



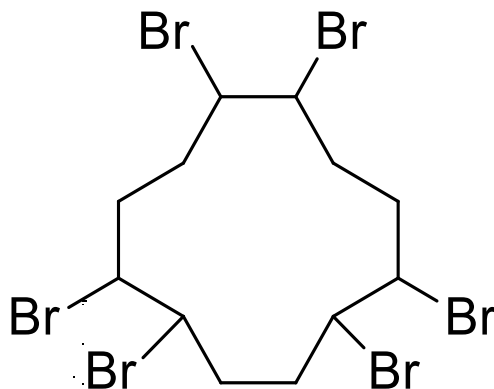
# Final Risk Evaluation for Cyclic Aliphatic Bromides Cluster (HBCD)

## Systematic Review Supplemental File: Data Extraction Tables for Environmental Fate and Transport Studies

CASRN: 25637-99-4

CASRN: 3194-55-6

CASRN: 3194-57-8



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**Table 1. Biodegradation Study Summary for HBCD**

Study Type (year)	Initial Concentration	Inoculum Source	(An)aerobic Status	Duration	Result	Comments	HERO	Data Quality Rating
<b>Water</b>								
OECD Guideline 301 D (Ready Biodegradability: Closed Bottle Test)	7.7 mg/L	activated sludge, domestic, adapted	aerobic	28 days	0% based on Theoretical oxygen demand (0.75 mg/O <sub>2</sub> mg)		<a href="#">3970217</a>	High
OECD Guideline 302 B (Inherent biodegradability: Zahn-Wellens/EMPA Test)	3.64 mg/L	activated sludge, domestic, non-adapted	aerobic	56 days	After 56 days: Viable sludge mixtures [21%] with less than 2% [14C] products throughout the study; biologically inhibited controls = 40% [14C] HBCD with 25% [14C] products at 25 days and 44% [14C] products at 56 days.		<a href="#">3970739</a>	High
Digested sewage sludge under anaerobic conditions	3.9 nmol	sewage, domestic, non-adapted	anaerobic	238 days	(±)-alpha-HBCD degraded more slowly than (±)-beta-HBCD and (±)-gamma-HBCD by an estimated factor of 1.6 and 1.8, respectively		<a href="#">1443845</a>	High
Digested sewage sludge under anaerobic conditions	3.9 nmol	sewage, domestic, non-adapted	anaerobic	238 days	(±)-beta-HBCD degraded more rapidly than (±)-alpha-HBCD by an estimated factor of 1.6		<a href="#">1443845</a>	High
Digested sewage sludge under anaerobic conditions	3.9 nmol	sewage, domestic, non-adapted	anaerobic	238 days	(±)-gamma-HBCD degraded more rapidly than (±)-alpha-HBCD by an estimated factor of 1.8		<a href="#">1443845</a>	High
Digested sewage sludge under anaerobic conditions	10 to 11 nmol	sewage, domestic, non-adapted	anaerobic	238 days	half-life = 0.66d		<a href="#">1443845</a>	High
OECD Guideline 301 D (Ready	7.7 mg/L	activated sludge,	aerobic	28 days	0% based on Theoretical oxygen demand	Although this IUCLID summary omits several	<a href="#">3970216</a>	High































