
REPORT

Substitutes for regulated plasticizers

Ersättningsämnen för reglerade mjukgörare

PROJECT NUMBER 13005713



HELSINGBORG MILJÖ OCH ARBETSMILJÖ 2018-09-27



ÅSE JOHANSSON, PROJECT MANAGER

**CARINA BJÖRKBLOM, MATS ERICSON, SANDRA NILSSON, ELISABET TOUMIE
REVIEWED BY PETRA WALLBERG**



Substitutes for regulated plasticizers

<p>Report authors Björkblom Carina, Sweco Environment AB Wallberg Petra, Sweco Environment AB Johansson Åse, Sweco Environment AB Sundberg Elisabet, Sweco Environment AB Nilsson Sandra, Sweco Environment AB Ericson Mats, Lysmask Innovation AB</p>	<p>Responsible publisher Sweco Environment AB</p> <p>Postal address Gjörwellsgatan 22 100 26 STOCKHOLM</p> <p>Telephone 08-695 60 00</p>
<p>Report title and subtitle Substitutes for regulated plasticizers</p>	<p>Purchaser Swedish Environmental Protection Agency, Environmental Monitoring Unit SE-106 48 Stockholm, Sweden</p> <p>Funding National environmental monitoring</p>
<p>Keywords for location (specify in Swedish) Sweden (Sverige)</p>	
<p>Keywords for subject (specify in Swedish) Substitute substance (ersättningsämne), plasticizer (mjukgörare), plasticiser (mjukgörare) regulated plasticizers (reglerade ersättningsämnen), regulated plasticisers (reglerade ersättningsämnen), phthalates, screening</p>	
<p>Period in which underlying data were collected 2018</p>	
<p>Summary A literature and database review was conducted with the aim of identifying substitute substances for regulated plasticizers that are of relevance within Sweden. Based on this survey substitute substances were prioritized and suggested for national screening studies.</p> <p>Information sources used were lists/databases, scientific literature, reports, interviews with business organizations (within or connected to the plasticizers industry), manufacturers, importers and users. Plasticizers that are already regulated or on their way to be have been listed, as well as a list of possible substitute substances for these regulated plasticizers.</p> <p>The first list of potential candidates for screening constituted 152 substances. To be able to prioritize between identified plasticizers, a multicriteria model was developed based on usage, presence of substance on different lists, and classification. In total 40 substances were selected for further evaluation. As volume is a critical parameter for exposure, 15 substances were thereafter selected. This prioritization was crosschecked with the information obtained from interviews with selected representatives from the industry, which added one more substance to the priority list. Since the Swedish Environmental Protection Agency requested that substances previously included in various screenings should be excluded, the final list consisted of eleven selected plasticizers.</p> <p>From the developed multicriteria model, the following plasticizers were identified: Dipropylene glycol dibenzoate (DGD); Alkanes, C14-17, chloro; Dioctyl adipate (DOA); Benzyl 3-isobutyryloxy-1-isopropyl-2,2-dimethylpropyl phthalate; 2,2,4-trimethyl-1,3 pentanediol di-isobutyrate (TXIB); Diisononyl adipate (DINA); Diethylene glycol dibenzoate (DEGD; DEGDB); Hexanedioic acid, polymer with 1,4-butanediol and 2,2-dimethyl-1,3-propanediol, isononyl ester (Palamoll 654; Palamoll 656); Epoxidised soybean oil (ESBO); (second DINP line) 1,2-Benzenedicarboxylic acid, di-C8-10-branched alkyl esters, C9-rich (DINP); and Tris-2-ethylhexyl trimellitate (TOTM).</p> <p>These plasticizers are suggested to be prioritized in future screening studies.</p>	

Preface

In April 2018, Sweco Environment AB received the assignment from the Swedish Environmental Protection Agency to carry out a mapping of potential substitutes for plasticizers based on phthalates. The assignment manager was Åse Johansson. Other members in the working group were Mats Ericson, at Lysmask Innovation AB; and Petra Wallberg, Elisabet Sundberg, Sandra Nilsson and Carina Björkblom at Sweco Environment AB. The assignment was finalized on 30th September 2018. The target group for this report is the Swedish Environmental Protection Agency.

Contents

1	Scope of the assignment	10
1.1	Boundaries of the assignment	10
2	Introduction	10
2.1	Volumes, use and concerns of plasticizers	10
2.2	PVC	11
2.3	Legislation	11
3	Survey methodology	12
3.1	Information sources	12
3.1.1	Databases & lists	13
3.1.2	Patent databases	13
3.2	Compilation of regulated and not regulated plasticizers	14
3.2.1	Information about volumes from the Swedish Products Register	14
3.3	Interviews with representatives of the industry	14
3.4	Multicriteria model developed for prioritization among plasticizers	15
3.4.1	Volumes	15
3.4.2	Presence on ECHA's lists	15
3.4.3	Classification	15
3.4.4	Final prioritization	16
3.5	Literature search	16
4	Results and discussion	16
4.1	Potential substitutes for restricted plasticizers	16
4.2	Trends regarding substitution – results from the interviews	22
4.3	Screening of plasticizers in Sweden	23
4.4	Multicriteria model	24
4.4.1	Comments concerning the selection process	24
4.5	Proposed substances for screening	24
5	Suggested matrices for screening and conclusions	29
6	References	36
7	Appendices	39

SUMMARY

A literature and database review was conducted with the aim of identifying substitute substances for regulated plasticizers that are of relevance within Sweden. Based on this survey substitute substances were prioritized and suggested for national screening studies.

Information sources used were lists/databases, scientific literature, reports, interviews with business organizations (within or connected to the plasticizers industry), manufacturers, importers and users. Plasticizers that are already regulated or on their way to be have been listed, as well as a list of possible substitute substances for these regulated plasticizers.

The first list of potential candidates for screening constituted 152 substances. To be able to prioritize between identified plasticizers, a multicriteria model was developed based on usage, presence of substance on different lists, and classification. In total 40 substances were selected for further evaluation. As volume is a critical parameter for exposure, 15 substances were thereafter selected. This prioritization was crosschecked with the information obtained from interviews with selected representatives from the industry, which added one more substance to the priority list. Since the Swedish Environmental Protection Agency requested that substances previously included in various screenings should be excluded, the final list consisted of eleven selected plasticizers.

From the developed multicriteria model, the following plasticizers were identified: Dipropylene glycol dibenzoate (DGD); Alkanes, C14-17, chloro; Dioctyl adipate (DOA); Benzyl 3-isobutyryloxy-1-isopropyl-2,2-dimethylpropyl phthalate; 2,2,4-trimethyl-1,3 pentanediol di-isobutyrate (TXIB); Diisononyl adipate (DINA); Diethylene glycol dibenzoate (DEGD; DEGDB); Hexanedioic acid, polymer with 1,4-butanediol and 2,2-dimethyl-1,3-propanediol, isononyl ester (Palamoll 654; Palamoll 656); Epoxidised soybean oil (ESBO); (second DINP line) 1,2-Benzenedicarboxylic acid, di-C8-10-branched alkyl esters, C9-rich (DINP); and Tris-2-ethylhexyl trimellitate (TOTM).

These plasticizers are suggested to be prioritized in future screening studies.

SAMMANFATTNING

En litteratur- och databasstudie genomfördes med syfte att identifiera nya mjukgörare av relevans för Sverige, dvs. ämnen som används som ersättningskemikalier för reglerade ftalater. Baserat på denna kartläggning presenteras en lista med mjukgörare som föreslås ingå i kommande screeningundersökningar.

Informationskällor som använts är listor/databaser, vetenskaplig litteratur, rapporter, intervjuer med företagsorganisationer (inom eller nära anslutna till industrier som använder mjukgörare), tillverkare, importörer och användare. En förteckning över mjukgörare som redan är reglerade eller som är på väg att bli reglerade har sammanställts, samt en lista över möjliga substitutionsämnen för dessa reglerade mjukgörare.

Den sammanställda listan över potentiella kandidater för screening utgjordes av 152 ämnen. För att kunna prioritera mellan identifierade mjukgörare användes en multikriteriemodell baserad på ämnets användning/volym, närvaro på olika listor, klassificering och information om tidigare miljödetektering/screening inom Sverige. Totalt 40 ämnen valdes för vidare utvärdering. Eftersom volymen är en kritisk parameter för exponering, användes detta kriterium för att ranka substanserna och 15 ämnen prioriterades. Denna prioritering matchades med information från intervjuerna med branschen, vilket resulterade i att ytterligare ett ämne tillkom i prioriteringslistan. Eftersom Naturvårdsverket begärde att de ersättningsämnen som tidigare varit inkluderade i olika screeningar, skulle uteslutas, utgjorde den slutliga listan av elva mjukgörare.

Baserat på denna multikriteriemodell identifierades därmed följande mjukgörare; Dipropylene glycol dibenzoate (DGD), Alkanes, C14-17, chloro, Dioctyl adipate (DOA), Benzyl 3-isobutyryloxy-1-isopropyl-2,2-dimethylpropyl phthalate, 2,2,4-trimethyl-1,3 pentanediol di-isobutyrate (TXIB), Diisononyl adipate (DINA), Diethylene glycol dibenzoate (DEGD; DEGDB), Hexanedioic acid, polymer with 1,4-butanediol and 2,2-dimethyl-1,3-propanediol, isononyl ester (Palamoll 654; Palamoll 656), Epoxidised soybean oil (ESBO), (second DINP line) 1,2-Benzenedicarboxylic acid, di-C8-10-branched alkyl esters, C9-rich (DINP), och Tris-2-ethylhexyl trimellitate (TOTM).

Dessa mjukgörare föreslås bli prioriterade i framtida screeningsundersökningar.

ABBREVIATIONS

ASE	Alkylsulphonic acid ester with phenol
ATBC	Acetyl tributyl citrate
ATHC	Acetyl tri-n-hexyl citrate
ATP	Adaptation to Technical Progress
BBSA	N-butyl benzene sulfonamide
BCP	Butyl cyclohexyl phthalate
BDP	Butyl decyl phthalate
BEH-TEBP	Bis(2-ethylhexyl) tetrabromophthalate
CAS	Chemical Abstracts Service
CLP	Classification, Labelling and Packaging of substances and mixtures
CMR	Carcinogenic, mutagenic or toxic to reproduction
COMGHA	Fully acetylated monoglyceride
CoRAP	Community Rolling Action Plan
CPC	Cooperative Patent Classification
DBA	Di-n-butyl adipate
DBEA	Di-(2-butoxyethyl)adipate
DBEEA	Bis[2-(2-butoxyethoxy)ethyl]adipate
DBS	Dibutyl sebacate
DBT	Diisobutyl terephthalate
DCHP	Dicyclohexyl phthalate
DEGD; DEGDB	Diethylene glycol dibenzoate
DEHA	Di-2-ethylhexyl adipate
DEHPA	Bis(2-ethylhexyl) hydrogen phosphate
DEP	Diethyl phthalate
DES	Diethylsuccinate
DGD	Dipropylene glycol dibenzoate
DHP	Diisohexyl phthalate
DIBA	Diisobutyl adipate
DIDA	Diisodecyl adipate; Diisodecyl azelate
DIDP	Diisodecyl phthalate (1,2-Benzenedicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich)
DIDS	Di-isodecyl sebacate
DINA	Diisononyl adipate
DINCH	Di-isononyl cyclohexane dicarboxylate; 1,2-Cyclohexanedicarboxylic acid, 1,2-dinonyl ester, branched and linear
DINP	Diisononyl phthalate

DINP	(second DINP line) 1,2-Benzenedicarboxylic acid, di-C8-10-branched alkyl esters, C9-rich
DIOP	Diisooctyl phthalate
DIOS	Diisooctyl sebacate
DIOZ	Diisooctyl azelate
DITP	Diisotridecyl phthalate
DIUP	Diisoundecyl phthalate
DMP	Dimethyl phthalate
DMS	Dimethylsuccinate; Dimethyl sebacate
DNOP	Di-n-octyl phthalate
DNP	Dinonyl phthalate
DOA	Diocetyl adipate
DOS	Diocetyl sebacate; Di-2-ethylhexyl sebacate
DOTP	Diocetyl terephthalate
DOTP/DEHT/DEHTP	Diocetyl terephthalate; bis(2-ethylhexyl) tereftalat
DOZ	Bis(2-ethylhexyl) azelate
DPHP	Di(2-propyl heptyl) phthalate
DPP	Di-n-propyl phthalate; Diphenyl phthalate
DTDA	Ditridecyl adipate
DTDP	Diisotridecyl phthalate (1,2-Benzenedicarboxylic acid, di-C11-14-branched alkyl esters, C13-rich); Di(tridecyl) phthalate
DTDTP	Ditridecyl thiodipropionate
EC	European Community
ECHA	European Chemicals Agency
EEC	European Economic Community
ELO	Epoxidised linseed oil
EPA	Environmental Protection Agency
ESBO	Epoxidised soybean oil
EU	European Union
GTA	Glyceryl triacetate
IDB	Isodecyl benzoate
INB	Isononyl benzoate
INRS	The French National Research and Safety Institute for the Prevention of Occupational Accidents and Diseases
KemI	The Swedish Chemicals Agency
L911P	1,2-Benzenedicarboxylic acid, di-C9-11-branched and linear alkyl esters
ODP	Decyl octyl phthalate
Palamoll 646	Hexanedioic acid, polymer with 2,2-dimethyl-1,3-propanediol and 1,2-propanediol, isononyl ester
Palamoll 652	Hexanedioic acid, polymer with 2,2-dimethyl-1,3-propanediol and 1,2-propanediol, isononyl ester
Palamoll 654; Palamoll 656	Hexanedioic acid, polymer with 1,4-butanediol and 2,2-dimethyl-1,3-propanediol, isononyl ester

8(39)

REPORT
 HELSINGBORG MILJÖ OCH ARBETSMILJÖ 2018-09-27
Substitutes for regulated plasticizers

PETV	Pentaerythritol ester of valeric acid
PS	Polystyrene
PVAc	Polyvinyl acetate
PVC	Polyvinyl chloride
REACH	Registration, Evaluation, Authorisation and restriction of Chemicals
SVHC	Substances of very high concern
STP	Sewage Treatment Plant
TBC	Tributyl citrate
TCP	Tricresyl phosphate
TDP	Trisodecyl trimellitate
TEC	Triethyl citrate
TEHPA	Tris(2-ethylhexyl) phosphate
TIOTM	Triisooctyl trimellitate
TOTM	Tris-2-ethylhexyl trimellitate
TPP	Triphenyl phosphate
TXIB	2,2,4-trimethyl-1,3 pentanediol di-isobutyrate

1 Scope of the assignment

The overall aim for this assignment was to carry out a literature study gaining information about substitute substances to restricted plasticizers, such as phthalates, and based on this survey prioritize substitute substances suggested for national screening studies.

