Vinyltrimethoxysilane (CAS# 2768-02-7) GreenScreen® for Safer Chemicals (GreenScreen®) Assessment

Prepared for:

Washington State Department of Ecology

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December 1, 2014

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GreenScreen® Executive Summary for Vinyltrimethoxysilane (CAS #2768-02-7)

Vinyltrimethoxysilane is a chemical that functions as a chemical intermediate, cross-linking agent, and adhesion promoter in coatings.

Vinyltrimethoxysilane was assigned a GreenScreen® Benchmark Score of 1_{TP} ("Avoid-Chemical of High Concern due to Transformation Products"). It has Moderate Group I Human Toxicity (reproductive toxicity-R and developmental toxicity-D), High Group II* Human Toxicity (systemic toxicity-repeated dose-STr*), and High Flammability-F. This corresponds to GreenScreen® benchmark classifications 2e, 2f, and 2g in CPA 2011. Data gaps (DG) exist for endocrine activity-E, neurotoxicity-repeated dose-Nr*, and respiratory sensitization-SnR*. As outlined in CPA (2013) Section 12.2 (Step 8 – Conduct a Data Gap Analysis to assign a final Benchmark score), vinyltrimethoxysilane meets requirements for a GreenScreen® Benchmark Score of 2 despite the hazard data gaps. However, the transformation product methanol, which is formed by hydrolysis, is an LT-1 chemical. Therefore the final Benchmark score is reduced to a 1_{TP}. In a worst-case scenario, if vinyltrimethoxysilane were assigned a High score for the data gap E it would be categorized as a Benchmark 1 Chemical.

GreenScreen® Benchmark Score for Relevant Route of Exposure:

As a standard approach for GreenScreen® evaluations, all exposure routes (oral, dermal and inhalation) were evaluated together, so the GreenScreen® Benchmark Score of 1_{TP} ("Avoid-Chemical of High Concern due to Transformation Products") is applicable for all routes of exposure.

GreenScreen® Hazard Ratings for Vinyltrimethoxysilane

Group I Human					Group II and II* Human									Ecotox		Fate		Physical	
C	**M**	**R**	**D**	**E**	**AT**	**ST**		**N**		**SnS***	**SnR***	**IrS**	**IrE**	**AA**	**CA**	**P**	**B**	**Rx**	**F**
						single	repeated*	single	repeated*										
L	**L**	**M**	*M*	DG	**M**	**H**	*H*	**M**	DG	*M*	DG	*L*	**L**	**L**	**L**	*M*	**vL**	*L*	**H**

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect estimated values, authoritative B lists, screening lists, weak analogues, and lower confidence. Hazard levels in **BOLD** font are used with good quality data, authoritative A lists, or strong analogues. Group II Human Health endpoints differ from Group II* Human Health endpoints in that they have four hazard scores (i.e., vH, H, M, and L) instead of three (i.e., H, M, and L), and are based on single exposures instead of repeated exposures. Please see Appendix A for a glossary of hazard acronyms.

GreenScreen® Assessment for Vinyltrimethoxysilane (CAS #2768-02-7)

Method Version: GreenScreen® Version 1.2[1]
Assessment Type[2]: Certified

Chemical Name: Vinyltrimethoxysilane

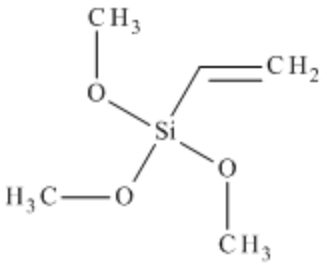
CAS Number: 2768-02-7

GreenScreen® Assessment Prepared By:
Name: Jennifer Rutkiewicz, Ph.D.
Title: Toxicologist
Organization: ToxServices LLC
Date: September 26, 2014
Assessor Type: Licensed GreenScreen® Profiler

Quality Control Performed By:
Name: Bingxuan Wang, Ph.D.
Title: Toxicologist
Organization: ToxServices LLC
Date: December 1, 2014

Confirm application of the *de minimus* rule[3]: N/A

Chemical Structure(s):



Also called: (Trimethoxysilyl)ethane; Trimethoxyvinylsilane; Ethenyltrimethoxysilane; Silane, ethenyltrimethoxy-; Vinyl trimethoxy silane; Silane, trimethoxyvinyl- (ChemIDplus 2014)

Chemical Structure(s) of Chemical Surrogates Used in the GreenScreen®:
No surrogates were used in this assessment, as a relatively complete dataset was identified for vinyltrimethoxysilane.

Identify Applications/Functional Uses: (Evonik 2010)
1. Chemical intermediate
2. Cross-linking agent
3. Adhesion promoter in coatings

[1] Use GreenScreen® Assessment Procedure (Guidance) V1.2
[2] GreenScreen® reports are either "UNACCREDITED" (by unaccredited person), "AUTHORIZED" (by Authorized GreenScreen® Practitioner), "CERTIFIED" (by Licensed GreenScreen® Profiler or equivalent) or "CERTIFIED WITH VERIFICATION" (Certified or Authorized assessment that has passed GreenScreen® Verification Program)
[3] Every chemical in a material or formulation should be assessed if it is:
1. intentionally added and/or
2. present at greater than or equal to 100 ppm

GreenScreen® Summary Rating for Vinyltrimethoxysilane[4]: Vinyltrimethoxysilane was assigned a GreenScreen® Benchmark Score of 1_{TP} ("Avoid-Chemical of High Concern due to Transformation Products"). It has Moderate Group I Human Toxicity (reproductive toxicity-R and developmental toxicity-D), High Group II* Human Toxicity (systemic toxicity-repeated dose-STr*), and High Flammability-F. This corresponds to GreenScreen® benchmark classifications 2e, 2f, and 2g in CPA 2011, 2012a. Data gaps (DG) exist for endocrine activity-E, neurotoxicity-repeated dose-Nr*, and respiratory sensitization-SnR*. As outlined in CPA (2013) Section 12.2 (Step 8 – Conduct a Data Gap Analysis to assign a final Benchmark score), vinyltrimethoxysilane meets requirements for a GreenScreen® Benchmark Score of 2 despite the hazard data gaps. However, the transformation product methanol, which is formed by hydrolysis, is an LT-1 chemical. Therefore the final Benchmark score is reduced to a 1_{TP}. In a worst-case scenario, if vinyltrimethoxysilane were assigned a High score for the data gap E it would be categorized as a Benchmark 1 Chemical.

Figure 1: GreenScreen® Hazard Ratings for Vinyltrimethoxysilane

Group I Human					Group II and II* Human									Ecotox		Fate		Physical	
C	M	R	D	E	AT	ST		N		SnS*	SnR*	IrS	IrE	AA	CA	P	B	Rx	F
						single	repeated*	single	repeated*										
L	**L**	**M**	*M*	DG	**M**	**H**	*H*	**M**	DG	*M*	DG	*L*	**L**	**L**	**L**	*M*	**vL**	*L*	**H**

Note: Hazard levels (Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)) in *italics* reflect estimated (modeled) values, authoritative B lists, screening lists, weak analogues and lower confidence. Hazard levels in **BOLD** font are used with good quality data, authoritative A lists, or strong analogues. Group II Human Health endpoints differ from Group II* Human Health endpoints in that they have four hazard scores (i.e. vH, H, M, and L) instead of three (i.e. H, M, and L), and are based on single exposures instead of repeated exposures. Please see Appendix A for a glossary of hazard acronyms.

Transformation Products and Ratings:

Identify feasible and relevant fate and transformation products (i.e., dissociation products, transformation products, valence states) **and/or moieties of concern**[5]

Vinyltrimethoxysilane undergoes rapid hydrolysis in the environment, producing 3 moles of methanol and 1 mole of ethenyl silanetriol (OECD 2009). Methanol is readily biodegradable in the environment. Therefore, methanol is likely to be rapidly released after the hydrolysis of the parent compound and then rapidly degraded, reducing the potential for human/environmental exposure. However, as a conservative approach, ToxServices considered methanol a feasible and relevant transformation product and used the LT-1 score for methanol to reduce the Benchmark score of the parent compound.

[4] For inorganic chemicals with low human and ecotoxicity across all hazard endpoints and low bioaccumulation potential, persistence alone will not be deemed problematic. Inorganic chemicals that are only persistent will be evaluated under the criteria for Benchmark 4.

[5] A moiety is a discrete chemical entity that is a constituent part or component of a substance. A moiety of concern is often the parent substance itself for organic compounds. For inorganic compounds, the moiety of concern is typically a dissociated component of the substance or a transformation product.

