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Pollution Prevention

An Alternatives Assessment for Use of n-Methylpyrrolidone

(EPA Docket EPA-HQ-OPPT-2020-0744, RIN 2070-AK85)

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ABBREVIATIONS AND ACRONYMS

1-BP	1-Bromopropane
ATSDR	Agency for Toxic Substances and Disease Registry
BAF	Bioaccumulation factor
BCF	Bioconcentration factor
CalEPA	California Environmental Protection Agency
CASRN	Chemical Abstracts Service Registry Number
CDC	Centers for Disease Control and Prevention
COC	Concentration of Concern
COU	Condition of use
DfE	Design for the Environment (*historical EPA program*)
ECHA	European Chemicals Agency
EPA	U.S. Environmental Protection Agency
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GHS	Globally Harmonized System
GWP	Global warming potential
HCM	Hazard Comparison Module
HPV	High production volume
IPCC	Intergovernmental Panel on Climate Change
IRIS	Integrated Risk Information System
LC_{50}	Lethal concentration of 50 percent of test organisms
LD_{50}	Lethal dose of 50 percent of test organisms
LOAEC	Lowest-observed-adverse-effect-concentration
LOAEL	Lowest-observed-adverse-effect-level
MC	Methylene chloride (also known as dichloromethane, DCM)
MOA	Mode of action
NIOSH	National Institute for Occupational Safety and Health
NMP	n-Methylpyrrolidone (also known as n-methyl-2-pyrrolidone)
NOAEL	No-observed-adverse-effect-level
NTP	National Toxicology Program
ODP	Ozone depletion potential
OCSPP	Office of Chemical Safety and Pollution Prevention
OECD	Organisation for Economic Cooperation and Development
OPP	Office of Pesticide Programs
OPPT	Office of Pollution Prevention and Toxics
OSHA	Occupational Safety and Health Administration
POD	Point of departure
PBPK	Physiological based pharmacokinetic modeling and simulation
PCE	Perchloroethylene, also known as tetrachloroethylene or 1,1,2,2-tetrachloroethylene
QSAR	Quantitative structure-activity relationship
RQ	Risk quotient
SDS	Safety data sheets (previously known as material safety data sheets, MSDS)
TRACI	Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts
TCE	Trichloroethylene
T.E.S.T	Toxicity Estimation Software Tool
TSCA	Toxic Substances Control Act
UVCB	Unknown or variable composition, complex reaction products or biological materials
WHO	World Health Organization
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

EPA is undertaking proposed rulemaking under section 6(a) of the Toxic Substances Control Act (TSCA) for n-methylpyrrolidone (NMP) after completing a TSCA section 6(b) risk evaluation and determining that the chemical substance presents unreasonable risk of injury to health under the conditions of use (COUs). This document was developed consistent with the statutory requirements of TSCA section 6(c)(2)(C) "Consideration of Alternatives" in support of the section 6(a) proposed rulemaking in docket EPA-HQ-OPPT-2020-0744 in regulations.gov (RIN 2070-AK85).

EPA's methodology for this analysis is described in detail below. As an overview, each of the COUs of NMP proposed to be prohibited or substantially restricted was mapped to 23 product categories for further analysis. EPA then identified products within those product categories that do not contain NMP and are known to be reasonably available to achieve similar functions as NMP-containing products. All identified chemical ingredients of those products, including chemical ingredients performing the same or similar functions as NMP, were then screened to identify reasonably available hazard information. This search of reasonably available information resulted in the identification of several hundred substitute products across the product categories that do not contain NMP (see Section 5). Only one alternative product was identified for three product categories: Category: Electronic and Semiconductor Manufacturing: Processing Aid, Category: Leather Care, and Category: Tape. As part of this search of reasonably available information, EPA also determined that there do not appear to be reasonably available alternative chemicals or products for nine COUs based on reasonably available information (see Appendix C and Section 5.2 of the Economic Analysis).

Specifically, EPA screened all identified product ingredients for toxicological and environmental endpoints using the Hazard Comparison Module (HCM). The HCM aggregates data from authoritative sources, quantitative structure-activity relationship (QSAR) modeling, and other screening tools to present a high-level assessment of fate properties and human health and environmental hazard endpoints, generally following historical peer-reviewed, hazard-based Design for the Environment (DfE) criteria where hazard data are converted into scores of low, medium, high, or very high for comparability. In addition, the ingredients were compared to established lists of global warming potential (GWP) and ozone depletion potential (ODP) chemicals to identify which ingredients were included on the lists. Finally, Occupational Safety and Health Administration (OSHA) flammability categories were calculated for the individual ingredients to inform feasibility considerations given certain stakeholder concerns about more flammable alternatives to NMP.

The identification of chemical product alternatives and the results of the ingredients screening form the basis for considering whether various alternatives benefit health or the environment compared to the use of NMP. These screening results are presented in hazard tables coded using the DfE criteria, with ratings assigned from low to high or very high across 17 hazard endpoints and persistence and bioaccumulation potential. The results section is organized by product category and summarizes the screening analysis tables, providing descriptions of the toxicological and environmental endpoints for the product ingredients, and highlighting those that perform similar functions as NMP. Dozens of solvents were identified and varying levels of hazard screening data are reasonably available for these solvents. This document considers a broad range of available products and chemical substances that are available for NMP-containing products, enabling EPA to analyze whether there are feasible alternatives that are beneficial to health or the environment relative to NMP. These chemicals reflect a diverse set of ratings for human health and environmental hazard endpoints and have varying degrees of flammability. In addition, some of these solvents have potential for either global warming or ozone depletion.

Importantly, this report does not make recommendations of products that should be used in place of NMP; rather, its purpose is to present a representative list of alternative products and chemical ingredients and their hazard relative to NMP to ensure that the screening results for potential alternatives are considered as part of the development of a regulation under TSCA section 6(a) for NMP.

1 BACKGROUND AND PURPOSE

EPA issued the TSCA risk evaluation for NMP (CASRN 872-50-4) in December 2020 (U.S. EPA, 2020), and subsequently determined that NMP presents an unreasonable risk of injury to health under its COUs (U.S. EPA, 2022). The analyses presented in TSCA risk evaluations consider the weight of the scientific evidence including the result of systematic review, and involve application of expert scientific judgement (U.S. EPA, 2018). Based on reasonably available animal evidence, the risk evaluation identified reproductive and developmental toxicity as the most sensitive human health effects of NMP. The risk evaluation also identified evidence for liver toxicity, kidney toxicity, immunotoxicity, neurotoxicity, and irritation.

EPA has produced this Alternatives Assessment for NMP to support rulemaking under TSCA section 6(a) in docket EPA-HQ-OPPT-2020-0744 in regulations.gov (RIN 2070-AK73). TSCA section 6(c)(2)(C) states the following:

> Based on the information published under subparagraph (A), in deciding whether to prohibit or restrict in a manner that substantially prevents a specific condition of use of a chemical substance or mixture, and in setting an appropriate transition period for such action, the Administrator shall consider, to the extent practicable, whether technically and economically feasible alternatives that benefit health or the environment, compared to the use so proposed to be prohibited or restricted, will be reasonably available as a substitute when the proposed prohibition or other restriction takes effect.

This analysis compares the hazard endpoints and fate characteristics of NMP (the subject of this TSCA section 6(a) risk management proposed rulemaking) to chemical ingredients in alternative products known to be reasonably available. Consideration of whether there are technically and economically feasible alternatives, when compared with NMP for the uses proposed to be prohibited or restricted is discussed in Section 5.2 of the Economic Analysis of the Proposed Regulation of NMP Under TSCA section 6(a). This alternatives analysis primarily focuses on commercial and consumer uses of NMP. As described in more detail in Section 2.1 and Appendix C, several uses of NMP appear to have no known alternatives based on reasonably available information. As a result, specific alternative products and chemical ingredients were not identified or assessed for these COUs.

EPA has focused this Alternatives Assessment on chemical ingredients that perform the same or similar functions as NMP in products for consumer or commercial/industrial use. In some cases, the Agency did not find it practicable to consider alternative processes that may be reasonably available as a substitute for processes involving NMP when the proposed prohibitions or restrictions would take effect, as described in more detail in Appendix C. This is due to numerous considerations including uncertainties about alternative processes that may be reasonably available, the difficulty of ascertaining whether any alternative processes may be technically and economically feasible, and the challenges of comparing the benefits of alternative processes to the benefits of the NMP-containing processes. When the above considerations are not applicable (*e.g.,* when a one-for-one or drop-in substitute for NMP in an established industrial process is available), EPA may have found it practicable to consider alternative processes.

Although the list of alternatives to NMP presented in this report is not intended to be exhaustive of every alternative product or chemical, it presents (1) a representative list of reasonably available alternatives for consideration by EPA, to the extent practicable to form a snapshot of the current market; and (2) where practicable, information to enable EPA to compare the human health hazards, environmental hazards, potential persistence, and bioaccumulative properties of each chemical for each product in each

product category. These comparisons are comprised of the side-by-side presentation of hazard data, as discussed below. This report is limited to hazard comparisons; it does not compare risks between NMP and alternatives, as there are not exposure estimations or discussions of exposure potential presented for the alternatives.

2 IDENTIFYING PRODUCT ALTERNATIVES

2.1 n-Methylpyrrolidone Conditions of Use and Product Categories

For this analysis, EPA principally identified and assessed alternatives to NMP in products relevant to several commercial and consumer uses proposed to be prohibited or significantly restricted or for which prohibition or significant restriction was considered as a potential regulatory action. In assessing the scenario in which there is market adoption of these alternative commercial and consumer products that do not contain NMP, the earlier and later life cycle stages are no longer relevant to the assessment: these COUs for NMP are dependent on continued use in the commercial and consumer life cycle stages. As such, this Alternatives Assessment excludes manufacturing (including import), repackaging, distribution in commerce, disposal, and recycling. The COUs included in this assessment are listed in Table 5-1 with a crosswalk to the 23 product categories used in this assessment. Due to the lack of reasonably available information, this analysis did not assess alternatives for every individual COU EPA is proposing to prohibit or significantly restrict; the COUs not analyzed and explanations for exclusion from this analysis are listed in Appendix C.

2.2 Alternative Products and Product Ingredients

For each product category, EPA researched NMP-based products and products containing alternative chemical ingredients available for sale in the United States to identify a representation of the types of products available for consideration, to the extent practicable and based on reasonably available information and prepared a comparison between NMP-based products and alternatives. To this end, EPA performed Internet searches, reviewed published market research, and used the expertise of industry experts to find examples of NMP-based products and alternative product formulations. Specifically, EPA undertook a web-based search of products advertised by function (*e.g.*, laundry detergent) to identify safety data sheets or material safety data sheets (collectively, SDS) that identify product ingredients by chemical name and/or Chemical Abstract Services Registry Number (CASRN).

Safety data sheets (SDSs) for alternative products were collected to identify chemical ingredients listed by the manufacturers for each product category. Alternative and baseline products typically contained multiple ingredients. In some cases, the chemical identities of ingredients were not provided on a product's SDS (*e.g.*, the chemical identities of proprietary ingredients may be withheld to protect trade secrets). If the chemical identity of at least 40 percent of a product's formulation was not given on the SDS (*i.e.*, approximately half the mass of the product is unknown) the product was removed from consideration due to poor characterization and was not analyzed further.