Study Type (year)	Initial Concentration	Species	Duration	Result	Comments	HERO ID	Data Quality Rating
				1/1.3/3.6; Goldeye/mussels: 8.2/1/0.3.			
OECD Guideline 305 C (Bioaccumulation: Test for the Degree of Bioconcentration in Fish) - [before 14 June 1996]		carp ( <i>Cyprinus carpio</i> )	14 weeks	Low/high BCFs for 3 isomers: 3390-16100/834-3070, 3350-8950/816-1780, and 479-2030/118-418; Low/high DT50s for 3 isomers: 38.3/38.6 days, 10.5/16.2 days, and 15.2/22.6 days steady state had been reached by 14 weeks; specific BCF for fillet, head, integument, and viscera were also reported		<a href="#">4140430</a>	High
Diastereomer-specific accumulation and trophic transfer of HBCD in a Norwegian coastal food web	≤280 ng/g lw	Blue mussel ( <i>Mytilus edulis</i> ), lugworm ( <i>Arenicola marina</i> ), shore crab ( <i>Carcinus maenas</i> ), common eider ( <i>Somateria mollissima</i> ), great black-backed gull ( <i>Larus marinus</i> )	1RW DSSOLFDEOH	TMF alpha-HBCD = 9.1 (ww) and 2.6 (lw), gamma-HBCD = 0.9 (ww) and 0.3 (lw); BMFs = 0.1 to 1285 (ww); 0.1 to 26 (lw); specific values in report, corrected for trophic level Predator/prey BMF wet weight: alpha-HBCD range 0.1-1285 and gamma-HBCD 0.2-116 (Sum HBCD = 0.2-425); BMF lipid-normalized alpha-HBCD range 0.2-26 and gamma-HBCD 0.1-2.0 (Sum HBCD = 0.5-7.9)		<a href="#">1927667</a>	High
Accumulation in a freshwater food web	≥11 to ≤2370 ng/g lw (in aquatic species)	Chinese mystery snail, Prawn, Mud carp, Crucian carp, Northern snakehead, Water snake	1RW DSSOLFDEOH	TMF (+)-alpha-HBCD = 2.22; TMF (±)-alpha-HBCD = 2.19; TMF = 2.18 (-)-alpha-HBCD TMF basis: concentration and TL correlation, considered not significant for (-)-alpha-HBCD		<a href="#">1927678</a>	High
Accumulation in a freshwater food web	≥11 to ≤2370 ng/g lw (in aquatic species)	Chinese mystery snail, Prawn, Mud carp, Crucian carp,	1RW DSSOLFDEOH	TMF = 1.83 TMF basis: concentration and TL correlation, considered not		<a href="#">1927678</a>	High

Study Type (year)	Initial Concentration	Species	Duration	Result	Comments	HERO ID	Data Quality Rating
		Northern snakehead, Water snake		significant; (±)-beta-HBCD not detected at levels appropriate for quantification and accumulation analysis			
Accumulation in a freshwater food web	≥11 to ≤2370 ng/g lw (in aquatic species)	Chinese mystery snail, Prawn, Mud carp, Crucian carp, Northern snakehead, Water snake	Not applicable	No correlations between TL and (±)-gamma-HBCD, (-)-gamma-HBCD or (+)-gamma-HBCD		<a href="#">1927678</a>	High
EPA OPPTS 850.1730 (Fish Bioconcentration Test)*This report starts on the bottom half of page 37 of HERO ID: 3970216.	0.34 to 3.4 µg/L	Oncorhynchus mykiss (Fish, fresh water)	70 days: 35 uptake, 35 days depuration	BCF values. 3.4ug/L: Whole fish = 8,974; Edible tissue = 4,650; Non-edible tissue: 12,866.Steady state not achieved for 0.34ug/L test, no BCF reported.		<a href="#">3970216</a>	High
Freshwater BAF		Oncorhynchus mykiss; Perca fluviatilis; Carassius carassius; Rutilus rutilus; Cyprinus carpio; Scardinius erythrophthalmus; Rudd/Roach hybrid; Tinca tinca; Esox lucius	Not applicable	1300 (250-3500)Average BAF based on fish muscle samples (range); steady-state/equilibrium not confirmed		<a href="#">1927694</a>	High
Biota monitoring/metabolism		Japanese common squid (Todarodes pacificus)	Not applicable	alpha-HBCD: 85-89%, beta-HBCD: 1.2-1.4%, gamma-HBCD: 9.4-14%Proportion of each stereoisomer to total HBCD from the two sites	Monitoring study where BAF/BCF values were not reported.	<a href="#">1927684</a>	Unacceptable
Freshwater BAF		Oncorhynchus mykiss; Perca fluviatilis; Carassius; Rutilus rutilus; Cyprinus carpio; Scardinius erythrophthalmus; Rudd/Roach hybrid; Tinca tinca; Esox lucius	Not applicable	810 (110-3200)Average BAF based on fish muscle samples (range); steady-state/equilibrium not confirmed		<a href="#">1927694</a>	High

