Lower Neuse Basin Association® / Neuse River Compliance Association®
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March 28, 2025

Pam Behm, Branch Chief DWR Modeling & Assessment Branch
N. C. DEQ Div. of Water Resources
1611 Mail Service Center
Raleigh, N. C. 27699 - 1611

Subject: Comments on Neuse River Watershed HSPF Modeling Report
RESPEC Revision 2 Report RSI-3348 December 9, 2024

Dear Mrs. Behm,

I am writing this letter as Chairman of the Neuse River Compliance Association (NRCA) and The Lower Neuse Basin Association (LNBA) on behalf of the Associations' members. The NRCA has been the primary vehicle for point source nitrogen reductions in the Neuse Basin through its innovative approach to provide our members with various incentives to reduce nitrogen discharged to the surface waters. Our members' investment in facility improvements has exceeded $500,000,000 with reductions exceeding 60% in total nitrogen delivered to the Neuse Estuary since the Neuse Management Strategy went into effect in 2003. I respectfully submit the attached comments on the Final HSPF Model.

Subject to the findings of the two "qualified professionals" selected by the EMC to validate the modeling, the Model document appears to meet the requirements of Session Law 2023-137 Section 15(c). The model and tools from this effort not only provide for the calculation of nutrient transport factors for the Neuse Watershed but also provides an opportunity to compare nutrient loading from the Final Phase II TMDL of Dec 2001 (page 44) to the RESPEC HSPF modeling report of December 2024. The NRCA members understand that the Division of Water Resources is specifically seeking comments on the HSPF Model Report. The attached comments, prepared with the assistance of our contractors, are specific to the HSPF Model Report but we also take this opportunity to include comments relevant to the usefulness of this report in altering the water quality management of the Neuse Basin.

Thank you for the opportunity to submit these comments. If you require additional information or have questions about our comments, please contact Haywood Phthisic.

Sincerely,

Charles Smithwick, Chairman

cc: LNBA/NRCA Board Members
J.D. Solomon, Chairman N.C. EMC
Richard Rogers, Director N.C. DWR

Neuse River Compliance Association® and Lower Neuse Basin Association®

Comments on the Neuse River Watershed HSPF Modeling Report prepared by

RESPEC Revision 2 Report RSI-3348 December 9, 2024

- Subject to the findings of the two "qualified professionals" selected by the EMC to validate the modeling, the document appears to meet the requirements of Session Law 2023-137 Section 15(c).
- The HSPF Model seems to be a reasonable tool, but like all models, many assumptions have been included without the benefit of actual data thus raising concerns for the implied accuracy of the model's calculations. Thus, confidence in the implied accuracy of the model must be questioned especially since the uncertainty is not estimated or quantified.
  - The interface developed with the model tracks direct inputs (e.g. outfall), the settling of a portion of the Nitrogen to the stream bed, and the resuspension of Nitrogen stored in the stream channel from each sub-watershed. This appears to be conceptually correct, but accuracy depends on the assumptions needed to implement.
  - There are key limitations with the HSPF model in terms of stream bank erosion simulation that affect predictions of downstream transport of Nitrogen discharged from a facility in the watershed to estuarine waters (appropriately highlighted on p.82 of report).
  - The efficiency of permanent storage of Nitrogen in the stream channel from upstream loading is based on assumptions about resuspension and scour. The importance of accurate calculation of permanent storage is higher permanent loss decreases the transport factor (i.e. lower percentage reaches the estuary) and lower loss increases the transport factor. This issue creates uncertainty in calculated transport factors.
  - The review of model calibration provided by Dr. Martin Lebo with WSP, Inc. to the LNBA/NRCA on June 11, 2024 on the hydrology and water quality calibration for the model received March 23, 2024 remains pertinent to the final model, as the final report included plots that illustrate the areas for improvement identified in the June 11th review. A copy is attached.
  - The uncertainty in the partitioning Nitrogen loads to resuspension versus permanent deposition affects the calculated transport factors. Use of three significant digits overstates the accuracy thus, reporting to two digits is more appropriate.
- Perhaps a reasonable path forward is to confirm that the current transport factors used for Point Source permitting are consistent with model output. The modeling tool could potentially be used to translate Nitrogen credits from one discharge location to another one within the watershed. But this needs further exploration.
- It is significant that this new HSPF model provides an opportunity to compare nutrient loading from the Final Phase II TMDL of Dec 2001 (page 44) to the RESPEC modeling report of December 2024.
  - The Final Phase II TMDL recognizes Point Source TN was 3,320,000 million pounds per year which arrives at New Bern and Nonpoint Source TN 6,330,000 million pounds per year arrive at New Bern. Thus, the ratio of TN is 34% point source and 66% non-point source.

