Parameters	Min	Max	Additional Information	Effects of Levels Outside Acceptable Range
Biochemical Oxygen Demand (BOD)	20 mg/l	30 mg/l	Although there are no Michigan Water Quality Standards pertaining directly to BOD, effluent limitations for BOD must be restrictive enough to insure that the receiving water will meet Michigan Water Quality Standards for dissolved oxygen. See Rule 62 of the Michigan Water Quality Standards (Part 4 of Act 451)	If elevated levels of BOD lower the concentration of dissolved oxygen in a water body, there is a potential for profound effects on the water body itself, and the resident aquatic life. When BOD levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by the bacteria. Since less dissolved oxygen is available in the water, fish and other aquatic organisms may not survive. When the dissolved oxygen concentration falls below 5 milligrams per liter (mg/l), species intolerant of low oxygen levels become stressed. The lower the oxygen concentration, the greater the stress. Eventually, species sensitive to low dissolved oxygen levels are replaced by species that are more tolerant of adverse conditions, significantly reducing the diversity of aquatic life in a given body of water. If dissolved oxygen levels fall below 2 mg/l for more than even a few hours, fish kills can result. At levels below 1 mg/l, anaerobic bacteria (which live in habitats devoid of oxygen) replace the aerobic bacteria. As the anaerobic bacteria break down organic matter, foul-smelling hydrogen sulfide can be produced
Chlorides	50 mg/l Great Lakes and connecting waters	125 mg/l public water supply source	Chloride is commonly found in streams and wastewater. Chloride may get into surface water from several sources including: • Wastewater from industries and municipalities • Wastewater from water softening • Road salting • Agricultural runoff • Produced water from gas and oil wells	In large concentrations, chlorides cause a brackish, briny taste that definitely is undesirable. Although chlorides are extremely soluble, they possess marked stability. This enables them to resist change and to remain fairly constant in any given water unless the supply is altered by dilution or by industrial or human wastes. High concentrations of chloride ions add to the electrical conductivity of water.
Conductivity	0.5-3 uS/cm distilled water	100-2,000 uS/cm freshwater streams	Freshwater has low conductivity. A sudden increase or decrease in conductivity in a body of water can indicate pollution. Agricultural runoff or a sewage leak will increase conductivity due to the additional chloride, phosphate and nitrate ions. An oil spill or addition of other organic compounds would decrease conductivity as these elements do not break down into ions. In both cases, the additional dissolved solids will have a negative impact on water quality. Conductivity is dependent on water temperature and salinity/TDS.	Fish and other aquatic life that live in fresh water (low-conductivity) are hyperosmotic 15. Hyperosmotic defines a cell's ability to eliminate water and retain ions. Thus these organisms maintain higher internal ionic concentrations than the surrounding water. Altering the conductivity of the environment by increasing or decreasing salt levels will negatively affect the metabolic abilities of the organisms. Even altering the type of ion (such as potassium for sodium) can be detrimental to aquatic life if their biological processes cannot deal with the different ion.
Dissolved Oxygen (DO)	7 mg/l Coldwater fisheries 5 mg/l Warm water	N/A	Rule 64 of the Michigan Water Quality Standards (Part 4 of Act 451) includes minimum concentrations of dissolved oxygen which must be met in surface waters of the state. This rule states that surface waters designated as Coldwater fisheries must meet a minimum dissolved oxygen standard of 7 mg/l, while surface waters protected for warm water fish and aquatic life must meet a minimum dissolved oxygen standard of 5 mg/l.	Prolonged exposure to low dissolved oxygen levels (less than 5 to 6 mg/L oxygen) may not directly kill an organism, but will increase its susceptibility to other environmental stresses. Exposure to less than 30% saturation (less than 2 mg/L oxygen) for one to four days may kill most of the aquatic life in a system.
E. coli	N/A	130 count/100mL monthly avg 300 count/100mL maximum concentration **Total Body Contact Recreation** 1,000 count/100ml **Partial Body Contact**	Rule 62 of the Michigan Water Quality Standards (Part 4 of Act 451) limits the concentration of microorganisms in surface waters of the state and surface water discharges. Waters of the state which are protected for total body contact recreation must meet limits of 130 *Escherichia coli (E. coli)* per 100 milliliters (ml) water as a 30-day geometric mean, and an average of 300 *E. coli* per 100 ml water at any one time. The limit for waters of the state which are protected for partial body contact recreation is 1,000 *E. coli* per 100 ml water.	The most commonly reported symptoms of exposure to *E. coli* are stomach cramps, diarrhea, nausea, vomiting, and low-grade fever. When *E. coli* exceeds the permissible level in recreational water, it results in the closing of beaches, ponds, lakes, and swimming and fishing areas to the public.

