Montana Department of Environmental Quality

Economic Analysis of Meeting Base Numeric Nutrient Standards

Supplement to *First Triennial Review of Base Numeric Nutrient Standards and Variances*

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Executive Summary

The Department of Environmental Quality (DEQ) reviewed its two 2012 reports (one for the public sector, one for the private sector) that justified a general variance for incrementally meeting base numeric nutrient standards in Montana. The public-sector report, entitled "*Demonstration of Substantial and Widespread Economic Impacts to Montana That Would Result if Base Numeric Nutrient Standards had to be Met in 2011/2012*", demonstrates that almost all Montana towns would have experienced significant economic distress trying to meet the nutrient standards at that time. As part of the current (2016/2017) triennial review, DEQ demonstrates that the general variance is still justified, given current economic conditions. For the current report, DEQ only looked at those towns included in the 2012 study that would qualify for and are likely to need a general variance, along with four additional towns that quality for (and would likely need) a general variance. DEQ used updated economic data for these communities and found that almost all would experience substantial economic impacts from trying to comply with the state's base numeric nutrient standards. Similar analysis was undertaken on a number of private facilities, and the same general conclusion was reached; namely, that private facilities would also currently face significant economic distress by having to meet the standards. Collectively, these findings indicate the basic tenet of the general variance—that meeting the nutrient standards in the absence of dilution would cause substantial and widespread economic harm—continues to hold true.

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ACRONYMS

Acronym	**Definition**
DEQ	Department of Environmental Quality (Montana)
EPA	United States Environmental Protection Agency
MHI	Median Household Income
RO	Reverse Osmosis
TN	Total Nitrogen
TP	Total Phosphorus
WERF	Water Environment Research Foundation, recently updated to Water Environment & Reuse Foundation

1.0 INTRODUCTION

This document provides supplemental analysis on the economic effects of meeting Montana's base numeric nutrient standards, which were adopted in 2014. This work is supplemental to analyses found in Section 3.0 of "*First Triennial Review of Base Numeric Nutrient Standards and Variances*" (Water Quality Planning Bureau, 2017). To begin this supplemental analysis, the Department of Environmental Quality (DEQ) reviewed its 2012 report which justified a general variance for incrementally meeting base numeric nutrient standards in Montana. That study, "*Demonstration of Substantial and Widespread Economic Impacts to Montana That Would Result if Base Numeric Nutrient Standards had to be Met in 2011/2012*" (Blend and Suplee, 2012), analyzed data primarily from 2011 and shows that almost all Montana towns would have experienced significant economic distress trying to meet the nutrient standards at that time. As part of the current (2016/2017) triennial review, DEQ demonstrates here that the general variance is still justified, given the state's current economic conditions. DEQ demonstrates that a general variance is still justified by looking at those towns included in the 2012 report that qualify for and are likely to need a general variance, using updated economic data; these communities would experience substantial impacts. DEQ also looks at four additional towns that would qualify for and are likely to need a general variance but were not included in the 2012 report, to see if they would also experience substantial economic impacts (they would). A similar analysis has been undertaken for a number of private facilities.

2.0 METHODS AND RESULTS: PUBLIC ENTITIES

DEQ obtained the latest available data on Median Household Income (MHI), and number of households in each town analyzed. These data were taken from the American Community Survey 2011-2015 (2015 data). Other data that were part of the 2012 report, mainly the cost data for reaching numeric nutrient standards by reverse osmosis (RO), were conservatively assumed to remain the same today as in the 2012 study, even though such costs are likely to be higher now. Although the cost numbers are from 2012, they should still hold within a reasonable range for costs to facilities to meet the nutrient standards and still reflect the best cost numbers available for meeting basic numeric nutrient standards. Also, since nutrient treatment technology has not significantly advanced in the past five years (Water Quality Planning Bureau, 2017), RO is still considered the technology needed to meet nutrient criteria for most towns in Montana. While it is uncertain whether RO will reduce total nitrogen (TN) to Montana's nutrient standards, the 2011 WERF study from which costs were derived (Falk et al., 2011a) used RO as its most strict nutrient control for cost purposes and is still the best cost study DEQ has on this. In addition, DEQ considers economically feasible Limits of Technology (LOT) as something short of (less stringent than) RO due to RO's expense (Montana Department of Environmental Quality, 2017). Finally, Schmidt (2010) shows that for TP, TN, and other micro-pollutants, RO was indeed the most effective method for removing TN and TP (better than membrane bioreactor, MBR). Thus, this updated justification assumes the use of RO technology for this demonstration of economic hardship.