Study Type (year)	Initial Concentration	Species	Duration	Result	Comments	HERO ID	Data Quality Rating
Freshwater BAF		Oncorhynchus mykiss; Perca fluviatilis; Carassius carassius; Rutilus rutilus; Cyprinus carpio; Scardinius erythrophthalmus; Rudd/Roach hybrid; Tinca tinca; Esox lucius	Not applicable	2100 (3100-6000)Average BAF based on fish muscle samples (range); steady-state/equilibrium not confirmed		<a href="#">1927694</a>	High
Freshwater BAF		Oncorhynchus mykiss; Perca fluviatilis; Carassius carassius; Rutilus rutilus; Cyprinus carpio; Scardinius erythrophthalmus; Rudd/Roach hybrid; Tinca tinca; Esox lucius	Not applicable	5900 (1200-23000)Average BAF based on fish muscle samples (range); steady-state/equilibrium not confirmed		<a href="#">1927694</a>	High
This study investigated total HBCD concentration and enantiomeric fractions of (+)- and (-)-alpha-HBCD in mud carp and northern snakehead in a contaminated pond in South China.		Prey fish: mud carp, Cirrhinus molitorella. Predator fish: northern snakehead, Ophicephalus argus.	Not applicable	Mop carp = 625, northern snakehead = 6431.enantiomeric fraction (EF, expressed as (+) concentration over (-) concentration) in mud carp = 0.53-0.62 (greater than standard solution of 0.5). Northern snakehead EF = 0.35-0.50. Results indicate metabolism of enantiomers varies between species since EF values changed between prey fish (mud carp) and predator fish (northern snakehead)		<a href="#">3350534</a>	High
Measured concentrations of (+) and (-) $\alpha$ -, $\beta$ -, and $\gamma$ -HBCD in several marine organisms and field plants.		Several organisms	Not applicable	$\alpha$ -HBCD comprised more than 60% of HBCD concentration in all but 3 species at site A and 2 at site		<a href="#">2343741</a>	High

Study Type (year)	Initial Concentration	Species	Duration	Result	Comments	HERO ID	Data Quality Rating
This report addresses to the marine organism portion.				B. $\gamma$ -HBCD was the next most abundant. Trophic magnification factor for $\alpha$ -HBCD = 2.58. TMF for total HBCD = 2.44. Enantiomeric fractions for $\alpha$ -, $\beta$ -, and $\gamma$ -HBCD were 0.495-0.688, 0.290-0.431, 0.244-0.531 (ND in half of the $\gamma$ -HBCD samples), respectively.			
EPA OPPTS 850.1730 (Fish Bioconcentration Test) Non-steady state BCF test.		Oncorhynchus mykiss (previous name: Salmo gairdneri) (Rainbow trout)	70 days (35 days of exposure/uptake and 35 days of depuration)	Edible fraction: 14,039, Non-edible fraction: 30,242, Whole body d.w.: 21,940. No mortalities observed. No treatment-related clinical signs of toxicity observed during test.		<a href="#">3970741</a>	High
EPA OPPTS 850.1730 (Fish Bioconcentration Test) Steady-state bioconcentration factor (BCF) test		Oncorhynchus mykiss (previous name: Salmo gairdneri) (Rainbow trout)	70 days (35 days of exposure/uptake and 35 days of depuration)	Edible fraction: 4,650, Non-edible frac: 12,866, Whole body d.w.: 8,974.		<a href="#">3970741</a>	High
Biomagnification from a simple food chain model	$\geq 1.08$ to $\leq 50.5$ other	Atlantic cod (Gadus morhua); polar cod (Boreogadus saida); harbor seal (Phoca vitulina); ringed seal (Phoca vitulina); Eggs of common tern (Sterna hirundo); eggs of arctic terns (Sterna paradisaea)	Not applicable	BMF = 2.0 (Atlantic Cod:Oslofjord Seal), BMF = 1.2 (Atlantic Cod:Froan Seal), BMF = 2.0 (Polar Cod:Spitsbergen Seal) Simple cod-harbor seal food chain model BMF = [concentration in predator]/[concentration prey]		<a href="#">1927762</a>	High
		benthivorous barbel (Barbus graellsii); pelagic bleak (Alburnus alburnus)	Not applicable	Dynamic BSAF = 0.7 (Bleak) 0.9 (Barbel); Steady state BSAF = 0.75 (Bleak) 0.9 (Barbel) BSAF = Measured BSAF = 0.7 (measured range 0.10-1.44)		<a href="#">1927786</a>	High

