-Vegetated BMPs Will There Be Pre- or Post-Treatment?  Yes (Pre-)  Yes (Post-)  No

If Yes, Identify Proposed Pre- or Post-Treatment: Pre: Impervious runoff crosses vegetated buffer and verge area

Name of Surface Water to Receive MRC BMP Discharges: West Branch Red Clay Creek

Designated Use of Surface Water: TSF-MF Existing Use of Surface Water (if different): \_\_\_\_\_

Is the Surface Water Impaired?  Yes  No

If Yes, Identify Cause(s): Siltation from Agriculture

Will the BMP have an impermeable liner?  Yes  No

If Yes, explain why a liner is proposed: \_\_\_\_\_

BMP Media Description: Stone aggregate

Are Any Deviations from MRC Design Standards Proposed?  Yes  No

If Yes, Identify Deviations: \_\_\_\_\_

**MRC BMP DESIGN VALUES AND STANDARDS**

Parameter	Design Value	Design Standard
Actual Contributing Impervious Area to BMP (acres)	0.091	
Equivalent Contributing Impervious Area to BMP (acres)	0.050	
Total Drainage Area to BMP (acres)	0.114	
MRC BMP Release Rate (cfs)	0.00	No greater than 0.01 cfs / acre of equivalent contributing impervious
Underdrain Outflow Rate During 1.2-Inch/2-Hour Storm (cfs)	0.00	<= MRC BMP Release Rate (cfs)
Maximum Storm Event Routed to MRC BMP	100 yr	

**MRC BMP Design Summary**  
**Revised, August 25, 2020**

Parameter	Design Value	Design Standard
BMP Footprint Area (ft <sup>2</sup> )	<b>1002</b>	
Bottom BMP Elevation (Native Soils) (ft)	<b>247.50</b>	
2-Yr/24-Hr Storm Ponding Depth (ft)	<b>2.52</b>	1 ft (recommended) (2 ft max)
Maximum Ponding Depth (ft)	<b>3.44</b>	4 ft (max)
Overflow Bypass Elevation (ft)	<b>250.00</b>	
Media Depth (ft)	<b>3.70</b>	2 ft (min) – 4 ft (max)
Media Void Space (%)	<b>40</b>	
Internal Water Storage (IWS) Depth (ft)	<b>1.50</b>	1 ft recommended
Top of IWS Elevation (ft)	<b>249.50</b>	
Underdrain Pipe Diameter (in)	<b>6</b>	
Underdrain Orifice Diameter (in)	<b>0.25</b>	
Underdrain Outlet Elevation (ft)	<b>249.50</b>	
IWS Available for Routing (%)	<b>20</b>	50% max
Separation Distance (Groundwater) (ft)	<b>&gt;2</b>	1 ft (min) (2 ft recommended)
Infiltration Rate (in/hr)	<b>n/a</b>	
Volume of Overflow During 1.2-Inch/2-Hour Storm (cf)	<b>0</b>	0 (No overflow allowed)
1-Yr/24-Hr <b>Pre</b> -Development Peak Rate (cfs)	<b>0.383</b>	
2-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.00</b>	1-Yr/24-Hr Pre-Development Peak Rate (or per approved Act 167 Plan)
10-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.029</b>	10-Yr/24-Hr Pre-Development Peak Rate
50-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.591</b>	50-Yr/24-Hr Pre-Development Peak Rate
100-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.861</b>	100-Yr/24-Hr Pre-Development Peak Rate
Total 2-Yr/24-Hr Runoff Volume Managed by BMP (cf)	<b>1060</b>	* - Disturbed Area Volume used on PCSM spreadsheets
Ponding Time @ 2-Yr/24-Hr Storm (hrs)	<b>61</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 10-Yr/24-Hr Storm (hrs)	<b>84</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 50-Yr/24-Hr Storm (hrs)	<b>87</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 100-Yr/24-Hr Storm (hrs)	<b>88</b>	72 hrs (surface), 7 days (underground)

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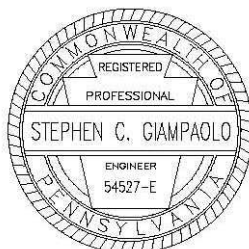
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**Date**





**INFILTRATION BED (MRC) 57 (BMP 57)  
MANAGED RELEASE CONCEPT (MRC) DESIGN SUMMARY**

*Complete One Design Summary Sheet for Each BMP Designed for MRC*

**GENERAL INFORMATION**

Applicant Name: Kennett Township Project Name: Greenway Trail along Chandler Mill Road  
 Applicant Address: 801 Burrows Run Road Municipality: Kennett Township  
 City, State, Zip: Chadds Ford, PA 19317 County: Chester  
 Permit Type:  NPDES PAG-02  NPDES IP  ESCGP  ESP

	Pre-Development	Post-Development	Change
Impervious Area (acres):	0.028	0.037	0.009

**MRC BMP INFORMATION**

MRC BMP Type: Underground Chambers Stormwater BMP Manual Section: 6.4.3

Will the BMP Include Vegetation?  Yes  No

If Yes, Identify Proposed Vegetation: \_\_\_\_\_

For Non-Vegetated BMPs Will There Be Pre- or Post-Treatment?  Yes (Pre-)  Yes (Post-)  No

