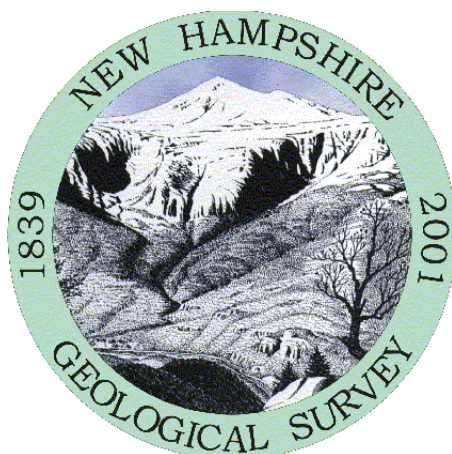


Proposed Changes to the Watershed Boundary Dataset (WBD) in NH

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Purpose

This report serves to inform the New Hampshire GIS Advisory Committee of the proposed changes to the Watershed Boundary Dataset (WBD) by the White Mountain National Forest in cooperation with the United States Geological Survey and the New Hampshire Geological Survey (NHGS). The NHGS would like to give the GIS community in New Hampshire the ability to view the changes and report errors or provide suggestions by submitting them directly to Joshua.Keeley@des.nh.gov. Joshua is the data steward for the WBD and the National Hydrography Dataset (NHD) in New Hampshire. While we acknowledge that these lidar-based changes are an improvement to the existing WBD, we ask that you please consider the changes with respect to your areas of expertise and comment if you notice any errors or foresee any issues with regard to your work practices. There will be no deadline for comment submission, as edits can be made anytime. The figures below are provided as an introduction to the major proposed changes, but we recommend that the attached shapefiles be used to examine the vector data more closely in GIS.

The report is divided into two parts. Part I consists of a table and figure that summarize the changes that **will be made** by USGS in the next update to the National Map. These include name changes to several Hydrologic Unit Codes (HUCs) at the HUC8 level in NH and serve to correct existing errors. Part I does not include spatial changes, solely tabular information. Part II summarizes the **proposed** spatial changes/re-delineations of HUC12 watersheds and the addition of an entirely new HUC14 dataset in the White Mountain National Forest area. These include 72 HUC12 re-delineations with 2 new HUCs and 5 name changes, and 316 new HUC14 delineations. Please keep in mind that the “White Mountain National Forest area” includes some areas outside of National Forest land.

I. HUC8 name changes in New Hampshire

The following name changes **will be made** by USGS in the next WBD update to correct existing errors (Table 1, Figure 1). The corrections rename hydrologic units based on the actual rivers within them and complete their names by adding 'River', such as smaller HUCs are named for their brooks, for example. There will be no spatial changes in this update. The current Merrimack and Seacoast HUC names are consistent with the current convention and are not involved in these changes.

Table 1. Summary of WBD name changes in NH

STATES	HUC8	NAME	New Name	Comments
NH	1070001	Pemigewasset	Pemigewasset River	Added River to name to match GNIS name
NH	1070003	Contoocook	Contoocook River	Added River to name to match GNIS name
CN,ME,NH	1040001	Upper Androscoggin	Upper Androscoggin River	Added River to name to match GNIS name
ME,NH	1060002	Saco	Saco River	Added River to name to match GNIS name
NH,VT	1080103	Waits	Ammonoosuc River-Connecticut River	Added Connecticut River as it is the mainstem and should be included in name. Waits River is not in this unit, suggest updating to feature in unit
NH,VT	1080104	Upper Connecticut-Mascoma	Waits River-Connecticut River	Added River to name to match GNIS name. Mascoma is not in this unit, selected prominent feature in unit for name. Swapped name order as Connecticut River is the mainstem and should come second in name.
NH,VT	1080106	Black-Ottauquechee	Black River-Connecticut River	Added River to name to match GNIS name. Added Connecticut River as it is the mainstem and should be included in name. Selected most prominent of suggested features for name.
NH,VT	1080107	West	West River-Connecticut River	Added River to name to match GNIS name. Added Connecticut River as it is the mainstem and should be included in name
CN,ME,NH,VT	1080101	Upper Connecticut	Headwaters Connecticut River	Added River to name to match GNIS name. Updated to Headwaters as Upper cannot be used alone
NH,VT	1080102	Passumpsic	Passumpsic River	Added River to name to match GNIS name
MA,NH	1070004	Nashua	Nashua River	Added River to name to match GNIS name
MA,NH	1080202	Miller	Millers River	Added River to name to match GNIS name
MA,NH,VT	1080201	Middle Connecticut	Ashuelot River-Connecticut River	Added River to name to match GNIS. Selected prominent hydro feature and updated to hyphenated name
ME,NH	1040002	Lower Androscoggin	Lower Androscoggin River	Added River to name to match GNIS name

