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Ramsey County, MN

STATE OF MINNESOTA DISTRICT COURT

COUNTY OF RAMSEY SECOND JUDICIAL DISTRICT

Case Type: Other Civil

Court file: 62-CV-13-2414

White Bear Lake Restoration Association,
ex rel. State of Minnesota,

Plaintiff,

and

White Bear Lake Homeowners' Association,
Inc., *ex rel.* State of Minnesota,

Intervenor,

v.

Minnesota Department of Natural Resources,
and Thomas J. Landwehr, in his capacity as
Commissioner of the Minnesota Department of
Natural Resources,

Defendants,

and

Town of White Bear Lake and City of White
Bear Lake,

Defendant/Intervenors.

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This matter was tried before the Court from March 6 through March 29, 2017, pursuant to the claims of Plaintiff White Bear Lake Restoration Association and Plaintiff-Intervenor White Bear Lake Homeowners' Association against Defendants Minnesota Department of Natural Resources and the DNR Commissioner Thomas J. Landwehr (collectively, "DNR") for violations of the Minnesota Environmental Rights Act ("MERA") and violations of the Public Trust Doctrine. The interests of the Township of White Bear Lake and City of White Bear Lake were represented as Defendant-Intervenors.

Throughout this Order, the Court has cited to the testimony of several witnesses. These citations are based on the partial transcripts ordered by counsel and referenced in their respective memoranda. These partial transcript citations will not correspond with the complete trial transcript, assuming one is ordered for appeal purposes. Because of that, the partial transcripts have been saved on a flash drive as Court Exhibit A (PDF format), which will be included with the trial exhibits.

FINDINGS OF FACT

I. The Parties

1. Plaintiff White Bear Lake Restoration Association ("WBLRA"), a registered Minnesota non-profit organization dedicated to the restoration and preservation of White Bear Lake, initiated this MERA lawsuit in the name of the State of Minnesota to protect White Bear Lake and the Prairie du Chien-Jordan Aquifer from impairment, pollution, or destruction. WBLRA is comprised of owners and renters of riparian residential and commercial property, lake users, and other citizens adversely affected by impairment of the lake and the aquifer that underlies it.

2. Plaintiff-Intervenor White Bear Lake Homeowners' Association ("WBLHA"), an association of homeowners living on White Bear Lake, is dedicated to helping restore the lake.

3. Defendant Minnesota Department of Natural Resources ("DNR"), the state

agency responsible for preserving and protecting the State of Minnesota's water resources, is charged with managing groundwater appropriation. Among its duties are the issuance of high capacity well permits, and the monitoring and controlling of high-capacity groundwater pumping within the state.

4. Defendant Thomas J. Landwehr, the commissioner and executive head of the DNR, has statutory authority over the authorization of water appropriation permits.[1]

5. The City of White Bear Lake and White Bear Lake Township are Defendant-Intervenors in this action.

II. White Bear Lake

A. The lakebed and waters of White Bear Lake are Public Trust Assets

6. For well more than a century, White Bear Lake has been recognized as an important state natural resource and unique recreational lake. It is a longstanding community resource enjoyed by inhabitants of the Twin Cities' northeast metro area, and the sole large, recreational lake serving this area. As such, it is the epicenter of the northeast metro for fishing, boating, sailing, swimming and general recreation.

7. Because it is primarily fed by groundwater, it has a high water quality as well as moderate water clarity when compared to other Minnesota lakes. As time goes on, the number of such high-quality, recreational lakes is decreasing. Defendant DNR agrees that "high value" lakes such as White Bear Lake are extremely valuable and deserve special attention.

8. The lake and its lakebed are also public trust assets, as previously found by this Court in its Summary Judgment Order and Memorandum (August 29, 2014). Title to these assets is vested in the State of Minnesota, in its sovereign capacity, as trustee for the benefit of the public, and the Commissioner of the DNR is the state's agent with respect

[1] M.S. §103G.271.

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to that trust.[2] The public trust doctrine affords Intervenor-Plaintiff Homeowners' Association a common law cause of action to protect the public's use rights as to the water and lakebed of White Bear Lake.

B. Vital Statistics for White Bear Lake

9. Located approximately 10 miles northeast of downtown St. Paul, White Bear Lake lies in the northeastern part of the Twin Cities metropolitan area amidst a gently rolling, glaciated landscape bordering on Ramsey and Washington Counties. It is the third largest lake in the metropolitan area and is surrounded by the cities of White Bear Township, Mahtomedi, White Bear Lake, Birchwood Village and Dellwood. Nearby cities include Lino Lakes, Columbus, Centerville, Forest Lake, Hugo, North St. Paul and Vadnais Heights.

10. Originally part of a chain of lakes formed from melting glacial ice blocks that were left in bedrock valleys, the lake consists of three main bays divided by Manitou Island, located in the west-central part of the lake, and a peninsula that stretches from the east shore of the lake toward Manitou Island. At the time of statehood in 1858, the lake was, and is now, a navigable water. It is both a public water[3] and a natural resource.[4]

11. Although at its average elevation the lake covers approximately 2400 acres, its surface area correspondingly increases or decreases with similar changes in the lake levels. At its deepest point in the southeast bay, it is about 80 feet deep.[5]

12. White Bear Lake has a large shallow area or “littoral zone” with gently sloping

[2] M.S. § 84.027, Subd. 2.
[3] M.S. § 103G.201.
[4] M.S. § 116B.02.
[5] The parties have stipulated that the actual lake basin is 500 acres.

sides. At 923.8 feet above sea level (its long-term average elevation), the littoral zone[6] makes up 54% of the total lake surface area, and most of the lake's biology grows here. Because more than half the lake is shallow (less than 15 feet), this zone is extensive.[7]

13. The lake has a small drainage area. Its watershed[8] is only about 5000 acres, resulting in a 2:1 ratio of watershed area to lake surface area. A closed-basin lake, it has no natural input from streams or rivers and has no natural outlet.

14. A man-made outlet for White Bear Lake is located on the north-northwest part of the lake and flows toward Bald Eagle Lake, approximately a mile to the northwest. From 1906 to 1943, the spillway elevation of this outlet was 926.30 feet above sea level. The outlet elevation has been lowered twice: first, in 1943, to 925.4 feet; once again, in approximately 1982, to its current elevation of 924.3 feet. (The 1982 change in elevation was not approved by the DNR before its execution. Rather, the approval was given after-the-fact as a post-change permit.)

15. Of the 96 lakes studied in the 2016 USGS Study, "the most vulnerable to water level change/decline were located in the region between White Bear Lake and Goose Lake".[9] Over the years, the lake level of White Bear has fluctuated approximately 8 feet.

A. Its highest level: June, 1943, at 926.7 feet above sea level;

B. Its lowest level: January, 2013, at 918.54 feet;

C. Its ordinary high water level is 924.89 feet;

D. According to the DNR, its normal range is between 923 to 925 feet;

E. Long-term average elevation (1978-2002)[10]: 923.8 feet;

[6] Limnologists consider a "littoral zone" as any area of a lake less than 15 feet deep. In practice, it is the area where sunlight can penetrate to the lake bottom and support submerged and partially submerged plant growth through photosynthesis. It is critical for wildlife habitat, water quality and erosion control.

[7] Ex. 2036, p. 3.

[8] The watershed of a lake is the area of land surrounding it that is higher in elevation than the lake.

[9] Ex. 423, p. 3 (USGS Summary). Goose Lake, approximately 145 acres and 6 feet deep, is less than a mile from White Bear Lake.

[10] This was after augmentation ended.

F. The last available elevation before trial: 922.88 feet.

16. Factors affecting the level fluctuations of the lake are the same as those affecting any other lake: precipitation, runoff, surface outflow, evaporation and lake-groundwater exchange. Over the years, another factor has influenced the level of White Bear Lake: augmentation. From the early 1900s to 1977, Ramsey County augmented the lake with water from four groundwater wells.[11] Between 1924 and 1978, the lake had been augmented approximately 1 foot per year. The maximum pumped in any year was 3.56 feet in 1932. Augmentation did not occur during the following years: 1943-1947, 1952-1953, 1957, 1962, 1966-1967, 1971-1976, 1978-present. It was later discovered that pumping water out of the ground to refill White Bear Lake was only 14% efficient and actually **increased** the volume of water lost from the lake to groundwater.

C. Geology/Hydrogeology of White Bear Lake and Environs

17. St. Peter Sandstone and Prairie du Chien group bedrock units underlie White Bear Lake. The area has a "layer cake" bedrock geology; that is, horizontal layers of different types of rock layered on top of each other. Immediately below the lake are glacial sediments of sand, silt, and gravel deposited by glaciers over the top of the bedrock. The first bedrock layer beneath the lake is St. Peter Sandstone,[12] a medium- to coarse-grained sandstone. The lower levels of this formation, being fine-grained, do not transmit water very well and often act as a confining layer; they will not allow groundwater to pass vertically through them. Erosion in part of this area by the St. Peter Sandstone and part of the Prairie du Chien group has led to backfilling by glacial deposits in what is known as "bedrock valley". These glacial deposits allow for high transmissivity of water,

[11] Use of groundwater augmentation was outlawed by the Minnesota legislature in 1990 because groundwater is viewed as a pure source of drinking water. Ex. 145, p. 4.

[12] This stratum contains the aquifer of the same name which, although a significant drinking water aquifer in other parts of the Twin Cities, is not used as much around this lake because erosion has left it fairly thin. Because of this erosion in some areas, there is little to none of it left in this vicinity.

and as a consequence, water flows straight from the lake into the Prairie du Chien-Jordan Aquifer, with no restriction from the St. Peter sandstone. This is illustrated, for example, by the deep "V" representing the 80 foot depth of the lake found on Ex. 12A-19.

18. Below the St. Peter Sandstone lies the Prairie du Chien formation, created by a vast inland sea that existed millions of years ago during the Cambrian and Ordovician periods. A huge geologic formation that extends from as far west as South Dakota to Prairie du Chien, Wisconsin, and south into Iowa, it extends a few miles to the north of the lake, and consists of several layers that are primarily limestone or dolostone[13].

19. Beneath the Prairie du Chien lies the Jordan Aquifer. Because there are many areas where the two are connected, wells are often drilled into both and act as a conduit between the two aquifers. As a result, the two aquifers are frequently referred to as a single aquifer – the Prairie du Chien-Jordan Aquifer. These two aquifers, the most commonly used aquifers for drinking water in the Twin Cities metropolitan area, are both natural resources under M. S. § 116B.02.

20. There are some natural breaks in the aquifer system. For example, the Mississippi River, both between the west side of Minneapolis and the east side of the Twin Cities, has created a physical break in the aquifer, so that groundwater cannot flow through the Prairie du Chien from one side of the Mississippi to the other side of the Mississippi. The same is true for the St. Croix River; water that enters the aquifer near White Bear Lake cannot end up as far south as Iowa because it cannot breach that natural barrier.

D. **White Bear Lake's Vulnerability to Groundwater Fluctuations.**

21. The individual characteristics of every lake influence its water quality, water levels, and diversity of plant and animal life. These same characteristics determine its reaction to weather and groundwater fluctuations. Unique factors that make White Bear

[13] Dolostone is a close relative of limestone,

Lake particularly sensitive to water level fluctuation and decline include the lake's high elevation relative to its surrounding region, the geologic composition of its basin and its isolation from other surface water systems.

22. Closed-basin lakes such as White Bear Lake have more limited sources of water, causing them to be vulnerable to low and fluctuating lake levels. In terms of surface water connections, closed-basin lakes are “isolated,” making them dependent primarily on the underlying groundwater levels. Because of this relationship, water levels in closed-basin lakes tend to reflect the levels in nearby aquifers. According to the United States Geological Survey (“USGS”),[14] “any factor that affects groundwater levels will be reflected in the water levels of closed-basin lakes sooner, and more noticeably, than in flow-through lakes.” [15] Even when compared with other closed-basin lakes, White Bear Lake is anomalous. The DNR expert Dr. Matthew Tonkin described it as having “a greater oscillation of variability than most other lakes” of its type, having "extreme values" and being "highly abnormal".[16]

23. With such a small watershed, this lake is also more sensitive to precipitation and groundwater fluctuations. Lakes like White Bear, with small watershed-to-lake ratios and no major surface water inlets or outlets during low lake levels, depend on a hydrologic balance between precipitation, evaporation, and groundwater inflow and lake-water discharge to aquifers to maintain their water levels.[17] The combination of being a closed-basin lake with such a small watershed "means that [it] relies on groundwater levels beneath the lake to help support the lake levels". Consequently, "a decline in groundwater levels in the northeast metro affects the lake’s ability to hold

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[14] The full title to this document (Ex. 293) is "Statistical Analysis of Lake Levels and Field Study of Groundwater and Surface-Water Exchanges in the Northeast Twin Cities Metropolitan Area, Minnesota, 2002 through 2015."
[15] Ex. 293, p. 86.
[16] Tonkin testimony, March 22, p. 156.
[17] Ex.12A, p. 16.

water."[18]

24. Yet another factor that heightens its vulnerability to fluctuation is the lake's strong hydraulic connection to the groundwater below. With the permeable, sandy soils beneath the lake (as opposed to clay soils), water is easily transmitted from the lake to the aquifer.

25. The fact that this lake has a broad, gently sloped bottom makes it even more susceptible to water level changes; thus, even small decreases in lake depth result in disproportionately larger shrinkages in the surface area of the water basin.

E. White Bear Lake Has Been Experiencing Historically Low Levels Despite Significant Rainfall.

26. White Bear Lake naturally fluctuates, with a normal range of 923 to 925 feet.

27. From 2003 to 2013, however, it consistently declined, losing more than a fourth of its volume. On January 10, 2013, White Bear Lake reached its historic low of 918.84 feet – **four feet** below its "normal" range.

28. Between 2005 and 2014, the average lake elevation was 2.39 feet below the long-term average of 923.8. By comparison, during the same time period, Lake Minnetonka was .71 feet above the average lake elevation, for a net difference of more than 3 feet.

29. It is unusual for White Bear Lake to fall below 922 feet; it has done so only three times in history:

A. During the Dust Bowl (1924-1938);

B. During the state-wide drought of 1988-89; and

C. For nine straight years from 2007 to 2016.

[18] Ex. 145, p. 2.

30. At such low levels, the shoreline recedes dramatically. What was once water has become dry land, populated with grass and towering trees. Comparison photographs from 1999 to 2013 show a striking depletion of White Bear Lake.

31. Exhibit 506 reflects the impact that these losses inflict on the lake. At a drop of five feet in the lake level, the lake as a whole loses 16% of its total surface area as well as 25% of its volume. The shallow west bay loses 19% of its total surface area and 45% of its volume. At a drop of ten feet in lake level,[19] the lake as a whole would lose 37% of its total surface area and 45% of its total volume; the west bay would lose 63% of its total surface area and 79% of its total volume.

32. Unlike the Dust Bowl and the 1988-89 drought, the period from 2007 to 2016 in which White Bear Lake was historically low was *not* a drought period. Based on rain data from the Minneapolis-St. Paul airport,[20] from 2007 to 2016, seven years were above the median. Between 1978 and 2016, the top three years for rainfall were 2014, 2015 and 2016, with rainfall of 35.40, 36.14 and 40.32 inches respectively. Despite this, at the time of trial, White Bear Lake had not reached its long-term average elevation of 923.8 feet.

33. Over the last several years, White Bear Lake's ability to rebound following very wet years has differed dramatically from its previous history.[21] For example, following the drought of 1988-89, there were three relatively wet years, and the lake recovered in just a year or two. But since then, the sustained low levels of White Bear Lake have not only been lower than the levels following the 1988-89 drought, but have remained lower "way longer than what we saw in the late '80s, early '90s".[22] This phenomena cannot be explained by climate alone.

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[19] To date there has not been a 10-foot drop. The largest drop is 8 feet, and thus with losses being correspondingly less than the 10-foot calculations.

[20] Rain data taken from the Minneapolis-St. Paul airport shows drier conditions than data measured locally in the area around White Bear Lake. The distance between the two locations is approximately 20 miles.

[21] See Ex. 589: White Bear Lake Levels and Annual Precipitation (1980-2016).

[22] Testimony of Stu Grubb, March 9, Trans. p. 24, ll.4-5.

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III. Dramatic Increase in Groundwater Use in the Northeast Metro Area

34. The Twin Cities Metropolitan Area accounts for over half of the water demand in the state. In the seven county metropolitan area, the primary pumping center of the state, groundwater levels in bedrock aquifers are strongly influenced by seasonal pumping for irrigation and air conditioning purposes.[23] Water use in this area reflects a major shift in the sources for water supply over the last several decades.

35. In 1960, 70% of the water was supplied from surface water, with the remaining 30% from groundwater. In 1980, use of groundwater surpassed surface water use. By 2010, that ratio had shifted dramatically: 30% from surface water and 70% from groundwater.[24] By 2013, 75% of the metro's water supply came from groundwater.[25] Surface water used is taken from the Mississippi River and is used primarily by the cities of St. Paul and Minneapolis. The rest of the metro area relies on groundwater pumped through municipal and private wells. The northeast metro area relies 100% on groundwater resources.[26]

36. In earlier years, most new development took place near the core cities, and relied on extensions of their surface water supply. However, as development moved to suburbs farther out, the easiest (and cheapest) option was to drill wells.[27]

37. Since 1980, groundwater use within a 2-, 5-, and 7-mile radius around White Bear Lake has at times doubled since 1980. In 1980, groundwater use was about 850 million

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[23] Ex. 601, p. 39: "Drought of 1988". DNR 1989. This document addressed issues relating to the severe drought that followed a 10-year period of some of the wettest conditions on record.
[24] Ex. 19, p. 6.
[25] Ex. 283, p. 3.
[26] *Id.*, at p. 9.
[27] Ex, 19, p. 6.

gallons. By 2005, groundwater use in the Prairie du Chien and Jordan Aquifers had increased to more than 1600 million gallons, and groundwater use in the Prairie du Chien alone had more than doubled.[28] White Bear Township's water use, for example, increased from 199 million gallons in 1980 to 543 million gallons in 2012 – *a 173% increase.*[29]

38. Groundwater use is increasing in Minnesota largely to accommodate growth in municipal water supply and irrigation, including both residential and agricultural irrigation.[30] According to the Met Council, the only area of water use growth in the metro area is from public water supply systems.[31] Private wells make up less than 1% of total groundwater pumping.[32]

39. As a general rule, groundwater use increases in dry years and declines in wet years. The increase in use is primarily due to non-agricultural irrigation;[33] that is, lawn watering. This non-essential use[34] accounts for about 30% of *annual* (not just summer) water use in the northeast metro. Across the northeast metro, summer water use is typically "multiples" (*i.e.*, two to six times) higher than winter use due to the use of irrigation. See, for example, Exhibit 320, which profiles this use for several communities in the northeast metro, including the City, as well as Township, of White Bear Lake.[35]

40. Since 2010, Minnesota has had many more wet years than dry years—including very high rainfall the last three years (2014-2016)—and groundwater use in some areas of the state has gone down. The primary reason for that decline in water use is increased

[28] Ex. 2143, p. 13; Stu Grubb Direct of March 10, pp. 119-122.
[29] Ex. 3112.
[30] Ex. 359, p. 14.
[31] Ex.320, p. 33.
[32] Ex. 32, p. 13.
[33] For purposes of this Order, when the Court refers to "irrigation," it refers to non-agricultural irrigation.
[34] M.S. § 103G.261 (a) requires the Commissioner to adopt rules for allocation of waters based on certain priorities, the first of which is for domestic water supply and power production; the last, and sixth, is for nonessential uses.
[35] Ex. 320, pp. 238-242.

rain. 2016 was the *wettest year on record* and a lot of that rain fell during the summer. In terms of water use, 2016 was an "ideal year," as "irrigation goes down dramatically".[36] With more rain and less irrigation, less groundwater use would be expected.

41. However, that expected decrease in groundwater use did not occur in communities around this lake. Instead, despite record rains in the last several years in the area, from 2015-2016, groundwater use in the 11 communities around White Bear Lake actually *increased.* In 2015, cumulative total municipal groundwater extraction for the cities of Centerville, Columbus, Hugo, Lake Elmo, Lino Lakes, Mahtomedi, North St. Paul, Oakdale, Vadnais Heights, White Bear Lake, and White Bear Township was 4,090 million gallons. In 2016, the cumulative total municipal groundwater extraction was 4,186 million gallons.[37]

42. A specific example of this is found in the water use records from White Bear Township between 2014 and 2016. These reflect the inconsistency between increased precipitation and water use:[38]

Year	Water Use in Millions of Gallons	Precipitation
2014	367,887	35.40"
2015	176,519	36.14"
2016	429,127	40.32"

IV. White Bear Lake Is Strongly Hydraulically Connected to the Prairie du Chien-Jordan Aquifer, and Groundwater Pumping Is a Direct Cause of the Lake's Decline.

42. White Bear Lake and the Prairie du Chien-Jordan Aquifer are hydraulically connected. Both Plaintiffs' and Defendants' experts agree on this connection. The DNR has known "for decades that there is a relationship between surface water and

[36] Ali Elhassan, testimony of March 8, p. 12.
[37] Ex. 701; March 10, Grubb testimony, pp. 4-5.
[38] Ex. 3112.

groundwater at White Bear Lake".[39]

43. In August of 2013, addressing the record low levels of the lake and the possible options to address the problem, the Met Council discussed the option of augmentation of the lake. In doing so, it described the lake as being "like a bathtub with holes in it, connected to the underlying Prairie du Chien Aquifer [and that] [r]esidents need to understand it would refill more like a sieve in a bed of sand than a sealed bucket." [40]

44. Since the 1990s, there have been many studies done on White Bear Lake and its relationship to groundwater. Among them:

A) The Lake-Groundwater Interaction Study of 1998 by the DNR;[41]

B) The Evaluation of Groundwater and Surface-Water Interaction: Guidance for Resource Assessment (2010 study by the Met Council);[42]

C) The 2013 U.S. Geological Survey of 2013 (Groundwater and Surface-water Interactions near White Bear Lake, Minnesota, through 2011);[43]and

D) The 2016 USGS Study of 2016, Ch. A (Statistical Analysis of Lake Levels and Field Study of Groundwater and Surface-water Exchanges in the Northeast Twin Cities Metropolitan Area, Minnesota, 2002 through 2015).[44]

These studies are consistent in recognizing that White Bear Lake is strongly connected to the groundwater system, and that groundwater pumping affects the level of White Bear Lake.

[39] Fact Stipulation ¶ 20.
[40] Ex.40.
[41] Ex. 2.
[42] Ex. 25.
[43] Ex. 12A.
[44] Ex. 293.

A. The 1998 DNR Study: White Bear Lake Is Strongly Connected to Groundwater: Pumping Lowers the Lake.

45. In 1998, the DNR authored a study on White Bear Lake and concluded that water level fluctuations in the lake are "strongly correlated" to aquifer fluctuations.[45]

46. The 1998 Report was prompted by the drought of 1988-1989. During and after the drought, levels of White Bear Lake declined dramatically: four feet over a three-year period. But after the drought dissipated and area lakes had recovered, White Bear Lake still remained below long-term averages.[46]

47. In its study, the DNR found that comparisons of lake level graphs of White Bear Lake with groundwater level graphs showed a "strong correlation" between the timing of highs and lows of lake levels and of observation well levels. This was a "strong indication" that White Bear Lake and the underlying aquifers are "strongly hydraulically connected and therefore interact with one another".[47]

48. To help understand the connection, the DNR used a steady state MODFLOW groundwater model to mimic the actual behavior of the groundwater system.[48] Using this model, the DNR analyzed data from wells pumping more than 10 million gallons per year from the Prairie du Chien-Jordan Aquifer. All of the wells analyzed had been issued permits by the DNR.

50. The DNR ran the model both with and without high capacity pumping wells, and found changes in the head[49] potential surface configuration of the Prairie du Chien-Jordan Aquifer when the pumps were on. This indicated to the DNR that pumping from the

[45] Ex. 2, p. 11.
[46] *Id.*, at p. 8.
[47] *Id.*, at p. 14.
[48] *Id.,* at pp. 44-47.
[49] "Head" is used to describe the level of water, whether in the lake or the aquifer.

groundwater wells was having a "significant effect" on the water level in the aquifer. Absent pumping, the groundwater levels would be "much higher".[50]

51. Based on its findings, the DNR concluded in 1998 that "the key to ensuring that White Bear Lake levels can continue to at least periodically exceed elevation 924 or 925 is contingent on ensuring groundwater levels do not permanently drop to levels similar to those of the drought."[51] To this day, the DNR still agrees with this finding.

52. This means that for White Bear Lake to at least periodically reach the higher end of average, groundwater levels must remain high as well. Conversely, if groundwater levels were to permanently drop to levels of the 1988-89 drought, White Bear Lake "will, essentially, never recover".[52]

53. Comparing the impact of surface water and groundwater on the lake, the study concluded that:

A) "Increased use of groundwater via high capacity wells for municipal water supply and commercial use has resulted in lower groundwater levels."

B) "Over the long term (years, decades), White Bear Lake levels are controlled principally by the region's groundwater level fluctuations and in the short term (monthly, seasonally) by the surficial elements of the lake water balance parameters (which include precipitation, runoff, and augmentation)."

C) "The key to ensuring that White Bear Lake levels can continue to at least periodically exceed elevation 924 or 925 is contingent on ensuring groundwater levels do not permanently drop to levels similar to those resulting from the

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[50] Grubb testimony of March 9, pp. 33-34.
[51] Ex. 2, p. 84.
[52] Grubb testimony of March 9, pp. 35-36.

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drought of the 1980s"; and

D) "How long levels above elevation 925 or 924 or 923 will be sustained is subject to the vagaries of long-term precipitation and other factors affecting local groundwater levels. These factors certainly include long-term impacts of future groundwater appropriations."[53]

54. Hydrogeologist Stu Grubb, DNR hydrogeologist Paul Putzier, and Dr. Matthew Tonkin (the DNR's expert witness) agreed with the findings and conclusions of the DNR 1998 study and confirmed they are still true today.

B. The 2010 Met Council Study: White Bear Lake Is "Connected," "Vulnerable," and a Net Loser to Groundwater.

55. Although the Metropolitan Council had some responsibility in water supply planning following the 1988 drought, its role ramped up significantly after 2005 legislation charged it with developing a Metropolitan Area Master Water Supply Plan, with a goal of ensuring "a sustainable water supply for current and future generations". It works with other entities such as the University of Minnesota, the Minnesota and U.S. Geological Surveys and other consultants.[54]

56. Relying on the 1998 DNR study, in 2010 the Met Council retained hydrologists and hydrogeologists[55] from Barr Engineering to prepare another study on the lake.[56] Although the report was released in 2010, the Met Council had been providing information for several years to both the DNR and local communities on the cumulative impact of their individual approaches to water usage. Its purpose was to educate communities and to

[53] Ex. 2, pp. 83-84. This comports with the testimony of Dr. Ali Elhassan of the Metropolitan Council that "groundwater levels control [the lake's] level over the long term". Elhassan testimony of March 7, p. 64.
[54] Ex. 19, p. 2.
[55] "Hydrology" is the study of the properties, distribution and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere. "Hydrogeology" is the area of geology that deals with the distribution and movement of groundwater in the soil and rocks of the Earth's crust (commonly in aquifers).
[56] Ex. 25: Evaluation of Groundwater and Surface-Water Interaction: Guidance for Resource Assessment. Twin Cities Metropolitan Area. June 2010.

support water appropriation permitting by the DNR.[57]

57. The Met Council's report relied on and confirmed many of the same findings as the 1998 DNR report. Among them:

A) The lake is connected to groundwater with a net loss of water from the lake to groundwater of 6.5 inches per year.

B) The lake level fluctuations are strongly correlated to aquifer fluctuations.

C) The lake is classified as a flow-through lake[58] connected to groundwater and potentially vulnerable to groundwater pumping.