Parameters	Min	Max	Additional Information	Effects of Levels Outside Acceptable Range
Fats, Oils and Grease (FOG)	N/A	5 mg/l	Rule 4. Oil storage and on-land facilities shall maintain adequate surveillance of all manufacturing processes, treatment systems, storage areas, and other such areas so that any polluting material loss therefrom can be detected in a timely manner and procedures implemented to prevent any polluting materials from reaching the waters of this state.	Fats, oils, and grease can cause serious problems in sewer systems. From spills to clogged pipes, these contaminants can debilitate any hydrologic system through coagulation within internal piping and over time—cause manhole overflows, sewage spills and backups into public homes and businesses. As these contaminants are poured down the drain, they can clog pipes, restricting the flow of water. As a result, sewer back-ups and overflows occur creating health hazards and harmful impacts on the environment, sometimes even entering stormwater drains flowing into streams or oceans. These contaminants can cause a depletion of oxygen residing within natural waterways causing harm to the aquatic life dependent on the oxygen. In addition to harming aquatic life, Sanitary sewage overflows (SSO's) caused by excess grease build-up can expose wastewater. According to the EPA, hundreds of billions of gallons of untreated sewage flow into waterways, lakes and coastal waters. Unknowingly, many risk exposure of serious illness when this untreated waste seeps into recreational waterways; estimating up to 3.5 million cases of illness caused by SSO's every year (American Rivers). Illnesses can include gastroenteritis– an intestinal infection which can lead to serious side-effects.
Fecal Coliform	N/A	1 colony/100 mL drinking water 200/100ml monthly avg 400/100ml 7 day avg body contact	For infectious organisms which are not addressed by Rule 62, the Department of Environmental Quality has the authority to set limits on a case-by-case basis to assure that designated uses are protected. Bacteria numbers can be effectively reduced by disinfection procedures including chlorination and ozonation. If chlorine is used for disinfection, the treated wastewater must be dechlorinated prior to discharge to protect fish and other aquatic life.	The presence of fecal coliform bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals. At the time this occurred, the source water may have been contaminated by pathogens or disease producing bacteria or viruses which can also exist in fecal material. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis and hepatitis A. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Fecal coliform bacteria may occur in ambient water as a result of the overflow of domestic sewage or nonpoint sources of human and animal waste.
Mercury	N/A	0.0013 ug/L Wildlife Value - see MDEQ page 0.0018 ug/L	**EPA** - Thousands of waterbodies are listed on state Clean Water Act Section 303(d) lists as impaired due to mercury, often due to high mercury levels in fish. Mercury accumulates in fish tissue as methylmercury, the form that presents the greatest risk to human health through consumption of contaminated fish. Many states have issued advisories to limit consumption from certain waters of certain fish due to high levels of mercury. MDEQ page - http://www.michigan.gov/deq/0,4561,7-135-3313_3681_3686_3728-301290--,00.html **Safe Drinking Water Act (SDWA)** Under the SDWA, EPA sets standards for drinking water that apply to public water systems. These standards protect people by limiting levels of mercury and other contaminants in drinking water. Mercury contamination in drinking water can come from many sources, including: Erosion of natural deposits of mercury, Discharges into water from refineries and factories Runoff from landfills and cropland, U.S. states have the primary responsibility for enforcing drinking water standards.	Signs and symptoms of methylmercury poisoning may include: Impairment of peripheral vision, Disturbances in sensations ("pins and needles" feelings), Lack of coordination, Impairment of speech, hearing, and walking, Muscle weakness, Elemental (metallic) mercury primarily causes health effects when it is breathed as a vapor where it can be absorbed through the lungs. Signs and symptoms of acute elemental (metallic) mercury poisoning include: Tremors, Emotional changes, Insomnia, Weakness, Muscle atrophy, Twitching, Headaches, Disturbances in sensations, Changes in nerve responses, Performance deficits on tests of cognitive function. Higher exposures may result in kidney effects, respiratory failure and death.
Nitrates	1 mg/l Nitrite	10 mg/l Nitrate	The U.S. EPA has established and MDEQ has adopted, a Maximum Contaminant level (MCL) for **nitrate** as 10 mg/l and 1.0 mg/l for **nitrite**. If nitrate or nitrite results exceed 5 mg/l or .0 mg/l respectively (50% of MCL), quarterly monitoring is required for nontransient supplies.	Large amounts of nitrate in drinking water can cause serious illness in infants under six months of age. Nitrates in large amounts may bond with hemoglobin in the red blood cells of infants and prevent it from carrying oxygen. This may cause methemoglobinemia or "blue baby syndrome". The acutely poisoned person will have a blue discoloration of the skin due to the reduction of the amount of oxygen in the blood stream.
pH	<6.5	>9	Rule 53 of the Michigan Water Quality Standards (Part 4 of Act 451) states that the hydrogen ion concentration expressed as pH shall be maintained within the range of 6.5 to 9.0 in all waters of the state. Wastewater treatment plants and most industrial facilities which discharge to waters of the state are required to monitor for pH on a frequent basis. Limits are usually 6.5 as a daily minimum and 9.0 as a daily maximum. Limits for pH are not necessary for all permits, such as discharges of clear noncontact cooling water, which are expected to have pH levels between 6.5 and 9.0 without treatment.	Aquatic species can be harmed by water that is above or below range, immature stages are especially vulnerable to pH below 5. Potentially toxic metals are released from organic matter and sediment when too acidic. All fish die at pH below 4.5