    - The Neuse River Watershed HSPF Modeling Report indicates that Point Sources contribute 7.9% of Nitrogen and 14.2% of Phosphorous of the load from the basin (page 59). Further, 1,761,576 pounds of nitrogen are generated from point sources (page 61).
    - In comparing the Final Phase II TMDL Report to the HSPF Report, the RESPEC model indicates there has been a 53% reduction in nitrogen from point sources.
- Overall, the HSPF calculated delivery factors suggest that approximately 50% of the discharged N actually reaches the estuary. If this is a correct understanding, Point Sources are now only about 4% of the delivered N load to the estuary. While the previous TMDL 2001 Report indicated that Point Sources contribute 34% of the N load to the estuary.
- Adding additional context to the HSPF report would be very beneficial. Perhaps the addition of a DWR forward, or some plain language discussing the PS/NPS management significance of this report would be particularly helpful. The report could better inform DWR and the EMC of any appropriate application limitations of the modeling. Further, it is noted that the new HSPF Model Report does not seem to explain the derivation of the point source data or the period of record that was used to prepare the point source effluent loading data.
- It is strongly suggested to provide an additional column to Table 2.3 that would clearly show the N&P delivery factors calculated for each individual Point Source. Thus, simplifying and targeting the interests of the NPDES Permit holders.
- Attached please find a set of calculations offered by the NRCA/LNBA to help illustrate the effect of the HSPF transport revisions should they be implemented into NPDES permit calculations. The Session Law does not address whether the new model values will be applied to existing TN Estuary allocations. Should the new model values shown in this table be applied to existing TN Estuary allocations, 8 members of the NRCA will lose allocation, up to as much as 25%. This may impact not only the operational capacity of the already permitted Point Sources, it may also place those members in jeopardy with their bond holders. The remaining members of the NRCA are shown to be eligible for an increase in their loading equal to a potential Net increase to the allowable end-of-pipe Nitrogen discharged by NRCA members of 248,284 pounds end of pipe.

Current TN Allocation & Transport Factor				Neuse Watershed Model New Transport Factor & EOP Total Nitrogen w/ no Change in Estuary Allocation.			
NRCA Member	**Transport Factor**	**Estuary Allocation**	**EOP Allocation**	**Model HSPF Reach**	**Transport Factor**	**(New) EOP Allocation**	**Net Allocation Change**
Apex	0.5	20,274	40,548	171	0.353	57,433	16,885
Benson	0.5	16,535	33,070	253	0.412	40,133	7,063
Cary - North	0.5	71,623	143,246	33	0.344	208,206	64,960
Cary - South	0.5	90,105	180,210	173	0.384	234,648	54,438
Raleigh - SC	0.5	35,407	70,814	10	0.405	87,425	16,611
Raleigh - NR	0.5	356,687	713,374	110	0.462	772,050	58,676
Raleigh - LC	0.5	13,330	26,660	531	0.237	56,245	29,585
Clayton	0.5	13,318	26,636	130	0.475	28,038	1,402
Neuse Colony	0.5	4,224	8,448	150	0.480	8,800	352
JoCo	0.5	36,738	73,476	210	0.529	69,448	-4,028
Kenly	0.5	3,548	7,096	329	0.525	6,758	-338
Farmville	0.5	21,106	42,212	613	0.669	31,549	-10,663
Snow Hill	0.5	2,816	5,632	595	0.657	4,286	-1,346
Wilson	0.5	78,943	157,886	553	0.516	152,990	-4,896
Duke Energy	0.7	2,282	3,260	310	0.628	3,634	374
Goldsboro	0.7	139,876	199,823	350	0.620	225,606	25,784
La Grange	0.7	5,913	8,447	451	0.608	9,725	1,278
Kinston	0.7	88,697	126,710	510	0.767	115,641	-11,069
Contentnea MSD	0.7	25,970	37,100	619	0.760	34,171	-2,929
Covation Bio	0.7	17,845	25,493	530	0.790	22,589	-2,904
New Bern	1	64,210	64,210	717	0.981	65,454	1,244
Cherry Point	1	39,421	39,421	761	0.887	44,443	5,022
Havelock	1	21,400	21,400	761	0.887	24,126	2,726
CWS	1	11,263	11,263	779	0.995	11,320	57
		1,181,531	2,066,435			2,314,719	248,284

