Orange County's Groundwater Replenishment System: Water Quality Monitoring and Facility Expansion in the Face of Changing Regulations

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ABSTRACT

The Groundwater Replenishment System (GWRS) is a 70 MGD indirect potable reuse project located in Fountain Valley, California. Two ongoing state regulatory processes have the potential to influence operations and water quality monitoring for GWRS and other groundwater recharge reuse projects (GRRPs) in California. The first is the effort by the State Water Resources Control Board (SWRCB), in collaboration with the California Department of Public Health (CDPH), to establish monitoring requirements for constituents of emerging concern (CECs), such as pharmaceuticals and personal care products (PPCPs) and endocrine disrupting compounds (EDCs), for GRRPs. The second process is the legislative mandate for formal adoption of the CDPH Draft Groundwater Recharge Reuse Regulations (Draft Regulations) by December 2013. OCWD's current treatment processes and monitoring programs should address most, if not all, of the immediately forthcoming CEC testing requirements. However, potential changes to requirements for subsurface retention time, blending, and unit process monitoring would impact future GWRS operations and uses.

KEYWORDS: Reuse, Recharge, Indirect, Micropollutants, Legislation

INTRODUCTION

A joint project between the Orange County Water District (OCWD) and the Orange County Sanitation District (OCSD), the Groundwater Replenishment System (GWRS) features a 70 MGD, $481 million indirect potable reuse advanced water purification facility (AWPF) located in Fountain Valley, California. GWRS has been online and operated by OCWD since January 2008 and employs an advanced treatment proceas featuring microfiltration (MF), reverse osmosis (RO), and an ultraviolet light-advanced oxidation process (UV-AOP). Water produced by GWRS supplies the nearby Talbert Gap Seawater Intrusion Barrier (Talbert Barrier) for direct aquifer injection and surface spreading basins in Anaheim, California for groundwater recharge. Construction of a 30 MGD expansion to GWRS is scheduled to begin in Fall 2011.

CURRENT GWRS PERMIT REQUIREMENTS

The GWRS project is permitted under a California Regional Water Quality Control Board, Santa Ana Region (RWQCB) Order No. R8-2004-0002 and as amended by Order No. R8-2008-0058 (RWQCB, 2004) (RWQCB, 2008). The permit not only contains

RWQCB regulations and limits, but also contains CDPH "Conditions" based on "Findings of Fact" from a 2003 CDPH public hearing on the project. This approach was and remains consistent with the 1997 Memorandum of Agreement (MOU) between the State Water Resources Control Board (SWRCB) and CDPH on the use of reclaimed water (CDPH & SWQCB, 1997). The GWRS permit contains the following important requirements for subsurface retention time and blending:

- *A six-month retention time buffer area with a minimum 500-foot separation between the surface spreading basins and the nearest downgradient drinking water production well.* OCWD established this buffer area via multiple artificial tracer tests conducted at these basins prior to the onset of GWRS water recharge (LLNL, 2004; Clark, 2009).

- *A one-year retention time buffer area with a minimum 2000-foot separation between the Talbert Barrier and the nearest downgradient production well.* OCWD established this buffer area on the basis numerical groundwater flow and advective transport modeling (OCWD, 2000).

- *A Recycled Water Contribution (RWC) limit of 75% at the surface spreading basins, requiring blending of recycled water with other sources of non-wastewater origin*. RWC is calculated as a 60-month flow-weighted running average percentage of GWRS water recharge relative to other recharge of non-wastewater origin (e.g., MWD imported water and Santa Ana River stormflow) percolated in the same vicinity.

- *An RWC limit of 75% at the Talbert Barrier, with provisions for an increase to 100% if certain conditions are met.* RWC is calculated as a 60-month flow-weighted running average percentage of GWRS water injection relative to other injection supplies of non-wastewater origin (e.g., MWD imported water). OCWD was granted CDPH and RWQCB approval for 100% RWC at the Talbert Barrier in November 2009 after fulfilling the stated permit requirements. This represented the first approval of 100% RWC for a California GRRP.

