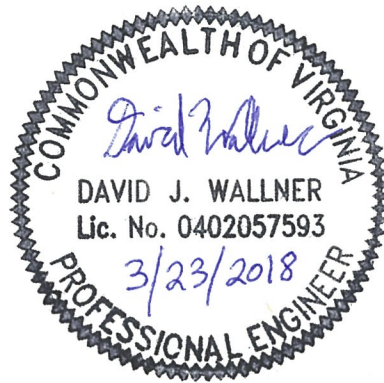


By virtue of this seal and signature, all supporting documents included in this package are accurate and support the design presented herein.





SPREAD 10 SWM NARRATIVE

I. PROJECT DESCRIPTION

The Project will extend from the existing Equitrans, L.P transmission system and other natural gas facilities in Wetzel County, West Virginia to TRANSCONTINENTAL GAS PIPE LINE COMPANY, LLC'S ZONE 5 COMPRESSOR STATION 165 IN PITTSYLVANIA COUNTY, VIRGINIA. IN ADDITION, THE PROJECT WILL INCLUDE APPROXIMATELY 171,600 HORSEPOWER OF COMPRESSION AT THREE COMPRESSOR STATIONS CURRENTLY PLANNED ALONG THE ROUTE, AS WELL AS MEASUREMENT, REGULATION, AND OTHER ANCILLARY FACILITIES REQUIRED FOR THE SAFE AND RELIABLE OPERATION OF THE PIPELINE. THE PIPELINE IS DESIGNED TO TRANSPORT UP TO 2.0 MILLION DEKATHERMS PER DAY OF NATURAL GAS.

II. TYPICAL PIPELINE CORRIDOR POST-DEVELOPMENT CONDITION

THE TYPICAL 125-FOOT WIDE PIPELINE CONSTRUCTION CORRIDOR WITHIN THE SITE AREA WILL BE RESTORED FOLLOWING CONSTRUCTION IN THE MANNER DESCRIBED BELOW. REFER TO THE *SECTION 4.1 POST-DEVELOPMENT CONDITION* OF THE PSS&S FOR ADDITIONAL INFORMATION. THE TOTAL SPREAD 10 LOD IS 505.4

**FIGURE 1** BELOW SHOWS THE TYPICAL PIPELINE CORRIDOR.

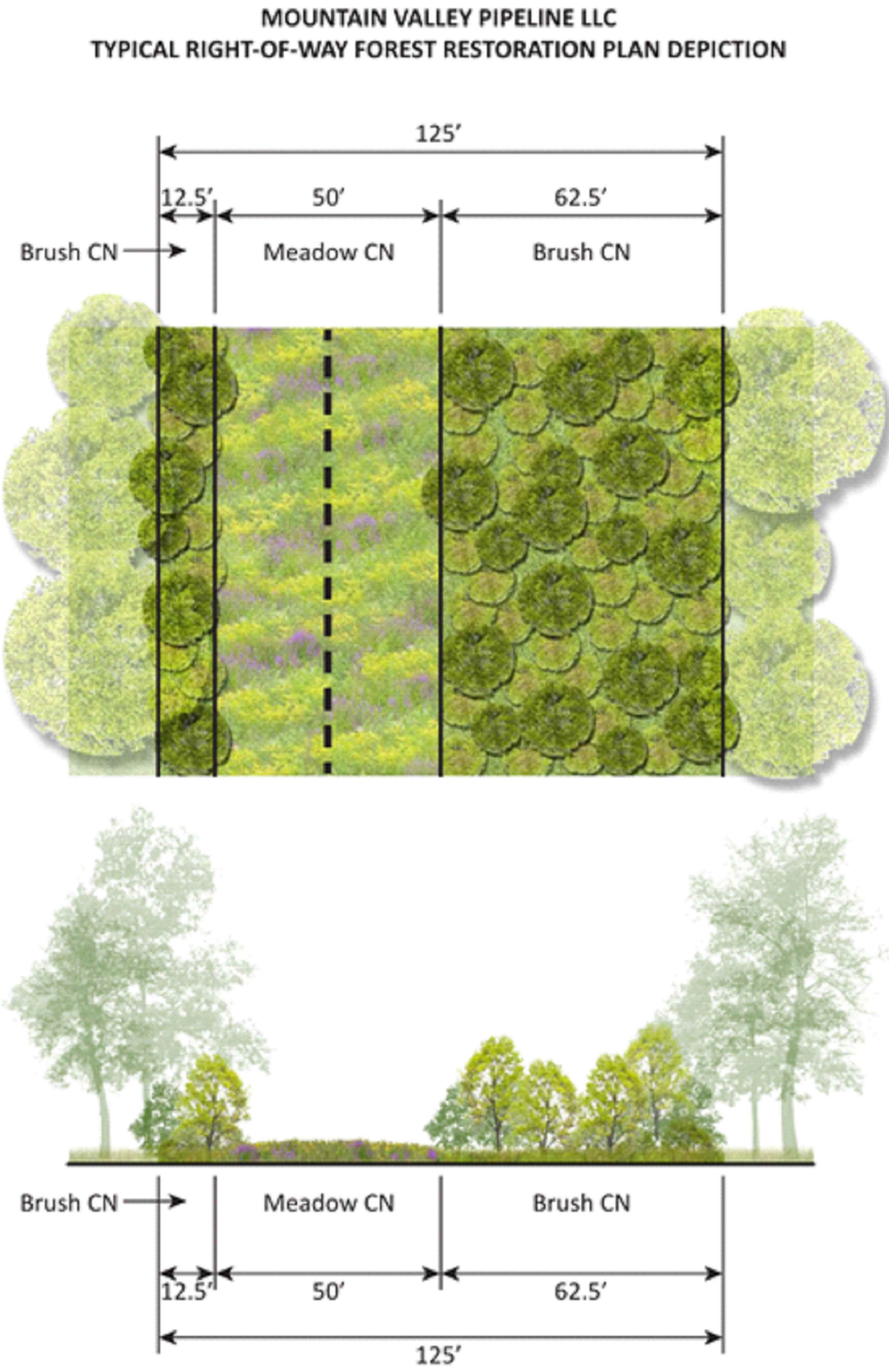
A. 75-FOOT TEMPORARY CONSTRUCTION ROW WILL BE RESTORED TO PRE-DEVELOPMENT CONDITIONS.

- IF FORESTED, POST-DEVELOPMENT CONDITION WILL BE BRUSH (SEEDED WITH HERBACEOUS AND WOODY SPECIES PER *SECTION 2.9.2 PERMANENT SEEDING AND MVP-ES11* OF THE PSS&S) AND ALLOWED TO NATURALLY RETURN TO FOREST CONDITION SUBJECT TO LANDOWNER ACTIONS.
- IF AGRICULTURAL LAND, POST-DEVELOPMENT CONDITION WILL RETURN THE TEMPORARY ROW TO AGRICULTURAL USE AND WILL BE MODELED AS SUCH IN THE STORMWATER CALCULATIONS.
- IF PRE-DEVELOPMENT CONDITIONS INCLUDED ANY IMPERVIOUS COVER, SUCH AS ASPHALT OR GRAVEL ACCESS ROADS, THESE IMPERVIOUS SURFACES WILL REMAIN AND/OR BE RESTORED IN THE POST-DEVELOPMENT CONDITION.
- OTHER PRE-DEVELOPMENT CONDITIONS SUCH AS MEADOW, WETLAND, LAWN, ETC. WILL BE RESTORED TO PRE-DEVELOPMENT CONDITIONS AND WILL BE MODELED AS SUCH IN THE STORMWATER CALCULATIONS.
- NOTE: WHERE APPLICABLE FOR WATER QUANTITY PURPOSES, THE ENTIRE LIMITS OF DISTURBANCE (LOD), INCLUDING BOTH THE TEMPORARY AND PERMANENT ROW, WILL BE ANALYZED.

B. 50-FOOT PERMANENT ROW WILL BE SEEDED AND RESTORED TO MEADOW CONDITIONS IF THE PRE-DEVELOPMENT LAND USE IS NOT AGRICULTURAL. THE FOLLOWING PRACTICES WILL APPLY:

- MOWING AND GENERAL MAINTENANCE WILL BE CONSISTENT WITH THE "FOREST & OPEN SPACE" PRACTICES LISTED IN THE VIRGINIA RUNOFF REDUCTION METHOD (VRRM) COMPLIANCE SPREADSHEET USER'S GUIDE & DOCUMENTATION (APRIL 2016), TABLE 1. *LAND COVER GUIDANCE FOR VRRM COMPLIANCE SPREADSHEETS*.
- THE FULL WIDTH PERMANENT ROW WILL NOT BE MOWED ANY MORE FREQUENTLY THAN ONCE EVERY THREE (3) YEARS.
- A CORRIDOR NOT EXCEEDING 10 FEET IN WIDTH LOCATED DIRECTLY OVER THE PIPELINE WILL BE MOWED ANNUALLY FOR INSPECTION PURPOSES IN ACCORDANCE WITH FEDERAL ENERGY REGULATORY COMMISSION (FERC) PLAN AND PROCEDURES.
- NOTE: WHERE APPLICABLE FOR WATER QUANTITY PURPOSES, ONLY THE PERMANENT ROW WILL BE ANALYZED.