MEMO

TO: Haywood Phthisic, LNBA/NRCA

FROM: Seth Jelen and Martin Lebo

SUBJECT: **Neuse Watershed Model – Nutrient Review**

DATE: **June 11, 2024**

OBJECTIVE

The working files for the Neuse River Watershed Model developed in HSPF by RESPEC were examined relative to the updated hydrology calibration and to parameters associated with the nutrient calibration to provide feedback to the model development process.

BACKGROUND

An initial set of files for the working model for the Neuse River Watershed was provided to WSP on January 11, 2024, from the model development team. Preliminary feedback was provided on February 1, 2024, at the regular meeting of the LNBA/NRCA. Additional review of the hydrology calibration of the working model was completed in February 2024, and observations were summarized in a February 26, 2024, memo.

Revised files for the working model were provided to WSP on March 23, 2024, for the updated hydrology calibration and the calibration of nutrient parameters. This memo summarizes observations for the working model received March 23, 2024.

REVIEW APPROACH

The initial review for the hydrology calibration in February 2024 reviewed flows at the primary gaging locations throughout the Neuse River watershed downstream of Falls Lake Dam. **Figure 1** plots the HSPF model reaches (GIS info provided to WSP) by color of degree of concern with the hydrologic calibration to-date. The review of the revised calibration of hydrology selected three mainstem stations (Reaches 130, 350, and 630) and three key tributaries (Little River, Reach 331; Crabtree Creek, Reach 41; Contentnea Creek, Reach 544). Review of revised working model was mainly a visual review of flow duration curve, monthly averages, and annual averages at each reach.

Review of the revised working model for the nutrient calibration began with general water quality parameters of temperature and dissolved oxygen and progressed to solids and nutrient parameters. Files and plots provided were reviewed.

OBSERVATIONS

The following are general observations for the revised calibration of hydrology:

- Modest improvements in the flow duration curve for Neuse River mainstem stations (Reach 130, 350, and 630), with more improvements in upper and middle portions of the watershed.
- Crabtree Creek (Reach 41) showed an improved flow duration curve.
- Little River (Reach 331) showed limited improvement relative to the January 2024 working model.
- Contentnea Creek (Reach 544) showed an improvement on high flows but unclear if the calibration for low flows changed.
- Thus, the modeling team achieved modest improvements in the calibration of hydrology for the March 2024 working model compared to the version distributed in January 2024.

The following are general observations for the March 2024 working model for temperature, dissolved oxygen, and solids:

- Simulated temperature in several tributaries in upstream (Reaches 41 and 83) and middle (Reaches 179, 193, 265, 281, and 339) portions of watershed and in Contentnea Creek subwatershed (Reaches 545, 569, 593, and 615) were 3-5°F higher than observed in warm months. This temperature difference was systematic and of concern because it affects the dissolved oxygen saturation.
- Simulated temperature for reaches along the mainstem of the Neuse River (Reaches 130, 170, 230, 350, 410, 470, 510, 595, and 630) were generally good, although there was a 1-2°F overestimation at the headwater reaches (Reaches 90 and 130), which raises the same concern as for tributaries.
- Simulated dissolved oxygen was low at some stations in tributaries (Reaches 179, 545) but high in others (Reaches 339, 593). Mainstem stations along the Neuse were generally good but had lower simulated dissolved oxygen at some (Reaches 350, 630). In general, the lower simulated dissolved oxygen is consistent with higher simulated temperature. It is expected that addressing the temperature issue will also address the dissolved oxygen.
- TSS simulation was good at many locations but low at a number of model reaches, including Walnut Creek (Reach 83) and the Neuse mainstem (Reach 90) in the

upstream portion of the watershed, Reach 230 in the Neuse mainstem, and Contentnea Creek (Reach 545). Simulated TSS is actually overestimated at the downstream location in the Neuse mainstem during warm season months (Reach 630).

