Occurrence and Distribution of Organic Wastewater Contaminants in Waters of the Gallatin Valley, Gallatin County, Montana

Photo Credit: A. English

Gary A. Icopini,[1] Tammy Swinney,[2] and Alan English[1,2]

[1]Montana Bureau of Mines and Geology
1300 West Park Street
Butte, MT 59701
[2]Gallatin Local Water Quality District
215 W. Mendenhall, Suite 300
Bozeman, MT 59715

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Acronyms and Abbreviations

Ag	silver
Al	aluminum
As	arsenic
avg.	average
B	boron
Ba	barium
bgs	below ground surface
Br	bromine
Ca	calcium
CAS	Columbia Analytical Services Laboratory
Cd	cadmium
Ce	cerium
cfs	cubic feet per second
Cl	chloride
Co	cobalt
Cs	cesium
Cu	copper
DEET	N,N-diethyl-meta-toluamide
DEQ	Department of Environmental Quality
DNRC	Department of Natural Resources & Conservation
DOC	dissolved organic carbon
DWE	depth water enters
EDC	endocrine disrupting compounds
ELISA	enzyme-linked immunosorbent assay
F	fluorine
Fe	iron
gpd	gallons per day
g/yr	grams per year
GWIC	Ground-Water Information Center
Ga	gallium
GLWQD	Gallatin Local Water Quality District
HCO_3	bicarbonate
HDPE	high-density polyethylene
Hg	mercury
HPLC	high performance liquid chromatography
K	potassium
La	lanthanum
Li	lithium
MBMG	Montana Bureau of Mines and Geology
Mg	magnesium
µg/L	microgram per liter
mg	milligram per liter
Mn	manganese
Mo	molybdenum
MT	Montana

MS	mass spectrometry
MSU	Montana State University
N	nitrogen
Na	sodium
Nb	niobium
Nd	neodymium
ng/L	nanograms per liter
Ni	nickel
NO_3	nitrate
OWC	organic wastewater contaminant
OWCs	organic wastewater contaminants
Ortho-PO_4	orthophosphate
Pb	lead
Pd	palladium
PPCP	pharmaceuticals and personal care products
PPE	personal protective equipment
PTFE	polytetrafluoroethylene
PVC	polyvinylchloride
QA	quality assurance
QC	quality control
Rb	rubidium
%RSD	percent relative standard deviation
Sb	antimony
SBR	sequencing batch reactor
Se	selenium
SiO_2	silicon dioxide
Sn	tin
SO_4^{-2}	sulfate
SPE	solid phase extraction
Sr	strontium
Th	thorium
Ti	titanium
Tl	thallium
U	uranium
USDA	U.S. Department of Agriculture
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
V	vanadium
W	tungsten
WWTP	wastewater treatment plant
Zn	zinc
Zr	zirconium

Abstract

The Montana Bureau of Mines and Geology and the Gallatin Local Water Quality District collected wastewater, groundwater, and surface-water samples at selected locations in the Gallatin Valley. The samples were collected from different land-use settings to screen for the occurrence and distribution of pharmaceuticals and personal care products, collectively referred to as organic wastewater contaminants (OWCs), and to evaluate the effectiveness of different wastewater treatment processes on OWC removal.

Eight wastewater treatment systems were sampled. Two systems discharge effluent to surface water, and the remaining six systems discharge effluent to groundwater. Influent and effluent samples were collected at six municipal wastewater treatment plants (WWTPs), five of which were sampled three times (summer, fall, and winter). Effluent samples were collected from two septic systems, one of which was sampled three times (summer, fall, and winter); access to the septic-system influent was not available. WWTP effluent OWC concentrations were generally one to five orders of magnitude lower than influent concentrations. Many OWCs, including most of the hormones, were effectively removed by the WWTPs. However, several OWCs were minimally removed by passage through the WWTP, including carbamazepine, DEET, fluoxetine, meprobamate, phenytoin, and trimethoprim.

Concentrations of OWCs in the WWTP effluents were greatest during the colder months, most likely due to decreased microbial degradation. This variation with temperature was least pronounced in the WWTPs with the longest water retention times. No trend was observed in the seasonal septic-system samples. Mass loading of OWCs to groundwater and surface water, in grams of OWCs per year (g/yr), varied for the wastewater treatment systems based on OWC removal efficiency and the effluent discharge volume. Loading rates from the WWTPs ranged from 76 to 36,000 g/yr, and loading rates from the two septic systems sampled ranged from 600 to 7,600 g/yr. However, these loading rates are highly skewed by the volumes of effluent discharged. In general, OWC concentrations in WWTP effluents were much lower than the septic effluents, indicating that the WWTPs were more effective at removing OWCs than the septic systems.

OWC samples were collected from 41 wells (14 monitoring, 14 private, and 13 public water supply wells). The groundwater samples were also analyzed for major ions, trace elements, and dissolved organic carbon (DOC). OWCs were detected in 73 percent of the groundwater samples; 67 percent of the sites with OWC detections were upgradient wastewater treatment plant (WWTP) discharges. Seventeen different OWCs were detected in the groundwater samples; the most common were sulfamethoxazole, carbamazepine, bisphenol A, meprobamate, and fluoxetine. Neither well depth nor depth to groundwater exhibited a strong control on OWC occurrence. Samples from wells in unsewered subdivisions and downgradient of WWTP discharges commonly contained OWCs (88 percent and 100 percent, respectively). Although unsewered subdivisions and WWTPs appear to be predictive of OWC presence in groundwater, land use is not a reliable predictor of OWC presence, because 80 percent of the wells without nearby infrastructure (>0.5 mi) also had detectable OWCs. For this reason, the other geochemical parameters were evaluated to determine if indicator species could be identified that were predictive of OWC presence. Threshold values for multiple indicator species (ortho-phosphate, DOC, nitrate, chloride, cobalt, and nickel) was a more accurate predictor of OWC detections

than land use. When concentrations exceeded the threshold values for all six of these species, the use of indicator species was predictive for 93 percent of the OWC occurrences.

Ten surface-water sites were sampled during summer, fall, and winter. OWCs were detected at all 10 sites during all the sampling times, with the exception of one stream site that was located above any residential development or WWTP discharges. No seasonal trends in OWC occurrences were observed. Eighteen different OWCs were detected in the surface-water samples; the most common were salicylic acid, sulfamethoxazole, DEET, caffeine, gemfibrozil, and naproxen. The most occurrences and the highest concentrations were observed in surface-water samples collected immediately downgradient of a municipal wastewater treatment plant discharge point. However, two sites with OWC detections were on streams that flowed through unsewered subdivisions and were upgradient of WWTP discharges, which indicates a groundwater source for OWCs at these sites.

Introduction

Organic Wastewater Contaminants in the Environment

Organic wastewater contaminants (OWCs) originate from human and animal waste discharges (treated or untreated) to the environment. OWCs encompass a wide variety of chemicals, including: pharmaceuticals, hormones, fire retardants, industrial chemicals, personal care products, and pesticides. Many of these contaminants have been shown to interfere with the endocrine system of both animals and humans at very low concentrations. In the environment, OWCs are generally present at very low concentrations [nanogram per liter (ng/L) to microgram per liter (µg/L ranges); part per trillion to part per billion]. Even at these low concentrations some OWCs can have a physiological effect (e.g., Kidd and others, 2007).

In 1999 and 2000, the U.S. Geological Survey (USGS) conducted the first nationwide reconnaissance of the occurrence of OWCs in streams (Kolpin and others, 2002). Ninety-five OWCs were analyzed in samples from streams susceptible to contamination from urbanization and/or livestock production. Kolpin and others (2002) found OWCs in 80 percent of the 139 streams sampled. Three streams were selected for evaluation in Montana, including the Little Bighorn River (three sites), the Clark Fork River at St. Regis, and Godfrey Creek near Churchill (Gallatin Valley). OWCs were detected in all five of the Montana sites. Some of the more commonly occurring OWCs detected by the USGS in Montana waterways included caffeine, tri (2-chloroethyl) phosphate (antimicrobial disinfectant), cis-androsterone (steroid), cholesterol (plant/animal steroid), and coprostanol (fecal steroid). Cholesterol and coprostanol were detected in Godfrey Creek, which is within the current study area.

OWC occurrences in groundwater have not been studied as extensively as in surface water; however, a number of studies have demonstrated groundwater is susceptible to OWC contamination. For example, a national reconnaissance of groundwater deemed at risk for OWC contamination (i.e., downgradient of a landfill, an unsewered residential development, or an animal feedlot) collected samples from 47 sites across the nation; 81 percent of the sites contained at least one of the 65 OWCs analyzed (Barnes and others, 2008). Other studies have documented groundwater OWC contamination originating from unsewered residential development (Miller and Meek, 2006) and livestock operations (Batt and others, 2006). Miller and Meek (2006) sampled 35 water supply wells in the Helena Valley of Montana. OWCs were found in 91 percent of the wells sampled with sulfamethoxazole (80 percent of wells), atrazine, carbamazepine, dilantin, and diclofenac being the most frequently detected. Individual septic systems were deemed the most likely source. Batt and others (2006) documented plumes of sulfamethazine and sulfadimethoxine emanating from a large-scale commercial feedlot operation. Sulfamethazine and sulfadimethoxine are antibiotics that have been approved for use in cattle feed (USDA, 2007).

Potential Human and Animal Health Impacts

OWC exposure can adversely affect the health of humans and wildlife. Endocrine disrupting chemicals (EDCs) can impact processes that affect mood, metabolism, reproductive processes, growth, and development. Human exposure to EDCs is suspected to cause sperm maladies, altered sex ratios, early onset of puberty, cancer hypospadia, endometriosis, diabetes, obesity, and many other issues (Colborn, 2007). The manifestations of exposure in rats, and presumably other mammals, can be expressed not only years after exposure but also in successive generations that were not exposed to the EDC (Anway and others, 2005). A scientific position paper by the Endocrine Society (Diamanti-Kandarakis and others, 2009) stated that "Results from animal models, human clinical observations, and epidemiological studies converge to implicate EDCs as a significant concern to public health."

Human exposure pathways include ingestion (food and water), inhalation, and adsorption through the skin. Inhalation and adsorption can cause exposure of these chemicals at higher concentrations (mg/L or µg/L) than are often found through groundwater or surface water (ng/L). As a result, many studies on endocrine disruption evaluate chemical exposures in the mg/L or µg/L range. However, estrogens or compounds that mimic estrogens (estrogenic compounds) can have a significant effect at very low concentrations. For example, exposure to the estrogenic compound bisphenol A, which is found in plastics, has been shown to have measurable physiological effects at concentration in the ng/L range (e.g., Kester and others, 2002; Hugo and others, 2008). The most pronounced effects of EDC exposure are often observed with fetal, infant, or childhood exposure (Colborn, 2007). In 2010 the U.S. Food and Drug Administration issued a report detailing the steps the agency is taking to limit fetal, infant, and childhood exposure to bisphenol A (U.S. FDA, 2014). A complete review of all the scientific evidence for the impact EDCs may be having on human health is beyond the scope of this report, and the reader is referred to the following websites for further information (http://www.epa.gov/ and http://www.endocrinedisruption.com/).

There is compelling evidence that OWCs, especially estrogenic substances, can have adverse impacts on aquatic life, such as the feminization of male fish and amphibians. This may include anything from subtle hormonal changes to the complete conversion from a male to a female organism. Fathead minnows exposed to feedlot effluent developed significant alterations to reproductive biology including decreased testosterone synthesis, altered head morphology, smaller testis size in males, and decreased estrogen:androgen ratio in females (Orlando and others, 2004). Researchers in Colorado observed that downstream of the wastewater treatment plant (WWTP) outfall for the city of Boulder, CO, 83 percent of the white sucker population were female compared to 45 percent upstream of the WWTP (Woodling and others, 2006). In a Canadian experiment, a lake was doped with 5–6 ng/L 17α-ethynylestradiol (EE2; synthetic hormone), which caused the feminization of fathead minnows and led to the population collapse after 2 years (Kidd and others, 2007). Not all estrogenic compounds are equally potent, and EE2 is one of the most potent estrogens. However, most estrogenic activity is additive, meaning that the effects of exposure to many mildly estrogenic compounds at low doses may be similar to the effects observed from exposure to one highly potent estrogenic compound at a higher dose (Norris and Vajda, 2007). While arguments may be made that low levels (ng/L) of other EDCs may not be a health concern, low levels of estrogenic compounds have been demonstrated to have adverse health impact on animals.

Another class of compounds known to affect fish at environmentally relevant concentrations is antidepressants, such as fluoxetine (Prozac). Exposure to relatively high concentrations of antidepressants (≥500 ng/L) has been shown to cause fish to become lethargic (Henry and Black, 2008). Embryonic and larval fish have been shown to have diminished prey avoidance responses when exposed to environmentally relevant concentrations (≥25 ng/L) of four common antidepressants both individually and in combinations (Painter and others, 2009). More recently, fluoxetine and its active metabolite norfuoxetine have been found to bioaccumulate in wild-caught fish (Mennigen and others, 2011).

The release of human and agricultural antibiotics to the environment may be promoting the emergence of antibiotic-resistant bacteria (Levy, 1997; Boxall and others, 2003; Kumar and others, 2005). Bacteria exposed to sub-lethal concentrations of antibiotics can develop multidrug resistance not only to the antibiotics used in the study but also other antibiotics (Kohanski and others, 2010). Another recent study using archived soils from the Netherlands has demonstrated that the antibiotic resistance gene abundance in soil bacteria has increased since 1940 (Knapp and others, 2010). The increased prevalence of antibiotic-resistant strains of bacteria is a serious human health threat.

Gallatin Valley

The 540-mi^2 project area encompasses the Gallatin Local Water Quality District boundary, and includes the Gallatin Valley and the Big Sky area located at the headwaters of the Upper Missouri River Basin (fig. 1). The Gallatin Valley consists of a large alluvial plain bounded by the Gallatin and Madison mountain ranges to the south, the Bridger mountain range to the east, the Madison Plateau to the west, and the Horseshoe Hills to the north. The valley is drained by the West Gallatin and East Gallatin Rivers. Main tributaries include Bridger, Rock, Hyalite, Bozeman, and Camp Creeks. Elevations in the valley range from about 6,300 ft at the southeastern mountain front to about 4,100 ft where the Gallatin River (East and West combined) leaves the watershed.

The Gallatin Valley climate is characterized by cool summers and long, cold winters, typical for a Northern Rocky Mountain intermontane basin (Hacket and others, 1960). Average annual precipitation ranges from 55 in. in the mountains to 12 in. in the valley near Logan.

Land use is primarily agricultural with an extensive ditch system that diverts surface water for irrigation and livestock use. Population growth in the valley is resulting in the conversion of agricultural land to suburban/urban use. The City of Bozeman obtains municipal water from Bozeman Creek, Hyalite Reservoir, and Lyman Creek (spring). All other towns and rural/suburban areas in the valley obtain their municipal and domestic water from groundwater.

The Gallatin Valley is underlain by Cenozoic basin-fill deposits that can be subdivided into three hydrogeologic units: Quaternary river and stream alluvium, Quaternary and late Tertiary alluvial fan deposits, and middle to late Tertiary basin-fill deposits (Vuke and others, 2014; Lonn and English, 2002; Hackett and others, 1960; fig. 2). The majority of the Gallatin Valley is underlain by 50 to over 400 ft of unconsolidated Quaternary river and stream alluvium deposited by the West Gallatin and East Gallatin Rivers and their tributaries. Late Tertiary alluvial fan deposits underlie the valley margins along the northern boundary of the Gallatin Range and western boundary of the Bridger Range. Middle to late Tertiary deposits underlie the Camp Creek Hills and Madison Plateau along the west side of the valley, and crop out along the Madison Bluffs south of Logan. The middle to late Tertiary deposits also underlie most of the valley at depth, and underlie the Camp Creek Hills and Madison Plateau.

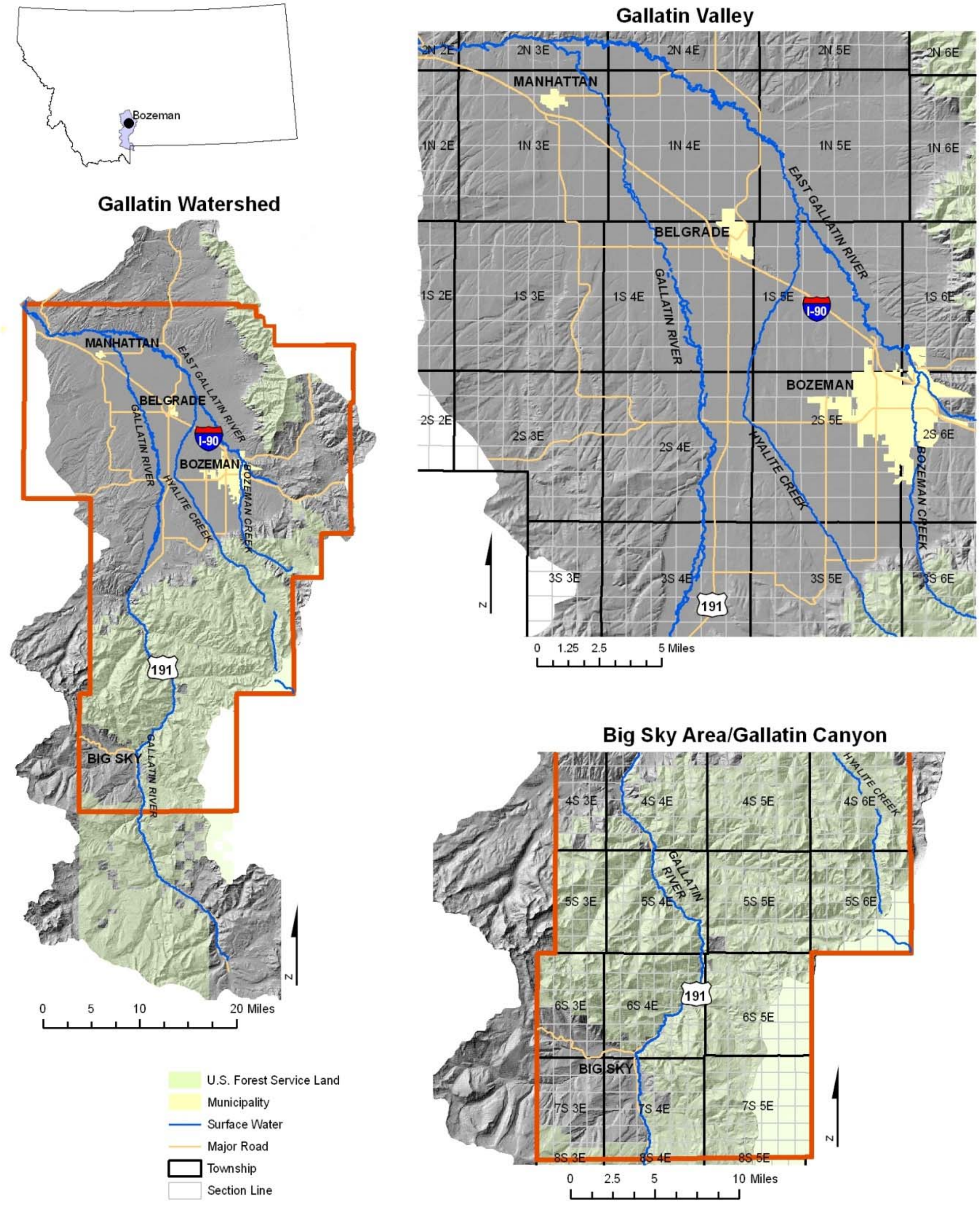


Figure 1. Maps showing the study site area with major roadways, streams, and section lines.

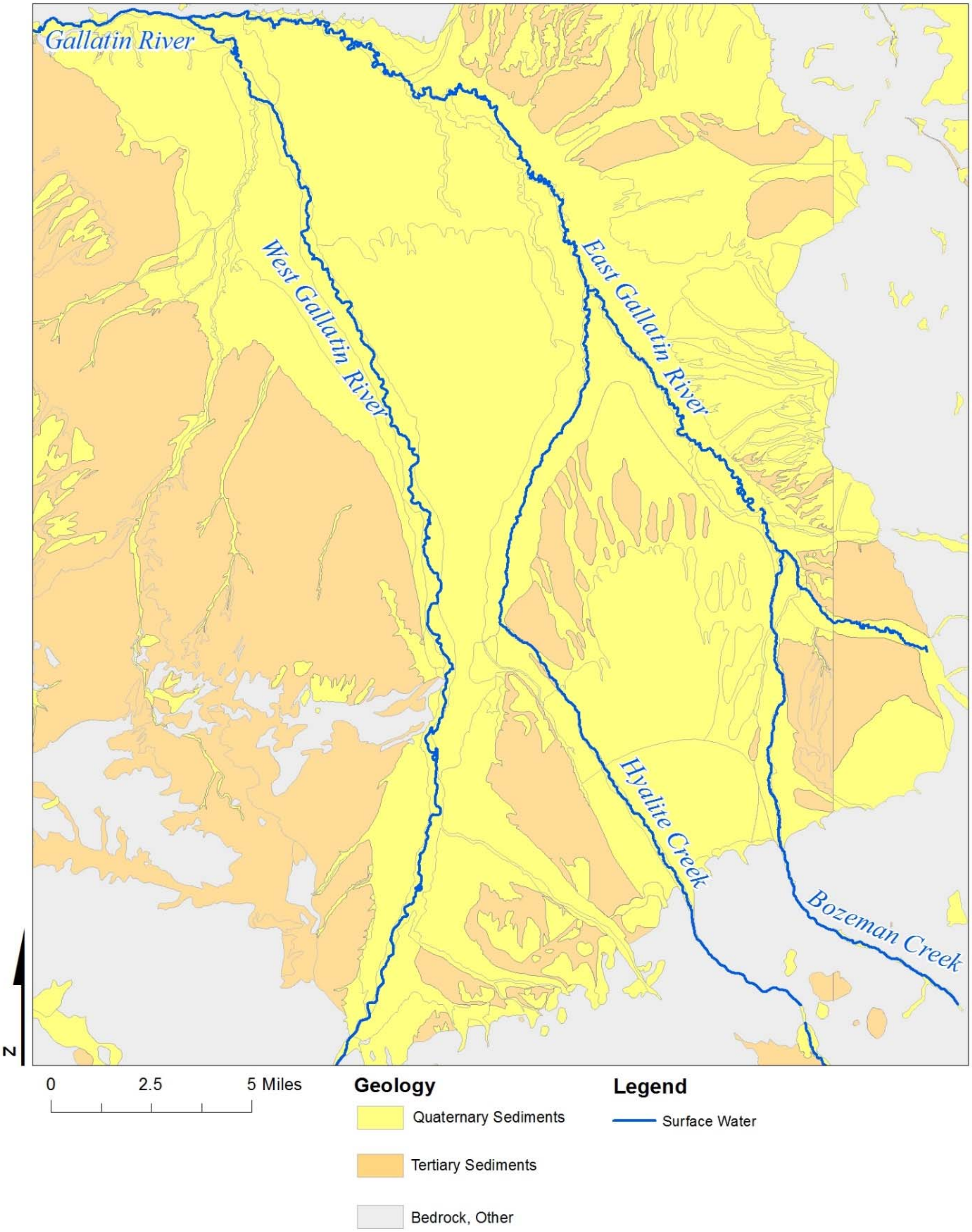


Figure 2. Geology of the Gallatin Valley.

Regional groundwater flow in basin-fill aquifer is generally to the north–northwest toward Logan. The bedrock gorge near Logan constricts the basin-fill aquifer and forces groundwater into the Gallatin River. The estimated annual discharge of groundwater to the Gallatin River ranges from 120,000 to 320,000 acre-ft and averages about 240,000 acre-ft (Hackett and others, 1960). In general, groundwater levels fluctuate seasonally and are influenced by irrigation. Groundwater elevations tend to be highest in spring through summer and decline for the rest of the year. Spring runoff from mountain snowpack is the major source of recharge to the aquifer system in the Gallatin Valley along with infiltration of irrigation water and seepage from streams (Hackett and others, 1960).

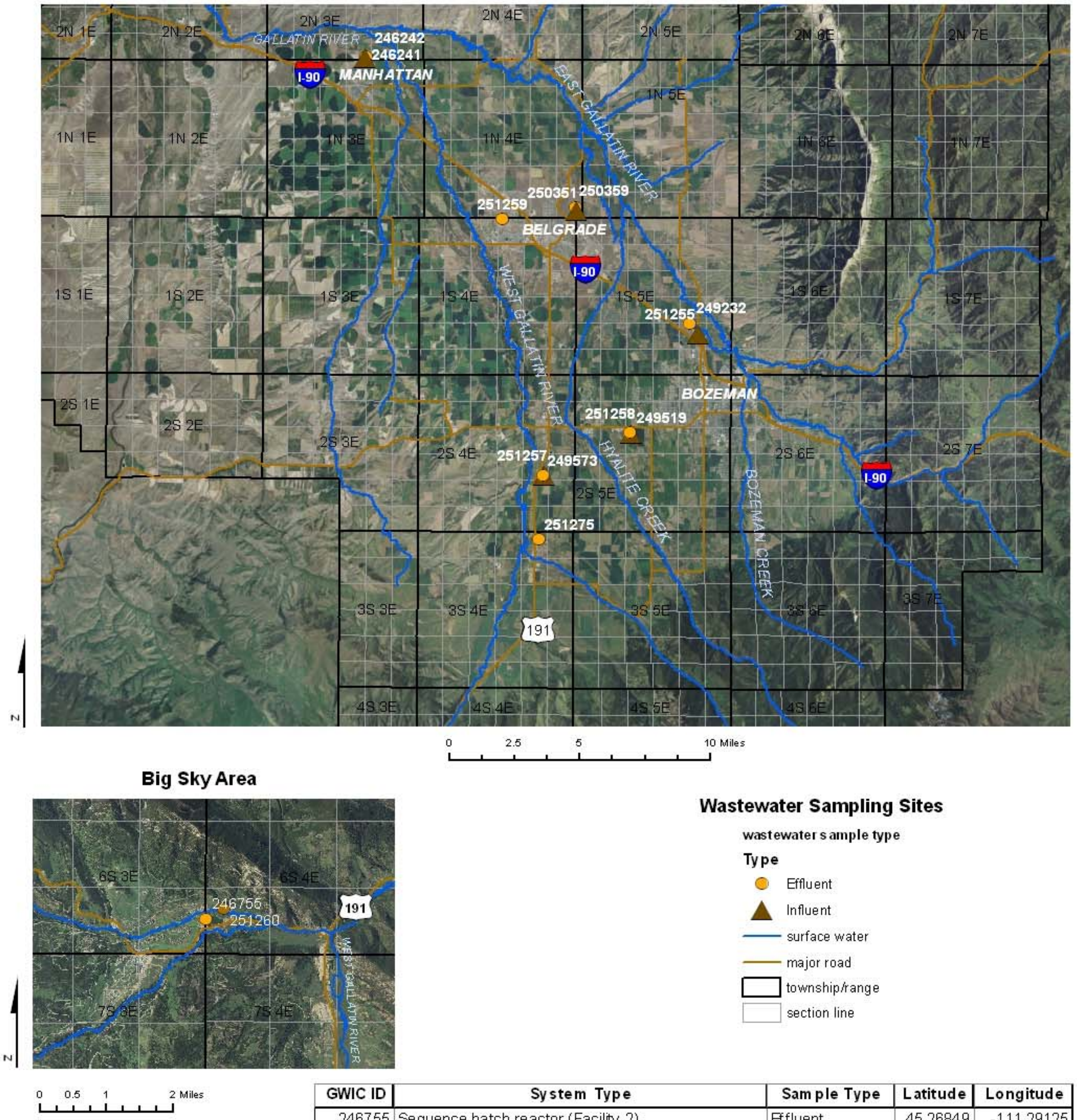
Materials and Methods

Sampling

Sampling protocols used for this study are in Appendix A. Sample contamination is a primary concern when collecting OWC samples. Therefore, precautions were taken to minimize or eliminate potential sample contamination from the sampling personnel. Personal protective equipment (PPE) consisting of Tyvek™ suits with hoods, nitrile gloves, and face masks were worn by personnel collecting samples and handling equipment. Samplers used the clean hands/dirty hands technique for water-quality sampling. Face shields were worn during wastewater sampling. The use of sunscreens, lotions, caffeine, and other potentially contaminating substances prior to and during sampling events was avoided. All equipment that contacted the sample was purchased as pre-cleaned or decontaminated prior to use following standard cleaning protocols for OWC sampling (Lewis and Zaugg, 2003; Appendix A). HPLC-grade methanol and HPLC-grade deionized water were used for the final two rinses.

Wastewater samples were collected from eight public wastewater treatment systems, including six municipal wastewater treatment plants (WWTP) and two multi-user (community) septic systems (fig. 3). Five of the municipal WWTP and one of the multi-user septic systems were sampled seasonally. Influent and effluent samples were collected; facility personnel helped determine appropriate sampling locations. With the exception of the first round of sampling, sample collections for influent and effluent were scheduled based upon fluid residence-time estimates provided by the system operators. Samples during the first round were collected at roughly the same time without regard to fluid residence time. Most samples were collected as grab samples by hand dipping the sample bottle or by attaching a bottle to an extendible sampling pole, or by using a disposable high-density polyethylene (HDPE) beaker on a pole (dipper; used at one site). Sample bottle exteriors were decontaminated with a bleach-water solution after collection and placed in one-gallon, sealable plastic bags. Sampling equipment (extendable pole) was also decontaminated with a bleach-water solution prior to the standard decontamination procedure. The extendable pole used for wastewater sampling was not used for surface-water sampling to avoid potential cross contamination.

Time integrated samples were collected from five wastewater treatment facilities. Existing, dedicated sampling equipment was used at two sites to collect 24-hr composite samples of the influent and at one site to collect 24-hr composite effluent samples. The dedicated sampling



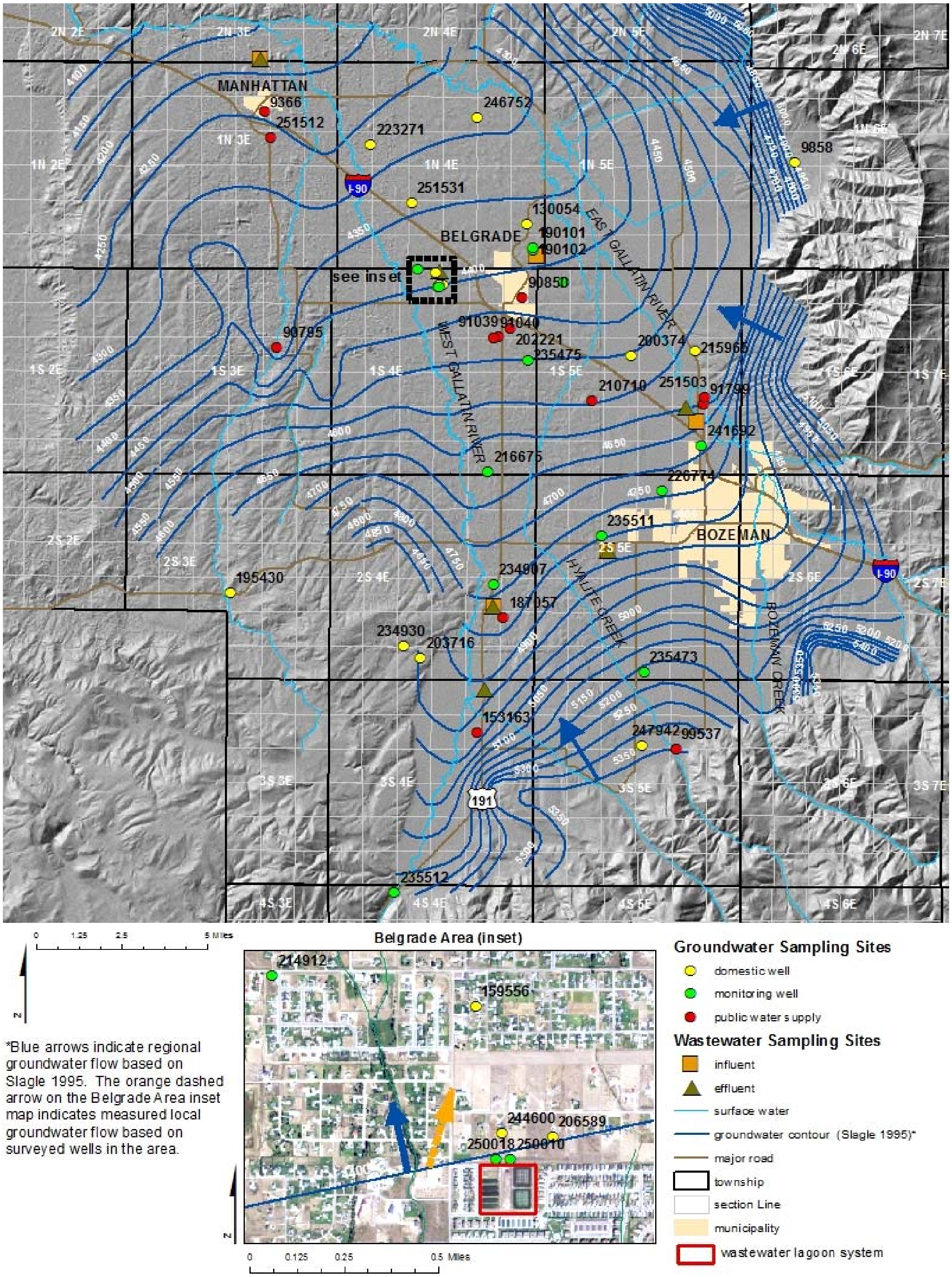
GWIC ID	System Type	Sample Type	Latitude	Longitude
246755	Sequence batch reactor (Facility 2)	Effluent	45.26849	-111.29125
251260	Sequence batch reactor (Facility 2)	Influent	45.27068	-111.28563
251275	Level II recirculating textile-filter treatment	Effluent	45.609	-111.199
251257	Oxidation ditch	Influent	45.64411	-111.19022
249573	Oxidation ditch	Effluent	45.64413	-111.18838
251258	Sequence batch reactor (facility 1)	Influent	45.66821	-111.12177
249519	Sequence batch reactor (facility 1)	Effluent	45.66821	-111.12177
251255	Modified activated sludge Bardenpho process	Influent	45.7222	-111.06692
249232	Modified activated sludge Bardenpho process	Effluent	45.72869	-111.07405
251259	Community pressure-dose septic system	Effluent	45.78643	-111.22365
250351	Aeration lagoon	Effluent	45.79301	-111.16494
250359	Aeration lagoon	Influent	45.79301	-111.16594
246242	Fixed film activated sludge (BioWheel)	Influent	45.87638	-111.33174
246241	Fixed film activated sludge (BioWheel)	Effluent	45.8773	-111.33123

Figure 3. The locations of the wastewater treatment facilities sampled for the project.

equipment was not decontaminated prior to collecting samples for this project. A portable ISCO™ automated sampler was used to collect 24-hr composite influent samples at three facilities and effluent samples at two facilities during the final sampling event. The composite sample was collected in a 4-L amber glass bottle that was housed in a portable cooler during sample collection. Polytetrafluoroethylene (PTFE) tubing and a short length of silicon peristaltic tubing were used with the integrated samplers. Stainless steel screen was attached with stainless steel hose clamps to the end of the PTFE tubing during influent sample collection to prevent plugging. All material that came in contact with the samples was decontaminated prior to use, which included cycling cleaning fluids through the tubing. New tubing was used to collect each sample to avoid potential cross contamination.

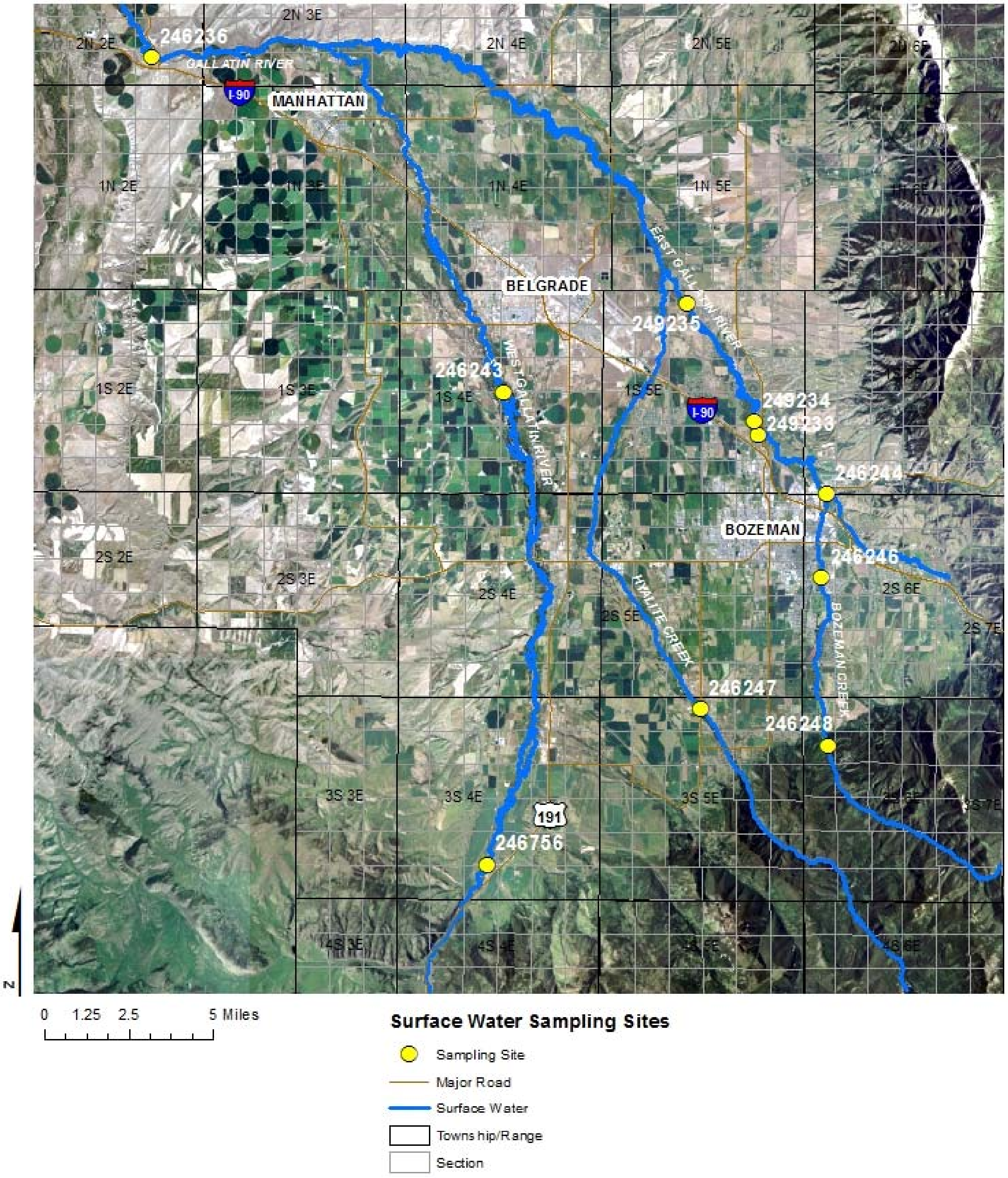
Groundwater samples were collected from 41 wells (14 domestic, 14 monitoring, and 13 public water supplies; fig. 4). Monitoring wells without pumps were purged using either a Grundfos Rediflow II™ portable pump or precleaned disposable Teflon™ bailers. Wells with pumps were purged with the existing pump and the taps used for sampling were decontaminated with HPLC-grade methanol and HPLC-grade deionized water prior to sampling. All wells were purged of at least three well volumes and sampled after field parameters stabilized. In addition to OWCs, samples were collected for major ions and trace elements, and dissolved organic carbon (DOC). Field parameters, including pH, dissolved oxygen, water temperature, specific conductivity, and reduction-oxidation (redox) potential were measured throughout the well purging process and recorded at the time of sample collection. A flow-through cell was used to measure field parameters if an existing or portable pump was used to purge the well. If a disposable bailer was used, field parameters were measured in a 5-gal bucket. Alkalinity titrations were performed in the field. For domestic and dedicated monitoring wells, discharge rate, static water level, and pumping water level were measured.

Surface-water samples were collected from 10 sites on Bozeman Creek, Hyalite Creek, East Gallatin River, West Gallatin River, and Gallatin River (fig. 5). Grab samples were collected in the thalweg of stream sites small enough to wade. Stream sites too large to wade were sampled from either a bridge or the stream bank using an extendable sampling pole. Field measurements including pH, dissolved oxygen, water temperature, specific conductivity, total dissolved solids, and redox potential were obtained at the time of sample collection. Discharge measurements were made during each sampling event on the small streams using a Marsh-McBirney™ flow meter. USGS gauging stations (06043500, 06052500, and 06048700) were used to obtain discharge data during sampling of the Gallatin, West Gallatin, and East Gallatin Rivers. The streams were sampled on three occasions: late summer to represent a late season irrigation low flow condition, late winter to represent a late winter baseflow condition, and spring to coincide with the first major runoff event.



*Blue arrows indicate regional groundwater flow based on Slagle 1995. The orange dashed arrow on the Belgrade Area inset map indicates measured local groundwater flow based on surveyed wells in the area.

Figure 4. Map showing the locations of the domestic, monitoring, and public water-supply wells sampled in relation to the wastewater sampling sites. Blue arrows indicate groundwater flow directions.



SiteID	long	lat	gwicID
East Gallatin River at USGS Gaging Station	-111.06951	45.72507	249233
East Gallatin River at Riverside Country Club	-111.07169	45.73099	249234
West Gallatin River at Cameron Bridge Rd	-111.22534	45.74321	246243
Hyalite Creek at Cottonwood Road	-111.10439	45.6075	246247
Bozeman Creek at Sourdough Trailhead	-111.02619	45.59194	246248
Bozeman Creek at East Lincoln Street	-111.03041	45.66402	246246
West Gallatin River at Williams Bridge	-111.23456	45.54053	246756
Bozeman Creek at Griffin Dr	-111.02733	45.69964	246244
East Gallatin River at Spain Bridge Rd	-111.11308	45.7815	249235
Gallatin River at Logan Bridge	-111.44206	45.88618	246236

Figure 5. Location of the surface-water sites sampled for the project.

Wastewater Treatment Facilities

The wastewater treatment systems ranged in size and complexity from a simple community septic system serving 48 homes to a large municipal modified activated sludge treatment facility serving over 35,000 people. All are classified as public sewage systems in the Administrative Rules of Montana, that serve 15 or more connections or 25 or more people [ARM 17.38.101]. A more detailed description of the types of systems sampled is presented below.

Community Pressure-Dosing Septic System

This community/public pressure-dosing septic system serving 48 homes was approved in 1995. The wastewater treatment system consists of a 20,000 gal cast-in-place septic tank, a 17,150 gal dosing tank followed by a 3,590 gal wet well housing two 4-pump systems, alternating tandem doses. The term "pressure-dosing" describes a system where the effluent is pumped into the drainfield, as opposed to the typical septic system that has a gravity-fed drainfield. The septic tank and pumping system is followed by a shallow-capped, pressure-dosed, 7,200 linear feet subsurface drainfield which provides 21,600 ft^2 of absorption area. The system also contains associated distributing valves, manifolds, and distribution lines. Samples for this project were collected from the wet well on three occasions (August 2008, November 2008, and March 2009). Assuming a discharge of 300 gpd for the average home (MDEQ Circular-4), the estimated daily discharge of wastewater for this system is approximately 14,400 gpd. The system was designed and permitted for up to 34,300 gpd.

Level II Recirculating Trickling-Filter Treatment System

A Level II wastewater treatment system is a nitrogen-reducing septic system that provides secondary treatment of wastewater focused on removal of nitrogen from the wastewater. This type of septic system is defined in the Administrative Rules of Montana [ARM 17.30.702(11)] as a treatment system that "(a) removes at least 60% of total nitrogen as measured from the raw sewage load to the system; or (b) discharges a total nitrogen effluent concentration of 24 mg/L or less." To obtain Level II treatment designation systems must be reviewed and approved by the Montana Department of Environmental Quality.

The Level II wastewater treatment system sampled for OWCs uses a recirculating trickling-filter design with a proprietary treatment media (filter). Wastewater from a dosing/recirculation tank is periodically pumped to the top of the proprietary filter media, evenly applied, and allowed to trickle through the filter media. Effluent collected at the bottom of the filter bed flows back to a dosing/recirculation tank, where about 20% is split off and discharged to a final disposal structure, and the remainder is again passed over the filter media. This recirculation design allows the wastewater to be passed over the filter media multiple times. The environment inside the filter media unit is generally aerobic, but microscopic anaerobic environments on the filter media also develop. As the wastewater repeatedly encounters aerobic and anaerobic conditions, ammonia and organic nitrogen compounds are aerobically oxidized to nitrate (nitrification), and then reduced to nitrogen gas by anaerobic bacteria (denitrification). Nitrogen reduction is accomplished by venting the nitrogen gas to the atmosphere.

The system sampled for this study was constructed in 2007 and serves 17 residential units with the potential for an additional four commercial or residential units. Eight 2,000-gal treatment tanks and five 1,000-gal treatment tanks, all with textile type effluent suspended matter filters, are used to treat the wastewater. The effluent from all the treatment tanks discharges to one 8,000-gal fiberglass recirculation tank. From the recirculation tank a small portion of the wastewater is discharged to a 2,000-gal dosing tank for subsurface disposal via two pressure-dosed drainfields. A majority of the wastewater entering the recirculation tank is redirected back through the treatment tanks and sprayed over the textile filters. The pressure-dosed drainfields have an adsorption area of sufficient size to provide 0.6 gpd/ft^2 with daily flows not to exceed a maximum flow of 5,100 gpd. The drainfields consists of 12 63-ft laterals. Samples for this project were collected from the 2,000-gal dosing tank on one occasion (May 2009).

