

Graphs of Flambeau Mine¹ Surface and Groundwater Quality Data (Time Period 1987-2020+)

Graphs created by Deer Tail Scientific² for educational purposes using data submitted by Flambeau Mining Company to the Wisconsin Department of Natural Resources

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(linked)

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<https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>



Deer Tail Scientific
Duluth, Minnesota

¹ The Flambeau Mine was an open pit copper-sulfide mine constructed on the banks of the Flambeau River near Ladysmith, Wisconsin in the mid-1990s. It was owned by Rio Tinto/Kennecott and operated by their subsidiary, Flambeau Mining Company.

² **Deer Tail Scientific** is a 501(c)3 nonprofit organization founded in 2017. As stated in its bylaws: *The mission of Deer Tail Scientific is to educate the public, government officials and tribal sovereign nations with fact-based information on: (1) the permitting, development, reclamation, environmental performance and economics of Wisconsin's Flambeau Mine; and (2) how the Flambeau Mine compares to other mines (closed, currently operating or proposed) in the Great Lakes region and beyond.*

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Table 1. Data sources utilized by Deer Tail Scientific for creating the graphs in the present collection.

Title	Date	Author
Environmental Impact Report for the Kennecott Flambeau Project, Vol. V, Appendix 3.6-H (Groundwater Quality Data – 1987-88)	1989	Foth ¹
Mining Permit Application for the Flambeau Project, Vol. 2, Appendix L (Prediction of Groundwater Quality Downgradient of the Reclaimed Pit for the Flambeau Project)	1989	Foth
Decision, Findings of Fact, Conclusions of Law and Permits for the Flambeau Mine	1991	Wisconsin Division of Hearings and Appeals
1991 Annual Report	1991	Flambeau Mining Company
1992 Annual Report	1992	Flambeau Mining Company
1997 Backfilling Plan for Stockpiled Type II Material	1997	Foth
Compilation of FMC Stream C and Biofilter Monitoring Data (1999-2010)	2010	Dr. David M. Chambers ²
2010 Stipulation Monitoring Report – and corresponding reports issued in 2011 and 2012	2010-2012	Flambeau Mining Company
Surface Water Quality Assessment of the Flambeau Mine Site	2012	Wisconsin Department of Natural Resources
Fall 2015 Surface Water Results	2015	Flambeau Mining Company
2017 Annual Report , Appendix B (Historical Groundwater Results: 1987-2017)	2017	Flambeau Mining Company
Compilation of FMC Stream C Surface Water Quality Data (2013-2018)	2020	Wisconsin Department of Natural Resources
2018 Impairment Assessment for Stream C.	2018	Wisconsin Department of Natural Resources
2020 Impairment Assessment for Stream C.	2020	Wisconsin Department of Natural Resources
2022 Impairment Assessment for Stream C.	2022	Wisconsin Department of Natural Resources
2018 Annual Summary Memo , Attachment A (Groundwater Quality) and corresponding memos issued for 2019 , 2020 , 2021 and 2022	2018-2022	Flambeau Mining Company
Findings of Fact, Conclusions of Law and Revised Mining Permit – Flambeau Mining Company	2022	Wisconsin Department of Natural Resources
Spring 2023 Groundwater Monitoring Results	2023	Flambeau Mining Company
Spring 2023 Split-Sample Groundwater Results	2023	Wisconsin Department of Natural Resources
Spring 2023 Stream C Results	2023	Foth

¹ Foth (Green Bay, WI) was/is the primary engineering consultant utilized by Flambeau Mining Company for the Flambeau project.

² Dr. Chambers is the founder of [Center for Science in Public Participation](http://www.csp2.org/) (Bozeman, MT; <http://www.csp2.org/>).

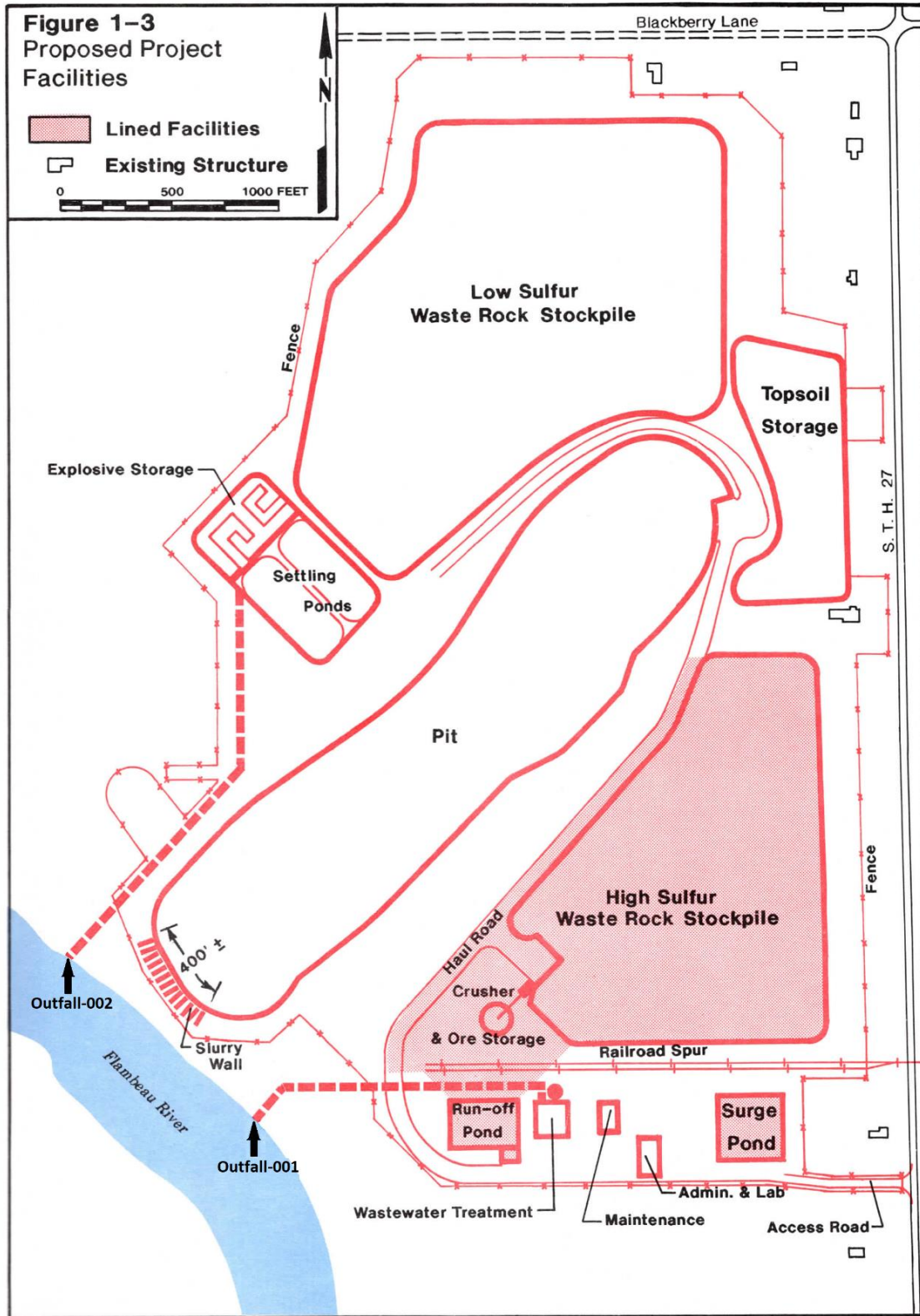


Figure 1. Historical Flambeau Mine features [Figure adapted from Figure 1-3 in: Final Environmental Impact Statement for Flambeau Mining Co. Copper Mine, Wisconsin Department of Natural Resources, 1990].

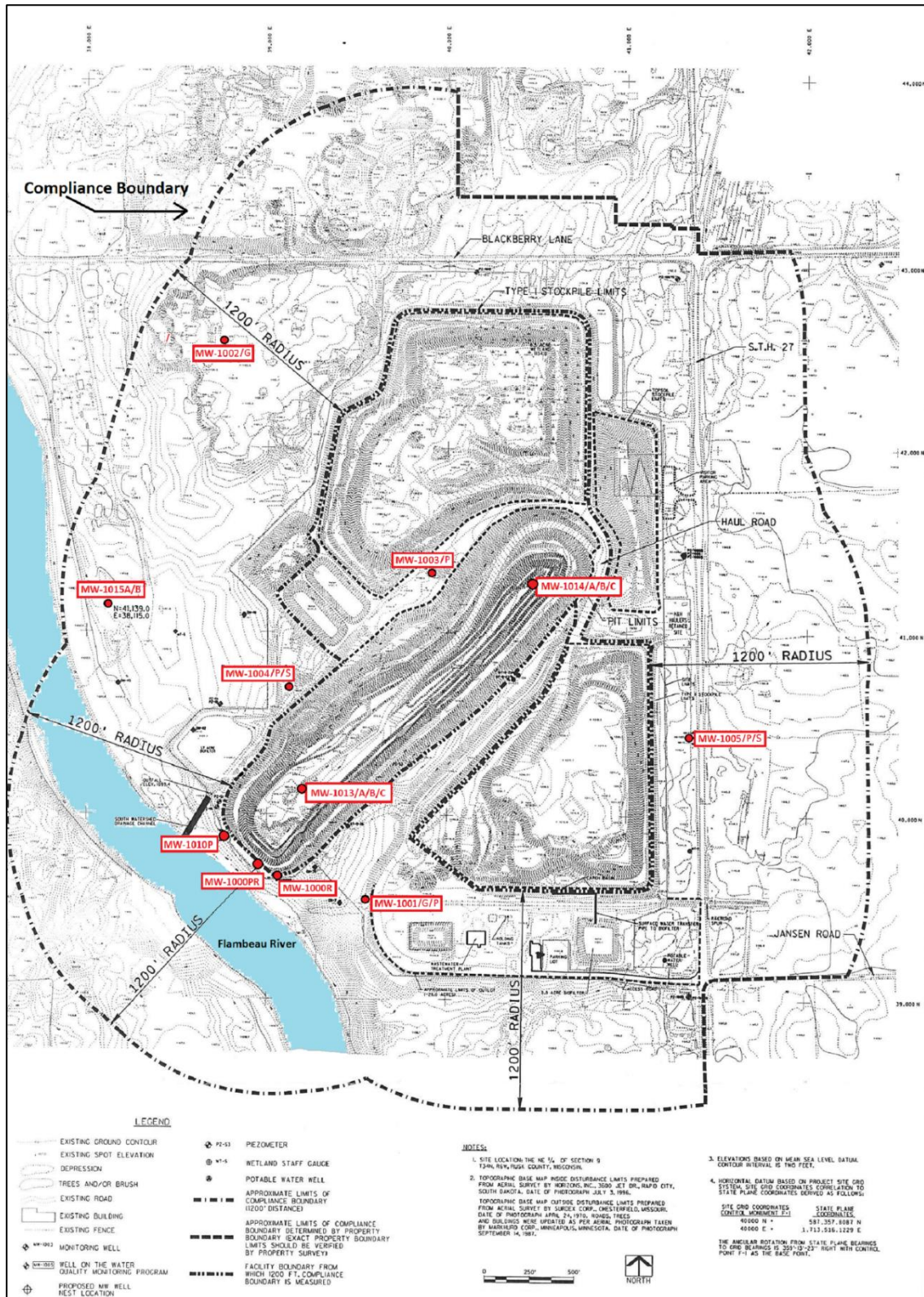


Figure 2. C Monitoring well (MW) locations at the Flambeau Mine project site. The location of the Compliance Boundary established by the Wisconsin Department of Natural Resources for enforcement of groundwater quality standards is also shown. Please note that, contrary to the requirements of state law, no wells have been drilled along the compliance boundary to monitor for compliance with permit-specified groundwater quality standards [Figure adapted from Fig. 1 in: Groundwater Monitoring Well Nest Installation, FMC, 2000].

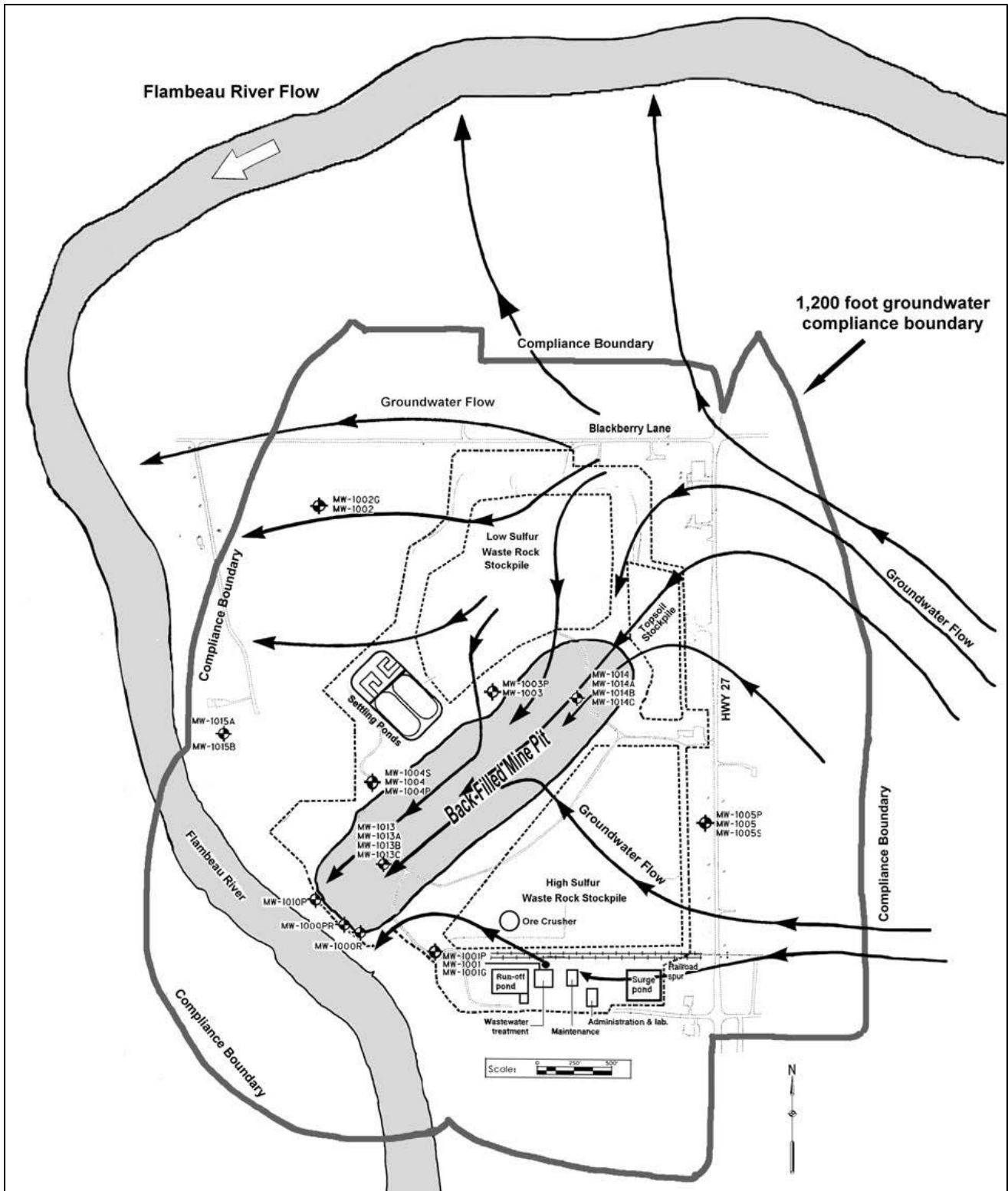


Figure 3. Approximate groundwater flow vectors at the Flambeau Mine project site. Diagram also shows the mine’s compliance boundary and monitoring well (MW) locations [Source: Report on Groundwater and Surface Water Contamination at the Flambeau Mine, Dr. David M. Chambers and Dr. Kendra Zamzow (Center for Science in Public Participation, Bozeman, MT), June 2009, Figure A [NB: The source of the groundwater flow vector overlay was Figure 3-5 in Final Environmental Impact Statement for Flambeau Mining Company Copper Mine, Wisconsin DNR, 1990].