Parameters	Min	Max	Additional Information	Effects of Levels Outside Acceptable Range
Polychlorinated biphenyl (PCBs)	N/A	0.00012 ug/L Wildlife Value 0.000026 ug/L Human Cancer Value	The Wildlife Value (WV), 0.12 ng/L, is used to assess whether the wildlife component of the indigenous aquatic life and wildlife designated use is being protected (MDEQ, 2011). The WV is the maximum ambient water concentration of a substance at which adverse effects are not likely to result in population-level impacts to mammalian and avian wildlife populations from lifetime exposure through drinking water, and an aquatic food supply, using the methodology specified in R 323.1057(3) of the Part 4 Rules. The Human Cancer Value (HCV), 0.026 ng/L for PCBs, is used to assess whether the fish consumption designated use is being protected (MDEQ, 2011). The HCV is the maximum ambient water concentration of a substance at which a lifetime of exposure from either drinking the water, consuming fish from the water, or conducting water-related recreation activities will represent a plausible upper bound risk of contracting cancer of 1 in 100,000 using the exposure assumptions and methodology specified in R 323.1057(4) of the Part 4 WQS.	The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs. Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects.
Temperature Change	N/A	Δ2°F Coldwater Δ5°F warm water	Rules 69 through 75 of the Michigan Water Quality Standards (Part 4 of Act 451) specify temperature standards which must be met in the Great Lakes and connecting waters, inland lakes, and rivers, streams and impoundments. The rules state that the Great Lakes and connecting waters and inland lakes shall not receive a heat load which increases the temperature of the receiving water more than 3 degrees Fahrenheit above the existing natural water temperature (after mixing with the receiving water). Rivers, streams and impoundments shall not receive a heat load which increases the temperature of the receiving water more than 2 degrees Fahrenheit for Coldwater fisheries, and 5 degrees Fahrenheit for warmwater fisheries. The Great Lakes and connecting waters shall not receive a heat load which would warm the receiving water at the edge of the mixing zone to temperatures in degrees Fahrenheit higher than the following monthly maximum temperature: **Table 2**	As temperatures increase, Coldwater species, such as trout and stonefly nymphs, may be replaced by warm water species, like carp and dragonfly nymphs. Thermal pollution may also increase the extent to which fish are vulnerable to toxic compounds, parasites, and disease. If temperatures reach extremes of heat or cold, few organisms will survive.
Total Dissolved Solids (TDS)	N/A	500 mg/L monthly avg 750 mg/L at any time	Rule 51. (1) The addition of any dissolved solids shall not exceed concentrations which are or may become injurious to any designated use. Point sources containing dissolved solids in the waters of the state shall be limited through the application of best practicable control technology currently available	Elevated total dissolved solids can result in your water having a bitter or salty taste; result in incrustations, films, or precipitates on fixtures; corrosion of fixtures, and reduced efficiency of water filter and equipment
Total Phosphorus	N/A	1 mg/l monthly average	Rule 60 of the Michigan Water Quality Standards (Part 4 of Act 451) limits phosphorus concentrations in point source discharges to 1 mg/l of total phosphorus as a monthly average. The rule states that other limits may be placed in permits when deemed necessary. The rule also requires that nutrients be limited as necessary to prevent excessive growth of aquatic plants, fungi or bacteria, which could impair designated uses of the surface water.	Phosphate itself does not have adverse health effects. However, phosphate levels greater than 1.0 may interfere with coagulation in water treatment plants. As a result, organic particles that harbor microorganisms may not be completely removed.
Total Suspended Solids (TSS)	40-80 mg/l appearance cloudy	150≤ mg/l appearance dirty	Rule 50 of the Michigan Water Quality Standards (Part 4 of Act 451) states that waters of the state shall not have any of the following unnatural physical properties in quantities which are or may become injurious to any designated use: turbidity, color, oil films, floating solids, foam, settleable solids, suspended solids, and deposits. This kind of rule, which does not establish a numeric level, is known as a "narrative standard." Most people consider water with a TSS concentration less than 20 mg/l to be clear. Water with TSS levels between 40 and 80 mg/l tends to appear cloudy, while water with concentrations over 150 mg/l usually appears dirty. The nature of the particles that comprise the suspended solids may cause these numbers to vary. In addition, the permit writer must also apply treatment technology based effluent limits when appropriate. The U.S. Environmental Protection Agency has promulgated treatment technology based limits for total suspended solids for municipal wastewater treatment plants and many industrial categories. Municipal wastewater treatment plants must provide treatment to meet TSS limits of 30 mg/l as a monthly average and 45 mg/l as a 7-day average. Some industrial categories have treatment technology based concentration limits. Others have production-based loading limits, which are expressed in lbs/day or lbs/year.	High TSS levels decrease a water body's ability to support a diverse system, increases water temperature, decrease DO, destroy fish habitat, smother fish and insect eggs, suffocate newly hatched larvae, clog fish gills, reducing growth rates, and lowering resistance to disease, and may disrupt natural migration patterns.