Functional Use	Life Cycle Stage	Transformation Pathway	Transformation Products	CAS #	Feasible and Relevant?	List Translator Results[6,7]
Unknown	Unknown	Hydrolysis	Ethenyl silanetriol	NA	Y	Not in Pharos Database
Unknown	Unknown	Hydrolysis	Methanol	67-56-1	Y	LT-1

Introduction

Vinyltrimethoxysilane is used as a chemical intermediate, cross-linking agent, and adhesion promoter in coatings (Evonik 2010).

ToxServices assessed vinyltrimethoxysilane against GreenScreen® Version 1.2 (CPA 2013) following procedures outlined in ToxServices' SOP 1.69 (GreenScreen® Hazard Assessment) (ToxServices 2013).

GreenScreen® List Translator Screening Results

The GreenScreen® List Translator identifies specific authoritative or screening lists that should be searched to identify GreenScreen® benchmark 1 chemicals (CPA 2012b). Pharos (Pharos 2014) is an online list-searching tool that is used to screen chemicals against the List Translator electronically. It checks all of the lists in the List Translator with the exception of the U.S. Department of Transportation (U.S. DOT) lists (U.S. DOT 2008a,b) and these should be checked separately in conjunction with running the Pharos query. The output indicates benchmark or possible benchmark scores for each human health and environmental endpoint. The output for vinyltrimethoxysilane can be found in Appendix C and a summary of the results can be found below:

Mammalian Toxicity

New Zealand HSNO/GHS (GHS-New Zealand): 6.1D (inhalation) - Acutely toxic (Category 4)

Flammability

New Zealand HSNO/GHS (GHS-New Zealand): 3.1B - Flammable Liquids: high hazard (Category 2)

Other

German FEA - Substances Hazardous to Waters (VwVwS): Class 1 Low Hazard to Waters

When appropriate, the equivalent GHS hazard classifications were identified for GHS New Zealand classifications (EPA 2012)

PhysicoChemical Properties of Vinyltrimethoxysilane

Vinyltrimethoxysilane is a liquid at room temperature. Its high vapor pressure of 8.9 mmHg indicates that it is likely to form a gas. It is highly soluble in water and its log K_{ow} of 1.1 indicates a low potential for bioaccumulation.

[6] The GreenScreen® List Translator identifies specific authoritative or screening lists that should be searched to screen for GreenScreen® benchmark 1 chemicals (CPA 2012b). Pharos (Pharos 2014) is an online list-searching tool that is used to screen chemicals against the lists in the List Translator electronically.
[7] The way you conduct assessments for transformation products depends on the Benchmark Score of the parent chemical (See Guidance).

Table 1: Physical and Chemical Properties of Vinyltrimethoxysilane (CAS #2768-02-7)		
Property	**Value**	**Reference**
Molecular formula	C5-H12-O3-Si	ChemIDplus 2014
SMILES Notation	CO[Si](OC)(OC)C=C	ChemIDplus 2014
Molecular weight	148.233	ChemIDplus 2014
Physical state	Liquid	Evonik 2010
Appearance	Colorless	Evonik 2010
Melting point	-97°C	Evonik 2010
Vapor pressure	11.9 hPa (8.9 mmHg) at 20°C	Evonik 2010
Water solubility	9.4 g/L at 20°C (undergoes hydrolysis)	Evonik 2010
Dissociation constant	Not identified	
Density/specific gravity	0.97 g/cm^2 at 20°C	Evonik 2010
Partition coefficient	log K_{ow} = 1.1 at 20°C	Evonik 2010

Hazard Classification Summary Section:

Group I Human Health Effects (Group I Human)

Carcinogenicity (C) Score (H, M, or L): *L*
Vinyltrimethoxysilane was assigned a score of Low for carcinogenicity based on modeling results predicting that it is not a carcinogen. GreenScreen® criteria classify chemicals as a Low hazard for carcinogenicity when adequate data are available and are negative for carcinogenicity, and the chemical is not present on authoritative or screening lists (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- U.S. EPA 2012.
  - OncoLogic predicts that silicon compounds are of marginal concern for carcinogenicity. See Appendix D for justification.
- ToxTree 2013
  - Vinyltrimethoxysilane was predicted to be negative for both genotoxic carcinogenicity and nongenotoxic carcinogenicity using the ToxTree model using decision tree methodology. See Appendix E for justification.
- Based on the weight of evidence, a score of Low was assigned. OncoLogic predicts that silicon compounds are of marginal concern for carcinogenicity, and ToxTree predicts that vinyltrimethoxysilane is not a genotoxic or nongenotoxic carcinogen. Confidence in this score is reduced because it is based on modeling.

Mutagenicity/Genotoxicity (M) Score (H, M, or L): L
Vinyltrimethoxysilane was assigned a score of Low for mutagenicity/genotoxicity based on negative results in GLP-compliant *in vitro* bacterial and mammalian cell mutagenicity assays in an *in vivo* mouse micronucleus assay. GreenScreen® criteria classify chemicals as a Low hazard for mutagenicity/genotoxicity when adequate data are available and are negative for both mutagenicity and clastogenicity, and the chemical is not present on authoritative or screening lists (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- ECHA 2014
  - Vinyltrimethoxysilane (purity not reported) was negative in a GLP-compliant *in vitro* mammalian cell mutagenicity assay according to OECD Guideline 476 in Chinese hamster ovary (CHO) cells when tested at concentrations of 18, 60, 180, 600, and 1,800 µg/ml with metabolic activation and 10, 30, 100, 300 and 1,000 µg/ml without metabolic activation. Cytotoxicity was seen at concentrations > 1,800 µg/ml without metabolic activation and all concentrations with metabolic activation. Statistically significant increases in mutant frequency compared to controls were seen at some concentrations, but were considered to result from normal assay variation as values were within the range of historical controls and did not show a dose response relationship. Authors concluded that the substance was negative for mutagenicity with and without metabolic activation.
  - Vinyltrimethoxysilane (purity not reported) was positive in a GLP-compliant *in vitro* mammalian cell chromosome aberration assay according to OECD Guideline 473 in Chinese hamster lung (CHL/IU) cells when tested at concentrations of 0, 93.8, 187.5, 375, 750, 1,500 µg/mL. Cytotoxicity was seen at the highest dose. A dose related increase in chromosome aberrations was seen with but not without metabolic activation.
  - Vinyltrimethoxysilane (purity not reported) was negative in a GLP-compliant bacterial reverse mutation assay according to OECD Guideline 471 in *S. typhimurium* strains TA100, TA1535, TA98, and TA1537, and *E. coli* WP2uvrA when tested at concentrations of 0, 156.3, 312.5, 625, 1,250, 2,500 and 5,000 µg/plate with and without metabolic activation. Cytotoxicity was seen at the highest dose in all strains without metabolic activation and strain TA1537 without metabolic activation. No increase in revertants was seen in any strain at any dose.
  - Vinyltrimethoxysilane (purity not reported) was negative in a GLP-compliant bacterial reverse mutation assay according to OECD Guideline 471 in *S. typhimurium* strains TA1535, TA1537, TA98, and TA100 when tested at concentrations of 50, 160, 500, 1,600, and 5,000 µg/plate with and without metabolic activation. Cytotoxicity was seen at the highest dose. No increase in revertants was seen in any strain at any dose.
  - Vinyltrimethoxysilane (purity not reported) was negative in a GLP-compliant *in vitro* mammalian cell mutagenicity assay according to U.S. EPA's Health Effects Test Guidelines in Chinese hamster ovary (CHO) cells when tested at concentrations of 1.4 to 2.2 mg/ml without metabolic activation and 1.8 to 2.6 mg/ml with metabolic activation. A dose dependent increase in chromosome aberrations was seen with metabolic activation, and an ambiguous response was seen without metabolic activation.
  - Vinyltrimethoxysilane (purity not reported) was negative in a GLP-compliant micronucleus assay according to EPA Health effects guidelines 560/6-83-001 in male and female Swiss Webster mice. Animals (5/sex/dose) received a single i.p. injection of 300, 700, or 1,125 mg/kg and bone marrow was examined after 30, 48, or 72 hours. There was evidence of slight toxicity to bone marrow at the highest dose in females. There was no significant increase in micronuclei in any treatment group.
- Based on the weight of evidence, a score of Low was assigned. Although positive results were seen in in *in vitro* chromosome aberration assays, negative results in the micronucleus assay indicate that it is not clastogenic *in vivo*.