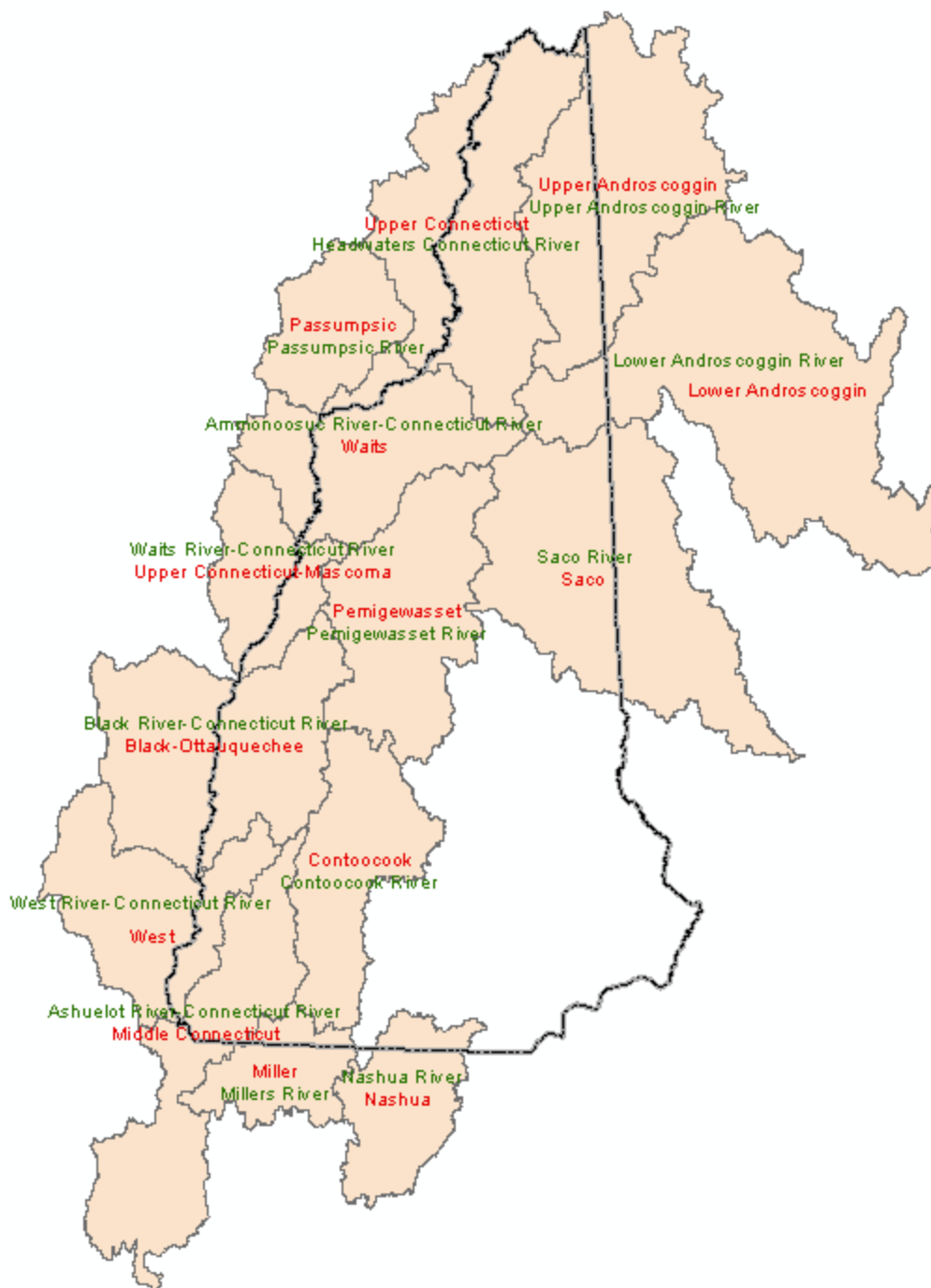


Figure 1. HUC8 watershed name changes in NH showing old names in red and new names in green

II. Proposed Changes to the WBD in the White Mountain National Forest Region (WMNF)

Justification and Introduction

“The changes are aimed at reducing the number of hyphenated watersheds and isolating the main brook/river as its own HUC12 watershed. Based on this proposal, the following brooks/ivers would have their very own HUC12: Beebe River, West Branch Brook, Peabody River, Pond Brook, Dry River, and Moose River.” –Landon Gryczkowski, Hydrologist with the WMNF. Also see Appendix 1.

In cooperation with the USGS and NHGS, the WMNF has re-delineated 72 HUC12s using lidar and the stream extraction tools developed by NHGS. This work is an important first step in generating an elevation-aligned WBD. The WMNF has broken out 2 new HUC12s making a total of 72 from the original 69 in the NH portion of the WMNF. The two new HUCs are Dry River (HUC: 010600020107) and Moose River (HUC: 010400020104). All re-delineations show edge refinements due to improved lidar-based delineations. Other than the 2 new HUC12s, there are 5 additional proposed name changes, but the remaining hydrologic codes would remain the same. The sections below offer a more detailed summary.

Methods

WMNF staff accessed lidar tiles from GRANIT and mosaicked them together into a seamless DEM (Appendix 2). In collaboration with NHGS, the WMNF used NHGS’s tools and Python script to extract a digital stream network from lidar over the entire forest. The extraction methods are summarized [here](#). USGS then used the lidar-derived hydrography to guide their delineation of HUC14 boundaries by using GIS tools to generate watersheds that were used to delineate the new Hydrologic Units. The HUC14 watersheds were then dissolved into the existing HUC12s, which resulted in the following HUC12 changes. Outlets may have moved upstream/downstream if the confluence of streams near or at an outlet moved according to lidar. New units were created to separate larger rivers from the mainstem, which in turn may have extended the length of a 12-digit along the mainstem. USGS manually manipulated units near outlets or missed culverts that were not represented in the lidar-derived hydrography. The guidelines outlined in the [WBD Standards](#) were followed as well.

Significant Changes

Figure 2 highlights four zones with significant changes. Zone 1 shows the new delineation of the Moose River and Moose Brook-Androscoggin River HUC12s and the subsequent change to the Peabody River-Androscoggin River HUC12. Zone 2 shows the splitting of the Saco Headwaters to create a new HUC for Dry River. Zone 3 shows outlet shifts in the Mill Brook, Beebe River, and West Branch Brook HUCs. Zone 4 shows an upstream shift of the Pond Brook outlet to excise the Baker River from its HUC. Some outlet shifts have caused several name changes (Table 2 and figures below).