Fixed Film Activated Sludge (BioWheel™) Facility

This facility serves a town with a population of about 1,400 and has been in operation since 2008. At the time of sampling the system was treating approximately 150,000 gpd with a permitted capacity of up to 250,000 gpd. The fluid residence time through the system was approximately 48 hr. Raw influent flows into large equalization tanks where it is continually mixed. Because flow into the treatment facility is sporadic throughout any given day, the equalization basins effectively serve as activated sludge treatment. The wastewater then flows into a large tank containing a series of BioWheels™ where aeration occurs. The BioWheels™ provide a large surface area for microbial attachment and biological activity much like a fixed film process. From the BioWheel™ tank the wastewater enters a clarification tank and then effluent is disinfected using ultraviolet light prior to discharge. The treated wastewater is discharged to a ditch that discharges to the Gallatin River.

Samples for this project were collected from the equalization basin (influent) and the effluent discharge stream after ultraviolet treatment on three occasions (August 2008, November 2008, and March 2009). During the August sampling both the influent and effluent samples were collected at the same time. During the November sampling the effluent sample was collected approximately 48 hr after the influent sample to coincide with the fluid residence time for the facility. During the March sampling 24-hr composite samples were collected from both the influent and effluent with the effluent sample collected 48 hr after the influent sample collection.

Sequencing Batch Reactor Facilities

Two Sequencing Batch Reactor (SBR) facilities were sampled for this project. A sequencing batch reactor is a fill and draw activated sludge system for treating wastewater. Wastewater influent is collected in a holding tank, which discharges to one or more reactor tanks where treatment occurs. Treatment in the reactor tank includes equilibration, aeration, and clarification, which are performed in a five-phase process: fill, react, settle, decant and idle.

The first SBR system sampled for this study was constructed in 2002 and at the time of sampling treated approximately 100,000 gpd serving approximately 770 people. The system is permitted to treat up to 200,000 gpd. Treated wastewater from the batch tanks is discharged to an equalization tank, exposed to ultraviolet light for disinfection, and then pumped via a pressure-dosing process to a large drainfield. Samples for this project were collected from the influent stream during a batch fill and the effluent stream during a batch discharge on three occasions (August 2008, November 2008, and March 2009). During the August sampling both the influent and effluent samples were collected at approximately the same time from different batch reactor tanks.

During the November and March sampling events samples were collected from influent and effluent streams from the same treatment batch. The batch treatment cycles for this system are approximately 6 hr.

The second SBR system sampled for this project was constructed in 2004 and at the time of sampling treated approximately 300,000 gpd during the summer and approximately 450,000 gpd during the winter months. The system is permitted to treat up to 650,000 gpd. For this facility, treated wastewater is discharged from the batch tanks to a large holding tank, which then discharges to a final treatment building. From here the wastewater is filtered, chlorinated, and then discharged to a large outdoor storage basin where it is stored until it is used for golf course irrigation during the summer. Samples for this project were collected on three occasions (September 2008, November 2008, and February 2009). For all sampling events at this site a 24-hr composite of the influent was collected from the reactor tank influent stream and grab samples were collected of the effluent from the effluent stream at a point just prior to discharge to the large holding pond.

Oxidation Ditch Facility

Constructed in 2001, this centralized wastewater-treatment facility was treating approximately 85,000 gpd with a plant capacity of just over 150,000 gpd at the time of sampling. Wastewater coming into this facility is collected in a holding tank that periodically discharges to the treatment tank. Aeration of wastewater occurs in a round cement ditch through the use of rotating mechanical paddles. A ring inside the ditch is used to clarify the wastewater prior to discharge to a holding tank. Water from the effluent holding tank is then discharged to infiltration beds and ultimately groundwater.

Samples for this project were collected during three sampling events (August 2008, November 2008, and March 2009). During the August and November sampling events grab samples of influent were collected from the influent stream filling the treatment tank and grab samples of the effluent were collected from the effluent stream filling the effluent holding tank. During the August sampling grab samples of the influent and effluent were collected at the same time. During the November sampling the effluent sample was collected approximately 72 hr after the influent sample to coincide with the fluid residence time for the facility. During the March sampling 24-hr composite samples were collected of both the influent stream prior to entering the influent holding tank and the effluent sample was collected 72 hr later from the effluent holding tank.

Aeration Lagoon Facility

This facility was originally constructed in 1973 as a facultative lagoon system. Since that time, the facility has been upgraded and capacity expanded in 2004. The system was treating approximately 600,000 gpd at the time of sampling. The facility holds a groundwater discharge permit to discharge up to 903,000 gpd of treated wastewater. The upgraded facility now consists of two lined, mechanically aerated lagoons with a capacity of 17 million gal each, and a single, lined storage lagoon for treated wastewater with a capacity of 80 million gal. The fluid retention time is approximately 3–4 mo. The treated wastewater is pumped to 15 rapid infiltration beds, 10 of which are located adjacent to the storage lagoon, and 5 that are located southeast of the lagoon system. Additionally, treated wastewater is used for spray irrigation in the immediate area.

Samples for this project were collected during one sampling event (May 2009). A 24-hr composite sample was collected of the influent stream and a grab sample was collected from the effluent stream.

Modified Activated Sludge Bardenpho Process Facility

Constructed in 1970, this municipal secondary treatment facility has undergone several upgrades and expansions to accommodate population growth. At the time of sampling for this project, the facility was treating approximately 5.5 million gpd with a capacity for 5.8 million gpd. However, during large precipitation events the flows could reach up to 11 million gpd. This was due to illicit connections (e.g., sump pumps and roof drains) and groundwater infiltration into sewer lines. The facility is an activated sludge, complete mix plant that has been modified to enhance nitrogen removal from the effluent. The modification, called the Bardenpho process, is phased nitrogen denitrification and involves alternating aerobic and anaerobic cycles during treatment in the first two of the plants four basins. This process encourages both aerobic microbial and facultative anaerobic microbial activity allowing nitrification and denitrification to occur.

Raw influent pumped to the facility goes through primary clarification and then enters large aeration basins where the wastewater is mixed and aerated (modified as mentioned above). The wastewater then enters secondary clarifiers and is chlorinated before discharge to the East Gallatin River. The solids are settled from the wastewater in clarifiers and are recirculated in order to maintain microbial activity in the system. The fluid retention time is approximately 16-20 hr. Waste solids are thickened and then reduced in an anaerobic digester. These waste solids, referred to as biosolids, are low in pathogens. The biosolids are land-applied through an injection process to agricultural fields in the Gallatin Valley.

Samples from this facility were collected during three sampling events (August 2008, November 2008, and March 2009). During all of the sampling events 24-hr samples were collected from dedicated integrated samplers maintained by the facility, which are used by facility personnel to monitor the daily efficiency of the plant. These samples were collected every morning. During the August sampling event influent and effluent samples were collected on the same day. However, during the November and February sampling events the effluent samples were collected 24 hr after collection of the influent samples.

Sample Analysis Methods

OWC samples for this study were analyzed by three different laboratories utilizing three different methods. Replicates collected for the samples were sent to different laboratories. The primary laboratory used for this study was Columbia Analytical Services (CAS) located in Kelso, Washington. All OWC samples collected were sent to CAS and these data are the primary data used in this report. CAS used an analytical method developed by the U.S. Environmental Protection Agency (U.S. EPA, 2007a) that employs high-performance liquid chromatography combined with tandem mass spectrometry (HPLC/MS/MS) to quantify analytes. The method also requires a solid phase extraction (SPE) step to concentrate the sample. The method was designed for the analysis of pharmaceutical and personal care products; however, CAS modified this method to include the analysis of additional OWCs including hormones. The CAS analyte list includes 32 compounds (table 1). In addition to the analytes, 23 isotopically labeled internal standards were also quantified. The internal standards consist of spiking the sample with analytes that are chemically identical to the target analytes but the internal standards have a slightly different mass than the target analytes. The internal standards are used to correct for SPE recovery inefficiencies in the quantification of the target analytes.

Table 1. A list of the OWCs analyzed by Columbia Analytical Services and Montana Bureau of Mines and Geology Organics Laboratory with their uses and characteristics.

COMPOUND	USES/CHARACTERISTICS
17-α-estradiol	natural estrogenic hormone
17-β-estradiol*Ŧ	natural estrogenic hormone
17-α-ethinyl estradiol*Ŧ	oral contraceptive/synthetic ovulation inhibitor
acetaminophen*	pain reliever, fever reducer
androstenedione	natural steroid hormone/performance enhancing hormone
atrazineŦ	herbicide
bisphenol A*Ŧ	industrial chemical used in polycarbonate and epoxy resins
caffeine*	stimulant, mild diuretic
carbamazepine*	anti-convulsant, mood stabilizer
DEET*	insect and tick repellant
diazepam*	anti-anxiety, muscle relaxer
diclofenac*	non-steroidal anti-inflammatory, anti-arthritic
diethylstilbestrol	synthetic estrogen
estriol*	estrogenic hormone
estroneŦ	estrogenic hormone
fluoxetine*	antidepressant
gemfibrozil*	high cholesterol/lipid regulator
hydrocodone*	pain reliever
ibuprofen*	pain and inflammation reliever
iopromide	radiology contrast enhancer
meprobamate	anti-anxiety
methadone*	pain reliever, drug addiction detoxification
naproxen*	pain and inflammation reliever
oxybenzone	active ingredient in sunscreen
pentoxifylline*	increases blood flow, circulation
progesterone*Ŧ	birth control pills, menopausal hormone therapy, natural hormone
phenytoin	anti-epileptic, anti-convulsant
salicylic acid	acne, corn, wart and dandruff treatment
sulfamethoxazole*Ŧ	antibiotic
testosterone*	steroid hormone
triclosan*	antibacterial, agent in soaps
trimethoprim*	antibiotic/urinary tract infections

*Isotopically labeled internal standard

Ŧ ELISA analysis also conducted by MBMG Organics Laboratory

The Montana Bureau of Mines and Geology (MBMG) Organics Laboratory used enzyme-linked immunosorbent assay (ELISA) to quantify eight OWCs (17-β-estradiol, 17-α-ethinyl estradiol, atrazine, bisphenol A, estrone, progesterone, sulfamethazine, sulfamethoxazole) in 83 samples (including triplicate and blank samples). The ELISA analyses were conducted primarily to assess its use as a screening tool. ELISA techniques (Crowther, 2001; Huang and Sedlak, 2001; Farré and others, 2006) utilize antibodies that respond to a specific molecule (antigen). In the ELISA assays used for this project the antibodies are tagged with photoactive functional groups and attached to a surface, which allows for colorimetric visualization of the antibody. When the antigen binds with the antibodies the result is either an increase or decrease in light absorbance at a specific wavelength, which is then used to quantify the amount of antibody (the OWC in this case) that is binding to the antigen.

The MBMG Organics Laboratory used two ELISA formats: microtiter plate and magnetic particle formats. The magnetic particle format is very sensitive and does not require pre-concentration of the sample. Three analytes (17β-estradiol, atrazine, and sulfamethazine) were quantified using magnetic particle format kits. The microtiter plate format is less sensitive and requires a pre-concentration step using solid phase extraction media (SPE; see Appendix B for SPE protocol). Five analytes (17α-ethynylestradiol, bisphenol A, estrone, progesterone, sulfamethoxazole) were quantified using the microtiter plate format. The SPE efficiency is a major source of error for all analytical methods requiring a pre-concentration step. Therefore, the data from the magnetic particle format are likely to be more reliable than are data from the microtiter plate format.

AXYS Analytical Services (Sidney, BC, Canada) was contracted to provide a third analysis on 16 samples, as a result of discrepancies between the CAS and ELISA data. AXYS used the same method as CAS for the pharmaceuticals analysis and personal care products (U.S. EPA, 2007a), but used EPA Method 1698 (U.S. EPA, 2007b) to quantify hormone and sterol analytes. Method 1698, designed for the analysis of hormones and sterols, is similar to Method 1694, which is designed to screen wastewater treatment plant matrices (influent, effluent, and biosolids) for pharmaceuticals and personal care products, except that high-resolution gas chromatography combined with high-resolution mass spectrometry (HRGC/HRMS) is used to quantify the analytes. In all, 75 analytes with 17 internal standards were quantified by AXYS Analytical Services; 18 of these analytes were the same as those analyzed by CAS (Appendix C).

OWC Sample Preservation

OWC samples were collected in 1-L amber glass bottles and acidified at the time of collection with sulfuric acid to below pH 2 for CAS and ELISA analysis (U.S. EPA, 2007a). The sulfuric acid was added to the CAS bottles by laboratory personnel prior to receipt of the bottles by the sampling crew. Concentrated sulfuric acid (~1 mL) was added to the ELISA samples at the time of collection. Sodium thiosulfate was added to CAS samples that were thought to contain chlorine (e.g., municipal water supply, WWTP effluent) at the time of collection. The OWC samples were not filtered in the field. Two bottle types were used for the AXYS samples: amber glass bottles were used for OWC samples and HDPE bottles were used for the hormone/sterol samples. AXYS samples were preserved with acid. All samples were stored on ice or refrigerated until shipment to the laboratories. Samples were shipped with overnight delivery to AXYS and CAS.

Quality Control–Quality Assurance

Fourteen of the 109 samples (~13 percent) submitted to CAS were collected in triplicate. Nine of the 65 samples (~14 percent) submitted for ELISA analysis were collected in triplicate and 2 of the 12 samples (~17 percent) submitted to AXYS were collected in triplicate. Triplicates were chosen at random by the sampling personnel and consisted of filling three bottles sequentially from the water source and were not splits from one homogenized sample. In addition to the triplicates collected in the field, triplicate splits were analyzed for all the samples submitted for ELISA analysis. The triplicate data were assessed by using the percent relative standard deviation (%RSD), which is the standard deviation divided by the mean and multiplied by 100. Triplicate analyses with %RSDs less than 25 were deemed accurate replicate data. The average of the triplicate data was used in the data analysis and evaluation. Triplicate data with %RSDs greater than 25 were flagged as estimated data, as were samples with two detections out of three in a triplicate set. If only one sample in a triplicate set had a detectable OWC, the data were deemed unreliable and were not used in further evaluation.

In addition to the triplicate samples, field and equipment blanks were collected at eight sites and submitted to CAS for analysis. Field blanks consisted of pouring HPLC-grade deionized water into a sample bottle under field conditions; four were submitted to CAS and two were submitted for ELISA analysis. Equipment blanks consisted of two bailer blanks (both also submitted for ELISA analysis), one dipper blank (also submitted for ELISA analysis), and one ISCO™ sampler blank. Bailer and dipper blanks consisted of filling the equipment with HPLC-grade deionized water and pouring the water into sample bottles under field conditions. The ISCO™ sampler blank was collected by cycling HPLC-grade water through the sampling tubing after decontamination (new tubing was used for each sample). No blanks were submitted to AXYS.

Results and Discussion

Data Quality

A significant amount of project attention was directed towards ensuring satisfactory data quality. Data integrity was assessed by the triplicate sample reproducibility and absence of detections in field and equipment blanks. Additionally, the laboratory blanks were evaluated. The reproducibility of the triplicate samples was assessed on the basis of the percent relative standard deviation (%RSD). Triplicate samples with %RSD greater than 25 were considered estimated data, as were samples with one or two detections out of three.

Columbia Analytical Services (CAS) Analyses

There were no detections in the four field blanks submitted to CAS, but there were two detections in the four equipment blanks (21 ng/L bisphenol A and 16 ng/L salicylic acid in separate samples; Appendix D). These detections may be the result of laboratory contamination or contamination during sample collection. The bisphenol A detection was in a dipper blank and the dipper was used to sample a WWTP influent. The concentration of bisphenol A in the dipper blank was less than 10% of the concentration of bisphenol A in the sample subsequently collected with the dipper, which is within the overall error of the method. The field blank containing salicylic acid was collected as the final rinse of the cleaning procedure for an ISCO sampler and unlike the rest of the equipment blanks, it was collected at the office. It is possible enough residual salicylic acid was present from the soapy tap-water rinse. All samples collected with ISCO samplers had salicylic acid concentrations that were at least an order of magnitude higher than those detected in the ISCO sampler blank, so it is unlikely that this possible source of contamination strongly influenced the results.

Seven different analytes were detected in the 29 laboratory method blanks that were analyzed by CAS with each analysis set (Appendix D). Androstenedione, oxybenzone, and iopromide were detected in one laboratory blank at or near the reporting limit for each analyte and the samples run at the same time as these blanks had no detections for these analytes, which indicates that these occurrences had little impact on data quality. Bisphenol A was detected in two laboratory blanks at 20 ng/L and 99 ng/L. Both bisphenol A laboratory blank occurrences were higher than at least one sample concentration in the associated analysis set, and these data should be considered suspect. Pentoxifylline was detected in three laboratory blanks and may have negatively impacted the 3 ng/L pentoxifylline detection in the sample GLWQD-95 (1 ng/L in blank). The other laboratory blank detections of pentoxifylline were in analysis sets that had no pentoxifylline detections in the samples. Fluoxetine was detected in four laboratory blanks at concentrations near the detection limit for fluoxetine. Fluoxetine was detected in nine samples that were in analysis sets with blank detections, but for six samples the amount in the blank was less than 5 percent of that observed in the sample. The fluoxetine concentrations in three samples (GLWQD-125, -130, and -131) were in the range of the concentrations observed in the laboratory blanks analyzed with the sample set, and these data should be treated as suspect. Hydrocodone was detected in eight laboratory blanks; however, hydrocodone concentrations in the samples associated with these blank detections were all much higher than those observed in the blanks, except for one. The hydrocodone concentration in GLWQD-79 was 6.1 ng/L, which was lower than the concentration in the blank (7.2 ng/L). In addition, GLWQD-79 is an up-gradient stream location that is unlikely to have a hydrocodone source. For these reasons the detection of hydrocodone in GLWQD-79 is likely a false positive.

There were 103 OWC detections in the 14 triplicate samples collected and submitted to CAS (Appendix E). OWC occurrences in the triplicate samples included 26 of the 32 OWCs quantified, and therefore these analyses provide an adequate database for the evaluation of the overall data quality. In general, the reproducibility of the CAS analyses was very good, with most of the %RSDs below 10 percent and only 8 above 25 percent (Appendix E; summary in table 2). Four of the eight %RSD values above were based on estimated data, which were below the quantification limit but above the detection limit. Most of the occurrences detected in the triplicates were associated with the four wastewater triplicate sets, but low %RSDs were also associated with the more dilute stream and groundwater OWC occurrences (Appendix E; summary in table 2).

Of the 103 detections, 15 were non-reproducible analyses where an OWC was detected in only one or two samples in the triplicate set (11 and 4 occurrences, respectively). Most of these non-reproducible analyses were within two times the detection limit and therefore within the error of the analysis method (Appendix E). Estimated data below the typical reporting limit were supplied by CAS for four of the non-reproducible sets; however, the %RSD were typically quite poor for triplicate sets with these estimated data (Appendix E). The non-reproducible data, either with or without estimated data, were not included in the table 2 summary. The average of the available data from non-reproducible triplicate sets containing two detections was treated as estimated data and used for data analysis and interpretation. Individual analyte data from triplicate sets with only one detection were not used in the data analysis and interpretation.

Table 2. A summary of the triplicate sample analyses conducted by Columbia Analytic Services, where: n = number of triplicate sets, # = number of detections, Avg. %RSD = average of percent relative standard deviations (Avg. %RSD without estimated values). All values have been rounded to two significant figures.

	Wastewater Samples (n=4)			**Surface-water Samples (n=2)**			**Groundwater Samples (n=8)**		
Analyte	**#**	**Range of Averages (ng/L)**	**Avg. % RSD**	**#**	**Range of Averages (ng/L)**	**Avg. % RSD**	**#**	**Range of Averages (ng/L)**	**Avg. % RSD**
17 α-estradiol	1	16*	8.8*						
17 β-estradiol	1	5.3	20						
17 α-ethynylestradiol									
acetaminophen	1	160	13						
androstenedione	2	29,000–210,000	5.0						
atrazine							1	2.0	5.9
bisphenol A	4	31–540	9.7	1	14*	43*	2	11*–16	35* (17)
caffeine	4	110–72,000	6.2	1	15	3.9			
carbamazepine	3	170–370	5.7	1	14	4.0	3	2.3–160	9.3
DEET	4	83–14,000	3.1	1	79	3.3	1	50	18
diazepam									
diclofenac	2	18–660	15						
diethylstilbestrol									
estriol	3	83–260	10						
estrone	3	7.1–59	9.6						
fluoxetine	4	25–89	9.8	1	1.5	21			
gemfibrozil	3	470–2,600	11	1	60	1	1	60	13
hydrocodone	2	42–73	19						
ibuprofen	4	350–12,000	13	1	17	24			
iopromide									
meprobamate	3	7.4–4,300	8.2	1	5.9	4.9	1	28	4.1
methadone	1	24	8.8						
naproxen	4	260–8,900	6.3	1	15	3.8	1	16	33
oxybenzone	4	22*–980	11*	1	5.6	18			
pentoxifylline									
phenytoin									
progesterone	1	190	11						
salicylic acid	2	210*–69,000	9.7*	1	84	22			
sulfamethoxazole	3	16–480	20	2	1.5–18	8.9	6	0.5*–440	26* (13)
testosterone	1	91*	30*						
triclosan	2	120–350	13						
trimethoprim	2	530–590	5.7	1	9.8	12			

*Based on one or more estimated values

ELISA Analyses

Three equipment blanks and one field blank were submitted for ELISA analysis (Appendix F). Sulfamethoxazole (1.09 ng/L, %RSD = 0.9) was detected in one equipment blank, which was very near the reporting limit of 1 ng/L. Since the concentrations were near the reporting limit, little weight was put on the detection of sulfamethoxazole in this blank. Bisphenol A was detected in the field blank at approximately twice the reporting limit (3.03 ng/L), but the reproducibility was very low (%RSD = 72). Bisphenol A (3.87 ng/L) was also the only analyte detected in the two laboratory blanks, but again the reproducibility was low (%RSD = 30). Both the field and laboratory blanks were extracted and analyzed on the same days. Also, since the concentrations are similar in the field and laboratory blanks, it seems possible that there was a systemic contamination source in the laboratory and that bisphenol A concentrations less than 4 ng/L should be treated as suspect data.

There were 28 OWC detections in the nine samples submitted in triplicate for ELISA analysis (table 3). There were nine non-reproducible triplicate analyses: four with detections in two of three samples and five with detections in one of three samples. As with the CSA data, most of the non-reproducible detections were near the reporting limits, and most detections were bisphenol A, which accounted for six of the non-reproducible analyses (each with single and double detections). When bisphenol A is removed from the analysis, the percent of non-reproducible ELISA analyses is comparable with the CSA analyses. Bisphenol A was detected in eight triplicate sets, but in only one set was the data reproducible enough to be fully reportable, which along with the detections in the blanks indicates that the ELISA bisphenol A data are not of sufficient quality to be useful. Aside from bisphenol A, the precision of the replicate samples was generally good with all but two triplicate sets having %RSD less than 25, but the average %RSD appeared to be slightly larger than in the CSA data.

Table 3. A summary of the ELISA triplicate sample analyses conducted by the MBMG (%RSD = percent relative standard deviation).

Analyte	Groundwater Samples									
	235473		244600		226774		91039		203716	
	ng/L	% RSD	ng/L	% RSD	ng/L	% RSD	ng/L	% RSD	ng/L	% RSD
17 β-estradiol	<2.5		<2.5		<2.5		<2.5		<2.5	
17 α-ethynylestradiol	<0.5		<0.5		<0.5		0.51		<0.5	
atrazine	<20		<20		<20		<20		<20	
bisphenol A	1.78[+]	9.2[+]	2.28[+]	52.6[+]	1.61*		2.06*		<1.6	
estrone	<0.5		1.21	16.6	0.757[+]	15.9[+]	<0.5		<0.5	
progesterone	<1.0		<1.0		<1.0		<1.0		<1.0	
sulfamethazine	<50		<50							
sulfamethoxazole	1.3*		10.9	16.4	<1.0		<1.0		<1.0	

Analyte	WWTP Effluent Samples				Stream Samples			
	249519		249519		249235		246244	
	ng/L	% RSD	ng/L	% RSD	ng/L	% RSD	ng/L	% RSD
17 β-estradiol	17.43	6.8	134.0	17.0	2.25	52.5	9.05*	
17 α-ethynylestradiol	0.67	21.0	3.59	6.9	<0.5		<0.5	
atrazine	<20		<20		<20		<20	
bisphenol A	23.5	42.9	6.38	13.3	1.96[+]	19.8[+]	4.86*	
estrone	1037	0.3	67.2	16.4	2.19	5.5	< 1.0	
progesterone	15.8	6.5	19.4	14.8	2.17	8.3	<1.0	
sulfamethazine	<50		<50		<50			
sulfamethoxazole	5.0	41.1	13.5	17.5	2.26	16.5	<1.0	

*Single detection in the triplicate set

[+] Two detections in the triplicate set

AXYS Analytical Services (AXYS) Analyses

In general, the reproducibility of the AXYS data was less than the other two labs. Blanks were not submitted to AXYS due to the high costs of the analysis and budget constraints. The AXYS data were reported in three separate groups (pharmaceuticals, hormones, and sterols), and the reproducibility was different with each group. The pharmaceutical data were the most reproducible of the three types of data (Appendix G). There were 25 pharmaceutical detections in two triplicate sets (48 analytes) with three non-reproducible analyses (one with two detections and two with one detection). There were also only three %RSD of 25 or greater, but there were nine %RSD of 20 or greater. Many of the triplicate sets having higher %RSD showed a trend in the analyses of increasing or decreasing concentrations between the first and last analyses, which indicates there was carry over between analyses. While the %RSD generally fall within the criteria for acceptable data, the potential carry over problems increase the likelihood of false positives with all the AXYS data.

The apparent carry over problems were more pronounced for the AXYS hormone data. The data evaluation was hampered by the non-quantification of six analytes in two samples from one set and the fact that most of the quantified data were reported as "estimated data." There were 14 hormone detections in the two triplicate sets, but three of these detections were analytes that were not quantified in all three samples. Of the 11 detections that were fully quantified only five were reproducible in all three samples and only one of these five had a %RSD below 25. Most of the detectable concentrations started out high and decreased to the last analysis. For example, the first sample in one triplicate set had a 192 ng/L norgestrel concentration, the next analysis reported 11.9 ng/L norgestrel concentration, and the last analysis reported 3.76 ng/L norgestrel concentration. The samples were analyzed in the order presented. It seems apparent that there was significant carry over from a previous analysis, which was slowly working its way out of the system. These trends indicate that the hormone data are unreliable.

The quality of the sterol data was better than the hormone data, but not as good as the pharmaceutical data. Again, the data evaluation was hampered by the fact that most of the data were reported as "estimated data." There were 19 sterols detected in the two triplicate sets and only one non-reproducible sample with two detections of desmosterol. Most of the %RSD were less than 15 and only four were 25 or greater. The carry over problem is also less apparent in the sterol data, but not completely absent. If not for the majority of the data being reported as estimated data, the sterol data would compare favorably with the CAS and ELISA data.

Analytical Comparison

To assess data accuracy, the ELISA results were compared to CAS results. The initial method comparison indicated significant differences between the two methods. Additionally, the MBMG Laboratory could not handle the proposed sample volume. For these reasons, CAS became the primary analytical laboratory for the project.

A total of 66 samples were submitted for OWC analysis to both MBMG and CAS. The influent WWTP samples were not submitted for ELISA analysis because of safety concerns. A comparison summary of the two data sets is presented in table 4. The value of two times the detection limit or the lowest concentration was arbitrarily chosen as a measure for the similarity of the results. For example, if a detected concentration was within twice the concentration of the reporting limit of the other method, the comparison was grouped as a non-detect. If the detected concentration was more than twice the reporting limit of the other method, the comparison was labeled either a false positive or a false negative depending on which analysis method was assumed to be correct. The concentrations were similarly compared when the analyte was detected by both methods for a given sample. For each analyte, two means were used to compare the results from the different methods. First, the sum of all positive co-occurrences (all categories except false positives and false negatives) were divided by the total number of samples and multiplied by 100, which yielded a measure of how well the two methods compared with respect to presence or absence of the analyte. Second, the sum of all positive co-occurrences not counting non-detections was divided by the total number of occurrences, including false positives and false negatives and multiplied by 100.

Table 4. Comparison between the Columbia Analytical Services (CAS) data and the MBMG ELISA data for duplicate samples collected for each analysis.

Comparison Criteria	**17 α-ethinyl estradiol**	**17 β-estradiol**	**estrone**	**progesterone**	**bisphenol A**	**sulfamethoxazole**	**atrazine**
Sum of all comparison samples	66	66	66	66	66	66	66
Below detection for both	56	45	37	42	23	21	60
Detection for one within 2 times reporting limit of non-detect	10	10	11	24	24	10	2
Detections for both within 2 times the lowest concentration	0	0	1	0	3	2	0
Detections for both but not within 2 times the lowest concentration	0	1	7	0	11	22	0
False positive assuming CAS data are correct	0	10	10	0	1	2	4
False negative assuming CAS data are correct	0	0	0	0	4	9	0
Positive co-occurrences in percent including non-detections (%)	100	85	85	100	92	83	94
Positive co-occurrences in percent excluding non-detections (%)	NA	9	44	NA	74	69	0

NA – not applicable since there were no detections above 2 times the reporting limit

In general, there was good agreement between the two methods. Sulfamethoxazole had the lowest co-occurrence rate of 83 percent, and 17α-ethinyl estradiol and progesterone the highest with 100 percent. Although the high co-occurrence rates are somewhat misleading because most of the analytes were not detected by either method, it does appear that the ELISA data are predictive of the presence or absence of OWCs. When the non-detect results are excluded, the comparison between the two methods is less favorable. The occurrence rates for bisphenol A (74%) and sulfamethoxazole (69%) compared fairly well between the two methods, but 17 β-estradiol (9%), estrone (44%), and atrazine (0%) did not. ELISA often overestimates hormone concentrations (Farré and others, 2006, 2007), so the high rate of false positives for 17 β-estradiol and estrone was not unexpected. The overestimation of hormones by ELISA has yet to be explained fully, but there is some cross reactivity with other hormones that may lead to false positives (Farré and others, 2006). It is also possible that the ELISA method may be reacting with conjugated (complexed) forms of the target analytes that would have different masses and therefore not be detected in the LC-MS-MS analysis unless targeted. Because it is most likely that the ELISA method is measuring one or more hormones in the water, it could be argued that it is a better hormone screening tool than would be LC-MS-MS, which has a greater specificity.

The non-corroboration of the atrazine data is surprising because the ELISA analytical procedure for atrazine is well established. The concentrations of the four ELISA atrazine detections were 20 to 50 times greater than the reporting limit for the CAS data and %RSD were below 25 percent for all analyses (all ELISA analyses were done in triplicate). It is also surprising that the detection rate for atrazine in groundwater for this study was low (5 percent; data below). A previous study in a similar geologic setting, which also used CAS, had an atrazine occurrence rate of 40% (Miller and Meek, 2006).

In an attempt to identify which laboratory was providing the more accurate data, 15 samples were sent to AXYS Analytical, which used the same method as CAS for OWC analysis but a different method for hormone analysis. As reported above, the data from AXYS had significant reproducibility problems. However, when comparing the presence or absence of specific analytes the CAS and AXYS data compared favorably (table 5). Ten of the twelve analytes had co-occurrence rates greater than 92 percent. Estrone and progesterone had co-occurrence rates of 75 percent. When samples with non-detectable concentrations are excluded, the comparison between CAS and AXYS data is still good (83 to 100 percent) for the analytes analyzed by the same method (acetaminophen, caffeine, carbamazepine, fluoxetine, and sulfamethoxazole). The hormone data from CAS and AXYS compared well for some analytes and poorly for others. The co-occurrence rates 17 β-estradiol and estriol were 100 percent, but the co-occurrence rates for estrone and testosterone were 57 and 67 percent, respectively, and the co-occurrence rate for progesterone was zero percent.

The CAS laboratory appeared to provide the highest quality OWC data set based on the blanks and the triplicate analysis. The CAS data supported the use of ELISA as an indicator for the presence of OWCs. The apparent carry over problems with the AXYS data and the prevalence of detections in the blanks limits the reliability and usefulness of the AXYS data. For these reasons the CAS OWC data set was used for the majority of the data analysis and interpretation.

Table 5. Comparison between the Columbia Analytical Services (CAS) data and the AXYS analytical data for duplicate samples collected for each analysis.

Comparison Criteria	**17 α-ethynylestradiol**	**17 α-estradiol**	**17 β-estradiol**	**acetaminophen**	**caffeine**	**carbamazepine**	**estrone**	**estriol**	**fluoxetine**	**progesterone**	**sulfamethoxazole**	**testosterone**
Sum of all comparison samples	12	12	12	12	12	12	12	12	12	12	12	12
Below detection for both	1	8	1	4	3	1	5	7	5	7	1	9
Detection for one within 2 times reporting limit of non-detect	11	3	11	5	1	0	0	1	1	2	0	0
Detections for both within 2 times the lowest concentration	0	0	0	2	5	8	3	1	4	0	8	0
Detections for both but not within 2 times the lowest concentration	0	1	0	1	2	3	1	3	1	0	3	2
False positive assuming CAS data are correct	0	0	0	0	1	0	3	0	0	2	0	1
False negative assuming CAS data are correct	0	0	0	0	0	0	0	0	1	1	0	0
Positive co-occurrences in percent including non-detections (%)	100	100	100	100	92	100	75	100	92	75	100	92
Positive co-occurrences in percent excluding non-detections (%)	NA	100	NA	100	88	100	57	100	83	0	100	67

NA – not applicable since there were no detections above 2 times the reporting limit

Wastewater Treatment Facilities

Influent and effluent wastewater samples were collected from six WWTPs; five WWTPs were sampled three times (summer, fall, winter) and one WWTP was sampled once. Effluent samples were collected from two septic systems (one sampled summer, fall, winter; one sampled once); it was not possible to collect influent samples from the two septic systems. The systems ranged in size and complexity from a small, community pressure-dose septic system serving 48 homes to a large-scale modified activated sludge treatment facility serving over 30,000 people. Nearly all of the OWC analytes (29 out of 32) were detected in at least one influent sample (fig. 6). OWC concentrations in the influent samples often ranged over several orders of magnitude, but the average concentrations were generally greater than 100 ng/L and several OWCs had average influent concentrations greater than 100,000 ng/L (fig. 6). In general, the more intensive wastewater treatment plant approaches resulted in greater reductions of OWCs than the septic systems when comparing dissolved OWC concentrations of the influent and effluent streams (Appendix L).

The OWC concentrations in the effluent samples from the WWTPs were generally one to two orders of magnitude lower than the influent samples. The majority of the effluent analytes were either not detected or had average concentrations less than 100 ng/L (fig. 7). For example, androstenedione was detected in all of the influent samples with an average concentration of 150,000 ng/L; however, it was detected in only three effluent samples with an average concentration of 140 ng/L. There were also several analytes that were detected more frequently in the effluent samples than the influent samples. For example, carbamazepine was detected in 14 influent samples and 16 effluent samples. The higher detection rate in the effluent samples is most likely a result of the lower reporting limits for the effluent samples relative to the influent samples (reporting limits were a function of the dilution required to analyze the samples and was determined on a sample by sample basis by laboratory personnel). The carbamazepine reporting limit was typically 10 ng/L for influent samples and 1 ng/L for effluent samples. In general, the frequency of OWC occurrences and the average concentration of most OWCs were much reduced in the WWTP effluent samples, which indicates that the WWTPs were effective at removing OWCs from the waste stream. A comparison of the sum of the average concentrations for all the analytes detected in all of the influent samples (400,000 ng/L; sum of averages in fig. 6) with the sum of average concentrations for all of the corresponding effluent streams (6,600 ng/L; sum of the averages in fig. 7) indicates that on average the WWTP removed approximately 98% of the OWCs from the influent.

The septic system OWC concentrations (fig. 8) were generally higher than the concentrations observed in the WWTP effluents (fig. 7). Eleven of the OWC analytes exceeded 1,000 ng/L in the septic system samples; only three compounds had average concentrations less than 100 ng/L. The septic system sample reporting limits were similar to those for the WWTP influent samples. The analytes detected were most often in three or four of the four samples collected, which indicates the higher reporting limits did not affect the average concentrations for most of the analytes detected. However, the higher reporting limits may explain the higher rate of non-detections for some analytes in the septic system effluent samples. The higher average OWC concentrations in the septic system effluents indicate that the community septic systems may be less effective at removing OWCs than the WWTPs.

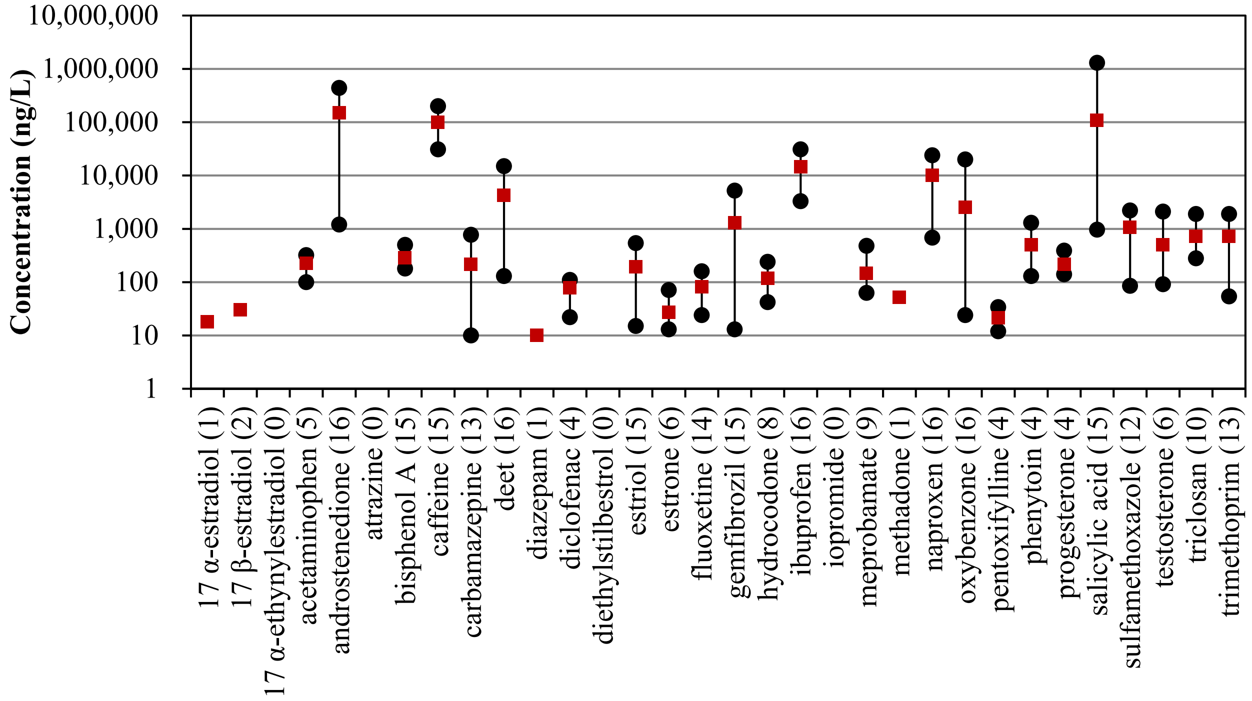


Figure 6. The range (bars) and mean concentrations (squares) of OWCs measured in the wastewater influent samples (16 influent samples) with the frequency of detection for each compound in parentheses after the name (six WWTP facilities sampled).

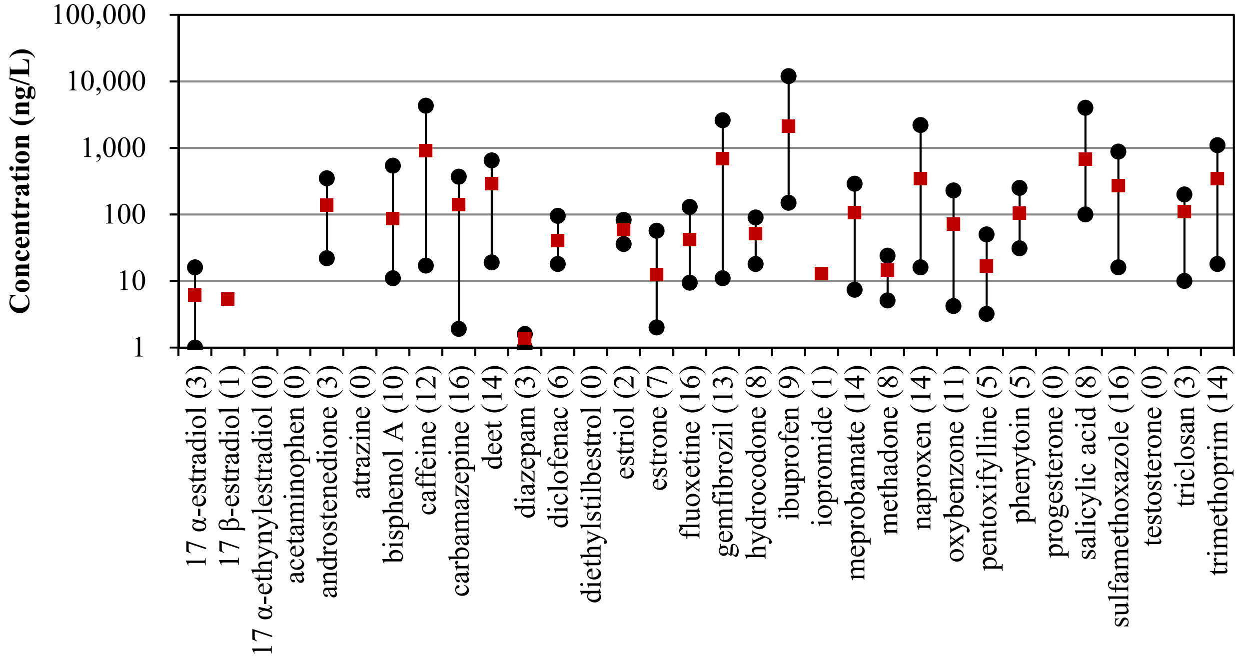


Figure 7. The range (bars) and mean concentrations (squares) of OWCs measured in the wastewater effluent samples (16 samples) with the frequency of detection for each compound in parentheses after the name (six WWTP facilities sampled).

The septic system effluent samples analyzed by the ELISA method detected more hormones at higher concentrations than the CAS results (fig. 9). Estrone and progesterone were detected in all 13 effluent samples submitted for ELISA analysis and 17 β-estradiol was detected in 12 samples. For comparison, estrone was only detected in 7 of the 20 effluent samples submitted to CAS, and no detections were reported for progesterone and only one for 17 β-estradiol. This is likely a function of the ELISA method, which tends to estimate higher concentrations of estrogens relative to mass spectrometric methods. The occurrence rates for sulfamethoxazole in effluent samples compared fairly well between the two analytical methods. It was detected in 80 percent of the CAS samples and 85 percent of the ELISA samples. The ELISA method was not considered reliable for bisphenol A.

The influent and effluent sample results were used to assess the removal efficiencies of the different WWTPs. OWC removal efficiencies for the WWTPs were determined by subtracting the effluent concentration from the influent concentration and dividing by the influent concentration. The greatest removal efficiency would be 1.00, which indicates complete removal or that the concentration in the effluent was below the limit of quantification. Because we were unable to collect influent samples from the the septic systems, the average concentration of all the influent samples for each OWC was used as the influent concentration to calculate the removal efficiency for the septic systems. Only OWCs that were detected in at least 12 of the 16 influent samples collected from WWTPs were used to calculate the removal efficiency for the septic systems. DEET was not used in the septic system removal efficiency calculations because the concentrations were too variable.

Removal efficiencies were calculated for each effluent sample concentration with a corresponding influent concentration (tables 6, 7, and 8). The most accurate measurement of OWC removal efficiency would be to compare the influent and effluent concentrations associated with the same parcel of wastewater. However, given the nature of wastewater treatment the collection of influent and effluent samples from exactly the same volume of water is not possible. With the exception of the first round of sampling, influent and effluent samples were collected based on the average fluid retention time for the facility when possible. For example, when the fluid retention time was 72 hr the effluent sample was collected 72 hr after the influent sample. During the final sampling round 24-hr time integrated samples were collected at two sites that were previously sampled as grab samples (see methods section for a more complete description of the WWTP sampling).

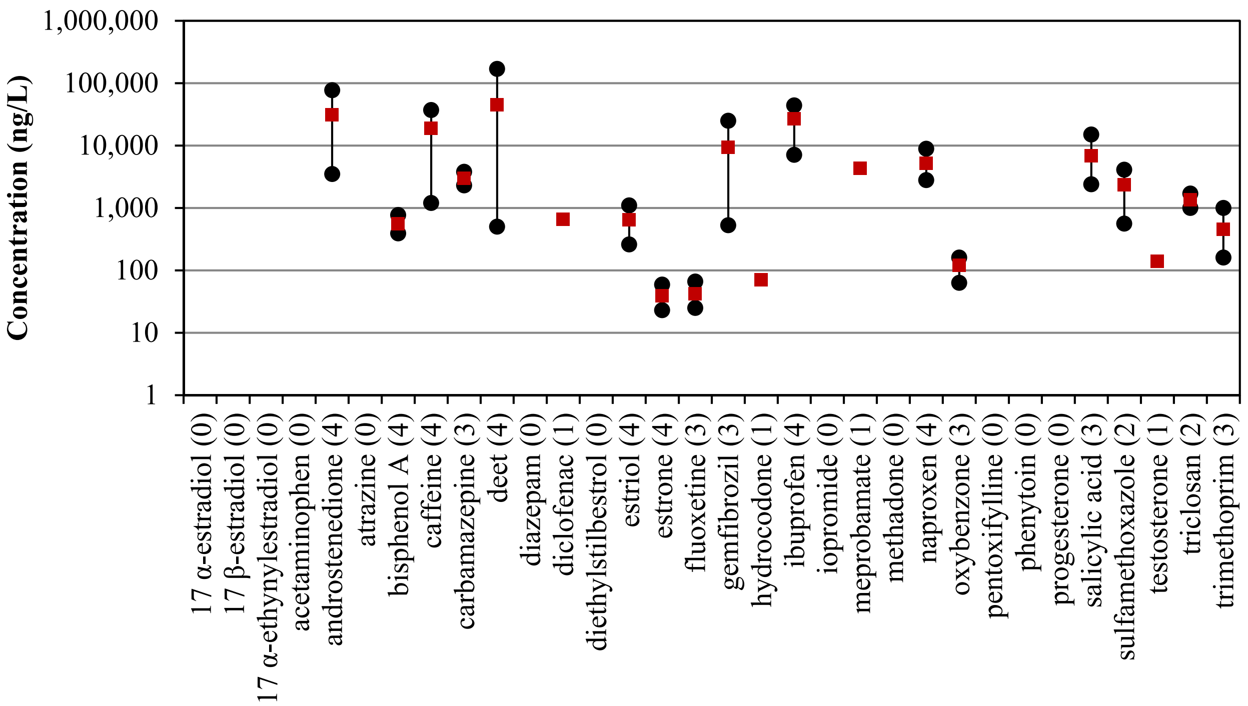


Figure 8. The range (bars) and mean concentrations (squares) of OWCs measured in the wastewater effluent samples (4 samples) with the frequency of detection for each compound in parentheses after the name (2 community septic systems sampled).