Reproductive Toxicity (R) Score (H, M, or L): M
Vinyltrimethoxysilane was assigned a score of Moderate for reproductive toxicity based on effects on the estrus cycle of rats in a reproductive toxicity screening study. GreenScreen® criteria classify chemicals as a Moderate hazard for reproductive toxicity when there is limited or marginal evidence of reproductive toxicity (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- ECHA 2014
  - In a GLP-compliant combined oral repeated dose toxicity study with reproductive/developmental toxicity screening test according to OECD Guideline 422 in male and female T23-48:Crj:CD(SD)IGS rats, animals (6 males/dose, 12 females/dose) were administered vinyltrimethoxysilane (purity not reported) at doses of 62.5, 250, or 1,000 mg/kg/day for 14 days prior to mating, during mating, and post mating for a total of 43 days for males or through pregnancy and until postpartum day 4 for females. No effects on copulation index, number of conceiving days, number of pregnant females fertility index, gestation length, gestation index, delivery conditions, nursing conditions, number of corpora lutea, number of implantation sites, or the implantation rate were seen. A low number of estrus cases were seen in females at the high dose. Authors identified a NOAEL of 250 mg/kg/day and LOAEL of 1,000 mg/kg/day based on effects on estrus cycles.

Developmental Toxicity incl. Developmental Neurotoxicity (D) Score (H, M, or L): *M*
Vinyltrimethoxysilane was assigned a score of Moderate for developmental toxicity based on effects on fetus ossification in an inhalation toxicity study in rats. GreenScreen® criteria classify chemicals as a Moderate hazard for developmental toxicity when there is limited or marginal evidence of developmental toxicity (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- ECHA 2014
  - In the GLP-compliant combined oral repeated dose toxicity study with reproductive/developmental toxicity screening test according to OECD Guideline 422 in male and female T23-48:Crj:CD(SD)IGS rats described above for reproductive toxicity, there were no effects on sex ratio, offspring survival, the number of live pups on postnatal day 4, pup viability index on postnatal day 4, appearance, body weight, or necropsy findings. Authors identified a NOAEL of 1,000 mg/kg/day for developmental toxicity based on the lack of effects at the highest dose.
  - In a GLP-compliant inhalation developmental toxicity test according to EPA OTS 798.4350 in CD(R) rats, dams (25/dose) were administered vinyltrimethoxysilane (purity not reported) at analytical doses of 24.6, 96.7 or 312.0 ppm (0.15, 0.60, or 1.8 mg/L) via whole body inhalation for 6 hours/day on gestation days 6-15 and animals were sacrificed on gestation day 21. Maternal toxicity (dose-dependent reductions in body weight gain) was seen at the mid and high dose. There was no evidence of embryolethality or teratogenicity, or effects on fetal body weight or litter weight. Evidence of developmental delays (increased incidence in the incidence of delayed skeletal ossification of the anterior arch of the atlas, thoracic entra, interparietal, matatarsals, and phalanges) was seen at the high dose. Authors identified a NOAEC of 96.7 ppm (0.6 mg/L) and LOAEC of 312 ppm (1.8 mg/L) based on skeletal effects at the high dose.

- Based on the weight of evidence a conservative score of Moderate was assigned based in effects in skeletal ossification at the high dose in a prenatal inhalation developmental toxicity study in rats. Confidence in this score is reduced as it is unclear whether the effects may have resulted from maternal stress, as maternal toxicity was also observed.

Endocrine Activity (E) Score (H, M, or L): DG
Vinyltrimethoxysilane was assigned a score of Low for endocrine disruption based on a lack of data for this endpoint.

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- Not listed as a potential endocrine disruptor on the EU Priority List of Suspected Endocrine Disruptors.
- Not listed as a potential endocrine disruptor on the OSPAR List of Chemicals of Possible Concern.
- High Throughput Screening (HTS) Data –
  - HTS data were identified for vinyltrimethoxysilane using PubChem (http://pubchem.ncbi.nlm.nih.gov/).
  - The data included the following results:
    - Vinyltrimethoxysilane was active in 0/3 androgen receptor agonist assays and 0/6 androgen receptor antagonist assays.
    - Vinyltrimethoxysilane was active in 0/4 estrogen receptor-alpha agonist assays and 0/5 estrogen receptor-alpha antagonist assays.
    - Vinyltrimethoxysilane was active in 0/1 thyroid receptor agonist assay and 0/3 thyroid receptor antagonist assays.
    - The activity of vinyltrimethoxysilane towards the thyroid stimulating hormone receptor was not evaluated.
- These data are insufficient to assign a score for endocrine activity.

Group II and II* Human Health Effects (Group II and II* Human)
Note: Group II and Group II* endpoints are distinguished in the v 1.2 Benchmark system. For Systemic Toxicity and Neurotoxicity, Group II and II* are considered sub-endpoints and test data for single or repeated exposures may be used. If data exist for single OR repeated exposures, then the endpoint is not considered a data gap. If data are available for both single and repeated exposures, then the more conservative value is used.

Acute Mammalian Toxicity (AT) Group II Score (vH, H, M, or L): M
Vinyltrimethoxysilane was assigned a score of Moderate for acute toxicity based on oral LD_{50} values between 300 and 2,000 mg/kg in rats and 500 and 2,000 mg/kg in mice, and an inhalation LC_{50} of 16.8 mg/L in rats. GreenScreen® criteria classify chemicals as a Moderate hazard for acute toxicity when the most conservative oral LD_{50} values are between 300 and 2,000 mg/kg and inhalation LC_{50} values are between 10 and 20 mg/L (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* New Zealand HSNO/GHS (GHS-New Zealand): 6.1D (inhalation) - Acutely toxic (Category 4)
- ECHA 2014

  Note: Due to the large number of studies available in the REACH dossier, only those receiving a Klimisch score of 1 or 2 for reliability were considered in the assessment.

- *Oral*: LD_{50} (rat, male and female Hilltop Wistar albino) = 7.34 mL/kg (males). 7.46 mL/kg (females) = 7.1 g/kg (males), 7.2 g/kg[8] (females)
- *Oral*: LD_{50} (rat, male, strain not specified) = 11.3 mL/kg = 11.0 g/kg[9]
- *Oral*: LD_{50} (rat, female Crl:CD(SD)IGS) = 300-2,000 mg/kg
- *Oral*: LD_{50} (rat, male and female Wistar) = 8.2 mL/kg = 7.9 g/kg[10]
- *Oral*: LD_{50} (mouse, male and female, strain not specified) = 500-3,750 mg/kg
- *Inhalation*: LC_{50} (rat, male and female Fischer 344) = 16.8 mg/L/4h
- *Dermal*: LD_{50} (rabbit, male and female New Zealand white) = 3.36 mL/kg (males), 4.0 mL/kg (females) = 3.3 g/kg (males), 3.9 g/kg (females)[11]
- *Dermal*: LD_{50} (rabbit, male New Zealand white) = 3.54 mL/kg = 3.4 g/kg[12]

Systemic Toxicity/Organ Effects incl. Immunotoxicity (ST)
***Group II Score (single dose)* (vH, H, M, or L): H**
Vinyltrimethoxysilane was assigned a score of High for systemic toxicity (single dose) based on atrophy of the thymus and spleen at oral doses between 300 and 2,000 mg/kg in rats. GreenScreen® criteria classify chemicals as a High hazard for systemic toxicity (single dose) when evidence of systemic toxicity is seen between doses of 300 and 2,000 mg/kg for an acute oral toxicity study (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- ECHA 2014
  - *Oral*: In the acute oral toxicity study in male and female Hilltop Wistar albino rats that identified LD_{50} values of 7.1 mg/kg for males and 7.2 mg/kg for females, animals (45/sex/dose) received a single oral dose of 1, 2, 4, 8, or 16 mL/kg (males) or 2, 4, 8, or 16 mL/kg (females) vinyltrimethoxysilane (purity not reported) via gavage and were observed for 14 days. Examinations of clinical signs, body weight, organ weights, histopathology, and gross pathology were performed. Clinical signs, which resolved within 5 days, included sluggishness, discharge around nose, eyes, and anus, lacrimation, piloerection, unkempt appearance, prostration, emaciation, and unsteady gait. No treatment-related gross pathological changes were seen in survivors. Among victims there were several instances of dark red kidney section.
  - *Oral*: In the GLP-compliant acute oral toxicity study in female Crl:CD(SD)IGS rats that identified an LD_{50} of 300-2,000 mg/kg, animals (9/dose) received a single oral dose of 300 or 2,000 mg/kg vinyltrimethoxysilane (purity not specified). Duration of observations was not specified. Diarrhea and perianal soiling was seen at both doses. Small spleen and thymi were seen in animals of the high dose group that died, and atrophy of the cortex of the thymus and red and white pulp of the spleen was seen on histopathological examination.
  - *Inhalation*: In the acute inhalation study in male and female Fischer 344 rats that identified an LC_{50} of 16.8 mg/L, animals (5/sex/dose) were administered vinyltrimethoxysilane (purity not specified) at doses of 1,981, 2,335, 2,798, 3,547, and 5,372 ppm (12, 14, 17, 21.5, or 32.6 mg/L[13]) for 4 hours and were observed for 14 days. Perinasal, encrustation, unkempt fur, hypoactivity, blepharospasm, lacrimation, respiratory difficulties (mouth breathing, audible respiration, decreased respiration rate), ataxia, prostration, tremors, distended

[8] 7.46 mL/kg * 0.97 g/mL = 7.2 g/kg
[9] 11.3 mL/kg * 0.97 g/mL = 11.0 g/kg
[10] 8.2 mL/kg * 0.97 g/mL = 7.9 g/kg
[11] 4.0 mL/kg * 0.97 g/mL = 3.9 g/kg
[12] 3.54 mL/kg * 0.97 g/mL = 3.4 g/kg
[13] 1,981 ppm * 148.233)/24,450 = 12.0 mg/L

stomachs, a negative surface and air righting reflex, and negative toe and tail pinch reflex were observed. Body weight gain was decreased in both sexes at the 1,981 and 2,335 ppm (12 and 14 mg/L) doses during the first week of exposure. Two males and 4 females of the high dose had eye opacities, and three males and five females had gas-filled stomachs.

