Supporting Information

Transport of the Pathogenic Prion Protein through Landfill Materials

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Text S1. Parametric Simulations to Evaluate K_d, k_{att}, and k_{det} for Cases where No PrP^{TSE} was Detected in Quartz Sand Column Effluent.

Forward simulations of PrP^{TSE} transport in the quartz sand column experiments were conducted with HYDRUS to evaluate the relevance of K_d, k_{att}, and k_{det} for cases where effluent concentrations were below detection limits throughout the duration of the experiments. All conditions were identical to those used for the column tests. A constant flow rate boundary was applied (0.098 $m \cdot d^{-1}$), and the sand was assigned a porosity of 0.45 and dispersivity of 0.11 mm (Table 1).

Predicted PrP^{TSE} concentrations in effluent from a column are shown in Figure S1 for k_{att} = 0 and K_d = 0.0 and 3.0 $L \cdot kg^{-1}$. These distribution coefficients bracket the range reported by Ma et al. (ref. 1) for PrP^{TSE} binding to quartz sand in batch tests. For these conditions, PrP^{TSE} concentrations in effluent above the detection limit were predicted, whereas no concentrations exceeding the detection limit were observed in the column experiments. In contrast, when k_{att} = 2.60 h^{-1} and K_d = 0 $L \cdot kg^{-1}$, the peak predicted effluent concentration is at the detection limit at one PV (not shown). This suggests that attachment is a more likely binding mechanism than instantaneous linear adsorption, and that the binding observed in the batch tests by Ma et al. (ref. 1) was likely attributable to attachment rather than adsorption. This conclusion is supported by the breakthrough observed from the column tests where PrP^{TSE} was detected in the effluent. When PrP^{TSE} was detected, breakthrough was first observed at < 1 PV, suggesting minimal retardation due to adsorption.

The effect of k_{det} on PrP^{TSE} transport was evaluated by varying k_{det} while setting K_d = 0.0 $L \cdot kg^{-1}$ and k_{att} = 2.6 h^{-1}. When k_{det} = 0.0, these input parameters yield PrP^{TSE} concentrations equal to the detection limit in the column effluent. In contrast, increasing k_{det} only slightly above zero (viz. 0^{-13} h^{-1}) resulted in effluent concentrations exceeding the detection limit in less than 10 PV.

Given that PrP^{TSE} was not observed in any effluent in any of the column tests on soil over 40 PV, and that none of the columns where PrP^{TSE} was observed in the effluent (MSW, GWR columns) exhibited effluent concentrations with a rising tail, detachment of PrP^{TSE} appears unlikely. Consequently, k_{det} was set at 0 for all simulations reported in this manuscript.

Text S2. Estimation of PrP^{TSE} Disposed Annually in Wisconsin.

Several assumptions were required to estimate the mass of PrP^{TSE} disposed in each pit. Levels of prion infectivity in deer tissues have not been reported to date. Therefore, the distribution of prion infectivity in deer tissue was assumed similar to that of scrapie-infected sheep displaying clinical symptoms. Qualitative studies on CWD-infected mule deer support this assumption (2). Levels of infectivity per mass of various ovine tissue assayed by intercerebral injection in mice (3) were scaled by 1000 to account for the mouse-sheep species barrier (4). The remainder of the carcass was assumed to have infectivity at the limit of detection of the mouse bioassay ($10^{2.1}$ infectious unit (IU_{50})·g^{-1}, ref. 1). These values were then multiplied by the total tissue mass of an average adult deer (full data for mule deer can be found in Hakonson et al. [5], similar limited data for white tailed deer in Robinson [6]) to estimate the infectivity per deer. This approach is believed to provide an upper bound estimate of the amount of infectious material disposed. Many of the CWD-positive deer that are disposed do not manifest overt disease symptoms and may contain lower levels of PrP^{TSE} per unit mass of tissue than clinically affected animals.