Using the most recent data for MHI and the updated number of households in the towns in the report, the results clearly showed that reaching nutrient standards would still be too expensive for most towns that qualify for and are likely to need a general variance today. Most towns today would be pushed well over the 2.0% MHI level if they were to install RO, as they would have been six years ago. A table (**Table 2-1**) and two figures (**Figures 2-1**, **2-2**) are given below, showing this result. **Figure 2-1** compares cost

—as a function of community MHI—for installing RO to treat wastewater, using both 2011 and today's numbers, for eight applicable towns. Although some of the MHI percentage numbers are lower (i.e., less expensive) than in 2011, all but two communities (Missoula[1] and Helena) remain over 2.0% MHI. This indicates that the economic findings from the 2012 report hold true today. **Figure 2-2** shows the four additional towns which were not included in the 2012 report; they also would have to spend over 2.0% of MHI to reach RO in an attempt to meet the base numeric nutrient standards.

DEQ updated the 'secondary score' numbers from the 2012 report using the latest data from the American Community Survey 2011-2015 (2015 data). It is important to note that EPA's Guidance (1995) and DEQ's updated guidance (Montana Department of Environmental Quality, 2017) indicate that if towns must pay more than 2% MHI for wastewater treatment (including current costs), then that scenario qualifies as a 'significant economic impact' regardless of the town's secondary score, and move on to the widespread test regardless of the secondary score. The secondary scores are also part of a sliding scale remedy for what towns would be expected to pay if they qualify for a variance. The most up-to-date average secondary scores for towns that would qualify for a general variance range from 1.6 for Butte and Stevensville to 2.6 for Manhattan. Every other town that would qualify for a general variance has an average secondary score between 1.8 and 2.2. This means that the sliding scale MHI cost cap is 1.3% to 1.7% MHI for most towns that would qualify for a general variance.

DEQ recently analyzed for these towns what it would take to achieve various wastewater treatment levels, all of which were more stringent than the current general variance (*see* Section 6.0 of Water Quality Planning Bureau, 2017). It was found that the majority of small towns (less than 1 million gallons per day, MGD) would find it too expensive, greater than 2.0% MHI, to get to 7 mg/l TN and 0.1 mg/l TP. For larger towns (wastewater discharge volumes ≥1MGD), it was found that 7 mg/L TN and 0.1 mg/L TP were much more affordable, and for more towns, due to economies of scale. As of this writing, DEQ has proposed treatment levels of 6 mg/L TN and 0.3 mg/L TP as affordable for ≥1MGD communities, under the general variance. But these levels of treatment are much less stringent than the nutrient standards themselves (e.g. 0.3 mg/L TN and 0.03 mg/L TP), providing another justification for the general variance.

[1] Missoula is currently meeting its nitrogen and phosphorus wasteload allocations for its discharge permit to the Clark Fork River, and therefore it is fairly unlikely that they will need a variance, at least in the immediate future.

Table 2-1. MHI Comparison for Towns in the 2012 Study with Today, and MHI for Four Additional Towns that Would Qualify (in red).