If Yes, Identify Proposed Pre- or Post-Treatment: Pre: Impervious runoff crosses vegetated buffer and verge area

Name of Surface Water to Receive MRC BMP Discharges: West Branch Red Clay Creek

Designated Use of Surface Water: TSF-MF Existing Use of Surface Water (if different): \_\_\_\_\_

Is the Surface Water Impaired?  Yes  No

If Yes, Identify Cause(s): Siltation from Agriculture

Will the BMP have an impermeable liner?  Yes  No

If Yes, explain why a liner is proposed: \_\_\_\_\_

BMP Media Description: Stone aggregate

Are Any Deviations from MRC Design Standards Proposed?  Yes  No

If Yes, Identify Deviations: \_\_\_\_\_

**MRC BMP DESIGN VALUES AND STANDARDS**

Parameter	Design Value	Design Standard
Actual Contributing Impervious Area to BMP (acres)	0.037	
Equivalent Contributing Impervious Area to BMP (acres)	0.031	
Total Drainage Area to BMP (acres)	0.049	
MRC BMP Release Rate (cfs)	0.00	No greater than 0.01 cfs / acre of equivalent contributing impervious
Underdrain Outflow Rate During 1.2-Inch/2-Hour Storm (cfs)	0.00	<= MRC BMP Release Rate (cfs)
Maximum Storm Event Routed to MRC BMP	100 yr	

**MRC BMP Design Summary**  
**Revised, August 25, 2020**

Parameter	Design Value	Design Standard
BMP Footprint Area (ft <sup>2</sup> )	<b>420</b>	
Bottom BMP Elevation (Native Soils) (ft)	<b>247.50</b>	
2-Yr/24-Hr Storm Ponding Depth (ft)	<b>2.62</b>	1 ft (recommended) (2 ft max)
Maximum Ponding Depth (ft)	<b>3.26</b>	4 ft (max)
Overflow Bypass Elevation (ft)	<b>250.25</b>	
Media Depth (ft)	<b>3.99</b>	2 ft (min) – 4 ft (max)
Media Void Space (%)	<b>40</b>	
Internal Water Storage (IWS) Depth (ft)	<b>1.75</b>	1 ft recommended
Top of IWS Elevation (ft)	<b>249.75</b>	
Underdrain Pipe Diameter (in)	<b>6</b>	
Underdrain Orifice Diameter (in)	<b>0.25</b>	
Underdrain Outlet Elevation (ft)	<b>249.75</b>	
IWS Available for Routing (%)	<b>20</b>	50% max
Separation Distance (Groundwater) (ft)	<b>&gt;2</b>	1 ft (min) (2 ft recommended)
Infiltration Rate (in/hr)	<b>n/a</b>	
Volume of Overflow During 1.2-Inch/2-Hour Storm (cf)	<b>0</b>	0 (No overflow allowed)
1-Yr/24-Hr <b>Pre</b> -Development Peak Rate (cfs)	<b>0.168</b>	
2-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.001</b>	1-Yr/24-Hr Pre-Development Peak Rate (or per approved Act 167 Plan)
10-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.018</b>	10-Yr/24-Hr Pre-Development Peak Rate
50-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.354</b>	50-Yr/24-Hr Pre-Development Peak Rate
100-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.484</b>	100-Yr/24-Hr Pre-Development Peak Rate
Total 2-Yr/24-Hr Runoff Volume Managed by BMP (cf)	<b>451</b>	* - Disturbed Area Volume used on PCSM spreadsheets
Ponding Time @ 2-Yr/24-Hr Storm (hrs)	<b>26</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 10-Yr/24-Hr Storm (hrs)	<b>41</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 50-Yr/24-Hr Storm (hrs)	<b>45</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 100-Yr/24-Hr Storm (hrs)	<b>47</b>	72 hrs (surface), 7 days (underground)

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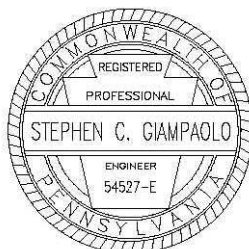
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**INFILTRATION BED (MRC) 58 (BMP 58)  
MANAGED RELEASE CONCEPT (MRC) DESIGN SUMMARY**

*Complete One Design Summary Sheet for Each BMP Designed for MRC*

**GENERAL INFORMATION**

Applicant Name: Kennett Township Project Name: Greenway Trail along Chandler Mill Road  
 Applicant Address: 801 Burrows Run Road Municipality: Kennett Township  
 City, State, Zip: Chadds Ford, PA 19317 County: Chester  
 Permit Type:  NPDES PAG-02  NPDES IP  ESCGP  ESP

	Pre-Development	Post-Development	Change
Impervious Area (acres):	0.026	0.042	0.016

**MRC BMP INFORMATION**

MRC BMP Type: Underground Chambers Stormwater BMP Manual Section: 6.4.3

Will the BMP Include Vegetation?  Yes  No

If Yes, Identify Proposed Vegetation: \_\_\_\_\_

For Non-Vegetated BMPs Will There Be Pre- or Post-Treatment?  Yes (Pre-)  Yes (Post-)  No

