STATE OF CALIFORNIA
REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION

STAFF REPORT FOR REGULAR MEETING OF SEPTEMBER 22-23, 2016
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ITEM NUMBER: **17**

SUBJECT: **Chemicals of Emerging Concern in Ambient Waters and Regulated Discharges**

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THIS ACTION: **Informational**

DISCUSSION

Chemicals of emerging concern (CECs) is a term used to denote a broad range of unregulated chemical compounds found at trace levels in many of our water supplies, including surface water, groundwater, drinking water, wastewater, and recycled water. Other terms include "constituents of emerging concern," "contaminants of emerging concern," "emerging constituents," "endocrine disrupting chemicals," and "pharmaceuticals and personal care products". CECs are increasingly being detected, typically at low levels, in surface water and groundwater, and there is concern that these compounds may have a negative effect on human health and the environment.

CECs enter the environment primarily through discharges of wastewater, recycled water and storm water. Because of a lack of information regarding CECs' effects on human health and the environment, drinking water standards and water quality objectives do not exist for CECs. Improved analytical techniques are making it easier to detect CECs, but until research and evaluation of health effects catches up, regulating CECs based on effluent or discharge limits or maximum contaminant levels will remain problematic. Other strategies for regulating CECs include legislation to eliminate usage of risky or problematic chemicals and proactive measures to keep these chemicals out of wastewater. See the EPA's and National Water Research Institute's websites for additional information.

Recycled Water

Recycled water policy: The State Water Board adopted the Recycled Water Policy in 2009. The purpose of the policy is to increase the use of recycled water from municipal wastewater sources. While adopting the policy, the State Water Board recognized that the state of knowledge regarding CECs is incomplete and that additional research is needed. The State Water Board convened an advisory panel to guide actions relating to CECs. The panel was tasked with answering the following questions (Recycled Water Policy, page 16):

- What are the appropriate constituents to be monitored in recycled water, including analytical methods and method detection limits?
- What is the known toxicological information for the above constituents?
- Would the above lists change based on level of treatment and use? If so, how?

- What are possible indicators that represent a suite of CECs? Such indicators are also known as surrogates.
- What levels of CEC's should trigger enhanced monitoring of CEC's in recycled water, groundwater and/or surface waters?

The panel produced several products to guide the state's recycled water management approaches. First, they developed a framework for prioritizing and selecting CECs for recycled water monitoring programs. The framework involved identifying and compiling measured environmental concentrations of various CECs and developing triggering levels based on toxicological evidence. CECs with measured concentrations greater than their triggering levels should be prioritized for monitoring. This framework was then applied to recommend a short list of monitoring parameters, including both health-based indicators (i.e., toxicologically relevant CECs) and performance-based indicators (i.e., CECs with representative physicochemical properties and structures tested to demonstrate a capacity for removal by a particular water treatment process). The list also incorporates CECs from multiple source classes (e.g., pharmaceuticals, personal care products, food additives, hormones). Four health-based indicators (17β-estradiol, triclosan, caffeine, and NDMA) and five performance-based indicators (gemfibrozil, DEET, caffeine, iopromide, and sucralose) were identified for recycled water used for groundwater recharge, while only three surrogate parameters were recommended for monitoring water used for landscape irrigation (turbidity, chlorine residual, and total coliform bacteria). The panel additionally developed guidance for interpreting and responding to monitoring results. The panel's final report is located here and includes much more detail.

The panel also recommended several key areas for future efforts. To overcome the limitations associated with measuring individual chemicals, the panel recommended use of bioanalytical screening tools, which use molecular and genetic techniques to test for different classes of toxicological effects. Other recommended future activities included (a) improving the recycled water CEC database through a comprehensive review of literature and occurrence studies outside California and (b) providing programmatic support for data management, application of the selection framework, and periodic review of the original monitoring recommendations.

The State Water Board subsequently modified the Recycled Water Policy to include the panel's recommendations. Groundwater recharge projects, which the regional water boards develop individually, must include the recommended CECs monitoring. The State Water Board has also adopted a general permit for irrigation with recycled water, which includes the recommended monitoring for processes that include disinfection.

