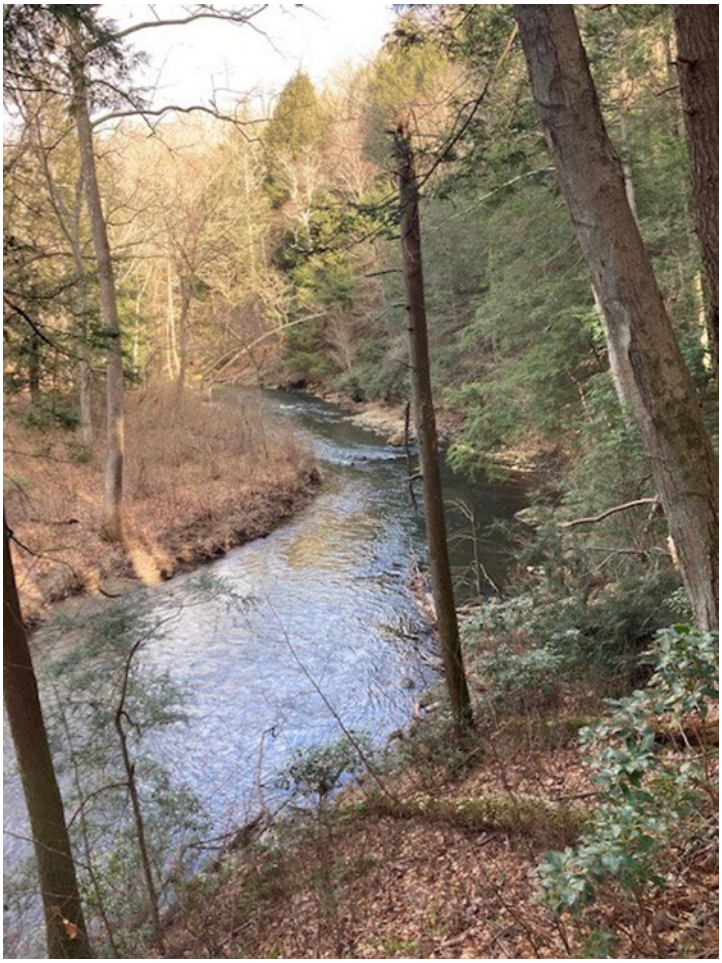
2022

US ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT
REGULATORY BRANCH



THE MARYLAND STREAM MITIGATION FRAMEWORK VERSION 1 (MSMF V.1.)

DRAFT MANUAL FOR STREAM IMPACT AND STREAM MITIGATION CALCULATION

AKNOWLEDGEMENTS

The Maryland Stream Mitigation Framework Version 1 (MSMF V.1.) is a product of collaboration between the U.S. Army Corps of Engineers (Baltimore District) and multiple partner agencies with valuable input from the regulated public. Project partners and other contributers are named below.

MSMF V.1. Team Members (Past and Present)

Nick Ozburn (USACE/Lead), Matt Hynson (USACE), Denise Clearwater (MDE), Randah Kamel (MDE), Alex Sicard (MDE), Mark Secrist (USFWS), Jack Dinne (USACE), Aaron Blair (EPA), Carrie Traver (EPA)

Contributions and feedback on MSMF V.1 and Beta Tool:

The Maryland Interagency Review Team, Maryland Environmental Service, The Ecosystem Restoration and Banking Association, Maryland Water Resources Registry Team, Maryland DNR, USACE Baltimore District (Regulatory Branch and Planning Division), The Maryland Wetland Assessment Team, USACE-Institute for Water Resources, Maryland State Highways Administration, Rich Starr (USFWS/EPR), and numerous consultants who provided valuable feedback on the MSMF Beta tool.

Stream Mitigation Protocols Reviewed In creation of MSMF V.1.

Several Mitigation Protocols from multiple Corps Districts were reviewed during creation of MSMF V.1. Reviews of the Minnesota Stream Quantification Tool (USACE-St.Paul District), The Unified Stream Methodology for Virginia (USACE-Norfolk District), The West Virginia Stream and Wetland Valuation Metric v2.1 (USACE-Huntington District), TXRAM (USACE-Galveston District), and The Tennessee SQT (USACE-Nashville District/TN Dept of Environment and Conservation), the Draft Maryland Wetland Assessment Methodology, and USACE-Louisville District mitigation protocols helped inform decisions made in development of MSMF V.1. Other mitigation protocols were also reviewed.

I. BACKGROUND

The Maryland Stream Mitigation Framework Version 1 (MSMF V.1.) provides a consistent and transparent process for stream impact and mitigation quantification where unavoidable impacts occur to Waters of the US, protected under Section 404 of the Clean Water Act. The Framework was established primarily as a tool for USACE (Baltimore District) regulators in Maryland to promote minimization and avoidance of impacts to streams and provide an accounting tool when unavoidable impacts occur and must be mitigated, with the goal of achieving "no net loss" of stream functions. Additionally, the framework has utility for project planners and mitigation providers in forecasting stream credits required or generated by various activities. The framework promotes impact minimization and avoidance, as well as strategic mitigation planning by allowing for distinction between stream habitats of different quality, landscape position, and sensitivity.

Initial testing was conducted using the MSMF Beta Tool on multiple impact and mitigation projects between May 2020 and February 2022, and knowledge from the associated project reviews informed creation of MSMF V.1.

The MSMF V.1. provides two calculators: the "Stream Impact Calculator" and the "Stream Mitigation Calculator," which share a common unit of measure (the functional foot). The functional foot reflects losses and gains in stream functions and conditions by combining factors such as stream quality and stream size to the traditional measure of stream length. Please note that the Stream Impact Calculator and Stream Mitigation Calculator sheets are not relational, each providing independent calculations for impact and mitigation sites respectively.

The Framework will be implemented by the USACE Baltimore District for quantification of stream losses associated with unavoidable impacts to Waters of the U.S. in Maryland. Stream mitigation should be considered only after diligent avoidance and minimization efforts have been completed during permit application review. Functional foot values provided by the calculation sheets may be adjusted by the Corps based on site specific factors. Further, while the tool provides functional foot estimates by comparing existing and proposed conditions, total functional feet awarded for mitigation proposals will be updated during the monitoring period, based on site performance.

The MSMF V.1. Calculation sheets are provided in a single Microsoft Excel Workbook titled "MSMF V.1.." Two calculation sheets are provided in the workbook: the "Stream Impact Calculator" and "Stream Mitigation Calculator." The calculators display text in **BLACK**, ORANGE (Impact Tab), and GREEN (Mitigation Tab). Note that the user will only enter data in the cells with **BLACK** text or those which are blank. Boxes with ORANGE and GREEN text are locked and will populate when necessary, data is entered in the worksheet.

Example scenarios and solutions are provided in *Appendix A* at the bottom of this document to help provide understanding of the tool.

SECTION II
MSMF V.1. STREAM IMPACT CALCULATOR

II. STREAM IMPACT CALCULATION TAB

To populate the Stream Impact Calculator Tab, the user will need the following documents and tools:

The Maryland Watershed Resources Registry, USGS Stream Stats, mapping software, and one or more of the stream assessments listed below (*see also Table 1*):

The Functions Based Rapid Stream Assessment (FBRSA with numeric scoring), the EPA Rapid Bioassessment Protocol Habitat Form for High Gradient Streams (RBP HG), EPA Rapid Bioassessment Protocol Habitat Form for Low Gradient Streams (RBP LG), EPA RBP Habitat form for High Gradient Intermittent/Ephemeral Streams (RBP HG Int/Eph), and the EPA RBP Habitat form for Low Gradient Intermittent/Ephemeral Streams (RBP LG Int/Eph). *See information regarding stream assessments selection under "Section II. c. vii Stream Quality" below*.