For use as a reactant/intermediate, EPA investigated industrial processes using alternate chemicals that could be substituted without fundamentally changing the process. In addition, alternative processes that produce the same product and that do not require the use of NMP were investigated. These alternative chemicals are listed under the appropriate product categories below and in Appendix A.

Within each product category, EPA compiled the chemical ingredients for each product to compare the baseline and alternative products. This allowed EPA to consider trends, such as whether chemicals were frequently found in each product or if they were more variable and present in only small amounts. The formulations described in the SDSs are listed in Appendix A for all identified products. In addition, the range of concentrations listed for NMP identified among the reasonably available products is also shown. Note that inherent errors in the original SDS, including inconsistencies between the CASRNs and chemical names, may carry through in Appendix A; the listed CASRN was used for screening in this assessment in the event of a discrepancy.

NMP is a solvent, which means it can dissolve other substances. This attribute can be used in a variety of ways, depending on the product. For instance, solvents can be used to dissolve and remove adhesives, paints, or other coatings. Solvents may also be used to create homogeneous mixtures or otherwise change a product to make it perform its role better. For example, solvents may be used to minimize clogs in spray nozzles or promote quick drying of inks and paints. Therefore, to further facilitate the comparison of the baseline and alternative products, the chemicals in the identified products were evaluated using professional judgment for their potential to function as a solvent.

In some cases, the alternative product may function without the use of a solvent as an ingredient. For example, NMP can be compared to other chemicals that do not function in a product as a solvent, but rather perform a different function, such as surfactants, which decrease surface tension. In these cases, the products were noted and, where appropriate, described further.

This report does not make recommendations for or against a specific alternative, or conclusions that a specific alternative does or does not benefit health or the environment compared to NMP. Instead, it compares hazard data between NMP and potential alternatives with the purpose of considering the landscape of potential chemical alternatives for NMP in accordance with TSCA section 6(c)(2)(C) as part of regulations under TSCA section 6(a).

2.3 Non-chemical Alternatives

Several of the functions of chemical products containing NMP can also be accomplished by non-chemical means, such as mechanical or thermal methods (*e.g.*, sanding, media blasting, heat guns). Where any of these alternative processes have been identified for a product use, they are described qualitatively in the corresponding results section.

For NMP, non-chemical alternatives are noted briefly under the product category of paint and coating remover (Section 5.20).

3 DATA SOURCES AND ASSESSMENT METHODOLOGY

This section describes the data sources used to screen identified chemical alternatives and explains key methodological differences from the TSCA risk evaluations or other work products from OPPT. For this analysis, EPA used publicly available tools and data that could rapidly screen hundreds of chemicals using existing methods and authoritative sources across a broad range of health and environmental endpoints. This is a high-level, semi-automated assessment compared to the in-depth analysis for risk evaluations under TSCA section 6(b). EPA surveyed chemicals across each use by examining the Hazard Comparison Module (HCM)[1] results for each endpoint for all ingredients identified in the alternative products.

3.1 Hazard Comparison Module for Chemical Alternatives

After the alternative chemical ingredients for products in each product category were identified, EPA used the HCM, which is part of a broader set of cheminformatics modules, to rapidly screen the ingredients. The HCM compiles and uses data generated within EPA and sourced from public databases, literature, and QSAR predictions. The HCM outputs support chemical read-across for each alternative chemical ingredient. The original data were gathered from GHS (Globally Harmonized System) hazard codes/categories, presence on hazardous chemical lists, and quantitative experimental toxicity values. HCM outputs describe the human health effects, environmental hazard to aquatic organisms, and the environmental fate properties of each chemical available in the referenced sources (Lowe and Williams, 2021; Williams et al., 2021; Vegosen and Martin, 2020; Williams et al., 2017). Data disseminated via the HCM are compiled from multiple authoritative sources, outlined in Table 3-1 and Table 3-2 below.

In the HCM, to fill data gaps where there are no records from authoritative or screening level sources, predicted toxicity values from WebTEST[2] are included (Martin et al., 2019). Where possible, EPA's Toxicity Estimation Software Tool (T.E.S.T.) predicts toxicity values and physical properties of chemicals using QSAR models based on Hierarchical Clustering, Single Model, Group Contribution, Nearest Neighbor, and Consensus methods (Vegosen and Martin, 2020).

Once the information is compiled by the HCM, the module rates each hazard and fate parameter according to EPA's historical DfE Program Alternatives Assessment Criteria for Hazard Evaluation Version 2.0, August 2011 (U.S. EPA, 2011) (described in further detail in Section 4).[3] Although there are many assessment methods and tools that are available for defining and comparing the hazards associated with chemicals, EPA has selected the peer-reviewed, hazard-based DfE Alternatives Assessments criteria that were also used in support of risk management actions for TSCA chemicals. Hazard screening data are converted into scores of low, medium, high, or very high (L, M, H, or VH, respectively) based on a modified version of the DfE criteria, described in Table 4-2. The final scores assigned are based on the 'trumping method' which selects the highest score from the most authoritative source as the integrated score (Vegosen and Martin, 2020).

[1] Previous versions of the HCM have been referred to as the Hazard Comparison Dashboard. HCM is part of the ChemInformatics modules, publicly accessible at https://www.epa.gov/chemical-research/cheminformatics.
[2] WebTEST is a web-services based application hosted within NCCT's CompTox Chemicals Dashboard. WebTEST can estimate toxicity values and physical properties through the web browser or directly through the web via web-services. https://cfpub.epa.gov/si/si_public_record_Report.cfm?Lab=NRMRL&dirEntryId=344752
[3] These 2011 criteria are historical criteria from the DfE Environment Alternatives Assessments and are not part of the current DfE product certification program that is now administered jointly with the Office of Pesticide Programs (OPP) and focuses solely on antimicrobial products under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) https://www.epa.gov/pesticide-labels/design-environment-dfe-certification-information-registrants.

The data presented in this Alternatives Assessment represents the output from the HCM, which is a dynamic resource subject to periodic updates. The data in these tables reflect data last updated in HCM in October 2021.

Table 3-1. Data Sources Consulted for the Hazard Analysis Sorted by Authority Level (from (Vegosen and Martin, 2020))

Authoritative
• European Chemicals Agency (ECHA) Classification Labeling and Packaging (CLP) • EPA mid-Atlantic Region Human Health Risk-Based Concentrations • Germany Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area • World Health Organization International Agency for Research on Cancer (IARC) Monographs on the Evaluation of Carcinogenic Risks to Humans • Integrated Risk Information System (IRIS) • U.S. National Institute for Occupational Safety and Health (NIOSH) list of potential occupational carcinogens • California Office of Environmental Health Hazard Assessment Proposition 65 List • EU European Chemicals Agency (ECHA) Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) Candidate List of Substances of Very High Concern for Authorization • U.S. Department of Health and Human Services National Toxicology Program Report on Carcinogens
Screening
• Safe Work Australia Hazardous Chemical Information System (HCIS) • Canada CNESST Workplace Hazardous Materials Information System (WHMIS) • ChemIDplus • Environment and Climate Change Canada Domestic Substance List (DSL) • Health Canada Priority Substances Lists (2006) (Carcinogenicity) • Health Canada Priority Substances Lists (2006) (Reproductive Toxicity) • National Institute of Technology and Evaluation (NITE) of Japan GHS Classification Results • Department of Occupational Safety and Health Ministry of Human Resources • Malaysia Industry Code of Practice on Chemicals Classification and Hazard Communication • New Zealand Environmental Protection Authority • Chemsec Substitute It Now (SIN) List • The Endocrine Disruption Exchange (TEDX) List of Potential Endocrine Disruptors • U.S. EPA Toxicity Estimation Software Tool (T.E.S.T.); Experimental toxicity values • U.S. EPA Toxicity Values (ToxVal) database, v8 • U.S. EPA Toxic Substances Control Act (TSCA) Work Plan for Chemical Assessments: 2014 Update • University of Maryland (UMD) List of Acute Toxins, Teratogens, Carcinogens, or Mutagens
QSAR model
• U.S. EPA Toxicity Estimation Software Tool (T.E.S.T.) Predicted toxicity values • Ministry of Environment and Food of Denmark Advisory List for Self-Classification of Dangerous Substances. Predicted GHS categories

Table 3-2. Reference Information for Data Sources Consulted for the Hazard Analysis (Described Further in (Vegosen and Martin, 2020))

Data Source
Safe Work Australia Hazardous Chemical Information System (HCIS)
Canada CNESST Workplace Hazardous Materials Information System (WHMIS)
U.S. National Library of Medicine ChemID*plus*
Ministry of Environment and Food of Denmark Advisory List for Self-Classification of Dangerous Substances
Environment and Climate Change Canada Domestic Substances List (DSL)
European Chemicals Agency (ECHA) Classification Labeling and Packaging (CLP) Annex VI
EPA mid-Atlantic Region Human Health Risk-Based Concentrations
Germany Permanent Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area (MAK Commission)
Health Canada Priority Substances Lists (2006) (Carcinogenicity)
Health Canada Priority Substances Lists (2006) (Reproductive Toxicity)
World Health Organization International Agency for Research on Cancer (IARC) Monographs on the Evaluation of Carcinogenic Risks to Humans
Integrated Risk Information System (IRIS) (via DSSTOX)
National Institute of Technology and Evaluation (NITE) of Japan GHS Classification Results
Department of Occupational Safety and Health Ministry of Human Resources Malaysia Industry Code of Practice on Chemicals Classification and Hazard Communication
New Zealand Environmental Protection Authority Chemical classification and information database (CCID)
U.S. National Institute for Occupational Safety and Health (NIOSH) list of potential occupational carcinogens
California Office of Environmental Health Hazard Assessment Proposition 65 List
EU European Chemicals Agency (ECHA) Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) Candidate List of Substances of Very High Concern for Authorization
U.S. Department of Health and Human Services National Toxicology Program Report on Carcinogens
ChemSec Substitute It Now (SIN) List
The Endocrine Disruption Exchange (TEDX) List of Potential Endocrine Disruptors
U.S. EPA Toxicity Estimation Software Tool (T.E.S.T.) Experimental
U.S. EPA Toxicity Estimation Software Tool (T.E.S.T.) Predicted
U.S. EPA Toxicity Values (ToxVal) database, v8;
U.S. EPA Toxic Substances Control Act (TSCA) Work Plan for Chemical Assessments: 2014 Update

Data Source
University of Maryland (UMD) List of Acute Toxins, Teratogens, Carcinogens, or Mutagens

An explanation of how the DfE Alternatives Assessment Criteria were modified within the HCM, as well as a discussion of how scores were determined in specific cases where multiple hazard scores were identified across multiple authoritative sources, is outlined in (Vegosen and Martin, 2020).

3.2 HCM and TSCA Risk Evaluation Methods Comparisons

This report differs from TSCA section 6(b) risk evaluations in its intention, scope, and methods. This alternatives assessment provides information on alternatives for consideration during risk management and regulatory development in accordance with TSCA section 6(c)(2)(C). To this end, it surveys hundreds of chemicals. Consequently, an in-depth analysis of each chemical is impracticable, and a high-throughput screening assessment is required. The hazard ratings presented in this report for ingredients in product alternatives for NMP were largely derived from a series of searchable databases and predictive modeling approaches that are automatically searched and ranked hierarchically according to the methodology of the HCM (Vegosen and Martin, 2020). A further discussion of why these hazard ratings were selected for this analysis and why consideration of additional endpoints was deemed impracticable for this screening-level approach is provided in the DfE Alternatives Assessment Criteria for Hazard Evaluation (U.S. EPA, 2011).

