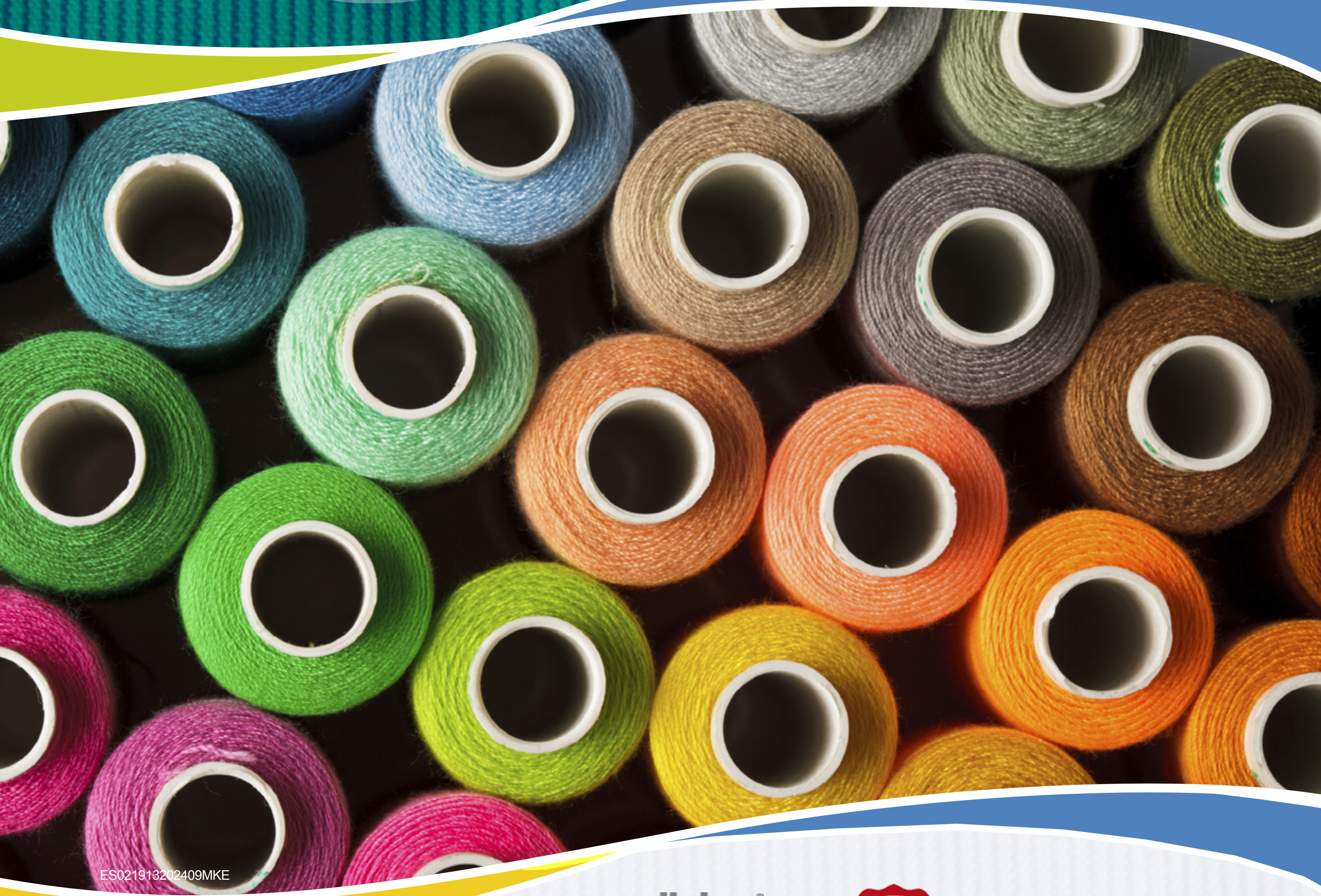
ZERO DISCHARGE OF HAZARDOUS CHEMICALS

2013 BENCHMARKING REPORT

July 2013



adidas GROUP C&A ESPRIT

G-STAR RAW H&M INDITEX Jack Wolfskin LEVI STRAUSS & CO.

LI-NING YOUR M&S NB PUMA

Contents

Acronyms and Abbreviations

APE	alkylphenols
APEO	alkylphenol ethoxylates
BOD	biological oxygen demand
COD	chemical oxygen demand
MSDS	Material Safety Data Sheets
N.D.	non detect
PFC	per- and poly- fluorinated chemicals
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PPB	parts per billion
PPE	personal protective equipment
PPM	parts per million
RSL	Restricted Substance List
SCCP	Short-Chained Chlorinated Paraffin
SDS	Safety Data Sheets
TSS	total suspended solids
µg/L	micrograms per liter
µg/mL	micrograms per milliliter
ZDHC	Zero Discharge of Hazardous Chemicals

Units comparison

PPM (part per million) = mg/L (milligrams per liter), mg/kg (milligrams per kilogram)
PPB (part per billion)= µg/L (micrograms per liter), µg/kg (micrograms per kilogram)
PPT (parts per trillion = ng/L (nanograms per liter), ng/kg (nanograms per kilogram)

Example: 20ppt = 20ng/L = 0.020µg/L

Introduction

The Zero Discharge of Hazardous Chemicals (ZDHC) Programme is an ambitious plan that sets a new standard of environmental performance for the global apparel and footwear industry. The group formed in 2011 to catalyze positive industry change and align to the goal of zero discharge of hazardous chemicals across the product life cycle by 2020.

A critical first step to eliminating and managing chemicals across the supply chain, not just in products, involves understanding how our supply chain partners identify and apply chemicals in different textile processes, including those that are used in manufacturing processes and not intentionally added to products. Before identifying and developing additional procedures and tools, we wanted to fully understand this complexity and created the Benchmarking Project with this in mind.

As part of its foundational work in 2012, the ZDHC Benchmarking Project team conducted informational site visits at 20 supplier locations to observe chemicals management practices, to note chemical inventories and to test influent, effluent and sludge discharges. The testing protocol covered chemicals across 11 chemical classes which have been targeted for restriction and/or elimination in the supply chain. This report provides an overview of these supplier benchmarking site visits, key findings and the action items that the group plans to undertake based on the study results.

The Benchmarking Project team would like to thank our factory partners who were key to making the benchmarking study a reality, and we would like to acknowledge their time, effort and patience with the number of sampling teams, consultants and ZDHC members who visited their sites.

Background

The ZDHC Joint Roadmap released in November 2011 identified the areas in which ZDHC members could conduct research and take action to guide the group toward the 2020 goal of zero discharge of hazardous chemicals.

The research conducted through this benchmarking project helped ZDHC to fully understand the complexity involved in eliminating chemicals across textile processes, including those used in manufacturing processes and not intentionally added to products.

One of the projects identified in the November 2011 Joint Roadmap involved conducting benchmarking site visits at supplier locations to better understand which chemicals from 11 restricted chemical classes are discharged in treated effluent at supplier facilities and how the chemicals detected might relate to the chemicals management, inventory and textile processes occurring within the suppliers' facility. The Joint Roadmap referred to this project as Project 1 or P01.[1]

Table 1 lists the 11 chemical classes the ZDHC community examined in this study and their typical uses in the textile industry. Brands have historically restricted chemical substances in at least 10 of the 11 chemical classes listed through Restricted Substance Lists (RSLs) and programmes, with a recent addition of long-chain per- or poly- fluorinated chemicals (PFCs), including perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS).

