# Title

## Objective

The third deliverable for GWTSC-044 N-Sink Decision Support Tool – Part II is to develop a plan for converting the current N-Sink model to a raster based model with the intent of applying N-Sink to a larger scale. A brief report or white paper, on the intended approach to be applied to larger watersheds, and/or other geographic regions.

*This should include the estimate of the time and effort to convert or apply the N-Sink approach to national level application with discussion of issues such as data acquisition and processing, regional climatic differences, and basic model assumptions on the nitrogen transformation in the landscape.*

NSink is a web-based tool for tracking relative Nitrogen removal from a user determined point, over land then along waterways to the coast. For more information about the NSink tool[[1]](#footnote-1), visit the website [[2]](#footnote-2)and the science in ACTION[[3]](#footnote-3) paper.

## What exists now

NSink currently uses vector data for input, processing and output. It contains the following sections.

#### Flow path over land

The first step creates a flow path from the user-defined location (by clicking anywhere on the landscape) to the nearest intersecting stream. If the surface flow path crosses hydric soils (wetlands), some N (equation) is removed based on the length of the flow through the wetland. If no wetlands are encountered, no N is removed and the input is the same as the output.

#### Flow through water channels

Once the flow hits the stream network, stream reaches are selected until they reach the coast. N removal is calculated for each stream reach (equation) and subtracted from the input N value (after it has crossed the land). N removal from waterbodies is part of this step (equation).

#### N Summary

The model creates an output table including the total relative amount of N upon reaching the coast as well as the breakdown of how much was removed in each step.

### Input Data

WRITE

## Vector vs Raster

Vector data consists of points, lines and polygons. A point is a single x,y coordinate. A line is a series of connected points. A polygon is a series of connected lines that has area. In GIS, each feature, whether it is a point, line, or polygon, has a unique ID and an individual record in the attribute table. Raster data is made of square picture elements, or pixels. Each pixel has a value, or a digital number. The number can refer to all types of things including reflectance of a specific wavelength of light, an elevation value or a constant. Both types of data are useful at different times and with different applications.

Vectors are advantageous because they can be high resolution without generalization, can maintain accurate geographic locations and they can be more aesthetically pleasing. The downside of vectors are that the locations of each vertex (the points that make up a point, the lines or the polygons) need to be stored explicitly. Processing and analyzing vectors can be resource and time intensive, especially or large or complicated data layers.

An advantage to rasters is that the geographic location of each pixel of a raster is implied by its position is the matrix and not all coordinates are explicitly stored. This means that data analysis is usually faster and rasters are well suited for quantitative analysis and calculations. Rasters can be stored as thematic data (discrete classes) or continuous data that is best for numeric data like elevation, reflectance or rainfall. The downside of rasters is that the cell size determines the minimum resolution. Linear, or skinny, features can be difficult to represent, especially at large pixel sizes. It is difficult to store large numbers of attributes and cartographic outputs can appear blocky, or pixelated.

In the mapping world, a common rule of thumb is “vector is better but raster is faster.” For the NSink model, the vector method works on the initial area; however, there is huge incentive to be able to expand the study area and speed up the geoprocessing. Utilizing raster models, instead of vector models, would likely decrease the processing time while keeping users interested and preventing them from bailing on the tool.

## The Vector Issues

In order for the vector data to work properly in the vector models, some data pre-processing was required. The layers originated as part of the NHD Plus and the edits included

* Joined tables to access flow/velocity numbers
* Added attributes for unit conversion
* Modified reach IDs and drainage areas because all segments in a water body needed to be treated as a single unit so that the stream had one value
* Added percent N removal so that each waterbody had a constant for removal due to retention time
* In the SSURGO data, removed hydric soils in developed areas

The biggest problem on the list is the manual editing of the reach IDs within waterbodies which was necessary to properly calculate removal due to retention time. Manual editing is time consuming and also means that new versions of NHD cannot easily be added to the model as the editing would have to be repeated. A goal of using a raster based model is to use the data as it is provided and avoid any manual pre-processing.

## NHDPlus V2 Raster Layers

The NHDPlus V2 contains raster layers ideally suited to the NSink model. They are the hydroDEM (digital elevation model), flow direction and flow accumulation. The **hydroDEM** is a raster grid of elevation values with flowlines, waterbodies and other features “burned” in. The hydroDEM is used to generate the flow direction grid. The **flow direction** raster has pixels with values representing the direction water would flow from each grid cell. The **flow accumulation** raster has pixels with values representing the number of cells flowing to that cell. The result is cells with higher values represent a stream channel.

## Raster Solution

#### Preprocessing

Where did Chris get his N values that he assigned to streams and lakes/ponds? In the paper it says from long-term stream gage data (per basin?). Would this need to be re-done? What kind of format is this data in?