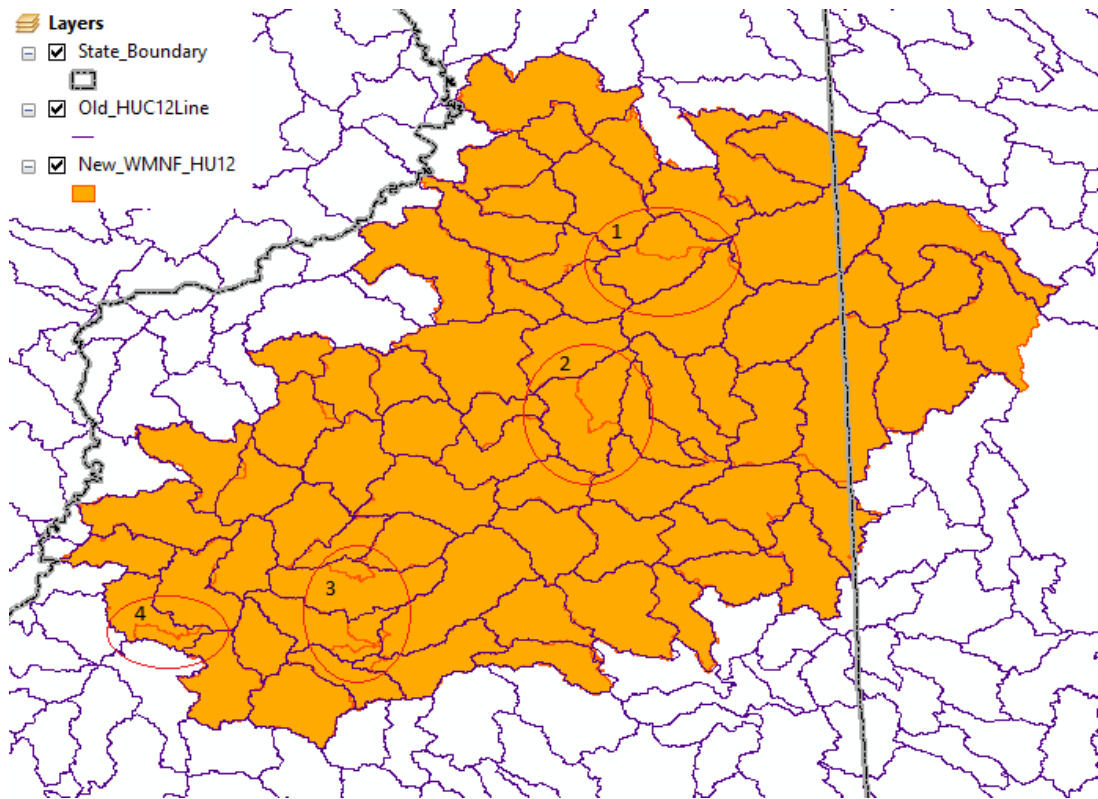


Figure 2. Overview of improved HUC12 delineations showing significant changes in zones 1-4.

Table 2. Summary of some of the larger proposed WBD name and hydrologic unit code (HUC) changes in the WMNF region that are addressed in more detail in the next section. Small to moderate spatial changes are not listed.

Original HUC Name	Original HU Code	Proposed HU Name	Proposed HU Code	Change(s)
Headwaters Saco	010600020101	Dry River	010600020107	New name and HUC, modified outlets
Moose River-Androscoggin River	010400020101	Moose River	010400020104	New name and HUC, Modified outlets
Moose River -Androscoggin River	010400020101	Moose Brook -Androscoggin River	010400020101	New name, Modified outlets
Beebe River-Pemigewasset River	010700010402	Beebe River	010700010402	Modified outlet, name change
Bog Brook-Pemigewasset River	010700010403	Bog Brook-Pemigewasset River	010700010403	Modified outlets
Mill Brook-Pemigewasset River	010700010205	Mill Brook-Pemigewasset River	010700010205	Modified outlets
Peabody River-Androscoggin River	010400020102	Peabody River	010400020102	New name, Modified outlets
Pond Brook-Baker River	010700010303	Pond Brook	010700010303	New name, Modified outlets
West Branch Brook-Pemigewasset River	010700010206	West Branch Brook	010700010206	New name, Modified outlets

Proposed New HUCs

Dry River: The existing HUC12 of the Headwaters Saco River (010600020101) would be split to define a new Dry River HUC12 (010600020107) (Fig 3). The southwestern portion would remain Headwaters Saco River (010600020101).