For more information about the phase out of specific PFCs, visit the ZDHC programme website at: www.roadmaptozero.com/df.php?file=pdf/Phaseout.pdf

Table 1

Eleven Chemical Classes and Typical Uses in Textile Production

Chemical Classes	Typical Uses in the Textile Industry	Specific Process Where Class of Chemical is Utilized
Alkylphenol Ethoxylates/Alkylphenols (APEOs/APEs)	Cleaners, detergents, sizing agents	Desizing, scouring, washing, dyeing, softening
Halogenated Flame Retardants	Flame retardants	Functional finishing
Chlorinated (Halogenated) Solvents	Spot cleaners, dry cleaning, scouring agents	Sizing, dry cleaning, scouring
Chlorinated Benzenes	Solvents, fiber swelling agents	Dyeing
Chlorophenols	Textile preservatives, pesticides	Pest control, sizing, dyeing, preservation
Heavy Metals	Dyes, pigments, catalyst	Fiber polymerising, dyeing, printing, tanning
Organotin Compounds (e.g., TBT)	Antimicrobial agents, preservatives, catalysts	Dyeing, leathering coating, pu synthesising
Per- and poly-fluorinated chemicals	Durable water repellents and their by-products	Functional finishing (water/oil repellent)
Ortho-phthalates	Plasticiser	Dyeing, printing, coating, softening
Short-Chained Chlorinated Paraffins	Leather conditioning	Tanning
Azo dyes that may release carcinogenic amines as defined in Annex XVII of REACH	By-product of banned dyes	Dyeing, printing

1 *The Joint Roadmap specifically stated the ZDHC members would "Benchmark and verify whether the nine classes of chemicals...are in discharge to water or sludge through a carefully designed process of on-site visits and audits, inventories and analytics where appropriate... Data would also be collected on the use and discharge of Alkylphenol ethoxylates (APEOs) and Perfluorinated Chemicals (PFCs)."*

Study Objectives

This Benchmarking Project is the first of a logical succession to Joint Roadmap commitments and projects. The information collected will inform development of an action plan to address prioritisation and management of any of the chemicals that were found during this study.

Given the history of restricted substances and the expansive scope and mission of the ZDHC group, the primary objectives of the benchmarking study were:

- To identify whether analytes from 11 chemical classes are present in discharges at supplier locations and at what levels
- To identify potential practices that lead to inconsistent control of chemical substances in products and/or processes

This study also had second level objectives to inform the ZDHC members regarding:

- The best pathways to engage and partner with suppliers on future chemicals management programmes
- The potential barriers that may be encountered in improving chemicals management in our supply chain
- The technical hurdles involving complex sampling and laboratory analytical testing capabilities

Using information gathered in this collaborative benchmarking effort, the ZDHC group will target and scale the key activities that will enable consistent management and/or phase out of chemicals to help us meet the goal of zero discharge of hazardous chemicals in our supply chains.

Approach

We evaluated the presence or absence of target chemicals in discharges through a carefully designed process that included site selection, on-site assessments and analysis, inventories and analytics, where appropriate. In developing the approach, we expected to understand the following:

- How do we know which restricted chemicals are still in use in our supply chain?
- How do we know which chemicals to prioritise (based on discharge information gathered)?
- Do we see any common factors contributing to the discharge of hazardous chemicals?

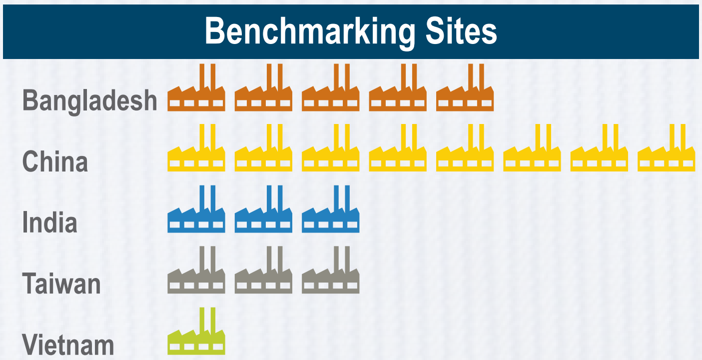
In building the approach, ZDHC members collaborated to select sites and develop the chemical list to be applied to investigations at each facility. Each of these important considerations is outlined below, as well as background on laboratory selection.

Benchmarking Site Selection

The ZDHC group selected a cross section of suppliers, considering processes, raw materials and geographic locations as selection criteria. The suppliers selected represent ones that ZDHC brand member's do business with on a regular basis. Key processes targeted were dyeing and finishing, washing, printing and durable water repellent application for a range of specific textile types including cotton, polyester, denim and leather. The Benchmarking Project team selected 20 sites in five countries including Bangladesh, China, India, Taiwan and Vietnam.

Figure 1

Site Visits by Country



Consultants and representatives from the ZDHC brands comprised the overall project team. A third-party supply chain consultant supported this project and collected chemicals management information and reviewed wastewater treatment facilities. Additional consultants were engaged to coordinate and guide the laboratories, assist with sample collection, oversee analytical data handling and compare results to available discharge limits.

Factory Information Collection

The ZDHC members outlined a coordinated effort to gain a firsthand look into practices regarding chemical inventories, waste treatment plant operations, inventories and detailed factory discharge information.

Laboratory Selection

At the outset of the study, the Benchmarking Project team developed a list of chemicals, lab procedures and recommended reporting limits based on internationally recognized analytical procedures and previous site investigations conducted by non-ZDHC member organisations. This information was used to identify lab partners that could meet all the requirements of the benchmarking study.

Laboratories were selected to perform analytical services based on several factors:

- Maintaining ISO17025 accreditation
- Ability to meet the requested reporting limits, which were below standard operating procedure in several cases
- Ability to handle the sample matrices
- Staff knowledge and availability to conduct the field sampling events
- Ability to deliver data in specified formats

ZDHC members identified and used three laboratories that satisfied all requirements for this study. In 2012 and early 2013, during project implementation, Benchmarking Project team members worked with the selected laboratories to gather the most appropriate set of data possible. Team members developed and conducted training for laboratory personnel, defined lists of chemicals for each site based on production type, developed solutions to expedite sample shipment and assisted in compiling data from several laboratories.

Limitations

The selection of 20 sites includes factory partners that are routinely in use by ZDHC brand's members. The number of sites in this study may not fully represent the complete supply chain but does however provide a snapshot of current practices at a number of key facilities. The Benchmarking Study will assist the ZDHC members in related work streams headed towards the goal of zero discharge of hazardous chemicals. The goal was to gather information on current practices and not continue to conduct this study as an ongoing work stream.

Site Visit Protocol

The site visit protocol was designed to collect two different types of information: qualitative information (related to chemicals management, inventory and waste treatment) and quantitative information (specifically water and sludge data).

Chemicals Management and Inventory Assessment

The Benchmarking Project teams conducted full chemicals management and inventory assessments at 18 of the 20 study sites. For two sites, the scope of work only covered analytical effluent sampling.

At each site visit, the third-party consultant and ZDHC team conducted an assessment of current chemicals management and inventory practices. The teams reviewed information with the facility staff and conducted a walk through to review the production floor and chemicals management in practice. Specific observations were made regarding chemical management policies and staff training, Material Data Safety Sheets (MSDS) or other inventory information, inventory storage and arrangement, handling, safety policies and practice and applicable certifications.

The site visits and assessments attempted to capture typical behavior but should be viewed as a snapshot in time and may not represent all possible factory configurations or practices in the supply chain.

Sampling

At each site, the teams collected sample types including: influent (water entering the facility), day effluent (discharge after treatment system), night effluent and sludge (solids captured from the wastewater stream).

The Benchmarking Project team coordinated with labs to ensure proper technical procedures for sampling, including the use of appropriate sample containers, preservation of samples and adherence to quality control measures. The team also worked directly with the supplier's staff to determine when a representative cross-section of materials or a manufacturing process would be on a production line.

Sampling plans were developed for each facility type, including tanneries, finishing, water repellent and washing, as sampling locations, times and even chemicals being investigated required adaptation. A full list of chemicals, methods used, reporting limits and results is provided in the report addendum.

Water Samples

The team analyzed a total of 28 effluent samples from 20 sites. For eight sites, the team took two effluent samples per site, one during the day and one during the night to compare changes in discharge concentrations across different production shifts.