Study Type (year)	Initial Concentration	Species	Duration	Result	Comments	HERO ID	Data Quality Rating
				(Bleak); 0.5 (measured range 0.14-1.23) (Barbel)Average BSAFs per chemical per species (approximation from bar graphs); Lipid and organic-matter normalized BSAF			
Biomagnification of $\alpha$ -HBCD and $\gamma$ -HBCD in an aquatic food web based on concentrations in predator/prey		Lake Trout ( <i>Salvelinus namaycush</i> ); Rainbow smelt ( <i>Osmerus mordax</i> ); Slimy sculpin ( <i>Cottus cognatus</i> ); Alewife ( <i>Alos pseudoharengus</i> ); Mysids ( <i>Mysis relicta</i> ); amphipods ( <i>Diporeia hoyi</i> ); Plankton	Not applicable	TMF = 6.3 (Total HBCD); BMF = 0.4-10.8 ( $\alpha$ -HBCD), 0.2-9.9 ( $\gamma$ -HBCD)lipid normalized BMFs based on concentrations in predator relative to prey; trout/alewife $\alpha$ -HBCD = 4.8, $\gamma$ -HBCD = 7.5; trout/smelt $\alpha$ -HBCD = 1.0, $\gamma$ -HBCD = 1.5; trout/sculpin $\alpha$ -HBCD = 1.1, $\gamma$ -HBCD = 0.8; sculpin/Diporeia $\alpha$ -HBCD = 3.5, $\gamma$ -HBCD = 2.5; sculpin/Mysis $\alpha$ -HBCD = 9.7, $\gamma$ -HBCD = 9.9; smelt/Mysis $\alpha$ -HBCD = 10.8, $\gamma$ -HBCD = 5.5; smelt/Diporeia $\alpha$ -HBCD = 4.0, $\gamma$ -HBCD = 1.4; alewife/plankton $\alpha$ -HBCD = 0.4, $\gamma$ -HBCD = 0.2		<a href="#">1927822</a>	High
Non-guideline food chain study		mysid shrimp, gudgeon, pranunus, copepods	Not applicable	BMF = 10-12 mysid shrimp to gudgeon	(Related to HERO ID 4269983).	<a href="#">4269990</a>	High
Accumulation in microalgae	$\leq 2$ ng/mL	Spirulina subsalsa and Scenedesmus obliquus	168 h	BCF: S. sub salsa; alpha: 350, beta: 270, gamma: 174. S. obliquus; alpha: 407, beta: 469, gamma: 390.		<a href="#">2343690</a>	High
Samples collected near an expanded polystyrene material manufacturing plant		mantis shrimp ( <i>Oratosquilla oratoria</i> ), helice crab ( <i>Helice tridens tientsinensis</i> ) and	Not applicable	aquatic trophic magnification factor = 1.75, 1.83, 1.64 and 1.72 for alpha-, beta-, gamma-, and total HBCDs, respectively		<a href="#">3546055</a>	High

Study Type (year)	Initial Concentration	Species	Duration	Result	Comments	HERO ID	Data Quality Rating
		partial flathead (Platycephalus indicus)					
Benthic macrofauna accumulation in experimental coastal ecosystems	0.043 to 0.079 ug/mg other	M. balthica	three tests: 21d, 13/14d, and 231 day	log BSAF > 1.25 Total HBCD; $\alpha$ -HBCD: log BSAF 2.1-5.2; $\beta$ -HBCD log BSAF < 1.8; $\gamma$ -HBCD log BSAF 0.4 Calculation details in supplemental data		<a href="#">3013490</a>	Low
<b>Terrestrial</b>							
bioaccumulation: terrestrial	Mean measured concentration in soil (ng/g soil d.w.): $\alpha$ -HBCD = 186; $\beta$ -HBCD = 156; $\gamma$ -HBCD = 172.	Eisenia fetida - [Annelida]	21 days	BSAF for E. fetida and M. Guillelmi: $\alpha$ -HBCD: 2.58 and 1.1; $\beta$ -HBCD: 0.270 and 0.497; $\gamma$ -HBCD: 0.444 and 0.205, respectively.		<a href="#">3350510</a>	High
Monitoring study		Adipose, brain, liver collected from m/f East Greenland polar bears (Ursus maritimus) between 1999-2000; blubber tissue from m/f ringed seals (Pusa hispida) between 2001-2002 in same area as bears	Not applicable	BMF in polar bear adipose 1.7; alpha-HBCD was not detected in brain or liver tissue		<a href="#">1443826</a>	High
Biomagnification in predatory terrestrial food chains		Predators: common kestrel (Falco tinnunculus), eagle owl (Bubo bubo), little owl (Athene noctua), prey: sparrow (Passer montanus) and rats (Rattus norvegicus)	Not applicable	Appears to be in the supplemental report which was not readily available	Biomagnification was not reported.	<a href="#">1927541</a>	Low