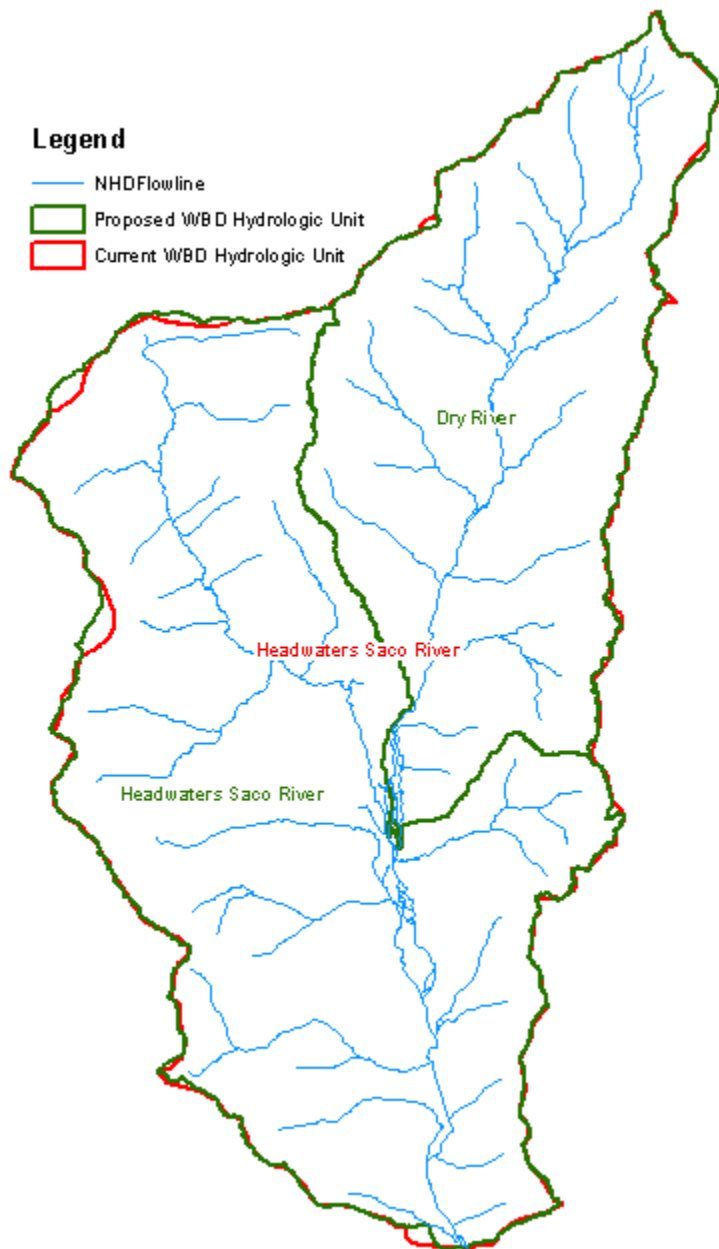


Figure 3. Proposed revisions to the Headwaters Saco River HUC12 and newly proposed Dry River HUC12.

Moose River: The existing Moose River-Androscoggin River HUC12 (010400020101) would be the only existing HUC12 completely excised from the dataset (Fig. 4). In its place, two newly named HUC12s, Moose River (010400020104), and Moose Brook-Androscoggin River (010400020101) would be added and the Androscoggin portion of the existing HUC12 would be allocated to the neighboring Peabody River-Androscoggin River (010400020102).

Peabody River: Not a new HUC, but included here due to its proximity to Moose River. The outlet of the existing Peabody River-Androscoggin River HUC12 (010400020102) would be moved upstream to cut out a small portion of the Androscoggin River and isolate the Peabody River (010400020102) to its own HU (Fig. 4).

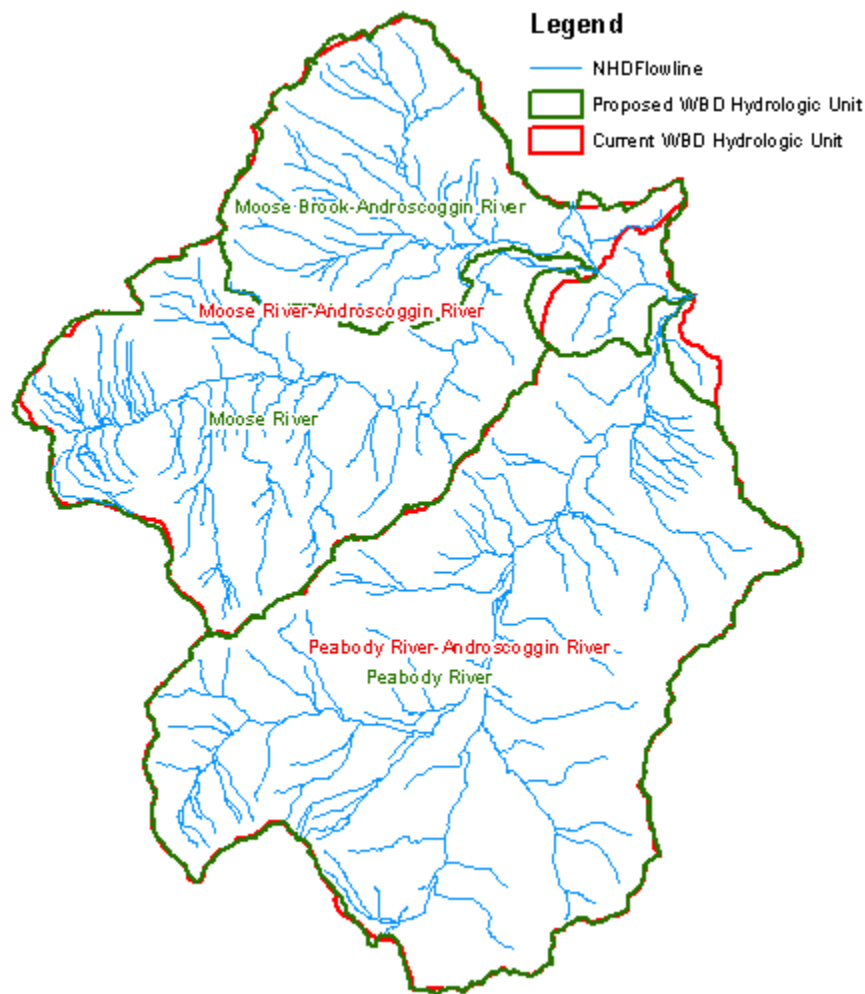


Figure 4. Proposed revisions to Moose River-Androscoggin River and Peabody River-Androscoggin River HUC12s.

Proposed Shifts of Outlet Locations

Beebe River

The Pemigewasset River portion of the exiting Beebe River-Pemigewasset River HUC12 (010700010402) would be allocated to the neighboring Bog Brook-Pemigewasset River HUC12 (010700010403) by moving this outlet upstream in order to isolate the Beebe River (010700010402) to its own HUC12 (Fig. 5). The name would be changed, but the code will not.

Bog Brook-Pemigewasset River

The existing inlet has been moved upstream on the Pemigewasset River to incorporate left-over Pemigewasset segments from neighboring HUCs (Fig. 5). No name or code change.