The permit also contained requirements that OCWD include endocrine disrupting compounds (EDCs), pharmaceuticals and personal care products (PPCPs), and tentatively identified compounds (TICs) in its GWRS water quality monitoring program; these compounds are collectively referred to as constituents of emerging concern (CECs). Additional CDPH guidance on the appropriate development of CEC monitoring programs was provided in Endnote 5 for the CDPH Draft Groundwater Recharge Reuse Regulations (Draft Regulations) (CDPH, 2003). While Endnote 5 did not formally require specific CECs for monitoring, it included four separate lists of individual CECs that Groundwater Recharge Reuse Projects (GRRPs) like GWRS "should investigate" under the following category headings: hormones, industrial EDCs, PPCPs, and other chemicals suggesting the presence of wastewater. Endnote 5 further stated that the "specific [CECs] targeted for monitoring would likely vary among GRRPs" due to site-specific factors (e.g., treatment processes, source water, groundwater basin characteristics, local public perception concerns, etc.) and that such monitoring "[would not be] for compliance purposes, but for informational use only." The majority of the CECs listed in Endnote 5 were incorporated into the GWRS monitoring program.

ADDITIONAL GUIDANCE ON GWRS CEC MONITORING

In addition to the suggestions provided by CDPH via Endnote 5, OCWD also sought the advice of the GWRS Independent Advisory Panel (IAP) on the development of a CEC monitoring program. Comprised of experts in a variety of relevant fields (e.g., wastewater engineering, chemistry, hydrogeology, toxicology, etc.), the IAP is convened under the auspices of the National Water Research Institute (NWRI), a non-profit organization devoted to addressing water supply and water quality issues through sponsored and cooperative research. The IAP has met regularly since 2004 and the GWRS permit requires annual meetings during the first five years of operations to review operational, water quality, and reliability issues. Recommendations from the IAP concerning the GWRS CEC monitoring program have included the following (NWRI, 2007; NWRI, 2010a):

- The CEC monitoring plan should be project-specific
- The monitoring should generally have three distinct purposes:
  - Identify organic constituents of potential public health risk.
  - Determine the removal efficiency of treatment processes.
  - Determine the presence/concentration of compounds of public interest.
- The purpose for monitoring a CEC should be explicit
- The concept of using indicators/surrogates in lieu of sampling large numbers of unregulated chemicals of health concern is a reasonable approach but needs to be tailored specifically to GWRS

PENDING SWRCB CEC MONITORING REQUIREMENTS

The SWRCB's 2009 Recycled Water Policy was developed after many years of negotiation with both the environmental community and water recycling agencies (SWRCB, 2009). The Policy included a requirement for the SWRCB to assemble a "Blue-Ribbon" Science Advisory Panel (SAP) that, in consultation with CDPH, would help guide future CEC monitoring requirements for recycled water projects in California. The six-member expert SAP was convened over a 12-month period and produced a final report in June 2010 with the following significant highlights and recommendations relevant to GRRPs like GWRS (Drewes et al., 2010):

- The Panel developed a framework to initially determine which CECs should be monitored in recycled water. The method involves comparing measured environmental concentrations (MEC) or predicted environmental concentrations (PECs) to health risk-based monitoring trigger levels (MTLs). Those CECs having a MEC/MTL ratio >1 would prioritized for health-based monitoring.

- Using the Panel's framework, the following four CECs were proposed for health-based monitoring of all GRRPs:

    - *N-Nitrosodimethylamine (NDMA)*: a propellant and disinfection byproduct that is that is also found in cured meats and beer
    - *17β-estradiol*: a steroid estrogen that is naturally excreted by humans
    - *Caffeine*: a natural stimulant
    - *Triclosan*: an antimicrobial found in toothpaste and hand soap

- The Panel recommended monitoring of the following CECs and bulk parameters at GRRPs like GWRS, representing advanced treatment process (i.e., RO/UV-AOP) performance indicators and surrogates, respectively:

    Indicators
    - *N,N-diethyl-m-toluamide (DEET)*: an insect repellent effectively removed (>90%) by RO
    - *Sucralose*: an artificial sweetener effectively removed (>90%) by both RO and AOP
    - *NDMA*: a propellant and disinfection byproduct moderately removed (25-50%) by RO, but effectively treated by UV (>90% removal)
    - *Caffeine*: a natural stimulant well removed (>90%) by both RO and AOP