- *Dermal*: In the acute dermal toxicity study in male and female New Zealand white rabbits that identified an LD_{50} of 3.3 mg/kg for males and 3.9 mg/kg for females, animals received a single dermal dose of 2, 4, or 8 mL/kg (1.9, 3.9, or 7.8 g/kg[14]) to clipped skin for 24 hours under occlusion and were observed for 14 days. In animals that died, lungs were red and mottled in animals that died, and a few livers were mottled or had red or white foci. No pathological changes were seen in survivors.

Group II* Score (repeated dose) **(H, M, or L):** *H*

Vinyltrimethoxysilane was assigned a score of High for systemic toxicity (repeated dose) based on evidence of systemic toxicity in subchronic oral and inhalation toxicity studies in rats. GreenScreen® criteria classify chemicals as a High hazard for systemic toxicity (repeated dose) when adverse effects are seen below the guidance values of 20 mg/kg/day for an oral toxicity study (doubled due to 43 day length of study) or 0.2 mg/L for an inhalation toxicity study (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- ECHA 2014
  - *Oral*: In the GLP-compliant combined oral repeated dose toxicity study with reproductive/developmental toxicity screening test according to OECD Guideline 422 in male and female T23-48:Crj:CD(SD)IGS rats described above for reproductive and developmental toxicity, animals (6 males/dose, 12 females/dose) were administered vinyltrimethoxysilane (purity not reported) at doses of 62.5, 250, or 1,000 mg/kg/day for 14 days prior to mating, during mating, and post mating for a total of 43 days for males or through pregnancy and until postpartum day 4 for females. Reduced body weight was seen in both sexes at the high dose. Occult blood, epithelial cells, erythrocytes, and leucocytes were also seen in both sexes at this dose. Also at the high dose, low red blood cell counts, hemoglobin concentrations, hematocrit, MCV, and MCH and high fibrinogen concentrations were see in males, and low hemoglobin concentrations and high APTT were seen in females. Low hematocrit was seen in females at the mid and high doses. Low total protein, albumin, A/G ratios, and potassium, and high g-GTP, urea nitrogen, and creatinine were seen in males at the high dose, and low total protein and triglycerides were seen in females at the high dose. Females in the mid and high dose had a tendency toward high g-GTP. In males at the high dose, absolute thymus weight was decreased and absolute kidney weight and relative spleen, kidney, and adrenal weights were seen. In females, relative thymus weights were decreased in all dose groups and absolute thymus weight was decreased and relative liver weight was increased at the high dose. Hyperplasia of the transitional epithelium of the urinary bladder was seen in males of all dose groups. Vacuolization of the lamina propria in the duodenum, jejunum, and ilium was seen in males at the mid and high doses, and sinus vacuolization in the mesenteric lymph nodes, hyperplasia of transitional epithelium and pyelonephritis in the kidneys, and hyperplasia of transitional epithelium of the urethra in males was seen in males at the high dose. Vacuolization of the lamina propria in the duodenum, jejunum, and ilium was also seen in females at the mid and high doses, and atrophy of the cortex and medulla in the thymus, sinus vacuolization in the mesenteric

[14] 2.0 mL/kg * 0.97 g/mL = 1.9 g/kg

lymph nodes, hyperplasia of transitional epithelium, regeneration of urinary tubules, and pyelitis in the kidneys, and hyperplasia of transitional epithelium, metaplasia of keratinized stratified squamous epithelium, cellular infiltration, and necrosis of epithelium in the urethra was seen at the high dose. Statistical significance of changes was not reported. Authors identified a LOAEL of 62.5 mg/kg/day based on decreases in relative thymus weight of females and histopathological changes in the urinary bladder of males at the low dose. A NOAEL was not identified. This value is compared to doubled guidance values due to the 43 day length of the study.

- *Inhalation*: In a GLP-compliant subchronic inhalation toxicity study in male and female Fischer 344 rats, animals (20/sex/dose) were administered vinyltrimethoxysilane (purity not specified) at doses of 10, 100, or 400 ppm (0.0605, 0.605, or 1.421 mg/L) for 6 hours/day, 5 days/week for 14 weeks. No effects on ophthalmoscopic examination, hematology, clinical chemistry, organ weights, or gross pathology were seen. At the mid dose, body weights were occasionally decreased in females and a decrease in urine osmolality with a concomitant increase in urine volume was seen in males. At the high dose, body weights were reduced by 11% in males and 16% in females. Water consumption was increased in males at the high dose during weeks 1, 5, 8, and 14, and in females during the first week. Also at this dose, males had decreased urine osmolality, reduced electrolyte concentrations, and decreased creatinine clearance. Similar changes were seen in females at week 14. Pathology revealed minimal cystitis in the bladder submucosa and submucosal mastocytosis, and renal lesions (papillary necrosis, interstitial edema, and/or papillary hyperplasia of the transitional epithelium) at the high dose. Authors identified a NOAEC of 10 ppm (0.0605 mg/L) and LOAEC of 100 ppm (0.605 mg/L) based on effects on urine osmolality and sodium, potassium, and chloride concentrations in males, and effects on body weight and weight gain in females. These doses are equivalent to 0.04 mg/L and 0.4 mg/L after accounting for 5 days/week exposure[15].

- Based on the weight of evidence, a conservative score of High was assigned. Adverse effects were seen at an oral dose of 65.5 mg/kg/day and inhalation dose of 0.4 mg/L, which corresponds to a score of Moderate. However, no NOAEL was identified in the oral study, and the NOAEC of 0.04 mg/L for the inhalation study falls below the guidance value of 0.2 mg/L for a High. Therefore data for both studies are insufficient to determine if effects would have been apparent below the guidance values of 20 mg/kg/day for an oral study (doubled due to the 43 day length of the study) or 0.2 mg/L for an inhalation study. The more conservative score of High was assigned. Confidence in this score is reduced as data were inadequate to refine the score.

Neurotoxicity (N)

***Group II Score (single dose)* (vH, H, M, or L): M**

Vinyltrimethoxysilane was assigned a score of Moderate for neurotoxicity (single dose) based on transient neurological effects seen in acute oral, dermal, and inhalation toxicity studies. GreenScreen® criteria classify chemicals as a Moderate hazard for neurotoxicity (single dose) when available data indicate that GHS Category 3 classification for transient narcotic effects is warranted (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- Not classified as a developmental neurotoxicant (Grandjean and Landrigan 2006, 2014).
- ECHA 2014

[15] 0.0605 mg/L * 5 days/7 days = 0.04 mg/L

  - *Oral*: In the acute oral toxicity study in male and female Hilltop Wistar albino rats that identified LD_{50} values of 7.1 g/kg for males and 7.2 g/kg for females, animals (45/sex/dose) received a single oral dose of 1, 2, 4, 8, or 16 mL/kg (males) or 2, 4, 8, or 16 mL/kg (females) vinyltrimethoxysilane (purity not reported) via gavage and were observed for 14 days. Sluggishness and unsteady gait were observed and resolved within 5 days.
  - *Oral*: In the acute oral toxicity study in male rats (strain tot specified) that identified an LD_{50} of 11.3 mL/kg (11.0 g/kg), animals (5/dose) received a single oral dose of 8, 16, or 32 mL/kg via gavage. Duration of observation was not specified. Animals were hyperactive soon after dosing.
  - *Inhalation:* In the acute inhalation study in male and female Fischer 344 rats that identified an LC_{50} of 16.8 mg/L, animals (5/sex/dose) were administered vinyltrimethoxysilane (purity not specified) at doses of 981, 2,335, 2,798, 3,547, and 5,372 ppm for 4 hours and were observed for 14 days. Hypoactivity, blepharospasm, ataxia, prostration, tremors, a negative surface and air righting reflex, and negative toe and tail pinch reflex were observed.
  - *Dermal*: In the acute dermal toxicity study in male and female New Zealand white rabbits that identified an LD_{50} of 3.3 mg/kg for males and 3.9 g/kg for females, animals received a single dermal dose of 2, 4, or 8 mL/kg (1.9, 3.9, or 7.8 g/kg) to clipped skin for 24 hours under occlusion and were observed for 14 days. Sluggishness was seen after dosing at all doses, and unsteady gait was seen at the mid and high doses. Animals recovered within 1-2 days.
- Based on the weight of evidence, a score of Moderate was assigned, as sluggishness, unsteady gait, and hyperactivity seen in acute oral toxicity studies in rats, hypoactivity, ataxia, tremors, and effects on reflexes in an acute inhalation study in rats, and sluggishness and unsteady gait seen in an acute dermal study in rabbits indicate that GHS Category 3 classification for transient narcotic effects is appropriate.

