Presented below are water quality standards that are in effect for Clean Water Act purposes.

EPA is posting these standards as a convenience to users and has made a reasonable effort to assure their accuracy. Additionally, EPA has made a reasonable effort to identify parts of the standards that are not approved, disapproved, or are otherwise not in effect for Clean Water Act purposes.

SD Department of Environment and Natural Resources

Mixing Zone and Dilution Implementation Procedures

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SOUTH DAKOTA
Mixing Zone and Dilution Implementation Procedures

Introduction

In 1972, Congress passed the federal Clean Water Act (CWA). One of the requirements of the CWA is that each state develop standards for their waters to ensure beneficial uses such as swimming and fishing were protected.

South Dakota has developed surface water quality standards for all waters of the state, as required by the CWA. A water quality standard defines the water quality goals of a water body, or portion of the water body. The water quality standards regulations establish the use or uses to be made of a water body, set criteria necessary to protect the uses, and establish policies to maintain and protect water quality. South Dakota's water quality standards are designed to protect public health and welfare, enhance the quality of water, and uphold the goals of the federal CWA.

The Administrative Rules of South Dakota, Chapters 74:51:01, 74:51:02, and 74:51:03 contain South Dakota's surface water quality standards. Chapter 74:51:01 contains both the numeric and narrative criteria to protect the uses of the state's water bodies. Chapters 74:51:02 and 74:51:03 designate the beneficial uses assigned to each specific water body in the state. South Dakota has developed the following 11 classifications of uses within the state:

(1) Domestic water supply waters;
(2) Coldwater permanent fish life propagation waters;
(3) Coldwater marginal fish life propagation waters;
(4) Warmwater permanent fish life propagation waters;
(5) Warmwater semipermanent fish life propagation waters;
(6) Warmwater marginal fish life propagation waters;
(7) Immersion recreation waters;
(8) Limited-contact recreation waters;
(9) Wildlife propagation and stock watering waters;
(10) Irrigation waters; and
(11) Commerce and industry waters.

In addition to requiring the development of water quality standards, the federal CWA required that the Environmental Protection Agency (EPA) develop a permitting program. This program would ensure that discharges from point sources would protect these beneficial uses. In response, EPA developed the National Pollutant Discharge Elimination System (NPDES). On December 30, 1993, EPA delegated authority for issuing NPDES permits to the state of South Dakota. South Dakota calls this program the Surface Water Discharge Program. Surface Water Discharge permits provide an important tool for implementing South Dakota's water quality standards and upholding the goals of the federal CWA.

In South Dakota, the Department of Environment and Natural Resources is the primary agency charged with implementing the water quality standards and issuing surface water discharge permits. The water quality standards are used to develop permit limits that will protect the beneficial uses assigned to each water body. In developing permit limits, the department considers how the discharge and receiving water mix together to achieve downstream pollutant concentrations. In the past, the department assumed that wastewater is completely mixed with the receiving waters in order to determine the wasteload allocation for pollutants. This approach is appropriate for conventional contaminants where the critical environmental effect is expected to occur far downstream from the discharge. If complete mixing occurs near the discharge point, such as in effluent-dominated streams, then these assumptions are also appropriate. However, in some cases, the effluent does not completely mix with the receiving stream. This could result in a plume of water that violates the water quality standards and potentially impact the use of that water body.

In accordance with the federal CWA and EPA's regulations, South Dakota's water quality standards allow dilution and a zone of mixing for discharges. In accordance with the state's water quality standards, chronic water quality criteria that are otherwise applicable to the water body might not be met within a mixing zone. However, acute water quality criteria must not be exceeded within the mixing zone.

This document has been developed to provide guidance to both the department and the general public in interpreting and implementing the mixing zone procedures. These procedures are simply guidelines, and are not rigid regulations or requirements.

Definitions

To assist the reader and ensure consistent implementation of these procedures, the following definitions are provided.

Critical low flow, see "High-quality fishery waters" and "Low-quality fishery waters."