    Surrogates
    - *Electrical conductivity*: surrogate for performance and integrity monitoring of RO membranes, can be measured online in real time
    - *Dissolved Organic Carbon:* surrogate for organics removal performance of RO membranes, can be measured online in real time

At a public hearing on held in December 2010, SWRCB staff proposed draft CEC monitoring requirements for GRRPs based on its interpretation of the 2009 Recycled Water Policy and the 2010 SAP final report. Representatives from a wide variety of water recycling agencies, including OCWD, provided testimony at the hearing and subsequent written comments that generally supported the SAP process, but also highlighted instances where the SWRCB staff had disregarded and/or misinterpreted important aspects of the supporting documents, including:

- Allowing individual Regional Boards the independent discretion to require monitoring for additional CECs beyond those recommended by the SAP or CDPH on a project-specific basis. One of the main purposes of the Recycled Water Policy was to bring consistency and clarity to CEC monitoring, and to prevent Regional Boards from inappropriately developing their own monitoring requirements.

- The addition of 13 additional required constituents for monitoring beyond the four health-based CECs proposed by the Panel. The additional constituents appeared to be based on CDPH recommendations specific to surface spreading recycled GRRPs. However, unlike the four CECs proposed by the SAP, no specific rationale for their inclusion was provided, creating confusion among stakeholders.

It was noted that, under current law, CDPH may independently require additional monitoring at individual GRRPs, so clarification was requested regarding the purpose for including the CDPH constituents within the proposed SWRCB requirements

- Assigning the same monitoring requirements to GRRPs employing the surface spreading of either tertiary treated effluent or recycled water receiving advanced treatment (e.g., RO/UV-AOP), while proposing different requirements for the direct injection of advanced treated water. This would result in inappropriate and burdensome requirements to collect performance indicator data for soil-aquifer treatment (SAT) processes that aren't relevant to the surface spreading of advanced treated water. The monitoring requirements for GRRPs employing advanced treatment should be consistent, regardless of the method of recharge used.

- Failure to identify the SAPs likely inappropriate use of overly conservative MTLs for caffeine and triclosan obtained from the 2008 Australian Guidelines for Water Recycling (EPHC et al., 2008). The Australian Guidelines developed these levels using Thresholds of Toxicological Concern (TTCs), which are not intended to be used in risk assessments for compounds with previously well-established toxicological characterization, but instead to prioritize toxicological data development for compounds lacking such information (NWRI, 2010a)

To date, the SWRCB is continuing to gather input from stakeholders, individual RWQCBs, and CDPH in support of revising the proposed draft CEC monitoring requirements for GRRPs, with final adoption projected to occur in late 2011 or early 2012.

CDPH GROUNDWATER RECHARGE REUSE REGULATIONS

Since their inception in the late 1980s, the CDPH Groundwater Recharge Reuse Regulations (Draft Regulations) have been updated several times and used as the basis for CDPH conditions contained within GRRP permits issued by RWQCBs, but have yet to be formally proposed, finalized, and official adopted into California law. The most recent update of the Draft Regulations occurred in August 2008 (CDPH, 2008). Subsequently, in 2010 the California legislature passed Senate Bill (SB) 918 requiring CDPH to adopt uniform water recycling criteria for indirect potable water reuse for groundwater recharge by the end of 2013. In response, CDPH staff has begun efforts to revise the current Draft Regulations in preparation for their formal adoption. On the basis of comments made by OCWD and other stakeholders previously on the current Draft Regulations, as well as operational experience at existing GRRPs, it is anticipated that many important requirements may be updated prior to the final adoption, including some of the following conditions:

