

# Contaminants of Emerging Concern

The table below provides an overview of the different categories of contaminants of emerging concern (CECs), different examples of chemicals found within those categories, where various CECs have been detected, and the health effects found in both environmental and lab-controlled studies. Click on any reference to be taken to the full citation. This table provides an overview of CECs, and is not intended to be a comprehensive review. For more information about any of the studies cited here, or to report an error, please contact [Sarah Zack](#)<sup>1</sup>.

Category	Definition	Examples <sup>2</sup>	Where have they been detected?	What are the potential health effects on aquatic organisms?	References
Pharmaceuticals	A compound manufactured for use as a medicinal drug.	antibiotics (e.g., ciprofloxacin, sulfonamide, tetracycline), painkillers (e.g., ibuprofen, acetaminophen), antidepressants (e.g., fluoxetine, sertraline), metformin, synthetic progesterin	organisms, surface waters <sup>3</sup> , treated wastewater, groundwater, drinking (tap) water, sediment	bioaccumulation in tissues, genotoxicity (DNA damage), altered feeding behavior, altered reproductive behavior, endocrine disruption, reduced survival, developmental delays, organ damage, antibiotic resistance, decreased diversity	<a href="#">Vernouillet et al. 2010</a> ; <a href="#">Richmond et al. 2019</a> ; <a href="#">Aguirre-Martínez et al. 2013</a> ; <a href="#">Brodin et al. 2013</a> ; <a href="#">Schultz et al. 2011</a> ; <a href="#">Niemuth and Klaper 2015</a> ; <a href="#">Fritts et al. 2016</a> ; <a href="#">Bahamonde et al. 2015</a> ; <a href="#">Fuzzen et al. 2015</a> ; <a href="#">Iwanowicz et al. 2016</a> ; <a href="#">Kidd et al. 2007</a> ; <a href="#">Frankel et al. 2016</a> ; <a href="#">Foster et al. 2010</a> ; <a href="#">Hoeger et al. 2005</a> ; <a href="#">Heberer et al. 2002</a> ; <a href="#">Fram and Belitz 2011</a> ; <a href="#">Ramil et al. 2010</a> ; <a href="#">Kolpin et al. 2013</a> ; <a href="#">Naslund et al. 2008</a> ; <a href="#">Sabri et al. 2018</a> ; <a href="#">Delgado-Gardea et al. 2016</a>
Personal Care Products	Chemical substances used in a diverse group of personal items like toiletries and cosmetics.	sodium lauryl sulfate, triclosan, musks and fragrances, parabens, oxybenzone, octinoxate, DEET	organisms, surface waters, treated wastewater, groundwater, drinking (tap) water, biosolids, sediment	altered behavior, altered gene expression, bioaccumulation in tissues, endocrine disruption, antibiotic resistance, cytotoxicity (cell damage), genotoxicity (DNA damage), reduced reproduction, reduced growth rates, reduced survival	<a href="#">Ramirez et al. 2009</a> ; <a href="#">Fritsch et al. 2013</a> ; <a href="#">Veldhoen et al. 2006</a> ; <a href="#">de Solla et al. 2016</a> ; <a href="#">Raut and Angus 2010</a> ; <a href="#">Bedoux et al. 2012</a> ; <a href="#">Klosterhaus et al. 2013</a> ; <a href="#">Shiple 2014</a> ; <a href="#">Olaniyan et al. 2016</a> ; <a href="#">Luckenbach and Epel 2005</a> ; <a href="#">Rimkus 1999</a> ; <a href="#">Gatermann et al. 2002</a> ; <a href="#">Lefebvre et al. 2017</a> ; <a href="#">Carlsson et al. 2000</a> ; <a href="#">Downs et al. 2013</a> ; <a href="#">Danovaro et al. 2008</a> ; <a href="#">Paredes et al. 2014</a> ; <a href="#">Roy et al. 2017</a> ; <a href="#">Campos et al. 2016</a> ; <a href="#">Martinez et al. 2016</a> ; <a href="#">Seo et al. 2005</a> ; <a href="#">Stackelberg et al. 2004</a> ; <a href="#">Glassmeyer et al. 2005</a> ; <a href="#">Kolpin et al. 2002</a>

<sup>1</sup> Date of last update: November 30, 2018

<sup>2</sup> This list is not meant to be inclusive of every example, but rather to give the reader an idea of what types of compounds might be found in this category.

<sup>3</sup> Surface waters include all types of water bodies on earth, including rivers, streams, creeks, lakes, and oceans.

