MASSACHUSETTS SURFACE WATER QUALITY STANDARDS

IMPLEMENTATION POLICY FOR MIXING ZONES

January 8, 1993

PREAMBLE

THE ISSUE OF MIXING ZONES IS COMPLICATED AND DETAILED DETERMINATIONS CAN BE MADE ONLY ON A CASE-BY-CASE BASIN. HOWEVER, SOME GENERAL GUIDANCE CAN BE PROVIDED AND THIS IS PRESENTED BELOW.

I. Introduction

A mixing zone is an area or volume of a waterbody in the immediate vicinity of a discharge where the initial dilution of the discharge occurs. Within a mixing zone excursions from certain water quality criteria may be tolerable, provided this does not interfere with the existing or designated uses of the segment. Water quality criteria apply at the boundary of the mixing zone. Where mixing zones are not permitted, water quality criteria apply at the outfall structure.

II. Water Quality Standards

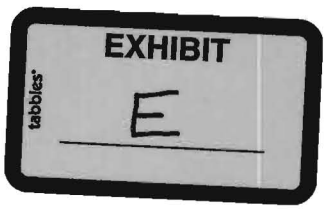
The Surface Water Quality Standards set forth the general requirements for mixing zones (314 CMR 4.03(2)). The regulation provides narrative statements for the protection of receiving waters where mixing zones are permitted.

Mixing Zones - In applying these standards the Division may recognize a limited area of volume of waterbody as a mixing for the initial dilution of a discharge. Waters within a mixing zone may fail to meet specific water quality criteria provided the following conditions are met:

a) Mixing zones shall be limited to an area or volume as small as feasible. The location, design and operation of the discharge shall minimize impacts on aquatic life and other beneficial uses.

b) Mixing zones shall not interfere with the migration or free movement of fish or other aquatic life. There shall be safe and adequate passage for swimming and drifting organisms with no deleterious effects on their populations.

c) Mixing zones shall not create nuisance conditions, accumulate pollutants in sediments or biota in toxic amounts or otherwise diminish the existing or designated uses of the segment disproportionately.



III. Location of Mixing Zones

Mixing zones are permitted at the discretion of the Division. Mixing zones are not appropriate in areas with critical water uses or where it is necessary to maintain a zone of passage.

a) Critical Uses

The most important site-specific factors governing the application of mixing zones are the actual and projected water uses in a segment. Certain uses may be deemed critical in that no excursions from criteria are desirable. These include areas that are highly sensitive or extensively used. In order to provide a reasonable margin of safety for these uses, no mixing zone can be permitted. These uses may include:

1. Public Water Supply Intakes - The Division will not authorize a mixing zone where the impacts are anticipated to encompass an intake for an existing or proposed Public Water Supply.

2. Shellfish Harvest Waters - Mixing zones in shellfish harvest waters (Class SA and Class SB) shall not be authorized unless it is affirmatively demonstrated that the mixing zone does not encompass important shellfish harvest areas and will not adversely diminish the established population of shellfish in the segment.

3. Public bathing beaches - and other heavily used recreation areas are generally inappropriate areas for mixing zones. In each case the goal shall be to eliminate mixing zones in these areas and, where this is unfeasible, to minimize their impacts.

4. Conservation Areas - wildlife refuges and sanctuaries, special habitats of endangered species or species of special concern, Areas of Critical Environmental Concern (ACEC's) may also be areas where mixing zones are not appropriate. Determinations shall be made case-by-case with intergovernmental cooperation and information for the public participation process.

For the purpose of this policy a critical use may include all or a discrete portion of a segment. For example, a bathing beach in a Class B segment or a shellfish bed in a Class SA segment may be deemed critical while other areas of the same segment are eligible for mixing zones.

b) Zone of Passage

Mixing zones should not impair the passage and free movement of migrating organisms. Waterbodies that serve as anadromous or catadromous fish runs may need at least a portion of the waterbody free from mixing zones in order to assure safe passage. Even if the in-zone quality of the mixing zone is high enough to prevent toxic effects, mixing zones may cause attraction or avoidance responses in migrating fish. Either response may serve as an effective barrier to migration.