D) The lake is classified as having a wide and shallow littoral zone, which increases the potential for impacts from changes in lake stage.[59]

58. In 2015, the DNR published the North and East Groundwater Management Area Plan.[60] This adopted the Met Council's 2010 description of White Bear Lake as strongly connected to groundwater and "vulnerable" to changes in the groundwater conditions of the aquifer.[61]

C. The 2013 USGS Report: Both Climate and Groundwater Pumping Are Direct Causes of White Bear Lake's Low Water Levels.

59. Continuing concern about the lake's declining water levels resulted in the 2013

[57] Id., at P. 5; March 7 testimony of Elhassan, p. 70.
[58] There are somewhat different definitions of the term "flow-through lake" as used by the Met Council and the USGS. The Met Council defines a flow-through lake as "a lake or wetland that has water going into part of the lake or wetland and out of other parts [of the same], so that there's water flowing in and water flowing out". That's not to say that the flowing water is necessarily a stream feeding the lake, but rather that the inflow may result from *groundwater* along the up gradient shore of the lake and discharge to the groundwater along the downgradient shore. By contrast, the USGS "consider a flow-through lake to be a lake that has *surface water* inflow and surface water outflow". March 9, Grubb, pp. 43-45.
[59] Ex. 25, p. 21.
[60] This includes all of Ramsey and Washington Counties, as well as parts of Anoka and Hennepin Counties.
[61] Ex. 306 (map at p. 34); March 7 testimony of Elhassan, pp. 73-75.

USGS Report[62] that addressed groundwater and surface water interaction near the lake. This report was prepared in cooperation with the White Bear Lake Conservation District, Minnesota PCA, the DNR, and the Met Council, among others. The USGS, the sole science agency for the U.S. Department of the Interior, is considered the "gold standard" nationwide for this type of work.[63]

60. The 2013 USGS report was a comprehensive study on the lake, and built upon the 1998 DNR study. It concluded that "groundwater and lake levels in the White Bear Lake area indicate the lake level in White Bear Lake is strongly associated with the groundwater level in the aquifer" and that "any factor affecting groundwater levels in the aquifer near White Bear Lake will likely affect the lake level of White Bear Lake."[64] This study was peer-reviewed by the DNR and other collaborators before its release. Both Dr. Tonkin and the DNR limnologist[65] Jason Moeckel agreed with the findings described above.

61. Before coming to its conclusions, the USGS undertook a comprehensive, detailed study of White Bear Lake. Studying groundwater flow patterns, it determined that in the glacial water table aquifer, groundwater flows *toward* White Bear Lake from the south and southeast and also from the northeast, while groundwater flows *away* from the lake on the north side toward Bald Eagle Lake. It found that in the Prairie de Chien-Jordan Aquifer, groundwater generally flows from northeast to southwest.[66]

62. The USGS bathymetry[67] analysis indicated that the deeper areas of the lake, which are connected to the lower aquifers, provide a way for surface water to leave the lake into the groundwater system below: water flows vertically out of the lake into the aquifer, and then as depicted in Ex.12A, away from the lake to the southwest.[68]

[62] Ex. 12A.
[63] March 7 testimony of ElHassan, p. 81.
[64] Id., at p.41.
[65] Limnology is the study of the physics, chemistry, geology and biology of lakes and inland waters.
[66] Ex. 12A, pp.48-50.
[67] Bathymetry is the measurement of the depth of large bodies of water.
[68] Ex. 12A, pp. 48-50.

63. The USGS determined that, overall, more groundwater leaves White Bear Lake than flows into it.[69]

64. The USGS study:

A) Collected samples from several groundwater wells and identified White Bear Lake surface water in wells downgradient from the lake. Ex. 12A-68 shows that wells to the south and southwest of the lake had more White Bear Lake surface water in them than wells to the north and northeast. This is consistent with the flow direction of the aquifer.

B) Performed several lake sediment analyses, including: 1) a seepage meter analysis, to determine whether White Bear Lake water could be leaving the lake into the groundwater; and 2) a piezometer analysis[70] in which it sunk a shallow well into the lake sediments and measured the head of the groundwater. From this was gathered information on the makeup of the sediment, its volume at different depths and the temperatures in the sediment. As to this last, where the temperatures were below 18° C, the study could pinpoint potential areas for groundwater inflow to the lake.

C) Chemically compared water samples from the wells with water samples from the lake. These tests confirmed their conclusions that White Bear Lake surface water was flowing into the groundwater below.

65. To understand the dynamics of the lake's declining water levels since 2002, the

[69] Id., at pp. 41-42; March 10 testimony of Grubb, pp. 14-15.
[70] A piezometer is an instrument that measures pressure, especially high pressure.

USGS analyzed precipitation trends and compared them to the levels in the lake. Between 1950 and 1980, average precipitation was 30.73 inches; between 1980 and 2010, it increased to 33.33 inches.

66. For any given year, the USGS determined whether precipitation was above or below that long-term average and compared that departure to the lake level. That comparison revealed that from 1980 until about 2002, the water level in the lake tracked very well with the cumulative departure from normal precipitation. However, from 2002 to 2012, the water level in White Bear Lake no longer correlated to precipitation changes.[71]

67. Ultimately, the USGS concluded that it was the "combination of lower precipitation and an increase in groundwater withdrawals" that "could explain the change in lake-level response to precipitation" in White Bear Lake and that "increases in groundwater withdrawals from [the Prairie du Chien-Jordan] aquifer are a likely cause for declines in groundwater levels and lake levels". [72]

68. These findings confirmed the DNR's findings from the 1998 study: 1) that in the short-term, precipitation affected White Bear Lake; but 2) that for the long-term, groundwater levels, including the impact from groundwater pumping, principally controlled.[73]

69. Summarizing its conclusions regarding the groundwater and surface-water interactions up through 2011, the USGS noted that between 1978 and 2002, periods of lower water levels correlated with periods of lower precipitation. However, with recent urban expansion and increased pumping from the aquifer, this dynamic changed: between 2003 and 2011, the relationship between precipitation and lake level required an average of 4 more inches of precipitation per year to maintain the lake level.

70. The study noted that annual and summer groundwater withdrawals from the

[71] Ex. 12A, p. 15, fig. B and C; March 10 testimony of Grubb, p. 17-20.
[72] Id., at p. 12.
[73] Id., at p. 84.

aquifer have more than doubled from 1980 through 2010, and that "annual volume of groundwater withdrawn from the aquifer indicated groundwater withdrawals had a greater effect than precipitation minus evaporation on water levels in the White Bear Lake area for all years since 2003". More troubling, it noted that the 2003-2011 decline in the lake "reflects the declining water levels in the aquifer; [that] increases in groundwater withdrawals from this aquifer are a likely cause for declines in groundwater levels and lake levels. Annual pumping [from the aquifer] has more than doubled from 1980 through 2010, increasing from a minimum of 1,873 million gallons in 1980 to a maximum of 4,557 million gallons in 2007. The increase in the annual groundwater withdrawals from the Prairie du Chien-Jordan Aquifer was due mainly to increases in summer withdrawals"… [74]

71. Dr. Tonkin agreed that the lake's fluctuations are strongly correlated to aquifer fluctuations and that the key to ensuring that its levels can periodically exceed 924 or 925 feet is contingent on ensuring that groundwater levels do not permanently drop to levels similar to those of the drought period. He agreed that the lake level is affected by both climate and groundwater pumping, and that there is a strong correlation between the lake's level and annual and seasonal groundwater pumping. He noted that as the groundwater level lowers, there is a greater potential for seepage from the lake to the groundwater by virtue of the difference between the head in the lake and that in the aquifer.[75]

72. The USGS also found that pumping in the summer months has a more significant impact on the lake and the aquifer than pumping in the winter months. For example, from 1995 to 2011, the average annual maximum hydraulic-head difference between White Bear Lake and the aquifer in the summer was 17.6 feet; in the winter, it was 14.9 feet.[76] The

[74] Id., at p. 73. These conclusions were echoed by DNR hydrogeologist Putzier in a July 16, 2013 email to Jason Moeckel: "I would submit that the 2013 USGS report confirms that White Bear Lake is in communication with shallow and bedrock groundwater systems, consistent with the findings in the June 1998 DNR Report…[which stated that] 'the key to ensuring that White Bear Lake levels can continue to at least periodically exceed elevation 924 or 925 is contingent on ensuring groundwater levels do not permanently drop to levels similar to those resulting from the drought of the late 1980s." (Ex. 453).

[75] March 22 testimony of Tonkin, pp. 134-152.

[76] Ex. 12A, p. 51.

increased head difference in the summer forces more water from White Bear Lake into the aquifer.[77]

73. As part of its study, the USGS used a MODFLOW finite difference model to simulate the flow of groundwater through the White Bear Lake study area. The purpose of the model is to replicate head potential for the aquifer in the vicinity of the lake, and involves a comparison of the head differences based on pumping and not pumping. Without pumping from wells, the steady state configuration shows heads ranging from 940 feet to 930 feet elevation in the White Bear Lake area. In contrast, with pumping from the high capacity wells, that head configuration ranges from 925 to 900 feet elevation in the same area. The report observed that:

> "The simulated higher heads without pumping indicates the potential exists for higher head levels in the aquifer directly below the lake. These higher levels would increase the upward water flow toward the lake. This would likely increase the moderating effect that the ground water connection has on the lake level."[78]

74. The DNR's 1989 Report on the 1988 drought observed this same dynamic (see Finding 35, *supra*).

75. The USGS noted that the average difference between summer and winter hydraulic-head measurements was increasing over time: in other words, that summer use and the impact on White Bear Lake from summer groundwater use is increasing. The Met Council data supports this finding on increasing summer water use. During the 1990s, summer use was about 1.6 times winter use. Starting in 2000, that ratio jumped to 2.3 or 2.4 times winter use on average, where it generally remains today.[79] Depending on the

[77] March 10 testimony of Grubb, p. 37.
[78] Ex. 2, p. 49.
[79] Ex. 320, p. 35. Metropolitan Council, "Master Water Supply Plan 2015". This document recognized that "[w]ater systems are sized to meet maximum demand, so summer water use can drive substantial investments in infrastructure that is underused the rest of the year….The region could reduce its total water use by over 15% by

weather, summer use can be as much as six times more than winter use.[80]

76. In describing the trends in groundwater withdrawals, the USGS discussed the correlation between periods of dry weather and the increased groundwater withdrawals from the Prairie de Chien-Jordan Aquifer, and noted that "seasonal groundwater withdrawals increased as seasonal precipitation decreased, especially in the summer". During dry years, the level in White Bear Lake is more significantly impacted by the combination of a decrease in precipitation and an increase in groundwater pumping. Groundwater withdrawals in the summer were almost three times as large as withdrawals in the spring and fall.[81] Groundwater pumping increases during dry periods because people pump more for irrigation,[82] and high groundwater use during dry seasons—especially droughts—"may have significant unacceptable impacts" to surface waters that it would not in different climatic conditions.[83]

D. The USGS 2016 Chapter A Study: White Bear Lake Is Uniquely Vulnerable to Groundwater Fluctuations, Including Groundwater Pumping.

77. In 2016, taking a more regional approach than the earlier study, the USGS released another set of reports characterizing surface water and groundwater interactions in selected lakes in the northeast metro area.[84] This study included all of Washington County and parts of Ramsey and Anoka Counties.

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simply returning to outdoor watering practices of [the period from 1990-1994]. This would conserve 16.8 billion gallons per year".

[80] March 7 testimony of ElHassan, p. 129, ll. 11-16: "In general, summer use is two times, at least, more than winter use in the metro area, including the northeast….[but] if we have dry summers, it could go to six times. Some of the communities use, in winter, three wells; in summer, they use 17 wells."

[81] Ex. 12A, p. 43.

[82] March 22 testimony of Tonkin, pp. 152-154.

[83] March 8 testimony of Putzier, p. 63.

[84] Ex. 293 (Statistical Analysis of Lake Levels and Field Study of Groundwater and Surface-water Exchanges in the Northeast Twin Cities Metropolitan Area, Minnesota, 2002-2015, Chapter A); Ex. 294A (Simulation and Assessment of Groundwater Flow and Surface-water Exchanges in Lakes of the Northeast Twin Cities Metropolitan Area, Minnesota, 2003-2013, Chapter B); Ex. 315, (USGS: Characterizing Groundwater and Surface-water Interactions in Selected Northeastern Twin Cities Lakes, Minnesota, 2013-2016.).

78. The 2016 report was released in two chapters: Chapter A (Ex. 293), a final, published, and peer-reviewed report containing the results of the field work; and Chapter B (Ex. 294A). Although the Chapter B model and report have not been finalized for publication, there have been no substantive changes since its draft release in December, 2016, and the conclusions in the report are final.

79. Chapter A of the 2016 report affirmed the conclusion of the earlier 2013 report that "analysis of the 2003-11 water level decline in White Bear Lake indicated that a combination of decreased precipitation and increased groundwater withdrawals from the underlying Prairie du Chien-Jordan Aquifers could explain the lake level response to precipitation." It referenced the result of stable isotope analyses of well-water, precipitation and lake-water samples taken for the earlier report, concluding that: "water from White Bear Lake was flowing to the underlying aquifer and reaching wells that were open to the aquifer downgradient from the lake, [and that] [i]ncreases in water withdrawals from the aquifer and a hydraulic connection between the lake and aquifer may result in an increased amount of water flowing from [the lake] to the aquifer, which could result in lower water levels in the lake".[85]

80. Chapter B of the 2016 report similarly affirmed the 2013 study, stating that "a USGS cooperative study for White Bear Lake determined that changes in other hydrologic variables besides precipitation were needed to explain the 2003-11 water level declines." [86] Experts Tonkin and Grubb agreed with this premise.

81. Overall, the 2016 USGS study conducted a more rigorous evaluation of surface water and groundwater interactions in the northeast metro than had been done in 2013. In the 2016 Chapter A report, the USGS studied the effect of the physical setting and climate on lake level fluctuations in several lakes in the northeast metro area, including White Bear Lake.

[85] Ex. 293, p. 16.
[86] Ex. 294A, p. 18.

82. Among the additional tests the USGS conducted on White Bear Lake were:

A. Stable isotope analysis of well water;

B. Age dating of water;

C. Lake sediment coring;

D. Piezometer and seepage meter monitoring; and

E. Analysis of waterborne seismic surveys.[87]

83. Isotope analysis: One of the most significant tests of the 2016 study, this analyzed well water in 40 different groundwater wells, finding some mix of surface water and groundwater in 31 of them. In 11 of the wells south and southwest of White Bear Lake, it found between 13 and 58 percent surface water. The USGS concluded that "White Bear Lake is the likely source of the surface water to those 11 wells."[88] Mr. Grubb opined that this is "conclusive proof that water from White Bear Lake is entering the Prairie du Chien Aquifer and is being pumped out by wells in the area of White Bear Lake" that are permitted by the DNR.[89]

84. Piezometer testing and seepage meter results: These confirmed that White Bear Lake water was in fact flowing "out of the lake and into the sediments".[90]

85. Lake sediment coring: Working with the University of Minnesota, the USGS took a number of sediment cores of White Bear Lake to estimate the thickness and permeability of the lake sediments.[91] The sandy sediment found from these cores, taken from many areas beneath the lake, indicates that water can easily move between the lake and the underlying aquifer.[92]

86. Seismic Reflection Testing: By measuring seismic reflections of the lake

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[87] Ex. 315, pp. 6-12.
[88] Ex. 293, pp. 70-71.
[89] March 10 testimony of Grubb, p. 68.
[90] Ex. 293, p. 42; March 10 testimony of Grubb, pp. 69-71.
[91] Ex. 293, p. 76.
[92] March 10 testimony of Grubb, pp. 72-73.

(creating a seismic pulse that acts like an echo that will bounce off the bottom of the lake and from which can be determined its subsurface structure and geology), the USGS discovered a number of sandy areas, which are more likely to have high permeability and high conductivity of water.[93] This testing comported with the results discussed in Findings 81-83.

87. In sum, the testing described above confirmed the strong hydraulic connection between White Bear Lake and the underlying aquifers.

88. When it compared the amounts the 97 lakes in the study deviated from their water levels between 2000 and 2014, the USGS found that White Bear Lake experienced more change in water level than 75% of the lakes in the area. This comparison indicated that White Bear Lake was more "vulnerable to groundwater" compared to other lakes and "was certainly more extreme than most" of those lakes.[94] The USGS determined that from 2005 to 2014, “White Bear Lake had the most negative anomaly from its long-term mean compared to the rest of the lakes” analyzed.[95] This conclusion was echoed by the DNR expert Tonkin, who observed that this lake shows "a greater oscillation of variability than most lakes" and, when compared to 44 closed-basin lakes, showed "greater fluctuations than average".[96]

89. Closed-basin lakes.

A. Because their sources of water are limited to direct precipitation and groundwater inflow, closed-basin lakes such as White Bear Lake are vulnerable to low and fluctuating lake levels.

B. Their water levels tend to reflect groundwater levels in nearby aquifers, which vary in response to multiyear climate events and "any factor that affects groundwater levels will be reflected in the water levels of closed-basin lakes

[93] Ex. 293, p. 79; March 10 testimony of Grubb, pp. 73-75.
[94] March 10 testimony of Grubb, pp. 75-76.
[95] Ex. 293, p. 63.
[96] March 22, Tonkin, pp. 155-157.

sooner, and more noticeably, than in flow-through lakes [and] any additional stresses, such as groundwater withdrawals, added to the watershed of the lake can make these lake-level changes more pronounced."[97]

C. Dr. Tonkin prepared a slightly revised analysis of the USGS' findings by comparing White Bear Lake to just other closed-basin lakes. He found that even among other closed-basin lakes, White Bear Lake "still experienced more change in its water level than 75 percent of the closed-basin lakes in the area". [98]

D. Even slight shifts in "hydrologic condition" can cause water level changes of several feet in closed-basin lakes.[99]

90. The USGS concluded that:

A. "Any additional stresses, such as groundwater withdrawals, added to the watershed of the lake can make these lake level changes more pronounced." [100] DNR's experts agreed.[101]

B. Both climate and groundwater pumping influence the level of White Bear Lake.[102] DNR's experts agreed.[103]

E. Independent Analysis by Plaintiff's Expert Concluded, Consistent with Prior Reports, that DNR's Conduct was a "Significant Factor" in the Decline of White Bear Lake.

91. Plaintiff's expert Stu Grubb, a hydrogeologist, constructed his own groundwater budget to determine the factors causing White Bear Lake to decline. He was the only expert testifying in this case to construct his own water budget model.

[97] Id., at p. 86.
[98] March 10 testimony of Grubb, p. 76-77.
[99] Ex. 293, p. 14.
[100] Id., at p. 86.
[101] For example, see March 22 Tonkin testimony, p. 163, ll. 15-20.
[102] March 10, Grubb, p. 77.
[103] March 22, Tonkin, p. 143; March 16, Moeckel, p. 4; March 27, Solstad, p. 3; March 28, Putzier, pp. 88-89; March 23, Berg, p. 13.

92. Based on his independent analysis, together with his review and study of the USGS reports and other information on White Bear Lake and the aquifers, Mr. Grubb concluded that, in his expert opinion, the groundwater pumping permitted by the DNR is a "significant" and "key" factor in White Bear Lake's low lake levels, causing the lake to hit "lower lows" than it would naturally.[104]

93. Grubb Analysis: Methodology

A. In constructing his groundwater model, Mr. Grubb employed a mathematical formula that accounted for both inputs and outputs into White Bear Lake's water budget. In such a model, all of the following factors must balance:

1. Inputs, which include precipitation on the lake, surface water runoff into the lake (*i.e.*, precipitation that falls on the lake's watershed), and groundwater inflow into the lake.

2. Outputs, which include groundwater outflow from the lake, evaporation and plant transpiration, surface water outflow (via the outlet), and artificial removal of water from the lake – for example, groundwater pumping.

B. As part of his analysis, Mr. Grubb considered basic characteristics of White Bear Lake, including:

1. Its small watershed (2:1), which indicates that surface water-runoff from precipitation falling on the watershed is less a part of White Bear Lake's hydrology than groundwater.[105]

2. Its groundwater contour, from maps like those prepared by the USGS, and from which he identified areas where groundwater flowed into and out of the lake.[106]

[104] March 10, Grubb, pp. 123-125; March 13, p. 85.
[105] March 10, Grubb, pp. 43-44.
[106] Id.

C. Mr. Grubb gathered information by:

1. Performing his own piezometer testing, inserting a small pipe into the sediment to measure whether water can go from the sediment to the lake and from the lake to the sediment. These tests indicated that there were places where water was flowing into and out of the lake.[107]

2. Examining soil permeability by reviewing information in soil surveys and surficial geology maps and finding porous, sandy soils underlying the lake.[108]

3. Reviewing the Trophic State Index for White Bear Lake, which is a measure of water clarity and water quality in a lake. White Bear Lake has a low TSI, a sign that the lake receives a significant amount of water from groundwater.

4. Collecting water samples from several high capacity pumping wells around White Bear Lake and, in conjunction with the University of Minnesota, performing a water chemistry analysis. The analysis, consistent with that of the USGS, showed that surface water from White Bear Lake flows out of the lake and into pumping wells south and southwest of the lake.[109]

94. <u>Grubb Findings:</u>

A. There is a "very good correlation" between the level of the lake and the water levels in the Prairie du Chien-Jordan wells. This indicates that the levels of the lake and the levels of the Prairie du Chien-Jordan Aquifer rise and fall together. [110]

B. White Bear Lake's groundwater component was confirmed by the correlation between precipitation and the lake level in White Bear Lake. While the

[107] Id., at p. 50; Ex. 527.
[108] March 10, Grubb, p. 45.
[109] Id., at pp. 51-52; Ex. 535.
[110] Id., at p. 46; Ex. 536.

correlation between *annual* rainfall and the lake level was "pretty low", the correlation between the lake level and "*five-year rainfall*" was much better. This lag time shows that "groundwater plays a significant part in the hydrology of the lake" because it takes time for rainfall to infiltrate the groundwater.[111]

95. Grubb Conclusions

A. White Bear Lake is a "flow-through" lake[112] that is both "vulnerable" and "well-connected" to the underlying aquifers. The lake has a "significant groundwater component" to its water budget and is exceptionally "susceptible to changes in the underlying aquifer".[113]

B. Based upon both his own analysis and his review of the USGS reports, White Bear Lake is more vulnerable to groundwater fluctuations compared to other closed-basin lakes, is "likely to be one of the first lakes to show effects of negative impacts from groundwater pumping", and "reacts more severely and to a greater degree than other lakes in the area".[114]

C. Based on his water budget model, groundwater is a significant outflow from the lake. Specifically, Mr. Grubb found that to make the water budget balance, one must take into account that 34% of the water that leaves the lake at any given time (e.g. over a period of a year) is lost to groundwater.[115]

D. Some, though not all, of that 34% is attributable to the DNR and groundwater pumping. Although groundwater leaves the lake naturally, "the amount of groundwater leaving the lake is increased because of pumping of permitted wells".[116]

E. Based on his research and modeling, Mr. Grubb concluded that:

1. The adverse impacts to the lake level could not be caused solely by

[111] Id., at p. 46.
[112] Mr. Grubb uses the Met Council's definition of "flow-through" lake found at Footnote 58, p. 18.
[113] Id., at p. 45, p. 119.
[114] Id., at p. 77.
[115] Id., at p. 55.
[116] Id.

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climatic cycles.

2. Groundwater pumping is a direct and significant factor in causing adverse impacts to the lake level. This conclusion is supported by his groundwater model: if the groundwater component were excluded, he could not simulate the actual measurements of White Bear Lake's water levels and make the water budget for White Bear Lake balance. However, once that groundwater component was included, he was able to very closely simulate the aquifer heads and lake levels in White Bear Lake.[117]

96. Grubb Opinion

A. By issuing large permits and allowing as many high capacity wells as it has in the Prairie du Chien Aquifer, the actions of the DNR cause both the level of the aquifer, as well as the pressure head in the aquifer, to decline.

B. Lowering the pressure head of the aquifer creates a "higher head differential" between the lake and the aquifer, and consequently causes more groundwater to flow from the lake to the aquifer.

C. As water is pumped from groundwater wells, it removes water not only from the aquifer, but also from connected water bodies, like White Bear Lake.

D. Simply put, pumping from the DNR-permitted, high capacity wells lowers the aquifer level, which causes more water to flow out of White Bear Lake into the groundwater than would normally occur, and thus artificially lowers the level of the lake.[118]

E. The DNR's permitting conduct has "directly contributed" to the lowering of White Bear Lake by causing the lake to hit "lower lows" than it would naturally.[119]

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[117] March 9, Grubb, p. 18-20; March 10, Grubb, pp. 55-57; March 13, Grubb, pp. 85-86; Ex. 523; Ex. 524.
[118] March 10, Grubb, pp. 57-58, 78, 119.
[119] Id., at pp. 123-125.

F. The lower lake levels are a "negative effect" on a natural resource.[120]

F. The DNR Witnesses Admit the Interconnection Between White Bear Lake and the Aquifer, and that Groundwater Pumping is a Direct and Material Cause of the Lowering of White Bear Lake.

97. According to the DNR's own witnesses, including Dr. Tonkin, its expert witness, there is "no question" that the "Prairie du Chien-Jordan Aquifer is interconnected with White Bear Lake" and that there is an "interchange" between the lake and the aquifer.[121] Barbara Naramore, Assistant DNR Commissioner since 2013, testified that she is "unaware of anyone" who has questioned the existence of the hydraulic connection between White Bear Lake and the Prairie du Chien-Jordan Aquifer.[122]

98. The DNR documents, including the 1998 DNR study, indicate that the lake and Prairie du Chien-Jordan Aquifer are "*strongly* connected".[123] Excerpts from the 1998 study note that:

> "The geology of the area, lake levels and groundwater levels (heads) all affect the volume of lake-groundwater exchange at any point of time. As lake and groundwater levels change over time, the exchange volume also varies…Comparisons of lake level graphs with groundwater level graphs show a strong correlation between the timing of highs and lows of lake levels and observation well levels…This is a strong indication the two are strongly hydraulically connected and therefore interact with one another. Understanding the degree to which lake level fluctuations affect groundwater level fluctuations and vice versa is extremely important in understanding the water balance of the

[120] Id., at p. 119.
[121] March 27, Naramore, p. 14; March 15, Moeckel, pp. 5-7; March 22, Tonkin, p. 8, 139; March 23, Berg, p. 13.
[122] March 27, Naramore, pp. 16-17.

[123] Ex. 134; Ex. 2, p.11.

lake."[124]

99. Dr. Tonkin testified that White Bear Lake is a “net discharger” or “net loser to groundwater”.[125] In 2016, the DNR expert James Berg similarly described the lake as a combination of “flow through” and “losing” to the groundwater below.[126] Ms. Naramore and Ms. Julie Ekman, a DNR hydrogeologist, agreed with this characterization.

100. The DNR witnesses admitted that:

A. Because of the interconnection between the lake and the aquifer below, “any factor” that affects the groundwater level of the Prairie du Chien-Jordan Aquifer will be reflected in the lake level.[127]

B. White Bear Lake is “vulnerable” to the DNR-permitted groundwater withdrawals from the Prairie du Chien-Jordan Aquifer and to the impacts from those appropriations.[128]

C. It is undisputed that one of the factors affecting local groundwater levels is groundwater pumping.[129] When groundwater is withdrawn from the Prairie du Chien-Jordan Aquifer, that action not only lowers the water level of the aquifer; it also lowers the water levels of White Bear Lake.[130] In sum, the levels of the Prairie du Chien-Jordan Aquifer and of the lake "rise and fall together".[131]

D. Since at least 1998, if not earlier, the DNR has known about the strong hydraulic connection between White Bear Lake and the aquifer, and that groundwater

[124] Ex. 134, p. 2.
[125] March 22, Tonkin, p. 6, 98.
[126] Ex. 361, p. 12.
[127] March 15, Moeckel, pp. 9-14.
[128] March 15, Moeckel, pp. 6-7; March 28, Naramore, pp. 8-9.
[129] March 22, Tonkin, p. 148; March 23, Berg, p. 13.
[130] March 15, Moeckel, pp. 7-9.
[131] Id., at p. 7; March 23, Berg, p. 13.

extraction from aquifers that are hydraulically connected to the lake "have the potential to change the level of [its] surface water".[132]

101. In a 2009 email regarding an upcoming presentation to the White Bear Lake Conservation District, Dave Leuthe from the DNR wrote to Craig Wills, the DNR area hydrologist for the east metro, regarding the connection between the lake and the groundwater system:

> "...The more they remove from aquifers, the more they increase the chance for recharge to be drawn from other sources, including surface water sources. In a wetter climate, the impacts will be less noticeable. In a drought, the impacts will obviously be greater. Water supply planning and conservation are the best tools for the future to minimize the impacts of the drought."[133]

By "impacts," the DNR was referring to lake levels.[134]

102. In June of 2010, the DNR discussed funding another study regarding White Bear Lake's falling lake levels. A chain of email communications[135] among its hydrologists and planners reflects their acknowledgment of the problem and discusses ways to address it:

A. June 25 emails from Mr. Leuthe to Craig Wills and Dale Homuth:

1) "…Drought, small watershed, increased pumping from aquifers that are in potential connection with surface waters. What else could explain it?"