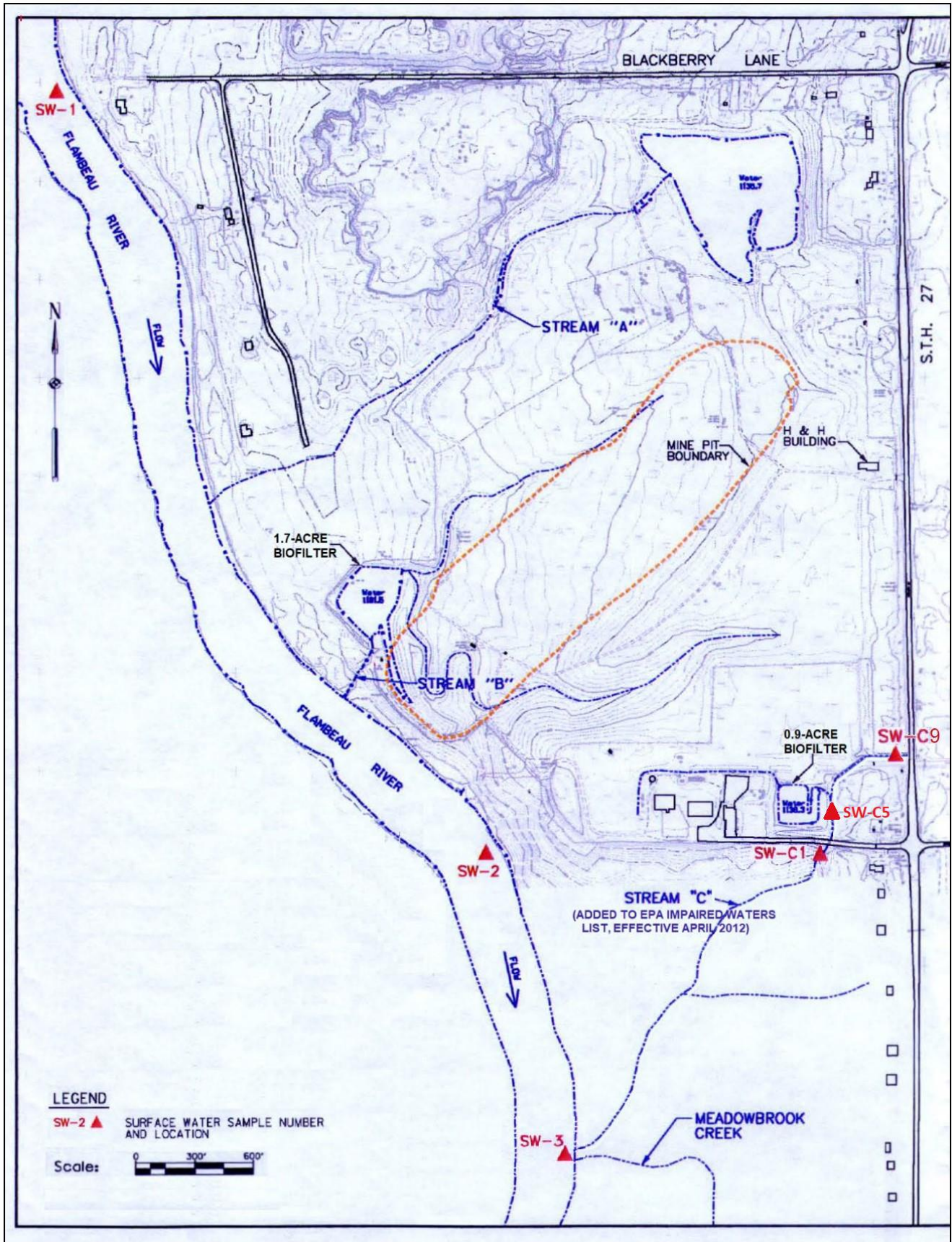
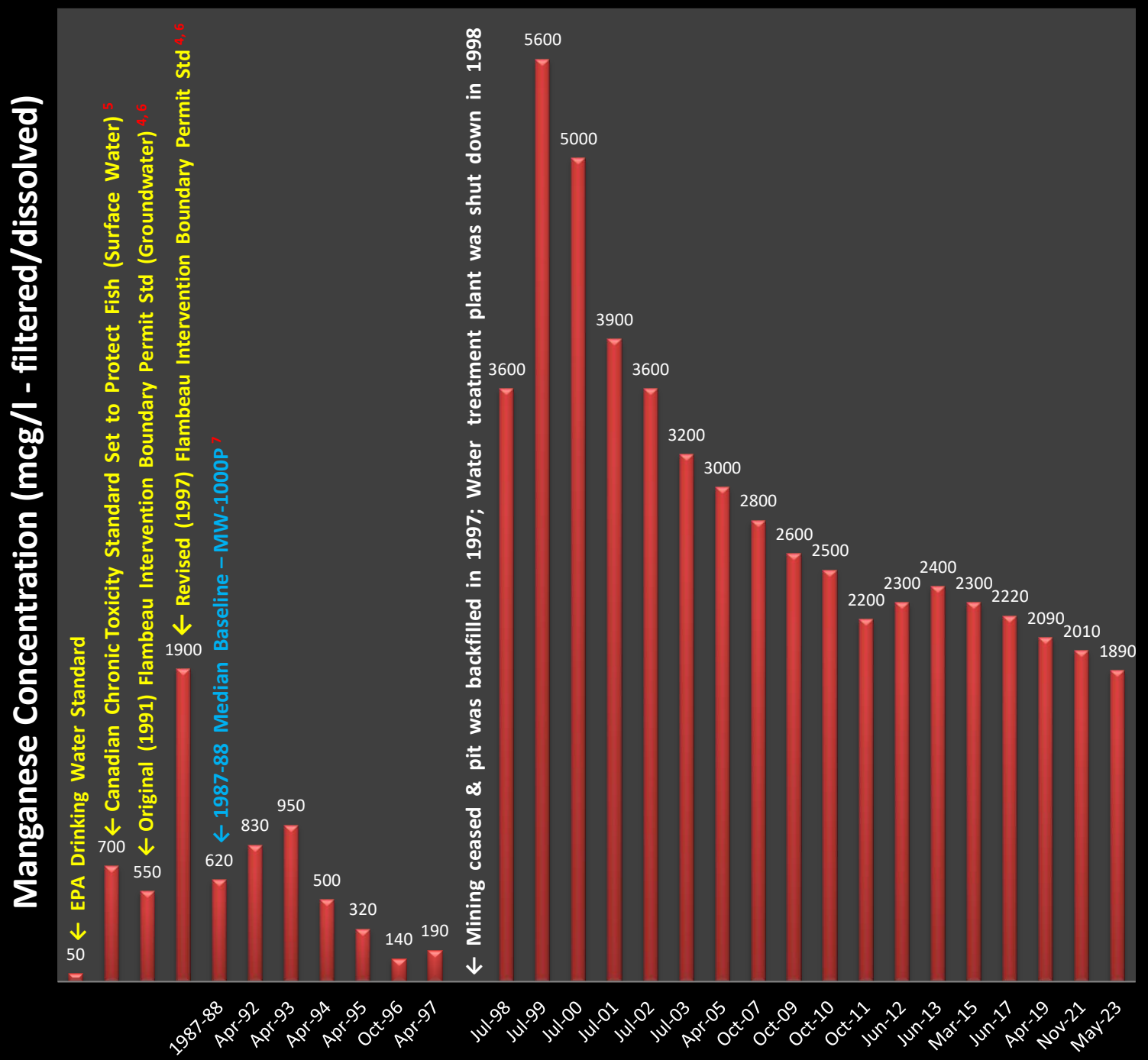


Figure 4. Location of Flambeau River and Stream C relative to backfilled Flambeau Mine pit and other historical mine features. Some surface water sampling sites utilized by FMC at one time or another are also shown. For example, sampling site SW-3 was established in 2007, marking the first time FMC was required to report Flambeau River water quality data near the Stream C discharge point [Figure adapted from Figure 6 in: Flambeau Certificate of Completion Stipulation Monitoring Plan, Foth, 2007].

Manganese Concentrations (filtered/dissolved)¹ in Monitoring Well-1000PR² at the Flambeau Mine Site (Intervention Boundary Well)^{3, 4}

MW-1000PR is located directly between the backfilled mine pit and Flambeau River. It is about 125' from the river, 57' deep and in line with the direction of groundwater flow toward the river.



1. Flambeau Mining Company (FMC) only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. use and consume unfiltered water). In addition, please note the significant increase in groundwater contamination after the pit was backfilled, this despite FMC's addition of limestone to the sulfide-containing waste rock in an attempt to minimize impacts. While permit standards in this particular well clearly have been exceeded, contamination *within* the backfilled pit is even higher, where manganese concentrations as high as 42,000 mcg/l (filtered/dissolved) have been reported. No citations have been issued.

2. MW-1000P was damaged in Jan 1996 during snow removal operations and was replaced with MW-1000PR in Feb 1996 at the same location and depth.

3. The MW-1000 nest was classified as an **intervention boundary well** in: *Flambeau Mine Permit*, Wisconsin Division of Hearings and Appeals, Jan 1991, p. 92; and *Revised Flambeau Mine Permit*, Wisconsin Department of Natural Resources, Dec 2022, p. 12.

4. The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located **at or beyond** what is known as the mine's **compliance boundary**, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine's waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. **Within** this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called **intervention boundary** somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified *before* they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the *numeric values* for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.

5. The *Wisconsin Administrative Code* lists no freshwater aquatic life standard for manganese, but British Columbia, Canada has established a chronic exposure standard of 700 mcg/L (unfiltered/total) at a hardness of 25 mg/L.

6. Water quality standards for the Flambeau Mine compliance and intervention boundaries were established in the 1991 *Flambeau Mine Permit* and renewed in the 2022 *Revised Flambeau Mine Permit*. All of the listed MCLs for the compliance boundary, *with the exception of manganese*, were identical to the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code* (see Figure 12 for more information regarding the manganese MCL specified for Flambeau's compliance boundary). An exception was also made for the manganese, iron, copper and sulfate **PALs** to be applied at the MW-1000 and MW-1010 nests (i.e., the **intervention boundary wells** directly between the Flambeau Mine pit and Flambeau River). For example, instead of using the PAL for manganese found in NR-140 (25 mcg/l), the 1991 permit changed it to reflect the maximum concentration of manganese that FMC *predicted* for groundwaters exiting the backfilled Flambeau Mine pit (550 mcg/l)^a. Six years after the permit was granted, FMC revised the prediction upward (1900 mcg/l), and the Wisconsin DNR willingly adopted it as the new PAL standard for manganese in the MW-1000 and MW-1010 nests^b.

7. *Environmental Impact Report for the Kennecott Flambeau Project*, Vol. V, Appendix 3.6-H (Groundwater Quality Data – 1987-88). Median = 620 mcg/L; Range = 260-750 mcg/l; n = 12; detects = 100%.

Data Sources: *Environmental Impact Report for the Kennecott Flambeau Project* (1989), Foth, Volume V, Appendix 3.6-H; *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2019 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding report issued in 2021; *Biannual Environmental Monitoring Results*, Flambeau Mining Company, July 2023.