Conversely, chemical risk evaluations under TSCA section 6(b) are more comprehensive because they have a different purpose. Focusing on one chemical or category of chemicals to determine whether it presents unreasonable risk, these risk evaluations require nuanced and more in-depth analyses. For example, they may contain additional endpoints—such as human immunotoxicity, human epigenetic toxicity, and animal reproduction—which are not included in the alternatives analysis. Generally, for the risk evaluations, EPA applies a robust systematic review process to identify reasonably available information for relevant scientific disciplines, including human health hazard, environmental hazard, exposure, environmental fate, engineering, and physical-chemical properties. These data are then screened for relevance and overall quality following the approaches outlined in the *Application of Systematic Review in TSCA Risk Evaluations* (U.S. EPA, 2018).

Although completing a risk evaluation for each ingredient in product alternatives is outside the scope of TSCA section 6(c)(2)(C), the conclusions of completed evaluations are valuable data in this analysis. Conclusions of the TSCA risk evaluations for trichloroethylene (TCE), perchloroethylene (PCE), and 1-bromopropane (1-BP) are not currently available for use as a source in the HCM. However, select hazard ratings for TCE, PCE, and 1-BP were added to this analysis to better reflect the endpoints described in their TSCA risk evaluations and are noted in the ratings in Appendix A. A detailed discussion of the quantitative differences between this report and a TSCA risk evaluation is included below.

3.2.1 Human Health Hazard

The human health hazard ratings in the HCM are based on a modified version of DfE criteria (U.S. EPA, 2011). These criteria have been used to consider hazard for all Alternatives Assessments conducted by DfE since 2011. In this alternatives assessment, a hazard rating was based on the exposure route with the highest hazard designation from the most authoritative source. Ratings applied ranged from very high to low, noting that ratings for target organ effects, cancer, genotoxicity, sensitization, and irritation are on different scales and are not directly comparable.

TSCA section 6(b) risk evaluations use a different approach for analyzing human health hazard. In those risk evaluations, point of departure (POD) values (*e.g.*, no-observed-adverse-effect-level [NOAEL]/lowest-observed-adverse-effect-level [LOAEL], Human Equivalent Dose [HED]/Human Equivalent Concentration [HEC], benchmark dose [BMD]) may be determined for each specific toxicity endpoint. They present hazard identification conclusions and dose-response analyses based on information resulting from a systematic review process and data integration procedures using a weight of the scientific evidence approach.

3.2.2 Environmental Hazard

The environmental hazard ratings in the HCM are based on DfE criteria for aquatic toxicity for fish and pelagic invertebrates only. Hazard designations for aquatic toxicity from acute and chronic exposures are described numerically in Table 4-2 below.

The TSCA risk evaluations may provide hazard values for specific endpoints (*e.g.*, LC50s, no-observed-effect-concentration [NOEC], etc.) for each trophic level of aquatic species—including aquatic vertebrates (*e.g.*, fish and amphibians), invertebrates (*e.g.*, pelagic and benthic invertebrates), and plants (*e.g.*, algae and vascular plants). However, in the TSCA risk evaluations these values are used in a risk context, integrating exposure and concentration estimates especially for ecotoxicological considerations. In lieu of hazard designations, environmental hazard values in TSCA risk evaluations are weighed for quality and relevance and integrated into Concentrations of Concern (COC) that are representative of the species in the available data.

3.2.3 Persistence and Bioaccumulation Fate Parameters

The fate scores for persistence and bioaccumulation potential of substances in the HCM used in this Assessment are based on the DfE Alternatives Assessment criteria (U.S. EPA, 2011). Conversely, TSCA section 6 risk evaluations, as well as other parts of OPPT's program under TSCA section 5, use different criteria to score persistence and bioaccumulation potential. Both sets of criteria are based on Agency guidelines and best practices, not statutory or regulatory requirements, with the DfE criteria providing a higher level of precision. A short discussion of the scientific basis of and distinction between the two scoring practices is included below.

The goal of DfE was to create a spectrum of ratings criteria to differentiate among chemicals. The Arnot and Gobas (2006) data showed that a significant percentage of subject chemicals had bioconcentration/accumulation factors (BCF/BAF) values below 1,000, making further differentiation desirable. After publication of the draft criteria, DfE discussed this issue with several technical experts within and outside of EPA who supported the use of a threshold at 100—an order of magnitude below the moderate range threshold of 1,000 as a useful means of differentiating among chemicals. A similar approach was taken for persistence criteria. The use of "very low" criteria and lowering the half-life threshold for chemicals with "moderate" persistence (16 to 60 days vs. 60 to 180 days in the New and Existing Chemicals Program) allowed further differentiation among readily biodegradable chemicals and chemicals with half-lives of less than 60 days.

Therefore, the TSCA persistence criteria and the DfE criteria have differing metrics for ratings, with the DfE metrics being more granular (see Table 3-3). Under DfE, persistence categorization was divided into five categories based on environmental degradation half-lives for both biodegradation and abiotic

degradation. Half-life in air was not intended to be used in determining persistence in the DfE criteria.[4] Under OPPT's TSCA New and Existing Chemicals Programs, chemicals are similarly assigned persistence ratings based on environmental half-lives; however, three categories are used, which do not align with the DfE criteria (*e.g.*, the OPPT high is the same as the DfE very high).

[4] The HCM uses screening data and ratings from Environment and Climate Change Canada's Domestic Substance List (DSL). Environment and Climate Change Canada does rate "high" persistence based on atmospheric half-life. This distinction is not apparent where DSL screening data have been used to inform the final persistence rating and may inflate ratings as compared to a strict read of the DfE criteria. For example, persistence of acetone, benzene, butane, ethanol, ethylbenzene, isopropanol, methanol, methyl acetate, propane, and toluene would otherwise be rated no higher than "low" in the HCM if the DSL values based on persistence in air were excluded.

Table 3-3. Comparison of TSCA Persistence Criteria

DfE Persistence Criteria (Water, Soil, Sediment)				
Very Low	**Low**	**Moderate**	**High**	**Very High**
Readily biodegradable Passes 10-day window criteria	Half-life <16 days Readily biodegradable	Half-life 16 to 60 days	Half-life 60 to 180 days	Half-life >180 days
TSCA new and existing chemicals persistence criteria (water, soil, sediment)				
Low			**Moderate**	**High**
Half-life <60 days			Half-life 60 to 180 days	Half-life >180 days
TSCA new and existing chemicals persistence criteria (air)				
Not Persistent			**Persistent**	
<2 days			≥2 days	

Similarly, the TSCA bioaccumulation criteria and the DfE criteria ratings have differing rating thresholds (Table 3-4). Under DfE, bioaccumulation ratings are divided into four categories based on measured bioconcentration or bioaccumulation factors. Where measured BCF or BAF values are not available, measured octanol/water (K_{OW}) or octanol/air (K_{OA}) partition coefficient values are used. If no related values are available, estimated K_{OW} and K_{OA} values and lastly estimated BAFs may be used.

Under OPPT's TSCA programs, chemicals are assigned bioaccumulation ratings based on measured or estimated BCF/BAF values, however, three categories are used. The BCF ranges designated as "very high" using DfE Criteria are classified as high under the TSCA criteria. The BCF ranges designated as "high" using DfE Criteria are classified as "moderate" under the TSCA criteria. The BCF ranges designated as "moderate" or "low" using DfE Criteria are classified as "low" under the TSCA criteria.

Table 3-4. Comparison of TSCA Bioaccumulation Criteria

DfE Bioconcentration Potential Criteria			
Low	**Moderate**	**High**	**Very High**
BCF/BAF <100 K_{OW} <100 OR K_{OA} < 100,000	BCF/BAF 100 to <1,000	BCF/BAF 1,000 to 5,000	BCF/BAF >5,000
TSCA new and existing chemicals bioconcentration potential criteria[a]			
Low		**Moderate**	**High**
<1,000		1,000 to 5,000	>5,000

[a] BCF values are unitless scores assigned based on relevant DfE or OPPT metrics.

3.3 Additional Assessment Sources

In addition to human health effects, environmental hazard to aquatic organisms, and environmental fate properties, EPA identified several chemical characteristics relevant to consideration of potential impact to health and the environment for screening and comparison to NMP. The data sources and methodology for identifying these additional characteristics are described below.

3.3.1 Global Warming Potential and Ozone Depletion Potential

EPA queried the Tool for Reduction and Assessment of Chemicals and Other Environmental Impacts (TRACI), an environmental impact assessment tool, to obtain information on the global warming potential (GWP) and ozone depletion potential (ODP) of a chemical (Bare, 2011). The chemicals were searched using their CASRNs. The latest version of TRACI 2.1 database was used for determining the GWPs and ODPs.

The GWP for each chemical, measured as kg CO_2eq/kg substance, indicate the potency of greenhouse gases relative to CO_2. TRACI provides GWPs with 100-year time horizons as per the guidelines of the United Nations Framework Convention on Climate Change (UNFCCC). TRACI contains GWPs sourced from a hierarchy of internationally accepted resources, including the Intergovernmental Panel on Climate Change (IPCC) assessment reports IPCC (1996) and IPCC (2001). In addition to GWPs, TRACI provided ODPs for the chemicals from recent sources (WMO, 2003). The ODPs, expressed as kg CFC-11 eq/kg substance, are an internationally recognized metric proposed by the World Meteorological Organization (WMO) to indicate the expected contribution of a substance to the breakdown of the ozone layer. Chemicals that are not listed in TRACI are assumed to have an indeterminant ODP and GWP.

3.3.2 Physical Hazard Warnings

Flammability of a chemical depends on its flash point, which in turn depends on the boiling point and vapor pressure of the liquid. EPA queried the EPA CompTox Chemicals Dashboard using the Batch Search feature and CASRNs to find flash point and boiling point data (U.S. EPA, 2021). The CompTox Chemicals Dashboard, supported by the EPA Chemical Safety for Sustainability Research Program, compiles information from U.S. federal, state, and international data sources. Using the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) definition of flammable liquid (a liquid having a flash point of no more than 93 °C [199.4 °F]), EPA used boiling point and flash point data to identify for each alternative chemical which OSHA flammable liquid category applied.

OSHA divides flammable liquids into the following four categories (29 CFR § 1910.106(a)(19)):

- Category 1 – flammable liquids have flash point <23 °C (73.4 °F) and initial boiling point ≤35 °C (95 °F)
- Category 2 – flammable liquids have flash point <23 °C (73.4° F) and initial boiling point >35°C (95°F)
- Category 3 – flammable liquids have flash point ≥23 °C (73.4 °F) and ≤60 °C (140 °F)
- Category 4 – flammable liquids have flash point >60 °C (140 °F) and ≤93 °C (199.4 °F)

Only flammable liquids were identified based on properties downloaded from CompTox Chemicals Dashboard.

4 HAZARD ENDPOINTS AND FATE PARAMETERS

The hazard profile for each chemical contains endpoint-specific summary statements (see Table 4-2). These summary statements provide a hazard designation for each of the endpoints in Table 4-1, as well as the type of data (experimental or estimated) and the rationale. The endpoint summaries may also include explanatory comments, a discussion of confounding factors or an indication of the confidence in the data to help put the results in perspective.

