

## Appendix 2: GreenScreen® Summaries

The following pages include the GreenScreen® summaries for chemicals identified in Table 3.

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**Green Screen Assessment Prepared By:**

Name: Brian Penttila, Ph. D.

Title: Chemical Engineer

Organization: PNW Pollution Prevention Resource Center

Date: 27 June 2012

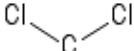
**Quality Control Performed By:**

Name: Alex Stone, Sc. D.

Title: Safer Chemical Alternative Chemist

Organization: WA Department of Ecology

Date: 16 May 2013

**GreenScreen™ Assessment for Dichloromethane (DCM) (CAS #75-09-2)****GreenScreen™ Version 1.2 Draft Assessment****Note: Validation Has Not Been Performed on this Green Screen Assessment****Chemical Name:** Dichloromethane (DCM)**Confirm application of the de minimus rule<sup>1</sup>:** (if no, what *de minimus* did you use?) Yes.**Chemical Name (CAS #):** Dichloromethane (DCM) (CAS#78-93-3)**Also Called:** "Bichloride, Methylene", "Chloride, Methylene", "Dichloride, Methylene", "Dichloromethane", "Methane, dichloro-", "Methylene chloride", "Methylene dichloride", "1,2-dichloromethane", "Freon 30", "R-30" (US EPA, ACToR database, [actor.epa.gov/](http://actor.epa.gov/))**Chemical Surrogates, analogs or moieties used in this assessment (CASs #):****Chemical Structure(s):** **Identify Applications/Functional Uses: (e.g. Cleaning product, TV casing)**

- Solvent in the pharmaceutical and chemical industry for reactions, and isolation of products.
- Used as a feedstock for the production of HCFC 32 (R32), as a blowing agent in foam blowing, for plastics processing (e.g., polycarbonate resins), a
- Used in aerosol products for applying or removing surface finishes or coatings, e.g., paints, varnishes, adhesives.
- Used for cleaning and degreasing products, e.g., metal cleaning (e.g., cold or vapor degreasing). See Substance Background section below for references.

**GreenScreen Rating<sup>2</sup>:** DCM was assigned a **Benchmark Score of 1** based on:

- Failure of Benchmark Rule 1e, due to High carcinogenicity.

GreenScreen Hazard Ratings: Dichloromethane																			
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	repeat*	single	repeat*										
<b>H</b>	NE	DG	DG	M	M	vH	H	vH	vH	L	DG	H	H	M	L	vH	vL	L	L

Note: Hazard levels [Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)] in *italics* reflect estimated values and lower confidence. Hazard levels in **BOLD** font reflect values based on test data (See Guidance). NE indicates no determination was made (conflicting data) and DG indicates insufficient data for assigning hazard level.

<sup>1</sup> Every chemical in a material or formulation should be assessed if it is:

- intentionally added and/or
- present at greater than or equal to 100 ppm.

<sup>2</sup> 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.

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### GreenScreen® Executive Summary for Benzyl Alcohol (CAS #100-51-6)

Benzyl alcohol is a chemical that functions as a solvent, plasticizer, fragrance and flavoring component, preservative, viscosity-controlling agent, and degreasing agent.

Benzyl alcohol was assigned a **GreenScreen Benchmark™ Score of 2** (“Use but Search for Safer Substitutes”). This score is based on the following hazard score combinations:

- Benchmark 2e (“Moderate T (Group I Human)”)
  - Moderate developmental toxicity (D)
- Benchmark 2f (“Very High T (Ecotoxicity or Group II Human) or High T (Group II\* Human)”)
  - High Group II\* Human (repeated dose neurotoxicity (Nr\*) and skin sensitization (SnS\*))

A data gap (DG) exists for endocrine activity (E). As outlined in CPA (2013) Section 12.2 (Step 8 – Conduct a Data Gap Analysis to assign a final Benchmark score), benzyl alcohol meets requirements for a GreenScreen® Benchmark Score of 2 despite the hazard data gaps. In a worst-case scenario, if benzyl alcohol were assigned a High score for the data gap endocrine activity (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 2 (“Use but Search for Safer Substitutes”) is applicable for all routes of exposure.

