Emerging Constituents Investigation Program for Santa Ana Watershed

1.0 Introduction

To protect human health and the environment, water quality is routinely monitored at tens of thousands of locations across the U.S. Samples are collected from rain water, storm water runoff, freshwater streams, lakes and reservoirs, groundwater wells and tap water to characterize the quality of various supply sources. Additional samples from the sewage collection systems are analyzed to ensure pollution prevention programs and wastewater treatment plants are meeting all federal and state water quality standards.

Most monitoring programs focus on a few hundred of the most common pollutants to assess overall water quality. These chemicals were selected from the larger universe of known chemicals because their was sufficient scientific evidence to indicate they may pose an increased risk to humans, plants or animals (including aquatic organisms) when they occur at elevated concentrations.

Several different state and federal regulatory agencies share responsibility for determining the "safe" concentration of various potential pollutants. This is a formidable task as there are, quite literally, an infinite number of chemical compounds that may be created by recombining the known elements in different proportions. Consequently, these agencies rely on sales/usage information and monitoring data to establish appropriate research priorities for setting new water quality standards.

Dramatic improvements in analytical technology have greatly increased the number of chemicals we can detect and the level at which we can detect them in any given water sample. Today, we are able to discover and quantify some potential pollutants in the range of one part-per-trillion (ppt). For perspective, one part-per-trillion is equivalent to identifying a plot of land the size of a postage stamp in an area the size of Texas.

This new found ability to detect such infinitesimally small chemical concentrations has fundamentally altered our understanding of what's in the water. Trace levels (approx. 1-100 ppt) of many different man-made chemicals, particularly pesticides, pharmaceuticals and personal care products, have been found nearly everywhere we looked. Collectively, these compounds are referred to as "Emerging Constituents" (ECs) because their presence is just starting to be revealed by rapid advances in analytical technology.[1]

1 Emerging Constituents is one of several similar phrases used to describe the same phenomena. Synonyms include: emerging contaminants of concern (CEC), chemicals of emerging concern, etc. Such phrases may mistakenly imply that it is the concern that is emerging rather than the knowledge that certain chemicals may be present in a water sample. Similarly, referring to such compounds as Emerging Pollutants or Emerging Contaminants may mistakenly imply that the levels detected pose a known hazard to people or the environment.

Once detected, the question naturally arises as to whether the water is safe or not. The California State Water Resources Control Board (SWRCB) recently convened a Blue Ribbon Panel of Experts to address this concern.[2] The Panel's mission is to recommend appropriate water quality monitoring strategies for ECs based on the best available pharmacological and toxicological information taking into consideration the fate and transport of such chemicals through the natural environment and existing wastewater treatment systems. The Panel is expected to complete its work in mid-2010.

2.0 Regulatory Context

In general, chemical compounds can be divided into two categories: regulated and unregulated. Regulated chemicals are those where a safe level has already been defined and codified as a formal water quality standard.[3] State and federal authorities may issue discharge permits or other orders governing the concentration of such compounds that can be released into the environment.

Unregulated chemicals are those for which no formal water quality standard has been developed. This is not to suggest that nothing is known of the safe level for such chemicals. Rather, these were assigned a lower priority for criteria development based on a wide variety of factors including: presence and persistence in the environment, existing pharmacological and toxicological data, similarity to other chemicals known to be hazardous, etc.

By definition, ECs fall into the category of unregulated chemicals. Because they were previously undetected, there was no urgent need to establish water quality standards for these compounds. Even now, the mere presence of such chemicals does not automatically imply new water quality standards are necessary. It does suggest that the Emerging Constituents should be evaluated along with all other potential pollutants to set priorities for developing such standards. To that end, some monitoring data is needed to characterize the presence and persistence of ECs throughout the water supply system.

The California Department of Health Services (now "Dept. of Public Health") began recommending that water and wastewater agencies analyze for a few select pharmaceutical and personal care products when the draft Groundwater Recharge Reuse Regulations were first proposed in the early 1990's. The draft regulations included various provisions to limit the influence of reclaimed water on nearby groundwater wells. The Department suggested sampling for various man-made chemicals that may indicate potential contamination by municipal or industrial wastewaters.

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2 SWRCB. Recycled Water Policy. Resolution No. 2009-0011 (adopted: 2/3/09). See also, www.sccwrp.org/xxxxxxxxx for a summary of the Blue Ribbon Panel's work in progress.

3 Water quality standards may be expressed as Maximum Contaminant Levels (MCLs) or as 304(a) Criteria or as Basin Plan Objectives, or as TMDL targets, or as wasteload allocations, or as effluent limits.

Over time, the Department of Public Health (DPH) revised the draft regulation to include a list of EC categories that should be monitored. The list included: hormones, pharmaceuticals, pesticides, common commercial and industrial chemicals. Within each category, DPH suggested specific ECs that typified that category. For example: common painkillers such as acetaminophen (aka "Tylenol"), ibuprofen (aka "Advil") were among the pharmaceuticals recommended.

Whenever and wherever the California Regional Water Quality Control Boards allowed large-scale groundwater recharge projects using reclaimed water, they accepted DPH's recommendation to include EC monitoring requirements in the associated permits. As the use of recycled water has increased, so have the number of permits containing such provisions.[4] By 2006, EC monitoring was on its way to becoming "boilerplate" in all NPDES permits and Waste Discharge Requirements (WDRs) even where only incidental recharge of reclaimed water was occurring.[5]

When questions arose as to the utility and feasibility of mandatory monitoring for unregulated chemicals, the SWRCB adopted the Recycled Water Policy and founded the aforementioned Blue Ribbon Panel of Experts to review the available science and make appropriate recommendations. The California Panel is only one of many different groups undertaking similar efforts. Recent news reports increased public awareness of the issue and provided impetus for an exponential increase in EC monitoring around the country.[6]

3.0 Current EC Monitoring Studies

Recently, several large-scale water quality characterization studies began monitoring for select ECs. The U.S. Geological Survey's National Ambient Water Quality Assessment (NAWQA) and Groundwater Ambient Monitoring Assessment (GAMA) is probably the largest and best known of these research efforts. Their preliminary results indicate the presence of ECs is nearly ubiquitous in the environment.