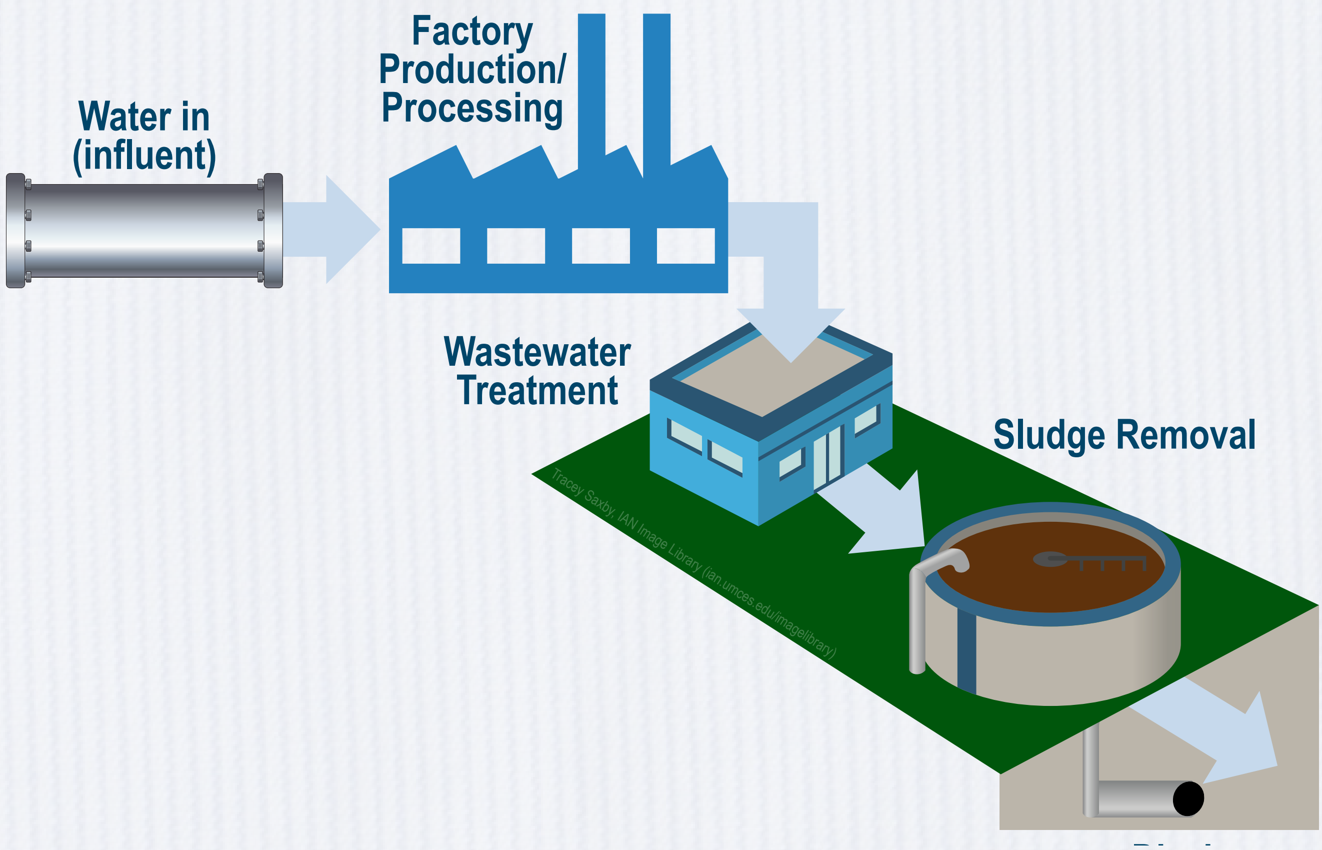
Sludge Samples

The team collected and analyzed a total of 18 sludge samples from 20 sites. Sludge samples were only collected and analyzed during daytime hours, as the sludge samples are a composite sample and each represents a longer "snapshot" of time than water samples.

Waste Treatment Assessment

Benchmarking Project teams collected information about on-site wastewater treatment facility operations. This information included sludge waste handling procedures and disposal types. Results from the eight sites are provided in the report addendum, which represent the majority of the technologies in use.

Factory Water Flow



Key Findings

This section outlines key findings regarding chemicals management and inventories, difficulties that factory partners have in receiving chemical information about complex mixtures from suppliers, factory waste treatment operations and analytical results from the laboratories.

Chemicals Management

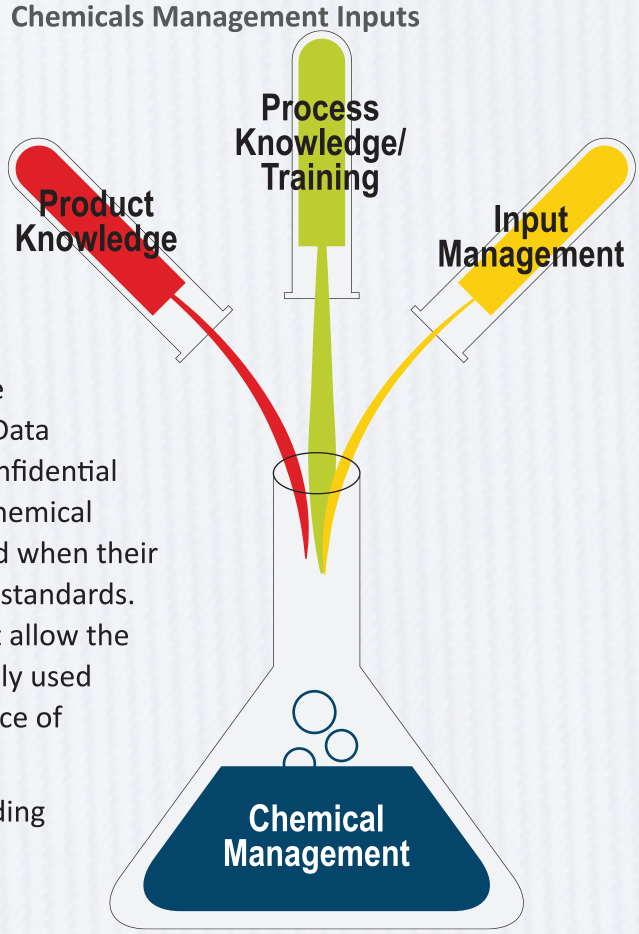
A proper chemicals management system can increase the transparency of the manufacturing process, provide a safe working environment for staff and benefit the ecological environment. In this study, 18 of 20 factories were assessed in the following areas: chemical policy, staff training, chemicals handling, safety policy and management of documents, including MSDS and chemical inventory.

Chemicals management in a large supply chain is complex; in many cases, hundreds of chemical formulations may be present in a single factory. Each of these formulations may contain from 1 to 20 or more different ingredients, with only some of the ingredients being divulged to the factory that is using the product.

The Benchmarking Project teams observed that most factories had documented chemical management system guidelines, but in practice, the implementation of the policy was less reliable and varied from supplier to supplier. Although all suppliers had an assigned person responsible for managing the chemicals used in facilities, the implementation of actual processing did not strictly follow the written guideline. For example, one site had formal written protocols and documentation, but implementation of protocols on the production floor was inconsistent.

The worker knowledge level regarding safe handling of chemicals varied. Although most of the sites provided personal protective equipment (PPE) to workers, three of the factories did not properly demonstrate the use of PPE and handling of the chemicals in a safe way.

Figure 2
Chemicals Management Inputs



Another significant observation from this study is the quality of MSDS. Only 11% of the suppliers had complete, correct information on file for chemicals. The issue was twofold: first, some chemical suppliers did not provide MSDS or Safety Data Sheets (SDS) of sufficient quality. Second, due to confidential business information concerns, the ingredients in chemical products were labeled as “Trade Secrets” or omitted when their concentrations were less than 1% per typical MSDS standards. The lack of sufficient chemical information does not allow the factory to judge whether the chemicals may be safely used in production and whether they prevent the presence of restricted ingredients in the chemicals.

During the assessments, the following trends regarding availability of chemical information at supplier locations were noted. The quality of chemical inventory and associated systems varied, ranging from being stored on an Excel spreadsheet to their maintenance in a formal database system, with the majority of the suppliers keeping complete inventories and properly labeling chemicals. However, the teams observed labeling issues (e.g., unlabelled containers) at 33% of supplier sites as shown in Figure 3. Proper labeling is imperative for ensuring the correct chemicals are used in a given process. In addition, this information is necessary to enable workers to know how to protect themselves properly when working with those chemicals.

In at least four cases, the supplier did not want to volunteer specific chemical inventory information regarding the commercial products they use in their processes. They noted concerns related to releasing confidential business information if they were to share this information.

