Appendix K

Stormwater Analysis

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APPENDIX K
Stormwater Analysis

1. Introduction

Preliminary stormwater designs were developed for the Minimum Action and the Preferred Action Alternatives. These designs were prepared in accordance with the Maryland Stormwater Act of 2007, which requires the use of Environmental Site Design (ESD) Best Management Practices (BMPs) to the maximum extent possible; Federal Aviation Administration (FAA) regulations regarding drainage; and for projects within the established Chesapeake Bay Critical Area, the Maryland Department of Natural Resources requirement for phosphorus removal.

For each of the alternatives, the following data sources were used:

- **Soils data**: Natural Resources Conservation Service (NRCS), Baltimore County, Maryland;
- **Watershed and drainage area boundaries and Points of Investigation (POIs):** *Approved Final Report, Comprehensive Stormwater Management Plan for Martin State Airport, Middle River, Baltimore County, Maryland*, March 2004 (MDE No. 04-SF-IMP2);
- **Storm drainage pipe capacity:** *Approved Final Report, Comprehensive Stormwater Management Plan for Martin State Airport, Middle River, Baltimore County, Maryland*, March 2004 (MDE No. 04-SF-IMP2);
- **Stormwater quantity:** TR55 and TR20 modeling prepared for the *Approved Final Report, Comprehensive Stormwater Management Plan for Martin State Airport, Middle River, Baltimore County, Maryland*, March 2004 (MDE No. 04-SF-IMP2);
- **Storm drainage outfall conditions:** *Approved Final Report, Comprehensive Stormwater Management Plan for Martin State Airport, Middle River, Baltimore County, Maryland*, March 2004;
- **Phosphorus reduction calculations:** *Maryland Chesapeake and Atlantic Coastal Bays, Critical Area 10% Rule Guidance Manual,* Fall 2003. Within this manual, four different pollution reduction strategies can be analyzed to determine the phosphorus reduction required. For this Environmental Assessment, two of these strategies were evaluated: 1) the calculation of the phosphorus reduction for the portion of the project site (limit of disturbance [LOD]) within the Critical Area; and 2) calculation of the phosphorus reduction for the entire project site (LOD). If the phosphorus reduction was met by either of these strategies, the requirement is fulfilled;
- **Applicability of stormwater management waivers:** *Maryland Stormwater Management and Erosion and Sediment Control Guidelines for State and Federal Funded Projects,* February 2015; and
- **Environmental Site Design and Structural BMP stormwater criteria**: *2000 Maryland Stormwater Design Manual, Volumes I & II,* April 2000, updated 2009; and *Maryland Stormwater Management and Erosion and Sediment Control Guidelines for State and Federal Funded Projects,* February 2015.

To analyze stormwater quantity control, the existing conditions TR55 models from the *Comprehensive Stormwater Management Plan for Martin State Airport* (*2004 Plan*) were modified to reflect the Minimum Action development in each drainage area that might require quantity control. Drainage area and the time of concentration (Tc) in the existing conditions model were assumed unchanged in the post-development conditions model. The soil classification information used in the existing conditions model was taken from the 1976 Soil Conservation Service (SCS) Soil Survey for Baltimore County, Maryland. During the quantity analyses, it was determined that since then, the Natural Resources Conservation Services (NRCS, formerly the SCS) has updated the soil classification information for Baltimore County, resulting in a change in the soil classifications for some drainage basins within the Martin State Airport property. This change in soil classification would result in different existing conditions discharges from those in the *2004 Plan*. Therefore, a corrected existing conditions TR55 model was developed for the drainage areas where soil classifications were revised after 2004. **The only change between this model and the existing conditions model was soil classification**. A post-development model was developed to reflect the post-development impervious area using the current soil classification.

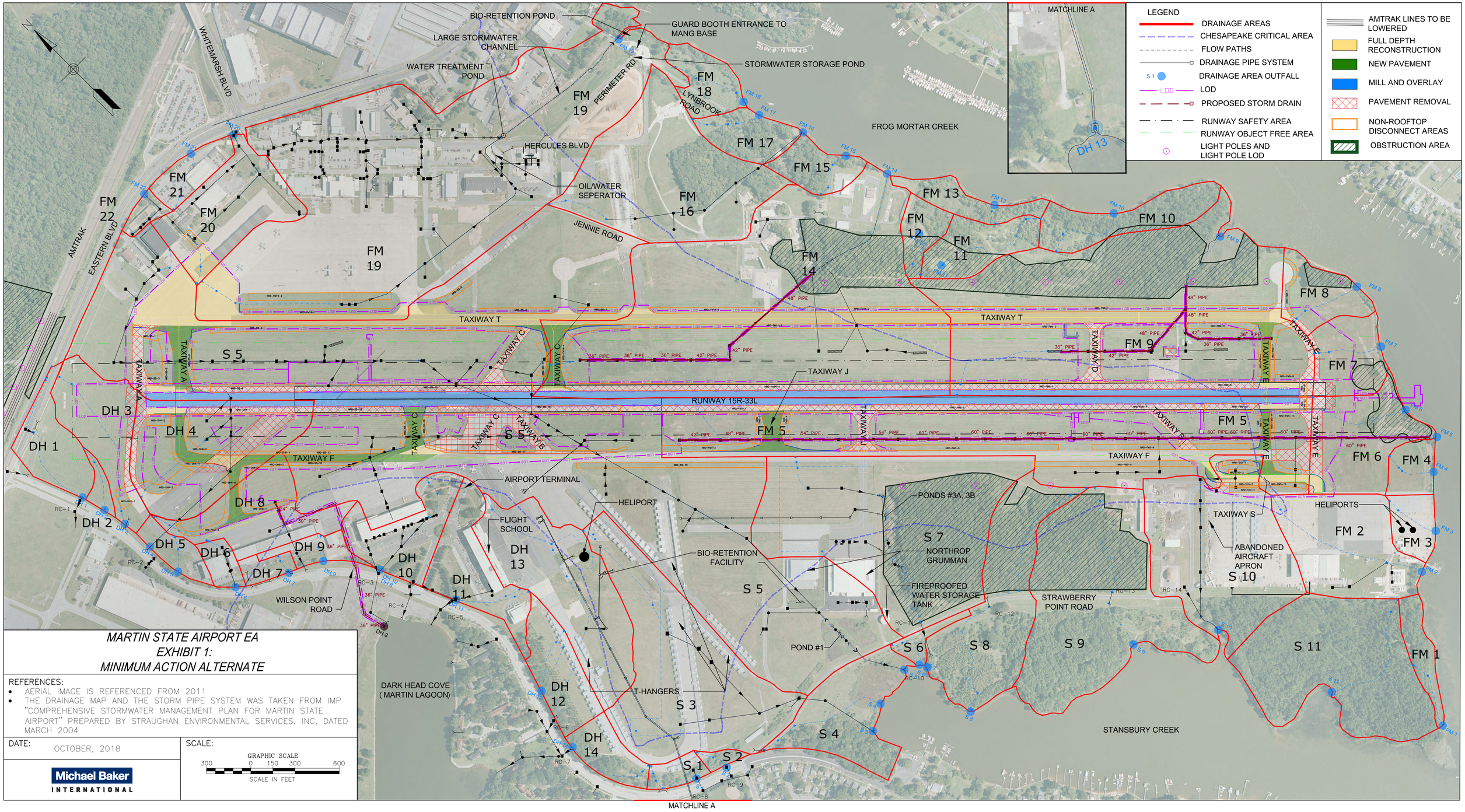
2. Minimum Action Alternative

In the Minimum Action Alternative, the runway ends for Runway 15/33 will be relocated and displaced to achieve the 7,000 feet of Accelerate-Stop Distance Available (ASDA) and compliant runway safety areas. This involves modifying the runway from 180-foot width to a 100-foot width with 20-foot wide turf shoulders. This alternative also includes the following actions:

- Remove off-airport obstructions for Runways 15 and 33;
- Extend Taxiway F to the end of Runway 15;
- Remove & Reconstruct Taxiways C and S;
- Remove Taxiways B and D;
- Remove and Relocate Taxiway J
- Add connecting perpendicular Taxiway C;
- Rehabilitate/Reconstruct Taxiway T;
- Relocate Taxiway A to align with the relocated end of Runway 15 & remove existing Taxiway A;
- Relocate Taxiway E to align with the relocated end of Runway 33 & remove existing Taxiway E;
- Add taxiway fillets;
- Relocate NAVAIDS;
- MANG Apron Reconstruction; and
- Installation of obstruction light poles

The proposed projects that fall within each of the three watersheds (Dark Head, Frog Mortar, and Stansbury) are shown in Table 1. **Exhibit 1** shows the proposed projects and the stormwater management BMPs for this alternative.

MARTIN STATE AIRPORT



MARTIN STATE AIRPORT EA
EXHIBIT 1:
MINIMUM ACTION ALTERNATE

REFERENCES:

- AERIAL IMAGE IS REFERENCED FROM 2011
- THE DRAINAGE MAP AND THE STORM PIPE SYSTEM WAS TAKEN FROM IMP "COMPREHENSIVE STORMWATER MANAGEMENT PLAN FOR MARTIN STATE AIRPORT" PREPARED BY STRAUGHAN ENVIRONMENTAL SERVICES, INC. DATED MARCH 2004

DATE: OCTOBER, 2018

SCALE:

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Table 1. Proposed Projects for Minimum Action Alternative

Maryland Watershed (8-digit Watershed Number)	Maryland Watershed (6-digit Watershed Number)	Stream	Drainage Areas	Proposed Projects	Notes/ Remarks
Middle River/ Browns (02130807)	Gunpowder River (021308)	Dark Head Creek	DH 3	Remove Taxiway A	
			DH 4	Remove Taxiway A and former high-speed exit taxiway, mill and overlay runway, remove runway shoulders, relocate Taxiway A, extend Taxiway F, add connector Taxilane to apron, relocate NAVAIDS	
			DH 8	Add connector Taxi-lane to apron from Taxiway F, extend Taxiway F	
Middle River/ Browns (02130807)	Gunpowder River (021308)	Frog Mortar Creek	FM 2	No construction; portion of LOD is within this drainage basin	
			FM 5	Mill and overlay runway, remove runway shoulders, remove Taxiways E and S, relocate Taxiway E, remove and relocate Taxiway J	
			FM 6	Remove Taxiway E, add/relocate NAVAIDs, add fillets to Taxiway S, reconstruct Taxiway S	Per the approved/ expired IMP (4-SF-IMP2) no new development shall occur in these Drainage Areas
			FM 7	Remove Taxiway E, Add/relocate NAVAIDs	
			FM 8	Remove Taxiway E, Reconstruct Taxiway T	
			FM 9	Mill and overlay runway, remove runway shoulders, rehab Taxiway T, remove Taxiways D and E, relocate NAVAIDs, relocate Taxiway E	

Maryland Watershed (8-digit Watershed Number)	Maryland Watershed (6-digit Watershed Number)	Stream	Drainage Areas	Proposed Projects	Notes/ Remarks
			FM 14	Mill and overlay runway, remove runway shoulders, reconstruct Taxiway T, add to Taxiway C	
			FM 19	Reconstruct Taxiway T, MANG Apron Reconstruction	
			FM 20	MANG Apron Reconstruction	
Middle River/Browns (02130807)	Gunpowder River (021308)	Stansbury Creek	S 5	Mill and overlay runway, remove runway shoulder, remove Taxiways A, B, and C, rehab Taxiway T, new locations of Taxiways A, B, and C, extend Taxiway F, MANG Apron Reconstruction, relocate NAVAIDS	
			S 10	Rehab Taxiway S and make fillet changes, edges of Connector Taxiway from Taxiway F to Taxiway S	

2.1 Dark Head Creek

Within the Dark Head Creek watershed, drainage areas DH3, DH4, and DH8 are impacted by the Minimum Action Alternative. A portion of DH8 lies within the Chesapeake Bay Critical Area; therefore, the phosphorus removal requirement must be evaluated for this drainage area. The following sections describe the stormwater management requirements for Dark Head Creek.

2.1.1 Water Quality Control

DH 3 - This project is classified as new development and will require stormwater management to meet water quality control requirements. These requirements can be met through the use of ESD BMPs, in particular, NRDs. Because water quality control would be met through ESD, channel protection volume (CPv) will not be required. Table 2 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 2. Dark Head 3: Impervious Area Changes and Proposed Stormwater BMPs

Dark Head 3	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	134,121	3.08	NRD-DH 3-1	75' x length of pavement	9,474	750
Existing Impervious	35,113	0.80				
Post-Development Impervious	2,276	0.05				
Removed Impervious	32,837	0.75				
Proposed New Impervious	0	0				
Existing Impervious Percent	26.18%					
New Development						
Area to Use	2,276	0.05			**Total (CF)**	**750**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**730**
ESDv=	730 CF				**Excess Treatment (CF)**	**20**

DH 4 - This project is classified as new development and would require treatment to meet water quality control requirements. These requirements can be met through the use of ESD BMPs, in particular, NRDs. Because water quality control would be met through ESD, channel protection volume (CPv) will not be required. Table 3 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 3. Dark Head 4: Impervious Area Changes and Stormwater Management BMPs

Dark Head 4	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	505,192	11.60	NRD-DH 4-1	50' x L of pavement	41,519	3,287
Existing Impervious	185,305	4.25	NRD-DH 4-2	75' x L of pavement	12,359	978
Post-Development Impervious	102,330	2.35	NRD-DH 4-3	66' x L of pavement	24,642	1,951
Removed Impervious	137,643	3.16	NRD-DH 4-4	25' x L of pavement	14,672	1,162
Proposed New Impervious	54,668	1.26	NRD-DH 4-5	35' x L of pavement	24,739	1,958
Existing Impervious Percent	36.68%		NRD-DH 4-6	35' x L of pavement	3,948	313
			NRD DH 4-7	45' x L of pavement	7,353	582
New Development						
Area to Use	102,330	2.35			**Total (CF)**	**10,231**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**9,780**
ESDv=	9,780 CF				**Excess Treatment (CF)**	**451**

DH 8 - This project is classified as new development and would require treatment to meet water quality control requirements. These requirements can be met through the use of ESD BMPs, in particular NRDs. Because water quality control would be met through ESD, CPv will not be required. Table 4 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 4. Dark Head 8: Impervious Area Changes and Stormwater Management BMPs

Dark Head 8	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	102,944	2.36	NRD-DH 8-1	35' x L of pavement	19,080	1,511
Existing Impervious	0	0.00	NRD-DH 8-2	33' x L of pavement	18,661	1,477
Post-Development Impervious	28,988	0.67	NRD-DH 8-3	25' x L of pavement	4,369	346
Removed Impervious	0	0.00	NRD-DH 8-4	14' x L of pavement	747	59
Proposed New Impervious	28,988	0.67				
Existing Impervious Percent	0.00%					
New Development						
Area to Use	28,988	0.67		**Total (CF)**		**3,393**
Pe=	1.2 inches			**ESDv Req'd (CF)**		**3,124**
ESDv=	3,124 CF			**Excess Treatment (CF)**		**269**

2.1.2 Phosphorus Removal

DH 3 and DH 4 are not within the Chesapeake Bay Critical Area. Therefore, there are no phosphorus removal requirements for these. A portion of DH8 lies within the Critical Area. For DH8, the phosphorus removal requirements were evaluated, and results are summarized in Table 5.

Table 5. Phosphorus Removal Requirement for DH 8

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	270	0.01
Existing Impervious	-	-
Post-Development Impervious	-	-
Existing Impervious, I_{pre}	0.00%	
Proposed Impervious, I_{post}	0.00%	
New Development		
Predevelopment Load, L_{pre}	0.0 lbs/year	
Post-Development Load, L_{post}	0.0 lbs/year	
Pollutant Removal Requirement[1]	0.0 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

2.1.3 Storm Drainage Pipe Capacity

The stormdrain capacity analysis presented in the *2004 Plan* was used to determine whether the pipe capacity was adequate. For drainage areas without inlets, no capacity analysis was performed.

DH 3 - Within DH 3, there are no storm drain inlets. Therefore, no storm drainage pipe capacity analysis was conducted. Sheet flow from airport property flows to an existing road drainage ditch and a county stormwater system that discharges into Dark Head Creek. The road crossing culvert (RC-2) is inadequate for a 25-year storm conveyance as reported in the *2004 Plan*.

DH 4 - The *2004 Plan* showed that two sections of the existing pipe system were surcharged during a 10-year storm event for the existing conditions. The removal of pavement in this drainage area should not exacerbate the storm drain system's lack of capacity issue.

DH 8 - The *2004 Plan* showed that one section of the existing pipe system was surcharged during a 10-year storm event for the existing conditions. With the addition of new pavement in this drainage area, the pipe system will still be surcharged, and an increase in capacity will be required for the new development. See Section 2.1.5 for proposed changes to the storm drain system for this drainage area.

2.1.4 Stormwater Waivers

Stormwater waivers, as defined in Section 3 of the *Maryland Stormwater Management Guidelines for State & Federal Projects,* do not apply to DH 3 and DH 4 for either quantity or quality control. For DH 8, a stormwater waiver in accordance with Section 3.3 (B) (1) (c) would be applicable to the storm drain system change described in the following section.

2.1.5 Water Quantity Control

For drainage areas DH 3, DH 4, and DH 8, the existing conditions TR55 model prepared for the *2004 Plan* was modified to reflect the change in impervious area. As discussed in Section 1, some soil classifications surrounding the airport changed between the *2004 Plan* and the current soil mapping developed by the NRCS. In those areas, a corrected TR55 existing conditions model was prepared to evaluate the change in discharges as a result of soil classification changes. Table 6 provides a comparison of the existing conditions discharges from the *2004 Plan*, the corrected existing conditions model (if appropriate), and the post-development discharges based on the Minimum Action Alternative.

Table 6. Comparison of Discharges for Minimum Action Alternative

Drainage Area	Existing Conditions[1]	Modified Existing Conditions[2]	Post-Development Conditions[3]
	Qp_{10} (cfs)	Qp_{10} (cfs)	Qp_{10} (cfs)
DH 3	19.0	25.0	22.9
DH 4	69.0	79.2	75.7
DH 8	36.0	41.0	45.7[4]

[1] Qp_{10} from the TR55 model developed for the 2004 *Comprehensive Stormwater Management Plan for Martin State Airport*

[2] Qp_{10} from corrected effective TR55 model. Soil groups in existing conditions TR55 model were corrected to reflect current NRCS soil group designations. No other changes were made to the existing conditions TR-55 model.

[3] Qp_{10} for post-development represents changes in land uses and current NRCS soil group designations.

[4] Qp_{10} represents ultimate development (entire drainage area modeled as impervious land) for sizing new storm drain pipe.

DH 3 - Based on Table 2 of the *Maryland Stormwater Management and Erosion and Sediment Control Guidelines for State & Federal Projects,* dated February 2015, the minimum flood control requirement for projects within Baltimore County is Qp_{10}. As stated in Section 2.1.3, the existing road crossing culvert had been determined to be inadequate for 25-year storm. However, the reduction in impervious area for this drainage area will reduce Qp_{10}; therefore, quantity control would not be required/anticipated.

DH 4 - The existing pipe system does not provide adequate conveyance, as stated in Section 2.1.3. Therefore, quantity control for the 10-year storm would be required. However, the reduction in the impervious area for this drainage area will reduce Qp_{10}; therefore, quantity control would not be required/anticipated.

DH 8 - The existing pipe system does not provide adequate conveyance, as stated in Section 2.1.3. The increase in impervious area for this drainage area will result in an increase in the Qp_{10} discharge. Therefore, quantity control or a waiver for quantity control will be required.

The existing pipe system that serves DH8 consists of an 18-inch reinforced concrete pipe (RCP) that runs from the infield area adjacent to the aircraft parking apron at Buildings 409 and 501-511, and discharges into a roadside ditch along Wilson Point Road. The pipe originates from an inlet in the grassed area, runs across the ramp to an inlet in the ramp, under Buildings 501-511 to a manhole, and then to the ditch. Another existing pipe connects to the 18-inch pipe on the ramp. The size of that pipe is unknown.

Quantity control would be required within the drainage area unless a stormwater waiver can be applied to this site. Options to address quantity control are either install an underground detention BMP or change the storm drain system and POI so that a stormwater waiver could be applied. The underground detention facility would be costly and hard to maintain. Therefore, the recommended design to address quantity control is to relocate the POI from its current location along Wilson Point Road to a location on the banks of Dark Head Creek, and to construct a new storm drainage system that would discharge directly at the location of the new POI into Dark Head Creek. Thus, a stormwater waiver under Part 3.3(B) (1) (c) would be applicable.

Based on the requirements stated above, the size of the pipe would have to be increased to convey the discharge and would also have to be realigned to discharge directly into Dark Head Creek. The new alignment is shown on Exhibit 1. The new alignment is recommended because the new pipe cannot be constructed along the same alignment as the existing pipe. The existing pipe alignment from the inlet on the ramp to Wilson Point Road is currently located under the building and it would be impractical to construct the new pipe under the building. With the new alignment, the existing pipe from the inlet on the ramp to the outlet to the ditch along Wilson Point Road would be abandoned. This pipe would be plugged at the inlet to prevent storm runoff from flowing into this pipe. The new pipe was sized for ultimate development conditions which assume that the entire DH 8 drainage area is impervious. The 10- and 25-year discharges were determined using the SCS NRCS TR55 program. The 10-year discharge is the allowable design discharge for the storm drainage system on the airport and the 25-year discharge is the design discharge for a culvert crossing State roads. Based on the calculations, the discharges were determined to be 45.7 cfs for the 10-year storm event and 49.3 cfs for the 25-year storm event.

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey the discharge from the infield area to the creek for both the 10- and 25-year storms. Based on the calculations, the existing 18-inch pipe would be replaced with a 30-inch pipe from the infield inlet to the manhole on the ramp. The pipe from the manhole on the ramp to the creek outfall would be a 36-inch RCP.

2.2 Frog Mortar Creek

Within the Frog Mortar Creek watershed, drainage areas FM 2, FM 5, FM 6, FM 7, FM 8, FM 9, FM 14, FM 19 and FM 20 are affected by the Minimum Action Alternative. With the exception of FM 19 & FM 20, all of the drainage basins have a project or a portion of a project within the Chesapeake Bay Critical Area. Therefore, the phosphorus removal requirement must be met for these drainage areas. The following sections describe the stormwater management requirements for Frog Mortar Creek.

2.2.1 Water Quality Control

FM 2 - No construction is proposed within this drainage area; however, a portion of the LOD for the Minimum Action Alternative falls within this drainage area. Therefore, this drainage area was evaluated for stormwater management and would be classified as redevelopment. Water quality control is not met through ESD; however, water quality overtreatment (credits) from drainage area FM 5 can be applied to meet these requirements. Because this project is classified as redevelopment, CPv treatment is not required. Table 7 summarizes the pavement changes that would occur within this drainage area.