FIGURE 1. TYPICAL RIGHT-OF-WAY FOREST RESTORATION PLAN DEPICTION



III. PROJECT STORMWATER METHODOLOGY

III. PROJECT STORMWATER METHODOLOGY

THE MOUNTAIN VALLEY PIPELINE PROJECT (PROJECT) TRAVERSES AGRICULTURAL AND FORESTED LANDS ALONG ITS 106-MILE ROUTE FROM GILES TO PITTSYLVANIA COUNTY. THE PROJECT WILL MEET ALL VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ) REQUIREMENTS AS DETAILED IN THIS AND ADDITIONAL REFERENCE DOCUMENTS. RUNOFF CONDITIONS ARE NOT DEGRADED AND WATER QUALITY REQUIREMENTS ARE MET OR EXCEEDED. WHERE WATER BARS SPACED PER *M.V.P. 17.2 SLOPE BREAKER/RIGHT-OF-WAY DIVERSION/WATERBAR* ARE INSTITUTED TO SLOW WATER FLOWS, END TREATMENTS HAVE BEEN DESIGNED TO FURTHER ASSURE THAT SHEET FLOW CONDITIONS AND NON-EROSIVE VELOCITIES ARE MAINTAINED. LAND USE CHANGES FROM PRE- TO POST-CONSTRUCTION ARE CATEGORIZED BELOW, ALONG WITH DISCUSSION ON HOW STORMWATER MANAGEMENT REQUIREMENTS WILL BE SATISFIED PER LAND USE CATEGORY.

INFORMATION FROM THE VGIN LAND COVER DATASET AND TRANSPORTATION DATA FROM VITA MAP LAYER 2016 WERE USED FOR LAND USE. THIS MAY BE SUPERSEDED IF FIELD SURVEY IS PRESENT (E.G. EXISTING GRAVEL ROADS). SEE PSS&S *APPENDIX D SECTION 1.2.3.3 CURVE NUMBER* FOR ADDITIONAL INFORMATION.

A. PRIOR DEVELOPED LANDS

PORTIONS OF PIPELINE EASEMENTS WHICH TRAVERSE PRIOR DEVELOPED LANDS (E.G. ACCESS ROADS, AGRICULTURAL AREAS, PASTURE, ETC.), WILL BE RESTORED TO EXISTING PREDEVELOPMENT CONDITIONS WITH NO IMPROVEMENTS. PER GUIDANCE MEMO NO. 15-2003 *POSTDEVELOPMENT STORMWATER MANAGEMENT IMPLEMENTATION GUIDANCE FOR LINEAR UTILITY PROJECTS*, PREPARATION AND IMPLEMENTATION OF STORMWATER MANAGEMENT CALCULATIONS IS UNNECESSARY FOR THESE AREAS. DEQ HAS CLARIFIED THAT IT IS NOT THEIR EXPECTATION THAT PERMANENT BEST MANAGEMENT PRACTICES (BMPs) BE INSTALLED ON RESTORED ROW.

AREAS WHERE PREDEVELOPMENT LAND COVER CONDITIONS WILL BE ALTERED AND MVP WILL COMPLY WITH POST-CONSTRUCTION STORMWATER QUALITY AND QUANTITY REQUIREMENTS, INCLUDING THE PREPARATION OF STORMWATER MANAGEMENT CALCULATIONS AND A STORMWATER MANAGEMENT PLAN PER 9VAC25-870 AND 9VAC25-880. IN SUCH INSTANCES, THE OUTFALL WITHIN THE PROJECT MUST COMPLY WITH PART IIB OF THE STORMWATER REGULATIONS, THEREBY ADDRESSING WATER QUANTITY CRITERIA FOR CHANNEL AND FLOOD PROTECTION.

B. PRE-CONSTRUCTION AGRICULTURAL LANDS

PRE-CONSTRUCTION AGRICULTURAL AREAS/FIELDS WILL BE RETURNED TO CROP PRODUCTION, PASTURE, MEADOW, HAY FIELDS, ETC., IN IDENTICAL CONDITION (I.E. WITH TOPSOIL STOCKED, RESPREADS, DISKED AND SEEDED), UPON COMPLETION OF PIPELINE CONSTRUCTION. AGRICULTURAL AREAS ARE THEREFORE EXEMPT FROM MEETING THE VIRGINIA WATER QUALITY (9VAC25-870-63) AND WATER QUANTITY (9VAC25-870-66) REQUIREMENTS PER § 62.1-44.15:34 AND 9VAC25-870-300.

C. PRE-CONSTRUCTION NON-AGRICULTURAL LANDS WITH NO IMPERVIOUS COVER

i. WATER QUALITY

PRE-CONSTRUCTION NON-AGRICULTURAL AND FORESTED AREAS WILL SATISFY VIRGINIA WATER QUALITY NEW DEVELOPMENT REQUIREMENTS PER THE MOST RECENT VERSION OF VIRGINIA'S 6TH ORDER NATIONAL WATERSHED BOUNDARY DATASET VIA THE VIRGINIA RUNOFF REDUCTION METHOD (9VAC25-870-63.A.1 AND 9VAC25-870-65.A, RESPECTIVELY).

UNDER NORMAL OPERATING CONDITIONS, THE POST CONSTRUCTION PERMANENT RIGHT-OF-WAY (ROW) WILL BE CONSIDERED "FOREST/OPEN SPACE" LAND COVER FOR VRRM WATER QUALITY CALCULATIONS PER *SECTION 4.3 STORMWATER QUALITY CALCULATIONS OF THE PROJECT SPECIFIC STANDARDS AND SPECIFICATIONS FOR VIRGINIA (PSS&S)*. AS SUCH, THE ROW PHOSPHORUS LOADING WILL ALWAYS BE LESS THAN THE 0.41 POUNDS PER ACRE PER YEAR MAXIMUM FOR NEW DEVELOPMENT, AS SHOWN IN THE FOLLOWING TABLE:

COVER TYPE	A SOILS	B SOILS	C SOILS	D SOILS	/AC/YR *
FOREST/OPEN SPACE	0.05	0.07	0.09	0.11	

\*BASED ON THE FOLLOWING DEFAULT VRRM VALUES:  
ANNUAL RAINFALL FOR THE STATE OF VIRGINIA = 43 INCHES  
TARGET RAINFALL EVENT = 1 INCH  
TOTAL PHOSPHORUS EVENT MEAN CONCENTRATION = 0.26 MG/L

THEREFORE, **NO PHOSPHORUS REDUCTION IS REQUIRED.**

ii. WATER QUANTITY: CONCENTRATED FLOW

PRE-CONSTRUCTION NON-AGRICULTURAL AND FORESTED AREAS RESULTING IN CONCENTRATED FLOW WILL SATISFY VIRGINIA WATER QUANTITY CHANNEL AND FLOOD PROTECTION REQUIREMENTS (9VAC25-870-66.B.3.A AND 9VAC25-870-66.C.2.B, RESPECTIVELY). BOTH CHANNEL AND FLOOD PROTECTION REQUIREMENTS COMPARE RUNOFF VOLUMES AND PEAK FLOWS FROM PRE- TO POST-CONSTRUCTION CONDITION. THESE VALUES ARE BASED ON CURVE NUMBERS ASSOCIATED WITH LAND USE. THE PROJECT WILL ALWAYS RESULT IN LOWER POST-DEVELOPMENT CURVE NUMBERS IN PRE-CONSTRUCTION NON-AGRICULTURAL AREAS WITH NO IMPERVIOUS COVER.

THE RESTORED ROW WILL BE A BRUSH/MEADOW COMBINATION AND, THEREFORE, RESULT IN A *LOWER* CN THAN THAT FOR "WOODS, GOOD" CONDITION FOR ALL HYDROLOGIC SOIL GROUPS (HSG'S), WITH THE EXCEPTION OF "A" SOILS WHERE IT WILL BE EQUIVALENT, AS EXPLAINED IN *SECTION 4.2.2 CURVE NUMBERS* OF THE PSS&S AND DEPICTED IN THE FOLLOWING TABLE:

TR-55 RUNOFF CURVE NUMBERS

COVER TYPE	A SOILS	B SOILS	C SOILS	D SOILS
WOODS, GOOD	30	55	70	77
PIPELINE, 125-FT RIGHT-OF-WAY*	30	52	67	75

\*THESE ARE WEIGHTED CURVE NUMBERS BASED ON 50-FEET OF MEADOW AND 75-FEET OF BRUSH CONDITIONS OF THE SAME HSG SOILS WITHIN THE RESTORED ROW PER *SECTION II. TYPICAL PIPELINE CORRIDOR POST-DEVELOPMENT CONDITION*.