The following are general observations for simulation of chlorophyll concentrations at reaches throughout the watershed:

- Comparison of simulated chlorophyll-a concentration to observed conditions showed a different seasonal distribution (summer peak versus late winter peak) at Reaches 350 and 630 along the Neuse River mainstem and in Contentnea Creek at Reach 595.

The following are general observations for orthophosphate / total phosphorus:

- Simulated time series and percentiles show a good match for orthophosphate with observed conditions. The exceptions are Contentnea Creek (Reach 595) and the Trent River (Reach 745) where the concentration is underestimated, which may reflect that the model does not reflect P-rich groundwater inflow and confined animal operations, respectively, in those areas.
- Simulated total phosphorus shows a good match with observed data for time series and percentile figures.

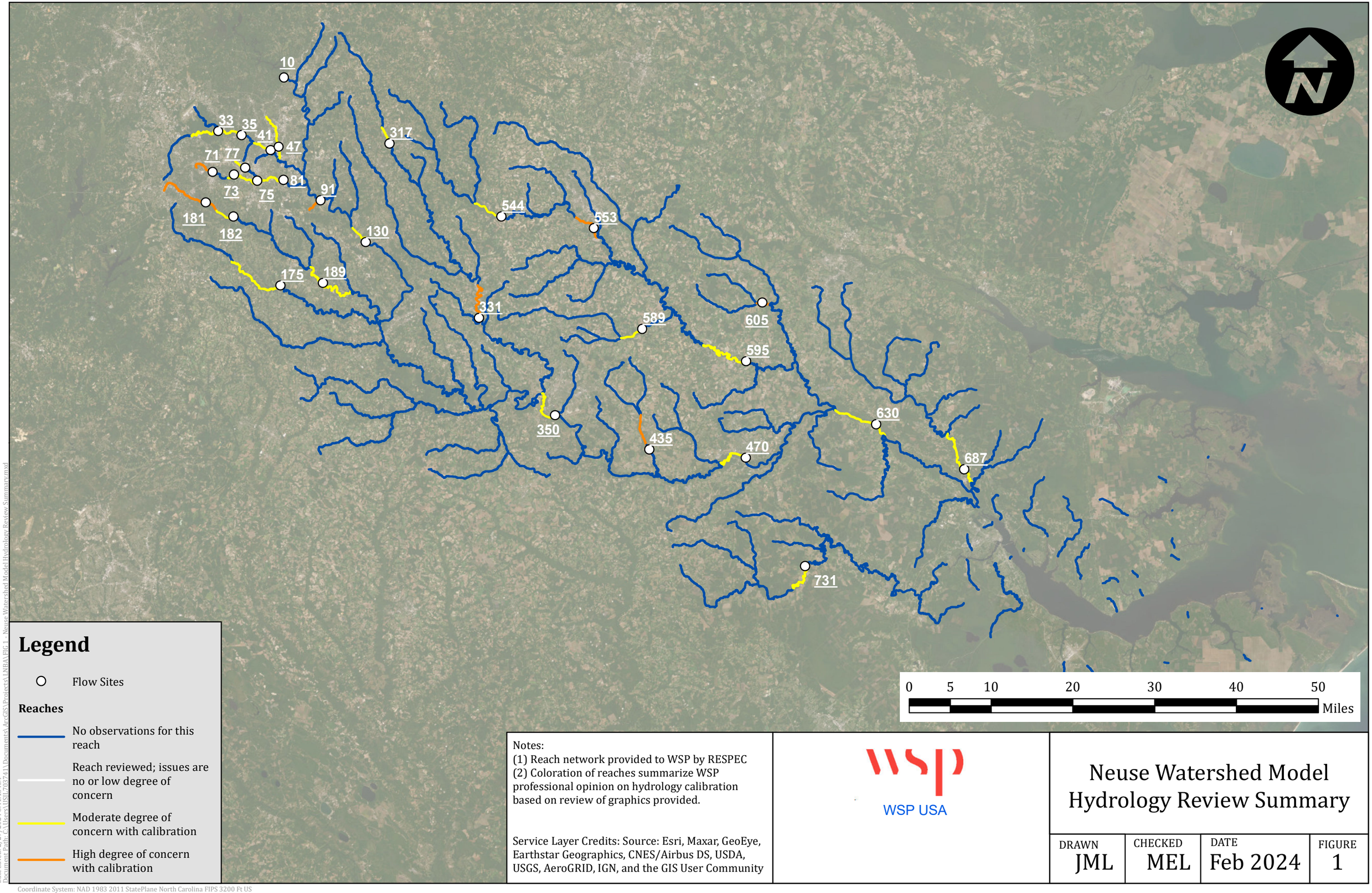
The following are general observations for nitrogen species:

- Nitrate along the Neuse River mainstem has a low bias for Reaches 90, 130, 170, 230, 410, 470, and 630 while there is a winter high bias for Reach 350. Simulated nitrate shows overestimated values at Reaches 179, 193, and 265 in the middle portion of the watershed.
- Ammonium has a different pattern versus observed with simulated high in winter and observed mostly constant. Simulated concentrations are mostly higher than observed values.
- Total Kjeldahl Nitrogen (TKN) has a low bias for Neuse River mainstem Reaches 230, 470, 510, and 630 and a good match for Reach 410. In contrast, TKN was generally overestimated for tributaries.
- The Neuse River gradient for Total Nitrogen reflected changes in nitrate and TKN, with a low bias for mainstem stations and a high bias for tributary locations.

DISCUSSION

1. Modeling team achieved incremental improvements in the calibration of hydrology for the March 2024 working model.

2. The overestimation of warm season temperature in tributaries may indicate that increased shading for tributary subwatersheds may be needed so that solar radiation is less effective at warming the water. Higher shading for tributaries than mainstem stations is consistent with the physical setting for tributaries in the Neuse River watershed.
3. The overestimation of temperature in warm months for tributaries may affect biological rates, including degradation of organic matter and depletion of dissolved oxygen. Also, dissolved oxygen is less soluble at higher temperature, which would affect reaeration processes.
4. Low TSS, particularly at low flows, may have some indirect effects on simulation of nutrient parameters.
5. Seasonal timing of peak chlorophyll-a observed (generally February-March) not captured in simulated values. Model predicted peak chlorophyll-a in warm season at peak values three-fold higher than observed winter peak. The higher chlorophyll-a in warm months could correlate with overestimating transport of Total N to the estuary.
6. The good fit for orthophosphate and total phosphorus suggests this may have been a primary modeling focus. However, research over the past two decades would support nitrogen as the limiting nutrient factor in the Neuse River rather than phosphorus.
7. Improvement to nitrate, ammonium, and TKN will improve the overall prediction of Total Nitrogen.
8. Priority for modification of calibration would be: (1) address temperature bias in tributaries, which affects dissolved oxygen, organic reaction rates and other processes that are temperature dependent; (2) investigate possible changes to adjust suspended sediment – does modeling indicate this is a limitation in hydraulic capacity linked to particle sizes simulated?; (3) investigate why the chlorophyll-a concentrations have such different patterns; and (4) investigate the sources of nitrate and ammonium that should be modeled differently to improve the seasonal fit – the systematic differences in nutrients are likely part of the difficulty in simulating nitrogen patterns.



Legend

- Flow Sites

Reaches

- No observations for this reach
- Reach reviewed; issues are no or low degree of concern
- Moderate degree of concern with calibration
- High degree of concern with calibration

Notes:
(1) Reach network provided to WSP by RESPEC
(2) Coloration of reaches summarize WSP professional opinion on hydrology calibration based on review of graphics provided.

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

WSP USA

Neuse Watershed Model Hydrology Review Summary

DRAWN	CHECKED	DATE	FIGURE
JML	MEL	Feb 2024	1

Coordinate System: NAD 1983 2011 StatePlane North Carolina FIPS 3200 Ft US

Date Saved: 2/27/2024 8:41:13 AM
Document Path: C:\Users\USJL703741\Documents\ArcGIS\Projects\LNBA\FIG 1 - Neuse Watershed Model Hydrology Review Summary.mxd