Table 7. Frog Mortar 2: Impervious Area Changes

Frog Mortar 2	SF	Acres
Limit of Disturbance (LOD)	6,862	0.16
Existing Impervious	6,862	0.16
Post-Development Impervious	6,862	0.16
Removed Impervious	0	0.00
Proposed New Impervious	0	0.00
Existing Impervious Percent	100.00%	
Redevelopment		
Area to Use	3,431	0.08
Pe=	1 inch	
ESDv=	272 CF	

FM 5 - This project is classified as new development and would require treatment to meet water quality control requirements. The proposed action removes more than 50 percent of the existing impervious area within the site area; therefore, water quality requirements have been met. A waiver for CPv treatment is applicable for this drainage basin. See Section 2.2.4 for more details on stormwater waivers. Table 8 summarizes the pavement changes that would occur within this drainage area.

Even though stormwater management is not required within this drainage area, there are opportunities to provide water quality treatment through the use of NRDs. These NRDs would provide water quality credits for the Maryland Aviation Administration (MAA) and could be used to compensate for treatment required in drainage areas where no opportunities for BMPs exist. Table 8 summarizes the opportunities for stormwater BMPs within this drainage area as part of the Minimum Action Alternative and the treatment provided by the NRDs.

Table 8. Frog Mortar 5: Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 5	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	848,399	19.48	NRD-FM 5-1	50' x L of pavement	67,424	5,338
Existing Impervious	326,428	7.49	NRD-FM 5-2	40' x L of pavement	24,730	1,958
Post-Development Impervious	157,638	3.62	NRD-FM 5-3	50' x L of pavement	10,640	842
Removed Impervious	249,503	5.73	NRD-FM 5-4	50' x L of pavement	10,509	832
Proposed New Impervious	80,713	1.85	NRD-FM 5-5	50' x L of pavement	70,555	5,586
Existing Impervious Percent	38.48%		NRD-FM 5-6	37.5' x L of pavement	56,019	4,435
The proposed action removes more than 50 percent of the existing impervious area within the site area; therefore, water quality requirements have been met.			NRD-FM 5-7	50' x L of pavement	34,361	2,720
			NRD-FM 5-8	40' x L of pavement	40,905	3,238
			NRD-FM 5-9	40' x L of pavement	40,240	3,186
			NRD-FM 5-10	50' x L of pavement	16,944	1,341
			NRD-FM 5-11	33' x L of pavement	4,363	345
			NRD-FM 5-12	35' x L of pavement	4,418	350
			NRD-FM 5-13	35' x L of pavement	8,153	645
			NRD FM 5-14	30' x L of pavement	18,804	1,489
			NRD FM 5-15	30' x L of pavement	8,999	712
New Development						
Area to Use	N/A	N/A			**Total (CF)**	**33,018**
Pe=	1.0				**ESDv Req'd (CF)**	**N/A**
ESDv=	N/A				**Excess Treatment (CF)**	**33,018**

FM 6 - This project is classified as redevelopment. The proposed action removes more than 50 percent of the existing impervious area within the site area; therefore, the water quality requirement has been met. Because this project is classified as redevelopment, CPv treatment is not required. Table 9 summarizes the pavement changes that would occur within this drainage area.

Table 9. Frog Mortar 6: Impervious Area Changes

Frog Mortar 6	SF	Acres
Limit of Disturbance (LOD)	139,060	3.19
Existing Impervious	59,547	1.37
Post-Development Impervious	10,064	0.23
Removed Impervious	50,549	1.16
Proposed New Impervious	1,066	0.02
Existing Impervious Percent	42.82%	
Redevelopment		
Area to Use	N/A	N/A
Pe=	1 inch	
Redevelopment ESDv=	N/A	

FM 7 - This project is classified as new development. However, there is no net increase in impervious area requiring treatment because the only action in this drainage area is the removal of all existing pavement (no new pavement is proposed). Therefore, no stormwater management for water quality is required. A waiver for CPv treatment is applicable for this drainage basin. See Section 2.2.4 for more details on stormwater waivers. Table 10 summarizes the pavement changes that would occur within this drainage area.

Table 10. Frog Mortar 7: Impervious Area Changes

Frog Mortar 7	SF	Acres
Limit of Disturbance (LOD)	124,805	2.87
Existing Impervious	25,694	0.59
Post-Development Impervious	-	0.00
Removed Impervious	25,694	0.59
Proposed New Impervious	-	0.00
Existing Impervious Percent	20.59%	
New Development		
Area to Use	N/A	N/A
Pe=	1 inch (calculations show 0.78 inch; use 1 inch to determine ESDv)	
ESDv=	N/A	

FM 8 - This project is classified as new development, and stormwater management would be required for water quality. Water quality requirements can be met through the use of an NRD. A waiver for CPv treatment is applicable for this watershed. See Section 2.2.4 for more details on stormwater waivers. Table 11 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 11. Frog Mortar 8: Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 8	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	35,842	0.82	NRD-FM 8-1	25' x L of pavement	11,052	875
Existing Impervious	9,380	0.22				
Post-Development Impervious	3,622	0.08				
Removed Impervious	5,771	0.13				
Proposed New Impervious	13	0.00				
Existing Impervious Percent	26.17%					
New Development						
Area to Use	3,622	0.08			**Total (CF)**	**875**
Pe=	1 inch (calculations show 0.63 inches; use 1 inch to determine ESDv)				**ESDv Req'd (CF)**	**421**
ESDv=	421 CF				**Excess Treatment (CF)**	**454**

FM 9 - This project is classified as redevelopment and requires stormwater management for water quality. This requirement can be met through the use of NRDs, and additional NRDs can be used in this drainage area to provide water quality credits for MAA. Because this project is classified as redevelopment, CPv treatment is not required. Table 12 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 12. Frog Mortar 9: Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 9	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	706,704	16.22	NRD-FM 9-1	35' x L of pavement	88,621	7,016
Existing Impervious	337,768	7.75	NRD-FM 9-2	35' x L of pavement	55,649	4,406
Post-Development Impervious	206,603	4.74	NRD-FM 9-3	35' x L of pavement	18,924	1,498
Removed Impervious	162,563	3.73	NRD-FM 9-4	25' x L of pavement	7,288	577
Proposed New Impervious	31,398	0.72	NRD-FM 9-5	50' x L of pavement	79,354	6,282
Existing Impervious Percent	48.22%		NRD FM 9-6	50' x L of pavement	22,125	1,752
			NRD-FM 9-7	30' x L of pavement	16,738	1,325
			NRD-FM 9-8	50' x L of pavement	7,677	608
			NRD-FM 9-9	50' x L of pavement	5,016	397
Redevelopment						
Area to Use	37,719	0.87			**Total (CF)**	**23,860**
Pe=	1.0 inches				**ESDv Req'd (CF)**	**2,986**
ESDv=	2,986 CF				**Excess Treatment (CF)**	**20,874**

FM 14 - This project is classified as redevelopment and requires stormwater management for water quality. This requirement can be met through the use of NRDs, and additional NRDs can be used in this drainage area to provide water quality credits for MAA. Because this project is classified as redevelopment, CPv treatment is not required. Table 13 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 13. Frog Mortar 14: Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 14	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	566,802	13.01	NRD-FM 14-1	35' x L of pavement	28,419	2,250
Existing Impervious	275,732	6.33	NRD-FM 14-2	35' x L of pavement	44,146	3,495
Post-Development Impervious	220,453	5.06	NRD-FM 14-3	35' x L of pavement	87,769	6,948
Removed Impervious	102,477	2.35	NRD-FM 14-4	33' x L of pavement	10,773	853
Proposed New Impervious	47,198	1.08	NRD-FM 14-5	50' x L of pavement	128,124	10,143
Existing Impervious Percent	48.65%					
Redevelopment						
Area to Use	82,587	1.90			**Total (CF)**	**23,689**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**6,538**
ESDv=	6,538 CF				**Excess Treatment (CF)**	**17,151**

FM 19 - This project is classified as redevelopment and requires stormwater management for water quality. This requirement can be met through the use of NRDs, and additional NRDs can be used in this drainage area to provide water quality credits for MAA. Because this project is classified as redevelopment, CPv treatment is not required. Table 14 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 14. Frog Mortar 19: Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 19	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	161,521	3.71	NRD-FM 19-1	39' x L of pavement	38,831	3,074
Existing Impervious	133,181	3.06	NRD-FM 19-2	50' x L of pavement	48,299	3,824
Post-Development Impervious	133,181	3.06				
Removed Impervious	0	0.00				
Proposed New Impervious	0	0.00				
Existing Impervious Percent	82.45%					
Redevelopment						
Area to Use	66,591	1.53			**Total (CF)**	**6,898**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**5,272**
ESDv=	5,272 CF				**Excess Treatment (CF)**	**1,626**

FM 20 - This project is classified as redevelopment and requires stormwater management for water quality. A portion of the water quality treatment can be met through the use of NRDs; however, water quality overtreatment (credits) from drainage area FM 5 can be applied to meet these requirements. Because this project is classified as redevelopment, CPv treatment is not required. Table 15 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 15. Frog Mortar 20: Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 20	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	38,122	0.88	NRD-FM 20-1	39' x L of pavement	7,483	592
Existing Impervious	34,438	0.79				
Post-Development Impervious	34,438	0.79				
Removed Impervious	0	0.00				
Proposed New Impervious	0	0.00				
Existing Impervious Percent	90.33%					
Redevelopment						
Area to Use	17,219	0.40			**Total (CF)**	**592**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**1,363**
ESDv=	1,363 CF				**Deficit Treatment (CF)**	**-771**

2.2.2 Phosphorus Removal

For the Minimum Action Alternative, FM 19 & FM 20 has no work proposed within the Critical Area. Therefore, no phosphorus removal is required in FM 19 & FM 20.

For drainage areas FM 2, 5-9, and 14, the requirements for phosphorus removal were evaluated. The requirement for phosphorus reduction was evaluated using the two strategies described in Section 1. For the drainage areas within Frog Mortar watershed, the phosphorus reduction requirement is met based on the entire project LOD. As shown in Table 16 through Table 22, no treatment for phosphorus removal is required for the Minimum Action Alternative.

Table 16. Phosphorus Removal for Frog Mortar 2

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	6,862	0.16
Existing Impervious	6,862	0.16
Post-Development Impervious	6,862	0.16
Existing Impervious, I_{pre}	100.00%	
Proposed Impervious, I_{post}	100.00%	
Redevelopment		
Predevelopment Load, L_{pre}	0.4 lbs/year	
Post-Development Load, L_{post}	0.4 lbs/year	
Pollutant Removal Requirement[1]	0.0 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 17. Phosphorus Removal for Frog Mortar 5

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	848,399	19.48
Existing Impervious	326,428	7.49
Post-Development Impervious	157,613	3.62
Existing Impervious, I_{pre}	38.48%	
Proposed Impervious, I_{post}	18.58%	
Redevelopment		
Predevelopment Load, L_{pre}	18.9 lbs/year	
Post-Development Load, L_{post}	10.4 lbs/year	
Pollutant Removal Requirement[1]	-6.6 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 18. Phosphorus Removal for Frog Mortar 6

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	139,060	3.19
Existing Impervious	59,547	1.37
Post-Development Impervious	10,064	0.23
Existing Impervious, I_{pre}	42.82%	
Proposed Impervious, I_{post}	7.24%	
Redevelopment		
Predevelopment Load, L_{pre}	3.4 lbs/year	
Post-Development Load, L_{post}	0.9 lbs/year	
Pollutant Removal Requirement[1]	-2.2 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 19. Phosphorus Removal for Frog Mortar 7

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	124,805	2.87
Existing Impervious	25,694	0.59
Post-Development Impervious	-	-
Existing Impervious, I_{pre}	20.59%	
Proposed Impervious, I_{post}	0.00%	
Redevelopment		
Predevelopment Load, L_{pre}	1.7 lbs/year	
Post-Development Load, L_{post}	0.4 lbs/year	
Pollutant Removal Requirement[1]	-1.1 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 20. Phosphorus Removal for Frog Mortar 8

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	35,842	0.82
Existing Impervious	9,380	0.22
Post-Development Impervious	3,622	0.08
Existing Impervious, I_{pre}	26.17%	
Proposed Impervious, I_{post}	10.10%	
Redevelopment		
Predevelopment Load, L_{pre}	0.6 lbs/year	
Post-Development Load, L_{post}	0.3 lbs/year	
Pollutant Removal Requirement[1]	-0.2 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 21. Phosphorus Removal for Frog Mortar 9

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	706,704	16.22
Existing Impervious	337,768	7.75
Post-Development Impervious	206,603	4.74
Existing Impervious, I_{pre}	47.79%	
Proposed Impervious, I_{post}	29.23%	
Redevelopment		
Predevelopment Load, L_{pre}	19.1 lbs/year	
Post-Development Load, L_{post}	12.4 lbs/year	
Pollutant Removal Requirement[1]	-4.7 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 22. Phosphorus Removal for Frog Mortar 14

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	566,802	13.01
Existing Impervious	275,732	6.33
Post-Development Impervious	220,453	5.06
Existing Impervious, I_{pre}	48.65%	
Proposed Impervious, I_{post}	38.89%	
Redevelopment		
Predevelopment Load, L_{pre}	15.5 lbs/year	
Post-Development Load, L_{post}	12.7 lbs/year	
Pollutant Removal Requirement[1]	-1.2 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

2.2.3 Storm Drainage Pipe Capacity

The stormdrain capacity analysis presented in the *2004 Plan* was used to determine if the pipe capacity was adequate. For drainage areas where there are no inlets, a capacity analysis was not performed.

FM 2 - The *2004 Plan* did not include a storm drain capacity analysis. The existing pipe system that serves FM-2 is unknown as the available data do not show the size of the pipe. The alignment shows the storm system running along the south side of the abandoned aircraft apron at the southeast end of the airport. The pipe discharges into a BMP that discharges into a swale that outlets directly into Frog Mortar Creek. Because of the lack of available information on this system, the existing capacity is not known. Additionally, no new construction is proposed within this drainage area only a portion of the LOD falls within this drainage area hence no stormdrain sizing analysis was performed.

FM 5 - The *2004 Plan* showed that seven sections of the existing pipe system were surcharged during a 10-year storm event under the existing conditions. With the reduction in new pavement in this drainage area, this would reduce the surcharge in the pipe system.

The existing pipe system that serves Drainage Area FM 5 consists of a combination of 18-, 24-, 30-, 36-, 42-, 48-, and 54-inch RCPs. The runoff from the drainage area sheet flows to inlets in the infield area of the airfield between the runway and Taxiway F. The pipes run parallel to the runway and cross underway Taxiways J, S, and E and discharge into Frog Mortar Creek.

Based on the limited data available for the existing pipes, a pipe slope of 0.1 percent was assumed to determine the capacity of the pipes. This slope was selected because it allows the pipes to cross under the taxiway with a minimum cover of approximately 2 feet. The pipes would protrude above the ground if a steeper slope was assumed. In addition, an invert of -2.00 feet was

assumed at the outlet to Frog Mortar Creek. Calculations based on these assumptions show existing pipe sizes are inadequate even with the reduction in impervious.

The Q_{10} discharge for the Minimum Action Alternate requires the pipe size increase to convey the discharge to Frog Mortar Creek. It was assumed that the alignment of the pipe would follow the alignment of the existing pipe. The alignment is shown in Exhibit 1. The 10- year discharges for the project were determined using the NRCS TR55 program. The 10-year discharge is the allowable design discharge for the storm drainage system on the airport. Based on the calculations, the total discharge IS as follows:

10-Year Storm (Q_{10}) – 177 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey the discharge from the infield area to the creek for the 10-year storm event. The hydraulic gradient calculations used a 0.1-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. Based on the calculations, the existing pipes should be replaced with a combination of 42-, 48-,54- and 60-inch RCPs from the inlet in the infield area to the outfall into Frog Mortar Creek to convey the 10- storm. A stormwater waiver for quantity control would be applicable under Section 3(B)(1)(c).

FM 6, FM 7, and FM 8 - Within these three drainage areas, there are no storm drain inlets. Therefore, no storm drainage pipe capacity analysis was conducted.

FM 9 - The *2004 Plan* showed that three sections of the existing pipe system were surcharged during a 10-year storm event for the existing conditions. With the reduction in new pavement in this drainage area, this would reduce the surcharge in the pipe system.

The existing pipe system that serves Drainage Area FM 9 consists of a combination of 18-, 24-, 30-, 36-, 42-, and 48–inch RCPs. This drainage area consists of two storm drainage systems that converge into one pipe that conveys the discharge to the outlet. The runoff from the drainage area sheet flows to inlets in the infield area of the airfield between the runway and Taxiway T at the southeast end of the airport. The pipes run parallel to the runway and then turn to the east and cross underway Taxiway T and discharge into a ditch that discharges into Frog Mortar Creek. Because of the two pipe systems, the area was subdivided into two drainage areas identified as Area 1 and Area 2. Area 1 consists of the pipe system in the northern portion of the drainage area and Area 2 consists of the pipe system in the southern portion of the drainage area. Both systems cross under Taxiway T to a manhole. The pipe from this manhole discharges to the ditch that connects directly to Frog Mortar Creek.

Based on the limited data available for the existing pipes, a pipe slope of 0.5 percent was assumed to determine the capacity of the pipes. This slope was selected because it allows the pipes to cross under the taxiway with a minimum cover of approximately 2 feet. The pipes would protrude from the ground if a steeper slope was assumed. In addition, an invert of 0.80 feet was assumed at the ditch that connects to Frog Mortar Creek. Calculations based on these assumptions show existing pipe sizes are inadequate even with the reduction in impervious.

It was assumed that the alignment of the pipe would follow the alignment of the existing pipe. The alignment is shown in Exhibit 1. The 10- year discharge for the future discharge was determined using the NRCS TR55 program. The 10-year discharge is the allowable design discharge for the storm drainage system on the airport. Based on the calculations, the total discharges are as follows:

10-Year Storm (Q_{10}) – 209 cfs

However, only a portion of the total discharge from the drainage area is conveyed by the storm drainage pipes. The amount of discharge to each system was determined by prorating the areas that discharge to the pipes. Based on this calculation, the discharge to each pipe system is shown below:

	10-Year Storm
Area 1	72 cfs
Area 2	43 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey the discharge from the infield area to the creek for the 10-year storm. The hydraulic gradient calculations used a 0.1-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. Based on the calculations, to convey the 10-year storm the existing pipes should be replaced with a combination of 36-,42-, and 48-inch RCPs, for both storm systems, from the inlet in the infield area to the ditch that outfalls into Frog Mortar Creek.

FM 14 - The *2004 Plan* showed that two sections of the existing pipe system were surcharged during a 10-year storm event for the existing conditions. With the reduction in new pavement in this drainage area, this would reduce the surcharge in the pipe system.

The existing pipe system that serves Drainage Area FM 14 consists of a combination of 18-, 24-, 30-, 36-, and 48-inch RCPs. This drainage area consists of two storm drainage systems that converge into one pipe that conveys the discharge to the outlet. The runoff from the drainage area sheet flows to inlets in the infield area of the airfield between the runway and Taxiway T near the midpoint of the airfield. The pipes run parallel to the runway and then turn to the east and cross underway Taxiway T and discharge into a ditch that discharges into Frog Mortar Creek. Because of the two pipe systems, the area was divided into two sub-drainage areas, identified as Area 1 and Area 2. Area 1 consists of the pipe system in the northern portion of the drainage area and Area 2 consists of the pipe system in the southern portion of the drainage. Both systems cross under Taxiway T and discharge to the ditch that connects directly to Frog Mortar Creek.

Calculations have shown that the pipe system in Area 1 is inadequate to convey the discharge from the Minimum Action Alternative development in the drainage area, but the existing pipe system in Area 2 is capable of conveying the future discharge for the 10-year storm. Based on the limited data available for the existing pipes, a pipe slope of 0.5 percent was assumed to determine the capacity of the pipes. This slope was selected because it allows the pipes to cross under the taxiway with a minimum cover of approximately 2 feet. The pipes would protrude from

the ground if a steeper slope was assumed. In addition, an invert of 1.50 feet was assumed where the pipe enters the ditch.

The Q_{10} discharge will increase from its current value and the sizes of the pipes would have to be increased to convey the discharge into Frog Mortar Creek for Area 1. It was assumed that the alignment of the pipe would follow the alignment of the existing pipe. The alignment is shown in Exhibit 1. The 10-year discharge for the project were determined using the NRCS TR-55 program. The 10-year discharge is the allowable design discharge for the storm drainage system on the airport. Based on the calculations, the total discharge is as follows:

10-Year Storm (Q_{10}) – 162 cfs

However, only a portion of the total discharge from the drainage area is conveyed by the storm drainage pipes. The amount of discharge to each system was determined by prorating the areas that discharge to the pipes. Based on this calculation, the discharge to each pipe system is shown below:

	10-Year Storm
Area 1	58 cfs
Area 2	31 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey the discharge from the infield area to the creek for the 10-year storm. The hydraulic gradient calculations used a 0.5-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. Based on the calculations, the existing pipes in Area 1 should be replaced with a combination of 36-, 42-, and 48-inch RCPs, from the inlet in the infield area to the ditch that outfalls into the Frog Mortar Creek to convey the 10-year storm. The pipes in Area 2 would not need to be replaced. A stormwater waiver for quantity control would be applicable under Section 3.3 (B)(1)(a).

FM 19 & FM 20 - The *2004 Plan* showed that no sections of the existing pipe system were surcharged during a 10-year storm event for the existing conditions. The projects within these drainage area is pavement improvement to Taxiway T and MANG apron, so no additional storm drain capacity is anticipated.

2.2.4 Stormwater Waivers

The stormwater waiver, as defined in Section 3.3(B)(1)(a) of the *Maryland Stormwater Management Guidelines for State & Federal Projects* for quantity control and CPv is applicable for all drainage areas within the Frog Mortar watershed that are affected by the Minimum Action Alternative. This waiver applies because the POIs discharge into tidally influenced receiving waters.

2.2.5 Water Quantity Control

Water quantity control is not required for the affected drainage areas within the Frog Mortar watershed because a stormwater waiver is applicable (see Section 2.2.4).

2.3 Stansbury Creek

Within the Stansbury Creek watershed, drainage areas S5 and S10 are affected by the Minimum Action Alternative. All or at least a portion of these drainage areas lie within the Chesapeake Bay Critical Area; therefore, the phosphorus removal requirement must be met. The following sections describe the stormwater management requirements for Stansbury Creek.

