Date: April 15, 2020

From: Tom Schueler and David Wood

To: Members, Urban Stormwater Work Group

Re: Cleanup of Removal Rate Crediting for Impervious Cover Disconnection (ICD) and Removal (ICR) BMPs in the Watershed Model

Problem: Over the past 15 years, the urban sector has come up with at least seven different schemes for crediting practices that either remove or disconnect impervious cover in the urban landscape, which has confused states and MS4s, and practically everybody else, as well.

So far, Bay states have not reported many acres of either ICR or ICD in the most recent progress runs for the Chesapeake Bay TMDL. As of 2018, only 550 acres of both kinds of practices were cumulatively reported for credit across the entire Bay watershed (see Appendix A).

A simple, single, unified approach for this class of projects is needed that can be reported and verified by all parties, and which accounts for the hydrologic response of the urban soils that exist after the site is developed or otherwise restored.

Action Requested: Review and adjust the recommendations for crediting ICD and ICR practices in this memo to provide more consistency in how the credit is qualified, calculated, reported and verified to the CBP program. Provide comments to USWG by no later than May 15, 2020.

Background on the Practices: The best way to compare these practices is to describe when and how they occur in the urban land development cycle. Impervious cover can either be physically removed (ICR) or simply disconnected so that some portion of the runoff filters or infiltrates into adjacent pervious soils (ICD). More specifically:

> ***ICR:*** This practice occurs in the land development cycle as: Soil -> Compacted Soil -> Impervious Cover –> Removal -> De-compaction + Amendments => Restored Soil. The degree of runoff reduction achieved depends on the degree to which existing soils are de-compacted or amended to restore their pre-construction hydrologic response. In its most simple formulation, ICR is simply handled as a change in load due to the shift from impervious to pervious land cover.
>
> ***ICD*****:** This occurs when a given area of impervious cover is disconnected, such that runoff is directed to pervious areas w/ either (a) undisturbed soils, (b) compacted urban soils (c) de-compacted urban soils or (d) de-compacted and amended soils. The disconnection may also require a minimum distance or area over the pervious area which receives the runoff.

Review of Past Efforts to Credit ICD and/or ICR

Phase 1: Category G Practices (2006-2008): The USWG produced general estimates for a wide range of urban BMPs to support local and state planning for the tributary strategies which were a non-regulatory precursor to the Chesapeake Bay TMDL. A category was created for a grab bag of assorted practices for which a BMP removal rate could not be assigned (at the time, circa 2005) due to a lack of research monitoring data. (CBP, 2006). The category included both engineering, site design and land conservation practices[1], as shown below**.**

Category G: Impervious Surface Reduction	Using a BMP to reduce the total area impervious area and therefore encouraging stormwater infiltration.
Natural area conservation	Maintaining areas such as forests, grasslands and meadows that encourage stormwater infiltration.
Disconnection of rooftop runoff	Disconnecting the rooftop drainage pipe and allowing it to infiltrate into the pervious surface thereby reducing the impervious area.
Disconnection of non-rooftop impervious area	Directing sheet flow from impervious surfaces, i.e. driveways and sidewalks, to pervious surfaces instead of stormwater drains.
Rain Barrels	Rain barrels retain a predetermined volume of rooftop runoff (Prince George's LID).
Green Roofs	A multi-layer construction material consisting of a vegetative layer that effectively reduces urban stormwater runoff by reducing the percentage of impervious surfaces in urban areas. (US EPA LID Fact Sheet)

The pollutant reduction credit for Category G practices was simple—site loadings were based on the shift from the higher nutrient loads associated with impervious cover to the lower ones simulated for pervious cover by the CB watershed model used at the time (version 4).

Phase 2 The Table B-4 Era: (2008- 2011): The evolution of stormwater crediting is explored in detail of Appendix B of SPS EPR (2012). Starting from around 2008, the CBP (2006) removal rates were superseded by those in "Table B-4," which were derived from an extensive review of performance of runoff reduction practices, that include rooftop disconnection, filter strips, green roofs and rain tanks (see Table 2 below).