Subsurface retention time requirements: The current Draft Regulations require a minimum of six months of underground retention time prior to extraction for potable use, with a stated rationale of control of pathogenic microorganisms. Furthermore, the retention time must be demonstrated via an artificial tracer test conducted under representative subsurface hydraulic conditions prior to the third month of initial GRRP operations. However, it has been generally recognized that GRRPs like GWRS which use advanced treatment processes (e.g., MF/RO/UV-AOP) employ multiple engineered treatment barriers with sufficient log-reduction for pathogens such that additional credit for subsurface treatment is unnecessary. For these GRRPs, a shorter retention time requirement leads to smaller buffer areas excluding potable groundwater extraction that are easier to define and allow fore badly need flexibility in recharge facility and well siting, while still allowing for sufficient time to react to a treatment process upset. The strict requirement for an artificial tracer test may also need to be reconsidered given the phase out of permitted sulfur hexafluoride (SF_6) usage, CDPH's suggested artificial tracer, under California AB 32 greenhouse gas regulations. OCWD has demonstrated the robustness of both intrinsic tracers and numerical groundwater flow/transport models to accurately determine recycled water residence times (DDBE, 2009)

Blending/RWC/TOC requirements: The current Draft Regulations require new GRRPs to begin operations with an initial RWC limits of 20% for surface spreading projects using tertiary treated effluent and 50% for the direct injection of advanced treated recycled water, with a series of more challenging requirements to progressively increase the RWC limit up to 100%. The GRRPs RWC also determines the allowable wastewater-derived TOC limits by the following relationship:

$$TOC_{\max} = \frac{0.5 mg/L}{RWC}$$

In the case of GRRPs employing advanced treatment, it has been demonstrated that TOC concentrations <0.5 mg/L can be consistently obtained using modern thin film composite polyamide RO membranes and that blending provides no measurable reduction in public health risk (NWRI, 2010a). Combined with the reduced availability of potable imported water blending in Southern California during the recent drought years, it is possible that these requirements may be eliminated and or at least relaxed to allow for reduced blending by increasing the allowable RWC or extending the current 60-month period for its calculation. This would be consistent with CDPH's recent modification to the RWC calculation methodology used by Inland Empire Utilities Agency (IEUA) for their recycled water recharge program featuring the surface spreading of filtered and disinfected tertiary effluent. After review and concurrence with the proposed methodology by an NWRI IAP assembled to address this specific issue at the request of CDPH (NWRI, 2010b), IEUA was granted a permit modification to increase to the RWC calculation interval to 120 months and to allow for the inclusion of groundwater underflow as a diluent water.

Unit process performance monitoring: Other than the use of TOC monitoring to track the performance of the SAT process in tertiary treated filtered and disinfected effluent surface recharge projects, the only substantial unit process performance requirements in the current Draft Regulations are for the UV-AOP process to provide, at minimum, a level of treatment equivalent to a 1.2 log NDMA reduction and 0.5 log 1,4-dioxane reduction, without regard to if NDMA or 1,4-dioxane are actually present at the GRRP. Given recent developments in and greater acceptance of treatment performance surrogates and indicators (Drewes et al., 2008; Drewes et al., 2010), general requirements for this type of monitoring may be incorporated in-lieu of or in addition to the aforementioned UV-AOP standards, and could be extended to the MF and/or RO processes.   Such monitoring employed can be employed via Hazard Analysis and Critical Control Points (HACCP) systems that are commonly used for quality assurance in the food and beverage industry, as well as in the recycled water industry in Australia (EPHC et al., 2008).

CEC monitoring: In light of the time since the original Endnote 5 CEC monitoring guidance was provided and ongoing involvement in developing the SWRCB CEC monitoring requirements, CDPH is likely to update the Draft Regulations' individual GRRP-specific CEC monitoring guidelines and requirements.

GWRS CEC MONITORING

OCWD currently tests GWRS Final Product Water (GWRS-FPW) and downgradient monitoring wells for a comprehensive list of CECs during regular quarterly permit compliance monitoring. Table 1 presents OCWD's current CEC monitoring program targets.