If Yes, Identify Proposed Pre- or Post-Treatment: Pre: Impervious runoff crosses vegetated buffer and verge area

Name of Surface Water to Receive MRC BMP Discharges: West Branch Red Clay Creek

Designated Use of Surface Water: TSF-MF Existing Use of Surface Water (if different): \_\_\_\_\_

Is the Surface Water Impaired?  Yes  No

If Yes, Identify Cause(s): Siltation from Agriculture

Will the BMP have an impermeable liner?  Yes  No

If Yes, explain why a liner is proposed: \_\_\_\_\_

BMP Media Description: Stone aggregate

Are Any Deviations from MRC Design Standards Proposed?  Yes  No

If Yes, Identify Deviations: \_\_\_\_\_

**MRC BMP DESIGN VALUES AND STANDARDS**

Parameter	Design Value	Design Standard
Actual Contributing Impervious Area to BMP (acres)	0.042	
Equivalent Contributing Impervious Area to BMP (acres)	0.035	
Total Drainage Area to BMP (acres)	0.054	
MRC BMP Release Rate (cfs)	0.00	No greater than 0.01 cfs / acre of equivalent contributing impervious
Underdrain Outflow Rate During 1.2-Inch/2-Hour Storm (cfs)	0.00	<= MRC BMP Release Rate (cfs)
Maximum Storm Event Routed to MRC BMP	100 yr	

**MRC BMP Design Summary**  
**Revised, August 25, 2020**

Parameter	Design Value	Design Standard
BMP Footprint Area (ft <sup>2</sup> )	<b>720</b>	
Bottom BMP Elevation (Native Soils) (ft)	<b>247.50</b>	
2-Yr/24-Hr Storm Ponding Depth (ft)	<b>1.59</b>	1 ft (recommended) (2 ft max)
Maximum Ponding Depth (ft)	<b>2.75</b>	4 ft (max)
Overflow Bypass Elevation (ft)	<b>249.50</b>	
Media Depth (ft)	<b>3.15</b>	2 ft (min) – 4 ft (max)
Media Void Space (%)	<b>40</b>	
Internal Water Storage (IWS) Depth (ft)	<b>1.0</b>	1 ft recommended
Top of IWS Elevation (ft)	<b>249.00</b>	
Underdrain Pipe Diameter (in)	<b>6</b>	
Underdrain Orifice Diameter (in)	<b>0.25</b>	
Underdrain Outlet Elevation (ft)	<b>249.00</b>	
IWS Available for Routing (%)	<b>20</b>	50% max
Separation Distance (Groundwater) (ft)	<b>&gt;2</b>	1 ft (min) (2 ft recommended)
Infiltration Rate (in/hr)	<b>n/a</b>	
Volume of Overflow During 1.2-Inch/2-Hour Storm (cf)	<b>0</b>	0 (No overflow allowed)
1-Yr/24-Hr <b>Pre</b> -Development Peak Rate (cfs)	<b>0.174</b>	
2-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.001</b>	1-Yr/24-Hr Pre-Development Peak Rate (or per approved Act 167 Plan)
10-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.019</b>	10-Yr/24-Hr Pre-Development Peak Rate
50-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.415</b>	50-Yr/24-Hr Pre-Development Peak Rate
100-Yr/24-Hr <b>Post</b> -Development Peak Rate (cfs)	<b>0.669</b>	100-Yr/24-Hr Pre-Development Peak Rate
Total 2-Yr/24-Hr Runoff Volume Managed by BMP (cf)	<b>494</b>	* - Disturbed Area Volume used on PCSM spreadsheets
Ponding Time @ 2-Yr/24-Hr Storm (hrs)	<b>44</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 10-Yr/24-Hr Storm (hrs)	<b>44</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 50-Yr/24-Hr Storm (hrs)	<b>68</b>	72 hrs (surface), 7 days (underground)
Ponding Time @ 100-Yr/24-Hr Storm (hrs)	<b>69</b>	72 hrs (surface), 7 days (underground)

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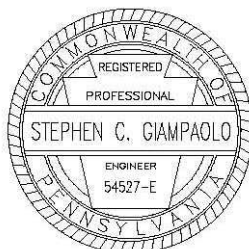
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## **MRC - 13 Design Standards**

NPDES Permit application number: [Click here to enter text.](#)

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Municipality: Kennett Township

County: Chester

MRC Identification: Infiltration Bed: 51 (BMP 51), 52 (BMP 52), 53 (BMP 53), 54 (BMP 54), 55 (BMP 55), 56 (BMP 56), 57 (BMP 57), 58 (BMP 58)

1. Runoff Capture – The runoff from the 1.2-inch/2-hour storm from the contributing watershed that the MRC is intended to treat should be captured and managed by the MRC BMP, filtered through vegetated media or treated and filtered to the extent practicable through the on-site undisturbed soils or other acceptable treatment systems, and released as indicated in MRC Standard 2. The MRC may be designed for offsetting when contributing non-regulated earth disturbance is present in the contributing drainage area, but the total volume managed may not exceed the volume of runoff generated in the 2-year/24-hour storm. Uncompacted pervious surfaces outside the disturbed area should be bypassed to the maximum extent practical.