Group II* Score (repeated dose) **(H, M, or L):** DG
Vinyltrimethoxysilane was assigned a score of Data Gap for neurotoxicity (repeated dose) based on a lack of data for this endpoint.
- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- Not classified as a developmental neurotoxicant (Grandjean and Landrigan 2006, 2014).

Skin Sensitization (SnS) Group II* Score (H, M, or L): *M*
Vinyltrimethoxysilane was assigned a score of Low for skin sensitization based on positive results in GLP-compliant Buehler tests. GreenScreen® criteria classify chemicals as a Moderate hazard for skin sensitization when available data indicate that GHS Category 1B classification is warranted (CPA 2012a).
- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- ECHA 2014
  - Vinyltrimethoxysilane (purity not specified) was not sensitizing in a GLP-compliant guinea pig maximization test according to OECD guideline 406 in male and female Hartley guinea pigs (10/sex/dose, 5/sex/controls). No positive responses were seen in animals that were induced with a 3 or 5% solution and challenged with a 5% solution. Authors concluded that vinyltrimethoxysilane was not sensitizing.

  - Vinyltrimethoxysilane (purity not specified) was positive in a GLP-compliant Buehler test in female Dunkin-Hartley guinea pigs (20/dose, 10/control) that were induced with 100% solutions and challenged with a 25% solution. Positive responses were seen in 13/30 treated animals. Authors concluded that the substance is sensitizing.
  - Vinyltrimethoxysilane (purity not specified) was not sensitizing in a GLP-compliant guinea pig maximization test according to OECD guideline 406 in female guinea pigs (10/sex/dose, 5/sex/controls, strain not specified) that were induced with a 10% (intradermal) and 50% (epidermal) solution and challenged with a 25% solution. No positive responses were seen.
  - The hydrolysis product of vinyltrimethoxysilane was negative for sensitization in a GLP-compliant guinea pig maximization test in male and female Hartley guinea pigs (10/sex/dose, 5/sex/controls) that were induced with a 50% solution and challenged with a 10% solution.
- Based on the weight of evidence, a conservative score of Moderate was assigned. Positive results were obtained in one Buehler test in guinea pigs, but results for 3 equally reliable (GLP-compliant) guinea pig maximization tests of vinyltrimethoxysilane and its hydrolysis product showed no evidence of sensitization. The Swedish Chemicals Agency (SCA) raised concern about the positive results in the Buehler test, as this assay is generally considered less sensitive than the maximization test. The SCA also commented that the induction dose in the maximization test was not sufficient to cause irritation, as is required per OECD Guideline 406 (SCA 2013). OECD concluded that this substance may present a hazard for skin sensitization. Therefore a score of Moderate was assigned, as results for the Buehler test indicate that GHS Category 1B is appropriate ($\geq$15% responding at > 20% topical induction dose). Confidence in this score is reduced due to conflicting results between studies.

Respiratory Sensitization (SnR) Group II* Score (H, M, or L): DG
Vinyltrimethoxysilane was assigned a score of Data Gap for respiratory sensitization based on a lack of data for this endpoint.
- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- No data were identified.

Skin Irritation/Corrosivity (IrS) Group II Score (vH, H, M, or L): *L*
Vinyltrimethoxysilane was assigned a score of Low for skin irritation/corrosivity based on a lack of irritation in a 24-hour dermal irritation study in rabbits. GreenScreen® criteria classify chemicals as a Low hazard for skin irritation/corrosivity when adequate data are available and indicate that the chemical does not warrant GHS classification for irritation, and the chemical is not present on authoritative or screening lists (CPA 2012a).
- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- ECHA 2014
  - Vinyltrimethoxysilane was not irritating in a dermal irritation study according to Handbook Appraisal of the Safety of Chemicals in Foods, Drugs and Cosmetics FDA guidelines. Four New Zealand white rabbits (sex not specified) were administered 0.5 mL vinyltrimethoxysilane to intact and abraded skin for 24 hours under occlusion and were observed for 72 hours. No evidence of erythema or edema was seen at any time point. The primary irritation score was 0.

  - Vinyltrimethoxysilane was moderately irritating in a dermal irritation study similar to OECD Guideline 404 in 6 rabbits (sex and strain not specified) when 0.5 mL was administered to shaved skin for 4 hours under occlusion. Minor to moderate erythema and minor edema was seen in all animals. Erythema persisted in 4 rabbits and edema persisted in one rabbit until day 3. No additional details were provided. Authors concluded that the substance is moderately irritating but does not meet EU criteria for classification.
- Based on the weight of evidence, a score of Low was assigned. One study in rabbits reported moderate irritation following a 4 hour exposure. Although no scores were provided to facilitate classification, authors noted that vinyltrimethoxysilane does not meet EU criteria for classification. In a second, more well described study, no irritation was seen following administration to intact or abraded rabbit skin for 24 hours. Based on the lack of irritation following a 24 hour administration in this study, and a report that the substance does not meet classification criteria based on the 4 hour exposure study, a score of Low was assigned. Confidence in this score is reduced due to the lack of available details for the 4 hour exposure study.

Eye Irritation/Corrosivity (IrE) Group II Score (vH, H, M, or L): L
Vinyltrimethoxysilane was assigned a score of Low for eye irritation/corrosivity based on negative results in a GLP-compliant ocular irritation study in rabbits. GreenScreen® criteria classify chemicals as a Low hazard for eye irritation/corrosivity when adequate data are available and indicate that the substance does not warrant GHS classification for irritation, and the chemical is not present on authoritative or screening lists (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- ECHA 2014
  - Vinyltrimethoxysilane was not irritating in a GLP-compliant ocular irritation study according to OECD Guideline 405 in 3 New Zealand white rabbits (sex not specified). The mean scores at 24, 48, or 72 hours for the cornea, iris, conjunctiva, and chemosis were 0.
  - Vinyltrimethoxysilane was not irritating in an ocular irritation study according to FDA Handbook, Appraisal of the Safety of Chemicals in Foods, Drugs and Cosmetics guidelines in 6 New Zealand white rabbits (sex not specified). Very mild ocular irritation (erythema scores of 0-2 and chemosis scores of 0-1) was seen only in eyes that remained unwashed, and did not persist after the 48 hour observation. Authors concluded that the substance is not irritating.
  - Vinyltrimethoxysilane was not irritating in an ocular irritation study in 12 rabbits (sex and strain not specified) that were administered 0.1 or 0.01 mL to the eye without rinsing. Minor to moderate conjunctival irritation was seen at one hour and resolved by 4-24 hours. Authors concluded that the substance is not irritating.