In the Impact Calculation Tab, rows with white backgrounds represent "existing" conditions, which rows with orange backgrounds represent "proposed" conditions.

When submitting the MSMF Impact Calculation sheet to the Corps for review, the user must also include site mapping (showing locations of each resource which is tabulated in the Impact Calculator), a stream assessment form for each reach with a reach photograph, and labeling must be consistent between assessment sheets and maps. In addition, mapping from the Watershed Resources Registry "Maryland Stream Mitigation Framework Layers: Site Sensitivity for Stream Impacts"

a. <u>Background Information</u>

i. Corps Project ID #
Enter the Corps Permit Number if known. The Corps Permit number will become available after a permit application is received by the Corps.

ii. Project Name

iii. Lat/Long
Provide site coordinates in decimal degrees (*ex. 39.54876, -78.09878*)

iv. County

v. Corps PM
Enter the Corps project manager (reviewer) name. This may be added at a later time if the Corps PM had not yet been assigned.

vi. Date
Enter the date the Impact Calculator Tab was populated with site information

vii. Sponsor
Indicate the project sponsor or applicant

viii. Collaborators
Provide the name and affiliation of users

b. Total Stream Losses
Located in the top far right corner of the Impact Calculator, a number will be seen which tabulates the functional foot values for all stream impacts provided in the sheet from Column O "Stream Losses (functional feet)."

c. *Raw Change in Reach Value (functional feet)*: The "Raw Change in Reach Value" section produces a raw functional foot value (Proposed Value–Existing Value) using several variables described below. The score will then be run through a second section (*See II.d Below* "Stream *Impact Adjustments"*) yielding "Stream Losses" by reach.

i. *Reach Name*: The user must identify a stream reach name. We recommend that you identify reaches which are unique in quality, drainage area, and proposed treatment. Specifically for stream impacts, where stream quality changes noticeably or a major tributary enters the stream, a new reach should be entered as a new Row in the Stream Impact Calculator.

ii. *Physiographic Region*: The user must identify a general physiographic region for their reach: Mountain, Piedmont, or Coastal Plain.

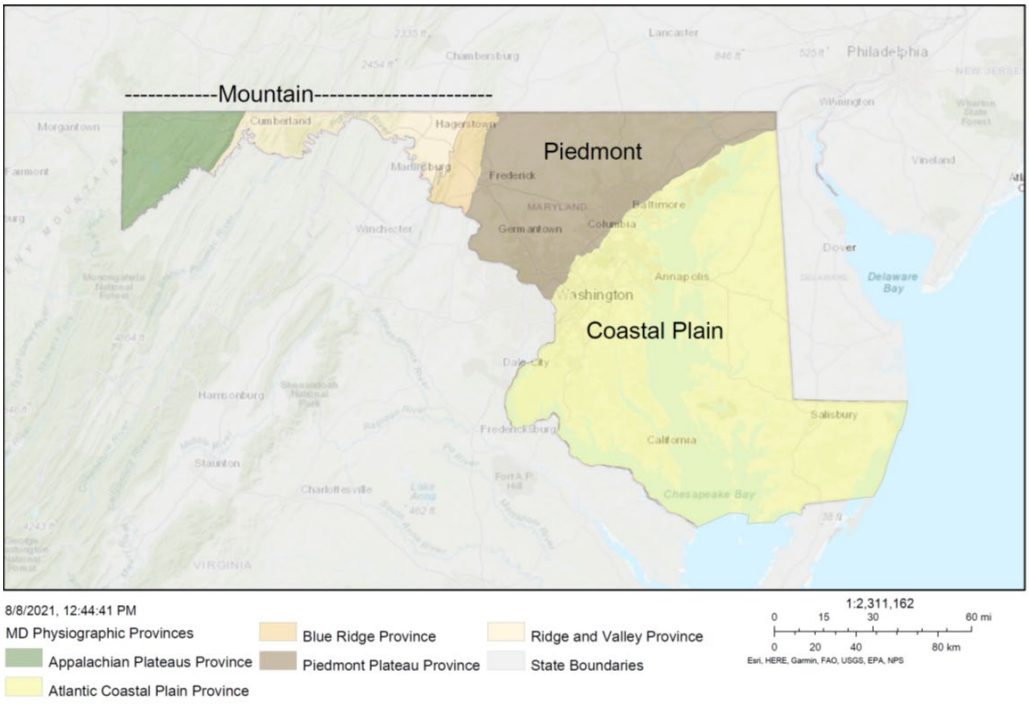


Figure 1 showing general physiographic regions of Maryland

iii. *Evaluation*: For each Stream Reach, there will be two evaluations (rows), one for existing conditions, the other for proposed conditions after an impact (See Table 1 above).

iv. *Activity*: Activity refers to the action affecting the stream reach. In the Stream Impact Calculator Tab, for Existing conditions, "Preliminary Resource Evaluation" is set. When a section of stream is proposed to be impacted, please select the appropriate impact type from the drop-down menu. Please note that the credits are determined from the existing vs. proposed stream

quality values, and the impact category is for categorical only purposes, and is not reflected in the crediting.

v. *Resource Type*: Resource type corresponds to channel flow. It may be either Ephemeral, Intermittent, Perennial Headwater, or Perennial Wadeable. Perennial Wadeable streams are defined as those with a drainage area exceeding 5 square miles. Select the "Resource Type" from the dropdown. Definitions of stream resource types by flow class can be found in the definitions section. Please note that the resource type is only descriptive and does not factor into the credit determination. Questions regarding Corps jurisdiction over aquatic resources should be coordinated with the assigned project manager or a jurisdictional determination request may be requested by sending an email to: NAB-regulatory@usace.army.mil.

vi. *Reach Length (linear feet)*: The user must indicate the length of the stream reach as measured from the centerline of the active baseflow channel.

vii. *Stream Quality*: Stream quality ranges from 0-100% based on the total score of a reach divided by total possible score (*X 100*) of an approved Functional or Conditional Assessment Methodology (FCAM). A Stream Quality of "100%" represents a perfect condition score. The user will enter values in the Stream Quality boxes for both existing and proposed condition scores. Where a stream will be filled or placed in a pipe or culvert as a result of the proposed activity, please enter the FCAM Score to the Stream Quality Column under "Existing" and a 0 in the "Proposed" condition. For all other impact types, the user will need to assess stream conditions before the impact and then project conditions following the impact to fill out the "proposed" stream quality. Streams will be assessed following stream impacts to ensure "proposed" condition values were accurate. As mentioned in Section "II. I Reach Name", when a stream reach changes noticeably in quality, treatment, or drainage area, a new stream reach should be entered in rows below the previous reach, and a separate stream quality assessment recorded.

FCAM's by Resource Type, stream gradient, and reach length:

The following FCAMS should be applied to determine stream quality for impact reaches less than 300 linear feet in length (*see also Table 1 below*): "EPA RBP Habitat Form HG" for perennial streams with slopes exceeding 2%, "EPA RBP Habitat Form LG" for perennial streams with slopes below 2%,, "EPA RBP Habitat Form Int/Eph HG" for intermittent and ephemeral streams with slopes exceeding 2%, and "EPA RBP Habitat Form Int/Eph LG" for intermittent and ephemeral streams with slopes less than 2%. For intermittent or perennial streams reaches exceeding 300 linear feet in length, or reaches exhibiting excellent quality, the "Function Based Rapid Stream Assessment (with numeric scoring)" must be used. Flexibility regarding the appropriate stream assessment for streams with slopes near 2% may be discussed with the Corps project reviewer. Citations for the EPA RBP Habitat forms can be found in the "References" section below (Barbour and others, 1999), and the Function Based Rapid Stream Assessment (USFWS, 2015). The manual for the FBRSA can be found at: https://www.fws.gov/chesapeakebay/restoring-habitat/stream-restoration/stream-protocols.html. Please disregard sections referring to the "Watershed Assessment" for the purpose of the MSMF V.1.