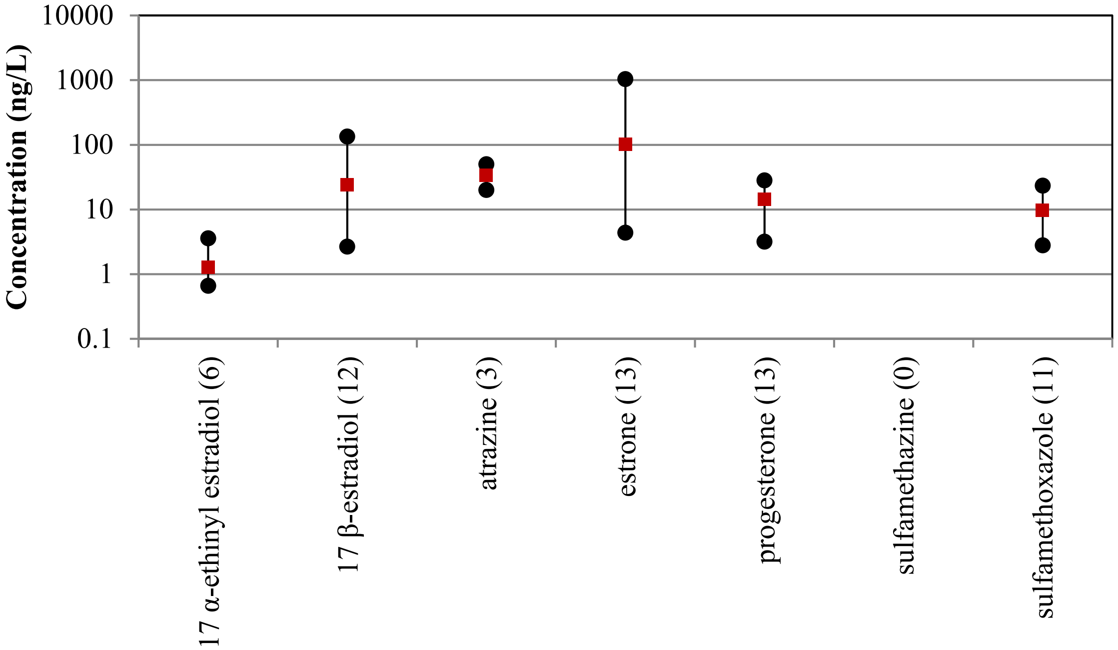


Figure 9. The range (bars) and mean concentrations (squares) of OWCs measured in wastewater effluent samples via the ELISA method (five WWTP facilities; 13 samples) with the frequency of detection for each compound in parentheses after the name (no septic systems sampled).

Removal efficiencies for OWCs detected in the November 2008 samples collected from the modified activated sludge WWTP are presented in figure 10. Most OWCs were effectively removed during treatment; concentrations of 14 OWCs decreased by at least 80 percent. However, a number of OWCs (carbamazepine, DEET, fluoxetine, meprobamate, pentoxifylline, phenytoin, and trimethoprim) were minimally removed from the wastewater. The negative value for phenytoin indicates that the measured effluent concentration was greater than the influent concentration. It is possible that the mixing of different waters resulted in the effluent sample having a higher concentration than the influent sample. However, phenytoin was often higher in the effluent sample than the influent sample for other WWTPs as well (Appendix L; removal efficiencies were not calculated when influent concentrations were not quantified), indicating that there may be a systematic laboratory error in the phenytoin analyses.

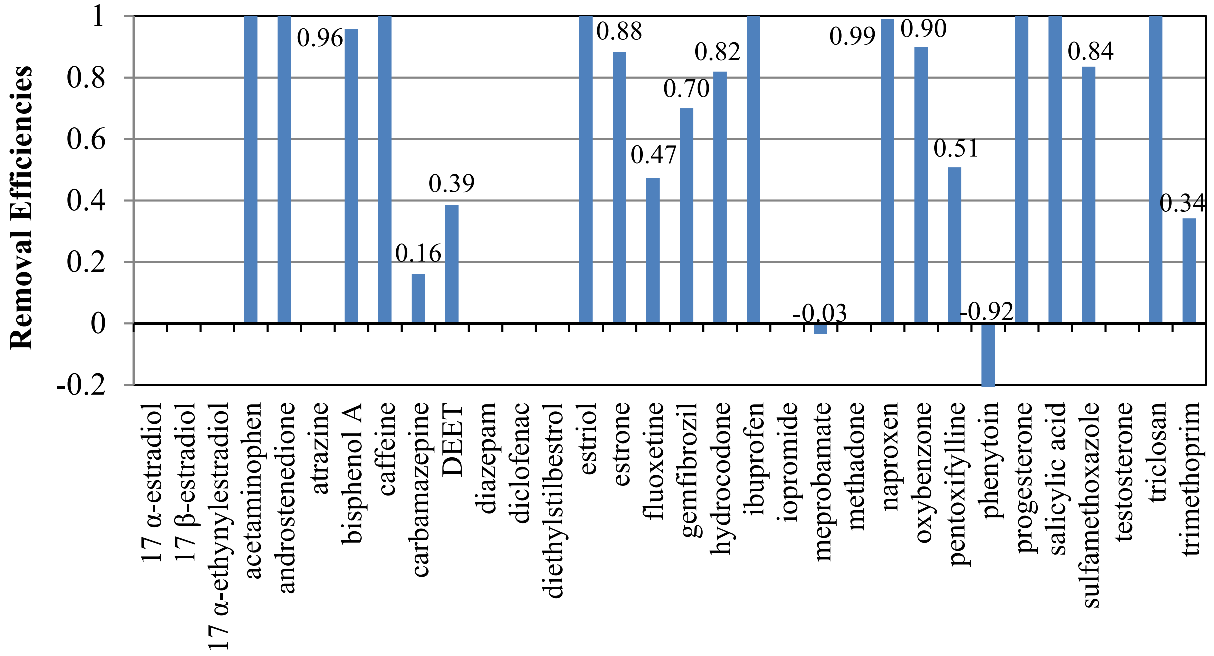


Figure 10. Individual OWC removal efficiencies for the November 2008 sampling of the modified activated sludge WWTP.

Table 6. A list of OWC removal efficiencies at three WWTPs sampled.

Treatment Method	Modified Activated Sludge			Oxidation Ditch			Fixed Film Activated Sludge		
Date	8/08	11/08	2/09	8/08	11/08	3/09	8/08	11/08	3/09
17 α-estradiol									1.00
17 β-estradiol									1.00
17 α-ethynylestradiol									
acetaminophen	1.00	1.00			1.00				
androstenedione	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
atrazine									
bisphenol A	0.91	0.96	0.88		0.91	1.00	1.00	1.00	1.00
caffeine	1.00	1.00		1.00	1.00	0.99	1.00	1.00	0.94
carbamazepine	0.06	0.16	-0.40				-0.36	-0.25	0.17
DEET	0.96	0.39	0.00	0.98	0.94	0.96	0.98	0.87	0.81
diazepam									
diclofenac			0.14						0.64
diethylstilbestrol									
estriol	1.00	1.00	1.00		1.00	1.00	1.00	1.00	1.00
estrone		0.88			0.92		1.00		1.00
fluoxetine	0.44	0.47	0.32		0.78	-0.54	0.33	0.63	0.19
gemfibrozil	0.94	0.70	-3.04		-0.43	0.58	0.98	0.75	-0.13
hydrocodone	1.00	0.82	0.25		0.60		1.00	0.44	
ibuprofen	0.98	1.00	1.00	0.96	0.99	0.97	0.99	1.00	0.85
iopromide									
meprobamate	0.13	-0.03					0.15	0.40	-0.79
methadone									
naproxen	0.97	0.99	0.92	0.89	0.97	0.98	0.99	1.00	0.98
oxybenzone	0.86	0.90	-2.54	1.00	0.99	1.00	0.95	0.97	1.00
pentoxifylline		0.51	0.40					0.37	-0.47
phenytoin		-0.92						0.42	
progesterone	1.00	1.00	1.00						
salicylic acid	1.00	1.00	0.99	1.00	1.00	0.98		1.00	0.83
sulfamethoxazole	-0.36	0.84	0.86	-0.80		-3.71	0.97	0.87	0.89
testosterone	1.00		1.00		1.00	1.00			
triclosan	1.00	1.00		1.00	1.00		1.00	1.00	
trimethoprim	0.59	0.34	0.22		0.60	0.97	0.06	0.42	0.30
Overall Removal Efficiency	0.77	0.68	0.23	0.78	0.84	0.51	0.77	0.73	0.61

Table 7. A list of OWC removal efficiencies at three WWTPs sampled.

Treatment Method	Sequencing Batch Reactor - 1			Sequencing Batch Reactor - 2			Aeration Lagoon
Date	8/08	11/08	3/09	8/08	11/08	2/09	5/09
17 α-estradiol							
17 β-estradiol				1.00			
17 α-ethynylestradiol							
acetaminophen					1.00	1.00	
androstenedione	1.00	1.00	1.00	1.00	1.00	1.00	1.00
atrazine							
bisphenol A	0.91	0.88	-2.00	1.00	1.00	0.92	0.66
caffeine	1.00	1.00	0.98	1.00	1.00	0.95	1.00
carbamazepine	0.88	-2.79	0.24	0.60	-3.70	0.09	0.25
DEET	0.99	0.98	-1.85	1.00	1.00	-0.35	0.32
diazepam						0.84	
diclofenac					1.00	1.00	
diethylstilbestrol							
estriol	1.00	0.85	-4.53	1.00	1.00	1.00	1.00
estrone		0.45			1.00		
fluoxetine		0.32	0.30	0.74	0.72	0.60	0.88
gemfibrozil	-0.10	-5.19	-35.15	1.00	1.00	0.98	-2.00
hydrocodone	0.78					0.85	
ibuprofen	1.00	0.93	-0.69	1.00	1.00	0.82	1.00
iopromide							
meprobamate				-0.24	-0.25	0.10	-0.25
methadone							1.00
naproxen	0.91	0.86	-0.47	1.00	1.00	1.00	1.00
oxybenzone	0.99	0.96	0.96	1.00	1.00	0.99	1.00
pentoxifylline							
phenytoin			1.00	1.00			
progesterone			1.00				
salicylic acid	1.00	1.00	0.96	0.99	1.00	0.88	1.00
sulfamethoxazole	0.88			0.93		0.50	0.51
testosterone				1.00			1.00
triclosan	0.65	0.65		1.00	1.00		
trimethoprim	0.78			1.00	1.00	0.89	0.81
Overall Removal Efficiency	0.84	0.14	-2.73	0.90	0.65	0.74	0.60

Table 8. A list of OWC removal efficiencies at two community septic systems sampled.

Treatment Method	Summary of Influents from all Systems Sampled			Community Septic Estimated Removal Efficiencies			Level II Community Septic Estimated Removal Efficiencies
Date	Average	%RSD	Occurrences	8/08	11/08	3/09	8/08
17 α-estradiol	18	0	1				
17 β-estradiol	30	0	2				
17 α-ethynylestradiol			0				
acetaminophen	220	36	5				
androstenedione	150000	88	16	0.98	0.90	0.49	0.81
atrazine			0				
bisphenol A	290	29	15	-1.69	-0.54	-1.24	-0.36
caffeine	100000	38	15	0.99	0.93	0.71	0.63
carbamazepine	220	93	13	-12.35	-16.50	-9.59	1.00
DEET	4261	120	16				
diazepam			1				
diclofenac	78	44	4				
diethylstilbestrol			0				
estriol	190	66	15	-4.74	-3.44	-0.83	-0.36
estrone	27	75	6				
fluoxetine	81	49	14	0.58	0.19	1.00	0.69
gemfibrozil	1300	116	15	0.59	-18.18	-0.99	1.00
hydrocodone	118	58	8				
ibuprofen	15000	56	16	-1.13	-2.02	-0.78	0.51
iopromide			0				
meprobamate	150	89	9				
methadone			1				
naproxen	10000	74	16	0.12	0.72	0.55	0.54
oxybenzone	2500	185	16	1.00	0.94	0.94	0.97
pentoxifylline	22	43	4				
phenytoin	500	95	4				
progesterone	220	48	4				
salicylic acid	110000	292	15	1.00	0.97	0.86	0.98
sulfamethoxazole	1100	69	12	1.00	-2.84	0.48	1.00
testosterone	500	143	6				
triclosan	730	70	10				
trimethoprim	720	70	13	0.74	-0.39	0.78	1.00
Overall Removal Efficiency				-0.99	-3.02	-0.59	0.65

Seasonal samples (summer, fall, winter) were collected from the five WWTPs and one septic system to assess the influence of temperature on the removal efficiencies. Bacteria, which catalyze OWC breakdown, are generally less active at cooler temperatures. Therefore, it was assumed that the OWC removal efficiency may decrease with temperature. WWTP operators typically take measures to minimize temperature reductions to maintain a viable microbial population, but temperatures do decrease somewhat during the cooler months.

The removal efficiencies of the wastewater treatment systems were compared for each sampling event by averaging the removal efficiencies for the individual analytes (fig. 11). The lowest removal efficiencies for four of the five WWTPs sampled seasonally were observed in the late winter samples (Feb–March). The winter sample from sequencing batch reactor-2 was the exception; however, the influent volume was 50 percent higher during this sampling event as compared to the other two sampling times and therefore may not be a valid comparison. Since all of the systems depend on bacterial activity to breakdown the OWCs during treatment and low temperatures suppress bacterial activity, it seems likely that the reduced removal efficiencies are related to reduced temperatures. The low efficiency values for sequencing batch reactor-1 are believed to be related to unstable bacterial population in the reactor due to contamination and not temperature.

The overall removal efficiencies for the traditional septic system were all below zero, which means that one or more analytes had higher effluent concentrations than influent concentrations (fig. 11). However, it is difficult to assess the value of these removal efficiencies, since influent concentrations were estimated using the average concentrations from the WWTPs influent concentrations and therefore were not directly related to the effluent concentrations. As with the WWTPs, phenytoin was the major analyte that caused a negative value, but there were other analytes that yielded negative removal efficiencies and most individual removal efficiencies

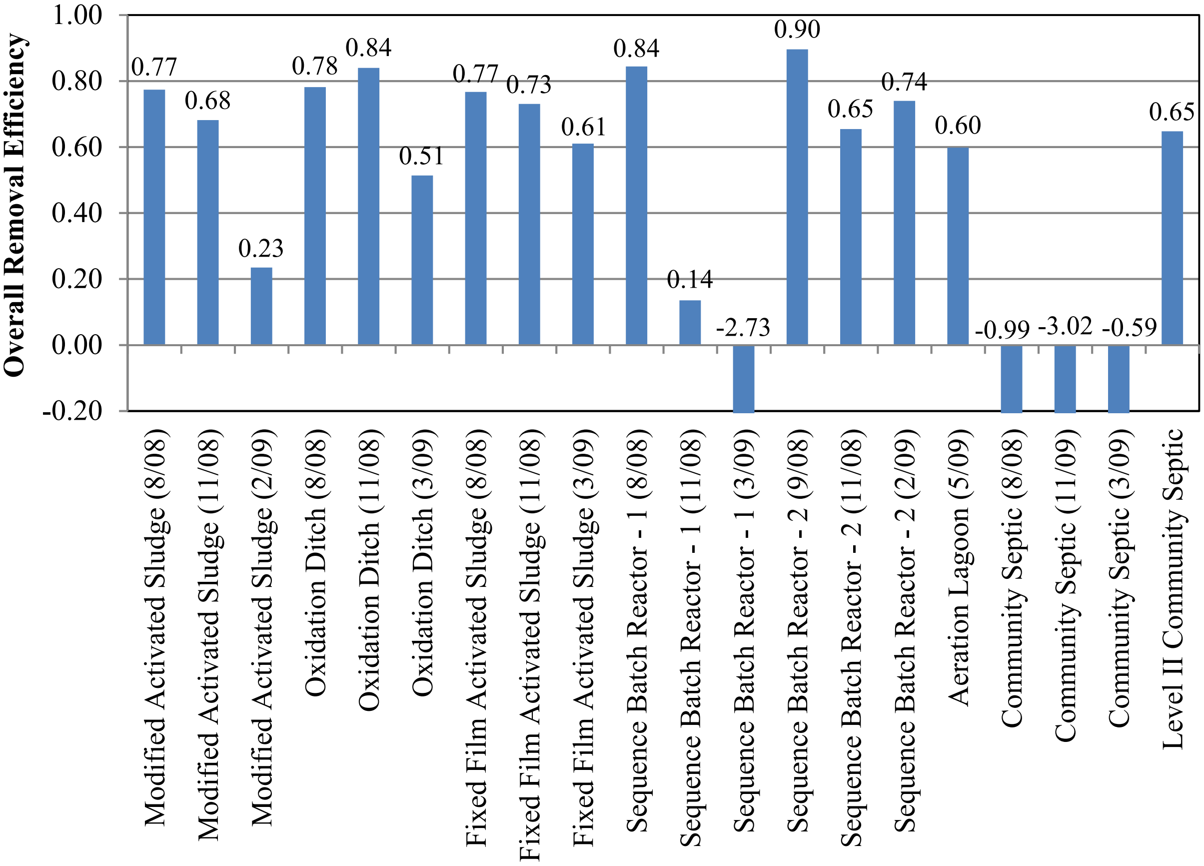


Figure 11. The overall OWC removal efficiencies for each sampling event at each WWTP with the sampling date in parentheses and the removal efficiencies at the top of the bars. The negative values are the result of influent concentrations being lower than the effluent concentrations for one or more OWCs.

were lower than the typical removal efficiencies for WWTPs (tables 6, 7, and 8). Although not exact, the removal efficiency for the traditional septic system indicates that it removed fewer OWCs than the WWTPs. On the other hand, the level II septic system had a removal efficiency that was similar to the WWTPs, which suggests that it more effectively removed OWCs from the waste stream than the traditional septic system.

Another way to assess the waterwater treatment facilities is to calculate the load of OWCs they are delivering to surface water or groundwater. The daily discharge volume and concentrations of each analyte were used to calculate an annual discharge load for each analyte (grams of OWC/year). The individual OWC loads were summed to obtain an annual OWC load for a given system (tables 9 and 10). Loading rates from the WWTPs sampled ranged from76 to 36,000 grams of OWC/year (g/yr) and loading rates from the two septic systems sampled ranged from 600 to 7,600 g/yr. Higher discharges generally resulted in greater annual loads (mass) delivered to receiving streams or groundwater. For example, the highest loading rate (31,000 g/yr) was associated with the WWTP that processed the greatest volume of effluent (5.5 million gpd). One of the septic systems had a loading rate of 7,600 g/yr but only processed 14,400 gpd. However, it is important to note that the OWC concentrations in the WWTP effluent are generally less than the septic effluent, suggesting that the WWTPs are more effective at OWC removal and that a normalized loading rate would be more useful in comparing the OWC removal efficiencies between systems.

The annual loading rate for each system was normalized by assuming all systems had a discharge rate of 100,000 gpd instead of the actual discharge rate for the system. The discharge rate of 100,000 gpd was arbitrarily chosen as a mid-range discharge rate. The normalized loading rates for the WWTPs ranged from 31 to 2,600 g/yr, with most systems discharging less than 500 g/yr (fig. 12). However, the normalized loading rates for the septic systems were between 12,000 and 31,000 g/yr. The normalized OWC loading rate from the level II septic system was lower than the traditional septic system estimates, but the level II loading rate was still an order of magnitude higher than the normalized discharge of the WWTPs. Only one sample was collected from the level II septic system, and more data are needed to further evaluate OWC removal from these systems. Although this analysis clearly shows that WWTPs are more efficient at OWC removal than septic systems, it must be pointed out that septic systems are designed to allow for continued degradation of contaminants within the drainfield and vadose zone. The septic system samples for this project were collected upstream of the drainfield. Septic systems appear less effective at OWC removal, but both septic systems and WWTPs release OWCs to the environment.

The highest OWC concentrations and loads were associated with the late winter sampling for all five WWTPs that were sampled seasonally. The operational difficulties associated with sequencing batch reactor No. 1 may have contributed to the increased discharge associated with the March sampling of that facility. Also, the increased discharge in March from sequencing batch reactor No. 2 was most likely related to the increased volume of wastewater during that sampling time relative to the other two sampling times. The consistent trend of higher discharges with colder temperatures indicates that the removal of OWCs is affected by air temperature.

Table 9. A list of the minimum and maximum OWC loading rates in grams/year for four different WWTPs.

Treatment Method	Modified Activated Sludge		Oxidation Ditch		Fixed Film Activated Sludge		Sequencing Batch Reactor - 1	
Discharge (gpd)	5,500,000		55,000		150,000		100,000	
Loading (g/yr)	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
17 α-estradiol		7.6					0.19	2.2
17 β-estradiol								0.73
17 α-ethynylestradiol								
acetaminophen								
androstenedione		170						5.5
atrazine								
bisphenol A	84	280	1.4	1.6			3.0	75
caffeine	130	910	3.3	33		890	4.3	300
carbamazepine	1,200	1,600	0.14	15	13	41	13	51
DEET	2,900	3,900	1.4	22	29	68	11	51
diazepam		11				0.21		
diclofenac		720	1.7	1.7	6.0	9.7		2.5
diethylstilbestrol								
estriol							5.0	11
estrone	15	99	0.16	0.19			0.48	7.9
fluoxetine	210	480	1.1	2.8	5.0	27	5.7	12
gemfibrozil	640	7,100	3.8	8.4	13	350	3.0	360
hydrocodone	290	680	1.7	4.3		12	7.5	10
ibuprofen		1,100	16	31		480	48	1,700
iopromide		99						
meprobamate	210	680	2.7	13	31	60		1.0
methadone	120	140	0.39	0.75		2.7		3.3
naproxen	990	5,900	5.5	14	9.5	85	17	300
oxybenzone	650	1,100	1.4	2.5	12	48	3.0	6.5
pentoxifylline	49	55			3.5	10		
phenytoin	400	1,900				23		
progesterone								
salicylic acid	990	2,000	15	17		52		29
sulfamethoxazole	690	2,100	30	42	11	60	2.2	66
testosterone								
triclosan	75	76					17	28
trimethoprim	1,800	5,200	1.4	3.0	93	230	7.0	73
Total OWC Loading Rate	11,000	36,000	88	210	230	2400	150	3100

Table 10. A list of the minimum and maximum OWC loading rates in grams/year for two WWTPs and two community septic systems.

Treatment Method	Sequencing Batch Reactor - 2			Aeration Lagoon	Level II Community Septic	Community Septic	
Discharge (gpd)	300,000 to 450,000			600,000	5,100	14,400*	
Loading (g/yr)	Min.	Max.				Min.	Max.
17 α-estradiol							
17 β-estradiol							
17 α-ethynylestradiol							
acetaminophen							
androstenedione			220		200	70	1,500
atrazine							
bisphenol A			17	110	2.8	8.8	15
caffeine		24	1,900	270	260	24	580
carbamazepine	19	50	62	69		46	76
DEET			400	430	3.5	17	3,400
diazepam			0.99				
diclofenac					4.7		
diethylstilbestrol							
estriol					1.8	7.0	22
estrone					0.42	0.46	0.74
fluoxetine	3.9	4.0	23	12	0.18	0.68	1.3
gemfibrozil			6.8	570		11	500
hydrocodone			11				1.4
ibuprofen			1,900		50	520	880
iopromide							
meprobamate	32	36	46	120	30		
methadone			8.1				
naproxen			9.9	30	32	56	180
oxybenzone			2.6		0.44	2.8	3.2
pentoxifylline			2.0				
phenytoin			19	66			
progesterone							
salicylic acid		41	2,500		17	62	300
sulfamethoxazole	21	26	120	730		11	82
testosterone							2.8
triclosan						20	34
trimethoprim			16	190		3.2	20
Total OWC Loading Rate	76	180	7300	2600	600	860	7600

*Estimated discharge based on 300 gpd discharge per household.

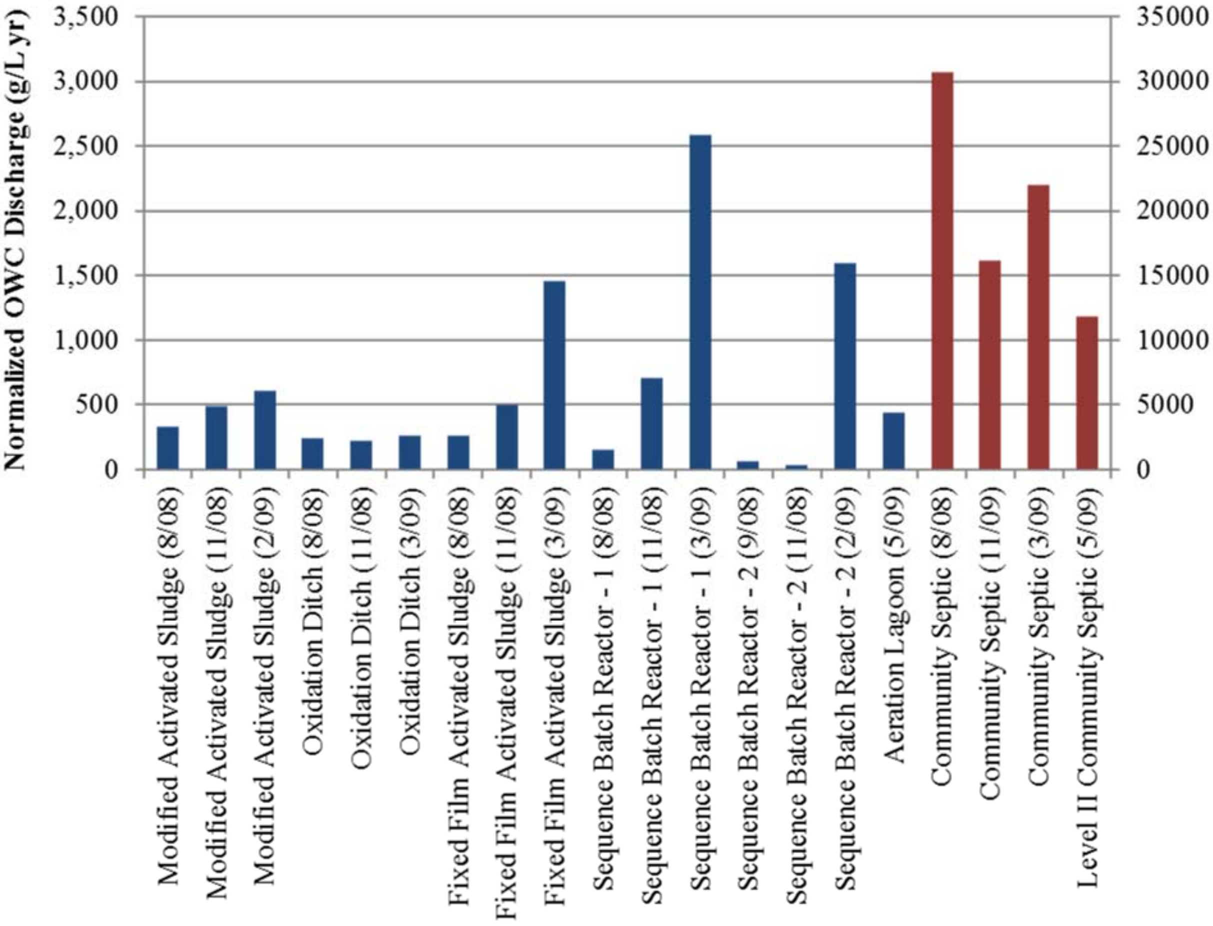


Figure 12. Estimates of the annual OWC loading rates normalized to 100,000 gpd of wastewater for each sampling event from each treatment system with the dates the system was sampled in parentheses. The WWTPs (blue columns) are plotted using the scale on the left and the septic systems (red columns) are plotted with the scale to the right of the graph.

The WWTP with the least seasonal variability in normalized loading rates was the oxidation ditch system (fig. 12). Discharges from the oxidation ditch facility were also consistently low (normalized discharge ranged from 220 to 260 g/yr) relative to the other WWTPs. One possible explanation for the stable and consistent performance of the oxidation ditch is the fluid retention time (residence time). The fluid retention time for the oxidation ditch was approximately 72 hr, which was the longest of all the WWTPs except for the aeration lagoon. The longer retention time maximizes the contact time between the microbial community and the OWCs, which may result in greater OWC degradation. Since the aeration lagoon has a residence time of approximately 3 months, it was initially hypothesized that this system would be very effective at removing OWCs. In fact, the aeration lagoon appeared to perform equally well to most of the other WWTPs, but more data are needed to fully evaluate this system.

This study only looked at dissolved aqueous OWC. Typically, solids that are not mineralized are collected from the facilities and land applied as fertilizer. The reduction of OWCs observed in this study may in part be a function of OWCs sorbing to solids in the wastewater treatment facilities and not a breakdown of the actual compound. When these solids are then applied to agricultural areas the OWCs may be released to the environment. It is possible that some of the OWCs detected in groundwater for this study originated from land-applied WWTP solids. More work is needed to assess this possible source of OWC contamination of the environment.

Groundwater

Groundwater samples were collected from 41 wells in the Gallatin Valley, which included 14 monitoring, 14 domestic, and 13 public water-supply wells (fig. 4). One domestic well was sampled twice (GWIC Id # 244600). Sampling locations were spatially distributed throughout the Gallatin Valley, as well as concentrated in areas that were deemed susceptible to OWC contamination because they were downstream or downgradient of WWTP discharges or areas of high septic system density. Eight wells (GWIC Id # 206589, 244600, 91039, 250018, 250010, 190102, 190101, and 193069) were within 500 ft downgradient of a WWTP groundwater discharge area.

Based on the CAS data, at least one OWC was detected in 73 percent of the well samples (Appendix H). All the samples from wells downgradient of WWTPs had detectable OWCs. Although well 244600 was sampled twice, the data from this well were only counted once for the frequency calculations. Sulfamethoxazole was the most frequently detected OWC, occurring in 21 different samples (51 percent). Other OWCs with high occurrence rates were carbamazepine (17 percent of well samples), meprobamate (12 percent), bisphenol A (12 percent), caffeine (12 percent), and fluoxetine (12 percent) (fig. 13). All of these OWCs have been previously observed in groundwater that has been impacted by wastewater disposal or landfill leachate (Eckel and others, 1993; Kreuzinger and others, 2004; Barnes and others, 2008; Avisar and others, 2009). Sulfamethoxazole and carbamazepine are so persistent in the environment they have been suggested as possible conservative tracers for wastewaters in the environment (Clara and others, 2004; Barber and others, 2009).

OWCs were detected in 12 of the 29 groundwater samples (41 percent) submitted for ELISA analysis. Similar to the CAS data, sulfamethoxazole was the most common ELISA-detected analyte (31 percent of the samples, fig. 14). The ELISA procedure detected 17 α-ethynylestradiol, 17 β-estradiol, estrone, and progesterone, whereas these compounds were not detected in the split samples analyzed by CAS. As described above, ELISA analysis tends to estimate higher concentrations of estrogens relative to mass spectrometric methods. However, it is not clear if the ELISA method is quantifying estrogen compounds or non-estrogen compounds. If the ELISA method is measuring estrogen compounds, the concentrations of these compounds may be high enough to interfere with biological processes. Because the ELISA bisphenol A data were not reliable, these data were not used for the evaluation.

The OWC groundwater concentrations were generally higher than the surface-water concentrations observed downgradient of WWTP discharges (see Surface Water Section of this report). Many of the OWCs detected in groundwater had concentrations greater than 100 ng/L and three OWCs had maximum concentrations greater than 1,000 ng/L (fig. 14). The highest concentrations were observed in samples from wells that were immediately downgradient of WWTP discharges. OWC concentrations have been demonstrated to decrease as water through aquifers (Cordy and others, 2004; Scheytt, 2004), and bank filtration (induced aquifer recharge by pumping wells near streams) has been used to treat drinking water from rivers (Heberer and others, 2001, 2004). Microbial degradation and sorption to aquifer materials are the processes thought to remove OWCs in aquifers. However, the elevated OWC concentrations observed 500 ft downgradient from a WWTP suggests that the effectiveness of these processes is variable.

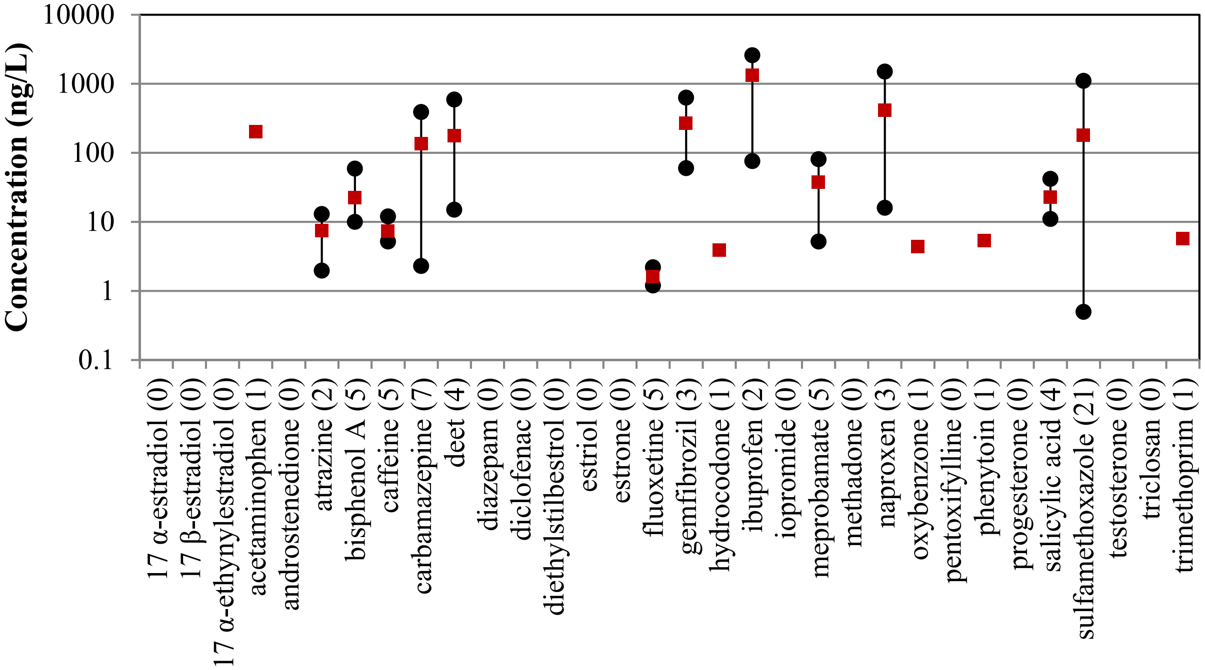


Figure 13. The range (bars) and mean concentrations (squares) of OWCs measured in the groundwater samples with the frequency of detection for each compound in parentheses after the name (data from 41 wells).

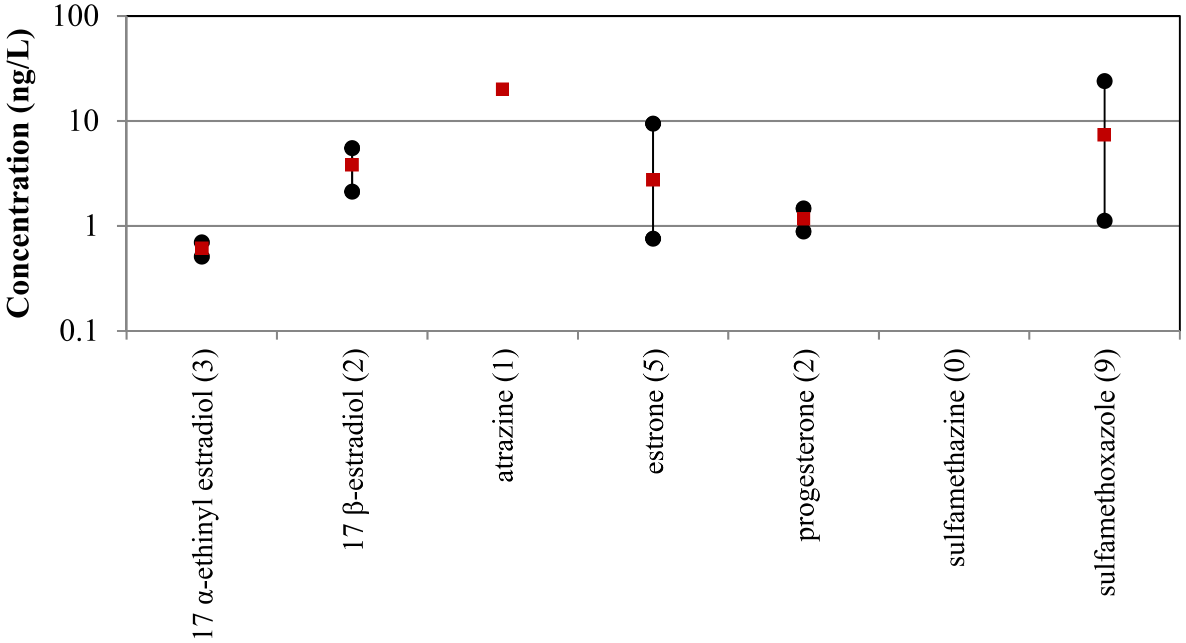


Figure 14. The range (bars) and mean concentrations (squares) of OWCs in the groundwater samples quantified via the ELISA method with the frequency of detection for each compound in parentheses after the name (data from 29 wells).

The wells that were not associated with WWTP discharges also had a relatively high occurrence rate of OWC detections but at lower concentrations. At least one OWC was detected in 67 percent of samples from wells upgradient of WWTP discharges. The maximum and mean OWC concentrations in these wells were generally much lower than concentrations in wells that were downgradient of WWTP discharges (fig. 15). The highest concentration was typically less than 10 ng/L, and the OWC occurrence frequency was generally much lower, with the exception of sulfamethoxazole (45 percent) and fluoxetine (15 percent). Although the concentrations of sulfamethoxazole and fluoxetine were lower in the wells that were not associated with WWTP discharges, the maximum concentrations were significantly higher than expected based on previously reported concentrations for these compounds in groundwater (Barnes and others, 2008).

The source for OWCs in wells not downgradient of WWTP discharges may be septic systems and/or livestock waste. These wells were associated with a variety of land uses: unsewered subdivisions (15 wells), single family rural dwellings (9 wells), sewered urban areas (3 wells), and isolated areas without immediate wastewater sources (5 wells). Wells associated with (or within and downgradient of) unsewered subdivisions had the highest OWC occurrence rate (87 percent). Eighty percent of the wells (five total) with no obvious nearby (< 0.5 mi) source of wastewater contamination also contained detectable OWCs. Three of these wells with detectable OWCs (216675, 235473, and 235512) were shallow groundwater wells (40, 36, and 57 ft, respectively) installed to monitor groundwater levels and water quality in the valley.

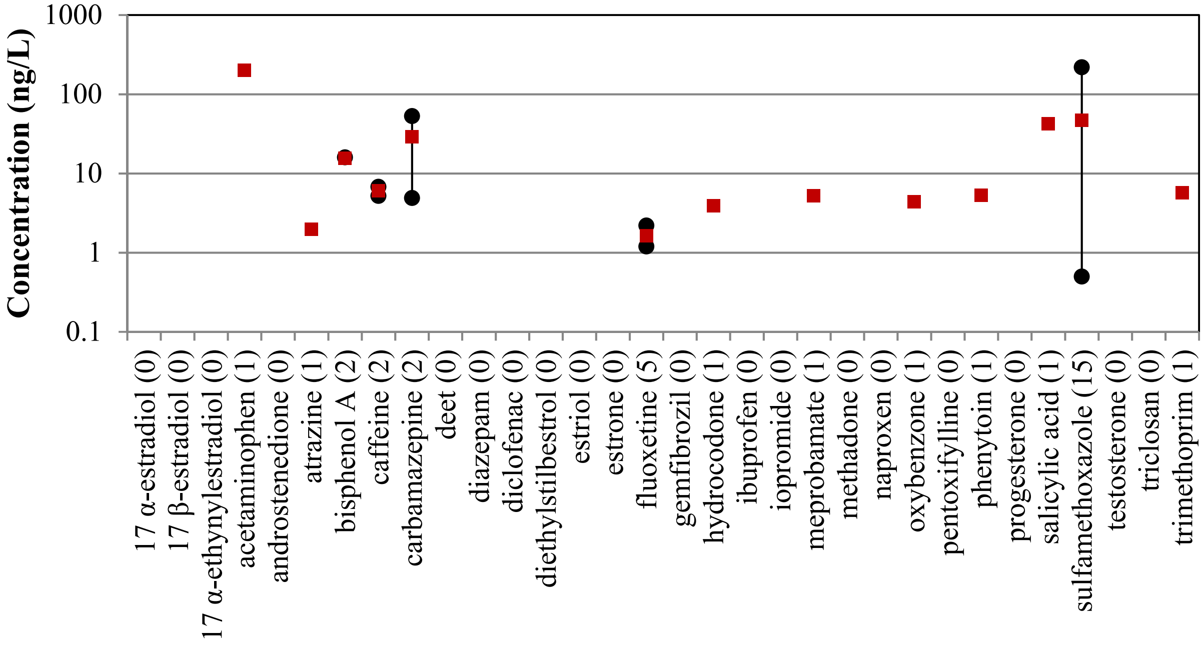


Figure 15. The range (bars) and mean concentrations of OWCs measured in the groundwater samples that were not downgradient of WWTP discharge sites with the frequency of detection for each compound in parentheses after the name (data from 33 wells).

Wells 216675 and 235473 also had detectable OWCs when sampled for a different project in 2007. Well 251512, a public water supply, is a developed spring with a horizontal collection line located in an area of intense farming and livestock use. Bisphenol A and Trimethoprim were detected at this site. The wells within sewered urban areas (3 wells) also had a relatively high OWC occurrence rate (67 percent), which may be coming from leaky sewer pipes. Wells associated with single residences (9 wells) had the lowest OWC occurrence rate, with 33 percent of these wells having detectable OWC concentrations. These data indicate the wells downgradient of WWTP discharges and wells associated with unsewered subdivisions are at the greatest risk of OWC contamination, but also that OWC contamination can persist in the aquifer and migrate to areas that are fairly distant (at least 0.5 mi) from possible sources.

The correlation between OWCs detected and depth water enters the well (DWE; Appendix I) was investigated using Spearman's rank correlation coefficient (Davis, 1973). Well completion information was not available for wells 251503 and 251512 (horizontal well/developed spring). The DWE was assumed to be the bottom of the well (198 ft) for well 251503 and less than 20 ft for well 251512. Since OWC contamination originates at or near the ground surface, physical and biological processes (e.g., sorption to subsurface material, diffusion, dilution, microbial degradation) in the vadose zone and aquifer should reduce the concentration of OWCs. As a result, wells with deeper screened intervals should theoretically have fewer OWC detections than shallower wells. A decrease in OWC detection frequency with well depth has been reported for both pesticides (Kolpin and others, 1995) and OWCs (Barnes and others, 2008). However, the number of OWCs detected in the wells sampled for this project was not correlated with the DWE for the dataset containing all the wells (rho = -0.145; Spearman's coefficient) even at the significance level of $\alpha = 0.2$ (lower critical value = -0.204; Ramsey 1989). Similarly, in wells that were not downgradient from WWTP discharges the frequency of compounds detected was not significantly correlated with the DWE (rho = -0.214; $\alpha = 0.2$; lower critical value = -0.232; Ramsey, 1989). This lack of a correlation is presented graphically in figure 16, which shows the percent of wells having at least one detectable OWC within a given DWE interval (fig. 16A). Although the uppermost interval (0 to 50 ft) had the highest frequency of detections (88 percent), the second highest frequency of detections (80 percent) was in the interval between 100 and 151 ft.

The DWE did not exceed 200 ft below ground surface for any of the wells sampled for this study, and it seems likely that wells with deeper intakes may show a decreasing OWC detection frequency similar to what has been previously reported (Barnes and others, 2008). However, the previous study (Barnes and others, 2008) had a similar percentage of wells less than 164 ft deep (76 percent) to the present study (80 percent). In an effort to provide a more direct comparison with the previous study, the correlation between well depth and OWCs was also examined, and although this relationship had a slightly higher correlation (rho = -0.196), it was still not statistically significant. One possible explanation for these divergent findings is the geological units in which the wells were completed. With the exception of two wells (195430 and 234930), all of the wells sampled for the current study were completed in unconsolidated valley fill deposits, which are likely to be well connected hydrogeologically with the land surface. The geological environment surrounding the well completions in the previous study was not identified and it is possible that some of the wells were completed in more stratified deposits than the valley fill deposits of the Gallatin Valley.