1.1 Boundaries of the assignment

There are many different types of plasticizers, but the major group used today are phthalates. Therefore, this survey has mainly focused on possible substitutes for phthalates.

Substitution of plasticizers has been going on for several years. In order to obtain relevant information for the present situation, the scope of the survey was mainly limited to five years back in time. Literature sources used in this assignment will be presented in section 3. Thesis reports have been excluded in this study.

The survey of plasticizers is limited to the situation within Sweden. Substances without Chemical Abstracts Service (CAS) or European Community (EC) numbers were not further investigated. Endocrine disrupting properties were not included in the assignment.

In the Swedish Products Register, several of the extracted registrations of plasticizers were not open for public access, due to confidentiality. Information about restricted or replaced substances in imported products from non-European Union (EU) countries is lacking.

2 Introduction

2.1 Volumes, use and concerns of plasticizers

A plasticizer is a substance or material incorporated in a material (usually a plastic or elastomer) to increase its flexibility, workability, or distensibility. A plasticizer may reduce the melt viscosity, lower the second-order transition temperature, or lower the elastic modulus of the polymer, but not alter the chemical nature of the macromolecule. Over the last 60 years more than 30,000 different substances have been evaluated for their plasticising properties. Of these, only a small number are in commercial use today after meeting the rigorous performance, cost, availability, health and environmental requirements, which are imposed by the market, users and regulators. The most common plasticisers include esters, such as adipates, azelates, citrates, benzoates, orthophthalates, terephthalates, sebacates, and trimellitates.

Globally, more than eight million tonnes of plasticisers are consumed every year, of which European consumption accounts for over 1.3 million tonnes. Orthophthalates, due to their high degree of compatibility with PVC, are the most widely consumed plasticisers.

Plasticizers are widely used in a variety of consumer products including medical devices, food wrap, building materials, packaging, automotive parts and children's toys. These substances provide a large variety of characteristics. For instance, in cosmetics they are added to hold fragrance, reduce cracking of nail polish, reduce stiffness of hair spray, and make products more effectively penetrate and moisturize the skin. Plasticizers are used as solvents in many applications and in articles made of polyvinyl chloride (PVC).

Because of health concerns, restrictions have come into force concerning some of the plasticizers. Specifically, phthalates have been identified as reproductive and developmental toxicants, though their toxicity varies somewhat depending on the specific phthalate structure. In addition, some of the substances have also been classified as probable and possible human carcinogens.

Plasticizers are released into the environment during production, processing, use and waste disposal. Once in the environment, phthalates bind to particles and can be carried with air over long distances. Human exposure of plasticizers occurs through inhalation, ingestion of contaminated food, as well as skin contact. Food may become contaminated in contact with packaging material that contains phthalates. An additional exposure route for young children is through mouthing products containing phthalates, for instance, toys and childcare articles.

2.2 PVC

PVC products may contain up to 50 percent by weight of plasticizers, most commonly phthalates. Today, over 85 percent of all plasticisers consumed in Europe are employed in flexible PVC applications, largely within the construction, automotive and wire & cable sectors. They are the major functional substances that transform the physical properties of PVC and other polymers, creating flexible and durable finished articles for high performing applications.

Phthalates have low volatility and are not chemically bound to the PVC polymer and may slowly be released from PVC products or dissolve in contact with liquids or fats. Thus, over time they leach out of products and diffuse into the air, water, food, house dust, soil, living organisms, and other media, particularly under conditions involving heat.

2.3 Legislation

Since the implementation of the Registration, Evaluation, Authorisation and restriction of Chemicals (REACH) in 2007, more than 50 plasticisers have been registered. REACH involves evaluation at many levels including dossier evaluation, evaluation of testing proposals, evaluation of classification and substance evaluation.

The authorisation process aims to ensure that Substances of Very High Concern (SVHCs) are progressively replaced by less dangerous substances or technologies where technically and economically feasible alternatives are available. The identification of a substance as a SVHC and its inclusion in the

Candidate List at the European Chemicals Agency (ECHA) can trigger certain legal obligations for the importers, producers and suppliers of an article that contains such a substance.

ECHA regularly assesses the substances from the Candidate List to determine which ones should be included in the Authorisation List (Annex XIV of REACH) as a priority. The prioritisation is based on information on the intrinsic properties, wide dispersive use or high volumes that fall within the scope of the authorisation requirement. These substances are then subject to an application by producers, importers or users for authorisation for specific uses.

Restrictions on substances, mixtures and/or articles are set out in Annex XVII of REACH. Restrictions are an instrument to protect human health and the environment from unacceptable risks posed by chemicals. Restrictions are normally used to limit or ban the manufacture, placing on the market (including imports) or use of a substance, but can impose any relevant condition, such as requiring technical measures or specific labels.

With respect to substance evaluation, the process involves a Community Rolling Action Plan (CoRAP), where several plasticisers are listed. The CoRAP specifies the substances that are to be evaluated over a period of three years. The plan is annually updated to include substances for the additional year as well as any revision to the substances that were included in the second and third year of the previous plan. These substances are not regulated, but there is some concern that these substances could pose a risk to the environment or human health.

Some products that may contain plasticizers are regulated in other directives. For instance, some of the orthophthalates (e.g. DEHP, DBP, BBP) are restricted in all toys and childcare articles (limit of 0.1% by weight) under the EU Toys Directive. The classified phthalates, as Category 1B reproductive agents, are restricted in cosmetic products under the EU Cosmetics Directive.

Because of the regulations and customer requests, the demand for plasticisers within the industry has been shifting away from CMR (carcinogenic, mutagenic or toxic to reproduction) classified phthalates towards non-CMR classified phthalates and other non-CMR classified plasticisers which today represent around 95% of all plasticisers being produced in Europe. A similar move away from CMR classified phthalates has occurred in North America, but in the rest of the world (Asia, the Middle East, Africa and Latin America), CMR classified phthalates including DEHP and DBP continue to be produced and used to a high degree.

3 Survey methodology

3.1 Information sources

This literature survey is based on information regarding substitute substances for regulated plasticizers. Information sources used were lists/databases, information on websites on the internet, scientific literature, reports, interviews with business

organizations (within or connected to the plasticizers industry), manufacturers, importers and users.

3.1.1 Databases & lists

Several databases were used in the search for plasticizers.

- European Plasticizers – database with 65 different plasticizers, all commercially available and currently used
- ECHA – Registered substances database
- ECHA – CoRAP
- ECHA – Candidate list
- ECHA – Authorization list
- ECHA – Restriction list
- Swedish Chemicals Agency– The Products Register
- Swedish Chemicals Agency- PRIO
- Swedish Chemicals Agency - Restricted Substances Database

Keywords used: Ftalater, mjukgörare, Phthalates, Plasticizers, Plasticisers

PRIO is a web-based tool produced by the Swedish Chemicals Agency that can be used to preventively reduce health and environmental risks from chemical substances. The Restricted Substances Database contains information on whether the restrictions placed on a substance or group of substances are in compliance with the provisions set out in Swedish Government regulations or are in compliance with those set out in the Swedish Chemicals Agency regulations.

The database from European Plasticizers was used as a starting point and to this list regulated plasticizers and possible substitutes for regulated plasticizers were compiled based web searches, databases (listed above), scientific literature, books, reports by ECHA and by Swedish agencies (see reference list).

To identify regulated substances, all databases extracted from ECHA were matched with the compiled list of plasticizers as well as extracts from PRIO and the Restricted Substances Database.

3.1.2 Patent databases

Patent databases are a possible information source in the search for new plasticizers.

An initial search in the patent database “Espacenet” (<https://worldwide.espacenet.com>) was conducted, using the following CPC (Cooperative Patent Classification) system codes:

- C08J 3/18 – Plasticizing macromolecular compounds
- C08K – Use of inorganic or non-macromolecular organic substances as compounding ingredients
- C08K 5/0016 – For an organic substance which is to be classified but not specifically defined and only described as “plasticizer”.

The keywords “plasticizer” and “plasticiser” were used.

To search and obtain information from patent databases turned out to be very time consuming. CAS- and EC-numbers are often not available and makes it difficult or impossible to find out more information about them in ECHA’s databases. Thus, it is difficult to identify whether a substance described in a patent is used within the industry. Due to the time limit of this assignment and in agreement with the Swedish Environmental Protection Agency, it was decided at a relatively early stage in the survey to not include information from patent databases.

3.2 Compilation of regulated and not regulated plasticizers

The list of both regulated plasticizers and possible replacement substances were then divided in two separate lists. One list (A) contained substances that are regulated and, thus, either listed on ECHA’s Candidate list or Authorization list.

The list with possible substitutes (B) consisted of not regulated substances and substances present on ECHA’s CoRAP list or ECHA’s Restriction list.

3.2.1 Information about volumes from the Swedish Products Register

The Swedish Products Register contains information on chemical products and biotechnical organisms, either manufactured in or imported to Sweden. An extract from this register was obtained from Swedish Chemicals Agency.

Information about volumes of chemical products of relevance for the assignment that had been registered over the period from January 2012 to December 2016 were requested. A minimum of 5 % presence of the plasticizer in the product was used as a criterium. Due to confidentiality, several of the extracted registrations of plasticizers were not open for public access as protection of the registrant, if there are fewer than three, and, thus, for these substances no information about volumes are shown. For the substances where information was available, the list was matched with the list of possible substitutes (B), to obtain information on volumes.

All substances on the list from the Products Register are not necessarily plasticizers, especially those in the category named “other”. Some substances on the list of possible substitute plasticizers (B) were not found in the Products Register and are marked with “-” in the presented tables.

3.3 Interviews with representatives of the industry

In total seven interviews were carried out with manufacturers, users of plasticizers and business organizations, mainly by telephone. A checklist with questions was used as support during the interview (Appendix 1). In order to be able to have an open discussion, the organization and person interviewed are not presented in this report, and the results are consolidated.

All organizations interviewed had international businesses, were active in Sweden with focus on different product areas and the material in common was plasticized PVC.

3.4 Multicriteria model developed for prioritization among plasticizers

The list of possible substituting substances for regulated plasticizers (B) is the basis for selection and suggestion of screening candidates. A multicriteria model was developed for this prioritization. The model includes information on volume, presence on ECHA's lists and classification. Each substance on the list of substitute plasticizers was given a score in these categories.

3.4.1 Volumes

In the category "volume", substances were given the following scores.

- Missing information/No data in the Products Register – 0
- Confidential information in the Products Register – 1
- 1-10 ton/year – 2
- 10-100 ton/year – 3
- 100–500 ton/year – 4
- 500–1000 ton/year – 5
- 1000–5000 ton/year – 6
- >5000 ton/year – 7

Based on the information on volumes from the Products Register an average volume was calculated. To normalize the score for each substance, the score was thereafter divided by the highest score (7).

In some cases, substances did not have open data for all years due to confidentiality. As no information was available, the volume was set to be zero for years where data was lacking.

3.4.2 Presence on ECHA's lists

Presence on ECHA's lists CoRAP and Restriction list were given the following scores.

- Not present on either of the lists – 0
- Present on one of the lists – 1
- Present on both lists – 2

The scores for each substance were normalized by dividing by the highest score (2).

3.4.3 Classification

Information about classification of the substances were given the following scores.

- Not classified as hazardous – 0

- Classification is missing/not available – 1
- Substance is classified as hazardous– 2

The score for each substance was normalized by dividing with the highest score (2).

3.4.4 Final prioritization

Scores for each substance in all categories were summarized to a final score. The final scores ranged between 0 and 2. The substances were sorted from highest to lowest score, and as a further basis for selection and suggestion of screening candidates.

In total 40 substances had final sum above 0,5 and were selected for further evaluation. As volume is a critical parameter for exposure, 15 substances with volumes scored ≥ 2 were thereafter selected. This prioritization was crosschecked with the information obtained from the interview with the industry, which added one more substance to the priority list. Since the Swedish Environmental Protection Agency (EPA) requested that new substances, not previously included in screening program should be selected, five substances were excluded, resulting in a final list of 11 plasticizers. Before further search of information in scientific literature, this selection procedure was discussed with and confirmed by the Swedish EPA.