Table 1: Functional and Conditional Assessment Methodologies to determine "Stream Quality" values for MSMF V.1. Stream Impact Calculator

Reach Length	Resource Type	Stream Slope	FCAM	Citation
<300 linear feet	Perennial	>2%	EPA RBP Habitat Form High Gradient	Barbour & others, 1999
<300 linear feet	Perennial	<2%	EPA RBP Habitat Form Low Gradient	Barbour & others, 1999
<300 linear feet	Intermittent or Ephemeral	>2%	EPA RBP Habitat Form High Gradient for Int/Eph Streams	Barbour & others, 1999
<300 linear feet	Intermittent or Ephemeral	<2%	EPA RBP Habitat Form Low Gradient for Int/Eph Streams	Barbour & others, 1999
>300 linear feet	Perennial	All	Function Based Rapid Stream Assessment (with numeric scoring)	USFWS, 2015

Table 1 showing applicable FCAM to determine "Stream Quality" values organized by impact reach length, resource type, and stream slope. Note that a Corps reviewer may require a more rigorous stream assessment for resources occurring in sensitive areas or exhibiting excellent quality.

viii. *Channel Thread*: Channel Thread was included in the Framework for multi-threaded channels and oxbow channels. There are three options for channel thread (primary, second, or third). Single thread channels are considered "primary" channels and awarded at a ratio of 1.0 (no adjustment). For multi-threaded channels, the user must designate a primary or main channel, then may label any additional channels as second channels (0.2 multiplier) or third channels (0.1 multiplier). For second or third channels, credit will only be debited (or awarded) for perennial channels with active channels at least 1 foot wide with pools 0.5 feet deep. Oxbows may be treated as second or third channels. For the Channel Thread factor, it is important that we note the difference between "Multi-thread channels" and "Braided Channels." For the purpose of the MSMF, multi-thread channels are those channels in the same valley and general flowpath of a primary channel separated by an upland (or wetland) island where vegetation is established and soil formation is occurring. Braided channels are typically very dynamic streams and a result of high bed load (where soil development and vegetation do not occur on areas between channels). Braided channels are to be treated as one single primary channel for a given valley.

ix. *Drainage Area (sqmi)*: For primary channels, enter the drainage area (in square miles rounded to the nearest tenth) in the top box of the column (I) and the adjustment factor will populate in the box below. Drainage area must be determined using USGS stream stats: https://www.usgs.gov/mission-areas/water-resources/science/streamstats-streamflow-statistics-and-spatial-analysis-tools?qt-science_center_objects=0#qt-science_center_objects The drainage area must be measured from the center of the subject reach. Where drainage area is unavailable on USGS Stream stats, the user must measure the drainage area from a topographic map. For multi-threaded streams, indicate the drainage area for primary channels in Column I, and for second or third channels, use a value of 1 sqmi for the drainage area. The Drainage Area Adjustment applies only to primary stream channels, and is a set value where

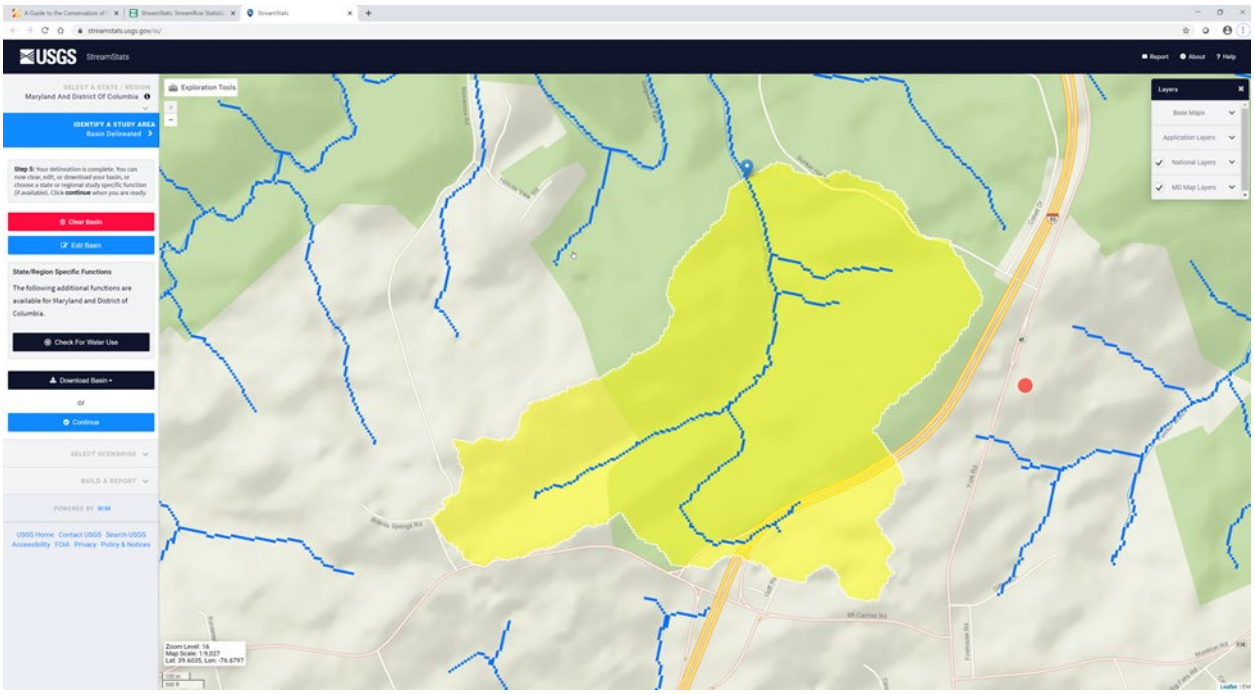


Figure 2 showing drainage area from the center of a subject reach using USGS Stream Stats (Mingo Branch, Baltimore County Maryland). The Drainage area (and other information) can be calculated when generating a report in USGS Stream Stats.

The drainage area adjustment is based on the bankfull regional curves for Maryland relating drainage area to bankfull stream width. It captures differences in stream sizes in the Framework and differences in estimated regulated stream area. For example, in the Maryland Piedmont (Wbkfl=14.78DA^0.39), (USFWS 2002). MSMF V.1. sets the benchmark drainage area value at 1 sqmi drainage area (Where DA of 1 square mile receives a multiplier of 1, or no adjustment). The Drainage area adjustment is effective in a range between 0.1-10 square miles, and values above and below the range are capped. The Stream Impact Calculator will apply the appropriate Maryland regional curve equation (USFWS 2002, USFWS 2003) based on the physiographic region you select in Column B.

x. *Raw Reach Value (Functional Feet):* The Raw Reach Value (Functional Feet) is the raw functional foot value of a reach before stream impact (or mitigation) adjustments are taken into account. Raw reach value is the product of Stream Length, Stream Quality, Channel Thread factor, and the Drainage Area factor. Raw Reach Value is calculated for both the existing and proposed conditions.

xi. *Raw Change in Reach Value (Functional Feet):* The Raw Change in Reach Value is the difference in the Raw Reach Value between existing and proposed conditions.

d. <u>Stream Impact Adjustments</u>

After the Raw change in stream reach value is determined, two adjustment factors apply to the Raw change in Reach value: Site Sensitivity Adjustment and the Mitigation Ratio.

i. *Site sensitivity*: "Site sensitivity" was included in the Framework to apply general concepts of landscape ecology (MacArthur & Wilson 1967) to mitigation and impact siting. The purpose is to incentivize minimization and avoidance of impacts to streams as well as implement a watershed approach to mitigation as encouraged by the Mitigation Rule (Final Rule, 2008). The Stream Sensitivity adjustment is added to both the Mitigation and Impact Calculators. The score will range from 1-3 where 10% or 0.1 will be added (max of 0.3 or 30%) for each item from the following list which is reflected in the Maryland Watershed Resources Registry (WRR) https://watershedresourcesregistry.org/states/maryland.html under the title: "Maryland Stream Mitigation Framework Layers: Site Sensitivity Analysis for Stream Impacts." The WRR also provides a color-coded map with a composite score for specific areas which reflect the following items below:

> *Low impervious Cover*: Streams in catchments with <10% impervious cover from National Land Cover Data 2016 receive a one point increase.
> *Located in Target Ecological Areas*: Sites located in Target Ecological Areas as defined by Maryland Department of Natural Resources receive a one point increase.
> *Located Near Protected Lands*: Sites located within 1 mile of protected lands or the Chesapeake Bay Critical Area receive a one point increase.