High-quality fishery waters, surface waters of the state designated for the beneficial use of coldwater permanent fish life propagation, coldwater marginal fish life propagation, or warmwater permanent fish life propagation. The critical low flow for a high-quality fishery is the minimum 7-day average low flow that can be expected to occur once in every 25 years (7Q25).

Low-quality fishery waters, a stream classified for the beneficial use of warmwater semipermanent fish life propagation or warmwater marginal fish life propagation. The critical low flow for a low-quality fishery is the minimum 7-day average low flow that can be expected to occur once in every five years (7Q5) or 1.0 cubic foot per second (cfs), whichever is greater. If one cubic foot per second is greater than the flow expected to occur once every five years (7Q5), the toxic pollutant standards contained in Appendix B of the water quality standards continue to apply to the water to the point where the flow in the stream drops to or below the 7Q5.

Zone of mixing, an area in a stream where an effluent or discharge mixes with the upstream water. A mixing zone is a limited portion of a body of water, where dilution is in progress but has not yet resulted in concentrations that will meet the water quality standards for all pollutants.

Mixing Zones for Streams

As stated above, South Dakota's surface water quality standards allow a zone of mixing for some discharges. ARSD § 74:51:01:25 established the state's mixing zone requirements for discharges to streams:

> **74:51:01:26. Zone of mixing for wastewater discharges to flowing waters.** A zone of mixing is allowed for the discharge of wastewater to a flowing water. Each properly treated wastewater discharge to a flowing water must meet the chronic criteria at the edge of its zone of mixing. Concentrations of substances in the discharge must not cause the acute criterion established for the designated beneficial uses of the receiving water to be exceeded. The water quality criteria set forth in §§ 74:51:01:06, 74:51:01:08, 74:51:01:09, and 74:51:01:10 apply within the zone of mixing.

This rule lays out several important requirements that the state must follow when evaluating a mixing zone. This rule allows a mixing zone for establishing compliance with the chronic criteria. However, it does not allow a mixing zone for the numeric acute criteria. Concentrations of substances in the discharge must not cause the acute criteria established for the beneficial uses of the receiving water to be exceeded.

A mixing zone is also not allowed for the criteria established in §§ 74:51:01:06, 74:51:01:08, 74:51:01:09, and 74:51:01:10. This means that all mixing zones shall be free from substances that:

- Settle to form objectionable deposits;
- Float as debris, scum, oil, or other matter;
- Produce objectionable color, odor, taste, or turbidity; and
- Produce undesirable or nuisance aquatic life.

In addition, the following parameters must be met at the point of discharge. A mixing zone will not be allowed when developing effluent limits for these parameters:

- The pH criteria in Chapter 74:51:01 established to protect the beneficial uses of the state's water bodies;
- The fecal and total coliform criteria in §§ 74:51:01:44, 74:51:01:50, and 74:51:01:51;
- The total petroleum hydrocarbons criteria in §§ 74:51:01:44 and 74:51:01:52; and
- The oil and grease criteria in § 74:51:01:52.

It is important to note that the surface water quality standards, § 74:51:01:43, classify Missouri River impoundments as streams. Therefore, a mixing zone may be allowed when permitting discharges to the Missouri River.

Mixing Zones for Lakes

ARSD § 74:51:01:27 establishes South Dakota's rule for mixing zones in lakes:

> **74:51:01:27. Lakes not allowed a zone of mixing.** No zone of mixing is allowed for lakes. Discharges to lakes must meet the water quality standards at the point of discharge. No discharge of pollutants is allowed which reaches a lake classified for the beneficial use of fish life propagation or causes impairment of an assigned beneficial use.

According to the 1978 rationale for this rule, the South Dakota Water Management Board stated:

> "This section was amended to prohibit discharges to lakes classified for fish life propagation if impairment to a beneficial use will result. Because of the nature of lakes, their ability to have pollutants flushed out is limited. This problem causes the phenomenon called eutrophication. Its effects are cumulative and difficult to reverse. A specific criteria for a designated use may not be violated by a discharge, but the entrapment of the pollutants in a lake over a period of time could cause the use to be impaired."