2.3.1 Water Quality Control

S5 - This project is classified as redevelopment and will require water quality treatment. This requirement can be met through the use of NRDs, with excess treatment available for water quality credits for MAA. Because this project is classified as redevelopment, CPv treatment is not required. Table 23 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 23. Stansbury 5 Impervious Area Changes and Stormwater Management BMPs

Stansbury 5	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	1,744,400	40.05	NRD-S 5-1	70' x L of pavement	12,378	980
Existing Impervious	791,188	18.16	NRD-S 5-2	75' x L of pavement	25,441	2,014
Post-Development Impervious	530,329	12.17	NRD-S 5-3	75' x L of pavement	8,073	639
Removed Impervious	393,827	9.04	NRD-S 5-4	37' x L of pavement	77,959	6,172
Proposed New Impervious	132,968	3.05	NRD-S 5-5	39' x L of pavement	10,777	853
Existing Impervious Percent	45.36%		NRD-S 5-6	39' x L of pavement	19,145	1,516
			NRD-S 5-7	39' x L of pavement	10,574	837
			NRD-S 5-8	33' x L of pavement	8,859	701
			NRD-S 5-9	55' x L of pavement	35,046	2,774
			NRD-S 5-10	50' x L of pavement	62,861	4,976
			NRD-S 5-11	35' x L of pavement	9,138	723
			NRD-S 5-12	50' x L of pavement	29,198	2,312
			NRD-S 5-13	25' x L of pavement	17,113	1,355
			NRD S 5-14	32' x L of pavement	7,088	561
			NRD S 5-15	50' x L of pavement	62,916	4,981
			NRD-S 5-16	33' x L of pavement	5,718	453
			NRD-S 5-17	20' x L of pavement	27,501	2,177
			NRD-S 5-18	24' x L of pavement	11,266	892
			NRD-S 5-19	36' x L of pavement	46,241	3,661
Redevelopment						
Area to Use	134,735	3.09			**Total (CF)**	**38,577**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**10,667**
ESDv=	10,667 CF				**Excess Treatment (CF)**	**27,910**

S7 - This project is classified as new development and will require water quality treatment. Table 24 summarizes the pavement changes that would occur within this drainage area. Since the new impervious is<0.01 acres no new BMP is proposed however, water quality overtreatment (credits) from drainage area S5 can be applied to meet these requirements.

Table 24. Stansbury 7 Impervious Area Changes and Stormwater Management BMPs

Stansbury 7	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	2,500	0.06				
Existing Impervious	0	0.00				
Post-Development Impervious	25	0.00				
Removed Impervious	0	0.00				
Proposed New Impervious	0	0.00				
Existing Impervious Percent	0.00%					
New Development						
Area to Use	25	0.00			**Total (CF)**	0
Pe=	1.95 inches				**ESDv Req'd (CF)**	**24**
ESDv=	24 CF				**Deficit Treatment (CF)**	**-24**

S10 - This project is classified as redevelopment and will require water quality treatment. This requirement can be met through the use of NRDs, and additional NRDs can be used in this drainage area to provide water quality credits for MAA. Because this project is classified as redevelopment, CPv treatment is not required. Table 25 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 25. Stansbury 10 Impervious Area Changes and Stormwater Management BMPs

Stansbury 10	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	89,045	2.04	NRD-S 10-1	33' x L of pavement	6,560	519
Existing Impervious	46,421	1.07	NRD-S 10-2	33' x L of pavement	3,733	295
Post-Development Impervious	44,221	1.02	NRD-S 10--3	33' x L of pavement	6,385	505
Removed Impervious	6,690	0.15	NRD-S 10-4	33' x L of pavement	6,823	540
Proposed New Impervious	4,489	0.10				
Existing Impervious Percent	52.13%					
Redevelopment						
Area to Use	21,010	0.48			**Total (CF)**	**1,860**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**1,663**
ESDv=	1,663 CF				**Excess Treatment (CF)**	**197**

2.3.2 Phosphorus Removal

The phosphorus removal requirements are not applicable to S5 & S7 because the LOD is not located within the Critical Area. For S10, the phosphorus removal requirements were evaluated, and results are summarized in Table 26.

Table 26. Phosphorus Removal Requirements for Stansbury 10

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	89,045	2.04
Existing Impervious	46,421	1.07
Post-Development Impervious	44,221	1.02
Existing Impervious, I_{pre}	52.13%	
Proposed Impervious, I_{post}	49.66%	
Redevelopment		
Predevelopment Load, L_{pre}	2.6 lbs/year	
Post-Development Load, L_{post}	2.5 lbs/year	
Pollutant Removal Requirement[1]	0.1 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

This removal requirement is met through the use of the NRD BMPs, as shown in Table 27.

Table 27. Phosphorus Removal by BMP

BMP Phosphorus Calculation					
BMP Name	**Post-Development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Treated(SF)**	**Percent Site Area Treated**	**Load Removed (lb/yr)**
NRD-S10-1	2.5	25%	6,560	7.37	0.05
NRD-S10-2	2.5	25%	3,733	4.19	0.03
NRD-S10-3	2.5	25%	6,385	7.17	0.04
NRD-S10-4	2.5	25%	6,823	7.66	0.05
				SUM	**0.17**
				Removal Requirement	**0.1**

2.3.3 Storm Drainage Pipe Capacity

The stormdrain capacity analysis presented in the *2004 Plan* was used to determine if the pipe capacity was adequate. For drainage areas where there are no inlets, no capacity analysis was performed.

S5 - The *2004 Plan* showed that seven sections of the existing pipe system that discharge into Pond 1 were surcharged during a 10-year storm event under existing conditions. A separate storm drain system collects runoff from the Taxilane K area and conveys the flow to Pond 3. This system has the capacity to convey the 5-year storm discharge for ultimate development.

The Minimum Action Alternative project will remove pavement from this drainage area. This reduction in pavement will decrease the surcharge to the existing pipe system. The capacity of this system should be verified when the design process is initiated.

S10 – In the *2004 Plan*, the stormdrain capacity analysis showed that the existing pipe system was not surcharged during a 10-year storm event for the existing conditions. Because the Minimum Action project will decrease the amount of impervious area within this drainage area, the storm drain pipe capacity will not change. No increase in capacity will be required/anticipated.

2.3.4 Stormwater Waivers

For Drainage Area S10, the stormwater waiver, as defined in Section 3.3 (B)(1)(a) of the *Maryland Stormwater Management Guidelines for State & Federal Projects* for quantity control, is applicable. This waiver applies because the POI discharges directly into tidally influenced receiving waters. For Drainage Area S5, the stormwater waiver, as defined in Section 3(B)(1)(c), is applicable because the stormdrain system discharges directly to tidal waters.

2.3.5 Water Quantity Control

Stormwater quantity control is not required for either S5 or S10 because the stormwater waiver applies, as discussed in Section 2.3.4.

2.4 Minimum Action Summary

The following tables summarize the stormwater requirements and BMPs that are proposed for treatment.

Table 28. Summary of Stormwater Requirements for the Dark Head Watershed - Minimum Action

Drainage Area		Water Quality					Quantity Control					
	New Development/ Redevelopment	Required ESD Volume (CF)	Entire Volume Treated? y/n	Comment	Channel Protection Volume (CPv) Met (y/n)	Comment	Quantity Control Required (y/n)	Q_{p10} Existing Conditions (cfs)[1]	Q_{p10} Corrected Existing Conditions (cfs)[2]	Q_{p10} Post Development Conditions (cfs)[3]	Stormwater Waiver Applicable?	Comment
DH 3	New Development	730	y	Treated by NRDs	y	CPv met through ESD	n	19.0	25.0	22.9	n	Reduction in impervious area reduces Q_p
DH 4	New Development	9,780	y	Treated by NRDs	y	CPv met through ESD	n	69.0	79.2	75.7	n	Reduction in impervious area reduces Q_p
DH 8	New Development	3,124	y	Treated by NRDs	y	CPv met through ESD	y	36.0	41.0	45.7[4]	y	Section 3.3 (B)(1)(c)-new storm drain system discharges directly to Dark Head Creek

[1] Q_{p10} from the TR55 model developed for the 2004 *Comprehensive Stormwater Management Plan for Martin State Airport*
[2] Q_{p10} from corrected effective TR55 model. Soil groups in existing conditions TR55 model were corrected to reflect current NRCS soil group designations. No other changes were made to existing conditions TR55 models.
[3] $Q_{p\,10}$ for post development represents changes in land use based on minimum action and current NRCS soil group designations.
[4] Q_{p10} represents ultimate development discharge (entire drainage area modeled as impervious land use). Because a new pipe was required for this drainage area, it was sized to accommodate ultimate development in the drainage area.

Drainage Area	Water Quality BMPs	ESD Volume Required (CF)	ESD Volume Provided (CF)	Excess ESD Volume (CF)	Shortage ESD Volume (CF)	Comment
DH 3	NRD-DH3-1	730	750	20	0	
DH 4	NRD-DH 4-1 thru NRD DH 4-7	9,780	10,231	451	0	
DH 8	NRD-DH 8-1 thru NRD DH 8-4	3,124	3,393	269	0	
	Total	**13,634**	**14,374**	**740**	**0**	

Drainage Area	Phosphorus Load Reduction					
	Phosphorus Load Reduction Required (y/n)	Pre-development Load (lbs/yr)	Post-development Load (lbs/yr)	Pollutant Removal Requirement (lbs/yr)[1]	Load Reduction Met (y/n)	Comment
DH 3	No	N/A	N/A	N/A	N/A	Project not located within Critical Area
DH 4	No	N/A	N/A	N/A	N/A	Project not located within Critical Area
DH 8	Yes	0.0	0.0	0.0	y	Requirement met

[1] Pollutant Removal Requirement = (Post-development Load) – (0.9*Pre-development Load)

Table 29. Summary of Stormwater Requirements for the Frog Mortar Watershed - Minimum Action

Drainage Area		Water Quality					Quantity Control					
	New Development/ Redevelopment	Required ESD Volume (CF)	Entire Volume Treated? y/n	Comment	Channel Protection Volume (CPv) Met (y/n)	Comment	Quantity Control Required (y/n)	Q_{p10} Existing Conditions (cfs)[1]	Q_{p10} Corrected Existing Conditions (cfs)[2]	Q_{p10} Post Development Conditions (cfs)[3]	Stormwater Waiver Applicable?	Comment
FM 2	Redevelopment	272	y	Excess treatment from FM 5 will be utilized	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3 (B)(1)(a)- POI discharges to tidally influenced receiving waters
FM 5	New Development	N/A	y	Requirement met through removal of > 50% existing impervious	N/A	Stormwater waiver for CPv	n	N/A	N/A	N/A	y	Section 3.3 (B)(1)(a)- storm drain system discharges to tidally influenced receiving waters
FM 6	Redevelopment	N/A	y	Requirement met through removal of > 50% existing impervious	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3 (B)(1)(a)- POI discharges to tidally influenced receiving waters
FM 7	New Development	N/A	N/A	No net increase in impervious area because the only project in this drainage area is the removal of existing pavement	y	Stormwater waiver for CPv	n	N/A	N/A	N/A	y	Section 3.3 (B)(1)(a)- POI discharges to tidally influenced receiving waters
FM 8	New Development	421	y	Treated by NRDs	y	Stormwater waiver for CPv	n	N/A	N/A	N/A	y	Section 3.3 (B)(1)(a)- POI discharges to tidally influenced receiving waters
FM 9	Redevelopment	2,986	y	Treated by NRDs	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3 (B)(1)(a)- POI discharges to tidally influenced receiving waters
FM 14	Redevelopment	6,538	y	Treated by NRDs	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3 (B)(1)(a)- POI discharges to tidally influenced receiving waters
FM 19	Redevelopment	5,272	y	Treated by NRDs	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3 (B) (1) (a)- POI discharges to tidally influenced receiving waters
FM 20	Redevelopment	1,363	y	Partially treated by NRD and excess treatment from FM 5 will be utilized	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3 (B) (1) (a)- POI discharges to tidally influenced receiving waters

[1, 2, 3]- Not provided because quantity control is not required.

Table 29. Summary of Stormwater Requirements for the Frog Mortar Watershed - Minimum Action (cont'd)**Drainage Area**	**Water Quality BMPs**	**ESD Volume Required (CF)**	**ESD Volume Provided (CF)**	**Excess ESD Volume (CF)**	**Shortage ESD Volume (CF)**	**Comment**
FM 2	None	272	0	0	-272	Use credits (excess volume) treated in FM 5
FM 5	NRD-FM 5-1 thru NRD FM 5-15	0	33,018	33,018	0	1,043 CF utilized to meet FM 2 & FM 20 deficit
FM 6	None	0	0	0	0	
FM 7	None	0	0	0	0	
FM 8	NRD-FM 8-1	421	875	454	0	
FM 9	NRD-FM 9-1 thru NRD-FM 9-9	2,986	23,860	20,874	0	
FM 14	NRD-FM 14-1 thru NRD-FM 14-5	6,538	23,689	17,151	0	
FM 19	NRD-FM 19-1 thru NRD-FM 19-2	5,272	6,898	1,626	0	
FM 20	NRD-FM 20-1	1,363	592	0	-771	Use credits (excess volume) treated in FM 5
	Total	**16,852**	**88,932**	**73,123**	**-1,043**	

Drainage Area	**Phosphorus Load Reduction**					
	Phosphorus Load Reduction Required (y/n)	Pre-development Load (lbs/yr)	Post-development Load (lbs/yr)	Pollutant Removal Requirement (lbs/yr)[1]	Load Reduction Met (y/n)	Comment
FM 2	y	0.4	0.4	0	y	Requirement met
FM 5	y	18.9	10.4	-6.6	y	Excess treatment provided
FM 6	y	3.4	0.9	-2.2	y	Excess treatment provided
FM 7	y	1.7	0.4	-1.1	y	Excess treatment provided
FM 8	y	0.6	0.3	-0.2	y	Excess treatment provided
FM 9	y	19.1	12.4	-4.7	y	Excess treatment provided
FM 14	y	15.5	12.7	-1.2	y	Excess treatment provided
FM 19	n	N/A	N/A	N/A	N/A	Project not located within Critical Area
FM 20	n	N/A	N/A	N/A	N/A	Project not located within Critical Area

[1] Pollutant Removal Requirement= (Post-development Load) – (0.9*Pre-development Load)

Table 30. Summary of Stormwater Requirements for the Stansbury Creek Watershed - Minimum Action

Drainage Area		Water Quality					Quantity Control					
	New Development/ Redevelopment	Required ESD Volume (CF)	Entire Volume Treated? y/n	Comment	Channel Protection Volume (CPv) Met (y/n)	Comment	Quantity Control Required (y/n)	Q_{p10} Existing Conditions (cfs)[1]	Q_{p10} Corrected Existing Conditions (cfs)[2]	Q_{p10} Post Development Conditions (cfs)[3]	Stormwater Waiver Applicable?	Comment
S5	Redevelopment	10,667	y	Treated by NRDs	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3 (B)(1)(c)- storm drain system discharges to tidally influenced receiving waters
S7	New Development	24	n	Treated by NRDs	N/A	Stormwater waiver for CPv	n	N/A	N/A	N/A	y	Section 3.3 (B)(1)(c)- storm drain system discharges to tidally influenced receiving waters
S10	Redevelopment	1,663	y	Treated by NRDs	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3 (B)(1)(a)- POI discharges to tidally influenced receiving waters

[1, 2, 3] - Not provided because quantity control is not required.

Drainage Area	Water Quality BMPs	ESD Volume Required (CF)	ESD Volume Provided (CF)	Excess ESD Volume (CF)	Shortage ESD Volume (CF)	Comment
S5	NRD-S 5-1 thru NRD-S 5-19	10,667	38,577	27,910	0	24 CF utilized to meet S7 deficit
S7	-	24	0	0	-24	Use credits (excess volume) treated in S5
S10	NRD-S 10-1 thru NRD-S 10-4	1,663	1,860	197	0	
	Total	**12,354**	**40,437**	**28,107**	**-24**	

Drainage Area	Phosphorus Load Reduction					
	Phosphorus Load Reduction Required (y/n)	Pre-development Load (lbs/yr)	Post-development Load (lbs/yr)	Pollutant Removal Requirement (lbs/yr)[1]	Load Reduction Met (y/n)	Comment
S5	n	N/A	N/A	N/A	N/A	Project not located within Critical Area
S7	n	N/A	N/A	N/A	N/A	Project not located within Critical Area
S10	y	2.6	2.5	0.1	y	Removal requirement met through the use of NRD BMPs. The four NRDs will remove 0.17 lb/yr of Phosphorus with a BMP efficiency removal rate of 25%.

[1] Pollutant Removal Requirement= (Post-development Load) – (0.9*Pre-development Load)

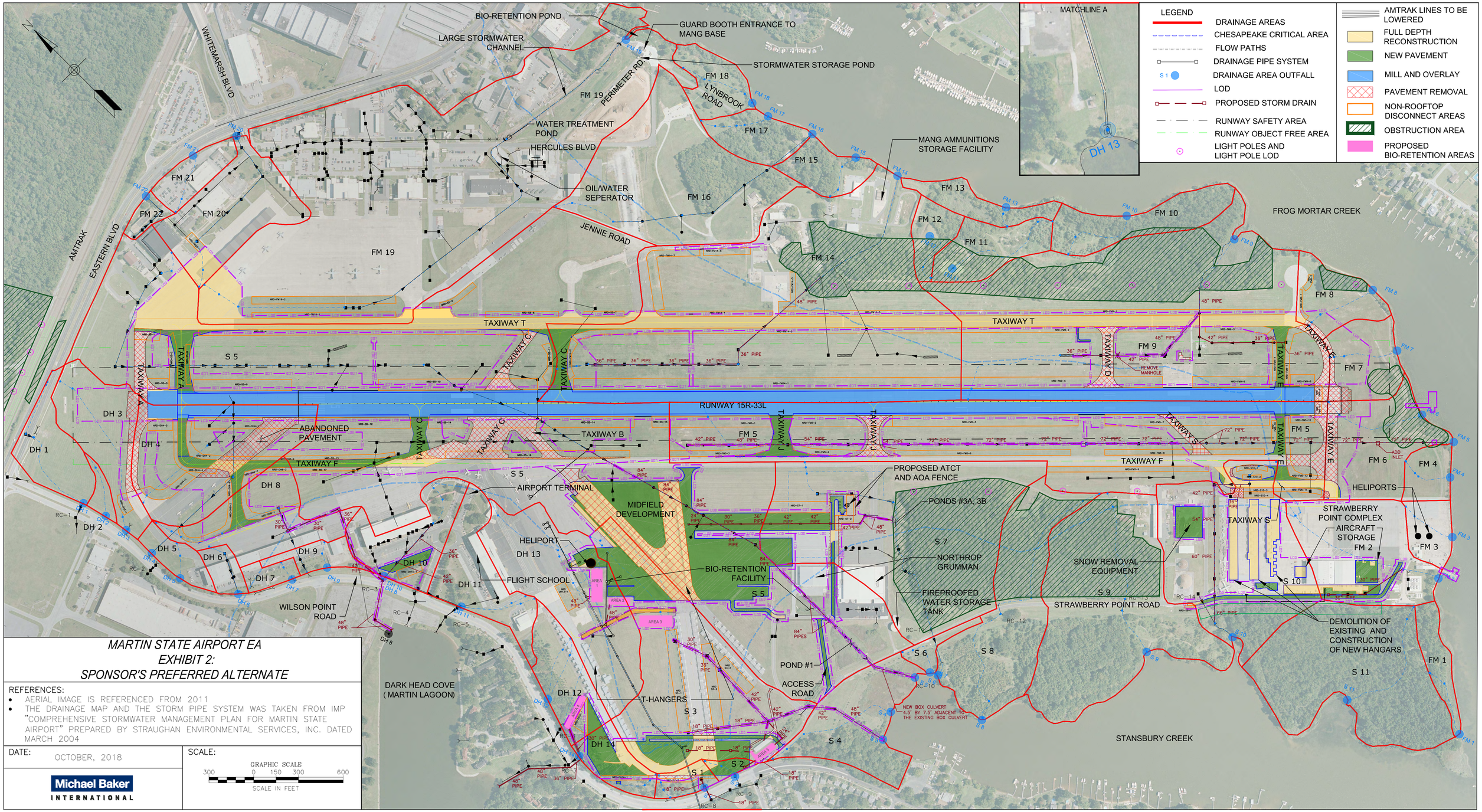
3. Sponsor's Preferred Alternative

In Sponsor's Preferred Alternative, the runway ends for Runway 15/33 will be relocated and displaced to achieve 7,100 feet of ASDA and compliant runway safety areas. This involves modifying the runway from 180-foot width to a150 feet wide with 15-foot-wide paved shoulders. This alternative also includes the following actions:

- Remove off-airport obstructions for Runways 15 and 33;
- Extend Taxiway F to the end of Runway 15;
- Remove & Reconstruct Taxiways C and S;
- Remove Taxiways B and D
- Remove and Relocate Taxiway J
- Add connecting perpendicular Taxiway C;
- Rehabilitate/Reconstruct Taxiway T;
- Relocate Taxiway A to align with the relocated end of Runway 15 & remove existing Taxiway A;
- Relocate Taxiway E to align with the relocated end of Runway 33 & remove existing Taxiway E;
- Add taxiway fillets;
- Relocate NAVAIDS;
- New ATCT;
- New Snow Removal Equipment Building;
- Addition of parking at terminal;
- Midfield General Aviation improvements;
- Strawberry Point Complex improvements; and
- MANG Apron Reconstruction.

The proposed projects that fall within each of the three watersheds (Dark Head, Frog Mortar, and Stansbury) are shown in Table 31. **Exhibit 2** shows the proposed projects and the stormwater management BMPs for this alternative.