NOTE – Runoff from existing similar impervious and compacted pervious areas can be used to offset undetained areas. The runoff volume for the 1.2 inch/2-hour storm from the two areas must be equivalent (See Figure 4). In addition, the pollutant contribution as determined through land use of the two areas should be similar.

**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

The runoff for the 1.2"/2hr storm is contained within the bed below the overflow orifice.

Infiltration Bed (MRC) 51: 1.2-In/2 HR Volume = 137 CF, Total Storage Volume = 660 CF. PG 351

Infiltration Bed (MRC) 52: 1.2-In/2 HR Volume = 50 CF, Total Storage Volume = 351 CF. PG 357

Infiltration Bed (MRC) 53: 1.2-In/2 HR Volume = 137 CF, Total Storage Volume = 442 CF. PG 465

Infiltration Bed (MRC) 54: 1.2-In/2 HR Volume = 145 CF, Total Storage Volume = 662 CF. PG 521

Infiltration Bed (MRC) 55: 1.2-In/2 HR Volume = 183 CF, Total Storage Volume = 649 CF. PG 577

Infiltration Bed (MRC) 56: 1.2-In/2 HR Volume = 277 CF, Total Storage Volume = 920 CF. PG 633

Infiltration Bed (MRC) 57: 1.2-In/2 HR Volume = 114 CF, Total Storage Volume = 407 CF. PG 691

Infiltration Bed (MRC) 58: 1.2-In/2 HR Volume = 126 CF, Total Storage Volume = 588 CF. PG 697

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

Refer to page numbers above.

- 
2. Release Rate for the 1.2-inch/2-hour storm – The stormwater release rate from the MRC BMP for the 1.2inch/2-hour storm should not exceed 0.01 cubic feet per second (cfs) from the equivalent impervious area. To obtain the equivalent impervious area being managed by a MRC BMP, determine the total volume of runoff generated during the 1.2-inch/2-hour event from all pervious and impervious areas contributing to the MRC and divide by 0.0833 feet. This release rate is rounded to the nearest hundredth of a cfs (e.g., 1.576 ac. is 0.01576 cfs, rounded to 0.02 cfs). Routing is necessary to demonstrate compliance with the standard for release rate.

## **MRC - 13 Design Standards**

NPDES Permit application number: [Click here to enter text.](#)

Page 2 of 12

Municipality: Kennett Township

County: Chester

MRC Identification: Infiltration Bed: 51 (BMP 51), 52 (BMP 52), 53 (BMP 53), 54 (BMP 54), 55 (BMP 55), 56 (BMP 56), 57 (BMP 57), 58 (BMP 58)

NOTE – This release rate (0.01 cfs / equivalent impervious acre) is approximately the expected rate of interflow (lateral movement of stormwater to a stream) after a 2-year/24-hour storm event for a Pennsylvania non-karst watershed based on the NRCS curvilinear unit hydrograph. Releasing at this rate will produce a condition where baseflow contributions will be similar to that of an undeveloped area during and after storm events. As the level of outflow would be similar to what would be expected during and after the storm, it would not be expected to impact the storm event's effects on flooding and erosion. This rate should also be used for karst watersheds unless it can be demonstrated that interflow on a particular project site differs from this standard (such a demonstration would be considered an alternative to the MRC Design Standard).

**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

The entire 1.2"/2hr storm is contained within the bed, resulting in a release rate of 0 cfs. This is less than the equivalent impervious area x 0.01 cfs.

Infiltration Bed (MRC) 51 Rates: Allowable release: 0.00 CFS. Actual release: 0.00 CFS PG 351

Infiltration Bed (MRC) 52 Rates: Allowable release: 0.00 CFS. Actual release: 0.00 CFS PG 357

Infiltration Bed (MRC) 53 Rates: Allowable release: 0.00 CFS. Actual release: 0.00 CFS PG 465

Infiltration Bed (MRC) 54 Rates: Allowable release: 0.00 CFS. Actual release: 0.00 CFS PG 521

Infiltration Bed (MRC) 55 Rates: Allowable release: 0.00 CFS. Actual release: 0.00 CFS PG 577

Infiltration Bed (MRC) 56 Rates: Allowable release: 0.00 CFS. Actual release: 0.00 CFS PG 633

Infiltration Bed (MRC) 57 Rates: Allowable release: 0.00 CFS. Actual release: 0.00 CFS PG 691

Infiltration Bed (MRC) 58 Rates: Allowable release: 0.00 CFS. Actual release: 0.00 CFS PG 697

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

The equivalent impervious area calculation and rate comparison can be found the page numbers indicated above.