<p><b>Lifestyle Products</b></p>	<p>A diverse group of chemicals found in products used by choice, sometimes in a recreational capacity.</p>	<p>caffeine, nicotine, artificial sweeteners (e.g., sucralose, saccharin, aspartame)</p>	<p>organisms, surface water, treated wastewater, groundwater, drinking (tap) water, bottled water, precipitation, sediment, landfill seepage</p>	<p>impaired feeding ability, cytotoxicity (cell damage), genotoxicity (DNA damage), impaired reproduction, inhibited or altered growth, altered locomotion, reduced survival</p>	<p>Sauvé et al. 2012; Kessler 2009; Calza et al. 2013; Van Stempvoort et al. 2011; Scheurer et al. 2009; Saucedo-Vence et al. 2017; Eriksson Wiklund et al. 2014; Gan et al. 2013; Slaughter et al. 2011; Micevska et al. 2006; Yang et al. 2015; Baker and Kasprzyk-Hordern 2013; Seckar et al. 2008; Schwarzbauer et al. 2002; Buerge et al. 2008; Gonzalez Alonso et al. 2012; Chen et al. 2008; Aguirre-Martínez et al. 2013; Martín-Díaz et al. 2009; Pollack et al. 2009; Moore et al. 2008; Rodríguez del Rey et al. 2012; Busse and Nagoda 2015</p>
<p><b>Microplastics</b></p>	<p>Plastic pieces less than five millimeters in size found in one of several forms (i.e., films, fragments, foam, fiber, beads).</p>	<p>polyethylene, polystyrene, nylon, polyester, polypropylene</p>	<p>organisms, surface water, treated wastewater, groundwater, drinking (tap and bottled) water, beer, sea salt, sediments</p>	<p>endocrine disruption, concentration of contaminants, reduced feeding ability, reduced growth, reduced reproduction, reduced survival</p>	<p>Barnes et al. 2009; Claessens et al. 2011; Foekema et al. 2013; Cole et al. 2011; Davidson and Dudas 2016; Farrell and Nelson 2013; Wegner et al. 2012; Desforges et al. 2015; Ogonowski et al. 2016; Au et al. 2015; Della Torre et al. 2014; Browne et al. 2008; de Sá et al. 2015; Panno (pers comm); Kosuth et al. 2018; Foley et al. 2018; Mason et al. 2018; Teuten et al. 2009; Rochman et al. 2014</p>
<p><b>Nanomaterials</b></p>	<p>Manufactured materials less than 100 nanometers in size that have great strength, thermal stability, and low permeability.</p>	<p>nanoparticles of compounds such as titanium dioxide, zinc oxide, carbon nanotubes, silver, copper</p>	<p>organisms, surface water, treated wastewater, sediments</p>	<p>reduced survival, reduced growth rate, reproductive failure, impaired feeding ability, decreased and altered diversity, cytotoxicity (cell damage)</p>	<p>Sanchís et al. 2015; Griffitt et al. 2009; Van Hoecke et al. 2009; Kwok et al. 2010; Jovanović and Guzmán 2014; Hanna et al. 2013; Trevisan et al. 2014; Miller et al. 2010; Wong et al. 2010; Lewicka et al. 2013; Binh et al. 2016; Paterson et al. 2011; Ates et al. 2013; Manzo et al. 2013; Sanchís et al. 2013</p>
<p><b>Disinfectants and Household Cleaners</b></p>	<p>Chemical agents used on non-living surfaces to destroy, neutralize, or inhibit the growth of disease causing microorganisms.</p>	<p>commercial laundry detergents, quaternary ammonium compounds</p>	<p>organisms, surface water, treated wastewater</p>	<p>eutrophication of water bodies, reduced survival, reduced feeding ability and nutrient uptake, inhibited breathing, cytotoxicity (cell damage)</p>	<p>Mathew et al. 2013; Sánchez-Fortún et al. 2008; Liang et al. 2013; Jawahar et al. 2015; Saxena et al. 2005; Kundu et al. 2015</p>