Therefore, the department has generally interpreted this rule to say that no discharge is allowed to a lake classified as a cold or warm water fishery (i.e. – uses 2, 3, 4, 5, or 6). A discharge to a lake or wetland not classified as a cold or warm water fishery must meet the water quality standards at the point of discharge to the lake.

However, a discharge to a lake classified as a cold or warm water fishery could be allowed if it is established, through a total maximum daily load or other study, that the discharge will not impair the lake's beneficial uses. In making this decision, one of the things considered is the distance to the lake. As a general rule, the department allows discharges that are more than ten miles to a lake classified as a fishery. If the discharge is less than five miles, the department generally has not allowed a discharge.

The nature of the pollutants would also be considered. Some pollutants in a discharge are naturally attenuated in the environment before reaching the lake. The lake may act as a sink for other pollutants. For example, the department has permitted the discharge of non-contact cooling water to lakes classified as warmwater fisheries.

Reasons to Deny a Mixing Zone

The decision to allow a mixing zone will be made on a case-by-case and parameter-by-parameter basis. To appropriately address site-specific environmental concerns and the mixing characteristics of an individual discharge, mixing zone decisions should be made

using the best information available at the time of the decision. In some cases, it may be appropriate to restrict the size of the mixing zone. In other cases, a mixing zone might not be allowed and the discharger may be required to comply with the standards at the end-of-pipe, or the discharge may not be allowed.

Individual mixing zones may be limited or denied after considering the designated uses or presence of the following concerns in the area affected by the discharge:

- Biologically important areas such as fish spawning/nursery area;
- Low acute to chronic ratio for the pollutant, such as zinc;
- Potential human exposure to pollutants resulting from drinking water or recreational activities;
- Attraction of aquatic life to the effluent plume;
- Toxicity/persistence of the substance discharged;
- Zone of passage for migrating fish or other species (including access to tributaries);
- Cumulative effect of multiple discharges and mixing zones;
- Bioaccumulative effects of the pollutant; and
- Segments with occurrences of federally listed threatened or endangered species.

Developing Water Quality-Based Effluent Limits

This section is intended to provide guidance in developing water quality-based effluent limits for Surface Water Discharge permits. The measures outlined are intended only to provide guidelines to establishing limits, and are not rigid regulations or requirements. Where site-specific data is available, the department may use modeling and/or instream analysis to determine the appropriate mixing zone. This may result in a mixing zone that is larger or smaller than suggested here. If site-specific data indicates that a mixing zone established in a Surface Water Discharge permit is not protective of the beneficial uses, the department secretary may reopen the permit and re-establish the mixing zone. In addition, the secretary will re-evaluate the appropriateness of a mixing zone when the permit is reissued.

As stated above, a mixing zone is a limited portion of a body of water, where dilution is in progress but has not yet resulted in concentrations that will meet the water quality standards for all pollutants. Mixing zones may be delineated for the purpose of guiding sample collection procedures and to determine permitted effluent limits. The size of the mixing zone shall not exceed 2,500 feet. This maximum size limit may be adjusted downward based on the site-specific factors discussed above.

Determining Complete Mix

The first consideration in determining the need for a mixing zone is evaluating whether the stream is completely mixed. Near instantaneous and complete mixing may be assumed under the following circumstances:

- Where an effluent diffuser covers the entire stream width at the critical low flow of the receiving stream.
- Where the mean daily effluent flow is greater than or equal to half the critical low flow of the receiving stream. In these cases, the stream is assumed to be effluent-dominated and the stream and effluent are mixed almost instantaneously.
- Where the discharge is to a receiving stream with a critical low flow of 1.0 cfs or less.

Field studies may be conducted by a permittee or the department to determine whether or not complete mix has occurred. A stream receiving a discharge will be considered completely mixed where there is a 10% or less difference in the sample results taken across the width of the stream, within a longitudinal distance not greater than two stream or river widths. Demonstration of complete mixing by the permittee must be consistent with a study plan that is developed in cooperation with the department.