3.5 Literature search

A literature review was conducted to summarize available information on different plasticizers in various environmental matrices reported in Sweden. The cited literature encompasses international peer-reviewed literature and reports from national environmental authorities. The literature review covered the time period 2005-2018.

Information concerning some of the identified plasticizers was also gathered from the internet.

4 Results and discussion

4.1 Potential substitutes for restricted plasticizers

In total, 152 alternative plasticisers have been identified (Table 1). In total 20 plasticisers were identified on the CoRAP list (Appendix 2), 14 plasticizers on ECHA's Candidate list (Appendix 3), 11 plasticizers on ECHA's Authorisation (Appendix 4), seven plasticizers on ECHA's Restriction list (Appendix 5), 16 plasticizers in the PRIO database (Appendix 6) and 14 plasticizers in the Restricted Substances Database (Appendix 7).

Table 1. Identified plasticizers with name, acronym, CAS-, and EC-number (if available) in alphabetic order based on category. Missing information is indicated with a "-".

16(39)

Category	Name	Acronym	EC	CAS
Acetate	Glyceryl triacetate	GTA	203-051-9	102-76-1
Adipate	Diisobutyl adipate	DIBA	205-450-3	141-04-8
Adipate	Di-2-ethylhexyl adipate	DEHA	203-090-1	103-23-1
Adipate	Diisononyl adipate	DINA	291-426-8	33703-08-1
Adipate	Diisodecyl adipate	DIDA	248-299-9	27178-16-1
Adipate	Ditridecyl adipate	DTDA	241-029-0	16958-92-2
Adipate	Di-n-butyl adipate	DBA	203-350-4	105-99-7
Adipate	Di-(2-butoxyethyl)adipate	DBEA	205-466-0	141-18-4
Adipate	Bis[2-(2-butoxyethoxy)ethyl]adipate	DBEEA	205-465-5	141-17-3
Adipate	Diisotridecyl adipate	DTDA	247-660-8	26401-35-4
Adipate	Benzyl octyl adipate	-	221-431-2	3089-55-2
Adipate	Didecyl adipate	-	203-349-9	105-97-5
Adipate	Dinonyl adipate	-	205-789-7	151-32-6
Adipate	Diocetyl adipate	DOA	204-652-9	123-79-5
Adipate	Hexanedioic acid, polymer with 1,2-propanediol (Polypropenadipat)	-	607-544-3	25101-03-5
Adipate	Benzyl 2-ethylhexyl adipate	BOA	261-234-9	58394-64-2
Adipate	Diisooctyl adipate	-	-	1330-86-5
Adipate	Polyester adipate	-	-	88650-54-8
Azelaate	Bis(2-ethylhexyl) azelaate	DOZ	203-091-7	103-24-2
Azelaate	Diisodecyl azelaate	DIDA	249-044-4	28472-97-1
Azelaate	Dibutoxyethyl azelaate	-	-	63021-23-8
Azelaate	Di-n-hexyl azelaate	-	-	109-31-9
Azelaate	Diisooctyl azelaate	DIOZ	-	26544-17-2
Benzoate	Neopentylglycol dibenzoate	-	224-081-9	4196-89-8
Benzoate	Diethylene glycol dibenzoate	DEGD; DEGDB	204-407-6	120-55-8
Benzoate	Dipropylene glycol dibenzoate	DGD; DPGDB	248-258-5	27138-31-4
Benzoate	Isononyl benzoate	INB	447-010-5	670241-72-2
Benzoate	Isodecyl benzoate	IDB	603-470-0	131298-44-7
Benzoate	Tri-ethylene glycol dibenzoate	-	-	51747-38-7
Benzoate	Hexane-1,6-diol benzoate	-	211-074-0	629-11-8
Benzoate	Ethylenebis(oxyethylene) dibenzoate	-	204-408-1	120-56-9
Benzoate	Pentaerythrityl tetrabenzoate	-	-	4196-86-5
Benzoate	Polypropylene glycol dibenzoate	-	-	72245-46-6

Category	Name	Acronym	EC	CAS
Benzoate	Sucrose benzoate	-	-	12738-64-6
Benzoate	2,2,4-Trimethyl-1,3-pentanediol dibenzoate	-	-	68052-23-3
Chlorinated paraffins	Chlorinated n-paraffin	-	264-150-0	63449-39-8
Chlorinated paraffins	Paraffin, chlorinated	-	264-150-0	63449-39-8
Chlorinated paraffins	Alkanes, C14-17, chloro	-	287-477-0	85535-85-9
Citrate	Triethyl citrate	TEC	201-070-7	77-93-0
Citrate	Tributyl citrate	TBC	201-071-2	77-94-1
Citrate	Acetyl tributyl citrate	ATBC	201-067-0	77-90-7
Citrate	Triethyl O-acetylcitrate	-	201-066-5	77-89-4
Citrate	Acetyl tri-n-hexyl citrate	ATHC	-	24817-92-3
Cyclohexanoate	Di-isononyl cyclohexane dicarboxylate	DINCH	431-890-2	166412-78-8
Cyclohexanoate	1,2-Cyclohexanedicarboxylic acid, 1,2-dinonyl ester, branched and linear	DINCH	610-353-8	474919-59-0
Epoxy ester	Epoxidised linseed oil	ELO	232-401-3	8016-11-3
Epoxy ester	Epoxidised soybean oil	ESBO; ESO	232-391-0	8013-07-8
Epoxy ester	Epoxidized octyl tallate	-	-	61788-72-5
Glutarate	Didecyl glutarate	-	-	3634-94-4
Glutarate	Diisodecyl glutarate	-	-	29733-18-4
Glycerol ester	Fully acetylated monoglyceride	COMGHA	451-530-8	736150-63-3
Heptanoate	PEG-4 diheptanoate	-	-	70729-68-9
Hydrocarbon oils	Naphthenic oil	-	265-156-6	64742-53-6
Maleate	Bis(2-ethylhexyl) maleate	DOM	205-524-5	142-16-5
Orthophthalate	Dimethyl phthalate	DMP	205-011-6	131-11-3
Orthophthalate	Diethyl phthalate	DEP	201-550-6	84-66-2
Orthophthalate	Di-n-propyl phthalate	DPP	205-015-8	131-16-8
Orthophthalate	Diisohexyl phthalate	DHP	276-090-2	71850-09-4
Orthophthalate	Dicyclohexyl phthalate	DCHP	201-545-9	84-61-7
Orthophthalate	Di-n-octyl phthalate	DNOP	204-214-7	117-84-0
Orthophthalate	Diisooctyl phthalate	DIOP	248-523-5	27554-26-3
Orthophthalate	Diisononyl phthalate	DINP	249-079-5	28553-12-0
Orthophthalate	(second DINP line) 1,2-Benzenedicarboxylic acid, di-	DINP	271-090-9	68515-48-0

Category	Name	Acronym	EC	CAS
	C8-10-branched alkyl esters, C9-rich			
Orthophthalate	Diisodecyl phthalate (1,2-Benzenedicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich)	DIDP	271-091-4	68515-49-1
Orthophthalate	Di(2-propyl heptyl) phthalate	DPHP	258-469-4	53306-54-0
Orthophthalate	Diisoundecyl phthalate	DIUP	287-401-6	85507-79-5
Orthophthalate	Diisotridecyl phthalate (1,2-Benzenedicarboxylic acid, di-C11-14-branched alkyl esters, C13-rich)	DTDP	271-089-3	68515-47-9
Orthophthalate	Di(tridecyl) phthalate	DTDP	204-294-3	119-06-2
Orthophthalate	Benzyl C7-9-branched and linear alkyl phthalate	-	271-082-5	68515-40-2
Orthophthalate	Di-C16-18 alkyl phthalate	-	290-580-3	90193-76-3
Orthophthalate	Diallyl phthalate	-	205-016-3	131-17-9
Orthophthalate	Bis(2-ethylhexyl) tetrabromophthalate	BEH-TEBP	247-426-5	26040-51-7
Orthophthalate	1,2-Benzenedicarboxylic acid, di-C9-11-branched and linear alkyl esters	L911P	271-085-1	68515-43-5
Orthophthalate	Butyl cyclohexyl phthalate	BGP	201-548-5	84-64-0
Orthophthalate	Butyl decyl phthalate	BDP	201-885-8	89-19-0
Orthophthalate	Decyl octyl phthalate	ODP; NONDP	204-295-9	119-07-3
Orthophthalate	Benzyl 3-isobutyryloxy-1-isopropyl-2,2-dimethylpropyl phthalate	-	240-920-1	16883-83-3
Other ester	2,2'-ethylenedioxydiethyl-bis-(2-ethylhexanoate)	-	202-319-2	94-28-0
Other ester	Alkylsulphonic acid ester with phenol	ASE	293-728-5	91082-17-6
Other ester	Pentaerythritol ester of valeric acid	PETV	239-937-7	15834-04-5
Other ester	Fatty acids, C14-22, 2-ethylhexyl esters, epoxidized	-	305-962-8	95370-96-0
Other ester (butyrate)	2,2,4-trimethyl-1,3-pentanediol di-isobutyrate	TXIB	229-934-9	6846-50-0
Phosphate	Diisodecyl phenyl phosphate	-	-	51363-64-5
Phosphate	Tri-p-t-butylphenyl phosphate	-	-	78-33-1
Phosphate	Tributyl phosphate	-	-	126-73-8
Phosphate	Tri-m-cresyl phosphate	-	-	563-04-2

Category	Name	Acronym	EC	CAS
Phosphate	Tri-p-tolyl phosphate	-	-	78-32-0
Phosphate	Tris (isopropylphenyl) phosphate	-	-	64532-95-2
Phosphate ester	Triphenyl phosphate	TPP	204-112-2	115-86-6
Phosphate ester	2-ethylhexyl diphenyl phosphate	-	214-987-2	1241-94-7
Phosphate ester	Tris(2-ethylhexyl) phosphate	TEHPA	201-116-6	78-42-2
Phosphate ester	Phosphoric acid, (1-methylethyl)phenyl phenyl ester	-	272-171-1	68782-95-6
Phosphate ester	Bis(2-ethylhexyl) hydrogen phosphate	DEHPA	206-056-4	298-07-7
Phosphate ester	Tricresyl phosphate	TCP	809-930-9	1330-78-5
Phthalate	Diisotridecyl phthalate	DITP	-	27253-26-5
Phthalate	Dimethyl cyclohexyl phthalate	-	-	27987-25-3
Phthalate	Dibutoxyethyl phthalate	-	204-213-1	117-83-9
Phthalate	Dimethyl isophthalate	-	-	1459-93-4
Phthalate	Dinonyl phthalate	DNP	-	84-76-4
Phthalate	Diphenyl phthalate	DPP	-	84-62-8
Phthalate	Diundecyl phthalate	DUP	222-884-9	3648-20-2
Phthalate	Hydroabietyl phthalate	-	-	36388-36-0
Phthalate	Di-p-t-butylphenyl phenyl phosphate	-	-	65652-41-7
Polymeric	Hexanedioic acid, polymer with 1,2-propanediol, acetate	-	-	55799-38-7
Polymeric	Hexanedioic acid, polymer with 1,2-propanediol, octyl ester	-	-	82904-80-1
Polymeric	Hexanedioic acid, polymer with 2,2-dimethyl-1,3-propanediol and 1,2-propanediol, isononyl ester	-	-	208945-13-5
Polymeric	Hexanedioic acid, polymer with 2,2-dimethyl-1,3-propanediol and 1,2-propanediol, isononyl ester	-	-	150923-12-9
Polymeric	Hexanedioic acid, polymer with 1,4-butanediol and 2,2-dimethyl-1,3-propanediol, isononyl ester	-	606-665-9	208945-12-4
Sebacates	Dimethyl sebacate	DMS	203-431-4	106-79-6

Category	Name	Acronym	EC	CAS
Sebacates	Dibutyl sebacate	DBS	203-672-5	109-43-3
Sebacates	Di-2-ethylhexyl sebacate	DOS	204-558-8	122-62-3
Sebacates	Di-isodecyl sebacate	DIDS	249-047-0	28473-19-0
Sebacates	Diocetyl sebacate	DOS; DEHS	-	122-62-3
Sebacates	Diisooctyl sebacate	DIOS	-	27214-90-0
Succinate	Dimethylsuccinate	DMS	203-419-9	106-65-0
Succinate	Diethylsuccinate	DES	204-612-0	123-25-1
Sulfonamide	N-butyl benzene sulfonamide	BBSA	222-823-6	3622-84-2
Terephthalate	Diisobutyl terephthalate	DBT	217-803-9	1962-75-0
Terephthalate	Diocetyl terephthalate; bis(2-ethylhexyl) tereftalat	DOTP/DEHT/DEHTP	229-176-9	6422-86-2
Terephthalate	Diocetyl terephthalate	DOTP	-	4654-26-6
Trimellitate	Tris-2-ethylhexyl trimellitate	TOTM	222-020-0	3319-31-1
Trimellitate	Tricaprylyl/Capryl Trimellitate	-	290-754-9	90218-76-1
Trimellitate	Tri n-hexyl trimellitate	-	-	1528-49-0
Trimellitate	Triisodecyl trimellitate	TDP	-	25448-25-3
Trimellitate	Triisononyl trimellitate	-	-	53894-23-8
Trimellitate	Triisooctyl trimellitate	TIOTM	-	27251-75-8
Trimellitate	Triocetyl trimellitate	-	-	89-04-3
-	Reaction mass of Polyester Plasticizer and Type R Fluid	-	927-156-0	-
-	di(C9-11-alkyl) cyclohexane-1,4-dicarboxylate	-	428-870-0	-
-	Pitch, petroleum, arom.	-	269-110-6	68187-58-6
-	Epoxidized octyl stearate	-	-	106-84-3
-	Butyl oleate	-	-	142-77-8
-	n-Butyl phtalyl-n-butyl glycolate	-	-	85-70-1
-	Coumarone/idene resin	-	-	35343-70-5
-	Dibutoxyethoxyethyl formal	-	-	143-29-3
-	Diisooctyl dodecanedioate	-	-	85392-86-5
-	Diocetyl dodecanedioate	-	-	42233-97-6
-	Distearyl thiodipropionate	-	-	693-36-7
-	Ditridecyl thiodipropionate	DTDTP	-	10595-72-9
-	2-Ethylhexoic acid	-	-	149-57-5
-	Glyceryl laurate	-	-	142-18-7
-	Glyceryl (triacetoxystearate)	-	-	139-43-6