Community	Median Household Income (2010) MHI.	Median Household Income (2015)	Estimated Number of Households (Population / 2.5) based on 2000 Census	Estimated Number of Households American Community Survey 2011-2015	Current Average Annual Household Wastewater Bill	Design Flow (MGD)	Actual Flow (MGD)	Current wastewater MHI	2011 Percent MHI needed to get to RO/Base Numeric Nutrient Criteria (including current fees)	2011 Increase over current Wastewater Bill to Reach RO	2015 Percent MHI needed to get to RO/Base Numeric Nutrient Criteria (including current fees)	2015 Increase over current Wastewater Bill to Reach RO
Missoula	34,319	41,421	27,553	29,860	$152.14	12	9	0.44%	1.47%	232%	1.15%	214%
Helena	47,152	49,852	12,337	13,095	$265.44	5	3	0.56%	1.74%	196%	1.59%	185%
Billings	45,004	51,012	41,841	44,092	$218.28	26	26	0.49%	2.41%	398%	2.04%	377%
Butte	37,335	37,686	14,041	14,798	$360.00	9	4	0.96%	2.15%	123%	2.07%	117%
Kalispell	39,953	41,097	7,705	8,608	$216.00	5	3	0.54%	2.58%	186%	2.34%	166%
Bozeman	41,661	45,729	14,614	16,573	$372.00	14	6	0.89%	2.92%	228%	2.45%	201%
Manhattan	50,729	52,135	523	547	$362.40	1	0	0.71%	2.60%	264%	2.45%	253%
Stevensville	33,776	32,337	795	818	$535.08	0	0	1.58%	3.17%	100%	3.27%	97%
Whitefish	NA	51,122	NA	3,032	$915.00	2	1	1.79%	NA	NA	4.10%	129%
East Helena	NA	44,828	NA	934	$797.00	0	0	1.78%	NA	NA	2.79%	57%
Conrad	NA	39,063	NA	1,003	$489.00	1	0	1.25%	NA	NA	2.27%	81%
Colstrip	NA	84,145	NA	783	$357.00	1	0	0.42%	NA	NA	2.16%	408%

