Association of
Metropolitan
Sewerage Agencies

March 8, 2005

Dear Member of Congress:

There has been significant discussion in Congress and the media over wastewater blending since the U.S. Environmental Protection Agency (EPA) proposed a November 2003 policy on this issue. Some activist groups are mischaracterizing the public health consequences of blending. The activists' public health claims rely largely on the November 2003 *Katonak-Rose Report* on *Public Health Risks Associated with Wastewater Blending* – submitted to EPA as an attachment to Natural Resources Defense Council comments strongly opposing the policy. The *Katonak-Rose Report* predicts devastating adverse public health consequences if municipalities continue to blend during wet weather. What the activists do not say is that the *Katonak-Rose Report* relies on a single case study to make its predictions, and that municipalities have used blending as an effective peak wet weather management practice for over three decades.

There has been no technical review of the *Katonak-Rose Report* – until now. Attached is the March 7, 2005 *Technical Review of the Katonak-Rose Report* by Adrienne Nemura, P.E. The *Nemura Technical Review's* conclusion summarizes the shortcomings of the single case study used in the *Katonak-Rose Report:*

> *Because of the significant unrealistic assumptions associated with this case study, however, it is inappropriate to extrapolate or infer anything from this exercise about the risks associated with implementing the proposed blending policy at this plant or any other plant. It is unfortunate that some have used the findings of this study to advocate that blending should be prohibited.*

The *Nemura Technical Review* carefully analyzes the significant limited assumptions contained in the *Katonak-Rose Report*. These assumptions result in the *Katonak-Rose Report* overstating and generalizing the risk of wastewater blending to public health.

To provide you with the facts about blending, the Water Environment Research Foundation (WERF), the Water Environment Federation (WEF), and the Association of Metropolitan Sewerage Agencies (AMSA) invite you to a Briefing on ***March 16, 2005 from 9:00-10:30 am in Rayburn House Office Building Room 2253.*** Leading experts in the field will be present to answer questions about blending. We hope to see you.

If you would like more information on the Briefing or the *Nemura Technical Review*, contact AMSA's Adam Krantz at 202/463-4651 or at *akrantz@amsa-cleanwater.org*.

Sincerely,

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Technical Review of the Katonak-Rose Report on Public Health Risks Associated with Wastewater Blending (November 17, 2003)

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Author's Statement

EPA's proposed blending policy has received much public attention and many people have expressed opposition over allowing this practice to continue any time, any where in the United States. As a professional engineer with 20 years of experience in water quality management, I am concerned that much of the debate over blending is occurring due to misinformation and a lack of understanding about this complex issue.

To begin, answering the question "*will discharge of blended effluent result in more people getting sick*" is difficult and cannot easily be answered through a relative risk assessment for a generic, single source for a single flow event. This is because site-specific sources of variability are significant when evaluating the relative risk when recreating in natural waters in wet weather. These sources of variability include environmental conditions (e.g., die-off and transport of pathogens in surface waters), actual recreational exposure, and presence of other potential sources of pathogens such as agricultural sources, urban runoff, sewer overflows, decentralized wastewater treatment systems, leaking septic systems, and other sources. This is important because these other sources in themselves can make the water unsafe for swimming, particularly during wet weather events (which is when the practice of blending is used).

The Katonak-Rose report has often been cited as demonstrating that the relative risks associated with blending are considerable. Because of this, I conducted a review of the report as to its technical adequacy and applicability for assessing the proposed national blending policy. The Katonak-Rose report does not consider the variabilities described above and therefore has inherent limitations. More so, however, the Katonak-Rose analysis has several other serious shortcomings that make its use inappropriate for assessing the national blending policy and the public health risk of blending.

In this review I am neither advocating nor opposing blending, nor am I making a statement about the relative risk associated with the practice of blending. Rather, I am attempting to demonstrate that it is inappropriate to use this single case study to extrapolate conclusions about the national significance of the proposed blending policy.