The Complex Supply Chain

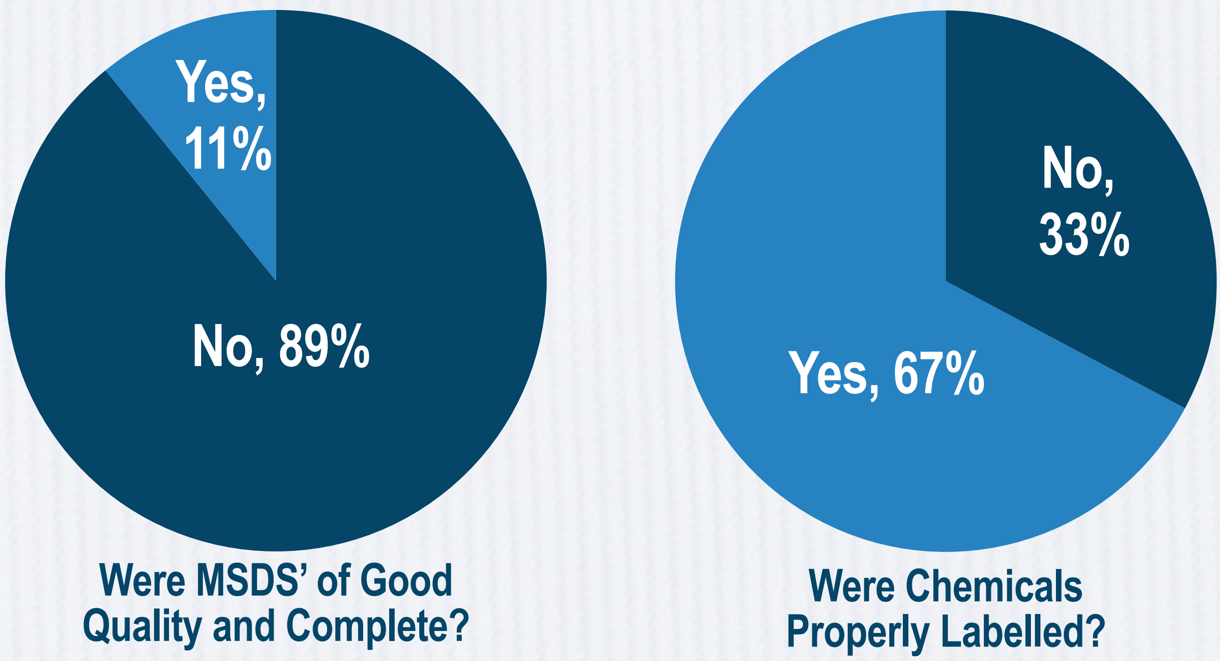
Ensuring proper chemicals management in a large supply chain is complex and we recognize the challenges faced by our supplying partners.

Hundreds of chemical formulations might be present in a single factory in the form of dyes, auxiliaries, detergents, lubricants, etc. Each of these formulations may contain many different ingredients, with only a portion of those ingredients being divulged by the manufacturer. This is due to trade secrets and limited reporting requirements.

Third and fourth tier suppliers add complexity to the supply chain and traceability of chemicals.

Figure 3

Availability of Chemical Information and Proper Labeling



Waste Treatment

All of the facilities visited in this benchmarking study were operating wastewater treatment systems during the visits. The factories were all in good standing with local authorities and discharge of water and sludge waste followed all applicable local regulations. However, in no case did local regulations cover the full suite of chemicals that were investigated in the benchmarking study.

A variety of water and sludge treatment systems were encountered in this study. To summarize the waste treatment operations in use, the processes can be combined into a small number of operative types for each discharge type:

Water

- Discharge of treated water directly to a surface water body
- Discharge of treated water to a secondary municipal treatment system

Sludge

- Sludge is incinerated
- Sludge is not incinerated
- Sludge is used as a fuel

Effluent (Wastewater)

The water treatment systems typically in use included a settling or filtration process, a cooling tower, pH adjustment, a solids separation process and biological degradation of sludge (either aerobic, anaerobic, or both) prior to discharge.

Secondary or tertiary treatment processes were in place at most facilities, but the variety of these treatments is more expansive. Approximately half of the facilities visited were currently recycling water from their own waste treatment facility for use in other industrial processes.

Sludge

Sludge is created by capturing the solids portion of the effluent stream prior to discharge. All facilities had systems in place to separate the sludge (solids waste) from the effluent stream using a variety of capture methods. Separation of solids from the waste stream was typically being performed by one or more of the following processes:

- Filtration using membranes, screens, or other physical barriers
- Settling the solids out in a large tank
- Coagulation (combining small particles into larger ones so they are more effectively segregated from the water)

Each facility also employed a sludge thickening process to remove water and increase sludge density prior to final discharge. Once separated and thickened or solidified, the sludge was disposed of in a variety of ways, including:

a. Factory contracts with authorized contractor to perform disposal work. Final disposal method was specified in some cases.

"Sludge" is the solid portion of the waste stream that collects over a period of time and which is segregated from the wastewater stream.

The solids in the waste stream may be comprised of small textile particles, dirt, cleaning products, chemical precipitates, or any other loosely bound material that enters a processing step.

Secondary and Tertiary Water Treatment Types Encountered

- Grit screening
- Secondary coagulation/flocculation
- Secondary aerobic and/or anaerobic sludge treatment
- Advanced oxidation process
- Constructed wetland treatment
- Sand filtration
- Ultra filtration
- Activated carbon adsorption
- Recycling of water for chromium reuse

b. Incineration

c. Sludge used by local power plant as fuel

d. Sludge used by the factory to power the boilers

All sites were operating treatment systems designed to treat chemical discharge in factory effluent. None of the factories was releasing untreated wastewater into a surface water body or to a municipal treatment system. The effectiveness of each type of treatment system varies and proper operation and maintenance of a treatment system is a key factor in eliminating unwanted chemicals once they enter the production process.

Laboratory Testing Results

In the majority of cases, the Benchmarking Project team observed that factory discharge was well below any available discharge limits for effluent. The information presented in this report includes all detections in the samples, as far down as the analytical methods and laboratories were capable of reporting, not only for chemical detections which were over an available regulatory limit. This information is imperative for industry-wide collaboration with the goal of zero discharge.

The ZDHC Benchmarking Project team examined approximately 150 analytes at each of the 20 sites in Bangladesh, China, India, Taiwan and Vietnam.

A full detail of laboratory results by individual chemical is presented in the report addendum.

As previously noted, the Benchmarking Project team examined approximately 150 analytes at each of 20 sites. This collection of analytes varied slightly from site to site based on the production processes and lab capabilities.

Water Sample Results Summary

The following sections summarize the laboratory results for water samples collected at each facility. Samples collected include water entering the factory from a well or a municipal water source (influent) and water exiting the waste treatment facility (effluent) which is then discharged to either a secondary waste treatment facility or directly to a source water body, such as a river or settling pond.

The chemical classes that were detected most often per site were heavy metals, SCCPs, ortho-

What levels of chemical detection have been reported?

The analytical methods used are capable of detecting chemicals in the parts per million, parts per billion, or parts per trillion ranges. Some approximate examples of what these levels mean by way of comparison:

One Part per Billion
1 second in 32 years time
1 foot of a trip to the moon
½ teaspoon of water in an Olympic sized (50,000 gallon) swimming pool

One Part per Trillion
1 second in 317 centuries of time
1 inch to 16 million miles
1 drop of water in 20 Olympic sized (50,000 gallon) swimming pools

To tie this comparison into the Benchmarking project, most MSDS or SDS information sheets only require reporting hazardous chemical constituents above 1% of a formulation. 1% is equivalent to 10,000 ppm or 10,000,000 ppb.

Units comparison

PPM (part per million) = mg/L (milligrams per liter), mg/kg (milligrams per kilogram)
PPB (part per billion)= µg/L (micrograms per liter), µg/kg (micrograms per kilogram)
PPT (parts per trillion = ng/L (nanograms per liter), ng/kg (nanograms per kilogram)

Example: 20ppt = 20ng/L = 0.020µg/L

phthalates, chlorinated benzenes and APEOs. The least detected classes were chlorophenols, organotins and halogenated flame retardants.

Figure 4 provides a summary of the number of sites that had at least one analyte detected within the 11 chemical classes. There was at least a single detection of an analyte in each chemical class.

Figure 5 compares the number of data points with an analyte detected to the total number of data points collected within each class (e.g., a single sample analyzed for 10 individual heavy metals is represented as 10 data points). This comparison was performed to obtain an overview of effluent discharges.