4.1 Definition of Each Endpoint Screened Against Criteria

EPA screened each ingredient using the HCM which directly compares experimental or estimated data to the Design for the Environment (DfE) Alternatives Assessment Criteria for Hazard Evaluation (U.S. EPA, 2011) for human health hazard, environmental hazard, and environmental fate endpoints. Table 4-1 provides brief definitions for each of these endpoints.

Table 4-1. Definitions of Toxicological and Environmental Endpoints for Hazard Assessment

Endpoint Category	Endpoint	Definition
Human Health Effects	Acute Mammalian Toxicity	Adverse effects occurring following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours.
	Carcinogenicity	Capability of a substance to increase the incidence of malignant neoplasms, reduce their latency, or increase their severity or multiplicity.
	Mutagenicity/ Genotoxicity	Mutagenicity: The ability of an agent to induce permanent, transmissible changes in the amount, chemical properties, or structure of the genetic material. These changes may involve a single gene or gene segment, a block of genes, parts of chromosomes, or whole chromosomes. Mutagenicity differs from genotoxicity in that the change in the former case is transmissible to subsequent cell generations. Genotoxicity: The ability of an agent or process to alter the structure, information content, or segregation of DNA, including those which cause DNA damage by interfering with normal replication process or that temporarily alter its replication in a non-physiological manner.
	Reproductive Toxicity	The occurrence of biologically adverse effects on the reproductive systems of females or males that may result from exposure to environmental agents. The toxicity may be expressed as alterations to the female or male reproductive organs, the related endocrine system, or pregnancy outcomes. The manifestation of such toxicity may include, but is not limited to, adverse effects on onset of puberty, gamete production and transport, reproductive cycle normality, sexual behavior, fertility, gestation, parturition, lactation, developmental toxicity, premature reproductive senescence, or modifications in other functions that were dependent on the integrity of the reproductive systems.
	Developmental Toxicity	Adverse effects in the developing organism that may result from exposure prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation. Adverse developmental effects may be detected at any point in the lifespan of the organism. The major manifestations of developmental toxicity include

Endpoint Category	Endpoint	Definition
Human Health Effects		(1) death of the developing organism, (2) structural abnormality, (3) altered growth, and (4) functional deficiency.
	Neurotoxicity	An adverse change in the structure or function of the central and/or peripheral nervous system following exposure to a chemical, physical, or biological agent.
	Repeated Dose Toxicity	Adverse effects (immediate or delayed) that impair normal physiological function (reversible and irreversible) of specific target organs or biological systems following repeated exposure to a chemical substance by any route relevant to humans. Adverse effects include biologically significant changes in body and organ weights, changes that affect the function or morphology of tissues and organs (gross and microscopic), mortality, and changes in biochemistry, urinalysis, and hematology parameters that are relevant for human health; may also include immunological and neurological effects.
	Respiratory Sensitization	Hypersensitivity of the airways following inhalation of a substance.
	Skin Sensitization	A cell-mediated or antibody-mediated allergic response characterized by the presence of inflammation that may result in cell death, following an initial induction exposure to the same chemical substance (*i.e.*, skin allergy).
	Eye Irritation/ Corrosivity	Irritation or corrosion to the eye following the application of a test substance.
	Dermal Irritation/Corrosion	Dermal irritation characterized by reversible damage to the skin following the application of a test substance for up to 4 hours. Dermal corrosion characterized by irreversible damage to the skin (*i.e.*, visible necrosis through the epidermis and into the dermis) following the application of a test substance for up to 4 hours.
Environmental Toxicity[a]	Aquatic Toxicity (Acute)	The property of a substance to be injurious to an organism in a short-term (days), aquatic exposure to that substance.
	Aquatic Toxicity (Chronic)	The property of a substance to cause adverse effects to aquatic organisms during aquatic exposures which were determined in relation to the life cycle of the organism.
Environmental Fate	Environmental Persistence	The length of time the chemical exists in the environment, expressed as a half-life, before it is destroyed (i.e., transformed) by natural or chemical processes. For alternative assessments, the amount of time for complete assimilation (ultimate removal) is preferred over the initial step in the transformation (primary removal).
	Bioaccumulation	The process in which a chemical substance is absorbed in an organism by all routes of exposure as occurs in the natural environment (*e.g.*, dietary, and ambient environment sources). Bioaccumulation is the net result of competing processes of chemical uptake into the organism at the respiratory surface and from the diet and chemical elimination from the organism including respiratory exchange, fecal egestion, metabolic biotransformation of the parent compound, and growth dilution.

Endpoint Category	Endpoint	Definition
[a] Environmental toxicity refers to adverse effects observed in living organisms that typically inhabit the wild; the assessment is focused on effects in three groups of surrogate aquatic organisms (freshwater fish, invertebrates, and algae).		

4.2 Ratings Criteria

Table 4-2 summarizes the DfE criteria that EPA used to interpret the data from the hazard profiles of the ingredients of the identified products in Appendix A. These criteria have been used to consider hazard for all Alternatives Assessments conducted by DfE since 2011; they underwent Agency-wide review and public comment and were finalized in 2011 (U.S. EPA, 2011).

In this analysis, hazard designation was based on the exposure route with the highest hazard designation, rather than for each human health endpoint for each route of exposure. Data may have been available for some or all relevant routes of exposure. Based on the DfE criteria, ratings were applied in a color-coded form ranging from very high to very low. Where multiple data sources were available, the HCM applies a "trumping method" that selects the highest score from the most authoritative source as the integrated score. EPA notes that most endpoints did not have criteria for all ratings. In many cases, hazard information was not reasonably available specific endpoints or fate properties, or the reasonably available data were determined to be conflicting or indeterminate. In those cases, the criteria are either left blank, or are given a rating of "I" for inconclusive.

The criteria in the final tables are as follows:

VH - Very High	H - High	M - Medium	L - Low	I - Inconclusive	No Data

The details of these criteria are summarized in Table 4-2 and in the DfE full criteria document, Design for the Environment (DfE) Program Alternatives Assessment Criteria for Hazard Evaluation Version 2.0, August 2011. Further explanation of how these criteria were used within the HCM, as well as a discussion of how scores were determined in specific cases where multiple hazard scores were identified across multiple authoritative sources is outlined in (Vegosen and Martin, 2020).

Table 4-2. Criteria Used to Assign Hazard Designations from the Alternatives Assessment[a]

Endpoint	Very High	High	Moderate	Low	Very Low
Human Health Effects					
Acute mammalian toxicity					
Oral median lethal dose (LD50) (mg/kg)	≤50	>50–300	>300–2,000	>2,000	–
Dermal LD50 (mg/kg)	≤200	>200–1,000	>1,000–2,000	>2,000	–
Inhalation median lethal concentration (LC50) – vapor/gas (mg/L)	≤2	>2–10	>10–20	>20	–
Inhalation LC50 – dust/mist/fume (mg/L)	≤0.5	>0.5–1.0	>1–5	>5	–
Carcinogenicity					
Carcinogenicity	*Known or presumed human carcinogen* Equivalent to Globally Harmonized System of Classification and Labeling of Chemicals (GHS) Categories 1A and 1B	*Suspected human carcinogen* Equivalent to GHS Category 2	*Limited or marginal evidence of carcinogenicity in animals and inadequate evidence in humans*	*Negative studies or robust mechanism-based structure-activity relationship (SAR)*	–
Mutagenicity/genotoxicity					
Germ cell mutagenicity	GHS Category 1A or 1B: Substances known to induce heritable mutations or to be	GHS Category 2: Substances which cause concern for humans owing to the possibility that they may induce heritable	Evidence of mutagenicity supported by positive results in *in vitro* OR *in*	Negative for chromosomal aberrations and gene	–

Endpoint	Very High	High	Moderate	Low	Very Low
	regarded as if they induce heritable mutations in the germ cells of humans	mutations in the germ cells of humans OR Evidence of mutagenicity supported by positive results in *in vitro* AND *in vivo* somatic cells and/or germ cells of humans or animals	*vivo* somatic cells of humans or animals	mutations, or no structural alerts.	
Mutagenicity and genotoxicity in somatic cells	Evidence of mutagenicity supported by positive results in *in vitro* AND *in vivo* somatic cells and/or germ cells of humans or animals	Mutagenicity and genotoxicity in somatic cells	Evidence of mutagenicity supported by positive results in *in vitro* AND *in vivo* somatic cells and/or germ cells of humans or animals	Negative for chromosomal aberrations and gene mutations, or no structural alerts.	–
Reproductive toxicity					
Oral (mg/kg/day)	–	<50	50–250	>250–1,000	>1,000
Dermal (mg/kg/day)	–	<100	100–500	>500–2,000	>2,000
Inhalation – vapor, gas (mg/L/day)	–	<1	1–2.5	>2.5–20	>20
Inhalation – dust/mist/fume (mg/L/day)	–	<0.1	0.1–0.5	>0.5–5	>5
Oral (mg/kg/day)	–	<50	50–250	>250–1,000	>1,000
Developmental toxicity					
Oral (mg/kg/day)	–	<50	50–250	>250–1,000	>1,000

Endpoint	Very High	High	Moderate	Low	Very Low
Dermal (mg/kg/day)	–	<100	100–500	>500–2,000	>2,000
Inhalation – vapor, gas (mg/L/day)	–	<1	1–2.5	>2.5-20	>20
Inhalation – dust/mist/fume (mg/L/day)	–	<0.1	0.1–0.5	>0.5-5	>5
Neurotoxicity					
Oral (mg/kg/day)	–	<10	10–100	>100	–
Dermal (mg/kg/day)	–	<20	20–200	>200	–
Inhalation – vapor, gas (mg/L/day)	–	<0.2	0.2–1.0	>1.0	–
Inhalation – dust/mist/fume (mg/L/day)	–	<0.02	0.02–0.2	>0.2	–
Repeated-dose toxicity					
Oral (mg/kg/day)	–	<10	10–100	>100	–
Dermal (mg/kg/day)	–	<20	20–200	>200	–
Inhalation – vapor, gas (mg/L/day)	–	<0.2	0.2–1.0	>1.0	–
Inhalation – dust/mist/fume (mg/L/day)	–	<0.02	0.02–0.2	>0.2	–
Sensitization					
Skin sensitization	–	High frequency of sensitization in humans and/or high potency in animals (GHS Category 1A)	Low to moderate frequency of sensitization in human and/or low to moderate	Adequate data available and not GHS Category 1A or 1B	–

Endpoint	Very High	High	Moderate	Low	Very Low
			potency in animals (GHS Category 1B)		
Respiratory sensitization	–	Occurrence in humans or evidence of sensitization in humans based on animal or other tests (equivalent to GHS Category 1A and 1B)	Limited evidence including the presence of structural alerts	Adequate data available indicating lack of respiratory sensitization	–
Irritation/corrosivity					
Eye irritation/corrosivity	Irritation persists for >21 days or corrosive	Clearing in 8–21 days, severely irritating	Clearing in ≤7 days, moderately irritating	Clearing in <24 hours, mildly irritating	Not irritating
Skin irritation/corrosivity	Corrosive	Severe irritation at 72 hours	Moderate irritation at 72 hours	Mild or slight irritation at 72 hours	Not irritating
Endocrine activity					
Endocrine activity	–	Positive for estrogenic activity either	–	Negative for estrogenic activity	–
Environmental Toxicity and Fate					
Aquatic toxicity					
Acute aquatic toxicity – LC50 or half maximal effective concentration (EC50) (mg/L)	<1.0	1–10	>10–100	>100 or no effects at saturation (NES)	–
Chronic aquatic toxicity – lowest observed effect concentration (LOEC) or chronic value (ChV) (mg/L)	<0.1	0.1–1	>1–10	>10 or NES	–

Endpoint	Very High	High	Moderate	Low	Very Low
Environmental persistence					
Persistence in water, soil, or sediment	Half-life >180 days or recalcitrant	Half-life of 60–180 days	Half-life <60 but ≥16 days	Half-life <16 days OR passes Ready Biodegradability test not including the 10-day window; no degradation products of concern	Passes Ready Biodegradability test with 10-day window; no degradation products of concern
Persistence in air (half-life days)	*For this endpoint, High/Moderate/Low etc. characterizations will not apply. A qualitative assessment of available data will be prepared.*				
Bioaccumulation					
Bioconcentration Factor (BCF)/ Bioaccumulation Factor (BAF)	>5,000	5,000–1,000	<1,000–100	<100	–
Log BCF/BAF	>3.7	3.7–3	<3–2	<2	–

[a] Very high or very low designations (if an option for a given endpoint in Table 4-2) were assigned only when there were experimental data located for the chemical under evaluation. In addition, the experimental data must have been collected from a well conducted study specifically designed to evaluate the endpoint under review. If the endpoint was estimated using experimental data from a close structural analog, by professional judgment, or from a computerized model, then the next-level designation was assigned (*e.g.*, use of data from a structural analog that would yield a designation of very high would result in a designation of high for the chemical in review). One exception is for the estimated persistence of polymers with an average molecular weight (MW) >1,000 Daltons, which may result in a very high designation.

