Project Summary

Occurrence of Estrogenic Endocrine Disruptors in Groundwater

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Project Summary

Background:

Concern has emerged about a group of trace organic compounds identified in the aquatic environment which might affect reproduction and development of wildlife species and humans due to endocrine disruption (Colborn et al., 1996; Roefer et al., 2000). Studies in recent years have documented a high occurrence of these endocrine disrupting compounds (EDCs) in aquatic ecosystems which may have serious implications for groundwater quality (e.g., Kolpin et al., 2002). As the hydraulic demand on groundwater supplies increases, resulting in greater groundwater draw downs, the potential for EDC contaminated surface water input to groundwater increases, especially in areas where high capacity wells are located near surface waters. An additional route for entrance of EDCs into groundwater is through the leaching of septic system effluents. Areas such as non-sewered subdivisions may have an increased susceptibility to contamination of the groundwater by EDCs.

Compounds with endocrine disrupting activity include both anthropogenic chemicals produced industrially (such as surface active agents, pesticides, polychlorinated biphenyls (PCBs), plasticizers, food additives, birth control pills, herbal supplements and cosmetics) and natural occurring compounds (such as sex steroids, plant-produced estrogens and heavy metals) (National Research Council, 1999). EDCs are used in large quantities by consumers and industry. Domestic and industrial wastewater and agricultural run-off are recognized as the major sources of EDCs. Due to their physical-chemical properties and partial resistance to biotransformation, EDCs have been detected not only in wastewater effluents, but also at low concentrations in surface and groundwaters used as a source for water supply, and at very low concentrations in tap water samples (Stumpf et al., 1996; Ternes, 1999; Baronti et al., 2000).

Objectives:

1. To test high capacity municipal water supply wells located near surface waters impacted by industrial and municipal effluents will be tested for estrogenic EDCs.
2. To sample wells constructed to monitor groundwater close to non-conventional small scale on site waste disposal systems will be tested.
3. The breast cancer cell line (MCF-7) assay (E-screen) will be used to evaluate groundwater samples and septic samples for estrogenic activity.

Methods:

High capacity wells that may be impacted by nearby surface waters were selected from five Wisconsin communities. Associated drinking water and WDNR personnel were enlisted to perform sample

collection. Each well and associated surface water were sampled four times per year to evaluate seasonal variability. A total of 21 samples were collected from traditional and non-conventional septic systems throughout Southeast Wisconsin. Soil pore water and groundwater samples were collected from lysimeters and monitoring wells installed beneath and adjacent to two of these systems.

Water samples were passed through a C_{18} solid phase extraction disk (Empore^{TM}). Compounds were eluted from the disks and concentrated to 1.5 ml. MCF-7 breast cancer cells were exposed to the extract. Cell proliferation was measured after five days of exposure using the SRB colorimetric protein assay.

Results and Discussion:

All surface waters contained some levels of estrogenic EDC activity. Water from high capacity wells did not contain any measurable estrogenic EDC activity. Estrogenic activity was detected in 20 of 21 septic effluent samples, although concentrations were markedly reduced in systems utilizing either sand filtration or aerobic pretreatment as compared to traditional systems. Although low levels of activity have been detected in soil water directly beneath one septic system, no estrogenic activity was found in groundwaters in this study.

Conclusions/Implications/Recommendations:

There appears to be no infiltration of estrogenic endocrine disrupting chemicals from the surface waters into the associated ground waters. Advanced pretreatment technologies (aerobic, sand filtration) appear to be quite effective at removing estrogenic compounds from septic effluent. Additional removal of EDCs occurs in unsaturated soils beneath septic leach fields; no EDCs were detected in groundwater beneath two systems without advanced pretreatment.

Related Publications:

Publication in progress: A manuscript based on the results from the septic effluents is in preparation in collaboration with Jeff Wilcox and will be submitted to the Journal of Environmental Quality.

Key Words:
Endocrine disruptors, high capacity wells, septic, non-sewered subdivisions, E-Screen.

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