CHANNEL PROTECTION REQUIREMENTS CAN BE SATISFIED USING THE ENERGY BALANCE METHOD PER 9VAC25-870-66.B.3.A. THE ENERGY BALANCE METHOD IS INTENDED FOR POST-DEVELOPMENT RUNOFF TO MIMIC FORESTED CONDITIONS, AND STATES THE FOLLOWING:

UNDER NO CONDITION SHALL ...  $Q_{Developed}$  BE REQUIRED TO BE LESS THAN THAT CALCULATED IN THE

EQUATION  $(Q_{Forest} * RV_{Forest})/RV_{Developed}$ ; WHERE

$Q_{Developed}$  = THE ALLOWABLE PEAK FLOW RATE OF RUNOFF FROM THE DEVELOPED SITE.

$RV_{Developed}$  = THE VOLUME OF RUNOFF FROM THE SITE IN THE DEVELOPED CONDITION.

$Q_{Forest}$  = THE PEAK FLOW RATE OF RUNOFF FROM THE SITE IN A FORESTED CONDITION.

$RV_{Forest}$  = THE VOLUME OF RUNOFF FROM THE SITE IN A FORESTED CONDITION;

FLOOD PROTECTION REQUIREMENTS CAN BE SATISFIED USING 9VAC25-870-66.C.2.B. THE MVP PROJECT IS ASSUMING A WORST-CASE SCENARIO IN WHICH LOCALIZED FLOODING CURRENTLY OCCURS DURING THE 10-YEAR 24-HOUR STORM EVENT. THEREFORE, THE POST-DEVELOPMENT PEAK FLOW RATE FOR THE 10-YEAR 24-HOUR STORM EVENT MUST BE "LESS THAN THE PRE-DEVELOPMENT PEAK FLOW RATE".

BECAUSE THE POST-CONSTRUCTION ROW ALWAYS RESULTS IN A CN LESS THAN OR EQUAL TO THAT OF WOODS, AND TIME OF CONCENTRATION WILL NEVER DECREASE DUE TO POSSIBLE RETENTION BEHIND THE WATER BAR END TREATMENTS, PEAK FLOWS WILL NEVER EXCEED THOSE OF FORESTED CONDITIONS. THEREFORE, THE ENERGY BALANCE METHOD REQUIREMENTS ARE AUTOMATICALLY SATISFIED, AND CHANNEL PROTECTION REQUIREMENTS ARE MET. ADDITIONALLY, BASED ON CN REDUCTION FROM PRE- TO POST-CONSTRUCTION CONDITIONS, 10-YEAR 24-HOUR STORM VOLUMES WILL ALSO ALWAYS BE REDUCED, THEREBY SATISFYING FLOOD PROTECTION REQUIREMENTS.

D. POST-CONSTRUCTION NEW IMPERVIOUS COVER

NEW IMPERVIOUS COVER MAY INCLUDE ACCESS ROADS AND MAIN LINE VALVE PAD SITES. STORMWATER ANALYSIS AND BMP DESIGNS WILL BE PERFORMED FOR ALL PROJECT SITE AREAS WITH NEW IMPERVIOUS COVER TO ENSURE THAT THE FOLLOWING VIRGINIA STATE REGULATIONS HAVE BEEN SATISFIED:  
WATER QUALITY (9VAC25-870-63)

WATER QUANTITY (9VAC25-870-66)  
OFFSITE COMPLIANCE OPTIONS (9VAC25-870-69)

i. WATER QUALITY

AREAS WITH NEW IMPERVIOUS COVER IN THE POST-CONSTRUCTION PERMANENT CONDITION WILL SATISFY VIRGINIA WATER QUALITY REQUIREMENTS VIA ONE OF TWO WAYS. FIRST, PRE-CONSTRUCTION NON-AGRICULTURAL AREAS WILL RESULT IN LOW PHOSPHORUS LOADING (SEE *III.C.1* ABOVE). THESE LOW LOADING AREAS WILL OFFSET HIGHER LOADING FROM NEW IMPERVIOUS COVER, RESULTING IN A BALANCE OR LOAD REDUCTION OVER EACH 6TH ORDER, OR HYDROLOGIC UNIT CODE (HUC) 12, BOUNDARY. ALTERNATIVELY, IF PHOSPHORUS LOAD REDUCTIONS ARE REQUIRED FOR INDIVIDUAL LOCATIONS, WATER QUALITY REQUIREMENTS COULD BE MET VIA OFFSITE COMPLIANCE OPTIONS (9VAC25-870-69) OR ONSITE BMPs.

ii. WATER QUANTITY

AREAS WITH NEW IMPERVIOUS COVER IN THE POST-CONSTRUCTION CONDITION WILL SATISFY VIRGINIA WATER QUANTITY REQUIREMENTS VIA APPROPRIATE STORMWATER MANAGEMENT CONTROLS. THESE CONTROLS MAY INCLUDE BMPs DESIGNED IN ACCORDANCE WITH THE VIRGINIA STORMWATER BMP CLEARINGHOUSE (9VAC25-870-65.B), BMPs REFERENCED IN THE PSS&S, PHYSICAL SPREADING OF RUNOFF INTO SHEET FLOW VIA WATER BAR END TREATMENTS (SEE *I.D* BELOW), LEVEL SPREADERS, OTHER SPECIFIC WATER QUANTITY CONTROL MEASURES, OR A COMBINATION THEREOF.

E. SHEET FLOW

WATER QUANTITY REGULATIONS FOR ANY ROW LAND USE CAN BE SATISFIED VIA SHEET FLOW CONDITIONS (9VAC25-870-66.D). THERE ARE TWO INSTANCES WHERE RUNOFF WILL BE IN THE FORM OF SHEET FLOW. THE FIRST IS IN AREAS WHERE RUNOFF LEAVES THE SITE ROW AS SHEET FLOW IN EXISTING CONDITIONS, DOES NOT RE-CONCENTRATE WITHIN 100 FEET DOWNSTREAM, AND THE PROPOSED CONDITION WILL MAINTAIN EXISTING SHEET FLOW. THE SECOND IS WHERE RUNOFF DIVERTED BY WATER BARS INSTALLED PER *M.V.P. 17 SLOPE BREAKER/RIGHT-OF-WAY DIVERSION/WATERBAR* WILL BE REDISTRIBUTED AS SHEET FLOW VIA WATER BAR END TREATMENTS.

i. PROJECT LIMITS

IN A SIMILAR MANNER TO THE CONCENTRATED FLOW SCENARIOS DESCRIBED ABOVE, THE CN'S IN THE POST-CONSTRUCTION CONDITION WILL BE LESS THAN OR EQUAL TO THE PRE-CONSTRUCTION CONDITION. IN AREAS OF SHEET FLOW WHERE NO WATER BARS ARE PRESENT IN THE POST-CONSTRUCTION CONDITION, EXISTING GRADES WILL BE RE-ESTABLISHED TO ENSURE SHEET FLOW IN THE POST-CONSTRUCTION CONDITION. THEREFORE, SHEET FLOW VOLUMES WILL NEVER INCREASE, THERE WILL BE NO DOWNSTREAM IMPACTS, AND "NO FURTHER QUANTITY CONTROLS ARE REQUIRED" PER *9VAC25-870-66.D*.

ADDITIONAL INFORMATION ON SHEET FLOW, INCLUDING CALCULATIONS FOR NON-EROSIVE VELOCITIES, IS AVAILABLE IN *SECTION 4.4.5 SHEETFLOW* AND *APPENDIX D SECTION 1.2.2 SHEET FLOW* OF THE PSS&S.

ii. WATER BARS

*M.V.P. 17.3 WATER BAR END TREATMENT SIZING* DETAILS THE METHODOLOGY FOR ENSURING SHEET FLOW FROM WATER BARS THROUGHOUT THE PROJECT IS ACHIEVED. TO SUMMARIZE, RATIONAL METHOD CALCULATIONS, INCLUDING THE USE OF PITTSYLVANIA COUNTY PRECIPITATION DATA AS A WORST-CASE SCENARIO (I.E. ALL OTHER PROJECT AREAS HAVE LOWER RAINFALL LEVELS), DEMONSTRATE NON-EROSIVE VELOCITIES AND 0.1-FOOT DEPTH ACROSS THE END TREATMENT WEIRS. FOR EASE OF CONSTRUCTION, THE LEVEL WEIR SECTIONS OF THE END TREATMENTS ARE CONSERVATIVELY SIZED TO THREE STANDARD LENGTHS BASED ON DRAINAGE AREA INSPECTION:

WATER BAR END TREATMENT LEVEL WEIR SECTION LENGTHS	
D.A. (AC)	LENGTH (FT)
≤0.5	10
0.5 ≤1.0	15
1.0 ≤1.5	20
> 1.5*	SITE SPECIFIC

\*OR CURVE NUMBERS > 71

WATER BAR SPACING IS BASED ON SLOPE AS SHOWN IN *M.V.P. 17.2 SLOPE BREAKER/RIGHT-OF-WAY DIVERSION/WATERBAR*, REPRODUCED HERE:

RECOMMENDED MAXIMUM SPACING FOR PERMANENT SLOPE BREAKERS	
PIPELINE GRADE	DISTANCE (FEET)
<2%	N/A
2-5%	400
6-15%	200
16-30%	100
>31%	50

MAXIMUM WATER BAR SPACING OF 400 FT WITH A 50 FT PERMANENT ROW RESULTS IN A DRAINAGE AREA OF 20,000 SF (0.46 ACRE) PER WATER BAR. THEREFORE, WATER BARS LOCATED IN SERIES, PERPENDICULAR TO SLOPE WILL ALWAYS HAVE DRAINAGE AREAS LESS THAN 0.5 ACRES AND WILL BE ASSIGNED THE 10-FT WATER BAR END TREATMENT.