Study Type (year)	Initial Concentration	Species	Duration	Result	Comments	HERO ID	Data Quality Rating
Inter-species Biomagnification from bird samples collected at e-waste, urban and rural sites in South China		Samples collected from 3 South China sites		BMF in OMR: e-waste = 0.04 - 2.7 (median 0.05), urban = 2.3, rural = 1.4, LVB: rural = 30; TMF of gamma could not be determined		<a href="#">1927580</a>	High
Inter-species Biomagnification from bird samples collected at e-waste, urban and rural sites in South China		Samples collected from 3 South China sites	Not applicable	BMF range 0.32 - 158; LTS: e-waste = 2.6, rural = 1.1, OMR: e-waste = 1.3, urban = 4.9, rural = 1.4, LVB: rural = 30; TMF of the alpha-isomer was implied by the data but not quantified		<a href="#">1927580</a>	High
Inter-species Biomagnification from bird samples collected at e-waste, urban and rural sites in South China		Samples collected from 3 South China sites	Not applicable	BMF could not be determined as the beta isomer was only present in one sample		<a href="#">1927580</a>	High
Kinetic study of gamma-HBCD oral administration to laying hens; conducted under the guidelines of the French Ministry of Agriculture for Animal Research		48 Laying hens (Gallus domesticus) Isa Brown, 22 weeks old, 1.78+/-0.09 kg	39 day	0.4 pg/g lipid relative to pg/g diet in egg yolk and 0.3 pg/g lipid relative to pg/g diet in liver; Half-lives for gamma-HBCD in egg yolk = 2.9 days, abdominal fat = 13 days and liver tissue = 0.41 days		<a href="#">1927629</a>	High
Aquatic and terrestrial BMF of HBCD via analysis of food webs in South China		40 samples collected from 6 bird species between 2005 and 2008 in Qingyuan County e-waste recycling region in Pearl River Delta; further detail referenced	Not applicable	BMF alpha-HBCD fish to fish-eating bird: 4.1 to 50 lw, BMF grain to terrestrial bird: 2.8 to 75 ww		<a href="#">1927673</a>	High
Aquatic and terrestrial BMF of HBCD via analysis of food webs in South China		40 samples collected from 6 bird species between 2005 and 2008 in Qingyuan County e-waste	Not applicable	BMF gamma-HBCD: fish to fish-eating bird: 1.6 to 3.0 lw and BMF grain to terrestrial bird; 7.1 to 51		<a href="#">1927673</a>	High

Study Type (year)	Initial Concentration	Species	Duration	Result	Comments	HERO ID	Data Quality Rating
		recycling region in Pearl River Delta; further detail referenced					
No guideline reported. *This report is found on page 38 of HERO ID: 3970216.		Earthworm	28 days	4.5		<a href="#">3970216</a>	High
Accumulation of HBCD in eggs of predatory birds		peregrine falcon eggs (Falco peregrinus), white-tailed sea eagle (Haliaeetus albicilla), guillemot (Uria algae), common tern (Sternahirundo), herring (Clupea harengus)	Not applicable	% HBCD in Herring: $\alpha$ -HBCD 65-70% $\beta$ -HBCD 5-9%, $\gamma$ -HBCD: 25.33%; Common tern $\alpha$ -HBCD 96% $\beta$ -HBCD nd, $\gamma$ -HBCD: nd; Guillemont: $\alpha$ -HBCD 100% $\beta$ -HBCD nd, $\gamma$ -HBCD: <1%; White-tailed sea eagle and Peregrine falcon: $\alpha$ -HBCD 100% $\beta$ -HBCD nd, $\gamma$ -HBCD: nd	Limitations in the analytical methods were reported and samples were collected at various times in multiple monitoring efforts previously reported; storage and handling of the samples were not reported; stability of the sample integrity not reported or confirmed.	<a href="#">1927746</a>	Unacceptable
Biomagnification in polar bear marine food web		amphipods Gammarus wilkitzkii; polar cod (Boreogadus saida); ringed seals (Pusa hispida); polar bears (Ursus maritimus)	Not applicable	BMF = 36.4 (ww) and 10.9 (lw) for Ringed seal/polar cod; BMF = 0.6 (ww) and 0.7 (lw) for Polar bear/ringed seal; amphipod BMF between higher species could not be calculated due to no detection of HBCD in the lower trophic level species		<a href="#">1927787</a>	High



**Table 3. Hydrolysis Study Summary for HBCD**

Study Type (year)	pH	Temperature	Duration	Results	Comments	HERO ID	Data Quality Rating
Bromide ion (detection limit = 200 ppm)	Tested, no significant trend		39 days	No degradation reported		<a href="#">4270831</a>	High
No guideline followed			39 days	No other data is reported besides what is shown in the previous fields.	Several deficiencies were noted. Neither target chemical or transformation product concentrations were reported. Percent recovery was not reported.	<a href="#">3970738</a>	Unacceptable