The department will use the criteria outlined above to help determine whether a stream is completely mixed. The portion of the stream where the discharge is not completely mixed is the mixing zone. Until the stream is completely mixed, certain criteria that are otherwise applicable to the water body might not be met. The un-ionized ammonia criteria and chronic toxic criteria must be met at the edge of the mixing zone, except where increased toxicity is expected to occur downstream of the mixing zone, considering pollutant fate and transport and/or changes in water chemistry. The department will determine the appropriate mixing zone for these criteria when developing the water quality-based effluent limits in the surface water discharge permit.

At no time shall acutely lethal concentrations be allowed within the mixing zone, as determined by bioassay or other approved procedure, such as whole effluent toxicity testing. A mixing zone will not be allowed for acute numeric water quality criteria. Concentrations of substances in the discharge must not cause the acute criteria established for the beneficial uses of the receiving water to be exceeded.

Dilution

A key measure for limiting the size of a mixing zone is determining the amount of allowable dilution. As stated earlier, the state does allow some dilution flows to be considered when developing water quality-based effluent limits. If the discharge is near instantaneously and completely mixed, the department may use up to the full amount of the critical low flow to establish the water quality-based effluent limits. The department may use field studies, modeling techniques, or the default method outlined above to determine whether a discharge is completely mixed. The basis for the complete mix assumption will be detailed in the statement of basis.

However, in some cases, the discharge does not completely mix with the receiving stream. In these cases, it may not be appropriate to consider that the full amount of the critical low flow is available for dilution and mixing. The appropriate amount of allowable dilution flow for developing water quality-based effluent limits will then need to be determined.

There are many factors that influence the rate of mixing in a stream. A few of these factors are: the flow and velocity of the receiving stream; the flow and velocity of the effluent; temperature; slope of the stream; and stream characteristics, such as amount of channelization, reaeration levels, width, and depth. As the receiving stream flow increases in relation of the effluent flow, there is actually less chance that the discharge will completely mix with the receiving stream. For example, if a discharge of 0.5 cfs enters the Missouri River, which has flows of over 12,000 cfs, it is unlikely that it will completely mix with the full flow of the Missouri River. Instead the discharge will likely mix with a small portion of the stream along the bank. If the same discharge enters a small prairie stream with a flow of 1.0 cfs, the discharge will likely be completely mixed. Therefore, to account for this, the permit writer should consider the ratio of the receiving stream to the effluent flow when developing water quality-based effluent limits.

In EPA's mixing zone and dilution guidance, EPA allows states to establish dilution procedures for certain minor publicly owned treatment works (POTWs) where the permit writer determines that the discharger's mixing zone poses little environmental risk. Therefore, the permit writer may also consider the size of the discharge and determine if it poses a significant environmental risk.

The following default procedure may be used to determine the amount of allowable dilution in cases where the discharge is not completely mixed. The percentages suggested below may be reduced, if necessary based on factors discussed previously. In addition, different percentages may be developed, based on site-specific data or field studies. For human health criteria, the department may use the critical flows discussed above and the following percentages, or other critical flows, as determined by the permit writer. The justification for the critical flows and the amount of dilution used to determine the water quality-based effluent limits will be detailed in the statement of basis.

- If the effluent flow is at least 25%, but less than 50%, of the critical low flow, up to 50% of the critical low flow may be used to determine the water quality-based effluent limits.
- If the effluent flow is at least 10%, but less than 25%, of the critical low flow, up to 25% of the critical low flow may be used to determine the water quality-based effluent limits.
- If the effluent flow is less than 10% of the critical low flow, up to 10% of the critical low flow may be used to determine the water quality-based effluent limits.
- If the receiving water that a minor POTW discharges to is classified for the beneficial uses of (2), (3), (4), (5), or (6), or if the classification of the receiving water changes to these classifications within one mile of the discharge, up to 50% of the critical low flow of the classified stream may be used to develop the water quality based-effluent limits.
- If a minor POTW discharges to a receiving water where the classification changes to the beneficial uses of (2), (3), (4), (5), or (6) more than one mile downstream, up to 100% of the critical low flow may be used to develop effluent limits.

- If the discharger has installed a diffuser, all or just a portion of the critical low flow may be considered available for dilution. This determination shall depend on the diffuser design. For example, if the diffuser covers only 60% of the length of the stream at the critical low flow, up to 60% of the critical low flow may be used to develop effluent limits.