2) "The [White Bear Lake Conservation District] may be too narrow in

[132] March 22, Tonkin, p. 140; March 23, Berg, p. 13.
[133] Ex. 129, p. 1.
[134] March 8, Putzier, p. 85.
[135] Ex. 133.

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their focus. It should be for the larger area that extends at least up to Hugo. I would like to cast the net wider than just WBL…..The obvious direction this will head will be a more extensive surface and groundwater monitoring plan that will then provide information into a water supply management plan for the surface and ground watershed…Hugo will be running their aquifer test soon and increased demand in Hugo will limit available supply sources from reaching places down-gradient…"

B. June 28 email from Dale Homuth to Craig Wills and Dave Leuthe:

"Unfortunately, the presentation [to the WBLCD] will lead to the obvious conclusion that increasing water use in the WBL area may be impacting lake levels…"

103. In February 2012, acknowledging a comment from an MPCA hydrogeologist that "pumping of groundwater by municipalities appears to be a major cause of the lake's decline", Mr. Leuthe emailed various employees of the DNR and MPCA regarding this issue:

"Finding the balance between a lakeshore owner's riparian rights and a municipality's need to provide for …an adequate *drinking water supply* [emphasis supplied]…will lead to more stringent conservation strategies…[T]here will be no easy solutions to this challenge. This will likely carve new ground in perhaps laws, rules, ordinances and policies to help all residents manage their limited natural resources more carefully than we have been. We are beginning to understand the unintended consequences of our past choices as they factor into some natural limits of some of our resources that have always been there…Everyone is part of the problem and needs to become part of the solution."[136]

104. In July 2012, the DNR wrote in an internal document[137]:

> "Current low levels in White Bear Lake are due primarily to precipitation since 2006 and partly due to increasing groundwater pumping in the area. If groundwater conservation measures are not adopted, it will be increasingly difficult to make up for precipitation deficits in the future."

Addressing various options to address those low lake levels, it went on to say:

> "Based on over 100 years of records, lake levels have risen in response to above normal precipitation. *Nevertheless, increased precipitation will not result in the same water level recovery seen after the 1976 and 1988 droughts because of the increased loss of lake water to groundwater caused by pumping from the aquifers beneath the lake."* (Emphasis supplied.)

105. In October 2012, a draft of the DNR talking points on the problem stated that:

> "WBL may be the 'canary in the coal mine' and be signaling the potential future impacts of metro area groundwater withdrawals on our lakes and rivers" and that "current record low water levels [in the lake] are due primarily to a precipitation deficit since 2006, but the increase in groundwater pumping in the area is probably to blame for making the low lake levels worse."[138]

[136] Ex. 139.
[137] Ex. 144.
[138] Ex. 148.

The DNR hydrogeologist Paul Putzier still agrees with that assessment.[139]

106. In an undated document "White Bear Lake FAQ",[140] the DNR discussed the fact that for most of its recorded history, the level of White Bear Lake has ranged between 923 and 925 feet. It noted that the agency was concerned about its low water level, and that:

> "Although fluctuations in water levels are a normal part of a lake, prolonged low levels may have negative effects on this highly valued recreational resource and local economies. In addition, the fish, plant and animal communities that are also dependent on the lake may also be affected by low lake levels."[141]

107. Referencing its closed basin and small watershed, the DNR observed that these characteristics cause the lake to rely on groundwater levels beneath it to help support the lake levels. "What this means is that a decline in groundwater levels in the northeast metro affects the lake's ability to hold water." It noted that the 2013 USGS Report "had confirmed previous studies by the DNR and others that low amounts [of precipitation], combined with increased groundwater use…since the 1980s are most likely two of the primary causes for the low lake levels".[142]

108. The DNR went on to observe that "the largest percentage of groundwater use and the largest growth in the northeast metro is by cities in response to population increases" and normal household use (drinking, showers, laundry). It pointedly remarked that "municipal groundwater is also increasingly used for lawn irrigation".[143]

109. In November 2015, in the final North & East Metro Groundwater Management

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[139] March 8, Putzier, p. 116.
[140] Ex. 145 was previously used in a December, 2013 deposition, and thus predates that date.
[141] Ex. 145, p. 3.
[142] Id., p. 2.
[143] Id., CITE ????

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Plan, the DNR agreed that "lower water levels in areas where groundwater has substantially increased over the past 20 years appear to reflect a combination of climate and pumping effects".[144]

110. The DNR witnesses repeatedly testified at trial that groundwater pumping is one of the direct causes of the water level declines in White Bear Lake,[145] and the only one that is within human control. These witnesses all agreed that the two major factors that control the lake level are weather (or climate) and groundwater pumping. Mr. Moeckel testified that these two factors also control groundwater levels in the Prairie du Chien-Jordan Aquifer. According to Ms. Naramore, both precipitation and groundwater pumping are "primary," "direct," and "material" causes for the lowering of White Bear Lake.[146]

V. The Negative Impacts on White Bear Lake from Groundwater Pumping Can be Quantified and Observed.

A. Groundwater Pumping from the Prairie du Chien-Jordan Aquifer has "Shifted the Hydrograph" of White Bear Lake.

111. Although its impact may not be immediately noticeable, groundwater pumping has a long term impact on the lake. Year over year, this pumping from the Prairie du Chien-Jordan Aquifer has a "piling on" effect on White Bear Lake water levels, and over time it has changed the "natural water cycle", lowering groundwater levels and reducing the amount of water going to the groundwater-dependent ecosystems.[147]

112. The effect of pumping groundwater from the Prairie du Chien-Jordan Aquifer in the area around White Bear Lake is to artificially lower the natural fluctuating range of the lake, and to exacerbate those fluctuations. It pushes the lake into a lower than normal by making "low water levels lower" and "high water levels lower". [148] This "shifting of the

[144] Ex. 306, p. 49.
[145] March 8, Putzier, pp. 88-89; March 16, Moeckel, p. 4; March 22, Tonkin, p. 143; March 23, Berg, p. 13; March 27, Solstad, p. 3; March 28, Naramore, p. 34.
[146] March 28, Naramore, p. 34.
[147] Ex, 275. March 15, Moeckel, pp. 14, 26.
[148] March 22, Tonkin, p. 163; March 15, Moeckel, pp. 9-13.

hydrograph" results in the lake being at lower levels more often, and for longer periods than it would have been naturally.[149]

112. Pumping causes the lake's natural fluctuations to occur at an overall lower range than they would naturally. Where previously the lake would normally fluctuate on the lower end between 922 and 924 feet, now it may fluctuate on that lower end between 918 and 920 feet—a four-foot difference. Pumping has impacts on the "high" end levels of the lake as well: it inhibits the lake from reaching its overflow elevation as often as it would otherwise.[150]

113. These lower levels will persist for a longer period than they would previously, because the pumping impedes the aquifer from being recharged as quickly as it had been in the past. The result is that the lake levels will "be lower than in the past" and the "time the lake will spend at [those] lower lake levels [will] be longer".[151]

114. The DNR data confirms that this shift into a lower range is already happening. Its exceedance chart for White Bear Lake shows that after 1980, the lowest 45% of the lake level readings for White Bear Lake are lower than the lows in the period before 1980, and that at the same time, the lake highs have been lower than those before 1980.[152]

115. In an internal DNR document from 2012, the DNR expressly recognized that:

A. "Increased precipitation will not result in the same water level recovery seen after the 1976 and 1988 droughts because of the increased loss of lake water to groundwater caused by pumping from the aquifers beneath the lake";

B. Going forward, "above average precipitation will . . .be needed to restore the lake levels" and that "if more sustainable groundwater management

[149] March 27, Naramore, p. 24; March 13, Funke, p. 147
[150] March 10, Grubb, p. 125.
[151] March 13, Funke, p. 155.
[152] Ex. 2027, p. 6; Ex. 302, p. 8, Finding 36; March 15, Moeckel, p. 10.

is not adopted, lake levels will be lower than historical levels for a given precipitation regime and will continue to decline"; and

C. That "restrict[ing] groundwater withdrawals by mandating conservation measures and/or prohibiting increased water usage" would, however, "maintain water levels in White Bear Lake".[153]

116. This shift in the hydrograph is consistent with the 2013 USGS findings that in dry periods, groundwater pumping effectively prevented the lake from rebounding in response to precipitation as it had previously.[154]

117. Similar to the figures in Ex. 12A, p. 15, Mr. Grubb and Dr. Funke prepared their own figures comparing precipitation and White Bear Lake level changes over time.[155] The graph at Ex. 589 reflects that within a year or two of the 1988-89 drought, the lake also fell to low levels. Following a couple of high rainfall years in the early 1990s, the lake "responded to those periods of high rainfall by rapidly rising back into its more typical elevation range of 924, 925",[156] recovering in just one or two years.[157]

118. In the years following 2003, the hydrograph changes. At that time, the level of the lake started to decline and dropped consistently for an entire decade until reaching its historic low of 918.9 feet in 2013. That loss did not track with precipitation. Unlike previous recorded periods, while the lake dropped precipitously, precipitation *fluctuated* – with some years of low precipitation and some periods of very high precipitation. For example, 2008-09 were dry years, but as precipitation increased following those dry years, the lake did not rebound as it had following the 1988-89 drought. Even with very high

[153] Ex. 144-2.
[154] Ex. 12A-15.
[155] Exhibits 589 and 515, respectively.
[156] March 10, Grubb, p. 19.
[157] March 13, Grubb, p. 87.

rainfall the last three years preceding trial, White Bear Lake has not reached its long-term historic average.[158]

119. In the opinion of expert Grubb, were there no groundwater pumping, White Bear Lake would likely be "well above" its long-term average level. [159]

120. Studying the reaction of the lake to precipitation, Dr. Funke compared its level data from 1924 to the present with precipitation data from both the Minneapolis-St. Paul airport, as well as local, gridded rain data for the same period of time.[160]

121. Exhibit 515, a hydrograph Dr. Funke prepared from that data, confirms the lake's abnormal response to increased precipitation in recent years. Since the mid-2000s, the lake was lower, and lower longer, than it had been in the past. In Dr. Funke's expert opinion, this indicated a "change in hydrologic condition" of the lake consistent with current understanding of the connection between White Bear Lake and the aquifers below.[161]

122. Exhibit 2100-4, a hydrograph prepared by the DNR expert Jim Solstad, supports Dr. Funke's opinion. It reflects that from 1920 through 2010, the level of the lake tracked precipitation. But starting in 2010, the level of the lake fell below the average precipitation and just stayed there. As precipitation increased during the last number of years, the level of the lake consistently lagged behind. This noticeable failure to rebound in the face of high rainfall has not happened since the 1920s.[162]

123. Other Twin Cities Metro lakes have not experienced the same shifts in the hydrograph. For example, while both White Bear Lake and Lake Minnetonka reacted the same way in rebounding following the 1988-89 drought,[163] this was not the case for the

[158] March 10, Grubb, p. 19; March 13, Grubb, p. 87; March 13, Funke, p. 153.
[159] March 13, Grubb, p. 90.
[160] Exhibits 503-505, 515-516.
[161] Ex. 515; March 13, Funke, pp. 147-154.
[162] Ex. 2100-4; March 27, Solstad, pp. 4-5.
[163] March 27, Solstad, p. 8, ll. 5-13; p. 13, l. 17-18.

period spanning 2005 through 2014. During that period, the average lake elevation for White Bear Lake was 2.39 feet below the long-term average, while Lake Minnetonka was .71 feet above its average lake elevation.[164] The USGS confirmed that from 2005 to 2014, "White Bear Lake has the most negative anomaly from its long-term mean compared to the rest of the lakes" analyzed.[165]

124. White Bear Lake's failure to rebound as quickly following drier years is a material, adverse impact on White Bear Lake and concrete evidence of the negative impact of groundwater pumping.[166]

B. Quantifying the Impact from Groundwater Pumping: The 2016 USGS Report, Part B.

1. The Report

125. Based on its field work and data from its 2016 (Chapter A) report, in December 2016, the USGS released Chapter B of that report, a steady-state groundwater model, in which it expressly quantified the impact of groundwater pumping on White Bear Lake.[167] The USGS used the steady-state groundwater model because it is impossible to *directly* measure the effect of groundwater pumping on a connected lake: the impact can only be *quantified* through such a model.[168] This report and the groundwater model itself have been peer reviewed.[169]

126. Steady-State Models are designed to quantify impact from cumulative changes in pumping behavior – for example, to determine what would happen to the lake or aquifer if area communities were to increase or reduce groundwater pumping by a given percent.[170] A Steady-State Model can measure impacts of increasing or decreasing groundwater

[164] Ex. 2130-27; March 27, Solstad, pp. 12-13; March 15, Moeckel, p. 23.
[165] Ex. 293-63, fig. 17; March 22, Tonkin, pp. 155-156.
[166] March 13, Grubb, p. 90; March 13, Funke, p. 148.
[167] Ex. 294A.
[168] Ex. 306-56; March 9, Putzier, p. 61, ll. 14-18.
[169] March 10, Grubb, p. 79.
[170] March 7, Elhassan, p. 30; March 14, Funke, p. 59.

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withdrawals on specific lakes.[171]

127. The model demonstrates that an increase in groundwater pumping of 30% from the 2002-2013 average causes White Bear Lake to fall by 1.5 feet. In contrast, a 30% reduction in groundwater pumping from that 2002-2013 average would cause White Bear Lake to rise by 1.5 feet.[172]

128. In addition to the effect of groundwater pumping on the lake, the USGS also considered the effect of a change in average precipitation. When accounting for the impact of precipitation on the lake, the USGS included not just precipitation in the lake's watershed, but also precipitation and evaporation from the entire region. In other words, the precipitation component modeled by the USGS accounts for *both* local and regional net precipitation, including the effective amount of groundwater recharge.[173] The USGS concluded that a 5% change, whether positive or negative, in average precipitation from 2002 to 2013 would itself cause a commensurate change in White Bear Lake's level of 2.9 feet.[174]

129. When combined, a 5% change, plus or minus, in average precipitation and a 30% change in groundwater pumping work in tandem to change the lake level by 4.8 feet.[175]

130. The model also shows how precipitation can mask the impacts from groundwater pumping in the short-term. For example, in years with above-average rainfall, if pumping increased by 30%, the lake would actually *rise* by about a foot. But then in a dry year, when precipitation is down by 5%, that 30% increase in pumping would cause at least a 4.8-foot drop in White Bear Lake.[176]

131. The results of this model confirm the conclusion from the 2013 USGS study of

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[171] There is no such thing as a "steady state" in nature. A Steady-State Model is based on data averaged over a period of time (in this case, a period of ten years).
[172] Ex. 294A-123, Fig. 19; March 10, Grubb, pp. 97-98; p. 101; March 23, Tonkin, pp. 4-5.
[173] March 22, Tonkin, p. 95.
[174] Ex. 294A-123, Fig. 19.
[175] Id., at CITE; March 10, Grubb, pp. 99-100.
[176] Ex. 294A-123; March 10, Grubb, pp. 103-104.

White Bear Lake that: "a combination of decreased precipitation and increased groundwater withdrawals could explain the lake level changes of White Bear Lake."[177]

132. The USGS also modeled the impact to the aquifer from changes in groundwater pumping: if pumping increases by 30%, the most significant drops in the water level of the aquifer occur in the areas that have the greatest number of wells and in the area around White Bear Lake. [178]

2. After Independent Testing of the Model, Expert Grubb Concluded It Was Reliable.

133. Mr. Grubb independently tested and ran the model and found the results matched the results that the USGS reported in its Chapter B report on the model. As part of his test, he turned off 8 key pumping wells. By shutting off those wells, he simulated an increase in White Bear Lake by 1.5 feet.[179]

134. The USGS had calibrated the model by comparing it to measurements taken in the real world, such as groundwater levels measured in wells in the area. The calibration data reflected that the model is "very accurate" in the area around White Bear Lake.[180]

135. In Mr. Grubb's opinion, the model is "the culmination of the best existing data to date" and accurately quantifies the cumulative impact of groundwater pumping on White Bear Lake under steady state conditions.[181]

3. The DNR Initially Supported the USGS' Groundwater Model for White Bear Lake--Until It Saw Unfavorable Results.

136. During the groundwater model's development, the DNR staff met with the USGS on several occasions to discuss it. In March of 2016, during the course of those discussions,

[177] Ex. 294A-85.
[178] Ex. 294A-120.
[179] Ex. 588, 595, 596, 574; March 10, Grubb, pp. 80-81; 105-107.
[180] March 10, Grubb, pp. 96-97; Ex. 294A-118.
[181] Id., at p. 96.

the DNR expressed concern that there was a lack of agreement between the DNR and the USGS on the geologic and hydrogeologic layering beneath the lake and that the USGS was not accounting for the department's views.[182] The DNR wanted the USGS to align itself with the DNR's position, or it was "going to be hard to explain".[183] In an internal DNR email in March of 2016, Mr. Moeckel wrote: "This is concerning. I'm puzzled as to why the model construction can get this far along without a better understanding and agreement. If there's not broad agreement by all parties, we will have some difficulty explaining why."[184]

137. In August, 2016, following a meeting with the USGS about the model, Julie Ekman, of the DNR, reported to DNR's Jim Berg that:

A. "So far, what [USGS is seeing in the 2016 study] negates their hypothesis from the 2013 report that low water levels in White Bear Lake are caused by groundwater pumping."

1. "Preliminary MODFLOW modeling shows that groundwater pumping has negligible effects on lakes in the area, including WBL;
2. Increasing area pumping by 30% modeled a 14-foot drawdown in the Prairie du Chien Aquifer to the south of WBL, but only a 3" drop in the lake level; and
3. Decreasing area pumping by 30% modeled a 14 foot rise in the Prairie du Chien aquifer to the south of WBL, but only a 2.5" rise in the lake level."[185]

138. As of August, 2016, and for some time afterward, the DNR planned to use the 2016 USGS Steady-State Model, believing it would minimize the impact of pumping on

[182] March 15, Moeckel, pp. 15-16; March 16, Moeckel, pp. 16-18; ex. 378.
[183] March 15, Moeckel, p. 16.
[184] Ex. 378.
[185] Ex. 364.

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White Bear Lake.[186] At the September, 2016 hearing before this Court, the DNR made no representation to the Court that the Steady-State Model was not reliable.

139. In January 2017, the USGS report was released. The published results from its groundwater model for the northeast metro area were "multiples different" from what the DNR had anticipated. Rather than a three-inch decline in the level of White Bear Lake, it showed that a 30% increase in groundwater pumping resulted in a 1.5 foot decline in the level of the lake.[187]

140. It was only after release of these results from the Steady-State Model that the DNR's position changed. Before this time, the DNR had never asked the USGS to employ a transient model. Now, it decided that it did want such a model.[188]

140. Mr. Moeckel admitted that the DNR could use the Steady-State Model to simulate a 30% reduction in groundwater pumping and see the resulting change on both the aquifer and the levels of White Bear Lake.[189] Ms. Naramore confirmed that the DNR could use the Steady-State Model, combined with other existing information, to analyze the impact of its permits when it came to implementing use of the protected level that had been established in December of 2016.[190] Despite the fact that this model is the most advanced scientifically available model for the northeast metro area, the DNR has not performed the analysis. In fact, it has refused to use the USGS model at all.[191]

4. Dr. Tonkin's Analysis

141. Describing the USGS Steady-State Model, including its package selections, code, and methods, as appropriate and “state of the art”, Dr. Tonkin agreed with both its analysis of the geology as well as with its selection of wells. He described its approach regarding

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[186] March 16, Moeckel, p. 23; March 28, Naramore, p. 28.
[187] March 16, Moeckel, pp.22-23.
[188] March 28, Naramore, p. 28-29.
[189] March 16, Moeckel, p. 59.
[190] March 28, Naramore, p. 37.
[191] March 15, Moeckel, p. 16, ll. 10-18.

recharge and evaporation, and boundary conditions as reasonable and appropriate.[192] Overall, Dr. Tonkin opined that in building the model, the USGS took "the right steps" and made "good choices".[193]

142. As Defendant DNR's expert witness, Dr. Tonkin did not perform any field tests,[194] or water budget modeling, nor did he rely on any DNR or the Met Council documents pertaining to the lake.[195] Rather, he relied on the work of the USGS and of Plaintiff's expert, Mr. Grubb. While criticizing them for not explicitly accounting for the impacts of regional precipitation and evaporation, he admitted that those factors were built into their groundwater models.[196]

143. Analyzing the USGS model calibration, Dr. Tonkin concluded that the hydraulic connectivity used in the model was too high. He based this conclusion on a small sample of only seven out of 900 wells. Furthermore, despite the fact the USGS study found that White Bear Lake water is the likely source of surface water found in 11 wells *south and downgradient to the lake*, Dr. Tonkin chose to plot the calibration of wells that were *northeast of the lake*. He offered no meaningful explanation for his choice of either the limited number of wells or their locations.[197]

144. Dr. Tonkin testified extensively on the potential impact of increased evaporation on White Bear Lake. His net precipitation chart, which includes evaporation rates, shows that from 2002 to 2004, the lake level was at or above net precipitation. Nonetheless, after 2004, the chart shows that the lines separate, and the lake's levels fall below net precipitation.[198] In other words, there exists a gap between net precipitation and the lake level that cannot be explained by increased evaporation.

[192] March 22, Tonkin, p. 38, p. 75.
[193] Id., at p. 39.
[194] For example, water sampling, sediment, piezometer, isotope or seepage meter analysis, soil permeability testing.
[195] March 22, Tonkin, pp. 127-131.
[196] Id., at p. 110.
[197] Id., at pp. 158-159.
[198] Ex. 2142, p. 9, figure 12.

145. Dr. Tonkin testified that in the period after 2002, there may have been increased temperatures, and thus increased evaporation regionally.[199] However, he did not explain how this impacts the USGS' conclusion, since he admits that the USGS accounted for regional evaporation and precipitation in its groundwater model, and yet still concluded that pumping has a substantial impact on White Bear Lake.[200]

146. Dr. Tonkin agreed that USGS' choice of the method for calculating evaporation[201] was reasonable.[202] He admitted that he did not do a specific analysis of evaporation at White Bear Lake. Although he agrees that evaporation increases as water levels increase, he did not do an analysis of any changes in evaporation that were caused by additional acres added to the lake when its level increases. Nor did he review or rely on ice-out information for White Bear Lake.[203]

147. In Dr. Tonkin's opinion, changes in the balance between precipitation and evaporation is the "dominant factor" causing low levels in White Bear Lake. However, he does not exclude groundwater pumping as a secondary factor,[204] and agreed that groundwater withdrawals make low water levels lower and high water levels lower.[205]

C. Pumping from Wells in at Least a Five-Mile Radius of White Bear Lake Impacts the Lake's Levels — and the Impacts are Cumulative.

148. In determining which wells impact White Bear Lake, distance is only one factor to consider. The volume and rate of water pumped must be considered, as well as transmissivity of the lake and aquifer.[206]

149. As did all the DNR witnesses, Dr. Tonkin admitted that pumping from wells close

[199] Pan evaporation data from the University of Minnesota shows that evaporation has been constant over the last decade. March 27, Solstad, p. 175.
[200] March 22, Tonkin, p. 112.
[201] Chapter A, 2016 USGS Report.
[202] March 22, Tonkin, pp. 38-39.
[203] March 23, Tonkin, p.11.
[204] Id., at p. 114.
[205] March 22, Tonkin, p. 163.
[206] March 16, Moeckel, pp. 13-14.

to the lake does affect its level, and that to understand the pumping impact on the lake's water levels, the entire North and East Groundwater Management Area is relevant, not just the lake's watershed or even a two-mile buffer around the lake. While admitting that wells 5 to 6 miles away may impact the lake,[207] he did not specify a list of those wells or the amount of their individual impact on the lake, even though he had the data and admitted that he could easily have done so.[208]

150. Pumping from wells five or more miles from the lake does impact it. Mr. Grubb testified that five miles is the minimum range of impact, and identified a number of wells of that distance that had a "very significant influence" on the lake. [209] Dr. Tonkin found a significant number of wells between 6-12 miles from White Bear Lake that had an impact, and Dr. Berg agreed that wells "far" from the lake can have "a significant effect" depending on their pumping rate.[210]

151. For purposes of its 2016 groundwater study, the USGS examined 900 wells extending 14-15 miles from White Bear Lake.[211]

152. To determine which wells have the most significant impact on the lake, Mr. Grubb performed a well-by-well analysis, taking into account both the distance and usage rate for those wells. Because wells closer to White Bear Lake tend to have a larger influence on the lake, he analyzed wells located within 5-7 miles of it. However, if a well farther away from the lake is pumping at a higher rate, that well may have more impact than a well closer to the lake that is pumping at a lower rate.[212]

153. Based on data from the DNR, Exhibit 575 shows the wells having the greatest

[207] March 22, Tonkin, p. 64, p. 138.

[208] Id., at pp. 148-151. As part of his analysis, Dr. Tonkin used the USGS model to change the pumping rate for each of the 900 wells studied by 20%. Rather than calculating the actual drawdown of the lake from that pumping, he analyzed a "response function" for each well. From this he concluded that generally wells closer to the lake tend to have a higher response function than those further away.

[209] March 10, Grubb, p. 109.

[210] Ex. 2145-2; March 23, Berg, 32.

[211] March 22, Tonkin, p. 138.

[212] Ex. 575; Ex. 590; March 10, Grubb, p. 11.

impact on the lake. These include municipal wells located in the City of White Bear Lake, Mahtomedi, Oakdale, White Bear Township, North St. Paul, Hugo, Little Canada, as well as St. Paul Regional Water Authority wells and wells from other private entities. Individually, no one well had a greater than 8% *individual* impact. In Mr. Grubb's opinion, to effect needed change, all wells within at least a 5-mile radius should be subject to groundwater use restrictions.[213]

154. The USGS model can be used to identify the groundwater wells that have the greatest cumulative impact on White Bear Lake. Selecting the top 8 wells from Exhibit 575 and using the USGS' Chapter B groundwater flow model, Mr. Grubb turned off those 8 wells. By doing so, he could simulate an increase of 1.5 feet in the lake, an increase of approximately 5.25 feet in the Prairie du Chien Aquifer, and of approximately 18.4 feet in the Jordan Aquifer.[214]

155. This approach is substantiated by the DNR's own findings regarding water users within the North and East Groundwater Management Area ("NEGWMA"), which includes Washington County, parts of Ramsey County, and parts of Anoka County. White Bear Lake is right in the middle of the area.[215]

156. Groundwater users in the NEGWMA are hydrogeologically related: their use impacts the same aquifers and vulnerable lakes in the area.[216] According to the DNR, groundwater pumping from **any area** within the NEGWMA impacts the Prairie du Chien-Jordan Aquifer, and because of the hydraulic connection between the aquifer and White Bear Lake, could impact the levels in White Bear Lake.[217]

VI. White Bear Lake Surface Water that has been Drained Because of the DNR-

[213] March 10, Grubb, p. 5; pp. 110-113.
[214] Ex. 595; Ex. 596; Ex. 574. March 10, Grubb, p. 106; p. 118.
[215] Ex. 306-34.
[216] Ex. 358-2; March 28, Naramore, p. 11; March 16, Moeckel, p. 40.
[217] March 15, Moeckel, p. 25.

