Exhibit I

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Technical Support Document For Water Quality-based Toxics Control

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TECHNICAL SUPPORT DOCUMENT FOR WATER QUALITY-BASED TOXICS CONTROL

This copy represents the second printing of this document.

Changes made to this document reflect corrections of typographical errors and the following update of the interim guidance on criteria for metals: The Agency has issued "Interim Guidance Interpretation and Implementation Aquatic Life Criteria for Metals." The interim guidance supersedes criteria document statements expressing criteria in terms of a acid soluble analytical method and also the metals discussion of Section 5.7.3. The availability of this document appeared in the June 5, 1992 Federal Register (Vol. 57, No. 109, pg. 24401).

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Office of Water Regulations and Standards
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APPENDIX D

DURATION AND FREQUENCY

Unless critical species are especially sensitive to particular toxicants, most excursions of criteria should have minor impacts on aquatic communities. However, whereas excursions above the CCC will probably reduce growth and reproduction, excursions above the CMC will probably cause death and other severe acute effects. In addition, special care should be exercised when many outfalls exist in a small segment of a receiving water, because if low flow causes an excursion for one discharge, that same low flow will probably also cause excursions for other discharges at the same time. Several "minor" excursions might thus add up to a "major" one.

Frequency

The purpose of the average frequency of allowed excursions is to provide an appropriate average period of time during which the aquatic community can recover from the effect of an excursion and then function normally for a period of time before the next excursion. The average frequency is intended to ensure that the community is not constantly recovering from effects caused by excursions of aquatic-life criteria. Because most regulated discharges are to flowing water (lotic) systems, this discussion will emphasize discharges to rivers and streams rather than to lakes, ponds, reservoirs, and estuaries.

General Considerations for Setting Frequency with Which Excursions of Criteria May Occur

Not long ago ecological communities were thought to be largely in equilibrium and their structure and function determined primarily by internal interactions between species, such as competition and predation. Communities were considered to be analogous to "super-organisms," with close parallels to organisms in their response to stress and in "health." Current understanding is that external factors, including disturbances, often play a major role in the structure of communities [32, 33]. The frequency of disturbance affects a community not only by decreasing the fitness of component species, but also by causing a natural selection of species or phenotypes having characteristics that allow them to tolerate or even thrive under the disturbance regime. Natural disturbances such as floods and droughts are common in lotic systems [32] and vary in intensity not only between headwater streams and large rivers, but also between similar sized lotic communities in different climatic regions. Rather than requiring more time to recover from the effects of additional anthropogenic disturbances, lotic communities with high natural background disturbance frequencies are actually predisposed to recover more rapidly because only species that are able to recolonize and reproduce quickly, or perhaps to avoid disturbances, can persist there [34-37]. This does not imply that they also are more resistant to novel anthropogenic disturbances with which they have had no previous evolutionary experience; it only implies that they are predisposed to recover quickly once the disturbance is gone. The question then is how frequently can aquatic communities experience these additional disturbances (excursions of criteria) without being unacceptably affected.

In an extensive review of the published literature, Niemi et al. [38] reviewed the published literature and identified more than 150 case studies of freshwater systems in which some aspect of recovery from the impact of a disturbance was reported. A case study was used only if the disturbance caused a death or displacement of organisms. This restriction was necessary because it was rarely possible to determine if an event was outside the normal intensity range (a common alternate definition of disturbance), mainly because it is usually difficult to define the normal intensity range. It also permitted the inclusion of natural as well as anthropogenic events. Approximately 80 percent of these systems were lotic, and the remainder were lentic (lakes and ponds). The impacts were due to such disturbances as persistent and nonpersistent chemicals, logging, flooding, channelization, dredging, and drought. Reported endpoints for recovery were sparse for phytoplankton, periphyton, and macrophytes, but were numerous for macroinvertebrates and fishes. Because more than one recovery endpoint was reported for most studies, the number of endpoints greatly exceeded the number of case studies. For short-term (nonpersistent) disturbances, approximately 85 percent of all macroinvertebrate endpoints indicated recovery in less than 2 years. Macroinvertebrate biomass, density, and taxonomic richness recovered in less than 1 year for approximately 95 percent of reported endpoints. Dipterans (flies, mosquitos, midges, etc.), which generally have short generation times or high dispersal ability, recovered most rapidly, whereas stoneflies and caddisflies recovered least rapidly. Fishes recovered in 2 years or less for over 85 percent of reported endpoints. However, as discussed below, important exceptions did occur.