#### GreenScreen® Hazard Ratings for Benzyl Alcohol

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	L	M	DG	M	L	L	M	H	H	L	L	H	L	L	vL	vL	L	L

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.

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### GreenScreen<sup>®</sup> Executive Summary for 2-(2-Butoxyethoxy) Ethanol (CAS 112-34-5)

2-(2-Butoxyethoxy) ethanol is used primarily as a solvent in coatings, inks, cleaners and specialty fluids, and to produce diethylene glycol butyl acetate.

2-(2-Butoxyethoxy) ethanol was assigned a **GreenScreen Benchmark<sup>™</sup> Score of 2** (“Use but Search for Safer Substitutes”). This score is based on the following hazard score:

- Benchmark 2f
  - High Group II\*Human Toxicity (System Toxicity (STr\*)) (repeated dose)

Data gaps (DG) exist for endocrine activity (E) 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), 2-(2-butoxyethoxy) ethanol meets requirements for a GreenScreen<sup>®</sup> Benchmark Score of 2 despite the hazard data gaps. In a worst-case scenario, if 2-(2-butoxyethoxy) ethanol were assigned a High score for the data gap E, it would be categorized as a Benchmark 1 Chemical.

#### GreenScreen<sup>®</sup> Benchmark Score for Relevant Route of Exposure:

As a standard approach for GreenScreen<sup>®</sup> evaluations, all exposure routes (oral, dermal, and inhalation) were evaluated together, so the GreenScreen<sup>®</sup> Benchmark Score of 2 (“Use but Search for Safer Substitutes”) is applicable for all routes of exposure.

#### GreenScreen<sup>®</sup> Hazard Ratings for 2-(2-Butoxyethoxy) Ethanol (CAS 112-34-5)

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*										
<i>L</i>	<i>L</i>	<i>L</i>	<i>L</i>	DG	<i>L</i>	<i>L</i>	<b>H</b>	DG	<i>L</i>	<i>L</i>	DG	<i>M</i>	<b>H</b>	<i>L</i>	<i>L</i>	<i>vL</i>	<i>vL</i>	<i>L</i>	<i>M</i>

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. DG: Data Gap

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### GreenScreen® Executive Summary for Dimethyl Sulfoxide (CAS #67-68-5)

Dimethyl sulfoxide is a polar solvent that is commonly used as a solvent for polar compounds, acids, alkalis and mineral salts. It is used as a solvent for chemical synthesis, pharmaceuticals, and paint and varnish removers. Dimethyl sulfoxide is also used as an analytical reagent, in the manufacture of synthetic fibers, industrial cleaners, pesticides, and electronics, as a preservative for organ transplantation, and in the treatment of interstitial cystitis.

Dimethyl sulfoxide was assigned a **GreenScreen Benchmark Score™ of 3** (“Use but Still Opportunity for Improvement”). This score is based on the following hazard score combinations:

- Benchmark 3c
  - Moderate Group II Human Toxicity (skin irritation (IrS) and eye irritation (IrE))
- Benchmark 3d
  - Moderate Flammability

Data gaps (DG) exist for endocrine activity (E) 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), dimethyl sulfoxide meets requirements for a GreenScreen® Benchmark Score of 3 despite the hazard data gaps. In a worst-case scenario, if dimethyl sulfoxide 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 3 (“Use but Still Opportunity for Improvement”) is applicable for all routes of exposure.