**Table 4. Sorption Study Summary for HBCD**

Study Type (year)	Sorbent Source	Sorbent Qualities (clay/silt/sand, OC, pH)	Duration	Results	Comments	HERO ID	Data Quality Rating
OECD Guideline 121 (Estimation of the Adsorption Coefficient (Koc) on Soil and on Sewage Sludge using High Performance Liquid Chromatography (HPLC))	soil/sewage sludge		Not applicable	Log Koc >5.0 at 22°C. The retention time of HBCD was outside the calibration range so no accurate value could be estimated (12.95 min retention, last reference substance was 9.46 min.)		<a href="#">3970742</a>	High

**Table 5. Other Fate Endpoints Study Summary for HBCD**

Study Type (year)	System	Results	Comments	HERO ID	Data Quality Rating
Concentrations of HBCD measured in air and precipitation samples from October 2008 to July 2010 in the Northern Lake Victoria Region, East Africa.	PUF+filters extracted with 70:30 hexane:acetone (ASE 200, Dionex) and eluted over 10% deactivated silica with 5% MeOH in DCM. Fractionated on activated silica using hexane and hex:DCM 1:1.	HBCD was below the MDL in 2008 and 2009 samples. In 2010, HBCD was detected in 71% of the samples. Arithmetic mean: 1.47 pg/m <sup>3</sup> ; geometric mean; 0.82 pg/m <sup>3</sup> ; median: 1.15 pg/m <sup>3</sup> .		<a href="#">2343716</a>	High
thermal degradation study	thermogravimetric analyzers and a laboratory-scale fixed-bed reactor	75% Bromine by weight is released as HBr		<a href="#">3575301</a>	High
Study investigates the uptake pathway, translocation, and isomerization of HBCD by Wheat.	In exposure chamber: 4 plants tested in unspiked and spiked soil. In control chamber (no HBCD): 4 plants tested in unspiked soil.	BCFs in the roots (RCF), stems (SCF), and leaves (LCF) were calculated for $\alpha$ -, $\beta$ -, and $\gamma$ -HBCD: RCFs were all between 1-3 except for $\gamma$ in weeks 1 and 2 (0.55 and 0.96). All SCFs and LCFs were between 0.100 and 0.880. All BCFs increased from week to week. For RCFs and SCFs: $\alpha$ - > $\beta$ - > $\gamma$ -HBCD, however for LCFs: $\gamma$ - > $\beta$ - > $\alpha$ -HBCD.		<a href="#">3350492</a>	High
Global screening of atmospheric HBCD concentrations from 2005-2006.	Passive air sampling	HBCD detected in 56% of samples. Samples ranged from <0.1-190 pg/m <sup>3</sup> (includes all HBCD isomers).		<a href="#">3350487</a>	High
Abiotic degradation of HBCD in indoor dust in the presence and absence of light		Loss of HBCD was observed in all samples with greater degradation observed in the presence of light with t <sub>1/2</sub> = 12.2wks vs. t <sub>1/2</sub> = 26wks in its absence; isomerization of $\gamma$ -HBCD to $\alpha$ -HBCD was observed and net degradation of standards in the presence of light varied from 5.5%/7d for $\alpha$ -HBCD and 8.5%/7d for $\gamma$ -HBCD; no change was		<a href="#">1927725</a>	High

Study Type (year)	System	Results	Comments	HERO ID	Data Quality Rating
		observed for enantiomeric fractions in all samples			
Sediment/water partitioning study that tested the impact of bioturbating microfauna on HBCD distribution.	Four experiments were done to test each combination of HBCD spiked/non-spiked phytoplankton in the presence/absence of benthic microfauna. Treatment a and c: unspiked phytoplankton, treatment c and d: macrofauna present. Nominal [HBCD]: 43ug/container.	[HBCD] was lower in filtered water than unfiltered, both showed decreases over 3 weeks however. Sediment concentrations increased largely over 3 weeks. [HBCD] in M. Balthica increased greatly after 7 days but changed very little from day 7-21. Filtered water was more enriched in alpha and beta HBCD. Sediment with microfauna had decreased beta and increased gamma than without microfauna. M. Balthica had decreased gamma and increased alpha over 21 days. After 21 days, 88% of HBCD was in the sediment, 11% was in the bivalves; and <1% was in the particulate or dissolved.		<a href="#">3013490</a>	High
Partitioning/transport from household dust to laundry wastewater	Not applicable	HBCD was detected in 95% of dust samples <1 to 3160 ng/g (median 300 ng/g), alpha-HBCD accounted for 69% of total-HBCD; HBCD was detected in 26% of laundry wastewaters <1 to 1270 ng/L, alpha-HBCD accounted for 63% of total-HBCD (after removal of one outlier sample)		<a href="#">2528320</a>	High
Measured HBCD enantiomer and diastereomer profiles in terrestrial plants.		Total HBCD concentrations: Leaf > root > soil. In all plants, alpha HBCD concentrations followed a trend of leaf < root < soil. Enantioselectivity was		<a href="#">2343741</a>	High