Graph Created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

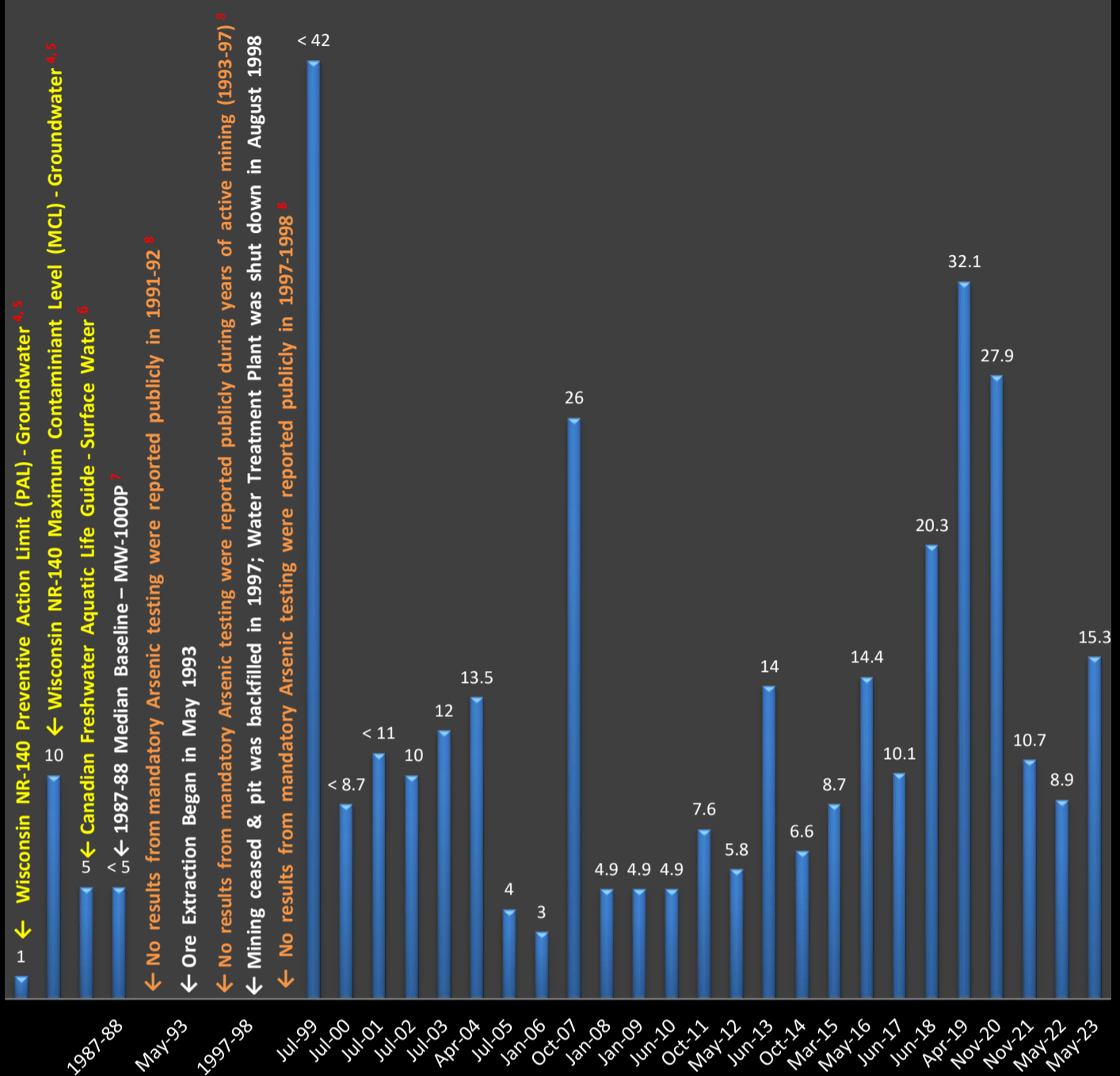
^a *Flambeau Mine Permit* (1991), Wisconsin Division of Hearings and Appeals, p. 92; and *Flambeau Mine Permit Application* (1989), Foth, Volume II, Appendix L, p. L-30.

^b *Revised Flambeau Mine Permit* (2022), Wisconsin DNR, p. 12; and *1997 Backfilling Plan for Stockpiled Material*, Foth, 1997, page iii and Table 4-23.

Arsenic Concentrations (filtered/dissolved)¹ in Monitoring Well-1000PR² at the Flambeau Mine Site (Intervention Boundary Well)^{3, 4}

MW-1000PR is located directly between the backfilled mine pit and Flambeau River. It is about 125' from the river, 57' deep and in line with the direction of groundwater flow toward the river.

Arsenic Concentration (µg/L) - filtered/dissolved



1. Flambeau Mining Company (FMC) only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. use and consume unfiltered water). In addition, please note the significant increase in groundwater contamination in some of the samples collected after the pit was backfilled, this despite FMC's addition of limestone to the sulfide-containing waste rock in an attempt to minimize impacts. While groundwater quality standards in this particular well clearly have been exceeded, contamination *within* the backfilled pit is even higher, where arsenic concentrations as high as 83 µg/L (filtered/dissolved) have been reported. No citations have been issued.

2. MW-1000P was damaged in Jan 1996 during snow removal operations and was replaced with MW-1000PR in Feb 1996 at the same location and depth.

3. The MW-1000 nest was classified as an intervention boundary well in: *Flambeau Mine Permit*, Wisconsin Division of Hearings and Appeals, Jan 1991, p. 92; and *Revised Flambeau Mine Permit*, Wisconsin Department of Natural Resources, Dec 2022, p. 12.

4. The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located at or beyond what is known as the mine's compliance boundary, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine's waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. Within this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called intervention boundary somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified *before* they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the *numeric values* for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.

5. The cited groundwater quality standards are those listed in the *Wisconsin Administrative Code*, Chapter NR-140 (Groundwater Quality), as published in the *Wisconsin Administrative Register*, Dec 2010. They apply to the Flambeau Mine intervention and compliance boundaries.

6. The *Wisconsin Administrative Code* lists no freshwater aquatic life standard for arsenic, but Canada has established a chronic exposure standard of 5 µg/L (total).

7. *Environmental Impact Report for the Kennecott Flambeau Project*, Vol. V, Appendix 3.6-H (Groundwater Quality Data – 1987-88). Median = < 5 µg/L; n = 12; detects = 0%.

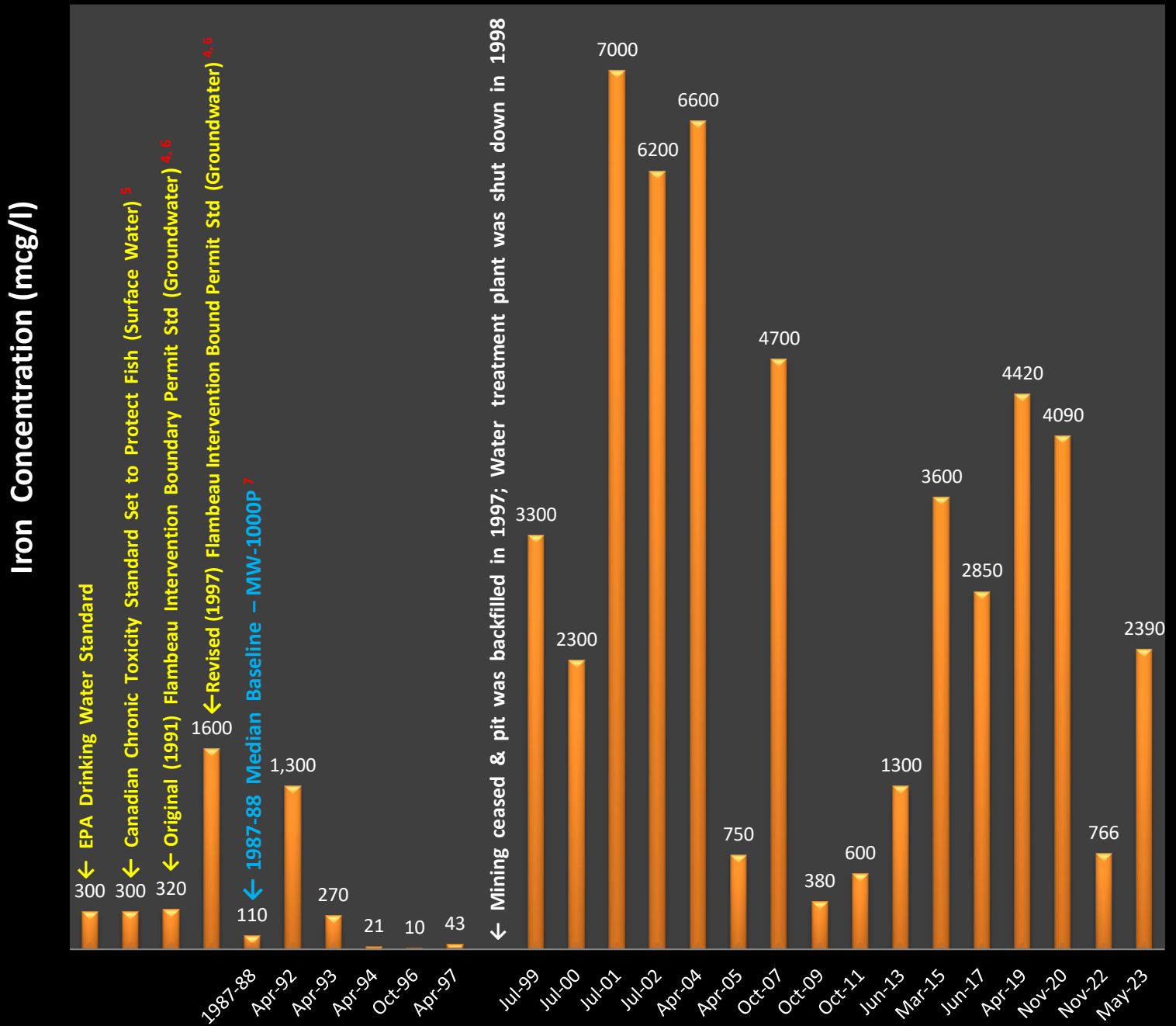
8. The DNR-approved monitoring plan for the Flambeau project required Flambeau Mining Company (FMC) to report arsenic concentrations in all wells once per year (*Updated Monitoring Plan for the Flambeau Project*, Foth, July 1991, p. 33). No such data for MW-1000PR, however, appears in any of the company's annual reports or quarterly environmental monitoring reports issued between 1991 and 1998, including the 4 years of active mining (1993-1997). The well was NOT dry during these years, as concentrations of other parameters like copper, manganese and sulfate were reported for MW-1000PR.

Data Sources: *Environmental Impact Report for the Kennecott Flambeau Project*, Vol. V, Appendix 3.6-H (Groundwater Quality Data – 1987-88); *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2018 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding reports issued in 2019 -2022; and *Split-Sample Groundwater Monitoring Results*, Wisconsin DNR, June 2023.

Graph Created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

Iron Concentrations (dissolved/filtered)¹ in Monitoring Well-1000PR² at the Flambeau Mine Site (Intervention Boundary Well)^{3, 4}

MW-1000PR is located directly between the backfilled mine pit and the Flambeau River. It is about 125' from the river, 57' deep and in line with the direction of groundwater flow toward the river.



- Flambeau Mining Company (FMC) only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. use and consume unfiltered water). In addition, please note the significant increase in groundwater contamination after the pit was backfilled, this despite FMC's addition of limestone to the sulfide-containing waste rock in an attempt to minimize impacts. While permit standards in this particular well clearly have been exceeded, no citations have been issued.
- MW-1000P was damaged in Jan 1996 during snow removal operations and was replaced with MW-1000PR in Feb 1996 at the same location and depth.
- The MW-1000 nest was classified as an **intervention boundary well** in: *Flambeau Mine Permit*, Wisconsin Division of Hearings and Appeals, Jan 1991, p. 92; and *Revised Flambeau Mine Permit*, Wisconsin Department of Natural Resources, Dec 2022, p. 12.
- The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located **at or beyond** what is known as the mine's **compliance boundary**, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine's waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. **Within** this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called **intervention boundary** somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified **before** they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the **numeric values** for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.
- The State of Wisconsin has established no Acute or Chronic Toxicity Criteria for iron in surface waters, but Canada has established a chronic toxicity standard of 300 mcg/l.
- Water quality standards for the Flambeau Mine compliance and intervention boundaries were established in the 1991 *Flambeau Mine Permit* and renewed in the 2022 *Revised Flambeau Mine Permit*. All of the listed MCLs for the compliance boundary, **with the exception of manganese**, were identical to the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*. An exception was also made for the manganese, iron, copper and sulfate **PALs** to be applied at the MW-1000 and MW-1010 nests (i.e., the **intervention boundary wells** directly between the Flambeau Mine pit and Flambeau River). For example, instead of using the PAL for iron found in NR-140 (150 mcg/l), the 1991 permit changed it to reflect the maximum concentration of iron that FMC *predicted* for groundwaters exiting the backfilled Flambeau Mine pit (320 mcg/l)^a. Six years after the permit was granted, FMC revised the prediction upward (1600 mcg/l), and the Wisconsin DNR willingly adopted it as the new PAL standard for iron in the MW-1000 and MW-1010 nests^b.
- Environmental Impact Report for the Kennecott Flambeau Project*, Vol. V, Appendix 3.6-H (Groundwater Quality Data – 1987-88). Median = 110 mcg/l; Range = < 100 - 450 mcg/l; n = 12; detects = 50%.

Data Sources: *Environmental Impact Report for the Kennecott Flambeau Project* (1989), Foth, Volume V, Appendix 3.6-H; *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2019 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding reports issued in 2020 and 2022; *Biannual Environmental Monitoring Results*, Flambeau Mining Company, July 2023.

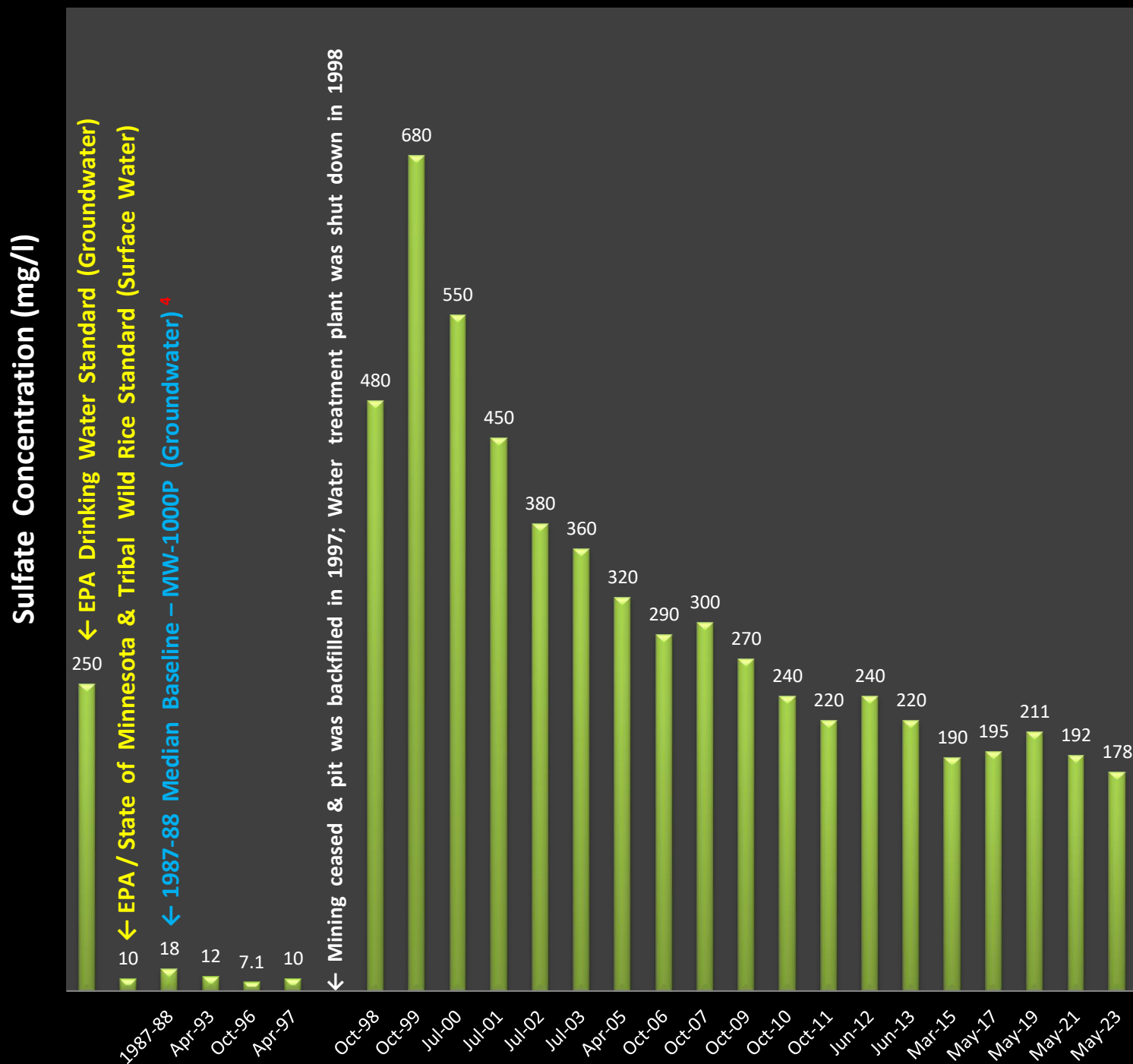
Graph created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

^a *Flambeau Mine Permit* (1991), Wisconsin Division of Hearings and Appeals, p. 92; and *Flambeau Mine Permit Application* (1989), Foth, Volume II, Appendix L, p. L-30.