The highest percentage of detections in descending order are heavy metals (53%), chlorinated paraffins (46%), PFCs (20%) and APEOs (13%). Each of these four classes is outlined further for detail on specific chemicals detected.

Figure 4

Number of Sites with at Least One Analyte Detected per Chemical Class (Effluent)

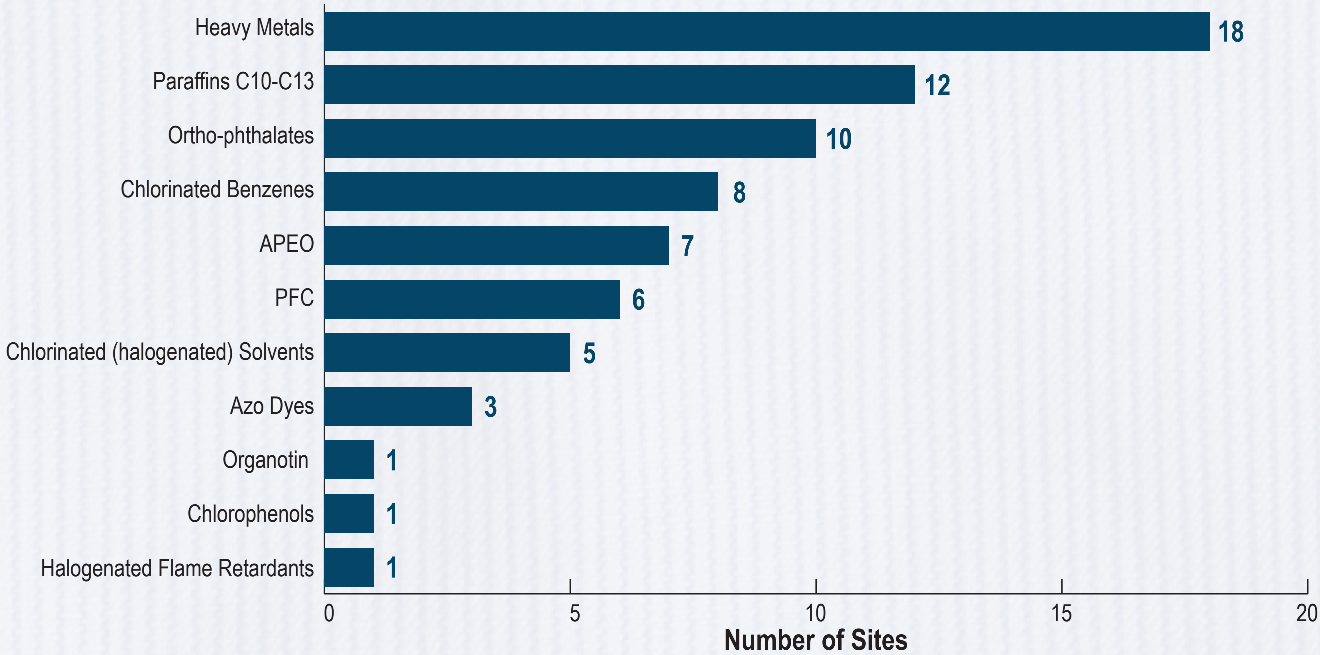
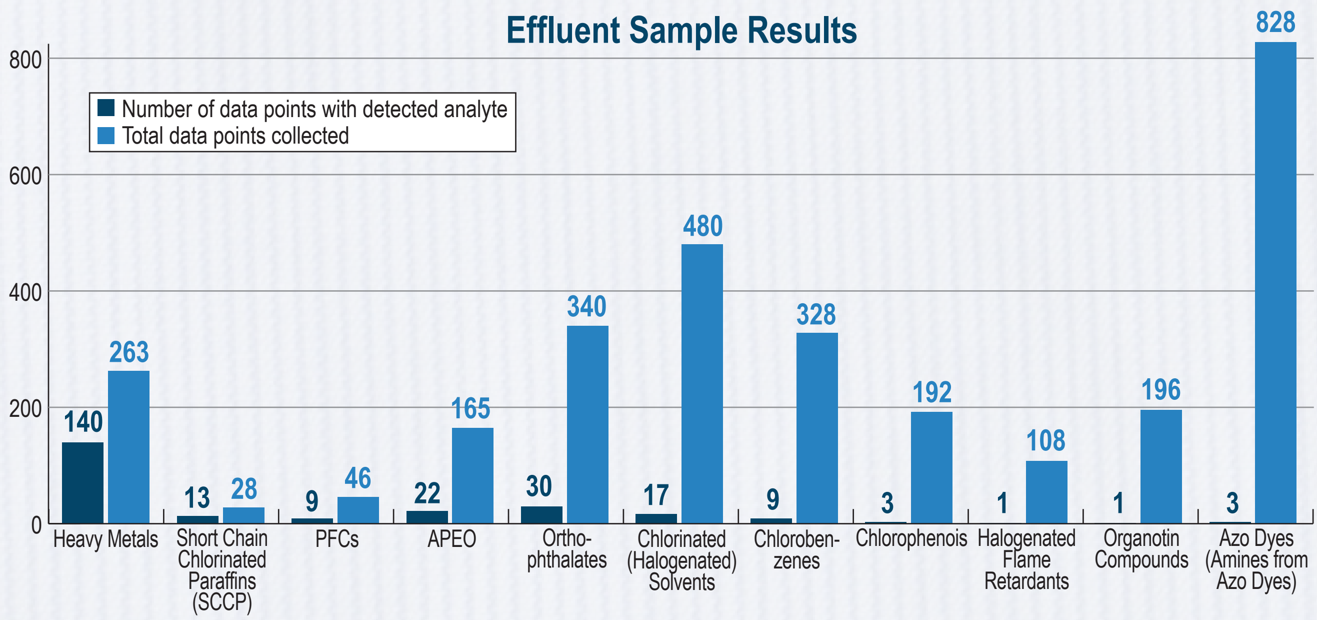


Figure 5

Number of Data Points with Detected Analyte vs. Total Data Points Collected, Effluent



Heavy Metals

Figure 6 presents the maximum concentration of each metal detected in the influent and effluent. Zinc was found in high levels in the factory effluent in one case, with the maximum discharge concentration at 447µg/L.

Zinc had the highest observed influent concentration at 4,960 µg/L – the highest metal analyte concentration overall. In fact, seven of the 17 sites (41%) with zinc detected in the effluent had higher concentrations of zinc in the incoming water than the effluent. Copper and lead also tended to have higher concentrations in influent and lower concentrations in effluent. This could be caused by copper or lead water infrastructure. Overall, this indicates the complexity of addressing heavy metals, which arise from a variety of sources, in wet processing and subsequent effluent.

Figure 6

Heavy Metals in Influent and Effluent

	Analyte									
	Antimony	Arsenic	Cadmium	Chromium, hexavalent	Cobalt	Copper	Lead	Mercury	Nickel	Zinc
Influent	8	5	N.D.	N.D.	3	400	27	2	123	4,960
Day Effluent	234	21	22	N.D.	16	285	16	1	7	447
Night Effluent	135	3	N.D.	N.D.	2	22	5	1	13	87

Maximum Metal Concentration (µg/L)

- N.D. (non detect)
- 2,000
- 4,000
- 6,000
- 8,000
- 10,000

Usage of Heavy Metals

Total heavy metals include Lead, Mercury and Cadmium. Paints are one of the most common sources of heavy metals as pigments and stabilizers. Red, yellow, orange, green and colors made of these base colors are the most likely sources. Pigments are often used to color molded plastic trims. Some low temperature melting plastics use heavy metals as stabilizers to prevent the plastic from breaking down at high application temperatures.

Lead

Lead is a naturally occurring metal element that can be present as a pure metal or as lead compounds (e.g., salts). In apparel and footwear, lead may be associated with plastics, paints, inks, pigments, surface coatings and metal components.

Cadmium

Cadmium is a naturally occurring and abundant metal that does not easily corrode (rust). It can be present as a pure metal or as cadmium compounds (e.g., salts). Cadmium compounds are found in or used as: pigments, a stabilizer for PVC plastic, alloys for plating of other metals, paints (e.g., surface paints on zippers and buttons).