When zone of passage is an issue, at least half of a waterbody's area or volume should remain free from mixing zones. If mixing zones are allowed they should not occur on alternating banks of a river for this may form a barrier to migration even though half of a waterbody remains open. Generally, shore hugging plumes should be avoided because food and cover for migrating fish are more likely to occur near the shoreline of a waterbody.

IV. In Zone Water Quality

The quality of water within a mixing zone must a) protect public health b) protect aquatic life and c) prevent nuisance conditions.

a) Protection of Public Health

The presence of mixing zones should not result in significant health risks when evaluated using reasonable assumptions about exposure pathways. The two primary exposure pathways are drinking water ingestion and fish and shellfish consumption. The principal means of protection means of protection is the designation of critical uses thereby prohibiting mixing zones from these sensitive areas.

Levels of chemicals that bioaccumulate in the edible portions of fish and shellfish to unacceptable levels are specifically prohibited by the Water Quality Standards (314 CMR 4.05(5)(e)(3)). Therefore concentrations of pollutants within a mixing zone may have to be controlled in order to meet standards outside of a mixing zone. Mixing zones should be restricted such that they do not encompass on areas used for fish harvesting; particularly of stationary species such as shellfish.

Genotoxic pollutants are those that cause carcinogenic, mutagenic and teratogenic responses in humans. The development of criteria for these pollutants incorporate significant margins of safety. Since rapid toxic effects generally do not occur with these pollutants restrictions within a mixing zone are unnecessary. Compliance with these criteria will be regulated at the edge of the mixing zone.

b) Protection of Aquatic Life

Aquatic life often becomes the governing concern with determining the in-zone water quality of mixing zones. In this regard the aquatic community can be divided into:

1. non-mobile and sessile benthic organisms;
2. swimming and drifting organism.

To protect populations of non-mobile and sessile benthic organisms the habitat exposed to the mixing zone must be minimized and critical habitats must be avoided. The organisms within a mixing zone may experience severe damage to individuals, including lethality, because chronic criteria can be exceeded. A mixing zone may represent a living space denied these organisms. Therefore a mixing zone must be located and sized such that any such loss is not significant to the biological

community of the receiving water segment.

To protect swimming and drifting organisms the in-zone quality must be such that these organisms can pass through the mixing zone without acute exposure to toxicants.

One way to prevent acute exposures is to prohibit acute concentrations at the outfall structure or within a short distance from it. The Division's toxic policy (reference 1) uses 0.3 toxic units as a criterion for acute toxicity. The policy places effluent limits of 1.0 toxic unit on discharges with less than 100:1 dilution and 2.0 toxic units on all others. Additional requirements are imposed where dilutions are very low. These effluent limitations assure that 0.3 toxic units are met within a short distance of the outfall and that acutely toxic exposures will not occur in the mixing zone.

Alternatively, EPA's Technical Support Document (reference 2) provides guidance for the prevention of lethality to passing organisms. The Division considers this information a valid basis for a site-specific demonstration or compliance with meeting the acute criterion with a "short distance" of the outfall. In any such site-specific demonstration the Division considers 2.0 toxic units the technology-based upper limit for whole effluent toxicity. In order to exceed this limit the proponent must further demonstrate that the technology to meet 2.0 Toxic Units in the effluent is not reasonably available or feasible.

The effluent limit of 2.0 Toxic Units also applies to intermittent discharges such as stormwater and combined sewer overflows in order to prevent lethality to passing organisms.

c) Prevention of Nuisance Conditions

Waters within a mixing zone are not expected to meet the same aesthetic requirements as waters outside of a mixing zone. However the waters within a mixing zone should not create a nuisance condition or detract from the overall aesthetic value of the segment.

Nuisance conditions may occur from pollutants that settle to form objectionable deposits; float as debris, scum or other matter; produce objectionable odor, color or turbidity; or produce undesirable species of aquatic life. The measurement of these criteria is often subjective. Implementation of technology based treatment requirements substantially reduces the possibility of aesthetics becoming a concern.

V. Size and Shape

Mixing zones should be limited to an area or volume as small as feasible. Available technology should be employed to insure that the design, operation and location of the outfall structure all insure minimum mixing zone size. In some cases levels of treatment higher than those necessary do meet criteria after complete mixing may be necessary to reduce or minimize the area or volume of a mixing zone.