RATHER THAN PERFORMING A DETAILED MEASUREMENT OF EACH WATER BAR DRAINAGE AREA, THE PROPOSED METHODOLOGY IS TO SELECT THE 10-FOOT WATER BAR END TREATMENT FOR ALL WATER BARS LOCATED IN SERIES, PERPENDICULAR TO SLOPE.

DRAINAGE AREAS FOR WATER BARS AT THE TOP AND BOTTOM OF ANY SERIES, AS WELL AS ANY WATER BARS NOT IN SERIES OR ON CROSS-SLOPES, WILL BE DELINEATED TO DETERMINE DRAINAGE AREA SIZE, CN, AND APPROPRIATE WATER BAR END TREATMENT LENGTH.

THIS PROCESS SHOULD YIELD REPEATABLE, CONSERVATIVE RESULTS IN TERMS OF SELECTING END TREATMENT LENGTHS. FOR LARGER WATERSHEDS OR ON CROSS-SLOPES, SITE SPECIFIC ANALYSES WILL BE PERFORMED TO DETERMINE IF A MAXIMUM 20-FT END TREATMENT LENGTH WILL SUFFICE, AN ADDITIONAL WATER BAR IS NEEDED TO REDUCE THE DRAINAGE AREA, OR IF A SITE-SPECIFIC DESIGN IS REQUIRED.

IN A SIMILAR MANNER TO THE CONCENTRATED FLOW SCENARIOS DESCRIBED ABOVE, THE CN'S IN THE POST-CONSTRUCTION CONDITION WILL BE LESS THAN OR EQUAL TO THE PRE-CONSTRUCTION CONDITION. HOWEVER, BECAUSE THE DRAINAGE AREA TO THE WATER BAR END TREATMENT IS SLIGHTLY LARGER IN POST-CONSTRUCTION THAN IN PRE-CONSTRUCTION CONDITION, SHEET FLOW VOLUMES AT THE END OF THE WATER BAR DO INCREASE. HOWEVER, CUMULATIVELY THE WATERSHED SHEET FLOW VOLUMES DO NOT INCREASE BECAUSE THE POST-CONSTRUCTION CNS ARE LESS THAN OR EQUAL TO THE PRE-CONSTRUCTION CNS OF THE WATERSHED. ADDITIONALLY, WATER BAR END TREATMENTS ARE DESIGNED TO ENSURE SHEET FLOW AND NON-EROSIVE VELOCITIES, RESULTING IN NO IMPACTS TO DOWN-GRADIENT PROPERTIES. THEREFORE, THE CONDITIONS OF 9VAC25-870-66.D ARE SATISFIED AND "NO FURTHER QUANTITY CONTROLS ARE REQUIRED."

F. PRE-CONSTRUCTION ROCK OUTCROPPINGS

DURING PLANNING OF THE PROJECT, MVP ROUTE SURVEY AND DEVELOPMENT SPECIFICALLY AVOIDED CONSTRUCTION CONSTRAINTS LIKE ROCK OUTCROPS BECAUSE OF THE SIGNIFICANT DIFFICULTIES ASSOCIATED WITH CONSTRUCTING IN THESE TYPES OF AREAS. IF ANY ROCK OUTCROPS ARE PRESENT THEY WILL CONSIST OF MINOR AREAS THAT REPRESENT A SMALL AMOUNT OF THE AREA OF DISTURBANCE AND WILL, THEREFORE, NOT AFFECT STORMWATER MANAGEMENT CALCULATIONS.

PRE-CONSTRUCTION CURVE NUMBERS ARE BASED ON OVERALL LAND USE. EXISTING ROCK OUTCROPPINGS WOULD BE CATEGORIZED AS DISCONNECTED IMPERVIOUS COVER AND HAVE A NEGLIGIBLE EFFECT ON CURVE NUMBERS OF THE SURROUNDING AREA. DURING CONSTRUCTION, ROCK OUTCROPPINGS WITHIN THE PERMANENT ROW WILL BE BLASTED IN TRENCHING ACTIVITIES. BLASTING WILL CONVERT LARGE SINGLE PIECES OF IMPERVIOUS ROCK TO SMALL-SIZED (LESS THAN 6-INCH DIAMETER) ROCK PIECES MIXED WITH NATIVE SOIL, RESULTING IN A POST-CONSTRUCTION INCREASE IN INFILTRATION RATE AND A RESULTING CURVE NUMBER REDUCTION. POST-CONSTRUCTION CURVE NUMBERS ARE CONSERVATIVE BECAUSE THEY DO NOT INCLUDE THIS IMPROVED INFILTRATION.



G. KARST FEATURES

MVP'S KARST HAZARDS ASSESSMENT (KHA) AND KARST MITIGATION PLAN (KMP) ARE CONSISTENT WITH APPLICABLE SECTIONS OF THE VIRGINIA DEPARTMENT OF CONSERVATION AND RECREATION (DCR) TECHNICAL BULLETIN NO. 2, HYDROLOGIC MODELING AND DESIGN IN KARST GUIDANCE. THE TECHNICAL BULLETIN IS INTENDED TO GUIDE LARGE-SCALE, LONG-DURATION DEVELOPMENT PROJECTS IN KARST TERRAIN, WHILE THE MVP PROJECT CONSTITUTES A SHALLOW, LINEAR SHORT-TERM CONSTRUCTION PROJECT WITH STRICT ENVIRONMENTAL CONTROLS AND LAND RECLAMATION TO PRE-CONSTRUCTION CONDITIONS.

THE KHA WAS INITIALLY PREPARED AS PART OF THE FERC ENVIRONMENTAL REPORT (RESOURCE REPORT #6 GEOLOGICAL RESOURCES), WITH THE MOST RECENT UPDATE SUBMITTED TO THE FERC IN FEBRUARY 2017. THE KHA INVOLVED DETAILED DESKTOP REVIEW OF PUBLIC AND PROPRIETARY DATA TO IDENTIFY KARST FEATURES, WITH FIELD VERIFICATION TO CONFIRM AND ENHANCE THE DESKTOP REVIEW. THIS IS CONSISTENT WITH THE KARST INVESTIGATION CRITERIA PRESENTED IN THE DCR TECHNICAL BULLETIN NO. 2. MVP CONSIDERED THE RESULTS OF THE KHA AND IMPLEMENTED HUNDREDS OF ALIGNMENT ADJUSTMENTS TO AVOID SENSITIVE KARST FEATURES. MVP COMPLETED FIELD VERIFICATION ON ALL PARCELS ALONG THE CURRENT MVP ROUTE (CERTAIN PROPERTY OWNERS HAD PREVIOUSLY DENIED ACCESS TO ALL MVP SURVEYORS), AND MVP WILL UPDATE THE KHA FOR SUBMITTAL TO THE FERC PRIOR TO INITIATING LAND DISTURBANCE.

THE KMP WAS MOST RECENTLY UPDATED IN OCTOBER 2017 TO INCORPORATE FERC ENVIRONMENTAL CONDITIONS (IMPLEMENTATION PLAN #21). THE KHA WAS ALSO INCORPORATED IN THE PSS&S, WHICH IS REVIEWED BY THE DEQ ON AN ANNUAL BASIS. MVP RECEIVED APPROVAL ON THE PSS&S ON JUNE 20, 2017. THE KMP REQUIRES THAT MVP KARST SPECIALIST INSPECTORS BE ON-SITE DURING ALL PHASES OF LAND DISTURBING ACTIVITIES IN KARST TERRAIN. IN ADDITION, THE KMP REQUIRES THE KARST SPECIALISTS TO CONDUCT A FIELD REVIEW OF THE KARST AREAS FOLLOWING TREE FELLING ACTIVITIES TO VERIFY THAT NO KARST FEATURES WERE OVERLOOKED. THE KMP INCLUDES INSPECTION PROTOCOLS FOR NEWLY IDENTIFIED KARST FEATURES (IF ANY ARE FOUND DURING TREE FELLING ACTIVITIES OR LAND DISTURBANCE), OUTREACH INSTRUCTIONS FOR THE DCR KARST PROTECTION COORDINATOR, EROSION AND SEDIMENT CONTROL AND STORMWATER MANAGEMENT BEST MANAGEMENT PRACTICES, AS WELL AS AVOIDANCE AND MITIGATION STRATEGIES FOR KARST FEATURES. IN SUMMARY, THE KMP IS CONSISTENT WITH APPLICABLE GUIDANCE IN THE DCR TECHNICAL BULLETIN NO. 2 FOR KARST EVALUATIONS DURING CONSTRUCTION, EROSION AND SEDIMENT CONTROL, AND STORMWATER MANAGEMENT.