- 
3. Internal Water Storage (IWS) – A volume for IWS should be provided that is at least one foot deep below the lowest structural outlet (i.e. the outlet for the underdrain) in the MRC BMP to encourage ET, infiltration and denitrification. To encourage ET, the overall soil media depth of a facility including the IWS can be no deeper than four (4) feet, and up to 50% of the IWS void volume can be included (only for vegetated MRC BMPs) as available storage during hydrologic routings to demonstrate compliance with the standards for the release rate (No. 2 above) and peak flow attenuation (No. 4 below). For soil media, a void space of 30% can be used to describe the soil volume storage and recovery. If an alternate void space is used for soil media,

## **MRC - 13 Design Standards**

NPDES Permit application number: [Click here to enter text.](#)

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Municipality: Kennett Township

County: Chester

MRC Identification: Infiltration Bed: 51 (BMP 51), 52 (BMP 52), 53 (BMP 53), 54 (BMP 54), 55 (BMP 55), 56 (BMP 56), 57 (BMP 57), 58 (BMP 58)

specific data demonstrating the void space should be submitted. For non-vegetated MRC designs, the IWS must be above the underdrain, but below the outlet, to promote a change of the stormwater stored during rain events.

Use of Liners – The MRC BMP should not have an impervious liner installed unless environmental or geological conditions necessitate use of a liner, or if an existing structure would be damaged as a result of not lining the facility.

NOTE – The presence of a project site in an area of known karst conditions does not, in itself, serve as evidence of the applicability of MRC to a project site or to the use of a liner to avoid infiltration. DEP and delegated CDs reserve the right to request a detailed subsurface investigation where considered warranted to evaluate the likelihood of sinkhole formation as a result of post-construction stormwater management.

**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

The IWS consists of the stone between the MRC orifice and the top of the underdrain for a subsurface (non-vegetated) MRC design. As indicated in the design standards, 100% of the void space (40% voids) was utilized as available storage during hydraulic routings.

Infiltration Bed (MRC) 51 IWS: Depth = 1.00 FT. IWS Vol. = 201 CF. PG 351

Infiltration Bed (MRC) 52 IWS: Depth = 1.00 FT. IWS Vol. = 77 CF. PG 357

Infiltration Bed (MRC) 53 IWS: Depth = 1.25 FT. IWS Vol. = 128 CF. PG 465

Infiltration Bed (MRC) 54 IWS: Depth = 1.50 FT. IWS Vol. = 243 CF. PG 521

Infiltration Bed (MRC) 55 IWS: Depth = 1.50 FT. IWS Vol. = 212 CF. PG 577

Infiltration Bed (MRC) 56 IWS: Depth = 1.50 FT. IWS Vol. = 301 CF. PG 633

Infiltration Bed (MRC) 57 IWS: Depth = 1.75 FT. IWS Vol. = 147 CF. PG 691

Infiltration Bed (MRC) 58 IWS: Depth = 1.00 FT. IWS Vol. = 144 CF. PG 697

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

Refer to page numbers above.

- 
4. Peak Flow Attenuation for the 2-year/24-hour Event – The peak flow from the post-construction 2-year/24hour storm should be managed back to the pre-construction 1-year/24-hour storm peak flow, unless an approved and current Act 167 Plan or another requirement (such as limited

## **MRC - 13 Design Standards**

NPDES Permit application number: [Click here to enter text.](#)

Page 4 of 12

Municipality: Kennett Township

County: Chester

MRC Identification: Infiltration Bed: 51 (BMP 51), 52 (BMP 52), 53 (BMP 53), 54 (BMP 54), 55 (BMP 55), 56 (BMP 56), 57 (BMP 57), 58 (BMP 58)

capacity of a downstream channel) is more restrictive. In general, this rate is determined at the project point of interest. In the event the MRC drainage area is part of a larger overall site with non-MRC BMPs, only the MRC drainage peak flows must be managed back to the 1-year/24-hour level and overflows can be combined with flows from the non-MRC BMPs.

In situations where the pre-construction drainage area to the MRC BMP varies significantly compared to the post-construction drainage area, the post-construction drainage area boundary to the MRC BMP (using existing land uses) can be used to calculate the target pre-construction 1-year/24-hour rate, as long as all areas in question are in close proximity to the MRC BMP and drain to the same surface water. In cases where the BMP is managing additional volume to offset adjacent areas that could not be captured in the MRC BMP, the targeted pre-construction 1-year/24-hour release rate should be calculated based on the combined flow rates from the BMP drainage area and adjacent area.

NOTE – This standard is used to ensure that MRC does not contribute to channel-eroding flows in receiving surface waters.

Flows Greater Than 2-Year/24-Hour Storm – The recommended design for MRC BMPs is to bypass storm events larger than the 2-year/24-hour storm to a rate control BMP; however, DEP understands that site and cost limitations may not allow for this bypass. When it is demonstrated by the licensed professional engineer that larger storm events cannot reasonably be bypassed, the MRC BMP surface component should be designed to manage the post-construction 10-, 50- and 100-year/24-hour storm event peak flows to their corresponding pre-construction rates and the MRC BMP should have an increased (i.e., more frequent) inspection and maintenance schedule that includes inspection and repair after extreme events (10-, 50- and 100-year/24-hour storm events).

**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

The contributing area to the bed was analyzed using the existing and proposed cover types. The routing calculations show that the 2-yr post discharge is reduced below the 1-yr pre discharge. An overflow will be placed in the outlet structure allowing larger storms to overtop the system; however, complete bypass for larger storms is not feasible, as this is a roadway improvement project with limited right-of-way.