The size of a mixing zone is determined by physical and hydrologic considerations such as, velocity, momentum, density, advection and dispersion. When an effluent is discharged to a waterbody these forces disperse the wastewater until it is uniformly distributed. This process can be divided into two parts; 1) initial dilution; and 2) complete mixing.

Initial dilution is the process which results in the rapid and irreversible turbulent mixing of the wastewater with the receiving water around the point of discharge. Initial dilution is considered complete when the momentum induced velocity of the discharge ceases to produce significant mixing of the wastewater. For the special case of a submerged buoyant discharge, characteristic of most municipal and industrial wastes that are released from submarine outfalls, the momentum of the discharge and the initial buoyancy act together to produce turbulent mixing. Initial dilution in this case is completed when the diluting wastewater ceases to rise in the water column and first begins to spread horizontally. Effluents that meet water quality standards within the zone of initial dilution (ZID), provided they do not violate other mixing zone restrictions, are considered to be de minimus. Further justification of the size and shape is not necessary.

Complete mixing occurs when the concentrations of pollutants within a waterbody reach a uniform concentration. This is accomplished by advection and dispersion. The use of this portion of the receiving water as a mixing zone needs to be justified by applying the following antidegradation considerations:

1. No less environmentally damaging alternative site for the activity, source for disposal, or method of elimination of the discharge is reasonably available or feasible;

2. To the maximum extent feasible the discharge or activity is designed and conducted to minimize the size and shape of the mixing zone; and

3 The mixing zone will not impair the integrity of the waterbody as a whole, including the existing and designated uses.

These antidegradation provisions (appropriately modified to apply to mixing zones) assure that mixing zone size and shape are minimized. When the mixing zone extends beyond the ZID acute criteria should be met within the ZID. If acute criteria are not met within a ZID it must be demonstrated that acute exposures are not likely to occur within the mixing zone.

Mixing zone size and shape will vary with hydrologic conditions. Mixing zone criteria apply at critical or worst case hydrologic conditions. Worst case conditions must be selected case-by-case, with critical resources being the determining factor. Worst case conditions are often those that produce the highest receiving water concentrations. However, it is possible that conditions with lower receiving water concentrations but larger areal extent may be considered worst case if the mixing zone encompasses a critical resource under these alternate conditions. Therefore the Division avoids delineating mixing zone areas on maps. Rather, the mixing zone is analyzed under critical conditions and effluent

limits are set in order to comply with mixing zone criteria. Compliance with mixing zone criteria can then be accomplished by effluent monitoring. The size and shape of any authorized mixing zone larger than a ZID, along with the assumptions and appropriate justification shall be documented for the public participation process as part of the Division's normal Permit Procedures (314 CMR 2.00).

Table I provides a decision tree for mixing zone policy and Table II provides a summary of the policy.