#### GreenScreen® Hazard Ratings for Dimethyl Sulfoxide

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*										
<i>L</i>	<i>L</i>	<i>L</i>	<i>L</i>	DG	<b>L</b>	<b>L</b>	<b>L</b>	<b>L</b>	<b>L</b>	<b>L</b>	DG	<i>M</i>	<i>M</i>	<b>L</b>	<i>L</i>	<i>L</i>	<b>vL</b>	<i>L</i>	<b>M</b>

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.

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### GreenScreen® Executive Summary for 1,3-Dioxolane (CAS #646-06-0)

1,3-Dioxolane is used as a monomer for the production of high-molecular weight polyacetals. It is also a chemical intermediate, process solvent, and stabilizer for halogenated solvents.

1,3-Dioxolane was assigned a **GreenScreen Benchmark Score™ of 2** (“Use but Search for Safer Substitutes”). This score is based on the following hazard score combinations:

- Benchmark 2e
  - Moderate Group I Human Toxicity (mutagenicity (M), reproductive toxicity (R) and developmental toxicity (D))
- Benchmark 2g
  - High Flammability (F)

Data gaps (DG) exist for endocrine activity (E) 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), 1,3-dioxolane meets requirements for a GreenScreen® Benchmark Score of 2 despite the hazard data gaps. In a worst-case scenario, if 1,3-dioxolane 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 2 (“Use but Search for Safer Substitutes”) is applicable for all routes of exposure.

#### GreenScreen® Hazard Ratings for 1,3-Dioxolane

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*										
<b>L</b>	<i>M</i>	<i>M</i>	<i>M</i>	DG	<b>L</b>	<b>M</b>	<b>M</b>	<b>M</b>	<b>L</b>	<b>L</b>	DG	<i>M</i>	<i>H</i>	<b>L</b>	<b>L</b>	<i>M</i>	<b>vL</b>	<i>L</i>	<b>H</b>

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.

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### GreenScreen® Executive Summary for Estasol (CAS #95481-62-2)

Estasol is a chemical that functions as a solvent, a plasticizer, a polymer intermediate, and a component in consumer paint strippers, polishes and lacquer thinners.

Estasol was assigned a **GreenScreen Benchmark Score™ of 2** (“Use but Search for Safer Substitutes”). This score is based on the following hazard score combination:

- Benchmark 2e
  - Moderate Group I Human Toxicity (developmental toxicity (D) and endocrine activity (E))

Data gaps (DG) exist for repeated dose neurotoxicity (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), Estasol meets requirements for a GreenScreen® Benchmark Score of 2 despite the hazard data gaps. In a worst-case scenario, if Estasol were assigned a High score for the data gaps Nr\* or SnR\*, it would still be categorized as a Benchmark 2 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 2 Use but Search for Safer Substitutes”) is applicable for all routes of exposure.

#### GreenScreen® Hazard Ratings for Estasol

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*										
<i>L</i>	<i>L</i>	<i>L</i>	<i>M</i>	<i>M</i>	<i>L</i>	<i>M</i>	<i>M</i>	<i>M</i>	DG	<i>L</i>	DG	<i>L</i>	<i>M</i>	<i>M</i>	<i>L</i>	<i>vL</i>	<i>vL</i>	<i>M</i>	<i>L</i>

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.

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### GreenScreen® Executive Summary for d-Limonene (CAS #5989-27-5)

d-Limonene is a chemical that functions as a solvent, fragrance ingredient, and flavoring agent.

d-Limonene was assigned a **GreenScreen Benchmark™ Score of 2** (“Use but Search for Safer Substitutes”). This score is based on the following hazard score combinations:

- Benchmark 2f (“Very High T (Ecotoxicity or Group II Human) or High T (Group II\* Human)”)
  - Very High Ecotoxicity (acute aquatic hazard (AA))
  - High Group II\* Human hazard (skin sensitization (SnS\*))

Data gaps (DG) exist for reproductive toxicity (R), endocrine activity (E), single and repeated dose neurotoxicity (Ns and 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), d-limonene meets requirements for a GreenScreen® Benchmark Score of 2 despite the hazard data gaps. In a worst-case scenario, if d-limonene were assigned a High score for the data gaps reproductive toxicity (R) or endocrine activity (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 2 (“Use but Search for Safer Substitutes”) is applicable for all routes of exposure.