Wastewater
Regulated discharges to groundwater and surface water of treated municipal wastewater may contain CECs. The Water Board prescribes requirements for these discharges using promulgated water quality standards. As noted above, water quality standards do not exist for CECs due to insufficient human health and ecological research to determine health-based exposure concentration limits for these compounds. As a result, there are no current or proposed monitoring programs for CECs in wastewater discharges in the Central Coast Region, resulting in a general lack of direct data on CECs in wastewater in our Region. However, other CEC monitoring is being done in ambient waters, as discussed below.

Ambient Waters
There are many CECs and pharmaceuticals and personal care products that act as so-called endocrine disruptors (EDCs). EDCs are compounds that alter the normal functions of hormones resulting in a variety of adverse health effects. EDCs can alter hormone levels leading to

reproductive effects in aquatic organisms, and evaluating these effects may require testing methodologies not typically available.

The emerging contaminants may also demonstrate low acute toxicity but cause significant adverse reproductive effects at very low levels of exposure. In addition, the effects of exposure to aquatic organisms during the early stages of life may not be observed until adulthood. Therefore, traditional toxicity test endpoints may not be sufficiently comprehensive for criteria derivation for these chemicals. These chemicals may also have specific modes of action that may affect only certain types of aquatic animals (e.g., vertebrates such as fish). In other words, currently used toxicity test methods may not adequately measure the adverse effects of many CECs.

A recent paper in the journal *Environmental Pollution* reported on the occurrence and concentration of CECs in three northwestern estuaries. See Attachment 1 for the complete paper.

Efforts to monitor and evaluate the presence of CECs in Central Coast ambient waters include:

- *Watershed-Scale Evaluation of Agricultural BMP Effectiveness in Protecting Critical Coastal Habitats*, Anderson et al., UC Davis, April 2010: This study evaluated the presence of agricultural chemicals in the Salinas, Santa Maria, and Pajaro river estuaries. Researchers sampled water, sediment, and biota tissue and identified a number of different contaminants in the lagoons, including some bioaccumulation in fish.

- Stream Pollution Trends (SPoT) monitoring: The SPoT program monitors trends in sediment toxicity and sediment contaminant concentrations in selected large rivers throughout California and relates contaminant concentrations and toxicity to watershed land uses. It is designed to improve our understanding of watersheds and water quality by monitoring changes in both over time, evaluating impacts of development, and assessing the effectiveness of regulatory programs and conservation efforts at the watershed scale.

  The overall goal of this long-term trends assessment is to detect meaningful change in the concentrations of contaminants and their biological effects in large watersheds at time scales appropriate to management decision making. Sediment toxicity and a suite of pesticides, trace metals, and industrial compounds have been analyzed from 100 sites annually since 2008.

  Monitoring generally shows increasing trends in pyrethroids, particularly bifenthrin, and particularly in urban areas. Fipronil and imidacloprid, new pesticides that are considered CECs, are also present at many sites.

- Neonicotinoid pesticides and toxicity: CCAMP and SPoT are adding neonicotinoid pesticides to chemistry analyses and are including additional toxicity tests to evaluate risk and effects locally. CCAMP monitoring will include both direct measurements of neonicotinoid concentrations in surface waters as well as toxicity tests using test organisms that are sensitive to neonicotinoid pesticides. The standard suite of toxicity test organisms will include *Chironomus* sp., a fly larvae known to be sensitive to this class of chemicals. Data show frequent detections of imidacloprid and pyrethroid pesticides in agricultural sites, with toxicity commonly found using *Hyalella* (an amphipod sensitive to pyrethroids) and *Chironomus*. The recently revised monitoring and reporting

programs for the irrigated lands program in 2017 includes monitoring of imidacloprid and toxicity testing using *Chironomus*.

- The Central Coast Long-Term Environmental Assessment Network, also known as CCLEAN, is a regional monitoring partnership funded by wastewater dischargers in the Monterey Bay area: CCLEAN samples wastewater effluent and ambient sediment and ocean water. Over the years, CCLEAN has published several reports on various CECs. For example, the 2008-2009 annual report found PCBs, DDT, dieldrin, polybrominated diphenyl ethers, and perfluorinated compounds in ocean water, river water, ocean sediment, and mussel tissue.

- *The Distribution of 4-Nonylphenol in Marine Organisms of North American Pacific Coast Estuaries*, Diehl, et al., Cal Poly: This study measured nonlyphenol levels in seawater, sediment, and tissues of 12 organisms in Morro Bay. Biomagnification, or increasing concentrations up the food web, was observed between three trophic links: mussel to sea otter, oyster to sea otter, and arrow goby to staghorn sculpin.