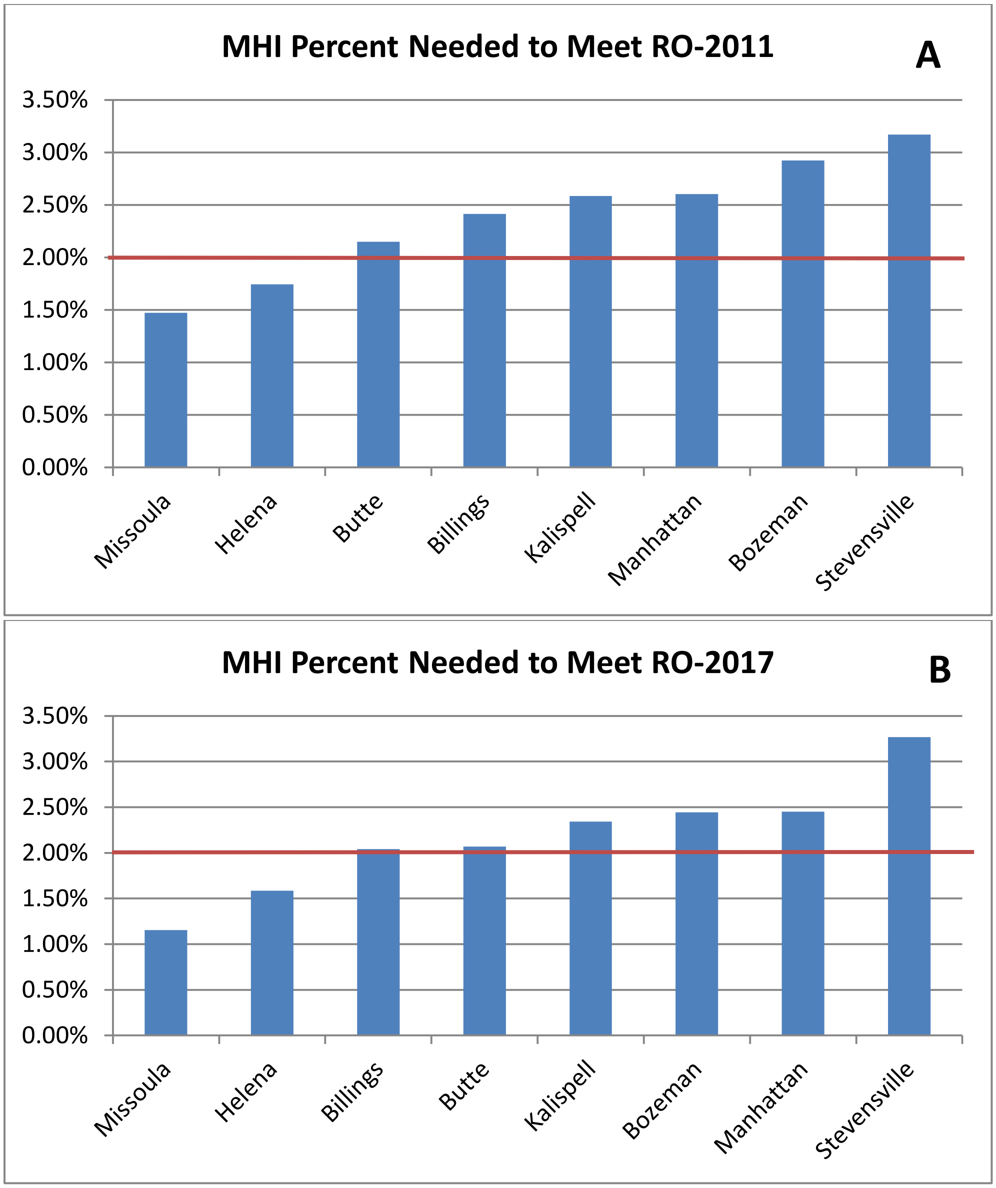

Figure 2-1. Eight communities common to the 2012 report (Blend and Suplee, 2012) and the present analysis. A. 2011 findings. B. 2017 findings. Each chart shows the cost (as % of community MHI) to install reverse osmosis for wastewater treatment for each community.

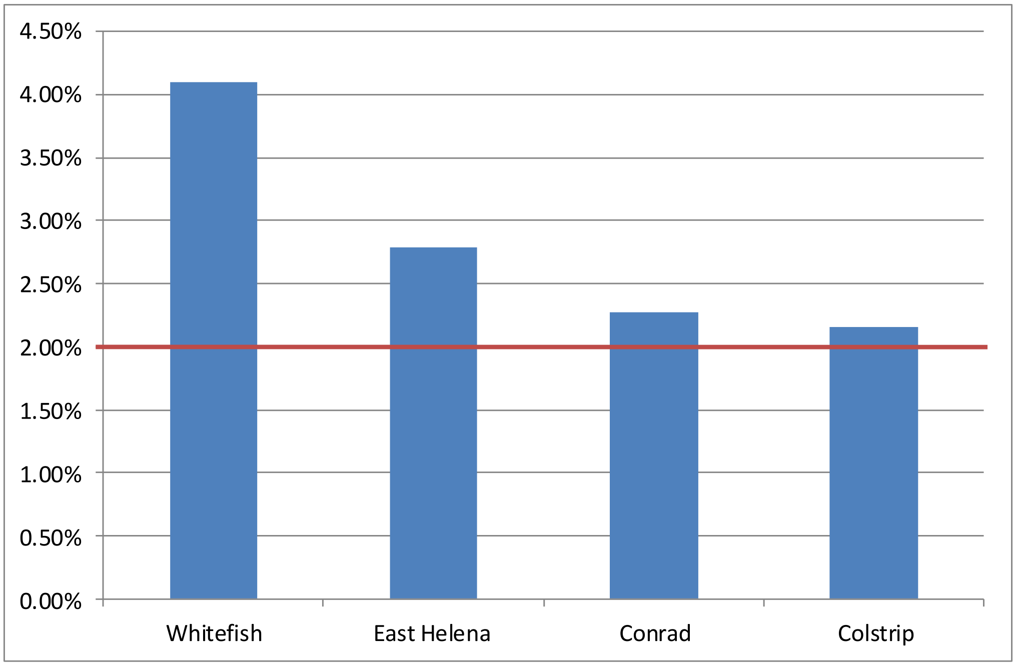

Figure 2-2. Four additional communities not included in the 2012 DEQ report (Blend and Suplee, 2012). The chart shows the cost (as % of community MHI) to install reverse osmosis treatment for each community.