Overview

The Katonak-Rose report was a single, hypothetical evaluation of the potential risks associated with wastewater blending (Katonak and Rose 2003). The case study was used to calculate the human health risk associated with recreational exposure to blended effluent[1]. The two findings in the hypothetical case study were:

- The untreated portion of blended wastewater flow accounts for more than 99 percent of the pathogenic viruses and parasites in the final effluent; and
- The risk associated with swimming in recreational waters that receive blended wastewater flows are 100 times greater than if the wastewater had been fully treated.

The risk assessment methodology followed in the Katonak-Rose paper could be acceptable for calculating relative risk for a single source (wastewater effluent) for a single flow event where site-specific sources of variability are neglected. The introductory text (which comprises the majority of the report) provides a summary of public health issues and risk methodologies. It includes several minor errors and inappropriate inferences (as discussed in Appendix A); however, these do not significantly affect the application of the risk assessment methodology for the hypothetical case study.

A number of unrealistic assumptions were made in applying the methodology to reach their general conclusions. These assumptions make the authors' analysis inappropriate to extrapolate to the proposed national blending policy. The assumptions also invalidate the general conclusions about the relative risk associated with blending for this plant as well as for other plants. My summary bases for this criticism are as follows:

- **The treatment processes portrayed for the plant are not typical.** Unlike the case example by Katonak-Rose, the majority of plants that use blending are activated sludge plants that do not have rotating biological contactors (RBCs) followed by tertiary treatment through biotowers (trickling filters). Generalizing results for this plant to national policy implications is inappropriate.

- **The blended routing of wastewater is not representative for this plant and is inconsistent with what is required under the proposed national policy.** The Katonak-Rose case study assumed that the plant diverts a significant amount of flow (2 million gallons per day or mgd) around primary treatment resulting in no treatment at all for 2 mgd. The Authority's comments (Dami 2004) on their review of the Katonak-Rose paper indicated that this scenario is not representative but reflects conditions when part of the plant was out of service. Also, assuming that portions of the blended wastewater do not receive at least the equivalent of primary treatment is in direct contrast to the proposed blending policy. The draft policy specifically states that an untreated discharge cannot be authorized in an NPDES permit. The Katonak-Rose example indicated that this primary bypass receiving no treatment constituted 99 percent of the pathogen load. The report's analysis <u>that there is a 100-fold increase in risk posed by blending is dramatically overstated</u>.

[1] The case study uses the Washington-East Washington Joint Authority's facility in Washington, Pennsylvania to calculate the comparative risk of increased pathogen load in blended versus non-blended effluent for a single discharge event.

- **The baseline comparison is unrealistic for both its assumed flow and pathogen levels.** The paper compared a blended discharge during a peak, wet weather flow condition (20 mgd) to a non-blended discharge during steady-state, dry weather flow conditions (12 mgd). This overstates the relative risk of blending because the appropriate comparison would be between blending and non-blending treatment schemes at the same wet weather flow. If the 20 mgd flow were used to evaluate the pathogen load for a non-blending scenario, the relative difference between the two scenarios would be decreased by 67 percent.

  The paper also did not address the inherent variability in influent concentrations and treatment process efficiencies associated with wet weather flows. Influent variability means that there is a range in pathogen and solids concentrations and therefore a range in treatment effectiveness for individual processes. Process variability means that the effectiveness of secondary and tertiary treatment processes will change depending on flow conditions. For example, shorter mean cell residence time in biological systems has been shown to result in higher levels of pathogens in wastewater (Rose et al. 2004). If the full 20 mgd were put through the facility, process times would be shorter thereby reducing treatment effectiveness and resulting in increased pathogen loading. At greater flows, the plant could also experience washout of its biological treatment systems. Since non-blended discharges were characterized by choosing a single, steady-state dry weather level of pathogens, this likely understates the risk associated with the non-blended discharge. These assumptions distort the relative risk between the blended discharge and the non-blended discharge in this example, making the relative risk larger than expected.

Because of the significant unrealistic assumptions associated with this case study, it is inappropriate to extrapolate or infer anything from this exercise about the risks associated with implementing the proposed blending policy at this plant or any other plant. The national significance of the proposed policy on blending cannot be determined through this study.