<u>Ecotoxicity (Ecotox)</u>

Acute Aquatic Toxicity (AA) Score (vH, H, M, or L): L
Vinyltrimethoxysilane was assigned a score of Low for acute aquatic toxicity based on LC/EC_{50} values of 191 mg/L in fish, 168.8 mg/L in daphnia, and 210 mg/L in algae. GreenScreen® criteria classify chemicals as a Low hazard for acute aquatic toxicity when the most conservative LC/EC_{50} values are greater than 100 mg/L (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists

- *Screening:* Not present on any screening lists

- ECHA 2014

  Note: Due to the large number of studies available in the REACH dossier, only those receiving a Klimisch score of 1 or 2 for reliability were considered in the assessment.
  - 96-hour LC_{50} (*Oncorhynchus mykiss*, rainbow trout) = 191 mg/L (nominal)
  - 96-hour LC_{50} (*Lepomis macrochirus*, bluegill) > 1,000 mg/L (nominal)
  - 96-hour LC_{50} (*Danio rerio*, zebrafish) > 1,000 mg/L (nominal)
  - 48-hour EC_{50} (*Daphnia magna*, water flea) = 167.8 mg/L (nominal)
  - 48-hour EC_{50} (*Daphnia magna*, water flea) > 100 mg/L (nominal)
  - 72-hour EC_{50} (*Desmodesmus subspicatus*, green algae) > 957 mg/L (nominal)
  - 168-hour EC_{50} (*Selenastrum capricornutum*, green algae) = 210 mg/L (nominal) (biomass)
  - 168-hour EC_{50} (*Anabaena flos-aquae*, blue green algae) > 1,000 mg/L (nominal) (growth and biomass)

Chronic Aquatic Toxicity (CA) Score (vH, H, M, or L): L

Vinyltrimethoxysilane was assigned a score of Low for chronic aquatic toxicity based on NOEC values of 28 mg/L in daphnia and 25 mg/L in algae. GreenScreen® criteria classify chemicals as a Low hazard for chronic aquatic toxicity when the most conservative chronic aquatic toxicity values are greater than 10 mg/L (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- ECHA 2014
  - 21-day NOEC (*Daphnia magna*, water flea) = 28 mg/L (nominal) (reproduction)
    - Note: This study is reported in ECHA with a score of 4 (not assignable) for reliability as results were obtained from a secondary source and reliability could not be assessed)
  - 72-hour NOEC (*Desmodesmus subspicatus*, green algae) = 957 mg/L (nominal)
  - 168-hour NOEC (*Selenastrum capricornutum*, green algae) = 25 mg/L (nominal) (biomass)
  - 168-hour NOEC (*Anabaena flos-aquae*, blue green algae) > 1,000 mg/L (nominal) (growth and biomass)
- Based on the weight of evidence, a score of Low was assigned. Although no chronic toxicity data were available for fish, acute toxicity data do not indicate that fish are more sensitive than other trophic levels. Therefore a score of Low was assigned based on data for daphnia and algae.

<u>Environmental Fate (Fate)</u>

Persistence (P) Score (vH, H, M, L, or vL): *M*

Vinyltrimethoxysilane was assigned a score of Moderate for persistence based on a modeled half-life of 30 days in soil, its dominant compartment. Confidence level is adjusted due to reliance on modeled data. GreenScreen® criteria classify chemicals as a Moderate hazard for persistence when the chemical has a half-life of 16 - 60 days in soil (CPA 2012a).

- Authoritative and Screening Lists
  - *Authoritative:* Not present on any authoritative lists
  - *Screening:* Not present on any screening lists
- ECHA 2014
  - In a GLP-compliant hydrolysis assay according to OECD Guideline 111(Hydrolysis as a Function of pH), a hydrolysis half-life of < 2.4 hours was measured for

vinyltrimethoxysilane at pH 4, 7, and 9. The test substance began to hydrolyze almost immediately after dissolving in the buffer, and was more than 50% degraded after 2.4 hours.
    - In a GLP-compliant biodegradation study according to OECD Guideline 301F (Ready Biodegradability: Manometric Respirometry Test) using activated domestic sludge inoculum, vinyltrimethoxysilane (104 mg/L) achieved 51% biodegradation in 28 days. Authors concluded that the substance is not readily biodegradable.
    - In a GLP-compliant biodegradation study according to EU Method C.4-C (Determination of the "Ready" Biodegradability - Carbon Dioxide Evolution Test) using activated domestic sludge inoculum, vinyltrimethoxy silane achieved 123% biodegradation (10.1 mg/L starting concentration) or 64% biodegradation (19.93 mg/L starting concentration) in 28 days. Authors concluded that the substance is readily biodegradable. This study is reported in ECHA with a score of 2 (reliable with restrictions) for reliability as no explanation was provided for the discrepancy in results.
- U.S. EPA 2012
    - The BIOWIN modeling Ready Biodegradable Predictor indicates that vinyltrimethoxysilane is not expected to be readily biodegradable. Fugacity modeling predicts 76.6% will partition to soil with a half-life of 30 days, 21.9% will partition to water with a half-life of 15 days, and 1.01% will partition to air with a half-life of 8.44 hours. See Appendix F for justification.
- Based on the weight of evidence, a score of Moderate was assigned. Vinyltrimethoxysilane produced equivocal results in one ready biodegradation (CO_2 evolution) test, which was reported with a reduced reliability score due to the lack of an explanation for contradictory results. In a second biodegradation assay (manometric respirometry test) that was considered by the notifiers to be more reliable, vinyltrimethoxysilane was not readily biodegradable. Based on available data, this compound does undergo biodegradation but the rate is unclear. This compound also undergoes rapid hydrolysis, with a hydrolysis half-life of 2.4 hours. Modeling predicts that this compound partitions primarily to soil, with a half-life of 30 days. This corresponds to a score of Moderate.

Bioaccumulation (B) Score (vH, H, M, L, or vL): vL
Vinyltrimethoxysilane was assigned a score of Very Low for bioaccumulation based on a modeled BCF of 2.118 and a measured log K_{ow} of 1.1. GreenScreen® criteria classify chemicals as a Very Low hazard for bioaccumulation when the BCF is less than 100 and/or log K_{ow} is less than 4 (CPA 2012a).
- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists
    - *Screening:* Not present on any screening lists
- OECD 2009
    - The bioaccumulation potential for vinyltrimethoxysilane cannot be accurately predicted due to its rapid hydrolysis; however, it is expected to be low.
- U.S. EPA 2012
    - BCFBAF predicts a BCF of 2.118 based on a log K_{ow} of 1.1, indicating this chemical is not likely to bioaccumulate because the BCF is less than 100 based on a log K_{ow} less than 5.

Physical Hazards (Physical)

Reactivity (Rx) Score (vH, H, M, or L): *L*
Vinyltrimethoxysilane was assigned a score of Low for reactivity based on a report that it has no explosive properties. GreenScreen® criteria classify chemicals as a Low hazard for reactivity when the

chemical is not explosive or otherwise reactive, and the chemical is not present on authoritative or screening lists (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists
    - *Screening:* Not present on any screening lists
- Evonik 2010
    - Vinyltrimethoxysilane has no explosive properties.

Flammability (F) Score (vH, H, M, or L): H

Vinyltrimethoxysilane was assigned a score of High for flammability based on its flash point of 22°C, and boiling point of 123°C. GreenScreen® criteria classify chemicals as a High hazard for flammability when available data indicate that GHS Category 2 classification is warranted (CPA 2012a).

- Authoritative and Screening Lists
    - *Authoritative:* Not present on any authoritative lists
    - *Screening:* New Zealand HSNO/GHS (GHS-New Zealand): 3.1B - Flammable Liquids: high hazard (Category 2)
- ECHA 2014
    - Vinyltrimethoxysilane has a flash point of 24.5°C in a test according to EU Method A.9 (Flash-Point) DIN 51755.
    - Vinyltrimethoxysilane has a flash point of 24°C in a test according to DIN 51755
    - Vinyltrimethoxysilane has a flash point of 22.7°C in a test according to ASTM D 3828-87 (closed cup)
    - Vinyltrimethoxysilane has a flash point of 22°C in a test according to DIN 51755
    - Vinyltrimethoxysilane has a boiling point of 123°C in a test according to DIN 51751
- Based on the weight of evidence, a score of High was assigned. The most conservative flash point for vinyltrimethoxysilane is 22°C, and it has a boiling point of 123°C. This corresponds to GHS Category 2, which applies to chemicals with a flash point < 23°C and initial boiling point > 35°C. This is consistent with the GHS classification in New Zealand, and corresponds to a score of High.