MARTIN STATE AIRPORT



MARTIN STATE AIRPORT EA
EXHIBIT 2:
SPONSOR'S PREFERRED ALTERNATE

REFERENCES:

- AERIAL IMAGE IS REFERENCED FROM 2011
- THE DRAINAGE MAP AND THE STORM PIPE SYSTEM WAS TAKEN FROM IMP "COMPREHENSIVE STORMWATER MANAGEMENT PLAN FOR MARTIN STATE AIRPORT" PREPARED BY STRAUGHAN ENVIRONMENTAL SERVICES, INC. DATED MARCH 2004

DATE: OCTOBER, 2018

SCALE:

GRAPHIC SCALE
300 0 150 300 600
SCALE IN FEET

Michael Baker INTERNATIONAL

HNTB ADCI

FILE NAME: C:\pw8i-local\baker_projects\ali.boga\d0632453\Sponsor Preferred Alternate BMP Exhibit.dwg LAYOUT NAME: Sponsor's Preferred Alt Exhibit Full PLOTTED: Thursday, October 04, 2018 - 2:48pm

Table 31. Proposed Projects for Sponsor's Preferred Alternative

Maryland Watershed (8-digit Watershed Number)	Maryland Watershed (6-digit Watershed Number)	Stream	Drainage Areas	Proposed Projects
Middle River/ Browns (02130807)	Gunpowder River (021308)	Dark Head Creek	DH 3	Remove Taxiway A
			DH 4	Remove Taxiway A and former high-speed exit taxiway, mill and overlay runway, add runway shoulders, relocate Taxiway A, extend Taxiway F and pavement removal, add connector Taxilane to apron
			DH 8	Add connector Taxilane to apron from Taxiway F
			DH 10	Add new parking lot in front of terminal and parking for buildings
			DH 12	Add Taxilane F and F-GA Hangars
			DH 13	Demo existing Helipad and add Hangar apron
			DH 14	Add Taxilane F and F-GA Hangars
Middle River/ Browns (02130807)	Gunpowder River (021308)	Frog Mortar Creek	FM 2	Addition of buildings at Strawberry Point Complex, fuel tank and ground pipeline removal and aircraft storage
			FM 5	Mill and overlay runway, add runway shoulders, remove Taxiways E, J and S, relocate Taxiway E and J, rehab pavement.
			FM 6	Remove Taxiway E, add/relocate NAVAIDs, add fillets to Taxiway S
			FM 7	Remove Taxiway E, Add/relocate NAVAIDs
			FM 8	Remove Taxiway E
			FM 9	Mill and overlay runway, rehab Taxiway T, add runway shoulders, remove Taxiways D and E, relocate NAVAIDs

Maryland Watershed (8-digit Watershed Number)	Maryland Watershed (6-digit Watershed Number)	Stream	Drainage Areas	Proposed Projects
			FM 14	Mill and overlay runway, rehab Taxiway T improvements, add Taxiway C, add runway shoulders,
			FM 19	Rehabilitation of Taxiway T, MANG Apron Reconstruction
			FM 20	MANG Apron Reconstruction
Middle River/Browns (02130807)	Gunpowder River (021308)	Stansbury Creek	S 1	Addition of Taxilane F and Relocation/Reconstruction of existing T-hangar
			S 2	Addition of Taxilane F and Relocation/Reconstruction of existing T-hangars,
			S 3	Addition of Taxilane F, Relocation/Reconstruction of existing T-hangars, Midfield GA improvements.
			S 5	Mill and overlay runway, add runway shoulders, remove Taxiways A, B, and C, rehab Taxiway T, new locations of Taxiways A and C, , extend Taxiway F, remove T-hangars, Midfield GA Improvements, MANG Apron Reconstruction
			S 7	Construct new ATCT, addition of F-GA Hangars and abutting road.
			S 9	Strawberry Point Road addition
			S 10	Strawberry Point Road addition and parking lot for new buildings (SRE), fuel tank removal, new hangars and associated apron, demolition of existing hangars.

3.1 Dark Head Creek

Within the Dark Head Creek watershed, drainage areas DH 3, DH 4, DH 8, DH 10, DH 12, DH 13, and DH 14, are affected by Sponsor's Preferred Alternative. With the exception of DH 3 & DH 4 all of the drainage areas have a project or a portion of a project within the Chesapeake Bay Critical Area; therefore, the phosphorus removal requirement must be evaluated for these subbasins. The following sections describe the stormwater management requirements for Dark Head Creek.

3.1.1 Water Quality Control

DH 3 - This project is classified as new development and will require stormwater management to meet water quality control requirements. These requirements can be met through the use of ESD BMPs, specifically NRDs. Because water quality control would be met through ESD, CPv will not be required. Table 32 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 32. Dark Head 3: Impervious Area Changes and Proposed Stormwater BMPs

Dark Head 3	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	134,121	3.08	NRD-DH 3-1	75' x length of pavement	9,474	750
Existing Impervious	35,113	0.81				
Post-Development Impervious	2,276	0.05				
Removed Impervious	32,837	0.75				
Proposed New Impervious		-				
Existing Impervious Percent	26.18%					
New Development						
Area to Use	2,276	0.05			**Total (CF)**	**750**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**730**
ESDv=	730 CF				**Excess Treatment (CF)**	**20**

DH 4 - This project is classified as new development and would require treatment to meet water quality control requirements. These requirements can be met through the use of ESD BMPs, specifically NRDs. Because water quality control would be met through ESD, CPv will not be required. Table 33 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 33. Dark Head 4: Impervious Area Changes and Stormwater Management BMPs

Dark Head 4	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	459,586	10.55	NRD-DH 4-1	50' x L of pavement	61,437	4,864
Existing Impervious	140,070	3.22	NRD-DH 4-2	75' x L of pavement	24,739	1,958
Post-Development Impervious	91,329	2.10	NRD-DH 4-3	66' x L of pavement	12,359	978
Removed Impervious	103,409	2.37	NRD-DH 4-4	25' x L of pavement	14,672	1,162
Proposed New Impervious	54,668	1.26	NRD-DH 4-5	35' x L of pavement	24,642	1,951
Existing Impervious Percent	30.48%		NRD-DH 4-6	35' x L of pavement	3,948	313
			NRD DH 4-7	45' x L of pavement	7,353	582
New Development						
Area to Use	91,329	2.10			**Total (CF)**	**11,808**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**8,765**
ESDv=	8,765 CF				**Excess Treatment (CF)**	**3,043**

DH 8 - This project is classified as new development and would require treatment to meet water quality control requirements. These requirements can be met through the use of ESD BMPs, specifically NRDs. Because water quality control would be met through ESD, CPv will not be required. Table 34 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 34. Dark Head 8: Impervious Area Changes and Stormwater Management BMPs

Dark Head 8	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	102,944	2.36	NRD-DH 8-1	35' x L of pavement	19,080	1,511
Existing Impervious	0	0.00	NRD-DH 8-2	33' x L of pavement	18,661	1,477
Post-Development Impervious	28,988	0.67	NRD-DH 8-3	25' x L of pavement	4,369	346
Removed Impervious	0	0.00				
Proposed New Impervious	28,988	0.67				
Existing Impervious Percent	0%					
New Development						
Area to Use	28,988	0.67			**Total (CF)**	**3,334**
Pe=	1.2 inches				**ESDv Req'd (CF)**	**3,124**
ESDv=	3,124 CF				**Excess Treatment (CF)**	**210**

DH 10 - This project is classified as new development and would require treatment to meet water quality control requirements. A portion of the water quality treatment can be met through the use of an NRD. The remainder of the water quality requirements can be met by using credits from DH 4. CPv can be met through a stormwater waiver as discussed in Section 3.1.4. Table 35 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 35. Dark Head 10: Impervious Area Changes and Stormwater Management BMPs

Dark Head 10	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	53,458	1.23	NRD-DH 10-1	75' x L of pavement	10,147	803
Existing Impervious	0	0.00				
Post-Development Impervious	19,603	0.45				
Removed Impervious		0.00				
Proposed New Impervious	19,603	0.45				
Existing Impervious Percent	0.00%					
New Development						
Area to Use	19,603	0.45			**Total (CF)**	**803**
Pe=	1.6 inches				**ESDv Req'd (CF)**	**2,709**
ESDv=	2,709 CF				**Deficit Treatment (CF)**	**-1,906**

DH 12 - This project is classified as new development and would require treatment to meet water quality control requirements. A portion of the water quality treatment can be met through the use of an NRD. Table 36 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs. A structural (bioretention) BMP is required to meet the remainder of the water quality volume requiring treatment. This BMP will also treat the portion of DH 14 that cannot be treated through ESD. It is assumed that the new pavement in DH 14 will be graded to flow into the BMP located in DH 12. During the design phase of a project, the drainage divides should be verified; drainage divides may change as a result of the proposed project. Table 37 & Table 38 summarize the volume to be treated by this structural BMP.

Table 36. Dark Head 12: Impervious Area Changes and Stormwater Management BMPs

Dark Head 12	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	35,970	0.83	NRD-DH 12-1	75' x L of pavement	12,566	995
Existing Impervious	4,347	0.10				
Post-Development Impervious	16,913	0.39				
Removed Impervious	-	0.00				
Proposed New Impervious	12,566	0.29				
Existing Impervious Percent	12.09%					
New Development						
Area to Use	16,913	0.39			**Total (CF)**	**995**
Pe=	1.6 inches				**ESDv Req'd (CF)**	**2,553**
ESDv=	2,553 CF				**Deficit Treatment (CF)**	**-1,558**

Table 37. Dark Head 12 Structural BMP Requirements

Total CPv required:				
RCN (TABLE 5.3)	=	**83**		
S	=	**(1,000/RCN) - 10**	=	**2.05**
P1	=	**2.6**	**in**	
Qe =	**$\frac{(P1 - 0.2\ S)^2}{(P1 + 0.8\ S)}$**	=		**1.13**
V=	**$\frac{Qe\ X\ A}{12}$**	=		**3,392.92 CF**
CPv provided by ESD BMPs:				
REDUCED RCN (TABLE 5.3)	=	**77**		
S	=	**(1,000/RCN) - 10**	=	**2.99**
P1	=	**2.6**	**in**	
Qe =	**$\frac{(P1 - 0.2\ S)^2}{(P1 + 0.8\ S)}$**	=		**0.80**
V=	**$\frac{Qe\ X\ A}{12}$**	=		**2,409.24 CF**

STRUCTURAL PRACTICE VOLUME REQUIRED: 3,392.92 CF-2,409.24 CF= 983.68CF

Table 38. Dark Head 12 Bioretention BMP Requirements

Dark Head 12 Bioretention BMP					
Drainage Area	**Volume Required (CF)**	**Media Depth (FT)**	**Ponding Depth (FT)**	**Drainage Time (DAY)**	**Surface area needed (SF)**
DH 12	984	2.5	1	1	1,640
DH 14	4,802	2.5	1	1	8,003
				Total	9,643
BMP		**Drainage Area**	**Width (FT)**	**Length (FT)**	**Surface Area Provided (SF)**
DH 12-1 (Area 4 in Exhibit 2)		DH 12 and DH 14	45	240	10,800

DH 13 - This project is classified as new development and would require treatment to meet water quality control requirements. A portion of the water quality treatment can be met through the use of an NRD. The proposed project within this drainage area will result in the removal of an existing bioretention BMP located near the helipad. This facility, constructed as part of the *Airfield Ramp Extension Project*, treated 4.51 acres of impervious area and provided treatment for a water quality volume of 16,144 CF. A structural BMP is required to meet the remainder of the water quality volume requiring treatment and to compensate for the loss of the existing bioretention facility. Two bioretention BMPs are proposed in this area to meet the requirements for water quality treatment. Table 39 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs. Table 40 and Table 41 summarize the structural (bioretention) BMP requirements.

Table 39. Dark Head 13 Impervious Area Changes and Stormwater Management BMPs

Dark Head 13	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	97,469	2.24	NRD-DH 13-1	75' x L of pavement	14,122	1,118
Existing Impervious	12,274	0.28				
Post-Development Impervious	50,394	1.16				
Removed Impervious	-	0.00				
Proposed New Impervious	38,120	0.88				
Existing Impervious Percent	12.59%					
New Development						
Area to Use	246,850	5.67			**Total (CF)**	**1,118**
Pe=	1.8 inches				***ESDv Req'd (CF)**	**35,529**
ESDv=	35,529				**Deficit Treatment (CF)**	**-34,411**

*The ESDv required includes the loss of water quality treatment from the removal of the existing bioretention BMP and the treatment required from the proposed action.

Table 40. Dark Head 13 Structural BMP Requirements

Total CPv required:				
RCN (TABLE 5.3)	=	**84**		
S	=	**(1,000/RCN) - 10**	=	**1.90**
P1	=	**2.6**	**in**	
Qe =	$\frac{(P1 - 0.2\,S)^2}{(P1 + 0.8\,S)}$	=		**1.19**
V=	$\frac{Qe \times A}{12}$	=		**29,247.54 CF**
CPv provided by ESD BMPs:				
REDUCED RCN (TABLE 5.3)	=	**77**		
S	=	**(1,000/RCN) - 10**	=	**2.99**
P1	=	**2.6**	**in**	
Qe =	$\frac{(P1 - 0.2\,S)^2}{(P1 + 0.8\,S)}$	=		**0.80**
V=	$\frac{Qe \times A}{12}$	=		**19,686.81 CF**

STRUCTURAL PRACTICE VOLUME REQUIRED: 29,247.54 CF-19,686.81 CF= 9560.73 CF

Table 41. Dark Head 13 Bioretention BMP Requirements

Dark Head 13 Bioretention BMP					
Drainage Area	**Volume Required (CF)**	**Media Depth (FT)**	**Ponding Depth (FT)**	**Drainage Time (DAY)**	**Surface area needed (SF)**
DH 13	9,561	2.5	1	1	15,935
				Total	15,935
BMP		**Drainage Area**	**Width (FT)**	**Length (FT)**	**Surface Area Provided (SF)**
DH 13-1 (area 1 in Exhibit 2)		DH 13	80	225	18,000
DH 13-2 (area 2 in Exhibit 2)		DH 13	50	150	7,500
				Total	**25,500**

DH 14 - This project is classified as new development and would require treatment to meet water quality control requirements. A portion of the water quality treatment can be met through the use of an NRD. A structural BMP is required to meet the remainder of the water quality volume requiring treatment. However, because of the amount of impervious area in this drainage area, there is no area available for a structural BMP. Therefore, the proposed bioretention BMP located in DH 12 is sized to meet the requirements of DH 14. It is assumed that a portion of the new pavement in DH 14 will be graded to flow into the BMP located in DH 12. During the design phase of a project, the drainage divides should be verified; drainage divides may change as a result of the proposed project.

Table 42 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs. The structural requirements for DH 14 are summarized in Table 43. These requirements are met by the BMP proposed for DH 12; see Table 38 for details on the proposed bioretention BMP.

Table 42. Dark Head 14 Impervious Area Changes and Stormwater Management BMPs

Dark Head 14	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	97,436	2.24	NRD-DH 14-1	75' x L of pavement	9,570	758
Existing Impervious	25,807	0.59				
Post-Development Impervious	84,540	1.94				
Removed Impervious	-	0.00				
Proposed New Impervious	58,733	1.35				
Existing Impervious Percent	26.49%					
New Development						
Area to Use	84,540	1.94			**Total (CF)**	**758**
Pe=	1.8 inches				**ESDv Req'd (CF)**	**12,144**
ESDv=	12,144 CF				**Deficit Treatment (CF)**	**-11,386**

Table 43. Dark Head 14 Structural BMP Requirements

Total CPv required:					
RCN (TABLE 5.3)	**=**	**87**			
S	**=**	**(1,000/RCN) - 10**	**=**		**1.49**
P1	**=**	**2.6**	**in**		
Qe =	$\frac{(P1 - 0.2\,S)^2}{(P1 + 0.8\,S)}$	**=**		**1.40**	
V=	$\frac{Qe \times A}{12}$	**=**		**11,328.47**	
CPv provided by ESD BMPs:					
REDUCED RCN (TABLE 5.3)	**=**	**77**			
S	**=**	**(1,000/RCN) - 10**	**=**		**2.99**
P1	**=**	**2.6**	**in**		
Qe =	$\frac{(P1 - 0.2\,S)^2}{(P1 + 0.8\,S)}$	**=**		**0.80**	
V=	$\frac{Qe \times A}{12}$	**=**		**6,526.19**	

STRUCTURAL PRACTICE VOLUME REQUIRED: 11,328.47 CF- 6,526.19 CF= 4,802.27 CF

3.1.2 Phosphorus Removal

For Sponsor' Preferred Alternative, portions of the proposed action in DH 8, DH 10, DH 12, DH 13, and DH 14 lie within the Chesapeake Bay Critical Area. Therefore, phosphorus removal requirements apply in these areas. The phosphorus removal requirements were evaluated, and the results are summarized in Table 44 through Table 52. Per direction provided in the Draft May 24, 2011 document entitled *Environmental Site Design in the Maryland Critical Area,* if a project is shown to be within 0.1 pounds per acre per year of the removal requirement, the site can be considered compliant. Therefore, for those subbasins with loads removed within 0.1 of the removal requirement, it is indicated that the subbasin has met the phosphorus removal requirement.

Table 44. Phosphorus Removal Requirement for DH 8

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	270	0.01
Existing Impervious	-	-
Post-Development Impervious	-	-
Existing Impervious, I_{pre}	0.00%	
Proposed Impervious, I_{post}	0.00%	
New Development		
Predevelopment Load, L_{pre}	0.0 lbs/year	
Post-Development Load, L_{post}	0.0 lbs/year	
Pollutant Removal Requirement[1]	0.0 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 45. Phosphorus Removal Requirement for DH 10

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	53,458	1.23
Existing Impervious	0	0.00
Post-Development Impervious	19,603	0.45
Existing Impervious, I_{pre}	0.00%	
Proposed Impervious, I_{post}	36.67%	
New Development		
Predevelopment Load, L_{pre}	0.6 lbs/year	
Post-Development Load, L_{post}	1.1 lbs/year	
Pollutant Removal Requirement[1]	0.6 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Only a portion of this removal requirement can be met through the use of the NRD BMP, as shown in Table 46.

Table 46. Phosphorus Removal by BMP for DH 10

BMP Phosphorus Calculation					
BMP Name	**Post-Development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Treated(SF)**	**Percent Site Area Treated**	**Load Removed (lb/yr)**
NRD-DH10-1	1.1	25%	10,147	18.98	0.1
				SUM	**0.1**
				Removal Requirement	**0.6**
				Shortage	**-0.5**

Table 47. Phosphorus Removal Requirement for DH 12

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	35,970	0.83
Existing Impervious	4,347	0.10
Post-Development Impervious	16,913	0.39
Existing Impervious, I_{pre}	12.09%	
Proposed Impervious, I_{post}	47.02%	
New Development		
Predevelopment Load, L_{pre}	0.4 lbs/year	
Post-Development Load, L_{post}	1.0 lbs/year	
Pollutant Removal Requirement[1]	0.6 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Only a portion of this removal requirement can be met through the use of the BMPs, as shown in Table 48.

Table 48. Phosphorus Removal by BMP for DH 12

BMP Phosphorus Calculation					
BMP Name	**Post-Development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Treated(SF)**	**Percent Site Area Treated**	**Load Removed (lb/yr)**
NRD-DH12-1	0.96	25%	12,566	34.93%	0.1
Bioretention Area 4	0.96	50%	10,800	33.03%	0.1
				SUM	**0.2**
				Removal Requirement	**0.6**
				Shortage	**-0.4**

Table 49. Phosphorus Removal Requirement for DH 13

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	14,774	0.34
Existing Impervious	2,452	0.06
Post-Development Impervious	6,977	0.16
Existing Impervious, I_{pre}	16.60%	
Proposed Impervious, I_{post}	47.23%	
Redevelopment		
Predevelopment Load, L_{pre}	0.2 lbs/year	
Post-Development Load, L_{post}	0.4 lbs/year	
Pollutant Removal Requirement[1]	0.2 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 50. Phosphorus Removal by BMP for DH 13

BMP Phosphorus Calculation					
BMP Name	**Post-Development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Treated(SF)**	**Percent Site Area Treated**	**Load Removed (lb/yr)**
NRD-DH13-1	0.39	25%	14,122	95.59%	0.1
Bioretention Area 1	0.39	50%	18,000	121.84%	0.2
Bioretention Area 2	0.39	50%	7,500	50.76%	0.1
				SUM	**0.4**
				Removal Requirement	**0.2**
				Excess	**0.2**

Table 51. Phosphorus Removal Requirement for DH 14

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	97,436	2.24
Existing Impervious	25,807	0.59
Post-Development Impervious	84,540	1.94
Existing Impervious, I_{pre}	26.49%	
Proposed Impervious, I_{post}	86.76%	
Redevelopment		
Predevelopment Load, L_{pre}	1.6 lbs/year	
Post-Development Load, L_{post}	4.5 lbs/year	
Pollutant Removal Requirement[1]	3.1 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Only a portion of this removal requirement can be met through the use of the NRD BMPs, as shown in Table 52.

Table 52. Phosphorus Removal by BMP for DH 14

BMP Phosphorus Calculation					
BMP Name	**Post-Development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Treated(SF)**	**Percent Site Area Treated**	**Load Removed (lb/yr)**
NRD-DH14-1	4.55	25%	9,570	9.82	0.1
Bioretention Area 4	4.55	50%	97,436	100.00	2.3
				SUM	**2.4**
				Removal Requirement	**3.1**
				Shortage	**-0.7**

The MAA recognizes that the proposed BMPs for Dark Head will not completely meet the phosphorus reduction requirements. The MAA will coordinate with the Chesapeake Bay Critical Area Commission on other approaches, such as stormwater offset options, to meet the phosphorus reduction requirements. Table 94 at the end of this section provides a summary of the phosphorus removal requirements.

3.1.3 Storm Drainage Pipe Capacity

The stormdrain capacity analysis presented in the *2004 Plan* was used to determine whether the pipe capacity was adequate. That capacity analysis evaluated the storm drain system for a 10-year storm event, which exceeds the FAA 5-year storm event requirement of drainage system design.

For the EA, the analysis done for the *2004 Plan* was supplemented in some drainage areas with additional analysis to determine if the current pipe system could accommodate post-development discharges for Sponsor's Preferred Alternative. The storm drainage capacity in the EA was evaluated for the 5-year storm event per FAA design criteria unless the system discharges directly to tidal waters. MDE criteria for a stormwater waiver for a storm drainage system that discharges directly to tidal waters requires that the storm drain system be designed for the 10-year storm event. Therefore, for some drainage areas, the 10-year storm was used for the design storm. For drainage areas without inlets, no capacity analysis was performed.

DH 3 - Within DH 3, there are no storm drain inlets. Therefore, no storm drainage pipe capacity analysis was conducted. Sheet flow from airport property flows to an existing road drainage ditch and the county stormwater system, which discharges into Dark Head Creek. The road crossing culvert (RC-2) is inadequate for a 25-year storm conveyance as reported in the *2004 Plan*. The removal of impervious area within DH 3 for the future development will decrease the peak discharges and reduce the runoff to the road crossing culvert.

DH 4 - The stormdrain capacity analysis showed that two sections of the existing pipe system were surcharged during a 10-year storm event for the existing conditions. The removal of

pavement in this drainage area results in a reduction of peak discharges. Therefore, this project should not exacerbate the storm drain system's lack of capacity issue.

DH 8 – The *2004 Plan* showed that one section of the existing pipe system was surcharged during a 10-year storm event for the existing conditions. With the addition of new pavement in this drainage area, the pipe system will still be surcharged, and an increase in capacity will be required for the new development. Section 3.1.5 for proposed changes to the storm drain system for this drainage area.

DH 10 - The storm drain system that services this drainage area consists of a combination of a 12-inch clay pipe; 15-, 18-, 24-, and 30-inch RCPs; and a 24-inch CMP. The pipes originate at the south side of Buildings 1-3 and run in a westerly direction to discharge into an SHA-owned drainage ditch adjacent to Wilson Point Road. The drainage system then crosses beneath the road into a county storm drain system and outlets into Dark Head Creek. The *2004 Plan* did not indicate that any of the existing system was surcharged during a 10-year storm event but did state the road crossing was inadequate to convey the flow. See Section 3.1.5 for information on the new proposed pipe system.

DH 12 - The runoff from the drainage area sheet flows to a drainage ditch located along Wilson Point Road and discharges to an inlet. An 18-inch RCP runs from this inlet under Wilson Point Road to a 24-inch pipe. This pipe runs along Wilson Point Road opposite the airport and connects to a 30-inch CMP and a 36-inch RCP that discharges into Dark Head Creek. The *2004 Plan* did not provide an analysis of the system but did state the road crossing was inadequate to convey the flow. An additional analysis showed that some of these pipes are inadequate to convey the drainage area's discharge for the future development. See Section 3.1.5 for information on the new proposed pipe system.