Review of Risk Assessment Methodology

The following discussion outlines the risk assessment methodology that was followed and the key assumptions that were made at each step of the risk assessment. The unrealistic assumptions are summarized in Appendix B. The background material that comprises the majority of the report also makes a number of inferences between waterborne disease outbreaks and blended sewage that are not appropriate.

The standard paradigm for risk assessments follows four steps:

1. *Hazard Identification:* a description of the acute and chronic health effects associated the hazard;

2. *Dose-Response Characterization:* a quantification of the relationship between the size of the dose and the extent of the effect;

3. *Exposure Assessment:* a determination of the amount and duration of the exposure; and

4. *Risk Characterization:* an estimate of the magnitude of the public health problem.

The Katonak-Rose paper follows this paradigm. A summary of the specific assumptions for each of these steps follows. In general, the hazard identification and dose-response characterization were adequately addressed. My major concern lies with the exposure assessment and risk characterization steps.

1. Hazard Identification

The paper describes the human health risks associated with raw sewage and lists known pathogens in length. The presence of pathogenic organisms in domestic sewage (treated and untreated) is not an issue subject to much, if any, debate although it is recognized that there are limited data to sufficiently quantify "average" levels. The paper's treatment of the subject is lengthy but not intrinsically problematic. Although more information is available on the use of chlorine and ultraviolet light for pathogen inactivation, the paper's treatment of this topic is limited, but not notably biased.

The hazard identification section has a general discussion of the effectiveness of primary treatment, secondary treatment and disinfection in reduction of pathogens in wastewater. The discussion presents previously published information on pathogen levels in undisinfected primary and secondary effluents; such data are not routinely collected, and the paper does an adequate job of presenting what was available at the time. The range in treatment effectiveness in Table 8 is not surprising given the difficulty in measuring pathogens in wastewater. For example, new methods are just being developed for measuring the presence of pathogens in different wastewater matrices, e.g., raw sewage, primary treated effluent, etc. (McCuin and Clancy 2005). These authors indicated that as treatment process improves the quality of the wastewater throughout the plant, it can appear that processes are "adding" rather than removing oocysts. They also note the need to use parameters other than pathogens (such as turbidity and solids removal) as indicators for treatment effectiveness.

2. Dose-Response Characterization

This section describes some dose-response models that have been evaluated for waterborne pathogens. The discussion is brief but adequately characterizes the approaches that are generally accepted.

3. Exposure Assessment

This section begins with a discussion of sanitary sewer overflows (SSOs) and basement backups. This discussion introduces the potential human health risks associated with other municipal wet weather flows (such as municipal stormwater runoff, basement backups, or SSOs). No further analysis, however, is provided to characterize the risks from these flows or potential trade-offs in managing wet weather flows through the practice of blending[2].

[2] The national experience with sewer separation of combined sewers (which carry both stormwater and sanitary sewage) illustrates the complexity associated with management of wet weather flows. Many communities that consider fully separating their combined sewers (thus "eliminating" discharges of untreated sewage) identify that other pollutant controls are more cost-effective than separation. Communities that have separated can also find that discharges of urban runoff from the newly separate storm sewer system contain pollutant loads that contribute to water quality problems.

The paper then introduces the single hypothetical blending scenario. This scenario needs to be examined in more detail, and a four-step method is proposed: define influent levels, define plant flows, determine process efficiencies, and calculate effluent levels. These steps are described below.

The paper uses a plant process flow diagram based on the Washington/East Washington Joint Authority in Pennsylvania for its blending comparison. It would have been more informative to use a generic flow diagram that would represent the majority of plants where blending occurs, and to identify how the generalized effects may vary when applied to specific plant layouts. A specific flow diagram can, however, still be used for comparisons as long as the assumptions used are appropriate to that flow diagram.

3a. Define Influent

In this step, the influent levels of pathogens are defined. The paper uses "typical" levels of enteroviruses, *Cryptosporidium* and *Giardia* that are acceptable for untreated wastewater. It should be noted that there is considerable variability in these influent levels under dry weather, let alone wet weather conditions. Levels in wet weather influent may be less due to dilution of the influent with inflow from the collection system. However, this assumption does not affect the relative risk comparison since the same assumption is made for both blending and non-blending scenarios, but it does reflect a lack of rigor in the analysis.