Category	Name	Acronym	EC	CAS
-	Glyceryl triacetate	-	-	101-34-8
-	Glycol dioelate	-	-	928-24-5
-	Hydroabietyl alcohol	-	-	1333-89-7
-	Isobutyl stearate	-	-	646-13-9
-	PEG-4 di-2-ethylhexonate	-	-	18268-70-7
-	Pentaerythrityl tetracaprylate/tetracaprate	-	-	68441-68-9
-	Poly- α -methylstyrene	-	-	25014-31-7
-	Trimellitic anhydride	-	-	552-30-7
-	Trimethylolethane tricaprylate-caprate	-	-	69226-98-8

4.2 Trends regarding substitution – results from the interviews

The main information gained from the interviews concerned the use of substitutes, when the substitution was carried out, if any regulated substances were still in use and, in that case, when substitution was planned. Both substitutes based on phthalic acid and other types were discussed.

No information concerning volumes was given. Businesses with production in Sweden export $\geq 90\%$ of their products.

Most of the interviewed organizations are aware of the chemical regulations and follow the news and actions in connection to classification and restriction of chemical substances.

All interviewed companies have substituted restricted plasticizers if their area of use has been included in restrictions. One company works with substitution of a restricted plasticizer for products within the medical business area. One company started with substitution of a restricted plasticizer in 1990 and finished in 1997, and another company has performed substitution in their products since 2000.

The most common substance that has been substituted is DEHP, and it has been substituted by DPHP, DIDP, DINP, DOTP, DINCH, Pevalen, citric esters, TOTM, MESAMOLL and ethoxylated vegetable oils, depending on application.

The substances used as substitute have changed over time. For instance, one organization has performed substitutions twice since DEHP. One substance can seldom equally replace a restricted substance in a recipe. The amount needs to be adjusted and it is common to combine two or more plasticizers. Combinations of plasticizers were common also before DEHP was restricted.

Availability on the market for alternative substances was mentioned as a bottleneck, and volumes and price were stated as important factors for implementation.

The quantity of product recycling was discussed with the manufacturing organizations. The information given was that it is difficult to recycle products contaminated with other materials. Most of the interviewed organizations, which have manufacturing of products, reuse spillage in their production and/or sell spillage to other manufacturers. In one case spillage was sent for combustion. No quantities were given.

4.3 Screening of plasticizers in Sweden

In total, 30 different plasticizers, in one or more matrices, have been reported from different screening projects conducted in Sweden (Appendix 8). A vast variety of matrices have been analysed: human milk, urine and blood, dust, snow, windscreen samples, petroleum products, air, in and outgoing water in sewage treatment plants (STPs), sludge, fish and other biota, sediment and food. In screening projects, the selection of matrices is reflected of the aim, i.e. human health, environmental concern and/or transport in the environment.

DEHA has been screened and detected in the largest number of different matrices.

The highest concentration of detected plasticizers in the screenings was presence of DINP in dust (66 000 µg/g; Larsson et al., 2017) and DEP in urine (250 000 ng/ml, Hagmar et al., 2006).

Human urine is the most frequently screened matrix for presence of plasticizers and their metabolites with the aim to investigate human health effects. The most common compounds that have been analysed (and the highest reported concentrations for that particular compound) are DEHP (354 ng/ml, Norén et al., 2017), DIDP (140 µg/l, Larsson et al., 2017), DINCH (207 µg/l, Larsson et al., 2017), BBzP (280 ng/ml, Hagmar et al., 2006), DINP (2900 µg/l, Larsson et al., 2017b), DEP (250 000 ng/ml, Hagmar et al., 2006) and DnBP (371 ng/ml, Gyllenhammar et al., 2016).

Potential risks to the environment have been addressed by screening of aquatic matrices such as water, sediment, fish and biota. For example, EHDPP was detected in fish in maximal concentration of 14 000 ng/g (Haglund and Marklund, 2009). There are, however, not that many studies investigating risk to the environment through analysis of plasticizers in aquatic matrices.

Long-distance transport of plasticizers has been assessed through screening of air and snow. Eight organophosphates (TBP, TDCPP, TCPP, TBEP, TPP, TCEP, TMP and TEHP) have been detected in snow samples, while TPP was the most dominant organophosphate to be detected in air (Haglund and Marklund, 2009)

Nine of the previously screened plasticizers in Sweden were also present on the compiled list of possible substitutes. The screening reports clearly show that there are on-going emissions of plasticizers to the Swedish environment. Physical

degradation of substances during usage and impact on emission rates have not been included in the studies.

4.4 Multicriteria model

The results from the multicriteria model is presented in Appendix 9.

4.4.1 Comments concerning the selection process

When interpreting the results, it should be kept in mind that there are some limitations in the use of the multicriteria model. For example, although several papers were included for the category of environmental detection, the literature review may not be completely comprehensive. Moreover, the total scores are influenced by whether data is available or not (e.g., volume); if no data are available (or if EC/CAS numbers are lacking and no database search is possible), the score will be low. Toxicity was not included as toxicity data is often lacking, especially for compounds that are new on the market. This could, however, have been a preferable criterion to add to the model in combination with volume. Nevertheless, the developed multicriteria model provides a simple and transparent way of prioritizing plasticizers, and changes in criteria will result in an alternative priority for monitoring studies.

4.5 Proposed substances for screening

Based on the results from the multicriteria model (Appendix 9), eleven plasticisers are proposed as candidates for further screening. The substances are listed in Table 2, and a short presentation of each substance is given below.

Table 2. Suggested plasticisers for screening in the Swedish environment. Category, name, acronym, EC and CAS-number are presented.

Category	Name	Acronym	EC	CAS
Benzoate	Dipropylene glycol dibenzoate	DGD	248-258-5	27138-31-4
Chlorinated paraffins	Alkanes, C14-17, chloro	-	287-477-0	85535-85-9
Adipate	Dioctyl adipate	DOA	204-652-9	123-79-5
Orthophthalate	Benzyl 3-isobutyryloxy-1-isopropyl-2,2-dimethylpropyl phthalate	-	240-920-1	16883-83-3
Other ester (butyrate)	2,2,4-trimethyl-1,3 pentanediol di-isobutyrate	TXIB	229-934-9	6846-50-0
Adipate	Diisononyl adipate	DINA	291-426-8	33703-08-1
Benzoate	Diethylene glycol dibenzoate	DEGD; DEGDB	204-407-6	120-55-8
Polymeric	Hexanedioic acid, polymer with 1,4-butanediol and 2,2-dimethyl-1,3-propanediol, isononyl ester	Palamoll 654; Palamoll 656	-	208945-12-4
Epoxy ester	Epoxidised soybean oil	ESBO	232-391-0	8013-07-8

24(39)

Orthophthalate	(second DINP line) 1,2-Benzenedicarboxylic acid, di-C8-10-branched alkyl esters, C9-rich	DINP	271-090-9	68515-48-0
Trimellitate	Tris-2-ethylhexyl trimellitate	TOTM	222-020-0	3319-31-1

Dipropylene glycol dibenzoate (DGD), CAS 27138-31-4

This substance is used in cosmetics and personal care products, coating products, inks and toners, adhesives and sealants, biocides (e.g. disinfectants, pest control products), plant protection products and polymers. Release to the environment of this substance can occur from industrial use, i.e. formulation of mixtures. Other release to the environment of this substance is likely to occur from indoor use (e.g. machine wash liquids/detergents, automotive care products, paints and coating or adhesives, fragrances and air fresheners), outdoor use, outdoor use in long-life materials with low release rate (e.g. metal, wooden and plastic construction and building materials) and indoor use in long-life materials with low release rate (e.g. flooring, furniture, toys, construction materials, curtains, foot-wear, leather products, paper and cardboard products, electronic equipment).

According to the classification provided by companies to ECHA in REACH registrations, this substance is harmful to aquatic life with long-lasting effects.

The substance is included in the Community Rolling Action Plan (CoRAP).

Alkanes, C14-17, chloro, CAS 85535-85-9

This substance is used in polymers, adhesives and sealants, coating products and textile treatment products and dyes. Release to the environment of this substance is likely to occur from indoor use in long-life materials with low release rate (e.g. flooring, furniture, toys, construction materials, curtains, foot-wear, leather products, paper and cardboard products, electronic equipment) and outdoor use in long-life materials with low release rate (e.g. metal, wooden and plastic construction and building materials).

According to the harmonized classification and labelling (ATP01) approved by the European Union, this substance is very toxic to aquatic life, also is very toxic to aquatic life with long-lasting effects and may cause harm to breast-fed children.

The substance is included in the CoRAP.

Dioctyl adipate (DOA), CAS 123-79-5

This substance is used as a plasticizer for PVC, rubber, commonly blended with general purpose plasticizers (DOP, DIOP), solvent, aircraft and industrial lubricants, vehicle for pigment dispersions in paint, textile spin finishes, pigment wetting agent, co-solvent in pharmaceuticals, plasticizer in food-contact polymers,

in closure-sealing gaskets for food containers, in cellophane and in food-contact rubber articles for repeated use.

According to the classification provided by companies to ECHA in Classification, Labelling and Packaging (CLP) notifications, this substance causes serious eye irritation and causes skin irritation.

The substance is not registered; only pre-registration is notified at ECHA's homepage.

Benzyl 3-isobutyryloxy-1-isopropyl-2,2-dimethylpropyl phthalate, CAS 16883-83-3

This substance is used within industry as a plasticizer, and within consumer uses as an adhesive and sealant.

According to the majority of notifications provided by companies to ECHA in CLP notifications, no hazards have been classified.

The substance is not registered; only pre-registration is notified at ECHA's homepage.

2,2,4-trimethyl-1,3 pentanediol di-isobutyrate (TXIB), CAS 6846-50-0

This substance is used in coating products, cosmetics and personal care products and adhesives and sealants. TXIB is used as a plasticizer for repeat-use vinyl chloride polymers that may contact food, including vinyl chloride polymer-based gloves used in processing food and as a component of coatings for paper and paperboard intended to contact dry food.

Release to the environment of this substance is likely to occur from indoor use (e.g. machine wash liquids/detergents, automotive care products, paints and coating or adhesives, fragrances and air fresheners) and outdoor use.

According to the classification provided by companies to ECHA in REACH registrations, this substance is harmful to aquatic life with long-lasting effects.

Diisononyl adipate (DINA), CAS 33703-08-1

This substance is manufactured from diester isononyl alcohol and adipic acid and is a colourless liquid. Uses include emollient in cosmetics; plasticizer for PVC, PS, cellulosic and food-contact polymers. This substance is also used in the following products: lubricants and greases. Release to the environment of this substance is likely to occur from: indoor use as processing aid, outdoor use as processing aid, indoor use in closed systems with minimal release (e.g. cooling liquids in refrigerators, oil-based electric heaters) and outdoor use in closed systems with minimal release (e.g. hydraulic liquids in automotive suspension, lubricants in motor oil and break fluids).

According to the notifications provided by companies to ECHA in REACH registrations, no hazards have been classified.

Diethylene glycol dibenzoate (DEGD, DEGDB), CAS 120-55-8

This substance is manufactured through a reaction of diethylene glycol with benzoic acid and is used as plasticizers for polymers, vinyl acetate resins, adhesives, latex coatings; emollient, plasticizer in cosmetics and in food packaging adhesives; plasticizer for PVAc coatings for paper/paperboard in contact with dry food.

This substance is used in the following products: adhesives and sealants, coating products, inks and toners, polymers, cosmetics and personal care products, biocides (e.g. disinfectants, pest control products) and plant protection products. Release to the environment of this substance can occur from industrial use: formulation of mixtures. Other release to the environment of this substance is likely to occur from: indoor use (e.g. machine wash liquids/detergents, automotive care products, paints and coating or adhesives, fragrances and air fresheners), outdoor use, outdoor use in long-life materials with low release rate (e.g. metal, wooden and plastic construction and building materials) and indoor use in long-life materials with low release rate (e.g. flooring, furniture, toys, construction materials, curtains, foot-wear, leather products, paper and cardboard products, electronic equipment).

According to the notifications provided by companies to ECHA in REACH registrations, no hazards have been classified.

