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MEMORANDUM

TO: Great Bay Municipal Coalition

CC:

FROM: Hall & Associates

DATE: May 29, 2018

RE: Evaluation of 2018 Cocheco River and Bellamy River Sonde Data

This memorandum provides an evaluation of the provisional 2018 Cocheco River and Bellamy River sonde data to see if the previously observed correlation between tidal condition and water quality (chlorophyll) is still present. Data sondes were deployed in the Cocheco River (Station CR7) and the Bellamy River (Station NH-0052A) by PREP on 4/11/2018 and 4/12/2018, respectively. The data for both sondes were retrieved on 5/10/2018 during routine servicing of the instruments. The sonde data were reviewed to investigate the occurrence and potential causes of a previously observed correlation between chlorophyll-a and tide stage in these rivers. Parameters evaluated include chlorophyll-a (uncorrected for pheophytin), depth (tide), and turbidity. Local precipitation and Cocheco River flow data were also reviewed to gain insight into factors influencing the observed results.

Initially, the chlorophyll-a data were graphed and reviewed (Figures 1, 2).

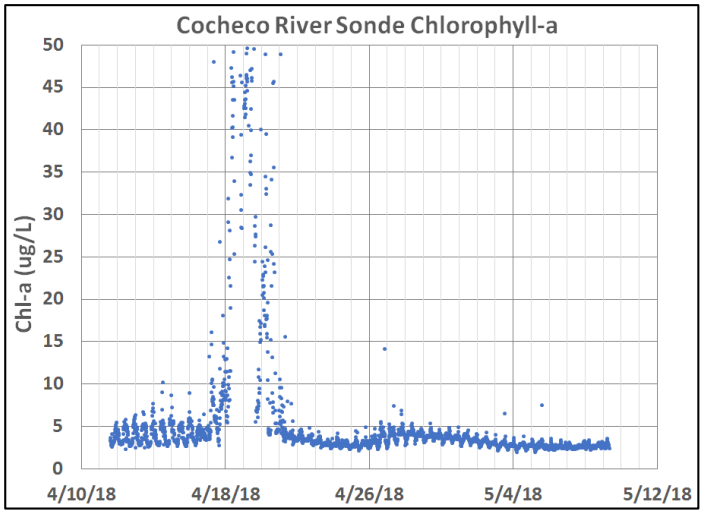

Figure 1: Cocheco River Sonde Chl-a. For improved resolution, data exceeding 50 ug/L (n=92), with a maximum of 402 ug/L, from 4/17-4/20 were omitted from the figure.

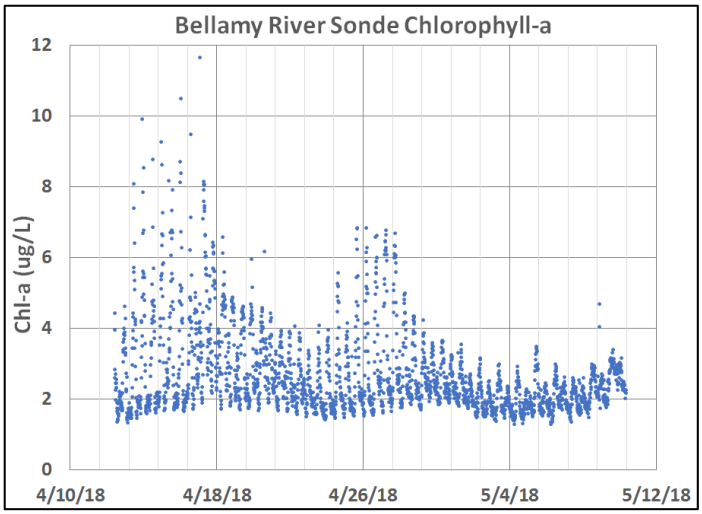

Figure 2: Bellamy River Sonde Chl-a. For improved resolution, data exceeding 12 ug/L (24.4, 50.3, 58.7, and 295 ug/L) on 4/20/18 were omitted from the figure.

Both sondes recorded a cyclically fluctuating pattern in measured chlorophyll concentration, that appears to be correlated with the tidal cycle (e.g., 4/27-5/2). This pattern is consistent with the previously observed relationship between chlorophyll-a and tide stage in the Cocheco River (2015 sonde data) and Bellamy River (2017 sonde data), although the amplitude of the fluctuations is much smaller than those observed later in the growing season in previous years. Representative data subsamples are provided in Figures 3 and 4 to illustrate this pattern.