Note that adjustments to Site Sensitivity factor may be made by the Corps reviewer where justified based on ecological factors (ex. site connecting two Target ecological areas, etc). The user may request an adjustment to this factor based on ecological justification.

ii. *Mitigation Ratio*: Per the recommendation of the 2008 mitigation Rule (33 CFR 332), the mitigation ratio addresses temporal loss and other adjustments to provide balance between the Stream Impact Calculator and Stream Mitigation Calculator to help achieve "no net loss." *Note: Temporal loss values applied by the USACE Jacksonville District, Huntington District, Louisville District, and others were considered in setting the temporal loss value applied to the Mitigation Ratio for MSMF V.1..*

e. Stream Losses (functional feet): Produces the stream mitigation required for an impact activity on a given reach in Functional Feet. Stream Losses are calculated automatically by adjusting the Raw change in reach value by the Site Sensitivity Adjustment and Mitigation Ratio.

f. Remarks: The remarks section provides space to make notes about the reach for the Corps project manager.

SECTION III

MSMF V.1. STREAM MITIGATION CALCULATOR

III. STREAM MITIGATION CALCULATION

To populate the Stream Mitigation Calculator Tab, the user will need the following documents and tools:

The Maryland Watershed Resources Registry, USGS Stream Stats, mapping software, the Stream Buffer Quality Assessment (with instructions), and one or more the following stream assessments The Functions Based Rapid Stream Assessment (FBRSA with numeric scoring), the EPA Rapid Bioassessment Protocol Habitat Form for Int/Eph High Gradient Streams (RBP Int/Eph HG), and the EPA Rapid Bioassessment Protocol Habitat Form for Int/Eph Low Gradient Streams (RBP Int/Eph LG). *See information regarding stream assessments selection under Section III. C. vii Stream Quality below*.

In the Mitigation Calculation Tab, rows with white backgrounds represent "existing" conditions, which rows with green backgrounds represent "proposed" conditions.

When submitting the MSMF Impact Calculation sheet to the Corps for review, the user must also include site mapping (showing locations of each resource which is tabulated in the Mitigation Calculator), a stream assessment form for each reach with a reach photograph, and labeling must be consistent between assessment sheets and maps. In addition, mapping from the Watershed Resources Registry "Maryland Stream Mitigation Framework Layers: Site Sensitivity for Stream Mitigation" is recommended.

a. <u>Background Information</u>

i. Corps Project ID #
Enter the Corps Permit Number if known. The Corps Permit number will become available after a permit application is received by the Corps.

ii. Project Name

iii. Lat/Long
Provide site coordinates in decimal degrees (*ex. 39.54876, -78.09878*)

iv. County

v. Corps PM
Enter the Corps project manager (reviewer) name. This may be added at a later time if the Corps PM had not yet been assigned.

vi. Date
Enter the date the Mitigation Calculator Tab was populated with site information

vii. Sponsor
Indicate the project sponsor or applicant

viii. Collaborators
Provide the name and affiliation of users

b. Total Stream Gains
Located in the top far right corner of the Impact Calculator, a number will be seen which tabulates the functional foot values for all stream impacts provided in the sheet from Column R "Stream Gains (functional feet)."

c. *Raw Change in Reach Value (functional feet)*: The "Raw Change in Reach Value" section produces a raw functional foot value (Proposed Value–Existing Value) using several variables described below. The score will then be run through a second section (*See II.d Below* "Stream *Mitigation Adjustments"*) yielding "Stream Gains" by reach.

i. *Reach Name*: The user must identify a stream reach name. We recommend that you identify reaches which are unique in quality, drainage area, and proposed treatment. Specifically for stream mitigation, where stream quality changes noticeably or a major tributary enters the stream, a new reach should be entered as a new Row in the Stream Mitigation Calculator. Reach splitting may also be helpful when a stream reach treatment changes (*ex. different restoration approach*).

ii. *Physiographic Region*: The user must identify a general physiographic region for their reach: Mountain, Piedmont, or Coastal Plain.

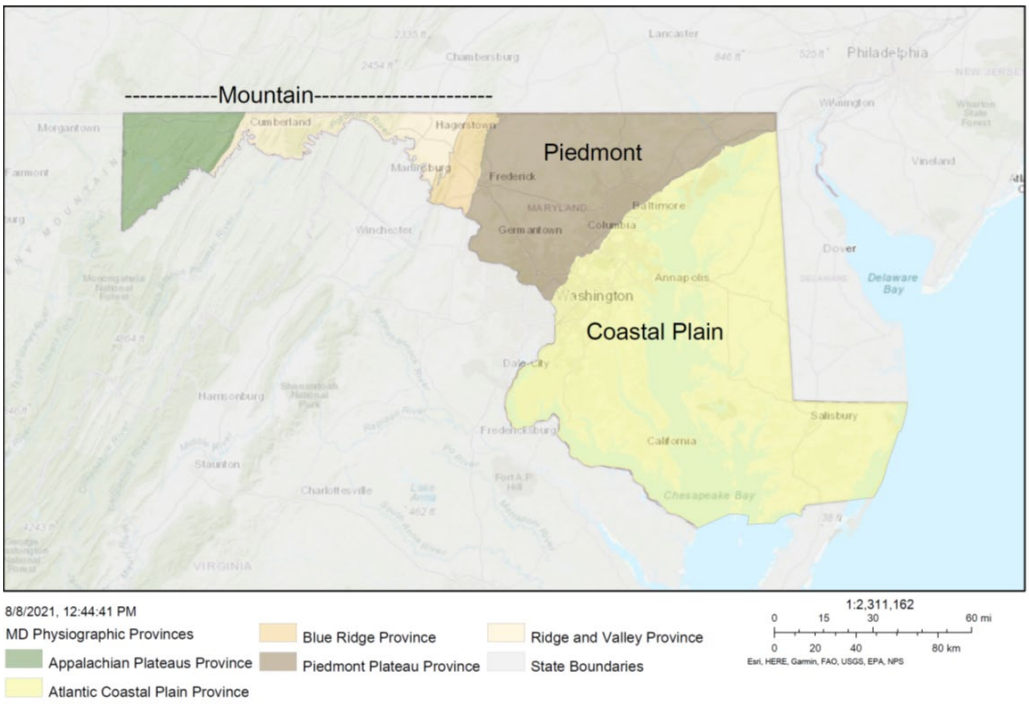


Figure 4 showing general physiographic regions of Maryland

iii. *Evaluation*: For each Stream Reach, there will be two evaluations (rows), one for existing conditions, the other for proposed conditions after an activity.