Infiltration Bed (MRC) 51 Rate Reduction: 2 Yr Post = 0.000 CFS, 1 Yr Pre = 0.180 CFS PG 351

Infiltration Bed (MRC) 52 Rate Reduction: 2 Yr Post = 0.000 CFS, 1 Yr Pre = 0.070 CFS PG 357

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Infiltration Bed (MRC) 53 Rate Reduction: 2 Yr Post = 0.003 CFS, 1 Yr Pre = 0.202 CFS PG 465

Infiltration Bed (MRC) 54 Rate Reduction: 2 Yr Post = 0.000 CFS, 1 Yr Pre = 0.227 CFS PG 521

Infiltration Bed (MRC) 55 Rate Reduction: 2 Yr Post = 0.000 CFS, 1 Yr Pre = 0.269 CFS PG 577

Infiltration Bed (MRC) 56 Rate Reduction: 2 Yr Post = 0.000 CFS, 1 Yr Pre = 0.383 CFS PG 633

Infiltration Bed (MRC) 57 Rate Reduction: 2 Yr Post = 0.001 CFS, 1 Yr Pre = 0.168 CFS PG 691

Infiltration Bed (MRC) 58 Rate Reduction: 2 Yr Post = 0.001 CFS, 1 Yr Pre = 0.174 CFS PG 697

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

The routing calculations can be found in Appendix H of the PCSM report.

- 
5. Stormwater BMP Manual – Follow the design considerations for BMPs as presented in the Pennsylvania Stormwater Best Management Practices Manual (Stormwater BMP Manual) (363-0300-002), as revised. MRC may be incorporated into the design of any BMP by a licensed professional engineer.

**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

The bed was designed following the guidelines specified in section 6.4.3 of the PADEP BMP Manual.

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

The plan details can be found on sheets 5, 6, and 12-14 of the PCSM Plan.

- 
6. MRC BMP Selection – Standard MRC BMPs include the following system types:
    - a. Vegetated MRC – Vegetation must be provided for 75% of the surface of the MRC BMP. Native vegetation should be selected by the licensed professional engineer in consultation with a professional that is knowledgeable in native plant ecology. Vegetation should be selected based on the plants' ability to grow within the anticipated conditions considering the depth and duration of stormwater stored in the MRC BMP.
    - b. Non-vegetated MRC: Porous Pavement – Porous pavements with a storage bed require a vacuum street sweeping maintenance regime adequate for the drainage area characteristics;

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the vacuum street sweeping equipment must provide adequate suction capacity to remove particles on the pavement's surface to provide a sufficient water quality demonstration and to maintain flow pathways.

c. Non-vegetated MRC: Underground Storage Chambers – The use of the MRC BMP with non-vegetated, non-porous pavement stormwater practices must have pre-treatment, post-treatment, or a combination of both pre- and post-treatment measures incorporated into the design, to provide sufficient water quality. Underground storage chambers must be accessible for maintenance, and for this reason underground storage is not recommended to be rock beds. Pre- and post-treatment can be achieved through a treatment train concept that includes other BMPs listed in the Stormwater BMP Manual (as revised) so that the combination of BMPs provide 85% removal of TSS and associated Phosphorus. The MRC is considered a primary BMP for nitrate removal through the use of the IWS. Preferred pre- and post-treatment BMPs include: level spreader with vegetated filter strip, vegetated swale, other vegetated systems, and manufactured treatment devices. An applicant must demonstrate that the treatment train will meet water requirements by using Worksheets 11 – 13 or by providing an alternative water quality demonstration that is acceptable to DEP.

**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

Underground chambers were selected due to the limited right-of-way available. Discharging the roadway pipe system into a surface BMP within the narrow strip and right-of-way would result in a very deep and narrow depression. This would create a safety hazard for vehicles and would also not have the necessary storage capacity. The beds will have pre-treatment through the runoff entering the BMP after flowing through a vegetated buffer area and vegetated verge area.

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

Pollutant calculations are found Appendix H of the PCSM report.

- 
7. Pre-Development Site Characterization and Assessment of Soil and Geology – Adequate and appropriate soils and geologic testing and evaluation must be performed to demonstrate the infiltration capacity of the entire project site to the satisfaction of DEP. At a minimum, one infiltration test for every 40,000 square feet of disturbed acreage should be performed with a minimum of four tests, equally distributed across a site. The infiltration tests must be done in

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the most accommodating soil horizon for infiltration as demonstrated by a deep hole test within 100 feet of the infiltration test. All other sections of Appendix C Protocol 1, Site Evaluation and Soil Infiltration Testing and Appendix C Protocol 2, Infiltration Systems Guidelines per the Stormwater BMP Manual (as revised) should be followed to clearly demonstrate the infiltration capability of on-site undisturbed soils at applicable elevations and for a variety of locations. Soil probes and infiltration test locations should be identified on the PCSM Plan drawing(s). The use of soil borings as a substitute for test pits can be used as a planning tool but will not generally be accepted for final design of infiltration MRC BMPs.