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APPENDIX A: Hazard Benchmark Acronyms
(in alphabetical order)

(AA) Acute Aquatic Toxicity

(AT) Acute Mammalian Toxicity

(B) Bioaccumulation

(C) Carcinogenicity

(CA) Chronic Aquatic Toxicity

(D) Developmental Toxicity

(E) Endocrine Activity

(F) Flammability

(IrE) Eye Irritation/Corrosivity

(IrS) Skin Irritation/Corrosivity

(M) Mutagenicity and Genotoxicity

(N) Neurotoxicity

(P) Persistence

(R) Reproductive Toxicity

(Rx) Reactivity

(SnS) Sensitization- Skin

(SnR) Sensitization- Respiratory

(ST) Systemic/Organ Toxicity

APPENDIX B: Results of Automated GreenScreen® Score Calculation for Vinyltrimethoxysilane (CAS #2768-02-7)

TOXSERVICES
TOXICOLOGY RISK ASSESSMENT CONSULTING

GreenScreen® Score Inspector

Table 1: Hazard Table

			Group I Human					Group II and II* Human								Ecotox		Fate		Physical	
			Carcinogenicity	Mutagenicity/Genotoxicity	Reproductive Toxicity	Developmental Toxicity	Endocrine Activity	Acute Toxicity	Systemic Toxicity		Neurotoxicity		Skin Sensitization*	Respiratory Sensitization*	Skin Irritation	Eye Irritation	Acute Aquatic Toxicity	Chronic Aquatic Toxicity	Persistence	Bioaccumulation	Reactivity	Flammability
Table 2: Chemical Details									S	R *	S	R *	*	*								
Inorganic Chemical?	**Chemical Name**	**CAS#**	**C**	**M**	**R**	**D**	**E**	**AT**	**STs**	**STr**	**Ns**	**Nr**	**SNS***	**SNR***	**IrS**	**IrE**	**AA**	**CA**	**P**	**B**	**Rx**	**F**
No	**Vinyltrimethoxysilane**	**2/7/2768**	*L*	**L**	**M**	*M*	DG	**M**	**H**	*H*	**M**	DG	*M*	DG	*L*	**L**	**L**	**L**	*M*	**vL**	*L*	**H**

Table 3: Hazard Summary Table

Benchmark	a	b	c	d	e	f	g
1	No	No	No	No	No		
2	No	No	No	No	Yes	Yes	Yes
3	STOP						
4	STOP						

Table 4

Chemical Name	Preliminary GreenScreen® Benchmark Score
Vinyltrimethoxysilane	2

Note: Chemical has not undergone a data gap assessment. Not a Final GreenScreen™ Score

Table 6

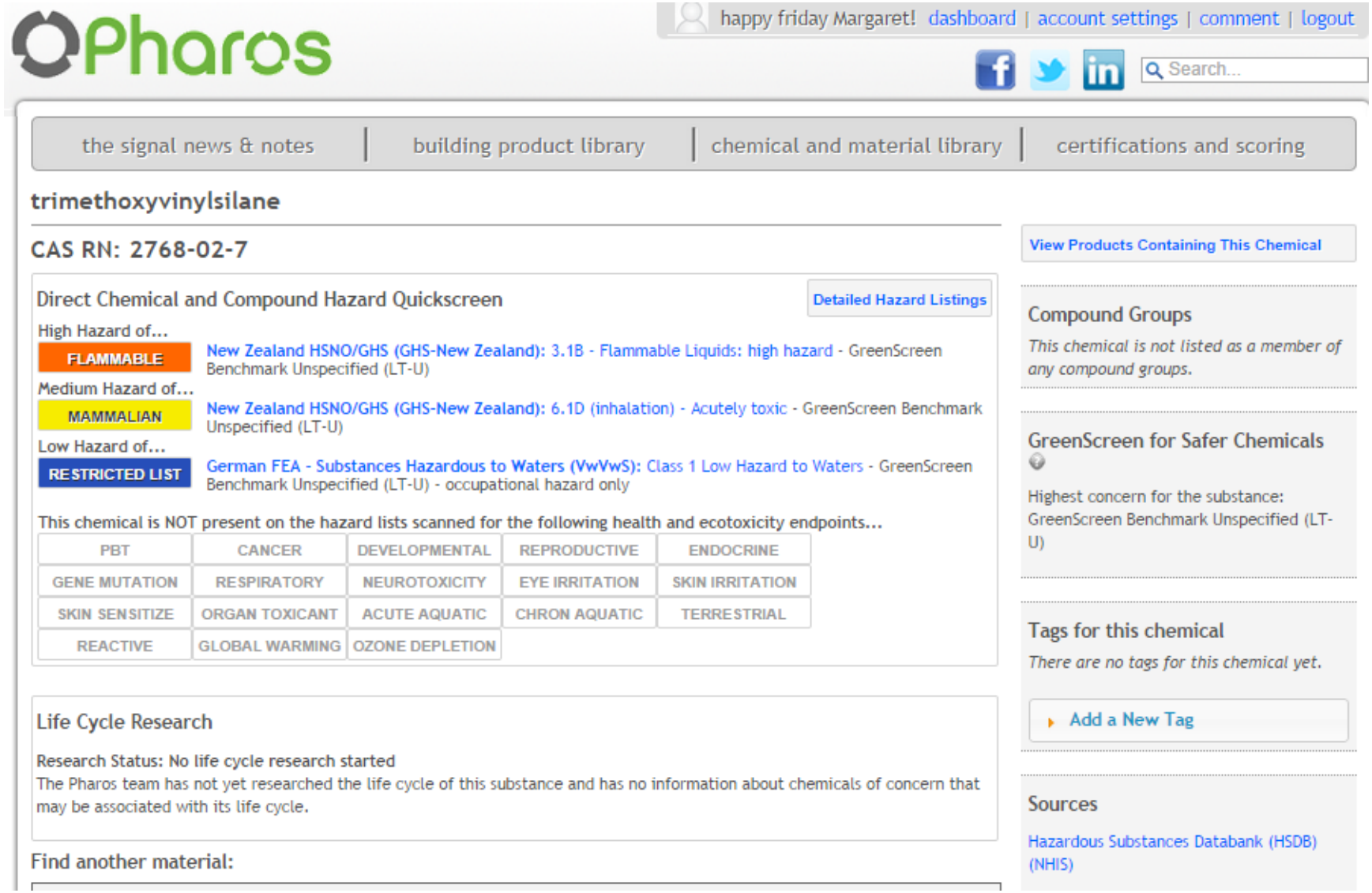
Chemical Name	Final GreenScreen® Benchmark Score
Vinyltrimethoxysilane	2

After Data gap Assessment
Note: No Data gap Assessment Done if Preliminary GS Benchmark Score is 1.

Table 5: Data Gap Assessment Table

Datagap Criteria	a	b	c	d	e	f	g	h	i	j	bm4	End Result
1												
2	Yes	Yes	Yes	Yes	Yes							2
3												
4												

APPENDIX C: Pharos Output for Vinyltrimethoxysilane (CAS #2768-02-7)



APPENDIX D: OncoLogic Carcinogenicity Results for Vinyltrimethoxysilane (CAS #2768-02-7)

OncoLogic Justification Report

SUMMARY :

Filename : 2768_02_7

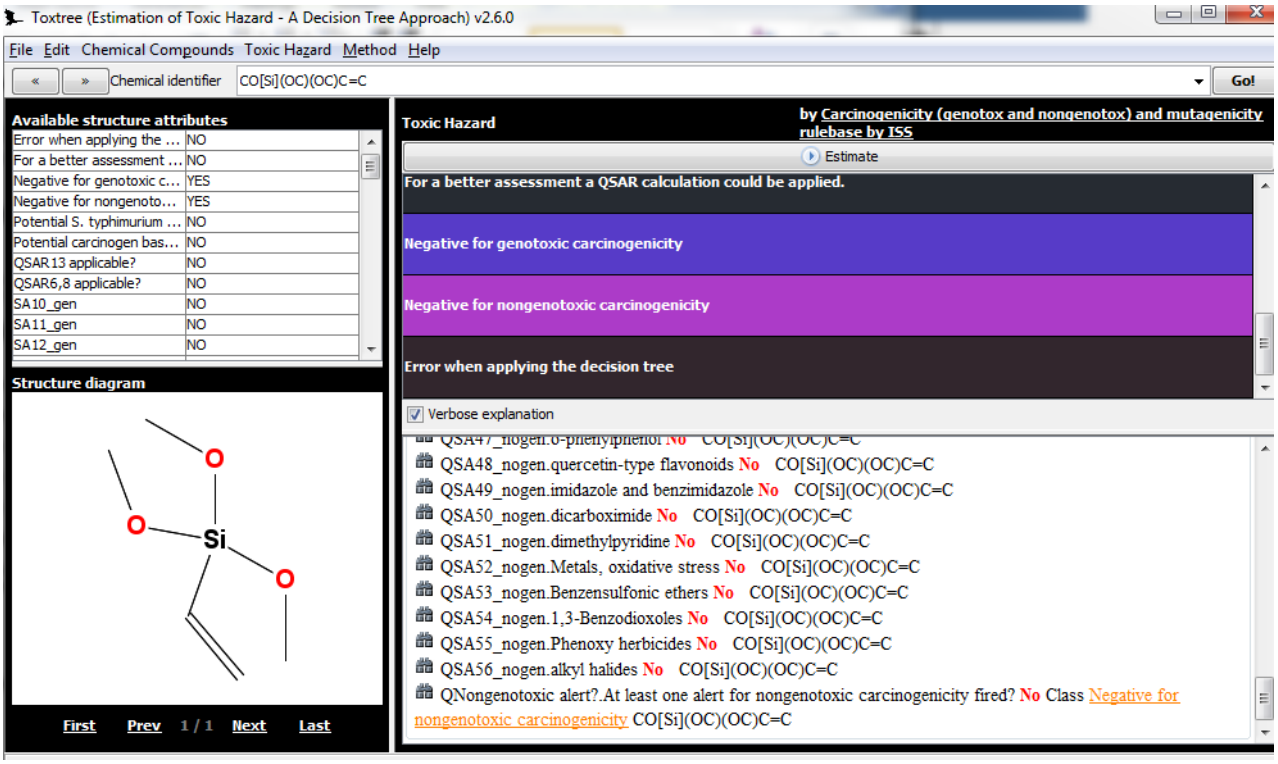
Substance ID :

Si Metals or Compounds : MARGINAL

JUSTIFICATION

Si metal(s) and compounds are considered to be of MARGINAL carcinogenicity concern, due to very limited information or lack of it.