The mass requiring disposal was assumed to consist of 36% road kill, 47% butcher and hunter waste, and 17% heads from deer obtained within a central region of Wisconsin where practices are in place to eradicate CWD (Alan Crossley, Wisconsin Department of Natural

Resources, personal communication). Worst-case estimates of CWD incidence in the deer populations responsible for each of these waste streams were 6% for road kill (7) and 3% for heads (Alan Crossley, personal communication), and 1% for butcher and hunter waste. Because some of the waste is processed (removal of meat) before disposal, each waste stream was broken down further to estimate its tissue content. We assumed that 50% of the carcass mass was removed from hunter and butcher waste, but all assayed organs remained. We also assumed road kill was composed of whole deer, while the heads contained only the brain and 5 kg of minimally infectious tissue (the remainder of the head). A summary of these estimates is presented in Table S3. For each waste stream, the mass of each relevant tissue type was multiplied by the corresponding level of infectivity per mass. The infectivity was summed across the waste streams waste to obtain 3.0×10^{14} IU_{50} disposed annually. This amount of infectivity was converted to PrP^{TSE} mass by assuming a 10^5:1 ratio of PrP^{TSE} molecules to IU_{50} (*8*) and an average PrP^{TSE} molecular mass of 30 kDa, resulting in 1.49 g PrP^{TSE} disposed annually.

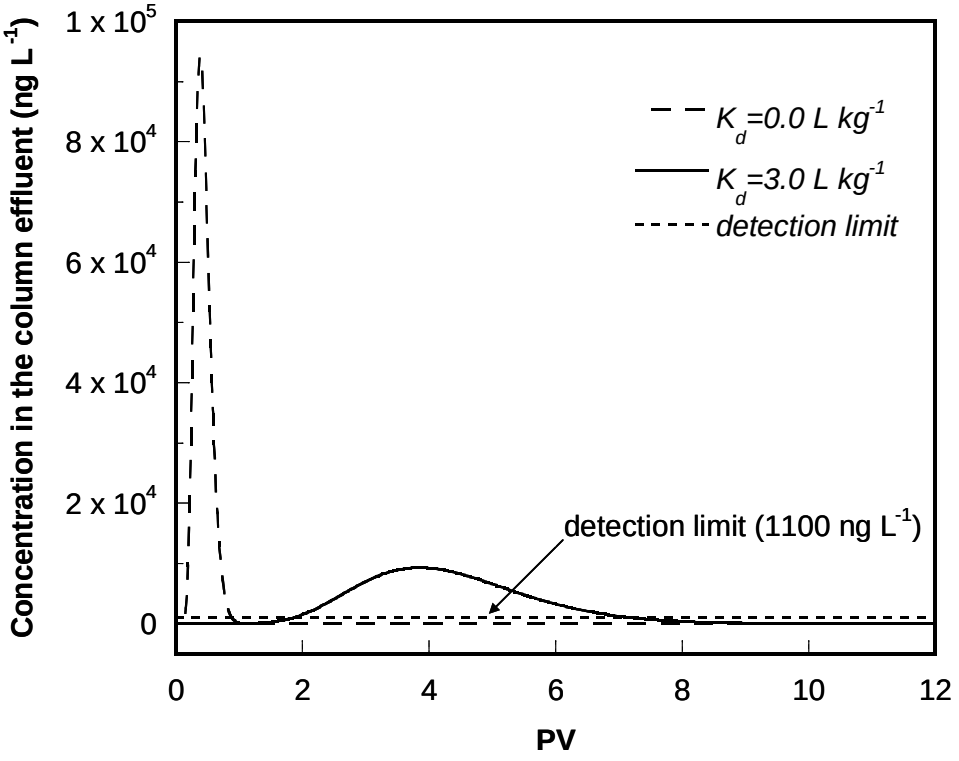

FIGURE S1. PrP^{TSE} concentrations predicted in column effluent using HYDRUS for K_d = 0 and 3.0 L kg^{-1} and k_{att} and k_{det} = 0.