DH 13 - The existing pipe system that services DH 13 consists of a combination of 42- and 48-inch RCP, 76-inch x 48-inch elliptical RCP, 83-inch x 53-inch elliptical RCP, and an 84-inch x 36-inch box culvert. A series of inlets along the pipe system captures the stormwater runoff. This closed drainage system discharges directly to Dark Head Creek. There is also an existing bioretention BMP, built as part of the Airfield Ramp Extension Project, located east of the existing helipad. This facility treats 4.51 acres of impervious area. The bioretention BMP receives runoff from the ramp area and also the helipad and taxilane areas. Water is discharged from the BMP via a 48-inch RCP which connects to the 76-inch x 48-inch RCP. This drainage system for DH 13, built in 2006 and partially replaced in 2015, was designed for the 5-year ultimate development storm. Calculations show that the existing pipe system is adequate to convey the discharges from future development for the 5-, 10-, and 25-year storms. The existing BMP will be removed as part of Sponsor's Preferred Alternative and two proposed bioretention BMPs will provide water quality treatment. These BMPs will connect to the existing pipe system via 48-inch RCPs similar to the connection for the existing bioretention BMP.

DH 14 - The existing pipe system that serves DH 14 consists of a combination of 24- and 36-inch RCP and a 30-inch CMP. The runoff from the drainage area sheet flows to an inlet then to the 24-inch pipe located in the drainage ditch along Wilson Point Road behind the T-Hangars at the south end of the airport. The 24-inch RCP runs from this inlet under Wilson Point Road to the

same 30-inch CMP and 36-inch RCP described for DH 12. The 36-inch RCP discharges directly into Dark Head Creek. The *2004 Plan* did not provide an analysis of the system but did state the road crossing was adequate for existing conditions. See Section 3.1.5 for information on the new proposed pipe system.

3.1.4 Stormwater Waivers

Stormwater waivers, as defined in Section 3 of the *Maryland Stormwater Management Guidelines for State & Federal Projects,* do not apply to DH 3 and DH 4 for either quantity or quality control. For DH 8, a stormwater waiver in accordance with Section 3.3(B)(1)(c) would be applicable for quantity control with the change to the storm drain system described in the following section. DH 12 would be applicable for a stormwater waiver for CPv in accordance with Section 3.3(B)(1)(c). For DH 10, and 14, a stormwater waiver in accordance with Section 3.3(B)(1)(c) would be applicable for CPv and quantity control with the change to the storm drain system, which is described in the following section.

3.1.5 Water Quantity Control

For drainage areas DH 3, DH 4, DH 8, DH 10, DH 12, DH 13, and DH 14, the existing conditions TR55 models prepared for the *2004 Plan* were modified to reflect the change in impervious area. As discussed in Section 1, some soil classifications surrounding the airport changed between the *2004 Plan* and the current soil mapping developed by the NRCS. In those areas, a corrected TR55 existing conditions model was prepared to evaluate the change in discharges as a result of soil classification changes. Table 53 provides a comparison of the existing conditions discharges from the *2004 Plan*, the corrected existing conditions model (if appropriate), and the post-development discharges based on Sponsor's Preferred Alternative.

Table 53. Comparison of Discharges for Sponsor's Preferred Alternative

Drainage Area	Existing Conditions[1]	Corrected Existing Conditions[2]	Post-Development Conditions[3]
	Qp_{10} (cfs)	Qp_{10} (cfs)	Qp_{10} (cfs)
DH 3	19.0	25.0	22.9
DH 4	69.0	79.2	75.7
DH 8	36.0	41.0	45.7
DH 10	35.0	36.3	36.9
DH 12	32.0	n/a	36.5[4]
DH 13	82.0	82.3	85.5
DH 14	14.0	n/a	16.8

[1] Qp_{10} from the TR55 model developed for the 2004 *Comprehensive Stormwater Management Plan for Martin State Airport*

[2] Qp_{10} from corrected effective TR55 model. Soil groups in existing conditions TR55 model were corrected to reflect current NRCS soil group designations. No other changes were made to existing conditions TR55 model.

[3] Qp_{10} for post-development represents changes in land uses and current NRCS soil group designations

[4] Qp_{10} represents ultimate development (entire drainage area modeled as impervious land) for sizing new storm drain pipe.

DH 3 - Based on Table 2 of the *Maryland Stormwater Management Guidelines for State & Federal Projects,* dated February 2015, the minimum flood control requirement for projects within Baltimore County is Qp_{10}. As stated in Section 3.1.3, the existing road crossing culvert had been determined to be inadequate for conveyance and quantity control for the 10-year storm would be required. However, the reduction in impervious area for this drainage area will reduce Qp_{10}; therefore, quantity control would not be required.

DH 4 - The existing pipe system does not provide adequate conveyance, as stated in Section 3.1.3. However, the reduction in the impervious area for this drainage area will reduce Qp_{10}; therefore, quantity control would not be required.

DH 8 and DH 10 - The 5-year discharge is the FAA allowable design discharge for the storm drainage system on the airport and the 10- and 25-year discharges are the design discharges for pipes or culverts crossing State roads. However, because the new proposed pipe system will connect directly to Dark Head Creek, the 10-year storm was used for the design storm in order to meet the requirements for a stormwater waiver. Based on the limited data available for the existing pipes, a pipe slope of 0.5 percent was assumed to determine the capacity of the existing pipes. This slope was selected because it allows the pipes to cross under Wilson Point Road with a minimum cover of approximately 2 feet. The pipes would rise out of the ground if a steeper slope was assumed. In addition, an invert of -1.75 feet was assumed in the pipe where it discharges into the ditch that connects to Dark Head Creek. Calculations show that the existing pipes are inadequate to convey the discharge for the future development in these drainage areas.

Because of the increased impervious area to be added in future conditions, the 10-year (Q_{10}) discharge for both DH 8 and DH 10 will increase from their current values. Quantity control would be required within both drainage areas unless a stormwater waiver can be applied to this site. Options to address quantity control include construction of an underground detention BMP or a change to the storm drain system and POI so that a stormwater waiver could be applied. The underground detention facility would be costly and hard to maintain. Therefore, the preferred design to address quantity control is to relocate the POI from its current location along Wilson Point Road to a location on the banks of Dark Head Creek, and to construct a new storm drainage system that would discharge directly into Dark Head Creek at the location of the new POI. The new POI would replace the existing POIs for DH 8 and DH 10. This entire system would be designed to convey the 10-year storm on and off airport property. Thus, a stormwater waiver under Part 3.3(B)(1)(c) would be applicable for DH 8 and DH 10.

Based on the requirements stated above, the size of the pipe would have to be increased to convey the 10-year discharge and would also have to be realigned to discharge directly into Dark Head Creek. The runoff from DH 8 and DH 10 would be combined to flow into one pipe to convey the discharge off the airport property to a manhole along Wilson Point Road. The alignment of pipe from DH 8 would originate at an inlet on the north side of the parking apron, run south to an inlet on the parking apron, then eastward along the aircraft parking apron and continue south between the buildings to a manhole along Wilson Point Road. The pipe from this manhole would connect with the new pipe from DH 10 at another manhole. The pipe from this manhole would then cross under Wilson Point Road and discharge directly to Dark Head Creek. The new alignment is shown in Exhibit 2. The new alignment was recommended because the new pipe

could not be constructed along the same alignment as the existing pipe. The existing pipe alignment is currently located under Buildings 1-3 for DH 8 and under Buildings 501-511 for DH-10 and it would be impractical to construct the new pipes under these buildings. The existing pipes beneath Buildings 1-3 and 501-511 would be abandoned.

Based on the proposed development within the drainage areas, the impervious areas would increase for the future conditions. The 5-, 10-, and 25-year discharges were determined using the NRCS TR55 program.

Based on the calculations, the discharges are as follows:

DH 8

5-Year Storm (Q5) - 37.5 cfs
10-Year Storm (Q10) - 45.7 cfs
25-Year Storm (Q25) - 49.3 cfs

DH 10

5-Year Storm (Q5) - 29.6 cfs
10-Year Storm (Q10) - 36.9 cfs
25-Year Storm (Q25) - 40.2 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipes that would convey the 10-year storm discharge from the infield area to Dark Head Creek. The hydraulic gradient calculations used a 0.5-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. Based on the calculations, the existing pipes would need to be replaced with a combination of 30-, 36-, 42-, and 48-inch RCPs to convey the discharge for the 10-year storm from the infield and parking apron inlets to the new outfall on Dark Head Creek. With this new system, a stormwater waiver for quantity control would be applicable under Part 3.3(B)(1)(c).

DH 12 and DH 14 - The 5-year discharge is the FAA design discharge for the storm drainage system on the airport and the 10- and 25-year discharges are the design discharges for pipes or culverts crossing State roads. However, because the new proposed pipe system will connect directly to Dark Head Creek, the 10-year storm was used for the design storm in order to meet the requirements for a stormwater waiver. Based on the limited data available for the existing pipes, a pipe slope of 0.5 percent was assumed to determine the capacity of the pipes. This slope was selected because it allows the pipes to cross under Wilson Point Road with a minimum cover of approximately 2 feet. The pipes would rise out of the ground if a steeper slope was assumed. In addition, an invert of -1.25 feet was assumed in the pipe where it discharges into the ditch that connects to Dark Head Creek. Calculations show that the pipe system is inadequate to convey the discharge from the future development in these drainage areas.

Because of the increased impervious area to be added in future conditions, the 10-year storm (Q_{10}) discharges for both DH 12 and DH 14 will increase from their current value. Quantity control would be required unless a stormwater waiver can be applied to this site.

The existing county storm drain system that currently receives stormwater from the airport is inadequate to convey the future discharges. The proposed new system will only convey stormwater from the airport property and it will connect directly to Dark Head Creek. The intent of the design is to align the new system parallel to the county's existing system and remain within the existing right-of-way. During design, the proposed alignment and availability of space within the right-of-way would need to be verified.

Based on the requirements stated above, the sizes of the pipes must be increased to convey the future discharges and realigned to directly discharge into Dark Head Creek. The runoff from DH 12 and DH 14 would be combined to flow in one pipe to convey the discharge off the airport property to a manhole along Wilson Point Road. The runoff from DH 14 would sheet flow to the proposed bioretention pond in DH 12. The alignment of the pipe from the BMP in DH 12 would run south, parallel to Wilson Point Road, to just south of the existing 24-inch pipe that currently serves DH 14 and crosses under the road. The proposed pipe would cross under Wilson Point Road south of the existing pipe to prevent crossing under or over this pipe. The proposed pipe would then follow the alignment of the existing county pipes from the road to the creek. The existing county pipes would remain in place. The alignment is shown in Exhibit 2.

The proposed development would increase the impervious area in the drainage area. The 5-, 10-, and 25-year future discharges were determined using the NRCS TR55 program. Based on the calculations, the discharges are as follows:

DH12

5-Year Storm (Q5) - 23.3 cfs
10-Year Storm (Q10) - 36.5 cfs
25-Year Storm (Q25) - 33.4 cfs

DH14

5-Year Storm (Q5) - 13.3 cfs
10-Year Storm (Q10) - 16.8 cfs
25-Year Storm (Q25) - 18.3 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey the 10-year storm discharge from the airport property to the inlet at the drainage ditch along Wilson Point Road to the creek. The hydraulic gradient calculations used a 0.5-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. Based on the calculations, the new pipe system would have a combination of 30-, 36-, and 48-inch RCPs to convey the 10-year storm from the bioretention pond to a manhole on the airport property adjacent to Wilson Point Road, then under the road to a new outfall for Dark Head Creek. A stormwater waiver for quantity control would be applicable under Part 3.3(B)(1)(c) with the new system.

DH 13 - A stormwater waiver under Part 3.3(B)(1)(c) is applicable because the existing storm drainage system connects directly into Dark Head Creek. An analysis of the existing pipe system, as described in Section 3.1.3, was performed and calculations show that the existing system has the capacity to convey the 10-year discharge from the future development. Therefore, quantity control would not be required and a stormwater waiver is still applicable for DH 13.

3.2 Frog Mortar Creek

Within the Frog Mortar Creek watershed, drainage areas FM 2, FM 5, FM 6, FM 7, FM 8, FM 9, FM 14, FM 19 and FM 20 are affected by Sponsor's Preferred Alternative. With the exception of FM 19 & FM 20, all of the drainage areas have a project or a portion of a project within the Chesapeake Bay Critical Area; therefore, the phosphorus removal requirement must be met. The following sections describe the stormwater management requirements for Frog Mortar Creek.

3.2.1 Water Quality Control

FM 2 - This drainage area was evaluated for stormwater management and would be classified as redevelopment. The amount of impervious area within this drainage area limits the placement of any stormwater BMPs. A SCA, is proposed to provide some water quality treatment. The remainder of the water quality treatment required can be met through the excess treatment (credits) from FM 5. Because this project is classified as redevelopment, CPv treatment is not required. Table 54 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 54. Frog Mortar 2 Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 2	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	158,400	3.64	SCA FM 2-1	75' x L of pavement	36,558	2,894
Existing Impervious	77,534	1.78				
Post-Development Impervious	127,990	2.94				
Removed Impervious	-	0.00				
Proposed New Impervious	50,456	1.16				
Existing Impervious Percent	48.95%					
Redevelopment						
Area to Use	89,223	2.05			**Total (CF)**	**2,894**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**7,063**
ESDv=	7,063 CF				**Deficit Treatment (CF)**	**-4,169**

FM 5 - This project is classified as new development. These requirements can be met through the use of ESD BMPs, specifically NRDs. CPv will not be required. Table 55 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 55. Frog Mortar 5 Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 5	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	661,439	15.18	NRD-FM 5-1	75' x L of pavement	51,187	4,052
Existing Impervious	156,630	3.60	NRD-FM 5-2	75' x L of pavement	50,781	4,020
Post-Development Impervious	134,387	3.09	NRD-FM 5-3	40' x L of pavement	27,185	2,152
Removed Impervious	97,107	2.23	NRD-FM 5-4	40' x L of pavement	27,163	2,150
Proposed New Impervious	74,864	1.72	NRD-FM 5-5	75’ x L of pavement	93,011	7,363
Existing Impervious Percent	23.68%		NRD-FM 5-6	37.5’ x L of pavement	44,810	3,547
			NRD-FM 5-7	75' x L of pavement	82,885	6,562
			NRD-FM 5-8	37.5' x L of pavement	40,905	3,238
			NRD-FM 5-9	37.5' x L of pavement	40,239	3,186
			NRD-FM 5-10	30' x L of pavement	4,363	345
			NRD-FM 5-11	46' x L of pavement	4,418	350
			NRD-FM 5-12	50' x L of pavement	8,153	645
			NRD-FM 5-13	30' x L of pavement	18,804	1,489
			NRD-FM 5-14	25' x L of pavement	8,999	712
New Development						
Area to Use	134,387	3.09			**Total (CF)**	**39,813**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**12,835**
ESDv=	12,835				**Excess Treatment (CF)**	**26,978**

FM 6 - This project is classified as redevelopment. The proposed action removes more than 50 percent of the existing impervious area within the site area; therefore, the water quality requirement has been met. Because this project is classified as redevelopment, CPv treatment is not required. Table 56 summarizes the pavement changes that would occur within this drainage area.

Table 56. Frog Mortar 6 Impervious Area Changes

Frog Mortar 6	SF	Acres
Limit of Disturbance (LOD)	139,060	3.19
Existing Impervious	59,547	1.37
Post-Development Impervious	10,064	0.23
Removed Impervious	50,549	1.16
Proposed New Impervious	1,066	0.02
Existing Impervious Percent	42.82%	
Redevelopment		
Area to Use	N/A	N/A
Pe=	1.0 inch	
ESDv=	N/A	

FM 7 - This project is classified as new development. However, there is no net increase in impervious area requiring treatment because the only action in this drainage area is the removal of all existing pavement (no new pavement is proposed). Therefore, no stormwater management for water quality is required. A waiver for CPv treatment is applicable for this drainage basin. See Section 3.2.4 for more details on stormwater waivers. Table 57 summarizes the pavement changes that would occur within this drainage area.

Table 57. Frog Mortar 7 Impervious Area Changes

Frog Mortar 7	SF	Acres
Limit of Disturbance (LOD)	124,805	2.87
Existing Impervious	25,694	0.59
Post-Development Impervious	-	0.00
Removed Impervious	25,694	0.59
Proposed New Impervious	-	0.00
Existing Impervious Percent	20.59%	
New Development		
Area to Use	N/A	N/A
Pe=	1.0 inch	
ESDv=	N/A	

FM 8 - This project is classified as new development and stormwater management would be required for water quality. The water quality requirements can be met through the use of NRDs; therefore, CPv is also met. Table 58 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 58. Frog Mortar 8 Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 8	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	34,592	0.79	NRD-FM 8-1	16' x L of pavement	3,743	296
Existing Impervious	9,380	0.22	NRD-FM 8-2	36' x L of pavement	4,004	317
Post-Development Impervious	3,622	0.08				
Removed Impervious	5,771	0.13				
Proposed New Impervious	13	0.00				
Existing Impervious Percent	27.12%					
New Development						
Area to Use	3,622	0.08		**Total (CF)**		**613**
Pe=	1.0 inch			**ESDv Req'd (CF)**		**416**
ESDv=	416 CF			**Excess Treatment (CF)**		**197**

FM 9 - This project is classified as redevelopment and requires stormwater management for water quality. The water quality requirements can be met through the use of NRDs; therefore, CPv is also met. Additional NRDs can be used in this drainage area to provide water quality credits for MAA. Table 59 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 59. Frog Mortar 9 Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 9	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	597,232	13.71	NRD-FM 9-1	35' x L of pavement	83,345	6,598
Existing Impervious	246,291	5.65	NRD-FM 9-2	35' x L of pavement	54,007	4,276
Post-Development Impervious	202,871	4.66	NRD-FM 9-3	35' x L of pavement	17,629	1,396
Removed Impervious	74,873	1.72	NRD-FM 9-4	25' x L of pavement	7,288	577
Proposed New Impervious	31,452	0.72	NRD-FM 9-5	50' x L of pavement	100,965	7,993
Existing Impervious Percent	41.24%		NRD FM 9-6	30' x L of pavement	38,386	3,039
			NRD-FM 9-7	50' x L of pavement	16,738	1,325
			NRD-FM 9-8	50' x L of pavement	12,212	967
			NRD-FM 9-9	50' x L of pavement	5,016	397
Redevelopment						
Area to Use	79,725	1.83			**Total (CF)**	**26,567**
Pe=	1.0 inches				**ESDv Req'd (CF)**	**6,312**
ESDv=	6,312 CF				**Excess Treatment (CF)**	**20,255**

FM 14 - This project is classified as redevelopment and requires stormwater management for water quality. The water quality requirements can be met through the use of NRDs; therefore, CPv is also met. Additional NRDs can be used in this drainage area to provide water quality credits for MAA. Table 60 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 60. Frog Mortar 14 Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 14	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	484,498	11.12	NRD-FM 14-1	75' x L of pavement	195,943	15,512
Existing Impervious	193,915	4.45	NRD-FM 14-2	30' x L of pavement	9,468	750
Post-Development Impervious	240,562	5.52	NRD-FM 14-3	37.5' x L of pavement	96,931	7,674
Removed Impervious	0.00	0.00	NRD-FM 14-4	33' x L of pavement	28,419	2,250
Proposed New Impervious	46,647	1.07	NRD-FM 14-5	37.5' x L of pavement	56,357	4,462
Existing Impervious Percent	40.02%		NRD-FM 14-6	45' x L of pavement	14,114	1,117
			NRD-FM 14-7	67' x L of pavement	39,488	3,126
Redevelopment						
Area to Use	143,605	3.30			**Total (CF)**	**34,890**
Pe=	1.0 inches				**ESDv Req'd (CF)**	**11,369**
ESDv=	11,369 cu. ft.				**Excess Treatment (CF)**	**23,521**

FM 19 - This project is classified as redevelopment and requires stormwater management for water quality. The water quality requirements can be met through the use of NRDs; therefore, CPv is also met. Table 61 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 61. Frog Mortar 19: Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 19	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	164,513	3.78	NRD-FM 19-1	39' x L of pavement	37,482	2,967
Existing Impervious	160,126	3.68	NRD-FM 19-2	39' x L of pavement	48,299	3,824
Post-Development Impervious	160,126	3.68				
Removed Impervious	0	0.00				
Proposed New Impervious	-	0.00				
Existing Impervious Percent	97.33%					
Redevelopment						
Area to Use	80,063	1.84		**Total (CF)**		**6,791**
Pe=	1.0 inch			**ESDv Req'd (CF)**		**6,338**
ESDv=	6,338 cu. ft.			**Excess Treatment (CF)**		**453**

FM 20 - This project is classified as redevelopment and requires stormwater management for water quality. The water quality requirements can be partially met through the use of NRDs. Because this project is classified as redevelopment, CPv treatment is not required. Table 62 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 62. Frog Mortar 20: Impervious Area Changes and Stormwater Management BMPs

Frog Mortar 20	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	38,122	0.88	NRD-FM 20-1	39' x L of pavement	7,483	592
Existing Impervious	34,438	0.79				
Post-Development Impervious	34,438	0.79				
Removed Impervious	-	0.00				
Proposed New Impervious	-	0.00				
Existing Impervious Percent	90.34%					
Redevelopment						
Area to Use	17,219	0.4		**Total (CF)**		**592**
Pe=	1.0 inch			**ESDv Req'd (CF)**		**1,363**
ESDv=	1,363 cu. ft.			**Deficit Treatment (CF)**		**-771**

3.2.2 Phosphorus Removal

For Sponsor's Preferred Alternative, FM 19 & FM 20 has no work proposed within the Critical Area. Therefore, no phosphorus removal is required in FM 19 & FM 20.

For drainage areas FM 2, 5-9, and 14, the requirements for phosphorus removal were evaluated and are shown in Table 63 through Table 71.

Table 63. Phosphorus Removal for Frog Mortar 2

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	158,400	3.64
Existing Impervious	77,534	1.78
Post-Development Impervious	127,990	2.94
Existing Impervious, I_{pre}	48.95%	
Proposed Impervious, I_{post}	80.80%	
Redevelopment		
Predevelopment Load, L_{pre}	4.4 lbs/year	
Post-Development Load, L_{post}	6.9 lbs/year	
Pollutant Removal Requirement[1]	3.0 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Only a portion of this removal requirement can be met through the use of the SCA BMP, as shown in Table 64.