APPENDIX E: ToxTree Carcinogenicity Results for Vinyltrimethoxysilane (CAS #2768-02-7)



APPENDIX F: EPISuite Modeling Results for Vinyltrimethoxysilane (CAS #2768-02-7)

CAS Number: 2768-02-7
SMILES: CO[Si](OC)(OC)C=C
CHEM: Silane, ethenyltrimethoxy-
MOL FOR: C5 H12 O3 Si1
MOL WT: 148.24
---------- EPI SUMMARY (v4.11) ----------

Physical Property Inputs:
Log K_{ow} (octanol-water): 1.10
Boiling Point (deg C): 123.00
Melting Point (deg C): -97.00
Vapor Pressure (mm Hg): 8.9
Water Solubility (mg/L): ------
Henry LC (atm-m^3/mole): ------

Log Octanol-Water Partition Coef (SRC):
Log Kow (K_{ow}WIN v1.68 estimate) = -0.32

Boiling Pt, Melting Pt, Vapor Pressure Estimations (MPBPVP v1.43):
Boiling Pt (deg C): 120.31 (Adapted Stein & Brown method)
Melting Pt (deg C): -48.83 (Mean or Weighted MP)
VP (mm Hg,25 deg C): 13.7 (Mean VP of Antoine & Grain methods)
VP (Pa, 25 deg C): 1.83E+003 (Mean VP of Antoine & Grain methods)

Water Solubility Estimate from Log K_{ow} (WSK_{ow} v1.42):
Water Solubility at 25 deg C (mg/L): 2.2e+004
log K_{ow} used: 1.10 (user entered)
melt pt used: -97.00 deg C

Water Sol Estimate from Fragments:
Wat Sol (v1.01 est) = 1e+006 mg/L

ECOSAR Class Program (ECOSAR v1.11):
Class(es) found:
Alkoxy Silanes

Henrys Law Constant (25 deg C) [HENRYWIN v3.20]:
Bond Method: 8.72E-005 atm-m^3/mole (8.84E+000 Pa-m^3/mole)
Group Method: Incomplete
For Henry LC Comparison Purposes:
User-Entered Henry LC: not entered
Henrys LC [via VP/WSol estimate using User-Entered or Estimated values]:
HLC: 7.891E-005 atm-m^3/mole (7.995E+000 Pa-m^3/mole)
VP: 8.9 mm Hg (source: User-Entered)
WS: 2.2E+004 mg/L (source: WSK_{ow}WIN)

Log Octanol-Air Partition Coefficient (25 deg C) [K_{oa}WIN v1.10]:

Log K_{ow} used: 1.10 (user entered)
Log K_{aw} used: -2.448 (HenryWin est)
Log K_{oa} (K_{oa}WIN v1.10 estimate): 3.548
Log K_{oa} (experimental database): None

Probability of Rapid Biodegradation (BIOWIN v4.10):
Biowin1 (Linear Model): 0.6770
Biowin2 (Non-Linear Model): 0.7117
Expert Survey Biodegradation Results:
Biowin3 (Ultimate Survey Model): 2.8716 (weeks)
Biowin4 (Primary Survey Model): 3.6339 (days-weeks)
MITI Biodegradation Probability:
Biowin5 (MITI Linear Model): 0.2909
Biowin6 (MITI Non-Linear Model): 0.1666
Anaerobic Biodegradation Probability:
Biowin7 (Anaerobic Linear Model): 0.3768
Ready Biodegradability Prediction: NO

Hydrocarbon Biodegradation (BioHCwin v1.01):
Structure incompatible with current estimation method!

Sorption to aerosols (25 Dec C)[AEROWIN v1.00]:
Vapor pressure (liquid/subcooled): 1.19E+003 Pa (8.9 mm Hg)
Log K_{oa} (K_{oa}win est): 3.548
Kp (particle/gas partition coef. (m^3/µg)):
Mackay model: 2.53E-009
Octanol/air (K_{oa}) model: 8.67E-010
Fraction sorbed to airborne particulates (phi):
Junge-Pankow model: 9.13E-008
Mackay model: 2.02E-007
Octanol/air (K_{oa}) model: 6.94E-008

Atmospheric Oxidation (25 deg C) [AopWin v1.92]:
Hydroxyl Radicals Reaction:
OVERALL OH Rate Constant = 28.7888 E-12 cm^3/molecule-sec
Half-Life = 0.372 Days (12-hr day; 1.5E6 OH/cm^3)
Half-Life = 4.458 Hrs
Ozone Reaction:
OVERALL Ozone Rate Constant = 0.175000 E-17 cm^3/molecule-sec
Half-Life = 6.549 Days (at 7E11 mol/cm^3)
Fraction sorbed to airborne particulates (phi):
1.47E-007 (Junge-Pankow, Mackay avg)
6.94E-008 (K_{oa} method)
Note: the sorbed fraction may be resistant to atmospheric oxidation

Soil Adsorption Coefficient (K_{oc}WIN v2.00):
K_{oc}: 647.9 L/kg (MCI method)
Log K_{oc}: 2.811 (MCI method)
K_{oc}: 9.001 L/kg (K_{ow} method)

Log K_{oc}: 0.954 (K_{ow} method)

Aqueous Base/Acid-Catalyzed Hydrolysis (25 deg C) [HYDROWIN v2.00]:
Rate constants can NOT be estimated for this structure!

Bioaccumulation Estimates (BCFBAF v3.01):
Log BCF from regression-based method = 0.393 (BCF = 2.47 L/kg wet-wt)
Log Biotransformation Half-life (HL) = -0.5473 days (HL = 0.2836 days)
Log BCF Arnot-Gobas method (upper trophic) = 0.326 (BCF = 2.118)
Log BAF Arnot-Gobas method (upper trophic) = 0.326 (BAF = 2.118)
log K_{ow} used: 1.10 (user entered)

Volatilization from Water:
Henry LC: 8.72E-005 atm-m^3/mole (estimated by Bond SAR Method)
Half-Life from Model River: 9.417 hours
Half-Life from Model Lake: 204.8 hours (8.534 days)

Removal In Wastewater Treatment:
Total removal: 6.16 percent
Total biodegradation: 0.09 percent
Total sludge adsorption: 1.74 percent
Total to Air: 4.33 percent
(using 10000 hr Bio P,A,S)

Removal in Wastewater Treatment:
Total removal: 75.62 percent
Total biodegradation: 73.54 percent
Total sludge adsorption: 0.64 percent
Total to Air: 1.44 percent
(using Biowin/EPA draft method)

Level III Fugacity Model:

	Mass Amount (percent)	Half-Life (hr.)	Emissions (kg/hr.)
Air	1.01	8.44	1000
Water	21.9	360	1000
Soil	76.6	720	1000
Sediment	0.533	3.24e+003	0

Persistence Time: 434 hr.

Sources to Check for GreenScreen® Hazard Assessment

Note: For a GreenScreen® Hazard Assessment, data queries should be initially limited to the following references. If data gaps exist after these references have been checked, additional references may be utilized.

U.S. EPA High Production Volume Information System (HPVIS):
http://www.epa.gov/hpvis/index.html

UNEP OECD Screening Information Datasets (SIDS):
http://www.chem.unep.ch/irptc/sids/OECDSIDS/sidspub.html

OECD Existing Chemicals Database: http://webnet.oecd.org/hpv/ui/SponsoredChemicals.aspx

European Chemical Substances Information System IUCLID Chemical Data Sheets:
http://esis.jrc.ec.europa.eu/index.php?PGM=dat

National Toxicology Program: http://ntp.niehs.nih.gov/

International Agency for the Research on Cancer:
http://monographs.iarc.fr/ENG/Classification/index.php

Human and Environmental Risk Assessment (HERA) on ingredients of household cleaning products:
http://www.heraproject.com/RiskAssessment.cfm

European Chemicals Agency (ECHA) REACH Dossiers: http://echa.europa.eu/

Licensed GreenScreen® Profilers

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