5 RESULTS OF CHEMICAL ALTERNATIVE SCREENING

NMP has a long history of use as a solvent. In many NMP product categories, there also are numerous products with alternative chemical ingredients. As described in Section 3.1, EPA mapped COUs from the risk evaluation to product categories for the purpose of identifying chemical alternatives; this crosswalk is in Table 5-1. Across all the following products and their applicable COUs, several hundred products, representing feasibility for use, were identified that did not contain NMP. For each of the listed product categories, EPA screened the identified ingredients in the identified products for their potential benefit to health or the environment compared to NMP. Results of this screening are provided in detailed tables in Appendix A; high-level summaries with supplementary references describing chemical or non-chemical alternatives for products in that product category are provided in the text below. Because of a lack of reasonably available information, the economic analysis and this analysis did not assess alternatives for every individual COU EPA is proposing to prohibit or significantly restrict. The COUs for which no technological and economic feasibility NMP alternatives were assessed is described in section 5.2 of the Economic Analysis of the Proposed Regulation of N-Methylpyrrolidone (NMP) Under TSCA Section 6(a). Therefore, because EPA was unable to locate reasonably available alternatives, these COUs were not analyzed. The excluded COUs and explanations for exclusion from this analysis are listed in Appendix C.

EPA reviewed four types of information as part of the consideration of alternatives in accordance with TSCA section 6(c)(2)(C). First, EPA considered the number of identified products per product category without NMP and the number of unique ingredients which perform the same or similar functions as NMP in that product, namely solvents. For identified ingredients, EPA prioritized HCM sources based on their authority, as defined by the HCM, in considering the information reasonably available for evaluating the associated endpoints: authoritative sources were prioritized over screening sources, which were, in turn, prioritized over QSAR model sources. EPA surveyed the human health and environmental hazard ratings themselves, including the proportion of highs and very highs across endpoints. Finally, EPA noted any additional characteristics of the identified ingredients, which may include having a combination of persistence and bioaccumulation potential, listed as having either ODP or GWP, or calculated to have a high flammability rating. High-level summaries of these considerations are described for each product category in the subsections that follow. Percent values, where given, should be considered approximate.

Table 5-1. Crosswalk between Product Categories and TSCA Conditions of Use for Screening

Product Category	Conditions of Use from TSCA Risk Evaluation for n-Methylpyrrolidone
Adhesives	Consumer use in adhesives and sealants in glues and adhesives, including lubricant adhesives and sealants Industrial and commercial use in adhesives and sealants including binding agents, single-component glues and adhesives, including lubricant adhesives, and two-component glues and adhesives including some resins
Adhesive Remover	Industrial and commercial use in paints, coatings, and adhesive removers
Anti-Corrosion	Industrial and commercial use in metal products not covered elsewhere, and lubricant and lubricant additives including hydrophilic coatings
Brush Cleaner	Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers

Product Category	Conditions of Use from TSCA Risk Evaluation for n-Methylpyrrolidone
Carpet Cleaner	Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers
Coating	Industrial and commercial use in metal products not covered elsewhere, and lubricant and lubricant additives including hydrophilic coatings Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers and floor finishes, powder coatings, surface preparation
Electronic and Semiconductor Manufacturing: Processing Aid	Industrial and commercial use as a solvent (for cleaning or degreasing) in electrical equipment, appliance, and component manufacturing for use in semiconductor manufacturing Industrial and commercial use as a solvent (for cleaning or degreasing) use in electrical equipment, appliance, and component manufacturing Industrial and commercial use in paint additives and coating additives in computer and electronic product manufacturing for use in semiconductor manufacturing Industrial and commercial use in paint additives and coating additives in computer and electronic product manufacturing in electronic parts manufacturing
Fertilizer/Fertilizer Additive	Industrial and commercial use in fertilizer and other agricultural chemical manufacturing-processing aids and solvents
Floor Cleaner	Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers
Floor Finish	Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers, floor finishes, powder coatings, and surface preparation
Floor Polish Remover and Stripper	Industrial and commercial use in paints, coatings, and adhesive removers
Graffiti Remover	Industrial and commercial use in paints, coatings, and adhesive removers
Grout	Consumer use in adhesives and sealants in glues and adhesives, including lubricant adhesives and sealants Industrial and commercial use in adhesives and sealants including binding agents, single-component glues and adhesives, including lubricant adhesives, and two-component glues and adhesives including some resins
Grout Haze Remover	Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers Industrial and commercial use in paints, coatings, and adhesive removers
Ink	Industrial and commercial use in ink, toner, and colorant products in printer ink, and inks and writing equipment
Laundry Detergent	Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers
Leather Care	Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers

Product Category	Conditions of Use from TSCA Risk Evaluation for n-Methylpyrrolidone
Lithium Ion Battery Manufacturing	Industrial and commercial uses in lithium ion battery manufacturing
Paint and Primer	Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers and floor finishes, and powder coatings, surface preparation
Paint and Coating Remover	Industrial and commercial use in paints, coatings, and adhesive removers
Processing Aid	Industrial and commercial use in processing aids, specific to petroleum production in petrochemical manufacturing, in oil and gas drilling, extraction and support activities, and in functional fluids (closed systems)
Roof Coating	Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers and floor finishes, and powder coatings, surface preparation
Soldering Material	Industrial and commercial use in soldering materials
Tape	Consumer use in adhesives and sealants in glues and adhesives, including lubricant adhesives and sealants Industrial and commercial use in adhesives and sealants including binding agents, single-component glues and adhesives, including lubricant adhesives, and two-component glues and adhesives including some resins
Wall Texture Coating	Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers and floor finishes, and powder coatings, surface preparation
Wood Finish	Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers and floor finishes, and powder coatings, surface preparation

The following subsections include analyses of the alternative products identified for each product category and the list of unique alternative chemicals found in those products. In addition, Appendix C lists COUs that are not included in this analysis and provides justifications for their exclusion. Although the alternative products presented in this section are not intended to be an exhaustive list of every alternative product or chemical, they present a representative list of reasonably available alternatives for consideration by EPA. Many identified products have formulations which do not include solvents or other chemicals that function like NMP. When such products are identified, their proportion of these total number of products is highlighted, and chemical ingredients responsible for their function (*i.e.*, their functional ingredients) are detailed. Additionally, for each product category, the most common direct chemical alternatives for NMP are highlighted and described further. These include solvents or other chemicals that perform a similar function to that of NMP in the product, such as surfactants. Where practicable, the three most commonly occurring chemicals that may function as solvents were reviewed in greater detail. In some cases, approximately two to four were reviewed, if doing so provided a more accurate overview of the alternatives for that category. The proportion of product alternatives that were formulated without the use of solvents are also identified for each product category.

Dozens of solvents and other chemicals that perform a similar function as NMP in the alternative products were specifically identified and screened using the HCM. These include four other solvents which have undergone TSCA section 6 evaluations and are the subject of ongoing risk management efforts (*i.e.*, methylene chloride, 1-BP, TCE, and PCE); the percentage of identified products within each

product category that do not contain any of these four solvents or NMP is given in each subsection in an attempt to address possible regrettable substitutions. Varying levels of hazard screening data are reasonably available for dozens of identified alternative solvents; many have authoritative sources documenting their hazard ratings. These chemical substances represent a diverse set of ratings for human health and environmental hazard endpoints and have varying degrees of flammability. In addition, some of these solvents do have potential for either global warming or ozone depletion. The screening ratings for these solvents can be compared to NMP, which has two endpoints that exhibit the highest possible hazard rating: reproductive and developmental. Specific alternative chemicals that were identified and screened using the HCM include, but are not limited to, the following:

- 1-Bromopropane (subject to risk management under TSCA section 6)
- 1-Methoxypropan-2-ol
- 2-Methylpentane-2,4-diol
- 2-Propanol
- Acetone
- Alcohol ethoxylate
- Aluminum hydroxide
- Benzyl alcohol
- Calcium carbonate
- Chloroalkyl phosphate ester
- Citrus extract
- Diethylene glycol ethyl ether
- Diethylene glycol monobutyl ether
- Dimethyl carbonate
- Dimethyl ether
- Dimethyl succinate
- Dimethyltetraglycol
- Dipropylene glycol methyl ether
- D-limonene
- Ethanol
- Ethoxylated alcohols (C12-16)
- Ethoxylated propoxylated alcohols (C8-10)
- Ethylbenzene
- Ethylene glycol monobutyl ether
- Hexane
- Hydrotreated heavy benzene <0.1% naphtha (petroleum)
- Hydrotreated light distillates (petroleum)
- Isohexane
- Isophorone diamine
- Liquefied petroleum gas
- Methanol
- Methyl ethyl ketone
- Methylene chloride (subject to risk management under TSCA section 6)
- Monoethanolamine
- n-Aminoethylpiperazine
- Naphtha (petroleum)
- N-butyl acetate

- Nonylphenol
- Nonylphenyl polyethoxylated
- Perchloroethylene (subject to risk management under TSCA section 6)
- Phosphoric acid
- Poly(oxypropylene)diamine
- Potassium hydroxide
- Respirable powder crystalline silica
- Sodium carbonate
- Sodium metasilicate
- Sodium tripolyphosphate
- Sodium xylenesulphonate
- Sorption process raffinates (petroleum)
- Stoddard solvent
- Talc
- Tetraethylene pentaamine
- Tetrasodium pyrophosphate
- Titanium dioxide
- Toluene
- Tributoxyethyl phosphate
- Trichloroethylene (subject to risk management under TSCA section 6)
- Urea hydrochloride
- Xylene

In addition, several chemical ingredients could not be profiled because their chemical names and CASRNs are not specific to a unique chemical structure for screening using the HCM. Instead, their chemical names and CASRNs are often referred to mixtures or compositions of multiple chemicals, which are incompatible with HCM analysis. As a result, the number of substitutes is likely underestimated. Specific examples that were commonly identified in the product ingredient lists include categories of hydrocarbons and other types or synonyms for petroleum distillates. In these cases, the chemical names instead refer to a chemical category, group, or class of chemicals—many of which are substances of unknown or variable composition (U.S. EPA, 2015).[5] A few of these generic chemicals are discussed below as an illustrative example:

- Oil-based formulations, including various petroleum distillates and naphthenic ingredients, were also prevalent in the following analyses and represent a range of organic chemicals of various characteristics.
- Xylene is a generic name for *ortho*-, *para*- and *meta*-substituted isomers. Xylene also falls under the broader category of aromatic hydrocarbon solvent on this list. Xylene isomers all have relatively low flash points and high flammability, as well as known potential health effects associated with acute exposure (ATSDR, 2007).