Hexanedioic acid, polymer with 1,4-butanediol and 2,2-dimethyl-1,3-propanediol, isononyl ester (Palamoll 654; Palamoll 656), CAS 208945-12-4

This substance is a polymeric plasticizer derived from adipic acid and polyhydric alcohols. It is used as a medium viscosity polymeric plasticizer for PVC with good resistance to oils, fats and water. It is also used as a plasticizer for PVC hoses, films, oil-resistance cables and electro-insulating films.

The substance is not registered; only pre-registration is notified at ECHA's homepage.

Epoxidized soybean oil (ESBO), CAS 8013-07-8

This substance consists of modified oil obtained from soybean oil by epoxidation and is an odourless pale yellow oily liquid. Uses include emollient, moisturizer in cosmetics; plasticizer, co-stabilizer for PVC, epoxy, coatings, medical tubing, toys, infant wear; pigment wetting agent; and plasticizer in food-contact coatings. This substance is used in the following products: coating products, fillers, putties, plasters, modelling clay, adhesives and sealants, finger paints, polymers and lubricants and greases. Other release to the environment of this substance is likely

to occur from: indoor use, outdoor use resulting in inclusion into or onto materials (e.g. binding agent in paints and coatings or adhesives), outdoor use in long-life materials with low release rate (e.g. metal, wooden and plastic construction and building materials), indoor use in long-life materials with low release rate (e.g. flooring, furniture, toys, construction materials, curtains, foot-wear, leather products, paper and cardboard products, electronic equipment) and outdoor use in long-life materials with high release rate (e.g. tyres, treated wooden products, treated textile and fabric, brake pads in trucks or cars, sanding of buildings (bridges, facades) or vehicles (ships)).

According to the notifications provided by companies to ECHA in REACH registrations, no hazards have been classified.

(second DINP line) 1,2-Benzenedicarboxylic acid, di-C8-10-branched alkyl esters, C9-rich (DINP), CAS 68515-48-0

This substance is mainly used as a plasticizer for PVC cable compounds, plastisols, PS, cellulosic, paints, food-contact polymers and as a vehicle for pigment dispersions.

Approximately 95% of DINP are used in PVC as a plasticizer. The remaining 5% are used in non-PVC applications. More than half of the DINP used in non-PVC applications involves polymer-related uses (e.g. rubbers). The remaining DINP is used in nonpolymeric applications including inks, adhesives and sealants, paints and lacquers.

ECHA has no public registered data indicating whether or in which chemical products the substance might be used. ECHA has no public registered data on the routes by which this substance is most likely to be released to the environment. Other release to the environment of this substance is likely to occur from: outdoor use in long-life materials with low release rate (e.g. metal, wooden and plastic construction and building materials) and indoor use in long-life materials with low release rate (e.g. flooring, furniture, toys, construction materials, curtains, foot-wear, leather products, paper and cardboard products, electronic equipment).

This substance can be found in complex articles, with no release intended: vehicles.

This substance can be found in products with material based on: rubber (e.g. tyres, shoes, toys).

According to the notifications provided by companies to ECHA in REACH registrations, no hazards have been classified.

A risk assessment report of the substances 1,2-Benzenedicarboxylic acid, di-C8-10-branched alkyl esters, C9-rich and di-“isononyl” phthalate has been prepared by France in the context of Council Regulation (EEC) No. 793/93 on the evaluation

and control of existing substances (Institut national de recherche et de sécurité (INRS), 2003). The conclusion in 2003 was that there is at present no need for further information and/or testing or for risk reduction measures beyond those which are being applied already.

Tris-2-ethylhexyl trimellitate (TOTM), CAS 3319-31-1

This substance is derived from esterification of trimellitic anhydride with 2-ethylhexyl alcohol. TOTM is used in the following products: washing & cleaning products, plant protection products, lubricants and greases, adhesives and sealants, polishes and waxes, fertilizers and coating products.

TOTM is used within food additives and is intended to be used as a plasticizer at levels not to exceed 50% by weight in repeated-use food-contact vinyl chloride polymers intended to contact all types of food. The finished product is not for use in contact with infant formula and breast milk.

TOTM is also used as a plasticizer for chlorinated plastic and rubber.

Release to the environment of this substance is likely to occur from: indoor use (e.g. machine wash liquids/detergents, automotive care products, paints and coating or adhesives, fragrances and air fresheners), outdoor use, indoor use in closed systems with minimal release (e.g. cooling liquids in refrigerators, oil-based electric heaters) and outdoor use in closed systems with minimal release (e.g. hydraulic liquids in automotive suspension, lubricants in motor oil and break fluids).

According to the notifications provided by companies to ECHA in REACH registrations, no hazards have been classified. The substance is included in CoRAP.

5 Suggested matrices for screening and conclusions

A number of substances have been identified as alternative plasticizers. These alternatives include, among others, citrates, sebacates, adipates, and phosphates, and are substituted in products that traditionally use phthalates, such as plastic toys, childcare articles and medical devices. In addition to their application as alternative PVC plasticizers, they are also being used as solvents and fixatives in cosmetic products, inks, adhesives, and other consumer products.

The knowledge about the potential effects on human health and on the environment of these alternative plasticizers are, however, very limited. Like phthalates, these alternative plasticizers are not chemically bound to the polymer and can leach out of products.

In total 152 chemical substances have been identified to be used as alternative plasticizers within this survey and finally 11 plasticizers are suggested for screening.

In order to suggest matrices of interest for screening chemical properties, usage, exposure sources to the environment and the purpose of the screening project, i.e. human health, environmental concern and/or transport in the environment, need to be considered.

The partition coefficient (logKow/LogPow) is an important parameter for predicting the distribution of a substance in various environmental compartments (water, soil, air, biota, etc; Table 3). Substances with high logKow/logPow values tend to adsorb more readily to organic matter in soils or sediments because of their low affinity for water. It is generally assumed that a value > 3.0 is indicative of potential for an elevated bioaccumulation potential. Chemicals with high values (i.e., >4.5) are of greater concern because of the potential to bio-concentrate in living organisms.

The selected plasticizers for screening have a logKow/logPow greater than 3 indicating potential bioaccumulation. For three substances this information is lacking. All substances are therefore suggested to be screened in aquatic compartments, such as in- and outgoing water in STPs or fish for evaluation of environmental risk. Most of the plasticizers are used in consumer products, such as cosmetics and food-packaging articles, and therefore human health effects are of concern. Urine and breast milk (especially for TOTM) should therefore be considered.

Table 3. Information about usage, quantities, exposure, classification and environmental risk for eleven plasticizers that are suggested to be prioritized for future screening studies.

Name	CAS	Usage	Quantities tonnes/year in Sweden	Exposure	Classification	LogKow/LogPow	Biodegradation
DGD	27138-31-4	Consumer products Plant protection products Polymers Used by consumers, in articles, by professional workers (widespread uses), in formulation or re-packing, at industrial sites and in manufacturing	52.8	Industrial use Indoor use Outdoor use	Harmful to aquatic life with long-lasting effects CoRAP	3.9	Readily biodegradable
Alkanes, C14-17, chloro	85535-85-9	Polymers, adhesives and sealants, coating products and textile treatment products and dyes Used by consumers, in articles, by professional workers (widespread uses), in formulation or re-packing, at industrial	41.2	Indoor use Outdoor use	Very toxic to aquatic life Very toxic to aquatic life with long-lasting effects May cause harm to breast-fed children CoRAP	7	46.5% C14-17 chlorinated paraffin was rapidly degraded (and not persistent), whereas the 63.2% C14-17 chlorinated paraffin was not readily biodegradable under these test conditions. Adsorption onto sludge is likely to be the major removal mechanism

Name	CAS	Usage	Quantities tonnes/year in Sweden	Exposure	Classification	LogKow/ LogPow	Biodegradation
		sites and in manufacturing					
DOA	123-79-5	Polymers/ PVC Consumer products, food contact	Confidential information	Industrial use Indoor use Outdoor use	Causes serious eye irritation Skin irritation	No available information	No available information
Benzyl 3-isobutyryloxy-1-isopropyl-2,2-dimethylpropyl phthalate	16883-83-3	Industrial use Consumer products	8.4			No available information	No available information
TXIB	6846-50-0	Coating products Consumer products Used by consumers, by professional workers (widespread uses), in formulation or re-packing, at industrial sites and in manufacturing	2.3	Indoor use Outdoor use	Harmful to aquatic life with long-lasting effects	10	Does not meet the criterion to demonstrate ready biodegradation; the degradation results indicate that the material is ultimately degradable during a short time period and would not be expected to persist in the environment
DINA	33703-08-1	Lubricants and greases Cosmetics	175.8	Indoor use Outdoor use	No hazards have been classified	9.56 - 10.4	Readily biodegradable

32(39)

Name	CAS	Usage	Quantities tonnes/year in Sweden	Exposure	Classification	LogKow/LogPow	Biodegradation
		<p>PVC</p> <p>Food-contact</p> <p>Used by consumers, in articles, by professional workers (widespread uses), in formulation or re-packing, at industrial sites and in manufacturing</p>					
DEGD; DEGDB	120-55-8	<p>Polymers</p> <p>Cosmetics</p> <p>Food contact</p> <p>Biocides</p> <p>Used by consumers, in articles, by professional workers (widespread uses), in formulation or re-packing, at industrial sites and in manufacturing</p>	68.9	<p>Industrial use</p> <p>Indoor use</p> <p>Outdoor use</p>	No hazards have been classified	3.2	Readily bio-degradable

Name	CAS	Usage	Quantities tonnes/year in Sweden	Exposure	Classification	LogKow/LogPow	Biodegradation
Palamoll 654; Palamoll 656	208945-12-4	Polymers, PVC	9.8	Indoor use Outdoor use	No hazards have been classified	No available information	No available information
ESBO	8013-07-8	Cosmetics PVC Used by consumers, in articles, by professional workers (widespread uses), in formulation or re-packing, at industrial sites and in manufacturing	431.3	Indoor use Outdoor use	No hazards have been classified	>6.20	Readily biodegradable
DINP	68515-48-0	PVC Food contact Used in articles, by professional workers (widespread uses), in formulation or re-packing and at industrial sites	412.4	Indoor use Outdoor use	No hazards have been classified	8.8-9.7	Readily biodegradable
TOTM	3319-31-1	Food additive Food-contact	409.1	Indoor use Outdoor use	No hazards have been classified.	8	Degradation and dissipation of the substance has been

34(39)

Name	CAS	Usage	Quantities tonnes/year in Sweden	Exposure	Classification	LogKow/LogPow	Biodegradation
		<p>Plastics and rubber</p> <p>Used by consumers, in articles, by professional workers (widespread uses), in formulation or re-packing, at industrial sites and in manufacturing</p>			<p>CoRAP</p> <p>Not for use in contact with infant formula and breast milk</p>		<p>demonstrated to be bi-phasic within a water-sediment system.</p> <p>Does not fulfil the persistence criterion according to REACH, Annex XIII for fresh water sediment</p>

6 References

Anna Wypych, 2017. Databook of Plasticizers. ChemTec Publishing, Toronto 2017.

Annika Hanberg et al., 2005. Phtalates and their metabolites in human breast milk, blood and urine as measures for monitoring exposure in human risk groups.

Ash, M & Ash, I. Handbook of plastic and rubber additives, Second edition, Synapse Information Resources Inc. (2005).

BASF, 2015. Palamoll 646. Available at:
http://www.weichmacher.basf.com/portal/load/fid228823/Palamoll_646_e_01_12.pdf
[2018-08-29](http://www.weichmacher.basf.com/portal/load/fid228823/Palamoll_646_e_01_12.pdf)

Bui, T., et al., 2016. Human exposure, hazard and risk of alternative plasticizers.

Christiansson, A., 2012. Miljöstyvningsrådet Rapport 2012:3 - Kemikalier i plaster. Miljöstyvningsrådet. Available at:
<https://www.upphandlingsmyndigheten.se/globalassets/upphandling/hallbarhet/kemikalier-i-plaster.pdf>
[2018](https://www.upphandlingsmyndigheten.se/globalassets/upphandling/hallbarhet/kemikalier-i-plaster.pdf)

ECHA, 2009. Data on manufacture, import, export, uses and releases of Bis(2-ethylhexyl)phthalate (DEHP) as well as information on potential alternatives to its use. Available at: <https://echa.europa.eu/documents/10162/8fd5a74b-6807-42b6-ae1f-d1d7f04f40f8> [2018-06-20](https://echa.europa.eu/documents/10162/8fd5a74b-6807-42b6-ae1f-d1d7f04f40f8)

ECHA, 2009. Data on manufacture, import, export, uses and releases of benzyl butyl phthalate (BBP) as well as information on potential alternatives to its use. Available at: https://echa.europa.eu/documents/10162/13640/tech_rep_bbp_en.pdf [2018-06-20](https://echa.europa.eu/documents/10162/13640/tech_rep_bbp_en.pdf)

ECHA, 2009. Data on manufacture, import, export, uses and releases of dibutyl phthalate (DBP) as well as information on potential alternatives to its use. Available at: <https://echa.europa.eu/documents/10162/6ce77be0-6c61-4e95-9241-0c262817555a> [2018-06-20](https://echa.europa.eu/documents/10162/6ce77be0-6c61-4e95-9241-0c262817555a)

ECHA; <https://echa.europa.eu/sv/search-for-chemicals>, searches were performed 2018-08-24

Erika Norén et al., 2017. Tidstrender för ftalater, bisfenoler, polyaromatiska kolväten (PAH:er) och triklosan i urinprov hos unga män och kvinnor – resultat från fyra undersökningar mellan år 2000-2013. Report to the Swedish EPA.