Table 64. Phosphorus Removal by BMP for Frog Mortar 2

BMP Phosphorus Calculation					
BMP Name	**Post-Development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Treated(SF)**	**Percent Site Area Treated**	**Load Removed (lb/yr)**
SCA-FM2-1	6.92	25%	36,558	23.08	0.4
				SUM	**0.4**
				Removal Requirement	**3.0**
				Shortage	**-2.6**

Table 65. Phosphorus Removal for Frog Mortar 5

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	214,608	4.93
Existing Impervious	99,921	2.29
Post-Development Impervious	85,921	1.97
Existing Impervious, I_{pre}	46.56%	
Proposed Impervious, I_{post}	40.04%	
Redevelopment		
Predevelopment Load, L_{pre}	5.7 lbs/year	
Post-Development Load, L_{post}	5.0 lbs/year	
Pollutant Removal Requirement[1]	-0.1 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 66. Phosphorus Removal for Frog Mortar 6

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	139,060	3.19
Existing Impervious	59,547	1.37
Post-Development Impervious	10,064	0.23
Existing Impervious, I_{pre}	42.82%	
Proposed Impervious, I_{post}	7.24%	
Redevelopment		
Predevelopment Load, L_{pre}	3.4 lbs/year	
Post-Development Load, L_{post}	0.9 lbs/year	
Pollutant Removal Requirement[1]	-2.2 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 67. Phosphorus Removal for Frog Mortar 7

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	124,805	2.87
Existing Impervious	25,714	0.59
Post-Development Impervious	0	0
Existing Impervious, I_{pre}	20.59%	
Proposed Impervious, I_{post}	0.00%	
Redevelopment		
Predevelopment Load, L_{pre}	1.7 lbs/year	
Post-Development Load, L_{post}	0.4 lbs/year	
Pollutant Removal Requirement[1]	-1.1 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 68. Phosphorus Removal for Frog Mortar 8

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	34,592	0.79
Existing Impervious	9,380	0.22
Post-Development Impervious	3,622	0.08
Existing Impervious, I_{pre}	27.12%	
Proposed Impervious, I_{post}	10.47%	
Redevelopment		
Predevelopment Load, L_{pre}	0.6 lbs/year	
Post-Development Load, L_{post}	0.3 lbs/year	
Pollutant Removal Requirement[1]	-0.2 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 69. Phosphorus Removal for Frog Mortar 9

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	497,828	11.43
Existing Impervious	229,106	5.26
Post-Development Impervious	185,686	4.26
Existing Impervious, I_{pre}	46.02%	
Proposed Impervious, I_{post}	37.30%	
Redevelopment		
Predevelopment Load, L_{pre}	13.0 lbs/year	
Post-Development Load, L_{post}	10.8 lbs/year	
Pollutant Removal Requirement[1]	-0.9 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 70. Phosphorus Removal for Frog Mortar 14

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	93,490	2.15
Existing Impervious	62,755	1.44
Post-Development Impervious	62,771	1.44
Existing Impervious, I_{pre}	67.12%	
Proposed Impervious, I_{post}	67.14%	
Redevelopment		
Predevelopment Load, L_{pre}	3.4 lbs/year	
Post-Development Load, L_{post}	3.4 lbs/year	
Pollutant Removal Requirement[1]	0.3 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 71. Phosphorus Removal by BMP for Frog Mortar 14

BMP Phosphorus Calculation					
BMP Name	**Post-Development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Treated(SF)**	**Percent Site Area Treated**	**Load Removed (lb/yr)**
NRD-FM14-5	3.4	25%	56,357	60.3%	0.5
				Sum	**0.5**
				Removal Requirement	**0.3**
				Excess	**0.2**

The MAA recognizes that the proposed BMPs for Frog Mortar will not completely meet the phosphorus reduction requirements. The MAA will coordinate with the Chesapeake Bay Critical Area Commission on other approaches, such as stormwater offset options, to meet the phosphorus reduction requirements. Table 95 at the end of this section provides a summary of the phosphorus removal requirements.

3.2.3 Storm Drainage Pipe Capacity

The stormdrain capacity analysis presented in the *2004 Plan* was used to determine whether the pipe capacity was adequate. That capacity analysis evaluated the storm drain system for a 10-year storm event, which exceeds the FAA 5-year storm event design requirement for drainage systems.

For the EA, the analysis done for the *2004 Plan* was supplemented in some drainage areas with additional analysis to determine if the current pipe system could accommodate post-development discharges for Sponsor's Preferred Alternative. The storm drainage capacity in the EA was evaluated for the 5-year storm event per FAA design criteria unless the system discharges directly to tidal waters. The MDE criteria for a stormwater waiver for a storm drainage system that discharges directly to tidal waters requires that the storm drain system be designed for the 10-year storm event. Therefore, for some drainage areas, the 10-year storm was used for the design storm. For drainage areas without inlets, no capacity analysis was performed.

FM 2 - The *2004 Plan* did not include a storm drain capacity analysis. The existing pipe system that serves FM 2 is unknown as the available data do not show the size of the pipe. The alignment shows the storm system running along the south side of the abandoned aircraft apron at the southeast end of the airport. The pipe discharges into a BMP that discharges into a swale that outlets directly into Frog Mortar Creek. Because of the lack of available information on this system, the existing capacity is not known.

Discharges will increase from their current values because of the increase in impervious area for future conditions. Although the 5-year discharge is the FAA design discharge for the storm drainage system on the airport, the 10-year storm was used for the design storm in order to meet the requirements for a stormwater waiver. Quantity control would be required within the drainage area unless a stormwater waiver can be applied to this site. However, because the existing storm

drainage system discharges into a BMP and then directly into Frog Motor Creek, a stormwater waiver under Part 3.3(B)(1)(a) would be applicable.

Based on the location of the storm pipe, approximately 50 percent of the drainage area contributes runoff to the storm pipe. The proposed storm pipes need to be sized to convey the future discharge into the existing swale, which discharges directly into Frog Mortar Creek. The alignment of the pipe would follow the alignment of the existing pipe and, where possible, the existing pipe will be removed, and the new pipes placed in the same location. The alignment is shown in Exhibit 2. The 5-, and 10-year discharges for the future conditions were determined using the NRCS TR55 program. Based on the calculations, the discharges are as follows:

5-Year Storm (Q5) - 35.3 cfs

10-Year Storm (Q10) - 43.5 cfs

As mentioned above, only about 50 percent of the drainage area contributes discharge to the storm drainage pipes. The amount of discharge to the proposed pipes was determined by prorating the areas that drain to the pipes. Based on these calculations, the discharge to the pipe system is shown below:

5-Year Storm (Q5) - 17.7 cfs

10-Year Storm (Q10) - 21.7 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey the discharge to Frog Mortar Creek for the 5- and 10-year storms. The hydraulic gradient calculations used a 0.5-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. Based on the calculations, a 30-inch pipe would be the required pipe size to convey the 10-year storm from the drainage area to the existing BMP and swale and then into the creek. Therefore, a stormwater waiver for quantity control would be applicable under Section 3(B)(1)(a).

FM 5 – The *2004 Plan* storm drain capacity analysis showed that seven sections of the existing pipe system were surcharged during a 10-year storm event under existing conditions. The existing pipe system that serves FM 5 consists of a combination of 18-, 24-, 30-, 36-, 42-, 48-, and 54-inch RCPs. The pipe sizes were obtained from the *2004 Plan*. The runoff from the drainage area sheet flows to inlets in the infield area of the airfield between the runway and Taxiway F. The pipes run parallel to the runway and cross under Taxiways J, S, and E before discharging into Frog Mortar Creek.

The 5-year discharge is the FAA design discharge for the storm drainage system on the airport and the 10- and 25-year discharges are the design discharges for pipes or culverts crossing State roads. However, because the pipe system connects directly to Frog Mortar Creek, the 10-year storm was used for the design storm in order to meet the requirements for a stormwater waiver. Based on the limited data available for the existing pipes, a pipe slope of 0.1 percent was assumed to determine the capacity of the pipes. This slope was selected because it allows the pipes to cross under the taxiway with a minimum cover of approximately 2 feet. The pipes would rise out of the ground if a steeper slope was assumed. In addition, an invert of -2.00 feet was assumed

at the outlet to Frog Mortar Creek. Calculations performed for the existing pipes show that the existing pipes are inadequate to convey the discharges from future development.

Based on the requirements stated above, the sizes of the pipes would have to be increased to convey the future 10-year discharge into Frog Mortar Creek. It was assumed that the alignment of the proposed pipe would follow the alignment of the existing pipes shown in Exhibit 2. The 5- and 10-year discharges for the future conditions were determined using the NRCS TR55 program. Based on these calculations, the future discharges are as follows:

5-Year Storm (Q10) - 143.8 cfs

10-Year Storm (Q25) - 186.3 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipe system necessary to convey the 10-year storm discharge from the infield area to the creek. The hydraulic gradient calculations used a 0.1-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. The discharges in the pipe were prorated over the length of the pipe using the ratio of the area that contributes to the inlets. Based on the calculations, to convey the 10-year storm the existing pipes would be replaced with a combination of 42-, 48-, 54-, and 72-inch RCPs from the inlet in the infield area to the outfall into Frog Mortar Creek. Therefore, a stormwater waiver for quantity control would be applicable under Section 3(B)(1)(c).

FM 6, FM 7, and FM 8 - There are no storm drain inlets within these three drainage areas. Stormwater sheet flows directly to Frog Mortar Creek in these drainage areas. Therefore, no storm drainage pipe capacity analysis was conducted.

FM 9 - The stormdrain capacity analysis showed that three sections of the existing pipe system were surcharged during a 10-year storm event for the existing conditions. The existing pipe system that serves FM 9 consists of a combination of 18-, 24-, 30-, 36-, 42-, and 48-inch RCPs. The pipe sizes were obtained from the *2004 Plan*. This drainage area consists of two storm drainage systems that converge into one pipe that conveys the discharge to the outlet. The runoff from the drainage area sheet flows to inlets in the infield area of the airfield between the runway and Taxiway T at the southeast end of the airport. The pipes run parallel to the runway and then turn east and cross under Taxiway T and discharge into a ditch that discharges into Frog Mortar Creek. Because of the two pipe systems, the area was divided into two sub-drainage areas identified as Area 1 and Area 2 for the pipe capacity analysis. Area 1 consists of the pipe system in the northern portion of the drainage area between the runway and Taxiway T, and Area 2 consists of the pipe system in the southern portion of the drainage area, also between the runway and Taxiway T. Both systems cross under Taxiway T to a manhole. The pipe from this manhole discharges to the ditch that connects directly to Frog Mortar Creek.

The 5-year discharge is the FAA design discharge for the storm drainage system on the airport and the 10- and 25-year discharges are the design discharges for pipes or culverts crossing state roads. However, because the pipe system discharges to a ditch that connects directly to Frog Mortar Creek, the 10-year storm was used for the design storm in order to meet the requirements for a stormwater waiver. Based on the limited data available for the existing pipes, a pipe slope of 0.5 percent was assumed to determine the capacity of the pipes. This slope was selected

because it allows the pipes to cross under the taxiway with a minimum cover of approximately 2 feet. The pipes would rise out of the ground if a steeper slope was assumed. In addition, an invert of 0.00 feet was assumed at the outlet to Frog Mortar Creek. Calculations performed for the existing pipes show that the existing pipes are inadequate to convey the discharges from future development.

Based on the requirements stated above, the pipe sizes must be increased to convey the discharge into Frog Mortar Creek. It was assumed that the alignment of the pipe system would follow the alignment of the existing system, as shown in Exhibit 2.

The 5- and 10-year future discharges were determined using the NRCS TR55 program. Based on the calculations, the area's total discharges from the ditch to Frog Mortar Creek are as follows:

5-Year Storm (Q5) - 161.1 cfs

10-Year Storm (Q10) - 215.3 cfs

As mentioned above, only the portion of the drainage area between the runway and Taxiway T will convey discharges to the storm drainage pipes. The amount of discharge to each system was determined by prorating the areas that discharge to the pipes. These drainage areas are identified as Area 1 and Area 2. Based on these calculations, the discharge to each pipe system is shown below:

	5-Year Storm	10-Year Storm
Area 1	52 cfs	70 cfs
Area 2	31 cfs	42 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey the 10-year storm discharge from the infield area to the creek. The hydraulic gradient calculations used a 0.1-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. Based on the calculations, the existing pipes would be replaced with a combination of 36-, 42-, and 48-inch RCPs to convey the 10-year storm from the inlet in the infield area to the ditch that outfalls directly into the Frog Mortar Creek. Therefore, a stormwater waiver for quantity control would be applicable under Section 3(B)(1)(a).

FM 14 – In the *2004 Plan*, the stormdrain capacity analysis showed that two sections of the existing pipe system were surcharged during a 10-year storm event for the existing conditions. The existing pipe system that serves Drainage Area FM 14 consists of a combination of 18-, 24-, 30-, 36-, and 48-inch RCPs. The pipe sizes were obtained from the *2004 Plan*. This drainage area consists of two storm drainage systems that converge into one pipe that conveys the discharge to a drainage ditch and then to the outlet. The runoff from the drainage area sheet flows to inlets in the infield area of the airfield between the runway and Taxiway T near the airfield's midpoint. The pipes run parallel to the runway and then turn east and cross under Taxiway T and discharge into a ditch that discharges into Frog Mortar Creek. Because of the two pipe systems, the drainage area was divided into two sub-drainage areas identified as Area 1 and Area 2 for the pipe capacity analysis. Area 1 consists of the pipe system in the northern portion of the drainage area between the runway and Taxiway T and Area 2 consists of the pipe system in the southern portion of the drainage area, also between the runway and Taxiway T. Both

systems cross under Taxiway T and discharge to the ditch that connects directly to Frog Mortar Creek.

The 5-year discharge is the FAA design discharge for the storm drainage system on the airport and the 10- and 25-year discharges are the design discharges for pipes or culverts crossing State roads. However, because the pipe system discharges to a ditch that connects directly to Frog Mortar Creek, the 10-year storm was used for the design storm in order to meet the requirements for a stormwater waiver. Based on the limited data available for the existing pipes, a pipe slope of 0.5 percent was assumed to determine the capacity of the pipes. This slope was selected because it allows the pipes to cross under the taxiway with a minimum cover of approximately 2 feet. The pipes would rise out of the ground if a steeper slope was assumed. In addition, an invert of 1.50 feet was assumed where the pipes enter the ditch. Using the 10-year storm event, calculations show that the pipe system in Area 1 is inadequate to convey the discharge from the future development in the drainage area, but the existing pipe system in Area 2 is capable of conveying the future discharge for the 10-year storm.

Based on the requirements stated above, the sizes of the pipes must be increased to convey the 10-year discharge into Frog Mortar Creek for Area 1. It was assumed that the alignment of the pipe would follow the alignment of the existing pipe, as shown in Exhibit 2. The 5- and 10- year discharges for future development were determined using the NRCS TR55 program. Based on the calculations, the total discharges are as follows:

5-Year Storm (Q5) - 121.5 cfs

10-Year Storm (Q10) - 162.1 cfs

However, only a portion of the total discharge from the drainage area is conveyed by the storm drainage pipes. The amount of discharge to each system was determined by prorating the areas that flow to the pipes. Based on this calculation, the discharge to each pipe system is shown below:

	5-Year Storm	10-Year Storm
Area 1	42 cfs	56 cfs
Area 2	22 cfs	30 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey the 10-year storm discharge from the infield area to the creek. The hydraulic gradient calculations used a 0.5-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. Based on the calculations, the existing pipes in Area 1 would be replaced with a combination of 36- and 48-inch RCPs to convey the 10-year storm from the inlet in the infield area to the ditch that outfalls into Frog Mortar Creek. The pipes in Area 2 would not be replaced for the 10-year storm because that system can convey the future 10-year discharge. A stormwater waiver for quantity control would be applicable for FM 14 under Section 3(B)(1)(a).

FM 19 - The *2004 Plan* storm drain capacity analysis showed no sections of the existing pipe system were surcharged during a 10-year storm event for the existing conditions. The projects within this drainage area is pavement improvement to Taxiway T & reconstruction of MANG apron pavement, no additional storm drain capacity is anticipated.

FM 20 - The *2004 Plan* storm drain capacity analysis showed no sections of the existing pipe system were surcharged during a 10-year storm event for the existing conditions. Because the only project within this drainage area is reconstruction of MANG apron pavement, no additional storm drain capacity is anticipated.

3.2.4 Stormwater Waivers

Stormwater waivers, as defined in Section 3(B)(1)(a) and Section 3(B)(1)(c) of the 2015 *Maryland Stormwater Management Guidelines for State & Federal Projects* for quantity control and CPv, are applicable for drainage areas within the Frog Mortar watershed that are affected by Sponsor's Preferred Alternative, as described in the previous section. These waivers apply because the POIs discharge into tidally influenced receiving waters.

3.2.5 Water Quantity Control

Water quantity control is not required for the affected drainage areas within the Frog Mortar watershed because stormwater waivers are applicable for the affected drainage areas (see Section 3.2.4).

3.3 Stansbury Creek

Within the Stansbury Creek watershed, drainage areas S1, S2, S3, S5, S7, S9, and S10 are impacted by Sponsor's Preferred Alternative. All mentioned drainage areas have a project or a portion of the project within the Chesapeake Bay Critical Area; therefore, the phosphorus removal requirement must be met. The following sections describe the stormwater management requirements for Stansbury Creek.

3.3.1 Water Quality Control

S1 - This project is classified as redevelopment and will require water quality treatment. Water quality requirements can be met through the use of NRDs. Because this project is classified as redevelopment, CPv treatment is not required. Table 72 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 72. Stansbury 1 Impervious Area Changes and Stormwater Management BMPs

Stansbury 1	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	36,436	0.84	NRD-S 1-1	33' x L of pavement	9,056	717
Existing Impervious	29,198	0.67				
Post-Development Impervious	23,427	0.54				
Removed Impervious	7,990	0.18				
Proposed New Impervious	2,219	0.05				
Existing Impervious Percent	80.13%					
Redevelopment						
Area to Use	8,828	0.20			**Total (CF)**	**717**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**699**
ESDv=	699 CF				**Excess Treatment (CF)**	**18**

S2 - This project is classified as new development and will require water quality treatment. There are no options for ESD BMPs within this project area. Therefore, a structural BMP (bioretention facility) is proposed to provide water quality treatment. This BMP will be located in S3. For the EA, the conceptual design is based on the stormwater being piped to that BMP. CPv treatment can be met through a stormwater waiver as a result of the new proposed drainage system (see Section 3.3.4). Table 73 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs. Table 74 summarizes the structural BMP requirements.

Table 73. Stansbury 2 Impervious Area Changes and Stormwater Management BMPs

Stansbury 2	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	29,426	0.68				
Existing Impervious	4,063	0.09				
Post-Development Impervious	25,513	0.59				
Removed Impervious	0	0.00				
Proposed New Impervious	21,450	0.49				
Existing Impervious Percent	13.81%					
New development						
Area to Use	25,513	0.59			**Total (CF)**	**---**
Pe=	1.8 inches				**ESDv Req'd (CF)**	**3,665**
ESDv=	3,665 cu. ft.				**Deficit Treatment (CF)**	**-3,665**

Table 74. Stansbury 2 Structural BMP Requirements

Total CPv required:				
RCN (TABLE 5.3)	=	87		
S	=	(1,000/RCN) - 10	=	1.49
P1	=	2.6	in	
Qe =	$\frac{(P1 - 0.2\,S)^2}{(P1 + 0.8\,S)}$	=		1.40
V=	$\frac{Qe \times A}{12}$	=		3,421.23
CPv provided by ESD BMPs:				
REDUCED RCN (TABLE 5.3)	=	77		
S	=	(1,000/RCN) - 10	=	2.99
P1	=	2.6	in	
Qe =	$\frac{(P1 - 0.2\,S)^2}{(P1 + 0.8\,S)}$	=		0.80
V=	$\frac{Qe \times A}{12}$	=		1970.93

STRUCTURAL PRACTICE VOLUME REQUIRED: 3,421.23 CF- 1,970.93 CF= 1,450.30 CF

S3 - This project is classified as redevelopment and will require water quality treatment. This requirement cannot be completely met through the use of NRDs. Therefore, two structural BMPs (bioretention facilities) are proposed to provide water quality treatment. The first BMP (Area 3 on Exhibit 2) is designed to treat a large portion of the Midfield Development located in the Northeast corner of S3. The second BMP (Area 5 on Exhibit 2) is sized to also provide water quality treatment for the portion of S2 that cannot be met through ESD. CPv treatment is not applicable for this drainage area because the project is redevelopment. Table 75 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs. Table 76 and Table 77 summarize the structural BMP requirements.

Table 75. Stansbury 3 Impervious Area Changes and Stormwater Management BMPs

Stansbury 3	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	432,178	9.92	NRD-S 3-1	75' x L of pavement	51,619	4,087
Existing Impervious	240,176	5.51	NRD-S 3-2	75' x L of pavement	42,362	3,354
Post-Development Impervious	319,964	7.35	NRD-S 3-3	70' x L of pavement	19,539	1,547
Removed Impervious	13,943	0.32				
Proposed New Impervious	93,731	2.15				
Existing Impervious Percent	55.57%					
Redevelopment						
Area to Use	199,876	4.59			**Total (CF)**	**8,987**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**15,824**
ESDv=	15,824 CF				**Deficit Treatment (CF)**	**-6,837**

Table 76. Stansbury 3 Structural BMP Requirements

Total CPv required:				
RCN (TABLE 5.3)	**=**	**85**		
S	**=**	**(1,000/RCN) - 10**	**=**	**1.76**
P1	**=**	**2.6**	**in**	
Qe =	**$\frac{(P1 - 0.2\,S)^2}{(P1 + 0.8\,S)}$**	**=**		**1.26**
V=	**$\frac{Qe \times A}{12}$**	**=**		**45,328.86**
CPv provided by ESD BMPs:				
REDUCED RCN (TABLE 5.3)	**=**	**77**		
S	**=**	**(1,000/RCN) - 10**	**=**	**2.99**
P1	**=**	**2.6**	**in**	
Qe =	**$\frac{(P1 - 0.2\,S)^2}{(P1 + 0.8\,S)}$**	**=**		**0.80**
V=	**$\frac{Qe \times A}{12}$**	**=**		**28,946.90**

STRUCTURAL PRACTICE VOLUME REQUIRED: 45,328.86 CF-28,946.90 CF= 16,381.96 CF

Table 77. Stansbury 3 Bioretention BMP Requirements

Stansbury 3 Bioretention BMP					
Drainage Area	Volume Required (CF)	Media Depth (FT)	Ponding Depth (FT)	Drainage Time (DAY)	Surface area needed (SF)
S2	1,450	2.5	1	1	2,417
S3	16,382	2.5	1	1	27,303
				Total	29,720
BMP		Drainage Area	Width (FT)	Length (FT)	Surface Area Provided (SF)
S3-1 (Bioretention Area 5)		S2, and S3	40	150	6,000
S3-1 (Bioretention Area 3)		S3	80	300	24,000
				Total	30,000

S5 - This project is classified as new development and will require water quality treatment. This requirement cannot be completely met through the use of NRDs. The remainder of the required treatment will be met through the use of existing Pond 1. Per the report entitled *Stormwater Management Hydrology Computation, Black & Decker Hangar Project, Martin State Airport*, dated March 10, 2008, and the *2004 Plan*, Pond 1 was designed to treat 72.90 acres of impervious area using three Bio-cells in series. The pond was constructed under the guidance of regulations that pre-date ESD requirements; therefore, the design of Pond 1 was based on a Pe of 1 inch. The resulting WQ_v for Pond 1 was 263,469 CF. Assuming Pond 1 is restored to working condition, the pond would have to meet current regulations for the contributing area that is within the project LOD and would also need to maintain the level of treatment for the impervious area that is not affected. The 27.36 acres of impervious area that is within the LOD has a treatment volume requirement of 179,354 CF for a Pe of 1.8 inch. The remaining impervious area of 31.84 acres in the drainage area has a treatment volume requirement of 119,070 CF with the Pe remaining at 1.0 inch. The total required treatment volume for the drainage area of S5 would be 298,424 CF. Pond 1, as it was originally designed, would not be sufficient to treat this volume, but with the addition of the 44,859 CF contributed by NRDs, the requirement is met and there is no further BMP selection needed.