^b *Revised Flambeau Mine Permit* (2022), Wisconsin DNR, p. 12; and *1997 Backfilling Plan for Stockpiled Material*, Foth, 1997, page iii and Table 4-23.

Sulfate Concentrations (dissolved/filtered)¹ in Monitoring Well-1000PR² at the Flambeau Mine Site (Intervention Boundary Well)³

MW-1000PR is located directly between the backfilled mine pit and the Flambeau River. It is about 125' from the river, 57' deep and in line with the direction of groundwater flow toward the river.



1. Flambeau Mining Company (FMC) only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. use and consume unfiltered water). In addition, please note the significant increase in groundwater contamination after the pit was backfilled, this despite FMC's addition of limestone to the sulfide-containing waste rock in an attempt to minimize impacts.

2. MW-1000P was damaged in Jan 1996 during snow removal operations and was replaced with MW-1000PR in Feb 1996 at the same location and depth.

3. The MW-1000 nest was classified as an **intervention boundary well** in: *Flambeau Mine Permit*, Wisconsin Division of Hearings and Appeals, Jan 1991, p. 92; and *Revised Flambeau Mine Permit*, Wisconsin Department of Natural Resources, Dec 2022, p. 12.

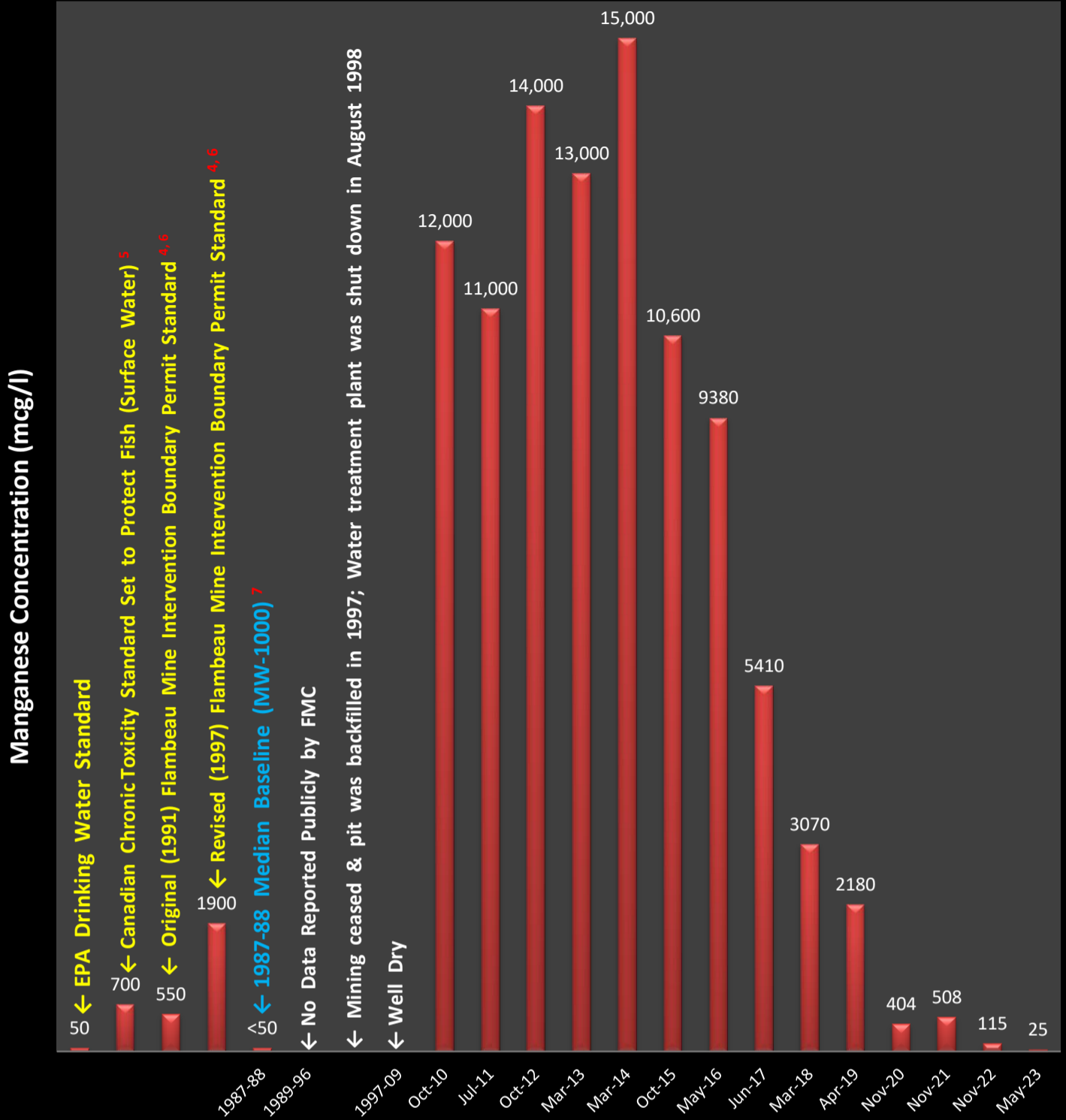
4. *Environmental Impact Report for the Kennecott Flambeau Project*, Vol. V, Appendix 3.6-H (Groundwater Quality Data – 1987-88). Median = 18 mg/l; Range = 6 - 31 mg/l; n = 12; detects = 100%.

Data Sources: *Environmental Impact Report for the Kennecott Flambeau Project* (1989), Foth, Volume V, Appendix 3.6-H; *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2019 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding report issued in 2021; and *Split-Sample Groundwater Monitoring Results*, Wisconsin DNR, June 2023.

Graph created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

Manganese Concentrations (dissolved/filtered)¹ in Monitoring Well-1000R² at the Flambeau Mine Site (Intervention Boundary Well)^{3, 4}

MW-1000R is located directly between the backfilled mine pit and Flambeau River. It is about 170' from the river, 24 feet deep, and in line with the direction of groundwater flow toward the river.



1. Flambeau Mining Company (FMC) only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. *use and consume unfiltered water*). In addition, please note the significant increase in groundwater contamination after the pit was backfilled, this despite FMC's addition of limestone to the sulfide-containing waste rock in an attempt to minimize impacts. While permit standards in this particular well clearly have been exceeded, no citations have been issued.

2. FMC constructed a Slurry Cutoff Wall System between the mine pit and Flambeau River in 1992 which required that MW-1000 be abandoned and replaced. The replacement well, MW-1000R (24 feet deep), was drilled in Nov 1992 and is located about 100 feet east of the original location of MW-1000 (22 feet deep). As described in FMC's 1992 *Annual Report*, "MW-1000 needed to be moved since its original location was downgradient of the Slurry Cutoff Wall System, negating the ability of the well to monitor the shallow till downgradient of the backfilled pit. MW-1000R is positioned to accomplish this intent."

3. The MW-1000 nest was classified as an intervention boundary well in: *Flambeau Mine Permit*, Wisconsin Division of Hearings and Appeals, Jan 1991, p. 92; and *Revised Flambeau Mine Permit*, Wisconsin Department of Natural Resources, Dec 2022, p. 12.

4. The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located at or beyond what is known as the mine's compliance boundary, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine's waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. Within this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called intervention boundary somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified *before* they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the *numeric values* for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.

5. The *Wisconsin Administrative Code* lists no freshwater aquatic life standard for manganese, but British Columbia, Canada has established a chronic exposure standard of 700 mcg/L (unfiltered/total) at a hardness of 25 mg/L.

6. Water quality standards for the Flambeau Mine compliance and intervention boundaries were established in the 1991 *Flambeau Mine Permit* and renewed in the 2022 *Revised Flambeau Mine Permit*. All of the listed MCLs for the compliance boundary, *with the exception of manganese*, were identical to the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code* (see Figure 12 for more information regarding the manganese MCL specified for Flambeau's compliance boundary). An exception was also made for the manganese, iron, copper and sulfate **PALs** to be applied at the MW-1000 and MW-1010 nests (i.e., the **intervention boundary wells** directly between the Flambeau Mine pit and Flambeau River). For example, instead of using the PAL for manganese found in NR-140 (25 mcg/l), the 1991 permit changed it to reflect the maximum concentration of manganese that FMC *predicted* for groundwaters exiting the backfilled Flambeau Mine pit (550 mcg/l)^a. Six years after the permit was granted, FMC revised the prediction upward (1900 mcg/l), and the Wisconsin DNR willingly adopted it as the new PAL standard for manganese in the MW-1000 and MW-1010 nests^b.

7. *Environmental Impact Report for the Kennecott Flambeau Project*, Vol. V, Appendix 3.6-H (Groundwater Quality Data – 1987-88). Median < 50 mcg/L; Range = <50 - 110 mcg/L; n = 12; detects = 25%.

Data Sources: *Environmental Impact Report for the Kennecott Flambeau Project* (1989), Foth, Volume V, Appendix 3.6-H; *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2018 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding reports issued in 2019 -2022; and *Biannual Environmental Monitoring Results*, Flambeau Mining Company, July 2023.

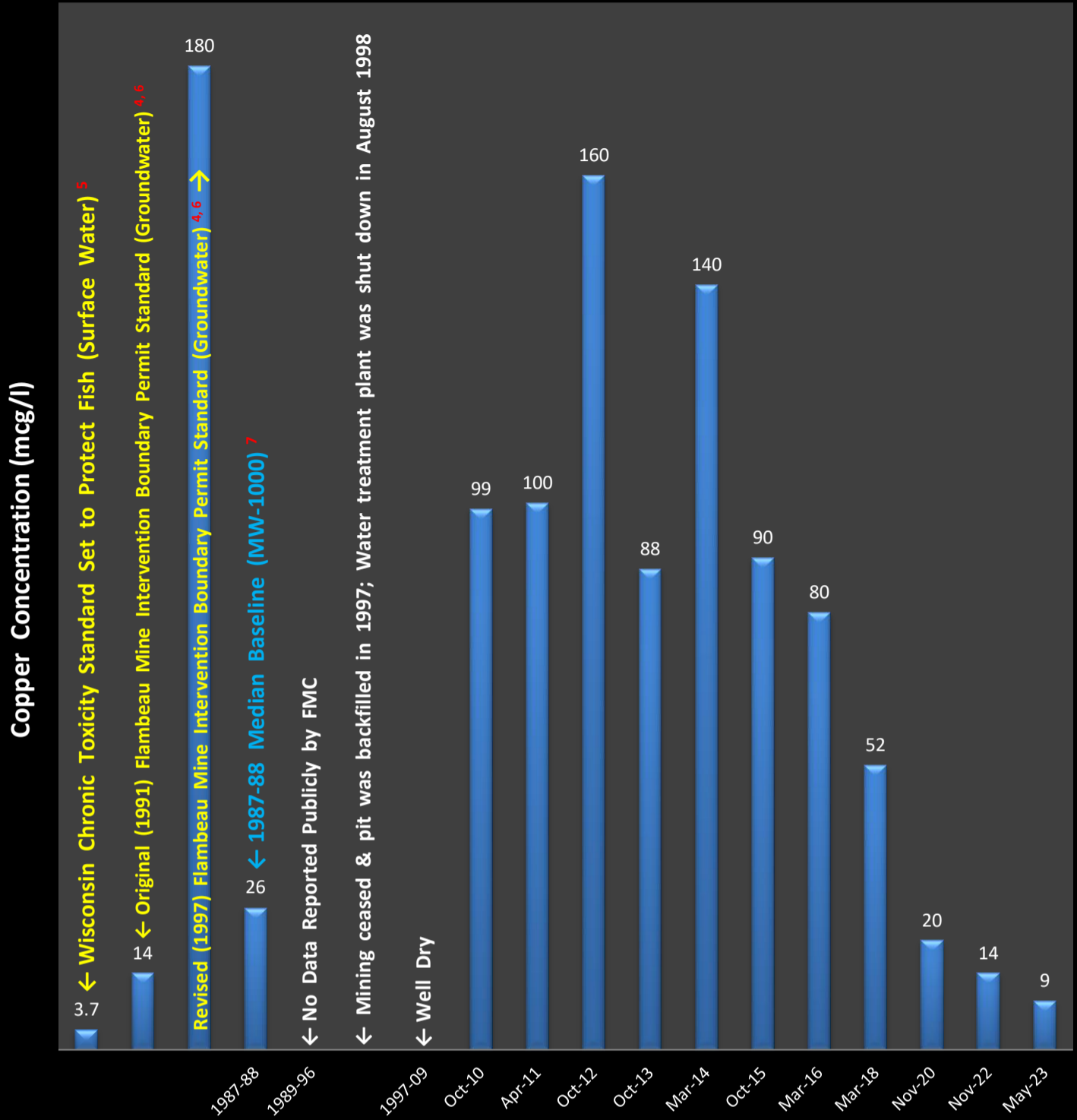
Graph created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

^a *Flambeau Mine Permit* (1991), State of Wisconsin, p. 92; and *Flambeau Mine Permit Application* (1989), Foth, Volume II, Appendix L, p. L-30.

^b *Revised Flambeau Mine Permit* (2022), Wisconsin DNR, p. 12; and *1997 Backfilling Plan for Stockpiled Material*, Foth, 1997, page iii and Table 4-23.