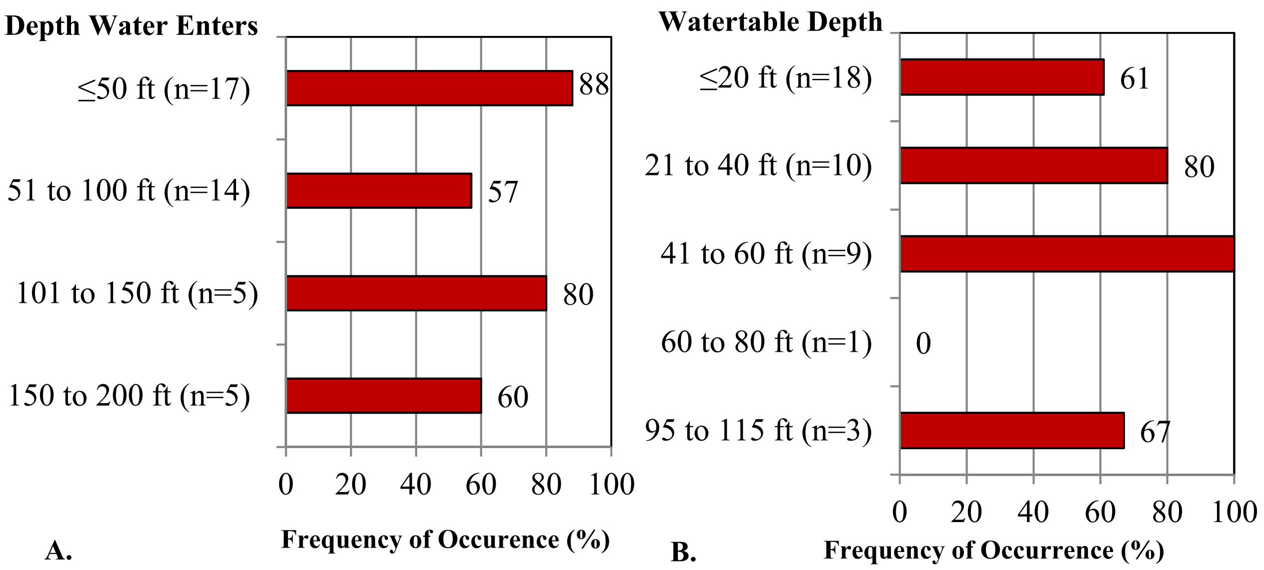


Figure 16. The frequency of wells having at least one detectable OWC for depth intervals of (A) the depth water enters the well and (B) the depth to the water table. The total number of wells in each depth interval is given in parentheses after the depth.

OWC detections were also elevated with regard to the depth to the water table (static water level measured in the well). The potential for microbial degradation and sorption of OWCs should increase with vadose zone thickness. If this hypothesis is correct, a thicker vadose zone should result in lower OWC concentrations in the underlying aquifer. Contrary to the expected behavior, OWC detections increased with depth to groundwater for those wells with water tables <60 ft below ground surface (fig. 16B). Also, the Spearman's rank correlation between water-table depth and OWC detection frequency for the entire data set showed a weak positive correlation that was statistically significant (rho = 0.307; α = 0.2; upper critical value = 0.204; Ramsey, 1989). The correlation between water-table depth and OWC detection frequency for the wells that were not downgradient of WWTP discharges was not statistically significant but also showed a positive correlation (rho = 0.163; upper critical value = 0.232; Ramsey 1989). The wells downgradient from WWTP discharges were in areas with deeper water tables (between 23 and 50 ft) relative to wells in the rest of the data set (18 wells with water tables < 20 ft below the ground surface). The detect frequency was also greatest (100 percent) in wells downgradient from WWTP discharges, which indicates that groundwater is susceptible to OWC contamination from highly concentrated sources.

In addition to an increasing detection rate with increasing depth to the water table, the two wells with the deepest water tables (102 and 113 ft below ground surface) also had detectable OWCs (sulfamethoxazole, fluoxetine, and phenytoin; fig. 16B). The presence of an OWC in an aquifer overlain by a thick vadose (92 ft) has been observed by others (Avisar and others, 2009). Avisar and others observed sulfamethoxazole in an aquifer that was situated under land that had been irrigated with wastewater effluents. These results suggest that physical and biological processes occurring in the vadose zone are inefficient at removing sulfamethoxazole, fluoxetine, and phenytoin. In addition, the positive correlation of OWC detections with depth indicates that the vadose zone is ineffective at reducing OWC contamination in general.

The results from inorganic water-quality samples, collected for 40 of the 41 wells, were evaluated for indicators of OWC contamination. For example, boron is often observed in samples with OWC contamination (e.g., Clara and others, 2004). In all, 57 water-quality parameters, including field parameters (Appendix I), were evaluated. The water-quality data were grouped into two populations based on the detection of OWCs. These two populations were then plotted to identify threshold concentrations that may be indicative of OWC contamination. The concentration data from six water-quality parameters (ortho-phosphate, DOC, nitrate, chloride, cobalt, and nickel) indicated that they may be useful as indicator parameters for OWC contamination (fig. 17). While most of the samples with detectable OWCs (63 percent) did not have detectable ortho-phosphate, all samples having detectable ortho-phosphate also had detectable OWCs. The other five water-quality parameters had threshold concentrations above which all of the analytes co-occurred with at least one OWC (DOC ≥ 1.5 mg/L; nitrate ≥ 2 mg/L; chloride ≥ 23 mg/L; cobalt ≥ 0.11 µg/L; and nickel ≥ 0.3 µg/L). These threshold concentrations likely represent the upper limit of the background concentrations for these analytes in this area. In fact, 2 mg/L nitrate has been used by others to represent the upper limit for background concentrations in other aquifers (USGS, 1999; LaFave, 2008). These data indicate that threshold values may be useful in identifying wells that may contain OWCs.

When the threshold concentrations for the six indicator parameters are used as a predictive tool on the current data set, they are good predictors of OWC detections. This was somewhat surprising considering no single indicator parameter was predictive of OWC occurrence 100 percent of the time. Nitrate was the most predictive of OWC occurrences with 67 percent of the samples with ≥ 2 mg/L nitrate also having detectable OWCs. The co-occurrence rate for the other indicator parameters ranged from 27 to 50 percent. In all, 93 percent (28 out of 30) of the samples with detectable OWCs also had concentrations above the threshold value for one or more of the indicator parameters. In most samples with detectable OWCs the threshold concentration was exceeded for multiple indicator parameters, and in only 5 samples was the threshold concentration exceeded for only one parameter. The two samples (90850 and 251503) that did not have a threshold concentration exceedance both had detections of 1.2 ng/L fluoxetine. In the analysis set for 90850 and the analysis set subsequent to the analysis of 252503 the laboratory control blank also had a detection of 1.2 ng/L fluoxetine. Fluoxetine detections in the laboratory control blanks were not common (Appendix D) but these detections indicate that the detections of fluoxetine in samples 90850 and 251503 may be false positives. Assuming that all the OWC detections are accurate, the threshold values predicted the presence of OWCs 93 percent of the time. Although the relationship seems strong, the use of these indicator parameter threshold concentrations needs to be strengthened with more data. Even if these threshold concentrations become a useful predictive tool, its application may be limited to the Gallatin Valley, because every basin will have a different background concentration of analytes and therefore a different set of threshold concentration values.

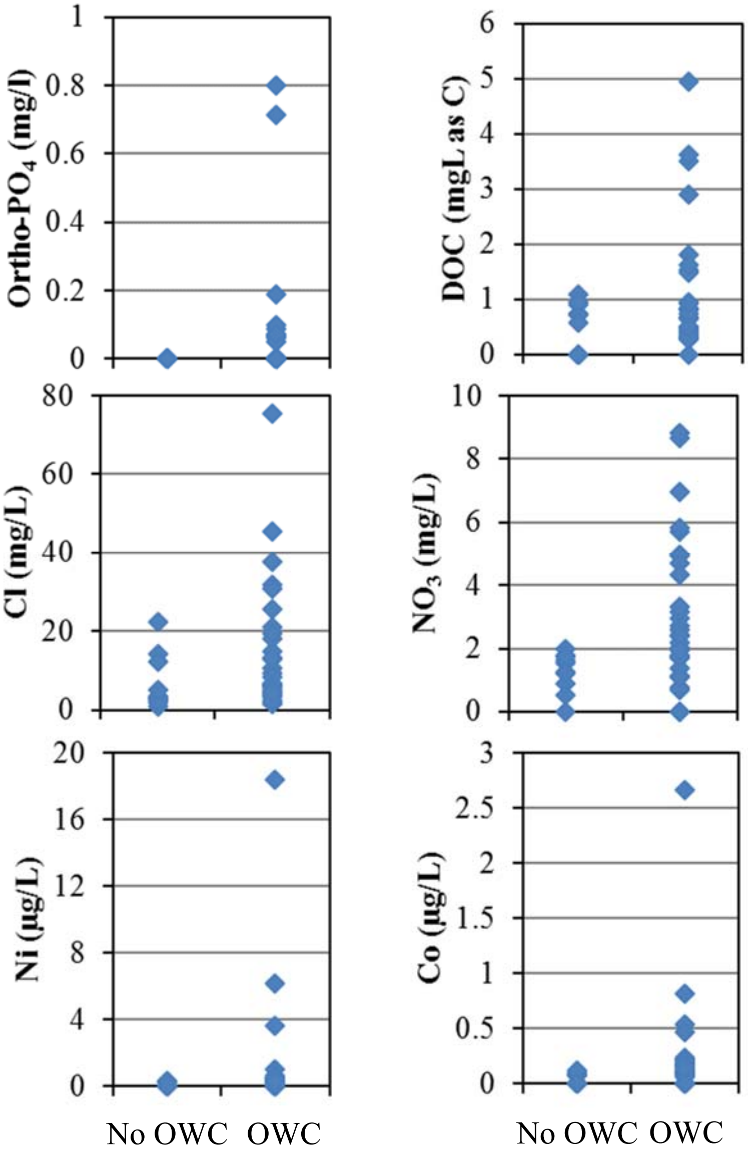


Figure 17. Concentrations of ortho-phosphate (ortho-PO_4), dissolved organic carbon (DOC), chloride (Cl), nitrate (NO_3), nickel (Ni), and cobalt (Co) in samples from wells that did not have detectable OWCs (No OWC) and had detectable OWCs (OWC).

Surface Water

Surface-water samples were collected from 10 sites in the Gallatin Valley (fig. 5). The sites were sampled three times each, in late summer, late winter, and the first large runoff event in the spring. At least one OWC was detected in samples from all of the surface-water sampling locations. Although a greater number of OWCs (21) were detected in the surface-water samples relative to the groundwater samples (17), the maximum concentrations were generally much lower than the groundwater samples (fig. 18; Appendix J). For example, the maximum concentrations of sulfamethoxazole, naproxen, and ibuprofen were an order of magnitude lower in surface water. The highest OWC concentrations in both surface water and groundwater were observed in locations downgradient of WWTP discharge areas. However, only 1 (249234) of the 10 sampling sites was directly downstream (within 1000 ft) of a WWTP discharge and only 2 sites (246236 and 249235) were within 10 mi downstream of WWTP discharge sites. Three sites (246246, 246247, and 246248) had no upstream wastewater discharges.

The most frequently detected OWC in surface water was salicylic acid, which was present in 21 of the 30 samples collected. Salicylic acid is a common component in skin care products and the highest salicylic acid concentrations were observed in the East Gallatin River below WWTP outfalls. However, low salicylic acid concentrations (15 to 25 ng/L) were also observed in the most isolated stream samples collected from Bozeman Creek at the Sourdough Trailhead (246248), which has no upstream wastewater sources. The low concentrations of salicylic acid are most likely from naturally occurring compounds in the watershed. Salicin is a glucoside produced by many trees, most notably willow trees (Hayat and others, 2007), and strong acids hydrolyze salicin to produce salicylic acid and glucose (Hudson and Paine, 1909). Since all OWC samples were acidified with sulfuric acid, it is likely that naturally occurring salicin was hydrolyzed to salicylic acid during sample collection and preservation. The range of salicin or salicylic acid in natural waters is unknown, so it is not possible to apportion between natural and non-natural salicylic acid in samples that have inputs from human wastewater. Samples from this study indicate that naturally derived salicylic acid concentrations may be at least as high as 25 ng/L (Bozeman Creek).

Similar to the groundwater samples, sulfamethoxazole was the most frequently detected OWC (13 out of 30 samples) after salicylic acid (fig. 18). The insect repellent DEET was also detected in many of the surface-water samples (12 samples). Other commonly detected OWCs included caffeine, naproxen, acetaminophen, carbamazepine, bisphenol A, and fluoxetine (fig. 18).

OWCs were also detected in all the surface-water samples submitted for ELISA analysis except one, from a site upstream from any wastewater sources (ID 246248). However, the most commonly ELISA-detected OWCs were the hormones estrone (12 of 22 samples total) and progesterone (10 of 22 samples total; fig. 19). Estrone was only detected in one sample and progesterone was not detected in any samples analyzed by CAS. However, all of the ELISA progesterone data were below the CAS minimum reporting limits. As described above, ELISA analysis tends to estimate higher concentrations of estrogens relative to mass spectrometric methods. If the ELISA method is quantifying estrogen compounds, the concentrations of these compounds may be high enough to interfere with biological processes. Since the ELISA bisphenol A data were not reliable, they was not used in this analysis.

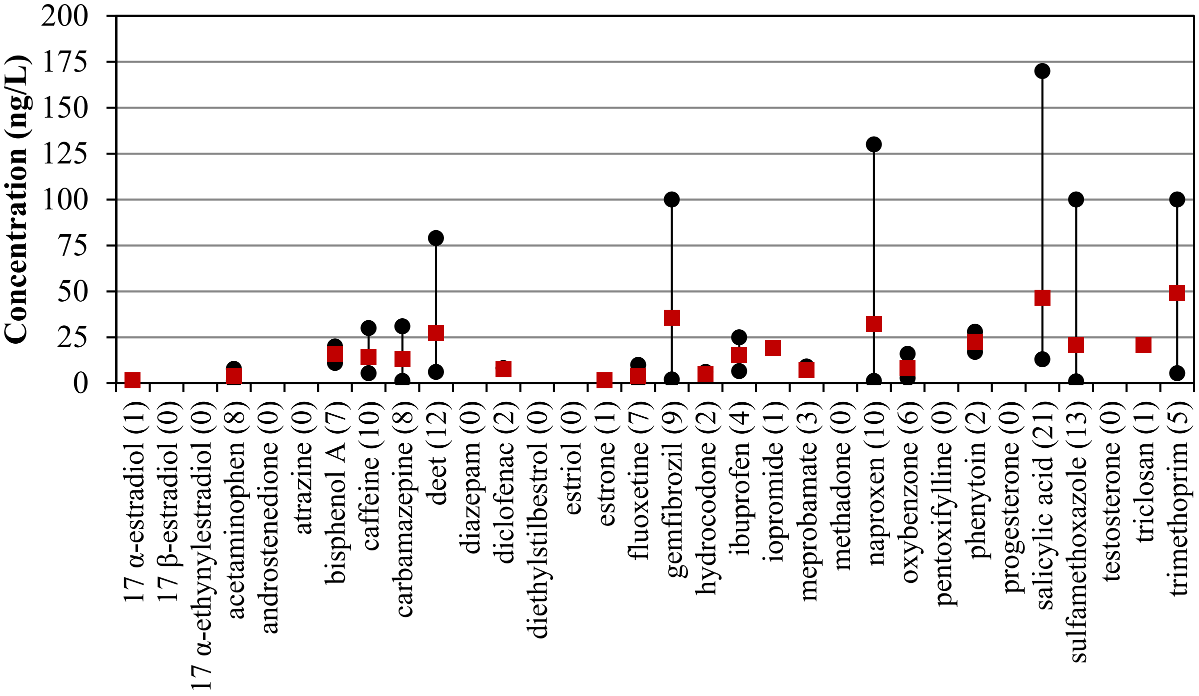


Figure 18. The range (bars) and mean concentrations (squares) of OWCs measured in the surface-water samples with the frequency of detection for each compound in parentheses after the name (data from 10 surface-water sites each sampled three times).

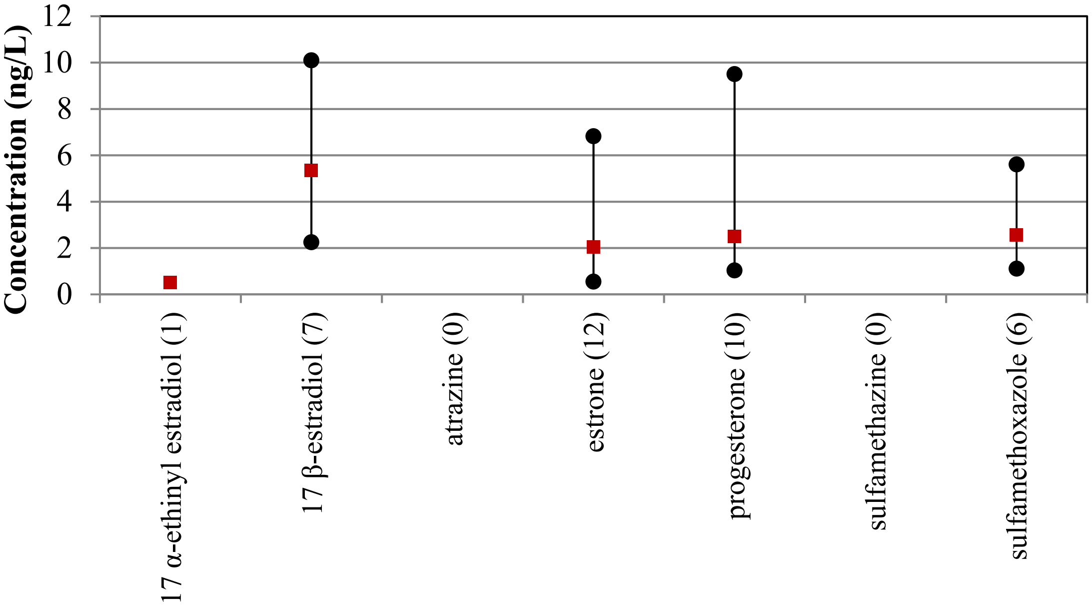


Figure 19. The range (bars) and mean concentrations (squares) of OWCs measured in the surface-water samples quantified via the ELISA method with the frequency of detection for each compound in parentheses after the name (data from 9 surface-water sites each sampled twice, one site sampled three times, and one site sampled once; 22 samples).

East Gallatin River

A modified activated sludge Bardenpho Process WWTP discharges treated wastewater to the East Gallatin River. The East Gallatin River was sampled upstream and downstream of this WWTP discharge (fig. 5). Sampling site 249233 was approximately 3,000 ft upstream from the WWTP effluent discharge. Sampling site 249234 was approximately 700 ft downstream from the effluent discharge site. Sampling site 249235 was approximately 4 mi downstream from the effluent discharge site; however, between site 249234 and 249235 there is another WWTP that may contribute to the OWC contaminate load.

All three sites consistently had detectable OWC concentrations during all three sampling events (table 11). The upstream site 249233 had the least number of detections, and lower concentrations than the downstream sites. However, the number of detections at site 249233 was not expected, because the only known sources above this location are septic systems. One explanation for OWCs at this location may be leakage from sewage lines. Some of the sewer lines in Bozeman are susceptible to groundwater infiltration during times of high groundwater elevations (Tom Adams, personal commun.) and these same sewer lines may leak sewage to groundwater during times of low groundwater elevations.

As expected, the downstream sites (249234 and 249235) had more OWCs at higher concentrations. Samples from sites 249234 and 249235 also had a similar number of occurrences and concentrations of OWCs for each of the seasonal sampling events. Possible discharges from the other WWTP and septic systems may have contributed OWCs between sites 249234 and 249235, and resulted in higher concentrations in the farthest downstream site. Also, these samples were not collected in a synoptic fashion and different pulses of effluent may have been sampled, as opposed to sampling river water that received the same pulse of effluent. Considering that site 249234 was fairly close to the WWTP outfall, there were surprisingly few hormones detected. Only one sample from site 249234 had detectable estrone concentrations, and no other hormones were detected in these samples. This occurrence of estrone coincided with the only recorded detection of estrone from the WWTP effluent.

Stream discharge for the two low-flow sampling events in August and February were similar—57 and 43 cubic ft per second (cfs), respectively—as measured at the U.S. Geological Survey gauging station (site 249233; Appendix K). The August sampling time was selected to represent a late season irrigation low-flow condition, and the February sampling time was selected to represent a late winter baseflow condition. The April sampling time was chosen to coincide with the first significant runoff event and had a flow rate of 422 cfs at site 249233. The OWC occurrences and concentrations were similar for both of the low flow samples, which were likely dominated by the WWTP effluent discharge (approximately 8.5 cfs). The river flow was roughly an order of magnitude higher during the April sampling. The concentrations of OWCs were generally an order of magnitude lower or below detection, reflecting the dilution effect.

Table 11. A list of OWC concentrations at three sampling sites on the East Gallatin River for the three sampling events.

Stream	East Gallatin River			East Gallatin River			East Gallatin River		
Date	8/14/08			2/12/09			4/21/09		
GWIC Number	249233	249234	249235	249233	249234	249235	249233	249234	249235
17 α-estradiol									
17 β-estradiol									
17 α-ethynylestradiol									
acetaminophen				1.3	6.1	7.8			
androstenedione									
atrazine									
bisphenol A	20	17	13.8*			11	20		
caffeine	12	10	15	7.1	19	30			
carbamazepine		27	14		31	24		3.5	3.6
DEET	16	61	79		62	43		7.5	10
diazepam									
diclofenac					8.2	6.8			
diethylstilbestrol									
estriol									
estrone					1.5				
fluoxetine		2.3		1.8	10	6.2			
gemfibrozil	2.1	100	60		42	90		11	11
hydrocodone									
ibuprofen		25	17						
iopromide					19				
meprobamate		9.1	5.9		6.5				
methadone									
naproxen		23	15		93	130		24	15
oxybenzone	2.8	16	5.6		10	8.4			
pentoxifylline									
phenytoin					17	28			
progesterone									
salicylic acid			110*	32	40	170	74	53	69
sulfamethoxazole		100	18		90	12		12	12
testosterone									
triclosan			21*						

*Estimated data

West Gallatin River and Gallatin River

The West Gallatin River was sampled upstream near the mouth of Gallatin Canyon at Williams Bridge (246756) and approximately midway between the mouth of the canyon and its confluence with the East Gallatin River at the Cameron Road Bridge (246243; fig. 5). The sources of OWCs in this stretch of the river are septic systems and WWTP effluents that are land applied or discharged to groundwater. The resort community of Big Sky, approximately 20 mi upstream from the mouth of Gallatin Canyon, has a WWTP with a permit to discharge to the West Gallatin River, but currently uses all the treated effluent for golf course irrigation.

The Gallatin River was sampled near Logan, MT (246236). The sampling site at Logan is at a geological pinch point where surface water and groundwater from the Gallatin Valley are funneled through a narrow bedrock constriction. The samples collected at Logan represent a composite of the water draining the basin (fig. 5). The Gallatin River receives WWTP discharge indirectly via the Dita Ditch and the East Gallatin River. The East Gallatin River WWTP discharge is located about 20 mi upstream from the Gallatin River confluence and contributes the greatest volume of treated WWTP effluent compared to the smaller WWTP facility discharge located about 2 mi from the Gallatin River. Stream discharge is monitored at the Logan site and just upstream of the Williams Bridge site by the U.S. Geological Survey.

At least one OWC was detected in all the samples collected from the West Gallatin River, with acetaminophen and salicylic acid being the most commonly detected (table 12). As described earlier, the presence of salicylic acid is not necessarily indicative of wastewater contamination. A national survey of streams indicates that acetaminophen contamination of streams is not uncommon (Kolpin and others, 2002); however, the source for these occurrences was attributed to WWTP discharges. The relatively high occurrence rate of acetaminophen in the West Gallatin River was unexpected since there are no WWTP discharges near these sampling sites and acetaminophen was not prevalent in the groundwater samples. Other OWCs detected in the West Gallatin River included one detection each of caffeine, DEET, fluoxetine, and hydrocodone. The West Gallatin River receives no direct WWTP effluent so the OWC source is not clear. Regardless of the source, the OWC load is small relative to the East Gallatin River. Also, there were no observable differences in OWC occurrences or concentrations between the high-flow sample and the two low-flow samples, which may have been due to the low occurrence rate of OWCs or the fact that the high-flow discharge was only about three times the low-flow discharges (Appendix K).

All three samples collected from the Gallatin River at Logan had detectable concentrations of at least three different OWCs other than salicylic acid (table 12). Sulfamethoxazole was detected in all three samples, and carbamazepine and gemfibrozil were each detected in two samples. Single occurrences of acetaminophen, DEET, and naproxen were also detected. Possible sources include WWTP effluent or groundwater discharge. Similar to OWC concentrations in the West Gallatin River, there were no clear differences between the samples that were collected at different times of the year.

Table 12. A list of OWC concentrations at three sampling sites on the West Gallatin River and the Gallatin River at Logan, MT for the three sampling events.

Stream	West Gallatin River						Gallatin River		
Date	8/08		2/09		4/09		8/08	2/09	4/09
GWIC Number	246756	246243	246756	246243	246756	246243	246236	246236	246236
17 α-estradiol									
17 β-estradiol									
17 α-ethynylestradiol									
acetaminophen			3.2	1.7	4.4	5.4		1.5	
androstenedione									
atrazine									
bisphenol A									
caffeine			5.4						
carbamazepine								1.4	1.2
DEET		6.1					6.2		
diazepam									
diclofenac									
diethylstilbestrol									
estriol									
estrone									
fluoxetine	1.2								
gemfibrozil							3.4		2
hydrocodone	3.7								
ibuprofen									
iopromide									
meprobamate									
methadone									
naproxen									13
oxybenzone									
pentoxifylline									
phenytoin									
progesterone									
salicylic acid	13			19	32	40		27	28
sulfamethoxazole							9.2	6.4	5.1
testosterone									
triclosan									

Bozeman Creek and Hyalite Creek

Bozeman Creek was sampled upstream near the mouth of the canyon at the Sourdough Trailhead (246248), near East Lincoln Street (246246), and just above the confluence with the East Gallatin River at Griffin Drive (246244) (fig. 5). There are no known wastewater sources or livestock grazing above the Sourdough Trailhead and this site was chosen as a background site. There are no WWTP discharges to Bozeman Creek and the only known wastewater sources are septic systems. There are several unsewered subdivisions adjacent to Bozeman Creek between the Sourdough Trailhead and East Lincoln Street. Hyalite Creek was sampled where it was crossed by Cottonwood Road. Similar to Bozeman Creek, the primary sources of OWCs to Hyalite Creek are septic systems associated with unsewered subdivisions.

Only one non-salicylic acid OWC (hydrocodone) was detected in the samples from the Sourdough Trailhead site (table 13). The hydrocodone detection (6.2 ng/L) was in an analysis set that also had a 7.2 ng/L hydrocodone detection in the laboratory control blank, and therefore this detection is most likely a false positive. Assuming the hydrocodone detection is a false positive, the Bozeman Creek Sourdough Trailhead site represents a good background control for the surface-water OWC samples.

Samples from the East Lincoln Street site consistently had non-salicylic acid OWC detections. The only OWC source for the samples collected from Bozeman Creek at the East Lincoln Street site is groundwater. During low-flow conditions the majority of the water in the stream is coming from groundwater discharge, and it follows that OWC frequency and concentrations should be greatest when groundwater is the dominant source of stream water. In fact, the greatest number of OWC detections at the East Lincoln Street site were associated with the low-flow samples collected in August and February. The high-flow (run-off-dominated) sample from this site only had one detectable OWC at a fairly low concentration (1 ng/L sulfamethoxazole).

Samples from the Griffin Drive site also consistently had detectable OWC concentrations, but the relationship between OWC frequency and concentrations is less clear than at the East Lincoln Street site (table 13). The low-flow sample (February, 15 cfs; Appendix K) also had the least number of OWCs. The Griffin Drive site is upstream from site 249233 on the East Gallatin River, and Bozeman Creek may be the source of the OWCs found in the East Gallatin River above the WWTP discharge point.

The two low-flow samples collected from Hyalite Creek had detectable concentrations of DEET (15 and 6.8 ng/L) and bisphenol A (18 ng/L; Appendix J). Similar to Bozeman Creek the only source for these OWCs to Hyalite Creek is septic systems associated with unsewered subdivisions. The high-flow samples from Hyalite Creek did not contain OWCs, aside from salicylic acid.

Table 13. A list of OWC concentrations at three sampling sites on Bozeman Creek for the three sampling events.

Stream	Bozeman Creek								
Date	8/08			2/09			4/09		
GWIC Number	246248	246246	246244	246248	246246	246244	246248	246246	246244
17 α-estradiol		1.5							
17 β-estradiol									
17 α-ethynylestradiol									
acetaminophen									
androstenedione									
atrazine									
bisphenol A					12				
caffeine			12		23				10
carbamazepine									
DEET			12						
diazepam									
diclofenac									
diethylstilbestrol									
estriol									
estrone									
fluoxetine						1.5			4.2
gemfibrozil									
hydrocodone				6.1*					
ibuprofen		12	6.6						
iopromide									
meprobamate									
methadone									
naproxen		4.7	1.2		1.8				
oxybenzone			5.9						
pentoxifylline									
phenytoin									
progesterone									
salicylic acid				13	41	84	25	39	42
sulfamethoxazole					2.2	1.5		1	1.4
testosterone									
triclosan									

*This sample is likely a false positive.

Domestic and Public Water Supplies

OWC samples were collected from 27 wells and 1 stream used for drinking water. The sites include 14 domestic wells, 13 public water-supply wells, and a surface-water source used for municipal water supply. One of the domestic wells (244600) was sampled twice, but only the data from the first sampling were frequency calculations. The distribution of OWC detections (fig. 20) is similar to the distribution observed for OWCs in groundwater (fig. 20), because the water supplies in this area predominately utilize groundwater. The most prevalent OWC detected was sulfamethoxazole, which was present in 39 percent of the samples. The other most frequently detected OWCs were fluoxetine (18 percent), bisphenol A (14 percent), and carbamazepine (14 percent). The occurrences of fluoxetine and sulfamethoxazole are significant, because they occur in wells that are not associated with a nearby WWTP discharge (compare fig. 20 with fig. 4), which suggests that these compounds may be highly mobile in subsurface environments.

The one surface-water supply was from Bozeman Creek with the intake near the Sourdough Trailhead. However, the sample for this project was collected from the distribution system just downstream from filtration and the treatment plant (Appendix J, 247764). As discussed in the preceding section, water from Bozeman Creek at the Sourdough trailhead is pristine with respect to OWC contamination. Salicylic acid (15 ng/L) and bisphenol A (13 ng/L) were the only OWCs detected in the surface-water sample from the public water supply. Salicylic acid concentrations below 25 ng/L are likely due to naturally occurring salicin in the watershed (see Surface Water section). There are numerous plastic components in the treatment and distribution system, and these plastic components are the most likely sources of bisphenol A in this sample. Since many wells are completed with plastic piping or plastic-coated electrical wires, the bisphenol A occurrences in all of these samples may be coming from the distribution system or the well itself.

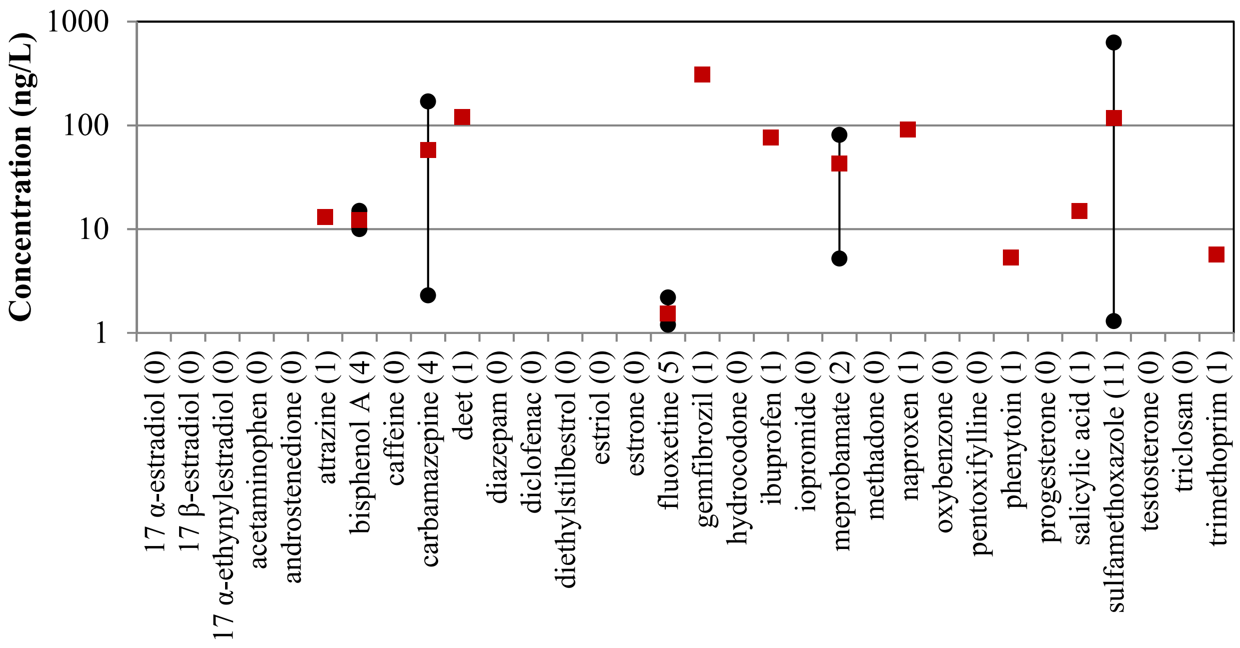


Figure 20. The range (bars) and mean concentrations (squares) of OWCs measured in the samples collected from water supplies (29 wells and one stream site) with the frequency of detection for each compound in parentheses after the name (data from 28 sites).

Conclusions

The municipal wastewater treatment plants remove most of the OWCs from wastewater. The more intensive wastewater treatment plant processes were more effective at removing OWCs than septic systems. The removal efficiency appears to decrease in some systems with colder weather. The data also suggest that longer residence or treatment times may result in higher removal rates of OWCs. Septic systems are much less efficient at removing OWCs than wastewater treatment plants, with normalized OWC loading rates (discharge) from septic systems being 10 to 100 times greater than from wastewater treatment plants. The one Level II septic system sampled did have slightly lower OWC concentrations and loading rate than the traditional septic system, but only one sample was collected and more data are needed to evaluate if this type of treatment is more effective at removing OWCs than traditional septic systems.

OWC contamination of the groundwater in Gallatin County appears to be widespread. OWCs were detected in 73% of all the wells sampled. In general, OWC concentrations were greater in groundwater receiving WWTP discharge through infiltration than in surface water receiving WWTP discharge. OWCs were detected in 66% of the wells that were not associated with a WWTP discharge. Sulfamethoxazole, carbamazepine, bisphenol A, DEET, fluoxetine, gemfibrozil, and meprobamate were found to be the most widespread in the subsurface environment. Unlike a previous study in the Helena Valley, atrazine was not prevalent in

Gallatin County groundwater. OWCs were commonly found in wells located in unsewered subdivisions and downgradient of WWTP discharges, but land use was a poor predictor of OWC presence in a well. The use of threshold values for multiple indicator species (ortho-phosphate, dissolved organic carbon, nitrate, chloride, cobalt, and nickel) was a much more accurate predictor of OWC presence in a well.

Depth water enters the well (well depth) did not appear to a controlling factor on the OWC detection frequency in the wells of Gallatin County. Deeper wells may also imply a deeper vadose zone, which can allow for greater biological reduction of OWCs and more adsorption as the OWCs migrate down to the water table. Instead of decreasing the OWC occurrences with depth to the water table, the frequency of OWC detections in wells increased with depth of the water table for depths up to 60 ft below ground surface. These results suggest that the presence of OWCs in groundwater is controlled more by groundwater flow paths or proximity to sources than well depth or depth to the water table.

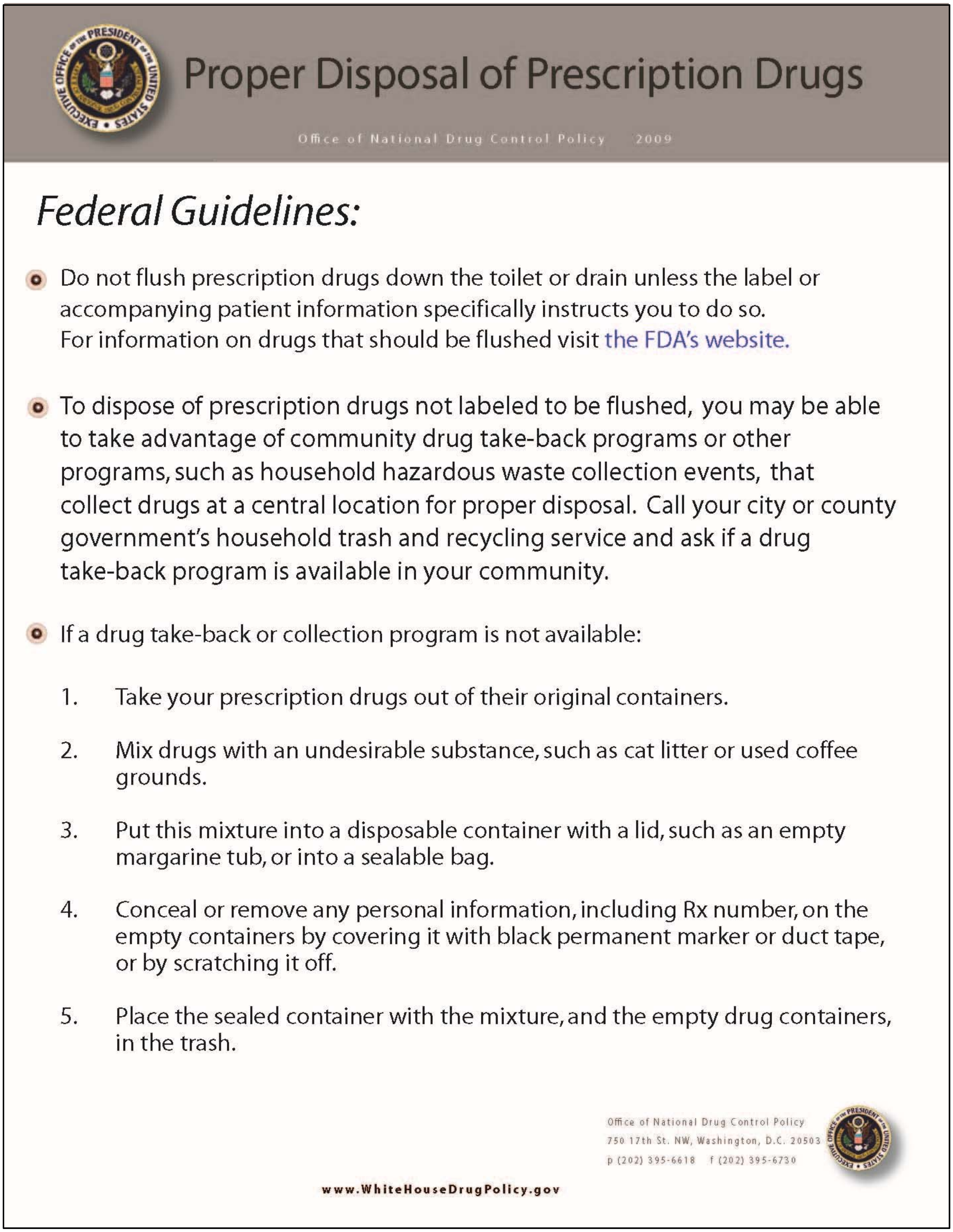
The intent of this study was to assess the occurrence and distribution of OWCs in surface water and groundwater in the Gallatin Valley. Although there is ample evidence that many OWCs can interfere with the endocrine systems of wildlife and humans at ng/L concentrations, there is less evidence that the concentrations of OWCs observed in the groundwater and surface water used for drinking water supplies in the Gallatin Valley poses a human health risk. In the ng/L concentration range, chemicals with estrogenic effects appear to represent the greatest threat to human health, but few water supplies had detectable estrogenic chemicals, with bisphenol A being the most prevalent. With the exception of several water-supply wells that are downgradient of a wastewater treatment plant discharge, the OWC data presented here would not warrant the abandonment of the wells or the installation of treatment systems. The highest OWC concentrations in surface water were observed downstream from wastewater treatment plants. This observation is consistent with results of previous studies screening for these compounds in our nation's waterways. However, OWCs were detected at three stream sites with no direct wastewater input. The most likely OWC source at these sites is discharge from groundwater impacted by septic systems.

Seasonal surface-water sampling (fall, winter, and spring) detected acetaminophen, bisphenol A, carbamazepine, DEET, fluoxetine, gemfibrozil, naproxen, salicylic acid and sulfamethoxazole, from each sampling event. While the data suggest seasonal persistence of OWCs in surface water, the data were limited to three grab samples at each site. More systematic sampling is needed to verify this observation. Excluding salicylic acid, sulfamethoxazole was the most commonly detected OWC in surface waters. The reproductive hormones were not prevalent in the stream samples; 17-α-estradiol and estrone were each detected only once. Further studies are recommended to look for effects these compounds may be having on local aquatic biota, especially downstream of wastewater discharge sites.

Recommendations for Decreasing OWCs in the Environment

There a number of things that can be done to decrease OWC loading to Montana waters. The first step would be to decrease the loading of OWCs to the wastewater treatment facilities. Federal guidelines have been released for the proper disposal of pharmaceuticals (fig. 21). Widespread adoption and promotion of these guidelines has the potential to decrease the loading of OWCs to Montana waters.

The results of this study demonstrate that the concentration of OWCs in effluent from municipal wastewater treatment systems is much lower than from septic systems. In other words, the WWTPs were much more effective at removing OWCs from the waste stream than were septic systems. In addition, at least one OWC was detected in 87 percent of wells sampled for this project in or near unsewered subdivisions. These results indicate that an increase in suburban areas served by WWTPs over septic systems would decrease the loading of OWCs to the environment and decrease the potential for these chemicals to end up in drinking water. In many areas WWTP service is not feasible; in these areas community septic systems may be a better option than individual septic systems. Community septic systems localize waste to a specific area that could be situated to minimize downgradient impacts. Another advantage to a community septic system is that the basic infrastructure would be in place should access to a WWTP become available.



Executive Office of the President of the United States

Proper Disposal of Prescription Drugs

Office of National Drug Control Policy 2009

Federal Guidelines:

- Do not flush prescription drugs down the toilet or drain unless the label or accompanying patient information specifically instructs you to do so.
  For information on drugs that should be flushed visit the FDA's website.

- To dispose of prescription drugs not labeled to be flushed, you may be able to take advantage of community drug take-back programs or other programs, such as household hazardous waste collection events, that collect drugs at a central location for proper disposal. Call your city or county government's household trash and recycling service and ask if a drug take-back program is available in your community.

- If a drug take-back or collection program is not available:

  1. Take your prescription drugs out of their original containers.
  2. Mix drugs with an undesirable substance, such as cat litter or used coffee grounds.
  3. Put this mixture into a disposable container with a lid, such as an empty margarine tub, or into a sealable bag.
  4. Conceal or remove any personal information, including Rx number, on the empty containers by covering it with black permanent marker or duct tape, or by scratching it off.
  5. Place the sealed container with the mixture, and the empty drug containers, in the trash.

Office of National Drug Control Policy
750 17th St. NW, Washington, D.C. 20503
p (202) 395-6618 f (202) 395-6730

www.WhiteHouseDrugPolicy.gov

Figure 21. Federal guidelines for the proper disposal of prescription drugs.

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Appendix A: Sample Collection Protocol for Analysis of Organic Wastewater Contaminants (OWCs)

Sample Collection Protocol for Analysis of Organic Wastewater Contaminants (OWCs)

I. GROUNDWATER

a. PURPOSE

- To focus on obtaining fresh groundwater samples from water-supply wells and dedicated monitoring wells. The goal is to obtain a representative sample of groundwater from selected wells for analysis of OWCs.

b. EQUIPMENT and SUPPLIES

- Two pre-cleaned 1-liter amber glass bottles for samples submitted to Columbia Analytical Services, Kelso, WA. One pre-cleaned 1-liter amber glass bottle for samples submitted to the MBMG Organics Laboratory, Butte, MT.
- Sample bottles for inorganic chemistry and DOC.
- Portable gasoline-powered electrical generator to power well pump (monitor wells only).
- Redi-flo II™ submersible pump to purge and sample monitoring wells.
- Decontamination container.
- Tap water containers and dispensing bottles.
- Distilled-deionized water containers and dispensing bottles.
- Pesticide-grade methanol containers and FEP dispensing bottles.
- HPLC water containers and FEP dispensing bottles.
- Flow-through cell or splitter and adaptors.
- Water-level monitoring probe (e-tape) to measure static water level and pumping water levels in sampled wells.
- Five-gallon plastic bucket to measure pumping rate and field water quality parameters (pH, SC, temperature).
- Water quality parameter field meters for pH, temperature, and specific conductance.
- Pre-cleaned, disposable, 2-inch-diameter, Teflon™ bailers with polypropylene rope (for hand bailing 2-inch monitoring wells only).
- Disposable Tyvek™ suits with hood.
- Garbage bags.
- 1-gallon zip-lock bags.

c. PRECAUTIONS

- Put on personal protective equipment (PPE) prior to working with the sampling equipment and handling sample bottles.
- Avoid the use of sunscreens, lotions, caffeine, etc. prior to the sampling event.

d. GROUNDWATER SAMPLE COLLECTION

- <u>MONITORING WELL</u>
  1. Put on new, clean, powder-free, nitrile gloves.