Most excursions of criteria will be minor and their impacts will therefore be difficult to detect. Although most disturbances in the above case studies caused more severe impacts than most criteria excursions are expected to cause, CMC excursions will result in death of some organisms. These data indicate that as a general rule, the purpose of the average frequency of allowed excursions will be achieved if the frequency is set at once every 3 years on the average. Excursions of the CCC are more difficult to evaluate because nonlethal excursions could not be evaluated from the data used by Niemi et al. [38]. It is reasonable to expect, however, that cumulative effects from too frequent excursion of the CCC also will result in unacceptable degradation of lotic communities.

Considerations for Proposing Site-specific Increases or Decreases in the Average Frequency of Allowed Excursions

Although an average frequency of one criterion excursion every 3 years should usually be protective of lotic communities, more frequent excursions might be acceptable in certain situations. Sedell et al. [39] have shown that lotic systems with refugia (areas of refuge) such as well-developed riparian zones, connected flood plains and meanders, snags, etc., recover more rapidly from disturbances than segments without such refugia, because organisms are better able to avoid disturbances and return or repopulate. However, many of these refugia are likely to be most restricted and vulnerable during the low-flow periods when criteria excursions also are most likely to occur. Evidence of action to preserve refugia, particularly during low-flow periods, or to create or restore them, might be grounds for demonstrating that an excursion frequency of more than once every 3 years on the average is acceptable. Schlosser [36] found that lower-order (i.e., headwater) streams, because of their natural high variability, contain communities consisting of species that have short life cycles and/or high dispersal ability and can recover from major disturbances in a year or even less. Thus, many lower-order streams, particularly those for which refugia are available, may be able to tolerate somewhat higher excursion frequencies, unless other considerations are important. For example, discharges to lower-order streams sometimes constitute a large fraction of the stream flow for most of the year.

Although lower-order streams are naturally highly variable and can therefore tolerate higher disturbance frequencies, the converse is true for higher-order lotic streams for at least two partially related reasons: (1) segments with tributaries draining a large watershed will be buffered from the effects of localized droughts in a portion of the watershed, and will therefore experience a less severe natural disturbance regime, and (2) organisms inhabiting these segments will therefore not be adapted to disturbances that are as frequent or severe as those in lower-order segments. Fish in particular will be larger and have longer generation times in larger streams and rivers. Consequently, it will take longer for these populations to reproduce and regain predisturbance densities and size class distributions. Schlosser [36] suggests that, based on such life-history characteristics, fish communities in larger rivers might take 20 to 25 years to re-establish the predisturbance age and size structure of their component populations after a severe disturbance such as a major drought or spill.

Extreme cases in which recovery has taken much longer than 3 years usually involve spills of persistent chemicals or severe habitat modification, such as stream channelization or clear-cutting of a watershed [38]. If the chemical contaminant is not widespread, recovery is limited primarily by the rate of disappearance of the chemical rather than by strictly ecological processes. Widespread contamination can affect recovery by increasing the distance over which recolonizers must travel. Watershed clear-cutting reduces the input of organic matter that provides the food base of streams in forested watersheds and also provides woody debris and snags that serve as refugia. Channelization and dredging reduce the in-stream habitat diversity and thereby decrease refugia. In addition to these anthropogenic disturbances, multiple excursions during a drought, due to low-flow conditions, can result in a severe cumulative impact on sensitive species even if the individual excursions are small. Special measures, such as plant shutdowns, might be required in extreme cases. Finally, severe chemical spills, which cannot be regulated but which will occur in any highly industrialized river segment, will affect aquatic life over a large area. If maintenance of long-lived fish species in these segments is desired, recovery periods up to 25 years may be necessary.

Based on the above considerations, recovery periods longer than 3 years may be necessary after multiple minor excursions or after a single major excursion or spill during a low-flow period in medium-to-large rivers, and up to 25 years where long-lived fish species are to be protected. Even longer times may be necessary as the size of the affected area or the persistence of the pollutant increases.