Because the existing storm drain system connects directly to tidal waters, a waiver for CPv is applicable for this drainage area. Table 78 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 78. Stansbury 5 Impervious Area Changes and Stormwater Management BMPs

Stansbury 5	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	2,462,962	56.54	NRD S 5-1	12' x L of pavement	13,022	1,031
Existing Impervious	881,730	20.24	NRD S5-2	12' x L of pavement	18,876	1,494
Post-Development Impervious	1,91,714	27.36	NRD S 5-3	12' x L of pavement	10,344	819
Removed Impervious	273,491	6.28	NRD S 5-4	12' x L of pavement	81,914	6,485
Proposed New Impervious	583,475	13.39	NRD S 5-5	12' x L of pavement	10,777	853
Existing Impervious Percent	35.80%		NRD- S 5-6	12' x L of pavement	19,145	1,516
			NRD- S 5-7	12' x L of pavement	10,574	837
			NRD- S 5-8	12' x L of pavement	8,044	637
			NRD- S 5-9	12' x L of pavement	49,756	3,939
			NRD- S 5-10	12' x L of pavement	80,066	6,339
			NRD- S 5-11	12' x L of pavement	11,022	873
			NRD- S 5-12	12' x L of pavement	47,731	3,779
			NRD- S 5-13	12' x L of pavement	19,200	1,520
			NRD S 5-14	12' x L of pavement	104,093	8,241
			NRD S 5-15	12' x L of pavement	8,846	700
			NRD- S 5-16	12' x L of pavement	61,963	4,905
			NRD- S 5-17	12' x L of pavement	11,266	892
New Development						
Area to Use	1,191,714	27.36			**Total (CF)**	**44,859**
Pe=	1.8 inches				**ESDv Req'd (CF)**	**179,354**
ESDv=	179,354				**Deficit Treatment (CF)**	**-134,495**

S7 - This project is classified as redevelopment and will require water quality treatment. Two NRD are proposed in this area; the remaining water quality requirements will be met through existing Pond 3. Pond 3 will treat 0.34 acres of impervious area as part of Sponsor's Preferred Alternative. CPv treatment can be met through a stormwater waiver (See Section 3.3.4). Table 79 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Previous approved MDE studies for Pond 3 state that the Pond has additional capacity for water quality treatment. The January 2005 study, *Drainage Study for Pond No. 3* (MDE No. 04-SF-IMP20299), stated that the pond had the capacity to treat 12.03 acres of new impervious area proposed for the Black & Decker Hangar 100% Build Out, plus an additional 5 acres of impervious area. As stated in the *Storm Drain and Stormwater Management Report for Taxilane K (*March 2008), the Black & Decker project only added 2.17 acres of impervious area (a decrease of 9.86 acres of impervious area than originally proposed) and the Taxilane K project added 0.74 acres of new impervious area. Therefore, based on these studies, 2.91 acres of new impervious area is treated by Pond 3 for the Northrop Grumman Buildings (previously Black & Decker) and the Taxilane K projects. Pond 3, therefore, still has additional capacity to treat impervious areas for water quality treatment: 12.03 acres -2.17 acres -0.74 acres + 5 acres = 14.12 acres. Therefore, the remaining 0.34 acres from the proposed action can be treated by the existing pond.

Table 79. Stansbury 7 Impervious Area Changes and Stormwater Management BMPs

Stansbury 7	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	188,617	4.33	NRD-S7-1	75' x L of pavement	30,695	2,430
Existing Impervious	85,952	1.97	NRD-S7-2	45' x L of pavement	14,046	1,112
Post-Development Impervious	100,896	2.32				
Removed Impervious	0	0.00				
Proposed New Impervious	14,944	0.34				
Existing Impervious Percent	45.57%					
Redevelopment						
Area to Use	57,920	1.33			**Total (CF)**	**3,542**
Pe=	1.0 inches				**ESDv Req'd (CF)**	**4,585**
ESDv=	4,585 CF				**Deficit Treatment (CF)**	**-1,043**

S9 - This project is classified as new development and will require water quality treatment. Water quality requirements cannot be completely met through the use of ESD NRDs in this drainage area, and there is no space within the LOD for structural BMPs. Because Stansbury, Dark Head, and Frog Mortar Creeks are all within the same MDE 6-digit watershed, Gunpowder River-021308, credits (excess treatment) from Frog Mortar Creek Subbasin 5 can be utilized for Stansbury. A stormwater waiver for CPv is applicable for this drainage area (see Section 3.3.4). Table 80 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 80. Stansbury 9 Impervious Area Changes and Stormwater Management BMPs

Stansbury 9	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	2,429	0.06	NRD-S9-1	75' x L of pavement	902	71
Existing Impervious	817	0.02				
Post-Development Impervious	817	0.02				
Removed Impervious	-	0.00				
Proposed New Impervious	-	0.00				
Existing Impervious Percent	33.64%					
New Development						
Area to Use	817	0.02			**Total (CF)**	**71**
Pe=	1.60 inches				**ESDv Req'd (CF)**	**114**
ESDv=	114 CF				**Deficit Treatment (CF)**	**-43**

S10 - This project is classified as redevelopment and will require water quality treatment. A portion of the water quality requirements can be met through NRDs and a conservation area located in the forested area south of Strawberry Point Road. The remainder of the requirements will be met through the use of credits in Frog Mortar 5. CPv treatment is not required because the site area is classified as redevelopment. Table 81 summarizes the pavement changes that would occur within this drainage area and the proposed stormwater BMPs.

Table 81. Stansbury 10 Impervious Area Changes and Stormwater Management BMPs

Stansbury 10	SF	Acres	Practice	Dimensions	Area Treated (SF)	Volume (ESDv, CF)
Limit of Disturbance (LOD)	441,468	10.13	NRD-S 10-1	33' x L of pavement	6,560	519
Existing Impervious	203,629	4.67	NRD S 10-2	33' x L of pavement	3,733	295
Post-Development Impervious	218,610	5.02	NRD S 10-3	33' x L of pavement	6,385	505
Removed Impervious	6,690	0.15	NRD S 10-4	33' x L of pavement	6,823	540
Proposed New Impervious	21,671	0.50	SCA-S10-1	67' x L of pavement	48,741	3,859
Existing Impervious Percent	46.13%					
Redevelopment						
Area to Use	116,795	2.68			**Total (CF)**	**5,719**
Pe=	1.0 inch				**ESDv Req'd (CF)**	**9,246**
ESDv=	9,246 CF				**Deficit Treatment (CF)**	**-3,527**

3.3.2 Phosphorus Removal

The phosphorus removal requirements are applicable to all impacted drainage areas within Stansbury Creek watershed. The phosphorus removal requirements are shown in Table 82 through Table 93.

Table 82. Phosphorus Removal Requirements for Stansbury 1

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	36,436	0.84
Existing Impervious	29,198	0.67
Post-Development Impervious	23,427	0.54
Existing Impervious, I_{pre}	80.13%	
Proposed Impervious, I_{post}	64.30%	
Redevelopment		
Predevelopment Load, L_{pre}	1.6 lbs/year	
Post-Development Load, L_{post}	1.3 lbs/year	
Pollutant Removal Requirement[1]	0.1 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

A portion of this removal requirement is met through the use of the BMP, as shown in Table 83

Table 83. Phosphorus Removal by BMP for Stansbury 1

BMP Phosphorus Calculation					
BMP Name	**Post-Development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Treated(SF)**	**Percent Site Area Treated**	**Load Removed (lb/yr)**
NRD-S 1-1	1.3	25%	9,056	24.9%	0.1
				Sum	**0.1**
				Removal Requirement	**0.1**

Table 84. Phosphorus Removal Requirements for Stansbury 2

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	29,426	0.68
Existing Impervious	4,063	0.09
Post-Development Impervious	25,513	0.59
Existing Impervious, I_{pre}	13.81%	
Proposed Impervious, I_{post}	86.70%	
New Development		
Predevelopment Load, L_{pre}	0.3 lbs/year	
Post-Development Load, L_{post}	1.4 lbs/year	
Pollutant Removal Requirement[1]	1.1 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

A portion of this removal requirement is met through the use of the BMP, as shown in Table 85.

Table 85. Phosphorus Removal by BMP for Stansbury 2

BMP Phosphorus Calculation					
BMP Name	**Post-Development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Treated(SF)**	**Percent Site Area Treated**	**Load Removed (lb/yr)**
Bioretention Area 5	1.4	50.00%	25,513	86.70%	0.6
				SUM	**0.6**
				Removal Requirement	**1.1**
				Shortage	**-0.5**

Table 86. Phosphorus Removal Requirements for Stansbury 3

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	159,077	3.65
Existing Impervious	63,368	1.45
Post-Development Impervious	138,164	3.17
Existing Impervious, I_{pre}	39.83%	
Proposed Impervious, I_{post}	86.85%	
Redevelopment		
Predevelopment Load, L_{pre}	3.7 lbs/year	
Post-Development Load, L_{post}	7.4 lbs/year	
Pollutant Removal Requirement[1]	4.1 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

A portion of this removal requirement is met through the use of the BMP, as shown in Table 87.

Table 87. Phosphorus Removal by BMP for Stansbury 3

BMP Phosphorus Calculation					
BMP Name	**Post-Development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Treated(SF)**	**Percent Site Area Treated**	**Load Removed (lb/yr)**
NRD-S3-1	7.44	25%	51,619	32.45%	0.6
NRD-S3-2	7.44	25%	42,362	26.63%	0.5
NRD-S3-3	7.44	25%	19,539	12.28%	0.2
Bioretention Area 3	7.44	50%	24,000	15.09%	0.6
Bioretention Area 5	7.44	50%	6,000	3.77%	0.1
				SUM	**2.0**
				Removal Requirement	**4.1**
				Shortage	**-2.1**

Table 88. Phosphorus Removal Requirements for Stansbury 5

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	100,590	2.31
Existing Impervious	25,876	0.59
Post-Development Impervious	38,277	0.88
Existing Impervious, I_{pre}	25.72%	
Proposed Impervious, I_{post}	38.05%	
Redevelopment		
Predevelopment Load, L_{pre}	1.6 lbs/year	
Post-Development Load, L_{post}	2.2 lbs/year	
Pollutant Removal Requirement[1]	0.8 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

This removal requirement is met through the use of the BMPs, as shown in Table 89.

Table 89. Phosphorus Removal by BMP for S5

BMP Phosphorus Calculation					
BMP Name	**Post-development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Served (ft.)**	**Percent Site Area Served**	**Load Removed (lbs/yr)**
NRD-S5-1	1.7	25%	13,022	17.95%	0.1
NRD-S5-2	1.7	25%	18,876	26.02%	0.1
NRD-S5-3	1.7	25%	10,344	14.26%	0.1
NRD-S5-5	1.7	25%	10,777	14.86%	0.1
NRD-S5-6	1.7	25%	19,145	26.39%	0.1
NRD-S5-7	1.7	25%	10,574	14.58%	0.1
NRD-S5-9	1.7	25%	49,756	68.59%	0.3
				Sum	**0.9**
				Removal Requirement	**0.8**
				Excess	**0.1**

Table 90. Phosphorus Removal Requirements for Stansbury 7

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	3,796	0.09
Existing Impervious	0	0.00
Post-Development Impervious	444	0.01
Existing Impervious, I_{pre}	0.00%	
Proposed Impervious, I_{post}	11.70%	
Redevelopment		
Predevelopment Load, L_{pre}	0.0 lbs/year	
Post-Development Load, L_{post}	0.0 lbs/year	
Pollutant Removal Requirement[1]	0.0 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 91. Phosphorus Removal Requirements for Stansbury 9

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	2,429	0.06
Existing Impervious	817	0.02
Post-Development Impervious	817	0.02
Existing Impervious, I_{pre}	33.64%	
Proposed Impervious, I_{post}	33.64%	
Redevelopment		
Predevelopment Load, L_{pre}	0.0 lbs/year	
Post-Development Load, L_{post}	0.0 lbs/year	
Pollutant Removal Requirement[1]	0.0 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

Table 92. Phosphorus Removal Requirements for Stansbury 10

Phosphorus Treatment for the Project LOD		
	SF	Acres
Limit of Disturbance (LOD)	340,346	7.81
Existing Impervious	131,918	3.03
Post-Development Impervious	153,589	3.53
Existing Impervious, I_{pre}	38.76%	
Proposed Impervious, I_{post}	45.13%	
Redevelopment		
Predevelopment Load, L_{pre}	7.6 lbs/year	
Post-Development Load, L_{post}	8.7 lbs/year	
Pollutant Removal Requirement[1]	1.9 lbs/year	

[1]Pollutant Removal Requirement = L_{post} - 0.9 x L_{pre}

A portion of this removal requirement is met through the use of the BMPs, as shown in Table 93.

Table 93. Phosphorus Removal by BMP for Stansbury 10

BMP Phosphorus Calculation					
BMP Name	**Post-Development Load, L_{post} (lb/yr)**	**BMP Efficiency**	**Area Treated(SF)**	**Percent Site Area Treated**	**Load Removed (lb/yr)**
NRD-S10-1	8.7	25%	6,560	1.93%	0.04
NRD-S10-2	8.7	25%	3,733	1.10%	0.02
NRD-S10-3	8.7	25%	6,385	1.88%	0.04
NRD-S10-4	8.7	25%	6,823	2.00%	0.04
SCA-S10-1	8.7	25%	48,741	14.32%	0.31
				SUM	**0.45**
				Removal Requirement	**1.86**
				Shortage	**-1.41**

The MAA recognizes that the proposed BMPs for Stansbury Creek will not completely meet the phosphorus reduction requirements. The MAA will coordinate with the Chesapeake Bay Critical Area Commission on other approaches, such as stormwater offset options, to meet the phosphorus reduction requirements.

Table 96 at the end of this section provides a summary of the phosphorus removal requirements.

3.3.3 Storm Drainage Pipe Capacity

The stormdrain capacity analysis presented in the *2004 Plan* was used to determine whether the pipe capacity was adequate. That capacity analysis evaluated the storm drain system for a 10-year storm event, which exceeds the FAA 5-year storm event design requirement for drainage systems.

For the EA, the analysis done for the *2004 Plan* was supplemented in some drainage areas with additional analysis to determine if the current pipe system could accommodate post-development discharges for Sponsor's Preferred Alternative. The storm drainage capacity in the EA was evaluated for the 5-year storm event per FAA design criteria unless the system discharges directly to tidal waters. The MDE criteria for a stormwater waiver for a storm drainage system that discharges directly to tidal waters requires that the storm drain system be designed for the 10-year storm event. Therefore, for some drainage areas, the 10-year storm was used for the design storm. For drainage areas without inlets, no capacity analysis was performed.

S1, S2, and S3 - The existing pipe system that serves S1 consists of 15- and 18-inch RCPs that run from the drainage area into an SHA drainage ditch parallel to Wilson Point Road. Drainage then flows into an inlet, connects to a storm drain pipe under Wilson Point Road, and then flows to a county storm sewer system. The storm system connects with a manhole on Dogwood Drive. All the pipe sizes mentioned for these drainage areas were obtained from the *2004 Plan*. The available data do not show the alignment or termination point for the county storm sewer from the manhole on Dogwood Drive.

The runoff from S2 sheet flows from the airport property to an SHA ditch parallel to Wilson Point Road. The flow then enters an inlet and discharges into a 15-inch RCP that runs under Wilson Point Road and connects to an 18-inch RCP that parallels the road. The storm system connects with the same storm manhole on Dogwood Drive as described for S1 above.

The pipes that serve S3 consist of a combination of 15-, 18-, and 24-inch pipes. This drainage consists of two storm drainage systems that converge into one pipe that conveys the discharge to the outlet. The storm drain system originates from the T-Hangar area and runs to the south side of the airfield, crosses beneath Strawberry Point Road, and discharges directly to Stansbury Creek. Because of the two-pipe system, the area was divided into two sub-drainage areas identified as Area S3A and Area S3B. Area S3A consists of the pipe in the eastern section of the drainage area and Area S3B consists of the area in the western section of the drainage area.

The 5-year discharge is the FAA design discharge for the storm drainage system on the airport and the 10- and 25-year discharges are the design discharges for pipes or culverts crossing State roads. However, because the pipe system from the BMP to the existing storm drain system will connect directly to Stansbury Creek, the 10-year storm was used for the design storm in order to meet the requirements for a stormwater waiver. Based on the limited data available for the existing pipes, a pipe slope of 0.5 percent was assumed to determine the capacity of the existing pipes. This slope was selected because it allows the pipes to cross under Wilson Point Road and Strawberry Point Road with a minimum cover of approximately 2 feet. The pipes would rise out of the ground if a steeper slope was assumed. In addition, an invert of -1.25 feet was assumed in the pipe where it discharges into the ditch that connects to Stansbury Creek.

The *2004 Plan* showed that three sections of the existing pipe system were surcharged during a 10-year storm event for the existing conditions for S3. Additionally, the road crossing culvert (RC-8) for S1 and the road crossing culvert (RC-9) for S2 had inadequate capacity for a 25-year storm conveyance as reported in the *2004 Plan*.

Quantity control would be required within the drainage area unless a stormwater waiver can be applied to this site. It is proposed to connect the pipes from S2 into the pipe system that serves S3 such that the runoff from these drainage areas discharges directly into Stansbury Creek. Thus, a stormwater waiver under Part 3.3(B)(1)(c) would be applicable.

Based on the requirements stated above, the size of the pipes that serve these drainage areas must be increased to convey the discharge. The proposed pipe system will collect flow from S2 and convey the stormwater via an 18-inch pipe to the proposed bioretention BMP located in S3. All proposed pipes within S2, and the portion of S3 that flows to the proposed BMP, were designed to convey the 5-year storm. A 24-inch pipe will convey the flow from the bioretention BMP to the existing storm sewer system that discharges to Stansbury Creek. The pipe that outlets from the bioretention BMP would connect to the storm drainage system that serves the entire area of S3. The storm sewer system from the BMP to Stansbury Creek was designed to convey the 10-year storm.

For S1 the pipe size for the road crossing will be increased to accommodate future development. Based on a 25-year storm an 18-inch pipe is proposed. To determine the pipe capacity for the new system, Area S3B (the western portion of S3) was further divided into Area S3B and Area S3C. Area S3C consists of the new impervious area that will be treated by the bioretention BMP. Runoff from Area S3C will be piped via an 18-inch pipe directly into the bioretention BMP. Runoff from Area S3B will discharge into the storm sewer pipe system in the western portion of Area S3.

The alignment of the new storm drain system from the bioretention BMP would follow the alignment of the existing pipes and, if possible, the existing pipes would be removed, and the new pipes placed in the same location. The new alignment is shown in Exhibit 2. Based on the proposed impervious area, the future 5-, 10-, and 25-year discharges were determined using the NRCS TR55 program. The future discharges are as follows:

Drainage Area S1

5-Year Storm (Q5) - 6.2 cfs

10-Year Storm (Q10) - 7.9 cfs

25-Year Storm (Q25) - 8.7 cfs

Drainage Area S2

5-Year Storm (Q5) - 3.6 cfs

10-Year Storm (Q10) - 4.4 cfs

25-Year Storm (Q25) - 4.7 cfs

Drainage Area S3

5-Year Storm (Q5) - 42.2 cfs

10-Year Storm (Q10) - 55.2 cfs

25-Year Storm (Q25) - 61.2 cfs

The amount of discharge to each pipe system in S3 was determined by prorating the areas that discharge to the pipe and weighing the development in those areas. Area S3A is the eastern pipe system in S3; Area S3B is the western pipe system in S3; and S3C flows directly to the bioretention BMP. Based on the calculations, the drainage to each pipe system in area S3 is shown below.

	5-Year Storm	10-Year Storm	25 Year Storm
Area S3A	28 cfs	37 cfs	41 cfs
Area S3B	4.8 cfs	6.2 cfs	6.8 cfs
Area S3C	9.4 cfs	12 cfs	13.4 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey the 10-year storm discharge from the infield area to Stansbury Creek. The hydraulic gradient calculations used a 0.5-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. Based on the calculations, the existing pipes would need to be replaced with a combination of 15-, 18-, 24-, 30-, 36-, 42-, and 48-inch pipes from the infield inlets to Stansbury Creek. These pipes will convey the 10-year storm discharges from the airport property to Stansbury Creek. Therefore, a stormwater waiver for quantity control would be applicable under Part 3.3(B)(1)(c).

S5 - The stormdrain capacity analysis showed that seven sections of the existing pipe system were surcharged during a 10-year storm event under existing conditions. With the addition of new pavement in this drainage area, the pipe system will still be surcharged, and an increase in capacity will be required for the new development.

The existing pipe system that serves S5 consists of a combination of 15-, 18-, 24-, 30-, 36-, 48-, and 54-inch RCPs that runs from the northwest end of Taxiway T to the south side of the airport, through Pond 1, and into a 4.5-foot x4.5-foot box culvert that runs under Strawberry Point Road and discharges into Stansbury Creek. The pipe sizes mentioned for these drainage areas were obtained from the *2004 Plan*.

The 5-year discharge is the FAA design discharge for the storm drainage system on the airport and the 10- and 25-year discharges are the design discharges for pipes or culverts crossing State roads. Using the 5-year storm event, calculations were performed on the pipes in the lower reaches of the storm drainage system (from the drainage structure between the runway and Taxiway F to Pond 1) that would be affected by the future development. Due to limited data for the storm sewers, a pipe slope of 0.5 percent was used for the calculations. This slope was selected because it allows the pipes to cross under the aircraft parking aprons with a minimum cover of approximately 2 feet. The pipes would rise out of the ground if a steeper slope was

assumed. In addition, an invert of -1.25 feet was assumed for the pipe where it discharges into Pond 1. The calculations show that the existing pipes are inadequate to convey the discharge that is contributed from the drainage area for the future development. The FHWA HY8 program was used to check the culvert capacity under Strawberry Point Road. The 10-year discharge was used for these calculations to meet the requirements for a stormwater waiver because this system will connect directly to Stansbury Creek. The calculations have shown that the 10-year discharge overtops the road by 0.49 feet at the lowest point on the road, which is at elevation 5.0 feet. The discharge used did not consider any attenuation in the peak discharge due to Pond 1.