2. Remove well cap and measure starting static water level using water-level probe.
3. Install Grunfos Rediflow II™ pump in well at a depth less than 5 feet below the water surface. Pump should have a functioning check valve.
4. Set up generator downwind from the well as far away as possible.
5. Begin pumping well, measure initial pumping rate with bucket and record initial pH, SC, DO, and temperature of discharge water.
6. Record field parameters at least every 5 minutes. Purge well until field parameters stabilize and a minimum of three well-volumes of water have been pumped from the well. Check flow rate during well purging, and at end of purging to verify flow rate.
7. Sample for inorganic chemistry and TOC.
8. Shut off the pump and remove from the well.
9. Put on new, clean personal protective equipment (PPE). This should include powder-free nitrile gloves, full Tyvek™ suit with hood and booties, and face mask.
10. Remove pre-cleaned Teflon™ bailer from packaging and attach suspension cord. Lower bailer to at least 10 ft below the water level to collect samples.
11. Collect EDC samples in amber glass bottles (2 for Columbia Analytical and 1 for MBMG Lab). If chloride is present or suspected, preserve samples by adding sodium thiosulfate solution provided with each Columbia Analytical sample bottle. Samples are not filtered. Place filled sample bottles for each laboratory in 1-gallon zip-lock bags and store samples at <6 ºC. Ship samples the same day as collected, via standard overnight to Columbia Analytical.

- <u>WATER-SUPPLY WELL</u>
    1. Put on new, clean, powder-free, nitrile gloves.
    2. Identify an outside tap closest to the well and that is not treated by a water treatment unit. Attach a standard garden hose to the tap and run the hose to a 5-gallon bucket.
    3. Turn on the tap and measure initial discharge rate with the bucket and record initial pH, SC, and temperature. Purge until field parameters stabilize and a minimum of three well-volumes of water have been pumped from the well. Check flow rate at least once during well purging, and at end of purging to verify flow rate.
    4. Sample for inorganic chemistry and TOC.
    5. Shut off the tap and remove the hose.
    6. Put on new, clean personal protective equipment (PPE). This should include powder-free nitrile gloves, full Tyvek™ suit with hood and booties, and face mask.
    7. Decontaminate the tap by rinsing with soapy water, deionized water, HPLC-grade methanol, and HPLC-grade water, then turn the water on. Catch methanol in a basin for proper disposal.

8. Put on new nitrile gloves and collect EDC samples directly from the tap in amber glass bottles (2 for Columbia Analytical and 1 for MBMG Lab). Samples are not filtered. Place filled sample bottles for each laboratory in 1-gallon zip-lock bags and store samples at <6 ºC. Ship samples the same day as collected, via standard overnight to Columbia Analytical.

II. SURFACE WATER

a. PURPOSE

- The goal is to obtain a grab sample of surface water at selected sites for analysis of EDCs.

b. EQUIPMENT and SUPPLIES

- Two pre-cleaned 1-liter amber glass bottles for samples submitted to Columbia Analytical Services, Kelso, WA.
- One pre-cleaned 1-liter amber glass bottle for samples submitted to the MBMG Organics Laboratory, Butte, MT.
- Extension sampling pole with swing sampler and attachment bands (zip-ties) for stream samples.
- Marsh-McBirney flow meter, tape measure, and stakes for obtaining wadeable stream discharge.
- Aluminum foil.
- Deionized water for detergent wash and Liquinox™ detergent.
- Deionized water for rinsing.
- HPLC-grade methanol for rinsing.
- HPLC-grade water for sample blanks and equipment final wash.
- 1-gallon zip-lock bags.
- Water quality parameter field meters for pH, temperature, dissolved oxygen, and specific conductance.
- Disposable Tyvek™ suits with hood.
- Nitrile gloves, disposable.
- Face mask, disposable.
- Site Visit Form, field book, and stream discharge form.

c. PRECAUTIONS

- Put on personal protective equipment (PPE) prior to working with the sampling equipment and handling sample bottles.
- Avoid the use of sunscreens, lotions, caffeine, etc. prior to the sampling event.
- Follow "Clean Hands/Dirty Hands" technique for water-quality sampling.

d. SURFACE-WATER SAMPLE COLLECTION

- <u>WADEABLE STREAMS</u>
  1. Select a sampling location that will allow for the collection of a sample as close to the center of the main channel as possible. If site access is

at a bridge/road crossing, the sample should be collected above the structure.

2. Put on new, clean personal protective equipment (PPE). This should include Tyvek™ suit with hood, face mask, and nitrile gloves.
3. Wade to stream thalweg and lower bottle into the water to collect the sample and replace the cap underwater. <u>Do not rinse sample bottle</u>. Place filled sample bottles for each laboratory in 1-gallon zip-lock bags and store samples at <6 ºC. Repeat for all sample bottles.
4. Place field meter probe in stream and record water-quality parameters: pH, DO, SC, ORP, and temperature, once stabilized.
5. Set up stream cross-section and record water depth and stream velocity at a minimum of 20 intervals from wetted edge to wetted edge to calculate stream discharge.
6. Ship samples the same day as collected, via standard overnight to Columbia Analytical. MBMG samples are hand-delivered to the MBMG Organic Laboratory.

- <u>NON-WADEABLE STREAMS</u>
    1. Put on new, clean nitrile gloves.
    2. Put on new, clean personal protective equipment (PPE). This should include powder-free nitrile gloves, full Tyvek™ suit with hood, and face mask.
    3. Extend the sampling device to the proper length and attach a clean PPCP bottle to the sampling pole. Remove bottle cap and place in a clean zip-lock bag. Lower bottle into the water to collect the sample, replace the cap. <u>Do not rinse sample bottle</u>, Place filled sample bottles for each laboratory in 1-gallon zip-lock bags and store samples at <6 ºC. Repeat for all PPCP sample bottles.
    4. Place field meter probe in stream and record water-quality parameters: pH, SC, DO, ORP, and temperature of water, once stabilized.
    5. Decontaminate the sampling pole and swing sampler following Decontamination Procedures for surface-water sampling. Place the swing sampler in a clean zip-lock bag.
    6. Ship samples the same day as collected, via standard overnight to Columbia Analytical. MBMG samples are hand-delivered to the MBMG Organic Laboratory.
    7. For sites at USGS gauging stations, return to office, access stream discharge real-time data for the gauging station that corresponds to the date and time water samples were collected. Record the discharge in cfs in the field book and on the site visit form.

III. WASTEWATER

a. PURPOSE

- The goal is to obtain a sample of wastewater influent and effluent at selected sites for analysis of EDCs.

b. EQUIPMENT and SUPPLIES

- Two pre-cleaned 1-liter amber glass bottles for samples submitted to Columbia Analytical Services, Kelso, WA.
- One pre-cleaned 1-liter amber glass bottle for samples submitted to the MBMG Organics Laboratory, Butte, MT (for effluent only).
- Extendable sampling pole with swing sampler and bottle ties (wastewater use only).
- Disposable dipper.
- Automated composite sampler with Teflon™ tubing.
- 5-liter amber glass bottles for composite sampling.
- Decontamination container and aluminum foil.
- Glass funnels.
- Deionized water.
- Liquinox™ detergent.
- HPLC-grade methanol.
- HPLC-grade water.
- Dilute bleach solution (~10% v/v) for rinsing bottles and equipment in contact with wastewater influent and effluent.
- Disposable Tyvek™ suits with hoods.
- Disposable face shields.
- Nitrile gloves, disposable.
- Disposable face masks.

c. PRECAUTIONS

- Put on personal protective equipment (PPE) prior to working with the sampling equipment and handling sample bottles.
- Avoid the use of sunscreens, lotions, caffeine, etc. prior to the sampling event.
- Collect samples and handle equipment following “Clean Hands, Dirty Hands” technique.

d. WASTEWATER SAMPLE COLLECTION

- Work with facility personnel to identify influent and effluent sampling locations and safe sampling procedures. Utilize existing, dedicated sampling equipment when possible. Equipment used for sampling raw influent and treated effluent samples will be chosen based on site-specific conditions at each location, but options include dedicated sampling equipment, precleaned disposable dipper, and extendable bottle-holding sampling poles.

e. INFLUENT

- Label bottles prior to sample collection. MBMG samples will not be collected for wastewater influent.
- Put on new, clean personal protective equipment (PPE). This should include powder-free nitrile gloves, full Tyvek suit with hood, face mask, and splash shield.
- If sampling with a pole, attach a clean bottle to the sampling pole while wearing clean gloves. Remove bottle cap and place in a clean zip-lock bag or

hold in clean gloves while bottle is filled. Lower bottle into the wastewater to collect the sample, when full place sample on clean aluminum foil to be decontaminated, and replace the cap. Repeat for all PPCP sample bottles.

- Decontaminate the outside of the sample bottles by spraying with bleach solution. Wipe dry with paper towels. Place filled sample bottles for laboratory in 1-gallon zip lock bags and store samples at <6 ºC.
- If sampling from a dipper or a dedicated automated sampling system, use a precleaned aluminum or glass funnel to pour sample into the sample bottle and cap the bottle. Decontaminate the outside of the bottles by spraying with bleach solution. Wipe dry with paper towels. Put bottle in a clean zip-lock bag and place in a cooler.
- Ship samples the same day as collected, via standard overnight to Columbia Analytical.

f. EFFLUENT

- Follow the same procedure as above for the collection of PPCP influent samples.

IV. DECONTAMINATION PROCEDURES

a. GROUNDWATER

- General cleaning protocols for items contacting water to be sampled for EDCs.
    1. Liquinox™ soapy water rinse.
    2. De-ionized water rinse.
    3. Methanol rinse.
    4. HPLC water rinse.
- Redi-flow II™ pump.
    1. Using a PVC stand pipe cycle soapy water through the pump and tubing sufficient for 5 tubing volumes and then cycle 5 tubing volumes of deionized water.
    2. Decontaminate the lower outside 5 feet of tubing and the pump by spraying with methanol and then reagent water. Place the cleaned pump and end tubing in a clean plastic bag

b. SURFACE WATER

- Rinse the lower foot of the sampling pole and bottle holder in the following order:
    1. Soapy water wash.
    2. De-ionized water rinse.
    3. HPLC-grade methanol rinse.
    4. HPLC-grade water rinse.
    5. Place cleaned portion of the sampling pole in a clean plastic bag and secure with a wire tie.

c. WASTEWATER

- Decontaminate all sampling equipment that will come in contact with the PPCP sample using the following procedure:
  1. Soapy, deionized water rinse.
  2. Deionized water rinse.
  3. HPLC-grade methanol rinse.
  4. HPLC-grade water rinse.
  5. NOTE: Sampling equipment that will be reused will be decontaminated with dilute bleach prior to the soapy-water rinse.
  6. Place cleaned portion of the sampling pole in a clean plastic bag and secure with a wire tie.

V. TRIPLICATES

- Triplicate water samples should be collected from 10 percent of sampling sites.
- Triplicate samples should be collected immediately after filling initial sample bottles.
- Use the same sample bottles supplied by each laboratory for triplicate samples, following the same sample processing methods.

VI. BLANKS

- Field blanks will be collected from 10–20 percent of the sampling sites.
- Blanks for monitoring-well sampling sites will consist of HPLC water passed through a clean bailer and collected in bottles for PPCP analysis just prior to collection of the groundwater sample.
- Blanks for water-supply wells will consist of HPLC water transferred to PPCP sample bottles just prior to collection of the groundwater sample.

VII. REFERENCES

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U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, ch. A1–A9, available online at http://pubs.water.usgs.gov/twri9A.

Appendix B: Solid Phase Extraction and ELISA Analytical Procedures

PROCEDURE FOR EXTRACTION AND ANALYSIS OF WATER SAMPLES FOR ENDOCRINE-DISRUPTING COMPOUNDS BY ENZYME LINKED IMMUNOASSAY

SAMPLE COLLECTION AND EXTRACTION

1.1 Sample Collection

Samples are collected in 1-liter amber glass bottles according to the appropriate protocol. The sampler should observe precautions to avoid contaminating the sample, such as wearing PVC or latex gloves. The bottle should be rinsed with the sample prior to filling the bottle. After filling, the bottle should be capped and immediately put on ice in a cooler. Samples should be sent from the field to the laboratory as expeditiously as possible, considering the location of the sampling sites and the proximity to shipping.

1.2 Sample Extraction

1.2.1 Equipment

1.2.1.1 Glassware

Note: All glassware is to be silanized with dichlorodimethylsilane (DCDMS) to minimize adsorption on the glass surface. Glassware should be cleaned with detergent and rinsed with deionized water, followed by acetone. After drying, a 2 percent v/v solution of DCDMS in octamethylcyclotetrasiloxane is swirled on the inner surface to coat the entire surface. Any excess is put in a waste solvent container. The coating is allowed to react for 10 minutes and the excess is wiped off with tissue paper. The glass is then rinsed three times with methanol and three times with deionized water.

Required glassware includes:
Millipore® vacuum filter and 0.45-µm glass fiber filters.
Erlenmeyer flasks 500 mL—one for each sample being extracted.
Graduated cylinder 500 mL.
Extraction manifold with valves, PFTE uptake tubes, and needles for cartridge top.
Silanized amber vials, 7.5 mL capacity for storing raw water and extracts.

1.2.1.2 Cartridges

The cartridges used for extraction are Strata® X 33 µm polymeric reversed phase from Phenomenex (PN 8B-S100-HCH). There is 500 mg of sorbent in a 6-mL cartridge.

1.2.2 Sample Preparation and Extraction

1.2.2.1 Filtration

Samples must be filtered through a 0.45-µm glass fiber filter membrane prior to extraction. Assemble the clean silanized funnel, inserting a glass membrane. First, transfer 5 mL of raw sample to a labeled silanized vial and refrigerate at 5° C. This water is used in the magnetic particle format tests. Wash a small amount of the sample through the filter. Use that to rinse the flask and discard. Pass the rest of the sample through the membrane and collect in the flask. Measure 500 mL of the sample using a silanized graduated cylinder into a labeled Erlenmeyer silanized flask. Cover the flask with parafilm. If there will be a delay in extracting, return to the refrigerator. Some samples will have duplicate extractions made. Label the flasks with A and B after the Lab ID.

1.2.2.2 Extraction

Samples should be extracted by SPE within 48 hours of collecting, if possible. A 1-liter sample will be split into two 500-mL fractions and extracted. One or both fractions will be extracted if a duplicate is to be sent to the EPA laboratory. If the second fraction is less than 500 mL, label the flask with the volume and enter into the extraction log. The extract from this fraction will be analyzed by HPLC MS-MS-MS and the appropriate volume correction will be made to calculate the final analyte concentration.

The SPE cartridges are labeled with the sample number followed by an A or B suffix. **A** samples are analyzed by ELISA and **B** samples are sent to the EPA laboratory in Colorado. The cartridges are placed in the vacuum extractor on top of a Luer valve body.
The cartridges are conditioned by passing the following volumes through the column:

2 mL of methanol 3x;
2 mL of DI water 3x; and
2 mL of pH 3 water 3x.

This procedure is performed with either no vacuum or minimal vacuum pulling on the manifold. The cartridges should not go dry. After the acidic conditioning, fill the cartridge with the pH 3 water, leaving just enough room for a needle and silicone stopper.

The filtrate in the flasks should be adjusted to pH 3 by adding 6N HCl dropwise, while checking the pH with a Colorphast® strip. After pH adjustment, the flasks are arranged on the sample rack and the Teflon® uptake tube is inserted through the parafilm into the flask. The end with the male Luer fitting is affixed to a stainless steel needle with a stopper that fits tight in the SPE cartridge. Reduce the manifold pressure to 15” using the bleed valve and open each one of the stopcock valves. Observe the rise of the liquid in the uptake tube and ensure that each sample is flowing through its cartridge into the catchment tray in the bottom of the manifold. When the tray is full of water, turn off the stopcocks and vent the manifold chamber to atmosphere. Shut off the vacuum. Carefully lift the lid with the cartridges and uptake lines and place on a rack. Lift out the tray and empty into the bucket. Replace the lid and resume the extraction.

After all the samples have been pulled through the cartridges, pick up each flask and ensure that the entire sample is extracted. Any remaining water should be vacuumed up into the tube. Shut off the stopcock valve and disassemble the uptake tube, removing the flask from the rack. Continue until all samples have been extracted. Empty any water and remove the catchment. Close the manifold bleed valve and allow the vacuum pressure to increase. Open all the stopcock valves and allow air to be drawn through the cartridges. Continue for 45 minutes. When all cartridges are dry, close the stopcocks, vent the manifold, and shut down the pump.

Remove the SPE cartridges from the rack and wrap them individually with aluminum foil. Place them in a resealable plastic bag and store in a freezer at -30º C until they will be eluted.

1.2.2.3 Elution

Remove the cartridges from the freezer, unwrap, and allow them to come to room temperature. Place them on the vacuum manifold with stopcocks. Affix needle guides to the bottom connections and place labeled silanized vials underneath. Load 2 mL of methanol on the column and allow it to soak in over a period of 5 minutes. Turn on the vacuum at minimum pressure. Open the stopcock and allow the extract to run through at a rate of 5 mL/min, stopping just before the level disappears beneath the surface. Add an additional 2 mL and repeat the extraction. Repeat the extraction a total of three times. It is not necessary to allow a 5-minute soak time for the second two extractions.

1.2.2.4 Solvent Change

Evaporate the methanol extracts in the vials to dryness at room temperature under a stream of nitrogen. Pipette in 56 µL of methanol and cap the vial with a Teflon lid. Vortex to contact the surfaces of the vial. Add 500 µL of deionized water and vortex again. Store the sample at -20º C until ready for analysis.

2.0 ANALYSIS

2.1 Equipment

ABRAXIS® ELISA test kit for each appropriate analyte.
SDI programmable single channel spectrophotometer with 450/600 nm filters.
Awareness Technology® 32XX 96 well plate reader.

2.2 Protocols

The determination of target analytes is performed by competitive ELISA. A specific antibody for the target analyte is immobilized on either a magnetic particle or coated on a well plate. The free analyte and analyte attached to an enzyme are allowed to compete for binding to the immobilized antibodies. The quantity of enzyme-conjugate bound to the antibody is allowed to react with a colored substrate in a manner that produces the chromophore, resulting in high absorbance of the solution. Therefore, there is an inverse relationship between the absorbance of the test solution and the amount of free analyte bound to the particle or plate. If little analyte was present in the sample, the binding was largely of the analyte-enzyme conjugate and the color is more intense. If a high concentration of analyte was present, the proportion of analyte-enzyme conjugate bound is less.

2.2.1 Magnetic Particle Format

The detection limit provided by this format is sufficiently low that the raw sample can be used as directed by the specific method. The test is conducted in 12 x 120 mm tubes made of either polystyrene or glass. The tubes are arranged in the magnetic base holder tray and the standards and controls are run after a deionized blank. The methods are programmed into the SDI spectrophotometer and are activated through the RUN key. Scroll through the stored methods using the up and down arrow keys. When the appropriate method appears, the ENTER key is pressed. The method will ask how many replicates per sample will be read. Enter 2 unless the ABRAXIS instructions specify otherwise.

2.2.2 Well Plate Format

Concentration by extraction must be used to provide a 1000x factor to achieve the detection limits. The standards which are used in the test are in a strictly aqueous matrix. An appropriate aliquot of methanol must be added to the well plate along with the standard or control sample. The final eluant from the cartridges was a 500 µL volume of water to which a 75 µL volume of standard is pipetted into the appropriate well plate and a 10 µL gas-tight syringe is used to add 8 µL of methanol.

Instructions for operating the instrument are given in the manual. Specific instructions for each analyte are given in the ABRAXIS Method. Concentration data will not be directly determined, only absorbance readings in the individual well plates. The absorbance data are used to construct a calibration curve, as given below

The analytes and their respective estimated detection limits are given in Table 1B.

Table B1. Analytes, test formats, and estimated detection limits for ELISA protocols

Analyte	Format	Detection Limits
17-β-estradiol	Magnetic Particle	2.5 ng/L w/o SPE
17-α-ethynyl estradiol	96 Well Plate	0.5 ng/L w/SPE
Atrazine	Magnetic particle	20 ng/L w/o SPE
bisphenol A	96 Well Plate	1.6 ng/L w/ SPE
estrone	96 Well Plate	0.5 ng/L w/ SPE
Progesterone	96 Well Plate	To be determined
Sulfamethoxazole	96 Well Plate	1.0 ng/L w/ SPE
Sulfamethazine	Magnetic Particle	50 ng/L w/o SPE

2.2.3 Determining Concentrations from Optical Density Measurements

2.2.3.1 Magnetic Particle Format

The protocols for measuring the optical density are specified in the methods. Samples are determined in duplicate and the average optical density is used in the calculation. The density data are expressed as a percentage of absorption relative to the zero standard (%B/B_0) and are transformed differently for different compounds. The calculation is transparent, as it is programmed in the method, and the concentration results are reported for each replicate in the programmed units, typically ng/L (ppt).

2.2.3.2 Well Plate Format

The data recorded for this format are solely the optical densities of each replicate reading. These data are reduced in Excel® Solver by

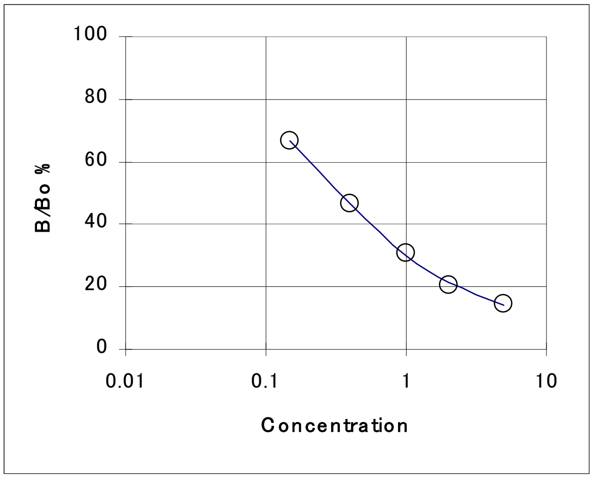

Figure 1B. A typical calibration curve for competitive ELISA non-linear least squares fitting the %B/B$_0$ vs. to a four parameter logistical model:

$$y = \frac{(a-d)}{1+\left(\frac{x}{c}\right)^{b}} + d$$

Where:
a = maximum signal;
d = minimum signal;
c = concentration at 50% B/B$_0$;
b = slope at curve inflection point; and
y = absorbance for intermediate standard or unknown.

B$_0$ = (a-d)
B = (y-d)

A Newton–Raphson algorithm is used by Solver to minimize the sum of squares error between the predicted and observed absorbance for the concentrations of standards by adjusting the fitting parameters a–d. The initial estimate of the parameters is provided by ABRAXIS. Note that the quasi-linear portion of the log concentration vs. B/B$_0$ curve is used to quantify unknowns. A typical calibration should plot as in figure 1B.

3.0 QUALITY CONTROL

Quality control consists of collecting duplicate and blank samples in the field. Laboratory Blank samples will also be analyzed at a frequency at one per batch of 20 samples. The instrumental protocols have internal quality control measures. Each determination requires duplicate readings of the sample. If the coefficient of variation (CV) exceeds 10%, the result is flagged. The methods incorporate a calibration check sample which must be within ± 20% of the nominal value to validate the calibration curve.

4.0 REPORTING

Concentrations derived from the programmed methods or calculated from raw absorbance data will be reported for each sample. Those that do not meet QA/QC guidelines will be reported with a comment about the deviance and will be noted as “estimated.” Those below the stated method detection limit will be reported as less than the method detection limit. The results will be provided in electronic format as an Excel spreadsheet and in hardcopy as a standard MBMG GWIC report.

Appendix C: AXYS Analytical Services Analyte List, Chemical Uses and Characteristics

Table 1C. Uses/Characteristics of analytes screened for by AXYS Analytical Services

COMPOUND	USES/CHARACTERISTICS	COMPOUND	USES/CHARACTERISTICS
17-α-Estradiol	Estrogenic hormone	β-Estradiol 3-benzoate	Synthetic, estrogenic compound
Acetaminophen	Pain reliever, fever reducer	Equilin	Equine estrogen, hormone replacement therapy
Androstenedione	Steroid hormone	Flumequine	Antibiotic, urinary tract infection treatment
Androsterone	Steroid hormone	Fluoxetine	Antidepressant
Atrazine	Herbicide	Lincomycin	Antibiotic
Azithromycin	Antibiotic	Lomefloxacin	Antibiotic
Bisphenol A	Organic compound used in polycarbonate & epoxy resins	Mestranol	Estrogen used in oral contraceptives
Caffeine	Stimulant, mild diuretic	Miconazole	Topical anti-fungal agent
Campesterol	Inhibits cholesterol absorption	Norethindrone	Estrogen, hormone replacement therapy
Carbadox	Anti-parasitic	Norfloxacin	Synthetic chemotherapeutic agent
Carbamazepine	Anticonvulsant, mood stabilizer	Norgestimate	Hormone used in oral contraceptives
Cefotaxime	Antibiotic	Norgestrel	Hormone used in oral contraceptives
Cholesterol	Lipidic, waxy steroid found in cell membranes	Ofloxacin	Antibiotic
Cholestanol	Cholesterol derivative found in human feces	Ormetoprim	Antibiotic, sulfa drug
Ciprofloxacin	Antibiotic	Oxacillin	Antibiotic
Clarithromycin	Antibiotic	Oxolinic Acid	Antibiotic
Clinafloxacin	Antibiotic	Penicillin G	Antibiotic
Cloxacillin	Semi-synthetic antibiotic	Penicillin V	Antibiotic
Codeine	Narcotic analgesic	Progesetrone	Oral contraceptive, menopausal hormone therapy
Coprostanol	Cholesterol derivative	Roxithromycin	Semi-synthetic antibiotic
Cotinine	Metabolite of nicotine	Sarafloxacin	Antibiotic
17 alpha-Dihydroequilin	Anti-atherosclerotic	Stigmasterol	Precursor in manufacturing synthetic progesterone
Dehydronifedipine	By-product of heart medication	β-Sitosterol	Reduces blood levels of cholesterol
Desmosterol	Lipidic compound similar to cholesterol	β-Stigmastanol	Plant sterol
Desogestrel	Hormone used in oral contraceptives	Sulfachloropyridazine	Antibiotic
1,7-Dimethylxanthine	Metabolite of caffeine in animals.	Sulfadiazine	Antibiotic
Diphenhydramine	Antihistamine	Sulfadimethoxine	Antibiotic
Digoxin	Used to treat heart conditions (atrial fibrillation)	Sulfamerazine	Antibiotic
Digoxigenin	Used as a probe for non-radioactive immunoassays.	Sulfamethazine	Antibiotic
Diltiazem	Anti-anginal, used to treat hypertension	Sulfamethizole	Antibiotic, urinary tract infection treatment
Enrofloxacin	Antibiotic	Sulfamethoxazole	Antibiotic
Epicoprostanol	Steroid	Sulfamethazine	Antibiotic
Ergosterol	Anti-fungal medication	Sulfanilamide	Antibiotic
Equilenin	Estrogenic steroid hormone found in horses	Sulfathiazole	Antibiotic
Erythromycin-H_2O	Main degradation product of Erythromycin, an antibiotic	Testosterone	Steroidal hormone
17-β-Estradiol	Estrogenic hormone	Thiabendazole	Fungicide and parasiticide
Estriol	Estrogenic hormone	Trimethoprim	Antibiotic, urinary tract infection treatment
Estrone	Estrogenic hormone	Tylosin	Antibiotic
17-α-Ethinylestradiol	Derivative of estradiol, oral contraceptives	Virginiamycin	Antibiotic used in animal feed as a growth stimulant

Appendix D: Columbia Analytical Services Blank Data

Table 1D. Columbia Analytical Laboratory data for the field and equipment blanks.

SAMPLE ID:			GLWQD-A	GLWQD-12	GLWQD-20	GLWQD-44	GLWQD-64	GLWQD-71	GLWQD-96	GLWQD-126
DATE & TIME:			7/31/08 12:30 PM	8/14/08 11:45 AM	8/20/08 1:40 PM	9/12/08 10:40 AM	11/3/08 2:35 PM	11/19/08 1:30 PM	2/23/09 4:00 PM	5/5/09 12:00 PM
TYPE OF SAMPLE**:			Blank	Equipment Blank dipper	Equipment Blank bailer	Equipment blank bailer	Blank	Blank	Equipment Blank Isco 2900 Sampler	Blank
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit								
17 α-Estradiol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
17 β-Estradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
17 α-Ethinyl Estradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Acetaminophen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Androstenedione	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Atrazine	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bisphenol A	1	10	< 10	**21**	< 10	< 10	< 10	< 10	< 10	< 10
Caffeine	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Carbamazepine	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
DEET	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Diazepam	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Diclofenac	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Diethylstilbestrol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Estriol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Estrone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Fluoxetine	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Gemfibrozil	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hydrocodone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ibuprofen	1	5 or 10	< 5.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Iopromide	1	10	< 10	< 100*	< 10	< 10	< 10	< 10	< 10	< 10
Meprobamate	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Methadone	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Naproxen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Oxybenzone	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Pentoxifylline	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Phenytoin	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Progesterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Salicylic acid	1	10	< 10	< 100*	< 10	< 10	< 10	< 10	**16**	< 10
Sulfamethoxazole	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Testosterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Triclosan	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Trimethoprim	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

*Dilution factor equaled 10 and the reporting limit equaled 100.

**HPLC-grade deionized water (DI) was used for all blank samples.

Table 2D. Columbia Analytical Laboratory data for the laboratory blanks.

GLWQD SAMPLE ID:			A-B	1-15	16-20	21-30	31-35	36-40	41-49	50-54	55	56-60	61-64
Lab Service Request #:			K0807080	K0807700	K0807700	K0807953	K0808044	K0808658	K0808741	K0808885	K0810339	K0810400	K0810467
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit											
17 α-Estradiol	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17 β-Estradiol	1	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17 α-Ethinyl Estradiol	1	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetaminophen	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Androstenedione	1	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Atrazine	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bisphenol A	1	10	ND	99	ND	ND	ND	ND	ND	ND	ND	ND	ND
Caffeine	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbamazepine	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DEET	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diazepam	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diclofenac	1	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylstilbestrol	1	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Estriol	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Estrone	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoxetine	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Gemfibrozil	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hydrocodone	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ibuprofen	1	5 or 10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iopromide	1	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Meprobamate	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methadone	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naproxen	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oxybenzone	1	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**2.6**
Pentoxifylline	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenytoin	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Progesterone	1	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Salicylic acid	1	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sulfamethoxazole	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Testosterone	1	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Triclosan	1	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trimethoprim	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 3D. Columbia Analytical Laboratory data for the laboratory blanks.

GLWQD SAMPLE ID:			65-74	75-78	79-84	79-84	85-93	85-93	94-96	94-96	97-106	97-106	107-110
Lab Service Request #:			K0811379	K0811478	K0901203	K0901203	K0901228	K0901228	K0901665	K0901665	K0902405	K0902405	K0902461
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit											
17 α-Estradiol	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17 β-Estradiol	1	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17 α-Ethinyl Estradiol	1	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acetaminophen	1	1.0	ND	ND	**1**	ND	ND	ND	ND	ND	ND	ND	ND
Androstenedione	1	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Atrazine	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Bisphenol A	1	10	ND	ND	20	ND	ND	ND	ND	ND	ND	ND	ND
Caffeine	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbamazepine	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
DEET	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diazepam	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diclofenac	1	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylstilbestrol	1	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Estriol	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Estrone	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoxetine	1	1.0	ND	ND	**1.7**	ND	ND	ND	ND	**1**	ND	ND	ND
Gemfibrozil	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Hydrocodone	1	1.0	ND	ND	**7.2**	**2.3**	**3**	**2.3**	**3.3**	**5.9**	ND	**4.3**	ND
Ibuprofen	1	5 or 10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Iopromide	1	10	ND	ND	**16**	ND	ND	ND	ND	ND	ND	ND	ND
Meprobamate	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methadone	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Naproxen	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Oxybenzone	1	2.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pentoxifylline	1	1.0	ND	ND	ND	15	ND	**15**	**1.1**	ND	ND	ND	ND
Phenytoin	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Progesterone	1	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Salicylic acid	1	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sulfamethoxazole	1	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Testosterone	1	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Triclosan	1	10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trimethoprim	1	5.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 4D. Columbia Analytical Laboratory data for the laboratory blanks.

GLWQD SAMPLE ID:			111-116	114, 117-124	114, 117-124	125-129	130-132	133-142
Lab Service Request #:			K0903550	K0903599	K0903599	K0903963	K0904081	K0904404
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit						
17 α-Estradiol	1	1.0	ND	ND	ND	ND	ND	ND
17 β-Estradiol	1	2.0	ND	ND	ND	ND	ND	ND
17 α-Ethinyl Estradiol	1	2.0	ND	ND	ND	ND	ND	ND
Acetaminophen	1	1.0	ND	ND	ND	ND	ND	ND
Androstenedione	1	10	ND	ND	ND	ND	ND	ND
Atrazine	1	1.0	ND	ND	ND	ND	ND	ND
Bisphenol A	1	10	ND	ND	ND	ND	ND	ND
Caffeine	1	5.0	ND	ND	ND	ND	ND	ND
Carbamazepine	1	1.0	ND	ND	ND	ND	ND	ND
DEET	1	5.0	ND	ND	ND	ND	ND	ND
Diazepam	1	1.0	ND	ND	ND	ND	ND	ND
Diclofenac	1	2.0	ND	ND	ND	ND	ND	ND
Diethylstilbestrol	1	2.0	ND	ND	ND	ND	ND	ND
Estriol	1	1.0	ND	ND	ND	ND	ND	ND
Estrone	1	1.0	ND	ND	ND	ND	ND	ND
Fluoxetine	1	1.0	ND	ND	ND	**1.2**	**1.2**	ND
Gemfibrozil	1	1.0	ND	ND	ND	ND	ND	ND
Hydrocodone	1	1.0	ND	ND	**1.2**	ND	ND	ND
Ibuprofen	1	5 or 10	ND	ND	ND	ND	ND	ND
Iopromide	1	10	ND	ND	ND	ND	ND	ND
Meprobamate	1	5.0	ND	ND	ND	ND	ND	ND
Methadone	1	5.0	ND	ND	ND	ND	ND	ND
Naproxen	1	1.0	ND	ND	ND	ND	ND	ND
Oxybenzone	1	2.0	ND	ND	ND	ND	ND	ND
Pentoxifylline	1	1.0	ND	ND	ND	ND	ND	ND
Phenytoin	1	5.0	ND	ND	ND	ND	ND	ND
Progesterone	1	10	ND	ND	ND	ND	ND	ND
Salicylic acid	1	10	ND	ND	ND	ND	ND	ND
Sulfamethoxazole	1	1.0	ND	ND	ND	ND	ND	ND
Testosterone	1	10	ND	ND	ND	ND	ND	ND
Triclosan	1	10	ND	ND	ND	ND	ND	ND
Trimethoprim	1	5.0	ND	ND	ND	ND	ND	ND

Appendix E: Columbia Analytical Services Triplicate Data

Table 1E. CAS triplicate groundwater data summary

SAMPLE ID:	GLWQD-17	GLWQD-18	GLWQD-19			GLWQD-28	GLWQD-29	GLWQD-30		
DATE & TIME:	8/20/08 2:00 PM	8/20/08 2:05 PM	8/20/08 2:10 PM	Average	%RSD	8/22/08 3:20 PM	8/22/08 3:25 PM	8/22/08 3:30 PM	Average	%RSD
GWIC ID #:	235475	235475	235475	226774	226774	226774	226774	226774	226774	226774
WELL TYPE:	Monitoring Well	Monitoring Well	Monitoring Well	Monitoring Well	Monitoring Well	Monitoring Well	Monitoring Well	Monitoring Well	Monitoring Well	Monitoring Well
CHEMICAL COMPOUND (ng/L)										
17-α-Estradiol	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
17-β-Estradiol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
17 α-Ethinylestradiol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Acetaminophen	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Androstenedione	< 10	< 10	< 10			< 10	< 10	< 10		
Atrazine	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Bisphenol A	13	17	18	16	16.5	< 10	< 10	< 10		
Caffeine	< 5.0	< 5.0	< 5.0			< 5.0	8.3	< 5.0	8.3	
Carbamazepine	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
DEET	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Diazepam	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Diclofenac	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Diethylstilbestrol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Estriol	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Estrone	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Fluoxetine	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Gemfibrozil	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Hydrocodone	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Ibuprofen	< 10	< 10	< 10			< 5.0	< 5.0	< 5.0		
Iopromide	< 10	< 10	< 10			< 10	< 10	< 10		
Meprobamate	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Methadone	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Naproxen	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Oxybenzone	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Pentoxifylline	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Phenytoin	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Progesterone	< 10	< 10	< 10			< 10	< 10	< 10		
Salicylic acid	< 10	< 10	< 10			< 10	< 10	< 10		
Sulfamethoxazole	< 1.0	< 1.0	< 1.0			0.23*	1.1	0.29*	0.5*	90*
Testosterone	< 10	< 10	< 10			< 10	< 10	< 10		
Triclosan	< 10	< 10	< 10			< 10	< 10	< 10		
Trimethoprim	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		

*Estimated value.

Table 2E. CAS triplicate groundwater data summary

SAMPLE ID:	GLWQD-36	GLWQD-37	GLWQD-38			GLWQD-46	GLWQD-47	GLWQD-48		
DATE & TIME:	9/10/08 11:45 AM	9/10/08 11:50 AM	9/10/08 11:55 AM	Average	%RSD	9/12/08 12:45 PM	9/12/08 12:45 PM	9/12/08 12:45 PM	Average	%RSD
GWIC ID #:	91039	91039	91039	91039	91039	203716	203716	203716	203716	203716
WELL TYPE:	Public Water Supply	Public Water Supply	Public Water Supply	Public Water Supply	Public Water Supply	Domestic	Domestic	Domestic	Domestic	Domestic
CHEMICAL COMPOUND (ng/L)										
17-α-Estradiol	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
17-β-Estradiol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
17 α-Ethinylestradiol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Acetaminophen	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Androstenedione	< 10	< 10	< 10			< 10	< 10	< 10		
Atrazine	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Bisphenol A	18	9.2*	6.4	11*	54.0*	< 10	< 10	< 10		
Caffeine	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Carbamazepine	2.3	2.2	2.4	2.3	4.3	< 1.0	< 1.0	< 1.0		
DEET	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Diazepam	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Diclofenac	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Diethylstilbestrol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Estriol	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Estrone	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Fluoxetine	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Gemfibrozil	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Hydrocodone	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Ibuprofen	< 5.0	< 5.0	< 5.0			< 10	< 10	< 10		
Iopromide	< 10	< 10	< 10			< 10	< 10	< 10		
Meprobamate	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Methadone	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Naproxen	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Oxybenzone	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Pentoxifylline	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Phenytoin	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Progesterone	< 10	< 10	< 10			< 10	< 10	< 10		
Salicylic acid	< 10	< 10	< 10			< 10	< 10	< 10		
Sulfamethoxazole	9.8	7.1	11	9.3	21.5	< 1.0	< 1.0	< 1.0		
Testosterone	< 10	< 10	< 10			< 10	< 10	< 10		
Triclosan	< 10	< 10	< 10			< 10	< 10	< 10		
Trimethoprim	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		

*Estimated value.

Table 3E. CAS triplicate groundwater data summary

SAMPLE ID:	GLWQD-57	GLWQD-58	GLWQD-59			GLWQD-98	GLWQD-99	GLWQD-100		
DATE & TIME:	10/24/08 11:30 AM	10/24/08 11:30 AM	10/24/08 11:30 AM	Average	%RSD	3/17/09 1:30 PM	3/17/09 1:30 PM	3/17/09 1:30 PM	Average	%RSD
GWIC ID #:	235473	235473	235473	235473	235473	244600	244600	244600	244600	244600
WELL TYPE:	Monitoring	Monitoring	Monitoring	Monitoring	Monitoring	Domestic	Domestic	Domestic	Domestic	Domestic
CHEMICAL COMPOUND (ng/L)										
17-α-Estradiol	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
17-β-Estradiol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
17 α-Ethinylestradiol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Acetaminophen	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Androstenedione	< 10	< 10	< 10			< 10	< 10	< 10		
Atrazine	1.9	1.9	2.1	2.0	5.9	< 1.0	< 1.0	< 1.0		
Bisphenol A	< 10	< 10	< 10			< 10	< 10	< 10		
Caffeine	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Carbamazepine	< 1.0	< 1.0	< 1.0			190	140	140	160	18.4
DEET	< 5.0	< 5.0	< 5.0			60	44	45	50	18.0
Diazepam	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Diclofenac	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Diethylstilbestrol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Estriol	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Estrone	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Fluoxetine	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Gemfibrozil	< 1.0	< 1.0	< 1.0			53	69	59	60	13.4
Hydrocodone	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Ibuprofen	< 10	< 10	< 10			< 10	< 10	< 10		
Iopromide	< 10	< 10	< 10			< 10	< 10	< 10		
Meprobamate	< 5.0	< 5.0	< 5.0			29	29	27	28	4.1
Methadone	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Naproxen	< 1.0	< 1.0	< 1.0			22	13	13	16	32.5
Oxybenzone	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Pentoxifylline	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Phenytoin	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Progesterone	< 10	< 10	< 10			< 10	< 10	< 10		
Salicylic acid	< 10	< 10	< 10			< 10	< 10	< 10		
Sulfamethoxazole	18	21	17	19	11.2	550	390	370	440	22.6
Testosterone	< 10	< 10	< 10			< 10	< 10	< 10		
Triclosan	< 10	< 10	< 10			< 10	< 10	< 10		
Trimethoprim	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		

*Estimated value.

Table 4E. CAS triplicate groundwater data summary

SAMPLE ID:	GLWQD-136	GLWQD-137	GLWQD-138			GLWQD-140	GLWQD-141	GLWQD-142		
DATE & TIME:	5/14/09 1:15 PM	5/14/09 1:15 PM	5/14/09 1:15 PM	Average	%RSD	5/15/09 11:54 PM	4/21/09 1:50 PM	4/21/09 1:50 PM	Average	%RSD
GWIC ID #:	190102	190102	190102	190102	190102	130054	130054	130054	130054	130054
WELL TYPE:	Monitoring	Monitoring	Monitoring	Monitoring	Monitoring	Domestic	Domestic	Domestic	Domestic	Domestic
CHEMICAL COMPOUND (ng/L)										
17-α-Estradiol	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
17-β-Estradiol	< 20	< 20	< 20			< 2.0	< 2.0	< 2.0		
17 α-Ethinylestradiol	< 20	< 20	< 20			< 2.0	< 2.0	< 2.0		
Acetaminophen	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Androstenedione	< 100	< 100	< 100			< 10	< 10	< 10		
Atrazine	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Bisphenol A	< 100	< 100	< 100			< 10	< 10	< 10		
Caffeine	< 50	< 50	< 50			< 5.0	< 5.0	< 5.0		
Carbamazepine	< 10	< 10	< 10			4.9	5.1	4.6	4.9	5.2
DEET	< 50	< 50	< 50			< 5.0	< 5.0	< 5.0		
Diazepam	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Diclofenac	< 20	< 20	< 20			< 2.0	< 2.0	< 2.0		
Diethylstilbestrol	< 20	< 20	< 20			< 2.0	< 2.0	< 2.0		
Estriol	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Estrone	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Fluoxetine	< 10	< 10	< 10			< 1.0	< 1.0	1.3	1.3	
Gemfibrozil	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Hydrocodone	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Ibuprofen	< 100	< 100	< 100			< 10	< 10	< 10		
Iopromide	< 100	< 100	< 100			< 10	< 10	< 10		
Meprobamate	< 50	< 50	< 50			< 5.0	< 5.0	< 5.0		
Methadone	< 50	< 50	< 50			< 5.0	< 5.0	< 5.0		
Naproxen	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Oxybenzone	< 20	< 20	< 20			< 2.0	< 2.0	< 2.0		
Pentoxifylline	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Phenytoin	< 50	< 50	< 50			< 5.0	< 5.0	< 5.0		
Progesterone	< 100	< 100	< 100			< 10	< 10	< 10		
Salicylic acid	< 100	< 100	< 100			< 10	< 10	< 10		
Sulfamethoxazole	110	130	130	120	9.4	99	100	99	99	0.6
Testosterone	< 100	< 100	< 100			< 10	< 10	< 10		
Triclosan	< 100	< 100	< 100			< 10	< 10	< 10		
Trimethoprim	< 50	< 50	< 50			< 5.0	< 5.0	< 5.0		

*Estimated value.

Table 5E. CAS triplicate surface-water data summary

SAMPLE ID:	GLWQD-7$^{\Diamond}$	GLWQD-8$^{\Diamond}$	GLWQD-9$^{\Diamond}$			GLWQD-91$^{\Diamond}$	GLWQD-92$^{\Diamond}$	GLWQD-93$^{\Diamond}$		
DATE & TIME:	8/14/08 10:30 AM	8/14/08 10:30 AM	8/14/08 10:30 AM	Average	%RSD	2/12/09 10:30 AM	2/12/09 10:30 AM	2/12/09 10:30 AM	Average	%RSD
GWIC ID #:	249235	249235	249235	249235	249235	246244	246244	246244	246244	246244
Site Description:	Spain Bridge Road					Griffin Drive				
CHEMICAL COMPOUND (ng/L)										
17-α-Estradiol	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
17-β-Estradiol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
17 α-Ethinylestradiol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Acetaminophen	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Androstenedione	< 10	< 10	< 10			< 10	< 10	< 10		
Atrazine	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Bisphenol A	15	19	7.4*	14*	42.7*	< 10	< 10	< 10		
Caffeine	15	15	14	15	3.9	< 5.0	< 5.0	< 5.0		
Carbamazepine	14	14	15	14	4.0	< 1.0	< 1.0	< 1.0		
DEET	77	82	78	79	3.3	< 5.0	< 5.0	< 5.0		
Diazepam	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Diclofenac	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Diethylstilbestrol	< 2.0	< 2.0	< 2.0			< 2.0	< 2.0	< 2.0		
Estriol	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Estrone	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Fluoxetine	< 1.0	< 1.0	< 1.0			1.9	1.4	1.3	1.5	21.0
Gemfibrozil	60	60	59	60	1.0	< 1.0	< 1.0	< 1.0		
Hydrocodone	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Ibuprofen	21	16	13	17	24.2	< 10	< 10	< 10		
Iopromide	< 100	< 10	< 100			< 10	< 10	< 10		
Meprobamate	5.7	5.7	6.2	5.9	4.9	< 5.0	< 5.0	< 5.0		
Methadone	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Naproxen	15	16	15	15	3.8	< 1.0	< 1.0	< 1.0		
Oxybenzone	4.8	6.7	5.3	5.6	17.6	< 2.0	< 2.0	< 2.0		
Pentoxifylline	< 1.0	< 1.0	< 1.0			< 1.0	< 1.0	< 1.0		
Phenytoin	< 5.0	< 5.0	< 5.0			< 5.0	< 5.0	< 5.0		
Progesterone	< 10	< 10	< 10			< 10	< 10	< 10		
Salicylic acid	< 100	< 100	110	110		64	88	100	84	21.8
Sulfamethoxazole	18	16	20	18	11.1	1.5	1.4	1.6	1.5	6.7
Testosterone	< 10	< 10	< 10			< 10	< 10	< 10		
Triclosan	< 10	21	< 10	21		< 10	< 10	< 10		
Trimethoprim	8.7	11	9.6	9.8	11.9	< 5.0	< 5.0	< 5.0		

*Estimated value.

