GREAT LAKES INDIAN FISH AND WILDLIFE COMMISSION

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Via Electronic Mail / Original by Mail

March 2, 2012

Memorandum

To: Thomas Hingsberger USACE
Erik Carlson Minnesota DNR

From: John Coleman, Environmental Section Leader

Re: Polymet model calibration to Partridge River low flows

The hydrologic models for the Polymet mine site have been calibrated to targets that under-represent true baseflow. Models should be calibrated to a strong set of observational data. Construction of the site's basic hydrologic model to unrealistically low baseflows has ramifications for all the flow and contaminant modeling at the site.

Under-representation of Partridge River baseflow.

Review of the winter baseflow measurements and comparison to predictions made by XP-SWMM indicate that XP-SWMM substantially underpredicts baseflow (Barr June 9, 2011, Comparison of MDNR winter flow gauging to Partridge River XP-SWMM model). This has ramifications throughout the parameter sets being used in models characterizing hydrology at the Polymet mine site.

In the above referenced memo, Barr points out that the average measured baseflow at Dunka Rd. was 5.0 cfs while the XP-SWMM predicted baseflow is 0.4 cfs. Even when discharge from Northshore Mining was taken into account, the average baseflow measured at Dunka is 4.3 cfs while XP-SWMM predicts 0.42 cfs.

In its memo, Barr correctly points out that: "At all locations along the main stem of the Partridge River, the XP-SWMM-estimated baseflow is less than the MDNR-measured baseflow. The XP-SWMM model provides a conservative estimate of Partridge River baseflow for the purposes of modeling water quality impacts (e.g., less dilution of loads from the Mine Site)." What is not acknowledged in the Barr memo is that calibration of hydrologic models to an underestimate of baseflow produces models that characterize the groundwater hydrologic system as moving an unrealistically small quantity of water.

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Additional flow measures over the last 9 months on the Partridge River at the Dunka Road (site SW-003) further support the position that baseflow predicted by XP-SWMM under-represents true baseflow. The least flow measured at the Dunka Road site was 3.8 cfs. While there have so far been only 7 measurements taken at that site, the flow measured and the stage recorded by the gauge do not appear to support XP-SWMM's low baseflow predictions for the upper Partridge River.

Mis-calibration of groundwater flow models.

The calibration of the Modflow model to a Partridge River baseflow of 0.76 cfs predicted by XP-SWMM results in a model that moves very little water through the groundwater system. This can result in low predicted rates of inflow to the mine pit and slow movement of contaminants from sources (stockpiles or reflooded pits) to points of evaluation. More generally, an incorrect baseflow calibration target results in excessively low estimates of recharge and likely incorrect estimates of horizontal and vertical conductivity. These hydrologic parameters are interrelated and getting one wrong, as appears to be the case with baseflow, will almost certainly result in the other parameters being incorrectly estimated. Although there has been little sensitivity analysis conducted in the Polymet modeling efforts, flow models tend to be sensitive to these interrelated parameters.

Based on Modflow model calibration to a baseflow of 0.76 cfs and recharge values set at 0.3 and 1.5 in/yr (see page 61 of Water Modeling Data Package Vol 1-Mine Site v9 DEC2011.pdf and page 11 of RS22, Appendix B), some horizontal and vertical conductivities (K) were calculated by Barr using PEST (see Table 1 of Attachment B of Water Modeling Data Package Vol 1-Mine Site v9 DEC2011.pdf). These K values are likely to be inaccurate since they are calculated with a model that is calibrated to a baseflow that appears to be almost an order of magnitude too low. It is unlikely that any accurate predictions of water movement, transport of contaminant mass, or contaminant levels can be made when the characterization of the hydrologic system is so out-of-kilter.

Unusually low recharge and vertical K:

The low values used for recharge (0.3 and 1.5 in/yr) and the low wetland and till vertical K (0.0000033 ft/day [$1.16X10^{-9}$ cm/s]) used in the Modflow model are a reflection of a model constructed and calibrated to move an unrealistically small amount of water through the hydrologic system. For context, note that engineered clay liners in landfills typically aim for $1.0X10^{-7}$ cm/s hydraulic conductivity. I was unable to find any reference in the literature to wetland soil vertical conductivity as low as is used in the Modflow model. The lower end of the spectrum I found for wetland soil vertical conductivity was $1X10^{-6}$ cm/s.

Our long standing concern that the mine site hydrologic models incorporate incorrect assumptions about recharge are supported by Fred Marinelli's comment on line 39 and elsewhere of: "Agency Responses MS and PS WP and Waste Characterization Data package V7 2-7-12.xls". His comment states that "A net infiltration (recharge) range of 0.3 to 1.5 in/yr represents 1.1 to 5.4 percent of mean annual precipitation (MAP). This range for local net infiltration is unrealistically low for this area of the US." These low recharge values and the low

vertical K values are related to calibration of the Modflow model to low baseflow. Until Modflow, and by extension the other related models XP-SWIMM and GoldSim, are calibrated to data from the site (e.g. observed baseflow and an adequate number of observed heads) and incorporate reasonable recharge rates, the results from the models are unlikely to accurately simulate current or future conditions.

Recalibration of models needed:

The Modflow model, in particular, needs to be calibrated with targets based on observed baseflow and observed well water heads. Calibration to projections by XP-SWMM, that appear to be incorrect, means that the fundamental characterization of the site hydrology is likely to be faulty. In the document referenced above (Agency Responses ...) Barr Engineering states that many hydrologic model parameters were "discussed as part of the IAP process and will not be considered further at this time." While some parameters were discussed in the groundwater IAP process, the discussion was almost exclusively concerning water quality parameters, not flow model parameters such as recharge, baseflow and Kv and Kh. The focus on water quality parameters to the near exclusion of hydrologic flow parameters is reflected in the Groundwater IAP summary memo of June 2011. Groundwater flow modeling underpins contaminant transport modeling and is interrelated to surface flow models. Without adequate vetting of flow model parameters and predictions, it is impossible to have confidence in predictions of contaminant movement and water quality.

Now that the hydrologic models have been more fully articulated by Barr and additional data are available, the models must be calibrated to observed baseflow and well water levels. This should include the new water level data from the newly installed mine site wells. PEST can then be used to more reasonably estimate values for recharge and conductivity. The observed baseflow and the PEST estimated recharge and conductivity values should then be used in the XP-SWMM and GoldSim modeling efforts. Modeling efforts that are based on faulty initial assumptions and not on field observations will not be able to reasonably predict impacts. The current Polymet modeling effort needs to be well founded on a strong base of observations of the physical conditions at the site.

Thank you for considering this issue. Please contact me at [redacted] if you have questions.

cc: Mike Olson, Minnesota DNR
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