DURING PLANNING OF THE PROJECT, MVP ROUTE SURVEY AND DEVELOPMENT SPECIFICALLY AVOIDED CONSTRUCTION CONSTRAINTS INVOLVING SENSITIVE KARST FEATURES, BASED ON THE RESULTS OF THE KHA, BECAUSE OF THE POTENTIAL DIFFICULTIES ASSOCIATED WITH CONSTRUCTION IN THE VICINITY OF SENSITIVE KARST FEATURES. AS NOTED, MVP IMPLEMENTED SEVERAL MAJOR AND HUNDREDS OF MINOR ROUTE ADJUSTMENTS TO AVOID SENSITIVE KARST FEATURES TO THE EXTENT PRACTICAL, WITH THE CURRENT ALIGNMENT HAVING ONLY A MINIMAL NUMBER OF MINOR KARST FEATURES (E.G., SINKHOLES) AND SENSITIVE WATER RESOURCES THAT WERE IDENTIFIED IN THE KHA. BASED ON THE RECOMMENDATIONS OF THE MVP AND DCR'S ONSITE KARST SPECIALIST INSPECTORS, ADDITIONAL MINOR ALIGNMENT ADJUSTMENTS WITHIN THE CONFINES OF THE LOD MAY BE COORDINATED WITH MVP AND IMPLEMENTED TO AVOID REMAINING FEATURES TO THE EXTENT PRACTICAL. THE KMP INCLUDES STABILIZATION AND MITIGATION MEASURES RECOMMENDED FOR KARST FEATURES THAT CANNOT BE AVOIDED.

MVP PROVIDED THE KHA AND KMP TO THE DCR - KARST PROTECTION COORDINATOR FOR REVIEW, AND INCORPORATED RECOMMENDATIONS FROM THE AGENCY. MVP ALSO COLLABORATED WITH THE DCR - KARST PROTECTION COORDINATOR TO COMPLETE SUPPLEMENTAL KARST HYDROGEOLOGIC EVALUATIONS (INCLUDING DYE TRACE STUDIES) IN THE VICINITY OF THE PROPOSED ALIGNMENT, IN SPECIFICALLY-IDENTIFIED KARST AREAS, AS A CONTINGENCY PLANNING EFFORT.

THE KMP DIRECTS, BASED ON OBSERVATIONS OF THE KARST SPECIALIST INSPECTORS, ADDITIONAL AVOIDANCE OR MITIGATION THAT MAY BE NECESSARY IF ANY NEW KARST FEATURES ARE ENCOUNTERED DURING LAND DISTURBANCE. AS NOTED, THE KARST SPECIALIST INSPECTORS WILL BE ON-SITE DURING ALL PHASES OF LAND DISTURBANCE IN KARST TERRAIN, AND UPON INITIATED LAND CLEARING WILL INSPECT THE LOD FOR KARST FEATURES THAT MAY HAVE BEEN OBSCURED BY VEGETATION.

PER SECTION 4.0-5 OF THE KMP, THE INTENT OF ESC AND RELATED BMPS IS TO CONFINE PROJECT-RELATED DISTURBANCE TO THE LOD, PROTECT SENSITIVE KARST FEATURES, AND MINIMIZE EROSION AND ENHANCE REVEGETATION IN THOSE AREAS. IN ADDITION TO ESC BMPS FOR STANDARD PIPELINE CONSTRUCTION, WHICH INCLUDES SPECIFICATIONS BY REGULATORY AGENCIES, ADDITIONAL BMPS WILL BE IMPLEMENTED AS SPECIFIED BY THE KARST SPECIALIST.

IV. SPREAD 10 ANALYSIS

SPREAD 10 CONSISTS OF APPROXIMATELY 28.4 MILES OF 42" NATURAL GAS PIPELINE, CONSTRUCTED WITHIN MONTGOMERY, ROANOKE, AND FRANKLIN COUNTIES. THE SPREAD STARTS JUST SOUTH OF U.S. 11 (LEE HIGHWAY) AND ENDS JUST EAST OF STATE ROUTE 701 (FOGGY RIDGE RD).

EXISTING CONDITIONS WITHIN SPREAD 10 INCLUDE FORESTED LANDS, AGRICULTURAL LANDS, NON-AGRICULTURAL LANDS, AND PRIOR DEVELOPED LANDS. POST-CONSTRUCTION NEW IMPERVIOUS COVER IN SPREAD 10 INCLUDES MAIN LINE VALVE SITES AND CORRESPONDING ACCESS ROADS.

THE REMAINDER OF THIS NARRATIVE PROVIDES DETAILED INFORMATION ON HOW THE PROPOSED STORMWATER MANAGEMENT METHODOLOGY IS IN FULL COMPLIANCE WITH VSMP REQUIREMENTS THROUGH A DETAILED ANALYSIS OF SPREAD 10.

A. PRE-CONSTRUCTION FORESTED LANDS

PORTIONS OF SPREAD 10 ARE IN PRE-CONSTRUCTION FORESTED LANDS, WITH THE ONLY EXCEPTION BEING THE EXISTING ACCESS ROADS IN SOME AREAS. RUNOFF CN'S FOR THE MAIN LINE PIPELINE RUNNING THROUGH FORESTED LANDS WILL ALWAYS BE LESS THAN OR EQUAL TO A "WOODS, GOOD" CONDITION, ASSUMING THERE ARE NO NEW IMPERVIOUS SURFACES OR CHANGES TO PRIOR DEVELOPED LANDS PROPOSED IN THE DRAINAGE AREA. AS DEPICTED IN THE TABLE BELOW, THE RESTORED ROW WILL RESULT IN A LOWER CN THAN THAT FOR "WOODS, GOOD" CONDITION FOR ALL HYDROLOGIC SOIL GROUPS (HSG'S), WITH THE EXCEPTION OF "A" SOILS WHERE IT WILL BE EQUIVALENT. THE IMPLICATION OF THIS CN ANALYSIS WILL BE DISCUSSED IN MORE DETAIL BELOW.

TR-55 RUNOFF CURVE NUMBERS

Cover Type	A Soils	B Soils	C Soils	D Soils
Woods, Good	30	55	70	77
Pipeline, 125-ft Right-of-Way*	30	52	67	75

\*THESE ARE WEIGHTED CURVE NUMBERS BASED ON 50-FEET OF MEADOW AND 75-FEET OF BRUSH CONDITIONS OF THE SAME HSG SOILS WITHIN THE RESTORED ROW PER SECTION II. TYPICAL PIPELINE CORRIDOR POST-DEVELOPMENT CONDITION.

B. Prior Developed Lands

Portions of Spread 10 traverse prior developed lands including access roads and agricultural areas, which will be restored to existing predevelopment conditions with no improvements. Per Guidance Memo No. 15-2003 *Postdevelopment Stormwater Management Implementation Guidance for Linear Utility Projects*, preparation and implementation of stormwater management calculations is unnecessary for these areas.

The following is a complete list of existing access roads within Spread 10:

a. Existing Roads Used for Permanent Access

- i. MVP-MN-279.01
- ii. MVP-RO-283
- iv. MVP-RO-288
- v. MVP-FR-289
- vi. MVP-FR-290
- vii. MVP-FR-291
- viii. MVP-FR-292
- ix. MVP-FR-292.01
- x. MVP-FR-293.01
- xi. MVP-FR-293.02
- xii. MVP-FR-299
- xiii. MVP-FR-300
- xiv. MVP-FR-303.01

a. EXISTING ROADS USED FOR TEMPORARY ACCESS

- i. MVP-MN-278.01
- j. MVP-RO-279.01
- ii. MVP-RO-280
- iii. MVP-RO-281
- iv. MVP-RO-282
- v. MVP-RO-285
- vi. MVP-RO-286
- vii. MVP-RO-287
- viii. MVP-FR-294
- x. MVP-FR-295
- xi. MVP-FR-296
- xii. MVP-FR-302
- xiv. MVP-FR-305

C. POST-CONSTRUCTION NEW IMPERVIOUS COVER

NEW IMPERVIOUS COVER IN SPREAD 10 INCLUDES THREE (3) MAIN LINE VALVE SITES (MVP-MLV-28 THROUGH -30) AND THREE (3) CORRESPONDING ACCESS ROADS (MVP-MLV-AR-28 THROUGH -30). INCREASES IN TP LOADING WILL BALANCE OVER SPREAD 10 AS A WHOLE, DISCUSSED IN SECTION IV.D. WATER QUALITY IMMEDIATELY BELOW. INCREASES IN STORMWATER RUNOFF ASSOCIATED WITH THESE NEW IMPERVIOUS SURFACES HAS BEEN ACCOUNTED FOR THROUGH THE DETENTION OF STORMWATER WITHIN THE STONE MATRIX. THIS HAS BEEN ACCOMPLISHED WITH A SERIES OF STONE BAFFLES AND SUMP CONDITIONS, DESIGNED IN ACCORDANCE WITH MVP-33.1 THROUGH MVP-33.3 GAP GRADED GRAVEL DETAIL. THE RESULTING STORAGE ACCOMMODATES RUNOFF FROM THE 10-YR STORM AND THEREFORE COMPLIES WITH VIRGINIA STATE WATER QUANTITY REGULATIONS (9VAC25-870-66) AS DISCUSSED IN SECTIONS IV.E.II AND III BELOW.