Table 6E. CAS triplicate wastewater data summary

SAMPLE ID:	GLWQD-1	GLWQD-2	GLWQD-3			GLWQD-72	GLWQD-73	GLWQD-74		
DATE & TIME:	8/14/08 7:30 AM	8/14/08 7:35 AM	8/14/08 7:40 AM	Average	%RSD	11/19/08 3:00 PM	11/19/08 3:00 PM	11/19/08 3:00 PM	Average	%RSD
GWIC ID #:	251255	251255	251255	251255	251255	249519	249519	249519	249519	249519
Wastewater Type	Modified Activated Sludge – Influent◊					Sequencing Batch Reactor – Effluent◊				
CHEMICAL COMPOUND (ng/L)										
17-α-Estradiol	< 10	< 10	< 10			< 1.0	1.4	< 1.0	1.4	
17-β-Estradiol	< 20	< 20	< 20			5.7	4.1	6.1	5.3	20.0
17 α-Ethinylestradiol	< 20	< 20	< 20			< 2.0	< 2.0	< 2.0		
Acetaminophen	200,000	210,000	210,000	156.7	13.3	< 10	< 10	< 10		
Androstenedione	150	180	140	206666.7	2.8	< 10	< 10	< 10		
Atrazine	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Bisphenol A	240	260	250	250.0	4.0	34	27	33	31.3	12.1
Caffeine	71,000	76,000	70,000	72333.3	4.4	130	110	100	113.3	13.5
Carbamazepine	180	170	160	170.0	5.9	240	200	210	216.7	9.6
DEET	14,000	14,000	13,000	13666.7	4.2	89	78	81	82.7	6.9
Diazepam	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Diclofenac	< 20	< 20	< 20			24	15	15	18.0	28.9
Diethylstilbestrol	< 20	< 20	< 20			< 2.0	< 2.0	< 2.0		
Estriol	160	120	150	143.3	14.5	< 1.0	< 1.0	36	36.0	
Estrone	< 10	< 10	< 10			6.8	7.6	6.9	7.1	6.1
Fluoxetine	59	49	41	49.7	18.2	90	87	90	89.0	1.9
Gemfibrozil	990	1,400	1,400	1263.3	18.7	2,400	2600	2,700	2566.7	6.0
Hydrocodone	56	33	36	41.7	30.0	70	70	79	73.0	7.1
Ibuprofen	6,300	7,000	8,900	7400.0	18.2	400	320	340	353.3	11.8
Iopromide	< 1,000	< 1,000	< 1,000			< 100	< 100	< 100		
Meprobamate	72	77	81	76.7	5.9	6.3	7.8	8.1	7.4	13.0
Methadone	< 50	< 50	< 50			26	22	23	23.7	8.8
Naproxen	8,300	9,200	9,200	8900.0	5.8	280	260	250	263.3	5.8
Oxybenzone	980	860	1,100	980.0	12.2	40	49	52	47.0	13.3
Pentoxifylline	< 10	< 10	< 10			< 1.0	< 1.0	< 1.0		
Phenytoin	< 50	< 50	< 50			< 5.0	< 5.0	< 5.0		
Progesterone	210	170	180	186.7	11.2	< 10	< 10	< 10		
Salicylic acid	72,000	69,000	67,000	69333.3	3.6	< 100	< 100	< 100		
Sulfamethoxazole	160	140	110	136.7	18.4	530	450	460	480.0	9.1
Testosterone	120	67*	85*	90.7*	29.7*	< 10	< 10	< 10		
Triclosan	280	380	400	353.3	18.2	130	110	120	120.0	8.3
Trimethoprim	600	580	580	586.7	2.0	580	480	540	533.3	9.4

*Estimated value.

Table 7E. CAS triplicate wastewater data summary

SAMPLE ID:	GLWQD-104	GLWQD-105	GLWQD-106			GLWQD-127	GLWQD-128	GLWQD-129		
DATE & TIME:	3/18/09 1:00 PM	3/18/09 1:00 PM	3/18/09 1:00 PM	Average	%RSD	5/5/09 2:00 PM	5/5/09 2:00 PM	5/5/09 2:00 PM	Average	%RSD
GWIC ID #:	249519	249519	249519	249519	249519	251275	251275	251275	251275	251275
Wastewater Type	Sequencing Batch Reactor – Effluent					Recirculating Sand Filter – Effluent				
CHEMICAL COMPOUND (ng/L)										
17-α-Estradiol	< 10	**17**	**15**	16*	8.8*	< 10	< 10	< 10		
17-β-Estradiol	< 20	< 20	< 20			< 20	< 20	< 20		
17 α-Ethinylestradiol	< 20	< 20	< 20			< 20	< 20	< 20		
Acetaminophen	< 10	**40**	< 10			**27,000**	**28,000**	**31,000**		
Androstenedione	< 100	< 100	< 100	40		< 100	< 100	< 100	29,000	7.3
Atrazine	< 10	< 10	< 10			< 10	< 10	< 10		
Bisphenol A	**530**	**580**	**510**	540	6.7	**340**	**460**	**370**	390	16.0
Caffeine	**2,300**	**2,300**	**2,100**	2200	5.2	**37,000**	**36,000**	**37,000**	37,000	1.6
Carbamazepine	**380**	**370**	**370**	370	1.5	< 10	< 10	< 10		
DEET	**370**	**370**	**370**	370	0.0	**500**	**500**	**510**	503	1.1
Diazepam	< 10	< 10	< 10			< 10	< 10	< 10		
Diclofenac	< 20	< 20	< 20			**660**	**660**	**650**	660	0.9
Diethylstilbestrol	< 20	< 20	< 20			< 20	< 20	< 20		
Estriol	**76**	**79**	**94**	83	11.6	**270**	**270**	**250**	260	4.4
Estrone	**58**	**53**	**59**	57	5.7	**53**	**71**	**54**	59	17.0
Fluoxetine	**86**	**87**	**79**	84	5.2	**23**	**23**	**29**	25	13.9
Gemfibrozil	**520**	**440**	**460**	470	8.8	< 10	< 10	< 10		
Hydrocodone	< 10	< 10	< 10			< 10	< 10	< 10		
Ibuprofen	**10,000**	**11,000**	**14,000**	12,000	17.8	**6,900**	**6,800**	**7,500**	7,100	5.4
Iopromide	< 100	< 100	< 100			< 100	< 100	< 100		
Meprobamate	< 50	< 50	< 50			**4,100**	**4,600**	**4,300**	4,300	5.8
Methadone	< 50	< 50	< 50			< 50	< 50	< 50		
Naproxen	**2,300**	**2,100**	**2,200**	2200	4.5	**4,900**	**4,100**	**4,700**	4,600	9.1
Oxybenzone	**23**	**21**	< 20	22*	6.4*	**64**	**56**	**70**	63	11.1
Pentoxifylline	< 10	< 10	< 10			< 10	< 10	< 10		
Phenytoin	< 50	< 50	< 50			< 50	< 50	< 50		
Progesterone	< 100	< 100	< 100			< 100	< 100	< 100		
Salicylic acid	**190**	< 100	**220**	205*	10.3*	**2,800**	**2,300**	**2,100**	2400	15.0
Sulfamethoxazole	**14**	**12**	**22**	16	33.1	< 10	< 10	< 10		
Testosterone	< 100	< 100	< 100			< 100	< 100	< 100		
Triclosan	< 100	< 100	< 100			< 100	< 100	< 100		
Trimethoprim	**51**	< 50	< 50	51		< 50	< 50	< 50		

*Estimated value.

Appendix F: ELISA Data

Table F1. ELISA groundwater data including triplicate data (MBMG Organic Laboratory).

GLWQD #	GWIC ID	17 α-Ethinyl estradiol (ng/L)	RSD %	Estrone (ng/L)	RSD %	Bisphenol A (ng/L)	RSD %	Sulfameth-oxazole (ng/L)	RSD %	Progesterone (ng/L)	RSD %	Sulfamethazine (ng/L)	RSD %	17 β-estradiol (ng/L)	RSD %	Atrazine (ng/L)	RSD %
GLWQD-B	206589	<0.5		<0.5		4.21*	65.0	1.12	7.4	<1.0		<50		2.12*	60.3	<20	
GLWQD-C	244600	<0.5		<0.5		3.34	10.4	1.19	7.8	<1.0		<50		<2.5		<20	
GLWQD-D	159556	<0.5		<0.5		3.20	8.3	10.8	6.7	<1.0		<50		<2.5		<20	
GLWQD-17	235475	<0.5		<0.5		6.17*	109	2.30	3.6	<1.0		<50		<2.5		<20	
GLWQD-28**	226774	<0.5		0.67*	47.6	<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-29**	226774	<0.5		0.84*	36.6	<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-30**	226774	<0.5		<0.5		1.61	21.0	<1.0		<1.0		<50		<2.5		<20	
Average	226774	<0.5		0.76	15.9	1.61		<1.0		<1.0		<50		<2.5		<20	
GLWQD-31	214912	<0.5		0.99	4.5	2.29	14.4	1.16	5.5	1.47	3.5	<50		<2.5		<20	
GLWQD-32	235511	0.63	10.1	<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-37**	91039	0.51	3.8	<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-38**	91039	<0.5		<0.5		2.06	4.2	<1.0		<1.0		<50		<2.5		<20	
GLWQD-36**	91039	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
Average	91039	0.51		<0.5		2.06		<1.0		<1.0		<50		<2.5		<20	
GLWQD-39	91040	<0.5		<0.5		1.66	7.3	<1.0		<1.0		<50		<2.5		<20	
GLWQD-40	246752	<0.5		<0.5		2.31*	46.3	<1.0		<1.0		<50		<2.5		<20	
GLWQD-41	91799	<0.5		<0.5		2.67*	86.0	<1.0		<1.0		<50		<2.5		<20	
GLWQD-42	200374	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-43	241692	<0.5		<0.5		1.61	13.0	<1.0		<1.0		<50		<2.5		<20	
GLWQD-45	235512	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-46**	203716	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-47**	203716	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-48**	203716	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
Average	203716	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-49	234930	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-50	9858	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-52	187057	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-53	153163	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-54	234907	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-55	210710	<0.5		<0.5		1.67*	143	<1.0		<1.0		<50		<2.5		<20	
GLWQD-56	195430	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-57**	235473	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-58**	235473	<0.5		<0.5		1.90	7.9	<1.0		<1.0		<50		<2.5		<20	
GLWQD-59**	235473	<0.5		<0.5		1.67	1.7	1.31*	33.9	<1.0		<50		<2.5		<20	
Average	235473	<0.5		<0.5		1.78	9.2	1.31		<1.0		<50		<2.5		<20	
GLWQD-60	216675	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-61	90795	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-62	223271	<0.5		<0.5		1.67	1.7	<1.0		<1.0		<50		<2.5		<20	
GLWQD-63	247942	<0.5		<0.5		<1.6		1.74*	31.9	<1.0		<50		<2.5		20	18.3
GLWQD-98**	244600	<0.5		1.01	5.4	1.43*	71.9	10.3	1.4	<1.0		<50		<2.5		<20	
GLWQD-99**	244600	<0.5		1.22	6.3	3.13	14.0	12.9	1.3	<1.0		<50		<2.5		<20	
GLWQD-100**	244600	<0.5		1.41	6.0	<2		9.52	0.7	<1.0		<50		<2.5		<20	
Average	244600	<0.5		1.21	16.6	2.28*	52.6	10.9	16.4	<1.0		<50		<2.5		<20	
GLWQD-103	250018	0.70	13.3	9.43*	75.7	4.11*	28.1	24.0	1.0	0.89	3.3	<50		5.51*	35.8	<20	
GLWQD-107	250010	<0.5		1.35	16.0	1.71	9.8	13.3	1.7	<1.0		<50		<2.5		<20	

*estimated value; ‡Public water supply; **Triplicate sample

Table F2. ELISA surface-water data including triplicate data (MBMG Organic Laboratory).

GLWQD#	GWIC ID	17 α-Ethinyl estradiol (ng/L)	RSD %	Estrone (ng/L)	RSD %	Bisphenol A (ng/L)	RSD %	Sulfamethoxazole (ng/L)	RSD %	Progesterone (ng/L)	RSD %	Sulfamethazine (ng/L)	RSD %	17 β-estradiol (ng/L)	RSD %	Atrazine (ng/L)	RSD %
GLWQD-5	249233	<0.5		1.03	3.6	<1.6		2.00	1.8	1.50	4.7	<50		2.54*	26.40	<20	
GLWQD-6	249234	<0.5		2.73	6.9	1.74	21.7	2.69	5.8	2.45	2.7	<50		3.14*	33.10	<20	
GLWQD-7**	249235	<0.5		2.32	3.3	<1.6		1.95	16.9	2.16	12.1	<50		1.65*	56.60	<20	
GLWQD-8**	249235	<0.5		2.09	13.2	2.23*	34.8	2.15	6.4	2.00	3.9	<50		3.61*	26.70	<20	
GLWQD-9**	249235	<0.5		2.16	5.7	1.68	13.3	2.67	5.3	2.36	6.7	<50		1.49	20.70	<20	
Average	249235	<0.5		2.19	5.5	1.96	19.8	2.26	16.5	2.17	8.3	<50		2.25*	52.47	<20	
GLWQD-21	246248	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-22	246247	<0.5		0.551	10.7	1.89	3.6	<1.0		<1.0		<50		<2.5		<20	
GLWQD-23	246246	<0.5		0.765	11.1	<1.6		1.11	6.1	1.09	15.0	<50		<2.5		<20	
GLWQD-24	246244	<0.5		1.10	10.0	2.17	6.4	<1.0		1.53	2.3	<50		<2.5		<20	
GLWQD-25	246243	<0.5		0.809	23.8	1.96	9.5	<1.0		1.03	5.0	<50		<2.5		<20	
GLWQD-27	246236	0.512	16.4	1.79	11.1	<1.6		<1.0		1.84	4.9	<50		<2.5		<20	
GLWQD-35	246756	<0.5		0.648	6.1	1.60*	42.2	<1.0		<1.0		<50		<2.5		<20	
GLWQD-51	247764	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	
GLWQD-79	246248	<0.5		< 1.0		<2		3.6	18.8	<1.0		<50		<2.5		<20	
GLWQD-80	246246	<0.5		< 1.0		<2		1.31*	33.9	<1.0		<50		<2.5		<20	
GLWQD-81	246244	<0.5		1.1	14.1	7.4*	54.4	<1.0		<1.0		<50		<2.5		<20	
GLWQD-82	246247	<0.5		< 1.0		<2		<1.0		<1.0		<50		<2.5		<20	
GLWQD-84	246756	<0.5		< 1.0		<2		<1.0		<1.0		<50		<2.5		<20	
GLWQD-85	246243	<0.5		< 1.0		3.70	17.0	1.74*	31.9	<1.0		<50		<2.5		<20	
GLWQD-86	246236	<0.5		< 1.0		<2		<1.0		<1.0		<50		2.27*	49.9	<20	
GLWQD-88	249233	<0.5		< 1.0		2.48	20.4	<1.0		9.5	0.0	<50		<2.5		<20	
GLWQD-89	249234	<0.5		5.11	20.5	<2		2.71*	63.7	1.36	2.5	<50		10.1*	69.9	<20	
GLWQD-90	249235	<0.5		6.82	15.0	<2		5.61	9.3	2.57	0.6	<50		8.15*	89.9	<20	
GLWQD-91**	246244	<0.5		< 1.0		<2		<1.0		<1.0		<50		<2.5		<20	
GLWQD-92**	246244	<0.5		< 1.0		<2		<1.0		<1.0		<50		<2.5		<20	
GLWQD-93**	246244	<0.5		< 1.0		4.86*	100.3	<1.0		<1.0		<50		9.05*	120.2	<20	
Average	246244	<0.5		< 1.0		4.86*		<1.0		<1.0		<50		9.05		<20	

*estimated value

‡Public water supply

**Triplicate sample

Table F3. ELISA wastewater effluent data including triplicate data (MBMG Organic Laboratory).

GLWQD #	GWIC ID	17 α-Ethinyl estradiol (ng/L)	RSD %	Estrone (ng/L)	RSD %	Bisphenol A (ng/L)	RSD %	Sulfamethoxazole (ng/L)	RSD %	Progesterone (ng/L)	RSD %	Sulfamethazine (ng/L)	RSD %	17 β-estradiol (ng/L)	RSD %	Atrazine (ng/L)	RSD %
GLWQD-10	249573	<0.5		5.50	6.4	3.28*	60.0	9.41	7.2	3.53	1.8	<50		3.00*	26.30	<20	
GLWQD-13	249519	<0.5		22.6	1.9	8.58	8.0	23.3	4.3	28.2	7.8	<50		21.4	6.80	<20	
GLWQD-26	246241	0.894	6.0	38.7	2.8	3.66*	26.6	8.47	6.0	16.7	4.4	<50		21.3	3.3	<20	
GLWQD-34	246755	0.66	3.5	34.4	6.8	9.12	16.4	7.05	3.5	16	1.0	<50		2.66*	34.3	32.0	1.9
GLWQD-68	249232	<0.5		7.81	1.3	40.8*	28.7	4.82*	42.3	18.1	7.4	<50		11.0	6	20	21.8
GLWQD-72**	249519	0.63*	86.7	1034	0.1	33.7*	31.5	2.71*	63.7	15.2	10.3	<50		18.8		<20	
GLWQD-73**	249519	0.82	16.0	1036	0.1	13.6*	30.2	5.61	9.3	17.0	7.4	<50		16.48	7.6	<20	
GLWQD-74**	249519	0.55*	86.6	1040	0.2	23.0	15.8	6.68	10.2	15.2	8.0	<50		17.0*	44.8	<20	
Average	249519	0.67	21.0	1037	0.3	23.5*	42.9	5.00*	41.1	15.8	6.5	<50		17.4	6.8	<20	
GLWQD-75	246241	<0.5		6.04	3.2	11.7	22.3	<1.0		12.1	5.5	<50		6.85*	68.2	<20	
GLWQD-76	249573	<0.5		4.36	7.5	11.6*	53.4	<1.0		7.4	7.2	<50		7.65	6.8	<20	
GLWQD-78	246755	<0.5		7.44	11.7	9.68*	26.3	2.78*	92.7	12.4	7.1	<50		<2.5		50	21.8
GLWQD-87	249232	0.86	22.1	28.9	12.6	29.7	18.3	4.82*	42.3	10	0.0	<50		37.3	21.4	<20	
GLWQD-104**	249519	3.73	8.5	54.6	16.0	6.98	6.8	15.8	0.5	16.1	2.8	<50		156*	31.2	<20	
GLWQD-105**	249519	3.30	5.0	72.0	7.1	5.41	19.0	11.1	2.1	20.9	3.3	<50		135	22.6	<20	
GLWQD-106**	249519	3.74	5.4	75.1	3.8	6.76	1.2	13.4	1.8	21.1	0.4	<50		111	9.1	<20	
Average	249519	3.59	6.9	67.2	16.4	6.38	13.3	13.5	17.5	19.4	14.8	<50		134	17.0	<20	
GLWQD-109	246241	1.05	8.6	44.3	7.7	6.16	2.7	13.3	0.9	25.5	1.0	<50		20.0	3.9	<20	
GLWQD-110	249573	<0.5		14.6	10.4	2.75*	40.3	15.1	0.8	3.2	0.9	<50		8.0	13.4	<20	

*estimated value

‡Public water supply

**Triplicate sample

Table F4. ELISA blank data including triplicate data (MBMG Organic Laboratory).

GLWQD #	Type of Blank	17 α-Ethinyl estradiol (ng/L)	RSD %	Estrone (ng/L)	RSD %	Bisphenol A (ng/L)	RSD %	Sulfamethoxazole (ng/L)	RSD %	Progesterone (ng/L)	RSD %	Sulfamethazine (ng/L)	RSD %	17 β-estradiol (ng/L)	RSD %	Atrazine (ng/L)	RSD %
GLWQD-12	Equipment (dipper)†	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	<0.5
GLWQD-20	Equipment (bailer)†	<0.5		<0.5		<1.6		1.09	0.9	<1.0		<50		<2.5		<20	<0.5
GLWQD-44	Equipment (bailer)†	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	<0.5
GLWQD-71	Equipment (field)†	<0.5		<0.5		3.03*	72.0	<1.0		<1.0		<50		<2.5		<20	<0.5
Lab Blank 1	Laboratory	<0.5		<0.5		<1.6		<1.0		<1.0		<50		<2.5		<20	<0.5
Lab Blank 2	Laboratory	<0.5		<0.5		3.87*	29.7	<1.0		<1.0		<50		<2.5		<20	<0.5

†HPLC-grade deionized water used

*estimated value

Appendix G: AXYS Data

Table G1. AXYS Laboratory Services PPCP summary data

SAMPLE ID	GLWQD-80	GLWQD-83	GLWQD-86	GLWQD-87	GLWQD-89	GLWQD-90	Lab Blank	Spiked Matrix
UNITS	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	% Recovery
Acetaminophen	< 61.4	97400	< 62.4	< 60.3	< 59.8	< 59.8	< 60.0	101
Azithromycin	< 2.15	1460	< 2.18	1460	81.2	4.5	< 2.10	58.8
Caffeine	**32.4**	**60200**	< 15.6	85.4	< 14.9	25.6	< 15.0	72.6
Carbadox	< 2.69	< 28.4	< 3.52	< 11.7	< 3.29	< 3.10	< 1.50	76.1
Carbamazepine	< 1.54	211	2.78	284	50.7	46.4	< 1.50	130
Cefotaxime	< 16.0	< 334	< 18.2	< 80.4	< 36.2	< 37.6	< 7.41	53.3
Ciprofloxacin	< 6.66	859	< 5.46	297	24.2	14.3	< 5.25	133
Clarithromycin	< 1.54	292	< 1.56	227	27.5	24.5	< 1.50	91
Clinafloxacin	< 11.6	< 32.2	< 8.00	< 27.6	< 11.3	< 9.09	< 6.00	115
Cloxacillin	< 3.07	< 17.9	< 3.12	< 9.11	< 2.99	< 2.99	< 3.00	82.8
Codeine	< 3.07	449	< 3.12	205	35.7	37.7	< 3.00	113
Cotinine	< 1.54	1400	< 1.56	< 1.51	< 1.49	< 1.49	< 1.50	143
Dehydronifedipine	< 0.614	< 1.86	< 0.624	2.13	0.791	0.631	< 0.600	127
Diphenhydramine	< 0.614	846	< 0.624	403	35.9	9.36	< 0.600	77.6
Diltiazem	< 0.307	145	< 0.312	74.2	11.4	11.5	< 0.300	120
Digoxin	< 15.4	< 15.2	< 15.6	< 15.1	< 14.9	< 14.9	< 15.0	75.3
Digoxigenin	< 6.14	< 29.0	< 6.24	< 11.4	< 7.81	< 5.98	< 6.00	102
Enrofloxacin	< 3.07	< 5.98	< 3.12	< 3.63	< 2.99	< 2.99	< 3.00	149
Erythromycin-H2O	< 1.13	231	1.77	194	29.6	22.1	< 1.10	105
Flumequine	< 1.54	< 1.52	< 1.56	< 1.51	< 1.49	< 1.49	< 1.50	94.2
Fluoxetine	< 1.54	27.3	< 1.56	38.9	5.47	< 1.49	< 1.50	110
Lincomycin	< 3.07	< 15.5	< 3.12	5.39	< 2.99	< 2.99	< 3.00	8.6
Lomefloxacin	< 3.07	< 3.04	< 3.12	< 3.02	< 2.99	< 2.99	< 3.00	142
Miconazole	< 1.54	7.74	< 1.56	< 4.52	< 1.49	< 1.49	< 1.50	110
Norfloxacin	< 15.4	< 58.4	< 15.6	< 57.3	< 14.9	< 14.9	< 15.0	150
Norgestimate	< 3.07	< 14.1	< 3.12	< 4.23	< 2.99	< 2.99	< 3.00	59.5
Ofloxacin	< 15.4	**500**	< 15.6	311	28.2	< 14.9	< 15.0	168
Ormetoprim	< 0.614	< 0.608	< 0.624	< 0.603	< 0.598	< 0.598	< 0.600	110
Oxacillin	< 3.07	< 9.38	< 3.12	< 3.02	< 2.99	< 2.99	< 3.00	85
Oxolinic Acid	< 0.614	< 1.82	< 0.624	< 0.603	< 0.991	< 0.745	< 0.600	96.7
Penicillin G	< 3.07	< 10.2	< 3.12	38.2	4.19	5.04	< 3.00	87.6
Penicillin V	< 3.07	**44.6**	< 3.12	< 6.43	< 2.99	< 3.16	< 3.00	76.8
Roxithromycin	< 0.307	< 1.80	< 0.312	1.2	< 0.299	< 0.299	< 0.300	83.6
Sarafloxacin	< 15.4	< 15.2	< 15.6	< 15.1	< 14.9	< 14.9	< 15.0	153
Sulfachloropyridazine	< 1.54	< 1.52	< 1.56	< 1.51	< 1.49	< 1.49	< 1.50	102
Sulfadiazine	< 1.54	< 3.33	< 1.56	< 1.89	< 1.49	< 1.49	< 1.50	113
Sulfadimethoxine	< 0.307	< 4.00	< 0.363	< 2.89	< 0.306	< 0.299	< 0.545	116
Sulfamerazine	< 0.614	**44.9**	< 0.624	< 0.603	< 0.598	< 0.598	< 0.600	99.1
Sulfamethazine	< 0.614	< 0.608	< 0.624	< 0.603	< 0.598	< 0.598	< 0.600	114
Sulfamethizole	< 0.614	< 1.64	< 0.624	< 6.54	< 0.598	< 0.598	< 0.600	97.3
Sulfamethoxazole	**1.47**	**1620**	**8.27**	**1020**	**109**	**148**	< 0.600	113
Sulfanilamide	< 15.4	< 15.2	< 15.6	< 15.1	< 14.9	< 14.9	< 15.0	18.1
Sulfathiazole	< 1.54	< 7.24	< 1.56	< 5.68	< 1.49	< 1.79	< 1.50	95.1
Thiabendazole	< 1.54	**29.7**	< 1.56	20.3	4.06	2.49	< 1.50	103
Trimethoprim	< 1.54	**770**	2.73	511	78.7	70.1	< 1.50	122
Tylosin	< 6.14	< 6.08	< 6.24	< 6.03	< 5.98	< 5.98	< 6.00	57.3
Virginiamycin	< 3.63	< 47.0	< 6.29	< 13.4	< 6.41	< 8.92	< 3.96	63.1
1,7-Dimethylxanthine	< 154	34000	< 156	501	< 149	< 149	< 150	73.2

Table G2. AXYS Analytical Services PPCP summary data

SAMPLE ID	GLWQD 98*	GLWQD 99*	GLWQD 100*	GLWQD 102	GLWQD 103	GLWQD 104*	GLWQD 105*	GLWQD 106*	GLWQD 107	GLWQD 108	Lab Blank	Spiked Matrix
UNITS	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	% Recovery
Acetaminophen	< 61.4	< 62.6	< 61.7	237000	< 74.8	< 182	< 183	< 181	< 63.7	96000	< 60.0	82.4
Azithromycin	< 2.15	< 2.19	< 2.16	24.5	< 2.17	2290	3000	3440	< 2.23	1260	< 2.10	41
Caffeine	< 18.6	< 15.6	< 46.3	OLR 218000	24	535	639	776	< 47.7	34500	< 15.0	62.6
Carbadox	< 1.53	< 2.48	< 2.66	< 1.51	13.7	< 28.9	< 24.3	7.23	3.63	< 4.93	< 1.50	76.9
Carbamazepine	277	264	277	1640	582	609	876	1040	453	5690	< 1.50	105
Cefotaxime	< 19.3	< 17.6	< 20.7	< 156	< 34.3	< 35.5	< 81.3	< 67.1	< 27.7	< 60.5	< 6.39	98.3
Ciprofloxacin	< 5.37	< 5.48	< 5.40	49.1	12.5	280	301	303	< 5.99	236	< 5.25	98.6
Clarithromycin	< 1.53	< 1.56	< 1.54	380	< 1.55	1090	1050	1090	< 1.59	11900	< 1.50	80.8
Clinafloxacin	< 8.65	< 7.14	< 6.21	< 34.1	< 14.2	< 30.0	< 18.3	< 55.4	< 9.12	< 45.2	< 6.00	86.6
Cloxacillin	< 3.07	< 3.13	< 3.08	< 12.9	13.8	< 10.5	< 17.1	< 12.5	< 3.18	< 9.87	< 3.00	79
Codeine	< 3.07	< 3.13	< 3.08	636	< 3.11	159	226	254	< 3.18	403	< 3.00	80
Cotinine	< 18.6	< 22.9	< 17.5	3580	< 21.1	2280	2300	2210	< 22.0	7150	< 16.1	110
Dehydronifedipine	< 0.614	< 0.626	< 0.617	2.23	< 0.621	9.13	13.8	13.4	< 0.637	< 2.37	< 0.600	94.5
Diphenhydramine	< 0.614	< 0.626	< 0.617	3660	< 0.621	1060	1470	1680	< 0.637	4520	< 0.600	91.3
Diltiazem	< 0.307	< 0.313	< 0.308	301	< 0.311	199	288	329	< 0.318	1.34	< 0.300	85.1
Digoxin	< 15.3	< 15.6	< 15.4	< 15.1	< 15.5	< 45.6	< 45.8	< 45.1	< 15.9	< 49.3	< 15.0	79.3
Digoxigenin	< 9.93	< 6.26	< 6.32	< 6.06	< 6.58	< 18.2	< 27.1	< 42.6	< 14.8	< 74.3	< 6.00	96.9
Enrofloxacin	< 3.18	< 3.59	< 3.71	< 17.0	< 8.41	< 9.11	< 9.15	< 9.03	< 3.79	< 9.87	< 3.00	90.5
Erythromycin-H2O	< 1.13	< 1.15	< 1.13	2.73	6.11	37.2	35	37.8	< 1.17	17.3	< 1.10	102
Flumequine	< 1.53	< 1.56	< 1.54	< 2.95	< 1.55	< 4.56	< 4.58	< 4.51	< 1.59	< 8.94	< 1.50	101
Fluoxetine	< 1.53	< 1.56	< 1.54	79.4	< 1.55	71.4	44.1	30.8	< 1.59	5.07	< 1.50	101
Lincomycin	< 3.07	< 3.13	< 3.08	< 13.2	< 4.14	< 9.11	< 9.15	< 9.03	< 3.18	< 9.87	< 3.00	37.6
Lomefloxacin	< 3.07	< 3.13	< 3.08	< 5.65	< 3.93	< 9.11	< 9.15	< 9.03	< 3.18	< 9.87	< 3.00	103
Miconazole	< 1.53	< 1.56	< 1.54	66	< 1.55	7.49	7.6	9.67	< 1.59	47.5	< 1.50	82.2
Norfloxacin	< 15.3	< 15.6	< 15.4	< 24.6	< 24.2	< 45.6	< 45.8	< 45.1	< 15.9	< 49.3	< 15.0	111
Norgestimate	< 3.07	< 3.13	< 3.08	< 8.89	< 3.11	< 9.11	< 9.52	< 9.42	< 3.18	< 13.5	< 3.00	50.3
Ofloxacin	< 15.3	< 15.6	< 15.4	1140	< 15.5	986	1040	1050	< 15.9	176	< 15.0	120
Ormetoprim	< 0.614	< 0.626	< 0.617	< 0.606	< 0.621	< 1.82	< 1.83	< 1.81	< 0.637	< 1.97	< 0.600	103
Oxacillin	< 3.07	< 3.13	< 3.08	< 6.11	< 3.11	< 9.11	< 9.15	< 9.03	< 3.18	< 9.87	< 3.00	80.6
Oxolinic Acid	< 0.614	< 0.626	< 0.617	< 1.90	< 0.805	< 1.82	< 1.83	< 2.63	< 0.637	< 3.30	< 0.600	111
Penicillin G	< 3.07	< 3.13	< 3.08	< 4.82	< 3.11	< 9.11	< 9.15	< 9.03	< 3.18	< 9.87	< 3.00	93
Penicillin V	< 3.07	< 3.13	< 3.08	38.5	< 3.54	29.7	42.9	37.7	< 3.18	121	< 3.00	88.1
Roxithromycin	< 0.307	< 0.313	< 0.308	< 1.22	< 0.311	< 0.911	< 0.915	< 0.903	< 0.318	2.5	< 0.300	83.4
Sarafloxacin	< 31.6	< 38.4	< 41.8	< 150	< 85.1	< 45.6	< 67.8	< 115	< 53.0	< 91.7	< 25.0	90.8
Sulfachloropyridazine	< 1.53	< 1.56	< 1.54	< 1.51	< 1.55	< 4.56	< 4.58	< 4.51	< 1.59	< 4.93	< 1.50	89.3
Sulfadiazine	5.52	4.61	4.67	< 1.51	17.2	< 4.56	< 4.58	< 4.51	9.3	81.5	< 1.50	83.5
Sulfadimethoxine	1.16	< 0.585	0.872	3.78	3.97	< 39.0	< 35.0	< 34.1	0.771	< 2.92	< 0.300	69.1
Sulfamerazine	< 0.614	< 0.626	< 0.617	< 0.606	< 1.76	< 1.82	< 1.83	< 1.81	< 0.637	< 1.97	< 0.600	77.1
Sulfamethazine	1.67	< 0.821	< 0.617	< 7.84	< 2.50	< 1.82	< 1.83	< 1.81	< 1.45	< 7.09	< 0.600	87.5
Sulfamethizole	< 0.614	< 0.626	< 0.617	3.89	< 0.749	< 1.82	< 1.83	< 1.81	< 0.637	3.18	< 0.600	74.3
Sulfamethoxazole	556	525	544	< 4.01	1140	13.8	10.4	17.3	816	497	< 0.600	82.5
Sulfanilamide	< 15.3	< 15.6	< 16.0	< 86.9	< 34.0	< 45.6	< 45.8	< 45.1	< 18.8	< 49.3	< 15.0	30
Sulfathiazole	< 1.53	< 1.56	< 1.54	< 2.20	< 1.56	< 4.56	< 4.58	< 4.51	< 1.59	< 4.93	< 1.50	76.5
Thiabendazole	< 1.53	< 1.56	< 1.54	21	< 1.55	28.3	26	27.8	< 1.59	24.9	< 1.50	104
Trimethoprim	< 1.53	< 1.56	< 1.54	< 26.5	< 1.55	53.5	36.9	58.6	< 1.59	169	< 1.50	88.1
Tylosin	< 6.14	< 6.26	< 6.17	< 6.06	< 6.21	< 18.2	< 18.3	< 18.1	< 6.37	< 19.7	< 6.00	52
Virginiamycin	< 4.88	< 4.78	< 5.32	< 71.0	< 7.73	< 10.7	< 17.2	< 23.0	< 5.41	110	< 4.59	58.4
1,7-Dimethylxanthine	< 153	< 156	< 463	22600	< 155	888	922	678	< 477	12300	< 150	102

Table G3. AXYS Analytical Services hormone summary data

CLIENT ID	GLWQD-80	GLWQD-86	GLWQD-87	GLWQD-89	GLWQD-90	Lab Blank	Spiked Matrix	Lab Blank	Spiked Matrix
UNITS	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	% Recovery	ng/L	% Recovery
Androsterone	< 0.650	< 0.0203	K 1.09	< 0.350	< 0.350	< 0.0574	103		
Desogestrel	< 0.280	< 0.334	K 1.76	< 0.348	< 0.361	< 0.248	109		
17 alpha-estradiol	< 0.387	0.436	< 0.693	< 0.251	< 0.353	< 0.168	112		
Estrone	< 0.651	< 0.425	22.6	K 2.74	K 2.99	< 0.203	86.2		
Equilin	< 2.50	< 0.443	K 3.59	< 1.34	< 1.03	< 0.176	72.8		
Androstenedione	< 6.18	< 2.82	K 11.3	< 3.00	< 5.40	< 3.13	59.2		
17 alpha-dihydroequilin	< 0.609	< 0.267	< 3.20	< 0.754	< 0.521	< 0.235	79.3		
17 beta-estradiol	K 0.846	K 0.859	K 1.85	K 0.969	K 1.18	K 0.934	192		
Testosterone	< 2.95	< 1.60	< 13.9	< 3.10	< 4.54	< 2.00	79.9		
Equilenin	< 0.358	K 0.490	K 2.08	K 0.478	K 0.669	K 0.422	60.2		
Mestranol	K 0.823	K 0.880	< 1.45	K 0.936	K 0.953	K 0.917	102		
Norethindrone	< 2.71	< 0.847	< 2.96	< 2.02	< 3.43	< 2.00	131		
17 alpha-ethinylestradiol	K 1.31	K 1.11	K 1.34	K 1.10	K 1.26	K 1.07	93.4		
Progesterone	< 7.59	< 7.02	< 9.95	K 68.3	< 9.77			< 7.51	142
Norgestrel	< 5.58	< 2.09	< 14.4	< 3.55	< 8.98	< 2.48	139		
Estriol	< 1.88	< 0.862	0.922	< 0.754	< 2.11	< 0.849	32.3		
beta-estradiol 3-benzoate	< 1.95	< 1.25	< 1.70	< 1.09	< 2.50	< 2.20	5		

Table G4. AXYS Analytical Services hormone summary data

CLIENT ID	GLWQD-83	Lab Blank	Spiked Matrix	GLWQD-98	GLWQD- 99	GLWQD-100	GLWQD-103	GLWQD-107	GLWQD- 108	Lab Blank	Spiked Matrix
UNITS	ng/L	ng/L	% Recov	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	% Recovery
Androsterone	135	< 0.267	119	< 0.751	< 1.15	< 1.59	< 4.53	< 1.83	4190	< 3.00	140
Desogestrel	K 5.55	< 1.12	127	< 1.30	< 0.733	< 1.48	< 2.04	< 1.49	< 9.48	< 0.478	131
17 alpha-estradiol	K 6.40	< 1.09	116	< 0.267	< 0.281	< 0.434	< 0.609	< 0.440	< 8.64	< 0.348	102
Estrone	88.1	K 1.42	108	< 0.584	< 0.509	< 0.565	< 1.35	< 1.08	50.4	< 1.15	99.8
Equilin	< 17.1	< 1.38	94.6	< 0.618	< 0.553	< 0.799	< 2.02	< 1.12	< 26.2	< 1.02	90.3
Androstenedione	K 415	< 24.3	101	< 5.38	< 6.36	< 7.66	< 15.4	< 9.82	K 526	< 9.06	118
17 alpha-dihydroequilin	< 8.03	K 1.39	88.2	< 0.734	< 0.553	< 0.497	< 1.18	< 0.756	< 7.26	< 0.747	73.4
17 beta-estradiol	K 26.8	K 9.38	167	K 0.707	K 0.537	K 0.653	< 0.500	K 0.605	K 14.6	K 0.689	162
Testosterone	K 672	60.9	129	< 3.86	< 3.23	< 3.98	< 7.07	< 5.33	7360	< 3.83	125
Equilenin	< 8.55	K 5.02	2010	K 0.417	< 0.416	< 0.470	< 0.742	< 0.967	< 6.71	< 0.576	68.9
Mestranol	K 25.1	K 9.93	107	K 0.658	K 0.516	< 0.693	< 0.895	< 0.695	< 4.91	< 1.05	87.8
Norethindrone	< 32.3	K 85.9	108	K 75.8	K 6.40	K 1.91	K 4.77	K 2.61	< 11.3	< 1.92	121
17 alpha-ethinylestradiol	K 11.4	K 13.4	104	K 1.69	K 0.951	K 1.02	K 1.25	< 0.430	K 5.37	K 0.776	83.8
Progesterone	< 199	K 583	164	K 130	K 27.4	< 9.49	< 18.2	< 24.7	169	< 15.9	232
Norgestrel	K 41.3	K 190	103	K 192	K 11.9	K 3.76	< 3.07	< 3.39	< 28.8	< 2.47	112
Estriol	91.1	< 2.96	21.6	< 2.87	< 0.677	< 0.646	< 0.762	< 0.841	81.8	< 0.376	12.1
beta-estradiol 3-benzoate	< 16.0	< 37.9	47.6	< 6.27	< 0.777	< 0.837	< 0.564	< 0.737	< 14.8	< 0.699	10.4

*Triplicate samples

K = estimated value.

< = less than detection limit. Number following this symbol is the detection limit.

Table G5. AXYS Analytical Services hormone summary data

CLIENT ID	GLWQD 102	Lab Blank	Spiked Matrix	GLWQD 104*	GLWQD 105*	GLWQD 106*	Lab Blank	Spiked Matrix
AXYS ID	L12461-4	WG28284-101	WG28284-102	L12461-6	L12461-7	L12461-8	WG28536-101	WG28536-102
WORKGROUP	WG28284	WG28284	WG28284	WG28536	WG28536	WG28536	WG28536	WG28536
UNITS	ng/L	ng/L	% Recovery	ng/L	ng/L	ng/L	ng/L	% Recovery
Androsterone	4190	< 0.0515	121	< 0.147	K 0.804	< 0.123	< 0.165	71
Desogestrel	60.2	< 0.542	108	< 4.38	5.83	< 4.03	< 0.415	60.8
17 alpha-estradiol	< 11.8	< 0.344	108	NQ	59.9	NQ	K 0.271	118
Estrone	61.8	K 0.543	109	NQ	517	NQ	< 0.673	128
Equilin	< 25.5	< 0.568	104	NQ	< 62.7	NQ	< 0.519	109
Androstenedione	< 779	< 9.14	128	< 17.2	< 21.0	< 20.4	< 1.11	67.2
17 alpha-dihydroequilin	< 12.8	K 0.829	86.8	NQ	< 20.6	NQ	< 1.21	98.9
17 beta-Estradiol	K 18.6	K 3.37	168	NQ	12.6	NQ	K 1.41	185
Testosterone	5160	< 12.4	135	< 13.0	< 13.2	< 13.4	< 0.470	69.3
Equilenin	< 8.72	K 1.54	72.9	NQ	< 13.8	NQ	< 0.781	57.5
Mestranol	K 19.3	K 3.94	112	K 3.00	< 2.67	< 3.54	< 0.357	103
Norethindrone	K 23.9	< 6.00	137	< 7.32	< 3.24	< 4.82	< 1.93	120
17 alpha-ethinylestradiol	K 9.93	K 4.90	110	< 2.33	K 2.67	< 2.51	K 1.28	94.9
Progesterone	< 167	< 60.0	142	< 7.58	< 6.98	< 6.40	< 1.40	62.1
Norgestrel	K 62.5	K 18.9	116	< 21.3	< 12.4	< 21.0	< 4.37	114
Estriol	26.5	< 1.02	8.4	30.5	15.1	21.3	< 0.458	9.8
beta-estradiol 3-benzoate	< 5.38	< 2.50	34	< 6.03	< 2.67	< 4.96	< 7.75	23.4

*K = estimated value

< = less than detection limit. Number following this symbol is the detection limit.

NQ = Not qualified

Table G6. AXYS Analytical Services Sterol summary data

CLIENT ID	GLWQD-80	GLWQD-86	GLWQD-87	GLWQD-89	GLWQD-90	Lab Blank	Spiked Matrix	GLWQD-83	Lab Blank	Spiked Matrix
UNITS	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	% Recovery	ng/L	ng/L	% Recovery
Coprostanol	24.2	61.7	22800	2750	1240	K 1.22	117	1190000	< 72.5	132
Epicoprostanol	4.52	12.9	361	52.7	32.2	< 0.585	110	K 7890	< 86.7	122
Cholesterol	604	772	36600	5740	3570	195	196	1300000	K 2380	120
Cholestanol	33.7	91.1	3110	484	268	K 2.38	133	34600	< 44.1	119
Desmosterol	84	99.9	K 710	K 177	K 126	< 2.26	126	K 8860	< 235	120
Ergosterol	30.1	80.5	8410	722	176	< 1.60	15.1	51500	< 216	48.8
Campesterol	99.5	226	2700	538	338	2.3	130	81600	< 152	128
Stigmasterol	132	303	8060	836	364	13.4	140	42500	K 774	105
beta-Sitosterol	1120	1590	8790	2910	1760	53.4	153	184000	3700	98.4
beta Stigmastanol	42.8	132	842	152	102	< 0.317	134	21700	< 93.0	120

Table G7. AXYS Analytical Services Sterol summary data

CLIENT ID	GLWQD 98*	GLWQD 99*	GLWQD 100*	GLWQD 103	GLWQD 107	Lab Blank	Spiked Matrix	GLWQD 108	Lab Blank	Spiked Matrix
UNITS	ng/L	ng/L	ng/L	ng/L	ng/L	ng/L	% Recovery	ng/L	ng/L	% Recovery
Coprostanol	1.31	K 1.37	1.37	24.9	10.8	K 1.92	96.9	259000	< 5.93	92.7
Epicoprostanol	1.05	K 0.959	K 0.794	5.4	8.86	K 1.29	97.6	7020	< 6.77	89.7
Cholesterol	132	375	213	342	1840	692	141	292000	142	180
Cholestanol	3.47	10.1	5.43	61.6	52.2	12.8	108	11400	K 2.64	92.2
Desmosterol	< 1.44	K 2.11	K 2.20	K 10.8	8.59	< 2.96	81.3	K 1730	< 12.9	72
Ergosterol	< 1.67	< 1.37	< 1.56	24.7	K 2.00	< 2.86	3.4	6780	< 32.9	5.7
Campesterol	2.46	3.52	3.99	29.3	12.2	5.49	97.3			
Stigmasterol	6.14	6.99	7.76	76.9	12.6	5.6	64.4			
beta-Sitosterol	17.8	13.4	22.3	102	29.7	20.4	67.2			
beta Stigmastanol	K 1.90	2.5	K 2.11	41.2	8.47	K 3.95	95.4			

Table G8. AXYS Analytical Services Sterol summary data

CLIENT ID	GLWQD 102	Lab Blank	Spiked Matrix	GLWQD 104*	GLWQD 105*	GLWQD 106*	Lab Blank	Spiked Matrix
UNITS	ng/L	ng/L	% Recovery	ng/L	ng/L	ng/L	ng/L	% Recovery
Coprostanol	2070000	< 28.7	146	K 21100	K 17900	K 17500	K 0.459	74.6
Epicoprostanol	< 58.6	< 34.0	142	672	432	416	0.318	72.5
Cholesterol	2620000	533	70.9	K 40800	K 36000	K 34200	36.4	91.8
Cholestanol	59900	< 20.2	151	K 3320	K 2880	K 2810	K 1.27	76.9
Desmosterol	K 11100	< 81.2	144	K 768	K 654	K 666	< 4.39	64.8
Ergosterol	21500	< 107	44	2740	2600	2150	< 1.57	4
Campesterol	141000	93.1	135	K 2280	K 1920	K 2000	K 2.42	86
Stigmasterol	74100	690	145	K 3760	K 3290	K 3350	K 12.4	76.3
beta-Sitosterol	336000	2020	39.7	K 5170	K 4960	K 4380	57.2	72.4
beta Stigmastanol	38300	72.3	141	782	636	681	K 1.36	74.9

*K = estimated value

< = less than detection limit. Number following this symbol is the detection limit.