Table 1: Current OCWD CEC Target List

CEC	RDL	Units		CEC	RDL	Units
Caffeine	3	ng/L		para-Chlorobenzene sulfonic acid	200	ng/L
Carbamazepine	1	ng/L		Bisphenol A	0.2	ug/L
Ibuprofen	1	ng/L		4-Nonylphenol	0.2	ug/L
Gemfibrozil	1	ng/L		4-n-Octylphenol	0.2	ug/L
Triclosan	1	ng/L		4-tert-Octylphenol	0.2	ug/L
Azithromycin	1	ng/L		Estrone	1	ng/L
Acetaminophen	5	ng/L		Epitestosterone (cis-testosterone)	1	ng/L
N,N-diethyl-m-toluamide (DEET)	1	ng/L		Testosterone (trans-)	1	ng/L
Primidone	1	ng/L		Estriol	1	ng/L
Sulfamethoxazole	1	ng/L		17a-Estradiol	1	ng/L
Diclofenac	5	ng/L		17b-Estradiol	2	ng/L
Erthromycin	1	ng/L		17a-ethynylestradiol	2	ng/L
Fluoxetine	5	ng/L		Progesterone	1	ng/L
Naproxen	5	ng/L		Diethylstilbestrol	1	ng/L
Trimethoprim	5	ng/L		Pentachlorophenol	0.2	ug/L
Dilantin	10	ng/L		4-Phenylphenol (4-Hydroxybiphenyl)	0.2	ug/L
Simazine	0.005	ug/L		Tetrabromobisphenol A	0.2	ug/L
Atenolol	5	ng/L		Iohexol	20	ng/L
Atrazine	0.001	ug/L		Iopromide	10	ng/L
Linuron	0.005	ug/L		Sucralose	100	ng/L
Meprobamate	5	ng/L		Aspartame	100	ng/L
Tris-2-chloroethyl phosphate (TCEP)	5	ng/L		Neotame	10	ng/L
Diuron	0.005	ug/L				

The targets are all analyzed using at OCWD's Advanced Water Quality Assurance Laboratory using a single Liquid Chromotography Quadrapole Mass Spectrometry (LC/MS/MS) method featuring isotope dilution on an AB Sciex 4000 QTRAP system. Samples are collected in a single 2.5 liter amber bottle preserved with sodium azide and ascorbic acid. It should be noted that this method serves not only for GWRS monitoring purposes, but also is used by OCWD to monitor its other major source of recharge, the Santa Ana River. The river is an effluent-dominated system that diverted by OCWD for recharge via surface spreading. As such, the CEC target list contains parameters that are appropriate for monitoring multiple recycled water recharge treatment processes including SAT, RO, and UV-AOP.

The CECs included and their associated Reportable Detection Limits (RDLs) have also changed as the method and analytical instrumentation have been optimized over time. For example, the included hormones (e.g., estrone, 17b-Estradiol, etc.) initially featured RDLs of 10 ng/L but now can be reliably quantified down to 1-2 ng/L. CECs have been dropped from the program due to poor quantification (e.g., 2,4,6 trichlorophenol, saccharin, acesulfame) or desire to reduce the number of methods (e.g., nonylphenol diethoxylate, total nonylphenol ethoxylates) while still covering a broad array of CEC categories. Targets such as Bisphenol-A have proven challenging to quantify when solid phase extraction (SPE) cartridges have been shared with other methods; dedicating SPE systems to the CEC method has improved recoveries and reduced cross-contamination such that Other CECs such as artificial sweeteners (e.g., sucralose, aspartame, neotame) and iodinated phase contrast media (iohexal, iopromide) have recently been added. Under guidance from the GWRS IAP and others, additional CEC targets such as perfluorooctanoic acids (PFOAs), perfluorooctanessulfonate acids (PFOS), perflouralkyl acids (PFAAs) are being evaluated for inclusion in the program.

FOCUSED GWRS CEC TESTING

At the request of the GWRS IAP, OCWD conducted six 24-hour composite CEC testing events between December 2009 and June 2010 at the GWRS AWPF. The testing covered the OCSD activated sludge (AS), trickling filter (TF), and combined (Q1) influent source waters , as well as the multi-barrier advanced treatment trains. Results were generally consistent across the sampling events and the June 24, 2010 results provided are Table 2 and indicate the following general trends:

- TF effluent contained significantly higher concentrations of caffeine, ibuprofen, gemfibrozil, tricolsan, acetaminophen, and naproxen as compared to AS effluent, while concentrations of the more recalcitrant primidone and carbamazepine compounds were generally similar. The AS process was being run in a nitrification-partial denitrification mode during testing.