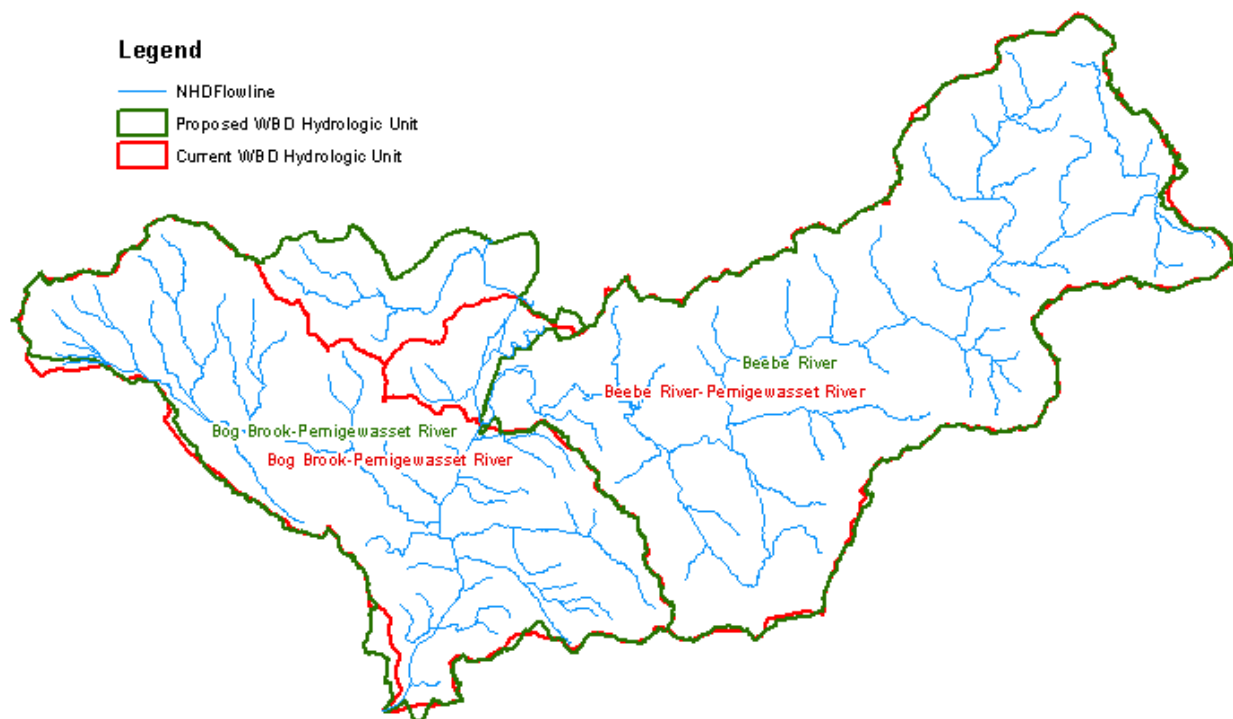


Figure 5. Proposed changes to Bog Brook-Pemigewasset River and Beebe River-Pemigewasset River HUC12s.

Mill Brook-Pemigewasset River

Both the inlet and outlet on the Pemigewasset River in the Mill Brook-Pemigewasset River HUC12 (010700010205) would be moved downstream (Fig. 6). The name and hydrologic code will not change.

West Branch Brook

The Pemigewasset River portion of the existing West Branch Brook-Pemigewasset River HUC12 (010700010206) would be allocated to a neighboring watershed by moving this outlet upstream in order to isolate the West Branch Brook (010700010206) to its own HUC12 (Fig. 6). The name would be changed, but the code will not.

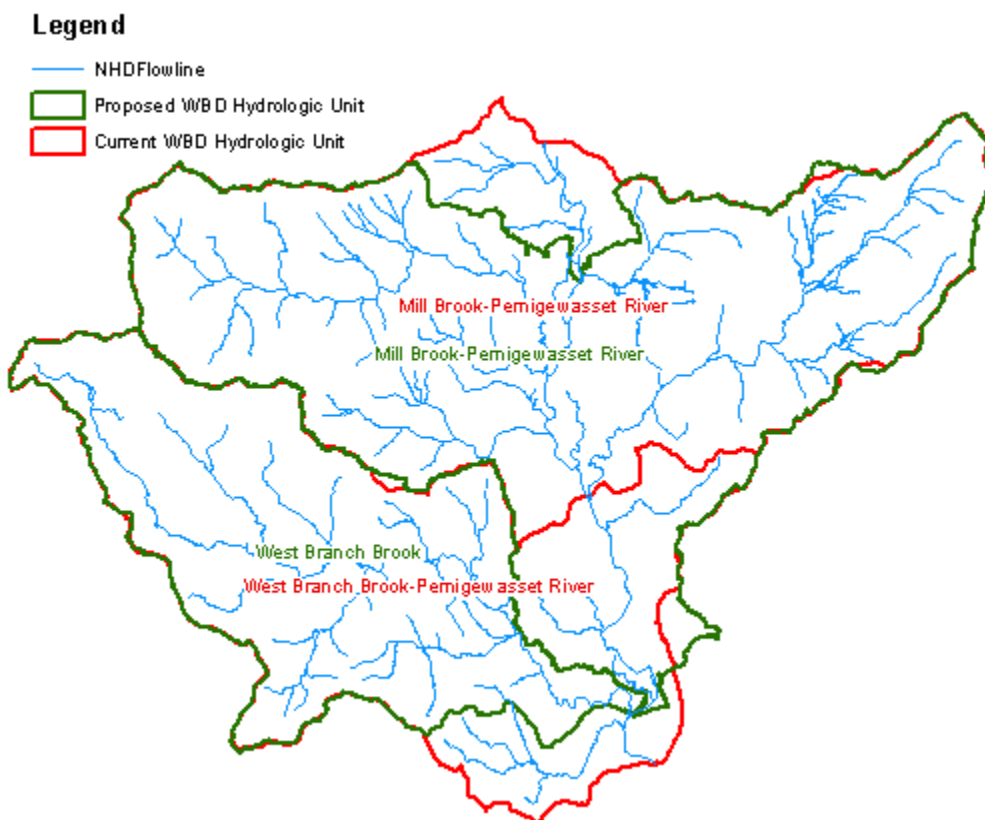


Figure 6. Proposed changes to Mill Brook-Pemigewasset River and West Branch Brook-Pemigewasset River HUC12s.

Pond Brook

The Baker River portion of the existing Pond Brook-Baker River HUC12 (010700010303) would be allocated to neighboring watersheds by moving this outlet upstream in order to isolate Pond Brook (010700010303) to its own HUC12 (Fig. 7). The name would be changed, but the code will not.