Copper Concentrations (dissolved/filtered)¹ in Monitoring Well-1000R² at the Flambeau Mine Site (Intervention Boundary Well)^{3, 4}

MW-1000R is located directly between the backfilled mine pit and Flambeau River. It is about 170' from the river, 24 feet deep, and in line with the direction of groundwater flow toward the river.



- Flambeau Mining Company (FMC) only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. *use and consume unfiltered water*). In addition, please note the significant increase in groundwater contamination after the pit was backfilled, this despite FMC's addition of limestone to the sulfide-containing waste rock in an attempt to minimize impacts. While permit standards in this particular well clearly have been exceeded, no citations have been issued.
- FMC constructed a Slurry Cutoff Wall System between the mine pit and Flambeau River in 1992 which required that MW-1000 be abandoned and replaced. The replacement well, MW-1000R (24 feet deep), was drilled in Nov 1992 and is located about 100 feet east of the original location of MW-1000 (22 feet deep). As described in FMC's 1992 Annual Report, "MW-1000 needed to be moved since its original location was downgradient of the Slurry Cutoff Wall System, negating the ability of the well to monitor the shallow till downgradient of the backfilled pit. MW-1000R is positioned to accomplish this intent."
- The MW-1000 nest was classified as an **intervention boundary well** in: *Flambeau Mine Permit*, Wisconsin Division of Hearings and Appeals, Jan 1991, p. 92; and *Revised Flambeau Mine Permit*, Wisconsin Department of Natural Resources, Dec 2022, p. 12.
- The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located **at or beyond** what is known as the mine's **compliance boundary**, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine's waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. **Within** this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called **intervention boundary** somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified **before** they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the **numeric values** for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.
- Wisconsin Administrative Code*, NR 105.06 (Nov 2008); Hardness-dependent toxicity; Reported value of 3.7 mcg/l (Total Recoverable) was calculated for a hardness of 30 mg/l.
- Water quality standards for the Flambeau Mine compliance and intervention boundaries were established in the 1991 *Flambeau Mine Permit* and renewed in the 2022 *Revised Flambeau Mine Permit*. All of the listed MCLs for the compliance boundary, **with the exception of manganese**, were identical to the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*. An exception was also made for the manganese, iron, copper and sulfate **PALs** to be applied at the MW-1000 and MW-1010 nests (i.e., the **intervention boundary wells** directly between the Flambeau Mine pit and Flambeau River). For example, instead of using the PAL for copper found in NR-140 (500 mcg/l), the 1991 permit changed it to reflect the maximum concentration of copper that FMC *predicted* for groundwaters exiting the backfilled Flambeau Mine pit (14 mcg/l)^a. Six years after the permit was granted, FMC revised the prediction upward (180 mcg/l), and the Wisconsin DNR willingly adopted it as the new PAL standard for copper in the MW-1000 and MW-1010 nests^b.
- Environmental Impact Report for the Kennecott Flambeau Project*, Vol. V, Appendix 3.6-H (Groundwater Quality Data – 1987-88). Median = 26 mcg/L; Range = <5 - 46 mcg/l; n = 12; detects = 92%.

Data Sources: *Env Impact Report for the Kennecott Flambeau Project* (1989), Foth, Volume V, Appendix 3.6-H; *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2018 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding reports issued in 2020 and 2022; and *Biannual Environmental Monitoring Results*, Flambeau Mining Company, July 2023.

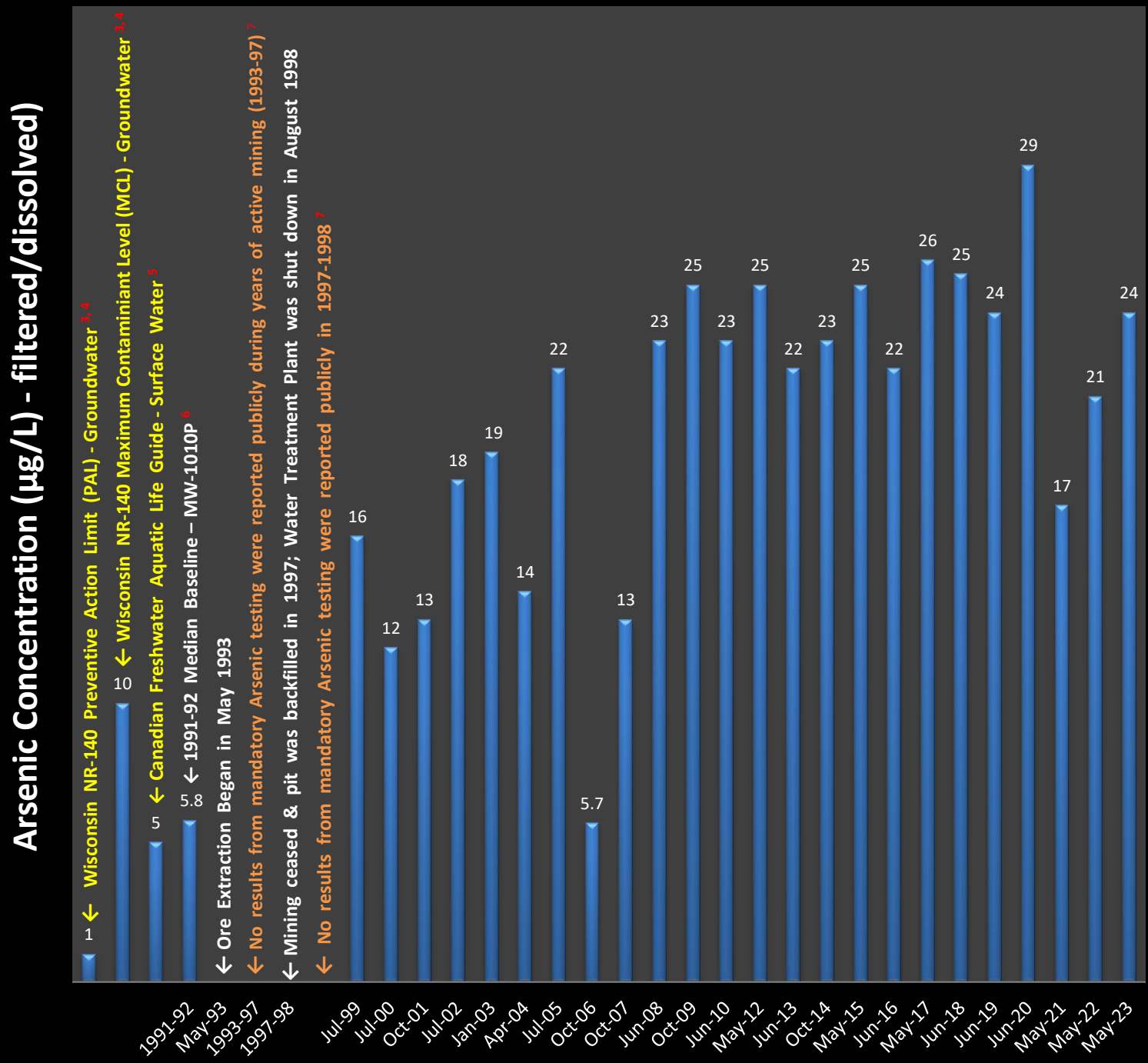
Graph created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

^a *Flambeau Mine Permit* (1991), State of Wisconsin, p. 92; and *Flambeau Mine Permit Application* (1989), Foth, Volume II, Appendix L, p. L-30.

^b *Revised Flambeau Mine Permit* (2022), Wisconsin DNR, p. 12; and *1997 Backfilling Plan for Stockpiled Material*, Foth, 1997, page iii and Table 4-23.

Arsenic Concentrations (filtered/dissolved)¹ in Monitoring Well-1010P at the Flambeau Mine Site (Intervention Boundary Well)^{2, 3}

MW-1010P is located directly between the backfilled mine pit and Flambeau River. It is about 140' from the river, 115' deep and in line with the direction of groundwater flow toward the river.



1. Flambeau Mining Company (FMC) only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. use and consume unfiltered water). In addition, please note the significant increase in groundwater contamination in some of the samples collected after the pit was backfilled, this despite FMC's addition of limestone to the sulfide-containing waste rock in an attempt to minimize impacts. While groundwater quality standards in this particular well clearly have been exceeded, contamination *within* the backfilled pit is even higher, where arsenic concentrations as high as 83 µg/L (filtered/dissolved) have been reported. No citations have been issued.

2. The MW-1010 nest was classified as an intervention boundary well in: *Flambeau Mine Permit*, Wisconsin Division of Hearings and Appeals, Jan 1991, p. 92; and *Revised Flambeau Mine Permit*, Wisconsin Department of Natural Resources, Dec 2022, p. 12.

3. The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located at or beyond what is known as the mine's compliance boundary, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine's waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. Within this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called intervention boundary somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified *before* they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the *numeric values* for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.

4. The cited groundwater quality standards are those listed in the *Wisconsin Administrative Code*, Chapter NR-140 (Groundwater Quality), as published in the *Wisconsin Administrative Register*, Dec 2010. They apply to the Flambeau Mine intervention and compliance boundaries.

5. The *Wisconsin Administrative Code* lists no freshwater aquatic life standard for arsenic, but Canada has established a chronic exposure standard of 5 µg/L (total).

6. Median = 5.8 µg/L; n = 6; range = < 3 - 9.1 µg/L; detects = 83% (see FMC 1991 and 1992 annual reports for raw data).

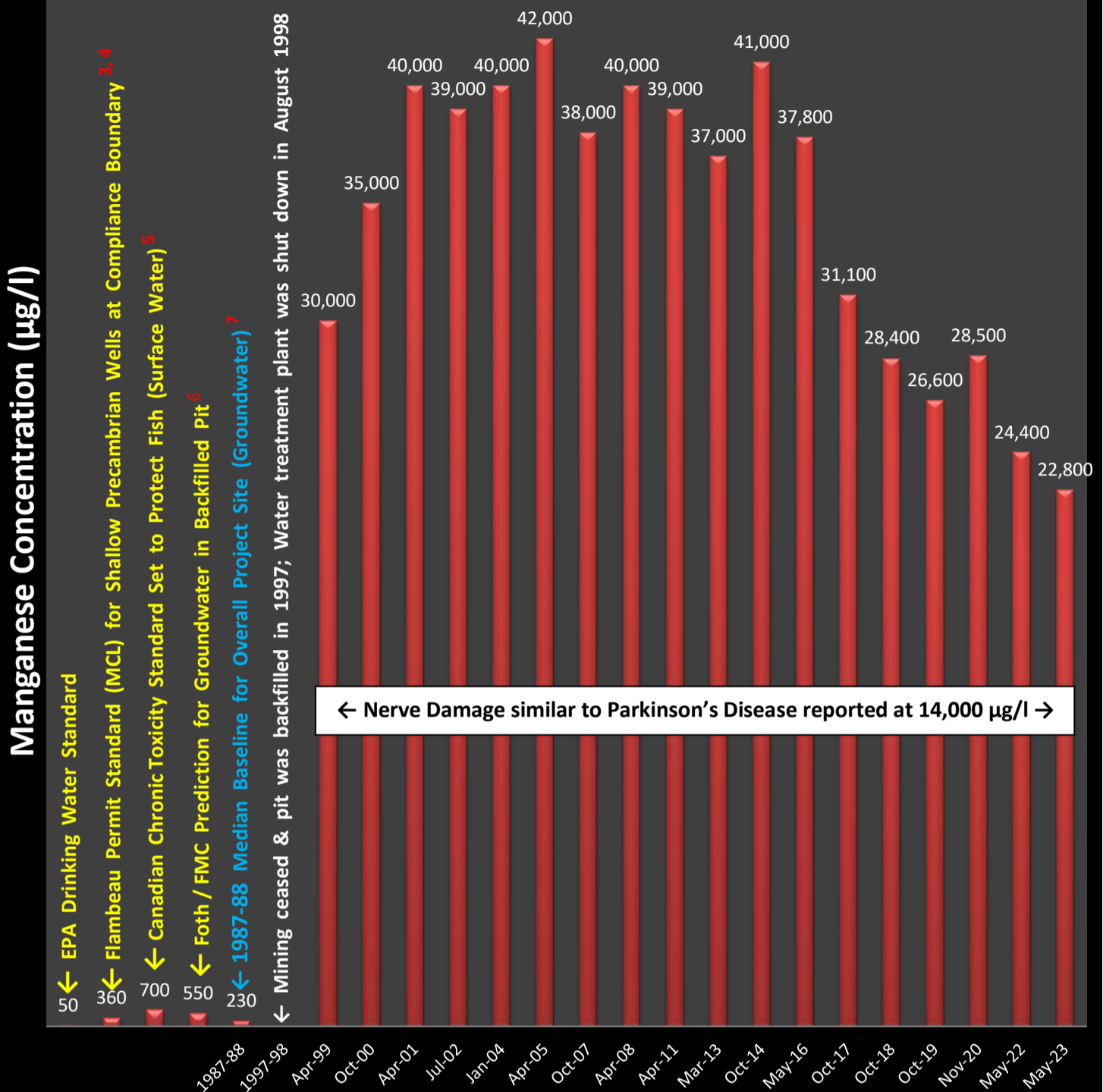
7. The DNR-approved monitoring plan for the Flambeau project required Flambeau Mining Company (FMC) to report arsenic concentrations in all wells once per year (*Updated Monitoring Plan for the Flambeau Project*, Foth, July 1991, p. 33). No such data for MW-1010P, however, appears in any of the company's annual reports or quarterly environmental monitoring reports issued between 1993 and 1998, including the 4 years of active mining (1993-1997). The well was NOT dry during these years, as concentrations of other parameters like copper, manganese and sulfate were reported for MW-1010P.

Data Sources: 1991 Annual Report, Flambeau Mining Company, p. 15; 1992 Annual Report, Flambeau Mining Company, p. 16; 2017 Annual Report, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; 2018 Annual Summary Memorandum, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding annual summary memoranda issued in 2019 -2022; and *Split-Sample Groundwater Monitoring Results*, Wisconsin DNR, June 2023.

Graph Created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

Manganese Concentrations (filtered/dissolved)¹ in Monitoring Well-1013B at the Flambeau Mine Site (Backfill Well)^{2, 3}

MW-1013B is located within the backfilled mine pit. It is about 600' from the Flambeau River, 86' deep and in line with the direction of groundwater flow toward the river.