European Plasticisers, <http://www.plasticisers.org/plasticisers/>

Fridén, Ulrika, McLachlan, Michael, and Urs Berger, Stockholm University, 2010. Human exposure to chlorinated paraffins via indoor air and dust. Final report. Programområde Miljögiftssamordning, Dnr 721-1539-07Mm.

Haglund, Peter (Umeå Universitet), 2015. Miljöövervakning av utgående vatten och slam från svenska avloppsreningsverk.

Haglund, Peter and Marklund Anneli, Umeå universitet 2009. Organofosfater i svensk miljö, slutrapport.

Helena Bjerme et al., 2013. Miljöföroreningar I blod och urin och kopplingar till rapporterat matintag I Riksmaten 200-1 -resultatsammanställning. Report to the Swedish EPA.

Institut national de recherche et de sécurité (INRS), 2003. 1,2-Benzenedicarboxylic acid, di-C8-10-branched alkyl esters, C9-rich (DINP), and di-“isononyl”phthalate (DINP), Summary of Risk Assessment Report. Available at: <https://echa.europa.eu/documents/10162/0645f0cb-7880-4d23-acea-27b05ed7de39>

Irina Gyllenhammar et al., 2016. Concentrations of phthalate metabolites and phenolic substances in urine from first time mothers in Uppsala, Sweden. Temporal trends 2009-2014. Report to the Swedish EPA.

Irina Gyllenhammar et al., 2017. Diverging temporal trends of human exposure to bisphenols and plasticizers, such as phthalates, caused by substitution of legacy EDCs? Environment Research 153; 48-54.

Kemikalienspektion, 2014. Kartläggning av ftalater i varor i Sverige. Available at: <https://www.kemi.se/global/pm/2014/pm-2-14-ftalater.pdf> 2018-06-20

Kristin Larsson et al., 2014. Exposure determinants of phthalates, parabens, bisphenol A and triclosan in Swedish mothers and their children. Environment International 73; 323-333.

Kristin Larsson et al., 2017. Phthalates, non-phthalate plasticizers and bisphenols in Swedish preschool dust in relation to children’s exposure. Environment International 102; 114-124.

Kristin Larsson et al., 2017. Tidstrender av kemiska ämnen I barns urin och utvärdering av förskoledamm som exponeringskälla. Programområde Hälsorelaterad miljöövervakning 2017.

Lars Hagmar, Anna Axmon and Bo AG Jönsson, 2006. Tidstrender för halter av ftalater i urin hos unga svenska män – resultat från den första uppföljningsundersökningen år 2004. Report to the Swedish EPA.

Lowell Center for Sustainable Production, University of Massachusetts, 2011. Phthalates and their alternatives: Health and environmental concerns.

M Ash, I Ash, 2005, Handbook of plastic and rubber additives, second edition, Synapse Information Resources Inc, 2005.

Maria Wennberg et al., 2015. Organic pollutants in urine 2014 and levels of bisphenol A 2009 and 2014 in the adult population of Northern Sweden. Yrkes- och miljömedicin i Umeå rapporterar, nr 4/2015.

PubChem; <https://pubchem.ncbi.nlm.nih.gov>, information downloaded 2018-08-24

Sundkvist, Anneli and Haglund, Peter, Umeå Universitet, 2008. Organofosfater i humanmjölk och fisk från svenska sjöar och kustnära områden; ett screeningsprojekt från Naturvårdsverket.

Swedish Environmental Research Institute, 2007. Results from the Swedish National Screening Programme 2006. Subreport 1: Phtalates.

Wilfa F. Chair, et al., 2015. Safety Assessment of Trialkyl Trimellitates as Used in Cosmetics. Available at: <https://www.cir-safety.org/sites/default/files/trimel062015TR.pdf>
[2018-08-29](#)

Yuan, Bo and de Wit, Cynthia, Stockholm University, 2018. Screening chlorinated paraffins in Swedish terrestrial birds and mammals (2012-2017).

7 Appendices

Appendix 1. Support questions, interviews

Appendix 2. Plasticizers identified in ECHA's CoRAP List

Appendix 3. Plasticizers identified in ECHA's Candidate List

Appendix 4. Plasticizers identified in ECHA's Authorisation List.

Appendix 5. Plasticizers identified in the Restriction List from ECHA.

Appendix 6. Plasticizers identified in the PRIO List from the Swedish Chemical Agency.

Appendix 7. Plasticizers identified in the Restricted substances database from the Swedish Chemicals Agency.

Appendix 8. Screening of plasticizers in different matrices in Sweden.

Appendix 9. Multicriteria model results for prioritization of alternative plasticizers.

Appendix 1. Support questions, interviews

This appendix lists the support questions used for interviews. Depending on business area questions could be adapted or excluded.

General information

- 1 Name of organization
- 2 Contact data
- 3 Time and date
- 4 Type of business?
- 5 Amount of export?
- 6 Which type of polymers are produced/used?
- 7 Where is headquarter situated?

Questions related to import/manufacturing/application

- 8 Which plasticizer do you use?
- 9 Which of them can be seen as substitutes to legally controlled/limited plasticizers?
- 10 Which of them can be seen as substitutes to phthalates?
- 11 When did the substitution take place?
- 12 To which application is the substitute used?
- 13 Which volume is used in Sweden of each substitute?
- 14 How much is imported of each substitute?
- 15 How much of each substitute is produced in Sweden?

Dispersion/recycling/afterlife

- 16 How are these substitute softeners dispersed in Sweden?
- 17 Amounts for dispersion/way of dispersion?
- 18 Which amounts are recycling?
- 19 Plasticizers that are not recycled, where do these end up?

Other

- 20 Suggestions on people we can contact for an interview?
- 21 How do you view/what is your opinion on different lists e.g. SIN-list (Substitute It Now!) and CoRAP, "Community rolling action plan"? Does your organization monitor these lists?

Appendix 2. Plasticizers identified in ECHAs CoRAP List

ECHA – CoRAP				
Category	Name	Acronym	EC	CAS
Adipate	Di-2-ethylhexyl adipate	DEHA, DOA	203-090-1	103-23-1
Adipate	Diisotridecyl adipate	DTDA	247-660-8	26401-35-4
Azelaate	Diisodecyl azelate	DIDA	249-044-4	28472-97-1
Benzoate	Diethylene glycol dibenzoate	DEGD; DEGDB	204-407-6	120-55-8
Benzoate	Dipropylene glycol dibenzoate	DGD	248-258-5	27138-31-4
Orthophthalate	Diethyl phthalate	DEP	201-550-6	84-66-2
Orthophthalate	Dicyclohexyl phthalate	DCHP	201-545-9	84-61-7
Orthophthalate	Di(2-propyl heptyl) phthalate	DPHP	258-469-4	53306-54-0
Orthophthalate	Diisoundecyl phthalate	DIUP	287-401-6	85507-79-5
Orthophthalate	Diisotridecyl phthalate (1,2-Benzenedicarboxylic acid, di-C11-14-branched alkyl esters, C13-rich)	DTDP	271-089-3	68515-47-9
Orthophthalate	Di(tridecyl) phthalate	DTDP	204-294-3	119-06-2
Orthophthalate	Diallyl phthalkate	DAP	205-016-3	131-17-9
Orthophthalate	Bis(2-ethylhexyl) tetrabromophthalate	BEH-TEBP	247-426-5	26040-51-7
Orthophthalate	1,2-Benzenedicarboxylic acid, di-C9-11-branched and linear alkyl esters	L911P	271-085-1	68515-43-5
Phosphate ester	Triphenyl phosphate	TPP	204-112-2	115-86-6
Phosphate ester	Tricresyl phosphate	TCP	809-930-9	1330-78-5
Phosphate	Tributyl phosphate	-	204-800-2	126-73-8
-	2-Ethylhexoic acid	-	205-743-6	149-57-5
Orthophthalate	Benzyl C7-9-branched and linear alkyl phthalate	-	271-082-5	68515-40-2
Chlorinated paraffins	Alkanes, C14-17, chloro	-	287-477-0	85535-85-9

Appendix 3. Plasticizers identified in ECHAs Candidate List

ECHA - CANDIDATE LIST				
Category	Name	Acronym	EC	CAS
Orthophthalate	Di-n-hexyl phthalate	DNHP	201-559-5	84-75-3
Orthophthalate	1,2-Benzenedicarboxylic acid, di-C6-10-alkyl esters	-	271-094-0	68515-51-5
Orthophthalate	1,2-Benzenedicarboxylic acid, mixed decyl and hexyl and octyl diesters	-	272-013-1	68648-93-1
Orthophthalate	Di-n-butyl phthalate	DBP	201-557-4	84-74-2
Orthophthalate	Diisobutyl phthalate	DIBP	201-553-2	84-69-5
Orthophthalate	Benzyl butyl phthalate	BBP	201-622-7	85-68-7
Orthophthalate	Di-n-pentyl phthalate	DNPP	205-017-9	131-18-0
Orthophthalate	Diisoheptyl phthalate	DIHP	276-158-1	71888-89-6
Orthophthalate	Bis(2-ethylhexyl) phthalate	DEHP, BEHP	204-211-0	117-81-7
Orthophthalate	Bis(2-methoxyethyl) phthalate	BMEP; DMEP	204-212-6	117-82-8
Orthophthalate	N-pentyl-isopentylphthalate	-	-	776297-69-9
Orthophthalate	Diisopentyl phthalate	DIPP	210-088-4	605-50-5
Orthophthalate	1,2-Benzenedicarboxylic acid, di-C7-11-branched and linear alkyl esters	DHNUP	271-084-6	68515-42-4
Orthophthalate	1,2-Benzenedicarboxylic acid, dipentyl ester, branched and linear	-	284-032-2	84777-06-0

Appendix 4. Plasticizers identified in the Authorisation List from ECHA.

ECHA – AUTHORISATION LIST				
Category	Name	Acronym	EC	CAS
Orthophthalate	Di-n-butyl phthalate	DBP	201-557-4	84-74-2
Orthophthalate	Diisobutyl phthalate	DIBP	201-553-2	84-69-5
Orthophthalate	Benzyl butyl phthalate	BBP	201-622-7	85-68-7
Orthophthalate	Di-n-pentyl phthalate	DNPP	205-017-9	131-18-0
Orthophthalate	Diisoheptyl phthalate	DIHP	276-158-1	71888-89-6
Orthophthalate	Bis(2-ethylhexyl) phthalate	DEHP, BEHP	204-211-0	117-81-7
Orthophthalate	Bis(2-methoxyethyl) phthalate	BMEP; DMEP	204-212-6	117-82-8
Orthophthalate	N-pentyl-isopentylphthalate	-	-	776297-69-9
Orthophthalate	Diisopentyl phthalate	DIPP	210-088-4	605-50-5
Orthophthalate	1,2-Benzenedicarboxylic acid, di-C7-11- branched and linear alkyl esters	DHNUP	271-084-6	68515-42-4
Orthophthalate	1,2-Benzenedicarboxylic acid, dipentyl ester, branched and linear	-	284-032-2	84777-06-0

Appendix 5. Plasticizers identified in the Restriction List from ECHA.

RESTRICTION LIST				
Category	Name	Acronym	EC	CAS
Orthophthalate	Di-n-butyl phthalate	DBP	201-557-4	84-74-2
Orthophthalate	Benzyl butyl phthalate	BBP	201-622-7	85-68-7
Orthophthalate	Bis(2-ethylhexyl) phthalate	DEHP, BEHP	204-211-0	117-81-7
Orthophthalate	Di-n-octyl phthalate	DNOP, DOP	204-214-7	117-84-0
Orthophthalate	Diisononyl phthalate	DINP	249-079-5	28553-12-0
Orthophthalate	(second DINP line) 1,2-Benzenedicarboxylic acid, di-C8-10-branched alkyl esters, C9-rich	DINP	271-090-9	68515-48-0
Orthophthalate	Diisodecyl phthalate (1,2-Benzenedicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich)	DIDP	271-091-4	68515-49-1

Appendix 6. Plasticizers identified in the PRIO List from the Swedish Chemical Agency.

SWEDISH CHEMICAL AGENCY – PRIO				
Category	Name	Acronym	EC	CAS
Orthophthalate	Di-n-butyl phthalate	DBP	201-557-4	84-74-2
Orthophthalate	Diisobutyl phthalate	DIBP	201-553-2	84-69-5
Orthophthalate	Benzyl butyl phthalate	BBP	201-622-7	85-68-7
Orthophthalate	Di-n-pentyl phthalate	DNPP	205-017-9	131-18-0
Orthophthalate	Diisooheptyl phthalate	DIHP	276-158-1	71888-89-6
Orthophthalate	Bis(2-ethylhexyl) phthalate	DEHP, BEHP	204-211-0	117-81-7
Orthophthalate	Bis(2-methoxyethyl) phthalate	BMEP; DMEP	204-212-6	117-82-8
Orthophthalate	N-pentyl-isopentylphthalate	-	-	776297-69-9
Orthophthalate	Diisopentyl phthalate	DIPP	210-088-4	605-50-5
Orthophthalate	1,2-Benzenedicarboxylic acid, di-C7-11-branched and linear alkyl esters	DHNUP	271-084-6	68515-42-4
Orthophthalate	1,2-Benzenedicarboxylic acid, dipentyl ester, branched and linear	-	284-032-2	84777-06-0
Orthophthalate	Di-n-hexyl phthalate	DNHP	201-559-5	84-75-3
Orthophthalate	1,2-Benzenedicarboxylic acid, di-C6-10-alkyl esters	-	271-094-0	68515-51-5
Orthophthalate	1,2-Benzenedicarboxylic acid, mixed decyl and hexyl and octyl diesters	-	272-013-1	68648-93-1
Orthophthalate	Diallyl phthalkate	DAP	205-016-3	131-17-9
-	Tetrahydrofurfuryl alcohol	THFA	202-625-6	97-99-4

Appendix 7. Plasticizers identified in the Restricted substances database from the Swedish Chemicals Agency.