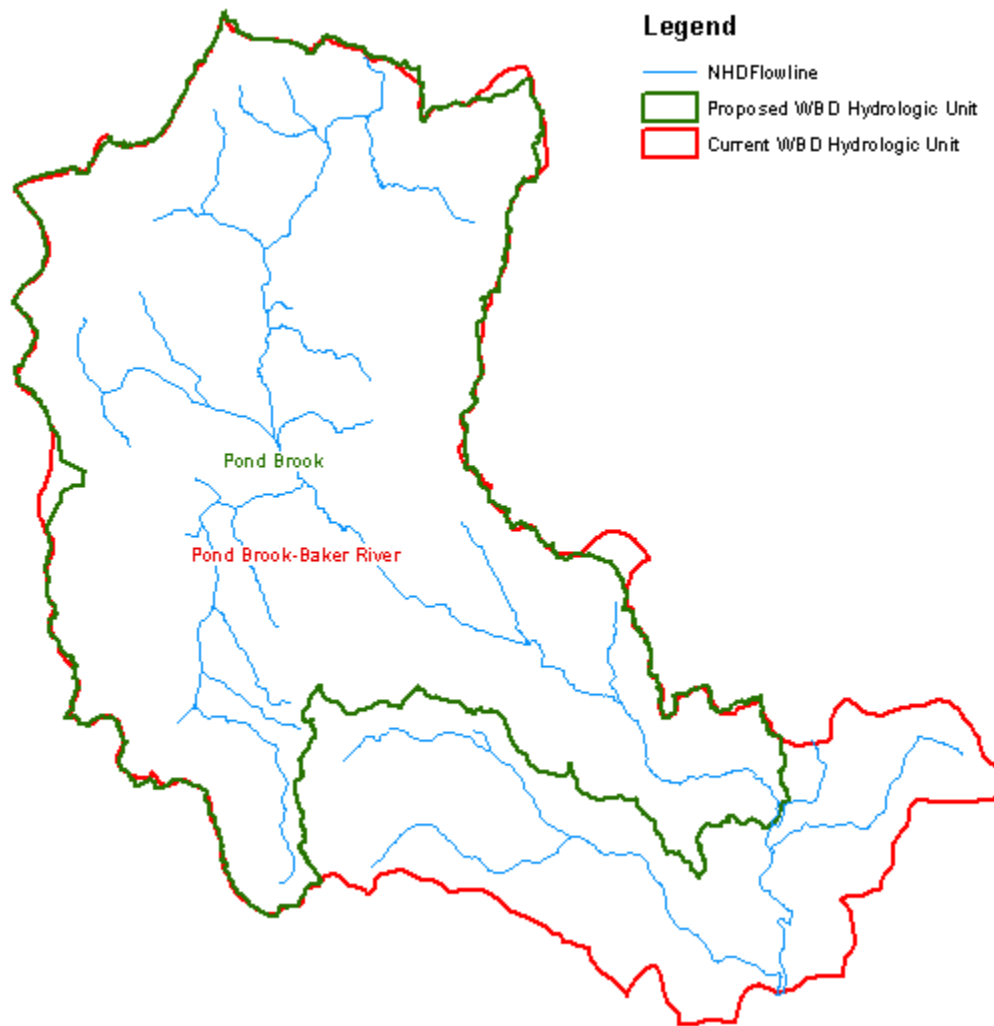
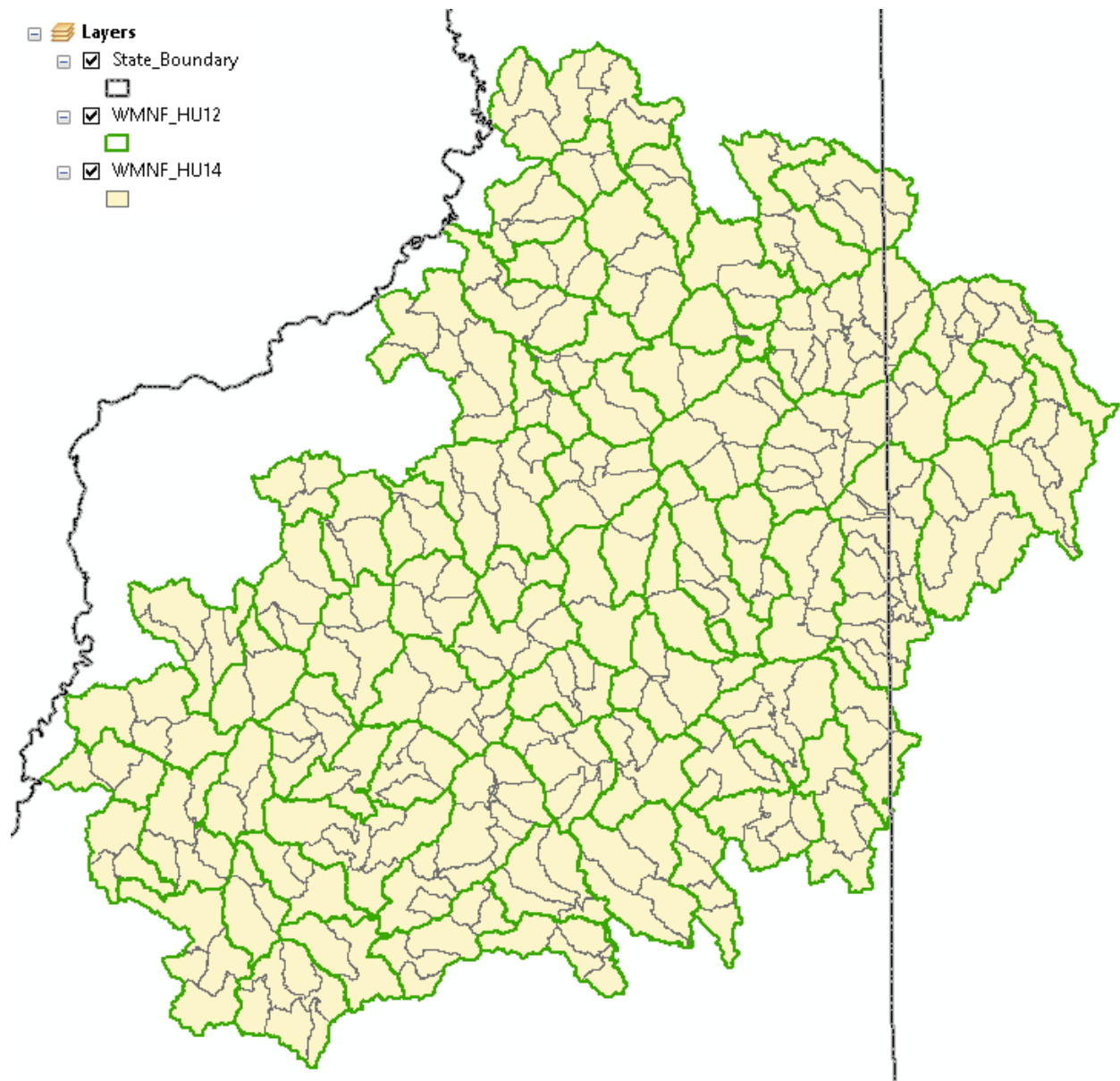