D. WATER QUALITY

PER 9VAC25-870-63.A.1, SPREAD 10 IS CONSIDERED NEW DEVELOPMENT AND MUST NOT EXCEED A TOTAL PHOSPHORUS LOAD OF 0.41 POUNDS PER ACRE PER YEAR. SPREAD 10 CROSSES SIX (6) 6TH ORDER, OR HUC 12, BOUNDARIES: 030101010301, 030101010105, 030101010102, 030101010502, 03010101501, AND 030101010503. LAND USE TOTAL ACREAGE FOR EACH 6TH ORDER BOUNDARY RESULT AS FOLLOWS:

030101010301					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	92.902	21.000	2.660	5.001	60.293
Managed Turf	0.000	0.000	0.000	0.000	0
Ag Lands	0.000	0.000	0.000	0.000	0
Ex. Impervious Cover	2.202	1.732	0.668	1.000	5.652
New Impervious Cover	0.000	0.000	0.000	0.000	0
	94.466	22.732	3.328	6.001	65.945

030101010105					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0.090	11.758	0.000	0.000	11.848
Managed Turf	0.000	0.000	0.000	0.000	0
Ag Lands	0.000	0.000	0.000	0.000	0
Ex. Impervious Cover	0.004	0.891	0.000	1.734	2.599
New Impervious Cover	0.000	0.000	0.000	0.000	0
	0.124	12.589	0.000	1.734	14.447

030101010102					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	65.480	6.901	3.157	13.963	89.493
Managed Turf	0.000	0.000	0.000	0.000	0
Ag Lands	0.000	0.000	0.000	0.000	0
Ex. Impervious Cover	17.447	0.999	0.000	4.033	22.479
New Impervious Cover	0.000	0.000	0.000	0.000	0
	82.927	7.900	3.157	17.996	111.882

030101010502					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	13.226	11.999	0.000	0.000	25.185
Managed Turf	0.000	0.000	0.000	0.000	0
Ag Lands	0.000	0.000	0.000	0.000	0
Ex. Impervious Cover	2.334	5.158	0.000	0.000	7.492
New Impervious Cover	0.000	0.000	0.000	0.000	0
	15.560	17.157	0.000	0.000	30.677

030101010501					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	29.286	74.691	0.000	0.000	103.977
Managed Turf	0.000	0.000	0.000	0.000	0
Ag Lands	0.000	0.000	0.000	0.000	0
Ex. Impervious Cover	1.230	3.405	0.000	0.000	4.635
New Impervious Cover	0.000	0.001	0.000	0.000	0.001
	30.516	78.137	0.000	0.000	106.673

030101010503					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0.000	149.770	4.702	1.083	155.557
Managed Turf	0.000	0.000	0.000	0.000	0
Ag Lands	0.000	0.000	0.000	0.000	0
Ex. Impervious Cover	0.000	16.011	0.000	0.004	16.105
New Impervious Cover	0.000	0.075	0.000	0.000	0.075
	0.000	167.856	4.702	1.179	173.737

PER SECTIONS III.A AND III.B ABOVE, PRIOR DEVELOPED LANDS INCLUDING EXISTING IMPERVIOUS COVER RETURNED TO PRE-CONSTRUCTION CONDITIONS ARE EXEMPT FROM SWM CALCULATIONS AND HAVE BEEN REMOVED FROM THE VRRM AREA TOTALS. PHOSPHORUS LOADING FROM EXISTING IMPERVIOUS COVER AND AGRICULTURAL LANDS IS, THEREFORE, NOT APPLICABLE AS LISTED AS "N/A" IN THE TOTAL PHOSPHORUS LOADING PER 6TH ORDER HUC BELOW. VRRM SITE DATA TABS FOR EACH OF THE SIX SPREAD 10 6TH ORDER BOUNDARIES ARE ATTACHED.

FOR THE REMAINING AREAS, VRRM CALCULATIONS SHOW THAT THE LOW PHOSPHORUS LOADING IN THE PRE- AND POST-CONSTRUCTION NON-AGRICULTURAL AREAS OFFSET LOADING INCREASES FROM NEW IMPERVIOUS COVER, PER SECTION III.D.I. WATER QUALITY ABOVE. ADDITIONAL ANALYSIS INCLUDED CALCULATING LOADING BASED ON THE VARYING ANNUAL PRECIPITATION VALUES ALONG SPREAD 10 PER PSS&S SECTION 4.2.1 ANNUAL PRECIPITATION, AS OPPOSED TO THE DEFAULT 43-INCH ANNUAL PRECIPITATION VALUE USED IN THE VRRM SPREADSHEET.

030101010301					
Total Phosphorus Loading [lb/yr]					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	1.560	1.349	0.169	0.555	3.632
Managed Turf	0.000	0.000	0.000	0.000	0.000
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0.000	0.000	0.000	0.000	0.000
	1.560	1.349	0.169	0.555	3.632

030101010105					
Total Phosphorus Loading [lb/yr]					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0.004	0.748	0.000	0.000	0.753
Managed Turf	0.000	0.000	0.000	0.000	0.000
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0.000	0.000	0.000	0.000	0.000
	0.004	0.748	0.000	0.000	0.753

030101010102					
Total Phosphorus Loading [lb/yr]					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	3.283	0.516	0.316	1.763	5.878
Managed Turf	0.000	0.000	0.000	0.000	0.000
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0.000	0.000	0.000	0.000	0.000
	3.283	0.516	0.316	1.763	5.878

030101010502					
Total Phosphorus Loading [lb/yr]					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0.555	0.894	0.000	0.000	1.450
Managed Turf	0.000	0.000	0.000	0.000	0.000
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0.000	0.000	0.000	0.000	0.000
	0.555	0.894	0.000	0.000	1.450

030101010501					
Total Phosphorus Loading [lb/yr]					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	1.399	5.109	0.000	0.000	6.467
Managed Turf	0.000	0.000	0.000	0.000	0.000
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0.000	0.132	0.000	0.000	0.132
	1.399	5.241	0.000	0.000	6.600

030101010503					
Total Phosphorus Loading [lb/yr]					
Land Cover	A	B	C	D	Totals
Forest/Open Space (ROW)	0.000	10.832	0.454	0.127	11.413
Managed Turf	0.000	0.000	0.000	0.000	0.000
Ag Lands	N/A	N/A	N/A	N/A	N/A
Ex. Impervious Cover	N/A	N/A	N/A	N/A	N/A
New Impervious Cover	0.000	0.170	0.000	0.000	0.170
	0.000	11.002	0.454	0.127	11.553

This further analysis supported the conclusion that total phosphorus loading is less than the 0.41 lb TP/ac/yr maximum within each 6th order boundary.

Spread 10				
6th Order HUC 12	Total Area [ac]	TP Load Area <sup>1</sup> [ac]	TP Load [lb TP/yr]	TP Load <sup>2</sup> [lb TP/ac/yr]
Total ROW	505.36	444.40	29.90	0.07
030101010301 ROW	65.95	60.29	3.63	0.06
030101010105 ROW	14.45	11.85	0.75	0.06
030101010102 ROW	111.88	89.40	5.88	0.07
030101010502 ROW	30.68	23.19	1.45	0.06
030101010501 ROW	108.67	104.04	6.60	0.06
030101010503 ROW	173.74	155.63	11.58	0.07

<sup>1</sup> Area contributing to loading including: Forest/Open Space (ROW),

Managed Turf, and New Impervious Cover.

<sup>2</sup> Cannot exceed 0.41 lb TP/ac/yr, or other reduction measures are required.