The State Water Board tasked the same scientific advisory panel that was looking at CECs in recycled water to make recommendations for monitoring CECs in aquatic ecosystems, including inland surface waters, estuaries, wetlands, and the ocean. In its final report, the panel provided four products intended to assist the state in developing a monitoring process for CECs:

1. A conceptual, risk-based approach to assess and identify CECs for monitoring in California receiving waters
2. Application of the risk-based screening framework to identify a list of CECs for initial monitoring
3. An adaptive, phased monitoring approach with interpretive guidelines that direct and update actions commensurate with potential risk.
4. Research needs to develop bioanalytical screening methods, link molecular responses with higher order effects, and fill key data gaps

The State Water Board is currently working on a statewide CEC pilot study monitoring plan to generate data to inform the Water Board of the status and trends of CECs in water. The plan is designed to narrow the data gap among regions by producing comparable CEC data throughout the state. The pilot study will be implemented in three regions, Southern California, San Francisco Bay, and Delta/Central Valley. It will measure concentrations of CECs in water, sediment, and tissue in inland freshwaters, embayments, and the ocean. In addition, bioanalytical tools will be implemented to determine the adverse impacts of CECs on aquatic species.

Groundwater

Ambient groundwater monitoring efforts in the Central Coast region include the State Water Board's Groundwater Ambient Monitoring and Assessment Program (GAMA) and the Central Coast Water Board's Groundwater Assessment Program (GAP). Neither of these programs includes regular, ongoing CEC data collection efforts. However, GAMA, in association with the United State Geologic Survey, has undertaken a limited number of special studies to evaluate the presence of CECs in groundwater. For example, *Validation of an Endocrine Disrupting Chemical (EDC) Microarray Gene Chip for the Detection of EDC Mixtures in Ambient Water* reports on an innovative bioassay method used to test groundwater from a domestic well near a septic system for the presence of endocrine disrupting chemicals. The results strongly suggested the presence of complex mixtures of EDCs in the groundwater samples.

Drinking Water Program: The Division of Drinking Water currently does not require any CEC monitoring of drinking water sources.

CONCLUSION

CECs have been an under-evaluated aspect of water quality protection for several decades, and the State Water Board and other state and federal agencies have struggled with the complexity of collecting adequate data, establishing appropriate discharge levels, and constructing a regulatory framework for these compounds. The traditional approach with most chemicals has been ambient monitoring to determine if the chemicals are present in the environment, research on human and environmental effects, establishment of water quality standards, and finally the development of discharge permit requirements. With respect to CECs, this traditional approach is not necessarily adequate. It may be fiscally impossible to identify all CECs and their effects on human health and the environment, and therefore it may be impossible to establish water quality standards. Moreover, for some of these emerging chemicals it may not be fiscally possible to implement treatment controls. Ongoing research is necessary to determine which chemicals can be dealt with via traditional methods (treatment to achieve water quality standards) versus those chemicals that must be dealt with using other approaches.

Non-traditional approaches such as legislation to eliminate the usage of highly risky compounds and proactive avoidance strategies, such as preventing compounds from entering waste streams, are critical to decreasing the prevalence of CECs in the environment. These approaches have proven effective in specific examples in the state (i.e., banning or phasing out compounds, pharmaceutical capture by pharmacies).

Policy-setting and research agencies and organizations continue to study aspects or specific compounds associated with this problem, although likely at an inadequate pace to keep up with the growing number of CECs. However, the Central Coast Water Board and Board members can continue to act by encouraging research, policy initiatives, and local actions, such as pharmaceutical disposal programs.

COMMENTS

Dr. Edo McGowan submitted some information, which is included as Attachment 2. Dr. McGowan again raises the issue of CECs, including antibiotic-resistant pathogens, in wastewater effluent and recycled water. In response to similar comments, staff pointed out that wastewater dischargers are in compliance with their permits and that we don't have water quality standards to regulate the chemicals discussed by Dr. McGowan, and that the CEC situation is an ongoing challenge. Dr. McGowan's concerns reflect the current situation with CECs as discussed in this report.

ATTACHMENT

1. *Contaminants of Emerging Concern in a Large Temperate Estuary*, J. Meader et al., Environmental Pollution, Volume 213, 2016.
2. Comments from Dr. McGowan

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