Figure 7. Proposed revisions to Pond Brook-Baker River HUC12.

New HUC14s

All HUC14s are nested within the newly delineated HUC12 boundaries and their edges are aligned. Please use the accompanying geodatabase in GIS to inspect closer.



Appendix 1: Summary of proposed changes to HUC12 watersheds (by WMNF)

Attached is a document that briefly summarizes all proposed changes to HUC12 watersheds that are not caused by improved delineations. In all cases except for one, the changes are aimed at reducing the number of hyphenated watersheds and isolating the main brook/river as its own HUC12 watershed. Based on this proposal, the following brooks/ivers would have their very own HUC12: Beebe River, West Branch Brook, Peabody River, Pond Brook, Dry River, and Moose River.

010400020102 Peabody River –Removed the small area that drains to the Androscoggin River to isolate Peabody River.

010400020104 Moose River – This is a new HUC12, which isolates Moose River from the old HUC12 010400020101 Moose River-Androscoggin River.

010400020101 Moose Brook-Androscoggin River – This is a new HUC12, which is the remainder of the old 010400020101 Moose River-Androscoggin River plus the small area removed from 010400020102 Peabody River.

010600020101 Headwaters Saco River – Dry River has been split out, forming its own new HUC12.

010600020107 Dry River – This is a new HUC12, which isolates Dry River from 010600020101 Headwaters Saco River.

010700010203 Glover Brook-Pemigewasset River – Area along the Pemigewasset River was added from 010700010205 Mill Brook-Pemigewasset River to increase the acres from 9918 to 12476 to help make HUC12 sizes a little more consistent.

010700010205 Mill Brook-Pemigewasset River – Area along the Pemigewasset River to the south was added to accommodate the changes to 010700010206 West Branch Brook HUC12. Area along the Pemigewasset River to the north was removed and added to 010700010203 Glover Brook-Pemigewasset River to help make HUC12 sizes a little more consistent.

010700010206 West Branch Brook – This HUC12 was changed to isolate West Branch Brook from areas that drain into the Pemigewasset River. The northern portion of the old HUC12 was added to 010700010205 Mill Brook-Pemigewasset River and the southern portion of the old HUC12 was added to 010700010403 Bog Brook-Pemigewasset River.

010700010402 Beebe River – Removed small area of HUC12 that drains to the Pemigewasset River, and added it to 010700010403 Bog Brook-Pemigewasset River to isolate Beebe River.

010700010403 Bog Brook-Pemigewasset River – Added the area from former HUC12 010700010402 Beebe River-Pemigewasset River that drains into the Pemigewasset River to isolate the Beebe River, and added an area from former HUC12 010700010206 West Branch Brook-Pemigewasset River to isolate West Branch Brook.

010700010303 Pond Brook – This HUC12 was changed to isolate Pond Brook from areas that drain into the Baker River. Areas removed were added to 010700010305 Halls Brook-Baker River.

010700010305 Halls Brook-Baker River – Areas from former HUC12 010700010303 Pond Brook-Baker River that drain into the Baker River were added to this HUC12.

Appendix 2: Assembling Seamless Lidar DEM (by WMNF)

In order to run the model across the White Mountain region, I needed to create a single seamless DEM (Figure 1). There are six different lidar surveys that cover the White Mountain region. I had to download the relevant data from each survey which overlapped our area of interest (Table 1.) Then, I took the individual tiles from each survey and I created one seamless DEM per survey. All of the datasets are at 1m resolution with cell values of elevation in meters, except for Connecticut Basin/Winnepesaukee which is at 2.5ft resolution and the cell values are elevation in feet. This DEM was projected to NAD_1983_UTM_Zone_19N and resampled to 1m resolution using bilinear interpolation and then converted the cell values from foot units to meter units. Next, I projected all other the datasets to NAD_1983_UTM_Zone_19N if that was not already their native projection. Then I mosaicked all of the individual datasets into one DEM at 1m resolution. The model was developed using a 2m DEM so the 1m DEM was resampled to a 2m DEM using bilinear interpolation. The final 1m DEM was 32.6 GB. This process took a long time because of the large file size, scattered locations of data collections, and many intermediate steps.