<p>Disinfection By-Products</p>	<p>Chemical substances resulting from the interaction of organic matter with disinfection agents during the water treatment process.</p>	<p>by-products of treated iodine, chlorine, and other disinfection compounds</p>	<p>treated wastewater, drinking water</p>	<p>cytotoxicity (cell damage), genotoxicity (DNA damage), carcinogenesis</p>	<p><a href="#">Liberatore et al. 2017</a>; <a href="#">Mitch and Sediak 2002</a>; <a href="#">Jeong et al. 2012</a>; <a href="#">Zhao et al. 2010</a>; <a href="#">Plewa et al. 2004</a>; <a href="#">Plewa 2010</a></p>
<p>Pesticides</p>	<p>Chemical substances or microbiological agents that kill, incapacitate, or otherwise prevent pests from causing damage.</p>	<p>atrazine, nitrapyrin, neonicotinoids, glyphosate, organochlorines</p>	<p>organisms, surface water, treated wastewater, groundwater, drinking water, precipitation, sediments</p>	<p>endocrine disruption, developmental delays, altered swimming behavior, reduced survival, reduced reproduction, immunosuppression</p>	<p><a href="#">Battaglin et al. 2009</a>; <a href="#">Miles et al. 2017</a>; <a href="#">Woodward et al. 2016</a>; <a href="#">Relyea 2005</a>; <a href="#">Rohr et al. 2008</a>; <a href="#">Forson and Storfer 2006</a>; <a href="#">Dodson and Hanazato 1995</a>; <a href="#">Gilliom et al. 2006</a>; <a href="#">Spalding et al. 2003</a>; U.S. EPA (accessed 11/2018); <a href="#">Vasanth et al. 2015</a>; <a href="#">Zhao et al. 2006</a>; <a href="#">Sankaramakrishnan et al. 2005</a>; <a href="#">Laabs et al. 2002</a>; <a href="#">Cerejeira et al. 2003</a>; <a href="#">Kole et al. 2001</a>; <a href="#">Caldas et al. 2013</a>; <a href="#">Hayes et al. 2010</a>; <a href="#">Hayes et al. 2011</a></p>
<p>Flame Retardants</p>	<p>Any of several classes of materials or coatings that inhibit or resist the spread of fire.</p>	<p>polybrominated diphenyl ethers (PBDEs), hexabromocyclododecane (HBCD), brominated and chlorinated flame retardants, organophosphorus flame retardants (OPFRs)</p>	<p>organisms, surface water, sediment</p>	<p>endocrine disruption, bioaccumulation in tissues, decreased reproductive success, reduced survival, developmental delays, neurobehavioral effects</p>	<p><a href="#">Klosterhaus et al. 2012</a>; <a href="#">Kitamura et al. 2005</a>; <a href="#">Noyes and Stapleton 2014</a>; <a href="#">van de Merwe et al. 2011</a>; <a href="#">Rattfelt Nyholm et al. 2008</a>; <a href="#">Liu et al. 2012</a>; <a href="#">Fayiga and Ipinmoroti 2017</a>; <a href="#">Qiu et al. 2007</a>; <a href="#">Wei et al. 2012</a>; <a href="#">Gauthier et al. 2007</a>; <a href="#">Hites et al. 2004</a>; <a href="#">Darnerud 2008</a>; <a href="#">Kuiper et al. 2007</a>; <a href="#">Verslycke et al. 2005</a></p>
<p>Plasticizers</p>	<p>A chemical additive that increases the plasticity or fluidity of a material.</p>	<p>phthalates, BPA (bisphenol A), DEHP</p>	<p>organisms, surface water, treated wastewater, biosolids, sediments</p>	<p>altered swimming, feeding, and general behavior, bioaccumulation in tissues, endocrine disruption, cytotoxicity (cell damage), genotoxicity (DNA damage), impaired reproduction, inhibited and/or abnormal development, metabolic disruption</p>	<p><a href="#">Espmark Wibe et al. 2002</a>; <a href="#">Huang et al. 2008</a>; <a href="#">Fromme et al. 2002</a>; <a href="#">Iwamuro et al. 2003</a>; <a href="#">Levy et al. 2004</a>; <a href="#">Oka et al. 2003</a>; <a href="#">Lee et al. 2006</a>; <a href="#">Mandich et al. 2007</a>; <a href="#">Lahnsteiner et al. 2005</a>; <a href="#">Sohoni et al. 2001</a>; <a href="#">Lindholst et al. 2001</a>; <a href="#">Brian et al. 2005</a>; <a href="#">Andersen et al. 2001</a>; <a href="#">Brennan et al. 2006</a>; <a href="#">Oehlmann et al. 2006</a>; <a href="#">Lee and Rao Veeramachaneni 2005</a>; <a href="#">Ohtani et al. 2000</a>; <a href="#">Barse et al. 2007</a>; <a href="#">Thibaut and Porte 2004</a>; <a href="#">Kim et al. 2002</a>; <a href="#">Norman et al. 2007</a>; <a href="#">Peijnenburg and Struijs 2006</a>; <a href="#">Barse et al. 2007</a></p>

Per- and Polyfluoroalkyl Substances

A group of man-made chemicals widely used to make carpets, clothing, fabrics, paper packaging for food, or other materials that are resistant to water, grease, or stains.

perfluorooctanoic acid (PFOA), perfluorooctane sulfonate (PFOS), GenX, Teflon, firefighting foam

organisms, surface water, treated wastewater, groundwater, drinking water, sediment

increased mortality, bioaccumulation in tissues, inhibited growth, reduced diversity

[Skutlarek et al. 2006](#); [Ankley et al. 2009](#); [Boudreau et al. 2003](#); [Phillips et al. 2007](#); [Phillips et al. 2010](#); [Yamashita et al. 2008](#); [Giesy and Kannan 2001](#); [Martin et al. 2003](#); [Norström et al. 2015](#); [Guelfo et al. 2018](#); [Möller et al. 2010](#); [Xiao et al. 2012](#); [Boiteux et al. 2012](#)



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