iv. *Activity*: Activity refers to the action affecting the stream reach. In the Stream Mitigation Calculator Tab, for Existing conditions, "Preliminary Resource Evaluation" is set. When a section of stream or its buffer is proposed to be restored or enhanced, select "Restoration/Enhancement" drop-down menu. When a stream reach or its buffer are to be

preserved, select "Preservation." Where a stream reach is restored but the buffer is to be preserved (or the other way around), create a new row for the stream buffer, and do not include buffer information for that reach and instead add the buffer preservation in its own row "existing" vs "proposed". Equations for "Restoration/Enhancement" and "Preservation" are unique. Stream reaches generally must be of excellent quality to be considered for preservation. In some instances, streams of above average quality may be preserved when part of a larger mitigation proposal and restoration is infeasible for the subject stream reach. Please note that channel creation is not generally supported in MSMF V.1. unless evidence supports its previous occurrence. In such an instance, the work would classified as "Re-establishment," "Restoration/Enhancement" should be selected from the dropdown list, and a note should be placed in the remarks section for that row. Channel creation ("Establishment") may be acceptable when creating multi-thread systems (new second and third channels).

v. *Resource Type*: Resource type corresponds to channel flow. It may be either Ephemeral, Intermittent, Perennial Headwater, or Perennial Wadeable. Perennial Wadeable streams are defined as those with a drainage area exceeding 5 square miles. Select the "Resource Type" from the dropdown. Definitions of stream resource types by flow class can be found in the definitions section. Please note that the resource type is only descriptive and does not factor into the credit determination. Additionally, mitigation work on ephemeral channels should be limited to the minimum necessary to provide stable elevations for a larger proposal and address erosion presenting design challenges for receiving waters that will be worked. Preservation is also acceptable on high quality ephemeral reaches. Questions regarding Corps jurisdiction over aquatic resources should be coordinated with the assigned project manager or a jurisdictional determination request may be requested by sending an email to: NAB-regulatory@usace.army.mil.

vi. *Reach Length (linear feet)*: The user must indicate the length of the stream reach as measured from the centerline of the active baseflow channel. For tributaries meeting a mainstem stream, excessive downstream extension of a channel may not be credited (extending a channel parallel with the receiving waterbody for an unnaturally long distance). The Corps reviewer will evaluate whether the proposed confluence between two channels is reasonably placed to assist in determining the credited stream length.

vii. *Stream Quality*: Stream quality ranges from 0-100% based on the total score of a reach divided by total possible score of an approved Functional or Conditional Assessment Methodology (FCAM). FCAMS are recommended by the 2008 Mitigation Rule to capture functional and conditional changes in resources (33 CFR 332). For the MSMF V.1. Stream Quality of "100%" represents a perfect FCAM score. The user will enter values in the Stream Quality boxes for both existing and proposed condition scores. As mentioned in Section "III.c.i Reach Name", when a stream reach changes noticeably in quality, treatment, or drainage area, a new stream reach should be entered in rows below the previous reach, and a separate stream quality assessment recorded.

FCAM's by Resource Type, stream gradient, and reach length:

One or more of the following FCAMS must be applied to determine stream quality for mitigation reaches for perennial and intermittent streams: the Function Based Rapid Stream Assessment (USFWS, 2015). The manual for the FBRSA can be found at:

https://www.fws.gov/chesapeakebay/restoring-habitat/stream-restoration/stream-protocols.html. Please disregard sections referring to the "Watershed Assessment" for the purpose of the MSMF V.1. For work in ephemeral streams, the user may use the EPA RBP Habitat Form Int/Eph HG for streams with slopes exceeding 2%, and "EPA RBP Habitat Form Int/Eph LG" for ephemeral streams with slopes less than 2%. Flexibility regarding the appropriate stream assessment for streams with slopes near 2% may be discussed with the Corps project reviewer. Citations for the EPA RBP Habitat forms can be found in the "References" section below (Barbour and others, 1999) and the Function Based Rapid Stream Assessment (USFWS, 2015).

Table 2: Functional and Conditional Assessment Methodologies to determine "Stream Quality" values for MSMF V.1. Stream Mitigation Calculator

Reach Length	Resource Type	Stream Slope	FCAM	Citation
All	Perennial and Intermittent	All	Function Based Rapid Stream Assessment (with numeric scoring)	USFWS, 2015
All	Ephemeral	<2%	EPA RBP Habitat Form Low Gradient for Int/Eph Streams	Barbour & others, 1999
All	Ephemeral	>2%	EPA RBP Habitat Form High Gradient for Int/Eph Streams	Barbour & others, 1999

Table 2 showing applicable FCAM to determine "Stream Quality" values organized by mitigation reach length, resource type, and stream slope. Note that a Corps reviewer may require a more rigorous stream assessment for resources occurring in sensitive areas or exhibiting excellent quality.

viii. *Channel Thread*: Channel Thread was included to describe calculations for multi-threaded channels and oxbow channels. There are three options for channel thread (primary, second, or third). Single thread channels are considered "primary" channels and awarded at a ratio of 1.0 (no adjustment). For multi-threaded channels, the user must designate a primary or main channel, then may be awarded additional credits for second (0.2 multiplier) or third channels (0.1 multiplier) improvements. For second or third channels, credit will only be debited (or awarded) for intermittent or perennial channels with active channels at least 1 foot wide with pools 0.5 feet deep. Oxbows may be treated as second or third channels. For the Channel Thread factor, it is important to note the difference between "Multi-thread channels" and "Braided Channels." For the purpose of the MSMF, multi-thread channels are those channels in the same valley and general flowpath of a primary channel separated by an upland (or wetland) island where vegetation is established and soil formation is occurring. Braided channels are typically very dynamic streams and a result of high bed load (where soil development and vegetation do not occur on areas between channels). Braided channels are to be treated as one single primary channel for a given valley.

ix. *Drainage Area (sqmi)*: For primary channels, enter the drainage area (in square miles rounded to the nearest tenth) in the top box of the column (I) and the adjustment factor will populate in the box below. Drainage area must be determined using USGS stream stats: https://www.usgs.gov/mission-areas/water-resources/science/streamstats-streamflow-statistics-and-spatial-analysis-tools?qt-science_center_objects=0#qt-science_center_objects