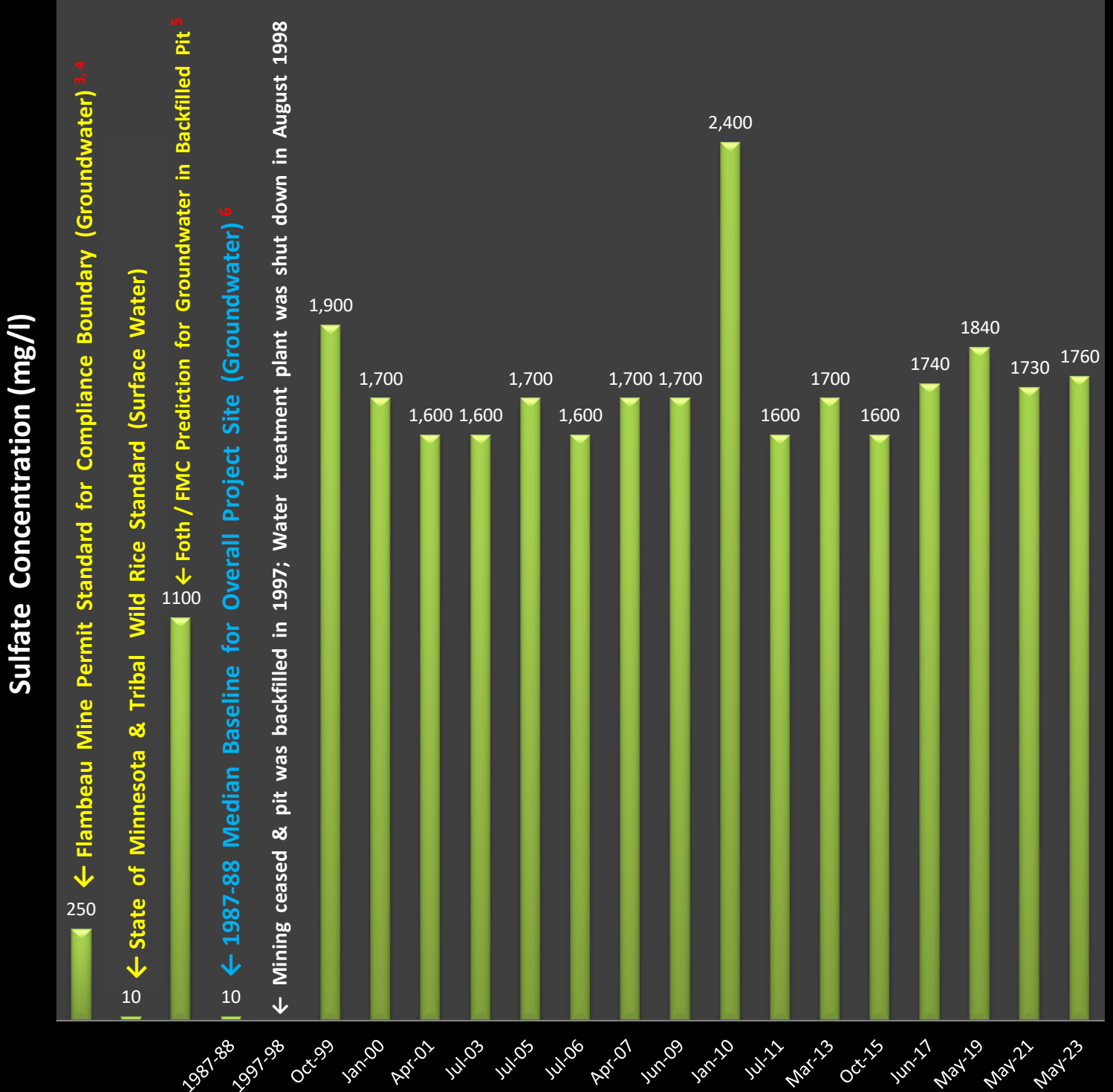
- Flambeau Mining Company (FMC) only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. use and consume unfiltered water).
- The Flambeau Mine pit was backfilled in 1997 with stockpiled waste rock (some of it amended with limestone due to sulfide content) and sludge from the mine's wastewater treatment plant (the plant was decommissioned in August 1998). Monitoring wells were installed in the backfill in September 1998. Please note the significant increase in groundwater contamination after the pit was backfilled, this despite FMC's limestone amendment program.
- The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located at or beyond what is known as the mine's compliance boundary, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine's waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. Within this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called intervention boundary somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified *before* they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the *numeric values* for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.
- Water quality standards for the Flambeau Mine compliance boundary were established in the 1991 *Flambeau Mine Permit* and renewed in the 2022 *Revised Flambeau Mine Permit*. All of the listed MCLs, *with the exception of manganese*, were identical to the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code* (*Register*, Oct 1990). Manganese was treated differently because some of the baseline monitoring wells at the project site already had manganese concentrations exceeding the NR-140 standard of 50 µg/L. Hence, the MCL for manganese was set at 90-360 µg/L in the mine permit to reflect median baseline conditions in wells drilled to various depths across the project site [90 µg/L (overburden); 230 µg/L (deep Precambrian) and 360 µg/L (shallow Precambrian)].
- The *Wisconsin Administrative Code* lists no freshwater aquatic life standard for manganese, but British Columbia, Canada has established a chronic exposure standard of 700 µg/L (unfiltered/total) at a hardness of 25 mg/L.
- Foth (Green Bay, WI), FMC's primary engineering consultant for the Flambeau project, predicted that manganese concentrations in contact water leaving the backfilled pit would top off at 550 µg/L (see *Flambeau Mine Permit Application* (1989), Foth, Volume II, Appendix L, p. L-30). Now that actual concentrations are being measured, levels as high as 42,000 µg/L have been measured in MW-1013B (76 times higher than what Foth predicted).
- The MW-1013/A/B/C well nest was constructed in the backfilled mine pit in September 1998. No specific pre-mining groundwater data for this exact location was reported by FMC. Hence, "baseline" data incorporated in the present graph for the MW-1013 nest are drawn from "baseline" values reported for the overall project site by FMC in their 1989 Environmental Impact Report, Appendix 3.6-H (Groundwater Quality Data: 1987-88). The median baseline manganese concentration was determined using data from 22 different wells drilled to a variety of depths in 3 different substrates (overburden, shallow Precambrian rock and deep Precambrian rock) plus one Artesian well and a "tank." Median = 230 µg/L; Range = <50 - 1400 µg/L; n = 193; detects = 72%.

Data Sources: *Environmental Impact Report for the Kennecott Flambeau Project* (1989), Foth, Volume V, Appendix 3.6-H; *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2018 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding reports issued in 2019 -2022; and *Split-Sample Groundwater Monitoring Results*, Wisconsin DNR, June 2023.

Graph created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

Sulfate Concentrations (dissolved/filtered)¹ in Monitoring Well-1013B at the Flambeau Mine Site (Backfill Well)^{2, 3}

MW-1013B is located within the backfilled pit. It is about 600' from the Flambeau River, 86' deep and in line with the direction of groundwater flow toward the river.



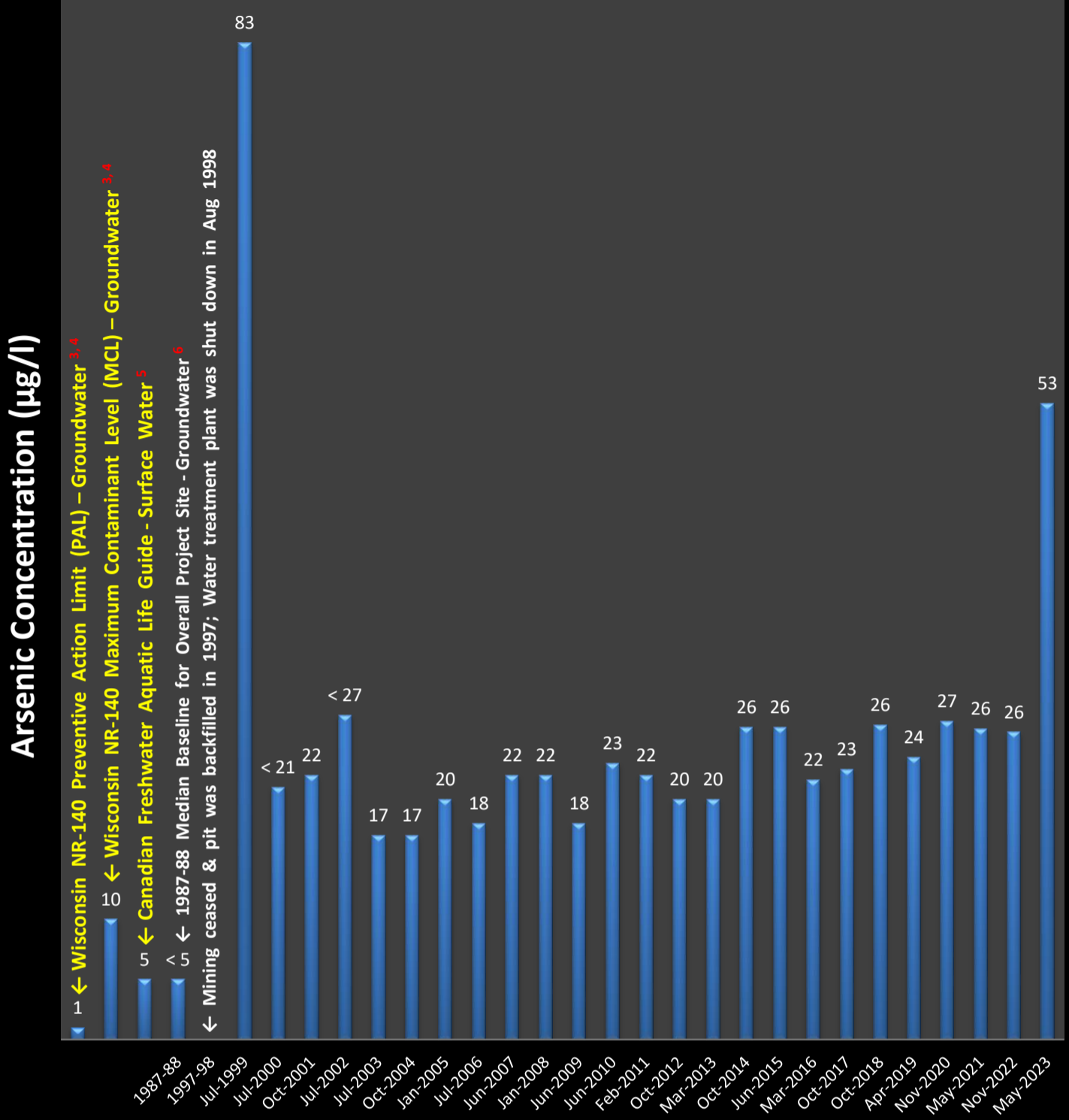
1. Flambeau Mining Company only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. use and consume unfiltered water).
2. The Flambeau Mine pit was backfilled in 1997 with stockpiled waste rock (some of it amended with limestone due to sulfide content) and sludge from the mine's wastewater treatment plant (the plant was decommissioned in August 1998). Monitoring wells were installed in the backfill in September 1998. Please note the significant increase in groundwater contamination after the pit was backfilled, this despite FMC's limestone amendment program.
3. The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located at or beyond what is known as the mine's compliance boundary, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine's waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. Within this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called intervention boundary somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified *before* they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the *numeric values* for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.
4. Water quality standards for the Flambeau Mine compliance boundary were established in the 1991 *Flambeau Mine Permit* and renewed in the 2022 *Revised Flambeau Mine Permit*. All of the listed MCLs, *with the exception of manganese*, were identical to the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code* (*Register*, Oct 1990).
5. Foth (Green Bay, WI), FMC's primary engineering consultant for the Flambeau project, predicted that sulfate concentrations in contact water leaving the backfilled pit would top off at 1100 mg/L (see *Flambeau Mine Permit Application* (1989), Foth, Volume II, Appendix L, p. L-30). Now that actual concentrations are being measured, levels as high as 2400 mg/L have been measured in MW-1013B (double what Foth predicted).
6. The MW-1013/A/B/C well nest was constructed in the backfilled mine pit in September 1998. No specific pre-mining groundwater data for this exact location was reported by FMC. Hence, "baseline" data incorporated in the present graph for the MW-1013 nest are drawn from "baseline" values reported for the overall project site by FMC in their 1989 Environmental Impact Report, Appendix 3.6-H (Groundwater Quality Data: 1987-88). The median baseline sulfate concentration was determined using data from 22 different wells drilled to a variety of depths in 3 different substrates (overburden, shallow Precambrian rock and deep Precambrian rock) plus one Artesian well and a "tank." Median = 10 mg/L; n = 193; range = < 5 - 48 mg/L; Detects = 75%.

Data Sources: *Environmental Impact Report for the Kennecott Flambeau Project*, Vol. V, Appendix 3.6-H (Groundwater Quality Data – 1987-88); *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2019 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding report issued in 2021; and *Split-Sample Groundwater Monitoring Results*, Wisconsin DNR, June 2023.

Graph created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

Arsenic Concentrations (dissolved/filtered)¹ in Monitoring Well-1013C at the Flambeau Mine Site (Backfill Well)^{2, 3}

MW-1013C is located within the backfilled mine pit. It is about 600' from the Flambeau River, 198' deep, and in line with the direction of groundwater flow toward the river.



1. Flambeau Mining Company (FMC) only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. *use and consume unfiltered water*).

2. The Flambeau Mine pit was backfilled in 1997 with stockpiled waste rock, some of it amended with limestone due to sulfide content. The filter sands and sludge from the mine's wastewater treatment plant, decommissioned in August 1998, were also buried in the pit. Monitoring wells were installed in the backfill in September 1998. Please note the significant increase in groundwater contamination after the pit was backfilled, this despite FMC's limestone amendment program.

3. The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located at or beyond what is known as the mine's compliance boundary, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine's waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. Within this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called intervention boundary somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified *before* they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the *numeric values* for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.

4. The cited groundwater quality standards are those listed in the *Wisconsin Administrative Code*, Chapter NR-140 (Groundwater Quality), as published in the *Wisconsin Administrative Register*, Dec 2010. They apply to the Flambeau Mine intervention and compliance boundaries.

5. The *Wisconsin Administrative Code* lists no freshwater aquatic life standard for arsenic, but Canada has established a chronic exposure standard of 5 µg/L (total).