Mercury

Mercury is a naturally occurring metal element that can be present as a pure metal or as Mercury compounds (e.g., salts). It can exist as metallic mercury (liquid), a gas (when heated), or as solids (inorganic and organic compounds). Mercury compounds can be present in pesticides and can also be used in paints.

Short Chain Chlorinated Paraffins

Figure 7 represents the maximum concentration of SCCPs detected in influent and effluent. While the highest concentration appeared in the influent, this was an anomaly. Only two of eight sites had higher influent concentrations.

Figure 7

Chlorinated Paraffins in Influent and Effluent

	Analyte: Short Chain Chlorinated Paraffins (SCCP) with C10-C13
Influent	72.70
Day Effluent	35.10
Night Effluent	11.20

Maximum SCCP Concentration (µg/L)
11.20
40.00
60.00
80.00
100.00

Usage of Short Chain Chlorinated Paraffins

SCCPs are chlorinated hydrocarbons with a straight carbon chain. They can be used as: flame retardants, leather greasing agents and for fat liquoring of leather.

PFCs

Figure 8 presents the maximum concentration of PFOA and PFOS detected in influent and effluent, which were low across the sites with PFC processing. At only one site, PFOA was detected in the incoming water.

Figure 8

PFOS/PFOA in Influent and Effluent

	Analyte: Perfluoroocatanoic Acid (PFOA)	Analyte: Perfluorooctane Sulfonate (PFOS)
Influent	1.48	0.01
Day Effluent	1.60	0.03
Night Effluent	0.30	N.D.

Maximum PFC Concentration (µg/L)	
N.D. (non detect)	6.00
2.00	8.00
4.00	10.00

Usage of PFCs

Fluorinated compounds investigated in this study were perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) and are commonly referred to as PFCs. These fluorinated surfactants are used in durable water repellent application to achieve a high level of water, oil and stain repellency. These two chemicals, PFOA and PFOS, are being phased out of use due to toxicity, bio-accumulative properties and longevity in the environment. The PFCs are only in use at a small number of facilities in this study where durable water repellents are applied. Alternatives that offer the same level of performance are not readily available at this time. See the ZDHC report on water repellency treatments here: http://www.roadmaptozero.com/df.php?file=pdf/DWR_Report.pdf

APEOs

Figure 9 represents the maximum concentration of APEOs in influent and effluent. Due to variations in testing protocols in different regions, the APEO results were reported differently by each laboratory[2]. The results are presented as reported, to avoid combining the results and missing any information. While a few APEO analytes appeared in the influent, none exceeded the effluent concentration, indicating the use of APEOs in production processes.

Figure 9

APEOs in Influent and Effluent

Analyte

	Nonylphenol	Nonylphenol diethoxylates, NP2EO	Nonylphenol monoethoxylates, NP1EO	Nonylphenol ethoxylates (NPEOS)	Nonylphenol ethoxylates, n=4 to n=15	Octylphenol	Octylphenol diethoxylates, OP2EO	Octylphenol monoethoxylates, OP1EO	Octylphenol ethoxylates (OPEOs)	Octylphenol ethoxylates, n=4 to n=15	Total non-iconic surfactants (Nonylphenol and octylphenol ethoxylates, n-4 to n-15
Influent	0.20	0.18	0.05	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Day Effluent	3.78	0.20	0.11	6.33	0.50	0.45	0.16	N.D.	N.D.	N.D.	0.50
Night Effluent	0.90	0.26	0.25		0.30	0.42	0.22	N.D.		N.D.	0.30

Maximum APEO Concentration (µg/L): N.D. (non detect) · 2.00 · 4.00 · 6.00 · 8.00 · 10.00

Usage of APEOs

APEOs are non-ionic surfactants including Nonylphenol Ethoxylates (NPEOs) and Octylphenol Ethoxylates (OPEO). NPEOs and OPEOs can degrade into nonylphenol and octylphenol, respectively. APEOs can be used as or found in: detergents, scouring agents, wetting agents, softeners, emulsifier/dispersing agents for dyes and prints, impregnating agents, degreasing agents for leather, leather finishing, de-gumming for silk production, dyes and pigment preparations, polyester padding and down/feather fillings. APEOs are increasingly prohibited and alternatives for their use in production does exist in many cases.

2 *APEOs can be assessed in a variety of ways. A portion of the labs reported APEOs grouped together as total nonyphenol ethoxylates and total octylphenol ethoxylates. The remaining labs reported APEOs separated into ranges based on number of ethoxylate units, and also reported total non-ionic surfactants.*

Regulatory Limits for Effluent

All of the locations that were sampled were confirmed to be in compliance with local discharge regulations, where applicable and in good standing with local authorities at the time of the visit. However, published discharge limits exist for only a small subset of the chemicals in this investigation. Where other stringent water quality limits were available, the team compared effluent detections to these limits.

Consultants reviewed the results and compared results to published water quality limits for the textile industry. Published limits pertaining to factory effluent were only found for pentachlorophenol, general chemistry and heavy metals. The sources of the effluent limits were:

» bluesign® Surface Water Discharge Limits[3]

» American Apparel and Footwear Association Global Textile Effluent Guidelines[4]

» Taiwan Effluent Water Standards[5]

» China Effluent Water Standards for Dyeing and Finishing in the Textile Industry[6]

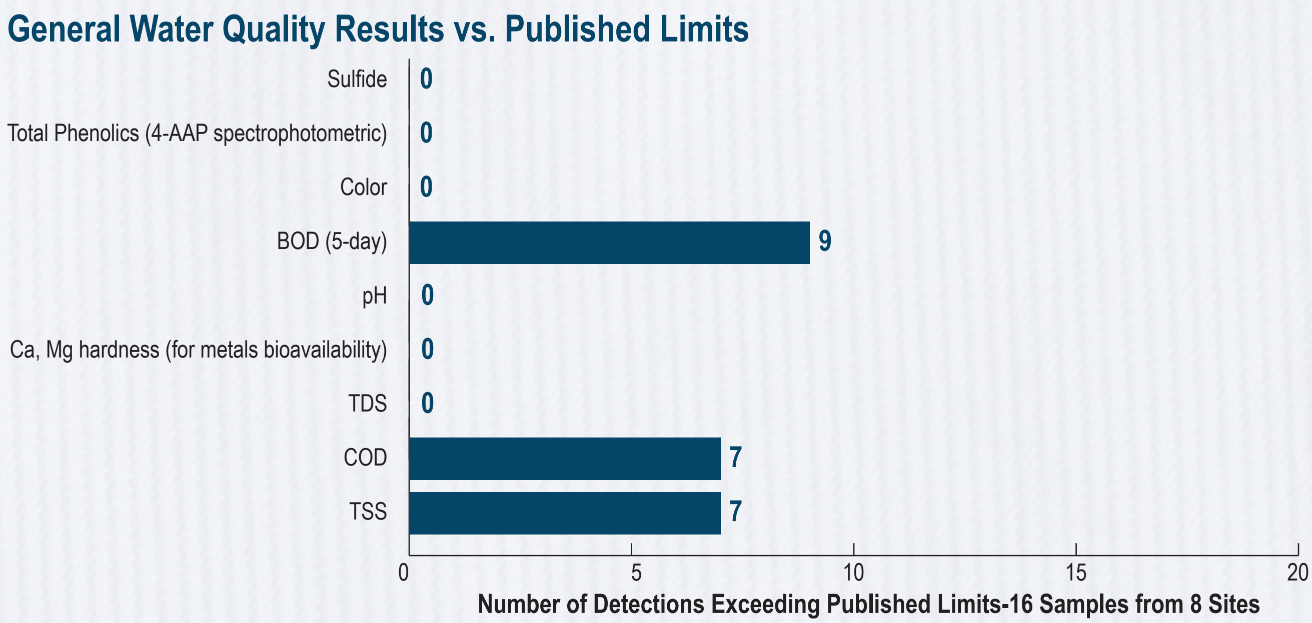
What published discharge limits did we find for effluent?

- Information from bluesign® Surface Water Discharge Limits[2]
- American Apparel and Footwear Association Global Textile Effluent Guidelines[3]
- Taiwan Effluent Water Standards[4]
- China Textile Effluent Water Standards[5]

Figure 10 shows a comparison between published effluent limits and detected analytes at the factories. Since the focus of the study was the 11 chemical classes, not every location was sampled for general water quality parameters, with a total of 16 samples collected from eight sites.