In South Dakota, the majority of the minor POTWs are lagoons systems that discharge infrequently, resulting in little environmental risk. Therefore, the procedures outlined above will protect the beneficial uses of the receiving stream. However, if modeling or field study determines this procedure is not protective for a specific discharge, the department may reopen the permit and further refine the allowable mixing zone to ensure protection of the beneficial uses of the stream.

Again, these are only guidelines that may be used in the absence of site-specific data regarding the actual mixing zone. These default methods will provide a conservative and consistent method for establishing water quality-based effluent limits. However, a permit writer may use a different method for determining the size of the mixing zone, such as modeling. As stated above, field studies may also be conducted to determine dilution allowances. The allowable amount of dilution would be determined within a longitudinal distance of 2,500 feet, unless a smaller mixing zone has been established. The permit writer must detail the justification for any alternative method in the permit's statement of basis.

Effluent Flow

Another important consideration when developing water quality-based effluent limits is determining the effluent discharge rate that will be used to develop these limits. If effluent data is available for a discharger, the 50^{th} or 80^{th} percentile of the daily flow is generally used to determine the effluent flow rate. Both the 50^{th} and 80^{th} percentile effluent flows will be considered when developing water quality-based effluent limits. In some cases, such as a seasonal lagoon discharge, a lower effluent flow rate may be more protective of the receiving stream's beneficial uses. This effluent flow rate may be calculated on either a seasonal or annual basis.

In many cases however, there is very limited data available to determine the effluent flow rate. The following alternatives may be used to develop the effluent flow rate in the mixing zone analysis:

- The effluent design flow of the treatment facility may be used as the effluent flow rate when determining water quality-based effluent limits.
- For lagoon systems, it may be appropriate to develop an effluent flow rate based on expected performance. For example, the permit writer may assume the final lagoon cell will be discharged to the two-foot operating level over a seven-day period. This provides an approximate effluent flow rate.

These are only guidelines. The permit writer may use these or other methods to determine the appropriate effluent flow rate. The methods for determining the effluent flow, along

REFERENCES

State of Nebraska. *Procedures for Developing Point Source Total Maximum Daily Loads.* Nebraska Department of Environmental Quality, Water Quality Division. Lincoln, NE 68509, April 1998

State of South Dakota. *South Dakota Surface Water Quality Standards*, Chapters 74:51:01; *Uses Assigned to Lakes,* Chapters 74:51:02; and *Uses Assigned to Streams,* Chapters 74:51:03. Division of Environmental Services. Pierre, SD 57501, July 1997.

State of Utah. *Utah Mixing Zone Policy and Implementation Procedure.* Utah Division of Water Quality. Salt Lake City, UT.

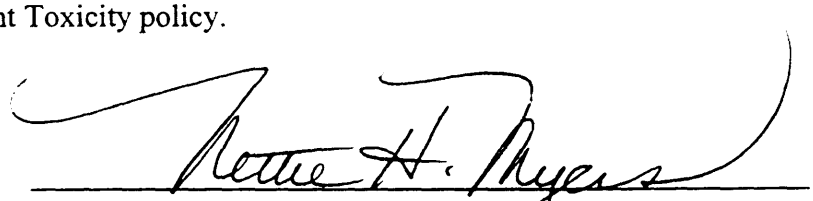
U.S. Environmental Protection Agency. *Technical Support Document for Water Quality-based Toxic Control.* Office of Water (EN-336). Washington, D.C. 20460, EPA/505/2-90-001, March 1991.

U.S. Environmental Protection Agency. *EPA Region VIII Mixing Zones and Dilution Policy.* Water Management Division (8WM). Denver, CO 80202, December 1994.

with any assumptions, will be described in the statement of basis for the surface water discharge permit.

Whole Effluent Toxicity Testing

Whole effluent toxicity (WET) is another tool for developing water quality-based effluent limits. WET testing provides a more comprehensive view of the toxicity of a discharge. WET testing requirements in permits help determine whether or not the chemical-specific limits are protective of a stream's beneficial uses. South Dakota follows the Region VIII Whole Effluent Toxicity policy.



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