Table 2
Excerpts from "Table B-4" Nutrient Removal Rates for Stormwater BMPs

Practice	**Design Level[1]**	**TN Load Removal[4]**	**TP Load Removal**
Rooftop Disconnect	*1*	*25 to 50*	*25 to 50*
	2	*50*	*50*
Filter Strips	*1*	*25 to 50*	*25 to 50*
	2	*50 to 75*	*50 to 75*
Green Roof	*1*	*45*	*45*
	2	*60*	*60*

Rain Tanks & Cisterns	*1*	*15 to 60*	*15 to 60*
	2	*45 to 90*	*45 to 90*
Notes – See Full Table B-4 in Appendix B of SPS EPR (2012) for the complete footnotes			

The primary technical resource for these revised rates was CWP and CSN (2008), which contained an extensive research review of removal rates for runoff reduction practices that were tied to a two-level BMP design approach featured in numerous Bay state stormwater design manuals proposed and adopted during this period (e.g., VA, WV, DC and DE). Since this stormwater design era preceded the Bay TMDL, however, they were only approved by individual states, and never officially approved by the entire Bay partnership (but were cited in Simpson and Weammert, 2009).

Phase 3: State Stormwater Performance Standards EPR (2012-15): A full-blown expert panel was convened in 2011 to provide consistency for all the stormwater BMPs contained (or proposed) in state stormwater design manuals of this era (SPS EPR, 2012). The report developed a series of adjustor curves to define the unique removal rate for runoff reduction practices, based on the actual runoff volume from the IC treated by stormwater practices at the site (Table 3). The EPR report also explicitly provided for two levels of design for several types of ICD:

- IC disconnection to amended or un-amended soils (using the RR curves)
- Urban filter strips and sheet flow to open space

VA was the only state at the time w/ detailed specs supporting the two-level design approach for these ICD practices, although several other state stormwater manuals subsequently adopted it.

In practice, however, the BMP design spreadsheets of this era tended to treat ICD as a "deduction" from the total site treatment volume, prior to the design of any structural BMPs. Consequently, the credit was seldom reported to the CBP even though it was widely used in many states to sharply reduce the total stormwater volume requiring treatment by engineered practices at individual new development sites.

Table 3 Classification of Runoff Reduction BMPs in SPS EPR *(adapted from SPS EPR, 2012)*
Accepted Non-Structural Runoff Reduction (RR) Practices
Landscape Restoration/Reforestation
Riparian Buffer Restoration
Rooftop Disconnection (aka Simple Disconnection to Amended Soils, to a Conservation Area, to a Pervious Area, Non-Rooftop Disconnection)
Sheetflow to Filter/Open Space* (aka Sheetflow to Conservation Area, Vegetated Filter Strip)

Non-Structural BMPs, PA 2006 BMP Manual, Chapter 5

Phase 4: ICD and Urban Filter Strips EPRs (~2015 -> ?): For reasons lost to bureaucratic time, a new expert panel was formed in 2014 to specifically credit a range of impervious cover disconnection practices (ICD EPR, 2016), shortly after another very similar one was approved by the CBP for urban filter strips (UFS EP, 2014).

The impervious cover disconnection EPR was facilitated by CWP and VA Tech and contained an extensive literature review on the available scientific research. The EPR built on the prior work of the state stormwater performance standards panel (SPS EPR, 2012) and applied their runoff reduction curves to credit disconnections to HSG C and D amended soils.

The EPR concurred w/ the rates for disconnections to A and B amended soil that the UFS (2014) had recommended. In addition, MDE insisted on a special curve number protocol for disconnections that would apply only to MD sites (see Appendix G of ICD EPR, 2016).

Despite all the work put into these panels, however, Bay states have rarely calculated or reported any credits for the various ICD methods proposed by these two expert panels in the last 5 years. Instead, most have relied instead on their own state stormwater design manual specs to define how the practice is applied on the ground.

Phase 5: Enhancing BMP Performance w/ Soil Media (2016-2018): The USWG sponsored a research synthesis to see if the performance of urban soils or LID media could be improved by adding amendments such as biochar, alum, iron and water treatment residuals. Hirschman (2016) conducted a thorough research review on how nutrient removal can be enhanced for soil amendments and bioretention media. The final memo outlined an approach for revising the RR and ST adjustor curves to reflect the higher nutrient removal associated with these “PEDs”.

To this point, the PED recommendations have yet to be incorporated into any Bay-wide or state credits, but could easily be integrated into the existing crediting framework for ICR and ICD projects that use soil amendments as part of a treatment train.