Authorized Groundwater Pumping has not been Replaced by that Agency

157. The DNR-permitted, high capacity well pumping of water from the Prairie du Chien-Jordan Aquifer not only lowers its groundwater level, but also causes its pressure head to decline, creating a higher head differential between it and the lake. Because of this differential, the aquifer suctions surface water from the lake and artificially lowers it by causing the water to drain into the aquifer.[218]

158. The DNR authorized pumping from a number of high capacity groundwater wells, including 11 that are south and southwest, i.e. downgradient, of White Bear Lake. The USGS found that the water from these 11 wells was comprised of between 13 and 58 percent White Bear Lake surface water. By contrast, for wells that were up gradient from the lake, water was mainly made up of groundwater.[219]

159. The USGS' findings are "conclusive proof that water from White Bear Lake is entering the Prairie du Chien Aquifer and is being pumped out by [DNR-permitted wells] in the area of White Bear Lake".[220]

160. The amount of water drained from the lake can be quantified. Using the USGS data, Mr. Grubb calculated the amount of surface water that the DNR removed from the aquifer by the pumping from wells south and southwest of the lake to be approximately 463 million gallons per year. None of this water has been replaced by the DNR.[221]

VII. It is Undisputed that Increased Groundwater Use by Northeast Metro Communities that are 100% Reliant on Groundwater is Not Sustainable.

A. Groundwater Use Is Projected to Increase by Between 30 to 56%.

161. In the last 25 years, statewide, groundwater use has increased 35%: an increase of 2.8 billion gallons per year.[222]

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[218] March 10, Grubb, pp.57-58, 78, and 119.
[219] Ex. 293, pp. 70-71.
[220] March 10, Grubb, p.68.
[221] March 8, Putzier, p. 65; March 28, Naramore, p. 27.
[222] Ex. 358-2; March 15, Moeckel, p. 30.

162. Given the size of the appropriation currently allowed under the DNR-issued groundwater permits, the existing groundwater permits of the northeast metro communities are "not sustainable at the current pumping rates".[223]

163. Projected groundwater demands currently exceed the 2010 groundwater permit allowances. If communities continue to be 100% reliant on groundwater, they will require "substantial" permit increases or entirely new permits to meet that demand.[224]

164. The Met Council is the planning agency for water supply for the seven-county metropolitan area. Its goal is to ensure a sustainable water supply for current and future generations.[225] By 2040, based on existing water use, it projects groundwater use in the northeast metro to increase by at least another 30-56%.[226] There is no dispute that populations will increase and water use will go up, especially in suburban areas.[227]

165. The area of significant growth in water use is in municipal water systems, not in industrial or commercial use. Much of that growth "is happening relying on groundwater".[228]

166. The DNR itself has projected a 47% growth in population for the NEGWMA. That brings with it an increase in water demand, which would swell to 42 billion gallons per year.[229]

167. Even White Bear Township, a community with relatively little room to grow compared to outer ring suburbs, has projected increases in population and groundwater demand through 2040. In fact, the Township has projected the need to drill yet another new well into the aquifer in the next ten years.[230]

[223] Ex. 287-9; March 9, Grubb, pp. 18-19.
[224] March 7, Elhassan, p. 142; March 9, Putzier, p. 54.
[225] March 7, Elhassan, pp. 7-9.
[226] Ex. 320-33; Ex. 328-12; March 7, Elhassan, pp. 121-122, pp. 143-144.
[227] March 9, Putzier, p. 53.
[228] Ex. 320-33; March 7, Elhassan, p. 9.
[229] March 15, Moeckel, p. 32.
[230] Ex. 3123-13, 20; March 21, Reed, pp. 100-103.

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B. The DNR and the Met Council Both Know that Increased Reliance on Groundwater in the Northeast Metro is Not Sustainable.

168. In the northeast metro, communities are 100% reliant on groundwater.[231] It is undisputed that the increased reliance on groundwater use in the northeast metro and the DNR's practice of continuing to permit groundwater users, even under current permits, is not sustainable.[232]

169. Symptoms of groundwater overuse include declining aquifer levels and declining levels in connected surface water bodies.[233] From the Met Council's perspective, the declining lake level in White Bear Lake is "a symptom of water supply issues" in the northeast metro area.[234] This lake is "the bellwether", the "tip of the iceberg", signaling sustainability issues and "showing us what will happen in other parts of the region if we continue current practices".[235]

170. The DNR admits that groundwater use is not sustainable if the use causes declining heads in aquifers or would have adverse (i.e. negative or unfavorable) impacts on White Bear Lake.[236] Despite this knowledge, the DNR has engaged in permitting practices that have had a negative impact on surface water bodies such as White Bear Lake.[237]

171. The DNR has repeatedly acknowledged pressing issues of groundwater sustainability, stating on many occasions that groundwater is at "risk of overuse," and that increasing reliance on its use in the northeast metro may not be sustainable.[238] Its officials have described that overuse as an "urgent issue", and have acknowledged that "What we're facing in the Twin Cities is a groundwater crisis".[239]

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[231] Ex. 306-8; March 7, Elhassan, p. 9.
[232] Ex. 19, p. 4; Ex. 358-2; March 7, Elhassan, pp. 30-31; pp. 173-174.; March 10 Grubb, p. 119; March 1, Moeckel, p. 30; March 8, Putzier, p. 120; March 27, Naramore, p. 5.
[233] March 7, Elhassan, p. 14.
[234] Id., at p. 21.
[235] Id., at p. 46.
[236] Ex. 356; Ex. 39-7; March 8, Putzier, p. 19; pp. 49-50; March 9, Putzier, p. 7; March 27, Naramore, p. 5.
[237] Ex. 348-10, 17; March 7, Elhassan, p. 13; March 10, Grubb, p. 119.
[238] Ex. 358-2; Ex. 287-3; Ex. 2022-2. March 15, Moeckel, p. 30; March 8, Putzier, p. 120.
[239] March 9, Putzier, pp. 50-51; March 16, Moeckel, pp. 41-42.

172. It is the Met Council's duty to plan for long-term sustainability of water resources, and it has known of the "significant issues" and "sustainability problems" with the Prairie du Chien-Jordan Aquifer and White Bear Lake since at least 2010, if not before.[240]

173. Worried about the future, both regarding lake level decline and the ability to maintain a water supply for the population growth expected by 2040, not to mention future generations beyond that, the Met Council has repeatedly told the DNR and the communities that there will be serious consequences if they continue to conduct "business as usual".[241] "Business as usual" refers to the practice in which communities wanting more water simply request, and automatically receive, a new well from the DNR. As Dr. Elhassan so clearly described it:

> "Our main intention is to provide information for the communities that, because you are adding a new straw to the existing 186 straws [wells] in the region,… there [will be] consequences that [are] different than what [happened] ten years ago or one year ago. So we wanted to have the communities [including agencies and businesses] be aware…that the way we have been getting our water supply that [easily] is going to be a little bit different. [To ensure a sufficient water supply for the next 5, 10, or 25 years, communities] "have to go beyond the regular way, or the business as usual [way]."[242]

174. In its 2013 publication "Water Supply Issues in the Metro Area", the Met Council concluded:

A. The "current approach to water supply management and development is unsustainable;"

[240] March 7, Elhassan, p. 109; pp. 173-175.
[241] Ex. 19; March 7, Elhassan, pp. 33-35.
[242] March 7, Elhassan, pp. 170-171.

B. "Aquifer levels [have] declined – depleted;"

C. "Lakes, streams, and wetlands are being damaged;" and

D. In some areas "groundwater levels have declined as much as 40 feet – roughly one foot each year."[243]

175. There is a built-in "inertia" in the system that operates to maintain the status quo when it comes to water use.[244] Municipalities "have generally made independent water system investments and have conducted autonomous resource evaluations without interjurisdictional cooperation and with little consideration for the regional implications of their decisions". [245] They naturally look out for their own interests and many are content to maintain the status quo and are resistant to change.[246] Many cities are content to maintain the status quo and are resistant to change. However, to ensure sustainability and continue providing these services, "they need to adapt to the new reality of . . . implement[ing] more options".[247]

VIII. White Bear Lake Has Suffered and Likely Will Continue to Suffer Material Adverse Impacts Caused by the DNR-Authorized Groundwater Pumping.

176. Excessive groundwater appropriations are a "significant" factor negatively impacting the surface water level of White Bear Lake and the DNR should have known that its actions in terms of groundwater appropriations permitting were having a negative impact.[248]

A. Ecological Harm

177. Dr. Megan Funke, Ph.D., a limnologist[249] with experience analyzing lakes,

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[243] Ex. 19, p. 4.
[244] March 16, Moeckel, p. 41.
[245] Ex. 32, p. 13.
[246] March 8, Putzier, p. 46.
[247] March 7, Elhassan, p. 148.
[248] March 9, Grubb, p. 19; March 10, Grubb, p. 140.
[249] Limnology is the study of lakes and streams.

testified about the ecological harm to the lake. Dr. Funke's extensive experience involves the analysis of lakes in order to understand their hydrology, geology, water quality, biology, chemistry, and ecology. Hydrogeology, hydrology, and geology were significant components of her doctoral limnology studies and degree. [250]

178. Before arriving at her opinions regarding her analysis of White Bear Lake, she:

A. Reviewed published data regarding:

1. Water quality data from the MPCA;
2. Precipitation data (both local and from the Minneapolis-St. Paul airport;
3. Lake level data from the DNR;
4. Information from fisheries and plant surveys from the DNR and conservation districts;
5. USGS studies;
6. Met Council presentations; and
7. Internal DNR documents and correspondence related to the ecology of White Bear Lake.[251]

B. Conducted independent fieldwork and analysis of White Bear Lake:

1. Toured its shoreline several times;
2. Analyzed and took a core of the underlying lake sediment;
3. Studied the lakebed at various locations;
4. Took plant rakes;
5. Measured temperature depths and dissolved oxygen;
6. Scouted the lake bays in the winter to study plant growth; and
7. Used lake contours to perform an independent analysis of lake

[250] March 14, Funke, p. 151.
[251] March 13, Funke, p. 124.

area and volume by depth.

C. Constructed a lake water quality response model to predict lake water quality based on its watershed characteristics.[252]

1. Sustained Low Water Levels Have Material, Adverse Impacts on White Bear Lake.

179. Groundwater pumping from the Prairie du Chien-Jordan Aquifer in the area around White Bear Lake lowers the natural fluctuating range of the lake by making "low water levels lower" and "high water levels lower". [253] It also causes the lake to remain at sustained lower levels longer than it has previously.[254]

180. Based on her experience, training, education, review of material, and independent analysis, Dr. Funke opined that White Bear Lake has been and will be materially adversely impacted by this "shift downward of the fluctuation range" of White Bear Lake and the "sustained low levels".[255]

181. The DNR agrees that "prolonged low levels" in White Bear Lake "may have negative effects" on recreation, economics, and fish, plant, and animal communities in White Bear Lake.[256]

182. Sustained lower water levels decrease the overall volume of the lake. A lake that naturally fluctuates significantly is extremely "sensitive" to lake level fluctuations. Even an additional foot-and-a-half swing caused by groundwater pumping can drastically change conditions and have a significant impact, especially in the lake's naturally shallower bays. Among the material adverse impacts to the lake will be a change in the kind and amount of aquatic plants that can grow. Those that cannot survive in exposed

[252] March 13, Funke, pp. 126-128.
[253] Ex. 302-8; Ex. 12A-15; Ex. 515; Ex. 2100-4. March 15, Moeckel, p. 9; March 15, Moeckel, p. 39; March 22, Tonkin, p. 163.
[254] Ex. 515; March 13, Funke, pp. 147, 155, 164, 173.
[255] March 13, Funke, pp. 129, 173.
[256] Ex. 145, p. 3.

areas will die. As the lake lowers and shallows continue to lose volume, increased impact between watercraft and the aquatic plant communities will destroy those communities.[257] Decreased water volume also has a negative impact on water quality. This, in turn, will bring additional negative impacts on the littoral area where plants and fish can survive.[258]

183. That the lake level has risen (at the time of trial) to 922.8 feet, nearly within its normal range, does not mean there is no negative impact to the lake. A specific water level must be taken within context of what is happening both before and after that level is reached. While this specific water level might seem "normal," in reality it is now the *top* part *of a new lower range*. White Bear Lake is not even at its long-term average after several years of significant rainfall. The present level of 922.8 feet, which used to be on the lower end of the normal range, is now on the *higher* end of that range, reflecting both lower lows and lower highs caused by groundwater pumping. [259]

184. To estimate *future* harms to the lake from pumping, Dr. Funke relied on the USGS groundwater model for the lake in the Chapter B report and upon the Met Council's growth projections predicting (at minimum) a 30% increase in groundwater pumping. Based upon these, she testified that it is reasonable and likely that with increased pumping and drier weather conditions, White Bear Lake could see drops of five feet or more and once again experience record lows – into the range of 917 feet – breaking new historical records.[260]

185. If even "a portion" of the five-foot decline modeled by the USGS is due to groundwater pumping (as opposed to climate or precipitation), that will have a significant impact on what is exposed in the west bay and upon the depth of other shallow areas,

[257] March 13, Funke, p. 174.
[258] Ex. 513; Ex. 514.
[259] March 13, Funke, pp. 156-159.
[260] Id., pp. 157-159.

which are critical for plants and known as the "nursery of White Bear Lake" for fish.[261]

2. Sustained Low Water Levels Cause the Lake to Shrink – a Material, Adverse Impact In Itself.

186. Using the DNR bathymetry data,[262] Dr. Funke performed an independent analysis of lake area and volume by depth to determine how much of White Bear Lake would be lost at sustained low water levels.[263]

187. Exhibit 506 is a chart of the summary of changes in total volume, total surface area, littoral zone volume and littoral lakebed areas of the west, north and southeast bays, as well as of the whole lake. The data upon which this exhibit is based was collected by the DNR in the 1970s. At the time of its collection, the lake level was approximately 920 feet.[264]

187. As water levels drop, so does the volume and surface area of the lake. Loss of volume, more than loss of surface area, determines the water quality as well as type of plant and fish communities in the lake. Low levels in each bay are of particular importance because they are critical ecological zones within the lake.[265]

188. Exhibit 506 reflects that:

A. At 920 feet:

1. The lake loses 18% of its total volume.
2. The shallower west bay, a prime habitat for plants and fish, loses 19% of its surface area and 37% of its total volume.

B. At 918.8 feet, the historic low as of 2013 (five feet below the long-term average):

[261] March 14, Funke, pp. 38-39.
[262] Bathymetry is the measurement of the depth of large bodies of water.
[263] Ex. 506; Ex. 507; Ex. 508.
[264] March 13, Funke, p. 159.
[265] March 13, Funke, p. 161-162.

1. The lake loses 25% of its volume.
2. The west bay loses 30% of its surface and 49% of its total volume.[266]

189. Exhibit 507 is a visual depiction of the loss of surface area in the west bay. Created by Dr. Funke using the DNR lake depth contours, it shows the result of that loss at both the 920- and 917-foot levels. At 920 feet, there are large, exposed areas throughout Matoska Bay; at 917 feet, Matoska Bay has disappeared. In addition, there are more visible areas of shoreline and exposed lakebed in the northwest and southeast bays.

190. Such losses to the lake, and in the west bay in particular, are significant and have material adverse impacts. The DNR admits that action must be taken before the lake hits these extremely low levels.[267]

191. In addition to the overall reduction of the lake itself, the decrease has a domino effect: it increases the phosphorus concentration which then can decrease water clarity by several feet. Since 2004, water clarity in the lake has been on the decline. [268] In turn, that decrease in clarity causes a change in the size of the littoral zone by impeding the penetration of light to the aquatic plants.

3. White Bear Lake's Littoral Zone, a Safe Harbor for Aquatic Plants, Fish, and Invertebrates, will be Materially Harmed by Sustained Low Water Levels.

192. Most of the lake's biology grows in the littoral zone. Because the submerged and emergent aquatic plants necessary to support the rest of the lake's food chain grow here, this is generally the most productive part of the lake. That food attracts zooplankton, fish and invertebrates, which reside in the submerged aquatic plants. It is also the nursery for the lake: most of its fish spawn here. When the lake is at its long-term average elevation

[266] Ex. 506; March 14, Funke, pp. 162-163.
[267] March 16, Moeckel, p. 49.
[268] March 24, Jennings, p. 24.

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(923.8 feet), the littoral zone comprises 54% of the total lake surface area.[269]

193. White Bear Lake is particularly vulnerable to water level declines.[270] With the lake's gently sloping sides, its wide and shallow littoral zone, even a small change in elevation can have a significant impact on its littoral zone.[271] The effect of these declines upon the lake is graphically depicted in several photographs in the court record. In its 2016 report to the Minnesota legislature, the DNR explained the cause of this vulnerability:

> "[T]he shape of the lake's basin, particularly the portion of the basin that is less than 15 feet deep (those water depths where the growth of rooted aquatic plants is most prevalent) is also important. Lakes that have broad, gently-sloped basins are likely to be more susceptible to water level changes compared with steeply sloped basins because small changes in lake depth result in proportionally larger changes in the surface area of the basin. The impact of water level changes may be particularly acute [in shallow bays]. In these situations, the amount of rooted aquatic plant habitat for important fish and/or wildlife populations may vary substantially as water levels move up and down…[272]

Even a half-foot change can mean a loss of several feet of littoral zone area.[273]

194. In the west bay of the lake's littoral zone is Matoska Marsh. Retired City of White Bear Lake city manager Mark Sather described the importance of this marsh as one

[269] March 24, Jennings, pp. 16-17; March 13, Funke, pp. 130-131.
[270] Ex. 25, p. 21; Ex. 359, p. 27.
[271] Ex. 25, p. 21.
[272] Ex. 359, p. 27.
[273] March 14, Funke, p. 138.

of two of the lake's nurseries. Prime habitat, it is both a large nesting location and a major area for the reproduction of fish and other aquatic creatures. This large marsh is recognized by the White Bear Lake Conservation District as being entitled to “a great deal of extra protection because of its unique sensitivity”.[274]

195. When the lake declines to 922 feet, its littoral zone starts to shrink. As seen in Finding 188, *supra*, when the lake experiences a decline of five feet from its long-term average (as it did in 2013), it loses 25% of its volume. However, the west bay loses 30% of its surface area and 49% of its total volume. Should the decline increase an additional foot, to a level of 917.8 feet, the northern part of the west bay is completely exposed and the littoral zone gone.[275]

196. These losses represent a significant drop in littoral area and volume, and have a significant negative impact to the lake, especially in the west bay.[276]

4. Sustained Low Water Levels Have Had, and will Have, a Material, Adverse Impact on Water Quality in White Bear Lake.

197. Aquatic plants furnish oxygen to higher organisms. For these plants to grow, there must be good water clarity so that sunlight is able to penetrate into the waters of the lake. The best measure of lake water quality lies in its clarity, which is determined by the level of phosphorous in the water. Phosphorous affects clarity by encouraging the growth of too much algae, which clouds the water and can turn the lake into pea soup. When that happens, it impedes the penetration of light into the lake's depths and blocks the plants from receiving the sunlight.[277] It follows that low phosphorous levels are important in maintaining the clarity and quality of the lake water.

[274] March 21, Sather, pp. 32-33.
[275] Ex, 508; March 14, Funke, p. 38,
[276] March 14, Funke, p. 37; March 16, Moeckel, p. 49; March 24, Jennings, p. 26.
[277] March 13, Funke, pp. 178-180.

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198. A lake's clarity is measured with the use of a Secchi Disk.[278] The disk is mounted on a pole or line and lowered slowly into the water. The depth at which it is no longer visible is the "Secchi depth," a measure of the water's transparency. This is a very good measure of water quality in a lake.[279]

199. Phosphorous impacts water clarity indirectly by causing the growth of too much algae. In lakes of very high water clarity, such as White Bear Lake, any small increase in phosphorous concentration has a significant effect in causing a noticeable and rapid decline in clarity. (On the other hand, where a lake already has a greater concentration of phosphorous (and algae), the effect of an identical increase will have less of an impact.)[280]

200. Since at least 2004, Secchi depth (water clarity) has been declining in the lake.[281]

201. Since at least 2007, phosphorous levels have been increasing in White Bear Lake.[282] In large lakes like this, water has a very long "residence" time (approximately seven years),[283] and consequently, nutrients like phosphorous will remain in the lake for years.[284]

202. Dr. Funke created a lake water quality response model (a "BATHTUB model")[285] for White Bear Lake in order to 1) determine the cause of its increased phosphorus and

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[278] Angelo Secchi, an Italian Jesuit priest and astrophysicist (1818-1878), invented this instrument to measure clarity in bodies of water. The Secchi disk used for lakes is an 8-inch disk that is divided into alternating black and white quadrants.
[279] March 13, Funke, p. 180-181.
[280] Id.
[281] Ex. 513; March 14, Funke, p. 4; March 24, Jennings, p. 24.
[282] Ex. 512; March 13, Funke, pp. 183-184.
[283] "Residence time" refers to the amount of water in a body (lakes, rivers, oceans) divided by either the rate of addition of water to the body or the rate of loss from it. Oceans have a water residence rate of 37,000 years, reflecting their large volume of water. In the atmosphere, the residence time of water vapor relative to total evaporation is only 10 days. Lakes, rivers and groundwaters have a residence time lying somewhere between these two extremes. Encyclopdia Britannica.
[284] March 14, Funke, pp. 6-7. While a shallow lake might have a residence time of a month, and smaller lakes a residence time of a year or less, larger lakes will have a residence time of over four years
[285] The BATHTUB model is an empirical lake eutrophication model developed for the U.S. Army Corps of Engineers in the 1980s. ("Eutrophication" is excessive nutrient richness in a body of water caused by runoff of chemicals from the land. It results in dense growth of algae that depletes the water of oxygen, resulting in the death of aquatic vegetation and animal life.)
The model employed here is Steady-State Model. It accounts for long-term averages of flow and nutrient runoff and predicts the response of the lake on a longer time scale.

declining water clarity, and 2) determine if there was a relationship between lower water levels and the observed MPCA water quality data. She has built "hundreds" of these models and is well versed in appropriate model calibration.[286]

203. She used a Steady-State Model because that is appropriate for a lake that has such a long residence time. The model takes into account the size and average depth of a lake, its volume and surface area, its sources of water (precipitation, watershed runoff, groundwater inflow), and sources of phosphorus (watershed runoff, precipitation, groundwater).[287]

204. With this model, Dr. Funke modeled two scenarios. The first examined the impact of loss of water volume on in-lake phosphorous concentrations, while the second considered an additional element: the increased phosphorus runoff from the expanded exposed lakebed.[288]

205. The model confirmed what Dr. Funke had expected, based on fundamental principles of chemistry: as the lake level declines, and the volume of the lake decreases, in-lake phosphorous concentrations will increase.[289]

206. The model showed that:

A. Where the lake declined 3.6 feet from its long-term average (923.8 feet) to a level of approximately 920 feet, the in-lake phosphorous concentration increased by 1.5 parts per billion.

B. Where the lake declined 5 feet from that long-term average to 918.8 feet, the in-lake phosphorous concentration increased to over 2 parts per billion.[290]

207. Although seemingly small, these increases are "ecologically significant." In a

[286] March 13, Funke, p.5-8.
[287] March 14, Funke, p. 5.
[288] Ex. 514.
[289] Ex. 514; March 14, Funke, p. 8.
[290] Ex. 514; March 14, Funke, pp. 8-10.

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relatively clear lake like White Bear Lake, a 1.5 part per billion change can cause the lake to lose "water clarity of a couple feet." A 1.5 or 2 part per billion increase in phosphorous will increase the growth of algae in the lake, thus reducing light penetration into the water and causing the littoral zone to shrink because the maximum depth at which plants can grow has been reduced from 15 feet to 13 feet.[291]

208. DNR expert Dr. Jennings agreed that declines in water clarity, as seen in the lake since 2004, reduce the size of the littoral zone and the size of the area in which plants can grow and fish can spawn.[292] Since the littoral area comprises more than half of the lake, the two-foot reduction in water clarity causes a significant loss of the littoral area,[293] and also affects the types of species that can grow in it.[294]

209**.** Because of the shallow slope of the lake, a small drop in its level exposes a disproportionate area of the lakebed. That increased exposure, taken in combination with the small watershed, is significant: a recently exposed lakebed has much higher phosphorous concentrations than a forest or an undisturbed natural area. The newly exposed lakebed may have an even *higher* phosphorous concentration than an urban area.[295] For this highly vulnerable lake, this is yet another way in which lowered lake levels cause declines in water quality.

210. Because of the long residence time in White Bear Lake, the impact of declining water quality may not be noticeable right away. The change in phosphorous level sets off a slowly moving domino effect: it reduces aquatic plant growth, and deprives smaller animals of their food. The decline of those smaller animals deprives their colleagues up the food chain (fish or invertebrates) of their food.[296]

211. Dennis Wasley, a limnologist with the Minnesota Pollution Control Agency,

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[291] March 14, Funke, p. 9.
[292] March 24, Jennings, p. 24.
[293] March 13, Funke, p. 131.
[294] March 14, Funke, p. 10.
[295] Ex. 514; March 14, Funke, p. 7; p. 116.
[296] March 14, Funke, p. 11.

agreed that phosphorus levels increase as a lake declines and that a 2 part per billion difference was significant.

212. Although he did not create his own BATHTUB model, Mr. Wasley did make comments on Dr. Funke's model. He took issue with the starting point for Dr. Funke's model (22 parts of phosphorus concentration per billion vs. the actual in-lake phosphorous concentration of 20 parts per billion), testifying that it does not accurately predict the effect of lake volume on phosphorous concentration.

213. Although 22 vs. 20 parts per billion is a very close prediction and well within standard variability for these types of models,[297] the purpose of Dr. Funke's model was to measure the *relative* change in phosphorous over time in relationship to water level. The BATHTUB model is designed to look at the effects of long-term, relative changes in concentration, not necessarily the exact concentration. The starting point does not impact that analysis.[298]

214. Mr. Wasley differed with Dr. Funke's analysis regarding runoff of phosphorous from the expanded exposed lakebed, stating that because of its natural vegetation, the exposed lakebed will absorb phosphorous, unlike impervious surfaces such as roofs and driveways. Dr. Funke, in turn, explained that exposed lakebed that is close to the shoreline would not necessarily "trap" phosphorous, because "it's also a source of phosphorus itself": it infiltrates into the sediment and is only bound temporarily.[299]

215. White Bear Lake is on the EPA Impaired Waters list for aquatic consumption because of high levels of mercury in fish tissue. On the other hand, because it has high water clarity and quality, it is not on that list for purposes of aquatic recreation.

216. EPA standards are but one of the guiding lights for the management of recreational lakes. Another is the MPCA nondegradation policy regarding lake

[297] Id., at p. 8.
[298] Id., pp. 116-118.
[299] Id., pp. 114-115.

management, which has established goals to maintain and protect high water quality lakes like White Bear Lake from *any* further impairment to water quality.[300] In terms of natural resource management, it would be a "negative impact" for a relatively clear recreational lake such as White Bear Lake to experience declining water quality or to lose plant and fish life in productive, ecological bays, even though this lake still has clearer water than other lakes in the Twin Cities.[301]

5. Sustained Low Water Levels Have Had, and Will Have, a Material Adverse Impact on the Aquatic Plants of White Bear Lake.