Generally, the physical and chemical properties of the chemicals within these groups differ such that the group are not screened using HCM.

[5] UVCBs are substances that do not have a static or well-defined composition; they are variable substances rather than being a single chemical or discrete mixture of several specific chemicals present in a known ratio. They include, for example, mixtures of similar chemical compounds with differing carbon chain lengths, like hydrotreated light distillate. The different carbon chain lengths and structures result in the individual chemicals within the group having varied physical and chemical properties, which, while they often follow a general trend, can cover a wide range.

5.1 Category: Adhesives

This product category includes two COUs from the NMP TSCA risk evaluation:

1. Consumer use in adhesives and sealants in glues and adhesives, including lubricant adhesives and sealants; and
2. Industrial and commercial use in adhesives and sealants including binding agents, single-component glues and adhesives, including lubricant adhesives, and two-component glues and adhesives including some resins.

EPA included 231 products in this product category that contain alternative chemical substances to NMP. In the 231 alternative products evaluated, EPA found 165 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 63 percent of the chemicals, and at least one authoritative data source is available for 42 percent of all the chemicals. None of the chemicals have an identified ODP or an identified GWP. Additionally, 39 percent are flammable, with ratings spanning from Category 1 to Category 4. Overall, EPA has identified acetone, dimethyl ether, and methylene chloride as the most common chemical ingredients.

Of the 165 chemicals, 43 may function as solvents. Of the 231 identified alternative products, 56 percent contained a solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. The most common chemical ingredients that may function as solvents are acetone, methylene chloride, and toluene. Acetone has five endpoints that exhibit the highest possible hazard rating: dermal, genotoxicity mutagenicity, endocrine disruption, developmental, and repeat exposure systemic toxicity. Methylene chloride has seven endpoints that exhibit the highest possible hazard rating: carcinogenicity, genotoxicity mutagenicity, endocrine disruption, developmental, neurotoxicity (both repeat and single exposure), and single exposure systemic toxicity. Toluene has seven endpoints that exhibit the highest possible hazard rating: inhalation, genotoxicity mutagenicity, endocrine disruption, reproductive, developmental, and neurotoxicity (both repeat and single exposure). Additionally, all three of these solvents are flammable (Categories 2, 3, and 3, respectively).

In addition, 13 percent of identified products were formulated without the use of a solvent, though nine of those products included unidentified chemicals that may be a solvent. These products primarily used adhesion promoters, bonding agents, curing agents, filler, pigment, and rheology modifiers as their functional ingredients.

5.2 Category: Adhesive Remover

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in paints, coatings, and adhesive removers.

EPA included 25 products in this product category that contain alternative chemical substances to NMP. In the 25 alternative products evaluated, EPA found 40 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 58 percent of the chemicals, and at least one authoritative data source is available for 43 percent of all the chemicals. None of the chemicals have an identified ODP, and 5 percent have an identified GWP. Additionally, 45 percent are flammable, with ratings spanning from Category 1 to Category 4. Overall, EPA has identified dipropylene glycol methyl ether, hydrotreated light distillates (petroleum), and d-limonene as the most common chemical ingredients.

Of the 40 chemicals, 27 may function as solvents. Of the 25 identified alternative products, 4 percent contained a solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. The most common chemical ingredients that may function as solvents are dipropylene glycol methyl ether, hydrotreated light distillates (petroleum), and d-limonene. It has five endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, repeat exposure systemic toxicity, skin sensitization, acute aquatic ecotoxicity, and chronic aquatic ecotoxicity. No hazard ratings are available for dipropylene glycol methyl ether or hydrotreated light distillates (petroleum). Additionally, d-limonene is flammable (Category 3).

In addition, one product, which accounts for 4 percent of identified products, was formulated without the use of a solvent. This product used surfactants and preservatives as its functional ingredients.

5.3 Category: Anti-corrosion

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in metal products not covered elsewhere, and lubricant and lubricant additives including hydrophilic coatings.

EPA included six products in this product category that contain alternative chemical substances to NMP. In 6 alternative products evaluated, EPA found 25 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 48 percent of the chemicals, and at least one authoritative data source is available for 24 percent of all the chemicals. None of the chemicals have an identified ODP, and 4 percent have an identified GWP. Additionally, 28 percent are flammable, with ratings spanning from Category 1 to Category 4. Overall, EPA has identified hydrotreated light distillates (petroleum), liquefied petroleum gas, and hydrotreated heavy benzene <0.1% naphtha (petroleum) as the most common chemical ingredients.

Of the 25 chemicals, 12 may function as solvents. None of the six alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Dipropylene glycol methyl ether, hydrotreated light distillates (petroleum), hexane, isohexane, naphtha (petroleum), and hydrotreated heavy benzene <0.1% naphtha (petroleum) are the most common chemical ingredients that may function as a solvent. Hexane has two endpoints that exhibit the highest possible hazard rating: endocrine disruption and repeat exposure neurotoxicity. Isohexane has no endpoints that exhibit the highest possible hazard rating. No hazard ratings are available for dipropylene glycol methyl ether, hydrotreated light distillates (petroleum), naphtha (petroleum), and hydrotreated heavy benzene <0.1% naphtha (petroleum). Additionally, hexane and isohexane are flammable (both Category 2).

None of the identified products were formulated without the use of a solvent.

5.4 Category: Brush Cleaner

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers.

EPA included 12 products in this product category that contain alternative chemical substances to NMP. In the 12 alternative products evaluated, EPA found 24 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 58 percent of the chemicals, and at least one authoritative data source is available for 46 percent of all the chemicals. None of the chemicals have an identified ODP or an identified GWP. Additionally, 58 percent are flammable, with ratings spanning

from Category 1 to Category 4. Overall, EPA has identified acetone, ethylene glycol monobutyl ether, methanol, monoethanolamine, sorption process raffinates (petroleum), and toluene as the most common chemical ingredients.

Of the 24 chemicals, 17 may function as solvents. None of the 12 alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Acetone, ethylene glycol monobutyl ether, methanol, sorption process raffinates (petroleum), and toluene are the most common chemical ingredients that may function as solvents. Acetone has five endpoints that exhibit the highest possible hazard rating: dermal, genotoxicity mutagenicity, endocrine disruption, developmental, and repeat exposure systemic toxicity. Ethylene glycol monobutyl ether has five endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, endocrine disruption, neuro single exposure, systemic repeat exposure, and systemic single exposure. Methanol has eight endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, endocrine disruption, reproductive, developmental, neurotoxicity (both repeat and single exposure), and systemic (both repeat and single exposure). Toluene has seven endpoints that exhibit the highest possible hazard rating: inhalation, genotoxicity mutagenicity, endocrine disruption, reproductive, developmental, and neurotoxicity (both repeat and single exposure). No hazard ratings are available for sorption process raffinates (petroleum). Additionally, acetone, ethylene glycol monobutyl ether, methanol, and toluene are flammable (Categories 2, 4, 1, and 3, respectively).

In addition, 33 percent of identified products were formulated without the use of a solvent, though three of those products included unidentified chemicals that may be a solvent. The remaining product used surfactants as its functional ingredient.

5.5 Category: Carpet Cleaner

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers.

EPA included three products in this product category that contain alternative chemical substances to NMP. In the 3 alternative products evaluated, EPA found 14 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 71 percent of the chemicals, and at least one authoritative data source is available for 64 percent of all the chemicals. None of the chemicals have an identified ODP or an identified GWP. Additionally, 21 percent are flammable, with ratings spanning from Category 2 to Category 4. Overall, EPA has identified d-limonene, phosphoric acid, sodium carbonate, sodium metasilicate, sodium tripolyphosphate, and tetrasodium pyrophosphate as the most common chemical ingredients.

Of the 14 chemicals, 6 may function as solvents. None of the three alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. D-limonene is the most common chemical ingredient that may function as a solvent. It has five endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, repeat exposure systemic toxicity, skin sensitization, acute aquatic ecotoxicity, and chronic aquatic ecotoxicity. Additionally, d-limonene is flammable (Category 3).

In addition, one product, which accounted for 33 percent of identified products, was formulated without the use of a solvent. This product used a surfactant, cleaner, water softener/pH control, and emulsifier as its functional ingredients.

5.6 Category: Coating

This product category includes two COUs from the NMP TSCA risk evaluation:

1. Industrial and commercial use in metal products not covered elsewhere, and lubricant and lubricant additives including hydrophilic coatings; and
2. Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers and floor finishes, powder coatings, surface preparation.

EPA included six products in this product category that contain alternative chemical substances to NMP. In the 6 alternative products evaluated, EPA found 17 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 59 percent of the chemicals, and at least one authoritative data source is available for 53 percent of all the chemicals. None of the chemicals have an identified ODP or an identified GWP. Additionally, 53 percent are flammable, with ratings spanning from Category 2 to Category 4. Overall, EPA has identified 2-propanol and ethanol as the most common chemical ingredients.

Of the 17 chemicals, 16 may function as solvents. None of the six alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. 2-Propanol and ethanol are the most common chemical ingredients that may function as solvents. 2-Propanol has one endpoint that exhibits the highest possible hazard rating: single-exposure neurotoxicity. Ethanol has six endpoints that exhibit the highest possible hazard rating: oral, inhalation, carcinogenicity, endocrine disruption, reproductive, and repeat exposure neurotoxicity. Additionally, both solvents are flammable (Categories 2 and 1, respectively).

None of the identified products were formulated without the use of a solvent.

5.7 Category: Electronic and Semiconductor Manufacturing: Processing Aid

This product category includes four COUs from the NMP TSCA risk evaluation:

1. Industrial and commercial use as a solvent (for cleaning or degreasing) in electrical equipment, appliance, and component manufacturing for use in semiconductor manufacturing;
2. Industrial and commercial use as a solvent (for cleaning or degreasing) use in electrical equipment, appliance, and component manufacturing;
3. Industrial and commercial use in paint additives and coating additives in computer and electronic product manufacturing for use in semiconductor manufacturing; and
4. Industrial and commercial use in paint additives and coating additives in computer and electronic product manufacturing in electronic parts manufacturing.

EPA included one product in this product category that contains an alternative chemical substance to NMP. In the alternative product evaluated, EPA found one unique chemical substance with an associated CASRN. Hazard information is reasonably available for this chemical, and at least one authoritative data source is available for the chemical as well. The chemical does not have an identified ODP or an identified GWP. Additionally, the chemical is flammable, with a rating of Category 4. EPA has identified N,N-Dimethylformamide as the alternative chemical ingredient.

N,N-Dimethylformamide may function as a solvent. The one identified alternative product does not contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. N,N-Dimethylformamide has six endpoints that exhibit

the highest possible hazard rating: carcinogenicity, endocrine disruption, reproductive, developmental, and repeat and single systemic exposure.