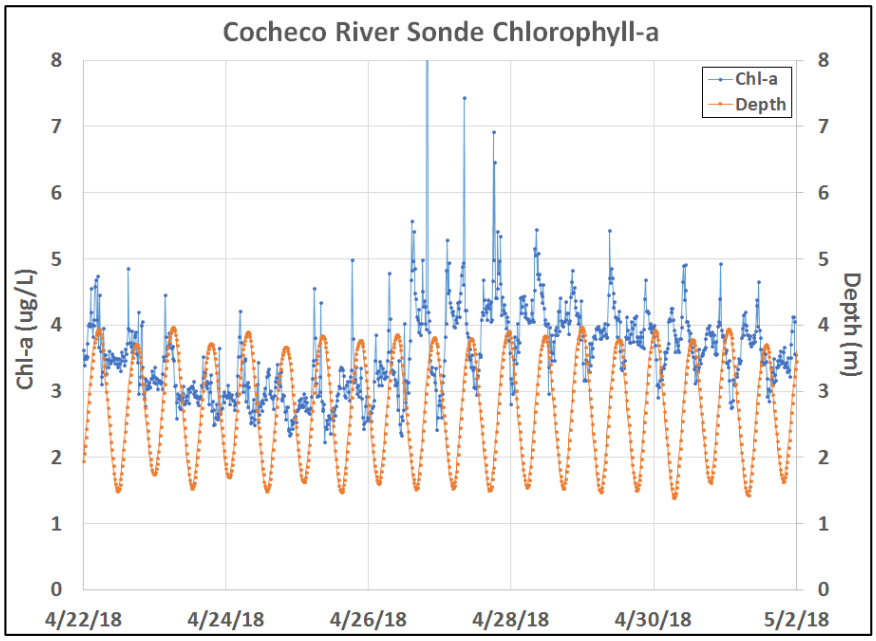

Figure 3: Cocheco River Chlorophyll-a and Tide Stage

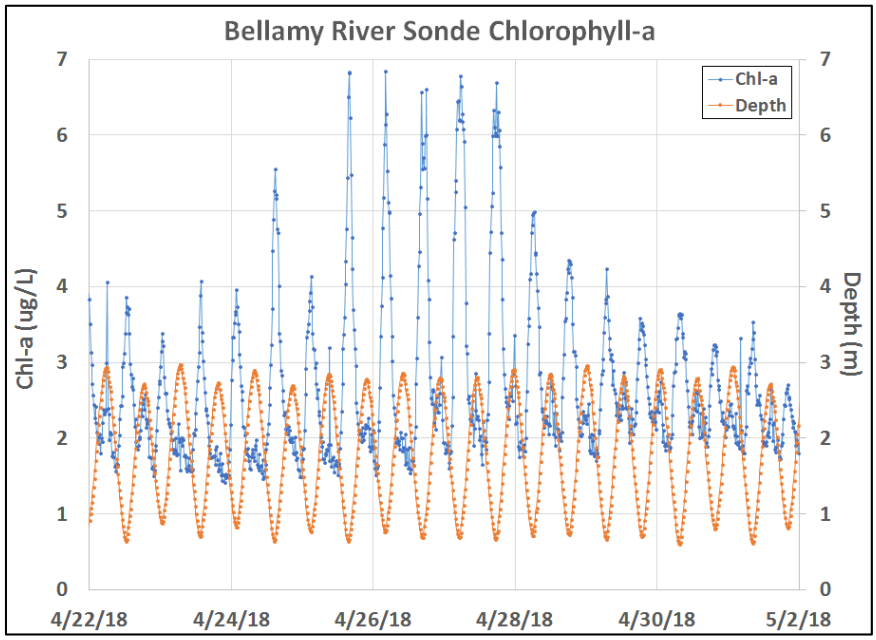

Figure 4: Bellamy River Chlorophyll-a and Tide Stage

The data for both sondes show that chlorophyll concentration and tidal stage are inversely correlated, with chlorophyll concentration increasing as the tide falls. The peaking that is correlated with low tide conditions may be attributed to the change in available dilution at high and low tide. Hydrological estimates of high water and low water volume developed by PREP[1] indicate that the water volumes in the Cocheco and Bellamy Rivers decrease by 98% and 90%, respectively. These volume changes would not affect the instream concentration if the primary source of chlorophyll was the ambient concentration. However, if the source is an external load, the large decrease in water volume at low tide would explain the observed pattern in concentration. While the primary driver of this cyclical pattern has not yet been determined, the evaluation below suggests that it is associated with scour in response to tidal currents.