Phase 6: ICR Punted to LUWG (~2010 to present): ICR was acknowledged to be a theoretical retrofit application during this era, especially for ultra-urban areas, but was considered to be too expensive and uncommon to have wide-spread application across the Bay watershed. Chairman Norm adroitly punted it over to the Land Use Work Group, where it was subsequently forgotten.

The un-written agreement with the modelers that ICR should be credited as a simple land use change --- from impervious to pervious cover. This approach to

crediting ICR has persisted over the last decade, although the unit area loading rates from both impervious and pervious cover has changed significantly with each subsequent edition of the CB watershed model (e.g., Phase 4 to Phase 6).

Phase 7: ICR Based on Measured Changes in Watershed Land Cover (2018 to present): One of the key enhancements of the Phase 6 watershed model was a vast improvement in the precision and resolution of land cover data used in the Phase 6 watershed model. The new 2013/14 land cover data was mapped at the 1-meter resolution for the entire Bay watershed (Chesapeake Conservancy, 2019).

These high-resolution data will be updated for the 2017/18 and 2021/22 periods. The LUWG raised the prospect that the improved multi-year IC data could be used to measure changes in ICR, and possibly even remotely verify individual practices. This approach will be evaluated in 2020 and 2021. In addition, the Phase 6 model also produced updated loading rates for both pervious and impervious cover that vary regionally (CBP, 2018).

The improved resolution in pervious cover was not helpful, however, in measuring the effect of ICD, as both the current model and land cover data cannot infer the degree of soil compaction for urban pervious areas, and the associated hydrological response.

Recommendations for going forward:

1. Set up a small joint team from USWG and LUWG to cleanup past efforts to credit ICR and ICD practices and propose a simpler, consolidated approach to calculate, report and verify the credits.

2. The basic approach should avoid complex protocols or detailed calculations and instead rely on simple default unit loading rates that reflect the change in land cover/hydrologic response achieved by these rather small and widely distributed practices (typically 0.1 to 0. 3 acres, in size). The preferred unit would be pounds per acre reduced by the change due to either ICR or ICD, and would be directly derived from CAST.

3. The default rates may be increased by a fixed increment to reflect additional site preparation such as decompaction, soil amendments or use of PEDs.

4. The team may choose to compile state-specific design specs and qualifying conditions for the ICR and ICD practices, as they may pertain to new land development or existing land development.

5. Although the accuracy and resolution of land cover data in the Chesapeake Bay watershed has vastly improved in recent years, it is still not practical to use current or future Bay land cover data to detect absolute changes in ICR or ICD at the watershed scale (although this may indeed be feasible for other practices,

such as increasing urban tree canopy). Given the small scale at which these practices have been reported in the past decade, this is not likely to create a significant double counting problem.

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UFS EP (Urban Filter Strip Expert Panel). 2014. Recommendations of the Expert Panel to Define Removal rates for Urban Filter Strips and Stream Buffer Upgrade Practices. Approved by Chesapeake Bay Partnership. Annapolis, MD.

Appendix A Acreage of ICR and ICD reported in the Chesapeake Bay Watershed [1]	
	IMPERVIOUS COVER REDUCTION (acres)

STATE [2]				
YEAR	DC	MD	PA	VA
2009	0	206 [3]	0	225
2018	0	122	10	297
2025	2	199	18	36,565
YEAR	IMPERVIOUS COVER DISCONNECTION (acres)			
2009	0	17	0	0
2018	0	111	0	0
2025	8	2012	0	0

[1] Source: Jeff Sweeney, CBPO
[2] DE, NY and WV did not report any implementation of either ICR or ICD
[3] For several years, MD reported BMPs in their "design by era" and/or "ESD to MEP" category

Note on Land Conservation. Anticipated future land conservation is included in the state custom land policy BMPs and for those using such BMPs in their WIPs, they should report on their progress annually but… conserved acres are not accepted as an annual BMP in NEIEN. This is because credit is based on avoided development which is a modeled estimate to account for uncertainty- we don't assume that every acre conserved equals an acre of avoided development, nor do we have a fixed percentage credit to apply. The credit percentage is derived from our models and updated every two years corresponding to each milestone period