3.0 METHODS AND RESULTS: PRIVATE ENTITIES

DEQ reviewed the joint DEQ-EPA study done in 2012 for the private sector, which justified a general variance for meeting base numeric nutrient standards in Montana. The study, "*Demonstration of Substantial and Widespread Economic Impacts to Montana That Would Result if Base Numeric Nutrient Standards had to be Met by Entities in the Private Sector in 2011/2012*" (DEQ 2012a), demonstrates that Montana businesses would experience significant economic distress trying to meet the base numeric nutrient standards at that time. In 2014 and now, as part of the current triennial review, DEQ demonstrates that the general variance is still justified, given current conditions. Only a few private companies identified in the 2012 report in Montana appear to require a general variance today. These include Elkhorn Rehab, MT Behavior Health, REC Silicon, the Phillips 66 Refinery, Barretts Talc, Stillwater Mine EDP, and the Stillwater mine. This list includes both large and small businesses in a variety of economic sectors.

Using the costs estimated in the 2012 DEQ report, Table 5, we restate below the estimated costs for these businesses of meeting nutrient standards. To estimate costs to each business of meeting nutrient standards, DEQ (with help from a contractor) in 2012 relied on a study that looked at costs associated with removing nutrients from wastewater at 5 different levels of treatment. The draft Water Environment Research Foundation (WERF) study relied upon for the costs of those five levels was entitled "*Finding the Balance between Wastewater Treatment Nutrient Removal and Sustainability, Considering Capital and Operating Costs, Energy, Air and Water Quality and More*" (Falk, et al., 2011a; finalized as Falk et al. 2011b). It looked at different levels of nutrient treatment ranging from minimal nutrient treatment (level 1) to a treatment that is close to Montana's base numeric nutrient standards (level 5).

Current effluent nutrient levels and estimates of current treatment costs at these businesses were compared to costs that would be needed to meet base numeric nutrient standards based on the WERF study. In this way, annual capital and operations costs needed for meeting base nutrient criteria (above current nutrient treatment costs) were applied to each business. In other words, existing nutrient removal treatment costs for private businesses were subtracted from estimated costs to meet the nutrient standards, if some treatment for nutrients was already being done. If a business already met WERF level 2 nutrient levels, for example, then the WERF level 2 costs for both capital expenditures and operations were subtracted from 100% RO costs (WERF level 5) to arrive at the additional cost to meet the criteria. Five scenarios measure sensitivity scenarios with discount rate and additional labor costs associated with Level 5. Again, RO is used as the assumed Level 5 technology with the same explanation as given above. (Please see the original DEQ report for more details.)

Table 3-1. Table 5 (from DEQ (2012a)) entitled "Estimated Average Annual Costs (Capital and O&M Cost) for Affected Montana Businesses." Costs shown are those needed to meet WERF Level 5 (i.e., close to Montana's numeric nutrient standards). ***Sector Codes: M-metal mining, C-Coal Mining, OG-Oil and Gas, E-Electric Generation, R-Refineries, Mfg-General Manufacturing, Oth-Other).***

Company (Sector code)	Original	Scenario A	Scenario B	Scenario C	Scenario D	Scenario E
MT Behavioral Health Inc WWTP (***Oth***)	$213,626	$236,495	$286,807	$240,512	$267,414	$326,598
Elkhorn Health Care WWTP (***Oth***)	$32,044	$35,474	$43,021	$36,077	$40,112	$48,990
Stillwater Mining Company-1 (M)	$1,341,870	$1,489,230	$1,813,422	$1,515,111	$1,688,457	$2,069,819
Stillwater Mining Company-2 (M)	$1,026,867	$1,135,282	$1,373,793	$1,154,322	$1,281,855	$1,562,426
Barretts Mineral (Mfg)	$2,498,711	$2,762,519	$3,342,896	$2,808,851	$3,119,180	$3,801,903
P66 Refinery (R)[i]	$5,682,449	$6,290,768	$7,629,070	$6,397,607	$7,113,200	$8,687,504
REC Advanced Silicon (***Mfg***)	$1,825,542	$2,018,278	$2,442,298	$2,052,129	$2,278,853	$2,777,646

It is important to note that the costs listed above likely underestimate what Montana firms would need to spend in order to meet nutrient standards. The reason is that WERF Level 5 plus RO (used to estimate these costs) may not get to the levels of the criteria in Montana—especially for TP. To compensate for that, the higher cost scenarios (Scenarios D and E) with additional labor costs and higher discount rates are probably the best numbers to consider. The companies are examined in greater detail below.