5.8 Category: Fertilizer/Fertilizer Additive

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in fertilizer and other agricultural chemical manufacturing-processing aids and solvents.

EPA included six products in this product category that contain alternative chemical substances to NMP. In the six alternative products evaluated, EPA found seven unique chemical substances with associated CASRNs. Hazard information is reasonably available for 86 percent of the chemicals, and at least one authoritative data source is available for 43 percent of all the chemicals. None of the chemicals have an identified ODP or an identified GWP. Additionally, 43 percent are flammable, with ratings of Category 4. Overall, EPA has identified n-butylphosphorothioic triamide as the most common chemical ingredient.

Of the seven chemicals, two may function as solvents. None of the six alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Benzyl alcohol and ethylenediamine are the chemical ingredients that may function as solvents. Benzyl alcohol has five endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, reproductive, repeat and single exposure neurotoxicity, and single systemic exposure. No hazard ratings are available for ethylenediamine. Additionally, both solvents are flammable (both Category 4).

In addition, 83 percent of identified products were formulated without the use of a solvent. These products primarily used nitrogen sources as their functional ingredients. However, three products include at least one unknown or proprietary chemical with an unknown function, which may be a solvent.

5.9 Category: Floor Cleaner

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers.

EPA included four products in this product category that contain alternative chemical substances to NMP. In the four alternative products evaluated, EPA found seven unique chemical substances with associated CASRNs. Hazard information is reasonably available for 14 percent of the chemicals, and at least one authoritative data source is available for 14 percent of all the chemicals. None of the chemicals have an identified ODP or an identified GWP. Additionally, 14 percent are flammable with a rating of Category 3. Overall, EPA has identified sodium xylene sulphonate as the most common chemical ingredient.

Of the seven chemicals, one may function as a solvent. None of the four alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. 1-Methoxypropan-2-ol is a chemical ingredient that may function as a solvent. It has one endpoint that exhibits the highest possible hazard rating: endocrine disruption. Additionally, 1-methoxypropan-2-ol is flammable (Category 3).

In addition, 75 percent of identified products were formulated without the use of a solvent. These products primarily used surfactants as their functional ingredients.

5.10 Category: Floor Finish

This product category includes one COUs from the NMP TSCA risk evaluation: Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers, floor finishes, powder coatings, and surface preparation.

EPA included 14 products in this product category that contain alternative chemical substances to NMP. In the 14 alternative products evaluated, EPA found 20 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 65 percent of the chemicals, and at least one authoritative data source is available for 55 percent of all the chemicals. None of the chemicals have an identified ODP or an identified GWP. Additionally, 40 percent are flammable, with ratings spanning from Category 2 to Category 4. Overall, EPA has identified dipropylene glycol methyl ether and tributoxyethyl phosphate as the most common chemical ingredient.

Of the 20 chemicals, 12 may function as solvents. None of the 14 alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Diethylene glycol ethyl ether, dipropylene glycol methyl ether, and Stoddard solvent are the most common chemical ingredients that may function as solvents. Diethylene glycol ethyl ether has one endpoint that exhibits the highest possible hazard rating, genotoxicity mutagenicity. No hazard ratings are available for dipropylene glycol methyl ether or Stoddard solvent. Additionally, diethylene glycol ethyl ether is flammable (Category 4).
In addition, 14 percent of identified products were formulated without the use of a solvent, though these two products included unidentified chemicals that may be a solvent.

5.11 Category: Floor Polish Remover and Stripper

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in paints, coatings, and adhesive removers.

EPA included six products in this product category that contain alternative chemical substances to NMP. In the six alternative products evaluated, EPA found seven unique chemical substances with associated CASRNs. Hazard information is reasonably available for 86 percent of the chemicals, and at least one authoritative data source is available for 86 percent of the chemicals. None of the chemicals have an identified ODP or an identified GWP. Additionally, 71 percent are flammable, with ratings spanning from Category 2 to Category 4. Overall, EPA has identified ethylene glycol monobutyl ether and monoethanolamine as the most common chemical ingredients.

Of the seven chemicals, five may function as solvents. None of the four alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Benzyl alcohol, d-limonene, and ethylene glycol monobutyl ether are the most common chemical ingredients that may function as solvents. Benzyl alcohol has five endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, reproductive, neurotoxicity (both repeat and single exposure), and single exposure systemic toxicity. D-limonene has five endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, repeat exposure systemic toxicity, skin sensitization, acute aquatic ecotoxicity, and chronic aquatic ecotoxicity. Ethylene glycol monobutyl ether has five endpoints that exhibit the highest possible hazard rating, genotoxicity mutagenicity, endocrine disruption, neuro single exposure, systemic repeat exposure, and systemic single exposure. Additionally, benzyl alcohol, d-limonene, and ethylene glycol monobutyl ether are flammable (Categories 4, 3, and 4, respectively).

None of the identified products were formulated without the use of a solvent.

5.12 Category: Graffiti Remover

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in paints, coatings, and adhesive removers.

EPA included five products in this product category that contain alternative chemical substances to NMP. In the 5 alternative products evaluated, EPA found 15 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 60 percent of the chemicals, and at least one authoritative data source is available for 40 percent of the chemicals. None of the chemicals have an identified ODP or an identified GWP. Additionally, 47 percent are flammable, with ratings spanning from Category 2 to Category 4. Overall, EPA has identified alcohol ethoxylate, benzyl alcohol, dimethyl succinate, and dipropylene glycol methyl ether as the most common chemical ingredients.

Of the 15 chemicals, nine may function as solvents. None of the five alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Benzyl alcohol, dimethyl succinate, and dipropylene glycol methyl ether are the most common chemical ingredients that may function as solvents. Benzyl alcohol has five endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, reproductive, neurotoxicity (both repeat and single exposure), and single exposure systemic toxicity. Dimethyl succinate has one endpoint that exhibits the highest possible hazard rating: developmental. No hazard ratings are available for dipropylene glycol methyl ether. Additionally, benzyl alcohol and dimethyl succinate are flammable (both Category 4).

5.13 Category: Grout

This product category includes two COUs from the NMP TSCA risk evaluation:

1. Consumer use in adhesives and sealants in glues and adhesives, including lubricant adhesives and sealants; and
2. Industrial and commercial use in adhesives and sealants including binding agents, single-component glues and adhesives, including lubricant adhesives, and two-component glues and adhesives including some resins.

EPA included three products in this product category that contain alternative chemical substances to NMP. In the three alternative products evaluated, EPA found 14 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 57 percent of the chemicals, and at least 1 authoritative data source is available for 50 percent of all the chemicals. None of the chemicals have an identified ODP and an identified GWP. Additionally, 29 percent are flammable, with ratings spanning from Category 3 to Category 4. Overall, EPA has identified benzyl alcohol, isophorone diamine, N-aminoethylpiperazine, nonylphenol, poly(oxypropylene)diamine, Stoddard solvent, and tetraethylene pentamine as the most common chemical ingredients.

Of the 14 chemicals, five may function as solvents. None of the three alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Benzyl alcohol and Stoddard solvent are the most common chemical ingredients that may function as solvents. Benzyl alcohol has five endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, reproductive, neurotoxicity (both repeat and single exposure), and single exposure systemic toxicity. No hazard information is available for Stoddard solvent. Additionally, benzyl alcohol is flammable (Category 4).

In addition, one product, which accounted for 33 percent of identified products, was formulated without the use of a solvent. This product used a curing agent as its functional ingredient.

5.14 Category: Grout Haze Remover

This product category includes two COUs from the NMP TSCA risk evaluation:

1. Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers; and
2. Industrial and commercial use in paints, coatings, and adhesive removers.

EPA included three products in this product category that contain alternative chemical substances to NMP. In the three alternative products evaluated, EPA found two unique chemical substances with associated CASRNs. Hazard information is reasonably available for both chemicals, and at least one authoritative data source is available for 33 percent of all the chemicals. None of the chemicals have an identified ODP or an identified GWP. Additionally, both chemicals are flammable, with ratings of Category 3 and Category 4. Overall, EPA has identified d-limonene and urea hydrochloride as the most common chemical ingredients.

Of the two chemicals, one may function as a solvent. None of the three alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. D-limonene is a chemical ingredient that may function as a solvent. It has five endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, repeat exposure systemic toxicity, skin sensitization, acute aquatic ecotoxicity, and chronic aquatic ecotoxicity. Additionally, d-limonene is flammable (Category 3).

In addition, 67 percent of identified products were formulated without the use of a solvent. These products primarily used detergent and pH modifiers as their functional ingredients.

5.15 Category: Ink

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in ink, toner, and colorant products in printer ink, and inks and writing equipment. EPA included 27 products in this product category that contain alternative chemical substances to NMP. In the 27 alternative products evaluated, EPA found 27 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 78 percent of the chemicals, and at least one authoritative data source is available for 74 percent of all the chemicals. None of the chemicals have an identified ODP or an identified GWP. Additionally, 37 percent of the chemicals are flammable, with ratings spanning from Category 2 to Category 4. Overall, EPA has identified silver, copper, and n-butyl acetate as the most common chemical ingredients.

Of the 27 chemicals, 10 may function as a solvent. None of the 27 alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. N-butyl acetate, ethylene glycol, and 1-methoxypropan-2-ol are the most common chemical ingredients that may function as a solvent. N-butyl acetate has two endpoints that exhibit the highest possible hazard rating: inhalation and genotoxicity mutagenicity. Ethylene glycol has six endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, endocrine disruption, developmental, single exposure neurotoxicity, repeat, and single systemic exposure. 1-methoxypropan-2-ol has one endpoint that exhibits the highest possible hazard rating: endocrine disruption. Additionally, all three chemicals are flammable (Categories 3, 4, and 3, respectively).

In addition, 56 percent of identified products were formulated without the use of a solvent. These products primarily used conductivity agents as their functional ingredients. However, one product includes a chemical with an unknown function, which may be a solvent.

5.16 Category: Laundry Detergent

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers.

EPA included three products in this product category that contain alternative chemical substances to NMP. In the three alternative products evaluated, EPA found six unique chemical substances with associated CASRNs. Hazard information is reasonably available for 33 percent of the chemicals, and at least one authoritative data source is available for 33 percent of all the chemicals. None of the chemicals have an identified ODP and an identified GWP. Additionally, none of the chemicals are flammable. Overall, EPA has identified ethoxylated alcohols (C12–16), citrus extract, and diethylene glycol monobutyl ether as the most common chemical ingredients.

Of the six chemicals, four may function as solvents. None of the three alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Citrus extract and diethylene glycol monobutyl ether are the most common chemical ingredients that may function as solvents. Diethylene glycol monobutyl ether has two endpoints that exhibit the highest possible hazard rating: endocrine disruption and systemic repeat exposure. No hazard information is available for citrus extract. Additionally, diethylene glycol monobutyl ether is not flammable.

5.17 Category: Leather Care

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in cleaning and degreasing, and cleaning and furniture care products, including wood cleaners and gasket removers.

EPA included one product in this product category that contains an alternative chemical substance to NMP. In this alternative product evaluated, EPA found one unique chemical substance with an associated CASRN. No hazard information is reasonably available for this chemical. Overall, EPA has identified a proprietary surfactant as a chemical ingredient.

5.18 Category: Lithium Ion Battery Manufacturing

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial uses in lithium ion battery manufacturing.