The chlorophyll data for both sondes show generally low concentrations with the exception of a spike in concentration that occurred in the middle of the month, which is particularly noticeable in the Cocheco River measurements (Fig. 1). The spikes in chlorophyll concentration were associated with greatly increased river flows in response to over 2" of precipitation on April 15-16 (Fig. 5).[2] When the daily average flow is plotted with the daily average chlorophyll concentration, the correlation between the flow increase and the spike in chlorophyll becomes obvious (Fig. 6).

[1] Hydrological Prarameters for New Hampshire's Estuaries. PREP Reports & Publications. 12-2007
[2] Rochester, NH, Weather History – April 2018. https://www.wunderground.com/history/airport/KDAW/2018/4/15/MonthlyHistory.html?req_city=&req_state=&req_statename=&reqdb.zip=&reqdb.magic=&reqdb.wmo=

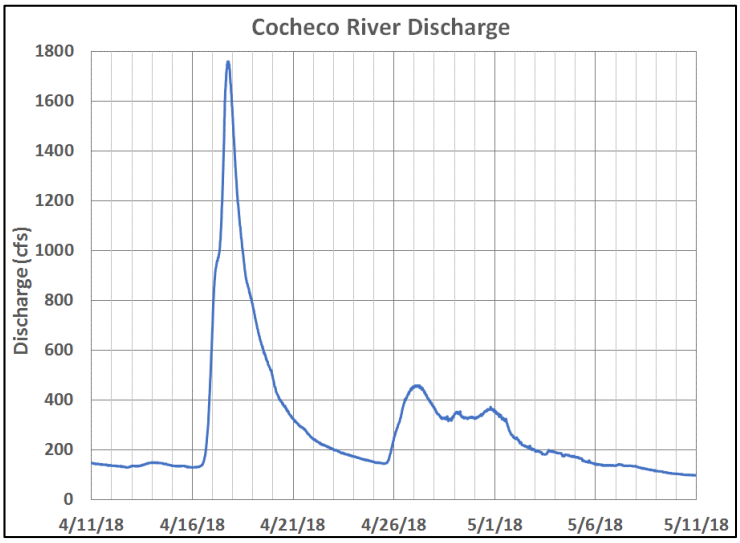

Figure 5: 15-Minute Cocheco River Discharge at Rochester (USGS 01072800)

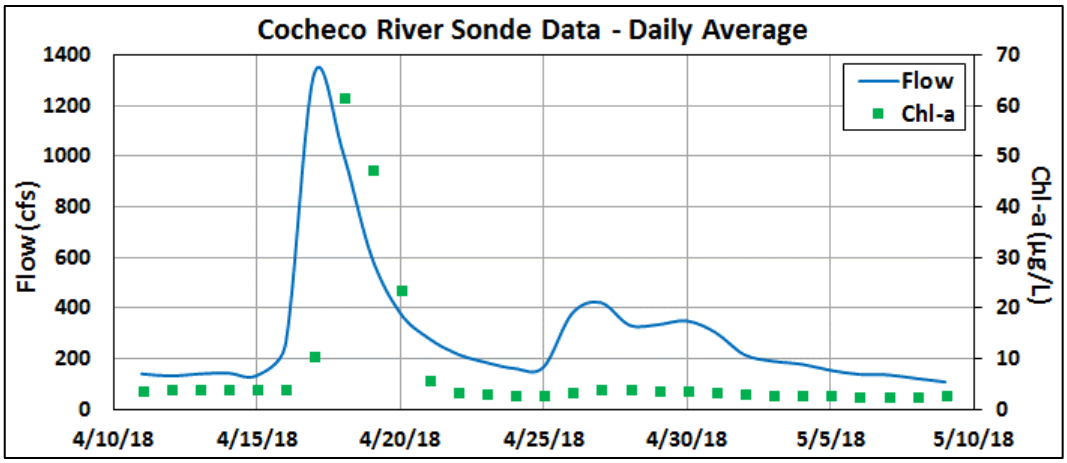

Figure 6: Cocheco River Daily Average Flow and Sonde Daily Average Chl-a

This high flow event was also associated with greatly increased turbidity in both the Cocheco and Bellamy River sondes (Figs. 7, 8). We expect that this increase in turbidity was attributed to the increase in river flow, carrying suspended particles from surface runoff. The increase in chlorophyll concentration in the Cocheco River occurred at the same time as the turbidity spike, suggesting the two are interrelated. A less pronounced increase in chlorophyll concentration also occurred in the Bellamy River.