SWEDISH CHEMICAL AGENCY - RESTRICTED SUBSTANCES DATABASE				
Category	Name	Acronym	EC	CAS
Orthophthalate	Di-n-butyl phthalate	DBP	201-557-4	84-74-2
Orthophthalate	Diisobutyl phthalate	DIBP	201-553-2	84-69-5
Orthophthalate	Benzyl butyl phthalate	BBP	201-622-7	85-68-7
Orthophthalate	Di-n-pentyl phthalate	DNPP	205-017-9	131-18-0
Orthophthalate	Diisoheptyl phthalate	DIHP	276-158-1	71888-89-6
Orthophthalate	Bis(2-methoxyethyl) phthalate	BMEP; DMEP	204-212-6	117-82-8
Orthophthalate	N-pentyl-isopentylphthalate	-	-	776297-69-9
Orthophthalate	Diisopentyl phthalate	DIPP	210-088-4	605-50-5
Orthophthalate	Di-n-hexyl phthalate	DNHP	201-559-5	84-75-3
Orthophthalate	1,2-Benzenedicarboxylic acid, di-C6-10-alkyl esters	-	271-094-0	68515-51-5
Orthophthalate	1,2-Benzenedicarboxylic acid, mixed decyl and hexyl and octyl diesters	-	272-013-1	68648-93-1
Orthophthalate	Di-n-octyl phthalate	DNOP, DOP	204-214-7	117-84-0
Orthophthalate	Diisononyl phthalate	DINP	249-079-5	28553-12-0
Orthophthalate	Diisodecyl phthalate (1,2-Benzenedicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich)	DIDP	271-091-4	68515-49-1

Appendix 8. Screening of plasticizers in different matrices in Sweden. The table shows detected concentration ranges of plasticizers in various matrices. Numbers in brackets corresponds to its reference.

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
TCPP	22-82 ng/g (3)			>0,03 mg/kg (2)	>LOD (2)	<18 µg (2)		<0,4 ng/m ³ (2)	1,1-24 µg/l (2) 1600-4600 ng/l (4)	61- 1900 ng/l (2) 980- 4500 µg/kg TS (4)			23-1300 ng/g (2)		
TDCPP	1,6- 5,3 ng/g (3)			>0,03 mg/kg (2)	>LOD (2)	18 µg (2)		>LOD (2)	0,13-0,98 µg/l (2) 160-360 ng/l (4)	3-260 ng/l (2) 46-240 µg/kg TS (4)			1,1-140 ng/g (2)		
TCEP	2,1- 8,2 ng/g (3)			>0,03 mg/kg (2)	>LOD (2)	<18 µg (2)		<0,4 ng/m ³ (2)	0,09-1 µg/l (2) 100-240 ng/l (4)	7-110 ng/l (2) 4,3-21 µg/kg TS (4)			1,5-160 ng/g (2)		
TBP	4,8-57 ng/g (3)			>0,03 mg/kg (2)	>LOD (2)	<18 µg (2)	<0,5- 190000 µg/g (2)	>LOD (2)	0,36-52 µg/l (2)	16- 2700 ng/l (2)			1,6-4900 ng/g (2)		

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
									40-300 ng/l (4)	13-580 µg/kg TS (4)					
TBEP	<0,8-63 ng/g (3)			0,014-5,3 g/kg (2)	>LOD (2)	<18 µg (2)		>LOD (2)	3,1-35 µg/l (2) 1000-6100 ng/l (4)	480-1900 ng/l (2) 52-530 µg/kg TS (4)			3-1000 ng/g (2)		
TPP	3,2-11 ng/g (3)		1,69 ng/ml (8)	>0,03 mg/kg (2)	>LOD (2)	<18 µg (2)	<0,3-8,9 µg/g (2)	>LOD (2)	0,05-0,29 µg/l (2) 7,6-58 ng/l (4)	52-320 ng/l (2) 88-650 µg/kg TS (4)			4,2-400 ng/g (2)		
EHDPP	3,5-13 ng/g (3)								<0,5-5,4 ng/l (4)	320-4600 ng/l (2) 790-3100 µg/kg TS (4)			1,5-14000 ng/g (2)		
TEHP				>0,03 mg/kg (2)	>LOD (2)		<0,3-4,2 µg/g (2)	>LOD (2)	0,06-0,13 µg/l (2)						

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
DEHP	0,45-305 ng/ml (5)	0,5-129 ng/ml (5)	0,7-11 µg/L (1) LOD-133 µg/L (7) 4,9-18 ng/ml (8) 13-284 µg/l (10) 1,6-354 ng/ml (11) 10-150 ng/ml (12) 1,52-10,5 ng/ml (13)					0,5-3 ng/m ³ (1)	<0,5 ng/l (4)	36-80 mg/kg TS (1) 21-120 µg/kg TS (4)	82-2800 µg/kg TS (1)			15-26 µg/kg (1)	140-1900 µg/kg (1)

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
			12,6-28,8 µg/l (14)												
			>0,1 ng/l (15)												
			0,39-174 ng/ml (16)												
DIDP			<50 µg/L (1)												
			0,04-140 µg/L (7)												
			1,5-7,17 ng/ml (8)	11-1800 µg/g (7, 10)				0,3-5,5 ng/m ³ (1)		15-51 mg/kg TS (1)	190-3400 mg/kg TS (1)			<50 mg/kg (1)	21-32 mg/kg (1)
			0,47-102 µg/l (10)							12-40 µg/kg TS (4)					

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
			0,048-81 ng/ml (11) <606 ng/ml (16)												
DPHP			0,04-40 µg/l (10) 0,10-387 ng/ml (11)	0,15-2600 µg/g (7, 10)											
DINCH			0,1-207 µg/l (7) 1,16 ng/ml (8) 0,15-171 µg/l (10)	4,7-5200 µg/g (7, 10)											

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
			<99 ng/ml (11) <42,2 ng/ml (16)												
DOP	0,24-42 ng/ml (5)	0,7-10 ng/ml (5)				<18 µg (2)			2,0 µg/l (2)	<0,7 µg/kg TS (4)					
BBzP	0,064-42 ng/ml (5)	0,05-1,4 ng/ml (5)	1-95 µg/l (7) 12,8 ng/ml (8) 1,4-76 µg/l (10) 3-280 ng/ml (12) 10,3-18,6 ng/ml (13)	0,01-240 µg/g (7, 10)				0,02-0,17 ng/m ³ (1)		0,03-0,34 µg/kg TS (4)					

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
			10,2-23,6 µg/l (14) >0,03 ng/l (15) 3,8-190 ng/ml (16)												
DINP			<50 µg/l (1) 0,7-2300 µg/l (7) 10,1-30,8 ng/ml (8) 4,2-2900 µg/l (10)	58-66000 µg/g (7, 10)				0,3-1,1 ng/m ³ (1)		37-65 mg/kg TS (1) 24-98 µg/kg TS (4)	130-3200 µg/kg TS (1)			<50 µg/kg (1)	54-260 µg/kg (1)

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
			2,09-9,60 ng/ml (13) 4,6-26,7 µg/l (14) >0,005 ng/l (15) 0,08-395 ng/ml (16)												
DEHA				0,72-340 µg/g (7, 10)				0,02-0,6 ng/m ³ (1)		0,11-0,18 mg/kg TS (1)	68-520 mg/kg TS (1)			5-23 mg/kg (1)	8,2-470 mg/kg (1)
DEP	0,22-42 ng/ml (5)	0,066-1,1 ng/ml (5)	2,7-1400 µg/L (7)	LOD-390 µg/g (7, 10)				0,05-1,2 ng/m ³ (1)		<0,05 µg/kg TS (4)					

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
			58,1 ng/ml (8)												
			4,7– 1200 µg/l (10)												
			10- 250000 ng/ml (12)												
			25,1- 52,5 ng/ml (13)												
			23,7- 54,4 µg/l (14)												
			>0,4 ng/l (15)												
			2,38- 1374												

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
			ng/ml (16)												
DMP				LOD-12 µg/g (7, 10)						<0,02 mg/kg TS (4)					
DBP	1,5-42 ng/ml (5)	0,21-9,1 ng/ml (5)	10-870 ng/ml (12) >0,6 ng/l (15)	1,2-21000 µg/g (7)				0,08-15 ng/m ³ (1)		0,02-0,48 µg/kg TS (4)					
DnBP			3,9-327 µg/L (7) 51,3 ng/ml (8) 7,5-237 µg/l (10) 49,2-60,9	1,2-21000 µg/g (10)											

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
			ng/ml (13) 53,6–86,7 µg/l (14) 4,09-371 ng/ml (16)												
DIBP				1-130 µg/g (10)				0,15-2,6 ng/m ³ (1)							
TPrP						<18 µg (2)									
CLP1						<18 µg (2)									
TMP					>LOD (2)				0,06-0,58 µg/l (2)						
TCP	<0,1-3,7 ng/g (3)						<0,3-12000 µg/g (2)		<0,5 ng/l (4)	120-600 µg/kg TS (4)			0,3-140 ng/g (2)		

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
BPA			0,2–19 µg/L (7, 10) 0,03– 134 ng/ml (11) 1,1–1,7 µg/l (14) <15,9 ng/ml (16)	<15 µg/g (7, 10)											
BPP													0,1- 3300ng/g (2)		
CPs				3,2- 17,9 µg/g (9)				5,9- 212 ng/m ³ (9)						Mammals and birds (6)	
DEHT				6,8- 3500 µg/g (7,10)											
ATBC				0,42- 1200											

Matrices	Milk	Blood	Urine	Dust	Snow	Windscreen	Petroleum products	Air	In/outgoing water in STPW	Sludge	Sediment		Fish	Biota	Food
Substance															
				µg/g (7,10)											

References;

- 1.Swedish Environmental Research Institute, 2007. Results from the Swedish National Screening Programme 2006. Subreport 1: Phtalates.
- 2.Haglund, Peter and Marklund Anneli, Umeå universitet, 2009. Organofosfater i svensk miljö, slutrapport.
- 3.Sundkvist, Anneli and Haglund, Peter, Umeå Universitet, 2008. Organofosfater i humanmjölk och fisk från svenska sjöar och kustnära områden; ett screeningsprojekt från Naturvårdsverket.
- 4.Haglund, Peter (Umeå Universitet), 2015. Miljöövervakning av utgående vatten och slam från svenska avloppsreningsverk.
- 5.Annika Hanberg et al., 2005. Phtalates and their metabolites in human breast milk, blood and urine as measures for monitoring exposure in human risk groups.
- 6.Yuan, Bo and de Wit, Cynthia, Stockholm University, 2018. Screening chlorinated paraffins in Swedish terrestrial birds and mammals (2012-2017).
- 7.Kristin Larsson et al., 2017. Phthalates, non-phthalate plasticizers and bisphenols in Swedish preschool dust in relation to children's exposure. Environment International 102; 114-124.
- 8.Irina Gyllenhammar et al., 2017. Diverging temporal trends of human exposure to bisphenols and plasticizers, such as phthalates, caused by substitution of legacy EDCs? Environment Research 153; 48-54.
- 9.Fridén, Ulrika, McLachlan, Michael, and Urs Berger, Stockholm University, 2010. Human exposure to chlorinated paraffins via indoor air and dust. Final report. Programområde Miljögiftssamordning, Dnr 721-1539-07Mm.
- 10.Kristin Larsson et al., 2017. Tidstrender av kemiska ämnen i barns urin och utvärdering av förskoledamm som exponeringskälla. Programområde Hälsorelaterad miljöövervakning 2017.
- 11.Erika Norén et al., 2017. Tidstrender för ftalater, bisfenoler, polyaromatiska kolväten (PAH:er) och triklosan i urinprov hos unga män och kvinnor – resultat från fyra undersökningar mellan år 2000-2013. Report to the Swedish EPA.
- 12.Lars Hagmar, Anna Axmon and Bo AG Jönsson, 2006. Tidstrender för halter av ftalater i urin hos unga svenska män – resultat från den första uppföljningsundersökningen år 2004. Report to the Swedish EPA.
- 13.Maria Wennberg et al., 2015. Organic pollutants in urine 2014 and levels of bisphenol A 2009 and 2014 in the adult population of Northern Sweden. Yrkes- och miljömedicin i Umeå rapporter, nr 4/2015.
- 14.Kristin Larsson et al., 2014. Exposure determinants of phthalates, parabens, bisphenol A and triclosan in Swedish mothers and their children. Environment International 73; 323-333.
- 15.Helena Bjerme et al., 2013. Miljöföreningar i blod och urin och kopplingar till rapporterat matintag i Riksmaten 200-1 -resultatsammanställning. Report to the Swedish EPA.
- 16.Irina Gyllenhammar et al., 2016. Concentrations of phthalate metabolites and phenolic substances in urine from first time mothers in Uppsala, Sweden. Temporal trends 2009-2014. Report to the Swedish EPA.