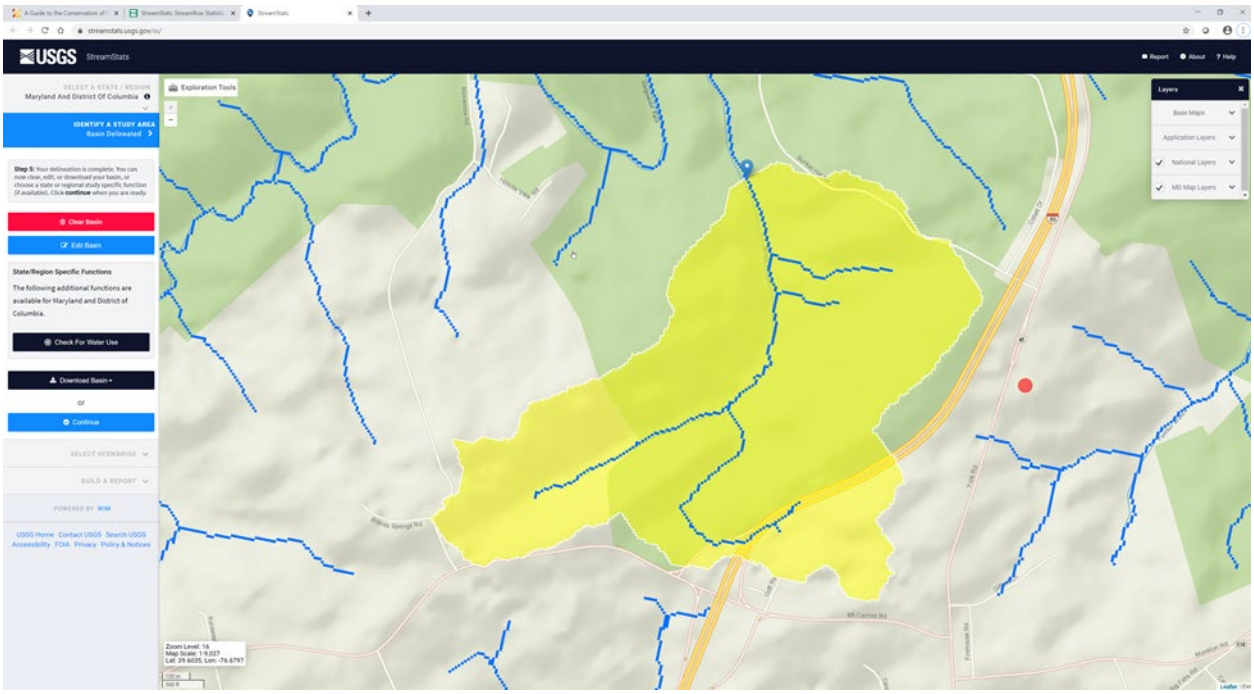


Figure 2 showing drainage area from the center of a subject reach using USGS Stream Stats (Mingo Branch, Baltimore County Maryland). The Drainage area (and other information) can be calculated when generating a report in USGS Stream Stats.

The drainage area adjustment is based on the bankfull regional curves for Maryland relating drainage area to bankfull stream width. It captures differences in stream sizes in the Framework and differences in estimated regulated stream area. For example, in the Maryland Piedmont (Wbkfl=14.78DA^0.39), (USFWS 2002). MSMF V.1. sets the benchmark drainage area value at 1 sqmi drainage area (Where DA of 1 square mile receives a multiplier of 1, or no adjustment). The Drainage area adjustment is effective in a range between 0.1-10 square miles, and values above and below the range are capped. The Stream Impact Calculator will apply the appropriate Maryland regional curve equation (USFWS 2002, USFWS 2003) based on the physiographic region you select in Column B.

x. *Raw Reach Value (Functional Feet):* The Raw Reach Value (Functional Feet) is the raw functional foot value of a reach before stream mitigation adjustments are taken into account. Raw reach value is the product of Stream Length, Stream Quality, Channel Thread factor, and the Drainage Area factor. Raw Reach Value is calculated for both the existing and proposed conditions.

xi. *Raw Change in Reach Value (Functional Feet):* The Raw Change in Reach Value is the difference in the Raw Reach Value between existing and proposed conditions.

d. Stream Mitigation Adjustments

After the Raw change in stream reach value is determined, three adjustment factors apply to the Raw change in Reach value: Site Sensitivity Adjustment, Site Protection, and Buffer Adjustment.

i. *Site sensitivity*: "Site sensitivity" was included in the Framework to apply general concepts of landscape ecology (MacArthur & Wilson 1967) to mitigation and impact siting. The purpose is to incentivize minimization and avoidance of impacts to streams as well as implement a watershed approach to mitigation as encouraged by the Mitigation Rule (Final Rule, 2008). The Stream Sensitivity adjustment is added to both the Mitigation and Impact Calculators. The score will range from 1-3 where 10% or 0.1 will be added (max of 0.3 or 30%) for each item from the following list which is reflected in the Maryland Watershed Resources Registry (WRR) https://watershedresourcesregistry.org/states/maryland.html under the title: "Maryland Stream Mitigation Framework Layers: Site Sensitivity Analysis for Stream Mitigation." The WRR also provides a color-coded map with a composite score for specific areas which reflect the following items below:

Low impervious Cover: Streams in catchments with <10% impervious cover from National Land Cover Data 2016 receive a one point increase.
Located in Target Ecological Areas: Sites located in Target Ecological Areas as defined by Maryland Department of Natural Resources receive a one point increase.
Located Near Protected Lands: Sites located within 1 mile of protected lands or the Chesapeake Bay Critical Area receive a one point increase.

Note that adjustments to Site Sensitivity factor may be made by the Corps reviewer where justified based on ecological factors (ex. site connecting two Target ecological areas, etc). They user may request an adjustment to this factor based on ecological justification. In instances where water quality is impaired or substantial constraints occur on the site, the Site Sensitivity factor should be reduced.

ii. *Site Protection*: The site protection factor captures the level of protection provided to the site. Easements are the preferred site protection mechanism, while Deed restrictions, or work on public lands may also be proposed. Adjustments to functional feet crediting based on site protection are as follows:

1. Easement (+3%): A Conservation easement held by a third party.
2. Accredited Easement (+5%): A conservation easement held by a third party which is accredited by the Land Trust Alliance.
3. Deed Restriction (0%): Deed restrictions are restrictions placed on the deed, limiting development and uses detrimental to the mitigation site.
4. Improved Protection (-3%): Improved protection is any form of protection listed above where existing protections exist on the site, but they are insufficient for mitigation purposes. Improved protection should be selected when additional protections are provided by the project sponsor.
5. Existing Protection (-5%): This includes work on public lands or other protected properties where no change in the level of site protection occurs as a result of the mitigation work. Note that the Corps reviewer will need to determine whether the

existing protection is sufficient, or if more rigorous protection is needed. If additional protections are provided, "Improved protection" should be selected instead.
Note: Conservation easements and deed restrictions were the assumed site protection mechanisms when setting the Mitigation Ratio for the Impact Calculator. "Improved Protection" and "Existing Protection" yield negative values because the assumed improvement to site protection is not in effect if working on land already protected.

iii. *Buffer adjustment:* The Stream Buffer Adjustment considers both buffer area (acres) and buffer quality and may be awarded only to stream buffers receiving permanent protection. The stream buffer adjustment is addressed in detail in the Stream Buffer Quality Assessment (and instructions). Stream buffers may receive credit for areas up to 200 feet from the edge of water at baseflow on a perennial stream and up to 100 feet from the edge of channel on intermittent or ephemeral streams. Buffers may extend out to the maximum distance on both sides of the stream, leaving a maximum stream buffer width of 400 feet on perennial channels and 200 feet on intermittent and ephemeral channels. The stream channel itself may not be included in the buffer area calculation (nor may credited wetlands). The user may elect to associate a stream buffer with each reach, or may elect to determine specific buffers areas based on topography and/or vegetation changes or planting zones. Delineated buffer areas may change for existing vs proposed conditions, and all changes are captured in the tabulations of the MSMF V.1. Stream Mitigation Calculator. See detailed instructions in "MSMF V.1. Stream Buffer Quality Assessment" and "MSMF V.1. Stream Buffer Quality Assessment Instructions."
Note: Mitigation proposals involving clearing of high quality mature forests or other high quality vegetative communities may result in a loss of stream credits (function feet) under the "Stream Buffer Adjustment."

e. Stream Gains (functional feet): Provides the stream mitigation produced by a restored or preserved stream reach and/or stream buffer measured in functional feet. Stream Gains are calculated automatically by adjusting the Raw change in reach value by the Site Sensitivity Adjustment, Site Protection Factor, and Buffer Adjustment.

f. Remarks: The remarks section provides space to make notes about the reach for the Corps project manager.

IV. DEFINITIONS

Baseflow channel: Stream channel observed during typical low flow conditions.

Enhancement: The manipulation of the physical, chemical, or biological characteristics of an aquatic resource to heighten, intensify, or improve specific aquatic resource function(s). Enhancement results in the gain of selected aquatic resource functions, but may also lead to decline in other resource functions. Enhancement does not result in a gain in aquatic resource area. (33 CFR 332.2).

Establishment (creation): The manipulation of the physical, chemical, or biological characteristics present to develop an aquatic resource that did not previously exist at an upland site. Establishment results in a gain in aquatic resource area and functions. (33 CFR 332.2). For the purposes of the MSMF Beta version, Establishment Activities are not included as mitigation activities.