#### GreenScreen® Hazard Ratings for d-Limonene

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*										
<b>L</b>	<b>L</b>	DG	<b>L</b>	DG	<b>L</b>	<b>L</b>	<b>L</b>	DG	DG	<b>H</b>	DG	<b>H</b>	<i>H</i>	<b>vH</b>	<b>H</b>	<b>vL</b>	<b>M</b>	<i>L</i>	<b>M</b>

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.



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**Green Screen Assessment Prepared By:**

Name: Brian Penttila, Ph. D.

Title: Chemical Engineer

Organization: PNW Pollution Prevention Resource Center

Date: 30 June 2012

**Quality Control Performed By:**

Name: Alex Stone, Sc. D.

Title: Safer Chemical Alternative Chemist

Organization: WA Department of Ecology

Date: April 22, 2013

**GreenScreen™ Assessment for Acetone (CAS # 67-64-1)**

GreenScreen™ Version 1.2 Draft Assessment

**Note: Validation Has Not Been Performed on this Green Screen Assessment**

**Chemical Name:** Acetone

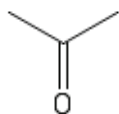
**Confirm application of the de minimus rule<sup>1</sup>:** (if no, what *de minimus* did you use?) Yes.

**Chemical Name (CAS #):** Acetone (CAS# 67-64-1)

**Also called:** 2-propanone, methyl ketone, beta-ketopropane, propan-2-one, pyroacetic acid.

**Chemical Surrogates, analogs or moieties used in this assessment (CAS #s):** Isopropanol (propan-2-ol)  
CAS # 67-63-0

**Chemical Structure(s):**



**Identify Applications/Functional Uses: (e.g. Cleaning product, TV casing)**

1. Chemical intermediate for methyl methacrylate, methacrylic acid and higher methacrylates, methyl isobutyl ketone, bisphenol a, acetic acid (ketene process), diacetone alcohol, chloroform, iodoform, bromoform, explosives, etc.
  2. Solvent for fats, oils, waxes, resins, rubber, plastics, lacquers, varnishes (including nail polish), adhesives, printing inks and cements; cleaning and drying parts of all kinds. Extraction solvent for various plant and animal products.
  3. Processing aid for manufacture of cellulose acetate.
- See Background section below for references.

**GreenScreen Rating<sup>2</sup>:** Acetone was assigned a **Benchmark Score of 2** based on:

- Did not fail any Benchmark 1 criteria.
- Failed Benchmark 2c (very high persistence and moderate neurotoxicity) and 2g (high flammability).

GreenScreen Hazard Ratings: Acetone																			
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	repeat*	single	repeat*										
<i>L</i>	<i>L</i>	<i>L</i>	<i>L</i>	DG	<b>L</b>	<b>L</b>	<b>L</b>	<b>M</b>	<b>M</b>	<b>L</b>	DG	<b>L</b>	<b>H</b>	<b>L</b>	<b>L</b>	<i>vH</i>	<i>vL</i>	<b>L</b>	<b>H</b>

Note: Hazard levels [Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)] in *italics* reflect estimated values and lower confidence. Hazard levels in **BOLD** font reflect values based on test data (See Guidance). NE indicates no determination was made (conflicting data); DG indicates insufficient data for assigning a hazard level.

<sup>1</sup> Every chemical in a material or formulation should be assessed if it is:

1. Intentionally added.
2. Present at greater than or equal to 100 ppm.

<sup>2</sup> 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.

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### GreenScreen® Executive Summary for Methanol (CAS #67-56-1)

Methanol is a chemical that is used as an industrial solvent for inks, resins, adhesives, and dyes, and is also used as antifreeze for automotive radiators, antifreezing agent and octane booster in gasoline, and fuel for picnic stoves.