Study Type (year)	System	Results	Comments	HERO ID	Data Quality Rating
		seen in most of the plants but not in the roots.			
Waste-water removal	Sewage treatment systems not described	Water treatment systems removal rate at 12-STP located in Japan was on average 93% (range 80-99%); the author suggests that HBCDs passed into sewage sludge during the treatment process, but no analysis was performed		<a href="#">2343678</a>	High
Stereo-isomer specific bioaccumulation in marine mammals	25ml Erlenmeyer flasks, shaking water bath	Biotransformation: beta-isomer 69±16%; gamma-isomer 60±10%, alpha-HBCD 17±14% after 90 mins		<a href="#">4140500</a>	High
Behavior of HBCD during incineration of solid wastes	Pilot-scale incinerator with rotary kiln, primary combustion unit and vertical secondary combustion chamber connected to gas cooling zone; air pollution control until includes filter bag, activated carbon adsorption tower and wet scrubber.	HBCD was steadily degraded for an overall removal of 99.99% along the gas treatment flow line and all isomers behaved similarly		<a href="#">2343703</a>	High
Monitoring influent/effluent concentration at several WWTPs.	Treatment system types included: Conventional-activated sludge process; SYMIO; Bio-Best-Bacillus process; Aerobic digestion (bacillus sp.); Modified Ludzach-Ettinger.	41.3% removal efficiency; HBCD [Effluent]/[Influent]: Human waste treatment plant = 0.39-0.92; sewage treatment plant = 0.54-0.63; waste water treatment plant = 0.36-0.84.	Study results not relevant to a specific/designated fate endpoint.	<a href="#">3545985</a>	High
HBCD concentrations in sediment and wildlife	Regional Monitoring Program	HBCD was detected in sediments (0.1 to 2 ng/g; median 0.3 ng/g; gamma 51-100%; beta 0-27%; alpha 0-36%) and all wildlife matrices, eggs 22-39 ng/g; shiner surfperch 3-25 ng/g; seal adults and pups 4-19 ng/g and 2-12 ng/g; white croaker <6-	Not a designated/specific Fate endpoint; monitoring study with a qualitative assessment of the results.	<a href="#">1443796</a>	High

Study Type (year)	System	Results	Comments	HERO ID	Data Quality Rating
		5ng/g. Increase in HBCD conc between seal adults and one of its prey suggest that biomagnification may be occurring.			
Trophodynamics in a marine food-web		alpha-HBCD trophic level adjusted BMF in predator/prey feeding relationships ranged from 0.1 to 1.7; the alpha isomer accounted for ca. 90% of the body burden for beluga while it was only 20% in its primary prey the arctic cod (beta: 4% and gamma 78%), indicating that the beluga can bioprocess the gamma isomer to the alpha-isomer.	Not a designated/specific Fate endpoint; non-guideline monitoring data field sampling used appropriately.	<a href="#">1279130</a>	High
Accumulation and biotransformation in two Dutch food chains		HBCD levels increased from invertebrates to fish but decreased from fish to tern egg; ca. 200 ng/g lw HBCD in tern egg; ca. 400 ng/g lw HBCD in sandeel (dominant food for terns); and ca. 100 ng/g lw HBCD in invertebrates; alpha-HBCD diastereomer is the primary isomer in tern eggs and fish	Study results not relevant to a specific/designated Fate endpoint.	<a href="#">4140495</a>	Medium
Activated Sludge Respiration Inhibition		29.1% inhibition was observed for HBCD treatment group.	This is a secondary source and does not apply to a specific/designate Fate endpoint; it is a robust summary and a reference was provided Schaefer E and Siddiqui A. 2003. Hexabromocyclododecane (HBCD): An Activated Sludge, Respiration Inhibition Test. Project	<a href="#">1443881</a>	Medium