#### Flow path over land

How do you create, or follow a path through a raster?

Use flow direction for least cost somehow? Raindrop analysis?

#### Flow through water channels

Some sort of cost method?

Maybe stream link tool to assign IDs to raster stream segments between intersections? Then what?

#### N Summary

## Further work

#### Explore Modeling with Map Services

Research and test existing map services for all inputs. If this works, it is an ideal scenario because the NSink team would not need to service or maintain basic map services. Some map services already exist and warrant further exploration are listed and described in Appendix XX.

#### Hydric Soils

Compare the PWSL attribute of the gSSURGO data to determine if developed lands need to be removed. If so, create a model to recode the NLCD so that developed land is 0 and all other classes are 1. Use this as a mask to the gSSURGO PWSL layer.

#### Geographic reach

If map services do not exist or are not adequate for input into the NSink raster models, the data layers will need to be downloaded and stored. The NHDPlusV2 data is available for RPU. The NRCS gSSURGO data is downloaded by state.

US consists of 20 RPU (raster processing units) which are downloaded by 23 sections. Two large RPUs (South Altantic and the Missouri) are downloaded in sections and the Alaska RPU is not listed for download. See <http://www.horizon-systems.com/NHDPlus/NHDPlusV2_data.php> for details

## Appendix XX. Burn Components

Burn components

BurnAddLine

BurnAddWaterbody

BurnLineEvent

BurnWaterbody

LandSea

Sink

Wall

## Appendix XX. Map Services

NRCS SSURGO via Esri

An indication of the proportion of the map unit, expressed as a class, that is hydric, based on the hydric classification of individual map unit components.

<http://www.arcgis.com/home/item.html?id=a9b70534e5eb42ae89486e7dd5c47c1f>

NLCD Land Cover

A 16-class land cover derived from Landsat satellite imagery and other sources. Layer 4 is the 2011 land cover for the continental US.

<http://raster.nationalmap.gov/arcgis/rest/services/LandCover/USGS_EROS_LandCover_NLCD/MapServer>

High Resolution NHD

The map service displays key layers of the NHD including vector flowlines, streams, rivers and waterbodies.

<http://www.arcgis.com/home/item.html?id=c3cbe1eaf6f4492db74e62f7f4ba2418>

USA National Hydrography Dataset Plus Version 2.1 Seamless

The map services contains many key features of the NHDPlusV2 including rivers and streams (flowlines), lakes, bays and other waterbodies, and sinks.

<http://www.arcgis.com/home/item.html?id=5600cf6b463043ec97b764fb258997be>

USA NHDPlusV2

This map service contains a subset of the NHDV2Plus dataset. The flowline attributes include some value added attributes including flow estimation models.

<http://www.arcgis.com/home/item.html?id=7c7aa61a3650490789545a515c24cc80>

EPA WATERS

The EPA Waters program maintains a number of web services that could be useful to the raster-based NSink model. Two services are of particular interest.

<http://water.epa.gov/scitech/datait/tools/waters/services/index.cfm>

The first is the Point Indexing Service. The Point Indexing service provides a raindrop point indexing function that utilizes the NHDPlus flow direction grid to travel “downhill” to the nearest NHD flowline.

<http://water.epa.gov/scitech/datait/tools/waters/services/upstream_downstream_service.cfm>

The second is the Upstream/Downstream Service. It is designed to provide standard traversal and discovery functions upon the NHDPlus stream network. It includes a start and end point.

<http://water.epa.gov/scitech/datait/tools/waters/services/upstream_downstream_service.cfm>

EPA WATERS also serves several map services. Of interest is the NHDSnapshot\_NP21 service which provides access to NHDPlusV2.1 features in the Web Mercator projection.

<http://water.epa.gov/scitech/datait/tools/waters/services/mapping_services.cfm>

## Acronyms

DEM – Digital Elevation Model. A raster dataset where the value of each pixel is elevation.

Esri – Environmental Systems Research Institute (geographic software company)

gSSURGO – gridded Soil Survey Geographic Database. From the USDA NRCS.

NHD – National Hydrography Dataset. A set of geographic-based hydrography data produced by USGS.

NLCD – National Land Cover Dataset. Produced by USGS and NOAA.

NRCS – Natural Resources Conservation Service. Part of the USDA.

PWSL – Potential Wetland Soils Landscapes

RPU – Raster Processing Unit. The area used by USGS for processing the NHD version 2 data.

1. http://www.edc.uri.edu/nsinkv2/ [↑](#footnote-ref-1)
2. http://clear.uconn.edu/projects/nsink/index.htm [↑](#footnote-ref-2)
3. Address? [↑](#footnote-ref-3)