NQ = Not qualified

Table G9. AXYS Analytical Services PPCP triplicate data

SAMPLE ID	GLWQD 98	GLWQD 99	GLWQD 100	Average	%RSD	GLWQD 104	GLWQD 105	GLWQD 106	Average	%RSD
UNITS	ng/L	ng/L	ng/L	ng/L		ng/L	ng/L	ng/L	ng/L	
Acetaminophen	< 61.4	< 62.6	< 61.7			< 182	< 183	< 181		
Azithromycin	< 2.15	< 2.19	< 2.16			2290	3000	3440	2910	19.9
Caffeine	< 18.6	< 15.6	< 46.3			535	639	776	650	18.6
Carbadox	< 1.53	< 2.48	< 2.66			< 28.9	< 24.3	7.23	7.23	
Carbamazepine	277	264	277	273	2.75	609	876	1040	842	25.8
Cefotaxime	< 19.3	< 17.6	< 20.7			< 35.5	< 81.3	< 67.1		
Ciprofloxacin	< 5.37	< 5.48	< 5.40			280	301	303	295	4.3
Clarithromycin	< 1.53	< 1.56	< 1.54			1090	1050	1090	1077	2.1
Clinafloxacin	< 8.65	< 7.14	< 6.21			< 30.0	< 18.3	< 55.4		
Cloxacillin	< 3.07	< 3.13	< 3.08			< 10.5	< 17.1	< 12.5		
Codeine	< 3.07	< 3.13	< 3.08			159	226	254	213	22.9
Cotinine	< 18.6	< 22.9	< 17.5			2280	2300	2210	2260	2.1
Dehydronifedipine	< 0.614	< 0.626	< 0.617			9.13	13.8	13.4	12.1	21.4
Diphenhydramine	< 0.614	< 0.626	< 0.617			1060	1470	1680	1400	22.5
Diltiazem	< 0.307	< 0.313	< 0.308			199	288	329	272	24.4
Digoxin	< 15.3	< 15.6	< 15.4			< 45.6	< 45.8	< 45.1		
Digoxigenin	< 9.93	< 6.26	< 6.32			< 18.2	< 27.1	< 42.6		
Enrofloxacin	< 3.18	< 3.59	< 3.71			< 9.11	< 9.15	< 9.03		
Erythromycin-H2O	< 1.13	< 1.15	< 1.13			37.2	35	37.8	36.7	4.0
Flumequine	< 1.53	< 1.56	< 1.54			< 4.56	< 4.58	< 4.51		
Fluoxetine	< 1.53	< 1.56	< 1.54			71.4	44.1	30.8	48.8	42.4
Lincomycin	< 3.07	< 3.13	< 3.08			< 9.11	< 9.15	< 9.03		
Lomefloxacin	< 3.07	< 3.13	< 3.08			< 9.11	< 9.15	< 9.03		
Miconazole	< 1.53	< 1.56	< 1.54			7.49	7.6	9.67	8.25	14.9
Norfloxacin	< 15.3	< 15.6	< 15.4			< 45.6	< 45.8	< 45.1		
Norgestimate	< 3.07	< 3.13	< 3.08			< 9.11	< 9.52	< 9.42		
Ofloxacin	< 15.3	< 15.6	< 15.4			986	1040	1050	1030	3.4
Ormetoprim	< 0.614	< 0.626	< 0.617			< 1.82	< 1.83	< 1.81		
Oxacillin	< 3.07	< 3.13	< 3.08			< 9.11	< 9.15	< 9.03		
Oxolinic Acid	< 0.614	< 0.626	< 0.617			< 1.82	< 1.83	< 2.63		
Penicillin G	< 3.07	< 3.13	< 3.08			< 9.11	< 9.15	< 9.03		
Penicillin V	< 3.07	< 3.13	< 3.08			29.7	42.9	37.7	36.8	18.1
Roxithromycin	< 0.307	< 0.313	< 0.308			< 0.911	< 0.915	< 0.903		
Sarafloxacin	< 31.6	< 38.4	< 41.8			< 45.6	< 67.8	< 115		
Sulfachloropyridazine	< 1.53	< 1.56	< 1.54			< 4.56	< 4.58	< 4.51		
Sulfadiazine	5.52	4.61	4.67	4.93	10.3	< 4.56	< 4.58	< 4.51		
Sulfadimethoxine	1.16	< 0.585	0.872	1.02		< 39.0	< 35.0	< 34.1		
Sulfamerazine	< 0.614	< 0.626	< 0.617			< 1.82	< 1.83	< 1.81		
Sulfamethazine	1.67	< 0.821	< 0.617	1.67		< 1.82	< 1.83	< 1.81		
Sulfamethizole	< 0.614	< 0.626	< 0.617			< 1.82	< 1.83	< 1.81		
Sulfamethoxazole	556	525	544	542	2.89	13.8	10.4	17.3	13.8	24.9
Sulfanilamide	< 15.3	< 15.6	< 16.0			< 45.6	< 45.8	< 45.1		
Sulfathiazole	< 1.53	< 1.56	< 1.54			< 4.56	< 4.58	< 4.51		
Thiabendazole	< 1.53	< 1.56	< 1.54			28.3	26	27.8	27.4	4.4
Trimethoprim	< 1.53	< 1.56	< 1.54			53.5	36.9	58.6	49. 7	22.8
Tylosin	< 6.14	< 6.26	< 6.17			< 18.2	< 18.3	< 18.1		
Virginiamycin	< 4.88	< 4.78	< 5.32			< 10.7	< 17.2	< 23.0		
1,7-Dimethylxanthine	< 153	< 156	< 463			888	922	678	829	15.9

Table G10. AXYS Analytical Services hormone triplicate data

CLIENT ID	GLWQD-98	GLWQD- 99	GLWQD-100	Average	%RSD	GLWQD-104	GLWQD-105	GLWQD- 106	Average	%RSD
UNITS	ng/L	ng/L	ng/L	ng/L		ng/L	ng/L	ng/L	ng/L	
Androsterone	< 0.751	< 1.15	< 1.59			< 0.147	K 0.804	< 0.123	0.804	
Desogestrel	< 1.30	< 0.733	< 1.48			< 4.38	5.83	< 4.03	5.83	
17 alpha-estradiol	< 0.267	< 0.281	< 0.434			NQ	59.9	NQ	59.9	
Estrone	< 0.584	< 0.509	< 0.565			NQ	517	NQ	517	
Equilin	< 0.618	< 0.553	< 0.799			NQ	< 62.7	NQ		
Androstenedione	< 5.38	< 6.36	< 7.66			< 17.2	< 21.0	< 20.4		
17 alpha-dihydroequilin	< 0.734	< 0.553	< 0.497			NQ	< 20.6	NQ		
17 beta-estradiol	K 0.707	K 0.537	K 0.653	0.632	14	NQ	12.6	NQ	12.6	
Testosterone	< 3.86	< 3.23	< 3.98			< 13.0	< 13.2	< 13.4		
Equilenin	K 0.417	< 0.416	< 0.470	0.417		NQ	< 13.8	NQ		
Mestranol	K 0.658	K 0.516	< 0.693	0.587	17	K 3.00	< 2.67	< 3.54	3	
Norethindrone	K 75.8	K 6.40	K 1.91	28.0	150	< 7.32	< 3.24	< 4.82		
17 alpha-ethinylestradiol	K 1.69	K 0.951	K 1.02	1.22	33	< 2.33	K 2.67	< 2.51	2.67	
Progesterone	K 130	K 27.4	< 9.49	78.7	92	< 7.58	< 6.98	< 6.40		
Norgestrel	K 192	K 11.9	K 3.76	69.2	150	< 21.3	< 12.4	< 21.0		
Estriol	< 2.87	< 0.677	< 0.646			30.5	15.1	21.3	22.3	35
beta-estradiol 3-benzoate	< 6.27	< 0.777	< 0.837			< 6.03	< 2.67	< 4.96		

K = estimated value.

< = less than detection limit. Number following this symbol is the detection limit.

NQ = Not qualified

Table G11. AXYS Analytical Services Sterol triplicate data

CLIENT ID	GLWQD 98	GLWQD 99	GLWQD 100	Average	%RSD	GLWQD 104	GLWQD 105	GLWQD 106	Average	%RSD
UNITS	ng/L	ng/L	ng/L	ng/L		ng/L	ng/L	ng/L	ng/L	
Coprostanol	1.31	K 1.37	1.37	1.35	2.6	K 21100	K 17900	K 17500	18800	10
Epicoprostanol	1.05	K 0.959	K 0.794	0.934	14	672	432	416	507	28
Cholesterol	132	375	213	240	52	K 40800	K 36000	K 34200	37000	9.2
Cholestanol	3.47	10.1	5.43	6.33	54	K 3320	K 2880	K 2810	3000	9.2
Desmosterol	< 1.44	K 2.11	K 2.20	2.155	3.0	K 768	K 654	K 666	696	9.0
Ergosterol	< 1.67	< 1.37	< 1.56			2740	2600	2150	2500	12
Campesterol	2.46	3.52	3.99	3.32	24	K 2280	K 1920	K 2000	2070	9.1
Stigmasterol	6.14	6.99	7.76	6.96	12	K 3760	K 3290	K 3350	3470	7.4
beta-Sitosterol	17.8	13.4	22.3	17.8	25	K 5170	K 4960	K 4380	4840	8.5
beta Stigmastanol	K 1.90	2.5	K 2.11	2.17	14	782	636	681	700	11

*K = estimated value

< = less than detection limit. Number following this symbol is the detection limit.

Appendix H: Columbia Analytical Services Groundwater Data

Table 1H. CAS groundwater data summary

SAMPLE ID:			GLWQD-A	GLWQD-C	GLWQD-D	GLWQD-17	GLWQD-18	GLWQD-19	GLWQD-28	GLWQD-29	GLWQD-30	GLWQD-31
DATE & TIME:			7/31/08 1:44 PM	7/31/08 10:10 AM	7/31/08 12:40 PM	8/20/08 2:00 PM	8/20/08 2:05 PM	8/20/08 2:10 PM	8/22/08 3:20 PM	8/22/08 3:25 PM	8/22/08 3:30 PM	9/8/08 1:45 PM
GWIC ID #:			159556	244600	206589	235475	235475	235475	226774	226774	226774	214912
WELL TYPE:			Domestic	Domestic	Domestic	Monitoring◊	Monitoring◊	Monitoring◊	Monitoring◊	Monitoring◊	Monitoring◊	Monitoring
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit										
17-α-Estradiol	1	10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
17-β-Estradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
17 α-Ethinylestradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Acetaminophen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	**200**
Androstenedione	1	1.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Atrazine	1	10	< 1.0	< 1.0	**13**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bisphenol A	1	5.0	< 10	< 10	10	**13**	**17**	**18**	< 10	< 10	< 10	< 10
Caffeine	1	1.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	**8.3**	< 5.0	< 5.0
Carbamazepine	1	5.0	< 1.0	**170**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
DEET	1	5.0	< 5.0	**120**	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Diazepam	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Diclofenac	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Diethylstilbestrol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Estriol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Estrone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Fluoxetine	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Gemfibrozil	1	1.0	< 1.0	**310**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hydrocodone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ibuprofen	1	5.0	< 5.0	**76**	< 5.0	< 10	< 10	< 10	< 5.0	< 5.0	< 5.0	< 5.0
Iopromide	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Meprobamate	1	5.0	< 5.0	81	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Methadone	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Naproxen	1	1.0	< 1.0	**91**	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Oxybenzone	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Pentoxifylline	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Phenytoin	1	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Progesterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Salicylic acid	1	1.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	**42**
Sulfamethoxazole	1	10	< 1.0	630	< 1.0	< 1.0	< 1.0	< 1.0	**0.23***	**1.1**	**0.29***	**5**
Testosterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Triclosan	1	5.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Trimethoprim	1	1.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

◊Triplicate sample.

*Estimated value.

Table 2H. CAS groundwater data summary

SAMPLE ID:			GLWQD-32	GLWQD-36	GLWQD-37	GLWQD-38	GLWQD-39	GLWQD-40	GLWQD-41	GLWQD-42	GLWQD-43	GLWQD-45
DATE & TIME:			9/8/08 4:45 PM	9/10/08 11:45 AM	9/10/08 11:50 AM	9/10/08 11:55 AM	9/10/08 1:00 PM	9/10/08 2:40 PM	9/11/08 10:15 AM	9/11/08 12:00 PM	9/11/08 2:05 PM	9/12/08 10:45 AM
GWIC ID #:			235511	91039	91039	91039	91040	246752	91799	200374	241692	235512
WELL TYPE:			Monitoring	Public Water Supply[◊]	Public Water Supply[◊]	Public Water Supply[◊]	Public Water Supply	Domestic	Public Water Supply	Domestic	Monitoring	Monitoring
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit										
17-α-Estradiol	1	10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
17-β-Estradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 20	< 2.0
17 α-Ethinylestradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 20	< 2.0
Acetaminophen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
Androstenedione	1	1.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 100	< 10
Atrazine	1	10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
Bisphenol A	1	5.0	< 10	18	9.2*	6.4	< 10	< 10	< 10	< 10	< 100	< 10
Caffeine	1	1.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 50	6.8
Carbamazepine	1	5.0	< 1.0	2.3	2.2	2.4	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
DEET	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 50	< 5.0
Diazepam	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
Diclofenac	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 20	< 2.0
Diethylstilbestrol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 20	< 2.0
Estriol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
Estrone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
Fluoxetine	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
Gemfibrozil	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
Hydrocodone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
Ibuprofen	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 10	< 10	< 100	< 10
Iopromide	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Meprobamate	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 50	< 5.0
Methadone	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 50	< 5.0
Naproxen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
Oxybenzone	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 20	4.4
Pentoxifylline	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
Phenytoin	1	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 50	< 5.0
Progesterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 100	< 10
Salicylic acid	1	1.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 100	< 10
Sulfamethoxazole	1	10	2	9.8	7.1	11	1.3	< 1.0	< 1.0	3.3	15	< 1.0
Testosterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 100	< 10
Triclosan	1	5.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 100	< 10
Trimethoprim	1	1.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 50	< 5.0

[◊]Triplicate sample.

*Estimated value.

Table 3H. CAS groundwater data summary

SAMPLE ID:			GLWQD-46	GLWQD-47	GLWQD-48	GLWQD-49	GLWQD-50	GLWQD-52	GLWQD-53	GLWQD-54	GLWQD-55	GLWQD-56
DATE & TIME:			9/12/08 12:45 PM	9/12/08 12:45 PM	9/12/08 12:45 PM	9/12/08 2:30 PM	10/20/08 1:10 PM	10/21/08 10:00 AM	10/21/08 11:50 AM	10/21/08 2:00 PM	10/21/08 3:40 PM	10/23/08 11:25 AM
GWIC ID #:			203716	203716	203716	234930	9858	187057	153163	234907	210710	195430
WELL TYPE:			Domestic[◊]	Domestic[◊]	Domestic[◊]	Domestic	Domestic	Public Water Supply	Public Water Supply	Monitoring	Public Water Supply	Domestic
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit										
17-α-Estradiol	1	10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
17-β-Estradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
17 α-Ethinylestradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Acetaminophen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Androstenedione	1	1.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Atrazine	1	10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bisphenol A	1	5.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Caffeine	1	1.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Carbamazepine	1	5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
DEET	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Diazepam	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Diclofenac	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Diethylstilbestrol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Estriol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Estrone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Fluoxetine	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Gemfibrozil	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hydrocodone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ibuprofen	1	5.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Iopromide	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Meprobamate	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Methadone	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Naproxen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Oxybenzone	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Pentoxifylline	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Phenytoin	1	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Progesterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Salicylic acid	1	1.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Sulfamethoxazole	1	10	< 1.0	< 1.0	< 1.0	1.6	< 1.0	< 1.0	< 1.0	3.1	27	< 1.0
Testosterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Triclosan	1	5.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Trimethoprim	1	1.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

[◊] Triplicate sample.

*Estimated value.

Table 4H. CAS groundwater data summary

SAMPLE ID:			GLWQD-57	GLWQD-58	GLWQD-59	GLWQD-60	GLWQD-61	GLWQD-62	GLWQD-63	GLWQD-98	GLWQD-99	GLWQD-100
DATE & TIME:			10/24/08 11:30 AM	10/24/08 11:30 AM	10/24/08 11:30 AM	10/24/08 1:30 PM	11/3/08 9:00 AM	11/3/08 11:15 AM	11/3/08 2:30 PM	3/17/09 1:30 PM	3/17/09 1:30 PM	3/17/09 1:30 PM
GWIC ID #:			235473	235473	235473	216675	90795	223271	247942	244600	244600	244600
WELL TYPE:			Monitoring[◊]	Monitoring[◊]	Monitoring[◊]	Monitoring	Public Water Supply	Domestic	Domestic	Domestic[◊]	Domestic[◊]	Domestic[◊]
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit										
17-α-Estradiol	1	10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
17-β-Estradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
17 α-Ethinylestradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Acetaminophen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Androstenedione	1	1.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Atrazine	1	10	1.9	1.9	2.1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bisphenol A	1	5.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Caffeine	1	1.0	< 5.0	< 5.0	< 5.0	5.2	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Carbamazepine	1	5.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	190	140	140
DEET	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	60	44	45
Diazepam	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Diclofenac	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Diethylstilbestrol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Estriol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Estrone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Fluoxetine	1	1.0	< 1.0	< 1.0	< 1.0	1.7	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Gemfibrozil	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	53	69	59
Hydrocodone	1	1.0	< 1.0	< 1.0	< 1.0	3.9	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ibuprofen	1	5.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Iopromide	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Meprobamate	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	29	29	27
Methadone	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Naproxen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	22	13	13
Oxybenzone	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Pentoxifylline	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Phenytoin	1	10	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Progesterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Salicylic acid	1	1.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Sulfamethoxazole	1	10	18	21	17	< 1.0	< 1.0	< 1.0	90	550	390	370
Testosterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Triclosan	1	5.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Trimethoprim	1	1.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

[◊] Triplicate sample.
*Estimated value.

Table 5H. CAS groundwater data summary

SAMPLE ID:			GLWQD-103	GLWQD-107	GLWQD-117	GLWQD-118	GLWQD-123	GLWQD-124	GLWQD-125	GLWQD-130	GLWQD-131	GLWQD-132
DATE & TIME:			3/18/09 12:20 PM	3/18/09 2:50 PM	4/21/09 12:30 PM	4/21/09 1:50 PM	4/23/09 2:35 PM	4/23/09 3:45 PM	5/5/09 12:40 PM	5/6/09 11:20 AM	5/6/09 2:30 PM	5/7/09 12:10 PM
GWIC ID #:			250018	250010	251503	215965	9366	251512	251531	99537	90850	202221
WELL TYPE:			Monitoring	Monitoring	Public Water Supply	Domestic	Public Water Supply	Public Water Supply	Domestic	Public Water Supply	Public Water Supply	Public Water Supply
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit										
17-α-Estradiol	1	10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
17-β-Estradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
17 α-Ethinyl Estradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Acetaminophen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Androstenedione	1	1.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Atrazine	1	10	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bisphenol A	1	5.0	59	< 1.0	< 10	< 10	< 10	15	< 10	< 10	< 10	< 10
Caffeine	1	1.0	12	< 5	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Carbamazepine	1	5.0	390	270	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
DEET	1	5.0	590	110	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Diazepam	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Diclofenac	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Diethylstilbestrol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Estriol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Estrone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Fluoxetine	1	1.0	< 1.0	< 1.0	1.2	< 1.0	< 1.0	< 1.0	1.8	2.2	1.2	< 1.0
Gemfibrozil	1	1.0	630	63	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hydrocodone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ibuprofen	1	5.0	2600	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Iopromide	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Meprobamate	1	5.0	58	34	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Methadone	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Naproxen	1	1.0	1500	38	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Oxybenzone	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Pentoxifylline	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Phenytoin	1	10	< 5.0	< 5.0	< 5.0	5.3	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Progesterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Salicylic acid	1	1.0	26	11	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Sulfamethoxazole	1	10	1100	700	< 1.0	220	< 1.0	< 1.0	51	< 1.0	< 1.0	< 1.0
Testosterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Triclosan	1	5.0	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Trimethoprim	1	1.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	5.7	< 5.0	< 5.0	< 5.0	< 5.0

◊Triplicate sample.

*Estimated value.

Table 6H. CAS groundwater data summary

SAMPLE ID:			GLWQD-134	GLWQD-136	GLWQD-137	GLWQD-138	GLWQD-139	GLWQD-140	GLWQD-141	GLWQD-142
DATE & TIME:			5/13/09 2:20 PM	5/14/09 1:15 PM	5/14/09 1:15 PM	5/14/09 1:15 PM	5/14/09 3:25 PM	5/15/09 11:54 PM	4/21/09 1:50 PM	4/21/09 1:50 PM
GWIC ID #:			193069	190102	190102	190102	190101	130054	130054	130054
WELL TYPE:			Monitoring	Monitoring◊	Monitoring◊	Monitoring◊	Monitoring	Domestic	Domestic	Domestic
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit								
17-α-Estradiol	1	10	< 1.0	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	< 1.0
17-β-Estradiol	1	2.0	< 2.0	< 20	< 20	< 20	< 2.0	< 2.0	< 2.0	< 2.0
17 α-Ethinyl Estradiol	1	2.0	< 2.0	< 20	< 20	< 20	< 2.0	< 2.0	< 2.0	< 2.0
Acetaminophen	1	1.0	< 1.0	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	< 1.0
Androstenedione	1	1.0	< 10	< 100	< 100	< 100	< 10	< 10	< 10	< 10
Atrazine	1	10	< 1.0	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	< 1.0
Bisphenol A	1	5.0	< 10	< 100	< 100	< 100	< 10	< 10	< 10	< 10
Caffeine	1	1.0	5.4	< 50	< 50	< 50	7.6	< 5.0	< 5.0	< 5.0
Carbamazepine	1	5.0	< 1.0	< 10	< 10	< 10	32	4.9	5.1	4.6
DEET	1	5.0	< 5.0	< 50	< 50	< 50	15	< 5.0	< 5.0	< 5.0
Diazepam	1	1.0	< 1.0	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	< 1.0
Diclofenac	1	2.0	< 2.0	< 20	< 20	< 20	< 2.0	< 2.0	< 2.0	< 2.0
Diethylstilbestrol	1	2.0	< 2.0	< 20	< 20	< 20	< 2.0	< 2.0	< 2.0	< 2.0
Estriol	1	1.0	< 1.0	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	< 1.0
Estrone	1	1.0	< 1.0	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	< 1.0
Fluoxetine	1	1.0	< 1.0	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	1.3
Gemfibrozil	1	1.0	< 1.0	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	< 1.0
Hydrocodone	1	1.0	< 1.0	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	< 1.0
Ibuprofen	1	5.0	< 10	< 100	< 100	< 100	< 10	< 10	< 10	< 10
Iopromide	1	10	< 10	< 100	< 100	< 100	< 10	< 10	< 10	< 10
Meprobamate	1	5.0	< 5.0	< 50	< 50	< 50	19	< 5.0	< 5.0	< 5.0
Methadone	1	5.0	< 5.0	< 50	< 50	< 50	< 5.0	< 5.0	< 5.0	< 5.0
Naproxen	1	1.0	< 1.0	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	< 1.0
Oxybenzone	1	2.0	< 2.0	< 20	< 20	< 20	< 2.0	< 2.0	< 2.0	< 2.0
Pentoxifylline	1	1.0	< 1.0	< 10	< 10	< 10	< 1.0	< 1.0	< 1.0	< 1.0
Phenytoin	1	10	< 5.0	< 50	< 50	< 50	< 5.0	< 5.0	< 5.0	< 5.0
Progesterone	1	10	< 10	< 100	< 100	< 100	< 10	< 10	< 10	< 10
Salicylic acid	1	1.0	< 10	< 100	< 100	< 100	12	< 10	< 10	< 10
Sulfamethoxazole	1	10	< 1.0	110	130	130	260	99	100	99
Testosterone	1	10	< 10	< 100	< 100	< 100	< 10	< 10	< 10	< 10
Triclosan	1	5.0	< 10	< 100	< 100	< 100	< 10	< 10	< 10	< 10
Trimethoprim	1	1.0	< 5.0	< 50	< 50	< 50	< 5.0	< 5.0	< 5.0	< 5.0

◊Triplicate sample.

*Estimated value.

Appendix I: Montana Bureau of Mines and Geology Laboratory Groundwater Chemistry Data

Table 1I. MBMG groundwater well and chemistry data summary (concentrations in µg/L, unless otherwise noted; TD = total tepth; DWE = depth water enters well; SWL = static water level).

Sample ID	GWIC ID	TD (ft)	DWE (ft)	SWL (ft)	Water Temp (°C)	Field SC (µS)	Field pH	Alkalinity (mg/l)	Redox	DO (mg/l)	DOC (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Fe (mg/l)	Mn (mg/l)	SiO_2 (mg/l)	HCO_3 (mg/l)
GLWQD-B	206589	80	80	45	11.7	329	7.23		157.5	6.82	0.66	78	18.1	5.71	2.08	0.196	0.019	16.4	268.6
GLWQD-C	244600	100	98.5	37	11.2	402	6.75		60	0.60	2.33	94.8	21.1	16.5	2.33	0.202	0.019	15.6	308.4
GLWQD-D	159556	80	80	36	11.4	464	7.00		132.2	5.82	1.8	83.3	18.6	9.8	2.14	0.207	0.019	15.5	259.9
GLWQD-17	235475	73	58	42	12.16	464	7.32		121.1	6.76	0.35	73.6	15.7	7.74	3.19	<0.001	<0.003	21.9	282.8
GLWQD-28	226774	23	12	6	11.63	742	7.42		37.9	3.78	3.51	79.7	28.9	10.2	6.6	0.046	0.018	30.5	408.4
GLWQD-31	214912	48	48	27	11.84	388	6.55		54.2	7.45	0.46	46.6	15.3	5.64	2.41	0.115	0.013	17.8	159.8
GLWQD-32	235511	36	26	2.5	11.34	451	6.85		28.8	1.54	0.28	62.9	15.4	6.55	3.66	0.033	0.004	32	267.7
GLWQD-36	91039	79.5	79.5	56.5	10.93	441	7.68		142.9	9.58	0.39	60.5	16.7	5.78	2.84	0.016	0.005	12.8	245
GLWQD-39	91040	64.5	63.5	14	10.97	434	7.78		54.5	7.74	0.30	60.5	16.7	5.78	2.84	0.016	0.005	27.5	250.6
GLWQD-40	246752	37	37	6	10.1	300	7.82		50.6	6.07	<0.25	60	9.48	5	2.57	0.013	0.005	14.7	195.4
GLWQD-41	91799	210	195	5	10.21	367	7.61		-3.5	4.06	<0.25	57.4	15.8	9.39	1.04	<0.003	<0.001	24.8	242.3
GLWQD-42	200374	117	117	40	10.07	498	7.28	249	20.6	6.11	0.41	61.1	16.5	22	3.18	0.017	0.005	12.4	302.8
GLWQD-43	241692	8.9	8.9	4.33	14.91	644	7.03	356	7.2	4.50	1.47	88.2	27.3	31.7	6.76	0.012	0.009	23.6	424
GLWQD-45	235512	57	47	40	11.01	240	7.20	123	-5	5.89	3.63	39.2	11	5.4	1.39	<0.003	<0.001	15.7	140.3
GLWQD-46	203716	180	100	95	9.57	289	7.39	195	-13.2	8.67	0.74	40.2	6.75	30.3	5.73	<0.003	<0.001	46.2	175.9
GLWQD-49	234930	158	138	53	12.61	495	6.67	189	15.6	5.98	1.63	70.2	15	23.5	4.7	<0.003	<0.001	36.9	207.2
GLWQD-50	9858	60	60	11	9.38	281	7.79	151	-4.1	5.55	<0.25	44	11.1	4.26	1.03	0.004	<0.001	13.9	189.3
GLWQD-53	153163	65	51	5.5	11.23	375	7.08	188	23.6	7.19	0.71	56.1	11.8	8.66	4.43	0.01	<0.001	36.1	232.8
GLWQD-54	234907	80	70	8.58	13.03	353	6.99	210	-18.5	5.58	0.65	61	14.8	5.11	3	0.008	<0.001	21.9	247.7
GLWQD-55	210710	28	16	12	10.77	497	7.31	239	-31.2	5.41	0.48	75.2	18.5	7.73	4.43	0.01	<0.001	34.5	298.9
GLWQD-56	195430	177	129	45.6	11	445	7.68	178	226	4.75	0.91	57.9	16.2	9.1	7.65	<0.004	<0.001	31.5	193.5
GLWQD-57	235473	100	80	31	11.39	294	7.42	148	23.7	5.31	0.83	45.4	9.64	4.03	2.12	<0.003	<0.001	29.3	180.8
GLWQD-60	216675	36	26	12	13.94	453	7.31	185	10.4	5.45	0.66	60.2	13.5	11.4	2.07	0.006	<0.001	24.1	255.5
GLWQD-61	90795	40	8	17	11.26	572	7.51	209	-15.9	6.64	1.09	53.5	12.9	45.8	9.91	<0.004	<0.001	48.1	258.3
GLWQD-62	223271	101	101	38	10.82	345	7.60	148	-0.4	3.30	<0.25	43	12.2	6.06	3.18	<0.004	<0.001	42.7	174.7
GLWQD-63	247942	60	40	10	8.59	488	7.34	240	-6.8	8.46	0.80	71.2	20	13.7	3.52	<0.004	<0.001	38.8	312.1
GLWQD-98	244600	100	100	55	9.68	417	6.63	233	37.2	1.38	1.52	77.6	22.8	22.3	1.44	<0.004	<0.001	21.4	256.8
GLWQD-103	250018	100	98.5	37	10.53	823	6.67	339	3	3.95	4.96	100	31.5	72.7	4.47	<0.004	0.358	28.7	396.5
GLWQD-107	250010	60	50	50	10.56	603	6.68	261	13	4.86	2.89	84.9	26.6	32.7	4.03	<0.215	<0.156	23.9	272.7
GLWQD-117	251503	60	50	50	12.81	290	7.63	155	81.6	9.49	<0.25	37.4	11	6.27	1.34	<0.043	<0.031	20.2	203.3
GLWQD-118	215965	198	198		10.07	458	7.13	178	80.8	10.91	0.82	57.5	21.1	7.28	2.33	<0.043	<0.031	13.1	201.3
GLWQD-123	9366	140	138	102	9.29	634	7.76	228	18.7	2.35	0.94	69.8	20.3	33.1	6.26	<0.043	<0.031	32.8	275.7
GLWQD-124	251512	335	98.5	11	8.11	297	7.58	183	19.7	3.85	0.73	55.1	17.6	9.3	3.49	<0.043	<0.031	18.9	225.9
GLWQD-125	251531	10	10	10	8.17	385	7.05	146	47.7	6.16	0.32	43	14.2	5.45	2.23	<0.043	<0.031	19.2	163.7
GLWQD-130	99536	80	78	5	9.04	234	7.11	124	24.3	7.82		38.7	9.28	4.43	3.52	<0.043	<0.031	29.1	169.1
GLWQD-131	90850	172	172	113	10.7	388	7.42	214	-2.7	6.91	0.30	71.7	17.1	5.37	3.41	<0.043	<0.031	25.4	260.8
GLWQD-132	202221	185	160	42	10.6	418	7.22	204	-3.2	6.38	0.57	72.2	18.5	6.88	3.85	<0.043	<0.031	26.3	258.2
GLWQD-134	193069	217	155	64.7	13.4	305	7.25			6.00		57.7	14.7	6.87	3.65	<0.043	<0.031	25.9	238.1
GLWQD-136	190102	48	21	23.65	9.58	572	7.50	244	185.1	3.55	0.95	64.6	18.7	24.4	4.37	<0.043	<0.031	28.1	321.5
GLWQD-139	190101	50	25	33.1	9.78	608	7.62	260	173.2	3.38	0.92	74.5	20.3	20.4	4.27	<0.043	<0.031	27.1	317
GLWQD-140	130054	45	21	30.9	10.29	599	7.41	223	122.4	5.20	0.50	78.8	21.4	12.1	4.29	<0.043	<0.031	24.7	294.3

Table 2I. MBMG groundwater chemistry data summary (concentrations in g/L, unless otherwise noted).

Sample ID	GWIC ID	SO_4 (mg/l)	Cl (mg/l)	NO_3 (mg/l)	F (mg/l)	oPO_4 (mg/l)	Ag	Al	As	B	Ba	Be	Br	Cd	Co	Cr	Cu	Hg	Li	Mo	Ni	Pb
GLWQD-B	206589	30	4.2	2.691P	0.112	0.088	<0.1	0.336	0.77	13.5	73.2	<0.1	<50	<0.1	<0.1	0.129	4.7		4.74	0.563	0.186	0.126
GLWQD-C	244600	41.2	28.9	4.354P	0.1	<0.5	<0.1	0.415	0.693	116	107	<0.1	<50	<0.1	0.421	<0.1	4.54	<0.1	5.62	0.537	2./02	<0.1
GLWQD-D	159556	41.2	15	5.705P	0.145	0.061	<0.1	0.159	0.645	64	81.3	<0.1	<50	<0.1	0.239	<0.1	6.37		5.09	0.472	1.02	<0.1
GLWQD-17	235475	26.4	4.41	1.70P	0.091	<0.05	<0.07	<0.95	0.534	9.74	194	<0.16	<50	<0.13	0.468	0.104	1.11		3.06	0.273	0.24	<0.56
GLWQD-28	226774	<25.0	18.1	5.84P	<0.5	<0.5	<0.07	<0.95	2.07	26.5	522	<0.16	<500	<0.13	0.21	<0.07	1.16		4.73	1.9	0.263	<0.56
GLWQD-31	214912	36.8	10.5	3.14P	0.16	0.068	<0.07	<0.95	0.484	11.1	71.5	<0.16	56	<0.13	0.153	0.258	0.693		3.26	0.157	0.496	<0.56
GLWQD-32	235511	12.3	5.62	0.675P	0.109	0.064	<0.07	<0.95	0.734	5.9	55.1	<0.16	<50	<0.13	0.098	0.161	0.383		<0.36	0.117	0.299	<0.56
GLWQD-36	91039	26	9.31	2.01P	0.14	0.07	<0.36	<0.95	1.02	10.3	133	<0.16	<50	<0.13	0.084	0.086	0.856		2.74	0.271	<0.17	<0.56
GLWQD-39	91040	26.2	5.94	2.58P	0.135	0.098	<0.36	<0.95	1.02	10.3	133	<0.16	<50	<0.13	0.084	0.086	0.856		2.74	0.271	<0.17	<0.56
GLWQD-40	246752	15.7	2.71	0.907P	0.126	<0.05	<0.07	<0.95	1.12	6.2	63.8	<0.16		<0.13	<0.07	1.22	<0.20		1.71	0.32	<0.17	<0.56
GLWQD-41	91799	10.4	3.22	0.514P	0.132	<0.05	<0.07	<0.94	0.805	19	22.2	<0.15	<50	<0.13	0.073	0.819	0.519		<0.35	0.498	<0.17	<0.56
GLWQD-42	200374	16.3	13	1.79P	0.167	<0.05	<0.07	<0.95	0.559	23.2	60.8	<0.16	<50	<0.13	0.108	0.39	1.47		3.2	0.567	0.319	<0.56
GLWQD-43	241692	<25.0	37.6	2.38P	<0.5	<0.5	<0.07	<0.95	1.52	27.5	132	<0.16	<500	<0.13	0.167	0.644	1		4.31	1.48	0.437	<0.56
GLWQD-45	235512	23.3	3.44	<0.5P	0.177	<0.05	<0.07	<0.94	0.761	9.5	48.1	<0.15	<50	<0.13	0.077	0.419	1.07		2.3	0.858	0.488	<0.56
GLWQD-46	203716	28.6	2.54	1.52P	0.743	<0.05	<0.07	<0.94	4.56	17.6	65.1	<0.15	<50	<0.13	<0.07	<0.07	0.243		0.97	1	<0.17	<0.56
GLWQD-49	234930	32.2	21.1	8.67P	0.325	0.19	<0.07	<0.94	2.12	15.2	85.7	<0.15	<50	<0.13	0.206	0.295	4.79		2.63	1.27	0.303	<0.56
GLWQD-50	9858	9.92	0.952	1.27P	0.089	<0.05	<0.07	<0.94	<0.18	5.34	33.6	<0.15	<50	<0.13	<0.07	1.08	1.13		0.96	1.12	0.289	<0.56
GLWQD-53	153163	14.3	3.52	1.74P	0.202	<0.05	<0.07	<0.94	1.1	7.9	159	<0.15	<50	<0.13	0.092	0.1	41.8		0.812	0.306	0.267	<0.56
GLWQD-54	234907	14.98	3.39	1.12P	0.118	<0.05	<0.07	<0.94	0.895	7.02	89.6	<0.15	<50	<0.13	0.11	0.086	1.18		1.39	0.286	0.631	<0.56
GLWQD-55	210710	<25.0	6.71	1.99P	<0.5	<0.5	<0.07	<0.94	1.18	8.17	41.4	<0.15	<500	<0.13	0.113	0.37	1.17		0.934	0.133	0.241	<0.56
GLWQD-56	195430	28.9	22.3	1.97P	0.21	<0.05	<0.11	<5.25	4.56	14	111	<0.30	63.1	<0.25	0.081	0.584	<1.98		3.4	1.1	0.226	0.1
GLWQD-57	235473	5.93	8.44	1.36P	0.168	0.049	<0.07	<0.94	0.744	4.46	32	<0.15	<50	<0.13	0.077	<0.07	1.17		<0.35	<0.10	0.329	<0.56
GLWQD-60	216675	26.6	6.44	1.72P	0.504	<0.05	<0.07	<0.94	0.7	17.4	149.9	<0.15	<50	<0.13	0.148	0.1	0.683		2.91	0.742	0.446	<0.56
GLWQD-61	90795	45.5	14.34	1.62P	0.553	<0.50	<0.11	<5.25	16.6	102	267	<0.30	<500	<0.25	0.113	<0.12	<1.98		4.5	5.1	<0.20	<0.11
GLWQD-62	223271	33.3	1.91	<0.5P	0.286	<0.05	<0.11	<5.25	1.01	8.64	56.9	<0.30	<50	<0.25	<0.08	0.765	<1.98		1.4	1	<0.20	<0.11
GLWQD-63	247942	5.88	6.38	4.92P	0.24	<0.05	<0.11	<5.25	0.762	13.1	51.8	<0.30	<50	<0.25	0.104	<0.12	<1.98		<0.61	0.2	<0.20	<0.11
GLWQD-98	244600	35.9	31.9	2.97P	<0.5	<0.5	<0.1	<6.1	0.585	102	148	<0.2	<500	<0.1	0.541	0.13	7.44		5.49	0.554	3.64	<0.2
GLWQD-103	250018	45.1	75.3	8.84P	<0.5	0.715	<0.1	<6.1	5.02	368	2.67	<0.2	<500	0.397	2.67	<0.1	13.1		8.95	1.99	18.4	<0.2
GLWQD-107	250010	37.4	45.5	6.97P	<0.5	<0.5	<0.1	<6.1	0.952	206	179	<0.2	<500	<0.1	0.818	<0.1	8.62		9.8	0.813	6.17	<0.2
GLWQD-117	251503	4.53	1.98	0.759P	0.109	<0.05	<0.04	<7.64	0.81	8.98	13.7	<0.18	<50	<0.05	<0.06	2.91	0.628		0.713	0.427	<0.11	<0.15
GLWQD-118	215965	<25.0	30.9	4.97P	<0.5	<0.5	<0.04	<7.64	0.373	10.4	8.7	<0.18	<500	<0.05	<0.06	2.78	<0.40		2.53	0.297	<0.11	<0.15
GLWQD-123	9366	86.6	12.2	1.21P	<0.5	<0.5	<0.21	<38.20	1.97	62.9	33	<0.91	<500	<0.24	<0.29	<0.20	<1.99		9.22	1.23	<0.57	<0.77
GLWQD-124	251512	28.78	5.96	2.17P	0.218	<0.05	<0.04	<7.64	1.03	24.8	141	<0.18	<50	<0.05	0.06	<0.04	59.2		7.65	1.18	<0.11	<0.15
GLWQD-125	251531	33.56	5.22	4.71P	0.17	<0.05	<0.04	<7.60	0.549	12	63.4	<0.20	<50	<0.05	<0.10	0.112	0.872		4.17	0.659	<0.10	<0.15
GLWQD-130	99536	7.41	1.49	4.34P	0.181	<0.05	<0.04	<7.60	0.554	6.33	32.6	<0.20	<50	<0.05	<0.10	<0.04	2.47		1.19	0.591	<0.10	<0.15
GLWQD-131	90850	24.89	2.62	1.08P	0.08	<0.05	<0.04	<7.60	1.36	7.45	109	<0.20	<50	<0.05	<0.10	0.048	0.602		2.95	0.285	<0.10	<0.15
GLWQD-132	202221	27.9	5.08	1.76P	0.08	<0.05	<0.04	<7.60	1.05	13.2	175	<0.20	<50	<0.05	<0.10	<0.04	0.871		5.58	0.298	<0.10	<0.15
GLWQD-134	193069	17.8	4.56	1.95P	0.102	0.072	<0.04	<7.60	0.717	11.7	111	<0.20	<50	<0.05	<0.10	0.335	1.99		2.72	0.466	0.379	0.393
GLWQD-136	190102	<25.0	13.22	<2.46P	<0.5	0.8	<0.04	<7.60	3.2	43.1	189	<0.20	<500	<0.05	0.189	<0.04	2.18		4.49	0.357	0.34	<0.15
GLWQD-139	190101	<25.0	19.5	2.44P	<0.5	<0.5	<0.04	<7.60	1.5	52.9	207	<0.20	<500	<0.05	0.177	<0.04	2.32		4.37	0.289	0.22	<0.15
GLWQD-140	130054	<25.0	25.6	3.33P	<0.5	<0.5	<0.04	<7.60	0.758	19.2	189	<0.20	<500	<0.05	0.127	0.089	1.18		3.63	0.303	0.205	<0.15

Table 3I. MBMG groundwater chemistry data summary (concentrations in g/L, unless otherwise noted).

