

Flambeau Mining Company  
N4100 Highway 27  
Ladysmith, WI 54848  
(715) 532-6690  
FAX (715) 532-6885

**Kennecott**  
Minerals

August 10, 2004

Mr. Larry Lynch  
Wisconsin Department of Natural Resources  
101 South Webster  
P.O. Box 7921  
Madison, WI 53707-7921

Dear Mr. Lynch:

RE: Ground Water Quality – MW-1015B  
Flambeau Mining Company

The Flambeau Mining Company (Flambeau) is providing the attached review of water quality in well MW-1015B performed by Mr. Steve Donohue with Foth & Van Dyke.

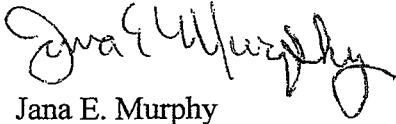
The review was completed due to trends in MW-1015B for iron and manganese showing a marked increase beginning in October 2002. Mr. Donohue's review found that the change in water quality at MW-1015B cannot be attributed to an impact derived from the migration of backfill pore water since an impact on water quality at MW-1015B from the backfill would contain a sulfate signature. The attached review goes into further detail regarding the sulfate signature, other likely impacts to MW-1015B water quality and comparison of water quality in other Flambeau monitoring wells.

Monitoring of MW-1015B will continue on a quarterly basis with the addition of oxidation-reduction potential (redox). Annual review of the analytical data will be included in Flambeau's Annual Report.

If you require any further information regarding this submittal, please contact me at 715-532-6690 Ext. 2.

Mr. Larry Lynch  
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Sincerely,

A handwritten signature in black ink, appearing to read "Jana E. Murphy". The signature is written in a cursive style with a large initial "J" and "M".

Jana E. Murphy  
Environmental & Reclamation Manager

Attachment

Cc: Al Christianson, City of Ladysmith  
Steve Donohue, Foth & Van Dyke  
Fred Fox, Kennecott Minerals  
Jim Hutchison, Foth & Van Dyke  
Ken Markart, WDNR  
Tom Riegel, Town of Grant  
Mark Steward, Rusk County Zoning  
Randy Tatur, Rusk County

**Foth & Van Dyke**  
**Memorandum**

June 28, 2004

TO: Jana Murphy, Flambeau Mining Company

CC: File 03F002 – 5001  
Jim Hutchison, Foth & Van Dyke

FR: Steve Donohue *SUD*

RE: Well MW-1015B – Analysis and Talking Points for Fe/Mn Trends

Per your request we have examined the Fe and Mn trends in well MW-1015B, a monitoring well screened in the Precambrian bedrock near the compliance boundary and downgradient of the backfilled mine.

Baseline monthly monitoring in this well began in April 2001. Monthly sampling of the well continued until April 2002 at which time the well was sampled on a quarterly basis. The trends in MW-1015B for Fe and Mn show a marked increase beginning in October 2002. This increase however cannot be attributed to an impact derived from the migration of backfill pore water. An impact on water quality at MW-1015B from the backfill would contain a sulfate signature. A sulfate signature would be expected substantially ahead of metals for a groundwater system with pH > 6 because the sulfate levels in the backfill are significantly above background and the advective transport of sulfate would not be retarded as it travels through the aquifer. Fe and Mn, also at increased levels in the backfill relative to surrounding background concentrations, would be retarded to some degree as they migrate through the aquifer. Thus any impact on the groundwater at MW-1015B due to the backfill would first show a sulfate increase. The sulfate levels at MW-1015B do not show this signature. In addition, there has not been a prior or comparable increase in Mn and Fe, or even of SO<sub>4</sub> at MW-1004P, which lies between the backfilled pit and MW-1015B. Thus it is reasonable to conclude that the backfill has not affected water quality at MW-1015B.

Fe and Mn concentrations in groundwater are sensitive to changes in redox conditions. Historical monitoring at the site has shown that the Fe and Mn concentrations in some site wells have fluctuated over time, and these changes are likely attributable to changing redox regimes. Evidence of this is provided in the Annual Report historical plots of Fe and Mn for wells MW-1004P and MW-1005P. Both of these wells are screened in the Precambrian bedrock. MW-1005P is immediately upgradient of the backfill mine. MW-1004P is immediately downgradient of the backfilled mine.

The attached graphs display the Fe and Mn concentration trends for MW-1015B, -1005P and -1004P. The time period selected is from April 2001 to the present. In the case of Fe, the trend for MW-1015B is similar to upgradient well MW-1005P. However, well MW-1005P has shown