3b. Define Plant Flows

This step involves defining a flow condition under which blending would occur, and determining how the flow is split among the various unit processes at the treatment plant. Here, the paper assumes a situation in which a portion of the flow does not receive any treatment at all prior to disinfection. As discussed previously, this is contrary to normal plant operations and is in direct conflict with the proposed blending policy where a minimum of primary treatment is required. Further, the paper does not define a non-blending scenario in which the full wet weather flow is put through the secondary process. Using the same flow rate is necessary for determining relative risk of blending versus not blending.

3c. Determine Process Efficiency

In this step, the pathogen reduction efficiency of each unit process is characterized. The preferred approach for this type of analysis would consider the dependency of reduction efficiency on flow rate so that blending versus non-blending can be compared. The paper applies a fixed percent-removal efficiency to the primary sedimentation process. For the secondary processes, the paper assumes effluent levels that have no dependency on influent levels. This approach cannot account for the effects of flow increases on process efficiency, and thus cannot properly compare different flow routing scenarios. A particularly key assumption is the pathogen levels in the effluent of the biological nitrification towers, which reflect a 99% removal through this process that the authors do not support with data or research.

As with the previous step, the paper does not discuss the performance of the plant under conditions in which blending is prohibited, and 100% of the wet weather flow is sent through the rotating biological contactors and nitrification towers. The deterioration of performance typically seen in fixed-film biological processes that are hydraulically overloaded should not be ignored when comparing blending versus non-blending scenarios.

3d. Calculate Effluent Levels

A mass-balance approach is applied to determine the pathogen levels in the final, blended effluent. The paper does this correctly, albeit unconventionally. An assumption of no disinfection of viruses and protozoa is made. While this is rather conservative (the paper bases the assumption partly on the presence of chloramines, which is questionable, and partly on particle association, which is more substantive), it would not affect the relative risk comparison if the same assumption is made for both blending and non-blending scenarios.

4. Risk Characterization

In this step, a dose is determined and a probability of infection is calculated using a dose-response model. The paper assumes a 10-fold dilution of the effluent in a receiving water and the ingestion of 100 mL by a person recreating in the receiving water. The calculations in the paper's Appendix appear to have neglected the dilution, but as with the disinfection assumption this error would not affect the relative risk comparison if the assumption is made for both scenarios. It does, however, again reflect a lack of rigor in the analysis.

This section compares the risks calculated for a blended flow of 20 mgd with risks calculated, apparently from the Appendix, for a steady-state flow of 12 mgd. This comparison is inappropriate and has no relevance to the issue of authorizing blending of peak wet-weather flows in an NPDES permit versus requiring biological treatment of 100 percent of the same peak flows.

Conclusion

I agree that risk assessment can be a useful tool to demonstrate relative risks associated with different treatment technologies. Because of the significant unrealistic assumptions associated with this case study, however, it is inappropriate to extrapolate or infer anything from this exercise about the risks associated with implementing the proposed blending policy at this plant or any other plant. It is unfortunate that some have used the findings of this study to advocate that blending should be prohibited.

References

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Appendix A
Errors and Inappropriate Inferences associated between Waterborne Disease Outbreaks and Blended Effluent in the Katonak-Rose Report (Nov. 17, 2003)

March 7, 2005

It is improper to associate outbreaks of waterborne disease outbreaks in recreational waters with wastewater discharges, without recognizing the other venues for exposure (e.g., child-to-child transmission in pools, etc.)

- Page 6 and 7, Figure 2, the apparent increase in reports of waterborne disease outbreaks in the US from recreational water is not due to increased discharges of wastewater. Further investigation reveals that this is due to reported increases associated with "treated" venues (like chlorinated swimming pools) (Yoder et al. 2004).

- Page 6, although there are a significant number of laboratory-confirmed cases of Cryptosporidiosis, children-to-children transmission in swimming pools is likely responsible for the large number of reported cases. CDC indicates that "Crytosporidium is the leading cause of reported recreational water-associated outbreaks of gastroenteritis; transmission through recreational water is facilitated by the substantial number of Cryptosporidium oocysts that can be shed by a single person…and the prevalence of improper pool maintenance…particularly of children's wading pools." (Hlavsa et al. 2005).