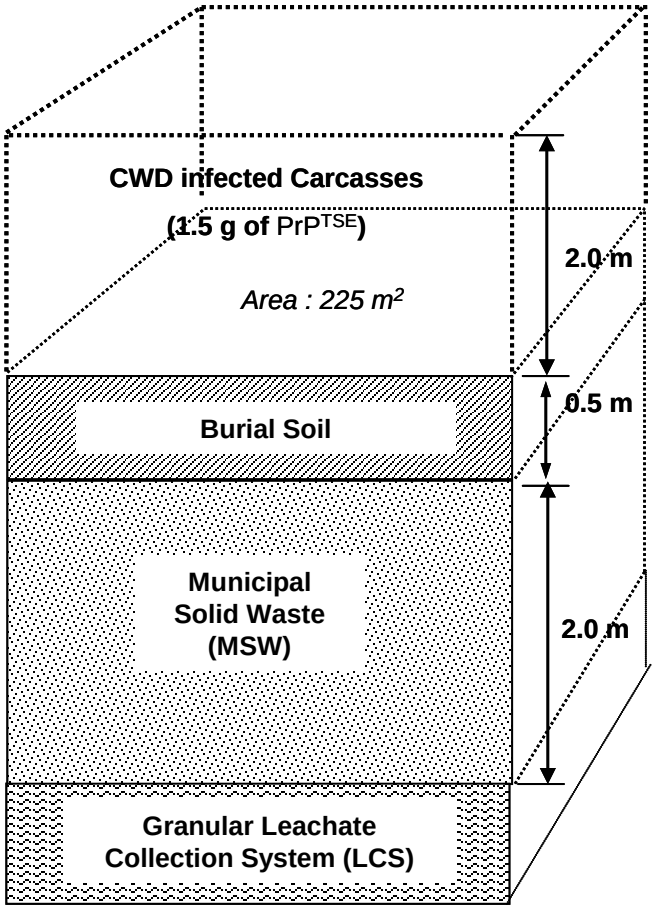

FIGURE S2. Schematic of MSW landfill profile used in simulations of flow and transport in the disposal pit and underlying materials.

TABLE S1. Mineralogy of porous media used in column tests (mass percent)[a]

	quartz sand	Bluestem clay	Boardman silt	green waste residual
quartz	85	67	34	70.4
K-feldspar	5.6	6.9	6.3	7.6
plagioclase	7.9	15	35	15.9
amphibole	–	2.5	1.7	–
calcite	–	0.4	2.3	–
dolomite	–	–	–	–
hematite	–	1.2	0.5	–
mixed-layer illite/smectite	–	4.4	5.9	1.8
illite + mica	0.4	1.3	10	2.7
kaolinite	0.7	1.7	1.7	0.7
chlorite	0.4	0.2	2.7	0.9

[a] Determined by X-ray diffraction analysis (K/T Geoservices Inc. Argyle, TX).

TABLE S2. Properties of MSW leachate

pH	7.7
alkalinity	1263 mg $CaCO_3 \cdot L^{-1}$
conductivity	3.84 $mS \cdot cm^{-1}$
ionic strength	37 mM
reduction potential	-70 mV versus SHE

element[a]	**concentration ($mg \cdot L^{-1}$)**
P	<0.05
K	117.38
Ca	80.12
Mg	93.90
S	11.37
Zn	0.02
B	3.10
Mn	0.06
Fe	1.95
Cu	0.01
Al	<0.05
Na	340.27
anion[b]	
F	5.4
Cl	829.2
Br	7.8
NO_3	208.2
PO_4	<0.02
SO_4	100.2

[a] Determined by Inductively Coupled Plasma Optical Emission Spectroscopy (Wisconsin Soil and Plant Analysis Lab) [b] Determined by Ion Chromatography (Wisconsin Soil and Plant Analysis Lab)

TABLE S3. Estimation of infectious material disposed annually

	mass of disposed infectious tissue per source ($kg \cdot y^{-1}$)					
tissue	**log_{10} estimated cervid infectivity ($ID_{50} \cdot g^{-1}$)[a]**	**roadkill (6% infectious)**	**hunter and butcher waste (1% infectious)**	**disease erradiacation zone heads (3% infectious)**	**log_{10} total infectivity disposed ($ID_{50} \cdot y^{-1}$)**	**mass of PrP^{TSE} disposed ($mg \cdot yr^{-1}$)[b]**
brains	9.9	7.8	3.4	26	14.5	1470
adrenal glands	6.4	0.2	0.1	-	8.9	<0.01
lymph nodes	7.6	7.9	3.4	-	11.7	2.24
pituitary glands	5.7	0.05	0.02	-	7.5	<0.01
spleen	7.8	7.8	3.4	-	11.8	3.51
other tissues	5.1	3000	630	670	11.7	2.70

[a]Cervid infectivity estimated from ovine infectivity data (3) and reported mouse/sheep species barriers to infectivity (4); [b]Mass of PrP^{TSE} estimated from infectivity assuming a 10^5:1 ratio of PrP^{TSE} molecules to IU_{50} [8] and an average PrP^{TSE} molecular mass of 30 kDa.

Text S3. Literature Cited in the Supporting Information

(1) Ma, X.; Benson, C.H.; McKenzie, D.; Aiken, J.M.; Pedersen, J.A. Adsorption of pathogenic prion protein to quartz sand. *Environ. Sci. Technol.* **2007,** *41*, 2324-2330.

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