Study Type (year)	System	Results	Comments	HERO ID	Data Quality Rating
			Number: 439E-108A. Wildlife International, Ltd. Easton, MD.		
Spatial trends of brominated flame retardants evaluated from the generation of backward air trajectories and air samples collected from Lake Michigan through the US Midwest to the Gulf of Mexico		Backward trajectories of HBCD were not included or reported. HBCD was only detected in particle-phase samples at concentrations ranging from 0.2-8.0 pg/m <sup>3</sup> (MI), 0.9-9.6 pg/m <sup>3</sup> (CH), 0.2-3.6 pg/m <sup>3</sup> (IN), 0.2-11 pg/m <sup>3</sup> (AR), 0.16-6.2 pg/m <sup>3</sup> (LA); gamma and alpha isomers varied within samples and were the most abundant overall while the beta accounted for 6-17%.	Air-transport modeling was not applied/reported for HBCD; however, informative data was reported on isomeric mixture in air.	<a href="#">999242</a>	Medium
In-house test chamber experiment for migration to dust of HBCDs from source material via volatilization and deposition	Stainless steel cylindrical test chamber	Migration of HBCD from point sources to dust was observed but not quantified	Overall this test is an indicator of the importance of sink effects when studying migration to dust since steady-state was not achieved due to limited study time.	<a href="#">2528329</a>	Medium
Evaluation of Arctic ice core to identify atmospheric deposition history	Field monitoring	HBCD was not detected in core samples representing 1953-1962 or 1971-1980; HBCD was detected in 1962-1971 ca. 6.07 ng/L, 1980-1988 ca. 11.97 ng/L, 1988-1996 ca. 9.01 ng/L, 1995-2005 ca. 19.53 ng/L; deposition trends show an increase over time and the peak input flux was calculated as 910 pg/cm <sup>2</sup> yr in 1995-2005; air-mass trajectories suggested that Europe is an important haze-season source and air mass	Study results not relevant to a specific/designated Fate endpoint.	<a href="#">1927665</a>	Medium

Study Type (year)	System	Results	Comments	HERO ID	Data Quality Rating
		flow from northern Russia and Siberia dominate year round.			
Estimating the amount of HBCD in air using established octanol/air partition coefficients and known concentration in tree bark.	Calculated octanol/air partition coefficients from log KOA = 0.98784 log P + 6.6914 to estimate amount of HBCD in air with known concentrations in tree barks via $K(BA) C(B)/C(A)$ .	Estimated K(OA) at 25 deg C: alpha-HBCD = 14.5; beta-HBCD = 15.2; gamma-HBCD = 14.6	Study does not lend new insight or valid data to an existing model. Studies that apply an existing model to a specific site/situation should be excluded unless it's also presented alongside new data. Could be considered for monitoring data.	<a href="#">1927637</a>	Low
photodegradation study		No loss after 371 d in two textile samples	Data not likely useful for photodegradation in the environment.	<a href="#">3809158</a>	Low
Temperature effects of water temperature on HBCD partitioning in the environment	Study conducted outside with natural light, sheltered from rain in 5-L polypropylene buckets with 3.75 L of Baltic Sea water (Salinity: 7.5) and ca. 2 cm of Imm-seived sediment and 4 M.balthic, 2 C. gluacum and 10 Hydrobiidae added	Significant differences were found in filtered and unfiltered water fractions at day 1: $\alpha$ -HBCD and $\beta$ -HBCD were enriched in filtered water while $\gamma$ -HBCD was depleted; an increase in $\alpha$ -HBCD was observed in the warmer water; No significant differences or trends were found in filtered and unfiltered water fractions at day 13; in sediment $\gamma$ -HBCD was enriched and $\beta$ -HBCD was depleted with no significance correlated to time or temperature; M. balthica were $\gamma$ -HBCD depleted and $\alpha$ -HBCD enriched, a trend not seen in the bivalves.	Analytical details were not included. Supplemental data should be evaluated for a more thorough assessment	<a href="#">3013490</a>	Unacceptable
Arctic marine food chain monitoring		HBCD concentration: in polar cod: 5-25 ng/g lw; ringed seal: 15-35 ng/g lw; polar bear: 5-15 ng/g lw; not detected in lower pelagic zooplankton	Study results not relevant to a specific/designated Fate endpoint. Limited details reported (i.e., no details were provided regarding the sampling,	<a href="#">4140373</a>	Unacceptable

Study Type (year)	System	Results	Comments	HERO ID	Data Quality Rating
			work-up, or analytical techniques).		
Accumulation (and disposition) of HBCD in <i>Oncorhynchus mykiss</i> via dietary exposure	Duration of test: 15 days	Diastereomer composition found in fish at 6h was similar to 0h but changed through the remainder of the experiment	BCF not reported. Disposition data may be useful to other disciplines; however, the analytical method may not be suitable for meaningful detection of the test substance.	<a href="#">1927701</a>	Unacceptable