Phillips 66 Billings Refinery

Phillips 66 and Montana's other two large refineries in the Billings area provide almost all of Montana's liquid petroleum products as well as about 50% of Spokane's and 25% of North Dakota's supply (Jeff Blend, DEQ Economist, personal communication, 4/28/2017).

An additional alternate analysis was performed for refineries in the Billings area. These refineries as a whole had an annual input of 60 million barrels of crude from 2004-2007 (Montana Department of Environmental Quality, 2012b), which still largely holds today. Based on the financial reports for one of the major oil companies in the US, earnings (which is revenues minus costs) from US-based refining for five fiscal quarters (the fourth quarter of 2009 and all four quarters of 2010) have fluctuated between ($1.80) and $2.68 per barrel (Exxon Mobil Corporation, 2011). This provides estimated earnings for each of the Billings-area refineries between ($36) million and $53.6 million per year (assuming about 20 million barrels of crude input to each annually), making an annual investment of $8.6 million annually a significant portion of the earnings of all the refineries combined or an exacerbation of their losses. In some fiscal quarters, refineries appear to be losing money, making such costs harder to bear. It is important to note that in recent years, barrel earnings margins have been higher with a roughly estimated earnings average closer to $20 a barrel, but $8.6 million per year would still cut into profits for Phillips 66, and oil prices can be quite volatile.

Stillwater Mining Company

The Stillwater Mining Company (SMC) operates two underground mines and processing facilities in south-central Montana and is one of the largest private employers in Montana (over 1000 employees). SMC is the only primary producer of palladium and platinum in the United States with the majority the metal production from the mines utilized in clean air technologies and catalytic converters for the auto industry. SMC's multiple stage water management and water treatment facilities are engineered for treatment of nitrogen species that occur in mine waters due to the use of blasting agents in underground mining operations. Ammonium nitrate (the same compound used in agricultural fertilizer) is the primary component of the explosives used for mining. Consistency of treatment efficiency is easier to maintain during the summer time when water temperatures are warmer and water chemistry is more consistent. (It should be noted that base numeric nutrient standards will only apply in summer in most cases.) During the summer, the SMC nutrient treatment systems are able to consistently achieve 5 mg/L, however, during the winter months (6 months of the year), colder temperatures and higher TDS in the mine waters can trigger periods of variability in treatment efficiency that can result in effluent concentrations of up to 15 mg/L. Because of this variability, it is difficult to numerically quantify the limits of technology (with less than 5 mg/L accuracy) for enhanced biological nutrient treatment such as SMC experiences in the mountainous headwaters areas across Montana. Below is a summary of capital expenditures for water treatment systems at each of the mine sites. The capital expenditures represent the time period of 1995 to 2011.

Table 3-2. Table 7 (from DEQ (2012a)) entitled "Capital expenditures for water treatment systems at each of the mine sites."

Water Treatment	Stillwater Mine	East Boulder Mine	Total
Capital Cost (1995-2011)	$7,500,000	$3,800,000	$11,300,000

In addition to capital expenditures, operating and maintenance costs for the SMC water treatment systems can range between $350K and $500K per year per site depending on flow rates, maintenance requirements (including labor), and mechanical replacements. Additionally, it should be noted that treatment capacity is more sensitive to flow than concentration which adds potential to inflate both capital and operating costs dramatically even if overall influent concentrations are relatively low. Mine size, hydraulic setting, changing hydraulic conditions, production rate and commodity pricing (to name a few) can impact significantly on capital requirements to sustain and grow the company and meet changing regulatory mandates. Complicating the picture further is the fact that current operational costs and future cost projections are influenced by more site-specific parameters (flow, temperature, pH, TDS, contact time, bacterial regime etc.) that are ever-changing. In order to meet these operating challenges and maintain operational flexibility, biological treatment design normally requires process redundancies and additional capacity to compensate for upset conditions and assure a reasonable availability in order to meet treatment design criteria. These factors all impact upon the ability of new and existing mines to meet the new, low surface water standards and add an additional complexity to the economic decision-making process inherent to mine development. Likewise, the variability and cyclic nature of commodity prices can significantly impact on a Company's ability to meet new or increased capital budget allocations associated with new regulatory standards. The proposed removal targets (Montana's base nutrient criteria) would require nitrogen removal rates of over 99% which are at least an order of magnitude lower than can be achieve with the current Best Available Technology, according to SMC.