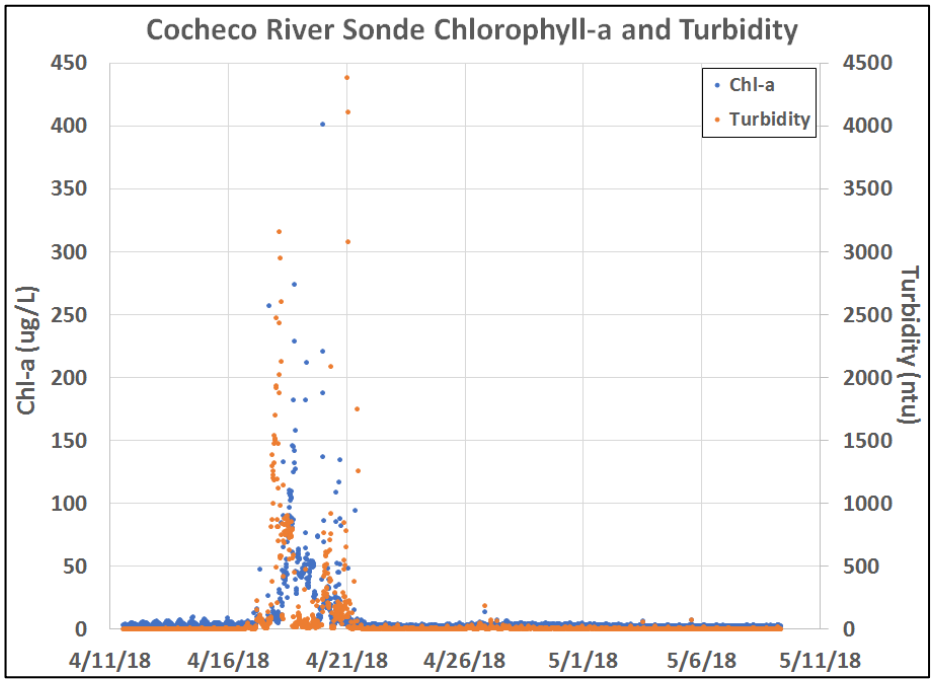

Figure 7: Cocheco Chlorophyll-a and Turbidity

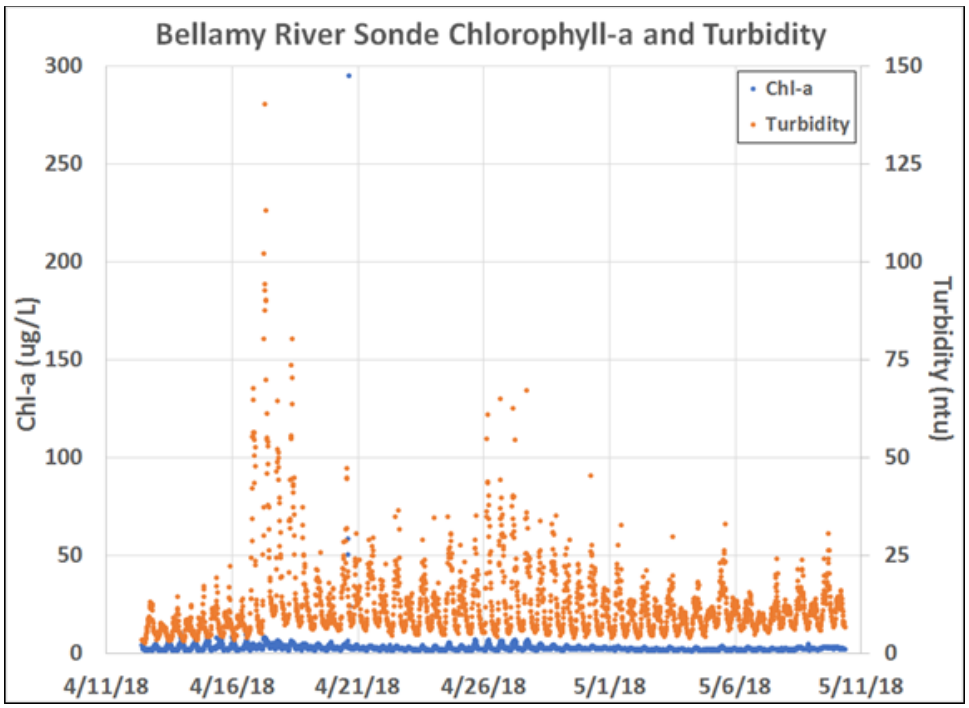

Figure 8: Bellamy Chlorophyll-a and Turbidity

This concurrent turbidity increase supports the hypothesis that the elevated chlorophyll-a readings were caused by rainfall-induced scour, flushing both live plant matter and detritus from the surrounding watershed. It is unlikely that the spike in chlorophyll concentration is due to a bloom or to the inflow of living algae from an upstream source because the observed

instantaneous chlorophyll concentration (up to 400 µg/L) cannot be explained by growth, but can be attributed to scouring.