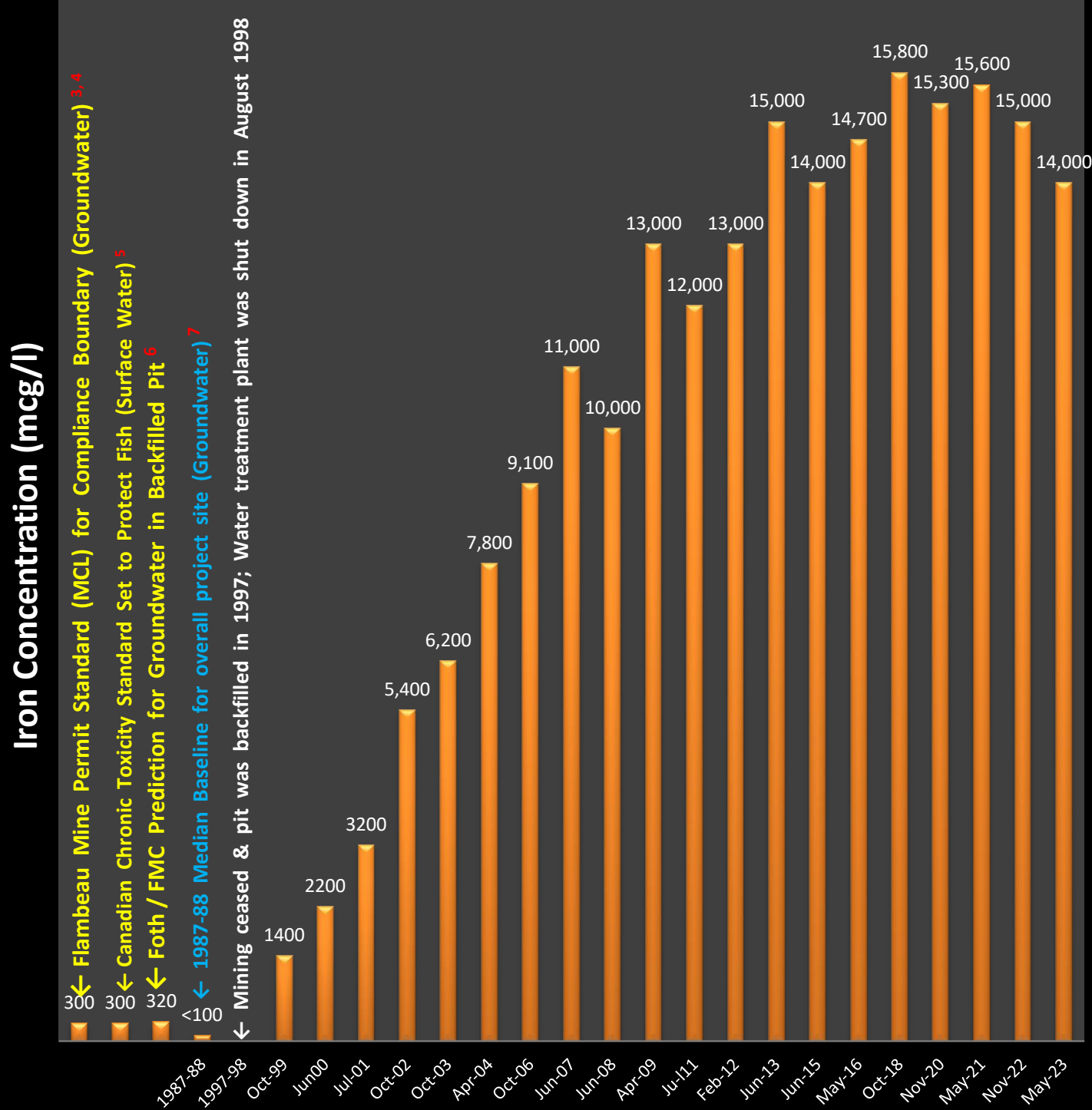
6. The MW-1013/A/B/C well nest was constructed in the backfilled mine pit in September 1998. No specific pre-mining groundwater data for this exact location was reported by FMC. Hence, "baseline" data incorporated in the present graph for the MW-1013 nest are drawn from "baseline" values reported for the overall project site by FMC in their 1989 Environmental Impact Report, Appendix 3.6-H (Groundwater Quality Data: 1987-88). The median baseline arsenic concentration was determined using data from 22 different wells drilled to a variety of depths in 3 different substrates (overburden, shallow Precambrian rock and deep Precambrian rock) plus one Artesian well and a "tank." Median < 5 µg/L; n = 193; range = < 5 - 21 µg/L; Detects = 2.6% (Arsenic was detected in 5 out of 193 samples collected. A lone detect of 21 µg/L occurred in MW-1004, where 11 of the 12 samples collected over the course of a year had undetectable concentrations of arsenic (< 5µg/L). The remaining 4 detects occurred in deep Precambrian piezometers which apparently have since been abandoned, or at least are no longer being reported publicly by FMC).

Data Sources: *Environmental Impact Report for the Kennecott Flambeau Project* (1989), Foth, Volume V, Appendix 3.6-H; *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2018 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding reports issued in 2019 -2022; and *Split-Sample Groundwater Monitoring Results*, Wisconsin DNR, June 2023.

Graph created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

Iron Concentrations (dissolved/filtered)¹ in Monitoring Well-1013C at the Flambeau Mine Site (Backfill Well)^{2, 3}

MW-1013C is located within the backfilled mine pit. It is about 600' from the Flambeau River, 202' deep, and in line with the direction of groundwater flow toward the river.



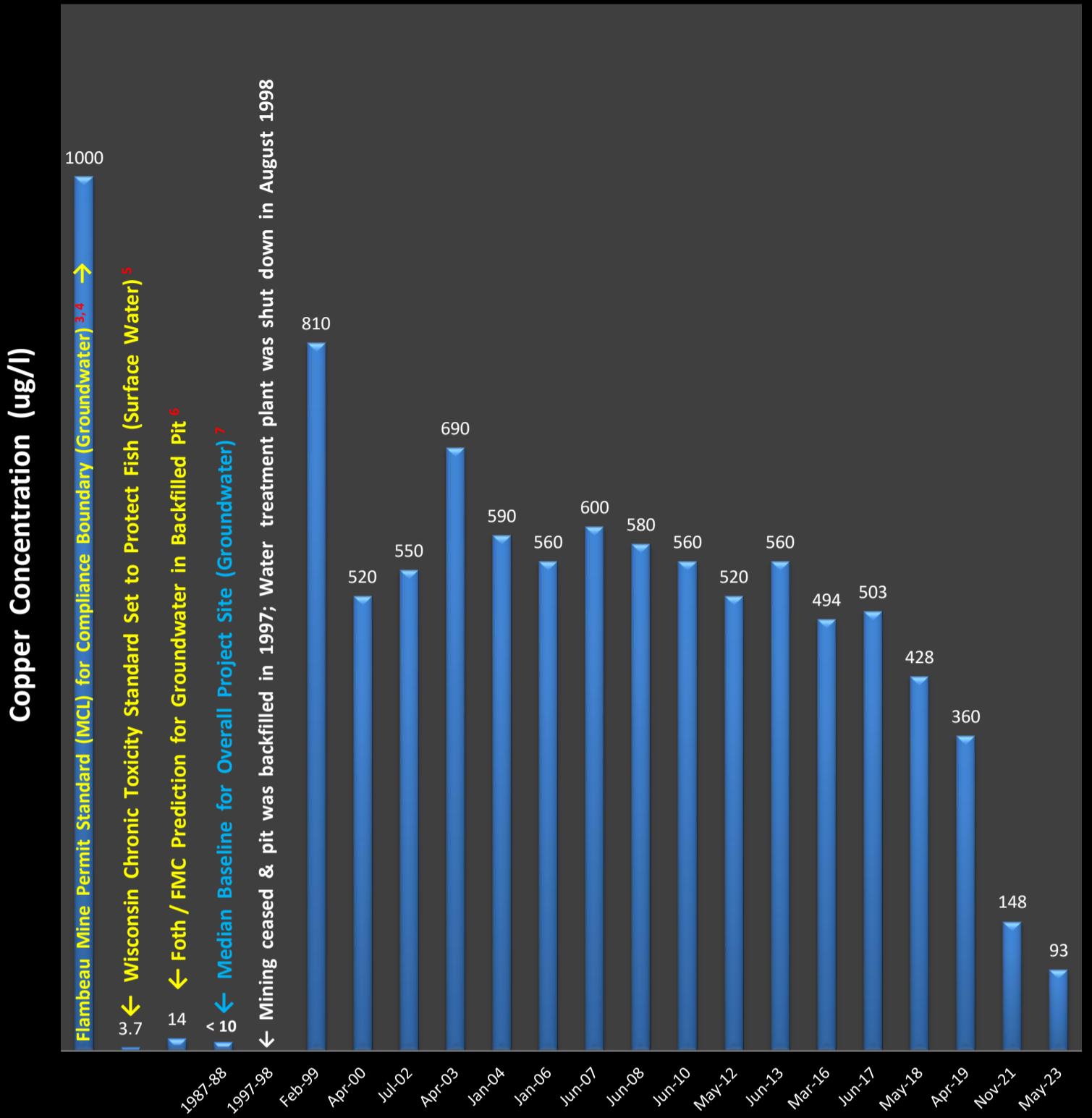
1. Flambeau Mining Company (FMC) only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. *use and consume unfiltered water*).
2. The Flambeau Mine pit was backfilled in 1997 with stockpiled waste rock (some of it amended with limestone due to sulfide content) and sludge from the mine's wastewater treatment plant (the plant was decommissioned in August 1998). Monitoring wells were installed in the backfill in September 1998. Please note the significant increase in groundwater contamination after the pit was backfilled, this despite FMC's limestone amendment program.
3. The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located at or beyond what is known as the mine's compliance boundary, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine's waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. Within this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called intervention boundary somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified *before* they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the *numeric values* for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.
4. Water quality standards for the Flambeau Mine compliance boundary were established in the 1991 *Flambeau Mine Permit* and renewed in the 2022 *Revised Flambeau Mine Permit*. All of the listed MCLs, *with the exception of manganese*, were identical to the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code* (*Register*, Oct 1990).
5. The State of Wisconsin has established no Acute or Chronic Toxicity Criteria for iron in surface waters, but Canada has established a chronic toxicity standard of 300 mcg/l.
6. Foth (Green Bay, WI), FMC's primary engineering consultant for the Flambeau project, predicted that iron concentrations in contact water leaving the backfilled pit would top off at 320 mcg/L (see *Flambeau Mine Permit Application* (1989), Foth, Volume II, Appendix L, p. L-30). Now that actual concentrations are being measured, levels as high as 15,800 mcg/l have been measured in MW-1013C (nearly 50 times higher than Foth predicted).
7. The MW-1013/A/B/C well nest was constructed in the backfilled mine pit in September 1998. No specific pre-mining groundwater data for this exact location was reported by FMC. Hence, "baseline" data incorporated in the present graph for the MW-1013 nest are drawn from "baseline" values reported for the overall project site by FMC in their 1989 Environmental Impact Report, Appendix 3.6-H (Groundwater Quality Data: 1987-88). The median baseline iron concentration was determined using data from 22 different wells drilled to a variety of depths in 3 different substrates (overburden, shallow Precambrian rock and deep Precambrian rock) plus one Artesian well and a "tank." Median = < 100 µg/L; Range = < 60 - 21,000 µg/L; n = 193; detects = 46%.

Data Sources: *Environmental Impact Report for the Kennecott Flambeau Project* (1989), Foth, Volume V, Appendix 3.6-H; *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2018 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding reports issued in 2020 -2022; and *Biannual Environmental Monitoring Results*, Flambeau Mining Company, July 2023.

Graph created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

Copper Concentrations (filtered/dissolved)¹ in Monitoring Well-1014B at the Flambeau Mine Site (Backfill Well)^{2, 3}

(MW-1014B is located within the backfilled mine pit. It is about 2300' from the Flambeau River, 105' deep and in line with the direction of groundwater flow toward the river).