Annualizing the above costs (existing, current treatment costs) would come to $1.8 million ($1.06 million capital annualized plus $350,000-$500,000 annual operating costs at each site). This is in addition to an estimated $3.6 million annually to get to base nutrient criteria or about $5.4 million per year total in annual costs for nutrient treatment. Is $3.6 million in additional annual cost significant and widespread? Here are Stillwater's (Stillwater Mining Company, 2011) most recent available earnings before taxes:

2010 $50.4 million
2009 -$8.7 million
2008 -115.8 million

Palladium and platinum prices reached high levels in 2010 from very low levels in 2008. In the best year, the annual additional cost of nutrient treatment beyond current treatment is 7% of profits. In the worst years, the company does not make a profit. Stillwater is experiencing great uncertainty in commodity prices and would probably not invest a lot of additional money for treatment beyond what it has already done. In addition, metal mines prices and thus revenues fluctuate a lot and present a further challenge to bearing additional costs. In addition, the Stillwater mine, consisting of two primary mines, is one of the only sources of palladium and platinum in North America.

<u>REC</u>

REC has a high overall cost at $2.8 million annually (with the highest cost scenario). In 2016, their EBITA return was a loss of $30.8 million (REC Silicon, 2016 Annual Report, http://epub.artbox.no/recsilicon/ar2016/#4, page 7). It is hard to say how much a $2.8 million annual cost would exacerbate their losses. Because most of these industries involve nationally or internationally traded commodities, costs of meeting base numeric criteria will not be primarily shifted to consumers. Rather, the private businesses themselves will have to incur the majority of costs.

Barretts

Barretts would have an annual cost of up to $3.8 million to meet nutrient standards. The best financial information we could find was from the parent company's most recent 10-K. Assuming that Barretts is their only talc producer, net sales of talc products were $55.7 million, $55.9 million and $55.5 million for the years ended December 31, 2016, 2015 and 2014, respectively. (Minerals Technologies 10-K form, page 6, 2/7/17, found at http://phx.corporate-ir.net/phoenix.zhtml?c=82665&p=irol-sec). This suggests that additional costs for nutrients would be almost 10% of total revenue (earnings on talc were impossible to find). This would almost certainly be a large fraction of total earnings (revenues minus costs).

Elkhorn and MT behavioral Health

These two facilities are small businesses and would likely be substantially impacted by any additional water treatment costs. Costs from the WERF study are under-estimated for small facilities and those with low flows, because the WERF cost data was multiplied by effluent flow providing a linear cost estimate based on flow. Clearly, there will be a minimum cost of treating to base nutrient standards for facilities with small flows such as pouring concrete, hiring labor, etc. that is greater than the linear cost estimates for these low-flow and small facilities. DEQ believes that small facilities could not afford RO or even mechanical treatment in many cases.

4.0 Overall Conclusions

DEQ found that a general variance is justified when looking at those towns included in the 2012 study that would qualify for and are likely to need a general variance, along with four additional towns that quality for (and will likely need) a general variance. DEQ used updated economic data for these communities and found that all but two would experience substantial economic impacts from trying to comply with the state's base numeric nutrient standards. One of the two communities where cost is below the cost threshold of 2% MHI (Missoula) currently meets its wasteload allocation for nutrients, so the need for a general variance is fairly far out into the future (if needed at all).

It is DEQ's best professional judgment that, for the companies reviewed here, the costs of complying with the base numeric nutrient standards today would result in substantial costs beyond what individual firms can internalize. This could result in the businesses affected closing or scaling down in economic activity in particular economic sectors of Montana. At this point in time, using reverse osmosis on 100% of effluent flow is too expensive for most businesses to operate, and comes with a host of technical problems given Montana's winters and the business operations of affected companies, such as highly variable water flows at certain mines and greatly fluctuating annual revenues. Therefore, we conclude that reaching nutrient standards for those private businesses in Montana that qualify for and that are likely to need a variance would be prohibitively expensive.

5.0 References

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