NOTE – The above recommended number of infiltration tests per disturbed area is to be based upon the disturbed area that is not considered a restoration activity or road maintenance activity. For example, a large sewer main installation project disturbs 30 acres in total, with 29 acres of disturbance for the sewer line installation (that will be covered by a restoration plan) and 1 acre of disturbance for a pumping station that requires a PCSM plan. The recommended number of infiltration tests would be based on the 1 acre, not 30 acres.

NOTE – The minimum number of tests can be reduced, if it can be demonstrated that the subsurface conditions are uniform; however, this is considered a deviation from MRC Design Standards, requiring an individual permit.

NOTE – Infiltration tests resulting in saturated hydraulic conductivities (as identified in the field) of less than or equal to 0.2 inches per hour classify as extremely limited. This is a saturated hydraulic conductivity representative of the lower part of the range of HSG C soils and HSG D soils.

NOTE – Results from the infiltration testing can be used to describe infiltration losses for unlined MRC BMPs as per Appendix C of the Stormwater BMP Manual (as revised).

**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

It is anticipated that areas within the floodplain along Chandler Mill Road could exhibit poor infiltration due to the frequency of the flooding experienced along this roadway. Therefore, infiltration testing was not completed for any of the proposed volume control Best Management Practices (BMP's) within the floodplain. Volume control BMP's within the floodplain have been designed following the Managed Release Concept (MRC) protocols in anticipation of poor infiltration. However, the project did complete

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soil borings along the length of the project, and the data gathered through these soil borings were used to identify depths of limiting zones for these BMPs. Additional infiltration tests were performed at other areas within the project area. Infiltration features were utilized where possible; however the necessary volume reductions cannot be achieved without using an MRC design.

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

The Infiltration report can be found in PCSM Report Appendix K.

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8. Separation Distance – At least one foot of separation distance should be maintained between groundwater or the seasonally high-water table and the bottom footprint of the MRC BMP’s soil media; however, a two-foot separation is preferred. There is no minimum separation required between bedrock or hardpan and the MRC BMP’s soil media.

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The bottoms of all proposed MRC BMPs are at least one (1) foot above any encountered bedrock or water table elevations.

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

The Infiltration report and Soil Boring data can be found in PCSM Report Appendix K.

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9. Ponding Depth and Drawdown time – The maximum ponding time (i.e., the time after end of storm event for stored surface water to lower to soil surface) should not exceed 72 hours for any storm event. In general, a maximum ponding depth (i.e., storage depth above BMP surface) of one to two feet at the peak of the 2-year/24-hour storm event should not be exceeded for the design of surface BMPs. In accordance with MRC Design Standard 4, the MRC might incorporate a multi-stage detention facility with the upper portions of the facility providing flow attenuation for storm events greater than a 2-year/24-hour storm, to meet 25 Pa. Code § 102.8(g)(3). An engineered overflow structure or reinforced spillway / berm should be installed to provide safe conveyance for storm events greater than a 2-year/24-hour storm. Ponding depth for storms larger than the 2-year/24-hour storm should not exceed four feet, and drawdown to the MRC BMP surface should not exceed 72 hours for all design storms. For underground storage chambers and porous pavement MRC systems, drawdown to the IWS storage level should not exceed 7 days.



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**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

The drawdown time was calculated by using the BMP hydrograph to determine the time to dewater to the overflow outlet. Due to the limitations of storm duration within the Hydraflow Hydrographs program, a stage-discharge calculation was then performed to determine the remaining time to dewater to the MRC orifice (top of IWS storage). Drawdown times are calculated and listed in the pages of the report:

Infiltration Bed (MRC) 51 Drawdown 2 Yr/24 Hr: 28 Hrs PG 352

Infiltration Bed (MRC) 52 Drawdown 2 Yr/24 Hr: 32 Hrs PG 358

Infiltration Bed (MRC) 53 Drawdown 2 Yr/24 Hr: 31 Hrs PG 466

Infiltration Bed (MRC) 54 Drawdown 2 Yr/24 Hr: 67 Hrs PG 522

Infiltration Bed (MRC) 55 Drawdown 2 Yr/24 Hr: 43 Hrs PG 578

Infiltration Bed (MRC) 56 Drawdown 2 Yr/24 Hr: 61 Hrs PG 634

Infiltration Bed (MRC) 57 Drawdown 2 Yr/24 Hr: 26 Hrs PG 692

Infiltration Bed (MRC) 58 Drawdown 2 Yr/24 Hr: 44 Hrs PG 698

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

Refer to the page numbers above.

- 
10. Soil Media – The selection of soil media should be done by considering anticipated pollutants to be treated and the vegetation that will be used. On-site soils should be evaluated for desired characteristics and infiltration capabilities as listed below. The depth of the soil media above the invert elevation of the underdrain pipe should be a minimum of 2 feet (24 inches) to provide pollutant removal. If on-site undisturbed soils are unsuitable for the purpose of providing IWS, an additional one to two feet of suitable soil media should be provided below the underdrain.

Soil Media Drainage – The designer will need to exercise caution when selecting a soil media, as there is a delicate balance between infiltration rate and residence time. As noted in Appendix C, Protocol 2 of the Stormwater BMP Manual (as revised), the design soil infiltration rate should be between 0.1 inch per hour and 10 inches per hour for native soils. To maximize water quality treatment, the residence time within the soil media used in MRC BMPs should be selected to be close to the parameters established for infiltration into native soils. The designer will need to select a soil media that provide the proper infiltration rate and ponding time to achieve water quality for the anticipated life cycle of the BMP.