E. WATER QUANTITY

i. NO NEW IMPERVIOUS COVER

FOR PORTIONS OF SPREAD 10 CONSISTING OF EITHER PRIOR DEVELOPED AREAS (AGRICULTURAL AREAS AND EXISTING ACCESS ROADS) OR PRE-CONSTRUCTION NON-AGRICULTURAL LANDS, NO ANALYSIS WAS NEEDED. TO REITERATE FROM SECTION III.C.2 ABOVE:

BECAUSE THE POST-CONSTRUCTION ROW ALWAYS RESULTS IN A CN LESS THAN OR EQUAL TO THAT OF WOODS, AND TIME OF CONCENTRATION WILL NEVER DECREASE DUE TO POSSIBLE RETENTION BEHIND THE WATER BAR END TREATMENTS, PEAK FLOWS WILL NEVER EXCEED THOSE OF FORESTED CONDITIONS. THEREFORE, THE ENERGY BALANCE METHOD REQUIREMENTS ARE AUTOMATICALLY SATISFIED, AND CHANNEL PROTECTION REQUIREMENTS ARE MET. ADDITIONALLY, BASED ON CN REDUCTION FROM PRE- TO POST-CONSTRUCTION CONDITIONS, 10-YEAR 24-HOUR STORM VOLUMES WILL ALSO ALWAYS BE REDUCED, THEREBY SATISFYING FLOOD PROTECTION REQUIREMENTS.

ii. NEW IMPERVIOUS COVER: ACCESS ROADS

NEW IMPERVIOUS COVER IN SPREAD 10 INCLUDES THREE (3) ACCESS ROADS (MVP-MLV-AR-28 THROUGH -30). INCREASED VOLUMES OF STORMWATER RUNOFF RESULTING FROM ACCESS ROADS WILL BE CONTROLLED UTILIZING THE METHODOLOGY ESTABLISHED IN MVP-33.1 THROUGH MVP-33.3 GAP GRADED GRAVEL DETAIL FOR MAINLINE VALVE PADS AND PERMANENT ACCESS ROADS.

EACH ACCESS ROAD CONSISTS OF A GEOGRID, UNDERLAIN BY A 2-INCH LAYER OF CLEAN-WASHED CHOKER STONE, GEOTEXTILE FABRIC, AN OPEN-GRADED SUBBASE RESERVOIR, AND COMPACTED EARTHEN BAFFLES TO DETAIN WATER WITHIN THE ACCESS ROAD. THE ACCESS ROAD SURFACE WILL CONSIST OF TWO GRAVEL TRACKS, WITH A CENTER AISLE TOP-DRESSED WITH SOIL AND SEEDDED WITH A MEADOW SEED MIX PER MVP-ES11.2 UPLAND MEADOW SEED MIX AND APPLICATION RATES OR MVP-ES11.3 UPLAND STEEP SLOPE SEED MIX AND APPLICATION RATES.

PRE- AND POST-CONSTRUCTION RUNOFF VOLUMES FOR THE 10-YEAR 24-HOUR STORM WERE CALCULATED USING THE MONTGOMERY AND FRANKLIN COUNTY DESIGN STORM VALUES OF 5.00 AND 5.70 INCHES, RESPECTIVELY, PER PSS&S SECTION 4.2.2 DESIGN STORMS. RUNOFF VOLUMES WERE CALCULATED FOR BOTH THE DRAINAGE AREA TO EACH GAP GRADED GRAVEL ACCESS ROAD AND FOR THE ACCESS ROAD FOOTPRINT ALONE. RESULTS ARE SHOWN BELOW.

10-YEAR STORM DATA FULL RUN-ON DRAINAGE AREA					
SITE	TIME OF CONCENTRATION (PRE / POST) [HR]	CURVE NUMBER (PRE / POST)	DRAINAGE AREA [FT²]	Q <sub>10</sub> PEAK FLOW (PRE / POST) [CFS]	Q <sub>10</sub> VOLUME (PRE / POST) [FT³]
MLV-AR-28	0.16 / 0.16	71 / 71	456,413	30.45 / 30.39	80,296 / 80,297
MLV-AR-29	0.12 / 0.12	55 / 56	582	0.02 / 0.03	63 / 72
MLV-AR-30	0.13 / 0.13	82 / 82	43,339	5.31 / 5.31	13,387 / 13,387



1. DETERMINE THE CROSS-SECTION AREA (CSA) OF STORAGE BEHIND EACH BAFFLE, ASSUMING A TRIANGLE BASED ON BOTTOM SLOPE.

CSA = 0.5 X A X F X SIN(E) + 0.5 X E1 X E2 X SIN(A)

WHERE CSA = CROSS-SECTIONAL AREA; FT2

a = 90 - tan<sup>-1</sup>(road slope)      A = 8 x (sin(a)/sin(b))  
b = tan<sup>-1</sup>(road slope) + tan<sup>-1</sup>(baffle slope)      B = baffle height  
d = tan<sup>-1</sup>(road slope)      E1 = A x sin(e)  
e = tan<sup>-1</sup>(baffle slope)      E2 = A x (sin(e)/sin(d))  
f = 180 - b      F = A x (sin(f)/sin(d))  
G = F - E1/baffle slope

2. DETERMINE THE STORAGE VOLUME AVAILABLE PER EARTHEN BAFFLE.

VAVAILABLE = CSA X W X N

where Vavailable = Storage volume per earthen baffle; ft<sup>3</sup>  
W = Stone width (12 ft)  
n = Stone porosity (0.40)

3. DETERMINE THE NUMBER OF BAFFLE CELLS NEEDED BY DIVIDING THE STORAGE VOLUME PER EARTHEN BAFFLE INTO THE REQUIRED TREATMENT VOLUME. BECAUSE IT IS NECESSARY TO ROUND UP TO THE NEXT INTEGER, THE BAFFLE DESIGN VOLUME WILL ALWAYS EXCEED THE REQUIRED TREATMENT VOLUME.

4. DETERMINE THE BAFFLE CELL SPACING BY DIVIDING THE NUMBER OF BAFFLES NEEDED INTO THE ACCESS ROAD LENGTH.

TO ENSURE THE ROADS DRAIN WITH THE 72-HOUR MAXIMUM DRAWDOWN TIME, THE DESIGN VOLUMES WERE DIVIDED BY THE MOST CONSERVATIVE SATURATED HYDRAULIC CONDUCTIVITY (KSAT) OF THE UNDERLYING SOILS. EACH CALCULATED DRAWDOWN TIME USED THE MAXIMUM DEPTH OF EACH TRIANGULAR CSA AND WAS MULTIPLIED BY A SAFETY FACTOR OF 2, RESULTING IN THE FOLLOWING DRAWDOWN TIMES (ALL LESS THAN THE 72-HOUR MAXIMUM). NOTE THAT SEVERAL ACCESS ROADS SPAN MORE THAN ONE DIFFERENT SOIL TYPES WITH DIFFERENT KSAT RATES.

MVP-MLV-AR-28	
MUSYM	3E [-]
HSG	B [-]
K <sub>SAT</sub>	1.46 [IN/HR]
Max Depth	0.96 [FT]
Drawdown Time	26 [HR]
MUSYM	29 [-]
HSG	D [-]
K <sub>SAT</sub> **	0.36 [IN/HR]
Max Depth	0.92 [FT]
Drawdown Time*	43 [HR]
MUSYM	29 [-]
HSG	D [-]
K <sub>SAT</sub> **	0.26 [IN/HR]
Max Depth	0.92 [FT]
Drawdown Time	43 [HR]

MVP-MLV-AR-29	
MUSYM	7C [-]
HSG	B [-]
K <sub>SAT</sub>	1.28 [IN/HR]
Max Depth	1.00 [FT]
Drawdown Time	19 [HR]

MVP-MLV-AR-30	
MUSYM	11A [-]
HSG	B [-]
K <sub>SAT</sub>	1.3 [IN/HR]
Max Depth	0.50 [FT]
Drawdown Time	9 [HR]

\*NOTE: 72-HOUR MAXIMUM DRAWDOWN TIME SATISFIED BY REDUCING SAFETY FACTOR.  
\*\*NOTE: MUSYM 29 KSAT ASSUMED TO EQUAL MUSYM 25 KSAT.

ii. NEW IMPERVIOUS COVER: MAIN LINE VALVE PADS

NEW IMPERVIOUS COVER IN SPREAD 11 ALSO INCLUDES FIVE (5) MAIN LINE VALVE SITES (MVP-MLV-31 THROUGH -35). INCREASED VOLUMES OF STORMWATER RUNOFF RESULTING FROM THE MAIN LINE VALVE PADS WILL BE CONTROLLED UTILIZING THE METHODOLOGY ESTABLISHED IN *MVP-33.1 THROUGH MVP-33.3 GAP GRADED GRAVEL DETAIL FOR MAINLINE VALVE PADS AND PERMANENT ACCESS ROADS*. ALL PADS WILL BE LOCATED ON RELATIVELY FLAT GROUND. THE RUNOFF VOLUME INCREASE WHEN CONSIDERING ONLY THE PAD IS GREATER THAN THE RESULTING RUNOFF VOLUME INCREASE WHEN CONSIDERING THE FULL DRAINAGE AREA. AS A RESULT, THE RESERVOIR WITHIN THE GAP GRADED GRAVEL PAD IS CONSERVATIVELY SIZED TO ACCOMMODATE THE REQUIRED VOLUME COMPUTED USING THE PAD FOOTPRINT ONLY.

PRE- AND POST-CONSTRUCTION RUNOFF VOLUMES FOR THE 10-YEAR 24-HOUR STORM WERE CALCULATED USING THE MONTGOMERY AND FRANKLIN COUNTY DESIGN STORM VALUES OF 5.00 AND 5.70 INCHES, RESPECTIVELY, PER PSS&S SECTION 4.2.2 DESIGN STORMS.