- CDC's recommended guidelines for preventing and controlling cryptosporidiosis in recreational waters deal solely with preventing contamination of waters by adults and children recreating in the water. No mention is made of wet weather flow management for wastewater or other sources (Hlavsa et al. 2005).

Page 6, the paper makes no mention that "[i]nfected cattle are an important reservoir of C. parvum and therefore are substantial contributors to sporadic cryptosporidiosis." (Hlavsa et al. 2005).

Page 7, the fact that *Shigella* is associated solely with human feces and is one of the leading causes of recreational waterborne outbreaks in lakes and rivers does not mean that untreated wastewater was the source of the *Shigella*. Investigation into individual outbreaks showed that the likely source was human-to-human transmission associated with bathing areas at beaches or with interactive water fountains at water parks (Yoder et al. 2004 and Lee et al. 2002).

Page 8, the CDC has not specifically identified blended wastewater as contributing to the Milwaukee outbreak (EPA 2004). Investigators concluded that improper filtration at the southern water treatment plant led to the outbreak. Although the environmental source of cryptosporidium is not known, inferences include agricultural run-off, slaughterhouses, and untreated wastewater leaks (MacKenzie et al. 1994).

Pages 9-10, the summary conclusions about what is known about waterborne disease outbreaks neglect to discuss what is not known about swimming beach advisories and closings. The majority of advisories and closures are associated with stormwater runoff (21 percent) or unknown sources (43 percent) (EPA 2003).

Page 13, The statement "there is no program to monitor for these pathogens in sewage discharge" is misleading. The use of indicator bacteria, although imperfect, have been instrumental in administering the NPDES permitting program and the nation's ambient monitoring programs for surface and groundwater. These programs have reduced waterborne disease outbreaks. The obstacles associated with monitoring for individual pathogens in wastewater effluent and natural waters are significant (e.g., probability of occurrence of specific pathogens at any one time, expense of individual tests, detection levels being too high, etc.). Studies show that *E. coli* and enterococci exhibit a strong relationship to swimming-associated gastrointestinal illness.

Page 13, Table 2, *E. coli 0157:H7* and *E. coli* are found in animal feces as well as domestic sewage.

Page 18, properly operating water treatment plants are effective at removing cysts of enteric protozoa from treated water, as demonstrated by years of data.

Page 19, the discussion of concentrations of different pathogens in wastewater neglects to address the dilution of pathogens from stormwater inflow during significant rainfall events. Plants typically use blending for management of the larger wet weather events, when there is more dilution of influent. This is related to the ultimate dose in the receiving water.

Page 25, if an activated sludge plant does not nitrify, there should be no appreciable differences in the ammonia levels which would not affect the formation of chloramines.

Page 26, I am unaware that there is a requirement that wastewater be no more than 10 percent of flow in any waterbody. The source of this statement needs to be identified.

Page 27, the first paragraph discussing factors affecting pathogen survival neglected to mention that salinity tends to kill cysts and other pathogens due to osmotic pressure.

Page 30, the statement that "[p]rimary treatment is not effective in the removal of microbial pathogens" is an overstatement. Primary treatment has been shown to remove up to 50 percent of pathogens.

Page 30, the statement "UV disinfection is ineffective when wastewater contains any solids" is incorrect. The efficiency of UV disinfection is reduced by increased suspended solids and turbidity. The use of UV has been recognized as an appropriate disinfection technology for CSOs and recent advances in UV technology are addressing the limitations associated with increased solids.

Page 30, the statement “Cryptosporidium is not inactivated due to chlorination” is an overstatement. Chlorine in high doses is effective in inactivating Cryptosporidium.

Page 33, the statement “[i]t is a potential that there may be an increase in SSOs in the future” ignores the significant efforts by EPA, the states, and municipalities to reduce the frequency and magnitude of SSOs.

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Appendix B. Unrealistic Assumptions in the Katonak-Rose Risk Assessment Case Study Example