Appendix 9. Multicriteria model results for prioritization of alternative plasticizers. Substances marked in blue are plasticizers that got a top score in the multicriteria model, have usages in high volumes and have not previously been screened in any matrices in Sweden.

Substance	Substance (Acronym)	Average/year [tonnes/year]	Usage	Lists	Classification	Normalized values			Occurs in previous screening studies in different matrices	ΣScore
						Usage	Lists	Classification		
Dipropylene glycol dibenzoate	DGD	52,8	3	1	2	0,4	0,5	1		1,93
Alkanes, C14-17, chloro	-	41,2	3	1	2	0,4	0,5	1		1,93
Diocetyl adipate	DOA	0	1	1	2	0,1	0,5	1		1,64
Isodecyl benzoate	IDB	0	1	1	2	0,1	0,5	1		1,64
Di-(2-butoxyethyl)adipate	DBEA	0	0	1	2	0	0,5	1		1,50
Isononyl benzoate	INB	0	0	1	2	0	0,5	1		1,50
Benzyl 3-isobutyryloxy-1-isopropyl-2,2-dimethylpropyl phthalate	-	8,4	2	0	2	0,3	0	1		1,29
2,2,4-trimethyl-1,3-pentanediol di-isobutyrate	TXIB	2,3	2	0	2	0,3	0	1		1,29
Triphenyl phosphate	TPP	5,5	2	0	2	0,3	0	1	x	1,29
Diisobutyl adipate	DIBA		1	2	0	0,1	1	0		1,14
Dicyclohexyl phthalate	DCHP	0	1	0	2	0,1	0	1		1,14
Diallyl phthalkate	-	0	1	0	2	0,1	0	1		1,14
Dibutoxyethyl phthalate	-	0	1	0	2	0,1	0	1		1,14
Naphthenic oil	-	0	1	0	2	0,1	0	1		1,14
Di-2-ethylhexyl adipate	DEHA	329,3	4	1	0	0,6	0,5	0	x	1,07
Diisononyl adipate	DINA	175,8	4	1	0	0,6	0,5	0		1,07
Benzyl octyl adipate	-	0	0	1	1	0	0,5	0,5		1,00
Tri-ethylene glycol dibenzoate	-	0	0	1	1	0	0,5	0,5		1,00

Substance	Substance (Acronym)	Average/year [tonnes/year]	Usage	Lists	Classification	Normalized values			Occurs in previous screening studies in different matrices	ΣScore
						Usage	Lists	Classification		
Di-isononyl cyclohexane dicarboxylate	DINCH	14674,1	7	0	0	1,0	0	0	x	1,00
Bis(2-ethylhexyl) maleate	-	0	0	0	2	0	0	1		1,00
Di-n-propyl phthalate	DPP	0	0	0	2	0	0	1		1,00
Diisooctyl phthalate	DIOP	0	0	0	2	0	0	1		1,00
Tricresyl phosphate	TCP	0	0	0	2	0	0	1		1,00
Diethylene glycol dibenzoate	DEGD; DEGDB	68,9	3	1	0	0,4	0,5	0		0,93
Diisononyl phthalate	DINP	1169,9	6	0	0	0,9	0	0	x	0,86
Hexanedioic acid, polymer with 1,4-butanediol and 2,2-dimethyl-1,3-propanediol, isononyl ester	Palamoll 654; Palamoll 656	9,8	2	0	1	0,3	0	0,5		0,79
Glyceryl triacetate	GTA		1	1	0	0,1	0,5	0		0,64
Diisodecyl adipate	DIDA	0	1	1	0	0,1	0,5	0		0,64
Bis[2-(2-butoxyethoxy)ethyl]adipate	DBEEA	0	1	1	0	0,1	0,5	0		0,64
Hexanedioic acid, polymer with 1,2-propanediol (Polypropenadipat)	-	0	1	1	0	0,1	0,5	0		0,64
Tricaprylyl/Capryl Trimellitate	-	0	1	0	1	0,1	0	0,5		0,64
2,2,4-Trimethyl-1,3-pentanediol dibenzoate	-	0	1	0	1	0,1	0	0,5		0,64
Butyl oleate	-	0	1	0	1	0,1	0	0,5		0,64
Dibutoxyethoxyethyl formal	-	0	1	0	1	0,1	0	0,5		0,64
Epoxidised soybean oil	ESBO	431,3	4	0	0	0,6	0	0		0,57
(second DINP line) 1,2-Benzenedicarboxylic acid, di-C8-10-branched alkyl esters, C9-rich	DINP	412,4	4	0	0	0,6	0	0		0,57

Substance	Substance (Acronym)	Average/year [tonnes/year]	Usage	Lists	Classification	Normalized values			Occurs in previous screening studies in different matrices	ΣScore
						Usage	Lists	Classification		
Diisodecyl phthalate (1,2-Benzenedicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich)	DIDP	128,6	4	0	0	0,6	0	0	x	0,57
Tris-2-ethylhexyl trimellitate	TOTM	409,1	4	0	0	0,6	0	0		0,57
Di-n-butyl adipate	DBA	0	0	1	0	0	0,5	0		0,50
Diisotridecyl adipate	-	0	0	1	0	0	0,5	0		0,50
Didecyl adipate	-	0	0	1	0	0	0,5	0		0,50
Dinonyl adipate	-	0	0	1	0	0	0,5	0		0,50
Benzyl 2-ethylhexyl adipate	-	0	0	1	0	0	0,5	0		0,50
Bis(2-ethylhexyl) azelate	DOZ	0	0	1	0	0	0,5	0		0,50
Diisodecyl azelate	DIDA	0	0	1	0	0	0,5	0		0,50
Neopentylglycol dibenzoate	-	0	0	1	0	0	0,5	0		0,50
Diisohexyl phthalate	DHP	0	0	0	1	0	0	0,5		0,50
Butyl cyclohexyl phthalate	BCP	0	0	0	1	0	0	0,5		0,50
Butyl decyl phthalate	BDP	0	0	0	1	0	0	0,5		0,50
Decyl octyl phthalate	ODP	0	0	0	1	0	0	0,5		0,50
Phosphoric acid, (1-methylethyl)phenyl phenyl ester	-	0	0	0	1	0	0	0,5		0,50
Bis(2-ethylhexyl) hydrogen phosphate	DEHPA	0	0	0	1	0	0	0,5	x	0,50
Hexanedioic acid, polymer with 2,2-dimethyl-1,3-propanediol and 1,2-propanediol, isononyl ester	Palamoll 646	0	0	0	1	0	0	0,5		0,50
Reaction mass of Polyester Plasticizer and Type R Fluid	-	0	0	0	1	0	0	0,5		0,50
di(C9-11-alkyl) cyclohexane-1,4-dicarboxylate	-	0	0	0	1	0	0	0,5		0,50

Substance	Substance (Acronym)	Average/year [tonnes/year]	Usage	Lists	Classification	Normalized values			Occurs in previous screening studies in different matrices	ΣScore
						Usage	Lists	Classification		
Pitch, petroleum, arom.	-	0	0	0	1	0	0	0,5		0,50
Tetrahydrofurfuryl alcohol	-	0	0	0	1	0	0	0,5		0,50
Diisooctyl adipate	-	0	0	0	1	0	0	0,5		0,50
Polyester adipate	-	0	0	0	1	0	0	0,5		0,50
Dibutoxyethyl azelate	-	0	0	0	1	0	0	0,5		0,50
Di-n-hexyl azelate	-	0	0	0	1	0	0	0,5		0,50
Diisooctyl azelate	DIOZ	0	0	0	1	0	0	0,5		0,50
Pentaerythrityl tetrabenzoate	-	0	0	0	1	0	0	0,5		0,50
Polypropylene glycol dibenzoate	-	0	0	0	1	0	0	0,5		0,50
Sucrose benzoate	-	0	0	0	1	0	0	0,5		0,50
Acetyl tri-n-hexyl citrate	ATHC	0	0	0	1	0	0	0,5		0,50
Epoxidized octyl tallate	-	0	0	0	1	0	0	0,5		0,50
Epoxidized octyl stearate	-	0	0	0	1	0	0	0,5		0,50
Didecyl glutarate	-	0	0	0	1	0	0	0,5		0,50
Diisodecyl glutarate	-	0	0	0	1	0	0	0,5		0,50
PEG-4 diheptanoate	-	0	0	0	1	0	0	0,5		0,50
Diisotridecyl phthalate	DITP	0	0	0	1	0	0	0,5		0,50
Dimethyl cyclohexyl phthalate	-	0	0	0	1	0	0	0,5		0,50
Dimethyl isophthalate	-	0	0	0	1	0	0	0,5		0,50
Dinonyl phthalate	DNP	0	0	0	1	0	0	0,5		0,50
Diphenyl phthalate	DPP	0	0	0	1	0	0	0,5		0,50
Hydroabietyl phthalate	-	0	0	0	1	0	0	0,5		0,50
Di-p-t-butylphenyl phenyl phosphate	-	0	0	0	1	0	0	0,5		0,50

Substance	Substance (Acronym)	Average/year [tonnes/year]	Usage	Lists	Classification	Normalized values			Occurs in previous screening studies in different matrices	ΣScore
						Usage	Lists	Classification		
Diisodecyl phemyl phosphate	-	0	0	0	1	0	0	0,5		0,50
Tri-p-t-butylphenyl phosphate	-	0	0	0	1	0	0	0,5		0,50
Tributyl phosphate	-	0	0	0	1	0	0	0,5		0,50
Tri-m-cresyl phosphate	-	0	0	0	1	0	0	0,5		0,50
Tri-p-tolyl phosphate	-	0	0	0	1	0	0	0,5		0,50
Tris (isopropylphenyl) phosphate	-	0	0	0	1	0	0	0,5		0,50
Diioctyl terephthalate	DOTP	0	0	0	1	0	0	0,5		0,50
Diisooctyl sebacate	DIOS	0	0	0	1	0	0	0,5		0,50
Tri n-hexyl trimellitate	-	0	0	0	1	0	0	0,5		0,50
Triisodecyl trimellitate	TDP	0	0	0	1	0	0	0,5		0,50
Triisononyl trimellitate	-	0	0	0	1	0	0	0,5		0,50
Triisooctyl trimellitate	TIOTM	0	0	0	1	0	0	0,5		0,50
Trioctyl trimellitate	-	0	0	0	1	0	0	0,5		0,50
n-Butyl phtalyl-n-butyl glycolate	-	0	0	0	1	0	0	0,5		0,50
Coumarone/idene resin	-	0	0	0	1	0	0	0,5		0,50
Diisooctyl dodecanedioate	-	0	0	0	1	0	0	0,5		0,50
Diocetyl dodecanedioate	-	0	0	0	1	0	0	0,5		0,50
Distearyl thiodipropionate	-	0	0	0	1	0	0	0,5		0,50
Ditridecyl thiodipropionate	DTDTP	0	0	0	1	0	0	0,5		0,50
2-Ethylhexoic acid	-	0	0	0	1	0	0	0,5		0,50
Glyceryl laurate	-	0	0	0	1	0	0	0,5		0,50
Glyceryl (triacetoxystearate)	-	0	0	0	1	0	0	0,5		0,50

Substance	Substance (Acronym)	Average/year [tonnes/year]	Usage	Lists	Classification	Normalized values			Occurs in previous screening studies in different matrices	ΣScore
						Usage	Lists	Classification		
Glyceryl triacetyl ricinoleate	-	0	0	0	1	0	0	0,5		0,50
Glycol dioelate	-	0	0	0	1	0	0	0,5		0,50
Hydroabietyl alcohol	-	0	0	0	1	0	0	0,5		0,50
Isobutyl stearate	-	0	0	0	1	0	0	0,5		0,50
Pentaerythrityl tetracaprylate/tetracaprate	-	0	0	0	1	0	0	0,5		0,50
Poly- α -methylstyrene	-	0	0	0	1	0	0	0,5		0,50
Trimellitic anhydride	-	0	0	0	1	0	0	0,5		0,50
Trimethylolethane tricaprylate-caprate	-	0	0	0	1	0	0	0,5		0,50
Dimethyl phthalate	DMP	12,5	3	0	0	0,4	0	0	x	0,43
Diisoundecyl phthalate	DIUP	29,7	3	0	0	0,4	0	0		0,43
Benzyl C7-9-branched and linear alkyl phthalate	-	44,0	3	0	0	0,4	0	0		0,43
1,2-Benzenedicarboxylic acid, di-C9-11-branched and linear alkyl esters	L911P	32,5	3	0	0	0,4	0	0		0,43
Alkylsulphonic acid ester with phenol	ASE	82,2	3	0	0	0,4	0	0		0,43
Chlorinated n-paraffin	-	39,3	3	0	0	0,4	0	0		0,43
Paraffin, chlorinated	-	39,3	3	0	0	0,4	0	0		0,43
2,2'-ethylenedioxydiethyl-bis-(2-ethylhexanoate)	-	1,5	2	0	0	0,3	0	0		0,29
Diocetyl sebacate	DOS	1,8	2	0	0	0,3	0	0		0,29
Hexane-1,6-diol benzoate	-	0	1	0	0	0,1	0	0		0,14
Ethylenebis(oxyethylene) dibenzoate	-	0	1	0	0	0,1	0	0		0,14
Tributyl citrate	TBC	0	1	0	0	0,1	0	0		0,14
Acetyl tributyl citrate	ATBC	0	1	0	0	0,1	0	0	x	0,14