Because of the increased impervious area to be added in future conditions, the 10-year storm (Q_{10}) discharges will increase from their current value. Quantity control would be required within the drainage area unless a stormwater waiver can be applied to this site. Because the existing storm drainage system connects directly into Stansbury Creek from the airport property, a stormwater waiver under Part 3.3(B)(1)(c) would be applicable.

Based on the requirements stated above, the pipe sizes must be increased, primarily in the area where new pavement will be added. The pipe sizes will be changed from the north side of Taxiway F to the outlet into Pond 1. The capacity of the box culvert that conveys the discharge from the pond directly into Stansbury Creek would also have to be increased. The existing pipes would be replaced with new pipes from the north side of Taxiway F to the outlet. The alignment of the new pipes would follow the alignment of the existing pipes and, where possible, the existing pipes will be removed, and the new pipes placed in the same location. The alignment is shown in Exhibit 2.

The 5-, 10-, and 25-year discharges for the future conditions were determined using the NRCS TR55 program. Based on the calculations, the discharges are as follows:

5-Year Storm (Q5) - 407.9 cfs

10-Year Storm (Q10) - 525.1 cfs

25-Year Storm (Q25) - 577.3 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey both the 5-, and 10- year storm discharges from the drainage area to Stansbury Creek. The hydraulic gradient calculations used a 0.5-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. Based on the calculations, the existing pipes would be replaced with a combination of 84- and 96-inch pipes from the drainage area to Stansbury Creek to convey the 10-year storm from the inlet between the runway and Taxiway F to Pond 1. Based on the depth of ground water at the airport, it would be more practical for the invert of any storm system to be as shallow as possible. Therefore, a 5.5-foot wide by 4.5-foot deep double box culvert would provide approximately the same flow area as the 96-inch RCP and would be recommended instead of the large RCPs to reduce the depth of the invert of the storm system. For the section of pipe from the outfall of Pond 1 to Stansbury Creek, the FHWA HY8 program was used to determine the culvert crossing size required under Strawberry Point Road to prevent the 10-year storm from overtopping the road. It was determined that a 7.5-foot wide by 4.5-foot deep box culvert in addition to the existing 4.5-

foot wide by 4.5-foot deep box culvert would be required to convey the discharge without overtopping the road.

S7 - The existing pipe system that serves S7 consists of a combination of 24-, 30-, 36-, and 42-inch RCPs that run adjacent to the Northrop Grumman (previously Black and Decker) hangar apron. The upstream storm drain system that impacts the pipe sizing is in drainage area S5. The pipe system discharges into Ponds 3A and 3B that outlet into Stansbury Creek. These pipe sizes were obtained from the drawings for Contract MAA-C0-09-014 "Taxilane K." This pipe system drains approximately 45 percent of the entire developed area. The remaining area consists of the ponds and wetland areas. The Taxilane K study indicated that the system was designed for the 5-year ultimate development condition. Because of the increased impervious area to be added in future conditions for S5, the 5-year storm (Q_5) discharge will increase from its current value. Quantity control would be required within the drainage area to attenuate the additional runoff. Ponds 3A and 3B have the potential capacity to provide the additional storage required but require further analysis at the time of project development.

Based on the requirements stated above, the pipe sizes must be increased to convey the 5-year storm discharge into the ponds. The existing pipes would be replaced with new pipes that follow the same alignment and, where possible, the existing pipes will be removed, and the new pipes placed in the same location. The alignment is shown in Exhibit 2.

The proposed development would increase the impervious area in the drainage area. The 5-, 10-, and 25-year future discharges were determined using the NRCS TR55 program. Based on the calculations, the discharges are as follows:

5-Year Storm (Q5) - 94.0 cfs

10-Year Storm (Q10) - 124.9 cfs

25-Year Storm (Q25) - 138.8 cfs

As mentioned above, only a portion of the drainage area contributes runoff to the storm drainage system. Therefore, it was assumed that about two-thirds of the discharge for the entire drainage area flows into the drainage system. Based on this determination, the amount of runoff that flows into the system is shown below.

5-Year Storm (Q5) - 63.0 cfs

10-Year Storm (Q10) - 83.7 cfs

25-Year Storm (Q25) - 93.0 cfs

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey the 5-year storm discharge from the drainage area to the ponds. The data for the pipe inverts and rim elevations were obtained from the Taxilane K project, as mentioned above. Based on the calculations, the existing pipes would be replaced with a combination of 24-, 30-, 36-, 42-, and 48-inch pipes to convey the 5-year storm to Ponds 3A and 3B.

S9 - Per the *2004 Plan*, stormwater sheet flows from the eastern portion of the drainage area west to Strawberry Point Road where it is collected at a culvert and conveyed Strawberry Point

Road to discharge to Stansbury Creek. The impervious area in S9 does not change when comparing existing conditions to Sponsor's Preferred Alternative. Therefore, there are no changes to the future discharges and no analysis on the culvert was required as part of the EA. The stormwater waiver under Section 3.3(B)(1)(a) is still applicable.

S10 - The pipe sizes for the existing pipe system that serves S10 are unknown. The size of the existing pipes would have to be determined in the field. The pipe system originates at an inlet between Taxiway F and the abandoned aircraft apron and runs south and then west below the existing concrete taxiway pavement. The pipe then runs south on the west side of the abandoned aircraft apron and crosses under Strawberry Point Road to Stansbury Creek. Because the existing pipe sizes are not known, the pipe capacity for existing conditions is not known.

The 5-year discharge is the FAA design discharge for the storm drainage system on the airport and the 10- and 25-year discharges are the design discharges for pipes or culverts crossing State roads. Because the pipe sizes are unknown, it could not be determined if the existing storm drainage system would be adequate to convey the runoff for future development. The pipe system connects directly to Stansbury Creek; therefore, these pipes should be capable of conveying the 10-year design storm to meet the requirements for a stormwater waiver.

The 10-year storm (Q_{10}) discharge will increase from its current value because of an increase in impervious area. Quantity control would be required within the drainage area to attenuate the additional runoff. Based on the requirements stated above, the pipe sizes must be adequate to convey the discharge to Stansbury Creek. New pipe sizes will be determined and if these pipe sizes are larger than the existing pipes field verified during design, the existing pipes would be replaced with new pipes that follow the existing alignment. The existing pipes will be removed, and the new pipes placed in the same location where possible. The alignment is shown in Exhibit 2.

The 5-, 10-, and 25-year future discharges were determined using the NRCS TR55 program. Based on the calculations, the discharges are as follows:

5-Year Storm (Q5) - 78.8 cfs

10-Year Storm (Q10) - 100.5 cfs

25-Year Storm (Q25) - 110.3 cfs

The calculations assumed that about 50 percent of the runoff flows to the pipe in the upper portion of the system and the total runoff amount flows in the lower portion of the pipe system.

Pipe hydraulic gradient calculations were used to determine the size of the pipe that would convey the 10-year storm discharge to Stansbury Creek. The hydraulic gradient calculations used a 0.1-percent slope for the pipes and ensured that the water-surface elevations in the inlets and manholes are lower than the grate and rim elevations. Based on the calculations, the existing pipes would be replaced with a combination of 36-, 42-, 54-, 60-, and 66-inch pipes to convey the 10-year storm directly to Stansbury Creek. Therefore, a stormwater waiver for quantity control would be applicable under Part 3.3(B)(1)(a).

3.3.4 Stormwater Waivers

Stormwater waivers, as defined in Section 3(B)(1)(a) and Section 3(B)(1)(c) of the 2015 *Maryland Stormwater Management Guidelines for State & Federal Projects* for quantity control and CPv, are applicable for drainage areas within the Stansbury Creek watershed that are affected by Sponsor's Preferred Alternative. These waivers apply because the POIs discharge into tidally influenced receiving waters

3.3.5 Quantity Control

Stormwater quantity control is not required for any of the drainage areas affected by Sponsor's Preferred Alternative because the stormwater waiver applies, as discussed in Section 3.3.4.

3.4 Sponsor's Preferred Alternative Summary

The following tables summarize the stormwater requirements and BMPs that are proposed for treatment.

Drainage Area		Water Quality					Quantity Control					
	New Development/ Redevelopment	Required ESD Volume (CF)	Entire Volume Treated? y/n	Comment	Channel Protection Volume (CPv) Met (y/n)	Comment	Quantity Control Required (y/n)	Q_p10 Existing Conditions (cfs)[1]	Q_p10 Corrected Existing Conditions (cfs)[2]	Q_p10 Post Development Conditions (cfs)[3]	Stormwater Waiver Applicable?	Comment
DH 3	New Development	730	Y	Treated by NRDs	y	CPv met through ESD	n	19.0	25.0	22.9	n	Reduction in impervious area reduces Qp
DH 4	New Development	8,765	y	Treated by NRDs	y	CPv met through ESD	n	69.0	79.2	75.7	n	Reduction in impervious area reduces Qp
DH 8	New Development	3,124	y	Treated by NRDs	y	CPv met through ESD	y	36.0	41.0	45.7	y	Section 3.3(B)(1)(c)-new storm drain system discharges directly to Dark Head Creek
DH 10	New Development	2,709	n	Treated by an NRD and credits from DH 4	n	Stormwater waiver for CPv	y	35.0	36.3	36.9	y	Section 3.3 (B)(1)(c)-new storm drain system discharges directly to Dark Head Creek
DH 12	New Development	2,553	y	Treated by an NRD and Bioretention BMP	y	CPv met through structural practice	n	32.0	N/A	36.5[4]	n	Section 3.3 (B)(1)(c)-new storm drain system discharges directly to Dark Head Creek
DH 13	New Development	35,529	y	Treated by NRD and Two Bioretention BMPs	y	CPv met through structural practice	y	82.0	82.3	85.5	y	Section 3.3(B)(1)(c) –storm drain system discharges directly to Dark Head Creek
DH 14	New Development	12,144	y	Treated by a Bioretention BMP located in DH 12	y	CPv met through structural practice	y	14.0	N/A	16.8	y	Section 3.3 (B)(1)(c)-new storm drain system discharges directly to Dark Head Creek

Table 94. Summary of Stormwater Requirements for the Dark Head Watershed - Sponsor's Preferred Alternative

[1] Q_{p10} from 2004 *Comprehensive Stormwater Management Plan for Martin State Airport*
[2] Q_{p10} from corrected existing conditions TR55 model. Soil groups in existing conditions TR55 model were corrected to reflect current NRCS soil group designations. No other changes were made to existing conditions TR55 models.
[3] $Q_{p\,10}$ for post-development represents changes in land use based on Sponsor's Preferred Alternative and current NRCS soil group designations.
[4] Q_{p10} represents ultimate development discharge (entire drainage area modeled as impervious land use).

Table 94. Summary of Stormwater Requirements for the Dark Head Watershed- Sponsor's Preferred Alternative (cont'd)

Drainage Area	Water Quality BMPs	ESD Volume Required (CF)	ESD Volume Provided (CF)	Excess ESD Volume (CF)	Shortage ESD Volume (CF)	Structural BMP Required (y/n)	Comment
DH 3	NRD-DH 3-1	730	750	20	0	n	Treated by NRD
DH 4	NRD-DH 4-1 thru NRD DH 4-7	8,765	11,808	3,043	0	n	Treated by NRDs
DH 8	NRD-DH 8-1 thru NRD DH 8-3	3,124	3,334	210	0	n	Treated by NRDs
DH 10	NRD-DH-10-1	2,709	803	0	-1,906	n	Treated by NRD and credits from DH 4
DH 12	NRD-DH-12-1; 1 Bioretention BMP (Area 4)	2,553	995	0	-1,558	y	Treated by NRD and Bioretention BMP; Bioretention BMP also provides treatment for DH 14
DH 13	NRD-DH-13-1; 2 Bioretention BMPs (Area 1 & 2)	35,529	1,118	0	-34,411	y	Treated by Bioretention Areas 1 and 2
DH 14	NRD-DH-14; 2 Bioretention BMPs (Area 4)	12,144	758	0	-11,386	y	Treated by NRD and Bioretention BMP; Bioretention Area also treats DH 12
	Subtotal	**65,554**	**19,566**	**3,273**	**-49,261**		
	Adjustment			**-1,906 CF (used for DH 10)**			
	Total	**65,554**	**19,566**	**1,367**			Structural BMPs required because ESD BMPs did not meet requirements

Drainage Area	Phosphorus Load Reduction					
	Phosphorus Load Reduction Required (y/n)	Pre-development Load (lbs/yr)	Post-development Load (lbs/yr)	Pollutant Removal Requirement (lbs/yr)	Load Reduction Met (y/n)	Comment
DH 3	n	N/A	N/A	N/A	N/A	Project not located within critical area
DH 4	n	N/A	N/A	N/A	N/A	Project not located within critical area
DH 8	n	N/A	N/A	N/A	N/A	Project not located within critical area
DH 10	y	0.6	1.1	0.6	n	Requirement partially met through NRD; MAA to coordinate with CBCA to meet remaining requirements
DH 12	y	0.4	1.0	0.6	n	Requirement partially met through NRD & structural BMP Area 4; MAA to coordinate with CBCA to meet remaining requirements
DH 13	y	0.2	0.4	0.2	y	Requirement met through NRD and Bioretention BMP Area 1 and 2
DH 14	y	1.6	4.5	3.1	n	Requirement partially met through NRD and bioretention BMP; MAA to coordinate with CBCA to meet remaining requirements

[1] Pollutant Removal Requirement= (Post-development Load) – (0.9*Pre-development Load)

Table 95. Summary of Stormwater Requirements for the Frog Mortar Watershed - Sponsor's Preferred Alternative

Drainage Area		Water Quality					Quantity Control						1, 2, 3 Not
	New Development/ Redevelopment	Required ESD Volume (CF)	Entire Volume Treated? y/n	Comment	Channel Protection Volume (CPv) Met (y/n)	Comment	Quantity Control Required (y/n)	Q_p10 Existing Conditions (cfs)[1]	Q_p10 Corrected Existing Conditions (cfs)[2]	Q_p10 Post Development Conditions (cfs)[3]	Stormwater Waiver Applicable?	Comment	
FM 2	Redevelopment	7,063	y	Sheet flow to conservation area and credits from FM 5	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(a)- discharges to tidally influenced receiving waters	
FM 5	New Development	12,835	y	NRDs	y	CPv met through ESD	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(a)- storm drain system discharges to tidally influenced receiving waters	
FM 6	Redevelopment	N/A	N/A	Requirement met through removal of > 50% existing impervious	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(a)- discharges to tidally influenced receiving waters	
FM 7	New Development	N/A	N/A	No net increase in impervious area because the only project in this drainage area is the removal of existing pavement	n	Stormwater waiver for CPv	n	N/A	N/A	N/A	y	Qp decreases because of reduction in impervious area; also, direct discharge to tidally influenced receiving water Section 3.3(B)(1)(a)	
FM 8	New Development	416	y	NRDs	y	CPv met through ESD	n	N/A	N/A	N/A	y	Qp decreased because of reduction in impervious area. Section 3.3(B)(1)(a)- discharges to tidally influenced receiving waters	
FM 9	Redevelopment	6,312	y	NRDs	y	CPv met through ESD	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(a)- discharges to tidally influenced receiving waters	
FM 14	Redevelopment	11,369	y	NRDs and credits from FM 5	y	CPv met through ESD	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(a)- discharges to tidally influenced receiving waters	
FM 19	Redevelopment	6,338	y	NRDs	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(a)- discharges to tidally influenced receiving waters	
FM 20	Redevelopment	1,363	y	NRDs and credits from FM 5	N/A	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(a)- discharges to tidally influenced receiving waters	

provided because quantity control is not required.

Table 95. Summary of Stormwater Requirements for the Frog Mortar Watershed- Sponsor's Preferred Alternative (cont'd)

Drainage Area	Water Quality BMPs	ESD Volume Required (CF)	ESD Volume Provided (CF)	Excess ESD Volume (CF)	Shortage ESD Volume (CF)	Structural BMP Required (y/n)	Comment
FM 2	SCA FM 2-1	7,063	2,894	0	-4,169	n	Use credits (excess volume) treated in FM 5
FM 5	NRD-FM 5-1 thru NRD FM 5-14	12,835	39,813	26,978	0	n	Excess Treatment provided
FM 6	None	0	0	0	0	n	More than 50% of existing impervious area removed
FM 7	None	0	0	0	0	n	Only action in this drainage area is pavement removal; all impervious area removed
FM 8	NRD-FM 8-1	416	613	197	0	n	Excess Treatment provided
FM 9	NRD-9-1 thru NRD-9-9	6,312	26,567	20,255	0	n	Excess Treatment provided
FM 14	NRD-14-1 thru NRD-14-7	11,369	34,890	23,521	0	n	Excess Treatment provided
FM 19	NRD-19-1 thru NRD-19-2	6,338	6,791	453	0	n	Excess Treatment provided
FM 20	NRD-20-1	1,363	592	0	-771	n	Use credits (excess volume) treated in FM 5
	Subtotal	**45,696**	**112,160**	**71,404**	**-4,940**		
	Adjustment			**-4,169 (FM2); -771 (FM20) -43 (S9); -3,527 (S10)**			
	Total	**45,696**	**112,160**	**62,894**			

Drainage Area	Phosphorus Load Reduction					
	Phosphorus Load Reduction Required (y/n)	Pre-development Load (lbs/yr)	Post-development Load (lbs/yr)	Pollutant Removal Requirement (lbs/yr)[1]	Load Reduction Met (y/n)	Comment
FM 2	y	4.4	6.9	3.0	n	Requirement partially met through SCA; MAA to coordinate with CBCA on remaining requirements
FM 5	y	5.7	5.0	0	y	Requirement met
FM 6	y	3.4	0.9	0	y	Requirement met
FM 7	y	1.7	0.4	0	y	Requirement met
FM 8	y	0.6	0.3	0	y	Requirement met
FM 9	y	13.0	10.8	0	y	Requirement met
FM 14	y	3.4	3.4	0.3	y	Requirement met through NRD.
FM 19	n	N/A	N/A	N/A	N/A	Project not located within critical area
FM 20	n	N/A	N/A	N/A	N/A	Project not located within critical area

[1] Pollutant Removal Requirement= (Post-development Load) – (.9*Pre-development Load)

Table 96. Summary of Stormwater Requirements for the Stansbury Creek Watershed - Sponsor's Preferred Alternative

Drainage Area		Water Quality					Quantity Control					
	New Development/ Redevelopment	Required ESD Volume (CF)	Entire Volume Treated? y/n	Comment	Channel Protection Volume (CPv) Met (y/n)	Comment	Quantity Control Required (y/n)	Q_{p10} Existing Conditions (cfs)[1]	Q_{p10} Corrected Existing Conditions (cfs)[2]	Q_{p10} Post Development Conditions (cfs)[3]	Stormwater Waiver Applicable?	Comment
S1	Redevelopment	699	y	Treated by NRD	n/a	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	New pipe system connects S1 and S2 to S3 which discharges directly to tidal waters Section 3.3(B)(1)(c)- storm drain system discharges to tidally influenced receiving waters
S2	New Development	3,665	y	Treated by Bioretention (Area 5) BMP in S3	n	Stormwater waiver for CPv	n	N/A	N/A	N/A	y	New pipe system connects S1 and S2 to S3 which discharges directly to tidal waters Section 3.3(B)(1)(c)- storm drain system discharges to tidally influenced receiving waters
S3	Redevelopment	15,824	y	Treated by 2 Bioretention (Area 3 & 5) BMPs in S3	n/a	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(c)- storm drain system discharges to tidally influenced receiving waters
S5	New Development	179,354	y	Treated by NRDs and Pond 1	n/a	Stormwater waiver for CPv	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(c)- storm drain system discharges to tidally influenced receiving waters
S7	Redevelopment	4,585	y	Treated by NRD and Pond 3	n	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(a)- POI discharges to tidally influenced receiving waters
S9	New Development	114	y	NRD and credits from FM 5	n	Stormwater waiver for CPV	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(a)- POI discharges to tidally influenced receiving waters
S10	Redevelopment	9,246	y	NRDs, SCA, and credits from FM 5	n/a	CPv not applicable for redevelopment	n	N/A	N/A	N/A	y	Section 3.3(B)(1)(a)- POI discharges to tidally influenced receiving waters

[1, 2, 3]- Not provided because quantity control is not required.

Table 96. Summary of Stormwater Requirements for the Stansbury Creek Watershed - Sponsor's Preferred Alternative (cont'd)

Drainage Area	Water Quality BMPs	ESD Volume Required (CF)	ESD Volume Provided (CF)	Excess ESD Volume (CF)	Shortage ESD Volume (CF)	Structural Volume Required (y/n)	Comment
S1	NRD- S1-1	699	717	18	0	n	
S2	Bioretention Area 5	3,665	0	0	-3,665	y	Two BMPs in S3 provide treatment for S2 and S3
S3	NRD- S3-1 thru NRD-S3-3 Bioretention Area 3 & 5	15,824	8,987	0	-6,837	y	
S5	NRD- S5-1 thru NRD-S5-17 and Pond 1	179,354	44,859	0	-134,495	n	Use capacity from existing Pond 1 to treat impervious area not treated by NRDs
S7	NRD- S7-1 and Pond 3	4,585	3,542	0	-1,043	n	Use capacity from existing Pond 3 to treat 0.34 acres of impervious area
S9	NRD- S9-1	114	71	0	-43	n	Use credits from FM 5 because Stansbury Creek is in the same 6-digit MD watershed
S10	NRD-S10-1 thru NRD-S10-4; SCA S10-1	9,246	5,719	0	-3,527	n	Use credits from FM 5 because Stansbury Creek is in the same 6-digit MD watershed
	Subtotal	**213,487**	**63,895**	**18**	**-149,610**		
	Adjustment						Structural BMPs required because ESD BMPs did not meet requirements
	Total	**213,487**	**62,783**	**18**			

Drainage Area	Phosphorus Load Reduction					
	Phosphorus Load Reduction Required (y/n)	Pre-development Load (lbs/yr)	Post-development Load (lbs/yr)	Pollutant Removal Requirement (lbs/yr)[1]	Load Reduction Met (y/n)	Comment
S1	y	1.6	1.3	0.1	y	Treatment met through NRD
S2	y	0.3	1.4	1.1	n	Treatment partially met through Bioretention Area 5; MAA to coordinate with CBCA to meet remaining requirements
S3	y	3.7	7.4	4.1	n	Treatment met through Bioretention Areas 3 and 5
S5	y	1.6	2.2	0.8	y	Treatment met through NRDs
S7	n	0	0	0	0	Requirement met
S9	y	0	0	0	y	Requirement met
S10	y	7.6	8.7	1.9	n	Treatment partially met through NRD and SCA sheet flow to conservation area; MAA to coordinate with CBCA to meet remaining requirements

[1] Pollutant Removal Requirement= (Post-development Load) – (.9*Pre-development Load)