Figure 10

Comparison of General Water Quality Results to Published Limits

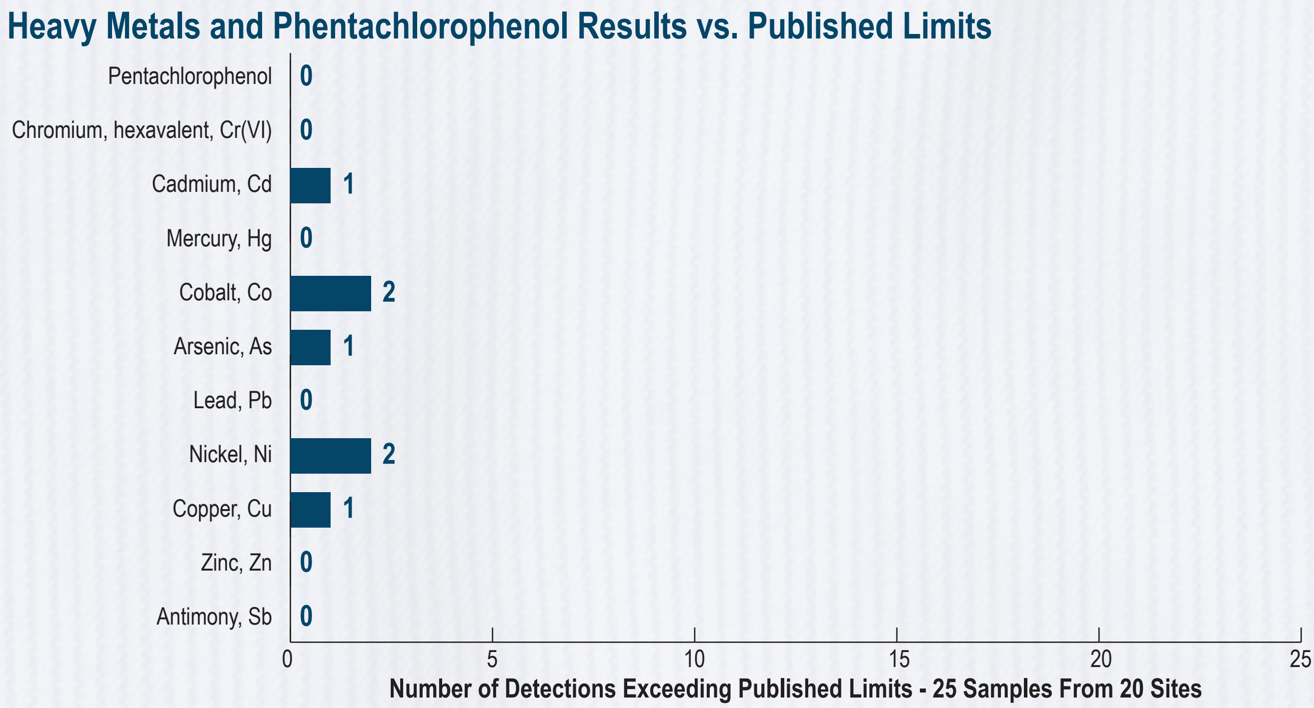


3 *bluesign® Criteria for Textile Manufacturers; http://www.bluesign.com/index.php?id=151*
4 *https://www.wewear.org/assets/1/7/EffluentGuidelines.pdf; Accessed 2/25/2013*
5 *http://law.epa.gov.tw/en/laws/480770486.html*
6 *GB 4287-2012, Discharge standard of water pollutants for dyeing and finishing of textile industry*

Total suspended solids (TSS), chemical oxygen demand (COD) and biological oxygen demand (BOD) showed detections over available effluent limits. These are general effluent monitoring parameters, not specific to any one chemical.

Figure 11

Comparison of Heavy Metals and Pentachlorophenol Results to Published Limits



Based on the available information, a very small number of heavy metals were detected over any available effluent limits.

Sludge Sample Results

Eighteen locations were sampled for sludge during daytime sampling events. Sludge samples typically represent a longer time frame of plant operation than water samples and, therefore, do not necessitate sampling during different shifts. The sludge samples may be more concentrated than effluent samples, as the concentration of chemicals in the sludge is expected as a natural outcome of wastewater treatment.

Once a chemical is segregated into the sludge matrix, it is reduced or eliminated from the effluent stream. The chemicals that concentrate in sludge are generally lower in solubility or have become chemically attached to solids in upstream processes. Figure 12 indicates the number of sites with at least one analyte detected per chemical class. For example, at least one heavy metal was detected at each of 18 sites. This information is useful because it provides a means to assess the extent of the discharge for each class of chemicals.

Figure 12

Number of Sites with at Least One Analyte Detected per Chemical Class (Sludge)

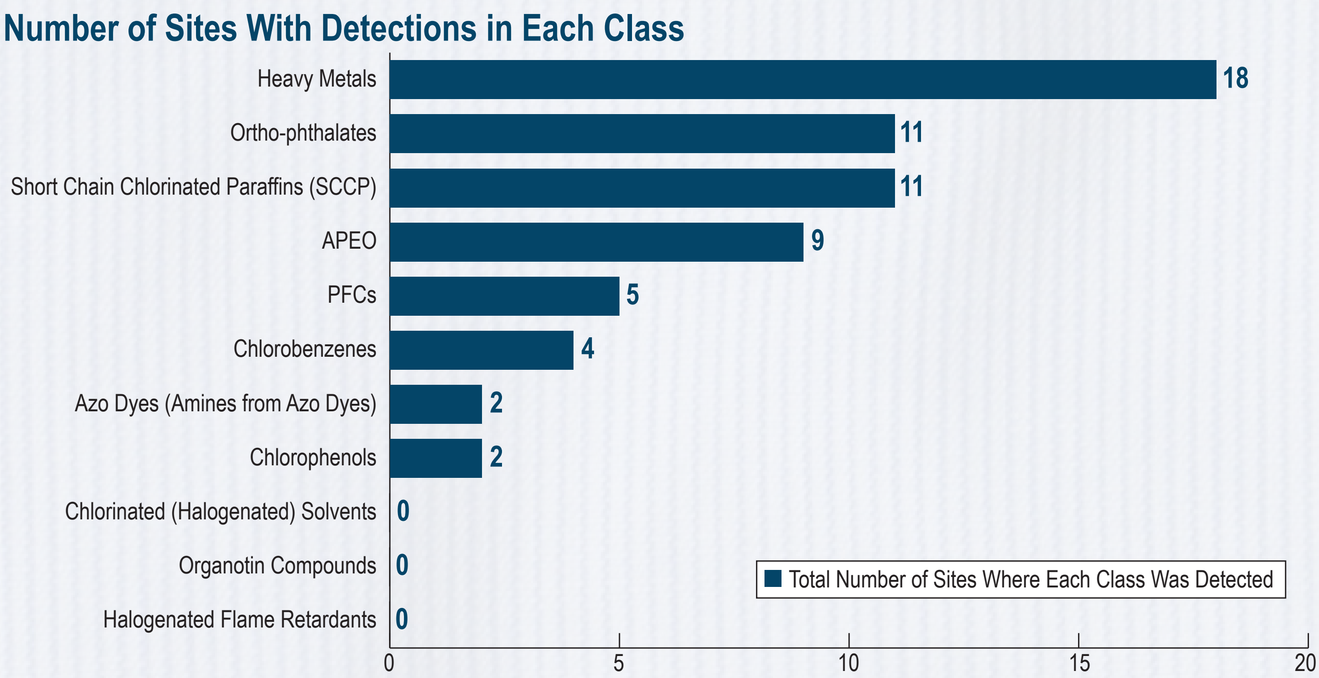
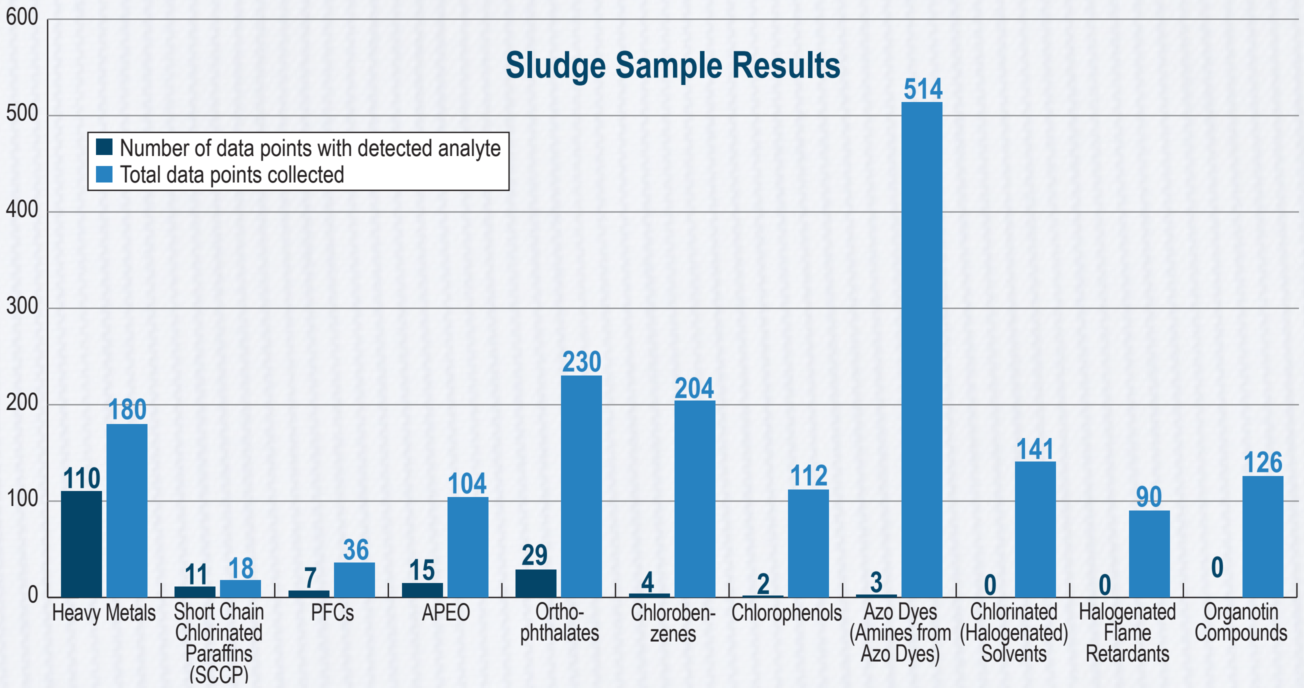