217. While it is beneficial to "*periodically*" expose a lakebed to help aquatic plants like bulrushes re-germinate, prolonged periods of that exposure allow terrestrial plants to take over and entirely crowd out the struggling aquatic plants. Where a periodic low would help aquatic plants, a sustained low would destroy them.[302] As the DNR has acknowledged, during dry periods, "water use may push water levels so low that water quality and biology are fundamentally changed".[303]

218. The transition from aquatic to terrestrial plants has already happened at White Bear Lake during the past decade of sustained low water levels, and was documented by the DNR in an April 2016 draft report, "Aquatic Plants of White Bear Lake." The report noted that a review of earlier surveys indicated, among other things, that:

A. "[C]hanges in water clarity would be expected to result in changes in maximum rooting depth and/or shifts in species composition. Factors that could change clarity include water level fluctuations and zebra mussel activity".

B. "[A]s water levels declined over the last XX years, the shore zone [i.e. dry land] around White Bear Lake has expanded lakeward,

[300] Id., p. 13-14.
[301] March 13, Funke, pp. 175-177.
[302] Id., p. 173; March 14, Funke, pp. 17-18; March 24, Jennings, p. 10.
[303] Ex. 359, p. 18.

below the ordinary high water mark. Areas that were once underwater are now exposed as dry land and terrestrial plant species have colonized the area. Common plant species include Aspen saplings, willow shrubs, goldenrod, asters and other terrestrial grasses and forbs."[304]

219. The prolonged low water levels caused the lakebed in the west bay to be exposed for so long that terrestrial plants and trees like black willows and speckled alder have taken over areas that were formerly water.[305] The trees growing in the former lakebed are now 25-30 feet high and four inches in diameter.[306] There is no historical precedence for this type of invasion: None of the historic lake surveys mention their presence.[307]

220. In the dry zone, where terrestrial species are superior competitors to wetland species and aquatic plants, this tree growth has displaced aquatic plants like bulrushes and cattails, which cannot survive if their roots do not have access to water.[308] This reflects "a succession from aquatic plants to terrestrial plants" in and around White Bear Lake.[309]

221. Even with a rise in lake level, the extensive growth of large trees is not a passing phenomenon. Although a slow process, as the water rises and ultimately kills the trees, whether they tip over or simply remain upright, the sheer amount of the increasing biomass that accumulates in this shallow bay will fill it in. Without an extensive effort to physically remove that plant material, what was once lake now will become land.[310]

222. The impacts in the west bay are the most detrimental in terms of ecological harm. As the shallower bays shrink in size, they will not be able to support the same amounts of aquatic plants and fish.[311]

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[304] Ex. 2036, pp. 1-2.
[305] Ex. 500, 501, 502; March 14, Funke, pp. 18-19; March 15, Moeckel, pp. 22-23; March 24, Jennings, p. 31.
[306] Exs. 500, 501, 502.
[307] March 14, Funke, p. 21.
[308] March 24, Jennings, pp. 30-33;
[309] March 16, Moeckel, p. 52.
[310] March 14, Funke, pp. 21-22.
[311] March 21, Sather, pp. 32-33; March 14, Funke, pp. 157-158.

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222. The invasion and growth of these terrestrial plants that push out and destroy aquatic plants is a clearly visible negative impact, not only to the aquatic plant community, but to the fish and other organisms that rely on the plants.[312]

223. The loss of water will directly harm the aquatic plants and will indirectly harm water quality by compromising it with increased growth of algae. As the algae increases, the depth into which sunlight can penetrate will be increasingly diminished,[313]and the area in which the plants can grow will be diminished as well.

6. Sustained Low Water Levels and Loss of Littoral Area Will Have a Material Adverse Impact on the Fish Communities in White Bear Lake.

224. Under sustained low water levels, the lake loses both surface area and volume, a significant part of which is in the littoral zone.[314] Lack of water clarity will further diminish the size of the littoral zone.[315]

225. The importance of the littoral zone cannot be underestimated. Most fish spawn there and spend much of their time in its aquatic vegetation, which provides both food and shelter for them. The zone fosters plant matter and insects that live in the aquatic plant communities, thus providing food for fish and other invertebrates. To maintain an abundant fish population in White Bear Lake, it is necessary to have high quality aquatic plant habitat.[316]

226. It is undisputed that a smaller littoral zone will support a smaller fish population. When the lake declines to 922 feet, its littoral zone begins to shrink. At 920 feet, the west bay loses 19% of its surface area and 37% of its volume. At 918.8 feet (the historic low), it loses 30 % of its surface and 49% of its total volume. Should the decline increase an additional foot, to a level of 917.8 feet, the northern part of the west bay is completely

312 Ex. 2036; March 14, Funke, pp.16, 22-23.
313 March 14, Funke, p. 10.
314 Ex. 506; Finding 188, *supra.*
315 March 24, Jennings, p. 24.
316 March 24, Jennings, pp. 16-23.

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exposed and the littoral zone gone.[317]

227. A loss of three feet significantly reduces the size of the habitat that fish need for food, shelter, spawning, nesting, and reproduction.[318] Dr. Funke likened this reduction to clear-cutting a portion of a forest, and found it to have a negative impact to the fisheries of the lake.[319] Dr. Jennings agreed that losing half of the littoral zone is a negative impact[320] to White Bear Lake. [321]

228. As with other natural phenomena, when it comes to fish populations, there is a time lag between the initial impact to a natural resource (here, a reduction in water level) and a detectable response to that impact.[322]

229. Dr. Jennings testified that one would not see an immediate drop in the fish population following a reduction in the size of the littoral zone and reduced fish habitat. Rather, because the littoral zone has decreased in size, one might temporarily see an increase in the concentration of fish because they are more consolidated.[323]

230. As Dr. Jennings testified, this lake is dynamic. It has been fluctuating for thousands of years, and the animal and plant life of the lake has adapted to those changes, be they light, temperature or water level changes. In a dynamic system like this, those changes aren't necessarily adverse.[324] However, Dr. Jennings' opinion is based on the premise that the water level of White Bear Lake will return to previous levels and that there would be no net loss of the littoral zone other than on a temporary basis.

231. Dr. Jennings' opinion relies heavily on a review of past DNR fish surveys (which by his own admission are "not real precise"),[325] and on limited fisheries data. There is no

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[317] Ex, 508; March 14, Funke, p. 38,

[318] March 14, Funke, pp. 24-25; March 24, Jennings, pp. 23-24.

[319] March 14, Funke, p. 25.

[320] The term "negative impact" applies to both quantitative and qualitative aspects.

[321] March 24, Jennings, p. 26.

[322] *Id.*

[323] *Id.*

[324] Id., p. 18.

[325] *Id.,* p. 13.

such data reflecting the impact that the lake's low levels had on fish populations from the Dust Bowl era (1920s-1930s). In fact, the earliest survey of this lake was performed in 1954. The DNR performs thorough surveys of biotic integrity and the fish community only every ten years; the last such survey was done in 2008.[326]

232. Dr. Jennings assumed that the historical pattern of lake fluctuations would continue, and admitted that he had not considered the impact of future dry periods or future drops in the lake levels. Consequently, he did not render an expert opinion as to whether these would negatively impact fisheries or aquatic plants in the future.[327]

233. While not opining as to the cause of the declines in lake level, Dr. Jennings testified that if the cause were "human conduct", rather than natural variation, that would constitute a negative impact to the lake.[328]

7. Minimizing the Degree of Cumulative, Adverse Impact that Our Conduct Has on Our Natural Resources.

234. Dr. Funke opined that in too many cases, resource managers fail to appreciate the *cumulative impact* that humans have on natural resources, and that is the case here with the DNR. That failure leads to inaction, which then magnifies the ultimate impact on the natural resource in question.

235. As an example of this failure to foresee the cumulative impact, Dr. Funke discussed the problem of storm water management in different parts of the state. There, responding to the volume of runoff caused by increasing amounts of impervious surfaces that had replaced ground that had previously soaked up the rainwater, the "solution" was the creation of a storm water infrastructure that routed all the water downstream to lakes and rivers. The cumulative effect of this was to pollute many of those lakes and streams,

[326] *Id.*, pp. 14-15; p. 28.
[327] *Id.,* p. 34.
[328] *Id.,* p. 26.

thus necessitating an about-face that required the disconnection of pipe systems and a return to the concept of allowing the water to be absorbed directly into the ground.[329]

236. Dr. Funke opined that the recognition of human impacts on groundwater resources and connected surface water bodies is long overdue. Because White Bear Lake is so vulnerable, it is "one of the first places that we should start, and we should start acting now". It may not be possible to fix everything at once, to execute a "perfect" all-encompassing plan, but you start "where problems are noticed first and where there's opportunity", picking off a larger problem in "small chunks." That is how surface water is, and should be, managed in Minnesota.[330] She noted that although heavy precipitation has increased the lake levels, that should not alter the management strategy. Even in the "good" times, natural resource managers must manage for the "bad."[331]

B. It Is Undisputed that Low Water Levels Have Had a Material Adverse Impact on White Bear Lake's Accessibility and Recreational Uses.

237. It is undisputed that low water levels have had a material adverse impact on White Bear Lake's accessibility and recreational use. The DNR admits that that there is "substantial evidence" that existing residential uses of this lake have "been affected by the low water" levels.[332] The Met Council observes that it is clear that these low levels have both a "recreational" and "economic" impact.[333] The USGS notes that low water levels have created limited access and recreational use of the lake, affecting boating, fishing, and swimming.[334]

238. These negative recreational impacts on the lake led to the DNR's establishing a

[329] March 14, Funke, pp. 47-53.
[330] *Id.,* pp. 53-54.
[331] *Id.,* p. 160.
[332] March 28, Naramore, p. 35.
[333] March 7, Elhassan, p. 54.
[334] Ex. 293, p. 14.

protected elevation[335] of 922 feet.[336]

239. The DNR admitted that the following are negative impacts to the lake resulting from lowered water levels:

A. The inability of the public to access the lake in the way they did when it was higher;[337]

B. The inability of the public to fish, as they had formerly, from docks or beaches rendered unusable;[338]

C. The difficulties experienced by people with disabilities in accessing the lake;[339]

D. The closure of the Ramsey County Beach.[340]

240. Material Adverse Impacts to White Bear Lake caused by excessive pumping from the Aquifer:

A. Diminished Boat Access and Navigability

1. The DNR acknowledges that it is a negative impact to the lake if people cannot access it in the way they used to when the lake was higher.

2. Because of several years of low water levels, boat access to the lake was dramatically diminished, to the point that launching a boat became extremely difficult, if not impossible.[341]

3. The Ramsey County Beach, at which there is a boat launch, was so affected by the lake level that the launch environs had to be dredged just to

[335] A protected elevation is the water level of the basin necessary to maintain fish and wildlife habitat, existing uses of the surface of the basin by the public and riparian landowners, and other values which must be preserved in the public interest. (Minn. Rules, part 6115.0630, subp. 13.)
[336] Ex. 302, p. 17; March 9, Ekman, pp. 135-136.
[337] March 15, Moeckel, p. 31.
[338] *Id.,* p. 18, 31; March 8, Putzier, p. 52.
[339] *Id.*
[340] March 15, Moeckel, p. 31; March 8, Putzier, p. 51.
[341] Ex. 552; March 13, McNeely; March 8, McGoldrick; March 6, Whitaker and Markoe.

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allow for the minimal depth needed to launch boats.[342]

4. Commercial Park, on the southwest shore, is the only privately owned launch ("the working man's marina"). 95% of its users do not live on White Bear Lake. Before the lowered lake levels, the marina had four docks, each with a length of 320 feet and a depth of between 5-7 feet at their ends. A minimal depth of 20 inches is necessary to sell a slip at this marina.

5. Exhibit 555 shows the slips left vacant at the marina: the depth of water was insufficient to float a boat. The first boat in the photo is moored at the point the dock previously ended. The launch was so severely affected by the lowered level that its owner, Brian McGoldrick, obtained a hardship variance to extend the length of his docks to 450 feet so that boaters would have the minimal 3 ½ feet water depth for navigation.

6. In the years following 2008, the marina lost 70% of its business because of the water level diminution. While water level has improved since 2012, at the time of trial, the number of boat slips had decreased by approximately 50%.

7. At nearby Lions Park, previously a favorite fishing hole for youngsters, the area is now knee-deep in muck, similar to quicksand, completely overgrown with bulrushes and cattails. The area has become particularly dangerous for kids. Boats have not launched there for the last five years. It is impossible—and dangerous because of the "quicksand"—

[342] March 6, Whitaker.

to fish or launch canoes.[343]

8. Even the DNR employees have commented on the difficulty of launching watercraft from the diminished levels. Bradford Parsons, a fisheries research scientist, testified regarding various surveys taken of the lake over the years. Describing his July, 2012 attempts to launch from the northwest side of the lake and navigate, he observed that "[e]ntrance to north end of basin is shallow and contains boulders, making passage thrilling!"[344]

9. Even as the lake has risen above 922 feet, access at the marinas remains compromised because of the extensive growth of aquatic vegetation during the extended period that White Bear Lake was very low.[345]

10. The lowered waters have given rise to a "menagerie of problems" for boats, not just in accessing the lake, but also navigating it. Among them, damage from mats of milfoil, limited navigability because of sand bars and islands previously beneath the waters.[346]

B. Compromised Lake for Shore or Dock Fishing at Low Lake Levels

1. Low lake levels make it difficult, and sometimes impossible, to access the shore for fishing or other activities. The shoreline has receded so far that many docks are totally out of the water.[347] Lake visitors and

[343] March 8, McGoldrick.
[344] Ex. 2033, p. 2; March 24, Parsons.
[345] March 15, Moeckel, p. 22.
[346] March 13, McNeely; March 8, McGoldrick.
[347] Ex. 159, p. 14; Ex. 287, p. 3; Ex. 509; Ex. 510; Ex. 348, pp. 17, 19; Ex. 545.

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residents, boats such as pontoons, cannot access the shore from the water.[348] The areas where sailboats formerly moored on the edge of the lake are now "high and dry" after the lake receded. [349]

2. Docks (in addition to those of Mr. McGoldrick) have been extended as far out as 450 feet from land to access navigable water. Neighbors have banded together to extend their docks out as much as 450 feet to access navigable water. The DNR's own photographs depict jerry-rigged dock systems extending out hundreds of feet to reach open water in the lake.[350]

3. The DNR admits that having to extend a dock out hundreds of feet is a negative impact.[351]

4. Lake level declines have left very few places where the public can fish from piers or from the shore. Large stones from which youngsters previously fished in Lions Park are no longer accessible to them. In fact, the area is not only unusable, it is unsafe.[352] Because of the difficulty of accessibility, fewer people are coming to the lake to fish.

5. The DNR admits that it is a negative impact to the lake when people cannot fish because of docks rendered unusable by the lowering of the lake.[353]

C. The Closing of Ramsey County Beach

1. A regional draw for people in the east metro, and the largest beach on the lake, this beach closed in 2009[354] after the lake level had fallen to

[348] March 6, Whitaker, Marcoe.
[349] March 10, Grubb, p. 124.
[350] March 16, Moeckel, p. 50; Ex. 2078, p. 50.
[351] March 9, Putzier, p. 28.
[352] March 8, McGoldrick; March 6, Markoe.
[353] March 15, Moeckel, pp. 18, 31; March 8, Putzier, p. 52.
[354] The beach reopened June 10, 2017 because of an increase in the water level of the lake.

922 feet. At that point, the lake had receded so far that where once there was a lengthy, shallow slope, now there was a dangerous drop-off just beyond the waterline. Deeming it too dangerous to keep the beach open, Ramsey County closed it.

2. Ramsey County Beach, the only public county beach on the lake, is unique. The largest beach on the lake, with the most parking and accessibility, it is the primary beach visited by beachgoers who do not live on the lake. While there are other beaches that remained open during the diminution of the lake, they are smaller, neighborhood beaches with very limited parking and cannot support the crowds that Ramsey County Beach did.

3. It is undisputed that the closure of this beach is a negative impact to the lake.[355] Exhibit 509 reflects a comparison of water levels at the beach at the lake's average level and in August 2013. Dr. Funke, who took this photo, explained its significance: in the upper photo can be seen the previous swimming beach, at this point disconnected from the water by the flora which had filled in the previous lakebed. The red line shows the approximate location of the historic shoreline. Ex. 545, an aerial photograph taken in October, 2013, graphically shows the size of the area, previously part of the lake, that was exposed lakebed in 2013.

4. Because Ramsey County Beach has been closed and unused for so long, plants have grown, making the beach even more inaccessible.[356]

IX. Groundwater Pumping Has Had, and Likely Will Have, a Material Adverse Impact on the Prairie du Chien-Jordan Aquifer.

[355] March 15, Moeckel, p. 31; March 8, Putzier, p. 51; March 14, Funke, p. 42.
[356] March 15, Moeckel, pp. 20, 22; March 21, Sather, pp. 11, 34.

241. In its 2013 report, the USGS studied the levels in the Prairie du Chien-Jordan Aquifer, concluding that although it has observed "short periods of rising water levels," in general, "the water levels in . . . the glacial aquifers and the Prairie du Chien-Jordan Aquifer have declined".[357] The areas with the greatest decline in water level were those under the influence of pumping from municipal wells, evidencing the stress that groundwater pumping has on the aquifer.[358]

242. The long-term trend for the Prairie du Chien-Jordan Aquifer clearly reflects that it is declining because of the increased reliance on groundwater.[359] In 2013, the Met Council found that "in some areas, groundwater levels have declined as much as 40 feet – roughly one foot each year", and concluded that "our current approach to water supply is not sustainable" because "aquifers are being depleted".[360]

243. The DNR reported in January 2016 that despite the fact that Minnesota has been experiencing a relatively wet period that started in the 1990s, measured groundwater levels in the aquifer are showing declines in more locations.[361]

244. As wells pump groundwater, a cone of depression develops around the well. The dynamic created is similar to what happens when drinking through a straw in a thick milkshake. The significance of the cone of depression is that it can lower the water level not just in the well, but also in the area around it. When there are many high capacity groundwater wells pumping, each lowers the water table around it for some distance away from the well itself. The net result is a cumulative impact on the water table.[362]

245. Assessing the impact of pumping on the aquifer requires an analysis of long-term

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[357] Ex. 12A, p. 41; March 10, Grubb, pp. 25-26.
[358] Ex. 12A, p. 51; March 10, Grubb, pp. 35-36.
[359] Ex. 19, pp. 4, 10; Exs. 801, 803; March 7, Elhassan, p. 31; March 10, Grubb, pp. 25-26.
[360] Ex. 19, p. 4.
[361] Ex. 359, p. 16.
[362] March 10, Grubb, pp. 26-28.

pumping trends and history. Groundwater pumping causes a significant seasonal drawdown in the aquifer. For example, in March, April and August of 2011, the DNR measured the groundwater levels in the White Bear area. While the aquifer level was high (as it usually is) in the spring, by August there had been a significant decrease (ten feet) in the water levels, particularly in the area to the south and southwest of White Bear Lake.[363]

246. The Met Council has predicted that if municipalities continue to rely on groundwater and to pump at the current rates, there will be significant aquifer decline by 2030, a mere 13 years from today. The water drawdown in the aquifers was already problematic in 2012, and these issues "will only continue into the future if we don't change course".[364]

247. In 2016, as part of its groundwater model, the USGS modeled the impact to the aquifer from changes in groundwater pumping. If pumping increases by 30%, the most significant drops in the water level of the aquifer occur in the areas that have the greatest number of wells and in the area around White Bear Lake.[365]

248. Referring to the DNR's trigger of a 75% drawdown in the aquifer before it would take any action regarding pumping, Mr. Grubb opined that given the stresses described above and the significant, adverse consequences that occur long before that level is reached, that protection should be implemented long before that trigger is reached.[366]

249. In Mr. Grubb's expert opinion, the lowering of the aquifer through human-induced conduct (i.e. pumping) is a "negative effect" on a natural resource.[367]

X. The DNR Did Not Manage Permitting Responsibly In Light of Its

363 Ex. 12A, p. 51; March 13, Grubb, pp. 84-84; March 10, Grubb, p. 35.
364 Ex. 348, pp. 24-25.
365 Ex. 294A, Fig. 16.
366 March 10, Grubb, p. 36.
367 March 10, Grubb, p. 58, pp. 119-120.

Knowledge.

A. The DNR is the Sole Responsible Authority for Managing Groundwater Appropriation Permits and Controlling Pumping.

250. Minn. Stat. § 103G.255, *et seq.* authorizes the DNR to issue, modify, or amend permits for groundwater appropriations.[368] By statute, the DNR is the sole entity authorized to manage groundwater appropriations and control groundwater pumping through its permitting process.[369]

251. The DNR has authorized the pumping of all the groundwater withdrawn from the Prairie du Chien-Jordan Aquifer pursuant to the issuance of groundwater appropriation permits.[370]

252. In order to pump more than a million gallons a year (10,000 gallons a day) from the aquifer, a DNR-issued permit is required. This permit is required for all municipal wells as well as those of the St. Paul Regional Water Authority.[371] These permits are permissive only and do not provide the permittee with an unlimited right to water.[372] They may be reviewed, modified, conditioned or terminated at any time.[373]

253. Since protecting natural resources is in the public interest, the permits themselves expressly state they are permissive only, and that "the commissioner may restrict, suspend, amend, or cancel this permit in accordance with the applicable laws and rules for any cause for the protection of public interests or in violation of the provisions of this permit."[374]

254. Under its broad authority with respect to permitting, the DNR has the power to:

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[368] Fact Stipulation ¶ 14.
[369] March 8, Putzier, pp. 40-41; March 15, Moeckel, p. 5.
[370] March 15, Moeckel, p. 6.
[371] March 9, Grubb, p. 37; March 8, Putzier, p. 42.
[372] March 16, Moeckel, p. 12. See also Ex. 227, p. 155, Amended Water Appropriation Permit for the City of White Bear Lake.
[373] *Id.;* Ex. 227, p. 156; Ex. 3122, p. 2.
[374] Ex. 3107, p. 2; Ex. 3122, p. 2.

A. Restrict total appropriation amounts in each groundwater appropriation permit;[375]

B. Issue permits with specific conditions on groundwater use to monitor whether the conditions are being followed, and to ensure that the permittee meets the conditions of its permit;[376]

C. Institute mandatory water conservation restrictions in its groundwater appropriation permits.[377] The permits themselves require conservation methods and practices. See, for example, Ex. 227, p. 156.[378]

D. Restrict or ban irrigation in the permits.[379]

255. As part of its permitting authority, the DNR has the responsibility to review the amount of groundwater withdrawals and to take action as needed when groundwater appropriations are affecting a "vulnerable resource" like White Bear Lake. [380]

256. Cities must follow the terms and conditions the DNR imposes on the groundwater appropriations permits.[381] Representatives from the City of White Bear Lake, the City of Shoreview, and White Bear Township testified that if the DNR amended their permits to impose conditions, they would follow those terms and conditions.

B. The DNR Did Not Consider the Cumulative Impact of Its Permitting Decisions, and Has Not Re-opened, Amended, or Right-Sized Municipal Permits.

257. As early as 1998, if not before, the DNR knew that the water appropriation

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375 March 9, Putzier, p. 48; March 7, Elhassan, pp. 38-39.
376 March 9, Ekman, pp. 102-103.
377 March 15, Moeckel, pp. 3-4; March 9, Ekman, pp. 19-22.
378 This permit, as similar permits, has specific requirements regarding the use of public water supplies by the permittee, which shall "employ water conservation methods and practices that promote **sound water management, including, but not limited to reuse and recycling of water, conservation rate structures**, water saving devices, water scheduling, and public education." In addition: "**Public water suppliers serving more than 1,000 people must employ water use demand reduction measures before requesting approval…to construct new public water supply wells, or requesting an increase in the authorized appropriation volume from the [DNR]. Demand reduction measures must include evaluation of conservation rate structures…"**(Emphasis supplied.)
379 March 15, Moeckel, p. 4.
380 *Id.,* p. 5.
381 March 8, Putzier, pp. 46-47.

permits it was issuing could have serious effects on groundwater levels and on White Bear Lake.[382]

258. As early as 2005, based on work done by the Met Council, the DNR had information available to consider the cumulative impact of water use by communities in the northeast metro.[383] In 2010, Met Council released a model and water plan that gave the DNR specific guidelines about how to account for cumulative and regional impacts in its permitting process. [384]

259. The DNR has acknowledged that groundwater appropriation permits *should* be reviewed on a cumulative basis because *each* high capacity groundwater well affects the other wells around it.[385] Despite this knowledge, in 2013 it admitted that it *had not been* considering regional or cumulative impact when reviewing permit requests. Instead, it had been using the "water appropriation permitting process on a *case-by-case* basis" because this had "*worked in the past* ***before the growth of groundwater use in the metro*** and other 'pinch points' around the state".[386] (Emphasis supplied.)

260. Historically, when a permittee wanted a permit increase, the request would be compared with *that community's* projections in its water supply plan, and as long as it was consistent, the request would be granted. In evaluating the request, the DNR did not consider water supply plans of other municipalities.[387]

261. When seeking a new well, communities would simply ask the DNR for a permit for one, and the DNR would grant it. Cities did not need to confer with the DNR before drilling the new well. To the contrary, they "have generally made independent water system investments and have conducted autonomous resource evaluations [on

[382] Ex. 2.
[383] March 7, Elhassan, pp. 70-71.
[384] Ex. 36.
[385] March 8, Putzier, pp. 35-36; March 15, Moeckel, p. 13.
[386] Ex. 39, p. 7; March 8, Putzier, pp. 34-36.
[387] March 9, Ekman, p. 82.

groundwater use] without interjurisdictional cooperation and with little consideration for the regional implications of their decisions".[388]

262. The DNR's groundwater appropriation permits are "evergreen": They have no expiration date and essentially continue into "perpetuity".[389] For example, the City of White Bear Lake's permit was issued in 1969, and the "expiration date" on the permit simply says "long-term appropriation."[390] Similarly, one of White Bear Township's permits dates back to 1984 and has no expiration date.[391]

263. When seeking a groundwater appropriation permit, communities calculate the total amount they want based on the highest pumping day of the year. In fact, the permitted amount under these evergreen permits is so large that under the existing municipal groundwater appropriation permits, cities could actually *increase* their water use by 25% from 2010 use without any approval from the DNR. For those cities which have reduced their groundwater use since 2010, they have even more room to grow without consultation or authorization from the DNR.[392]

264. As of March 2017, the DNR had not:

A. Amended a single municipal groundwater permit to take into account cumulative impact.

B. Right-sized any municipal groundwater appropriation permits (although it did so for St. Paul Regional Water Services).

C. Told any municipalities that their use of water for lawn irrigation in the summer months would be restricted or otherwise put irrigation restrictions in a

[388] Ex. 32, p. 13; March 7, Elhassan, p. 111.
[389] March 9, Ekman, pp. 83-85.
[390] Ex. 3008.
[391] Ex. 3106.
[392] March 8, Elhassan, pp.10-12.

permit.[393]

265. Even while acknowledging that there is a serious problem with the overuse of groundwater, the DNR has continued to permit excessive groundwater pumping from the aquifer. This practice is not sustainable. It has a negative effect on these natural resources, and is an unreasonable and irresponsible approach to managing groundwater appropriations.[394]

C. The DNR Has Not Followed the Surface Water Rules and Regulations in Minn. Stat. §103G.285.

266. Despite the fact that they are dynamically linked, traditionally surface water and groundwater were managed as separate systems.[395] Where they are connected—as with White Bear Lake—they should be managed "as one resource" because impacting one source "will impact the other".[396]

267. Before its amendment in 2013, M.S. § 103G.287 required precisely that, i.e., that the DNR follow the statutes for surface water appropriations in M. S. § 103G.285 if groundwater appropriations had a "potential impact" on connected surface water bodies. Yet, despite its knowledge of 1) the strong hydraulic connection between White Bear Lake and the groundwater in the aquifers and 2) the impact to the lake from groundwater pumping since 1998, the DNR did not follow the surface water rules.[397]

268. Rather than adjusting its groundwater management practices to fit the requirements of the then-existing statute (M.S. § 103G.287), instead, during the pendency of this lawsuit, the DNR persuaded the legislature to change the language of M.S. §103G.287 Subd. 2. Where previously the language of that subdivision provided that:

"Groundwater appropriations that will have *potential impact* to

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[393] March 9, Putzier, pp 46-47; March
[394] March 10, Grubb, pp. 119-122.
[395] Ex. 32, p. 54.
[396] March 7, Elhassan, pp. 66-67.
[397] Ex. 2.

surface waters are subject to applicable provisions in section 103G.285",

now that language was changed to read that:

> "Groundwater appropriations that will have a *negative impact* to surface waters are subject to applicable provisions in section 103G.285."[398]

269. Groundwater appropriations are having and will have a "negative impact" on White Bear Lake.[399]

270. M.S. § 103G.285 (Surface Water Appropriations) applies to White Bear Lake, and the DNR is required to follow the statute in implementing a protected elevation "below which an appropriation is not allowed". [400]

271. Subdivision 3 of that statute provides that:

> (a) Permits to appropriate water from water basins must be limited so that the collective annual withdrawals do not exceed a total volume of water amounting to one-half acre-foot per acre of water basin…;
>
> (b) As a condition of a surface water appropriation permit, the commissioner shall set a protective elevation for the water basin below which an appropriation is not allowed. During the determination of the protective elevation, the commissioner shall consider:
>
> (1) The elevation of important aquatic vegetation characteristics related to fish and wildlife habitat;
>
> (2) Existing uses of the water basin by the public and riparian landowners; and
>
> (3) The total volume within the water basin and the slope of the littoral zone.