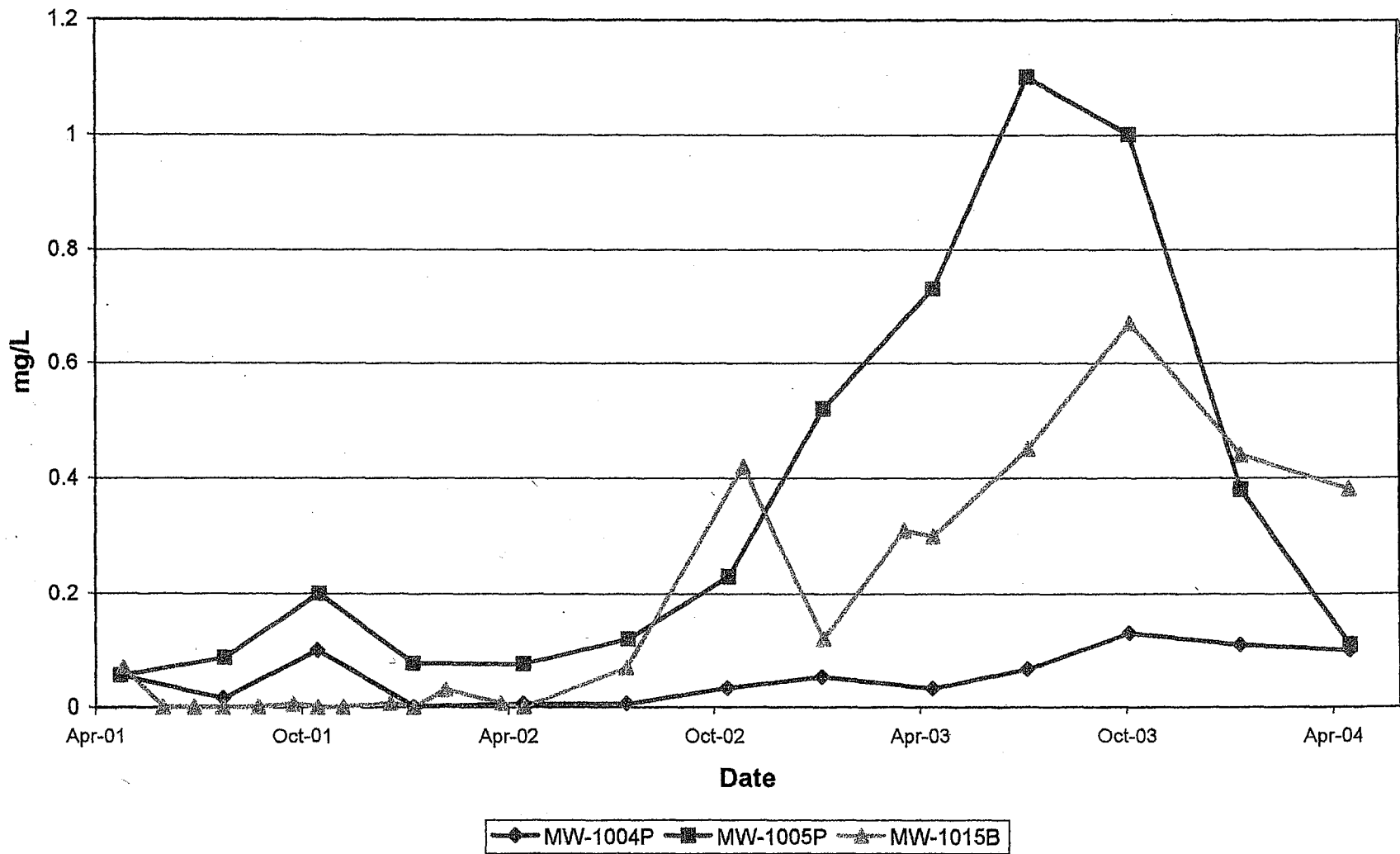
a greater increase in Fe than has MW-1015B, whereas MW-1004P has shown a much more subdued change. If the iron trend at MW-1015B were due to the backfill, MW-1004P would certainly have exhibited an increase. The similar Fe trends in the Precambrian wells, including the upgradient well, certainly indicate that there is a background fluctuation that cannot be attributed to flow from the backfill and most likely is due to a change in redox conditions. The time-series data also show that the Fe concentrations appear to be declining towards pre-October 2002 levels.

The Mn trend in the bedrock wells is a bit more complex. Wells MW-1005P and MW-1004P do not show the apparently pronounced increase exhibited in MW-1015B. The concentration in MW-1015B also fluctuates significantly in the post-October 2002 period. The Mn trend in MW-1015B appears to be tapering off in recent sampling events, similarly to Fe. Again, like Fe, the lack of an increase in MW-1004P confirms that the increase is not due to the backfill but most likely has been induced by changes in redox conditions near MW-1015B.

Based on the data trends for the Precambrian wells, the following talking points are provided for any discussion with the WDNR:

- The Fe and Mn changes at MW-1015B are not due to flow from the backfill because they do not carry an increase in sulfate that would be expected due the sulfate concentrations in the backfill and the fact that it is transported without retardation.
- The lack of comparable or greater changes in Fe and Mn at MW-1004P, which is much closer to the backfilled pit, also argue against a physically plausible pathway for transport that could causally connect the MW-1015B results with a source in the backfilled pit.
- The Fe and Mn are redox sensitive ions that are known to fluctuate in response to changes in redox conditions. These two redox-sensitive species are the only ones that show the time-series trends in MW-1015B.
- Historical data from site wells have already established that the concentrations of these parameters at upgradient locations have fluctuated in ways that are similar to MW-1015B.
- When the monitoring record for Fe and Mn at MW-1015B is compared to other site wells, the Fe trend is similar to other monitoring points and more subdued than the upgradient monitoring point.
- The trends observed at MW-1015B are consistent with localized redox (not backfill) induced changes. Comparable trends are being observed over this monitoring period and have been observed over longer periods at other site wells including upgradient monitoring points.

# Flambeau Groundwater Monitoring Iron



# Flambeau Groundwater Monitoring Manganese