Functional Foot: For the purpose of the Maryland Stream Mitigation Framework, a functional foot is defined as a linear foot of stream of perfect quality (100% or 1.0 score) and a drainage area of 1 square mile. A functional foot relates to streams of any flow type and quality in a stream network and these factors influence the value of a linear foot of stream as a functional foot.

Impact: For the purposes of the MSMF Beta Tool, an impact is defined as an adverse effect to streams pursuant to Section 404 where a loss in stream functions or conditions occur.

Mitigation: Activities undertaken for the purpose of offsetting unavoidable impacts to Waters of the US. This may occur in the form of Preservation, Restoration (Rehabilitation or Reestablishment), or Enhancement.

Resource Type:
Ephemeral Stream: An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow. [77 Fed. Reg. 10184 (February 21, 2012)]

Intermittent Stream: An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow. [77 Fed. Reg. 10184 (February 21, 2012)]

Perennial Stream: A perennial stream has flowing water year-round during a

typical year. The water table is located above the stream bed for most of the year. Groundwater is the primary source of water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow. [77 Fed. Reg. 10184 (February 21, 2012)]

Perennial Headwater Stream: A Perennial stream with a drainage area less than 5 square miles.

Perennial Wadeable Stream: A Perennial stream with a drainage area greater than 5 square miles.

Restoration: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: reestablishment and rehabilitation (33 CFR 332.2)

Re-establishment: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former aquatic resource. Re-establishment results in rebuilding a former aquatic resource and results in a gain in aquatic resource area and functions. (33 CFR 332.2)

Rehabilitation: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource. Rehabilitation results in a gain in aquatic resource function, but does not result in a gain in aquatic resource area. (33 CFR 332.2)

Riparian Areas: Riparian areas are lands adjacent to streams, rivers, lakes, and estuarine-marine shorelines. Riparian areas are transitional between terrestrial and aquatic ecosystems, through which surface and subsurface hydrology connects riverine, lacustrine, estuarine, and marine waters with their adjacent wetlands, non-wetland waters, or uplands. Riparian areas provide a variety of ecological functions and services and help improve or maintain local water quality. [77 Fed. Reg. 10184 (Feb. 21, 2012)]

REFERENCES

Barbour and others. 1999. U.S.EPA. Rapid Bioassessment Protocols: Habitat Assessment and Physciochemical parameters. Pages 5-9 through 5-34.

Jones, C, Jim McCann & Susan McConville. 2000. Critical Area Commission for the Chesapeake and Atlantic Coastal Bays. A Guide to the Conservation of Forest Interior Dwelling Birds in the Chesapeake Bay Critical Area.

Final Notice of Issuance and Modification of Nationwide Permits, as published in the February 21, 2012 Federal Register, Vol. 77, No. 34 [77 Fed. Reg. 10184 (Feb. 21, 2012)]

Final Rule for "Compensatory Mitigation for Losses of Aquatic Resources" as published in the April 10, 2008 Federal Register, Vol. 73, No. 70. (33 CFR 332)

Jennings, G and others. 2013. Eco-Geomorphic Rapid Assessment Approaches for Evaluating Stream Restoration Effectiveness. Presentation at Mid-Atlantic Stream Conference, Baltimore MD. Fall 2013.

MacArthur, R & E.O. Wilson. 1967. The Theory of Island Biogeography. Princeton Landmarks in Biology.

Schueler, T. 2000. The Importance of Imperviousness. Watershed Protection Techniques 1(3): 100-111.

U.S. Fish & Wildlife Service. March 2002. Maryland Stream Survey: Bankfull Discharge and Channel Characteristics of Streams in the Piedmont Hydrologic Region.

U.S. Fish & Wildlife Service. July 2003. Maryland Stream Survey: Bankfull Discharge and Channel Characteristics of Streams in the Coastal Plain Hydrologic Region.

U.S. Fish & Wildlife Service. May 2003. Maryland Stream Survey: Bankfull Discharge and Channel Characteristics of Streams in the Allegheny Plateau and Valley and Ridge Hydrologic Region.

U.S. Fish & Wildlife Service. May 2015. Final Draft Function-Based Rapid Stream Assessment Methodology.

Appendix A: Example Scenarios and Solutions for MSMF V.1. Impact Calculator and Mitigation Calculator

IMPACT EXAMPLE: A residential development is proposed on an abandoned golf course in the Piedmont Region of Baltimore County, Maryland. The initial impacts proposed include 2,500 linear feet of a perennial stream (Reach 1), and 500 linear feet of a perennial tributary (Trib 1). After avoidance and minimization efforts have been completed, the impacts were reduced to 1,000 linear feet of perennial streams (Reach 1) and 250 linear feet of an perennial tributary (Trib 1), considered unavoidable impacts.

Reach 1 information: Piedmont Physiographic Region, Activity: Culvert, Resource Type: Perennial headwater, Reach Length: 1000 linear feet, Stream Quality (From FBRSA) 45%, Channel Thread: Primary-single channel, Drainage area: 1 sqmi, Site sensitivity (From WRR "Maryland Stream Mitigation Framework: Site Sensitivity for Stream Impacts") scored a 2.

Reach 2 information: Physiographic Region: Piedmont, Activity: Channel hardening (riprap), Resource Type: perennial headwater, Reach Length: 250 linear feet, Stream Quality (From EPA RBP HG) Existing 40% proposed 25%, Channel Thread: Primary-single channel, Drainage area: 0.75 sqmi, Site sensitivity (From WRR "Maryland Stream Mitigation Framework: Site Sensitivity for Stream Impacts") scored a 2.

MITIGATION EXAMPLE: A mitigation provider proposes a mitigation site on Mill Creek. He plans to work on two stream reaches on the site and their buffers, and preserve a third. A conservation easement will protect the site in perpetuity. For Mill Creek Reach 1, a single thread natural channel design approach is selected. For Mill Creek Tributary 1, a multi-thread channel is proposed (two channels= two entries in the mitigation calculator). Mill Creek Tributary 2 is a high quality intermittent stream proposed for preservation.

Mill Creek Reach 1 Information: Physiographic Region: Piedmont, Activity: Restoration/Enhancement, Resource Type: perennial headwater, Reach Length: 1000 linear feet, Existing stream Quality (From FBRSA) 30% proposed 75%, Channel Thread: Primary-single channel, Drainage area: 1 sqmi, Site sensitivity (From WRR "Maryland Stream Mitigation Framework: Site Sensitivity for Stream Mitigation") scored a 2. Site protection is a conservation easement. The Buffer will be 100 feet on each side (totalling 4.59 acres). The existing buffer quality is 30%, and proposed buffer quality is 65%.

Mill Creek Trib 1 Information: Physiographic Region: Piedmont, Activity: Restoration/Enhancement, Resource Type: perennial headwater, Reach Length: 1000 linear feet primary thread, 300 ft secondary thread, Existing stream Quality (From FBRSA) 25% proposed 80%, Channel Thread: Primary-single channel and second channel, Drainage area: 1.25 sqmi, Site sensitivity (From WRR "Maryland Stream Mitigation Framework: Site Sensitivity for Stream Mitigation") scored a 2. Site protection is a conservation easement. The Buffer will be 200 feet on each side (totalling 4.59 acres). The existing buffer quality is 30%, and proposed buffer quality is 65%.

Mill Creek Trib 2: Physiographic Region: Piedmont, Activity: Preservation, Resource Type: intermittent, Reach Length: 1500 linear feet, Existing stream Quality (From FBRSA) 80% proposed 80%, Channel Thread: Primary-single channel, Drainage area: 0.3 sqmi, Site sensitivity (From WRR "Maryland Stream Mitigation Framework: Site Sensitivity for Stream Mitigation") scored a 2. Site protection is a conservation easement. The Buffer will be 100 feet on each side (totalling 4.59 acres). The existing buffer quality is 75%, and proposed buffer quality is 75%.