TABLE I

MIXING ZONE FLOW CHART

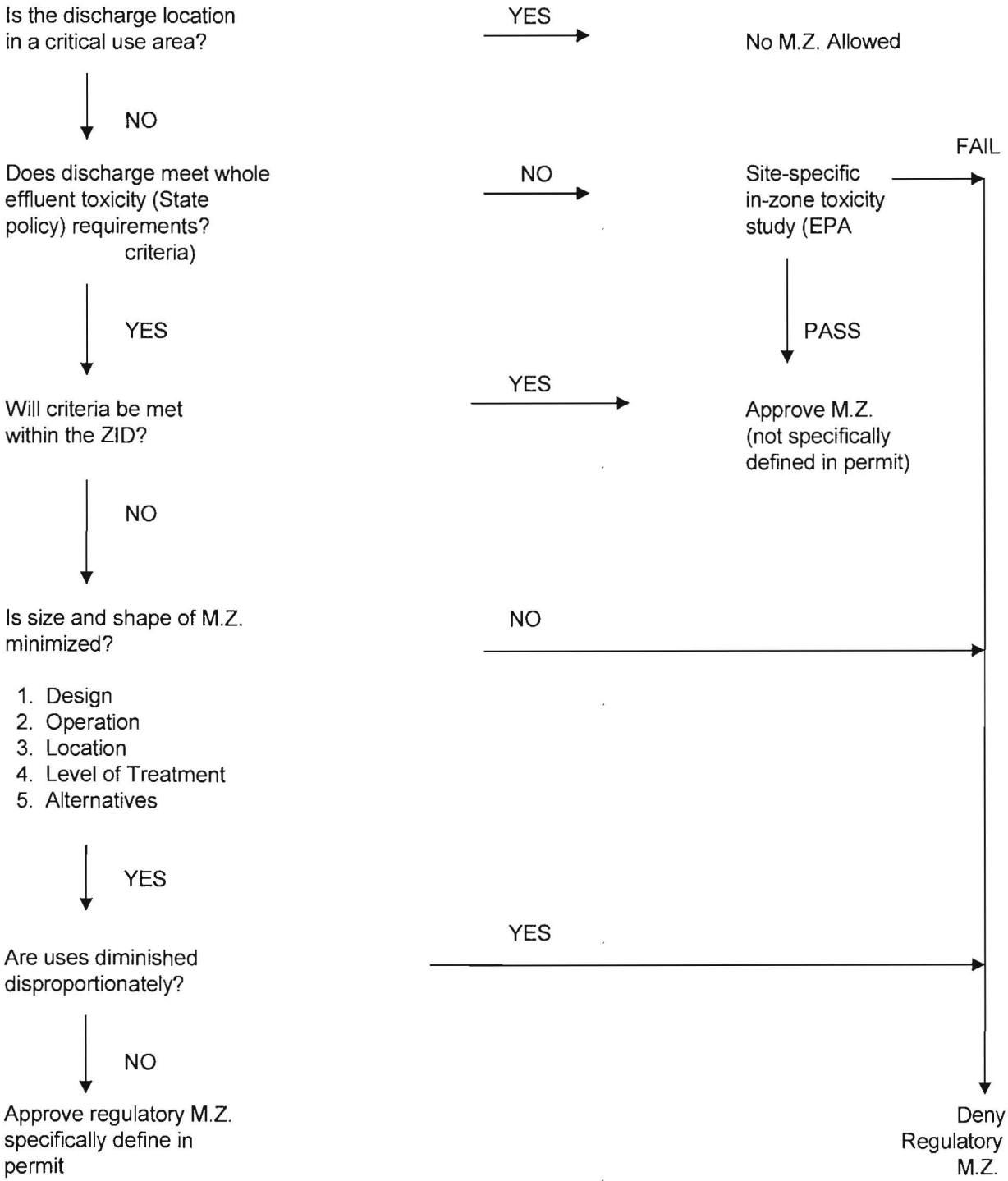


TABLE II

SUMMARY OF MIXING ZONE POLICY

PARAMETER	CRITERIA	IMPLEMENTATION
1. Location	a) Avoid Critical Uses	Avoid: - Water supply intakes - Productive shellfish areas - Bathing beaches - Sensitive aquatic life habitats
	b) Provide Zone of Passage	- Where necessary for anadromous or catadromous fisheries. Provide half the width or volume of the waterbody free from mixing zones.
2. In-Zone Quality	a) Protect Public Health	- Avoid sensitive areas - Where necessary limit concentrations for fish and shellfish edibility - Meet criteria at edge of zone
	b) Protect Aquatic Life	- Prohibit acute exposures to toxics within the zone by: a) State toxic policy, or; b) EPA TSD

			criteria
		c) Prevent Nuisance Conditions	Apply aesthetic criteria as applicable
3.	Size and Shape	Minimize Size	- Minimize by technology; design operation location level of treatment - Meet criteria within the ZID, or; justify larger area through antidegradation provisions

REFERENCES

1. Massachusetts Water Quality Standards, Implementations Policy for Control of Toxic Pollutants in Surface Waters, February 23, 1990.

2. U.S. EPA, Technical Support Document for Water Quality - based Toxics Control, Officer of Water EPA/505/2-90-001, March, 1991.

3. National Academy of Sciences, National Academy of Engineering, Water Quality Criteria 1972, EPA.R3.73.003, March, 1973, pp. 112-115.

4. Brungs, William A. Allocated Impact Zones for Areas of Non Compliance, Water Management Division, Region I, U.S. EPA, October, 1986.

5. Water Quality Standards Handbook, U.S. EPA Office of Water Regulations and Standards, Washington, D.C., December, 1983.

6. State of California, State Water Resources Control Board, Water Quality Control Plan, Ocean Waters of California. 1983, Adopted and Effective November 17, 1983.