Methanol was assigned a GreenScreen® Benchmark Score of LT-1, which may be considered equivalent to a Benchmark 1 (“Avoid-Chemical of High Concern”) chemical using the full GreenScreen® method as it has High developmental toxicity (D) based on classifications on Authoritative A lists in a GreenScreen® list translator search. This corresponds to GreenScreen® benchmark classification 1e in CPA 2011. Additional authoritative A listings were sufficient to assign hazard scores for acute toxicity (AT), systemic toxicity-single dose (STs), and flammability (F).

Under the scope of this project, ToxServices screened all paint components against Clean Production Action’s GreenScreen® List Translator (LT). Those identified as List Translator Benchmark 1 chemicals (“LT-1”) do not undergo a full GreenScreen® evaluation to save time and resources. Per the scope of work, only those hazard scores driven by authoritative listings in the List translator search were to be assigned. Upon inspection of the dataset, ToxServices expanded the assessments for all LT-1 chemicals in order to evaluate aquatic toxicity and environmental fate, as these endpoints are highly relevant to the alternatives assessment of nonbiocide boat paints. The expanded environmental fate and toxicity literature search or modeling for methanol did not identify any additional Benchmark 1 score combinations.

#### 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 (“Avoid-Chemical of High Concern”) is applicable for all routes of exposure.

#### GreenScreen® Hazard Ratings for Methanol

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*										
NA	NA	NA	<b>H</b>	NA	<b>H</b>	<b>vH</b>	NA	NA	NA	NA	NA	NA	NA	<b>L</b>	<b>L</b>	<b>vL</b>	<b>vL</b>	NA	<b>H</b>

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. NA: Not assessed.

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**Green Screen Assessment Prepared By:**

Name: Brian Penttila, Ph. D.

Title: Chemical Engineer

Organization: PNW Pollution Prevention Resource Center

Date: 30 June 2012

**Quality Control Performed By:**

Name: Alex Stone, Sc. D.

Title: Safer Chemical Alternative Chemist

Organization: WA Department of Ecology

Date: 17 April 2013

**GreenScreen™ Assessment for Toluene (CAS #108-88-3)**

GreenScreen™ Version 1.2 Draft Assessment

**Note: Validation Has Not Been Performed on this Green Screen Assessment**

**Chemical Name:** Toluene

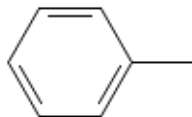
**Confirm application of the de minimus rule<sup>1</sup>:** (if no, what *de minimus* did you use?) Yes.

**Chemical Name (CAS #):** Toluene (CAS#108-88-3)

**Also Called:** “Benzene, methyl-”, “Methacide”, “Methylbenzene”, “Phenylmethane”, “TOLU”, “Toluene”, “Toluol” (US EPA, ACToR database, [actor.epa.gov/](http://actor.epa.gov/))

**Chemical Surrogates, analogs or moieties used in this assessment (CASs #):**

**Chemical Structure(s):**



**Identify Applications/Functional Uses: (e.g. Cleaning product, TV casing)**

1. Toluene is used commercially in the production of benzene and many other chemicals, e.g. benzoic acid, nitrotoluenes, dyes, pharmaceuticals, food additives, plastics, etc.
2. Toluene is also widely used as a solvent in coatings, adhesives, inks, pharmaceuticals and chemical processing.

Reference: European Union 2003, Risk Assessment Report (see references to Substance Background below).

**GreenScreen Rating<sup>2</sup>:** Toluene was assigned a **Benchmark Score of 1** based on:

- Failure of Benchmark Rule 1e, due to High reproductive and developmental toxicity.