STREAM IMPACT CALCULATOR

BACKGROUND INFORMATION

Corps Project ID #:		Corps PM:	
Project Name:		Date:	
Lat/Long:		Sponsor:	
County:		Collaborators:	

Total Stream Losses (Functional Feet): -899

Raw Change in Reach Value (Functional Feet)											Stream Impact Adjustments		Stream Losses (Functional Feet)	REMARKS
Reach Name	Physiographic Region	Evaluation	Activity	Resource Type	Reach Length (feet)	Stream Quality	Channel Thread	Drainage Area (sqmi)	Raw Reach Value (Functional Feet)	Raw Change in Value (Functional Feet)	Site Sensitivity	Mitigation Ratio (Temporal Loss)		
Reach 1	Piedmont	Existing	Preliminary Resource Evaluation	Perennial Headwater	1000	45%	Primary 1	1 1.00	450	-450	2 0.2 -90	1.55	-837	
	Piedmont	Proposed	Piping/culvert	Perennial Headwater	1000	0%	Primary 1	1 1.00	0					
Trib 1	Piedmont	Existing	Preliminary Resource Evaluation	Perennial Headwater	250	40%	Primary 1	0.75 0.89	89	-34	2 0.2 -7	1.55	-62	
	Piedmont	Proposed	Channel Hardening	Perennial Headwater	250	25%	Primary 1	0.75 0.89	56					
	Not Selected	Existing	Preliminary Resource Evaluation	NA			NA FALSE	FALSE	0	0	0 0 0	1.55	0	
	Not Selected	Proposed	NA	NA			NA 0	0 FALSE	0					
	Not Selected	Existing	Preliminary Resource Evaluation	NA			NA FALSE	FALSE	0	0	0 0 0	1.55	0	
	Not Selected	Proposed	NA	NA			NA 0	0 FALSE	0					
	Not Selected	Existing	Preliminary Resource Evaluation	NA			NA FALSE	FALSE	0	0	0 0 0	1.55	0	
	Not Selected	Proposed	NA	NA			NA 0	0 FALSE	0					
	Not Selected	Existing	Preliminary Resource Evaluation	NA			NA FALSE	FALSE	0	0	0 0 0	1.55	0	
	Not Selected	Proposed	NA	NA			NA 0	0 FALSE	0					
	Not Selected	Existing	Preliminary Resource Evaluation	NA			NA FALSE	FALSE	0	0	0 0 0	1.55	0	
	Not Selected	Proposed	NA	NA			NA 0	0 FALSE	0					
	Not Selected	Existing	Preliminary Resource Evaluation	NA			NA FALSE	FALSE	0	0	0 0 0	1.55	0	
	Not Selected	Proposed	NA	NA			NA 0	0 FALSE	0					
	Not Selected	Existing	Preliminary Resource Evaluation	NA			NA FALSE	FALSE	0		0 0			

STREAM MITIGATION CALCULATOR

BACKGROUND INFORMATION

Corps Project ID #:		Corps PM:	
Project Name:		Date:	
Lat/Long:		Sponsor:	
County:		Collaborators:	

Total Stream Gains (Functional Feet) 1681

Raw Change in Reach Value (Functional Feet)											Stream Mitigation Adjustments					Stream Gains (Functional Feet)	REMARKS
Reach Name	Physiographic Region	Evaluation	Activity	Resource Type	Length (Feet)	Stream Quality	Channel Thread	Drainage Area (sqmi)	Raw Reach Value (Functional Feet)	Raw Change in Value (Functional Feet)	Site Sensitivity	Site Protection	Buffer Adjustment				
Mill Creek Reach 1	Piedmont	Existing	Preliminary Resource Evaluation	Perennial Headwater	1000	30%	Primary 1	1 1.00	300	450	2 0.2	Easement 0.03	Evaluation Existing Buffer	Buffer Area (Acres) 4.59	Buffer Quality 30%	646	
	Piedmont	Proposed	Restoration/Enhancement	Perennial Headwater	1000	75%	Primary 1	1 1.00	750		104	19	Proposed Buffer Functional Feet	4.59	65% 72		
Mill Creek Trib 1 Primary channel	Piedmont	Existing	Preliminary Resource Evaluation	Perennial Headwater	1000	25%	Primary 1	1.25 1.09	273	600	2 0.2	Easement 0.03	Evaluation Existing Buffer	Buffer Area (Acres) 4.59	Buffer Quality 30%	831	
	Piedmont	Proposed	Restoration/Enhancement	Perennial Headwater	1000	80%	Primary 1	1.25 1.09	873		134	24	Proposed Buffer Functional Feet	4.59	65% 72		
Mill Creek Trib 1 Second Channel	Piedmont	Existing	Preliminary Resource Evaluation	Perennial Headwater	300	25%	Second 0.2	1 1.00	15	33	2 0.2	Easement 0.03	Evaluation Existing Buffer	Buffer Area (Acres)	Buffer Quality	41	Buffer already covered by the primary thread in this instance.
	Piedmont	Proposed	Restoration/Enhancement	Perennial Headwater	300	80%	Second 0.2	1 1.00	48		7	1	Proposed Buffer Functional Feet		0		
Mill Creek Trib 2 Preservation	Piedmont	Existing	Preliminary Resource Evaluation	Intermittent	1500	80%	Primary 1	0.3 0.63	750	0	2 0.2	Easement 0.03	Evaluation Existing Buffer	Buffer Area (Acres) 4.59	Buffer Quality 80%	164	High quality resource under threat of development.
	Piedmont	Proposed	Preservation	Intermittent	1500	80%	Primary 1	0.3 0.63	750		23	24	Proposed Buffer Functional Feet	4.59	80% 41		
	Not Selected	Existing	Preliminary Resource Evaluation	NA	0	0%	NA 0	0 FALSE	0	0	0 0	Select From List 0	Evaluation Existing Buffer	Buffer Area (Acres)	Buffer Quality	NA	
	Not Selected	Proposed	NA	NA	0	0%	NA 0	0 FALSE	0		0	NA	Proposed Buffer Functional Feet		0		
	Not Selected	Existing	Preliminary Resource Evaluation	NA	0	0%	NA 0	0 FALSE	0	0	0 0	Select From List 0	Evaluation Existing Buffer	Buffer Area (Acres)	Buffer Quality	NA	
	Not Selected	Proposed	NA	NA	0	0%	NA 0	0 FALSE	0		0	NA	Proposed Buffer Functional Feet		0		
	Not Selected	Existing	Preliminary Resource Evaluation	NA	0	0%	NA 0	0 FALSE	0	0	0 0	Select From List 0	Evaluation Existing Buffer	Buffer Area (Acres)	Buffer Quality	NA	
	Not Selected	Proposed	NA	NA	0	0%	NA 0	0 FALSE	0		0	NA	Proposed Buffer Functional Feet		0		
	Not Selected	Existing	Preliminary Resource Evaluation	NA	0	0%	NA 0	0 FALSE	0	0	0 0	Select From List 0	Evaluation Existing Buffer	Buffer Area (Acres)	Buffer Quality	NA	
	Not Selected	Proposed	NA	NA	0	0%	NA 0	0 FALSE	0		0	NA	Proposed Buffer Functional Feet		0		
	Not Selected	Existing	Preliminary Resource Evaluation	NA	0	0%	NA 0	0 FALSE	0		0 0	Select From List 0	Evaluation Existing Buffer	Buffer Area (Acres)	Buffer Quality		