- Removal of triclosan, sulfamethoxazole, estriol, and estrone were observed between Q1 and the MF Feed (MFF), likely due the addition of NaOCl as required to form a chloramine residual carried through the AWPF. These results confirm past studies indicating that these constituents can be effectively removed via chemical oxidation.

- The vast majority of CECs tested are non-detect (ND) at their respective RDLs in RO permeate (ROP). This is indicative of the effective organics removal provided by RO with molecular weights greater than 100-150 daltons. Those compounds detected in ROP in Table 2 occurred a very low ng/L concentrations and were not consistently detected across the multiple sampling events. Furthermore, those detected were generally are those PPCPs in most commonly found in the environment (e.g., caffeine, DEET, ibuprofen, etc.), suggesting the possibility of inadvertent and/or unavoidable contamination during sampling or laboratory analysis.

- All CECs were consistently non-detect in UV-AOP product water (UVP) and GWRS-FPW during the June 24, 2010 event and throughout the focused study, indicating effectiveness of the multiple treatment barriers used at GWRS. Occasional UVP and GWRS-FPW CEC detections have occurred during regular quarterly monitoring events at, but they have been of the same ubiquitous CECs at the same low ng/L levels found in the ROP results discussed above and occur sporadically and inconsistently.

Table 2: 24-hour composite CEC results at GWRS AWPF, collected on 6/24/10

TestName	RDL	Units	AS OCSD Effluent	TF OCSD Effluent	GWRS-Q1 GWRS Influent	GWRS-MFF MF Feed	GWRS-MFE MF Effluent	GWRS-ROF RO Feed
Caffeine	3	ng/L	ND	5730	1060	886	1050	1190
Carbamazepine	1	ng/L	264	256	263	259	265	250
Ibuprofen	1	ng/L	11	1330	280	254	292	352
Gemfibrozil	1	ng/L	608	1470	802	704	678	778
Triclosan	1	ng/L	136	666	324	106	113	101
Azithromycin	1	ng/L	386	373	391	343	332	351
Acetaminophen	5	ng/L	ND	776	78.4	163	205	238
N,N-diethyl-m-toluamide	1	ng/L	498	644	528	541	501	552
Primidone	1	ng/L	100	103	100	103	103	100
Sulfamethoxazole	1	ng/L	2290	1510	2130	1020	1500	1360
Diclofenac	5	ng/L	341	310	300	234	260	273
Erthromycin	1	ng/L	147	147	148	131	139	138
Fluoxetine	5	ng/L	27	25	25	23	19	21
Naproxen	5	ng/L	294	3420	872	652	705	780
Trimethoprim	5	ng/L	457	443	424	269	320	328
Dilantin	10	ng/L	194	210	197	165	173	152
Simazine	5	ng/L	12	11	10	11	11	12
Atenolol	5	ng/L	624	619	555	530	548	606
Atrazine	1	ng/L	2	1	1	1	1	2
Linuron	5	ng/L	ND	ND	ND	ND	ND	ND
Meprobamate	5	ng/L	439	423	401	408	389	444
Tris-2-chloroethyl phosphate	5	ng/L	347	382	338	337	347	353
Diuron	5	ng/L	68	71	66	66	72	73
para-Chlorobenzene sulfonic acid	200	ng/L	ND	ND	ND	ND	ND	ND
Bisphenol A	100	ng/L	ND	112	ND	108	ND	ND
4-Nonylphenol	100	ng/L	ND	ND	ND	ND	ND	ND
Estrone	1	ng/L	40	64	41	15.8	22	24.5
Epitestosterone (cis-testosterone)	1	ng/L	ND	ND	ND	ND	ND	ND
Testosterone (trans-)	2	ng/L	ND	ND	ND	ND	ND	ND
Estriol	1	ng/L	ND	27	3.9	ND	1.3	2.3
17a-Estradiol	1	ng/L	ND	1.6	ND	ND	ND	ND
17b-Estradiol	2	ng/L	ND	6.0	2.5	ND	ND	ND
17a-ethynylestradiol	2	ng/L	ND	ND	ND	ND	ND	ND
Progesterone	1	ng/L	ND	ND	ND	ND	ND	ND
Diethylstilbestrol	1	ng/L	ND	ND	ND	ND	ND	ND