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**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

Stone aggregate will be used within the bed to provide additional storage for rate reduction. The aggregate will not restrict flow more than the outlet orifice.

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

AASHTO No. 3 stone aggregate (clean washed) will be used, as noted on the detail found on Sheet 5 of the PCSM Plan.

- 
11. Underdrain Design – The licensed professional engineer can refer to PennDOT Publication 408 Section 610 for specifications of underdrains. However, underdrains should have a minimum flow rate of 10 gallons (1.34 cubic feet) per minute per linear foot of pipe not considering the flow control orifice or upturned elbow. For non-vegetated MRC BMPs, the underdrain should be located at the bottom of the IWS to promote movement of water from previous storms. There may need to be multiple underdrains, or longer underdrains, to provide adequate design capacity for drainage. Section 6.4.7 (Constructed Filter) of the Stormwater BMP Manual (as revised) has recommended design standards for lateral spacing of multiple underdrains.

IWS Outflow with Capped / Orifice Underdrain – It is highly recommended that an upturned elbow or an elevated weir be designed at the outlet of the underdrain (see Figure 1). The upturned elbow or elevated weir will create a zone within the soil media, referred to as the IWS. Research has shown that IWS can reduce runoff volume and improve water quality treatment. The upturned elbow or elevated weir can also help if site conditions present daylighting issues for the underdrain's discharge elevation. Underdrains should be capped within an outlet structure when used to allow access for maintenance. The cap should be drilled to provide an appropriately sized orifice. Figure 5 below provides an example of an underdrain detail. Note that all cleanouts and angles within the underdrain should not exceed 45 degrees. For lined, nonvegetated MRCs the underdrain leading to the upturned elbow should be located at the bottom of the IWS.

Underdrain Aggregate Envelope – A 6-inch stone envelope of AASHTO #57 should be placed around the underdrain. A geotextile (or pea gravel diaphragm) is needed around the aggregate envelope. Note that the stone should not be placed throughout the bottom of the BMP, but just in the envelope of the underdrain.

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Cleanout for Underdrain – The underdrain(s) should be equipped with a clean-out for maintenance. The design of any clean-out should ensure that surface water does not enter the underdrain system through the top of the cleanout. Consideration must be given for cleaning and inspecting underdrains and access to the upturned elbow or elevated weir.

Orifices – An appropriately sized orifice is necessary on the outlet of the underdrain to control flow to the required release rate (see Figure 6). The orifice should be clean, smooth and sanded so that no burs or irregularities are present. The orifice should be on a plate or cap of sufficient thickness, and the edges of the orifice should be ground so that flow through the orifice is smooth. Orifices should be vertical. The orifice plate and other connections should be water-tight and accessible for maintenance. Control valves cannot be substituted for an orifice.

**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

The underdrain will consist of 6" base drain with a minimum inlet area of 1.4 sq-in/linear foot. This will exceed the required 10 gal/min flow rate.

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

The orifice calculations for the underdrain system for each MRC BMP can be found on the pages listed for Design Standard #9.

- 
12. Discharge Flow Path – The MRC BMP should be directed to a suitably vegetated flow path, which can safely convey the releases without erosion or loss of stability. The discharge should be dispersed through the use of a level spreader. A licensed professional engineer can provide an analysis, with calculations, which identifies that a level spreader is not necessary, or that discharge to a channel will not cause increased erosion

**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

Each MRC BMP will discharge into an existing stormwater culvert that will have suitable outlet protection installed by the project to prevent downstream erosion. Flow and outlet structure calculations are contained in Appendix J of the PCSM report.

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

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The plan view for this configuration can be found on Sheet 8 of the PCSM Plan and Sheet 19 of the ESC plan.

- 
13. Antidegradation Requirements – Where the stormwater from the project site discharges to a special protection surface water, an MRC BMP can be used to satisfy the Antidegradation Best Available Combination of Technologies (ABACT) regulatory requirements from Chapters 93 and 102 (assuming that non-discharge alternatives do not exist).

**In the space below, the licensed professional should document and demonstrate how this design standard was specifically addressed in the PCSM Report (Narrative, Calculations, H&H Model, etc.).**

The project requires ABACT BMPs due to siltation impairments (agriculture). Since infiltration was maximized on the site and no other non-discharge options are available, the MRC bed will be considered an ABACT BMP.

**In the space below, the licensed professional should provide the cross reference (i.e. page number) to the specific location in the PCSM Report that addresses this design standard.**

The receiving waters description can be found on page 2 of the PCSM Report.

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### **SEAL AND CERTIFICATION BY LICENSED PROFESSIONAL**

I, Stephen C. Giampaolo, P.E. , do hereby certify pursuant to the penalties of 18 Pa.C.S.A. 4904 to the best of my knowledge, information and belief, that the accompanying report and drawings are in conformance with Chapter 102 of the rules and regulations of the Department of Environmental Protection.