Subsequent studies focused more exclusively on ECs and detected the presence of such chemicals in both source waters and tap waters.[7] Follow-on research documented the same phenomena even in highly treated reclaimed waters.[8] Consequently, , a coordinated effort to characterize EC concentrations in the Santa Ana River watershed was initiated. The USGS has already collected and analyzed local groundwater samples as part of the GAMA program. So, while stakeholders waited for results from the USGS, three water agencies undertook a monitoring program to characterize EC concentrations in local surface waters (including water imported to the region from the State Water Project or the Colorado River).[9]

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Preliminary data from the Santa Ana investigation were consistent with previous studies and confirmed the presence of ECs in surface waters throughout the region (see Table 1). This finding is not surprising considering that reclaimed water often comprises more than 90% of the flow in the Santa Ana River.

TABLE 1: EC Characterization for Surface Waters of Santa Ana Region

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Low levels of ECs were also detected in the treated municipal wastewater discharged to the Santa Ana River system (see Table 2). This, too, is consistent with similar investigations performed elsewhere.

TABLE 2: EC Characterization for Municipal Effluents in Santa Ana Region

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Finally, trace concentrations of some ECs were also identified in water imported to the Santa Ana Region from the State Project or from the Colorado River (see Table 3).

TABLE 3: EC Characterization for Water Imported to the Santa Ana Region

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Given the ubiquitous presence of ECs, water and wastewater agencies throughout the Santa Ana region elected to continue their characterization studies and to coordinate those efforts with one another. This voluntary program is intended to supplement the existing knowledge base pending receipt of recommendations from the SWRCB's Blue Ribbon Panel.

4.0 Purpose

The primary purpose for continuing to monitor select ECs is to establish the baseline conditions. This information will help inform federal and state authorities regarding the presence and persistence of ECs in the environment. Such data can also be used to evaluate potential trends in water quality.

If DPH's final Groundwater Recharge Reuse Regulation continues to recommend EC monitoring as one means to indicate that a well may be under the influence of wastewater, then it is appropriate to gather more detailed data on which Emerging Constituents are most frequently found in municipal effluent and the receiving waters.

Previous research indicates that the individual ECs most likely to be detected vary with the level and type of wastewater treatment that occurs. Disinfection processes based on rapid oxidation (e.g. chlorination or ozonation) are known to reduce EC concentrations more effectively than ultraviolet radiation (UV). Similarly, some studies have shown that residual levels of pharmaceutical and pesticides can be reduced by increasing hydraulic residence time, increasing the sludge retention time or increasing the concentration of mixed-liquor suspended solids in the wastewater treatment processes. Additional information gleaned from monitoring ECs may be used to help improve overall effluent quality.

General data characterizing the concentration of ECs may also be a useful method for indicating the effectiveness of pollution prevention and source control programs. For example, the California Department of Pesticide Regulation (DPR) may rely on such information to assess the adequacy of current labeling regulations.

Because the analytical techniques used to support EC monitoring are still in the earliest stages of development, great care must be exercised when using the results. Given the inherent imprecision of these new methods and exceptionally low ambient concentrations data that is generated as part of a preliminary characterization study is not sufficiently accurate for more critical regulatory purposes such as: 303(d) listing decisions, antidegradation analyses, or translating narrative criteria into numeric effluent limits. These determinations also depend on detailed risk assessments that are not part of the general characterization study. However, the data from such studies is useful for determining which ECs should be prioritized for additional method development in order to support future regulatory regulatory determinations.

The water and wastewater agencies serving the Santa Ana region are committed to develop an EC investigation program that addresses the public's desire to know more about what's in their drinking water. To that end, the stakeholders agree to provide results from the study to those state and federal authorities responsible for performing risk assessments and establishing appropriate water quality standards.

Because analytical technology is constantly improving and our knowledge of which chemicals may pose an unacceptable risk to people and the environment is always growing, it is agreed that any EC investigation program must be regularly revised and updated. The water and wastewater agencies proposing to undertake this study effort are also committed to a process of adaptive management to ensure the EC monitoring program fulfills its stated purpose using the best available science.

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6) 2010-11 Characterization Study

A) Locations
   1) All POTWs (NPDES Permittees)
   2) State Project Water (Metropolitan)
   3) Colorado River Water (Metropolitan)
   4) Santa Ana River at MWD Crossing (OCWD)
   5) Santa Ana River at Prado Dam (OCWD)
   6) Select Stormwater Outfalls (MS4 Permittees)

B) Chemicals
   1) Acetaminophen
   2) Atrazine
   3) BPA
   4) Caffeine
   5) Carbamazepine
   6) DEET
   7) Estrone
   8) Gemfibrozil
   9) Ibuprofen
   10) Sulfamethoxazole
   11) TCEP

C) Schedule and Frequency
   1) POTWs - Annual
   2) Imported Water (SPW, CRW) - Annual
   3) Santa Ana River Sites - 2x/Year (One Dry Season, One Wet Weather)
   4) Stormwater Outfalls - 2x/Year (One Dry Season, One Wet Weather)

D) Method:
   1) LC-MS-MS with Isotope Dilution
   2) Expected Reporting Limits
   3) QA/QC Requirements

E) Reporting

F) Program Management (SAWPA)