Sample ID	GWIC ID	Sb	Se	Sn	Sr	Ti	Tl	U	V	Zn	Zr	Ce	Cs	Ga	La	Nb	Nd	Pd	Pr	Rb	Th	W
GLWQD-B	206589	<0.1	0.178	<0.1	412	0.337	<0.1	3.214	0.951	8.75	<0.1	<0.1	<0.1	<0.1	<0.1	<0.11	<0.1	1.06	<0.1	1.568	<0.1	<0.1
GLWQD-C	244600	<0.1	<0.1	<0.1	527	<0.1	<0.1	2.31	0.801	5.38	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.106	1.35	<0.1	2.09	<0.1	<0.1
GLWQD-D	159556	<0.1	0.132	<0.1	441	0.525	<0.1	2.36	0.813	0.404	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.07	<0.1	1.81	<0.1	<0.1
GLWQD-17	235475	<0.11	<0.38	<0.06	225	<0.17	<0.04	2.18	1.02	<0.27	<0.11	<0.54	<0.04	<0.07	<0.85	<0.03	<0.22	0.364	<0.16	1.73	<0.005	0.08
GLWQD-28	226774	1	1.23	0.083	1450	<0.17	<0.04	20.2	5.66	<0.27	0.422	<0.54	0.062	<0.07	<0.85	0.079	<0.22	3.02	<0.16	14.6	<0.005	0.53
GLWQD-31	214912	<0.11	0.417	<0.06	265	0.374	<0.04	0.479	0.6	0.698	<0.11	<0.54	<0.04	<0.07	<0.85	<0.03	<0.22	0.46	<0.16	1.13	<0.005	<0.05
GLWQD-32	235511	<0.11	<0.38	<0.06	199	<0.17	<0.04	3.37	3.27	<0.27	<0.11	<0.54	<0.04	<0.07	<0.85	<0.03	<0.22	0.361	<0.16	3.1	<0.005	<0.05
GLWQD-36	91039	<0.11	<1.90	<0.30	191	<0.83	<0.22	1.46	1.95	<1.36	<0.53	<0.54	<0.04	<0.07	<0.85	<0.03	<0.22	0.302	<0.82	1.14	<0.02	<0.27
GLWQD-39	91040	<0.11	<1.90	<0.30	191	<0.83	<0.22	1.46	1.95	<1.36	<0.53	<0.54	<0.04	<0.07	<0.85	<0.03	<0.22	0.302	<0.82	1.14	<0.02	<0.27
GLWQD-40	246752	<0.11	<0.38	<0.06	229	<0.17	<0.04	1.24	2.17	0.746	<0.11	<0.54	<0.04	<0.07	<0.85	<0.03	<0.22	0.358	<0.16	1.64	<0.005	<0.05
GLWQD-41	91799	<0.11	0.532	<0.06	193	<0.17	<0.04	1.08	2.64	0.357	<0.11	<0.53	<0.04	<0.07	<0.84	<0.03	<0.22	0.379	<0.16	0.26	<0.005	<0.05
GLWQD-42	200374	<0.11	0.577	<0.06	232	0.203	<0.04	2.25	1.8	<0.27	<0.11	<0.54	<0.04	<0.07	<0.85	<0.03	<0.22	0.426	<0.16	1.3	<0.005	<0.05
GLWQD-43	241692	<0.11	1.04	<0.06	299	<0.17	<0.04	9.68	5.88	21.4	0.152	<0.54	<0.04	<0.07	<0.85	<0.3	<0.22	0.586	<0.16	3.52	<0.005	<0.05
GLWQD-45	235512	<0.11	<0.38	<0.06	185	0.297	<0.04	0.846	0.921	2.61	<0.11	<0.53	<0.04	<0.07	<0.84	<0.03	<0.22	0.35	<0.16	0.556	<0.005	0.081
GLWQD-46	203716	<0.11	<0.38	<0.06	106	0.239	<0.04	2.84	5.22	<0.27	<0.11	<0.53	<0.04	<0.07	<0.84	<0.03	<0.22	0.198	<0.16	7.46	<0.005	0.256
GLWQD-49	234930	<0.11	1.07	<0.06	209	0.29	<0.04	7.12	2.65	0.411	<0.11	<0.53	<0.04	<0.07	<0.84	<0.03	<0.22	0.41	<0.16	2.72	<0.005	0.179
GLWQD-50	9858	<0.11	<0.38	<0.06	86.2	<0.17	<0.04	2.61	1.08	1.15	<0.11	<0.53	<0.04	<0.07	<0.84	<0.03	<0.22	0.16	<0.16	0.509	0	<0.05
GLWQD-53	153163	<0.11	<0.38	<0.06	150	<0.17	<0.04	1.19	1.93	0.931	<0.11	<0.53	<0.04	<0.07	<0.84	<0.03	<0.22	0.316	<0.16	5.95	<0.005	0.077
GLWQD-54	234907	<0.11	<0.38	<0.06	145	<0.17	<0.04	1.16	2.13	0.5	<0.11	<0.53	<0.04	<0.07	<0.84	<0.03	<0.22	0.296	<0.16	0.594	<0.005	0.055
GLWQD-55	210710	<0.11	0.745	<0.06	265	0.214	<0.04	5.06	3.59	2.68	<0.11	<0.53	<0.04	<0.07	<0.84	<0.03	<0.22	0.512	<0.16	2.71	<0.005	<0.05
GLWQD-56	195430	<0.10	2.21	<0.16	368	<0.40	<0.02	4.21	9.49	10.6	<0.08	0.1	<0.07	<0.12	0.2	<0.07	<0.15	0.87	0.115	2.57	<0.09	<0.11
GLWQD-57	235473	<0.11	<0.38	<0.06	116	<0.17	<0.04	0.437	2.4	<0.27	<0.11	<0.53	<0.04	<0.07	<0.84	<0.03	<0.22	0.247	<0.16	2.71	<0.005	<0.05
GLWQD-60	216675	<0.11	<0.38	<0.06	142	0.37	<0.04	1.04	1.23	<0.27	<0.11	<0.53	<0.04	<0.07	<0.84	<0.03	<0.22	0.248	<0.16	0.843	<0.005	0.305
GLWQD-61	90795	0.12	2.13	<0.16	428	0.4	<0.02	27.4	37.5	2.47	<0.08	<0.06	<0.07	<0.12	<0.05	<0.07	<0.15	0.82	<0.04	12.6	<0.09	0.448
GLWQD-62	223271	<0.10	<0.91	<0.16	264	<0.40	<0.02	1.57	1.67	6.37	<0.08	<0.06	<0.07	<0.12	<0.05	<0.07	<0.15	0.48	<0.04	4.34	<0.09	<0.11
GLWQD-63	247942	<0.10	<0.91	<0.16	203	<0.40	0.024	1.7	2.81	5.7	<0.08	<0.06	<0.07	<0.12	<0.05	<0.07	<0.15	0.37	<0.04	4.11	<0.09	<0.11
GLWQD-98	244600	<0.1	<0.2	<0.1	487	0.408	<0.1	3.05	1.17	33.6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.072	0.192	<0.1	1.98	<0.1	<0.1
GLWQD-103	250018	0.11	0.321	<0.1	675	0.637	0.068	3.79	2.51	3.7	0.072	0.091	<0.1	<0.1	<0.1	<0.1	0.197	0.301	<0.1	4.31	<0.1	0.159
GLWQD-107	250010	0.105	<0.2	<0.1	642	0.61	<0.1	6.12	1.47	4.09	<0.1	<0.1	<0.1	<0.1	<0.1	0.034	0.096	0.321	<0.1	2.77	<0.1	0.317
GLWQD-117	251503	<0.05	0.192	<0.04	151	<0.19	<0.03	0.635	3.3	2.38	<0.05	<0.02	<0.04	<0.05	<0.02	<0.04	<0.05	<0.06	<0.02	0.221	<0.02	<0.05
GLWQD-118	215965	<0.05	1.12	<0.04	144	<0.19	<0.03	1.17	1.46	7.49	<0.05	<0.02	<0.04	<0.05	<0.02	<0.04	<0.05	<0.06	<0.02	0.309	<0.02	<0.05
GLWQD-123	9366	<0.24	1.34	<0.21	350	<0.96	<0.17	6.98	3.76	<4.71	<0.24	<0.10	<0.21	<0.23	<0.11	<0.22	<0.26	<0.32	<0.11	7.28	<0.12	<0.25
GLWQD-124	251512	0.86	0.563	<0.04	345	0.246	<0.03	2.55	1.92	12.2	<0.05	<0.02	<0.04	<0.05	<0.02	<0.04	<0.05	0.079	<0.02	1.81	<0.02	<0.2
GLWQD-125	251531	<0.05	0.343	<0.04	258	0.29	<0.03	1.24	0.943	15	<0.05	<0.02	<0.04	<0.05	<0.02	<0.04	<0.05	<0.10	<0.02	1.02	<0.02	<0.05
GLWQD-130	99536	<0.05	<0.10	<0.04	130	<0.20	<0.03	1.31	2.3	6.43	<0.05	<0.02	<0.04	<0.05	<0.02	<0.04	<0.05	<0.10	<0.02	3.86	<0.02	0.189
GLWQD-131	90850	<0.05	0.241	<0.04	230	0.209	<0.03	4.43	2.22	<0.90	<0.05	<0.02	<0.04	<0.05	<0.02	<0.04	<0.05	<0.10	<0.02	1.71	<0.02	0.062
GLWQD-132	202221	0.049	0.37	<0.04	227	0.276	<0.03	2.59	1.69	1.17	<0.05	<0.02	<0.04	<0.05	<0.02	<0.04	<0.05	<0.10	<0.02	1.69	<0.02	0.078
GLWQD-134	193069	<0.05	0.242	<0.04	189	<0.20	<0.03	1.52	2.58	4.2	<0.05	<0.02	<0.04	<0.05	<0.02	<0.04	<0.05	<0.10	<0.02	1.47	<0.02	<0.05
GLWQD-136	190102	<0.05	0.214	<0.04	246	0.464	<0.03	1.65	2.44	46.6	<0.05	0.034	<0.04	<0.05	0.026	<0.04	<0.05	<0.10	<0.02	1.72	<0.02	<0.05
GLWQD-139	190101	<0.05	0.158	<0.04	277	0.239	<0.03	2.05	2.09	7.3	<0.05	<0.02	<0.04	<0.05	<0.02	<0.04	<0.05	<0.10	<0.02	1.94	<0.02	<0.05
GLWQD-140	130054	<0.05	0.206	<0.04	262	0.234	<0.03	2.2	2.03	12.1	<0.05	<0.02	<0.04	<0.05	<0.02	<0.04	<0.05	<0.10	<0.02	1.9	<0.02	<0.05

Appendix J: Columbia Analytical Services Surface-Water Data

Table 1J. CAS surface-water data summary.

SURFACE WATERBODY:			East Gallatin River										
SAMPLE ID:			GLWQD-5	GLWQD-88	GLWQD-111	GLWQD-6	GLWQD-89	GLWQD-112	GLWQD-7◊	GLWQD-8◊	GLWQD-9◊	GLWQD-90	GLWQD-113
DATE & TIME:			8/14/08 9:00 AM	2/12/09 8:20 AM	4/21/09 12:00 PM	8/14/08 9:35 AM	2/12/09 9:30 AM	4/21/09 1:00 PM	8/14/08 10:30 AM	8/14/08 10:30 AM	8/14/08 10:30 AM	2/12/09 10:00 AM	4/21/09 1:30 PM
GWIC ID #:			249233	249233	249233	249234	249234	249234	249235	249235	249235	249235	249235
SITE DESCRIPTION:			USGS Gaging Station			Riverside Country Club			Spain Bridge Road				
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit											
17 α-Estradiol	1	1.0	< 1.0	< 10	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
17 β-Estradiol	1	2.0	< 2.0	< 1.0	< 2.0	< 2.0	< 1.0	< 2.0	< 2.0	< 2.0	< 2.0	< 1.0	< 2.0
17 α-Ethinyl Estradiol	1	2.0	< 2.0	1.8	< 2.0	< 2.0	10	< 2.0	< 2.0	< 2.0	< 2.0	6.2	< 2.0
Acetaminophen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Androstenedione	1	10	< 10	< 1.0	< 10	< 10	< 1.0	< 10	< 10	< 10	< 10	< 1.0	< 10
Atrazine	1	1.0	< 1.0	< 10	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 1.0	< 1.0	11	< 1.0
Bisphenol A	1	10	20	7.1	20	17	19	< 1.0	15	19	7.4*	30	< 1.0
Caffeine	1	5.0	12	< 1.0	< 5.0	10	31	< 5.0	15	15	14	24	< 5.0
Carbamazepine	1	1.0	< 1.0	< 5.0	< 1.0	27	62	3.5	14	14	15	43	3.6
DEET	1	5.0	16	< 1.0	< 5.0	61	< 1.0	7.5	77	82	78	< 1.0	10
Diazepam	1	1.0	< 1.0	< 2.0	< 1.0	< 1.0	8.2	< 1.0	< 1.0	< 1.0	< 1.0	6.8	< 1.0
Diclofenac	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Diethylstilbestrol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Estriol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.5	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Estrone	1	1.0	< 1.0	< 2.0	< 1.0	< 1.0	< 2.0	< 1.0	< 1.0	< 1.0	< 1.0	< 2.0	< 1.0
Fluoxetine	1	1.0	< 1.0	< 1.0	< 1.0	2.3	42	< 1.0	< 1.0	< 1.0	< 1.0	90	< 1.0
Gemfibrozil	1	1.0	2.1	< 1.0	< 1.0	100	< 1.0	11	60	60	59	< 1.0	11
Hydrocodone	1	1.0	< 1.0	< 10	< 1.0	< 1.0	< 10	< 1.0	< 1.0	< 1.0	< 1.0	< 10	< 1.0
Ibuprofen	1	5.0	< 5.0	< 10	< 10	25	19	< 10	21	16	13	< 10	< 10
Iopromide	1	10	< 10	< 5.0	< 10	< 10	6.5	< 10	< 100	< 10	< 100	< 5.0	< 10
Meprobamate	1	5.0	< 5.0	< 5.0	< 5.0	9.1	< 5.0	< 5.0	5.7	5.7	6.2	< 5.0	< 5.0
Methadone	1	5.0	< 5.0	< 1.0	< 5.0	< 5.0	93	< 5.0	< 5.0	< 5.0	< 5.0	130	< 5.0
Naproxen	1	1.0	< 1.0	< 2.0	< 1.0	23	10	24	15	16	15	8.4	15
Oxybenzone	1	2.0	2.8	< 1.0	< 2.0	16	< 1.0	< 2.0	4.8	6.7	5.3	< 1.0	< 2.0
Pentoxifylline	1	1.0	< 1.0	< 5.0	< 1.0	< 1.0	17	< 1.0	< 1.0	< 1.0	< 1.0	28	< 1.0
Phenytoin	1	5.0	< 5.0	< 10	< 5.0	< 5.0	< 10	< 5.0	< 5.0	< 5.0	< 5.0	< 10	< 5.0
Progesterone	1	10	< 10	32	< 10	< 10	40	< 10	< 10	< 10	< 10	170	< 10
Salicylic acid	1	10	< 10	< 1.0	74	< 10	90	53	< 100	< 100	110	12	69
Sulfamethoxazole	1	1.0	< 1.0	< 10	< 1.0	100	< 10	12	18	16	20	< 10	12
Testosterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Triclosan	1	10	< 10	< 5.0	< 10	< 10	100	< 10	< 10	21	< 10	82	< 10
Trimethoprim	1	5.0	< 5.0	< 1.0	< 5.0	47	< 1.0	5.4	8.7	11	9.6	< 1.0	< 5.0

◊Triplicate sample.

*Estimated value.

Table 2J. CAS surface-water data summary.

SURFACE WATERBODY:			Bozeman Creek											
SAMPLE ID:			GLWQD-51	GLWQD-21	GLWQD-79	GLWQD-114	GLWQD-23	GLWQD-80	GLWQD-115	GLWQD-24	GLWQD-91◊	GLWQD-92◊	GLWQD-93◊	GLWQD-116
DATE & TIME:			10/20/08 3:00 PM	8/21/08 10:00 AM	2/9/09 12:00 PM	4/21/09 2:45 PM	8/21/08 2:05 PM	2/9/09 12:30 PM	4/21/09 4:00 PM	8/21/08 2:45 PM	2/12/09 10:30 AM	2/12/09 10:30 AM	2/12/09 10:30 AM	4/21/09 4:45 PM
GWIC ID #:			247764	246248	246248	246248	246246	246246	246246	246244	246244	246244	246244	246244
SITE DESCRIPTION:			Public Water Supply	Sourdough Trailhead			East Lincoln Street			Griffin Drive				
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Report-ing Limit												
17 α-Estradiol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
17 β-Estradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
17 α-Ethinylestradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Acetaminophen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Androstenedione	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Atrazine	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bisphenol A	1	10	13	< 10	< 10	< 10	< 10	12	< 10	< 10	< 10	< 10	< 10	< 10
Caffeine	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	23	< 5.0	12	< 5.0	< 5.0	< 5.0	10
Carbamazepine	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
DEET	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	12	< 5.0	< 5.0	< 5.0	< 5.0
Diazepam	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Diclofenac	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Diethylstilbestrol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Estriol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Estrone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Fluoxetine	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.9	1.4	1.3	4.2
Gemfibrozil	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Hydrocodone	1	1.0	< 1.0	< 1.0	6.1	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ibuprofen	1	5.0	< 10	< 5.0	< 10	< 10	< 5.0	< 10	< 10	6.6	< 10	< 10	< 10	< 10
Iopromide	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Meprobamate	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Methadone	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Naproxen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.8	< 1.0	1.2	< 1.0	< 1.0	< 1.0	< 1.0
Oxybenzone	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	5.9	< 2.0	< 2.0	< 2.0	< 2.0
Pentoxifylline	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Phenytoin	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Progesterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Salicylic acid	1	10	15	< 10	13	25	< 10	41	39	< 10	64	88	100	42
Sulfamethoxazole	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	2.2	1	< 1.0	1.5	1.4	1.6	1.4
Testosterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Triclosan	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Trimethoprim	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

◊Triplicate sample.

*Estimated value.

Note: GLWQD-81 (Bozeman Creek @ Griffin Drive) sample bottle broke. No analysis performed.

Table 3J. CAS surface-water data summary.

SURFACE WATERBODY:			Hyalite Creek			West Gallatin River						Gallatin River		
SAMPLE ID:			GLWQD-22	GLWQD-82	GLWQD-119	GLWQD-35	GLWQD-84	GLWQD-120	GLWQD-25	GLWQD-85	GLWQD-121	GLWQD-27	GLWQD-86	GLWQD-122
DATE & TIME:			8/21/08 11:45 AM	2/9/09 3:30 PM	4/23/09 10:00 AM	9/9/08 12:00 PM	2/11/09 9:30 AM	4/23/09 12:00 PM	8/21/08 3:45 PM	2/12/09 10:00 AM	4/23/09 1:00 PM	8/22/08 10:40 AM	2/11/09 11:30 AM	4/23/09 1:30 PM
GWIC ID #:			246247	246247	246247	246756	246756	246756	246243	246243	246243	246236	246236	246236
SITE DESCRIPTION:			Cottonwood Road below Anderson School			Williams Bridge			Cameron Bridge Road			Logan Bridge below USGS Gaging Station		
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit												
17 α-Estradiol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
17 β-Estradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
17 α-Ethinylestradiol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Acetaminophen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	3.2	4.4	< 1.0	1.7	5.4	< 1.0	1.5	< 1.0
Androstenedione	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Atrazine	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Bisphenol A	1	10	18	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Caffeine	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	5.4	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Carbamazepine	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	1.4	1.2
DEET	1	5.0	15	6.8	< 5.0	< 5.0	< 5.0	< 5.0	6.1	< 5.0	< 5.0	6.2	< 5.0	< 5.0
Diazepam	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Diclofenac	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Diethylstilbestrol	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Estriol	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Estrone	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Fluoxetine	1	1.0	< 1.0	< 1.0	< 1.0	1.2	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Gemfibrozil	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	3.4	< 1.0	2
Hydrocodone	1	1.0	< 1.0	< 1.0	< 1.0	3.7	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Ibuprofen	1	5.0	< 5.0	< 10	< 10	< 5.0	< 10	< 10	< 5.0	< 10	< 10	< 5.0	< 10	< 10
Iopromide	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Meprobamate	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Methadone	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Naproxen	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	13
Oxybenzone	1	2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
Pentoxifylline	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Phenytoin	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0
Progesterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Salicylic acid	1	10	< 10	32	26	13	< 10	32	< 10	19	40	< 10	27	28
Sulfamethoxazole	1	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	9.2	6.4	5.1
Testosterone	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Triclosan	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Trimethoprim	1	5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0	< 5.0

◊Triplicate sample.

*Estimated value.

Appendix K: Stream Field Measurement Data

Table 1K. Stream field measurement data summary

SAMPLE ID	STREAM	SITE DESCRIPTION	DATE	TIME	DO (mg/L)	pH	SC (µs/cm)	TEMP (°C)	TDS (mg/L)	ORP	DISCHARGE (cfs)	DISCHARGE METHOD
GLWQD-5	East Gallatin River	at USGS Gaging Station	08/14/2008	9:00	7.97	7.65	402	13.7	-	318.3	57	USGS Gage
GLWQD-6	East Gallatin River	at Riverside Country Club	08/14/2008	9:35	8.37	7.92	410	14.3	-	221.9	65.87	Estimate*
GLWQD-7,8,9	East Gallatin River	at Spain Bridge Road	08/14/2008	10:30	9.8	8.27	412	15.8	-	196.8	70	Est - field obs
GLWQD-88	East Gallatin River	at USGS Gaging Station	02/12/2009	8:20	11.84	6.97	314	0.49	-	4.8	43	USGS Gage
GLWQD-89	East Gallatin River	at Riverside Country Club	02/12/2009	9:30	12.27	6.15	317	2.14	-	3.7	50.11	Estimate*
GLWQD-90	East Gallatin River	at Spain Bridge Road	02/12/2009	10:00	12.69	5.57	323	0.92	-	2.2	50.11	Est - field obs
GLWQD-111	East Gallatin River	at USGS Gaging Station	04/21/2009	12:00	11.54	5.23	204	4.88	102	281.8	422	USGS Gage
GLWQD-112	East Gallatin River	at Riverside Country Club	04/21/2009	13:00	11.8	6.79	219	5.82	109	130.6	434	Estimate*
GLWQD-113	East Gallatin River	at Spain Bridge Road	04/21/2009	13:30	11.31	6.89	178	7.13	90	152	450	Est - field obs
GLWQD-21	Bozeman Creek	at Sourdough Trailhead	08/21/2008	10:00	8.97	7.36	143	8.97	103	142.2	6.696	meter
GLWQD-23	Bozeman Creek	at East Lincoln Street	08/21/2008	13:51	8.24	8.29	316	14.22	158	148.4	15.27	meter
GLWQD-24	Bozeman Creek	at Griffin Drive	08/21/2008	14:51	8.52	8.49	300	14.69	150	34.5	19.291	meter
GLWQD-79	Bozeman Creek	at Sourdough Trailhead	02/09/2009	12:00	11.2	8.17	202	0.77	101	36.3	-	**
GLWQD-80	Bozeman Creek	at East Lincoln Street	02/09/2009	12:30	11.67	7.37	383	1.86	191	32	8.91	meter
GLWQD-81	Bozeman Creek	at Griffin Drive	02/09/2009	14:30	12.37	7.97	446	2.59	223	12.5	15.09	meter
GLWQD-91,92, 93	Bozeman Creek	at Griffin Drive	02/12/2009	10:30	13.5	5.19	246	1.27	-	10.7	15	Est - field obs
GLWQD-114	Bozeman Creek	at Sourdough Trailhead	04/21/2009	14:45	11:23	5.83	131	6.03	65	309.8	23.1	meter
GLWQD-115	Bozeman Creek	at East Lincoln Street	04/21/2009	16:00	10.27	7.65	248	10.96	124	71.6	42.84	meter
GLWQD-116	Bozeman Creek	at Griffin Drive	04/21/2009	16:45	10.49	8.12	274	11.27	137	60.1	70	Est - field obs
GLWQD-22	Hyalite Creek	at Cottonwood Road	08/21/2008	12:00	8.49	7.42	85	12.03	43	90.2	34.912	meter
GLWQD-82	Hyalite Creek	at Cottonwood Road	02/09/2009	15:30	11.56	7.25	90	0.16	45	31.8	-	**
GLWQD-119	Hyalite Creek	at Cottonwood Road	04/22/2009	10:00	10.97	7.64	25	3.53	13	111.2	59	meter
GLWQD-35	West Gallatin River	at Williams Bridge	09/09/2008	12:05	10.08	7.43	228	9.11	114	49.9	331	USGS Gage†
GLWQD-84	West Gallatin River	at Williams Bridge	02/11/2009	9:30	12.19	6.7	205	0.35	103	16.9	279	USGS Gage
GLWQD-120	West Gallatin River	at Williams Bridge	04/22/2009	12:00	10.17	8.89	180	5.98	90	17.9	968	USGS Gage
GLWQD-25	West Gallatin River	at Cameron Bridge Road	08/21/2008	15:45	8.12	8.89	277	17.7	138	17.2	451	Estimate‡
GLWQD-85	West Gallatin River	at Cameron Bridge Road	02/11/2009	10:00	12.87	6.73	207	0.44	103	18.8	279	Est - field obs
GLWQD-121	West Gallatin River	at Cameron Bridge Road	04/22/2009	13:00	9.77	9.13	201	7.63	101	13.7	950	Est - field obs
GLWQD-27	Gallatin River	at Logan	08/22/2008	11:10	11.03	8.51	366	14.93	183	45.2	461	USGS Gage
GLWQD-86	Gallatin River	at Logan	02/11/2009	11:30	12.25	6.32	248	0.42	124	21.6	660	USGS Gage
GLWQD-122	Gallatin River	at Logan	04/22/2009	13:30	8.86	8.34	258	8.91	129	36.1	1890	USGS Gage

*Estimate made based on discharge measurement from USGS gaging station and adding the effluent discharge from the Bozeman WWTP.

‡The discharge used for this site is an estimate. Used discharge from USGS gaging station upstream at Gallatin Gateway and subtracted the diversion rights for three irrigation ditches between the gage and Williams Bridge (200.37 cfs). River is over-appropriated, so subtracting all rights between gage and Cameron Bridge would result in a negative discharge.

†Discharge estimated using USGS gage discharge and subtracting irrigation diversion rights for the three ditches below gage and that are located above the sampling site. Diversion total = 200.37 cfs.

**Unable to measure flow due to thick ice spanning majority of stream channel.

Appendix L: Columbia Analytical Services Wastewater Data

Table 1L. CAS wastewater data summary

WASTEWATER SYSTEM:			Modified Activated Sludge							
SAMPLE ID:			GLWQD-1	GLWQD-2	GLWQD-3	GLWQD-4	GLWQD-65	GLWQD-68	GLWQD-83	GLWQD-87
DATE & TIME:			8/14/08 7:30 AM	8/14/08 7:35 AM	8/14/08 7:40 AM	8/14/08 8:30 AM	11/18/08 7:30 AM	11/19/08 7:30 AM	2/11/09 7:00 AM	2/12/09 7:00 AM
GWIC ID #:			251255	251255	251255	249232	251255	249232	251255	249232
WASTEWATER TYPE:			Influent◊ 24-hr composite	Influent◊ 24-hr composite	Influent◊ 24-hr composite	Effluent 24-hr composite	Influent 24-hr composite	Effluent 24-hr composite	Influent 24-hr composite	Effluent
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit‡								
17 α-Estradiol	1	10	< 10	< 10	< 10	< 1.0	< 10	< 1.0	< 10	1
17 β-Estradiol	1	20	< 20	< 20	< 20	< 2.0	< 20	< 2.0	< 20	< 2.0
17 α-Ethinyl estradiol	1	20	< 20	< 20	< 20	< 2.0	< 20	< 2.0	< 20	< 2.0
Acetaminophen	1	1,000	200,000	210,000	210,000	< 1.0	410,000	< 10	100,000	22
Androstenedione	1	100	150	180	140	< 100	280	< 10	< 100	< 10
Atrazine	1	10	< 10	< 10	< 10	< 10	< 10	< 1.0	< 10	< 1.0
Bisphenol A	1	100	240	260	250	23	260	11	310	37
Caffeine	1	5,000	71,000	76,000	70,000	17	83,000	< 50	< 50	120
Carbamazepine	1	10	180	170	160	160	250	210	150	210
DEET	1	50	14,000	14,000	13,000	500	830	510	380	380
Diazepam	1	10	< 10	< 10	< 10	< 10	< 10	1.5	< 10	< 1.0
Diclofenac	1	20	< 20	< 20	< 20	< 20	< 20	< 2.0	110	95
Diethylstilbestrol	1	20	< 20	< 20	< 20	< 2.0	< 20	< 2.0	< 20	< 2.0
Estriol	1	10	160	120	150	< 1.0	330	< 1.0	190	< 1.0
Estrone	1	10	< 10	< 10	< 10	< 1.0	17	2	< 10	13
Fluoxetine	1	10	59	49	41	28	74	39	92	63
Gemfibrozil	1	10	990	1,400	1,400	84	3,100	930	230	930
Hydrocodone	1	10	56	33	36	< 1.0	210	38	120	90
Ibuprofen	1	50	6,300	7,000	8,900	150	23,000	< 10	7,700	< 10
Iopromide	10	1,000	< 1,000	< 1,000	< 1,000	< 100	< 100	< 100	< 100	13
Meprobamate	1	50	72	77	81	67	87	90	< 50	28
Methadone	1	50	< 50	< 50	< 50	16	< 50	18	< 50	17
Naproxen	1	10	8,300	9,200	9,200	270	13,000	130	9,600	770
Oxybenzone	1	20	980	860	1,100	140	1,200	120	24	85
Pentoxifylline	1	10	< 10	< 10	< 10	< 1.0	13	6.4	12	7.2
Phenytoin	1	50	< 50	< 50	< 50	< 50	130	250	< 50	52
Progesterone	1	100	210	170	180	< 10	140	< 10	140	< 10
Salicylic acid	10	1,000	72,000	69,000	67,000	130	40,000	< 100	33,000	260
Sulfamethoxazole	1	10	160	140	110	190	1,700	280	640	91
Testosterone	1	100	120	67*	85*	< 10	< 100	< 10	130	< 10
Triclosan	1	100	280	380	400	< 10	1,100	< 100	< 5,000	10
Trimethoprim	1	50	600	580	580	240	790	520	870	680

‡Reporting limits for individual samples may differ.

◊Triplicate sample.

*Estimated value.

Table 2L. CAS wastewater data summary

WASTEWATER SYSTEM:			Sequencing Batch Reactor - 1									
SAMPLE ID:			GLWQD-13	GLWQD-14	GLWQD-69	GLWQD-72	GLWQD-73	GLWQD-74	GLWQD-102	GLWQD-104	GLWQD-105	GLWQD-106
DATE & TIME:			8/14/08 1:45 PM	8/14/08 1:50 PM	11/19/08 10:30 AM	11/19/08 3:00 PM	11/19/08 3:00 PM	11/19/08 3:00 PM	3/18/09 10:00 AM	3/18/09 1:00 PM	3/18/09 1:00 PM	3/18/09 1:00 PM
GWIC ID #:			249519	251258	251258	249519	249519	249519	251258	249519	249519	249519
WASTEWATER TYPE:			Effluent	Influent	Influent	Effluent[◊]	Effluent[◊]	Effluent[◊]	Influent	Effluent[◊]	Effluent[◊]	Effluent[◊]
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit[‡]										
17 α-Estradiol	1	10	< 10	< 10	< 10	< 1.0	1.4	< 1.0	< 10	< 10	17	15
17 β-Estradiol	1	20	< 20	< 20	< 20	5.7	4.1	6.1	< 20	< 20	< 20	< 20
17 α-Ethinylestradiol	1	20	< 20	< 20	< 20	< 2.0	< 2.0	< 2.0	< 20	< 20	< 20	< 20
Acetaminophen	1	1,000	3,500	120,000	440,000	< 10	< 10	< 10	51,000	< 10	40	< 10
Androstenedione	1	100	< 1,000	< 100	< 100	< 10	< 10	< 10	< 100	< 100	< 100	< 100
Atrazine	1	10	< 100	< 10	< 10	< 1.0	< 1.0	< 1.0	< 10	< 10	< 10	< 10
Bisphenol A	1	100	770	240	250	34	27	33	180	530	580	510
Caffeine	1	5,000	1,200	31,000	130,000	130	110	100	110,000	2,300	2,300	2,100
Carbamazepine	1	10	2,900	770	58	240	200	210	490	380	370	370
DEET	1	50	170,000	6,800	3,600	89	78	81	130	370	370	370
Diazepam	1	10	< 100	< 10	< 10	< 1.0	< 1.0	< 1.0	< 10	< 10	< 10	< 10
Diclofenac	1	20	< 200	< 20	< 20	24	15	15	< 20	< 20	< 20	< 20
Diethylstilbestrol	1	20	< 20	< 20	< 20	< 2.0	< 2.0	< 2.0	< 20	< 20	< 20	< 20
Estriol	1	10	1,100	73	240	< 1.0	< 1.0	36	15	76	79	94
Estrone	1	10	37	< 10	13	6.8	7.6	6.9	< 10	58	53	59
Fluoxetine	1	10	34	< 10	130	90	87	90	120	86	87	79
Gemfibrozil	1	10	530	20	420	2,400	2600	2,700	13	520	440	460
Hydrocodone	1	10	71	240	< 10	70	70	79	< 10	< 10	< 10	< 10
Ibuprofen	1	50	31,000	3,300	5,200	400	320	340	7,100	10,000	11,000	14,000
Iopromide	10	1,000	< 1,000	< 1,000	< 1,000	< 100	< 100	< 100	< 100	< 100	< 100	< 100
Meprobamate	1	50	< 500	< 50	< 50	6.3	7.8	8.1	< 50	< 50	< 50	< 50
Methadone	1	50	< 500	< 50	< 50	26	22	23	< 50	< 50	< 50	< 50
Naproxen	1	10	8,900	1,400	1,900	280	260	250	1,500	2,300	2,100	2,200
Oxybenzone	1	20	< 200	2,000	1,300	40	49	52	510	23	21	< 20
Pentoxifylline	1	10	< 100	< 10	< 10	< 1.0	< 1.0	< 1.0	< 10	< 10	< 10	< 10
Phenytoin	1	50	< 500	< 50	< 50	< 5.0	< 5.0	< 5.0	360	< 50	< 50	< 50
Progesterone	1	100	< 1,000	< 100	< 100	< 10	< 10	< 10	390	< 100	< 100	< 100
Salicylic acid	10	1,000	< 1,000	26,000	24,000	< 100	< 100	< 100	5,300	190	< 100	220
Sulfamethoxazole	1	10	< 10	1,500	< 100	530	450	460	< 10	14	12	22
Testosterone	1	100	< 1,000	< 100	< 100	< 10	< 10	< 10	< 100	< 100	< 100	< 100
Triclosan	1	100	1,700	570	340	130	110	120	< 100	< 100	< 100	< 100
Trimethoprim	1	50	190	1,000	< 50	580	480	540	< 50	51	< 50	< 50

[‡] Reporting limits for individual samples may differ.

[◊] Triplicate sample.

*Estimated value.

Table 3L. CAS wastewater data summary

WASTEWATER SYSTEM:			Fixed Film Activated Sludge						Community Pressure-Dose Septic		
SAMPLE ID:			GLWQD-16	GLWQD-26	GLWQD-67	GLWQD-75	GLWQD-97	GLWQD-109	GLWQD-15	GLWQD-70	GLWQD-108
DATE & TIME:			8/20/08 10:30 AM	8/22/08 9:30 AM	11/18/08 10:30 AM	11/20/08 10:30 AM	3/17/09 10:00 AM	3/19/09 5:00 PM	8/14/08 2:50 PM	11/19/08 11:30 AM	3/19/09 12:30 PM
GWIC ID #:			246242	246241	246242	246241	246242	246241	251259	251259	251259
WASTEWATER TYPE:			Influent	Effluent	Influent	Effluent	Influent 24-hr composite	Effluent 24-hr composite	Effluent	Effluent	Effluent
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit[‡]									
17 α-Estradiol	1	10	< 10	< 10	< 10	< 1.0	18	< 10	< 10	< 10	< 10
17 β-Estradiol	1	20	< 20	< 20	< 20	< 2.0	30	< 20	< 20	< 20	< 20
17 α-Ethinylestradiol	1	20	< 20	< 20	< 20	< 2.0	< 20	< 20	< 20	< 20	< 20
Acetaminophen	1	1,000	47,000	< 10	200,000	< 10	1,200	< 10	3,500	15,000	77,000
Androstenedione	1	100	< 100	< 100	< 100	< 10	< 100	< 100	< 1,000	< 100	< 100
Atrazine	1	10	< 10	< 10	< 10	< 1.0	< 10	< 10	< 100	< 10	< 10
Bisphenol A	1	100	310	< 100	220	< 10	270	< 100	770	440	640
Caffeine	1	5,000	95,000	< 50	110,000	< 50	77,000	4,300	1,200	7,500	29,000
Carbamazepine	1	10	45	61	120	150	240	200	2,900	3,800	2,300
DEET	1	50	15,000	330	1100	140	810	150	170,000	8,200	860
Diazepam	1	10	< 10	< 10	< 10	1	< 10	< 10	< 100	< 10	< 10
Diclofenac	1	20	< 20	47	< 20	33	80	29	< 200	< 20	< 20
Diethylstilbestrol	1	20	< 20	< 20	< 20	< 2.0	< 20	< 20	< 20	< 20	< 20
Estriol	1	10	160	< 10	540	< 1.0	200	< 10	1,100	850	350
Estrone	1	10	14	< 10	< 10	< 1.0	71	< 10	37	23	37
Fluoxetine	1	10	36	24	88	33	160	130	34	66	< 10
Gemfibrozil	1	10	2,600	65	5,200	1,300	1,500	1,700	530	25,000	2,600
Hydrocodone	1	10	53	< 10	100	56	< 10	< 10	71	< 10	< 10
Ibuprofen	1	50	18,000	250	30,000	< 10	15,000	2,300	31,000	44,000	26,000
Iopromide	10	1,000	< 100	< 100	< 100	< 100	< 100	< 100	< 1,000	< 100	< 100
Meprobamate	1	50	260	220	480	290	84	150	< 500	< 50	< 50
Methadone	1	50	< 50	< 50	< 50	13	< 50	< 50	< 500	< 50	< 50
Naproxen	1	10	9,600	140	20,000	46	17,000	410	8,900	2,800	4,500
Oxybenzone	1	20	4,500	230	1,800	56	560	< 20	< 200	140	160
Pentoxifylline	1	10	< 10	< 10	27	17	34	50	< 100	< 10	< 10
Phenytoin	1	50	< 50	< 50	190	110	< 50	< 50	< 500	< 50	< 50
Progesterone	1	100	< 100	< 100	< 100	< 10	< 100	< 100	< 1,000	< 100	< 100
Salicylic acid	10	1,000	< 100	< 100	960	< 100	1,500	250	< 1,000	3,100	15,000
Sulfamethoxazole	1	10	1,700	53	2,200	290	1,700	190	< 10	4,100	560
Testosterone	1	100	< 100	< 100	< 100	< 10	< 100	< 100	< 1,000	< 100	140
Triclosan	1	100	1,300	< 100	640	< 100	< 100	< 100	1,700	1,000	< 100
Trimethoprim	1	50	480	450	1,900	1,100	1,000	700	190	1,000	160

[‡] Reporting limits for individual samples may differ.

[◊] Triplicate sample.

*Estimated value.

Table 4L. CAS wastewater data summary

WASTEWATER SYSTEM:			Recirculating Sand Filter			Sequencing Batch Reactor - 2					
SAMPLE ID:			GLWQD-127	GLWQD-128	GLWQD-129	GLWQD-33	GLWQD-34	GLWQD-77	GLWQD-78	GLWQD-94	GLWQD-95
DATE & TIME:			5/5/09 2:00 PM	5/5/09 2:00 PM	5/5/09 2:00 PM	9/9/08 10:00 AM	9/9/08 10:30 AM	11/21/08 2:00 PM	11/21/08 2:00 PM	2/23/09 2:00 PM	2/23/09 3:00 PM
GWIC ID #:			251275	251275	251275	251260	246755	251260	246755	251260	246755
WASTEWATER TYPE:			Effluent[◊]	Effluent[◊]	Effluent[◊]	Influent	Effluent	Influent	Effluent	Influent	Effluent
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit[‡]									
17 α-Estradiol	1	10	< 10	< 10	< 10	< 10	< 1.0	< 10	< 1.0	< 10	< 1.0
17 β-Estradiol	1	20	< 20	< 20	< 20	30	< 2.0	< 20	< 2.0	< 20	< 2.0
17 α-Ethinylestradiol	1	20	< 20	< 20	< 20	< 20	< 2.0	< 20	< 2.0	< 20	< 2.0
Acetaminophen	1	1,000	27,000	28,000	31,000	34,000	< 1.0	210,000	< 10	84,000	350
Androstenedione	1	100	< 100	< 100	< 100	< 100	< 100	320	< 100	100	< 10
Atrazine	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 1.0
Bisphenol A	1	100	340	460	370	370	< 10	500	< 10	340	27
Caffeine	1	5,000	37,000	36,000	37,000	130,000	57	100,000	< 50	63,000	3,000
Carbamazepine	1	10	< 10	< 10	< 10	300	120	10	47	110	100
DEET	1	50	500	500	510	6,000	< 50	4100	< 50	480	650
Diazepam	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	10	1.6
Diclofenac	1	20	660	660	650	< 20	< 20	22	< 20	100	< 2.0
Diethylstilbestrol	1	20	< 20	< 20	< 20	< 20	< 2.0	< 20	< 2.0	< 20	< 2.0
Estriol	1	10	270	270	250	170	< 1.0	150	< 1.0	130	< 1.0
Estrone	1	10	53	71	54	< 10	< 1.0	21	< 1.0	< 10	< 1.0
Fluoxetine	1	10	23	23	29	36	9.4	35	9.7	92	37
Gemfibrozil	1	10	< 10	< 10	< 10	770	< 10	3,300	< 10	670	11
Hydrocodone	1	10	< 10	< 10	< 10	< 10	< 1.0	< 10	< 1.0	120	18
Ibuprofen	1	50	6,900	6,800	7,500	13,000	< 50	20,000	< 100	17,000	3,000
Iopromide	10	1,000	< 100	< 100	< 100	< 100	< 10	< 1,000	< 100	< 100	< 10
Meprobamate	1	50	4,100	4,600	4,300	63	78	69	86	82	74
Methadone	1	50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	< 50	13
Naproxen	1	10	4,900	4,100	4,700	7,600	< 10	11,000	< 10	24,000	16
Oxybenzone	1	20	64	56	70	970	< 20	1,600	< 20	290	4.2
Pentoxifylline	1	10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	3.2
Phenytoin	1	50	< 50	< 50	< 50	1,300	< 50	< 50	< 50	< 50	31
Progesterone	1	100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 10
Salicylic acid	10	1,000	2,800	2,300	2,100	8,700	100	8,600	< 100	34,000	4,000
Sulfamethoxazole	1	10	< 10	< 10	< 10	730	50	< 100	63	380	190
Testosterone	1	100	< 100	< 100	< 100	120	< 100	< 100	< 100	< 100	< 10
Triclosan	1	100	< 100	< 100	< 100	310	< 10	280	< 10	< 100	< 100
Trimethoprim	1	50	< 50	< 50	< 50	34,000	< 5.0	54	< 5.0	230	25

[‡] Reporting limits for individual samples may differ.

[◊] Triplicate sample.

*Estimated value.

Table 5L. CAS wastewater data summary

WASTEWATER SYSTEM:			Oxidation Ditch						Aeration Lagoon	
SAMPLE ID:			GLWQD-10	GLWQD-11	GLWQD-66	GLWQD-76	GLWQD-101	GLWQD-110	GLWQD-135	GLWQD-133
DATE & TIME:			8/14/08 12:00 PM	8/14/08 12:00 PM	11/18/08 9:30 AM	11/21/08 1:00 PM	3/17/09 2:30 PM	3/20/09 4:00 PM	5/14/09 11:00 AM	5/13/09 11:30 AM
GWIC ID #:			249573	251257	251257	249573	251257	249573	250359	250351
WASTEWATER TYPE:			Effluent	Influent	Influent	Effluent	Influent 24-hr composite	Effluent 24-hr composite	Influent	Effluent
CHEMICAL COMPOUND (ng/L)	Dilution Factor	Reporting Limit[‡]								
17 α-Estradiol	1	10	< 1.0	< 10	< 10	< 1.0	< 10	< 1.0	< 10	< 10
17 β-Estradiol	1	20	< 2.0	< 20	< 20	< 2.0	< 20	< 2.0	< 20	< 20
17 α-Ethinylestradiol	1	20	< 2.0	< 20	< 20	< 2.0	< 20	< 2.0	< 20	< 20
Acetaminophen	1	1,000	< 1.0	33,000	100,000	< 10	54,000	< 1.0	320,000	< 10
Androstenedione	1	100	< 100	< 2,000	250	< 10	< 100	< 10	< 100	< 100
Atrazine	1	10	< 10	< 200	< 10	< 1.0	< 10	< 1.0	< 10	< 10
Bisphenol A	1	100	21	< 100	210	18	200	< 1.0	380	130
Caffeine	1	5,000	44	100,000	200,000	120	73,000	440	130,000	330
Carbamazepine	1	10	200	< 200	< 10	1.9	< 10	11	110	83
DEET	1	50	290	13,000	740	41	450	19	760	520
Diazepam	1	10	< 10	< 200	< 10	< 1.0	< 10	< 1.0	< 10	< 10
Diclofenac	1	20	< 20	< 400	< 20	22	< 20	< 2.0	< 20	< 20
Diethylstilbestrol	1	20	< 2.0	< 20	< 20	< 2.0	< 20	< 2.0	< 20	< 20
Estriol	1	10	< 1.0	< 10	220	< 1.0	16	< 1.0	300	< 10
Estrone	1	10	< 1.0	< 10	26	2.1	< 10	2.5	< 10	< 10
Fluoxetine	1	10	15	< 10	78	17	24	37	120	14
Gemfibrozil	1	10	< 10	< 200	77	110	120	50	230	690
Hydrocodone	1	10	< 1.0	< 10	57	23	< 10	57	< 10	< 10
Ibuprofen	1	50	240	6,600	14,000	210	15,000	410	31,000	< 100
Iopromide	10	1,000	< 100	< 1,000	< 1,000	< 100	< 100	< 10	< 100	< 100
Meprobamate	1	50	54	< 1,000	< 50	170	< 50	36	120	150
Methadone	1	50	< 50	< 1,000	< 50	5.1	< 50	9.9	52	< 50
Naproxen	1	10	73	680	5,600	190	5,700	130	24,000	36
Oxybenzone	1	20	33	20,000	2,800	18	1,000	< 2.0	560	< 20
Pentoxifylline	1	10	< 10	< 200	< 10	< 1.0	< 10	< 1.0	< 10	< 10
Phenytoin	1	50	< 50	< 1,000	< 50	< 5.0	< 50	< 5.0	< 50	80
Progesterone	1	100	< 100	< 2,000	< 100	< 10	< 100	< 10	< 100	< 100
Salicylic acid	10	1,000	230	1,300,000	33,000	< 100	11,000	200	40,000	< 100
Sulfamethoxazole	1	10	450	250	< 100	550	85	400	1,800	880
Testosterone	1	100	< 100	< 2,000	2,100	< 10	270	< 10	310	< 100
Triclosan	1	100	< 10	1,900	470	< 100	< 100	< 10	< 5,000	< 100
Trimethoprim	1	50	18	< 50	100	40	1,000	29	1,200	230

[‡] Reporting limits for individual samples may differ.

◊Triplicate sample.

*Estimated value.