10-YEAR STORM DATA					
SITE	TIME OF CONCENTRATION (PRE / POST) [HR]	CURVE NUMBER (PRE / POST)	DRAINAGE AREA [FT <sup>2</sup> ]	Q <sub>10</sub> PEAK FLOW (PRE / POST) [CFS]	Q <sub>10</sub> VOLUME (PRE / POST) [FT <sup>3</sup> ]
MLV-28	0.10 / 0.10	55 / 85	2,396	0.07 / 0.28	174 / 653
MLV-29	0.10 / 0.10	55 / 85	2,396	0.10 / 0.26	261 / 610
MLV-30	0.10 / 0.10	58 / 85	2,396	0.12 / 0.33	305 / 784

ANY INCREASE IN RUNOFF VOLUME FROM PRE- TO POST-CONSTRUCTION CONDITION MUST BE STORED WITHIN THE GAP GRADED GRAVEL TO MEET FLOOD PROTECTION REQUIREMENTS PER 9VAC25-870-66.C.2. THE CALCULATED TREATMENT VOLUME REQUIRED WAS THEN DIVIDED BY THE PAD FOOTPRINT AND 40% VOID SPACE TO DETERMINE THE DEPTH OF GRAVEL REQUIRED TO STORE THE 10-YEAR 24-HOUR STORM EVENT. IN THIS INSTANCE, CALCULATED GRAVEL DEPTHS FOR ALL PADS WERE LESS THAN THE 8-INCH MINIMUM REQUIRED PER *MVP-33.1 THROUGH MVP-33.3 GAP GRADED GRAVEL DETAIL FOR MAINLINE VALVE PADS AND PERMANENT ACCESS ROADS*. THEREFORE, GRAVEL DEPTHS FOR ALL PADS ARE 8 INCHES, PROVIDING STORAGE BEYOND THE 10-YEAR 24-HOUR STORM EVENT.

MLV-28 Pad	Vreq	479	cf
	Area	2376	sf
	Dreq	0.50	ft
	Ddesign	8	in
	Vdesign	634	cf

MLV-29 Pad	Vreq	348	cf
	Area	2376	sf
	Dreq	0.37	ft
	Ddesign	8	in
	Vdesign	634	cf

MLV-30 Pad	Vreq	479	cf
	Area	2376	sf
	Dreq	0.50	ft
	Ddesign	8	in
	Vdesign	634	cf

TO ENSURE THE GRAVEL PADS DRAIN WITH THE 72-HOUR MAXIMUM DRAWDOWN TIME, THE DESIGN VOLUMES WERE DIVIDED BY THE MOST CONSERVATIVE SATURATED HYDRAULIC CONDUCTIVITY (KSAT) OF THE UNDERLYING SOILS. EACH CALCULATED DRAWDOWN TIME WAS MULTIPLIED BY A SAFETY FACTOR OF 2, RESULTING IN THE FOLLOWING DRAWDOWN TIMES, ALL LESS THAN THE 72-HOUR MAXIMUM.

MVP-MLV-28	
MUSYM	3E [-]
HSG	B [-]
K <sub>SAT</sub>	1.46 [IN/HR]
Depth	8 [IN]
Drawdown Time	11 [HR]

MVP-MLV-29	
MUSYM	7C / 7D [-]
HSG	B [-]
K <sub>SAT</sub>	1.28 [IN/HR]
Depth	8 [IN]
Drawdown Time	13 [HR]

MVP-MLV-30	
MUSYM	11A [-]
HSG	B [-]
K <sub>SAT</sub>	1.3 [IN/HR]
Depth	8 [IN]
Drawdown Time	12 [HR]

RESULTS SHOW THE 10-YEAR 24-HOUR STORM EVENT WILL BE STORED WITHIN THE GRAVEL LAYER WITH NO OVERTOPPING, AND WITH REASONABLE DRAWDOWN TIMES BEFORE THE NEXT STORM EVENT.

F. SHEET FLOW PROTECTION

THIS ANALYSIS INCLUDES A DRAINAGE AREA DELINEATION FOR EACH WATER BAR WITHIN SPREAD 10, EXCLUDING THOSE IN SERIES AND PERPENDICULAR TO SLOPE. WATER BAR END TREATMENT LENGTHS WERE ASSIGNED BASED ON DRAINAGE AREA SIZE AND CURVE NUMBER PER *M.V.P. 17.3 WATER BAR END TREATMENT SIZING*.

SPREAD 10 CONTAINS THREE (3) WATER BARS WITH DRAINAGE AREAS GREATER THAN 1.5 ACRES. SITE-SPECIFIC CALCULATIONS FOR THESE WATER BARS WERE COMPLETED WITH THE FOLLOWING RESULTS:

Water Bar	Drainage Area (ac)	Tc (min)	Calculated End Treatment Length (ft)	Proposed End Treatment Length (ft)
64	2.21	22	8	20
65	2.19	15	18	20
70	1.88	15	15	20

FOR CONSISTENCY WITH THE CONSERVATIVE DESIGN STANDARD TABLE (REFER TO DETAIL), ALL THREE WATER BARS WILL USE A 20-FOOT END TREATMENT LENGTH. SEE THE *SPREAD 10 WATER QUANTITY EXHIBITS* AND *SPREAD 10 WATER QUANTITY CALCULATIONS* FOR MORE INFORMATION.

SPREAD 10 CONTAINS EIGHTY-SIX (86) WATER BARS WITH CURVE NUMBERS GREATER THAN 71. SITE-SPECIFIC CALCULATIONS FOR THESE WATER BARS WERE COMPLETED WITH THE FOLLOWING RESULTS:

Water Bar	Drainage Area (ac)	*Tc (min)	Calculated End Treatment Length (ft)	Proposed End Treatment Length (ft)
1	0.2	5	3	10
2	0.13	5	2	10
3	0.11	5	2	10
4	0.58	16	6	15
5	0.95	28	8	15
6	0.61	9	8	15
7	0.32	5	5	10
8	0.16	5	3	10
9	0.12	5	2	10
10	0.12	5	2	10
11	0.08	5	1	10
12	0.08	5	1	10
13	0.07	5	1	10
14	0.07	5	1	10
15	0.05	5	1	10
16	0.07	5	1	10
17	0.04	5	0	10
18	0.06	5	1	10
19	0.09	5	1	10
20	0.06	5	1	10
21	0.1	5	2	10
22	0.14	5	2	10
23	0.06	5	1	10
24	0.13	5	2	10
25	0.06	5	1	10
26	0.06	5	1	10
27	0.19	5	3	10
29.1	0.04	5	1	10
29.2	0.05	5	1	10
29.3	0.05	5	1	10
29.4	0.11	5	2	10
29.5	0.06	5	1	10
29.6	0.06	5	1	10
29.7	0.05	5	1	10
29.8	0.07	5	1	10
29.9	0.05	5	1	10
29.10	0.06	5	1	10

29.10	0.06	5	1	10
30	0.07	5	1	10
31	0.05	5	1	10
31.1	0.05	5	1	10
31.2	0.05	5	1	10
31.3	0.05	5	1	10
32	0.05	5	1	10
33	0.09	5	1	10
34	0.04	5	1	10
35	0.11	5	2	10
36	0.05	5	1	10
37	0.15	5	2	10
38	0.09	5	2	10
39	0.12	5	3	10
40	0.07	5	2	10
41	0.07	5	1	10
42	0.25	5	8	10
43	0.1	5	2	10
44	0.11	5	2	10
45	0.11	5	2	10
46	0.25	5	4	10
47	0.08	5	1	10
48	0.09	5	1	10
49	0.12	5	2	10
50	0.09	5	1	10
51	0.05	5	1	10
51.1	0.05	5	1	10
51.2	0.05	5	1	10
51.3	0.06	5	1	10
51.4	0.06	5	1	10
51.5	0.06	5	1	10
51.6	0.06	5	1	10
51.7	0.05	5	1	10
51.8	0.07	5	1	10
51.9	0.04	5	1	10
51.10	0.05	5	1	10
51.11	0.05	5	1	10
52	0.13	5	2	10
53	0.05	5	1	10
54	0.07	5	1	10
56	0.29	5	4	10

57	0.91	24	8	15
58	0.2	5	3	10
59	0.08	5	1	10
60	0.08	5	1	10
61	0.18	5	3	10
62	0.37	5	6	10
63	0.48	5	7	10
66	0.11	5	2	10
67	0.1	5	2	10

\*A MINIMUM TIME OF CONCENTRATION OF 5 MINUTES WAS ASSUMED FOR WATER BAR DRAINAGE AREAS LESS THAN OR EQUAL TO 0.5 ACRES.  
SEE THE *SPREAD 10 WATER QUANTITY EXHIBITS* AND *SPREAD 10 WATER QUANTITY CALCULATIONS* FOR MORE INFORMATION.