GreenScreen Hazard Ratings: Toluene																			
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	repeat*	single	repeat*										
<b>DG</b>	<b>L</b>	<b>H</b>	<b>H</b>	<b>M</b>	<b>L</b>	<b>M</b>	<b>H</b>	<b>M</b>	<b>H</b>	<b>L</b>	<b>DG</b>	<b>H</b>	<b>L</b>	<b>H</b>	<b>H</b>	<i>H</i>	<b>vL</b>	<b>L</b>	<b>H</b>

Note: Hazard levels [Very High (vH), High (H), Moderate (M), Low (L), Very Low (vL)] in *italics* reflect estimated values and lower confidence. Hazard levels in **BOLD** font reflect values based on test data (See Guidance). NE indicates no determination was made (conflicting data) and DG indicates insufficient data for assigning hazard level.

<sup>1</sup> 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.

<sup>2</sup> 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.

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### GreenScreen® Executive Summary for Formic Acid (CAS #64-18-6)

Formic acid is a chemical that is used in textile dyeing and finishing, rubber manufacture, and as a chemical intermediate, catalyst in resins, plasticizer in resins, antiseptic and preservative, component of cleaning solutions, and oil well acidifying agent. It is also used as a direct food additive and in food packaging. In hydraulic fracturing, it is used as a corrosion inhibitor to protect pipes and related fracking components.

Formic acid was assigned a **GreenScreen Benchmark™ Score of 2** (“Use but Search for Safer Substitutes”). This score is based on the following hazard combinations:

- Benchmark 2f
  - Very High Group II Human Toxicity (systemic toxicity single dose (STs), neurotoxicity single dose (Ns), skin irritation (IrS) and eye irritation (IrE))
  - High Group II\* Human Toxicity (systemic toxicity-repeated dose (STr\*))

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), formic acid meets requirements for a GreenScreen® Benchmark Score of 2 despite the hazard data gaps. In a worst-case scenario, if formic acid were assigned a High score for the data gap endocrine activity, 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 2 (“Use but Search for Safer Substitutes”) is applicable for all routes of exposure.

#### GreenScreen® Hazard Ratings for Formic Acid

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	L	L	DG	H	vH	H	vH	DG	L	DG	vH	vH	M	M	vL	vL	L	M

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.

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**GreenScreen® Executive Summary for Caustic Soda (CAS 1310-73-2)**

Caustic soda is a chemical that is used for pH regulation, alkaline ore digestion, basic catalysis, removal of lignin in the paper industry, production of sodium phosphate in the detergent industry, manufacture of soaps via saponification of fats and oils, degreasing and cleaning in the food industry, and refining of vegetable oil.

Caustic soda was assigned a **GreenScreen Benchmark™ Score of 2** (“Use but Search for Safer Substitutes”). This score is based on the following hazard combination:

- Benchmark 2f
  - Very High Group II Human Toxicity (Skin Irritation (IrS), Eye Irritation (IrE), and Systemic Toxicity (STs) (single dose))

Data gaps (DG) exist for respiratory sensitization (SnR\*) and chronic aquatic toxicity (CA). As outlined in CPA (2013) Section 12.2 (Step 8 – Conduct a Data Gap Analysis to assign a final Benchmark score), caustic soda meets requirements for a GreenScreen® Benchmark Score of 2 despite the hazard data gaps. In a worst-case scenario, if caustic soda were assigned a High score for the data gap SnR\* or a Very High score for CA, it would still be categorized as a Benchmark 2 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 2 (“Use but Search for Safer Substitutes”) is applicable for all routes of exposure.

**GreenScreen® Hazard Ratings for Caustic Soda**

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*										
<i>L</i>	<i>L</i>	<i>L</i>	<i>L</i>	<i>L</i>	<b>H</b>	<b>vH</b>	<i>L</i>	<i>L</i>	<i>L</i>	<i>L</i>	DG	<b>vH</b>	<b>vH</b>	<b>M</b>	DG	<i>L</i>	<i>vL</i>	<i>M</i>	<i>L</i>

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. DG: Data Gap