Parameters	Min	Max	Additional Information	Effects of Levels Outside Acceptable Range
Turbidity	0.3 NTU	1 NTU	Surface water treatment series of rules -the rules applicable to Subpart H supplies as listed in the Authority section of this policy. The turbidity performance requirements applicable to this policy are: The turbidity at the combined filter effluent (CFE) shall at no time exceed: - 1 NTU for conventional, direct, membrane filtration, or softening plants - 5 NTU for slow sand or diatomaceous earth filtration plants Not less than 95 percent of measurements each month shall be less than or equal to - 0.3 NTU for conventional, direct, membrane filtration, or softening plants - 1 NTU for slow sand or diatomaceous earth filtration plant Nephelometric Turbidity Unit (NTU) -standard unit of measurement for turbidity.	High turbidity can significantly reduce the aesthetic quality of lakes and streams, having a harmful impact on recreation and tourism. It can increase the cost of water treatment for drinking and food processing. It can harm fish and other aquatic life by reducing food supplies, degrading spawning beds, and affecting gill function.
Volatile Organic Compounds (VOCs)	0.002 mg/L	10.0 mg/L	**See Table 1.** Many VOCs are carcinogenic ; thus, their presence in groundwater creates a serious problem. VOCs commonly are detected in groundwater in industrial and commercial areas where petroleum fuels and organic solvents are used. A major source is leaking fuel tanks, which contaminate the underlying aquifers with compounds such as benzene, toluene, ethylbenzene, and xylenes (BTEX) and methyl tert-butyl ether (MTBE), an additive used in gasoline to reduce smog-producing vehicular emissions.	Ingestion of these chemicals at certain levels in drinking water may lead to anemia, liver and spleen disorders, reproductive problems and an increased risk of certain cancers. Their presence in drinking water may be linked to possible contamination by these sources and may indicate a poorly constructed or damaged well, a vulnerable aquifer, a contaminated site or a combination of any of these.

Table 1

VOC Contaminant	MCL (mg/L)
Benzene	0.005
Carbon tetrachloride	0.005
Trichloroethylene	0.005
1,1,1-trichloroethane	0.2
Cis-1,2-dichloroethylene	0.07
O-dichlorobenzene	0.6
Tetrachloroethylene	0.005
1,1,2-trichloroethane	0.005
Trans-1,2-dichloroethylene	0.1
Dichloromethane	0.005
Vinyl Chloride	0.002
1,2-dichloroethane	0.005
1,2-dichloroethylene	0.007
Para-dichlorobenzene	0.075
Ethylbenzene	0.7
Styrene	0.1
Toluene	1
Xylenes (total)	10
1,2,4-trichlorobenzene	0.07
1,3-dichloropropane	0.005
Chlorobenzene	0.1

Table 2 - Monthly Temperatures

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lake Michigan north of a line due wast from the city of Pentwater	40	40	40	50	55	70	75	75	75	65	60	45
Lake Michigan south of a line due wast from the city of Pentwater	45	45	45	55	60	70	80	80	80	65	60	50
Inland lakes	45	45	50	60	70	75	80	85	80	70	60	50
Rivers, Streams, and Impoundments	38	38	43	54	65	68	68	68	63	56	48	40

Sources:

DEQ - Part 4. Water Quality Standards
DEQ - Rule 57. Water Quality Values
Water Encyclopedia - Land Use and Water Quality
DEQ - Rule 4.
Fundamentals of Environmental measurements
Water Research Center - TDS and Water Quality
National Secondary Drinking water Regulations
Environmental Assistance Office - Fats, Oils and Grease
EPA - Environmental Laws, Mercury
Evaluation of Drinking Water Quality Goals
Water Research Center - Fecal Coliform Bacteria in Water