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INNOVATIVE RESEARCH FOR A SUSTAINABLE FUTURE

SHC 3.62 ENVIRONMENTAL RELEASES OF OILS AND FUELS

Output 3.62.2 Tools for evaluating Impacts of Fuels/Oils for Use in Site Remediation, Restoration and Revitalization.

Science Question: How can we better determine the type, degree and extent of impacts of fuel and oils spills on community public health and their resources, especially those that are removed in time and distance from the original contamination?

Output Description: This output provides tools to help site managers and thereby communities to better evaluate and predict the potential public health impacts of fuels and oil spills. These tools will assist in identifying and addressing impacts to advance public health through prevention measures and improved response technologies to minimize impacts to land and water resources. The work reported here builds on previous contaminant fate and transport characterization work for fuels and oils (Conmy and Weaver, 2016), which is necessary to evaluate exposure to populations and impacts to ecosystem services that potentially impact human health and the environment. The work involves assessment of appropriate metrics for oil spill response, remediation, restoration, and revitalization, in the context of potential changes due to various environmental factors. Three specific tools are included in this output: (1) a report on fate of diluted bitumen, (2) a model for petroleum vapor intrusion, and (3) methods to understand the association of private domestic wells and underground storage tank sites.

(1) Report *on the biodegradation and toxicity of* diluted bitumen crude oils to determine fate of bitumen discharged in water.

Unconventional diluted bitumen (dilbit) oil products present an increasing environmental concern because of extensive transport in North America, recent spills into aquatic habitats, and limited understanding of environmental fate and toxicity. Dilbits are blends of highly weathered bitumen and lighter diluent oils that contain higher concentrations of resins and asphaltenes, and lower levels of saturates, with unique properties, including high

Figure 1. Dispersed oil in an experimental wave tank.

adhesion, and the potential for rapid weathering, sinking and associating with sediments. Information on biodegradation, toxicity, dispersion and fate of dilbit is limited and warrants further study, particularly given diversity in diluted bitumen types and weathering state. Recent reviews produced by federal agencies, the National Academies of Science, academics and industry highlight the pressing need to better understand the behavior and potential impacts of dilbit spills over land and water. To address knowledge gaps pertaining to the behavior and fate of spilled diluted bitumen, the SHC Project 3.62 produced a report in 2017 summarizing research on the dispersion effectiveness, physical/chemical characterization, biodegradation and toxicity of two types of diluted bitumen- Cold Lake Blend and Western Canadian Select. Findings support Regions and States for emergency response planning with respect to oil spills under the Oil Pollution Act and National Oil and Hazardous Substances Contingency Plan. These efforts have also been published in Deshpande, 2016; Deshpande *et al.*, 2017; Barron *et al.*, 2017.

(2) User's Guide for PVIScreen Model including distributable software.

Indoor air contamination from subsurface vapors is a potential pathway at contaminated sites. At leaking underground storage tank sites where petroleum fuels have been released, there may be suspected or actual impacts to indoor air of residences or business. Assessing these sites is difficult for both technical and social reasons, and models can play a part in site decision making. Models, are limited, however, in that all their needed parameters are not measured at typical field sites and unless indoor air measurements are made, calibration data are unavailable. The PVIScreen model was developed to provide a practical tool for assessing petroleum vapor intrusion while accounting for uncertainty in the unmeasured parameters. This feature is accomplished by a “Monte Carlo” simulation whereby the 1000 scenarios are constructed and evaluated by systematically using parameters representative of typical ranges of variability.

Figure 2. PVIScreen schematic of petroleum vapor intrusion scenario.

The results are presented in a way that is similar to a weather forecast, as an outcome (exceeding a health screening level) with an associated probability. Site managers can use these results where a line of evidence is needed to support/reject the need for indoor air sampling.

The model and user’s guide have undergone internal and external review by stakeholders from state agencies and industry. Final changes have been made to the software in preparation for a public webinar in 2018 and distribution of the model.

(3) Mapping Private Wells and Site Densities of Underground Storage Tank Sites

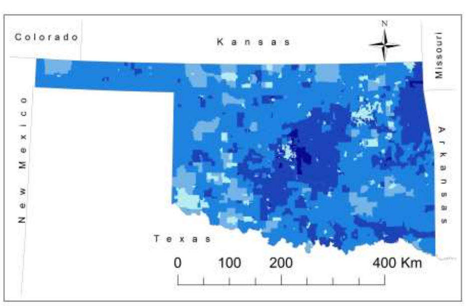

Figure 3. Estimated density of private domestic well use in Oklahoma (darker equals more use).

For protecting drinking water supplies, the locations of areas with reliance on private domestic wells (hereafter referred to as “wells”) and their relationship to contaminant sources need to be determined. A key resource in the U.S. was the 1990 Census where the source of domestic drinking water was a survey question. Because the question was dropped from later censuses, two methods are developed to update estimates of the areal density of well use using readily accessible data. The first uses well logs reported to the states and the addition of housing units reported to the Census Bureau at the county, census tract and census block group scales. The second uses housing units reported to the Census and an estimated well use fraction. To limit the scope and because of abundant data, Oklahoma was used for a pilot project. The resulting well density estimates were consistent among spatial scales, and were statistically similar. High rates of well use were identified to the north and east of Oklahoma City, primarily in expanding cities located over a productive aquifer. In contrast, lower rates of well use were identified in Oklahoma’s second largest city, Tulsa, attributable to a lack of suitable groundwater. Thus rural areas are more likely to have a public water system in the Tulsa area. High densities of private domestic well use may be expected in rural areas without public water systems, expanding cities and suburbs, and legacy areas of well usage. The completeness of reported well logs was tested by counts from neighborhoods with known reliance on wells which showed reporting rates of 20% to 98%. Well densities in these neighborhoods were higher than the larger-scale estimates indicating that locally high densities typically exist within analysis units. A Monte Carlo procedure was used to estimate that 27% of underground storage tanks in Oklahoma were within 300 m (1,000 ft) of one or more water supply wells. Work is continuing to extend these methods and results to the entire United States

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