[398] March 15, Moeckel, p. 17.
[399] Section X, *supra.*
[400] March 8, Putzier, pp. 75-76; March 28, Naramore, p. 15.

272. Despite the statute, DNR did not set a protected elevation for the lake. It was only as a result of interim negotiations related to settlement of this case that a protected elevation was set.[401]

273. M.S. § 103G.285, subd. 3 (*supra)* provides a framework for lake thresholds, allowing the DNR to approve the removal of up to six inches of water from a lake. In some cases, however, a "six inch threshold may be too much water for some lakes," and it must perform "an independent analysis on a lake by lake basis" to determine the appropriate threshold for that individual lake.[402]

D. The DNR Is Required by Statute to Ensure a Sustainable Water Supply; Admits Groundwater Is at Serious Risk of Overuse, but Has Not Acted.

274. The DNR is required to plan for and regulate groundwater use now and in the future.[403] Its role is to regulate use "through appropriation permits" to ensure sustainability.[404] As steward of these natural resources, the DNR must "not only be responsive to current problems, but also anticipate patterns and trends that point to sustainability problems . . . in the future". [405]

275. When establishing limits to protect a natural resource and when managing permits, the DNR must consider the sustainability of the resource, including current and projected water levels, water quality, protecting natural resources (like lakes and aquifers), and ensure that the needs of future generations will be met.[406]

276. "Unsustainable water use can take a variety of forms," including "declining heads

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[401] March 9, Ekman, p. 118.
[402] Ex. 359, p. 24; March 16, Moeckel, pp. 6-7.
[403] Ex. 32, p. 71; Ex. 358, p. 2; March 7, Elhassan, pp. 112-113; March 9, Putzier, pp. 23-24; March 15, Moeckel, pp. 16-17; 29-31.
[404] Ex. 2022, p. 2.
[405] Ex. 39, p. 7; March 8, Putzier, p. 47.
[406] Ex. 39, p.7; Ex. 432, p. 21; March 8, Putzier, p. 36; March 9, Ekman, p. 115.

in aquifers" or "impacts to surface waters such as lakes, wetlands, and streams".[407]

277. Increased reliance on groundwater use in the northeast metro, combined with the DNR's present practice of continuing to issue out-sized permits to groundwater users, is not sustainable.[408] This is particularly true when seen through the prism of expected population growth and demand in that area.

E. The Met Council Gave the DNR Tools for Managing Groundwater on a Cumulative Basis. The DNR Did not Implement the Recommendations.

278. The Met Council prepared a 2010 Master Water Supply Plan that provides a framework for a sustainable water supply. The goal of the plan was to provide information to communities, and to the DNR, so they could consider the cumulative and regional impacts of their individual water supply and use decisions. It addressed concerns about the impact of groundwater withdrawals on surface water resources, and underscored the fact that in the case of connected lakes, as here, the lowering of the water table through groundwater withdrawals winds up lowering the levels of these lakes. In view of that phenomenon, it emphasized the importance of viewing surface water and groundwater as a single system in the area around White Bear Lake because they are dynamically linked. [409]

279. In addition to providing information on cumulative regional impacts, the Master Water Supply Plan gave the DNR guidance for managing and reviewing groundwater appropriations to diminish pumping impacts on surface water features. In conjunction with the DNR, the Met Council outlined sample triggers and sample actions to take when a surface water body is impacted by pumping. Some of those sample actions included reducing pumping rates, adjusting the pumping schedule, and planning for alternative

[407] Ex. 39, p.7.
[408] Ex. 19, p. 4; Ex. 358, p. 2; March 7, Elhassan, pp. 30-31; 173-174; March 15, Moeckel, p. 30; March 8, Putzier, p. 120; March 27, Naramore, p. 5.
[409] Ex. 32, pp .6, 54, 71; March 7, Elhassan, pp. 109-112.

water supply sources.[410]

280. To date, none of those measures have been taken.[411]

281. The plan also emphasized the importance of determining a sustainable amount of groundwater that can be pumped from the aquifers without harming surface water bodies, and of setting resource protection thresholds for connected surface waters like White Bear Lake.[412]

282. To date, no such thresholds have been set for White Bear Lake.[413]

F. The DNR Established a Northeast Groundwater Management Area to Address Sustainability, But Has Not Followed Its Own Plan.

283. In 2010, the legislature authorized the DNR to establish groundwater management areas for purposes of addressing issues of groundwater sustainability. The legislation gave the DNR responsibility to "limit total annual water appropriations and uses within a designated area to ensure sustainable use of groundwater that protects ecosystems, water quality, and the ability of future generations to meet their own needs".[414]

284. In 2013, the DNR finally made the decision to establish a Groundwater Management Area in the Northeast Metro ("NEGWMA") because it was concerned with the declining lake levels of White Bear Lake, and believed that groundwater in the northeast metro was at "serious risk of overuse".[415]

285. As the first groundwater management area established in the state, the NEGWMA plan was designed to help restore water levels in White Bear Lake, which is described as a

[410] Ex. 32, pp. 71, 91, 356-357; March 7, Elhassan, pp.113-119.

[411] March 9, Putzier, p. 47.
[412] Ex. 320, p. 45; Ex. 32, p. 91; March 7, Elhassan, pp. 122-123.
[413] March 7, Elhassan, p. 123.
[414] March 8, Putzier, pp. 33-34.
[415] Ex. 11; March 8, Putzier, pp. 24-27; March 15, Moeckel, pp. 24-25.

surface water "connected to and affected by groundwater levels".[416]

286. DNR Commissioner Landwehr acknowledged this relationship in his June 10, 2013, letter to the White Bear Lake Conservation District in which he announced the creation of the Northeast Groundwater Management Area:

> “Given the importance of White Bear Lake to the surrounding community and the state of Minnesota and the complex issues and relationships, my staff and I believe a groundwater management area makes sense as part of a comprehensive solution to help restore water levels in White Bear Lake.” [417]

287. The entire area designated as the NEGWMA is hydrogeologically related, meaning that the entire designated area affects the Prairie du Chien-Jordan Aquifer, as well as the levels in the lake, because of their hydraulic connection.[418]

288. The first technical meeting of NEGWMA took place July 18, 2013. Paul Putzier was the lead contact from the DNR.[419] Starting at its earliest meetings in 2013 and continuing forward, members questioned whether, as the legislation contemplated, a groundwater allocation limit should be set to protect the lake.[420] In February 2015, discussing the NEGWMA and the forthcoming plan, the DNR publically recognized “locally pressing problems,” including the low levels in White Bear Lake, and the need to address these issues to avoid “even more serious problems in the future”. [421]

289. The official plan for the NEGWMA, released in November 2015, is a five-year plan for the DNR to follow to achieve sustainable water use in the northeast metro, to

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[416] Ex. 11; Ex. 306; March 8, Putzier, p. 24.
[417] Ex. 11.
[418] March 15, Moeckel, p. 25.
[419] Ex. 11.
[420] March 8, Putzier, p. 60.
[421] Ex. 358, p. 2.; March 15, Moeckel, pp. 29-30.

protect and restore White Bear Lake, and to improve the DNR's permitting process.[422] In it, the DNR echoed Met Council's language: "Warning signs are becoming evident. Business as usual is no longer an option" in the northeast metro area.[423]

290. Before NEGWMA, the DNR had not been accounting for the cumulative effects of groundwater use. Now, for the first time, the DNR was to account for those cumulative effects to help manage water resources over the long term.[424] This new aspect of the groundwater management tool allowed the DNR to "take into account cumulative impacts from multiple appropriations" and even "establish limits to total annual appropriations within a management area".[425]

291. The Plan:

A. Calls for imposing more restrictive conservation measures and right-sizing permits.[426]

B. Identifies a "process to understand the wells", but does not actually recommend specific changes to existing permits.[427]

C. Sets a number of deadlines for the DNR to follow for implementing it.[428] For example, by the end of 2016, the DNR was required to set sustainability thresholds for White Bear Lake and the Prairie du Chien-Jordan Aquifer, and amend permits to reflect the thresholds, if needed.[429]

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[422] Ex. 306; March 8, Putzier, p. 36; March 9, Putzier, pp. 38, 42.
[423] Ex. 306, p. 9; March 7, Elhassan, p. 75.
[424] March 15, Moeckel, p. 27; March 9, Putzier, p. 18; Ex. 39, p.7- 8; Ex. 357.
[425] March 8, Putzier, pp. 40-41; Ex. 39, p. 7.
[426] March 9, Putzier, pp. 42-44.
[427] Ex. 306, p. 12; March 9, Putzier, pp. 40-41.
[428] Ex. 306, pp. 81-93.
[429] Ex. 306, pp. 83, 91; March 9, Putzier, p. 52.

292. As of March, 2017, the DNR had not:

A. Amended a single municipal groundwater permit.[430]

B. Right-sized any municipal groundwater appropriation permits.[431]

C. Told any municipalities that their use of water for lawn irrigation in the summer months would be restricted or otherwise put irrigation restrictions in a permit.[432]

D. Set a sustainability threshold for White Bear Lake.[433]

E. Identified a maximum threshold for the amount of water that can be removed from the Prairie du Chien-Jordan Aquifer that would maintain the surface water level of White Bear Lake.[434]

F. Set a sustainability threshold anywhere in the northeast metro area.[435]

G. Set a diversion limit for the Prairie du Chien-Jordan Aquifer.[436]

H. Set a recharge threshold for the Prairie du Chien-Jordan Aquifer – or for any aquifer, for that matter.[437]

G. The DNR Attempts to Control Met Council's Message to the Governor.

293. From at least September of 2014, there were major areas of disagreement between

[430] March 9, Putzier, p. 47.
[431] March 16, Putzier. There is no citation to any transcript page for this date, because no transcript was ordered. This information comes from the court's trial notes.
[432] March 9, Putzier, p. 46.
[433] March 16, Moeckel, p. 4.
[434] March 27, Naramore, p. 13; March 9, Putzier, p. 25.
[435] March 9, Putzier, p. 52.
[436] March 28, Naramore, p. 13.
[437] March 9, Putzier, p. 25; March 9, Ekman, pp. 115-116.

the DNR and the Met Council regarding water sustainability and the focus on issues at White Bear Lake. The DNR's Jason Moeckel expressed frustration on a number of fronts:

A. Stating that the "message is not nuanced at all",[438] he took issue with a Met Council presentation slide photo showing a person mowing exposed lakebed on White Bear Lake and entitled "Visible Impacts" of groundwater use.

B. Stating that the Met Council made it difficult for the DNR to work with it because of the failure to incorporate the DNR's feedback.[439]

294. In October, 2016, the Governor's office sent Assistant Commissioner Barbara Naramore a copy of the Met Council's summary to the Governor regarding the results of the USGS' 2016 groundwater study (Chapter A). In that summary, the Met Council described White Bear Lake as "extremely vulnerable" to water level fluctuation and decline, and reported that of the 40 wells analyzed, 31 of them showed that water being pumped was a mixture of surface water and groundwater.

295. On receipt of this summary, the DNR was concerned because of the focus on White Bear Lake.[440] It wanted the Met Council to make more "general" statements, and chafed at the Met Council's use of the word "vulnerable," because it implied that groundwater use was a "causative factor" in White Bear Lake's decline.[441]

296. On October 20, 2016, Mr. Moeckel sent an e-mail to Ms. Naramore, selecting *one* sentence from the USGS Chapter A Report that he wanted her to send to the Governor. That sentence read: "Closed-basin lake-level changes were not correlated with the mean groundwater withdrawals within their watershed or within a two-mile buffer around the lake."[442] This sentence does not relate specifically to White Bear Lake: it was taken out of

[438] Ex. 373.
[439] March 16, Moeckel, pp. 14-15.
[440] Ex. 379.
[441] *Id.,*; March 16, Moeckel, p. 31.
[442] Ex. 293, p. 60; March 16, Moeckel, p. 33.

context. The full quote should read:

> "Other studies have determined that groundwater withdrawals can deplete surface water resources (citation omitted), but groundwater withdrawals do not seem to be the most significant factor in explaining lake-level changes *across the northeast Twin Cities Metropolitan Area.* Closed-basin lake-level changes were not correlated with mean groundwater withdrawals within their watershed…or within a 2-mi. buffer around the lakes……The statistical analysis in this report addresses a *different set of questions at a much broader scale than [the 2013 study of White Bear Lake] and is not well-suited to draw detailed conclusions about the effects of groundwater withdrawals on specific lakes.* [The 2013 study of White Bear Lake] addressed factors varying through time near White Bear Lake that could explain the lake-level decline from 2003 to 2010. *The present analysis addresses factors varying spatially that could explain lake level changes across the northeast Twin Cities Metropolitan Area…"*[443]

297. Under extensive cross-examination at trial, Mr. Moeckel admitted that he failed to provide the Governor with context for his cherry-picked sentence from the USGS report, and that he had not informed the Governor of the USGS'conclusions that White Bear Lake was indeed "vulnerable" to groundwater pumping.[444]

298. At trial, Mr. Moeckel admitted that groundwater use is, in fact, a causative factor in the decline of the level of White Bear Lake.[445] That is another piece of information he failed to give the Governor.

[443] Ex. 293, p. 60.
[444] March 16, Moeckel, p. 39.
[445] March 16, Moeckel, p. 31.

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H. The DNR Sets a Protected Elevation of 922 Feet—but Admits It Has No Plans to Enforce It.

299. In the November, 2015 NEGWMA Plan, the DNR set a number of objectives to be met, among them that groundwater use not harm aquifers and ecosystems, and have no negative impact on surface waters. It specifically stated that:

> "The DNR will set a protective elevation for White Bear Lake using the considerations listed in M.S. 103G.285, Subd. 3…"[446]

300. More than a year after defining the setting of a protected elevation as an objective in the NEGWMA Plan, the DNR set that protected elevation December 21, 2016.[447]

301. Were it not for this lawsuit, DNR would not have set a protected elevation for White Bear Lake at all.[448]

302. It is because of this lawsuit, and *only* as a condition of the settlement agreement, the DNR finally set a protected elevation of 922 feet for White Bear Lake.[449] The purpose of a protected elevation is to protect surface waters such as this.[450]

303. M. S. § 103G.285, Subd. 3, requires that the DNR cease water appropriations once the water basin falls below the protected elevation. This language is mandatory, not discretionary.[451]

304. White Bear Lake's lake levels are between 923 to 925 feet "most of the time."[452] Its level is at or below 922 feet 27% of the time and at or below 921 feet 10% of the

[446] Ex. 306, p. 72.
[447] Ex. 302.
[448] *Id.,* p. 3-4, Findings 10-15.
[449] *Id.,* p. 42.
[450] March 27, Naramore, p. 13.
[451] March 28, Naramore, p. 15.
[452] Ex. 145, p. 1; March 8, Putzier, pp. 107-108.

time.[453]

305. The DNR held no public hearing or public meetings before setting the protected elevation. No one outside of the DNR reviewed the DNR's protected elevation findings.[454] Instead, a small group of individuals from the DNR met and recommended the protected level to DNR Commissioner Landwehr. Jason Moeckel, Julie Ekman, Luke Skinner, Barbara Naramore, Dave Wright and Commissoner Landwehr were in the meeting(s).[455]

306. The group who recommended a protected elevation of 922 to the Commissioner did not inform him that the "normal" range for White Bear Lake was 923 to 925 feet.[456]

307. This protective elevation for White Bear Lake is supposed to represent "the elevation goal [the DNR aims] to maintain, while accounting for permitted water appropriation activity".[457] However, in setting the protected elevation for the lake, the DNR did not analyze the impacts to it from permitted groundwater appropriations.[458]

308. Nor did the DNR consider the volume and changes in volume in the lake when setting the protected elevation.[459]

309. In the process of setting the protected elevation for the lake, Ms. Naramore never asked anyone at the DNR whether the impact groundwater pumping was having on the lake was "negative". According to her, the question "was not particularly germane."[460]

310. Both the Ramsey County Commissioners and the White Bear Lake Conservation

[453] March 9, Ekman, p. 135.
[454] March 16, Moeckel, pp. 42-43.
[455] March 9, Ekman, pp. 119-124.
[456] Ex. 145, p. 1; March 9, Ekman, pp. 127-128.
[457] March 16, Moeckel, pp. 7-8; Ex. 359, p. 25.
[458] March 16, Moeckel, pp. 7-8.
[459] March 16, Moeckel, p. 48.
[460] March 28, Naramore, pp. 23-24.

District sent letters to the DNR requesting a protected elevation of 924 or 924.5 feet.[461] In its letter, Ramsey County informed the DNR that the Ramsey Count Beach will remain closed as long as White Bear Lake is below 923.26 feet, but that a protected elevation of *at least* 924 would provide a "safe public beach".[462] None of this was included in the DNR's presentation to the Commissioner. In fact, the DNR employees told the Commissioner that the Ramsey County Beach closed at *921 feet*.[463]

311. The DNR did not adopt recommendations from other stakeholders in setting the protected elevation of 922 feet for White Bear Lake.[464]

312. At this point, the protected elevation is a meaningless document.

A. The DNR has "not developed [an] implementation plan" for the protected elevation and has no "contingency plan" should the lake approach 922 feet.[465]

B. In fact, the DNR has *no plans* to enforce the protected elevation, and should White Bear Lake fall to 922 feet, "nothing will happen".[466]

C. The DNR has not set any sort of "trigger" to implement changes before the protected elevation is actually reached.

313. It is undisputed that in order to protect White Bear Lake, groundwater appropriations may need to be restricted *before* the protected elevation of 922 feet is reached.[467]

314. Ms. Naramore similarly testified that the DNR would seek to take action before

[461] March 16, Moeckel, p. 43; Ex. 415; Ex. 297.
[462] Ex. 297.
[463] Ex. 2027, p. 2; March 9, Ekman, p. 132.
[464] *Id.*
[465] March 28, Naramore, p. 16.
[466] March 16, Moeckel, p. 44.
[467] March 16, Moeckel, p. 47; March 8, Putzier, p. 67.

the lake reached 922 feet (since the DNR is legally required to stop water appropriations if the lake hit its protected elevation). However, the DNR has not determined *when* it would act or *what* it would do.[468]

315. Mr. Grubb testified that the DNR "cannot wait" until White Bear Lake falls to 922 feet to take action to protect it for it is impossible to curtail water use that quickly, and people depend on water use. Instead, it is critical that the DNR implement a trigger elevation before 922 at which it starts taking action, so that if the lake does reach its protective elevation, all corrective actions are not taken at once.[469]

316. The DNR has considered including in groundwater appropriation permits a "trigger for action" by communities around the lake. One idea under consideration is a multi-year watering ban, the purpose of which would be to restrict the removal of groundwater and thus increase the lake level of White Bear Lake.[470] The DNR can also prohibit increased use of groundwater,[471] and has admitted that in implementing the protected elevation, it must "consider the cumulative impact on White Bear Lake from all groundwater users."[472]

317. To date, the DNR has not amended any permits to include a trigger for action or impose irrigation restrictions.[473]

XI. "Business as Usual is not an Option": The DNR has Several Feasible Alternatives within its Power to Remedy the Harm to White Bear Lake.

318. There are a number of feasible alternatives to the DNR's practice of continuing to grant high capacity groundwater pumping permits at current rates.[474] Many of these, for

[468] March 28, Naramore, p. 38.
[469] March 10, Grubb, p. 130.
[470] March 16, Moeckel, pp. 44-45.
[471] March 27, Naramore, p. 24.
[472] March 16, Moeckel, p. 47.
[473] March 28, Naramore, p. 16.
[474] March 10, Grubb

example, amending of permits, cost nothing. Others are limited by economic considerations.

A. Amend Permits to Require 30% Less Groundwater Use by requiring conservation and banning Non-Essential Water Use in the Summer.

319. One feasible solution is for the DNR to amend permits to require that municipalities within at least 5 miles of White Bear Lake reduce water use by at least 30% over 2016 use by a date certain.[475] This can be accomplished in several ways.

320. The DNR has the power and authority to impose conditions on municipal groundwater permits, including a cap on total use or more specific mandatory conservation measures.[476] Exhibit 3122, a 2005 permit issued by the DNR to the Township of White Bear Lake, exemplifies the conditions under which such a permit is issued. Among them:

A. "The Commissioner may restrict, suspend, amend or cancel this permit in accordance with applicable laws and rules for any cause for the protection of public interests, or for violation of the provisions of this permit."

B. "The permittee shall, whenever practical and feasible, employ water conservation methods and practices that promote sound water management, including but not limited to the reuse and recycling of water, water saving devices, water scheduling and public education."

C. "Public water suppliers serving more than 1,000 people must employ water use demand reduction measures before requesting approval…to construct new public water supply wells, or requesting an increase in the authorized appropriation volume from the [DNR]. Demand

[475] March 10, Grubb, p. 129; March 13, Grubb, p. 82.
[476] March 21, Reed, pp. 96-97.

reduction measures must include evaluation of conservation rate structures and may include a toilet and showerhead retrofit program."[477]

321. A 30% reduction in groundwater use would cause White Bear Lake to rise about 1.5 feet and would temper impacts from future growth.[478] Dr. Tonkin agreed that if the communities around the lake reduced their "actual use" of groundwater, the lake would rise. To have an impact on the water level in this lake, actual groundwater *use* must be reduced, not just the permitted amount, since not everyone pumps their total appropriation.[479]

322. It is undisputed that a 30% reduction in use could be achieved primarily through cutting *nonessentia*l water use, for example, via a summer irrigation ban for cities in the northeast metro.[480] Residential irrigation (lawn watering) is a non-essential water use.[481]

323. The Met Council calculates that on average, summer lawn irrigation in the Twin Cities metro area accounts for **23%** of **annual** water use.

324. Most of the water in the metro area is used during the summer months.[482] Ms. Ekman, from the DNR, calculated that by implementing an irrigation ban, the DNR could reduce use by as much as **25 to 40%.[483]** The DNR admits there is "significant opportunity" to reduce water use by targeting summer water use,[484] and that "we need to find ways to reduce this dramatic increase [in water use] in the summer."[485]

325. Water use and conservation in the White Bear Lake area:

A. City of White Bear Lake:

1. Ellen Richter, present City Manager for the City of White Bear Lake,

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477 Ex. 3122, p. 2.
478 March 10, Grubb, p. 122.
479 March 22, Tonkin, pp. 146-147.
480 Ex. 283, p. 22; March 10, Grubb, p. 129; March 21, Sather, p. 23; March 7, Elhassan, p. 40.
481 March 28, Naramore, p. 12; March 9, Ekman, p. 105; March 8, Putzier, p. 64; March 10, Grubb, p. 124.
482 March 8, Putzier, pp. 63-64.
483 Ex. 283, p. 22; March 10, Grubb, p. 134.
484 March 27, Naramore, p. 9.
485 Ex. 283, p. 18.

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testified that:

a. The city is fully developed: 45% residential, 10% commercial/industrial and 45% parks, railroads and public lands. Its population is approximately 24,000.

b. It has encouraged, but not required, certain conservation measures such as the use of rain barrels, a water efficiency grant, and rebate program.

c. It has an ordinance limiting watering between 10:00 a.m. and 6:00 p.m.

d. It has implemented new water rate changes designed to target residential irrigation in the summer months.

e. Of the irrigation systems in the city, *only 6* have irrigation controls on them. Such controls prevent the systems from watering when it is raining or when the soil is already soaked.

f. Ex. 3013, p. 43, shows the highest volume of residential water users from April 1 to November 18, 2016: 26 properties consume 1/16 of the city's water: more than 50 million gallons of water during that period of time.

g. Even with a fee for this litigation that has been added to water bills, the city's water rates are still significantly lower than other cities.

h. Approximately 5.5 million gallons of water per year have been saved under its water efficiency program.

2. Mark Burch, City Engineer and Public Works Director for the City of White Bear Lake, testified that:

a. Despite record rains in 2016, there was an increased use of municipal water during that time.

b. Some of the high volume residential users are apartments, and that a large part of their consumption is because of irrigation.

3. Mark Sather, retired city manager for the City of White Bear Lake, discussed the realities of running a municipal water utility:

a. He agreed with the Met Council and the DNR that a 20-30% reduction in overall water use is achievable by curtailing irrigation, which is considered "low hanging fruit".[486]

b. Mr. Sather admitted that in supplying water to city consumers, the city never put a cap on water consumption because they always have met the demand, and never have exceeded their allocation from the DNR.

c. In terms of pricing, he admitted that the residential water rates for the city are the lowest of thirteen cities in the NEGWMA.

d. Ex. 328, p. 14, reflects the annual residential water bills for each of these communities. Six of them show bills of more than $200 per year; six show bills of more than $110 per year. Alone among them is the City of White Bear Lake: $86.97 per year, approximately $100 less than its neighbor, the Township of White Bear Lake, and 1/3 the charge of North St. Paul.

e. Mr. Sather testified that based on previous, voluntary restriction of water usage, were the Court were to order a decrease of 20%, the city could meet that decrease in consumption.

B. White Bear Township

1. White Bear Township Planner Thomas Riedesel testified that:

   a. The township population is approximately 11,000 and that 98% of the township is developed: 20-23% single family residences; 2% multi-family (1 apartment house of 60 units), 4% commercial; 20% industrial; open spaces: 55%.[487]

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[486] March 21, Sather, p. 23.

[487] The city owns 25 parks and has a conservation easement on the Benson Airport site. Although the preservation of these open spaces is impressive, the court notes that they carry with them a drawback: "Peak municipal water demands are primarily caused by lawn sprinkling, car washing, golf course and park irrigation and other nonessential uses." Ex. 601, p. 51, "Drought of 1988", published by the DNR in 1989.

b. The Township has been a diligent steward of natural resources.

c. Since 2006, there has been a gradual decline in pumping.

d. The installation of water meters in 2009 was one tool that helped it to get a handle on its water usage.

e. Since 2013, its per capita water usage has declined from 81 gallons per day to 76. This number includes industrial use. The Township's goal: 75 gallons per capita.

f. It now has tiered charging (i.e., as consumption increases, so does the per gallon charge).

g. It uses aggressive follow-up for accounts where consumption should be reduced: first letters, then phone calls.

h. Promotion of voluntary use of "smart meters" that show exactly how much water consumers are using for irrigation. (At present, this is used by only a few consumers, but is an eye-opener to those who use it.)

i. Among its other strategies to decrease use are: a restriction on irrigation, replacement of water-guzzling appliances and plumbing.

2. Despite these advances, in December, 2016, the Township applied to the DNR for a new well to be built in 2025. This was taken off the table because it was seen as unnecessary.