TestName	RDL	Units	GWRS-ROP RO Product	GWRS-UVF UV Feed	GWRS-UVP UV Product	GWRS-DPW Decarb PW	GWRS-FPW Final Product	Site Blank @ FPW
Caffeine	3	ng/L	5.2	6.4	ND	ND	ND	ND
Carbamazepine	1	ng/L	ND	ND	ND	ND	ND	ND
Ibuprofen	1	ng/L	ND	ND	ND	ND	ND	ND
Gemfibrozil	1	ng/L	ND	ND	ND	ND	ND	ND
Triclosan	1	ng/L	6.2	ND	ND	ND	ND	ND
Azithromycin	1	ng/L	ND	ND	ND	ND	ND	ND
Acetaminophen	5	ng/L	15	6.0	ND	ND	ND	ND
N,N-diethyl-m-toluamide	1	ng/L	4.0	1.2	ND	ND	ND	ND
Primidone	1	ng/L	ND	ND	ND	ND	ND	ND
Sulfamethoxazole	1	ng/L	1.2	ND	ND	ND	ND	ND
Diclofenac	5	ng/L	ND	ND	ND	ND	ND	ND
Erthromycin	1	ng/L	ND	ND	ND	ND	ND	ND
Fluoxetine	5	ng/L	ND	ND	ND	ND	ND	ND
Naproxen	5	ng/L	ND	ND	ND	ND	ND	ND
Trimethoprim	5	ng/L	ND	ND	ND	ND	ND	ND
Dilantin	10	ng/L	ND	ND	ND	ND	ND	ND
Simazine	5	ng/L	ND	ND	ND	ND	ND	ND
Atenolol	5	ng/L	ND	ND	ND	ND	ND	ND
Atrazine	1	ng/L	ND	ND	ND	ND	ND	ND
Linuron	5	ng/L	ND	ND	ND	ND	ND	ND
Meprobamate	5	ng/L	ND	ND	ND	ND	ND	ND
Tris-2-chloroethyl phosphate	5	ng/L	ND	ND	ND	ND	ND	ND
Diuron	5	ng/L	ND	ND	ND	ND	ND	ND
para-Chlorobenzene sulfonic acid	200	ng/L	ND	ND	ND	ND	ND	ND
Bisphenol A	100	ng/L	ND	ND	ND	ND	ND	ND
4-Nonylphenol	100	ng/L	ND	ND	ND	ND	ND	ND
Estrone	1	ng/L	ND	ND	ND	ND	ND	ND
Epitestosterone (cis-testosterone)	1	ng/L	ND	ND	ND	ND	ND	ND
Testosterone (trans-)	2	ng/L	ND	ND	ND	ND	ND	ND
Estriol	1	ng/L	ND	ND	ND	ND	ND	ND
17a-Estradiol	1	ng/L	ND	ND	ND	ND	ND	ND
17b-Estradiol	2	ng/L	ND	ND	ND	ND	ND	ND
17a-ethynylestradiol	2	ng/L	ND	ND	ND	ND	ND	ND
Progesterone	1	ng/L	ND	ND	ND	ND	ND	ND
Diethylstilbestrol	1	ng/L	ND	ND	ND	ND	ND	ND

CONCLUSIONS

Both the RWQCB and CDPH are in the process of advancing new and/or updated regulations related to the monitoring and operation of GRRPs in California. Many of these regulations are related to CEC monitoring and OCWD is well positioned to be in compliance due to guidance obtained from IAPs and proactive monitoring in support of its recharge of SAR water and GWRS produced water. Furthermore, OCWD's CEC monitoring has not only fulfilled permit requirements, but also helped win and maintain public support for its recycled water recharge efforts. The multi-barrier GWRS AWPF treatment train has been demonstrated to be very effective at removing CECs from the final product water. This is one reason why the same MF/RO/UV-AOP process train will be employed in the upcoming 30 MGD facility expansion. Finally, the anticipated changes to the CDPH Draft Regulations are likely to remove and/or modify some existing monitoring requirements, while potentially adding others, while hopefully providing for operational flexibility for GRRPs like GWRS in terms of less stringent subsurface retention time and blending requirements.

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