EPA included four products in this product category that contain alternative chemical substances to NMP. In the four alternative products evaluated, EPA found four unique chemical substances with associated CASRNs. Hazard information is reasonably available for 100 percent of the chemicals, and at least one authoritative data source is available for 100 percent of the chemicals. None of the chemicals have an identified ODP and an identified GWP. Additionally, all the chemicals are flammable, with ratings spanning from Category 2 to Category 4.

Of the four chemicals, all may function as solvents. None of the four alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is

currently undergoing risk management. Acetone, methyl sulfoxide, N,N-dimethylformamide, and tetrahydrofuran are the most common chemical ingredients that may function as solvents. Acetone has five endpoints that exhibit the highest possible hazard rating: dermal, genotoxicity mutagenicity, endocrine disruption, developmental, and repeat systemic exposure. Methyl sulfoxide has two endpoints that exhibit the highest possible hazard rating: developmental and chronic aquatic. N,N-Dimethylformamide has six endpoints that exhibit the highest possible hazard rating: carcinogenicity, endocrine disruption, reproductive, developmental, and repeat and single systemic exposure. Tetrahydrofuran has five endpoints that exhibit the highest possible hazard rating: oral, endocrine disruption, repeat and single neuro toxicity, and repeat systemic exposure. Additionally, all four solvents are flammable (Categories 2, 4, 4, and 2, respectively).

5.19 Category: Paint and Primer

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers and floor finishes, and powder coatings, surface preparation.

EPA included six products in this product category that contain alternative chemical substances to NMP. In the 6 alternative products evaluated EPA found 35 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 69 percent of the chemicals, and at least one authoritative data source is available for 63 percent of all the chemicals. None of the chemicals have an identified ODP and an identified GWP. Additionally, 37 percent are flammable, with ratings spanning from Category 2 to Category 4. Overall, EPA has identified xylene as the most common chemical ingredient.

Of the 35 chemicals, 17 may function as solvents. None of the four alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Xylene, ethylene glycol monobutyl ether, nonylphenyl polyethoxylate, and Stoddard solvent are among the most common chemical ingredients that may function as solvents. Ethylene glycol monobutyl ether has five endpoints that exhibit the highest possible hazard rating, genotoxicity mutagenicity, endocrine disruption, neuro single exposure, systemic repeat exposure, and systemic single exposure. Nonylphenyl polyethoxylate has no endpoints that exhibit the highest possible hazard rating. No hazard information is available for xylene or Stoddard solvent. Additionally, ethylene glycol monobutyl ether and nonylphenyl polyethoxylate are flammable (Categories 2 and 3, respectively).

5.20 Category: Paint and Coating Remover

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in paints, coatings, and adhesive removers.

EPA included 67 products in this product category that contain alternative chemical substances to NMP. In the 67 alternative products evaluated EPA found 72 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 71 percent of the chemicals, and at least one authoritative data source is available for 54 percent of all the chemicals. None of the chemicals have an identified ODP, and 1 percent has an identified GWP. Additionally, 49 percent are flammable, with ratings spanning from Category 1 to Category 4. Overall, EPA has identified acetone, alcohol ethoxylate, and methanol as the most common chemical ingredients. Mechanical or thermal methods (*e.g.*, sanding, media blasting, heat guns) may also be non-chemical alternatives to using products containing methylene chloride for paint and coating removers.

Of the 72 chemicals, 38 may function as solvents. Of the 67 identified alternative products, 10 percent contained a solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. The most common chemical ingredients that may function as a solvent are acetone, dimethyl carbonate, and methanol. Acetone has five endpoints that exhibit the highest possible hazard rating: dermal, genotoxicity mutagenicity, endocrine disruption, developmental, and repeat exposure systemic toxicity. Dimethyl carbonate has no endpoint that exhibits the highest possible hazard rating. Methanol has eight endpoints that exhibit the highest possible hazard rating: genotoxicity mutagenicity, endocrine disruption, reproductive, developmental, neurotoxicity (both repeat and single exposure), and systemic (both repeat and single exposure). Additionally, all three of these solvents are flammable (Categories 2, 3, and 1, respectively).

In addition, 24 percent of identified products were formulated without the use of a solvent, though five of those products included unidentified chemicals that may be a solvent. These products primarily used emulsifiers, plasticizers, surface-active agents, and thickeners as their functional ingredients.

5.21 Category: Processing Aid

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in processing aids, specific to petroleum production in petrochemical manufacturing, in oil and gas drilling, extraction and support activities, and in functional fluids (closed systems).

EPA included four products in this product category that contain alternative chemical substances to NMP. In the four alternative products evaluated EPA found five unique chemical substances with associated CASRNs. Hazard information is reasonably available for 80 percent of the chemicals, and at least one authoritative data source is available for 60 percent of the chemicals. None of the chemicals have an identified ODP and an identified GWP. Additionally, 60 percent of the chemicals are flammable, with ratings of Category 1, Category 3, and Category 4.

Of the five chemicals, all may function as solvents. None of the four alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Cresol, furfural, phenol, propane, and sulfur dioxide are the most common chemical ingredients that may function as solvents. Furfural has three endpoints that exhibit the highest possible hazard rating: carcinogenicity, genotoxicity mutagenicity, and repeat systemic exposure. Phenol has nine endpoints that exhibit the highest possible hazard rating: endocrine disruption, reproductive, developmental, repeat and single exposure neurotoxicity, single systemic exposure, skin sensitization, skin irritation, and eye irritation. Sulfur dioxide has nine endpoints that exhibit the highest possible hazard rating: oral, genotoxicity mutagenicity, endocrine disruption, developmental, repeat and single systemic exposure, skin irritation, eye irritation, and chronic aquatic. Propane has one endpoint that exhibits the highest possible hazard rating: developmental. Additionally, furfural, phenol, and propane are flammable (Categories 3, 4, and 1, respectively).

5.22 Category: Roof Coating

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers and floor finishes, and powder coatings, surface preparation.

EPA included five products in this product category that contain alternative chemical substances to NMP. In the 5 alternative products evaluated EPA found 22 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 50 percent of the chemicals, and at least one authoritative data source is available for 45 percent of all the chemicals. None of the chemicals have an

identified ODP and an identified GWP. Additionally, 9 percent are flammable, with ratings spanning from Category 3 to Category 4. Overall, EPA has identified aluminum hydroxide, titanium dioxide, and xylene as the most common chemical ingredients.

Of the 22 chemicals, five may function as solvents. None of the five alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Ethylbenzene, naphtha (petroleum), and xylene are the most common chemical ingredients that may function as solvents. Ethylbenzene has four endpoints that exhibit the highest possible hazard rating: carcinogenicity, genotoxicity mutagenicity, endocrine disruption, and reproductive. No hazard information is available for naphtha (petroleum) and xylene. Additionally, ethylbenzene is flammable (Category 3).

In addition, one product, which accounted for 20 percent of identified products, was formulated without the use of a solvent. This product used a mildewcide, pigment, stabilizer, rheological agent, and pigment as its functional ingredients.

5.23 Category: Soldering Material

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in soldering materials.

EPA included seven products in this product category that contain alternative chemical substances to NMP. In the 7 alternative products evaluated EPA found 15 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 73 percent of the chemicals, and at least one authoritative data source is available for 60 percent of all the chemicals. None of the chemicals have an identified ODP and an identified GWP. Additionally, 27 percent are flammable, with ratings of Category 1, Category 2, and Category 4. Overall, EPA has identified 2-methylpentane-2,4-diol, 2-propanol, ethoxylated propoxylated alcohols (C8–10), antimony, bismuth, copper, rosin, silver, tin and dimethyltetraglycol as the most common chemical ingredients.

Of the 15 chemicals, five may function as solvents. None of the seven alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. 2-Methylpentane-2,4-diol, 2-propanol, and dimethyltetraglycol are the most common chemical ingredients that may function as solvents. 2-Propanol has one endpoint that exhibits the highest possible hazard rating: single exposure neurotoxicity. Neither 2-methylpentane-2,4-diol nor dimethyltetraglycol has endpoints that exhibit the highest possible hazard rating. Additionally, 2-methylpentane-2,4-diol and 2-propanol are flammable (Categories 4 and 2, respectively).

In addition, one product, which accounted for 43 percent of identified products, was formulated without the use of a solvent. This product used emulsifiers and bonding agents as its functional ingredients.

5.24 Category: Tape

This product category includes two COUs from the NMP TSCA risk evaluation:

1. Consumer use in adhesives and sealants in glues and adhesives, including lubricant adhesives and sealants; and
2. Industrial and commercial use in adhesives and sealants including binding agents, single-component glues and adhesives, including lubricant adhesives, and two-component glues and adhesives including some resins.

EPA included one product in this product category that contains alternative chemical substances to NMP. In the one alternative product evaluated EPA found one unique chemical substance with associated CASRNs. However, no hazard information is available for this chemical. Overall, EPA has identified a chloroalkyl phosphate ester as the chemical ingredient.

In addition, one alternative product was formulated without the use of a solvent. This product used a fire retardant as its functional ingredient.

5.25 Category: Wall Texture Coating

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers and floor finishes, and powder coatings, surface preparation.

EPA included eight products in this product category that contain alternative chemical substances to NMP. In the eight alternative products evaluated EPA found four unique chemical substances with associated CASRNs. Hazard information is reasonably available for 25 percent of the chemicals, and no authoritative data sources are available for any of the chemicals. None of the chemicals have an identified ODP, and 25 percent have an identified GWP. Additionally, 25 percent are flammable, with a rating of Category 1. Overall, EPA has identified calcium carbonate, respirable powder crystalline silica, dimethyl ether, and talc as the most common chemical ingredients.

Of the four chemicals, none were identified as a solvent. None of the eight alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. These products used pigment, rheological agents, propellant, and weather resistance.

In addition, 100 percent of identified products were formulated without the use of a solvent. These products used pigments, rheological agents, propellant, and weather resistance as their functional ingredients.

5.26 Category: Wood Finish

This product category includes one COU from the NMP TSCA risk evaluation: Industrial and commercial use in paints and coatings in lacquers, stains, varnishes, primers and floor finishes, and powder coatings, surface preparation.

EPA included 10 products in this product category that contain alternative chemical substances to NMP. In the 10 alternative products evaluated EPA found 41 unique chemical substances with associated CASRNs. Hazard information is reasonably available for 51 percent of the chemicals, and at least one authoritative data source is available for 34 percent of all the chemicals. None of the chemicals have an identified ODP and an identified GWP. Additionally, 24 percent are flammable, with ratings spanning from Category 2 to Category 4. Overall, EPA has identified hydrotreated light distillates (petroleum), Stoddard solvent, and xylene as the most common chemical ingredients.

Of the 41 chemicals, 17 may function as solvents. None of the 10 alternative products contain any solvent that EPA has determined presents an unreasonable risk under TSCA section 6 and that is currently undergoing risk management. Hydrotreated light distillates (petroleum), ethylbenzene, Stoddard solvent, and xylene are the most common chemical ingredients that may function as solvents. No hazard information is available for hydrotreated light distillates (petroleum), Stoddard solvent, and xylene. Additionally, ethylbenzene is flammable (Category 3).

In addition, one product, which accounted for 10 percent of identified products, was formulated without the use of a solvent. This product used a curing agent, stabilizer, pigment, rheological agent, colorant, UV absorber, and lubricant as its functional ingredients.

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LIST OF APPENDICES