STATE WATER RESOURCES CONTROL BOARD
Recycled Water Research Needs Workshop
October 29, 2014

Thematic Topic #3: Ambient Water Effects

Definition of the Topic:

In addition to human health concerns, increased recycled water use may have consequences for the ambient environment. Changes in the amount, timing, and duration of discharges to streams and the ocean have the potential to affect biological communities by altering flow patterns and the concentrations of constituents present or being discharged into the environment. A need exists to develop a decision-making framework for balancing ecological needs against the goals of increasing sustainable water use.

Summary of the Issue:

Meeting the State of California's goals of sustainable local water supplies will require increased reuse of wastewater and the development of the capacity to reuse stormwater; however, each of these strategies could result in effects on the ambient environment.

The California Recycled Water Policy includes a goal of increasing stormwater reuse by 500,000 acre feet by 2020 and 1 million acre feet by 2030. Stormwater reuse could take many forms, from capturing peak flows for reuse to increased use of low flows and urban runoff. Increased stormwater reuse will alter flow characteristics, which has the potential for both positive and negative effects on stream environments. Ecological effects could be of greatest concern in streams that support important fishery resources, sensitive species, or habitats that rely on specific flow requirements. However, it will also be important to understand how changes in flow affect biological indicators, such as benthic invertebrates, that are routinely used for assessment and compliance purposes. On the positive side, reducing the amount of stormwater and/or urban runoff entering streams may be an important strategy for meeting existing water quality goals, such as Total Maximum Daily Loads (TMDLs) or Hydromodification Management requirements.

The increased reuse of wastewater may result in ambient effects in streams, estuaries, and the ocean. Urban runoff and wastewater effluent have replaced groundwater accretion, including spring flow, as the predominant sources of base flow in many urban streams and rivers. Ecological stress associated with decreased flows may occur with increased wastewater and stormwater reuse. However, the knowledge of flow-based impacts is minimal, particularly regarding arid streams where reuse needs are greatest. Increased wastewater recycling may also affect the ocean environment as the volume of wastewater discharged to the ocean decreases, but the mass of discharged constituents remains the same. The result could be increased concentrations of plume constituents, including salts, contaminants, or reclamation/disinfection

byproducts, potentially altering the current fate and transport of plumes (and, likely, resulting in impacts to biota).

State of the Knowledge:

Many studies have demonstrated that alterations of flow regime can be associated with changes in fish, amphibian, and macroinvertebrate communities. Although a basic understanding of the relationship between flow alteration and ecological response exists, few studies have provided mechanistic evidence on how specific ecological metrics respond to various degrees of flow alteration necessary for establishing instream flow requirements. Many states, including California, are beginning to use the *Ecological Limits of Hydrologic Alteration* (ELOHA) framework to support regional flow management programs. The States of New Jersey, Pennsylvania, and Ohio have recently proposed instream flow requirements based on this framework, and California is currently conducting ELOHA-based flow-ecology studies in the Sacramento-San Joaquin region (for fish) and in Southern California (for benthic macroinvertebrates). These studies will form a foundation for developing instream flow management programs that could be applied to recycled water policies.

Current wastewater outfalls are based on design flows that may be reduced by as much as two- to ten-fold, due to enhanced reuse. Outfall plume mixing and dilution has been a well-studied topic, and public domain models exist to support the recalculation of initial dilution (a critical element of regulatory compliance). However, the accuracy of the model may need validation if flows are sufficiently reduced to decrease full functionality of outfall engineering. There is also a need to increase our understanding of plume fate and transport because changes in density may alter current plume exposure due to varying buoyancy characteristics, advection distance from the outfall, and water column mixing or particle settling. Plume tracking to assess ecosystem exposure is less readily developed than initial dilution models, and wastewater agencies are just now developing and implementing new technology to quantitatively define plume presence in near-real time. Finally, current ecological effects from outfall plumes are relatively well-studied and routine monitoring approaches can assess any potential detrimental ecosystem impacts, although constituents of emerging concern may require unique approaches.

Research Needs:

1. Develop an assessment and management framework for considering effects on the ambient environment as part of recycled water polices. Include mechanisms to increase coordination among public and *private* agencies and programs.

2. Develop flow-ecology relationships to protect desired beneficial uses:
    a. Sensitive species.
    b. Fisheries.
    c. Benthic invertebrates and other bioassessment targets (e.g., algae).

3. Develop models to better predict how reduced flow may affect stream morphology in terms of the potential management of hydromodification effects.

4. Conduct studies to determine how recycled water practices can be designed to optimize flow management and application of best management practices to help meet water quality objectives.

5. Refine existing models (both Nearfield and regional circulation) and *in situ* measurements to assess the initial dilution and fate and transport of more concentrated (denser) wastewater plumes.

6. Investigate the effects of contaminants of emerging concern (including nanoparticles) on in-stream and marine and estuarine receiving water biological communities. Expand research on short- and long-terms effects of "new" constituents on biological communities:
    a. Chronic effects of higher salts and brines on marine benthic communities.
    b. Toxicity and bioaccumulation of advanced oxidation processes and disinfection byproducts on marine benthic communities.