3. Township Clerk Bill Short also agreed that implementing an irrigation ban to reduce water use by about 30% would be feasible, and that "something *should be done* with regard to irrigation" in order to restore and preserve White Bea Lake and the aquifers.[488]

4. Representatives from White Bear Township agreed it is "fair" for all municipalities whose groundwater use affects the water level in White Bear Lake to share

[488] March 21, Short, p. 137.

responsibility in restoring the lake's water level and protecting this shared natural resource.[489]

326. Across the board, in every community, summer water use is two to five times winter use, largely due to irrigation.[490] Using the DNR data, Mr. Grubb prepared a compilation of monthly water use data for certain municipalities around White Bear Lake.[491] The analysis shows consistent and large increases in summer water use among the communities:

A. Hugo and Lino Lakes: approximately 40% increase, primarily from irrigation.

B. Lino Lakes, Mahtomedi, North St. Paul, Oakdale, Vadnais Heights, White Bear Lake, and White Bear Township: increases ranging from 19% to 41%.[492]

327. Some of the measures intended to decrease this ballooning of water use in the summer either boomerang or are otherwise ineffective. For example, even/odd watering bans do not reduce water use that much; they simply change the timing of watering and may even encourage *more* water use: People tend to water on their designated day, regardless of whether it is actually needed: a hoarder's mentality.[493] Then, too, often the fines for violating odd/even water bans are not very strict. In White Bear Township, the first violation results in a warning, and each subsequent violation is a $40 fine. There is no gradated fine.[494]

328. This profligate use of summertime irrigation is the major driver of the outsized increase in water consumption in this area. By insatiably guzzling through the straws (wells) inserted into the aquifer, the users have drawn down that resource, and created the increase in pressure in head that then draws down White Bear Lake. Implementing the irrigation ban at a "trigger elevation" of 923.5 feet could prevent the lake from declining

[489] March 21, Riedesel, p. 26; March 21, Short, p. 147.
[490] Ex. 320A; Ex. 3112; March 27, Naramore, pp. 9-12; March 21, Reed, pp. 95-96.
[491] Ex. 577.
[492] Ex. 577; Ex. 597; Ex. 320A; March 10, Grubb, p. 133; March 21, Reed, pp. 93-94.
[493] March 15, Moeckel; March 10, Grubb, pp. 139-140; March 20, Sather, pp. 15-16.
[494] March 21, Short, 143-144.

further and from reaching its protected elevation of 922 feet.[495]

329. A 30% reduction in groundwater use can be achieved using a number of tools in tandem: an irrigation ban, mandatory conservation and efficiency measures. Among these are, for example, use of low-flow toilets and showers, smart meters, and sensor-controlled irrigation systems.[496]

330. If current practices persist, growth is not sustainable for communities that rely 100% on groundwater. However, they can achieve sustainability by reducing the inefficiencies in those practices, particularly as they exist in residential irrigation. Based on the Met Council's modeling, a 20% reduction in non-essential water use would likely provide a sustainable future in the region.[497]

B. Impose Mandatory Conservation Requirements: Voluntary Conservation Is Not Sufficient to Achieve Necessary Reductions.

331. Groundwater use can be reduced through conservation and irrigation restrictions.[498] However, *voluntary* conservation is neither consistent nor sufficient in aiding reduction of non-essential water use. For example, Mr. Sather testified that the citizens of the City of White Bear Lake voluntarily reduced their water use by 20% in response to a water emergency caused by drought. They did so only for a short time: With the passing of dry years and with the return of normal rainfall, they went back to using their previous volume of water. He also testified to the tepid response of the city's citizens to water-efficient technology: to date, the city has installed a mere 6 residential irrigation units, 49 Energy Star certified clothes washers, and 270 low-flow toilets.[499] In short, a mere drop in the bucket in terms of conservation.

332. When it comes to the issue of water use, there is both human and institutional

[495] March 10, Grubb, p. 139.
[496] March 10, Grubb, p. 130; March 7, Elhassan, pp. 168-169.
[497] March 7, Elhassan, pp. 34-39; p. 172.
[498] March 10, Grubb, pp. 20-22; March 7, Elhassan, p. 39; March 21, Sather, p. 23.
[499] Ex. 3014.

resistance to change, and inaction serves to maintain the status quo. Motivated to meet their citizens' water demands, cities aim to provide a steady stream of water, not just for essential uses, but for non-essential uses as well. Chief among these non-essential uses is residential irrigation in order to maintain lush, green lawns. Addressing this non-essential use, especially during dry periods, the DNR expert Solstad agreed that mandatory, as opposed to voluntary, irrigation restrictions and conservation measures may be necessary.[500]

333. With 32 years of experience as city manager for the City of White Bear Lake, Mr. Sather admitted that to ensure compliance with reduced use of water, there must be a consequence for failure to do so. Merely changing water rate structures to increase the price of water does not translate into significant reduction in water use.[501]

334. William Short, Clerk-Treasurer and former town planner from White Bear Township, testified that efforts by the township to encourage its residents to conserve water often fall on deaf ears. For example, the township has encouraged voluntary conservation, but even while implementing conservation measures, groundwater use *increased* by 35 million gallons from 2014 to 2015, and *increased* by another 27 million gallons from 2015 to 2016. **Over two very high rainfall years, groundwater use increased in White Bear Township by nearly 20%.**[502]

335. Mark Maloney, the former Director of Public Works and present City Manager for Shoreview,[503] testified regarding the impressive efforts that city has made in the area of water conservation.[504] Among these are the following:

A. Tiered water rates have been used since the late 1980s.

B. Lawn watering is confined to even/odd days for homes with corresponding

[500] March 27, Solstad, pp. 11-12.
[501] March 21, Sather, p. 24.
[502] March 21, Reed, pp. 111-112.
[503] Shoreview is 7-8 miles west of White Bear Lake.
[504] Ex. 2144.

even/odd addresses.

C. "Unaccounted for" water losses from leaks have dropped from 15% (2006) to 3% (2015).

D. All water meters in the city were replaced in 2009 at a cost of $4 million, funded through the city water utility.

E. Real-time readers of water meters have been installed in 400 volunteer homes, resulting in easier and quicker ability to pinpoint water use and amount.

F. Use of the Water Smart Program, used to track an individual home's use of water and inform the homeowner of the gallons used per day, and to suggest areas in which water may be leaking. Of the 5000 homes in the city, approximately 20% are using it at this time.

G. Use of the Home Water Report (all homes) that gives the owner a "water score" and compares it to other city neighbors.

H. Use of an "excess use rate" for customers. A sharp increase in rate (between $1.50 and $5 per gallon) is imposed for water use in excess of certain amounts.

I. Upgrading sensors and readers of soil moisture in city-owned irrigation systems.[505]

336. Over the last 20 years, despite the addition of 1500 households during that time, water use in Shoreview has been decreasing because of the aggressive enforcement of conservation. The residential consumption per capita has fallen from 82 (2012) to 60 gallons/day. This decrease in consumption has occurred since issuance of the Met Council Master Water Supply Plan (Ex. 320A), which had calculated that based on 2012 statistics, and allowing for population growth, Shoreview's per capita water consumption would

[505] The overwhelming majority of irrigation systems in the cities in NEGWMA, both residential and otherwise, lack sensors. As a consequence, regardless of whether it is raining, regardless of any high moisture content in the soil, these systems continue watering lawns and other green spaces. All of that water (except for cities supplied by surface water) is drawn from the Prairie du Chien-Jordan Aquifer.

grow to 125 gallons per day by 2020.[506]

C. Use the USGS Groundwater Model to Consider Future Permits.

337. The DNR can employ the USGS "state of the art" model to consider future permits and assess the effects they may have on the aquifer. The model incorporates the ability to evaluate the cumulative impacts of multiple, rather than just individual, wells. This is particularly important in the case of White Bear Lake and its environs.[507]

338. Using this model in tandem with other information available to it, the DNR can also determine in which wells pumping should be restricted in order to support the protected elevation.[508]

D. Close Prairie du Chien-Jordan Aquifer to New Wells or Appropriation Increases in Existing Permits.

339. Given the Met Council's growth projections, it is also critical to manage future growth. One way to achieve that would be disallowing appropriation increases from the Prairie du Chien-Jordan Aquifer, effectively closing it for future growth.[509] The ability to do so is within the DNR's power: it has previously closed the Mount Simon-Hinckley Aquifer to any new permits.[510]

340. Based on the Met Council's modeling, reducing water use by 20 to 30%, through an irrigation ban, would make up for projected growth and obviate the need for any new wells or appropriation increases.[511]

E. Require Contingency Planning for an Alternative, Feasible Water Source by a Date Certain.

341. M.S. § 103G.285 requires the DNR to mandate that communities identify and

[506] Ex. 320A, pp. 200-203.
[507] March 10, Grubb, p. 131.
[508] Naramore, p. 37.
[509] March 10, Grubb, p. 130.
[510] March 7, Elhassan, p. 19.
[511] *Id.* ,p. 172.

plan for alternatives to current groundwater use.[512] There are several different feasible alternatives, including use of deeper aquifers, use of surface water, use of a combination of surface and groundwater. There is plenty of water available from both the Mississippi River and from deeper wells, including the Tunnel City-Wonewoc Aquifer.[513]

342. From an engineering standpoint, both surface water conversion and augmentation are feasible alternatives: the systems can be built.[514] The limiting factors are both economic and political. Building the infrastructure for conversion to surface water is expensive. In contrast, directly tapping into an underlying aquifer provides high quality, cheap water.[515] Political bodies "like their economy with their groundwater" and "take pride" in the services they provide without reliance on others.[516]

343. The logistics for conversion to new water systems depend on the particular community.

A. In the case of North St. Paul, for example, connecting to the surface water supplied by the St. Paul Regional Water Authority would be relatively easy and cost approximately $6 million.[517]

B. In the case of a group of communities (Mahtomedi, North St. Paul, Shoreview, Vadnais Heights, White Bear Lake, and White Bear Township) also close to the existing St. Paul Regional Water Authority system, the effort would call for substantially more infrastructure and capital expenditure (approximately $155 million.)[518] Converting these six communities off of groundwater would reduce

[512] Although M.S. § 103G.285 is entitled "Surface water appropriations", its provisions are applicable to situations where groundwater appropriations will have negative impacts to surface waters (M.S. § 103G.287, subd. 2).
[513] March 10, Grubb, p. 138; March 7, Elhassan, p. 22; Ex. 348, p. 20.
[514] March 7, Elhassan, pp. 149-155.
[515] A good example of this is found in the July 28, 2017 Pioneer Press article "Woodbury has the cheapest water in the Metro" by reporter Bob Shaw. In that article, Woodbury's City Engineer boasted that the average water bill for a Woodbury home is "a mere $8.32 per month", that these rates are "remarkably cheaper" than the cities of St. Paul or Maplewood, and that the average residential use is 7,666 gallons a month—the equivalent of 100 bathtubs-full.
[516] March 7, Elhassan, pp. 23; 147-149.
[517] *Id.*, p. 146; Ex. 329-10; Naramore, p. 8.
[518] Ex. 329, p. 11; March 7, Elhassan, p. 150.

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groundwater use by 57% in the initial USGS study area.[519]

344. Hybrid solutions—often referred to as "conjunctive use"— are also feasible. "Conjunctive use" refers to switching some communities from 100% groundwater use to a mix of groundwater and surface water uses. For example, in an effort to preserve the Savage fen – a groundwater-dependent wetland—residents of Savage cut their groundwater pumping from municipal wells by almost 70% by supplementing their water supply with surface water from a nearby quarry. The fen is thriving and groundwater levels are rising because individuals have significantly reduced their reliance on groundwater.[520]

345. In its report, "Feasibility Assessment of Approaches to Water Sustainability in the Northeast Metro,"[521] the Met Council evaluated the cost and implementation considerations of different approaches to water sustainability from the supply side. In addressing conjunctive use, it evaluated switching 49% of communities' water supply to surface water, converting communities entirely to surface water as well as adding more groundwater wells.[522] The three approaches were selected based on their potential to reduce impacts to White Bear Lake from groundwater pumping and to cause the lake level to increase by reducing the strain on groundwater resources. All three approaches are "viable".[523] Alternatively, the Met Council also suggested using a "hybrid" of solutions based on community needs.[524]

346. The DNR itself has considered implementing mandated conjunctive use as a means to reduce reliance on groundwater. To date, no actions have been taken in this direction.[525]

[519] Ex. 329, p. 11.
[520] March 7, Elhassan, pp. 26-27.
[521] Ex. 328.
[522] Ex. 328, p. 9; March 7, Elhassan, p. 139.
[523] March 7, Elhassan pp. 139-146; Ex. 328, p. 9.
[524] Ex. 329, p. 4; March 7, Elhassan, p. 145.
[525] Ex. 2075, p. 19; March 16, Moeckel, pp. 50-51.

XII. Proposed Alternatives that are Neither Feasible nor Effective.

Augmentation of White Bear Lake

347. In past years, the lake was augmented, a costly and inefficient process.

348. Augmentation is unrealistically expensive.

A. Capital costs.

A pumping and filtration facility requires a capital cost ranging from $55 million (for connection with Lake Vadnais) to $67 million (for connection to Sucker Lake). In addition to this, $23-$40 million more would be incurred for either alternative if there were a need for more substantial treatment of phosphorus from the source water.

B. Operating costs.

The estimated annual cost for the first year of operation is $570,000. Annual operations and maintenance costs associated with higher levels of phosphorus reduction would increase to a range of $900,000 to $4.1 million per year.[526]

349. Augmentation is inefficient. Previous records regarding augmentation of this lake show that, because of the lakebed's composition and its relationship to the aquifer, within a half year or less of augmentation most of the water (86%) migrated to the aquifer rather than remaining in the lake.[527]

CONCLUSIONS OF LAW

A. THE PUBLIC TRUST CLAIM OF THE HOMEOWNERS' ASSOCIATION

1. The State of Minnesota owns the lakebed of White Bear Lake and holds it in trust

[526] Ex. 341, p. 8.

[527] Funke, pp. 139-141. See also Ex. 40, p. 1: "White Bear Lake is like a bathtub with holes in it, connected to the underlying Prairie du Chien Aquifer," cautioned Elhassan. "Residents need to understand it would refill more like a sieve in a bed of sand than a sealed bucket."

for the benefit of the public.[528]

2. The waters of White Bear Lake are public waters, held by the state in trust for the benefit of public users.

3. The lakebed of White Bear Lake and its surface water are both public trust assets.[529]

4. The public trust doctrine affords a common law cause of action to protect the riparian and public use rights to the water and lakebed of White Bear Lake.[530]

5. The above Findings establish actual, threatened and potential harm to the public trust assets of White Bear Lake sufficient for the Court to (a) conclude that the DNR has violated the public trust doctrine, and (b) grant equitable relief.

6. As a precautionary measure to ensure long-term sustainability of drinking water supplies, surface water levels and quality, and groundwater, the DNR has the statutory and regulatory powers to:

A. Impose conditions and timelines in water appropriation permits requiring municipal, joint, and regional planning for funding and developing alternative surface water sources for water supplies. To date, it has not done so.

B. Impose conditions and timelines in water appropriation permits requiring municipal permittees to impose and enforce binding law irrigation bans to reduce overall groundwater use when White Bear Lake and groundwater levels are reduced to levels which deprive or reduce the public's use of White Bear Lake.

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[528] This common law doctrine stretches back to the days of ancient Roman law. As it evolved in this country, the state holds title to the asset (here, the lakebed and its surface waters) not in the usual proprietary sense, but rather in its sovereign capacity and as trustee for the benefit of the people. "It is title held in trust for the people of the State that they may enjoy the navigation of the waters, carry on commerce over them, and have liberty of fishing therein freed from the obstruction or interference of private parties." *Illinois Central Railroad Co. v. Illinois,* 146 U.S. 387, 452 (1882).

[529] Summary Judgment Order Memorandum, p. 15.

[530] Summary Judgment Order ¶ 4; Memorandum, p. 16.

C. Impose conditions and timelines in water appropriation permits requiring municipal permittees to reduce their use volumes.

7. Defendant DNR's management of water appropriation permits and of the waters of White Bear Lake has violated its fiduciary duty to protect the public's use rights to the water and lakebed of White Bear Lake.

B. THE MERA CLAIM BROUGHT BY THE WHITE BEAR LAKE RESTORATION ASSOCIATION

8. The legislature's paramount concern in enacting M.S. Chapter 116B was to protect this state's natural resources. Accordingly, the conduct violating these statutory purposes "is very broadly defined—'any conduct which materially adversely affects or is likely to materially adversely affect the environment' is deemed sufficient to trigger the statute."[531]

9. Under M.S. § 116B.01 of the Minnesota Environmental Rights Act ("MERA"),[532]

> "…it is in the public interest to provide an adequate civil remedy to protect air, water, land and other natural resources located within the state from pollution, impairment, or destruction".

To that end, parties such as these Plaintiff associations have been given the right to maintain suits such as this in the district court "against any person, for the protection of the air, water, land or other natural resources located within the state".[533] "Persons" against whom MERA actions may be brought include "…any state, municipality or other governmental or political subdivision or other public agency or instrumentality".[534] The term "pollution, impairment or destruction" is defined as "any conduct…which violates, or is likely to violate, any environmental quality standard…or any conduct

[531] *State by Schaller v. County of Blue Earth,* 563 N.W. 2d. 260, 268 (Minn. 1997).
[532] Minnesota Statutes, Chapter 116B.
[533] M.S. §116B.03, subd. 1.
[534] M.S. § 116B.02, subd. 2.

which materially adversely affects or is likely to materially adversely affect the environment…"[535]

10. The DNR is subject to MERA.

11. Plaintiffs have brought this suit pursuant to M.S. § 116B.03, not M.S. § 116B.10. This Court has previously ruled that Plaintiff stated a claim under the former and was not required to bring a claim under M.S. § 116B.10.[536] That holding is the law of the case.

12. M.S. § 116B.03 provides a defense to a MERA claim if a person is acting "pursuant to" a permit. That defense does not apply here: Plaintiff has not sued persons (here, the municipalities) acting "pursuant to" a permit. Rather, its claims are brought against the DNR which *issues t*he permits.

13. This case does not present a review of a decision or ruling by an administrative agency.

14. MERA provides rights and remedies separate and apart from the administrative process. Case law is clear that courts have jurisdiction over MERA claims regardless of administrative processes or remedies otherwise available.

15. There are two elements to a MERA claim: 1) a protectable natural resource and 2) "pollution, impairment or destruction" of that resource.[537]

16. For the reasons explained below, the Court finds that the DNR's conduct has violated MERA and that Plaintiff is entitled to the relief set forth in the Order for Judgment.

I. The DNR's Conduct has Violated MERA

A. Burdens of Proof

17. M.S. § 116B.04 sets forth the burden of proof each party must bear in an action

[535] M.S. § 116B.02, subd. 5.
[536] Order Denying Motion to Dismiss, p. 6.
[537] *City of Freeborn v. Bryson,* 210 N.W.2d 290, 297 (Minn. 1973).

under MERA.

a. The plaintiff must make a prima facie showing that the defendant's conduct has, or is likely to cause, the pollution, impairment or destruction of a natural resource within the state. To meet this burden, the plaintiff must show 1) the existence of a protectable natural resource, and 2) the pollution, impairment or destruction (or the likelihood of the same) of that resource.

b. The defendant may attempt to rebut the plaintiff's prima facie case with either 1) a showing of contrary evidence, or 2) an affirmative defense. If the latter, the defendant must show that there is no feasible and prudent alternative and that the conduct at issue is consistent with, and reasonably required for, promotion of the public health, safety or welfare in light of the state's paramount concern for the protection of its air, water, land and other resources from pollution, impairment, or destruction. Economic considerations alone are not a defense.

B. MERA's First Element:

White Bear Lake and the Prairie du Chien-Jordan Aquifer are Natural Resources.

18. White Bear Lake and the Prairie du Chien-Jordan Aquifer are natural resources as defined in M.S. § 116B.02, subd. 4, and are subject to the protections afforded by MERA.

C. MERA's Second Element:

White Bear Lake and the Prairie du Chien-Jordan Aquifer Have Been, and Will Likely Be, Impaired by the DNR's Conduct.

19. Under MERA, two forms of conduct qualify as "pollution, impairment, or destruction" of a natural resource: "any conduct…which violates, or is likely to violate, any environmental quality standard…or any conduct which materially adversely affects, or is likely to materially adversely affect, the environment.[538]

[538] M.S. § 116B.02, subd. 5.

20. Conduct that violates the statutory purposes of MERA is broadly defined in *Shaller v. County of Blue Earth.* [539]

21. M.S. § 103G.255, *et seq.* authorizes the DNR to issue, modify or amend permits for groundwater appropriations. By statute, the DNR is the only entity authorized to manage groundwater appropriations and control groundwater pumping through its permitting process.

22. All groundwater withdrawn from the Prairie du Chien-Jordan Aquifer pursuant to groundwater appropriation permits was authorized by the DNR.

23. The DNR-issued groundwater appropriation permits are permissive: they do not provide the permittee a *right* to water.

24. The DNR has the power to review, modify, condition, or terminate groundwater appropriation permits at any time.

25. The DNR's action in issuing and managing groundwater appropriation permits, including a) granting groundwater appropriation permits on a case-by-case basis and b) failing to modify or terminate existing permits without consideration of the impacts of those permits on White Bear Lake and on the Prairie du Chien-Jordan Aquifer from the impacts of groundwater pumping:

A. Qualifies as "conduct" subject to the provisions of MERA.

B. Has impaired White Bear Lake and the Prairie du Chien-Jordan Aquifer.

26. The DNR's permitting of high capacity groundwater wells for groundwater pumping is a direct and material cause of the decline in both White Bear Lake and in the lower levels of the Prairie du Chien-Jordan Aquifer. While precipitation is also a cause of the lake's decline, it is not the sole cause. Rather, it is the combination of lack of

[539] 563 N.W.2d 260, 267 (Minn. 1977).

precipitation and increased groundwater withdrawals that explains the lake's change in lake-level response to precipitation and sustained low levels over the past 10-15 years.

27. Groundwater pumping is the only cause of White Bear Lake's lake levels that is within human control.

1. The DNR's Conduct has Materially Adversely Affected White Bear Lake and the Prairie du Chien-Jordan Aquifer and Will Likely Continue to Do so.

28. In *Shaller v. County of Blue Earth*, the Minnesota Supreme Court established a five-factor test (the *Schaller* factors) to be used as a "flexible guideline" in determining whether conduct materially adversely affects the environment".[540] These include:

1. The "quality and severity of any adverse effects of the proposed action on the natural resources affected".

2. Whether "the natural resources affected are rare, unique, endangered, or have historical significance".

3. Whether "the proposed action will have long-term adverse effects on natural resources, including whether the affected resources are easily replaceable".

4. Whether "the proposed action will have significant consequential effects on other natural resources (for example, whether wildlife will be lost if its habitat is impaired or destroyed)". And

5. Whether "the affected natural resources are significantly increasing or decreasing in number, considering the direct and consequential impact of the proposed action".[541]

29. These five factors are not exclusive and need not all be met to find a material

[540] *Schaller,* 563 N.W. 2d. 260, at 267.
[541] *Id.*

adverse impact to a natural resource. All appropriate factors should be considered based on the unique facts of each case.[542]

a. ***Schaller* Factor One: The Adverse Impacts are Severe**

30. The first *Schaller* factor is the *quality and severity* of any adverse effects of the proposed action on the natural resources affected. This factor measures the adverse effect *qualitatively*, not quantitatively. Because the severity of an impact is relative, it should be measured from the natural resource's baseline condition.[543]

31. The DNR's conduct has caused severe adverse effects to both White Bear Lake and to the Prairie du Chien-Jordan Aquifer.

32. The magnitude of groundwater pumping, as permitted by the DNR, causes White Bear Lake to hit lower lows, and to stay lower for a longer time, than it would naturally. The past permitting practices, combined with the failure to curtail groundwater pumping, caused the lake to experience sustained low water levels for over a decade. These sustained low levels were not part of the lake's natural fluctuation or cycle.

33. The impact to White Bear Lake from groundwater pumping represents a fundamental change in the lake's hydrologic condition that will persist so long as groundwater pumping continues at its current rates. The impact will worsen if groundwater pumping increases. Of course, the lake will continue to rise and fall because of changes in precipitation. However, the volume of allowed groundwater pumping materially exacerbates these natural fluctuations and artificially pushes the lake into a lower fluctuating range.

34. These sustained low water levels caused by excessive groundwater pumping are a qualitative and extreme departure from White Bear Lake's typical hydrologic condition. They constitute a severe and material adverse effect on the lake and its hydrology.

35. The USGS has modeled the impacts to White Bear Lake from groundwater

[542] *Id.*
[543] *Id.*

pumping: the declines are significant and material.

36. At sustained low levels, White Bear Lake loses significant amounts of both volume and surface area, which, in turn, exposes huge tracts of lakebed. These are severe and material adverse impacts to the lake.

37. At these sustained low levels, the water quality of the lake is materially diminished. Although that quality has not dropped so low as to violate EPA or MPCA standards, when the lake's baseline condition is taken into consideration, the observed decline in quality is nonetheless a severe adverse impact to the lake. Conduct violates MERA if it violates a rule or standard *or* if it materially adversely affects a natural resource. The conduct need not cause a rule violation to be actionable under MERA. Here, the decline in the lake's water quality at low water levels constitutes a severe adverse impact to the lake and supports the conclusion that the DNR's conduct has materially adversely affected White Bear Lake.

38. Recreational and community impacts to a natural resource are also relevant under *Schaller*.[544] This may include social, cultural and economic impacts.[545] The declining lake levels have resulted in the depletion and loss of public uses and enjoyment of the lake. It is undisputed that at sustained low levels, recreational uses of White Bear Lake, including boating, swimming, fishing, and simply enjoying the aesthetics of the lake, are severely, adversely affected, if not almost destroyed.

39. During the last two years, the level of the lake has risen to within its historic range because of above-average rainfall. This does not change the fact that the DNR's permitting practices have had severe or material effects on this natural resource. While rain may mask the impact from groundwater pumping, it does not correct or improve the underlying problem: the fundamental change in the lake's hydrology because of excessive groundwater pumping.

[544] *State ex rel. Fort Snelling State Park Ass'n v. Mpls. Park & Rec. Bd.,* 673 N.W. 2d 169, 176 (Minn. App. 2003).
[545] *Id.*

40. The current lake level must be viewed in terms of the new, lower range of the lake. Taken by itself, a specific water level taken at one point in time might suggest that the level is "normal". But where, as here, that level is in the ***top** end* of a ***lower** fluctuating range*, it actually supports the premise that White Bear Lake has been severely, adversely affected by excessive groundwater pumping.

41. Both the USGS' modeling and the Met Council's projected population growth support the likelihood that the adverse impacts to the lake from groundwater pumping will not only continue, but will increase in severity as pumping increases.

42. These projected future impacts to the lake from groundwater pumping are based on data, testimony, and analysis by experts, including the USGS and the Met Council; they are not unduly speculative. As observed by Justice Stringer in his concurring opinion in *Schaller:*

> "I wish to underscore that all environmental impact statements are, by their very nature, predictions of future impact on the environment and are therefore somewhat speculative. We therefore should admit of a high tolerance for the speculative nature of predictions of the impact of proposed conduct on the future of our environment and claims should be dismissed only where…the evidence is insufficient to show even a reasonable basis for concluding that the future harm will come to pass."[546]

43. Plaintiffs have presented strong, credible evidence that even a 1.5-foot decline in the lake's level, attributed by the USGS to the impact of a 30% increase in groundwater pumping, will drastically change the character of the lake and have a severe, adverse impact on its size, levels, recreational uses and water quality, particularly in its shallower bays.

[546] *Schaller,* 563 N.W.2d 260, 270.

44. Groundwater pumping also lowers the level of the Prairie du Chien-Jordan Aquifer. Its level has declined, and will continue to do so, given the projected increased reliance on groundwater use in the northeast metro area. Excessive pumping, caused in large part by residential irrigation, a non-essential use, unnecessarily and seriously depletes this aquifer and constitutes a severe, adverse effect on it.