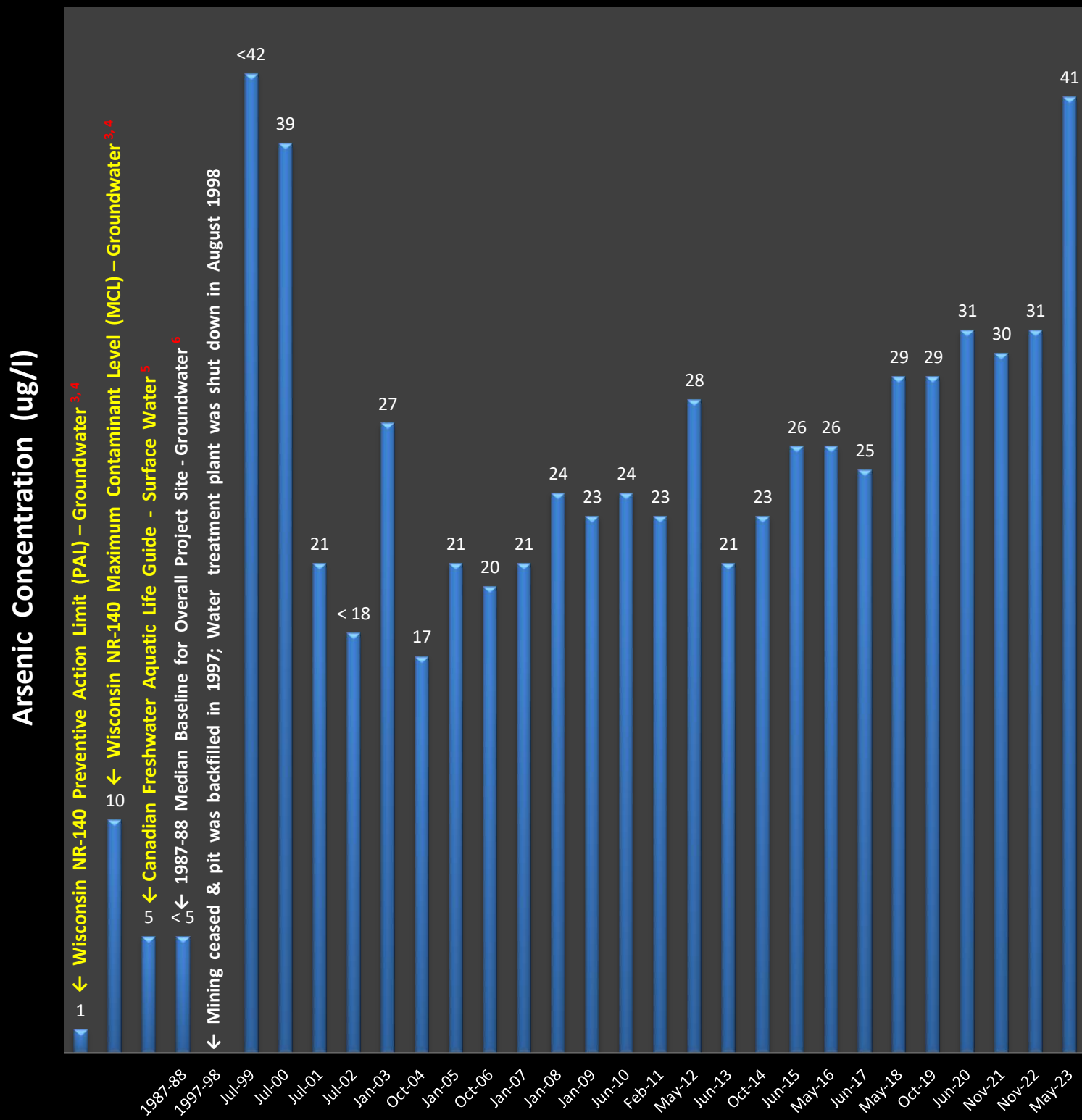
- Flambeau Mining Company (FMC) only reports data from **filtered** groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. *use and consume unfiltered water*).
- The Flambeau Mine pit was backfilled in 1997 with stockpiled waste rock (some of it amended with limestone due to sulfide content) and sludge from the mine’s wastewater treatment plant (the plant was decommissioned in August 1998). Monitoring wells were installed in the backfill in September 1998. Please note the significant increase in groundwater contamination after the pit was backfilled, this despite FMC’s limestone amendment program.
- The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located at or beyond what is known as the mine’s compliance boundary, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine’s waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. Within this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called intervention boundary somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified *before* they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the *numeric values* for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.
- Water quality standards for the Flambeau Mine compliance boundary were established in the 1991 *Flambeau Mine Permit* and renewed in the 2022 *Revised Flambeau Mine Permit*. All of the listed MCLs, *with the exception of manganese*, were identical to the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code* (*Register*, Oct 1990).
- Wisconsin Administrative Code*, NR 105.06 (Nov 2008); Hardness-dependent toxicity; Reported value of 3.7 mcg/L (Total Recoverable) was calculated for a hardness of 30 mg/l.
- Foth (Green Bay, WI), FMC’s primary engineering consultant for the Flambeau project, predicted that copper concentrations in contact water leaving the backfilled pit would top off at 14 mcg/L (see *Flambeau Mine Permit Application* (1989), Foth, Volume II, Appendix L, p. L-30). Now that actual concentrations are being measured, levels as high as 810 mcg/L have been measured in MW-1014B (58 times higher than Foth predicted).
- The MW-1014/A/B/C well nest was constructed in the backfilled mine pit in September 1998. No specific pre-mining groundwater data for this exact location was reported by FMC. Hence, “baseline” data incorporated in the present graph for the MW-1014 nest are drawn from “baseline” values reported for the overall project site by FMC in their 1989 Environmental Impact Report, Appendix 3.6-H (Groundwater Quality Data: 1987-88). The median baseline copper concentration was determined using data from 22 different wells drilled to a variety of depths in 3 different substrates (overburden, shallow Precambrian rock and deep Precambrian rock) plus one Artesian well and a “tank.” Median < 10 µg/L; n = 193; range = < 5 - 85 µg/L; Detects = 39%.

Data Sources: *Environmental Impact Report for the Kennecott Flambeau Project* (1989), Foth, Volume V, Appendix 3.6-H; *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2018 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding reports issued in 2019 and 2021; and *Split-Sample Groundwater Monitoring Results*, Wisconsin DNR, June 2023.

Graph created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

Arsenic Concentrations (filtered/dissolved)¹ in Monitoring Well-1014C at the Flambeau Mine Site (Backfill Well)^{2, 3}

MW-1014C is located within the backfilled mine pit. It is about 2300' from the Flambeau River, 154' deep and in line with the direction of groundwater flow toward the river.



1. Flambeau Mining Company (FMC) only reports data from *filtered* groundwater samples instead of following best practices, which would also entail reporting unfiltered **totals** (most families using private wells or springs and all farms, livestock, wildlife, fish and vegetation, etc. *use and consume unfiltered water*).
2. The Flambeau Mine pit was backfilled in 1997 with stockpiled waste rock, some of it amended with limestone due to sulfide content. The filter sands and sludge from the mine’s wastewater treatment plant, decommissioned in August 1998, were also buried in the pit. Monitoring wells were installed in the backfill in September 1998. Please note the significant increase in groundwater contamination after the pit was backfilled, this despite FMC’s limestone amendment program.
3. The statutes and natural resource (NR) rules governing mining in Wisconsin do not call for the enforcement of any groundwater quality standards within backfilled mine pits or beneath waste rock stockpiles at project sites. If, however, sufficiently high concentrations of contaminants are measured in monitoring wells located at or beyond what is known as the mine’s compliance boundary, citations can be issued by the Wisconsin Department of Natural Resources (DNR) for violations of permit-specified Maximum Contaminant Levels (MCLs). Provisions contained in Chapter NR-182 of the *Wisconsin Administrative Code* set the boundary at 1200 feet from the outer edge of the mine’s waste disposal site or at the boundary of the property owned or leased by the company, whichever distance is less. Within this zone MCL standards can be exceeded without penalty. The law also calls for establishing a so-called intervention boundary somewhere between the waste disposal site and compliance boundary so that emerging pollution problems might be identified *before* they have a chance to reach the compliance boundary or, in the case of the Flambeau Mine, before they reach the Flambeau River. As such, intervention boundary wells are subject to a more stringent set of groundwater quality standards than the MCLs enforced at the compliance boundary. Known as Preventive Action Limits (PALs), they are typically 10-20% of the corresponding MCLs. Unless otherwise specified in the mine permit, NR 182.107(1)(a) (*Register*, Dec 2021) calls for the *numeric values* for the applicable MCL and PAL standards at mine sites to be the same as the state-wide drinking water standards found in Chapter NR-140 of the *Wisconsin Administrative Code*.
4. The cited groundwater quality standards are those listed in the *Wisconsin Administrative Code*, Chapter NR-140 (Groundwater Quality), as published in the *Wisconsin Administrative Register*, Dec 2010. They apply to the Flambeau Mine intervention and compliance boundaries.
5. The *Wisconsin Administrative Code* lists no freshwater aquatic life standard for arsenic, but Canada has established a chronic exposure standard of 5 µg/L (total).
6. The MW-1014/A/B/C well nest was constructed in the backfilled mine pit in September 1998. No specific pre-mining groundwater data for this exact location was reported by FMC. Hence, “baseline” data incorporated in the present graph for the MW-1014 nest are drawn from “baseline” values reported for the overall project site by FMC in their 1989 Environmental Impact Report, Appendix 3.6-H (Groundwater Quality Data: 1987-88). The median baseline arsenic concentration was determined using data from 22 different wells drilled to a variety of depths in 3 different substrates (overburden, shallow Precambrian rock and deep Precambrian rock) plus one Artesian well and a “tank.” Median < 5 µg/L; n = 193; range = < 5 - 21 µg/L; Detects = 2.6% (Arsenic was detected in 5 out of 193 samples collected. A lone detect of 21 µg/L occurred in MW-1004, where 11 of the 12 samples collected over the course of a year had undetectable concentrations of arsenic (< 5 µg/L). The remaining 4 detects occurred in deep Precambrian piezometers which apparently have since been abandoned, or at least are no longer being reported publicly by FMC).

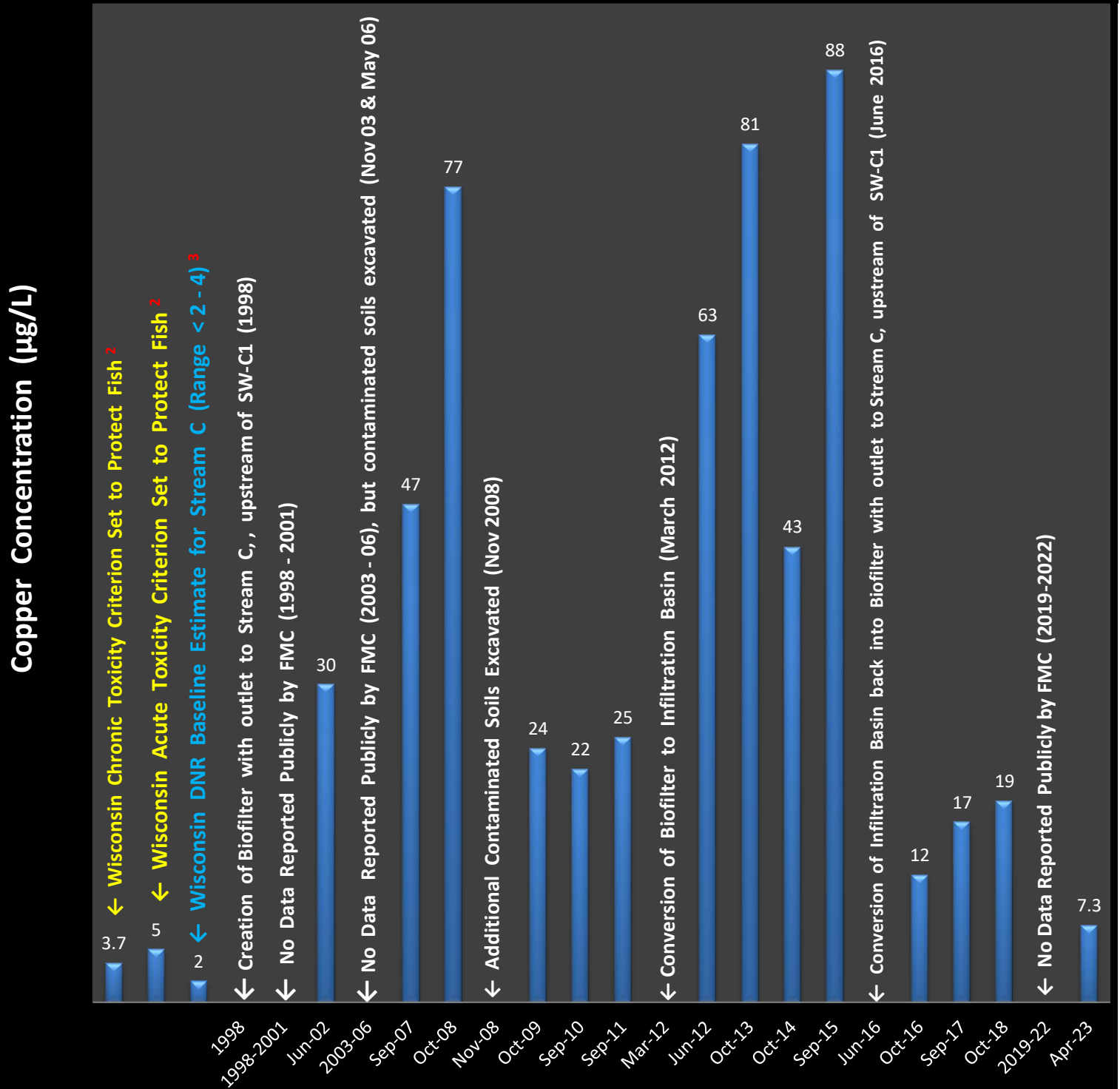
Data Sources: *Flambeau Mine Permit Application* (1989) & *Environmental Impact Statement* (1990); *2017 Annual Report*, Flambeau Mining Company, Appendix B (Historical Groundwater Results), pp. B-41 – B-71; *2018 Annual Summary Memorandum*, Flambeau Mining Company, Attachment A (Groundwater Quality) and corresponding reports issued in 2019 -2022; and *Split-Sample Groundwater Monitoring Results*, Wisconsin DNR, June 2023.

Graph created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.

Copper Concentrations (total recoverable) in Stream C at the Flambeau Mine Site

Stream C is a tributary of the Flambeau River that crosses the SE corner of the Flambeau Mine site, where the mine’s ore crusher, rail spur, water detention ponds and high-sulfur waste rock stockpile were located during operations.¹

Data shown below was reported by Flambeau Mining Company for Stream C sampling site **SW-C1** which is located downstream of where passively treated stormwater runoff from the mine site enters the stream.



1. Historically, Stream C has been used by Flambeau Mining Company (FMC) as a conduit for conveying contaminated stormwater runoff from the Flambeau Mine’s industrial outlot to the Flambeau River. A portion of the stream was added to the Environmental Protection Agency’s list of Impaired Waters in 2012 for copper toxicity linked to the mine operation. Over the years, FMC has tried to mitigate the problem by excavating contaminated soils nearby to the stream (as marked on the above graph – 2003, 2006, 2008) and installing different types of passive water treatment systems in the industrial outlot (1998, 2012, 2016). Not only has the contamination persisted, but an *additional* stretch of Stream C within the outlot was listed as impaired by the EPA in 2022.

2. Wisconsin Administrative Code, NR 105.06 (Nov 2008); Hardness-dependent toxicity; CTC value of 3.7 µg/L and ATC value of 5.0 µg/L (Total Recoverable) were calculated for a hardness of 30 mg/L (Hardness measured by FMC at SW-C1 in April 2023 was 27 mg/L).

3. FMC failed to report baseline surface water quality data for Stream C. In 2010, however, the Wisconsin Department of Natural Resources (DNR) identified a nearby stream deemed appropriate to use for estimating Stream C baseline conditions. A mean copper concentration of 2.2 µg/L was measured in the stream (range = <2 - 4; n = 5), as reported in: (1) Surface Water Quality Assessment of the Flambeau Mine Site, Wisconsin DNR, Apr 2012; and (2) Flambeau Mine Field and Surface Water Results, Wisconsin DNR, July 2011.

Data Sources: Compilation of FMC Stream C and Biofilter Monitoring Data (1999-2010), Dr. David M. Chambers (Center for Science in Public Participation, Bozeman, MT), 2010 [NB: The data table compiled by Dr. Chambers was submitted to the Wisconsin DNR in late 2010 in support of a successful citizen petition urging the Department to add Stream C to the state’s Impaired Waters List]; Compilation of FMC Stream C Surface Water Quality Data (2013-2018), Wisconsin DNR, 2020; 2010 Stipulation Monitoring Report – and corresponding reports issued in 2011 and 2012, FMC; Fall 2015 Surface Water Results, FMC; 2018 Stream C Impairment Assessment – and corresponding reports issued in 2020 and 2022, Wisconsin DNR; and Spring 2023 Stream C Surface Water Results, FMC.

Graph created by: Deer Tail Scientific, Duluth, MN (2023). For more information go to: <https://deertailscientific.wordpress.com/flambeau-pollution-graphs/>.