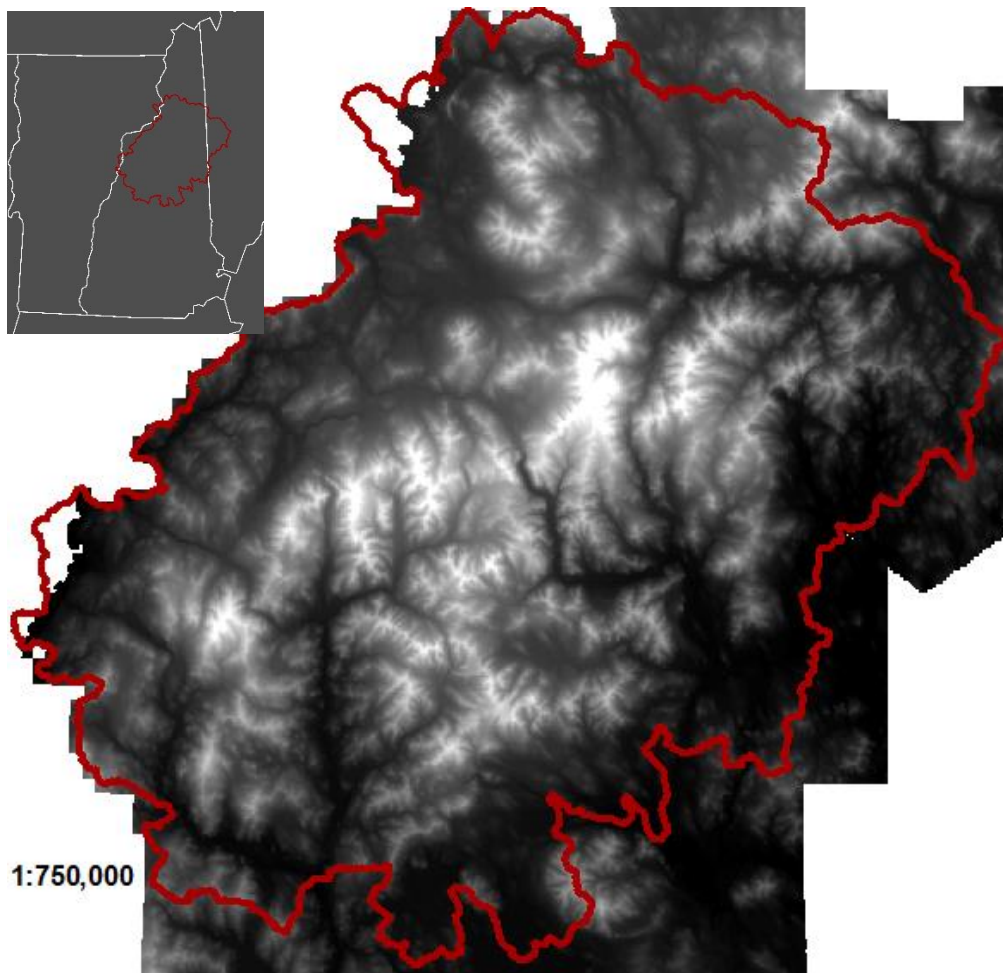


Figure 1. Seamless 1m DEM coverage with all HUC12 watersheds in the White Mountain region outlined in red. Red area is 1.7M acres. Areas with no DEM coverage inside red boundary are small areas in Vermont. This DEM only covers as far west as the Connecticut River.

Table 1. Individual lidar data collections and details about their coverage, some metadata, and preprocessing steps

Name	Location	Source	Resolution	Native Projection	Preprocess Steps
USGS-NRCS 2013 Maine	Cumberland, Kennebec, York Counties	Tiles from nationalmap.gov	1m	NAD_1983_UTM_Zone_19N	1. Mosaic tiles (Tool params – mosaic operator: mean, Environment params- snap raster to first tile in list, resample by bilinear interpolation)
2016 USGS Lidar DEM: Maine QL2	Franklin, Oxford, Piscataquis, Somerset Counties	Tiles from coast.noaa.gov	1m	NAD_1983_NSRS2007_StatePlane_Maine_West_FIPS_1802	1. Mosaic tiles (Tool params – mosaic operator: mean, Environment params- snap raster to first tile in list, resample by bilinear interpolation) 2. Project to NAD_1983_UTM_Zone_19N
CT River North 2015	Belknap, Carroll, Coos, Grafton Counties	Tiles from ftp://ftp.granit.sr.unh.edu	2.5ft	NAD_1983_2011_StatePlane_New_Hampshire_FIPS_2800_Ft_US	1. Mosaic tiles (Tool params – mosaic operator: mean, Environment params- snap raster to first tile in list, resample by bilinear interpolation) 2. Project to NAD_1983_UTM_Zone_19N (Environment params- cell size 1m, resample by bilinear interpolation) 3. Raster calculator to convert cell values from feet to meters
Umbagog 2017	Carroll, Coos, Grafton Counties	Tiles from ftp://ftp.granit.sr.unh.edu	1m	NAD_1983_2011_UTM_Zone_19N	1. Mosaic tiles (Tool params – mosaic operator: mean, Environment params- snap raster to first tile in list, resample by bilinear interpolation) 2. Project to NAD_1983_UTM_Zone_19N
WMNF 2011/2012	Coos, Grafton Counties	Tiles from WMNF GIS Staff	1m	NAD_1983_UTM_Zone_19N	1. Mosaic tiles (Tool params – mosaic operator: mean, Environment params- snap raster to first tile in list, resample by bilinear interpolation)
WMNF 2014	Carroll, Grafton Counties	Tiles from WMNF GIS Staff	1m	NAD_1983_UTM_Zone_19N	1. Mosaic tiles (Tool params – mosaic operator: mean, Environment params- snap raster to first tile in list, resample by bilinear interpolation)
<p><i>Mosaics of individual lidar data collections were mosaicked into one large mosaic with tool parameter mosaic operator of mean and environment parameters of snap raster WMNF 2011/2012 mosaic and resample by bilinear interpolation. This yielded one continuous raster dataset at 1m resolution covering all of the HUC 12 watersheds that overlap with the WMNF lands. For use in NHGS lidar-derived flowline script, raster needs to be at a 2m resolution. This raster was resampled to a cell size of 2m using bilinear interpolation.</i></p>					