45. The long-term dependence on groundwater sources in the White Bear Lake and northeast metro areas is not sustainable. White Bear Lake is but one symptom of water supply issues caused by the increasing use, and misuse, of this life-sustaining asset. The continued, imprudent and short-sighted reliance placed on groundwater as the sole source for water demand will have consequences far beyond the diminution of this lake: Current usage combined with predicted population growth carries with it the danger that some communities may not be able to supply water in the future.

46. Excessive groundwater pumping has inflicted, and likely will continue to inflict, a material, adverse impact on both White Bear Lake and the Prairie du Chien Aquifer. The first *Schaller* factor has been met.

b. *Schaller* Factor Two: White Bear Lake and the Prairie de Chien-Jordan Aquifer are Unique Resources.

47. The second applicable *Schaller* factor is "whether the natural resources are *rare, unique, endangered, or have historical significance"*.[547]

48. For more than a century, White Bear Lake has been recognized as a highly valued natural resource. It is the sole, large recreational lake in the northeast metro area. Subjected to the extreme low levels caused by a combination of excessive groundwater pumping and Mother Nature, its existence as a unique, valuable, and historically significant natural resource is endangered.

49. The Prairie du Chien-Jordan Aquifer has existed for thousands of years and has

[547] *Id.,* p. 267.

provided high quality drinking water to Minnesota residents. Given the admitted sustainability issues caused by the heavy demand placed on groundwater, its existence as a valuable, historic resource is also endangered.

50. The excessive groundwater pumping approved by the DNR has inflicted, and likely will continue to inflict, a material adverse impact on both White Bear Lake and on the Prairie du Chien-Jordan Aquifer.

c. *Schaller* Factor Three: There are Long-Term Adverse Effects on White Bear Lake and the Prairie du Chien-Jordan Aquifer.

51. The third applicable *Schaller* factor considers whether "the proposed action will have *long-term adverse effects* on natural resources, including whether the affected resources are easily replaceable".[548]

52. It is a truth, universally acknowledged, that all lakes fluctuate. In the case of this lake, its natural fluctuations have been exacerbated by the continued, and increasing, pumping of groundwater. *Nearly twenty years ago*, the DNR's 1998 study concluded that groundwater pumping has long-term impacts on White Bear Lake. The lower lows, lower highs, and longer rebound time all represent a fundamental change in the lake's hydrologic condition that has developed over time because of the increasing demands placed on it by groundwater pumping. This continued, excessive groundwater pumping, a substantial and increasing part of which is used for a nonessential water use, is a major factor in these sustained low levels. Should it continue at this rate, or, worse yet, increase as the Met Council has projected, these sustained low levels will persist and evolve into "the new normal".

53. Sustained lower levels have a significant ecological impact on the flora and fauna of the lake. The lake is still relatively clean because of its small watershed and lack of a natural inlet. However, as the water has receded, it has left exposed major portions of

[548] *Id.*

lakebed for a significant period of time. This exposure, particularly evident in the west bay, changes the flora from aquatic to terrestrial plants, many of which are of a permanent, rather than transient, nature. Along with that change comes a greater amount of phosphorous that is carried into the lake water. These changes are not easily reversible.

54. The establishment of terrestrial plants and large trees on former lakebed areas is also a step toward loss of public title to the lakebed. Under the legal doctrines of reliction and accretion, title to lakebed can move from public to private ownership if the lakebed becomes permanently dry, populated by terrestrial plants, and there is a gradual addition to the shore either from gradual recession of the waterline or washing ashore of sand, dirt and gravel.[549]

55. Given the undisputed sustainability issues with continued reliance on groundwater and the projected increases in groundwater use in the northeast metro area, the adverse impacts to both the lake and the aquifer from the DNR-authorized groundwater pumping are also projected to continue into the future. This is, and is likely to continue to be, a material adverse impact on both these public assets.

d. *Schaller* Factor Four: Consequential Effects on Other Natural Resources.

56. This factor considers whether "the proposed action will have significant consequential effects on other natural resources (for example, whether wildlife will be lost if its habitat is impaired or destroyed)."[550]

57. Because of the sustained low levels in the lake, its littoral zone shrinks, both in size and volume, particularly when the lake level is below 922 feet. At that point, the lake is unable to support the same amount of submerged and emergent aquatic plants. Even a one-foot decline in lake level in the already shallow zone destroys aquatic plants that cannot survive in exposed lakebed. Fish habitat is squeezed into a substantially smaller

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[549] *See: Webber v. Axtell,* 94 Minn. 375, 102 N.W. 915 (1905) (accretion); *Markuson v. Mortenson,* 105 Minn. 10, 106 N.W. 1021 (1908) (relictions).
[550] *Schaller,* 563 N.W.2d at 267.

universe than it was at the higher levels. Less water and fewer aquatic plants mean less food for fish and other invertebrates. This, in turn, has the effect of lowering the fish population.

58. Diminished water quality in the lake also causes more algae, which then reduces the area where sunlight can penetrate into the water. The consequence is a reduction in the area where aquatic plants can grow and fish can feed.

59. The DNR-approved, excessive groundwater pumping has a material adverse impact on the aquatic plants and fish communities that rely on them, and hence upon the lake itself.

e. *Schaller* Factor Five: The Natural Resources are Decreasing in Number.

60. This factor considers whether "the affected natural resources are significantly increasing or decreasing in number, considering the direct and consequential impact of the proposed action".[551]

61. There are a limited number of high-quality urban lakes and aquifers. White Bear Lake and the Prairie du Chien-Jordan Aquifer are among them. These natural resources are not on the increase: quite the opposite.

62. The DNR-authorized, excessive groundwater pumping depletes the water levels from both the lake and the aquifer, resulting in a material adverse impact on each. Continued at its present level, the pumping will continue to do so.

f. Viewed through the prism of the five *Schaller* factors, the evidence leads to the conclusion that the DNR has violated MERA.

63. Despite its knowledge as early as 1998 that 1) the northeast metro area's 100% reliance on groundwater appropriation was not sustainable long term based on the doubling of groundwater usage since 1980 and regional population growth projections for

[551] *Id.*

the area; 2) that the permits it was issuing could have serious effects on groundwater levels and on White Bear Lake; and 3) despite the guidance given by the 2010 Master Water Supply Plan regarding its groundwater appropriation process that would ameliorate the impacts of pumping on surface waters, the DNR:

A. Continued to issue outsized permits for groundwater appropriation on a case-by-case basis.

B. Failed to review groundwater permits on a cumulative basis and consequently failed to consider the overall impact of these multiple permits on both the lake and the aquifer.

C. Failed to re-open, amend or right-size municipal permits in light of the cumulative effect of high capacity municipal wells on the lake and aquifer.

D. Failed to require alternative source planning in any community as part of their required water plans, and planning for supply alternatives under the DNR appropriation permits.

E. Failed to impose mandatory irrigation bans, despite the facts that:

1) *30%* of the *annual* groundwater use in the northeast metro area is for residential irrigation. This is particularly important: the DNR has estimated that an irrigation ban would lead to a potential reduction of 25-40% in groundwater use in this area.

2) The DNR has the statutory and regulatory authority to impose conditions on all water appropriation permits in this area to reduce the volume of water use through residential irrigation bans tied to low lake levels in White Bear Lake or the underlying aquifers.

F. Imposed only one, solitary reduction in permitted pumping volumes (a recent reduction in the St. Paul Regional Water Supply).

64. The DNR has failed to rebut the Plaintiffs' prima facie case with a showing of contrary evidence.

65. In sum, the DNR has violated MERA by conduct causing the "pollution, impairment, or destruction" of both White Bear Lake and the Prairie du Chien Aquifer.

D. The DNR has Failed to Establish an Affirmative Defense

66. To establish this defense, the DNR must show two things: 1) that there is no "feasible and prudent" alternative, and 2) that its conduct is consistent with and reasonably required for health, safety or welfare, taking into account the state's paramount concern for its natural resources.

67. A feasible alternative is one that "is capable of being done, executed, or effected; possible of realization".[552] Economic considerations, by themselves, are insufficient to establish that there is no feasible alternative.

68. *Archabal v. County of Hennepin*[553] lends guidance in assessing whether the DNR has established an affirmative defense. It builds on earlier case law mandating the paramount protection of natural resources absent truly unusual facts or where "the cost of community disruption from the alternatives reaches an extraordinary magnitude".[554] Defendants have an extremely high standard to meet in establishing an affirmative defense: even where the evidence reveals "strong community interests in competition with MERA's emphasis on preservation of natural resources", when the defense fails to show that there is no feasible and prudent alternative, it has not satisfied its burden of proof.[555]

69. The DNR has not satisfied the extremely high standard of truly unusual or extraordinary factors that would prevent employment of feasible and prudent alternatives.

70. As the sole entity charged with permitting groundwater appropriations, the DNR possesses immense permitting power. Included with this power is a vast array of tools

[552] Webster's Third New International Dictionary (2002).
[553] 495 N.W.2d 416 (1993).
[554] *State by Powderly v. Erickson,* 285 N.W.2d 84, 88 (Minn. 1979).
[555] *Archabal, supra,* 495 N.W.2d at 423.

that can be used for the judicious allocation of this natural resource.

71. The DNR has the power and ability to reduce groundwater use through its permitting process.[556] This includes the power to review, modify, condition, or terminate groundwater permits or to restrict total appropriation amounts in each groundwater appropriation permit. *See* Minn. R. 6115.0610, *et seq.* All of these are feasible alternatives that the DNR could implement.

72. The DNR has the power and ability to 1) issue permits with specific conditions related to groundwater use; 2) institute mandatory water conservation restrictions in its permits; and 3) restrict or ban residential irrigation. All are feasible alternatives that the DNR could implement.

73. Permittees are required by law to follow the terms of their appropriation permits, subject to various administrative rights and remedies.

74. Other feasible options include the ability to close the Prairie du Chien-Jordan Aquifer to new wells, and to require communities to identify and plan for alternatives to groundwater use.

75. Yet another feasible alternative is the employment of the USGS' Steady-State Model to measure the impacts of groundwater withdrawals and to inform future permitting decisions. Although the DNR may prefer a transient groundwater model, that preference does not mean that it is not feasible to use the current Steady-State Model.

76. While Plaintiffs believe that augmentation of White Bear Lake with surface water from other sources is feasible, the Court does not. Augmentation is not only extremely expensive, but has been shown to result in a temporary "fix", with the bulk of the water being transmitted to the aquifer because of the hydraulic connection between the lake and aquifer. Furthermore, introducing outsourced water into this relatively clean lake is an

open invitation to pollutants from such a source. Expensive, short-sighted and risky, this is hardly a feasible alternative.

77. The DNR has failed to meet its burden of showing that there is no feasible alternative to its current permitting practices.

II. The DNR Has Violated MERA by Failing to Follow Environmental Quality Standards.

78. M.S. § 116.04 allows a plaintiff to establish pollution, impairment or destruction of environment through two possible means: 1) by proof that the conduct violates any environmental quality standard, rule or regulation of the state or its political subdivisions; and 2) by proof that the conduct materially, adversely affects, or is likely to affect, the environment. The second of these avenues has already been discussed.

79. M.S. § 116B.02, subd. 5 specifies that "' pollution, impairment or destruction' is any conduct…which violates, or is likely to violate, any environmental quality standard, limitation, [or] rule…"

80. Under the first paragraph of M.S. § 116.04, proof that a rule has been violated is sufficient to establish a MERA violation. Unlike the second paragraph of this statute, the affirmative defense of no feasible alternatives does not apply where the complaint is based on violation of an environmental quality standard or rule.

A. The DNR has Violated, and will likely Violate, M.S. § 103G.211

81. M.S. § 103G.211 provides that:

> "[P]ublic waters may not be drained and a permit authorizing drainage of public waters may not be issued, unless the public waters to be drained are replaced by public waters that will have equal or greater public value."

82. "Drainage" is defined as "any method" for removing or diverting waters from

public water basins, and specifically includes, but is not limited to, "pumping".[557]

83. This statute and rule apply to the DNR and to this case.

84. The DNR violated M.S. § 103G.211 by issuing groundwater appropriation permits for the high capacity groundwater wells that caused the surface water of White Bear Lake to drain into the underlying aquifer and by not replacing the water that it had caused to be drained.

85. Given the history of its permitting and failure to exercise oversight, it likely that the DNR will continue to authorize groundwater pumping under the same circumstances, without replacing the water drained from White Bear Lake. Should it do so, it will continue to violate M.S. § 103G.211.

B. The DNR has Violated, and will likely Violate, M.S. § 103G.287, subd. 5.

86. M.S. § 103G.287, subd. 5 provides that:

> [T]he DNR: "may issue water use permits for appropriation from groundwater only if the commissioner determines that the groundwater use is sustainable to supply the needs of future generations and the proposed use will not harm ecosystems, degrade water, or reduce water levels beyond the reach of the public water supply."

87. The DNR-issued water appropriation permits are subject to cancellation by the DNR "at any time…to protect the public interest".[558]

88. The DNR has the statutory and regulatory power to impose conditions and timelines in water appropriation permits requiring municipal, joint powers, and regional planning for funding and developing alternative water sources for water supplies. It has not done so to date.

[557] Minn. R. 6115.0170, Subp. 8.
[558] M.S. § 103G.315, subd. 11

89. The DNR has violated M.S. § 103G.287, subd. 5 by:

A. Issuing water use permits for appropriation from groundwater without a determination from the commissioner that the groundwater use is sustainable to supply the needs of future generations.

B. Issuing these permits with the knowledge that:

1) Groundwater pumping is harming White Bear Lake and the Prairie du Chien Jordan Aquifer; and

2) Continued reliance on groundwater in the northeast metro at current pumping rates is not sustainable to supply water for future generations.

C. Failing, in light of its knowledge, to reopen groundwater appropriation permits to determine if the current use is sustainable as required by the statute.

90. Should the DNR continue to authorize groundwater pumping from high capacity wells that are in hydraulic connection with White Bear Lake, or should it issue any new permits or increases in existing permits, without having first determined whether they are sustainable, it will violate M.S. § 103G.287, subd. 5. It is undisputed that this pumping is harming ecosystems in the lake and underlying aquifer, and that reliance on groundwater in the northeast metro at current pumping rates is not sustainable to supply water for future generations.

91. The DNR must comply with M.S. § 103G.287, subd. 5 by reopening and reviewing all groundwater appropriation permits to ensure that they are sustainable, and to cap total appropriations, if needed, to ensure sustainability. The DNR is also enjoined from authorizing any increases in groundwater use from the Prairie du Chien-Jordan Aquifer.

C. The DNR has Violated, and Will Likely Violate,

M.S. §§ 103G.287 and .285.

92. M.S. § 103G.287, subd. 2 requires that "groundwater appropriations that will have negative impacts to surface waters are subject to applicable provisions in section 103G.285".

93. Because the statute does not define "negative impact", it is defined by its plain meaning: "negative" means "not desirable" or "lacking positive qualities."

94. The DNR-authorized groundwater appropriations have, and will have, a negative impact on White Bear Lake. Because of this, they are subject to M.S. § 103G.285.[559]

95. M.S. § 103G.285, subd. 3 provides that:

> "(a) Permits to appropriate water from water basins must be limited so that the collective annual withdrawals do not exceed a total volume of water amounting to one-half acre-foot per acre of water basin…; and
>
> (b) As a condition to a surface water appropriation permit, the commissioner shall set a protective elevation for the water basin, below which an appropriation is not allowed…"

96. M.S. § 103G. 285, subd. 6 provides that:

> "An application for use of surface waters of the state is not complete until the applicant submits, as part of the application, a contingency plan that describes the alternatives the applicant will use if further appropriation is restricted due to…the level of a water basin. A surface water appropriation may not be allowed unless the contingency plan is feasible or the permittee agrees to withstand the results of not being able to appropriate water.

97. The DNR has violated M.S. §103G. 287 by:

    A. Failing to set collective annual withdrawal limits for White Bear Lake;

    B. Failing to require permittees to submit a contingency plan should their groundwater appropriation permits be suspended because the lake is

[559] M.S. § 103G.287, subd. 2.

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approaching its protected elevation.

98. While the DNR has set a protected elevation of 922 feet, that action is meaningless and rings hollow:

A. It has not developed an implementation plan for the protected elevation and has no contingency plan should the lake approach 922 feet.

B. It has no plans to enforce the protected elevation.

C. It has not set any sort of "trigger" to implement changes before the protected elevation is reached.

D. It has not determined *when* it would act or *what* it would do.[560]

99. The DNR must comply with M.S. § 103G.285. Specifically, it must:

A. Set collective annual withdrawal limits for White Bear Lake;

B. Require permittees to submit a contingency plan should their groundwater permits need to be suspended because the lake is approaching its protected elevation;

C. Set a meaningful trigger to allow for implementation of action before the protected elevation is reached.

D. Specify precisely how it intends to enforce the protected elevation.

D. The DNR has Violated, and will Likely Violate,

M. Rule 6115.0670

101. Minn. R. 6115.0670, subd. 3(c) (3) states that:

> "[A]ppropriation of groundwater **shall not be approved** *or* **shall be issued on a conditional basis** in those instances **where sufficient hydrologic data are not available** to allow the commissioner to adequately determine the effects of the proposed appropriation."

[560] See Findings 212-214.

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102. In its post-trial brief, the DNR asserts that there is a lack of available science for making a determination of the effect of reductions in permitting on the lake and aquifer. Given the lack of sufficient hydrologic data for adequately determining the effects of appropriations, the DNR has violated Minn. R. 6115.0670, subd. 3(c) (3).

103. It appears to the Court that the various tools described in testimony (among them, the USGS studies) do supply that necessary information. However, if the DNR's assertion is, indeed, the case, then under this rule, it cannot issue groundwater appropriation permits when it does not know the effect of its permitting actions.

III. Application of the Doctrine of Separation of Powers

103 Fundamental to both the state and federal constitutions is the doctrine of the separation of powers, which prohibits one branch of government from impinging on the powers of another branch.[561] The Minnesota legislature delegated the power to administer the use, allocation and control of the waters of the state to the DNR, a department of the executive branch.[562]

A. MERA CLAIMS

104. The City of White Bear Lake asserts that Plaintiffs' request for relief (in which it asked the Court to "mandate a sustainable water supply" (by (a) amending permits and (b) augmentation of the lake) seeks remedies that are beyond the power of the Court, because the discretion to spend money on the general public welfare belongs to the legislature. That position is correct, but only regarding the issue of augmentation. The evidence has shown that augmentation is a risky, expensive, and ineffective approach to restoring surface water to this lake. More to the point, for the Court to order that specific relief would run afoul of the doctrine of the separation of powers. Whether expenditures of public funds are good, bad or indifferent from a policy standpoint is a question for the

[561] Minn. Constitution, Art. III, Sec. 1.
[562] M.S. § 103G.255.

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legislature, not for the Court.[563]

105. Courts must "adhere to the fundamental concept that decisions of administrative agencies enjoy a presumption of correctness, and deference should be shown by courts to the agencies' expertise and their special knowledge in the field of their technical training, education and experience.[564] In *Reserve Mining v. Herbst*, the court endorsed "the need for exercising judicial restraint and for restricting judicial functions to a narrow area of responsibility, lest it substitute its judgment for that of the agency".[565]

106. As reflected in Conclusions of Law II, A, B, C and D, the DNR has violated MERA by failing to follow:

1) M.S. § 103G.211 (the draining of the lake resulting from the excessive pumping of the aquifer);

2) M.S. § 103G. 287, subd. 5 (issuance of permits for pumping without a determination that the amount of use is sustainable, particularly for future generations);

3) M.S. § 103G.287 and .285 (relating to failure to set collective annual withdrawal limits from the lake; failing to require permittees to submit contingency plans for alternate water sources; failure to set a meaningful trigger for implementation of action before the protected elevation is reached); and

4) M. Rule 6115.0670 (approval of groundwater appropriations without sufficient data to determine the effects of the appropriation allowed).

107. These are specific violations of statute by the DNR, and are properly the subject of court action.

B. PUBLIC TRUST CLAIMS

108. Minnesota's Constitution does not delegate protection of the public trust interests

[563] *Minnesota Energy & Econ. Dec. Auth. v. Printy,* 351 N.W.2d 319, 349 (Minn. 1984).
[564] *Reserve Min. Co. v. Herbst,* 256 N.W.2d 808, 824 (Minn. 1977).
[565] *Id.,* at 825.

in waters and lakebeds solely to the legislative and executive branches. The judicial branch has independent authority and jurisdiction to protect public trust interests from legislative or executive branch neglect and damage.

109. *Illinois Central R.R. Co. v. Illinois,*[566] stands for precisely that premise, i.e., that the court can create common law rights of action to protect public trust assets, both from legislative action to alienate the trust assets, and from executive branch trustee abdication of its fiduciary duties to prevent waste.

110. This Court has not been constitutionally deprived of its general common law and equitable jurisdiction to fashion a remedy to protect the public interest from the state's misuse of its sovereignty or neglect of its fiduciary duties regarding public trust assets.

IV. Plaintiffs are Entitled to Declaratory and Injunctive Relief under MERA and the Public Trust Doctrine

111. M.S. § 116B.07 allows the court to "grant declaratory relief, temporary and permanent equitable relief, [or to] impose such conditions upon a party as necessary or appropriate to protect the air, water, land, or other natural resources located within the state from pollution, impairment, or destruction". Irreparable harm is not required for injunctive relief to be granted.

112. The rights and remedies afforded by MERA are in addition to any administrative, regulatory, statutory or common law rights or remedies that may be available.

113. The district court may grant a negative or affirmative injunction.[567]

114. Because the DNR violated MERA, Plaintiffs are entitled to declaratory and injunctive relief as set forth in the Order for Judgment.

115. Similarly, because the DNR violated the Public Trust Doctrine, Plaintiffs are entitled to equitable relief as set forth in the Order for Judgment.

[566] 146 U.S. 387 (1892).

[567] *Swan Lake Area Wildlife Ass'n v. Nicollet Cty. Bd. of Comm'rs,* 799 N.W.2d 619, 626 (Minn. App. 2011).

NOW THEREFORE, IT IS HEREBY ORDERED:

1. The Court declares that the DNR's current and planned permitting of high capacity groundwater appropriations and management of White Bear Lake and the Prairie du Chien-Jordan Aquifer violate:

A. MERA, by impairing both White Bear Lake and the Prairie du Chien Aquifer.

B. The Public Trust Doctrine, by:

1) Causing a continuing decline in the levels of both the Prairie du Chien Jordan Aquifer and of White Bear Lake that diminishes the size of the lake and its lakebed, and adversely impacts public uses of the lake; and

2) Failing to take remedial measures within its authority to protect White Bear Lake and the Prairie du Chien Aquifer, when it had knowledge that its actions in issuing and failing to manage high capacity groundwater pumping permits were adversely affecting the lake and aquifer.

2. The Court declares that by virtue of its violating the following statutes and rules, the DNR has violated MERA:

A. M.S. § 103G.211 (the draining of the lake resulting from the excessive pumping of the aquifer);

B) M.S. § 103G. 287, subd. 5 (issuance of permits for pumping without a determination that the amount of use is sustainable, particularly for future generations);

C) M.S. § 103G.287 and .285 (failing to set collective annual withdrawal limits from the lake; failing to require permittees to submit contingency plans for alternate water sources; failing to set a meaningful trigger for implementation of action before the protected elevation is reached); and

D) M. Rule 6115.0670 (approval of groundwater appropriations without sufficient data to determine the effects of the appropriation allowed).

3. The DNR is prohibited from issuing appropriation permits for new groundwater wells, or increasing appropriation amounts in existing groundwater permits, within a 5-mile radius of White Bear Lake until it has **fully** complied with the requirements of the above statutes. To that end, it shall:

A) Review *all* existing groundwater appropriation permits within a 5-mile radius of White Bear Lake, analyzing them both individually, and cumulatively, to ensure compliance with the sustainability standard of M.S. §103G.287, subd. 5. The review will be completed within one year of the date of this order. The specific results of the analysis will be published in a public newspaper, in a form understandable to the general public.

B) In the event that any of the above permits do not comply with the sustainability standard set by statute, they will be reopened and down-sized within 6 months of failure to comply with the sustainability standard of M.S. § 103G.287, subd. 5.

C) Analyze the cumulative impact of these permits within the 5-mile radius of White Bear Lake to determine whether pumping at the maximum rates allowed by the permits is sustainable. The analysis will be completed within one year of the date of this order. The specific results will be published in a public newspaper, in a form understandable to the public.

4. For groundwater permits within a 5-mile radius of White Bear Lake, the DNR shall comply with all the applicable provisions of M.S. § 103G.285, including:

A) Setting a collective annual withdrawal limit for White Bear Lake;

B) Setting a trigger elevation of 923.5 feet for implementation of the protected elevation;

C) Preparing, enacting and enforcing a residential irrigation ban when the level of White Bear Lake is below 923.5 feet, to continue until the lake has reached an elevation of 924 feet. The preparation and enactment of this process will be completed within 6 months of this order.

D) Requiring that all existing permits include an enforceable plan to phase down *per capita* residential water use to 75 gallons per day and total *per capita* water use to 90 gallons per day. The enactment of this requirement will be completed no later than 1 year from the date of this order.

E) *Immediately* amending *all* permits within the five mile radius of White Bear Lake to require that within one year of the date of this order, permittees submit a contingency plan in their water supply plans for conversion to total or partial supply from surface water sources. This contingency plan will include a schedule for funding design, construction and conversion to surface water supply. The Court notes that while the DNR has previously ignored the mandate of this statute, submission of these water supply conversion plans is required for the issuance of permits. Whether any conversion would occur shall be determined by the DNR and the affected communities.

F) Requiring that all groundwater permittees report annually to the DNR on collaborative efforts with other northeast metro communities to develop plans as described in (D), above.

5. The DNR shall issue no groundwater appropriation permits unless it has sufficient hydrologic data to understand the impact, whether cumulative or otherwise, of those groundwater appropriations on White Bear Lake and the Prairie du Chien-Jordan Aquifer.

6. The DNR shall work with the Metropolitan Council to evaluate current conservation goals and update them as needed.

7. The DNR shall require that water supply plans include measurable conservation goals and shall evaluate compliance with water conservation requirements on all permits

issued within the 5 mile radius of the lake. Should the individual community be out of compliance with those requirements, the DNR shall take appropriate action in down-sizing that community's permit.

6. For each day that the DNR is out of compliance with this Order, it will be subject to a fine of $1000 per day.

7. Costs are awarded Plaintiff and Plaintiff/Intervenor against Defendant DNR.

8. The Court retains jurisdiction over this action to monitor the DNR's compliance with the conditions imposed by this Order.

LET JUDGMENT BE ENTERED ACCORDINGLY.

30 August 2017

BY THE COURT:

Margaret M. Marrinan
Judge of District Court

Memorandum

The last 12 months have been the wettest on record in Minnesota, a record that dates back to 1837. From August, 2016 to July, 2017, 40.72 inches of rain fell in the Twin Cities, well above the 30-year average for annual MSP rainfall of 31 inches (which is 20% wetter than the 1941-1970 rainfall average of 26 inches).[568] The span of time between the start of this trial and the date of this Order runs from March 6, 2017 to August 30, 2017. In that period of time, 24.02 inches of rain fell in the Twin Cities, as

[568] Paul Douglas, Minneapolis Tribune, August 16, 2017.

compared to the annual average rainfall of 19.33 inches.[569] In January, 2017, the level of White Bear Lake was approximately 923 feet; in May, 2017, 923.8 feet; on August 24, 2017, 923.17 feet.[570]

None of this information appears in the body of the Court's Order because most of it occurred after the time of trial. It is included in this Memorandum simply to alert the reader that 1) the Court recognizes the large amounts of rain have fallen in the last several months; 2) the fact that 24 inches of rain has fallen in a 6 month period does not translate to an increase to the lake of that amount—or anything near it; and that 3) the findings of fact remain valid: that in the long term (years, decades) White Bear Lake levels are controlled mainly by groundwater fluctuations, and in the short term (monthly, seasonally) by precipitation and runoff.

30 August 2017 MMM

[569] Weather Underground, August 29, 2017.
[570] Minn. DNR website, August 29, 2017.