Figure 13 compares the number of data points with an analyte detected to the total number of data points collected within each class (e.g., a single sample analyzed for 10 individual heavy metals is represented as 10 data points). This comparison was performed to obtain an overview of sludge discharges.

Figure 13

Number of Data Points with Detected Analyte vs. Total Data Points Collected, Sludge



As with the effluent samples, the benchmarking team noted the presence of the same four classes of chemicals - heavy metals, SCCPs, PFCs and APEOs - as the most prevalently detected in sludge.

The Benchmarking Project team expected to find chemicals in the sludge, as it is an indication that the treatment system is effectively segregating those chemicals from the effluent stream before the water is discharged. When chemicals that have been restricted for some time are found in sludge, however, there are issues beyond proper waste treatment operation, such as chemicals management, that may need to be addressed.

Conclusions

The Benchmarking Project results provide a general understanding of current practices and the state of discharge at sites conducting key wet processes. The study does not represent the entire supply chain and should be considered a snapshot in time of current practices. However, it allows ZDHC members to make more educated decisions and to prioritise future efforts as we work to achieve the important goal of zero discharge of hazardous chemicals.

Key Chemical Classes Found in Discharges

The key chemical classes found in the observed effluent and sludge are heavy metals, SCCPs, PFCs, APEOs and ortho-phthalates. Many brands have been targeting substances in these chemical classes through RSLs which restrict specific chemical substances in products. However, the frequency of detection in the effluent indicates these substances are still present in formulations and processes at the supplier locations.

In addition, there were noted instances of restricted substances in use on the production floor at a few sites. This observation and the discharge data indicated that suppliers have intentional and unintentional use of these chemical substances, especially on the factory floor, where chemicals may be used but not as an intentional addition to products.

Chemical Management and Information Improvement Opportunity

There are opportunities to collaborate with suppliers regarding chemicals management and inventories/information on chemicals used in production processes. There are three key focus areas for future ZDHC support:

- **Chemicals management implementation:** Most factories had written, stated chemical management system guidelines. However, in practice, the implementation of the policy was less reliable and varied from supplier to supplier.
- **Chemical information**: In most cases, the chemical information provided to factories by chemical suppliers lacks appropriate details to make informed decisions regarding chemical components. It was sometimes unclear whether a restricted substance is present in a formulation at trace amounts or if it is a minor ingredient and not listed as part of the formulation due to intellectual property concerns.
- **Inventories:** Many suppliers in this study kept good inventory records, but there is room for improvement in the quality of records and transparency.

Infrastructure Considerations

Laboratories in the region were able to handle the Benchmarking Study samples, but the project experienced a learning curve in this area. Shipping samples across borders to laboratory facilities that could process the samples was also a challenge and the time frame for delivery of laboratory data was longer than anticipated by the labs or project team. Complex sampling procedures and analytical testing beyond standard operating procedures already in use at the laboratories also proved difficult. Based on these experiences, infrastructure and laboratory capabilities are important to consider in future activities or large scale testing.

Training

Many staff at supplier locations noted that they do send personnel to training but the depth and breadth of training is unclear. In addition, staff handling of chemicals on the production floor was sometimes not the personnel that attended training.

Next Steps

Based on the findings from this study, the Benchmarking Project team has determined key actions the group will undertake to effect better environmental and human health outcomes at our supplier locations. Table 2 summarizes the next steps and action items.

Table 2

Next Steps and Action Items

<table>
<tr><th rowspan="2">Chemical Classes</th><th rowspan="2">Majority of chemicals on RSLs</th><th colspan="3">Develop/enforce Tools and Policies to Affect Phase Out of RSL Chemicals</th><th colspan="3">Chemicals Management Improvement</th></tr>
<tr><th>Communi-cations on Policies[a]</th><th>Resources to Develop Positive Lists</th><th>Guidebooks to Help Eliminate Chemicals</th><th>Chem. Best Practices Pilot Project</th><th>Chem. Mgmt Training</th><th>Disclosure & Info Exchange</th></tr>
<tr><td>Alkylphenol Ethoxylates/ Alkylphenols (APEOs/ APEs)</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td colspan="3" rowspan="11">Chemicals management improvement efforts will affect all chemical classes covered by the Benchmarking Study as well as all other chemicals in use.</td></tr>
<tr><td>Halogenated Flame Retardants</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Chlorinated (Halogenated) Solvents</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Chlorinated benzenes</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Chlorophenols</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Heavy Metals</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Organotin Compounds (e.g., TBT)</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Perfluorinated Chemicals</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Ortho-phthalates</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Short-Chained Chlorinated Paraffins</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Azo dyes that may release carcinogenic amines as defined in Annex XVII of REACH</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
</table>

a *Development of a manufacturing RSL is underway as part of the ZDHC Programme*

Action Items for Key Chemical Classes Found in Discharges

1. **Prioritise Chemicals Classes.** Where the team observed detections in supplier effluent, we will take action to address these substances and will prioritise the chemical classes that had the most frequent detections. In particular, the team will prioritise the chemicals classes that exhibit persistent, bioaccumulative and/or toxic characteristics: SCCPs, ortho-phthalates, APEOs and PFOA/PFOS. We will also look at heavy metals and the complexity associated with their reduction, specifically those due to natural water hardness and incoming water contamination.

The team will continue to address other chemical classes that were not detected in significant levels in this study. Results indicate there has been improved elimination of substances such as azo-dyes, organotins and chlorobenzenes that the industry has been addressing for many years.

Most of the analytes in this study have been targeted historically for restriction in the supply chain and will be addressed through specific action plans. This work is part of dedicated work streams outlined in the Joint Roadmap, version 2.

2. **Phase Out/Eliminate RSL Chemicals from Use.** When detected chemicals are already constituents on a restricted substances list, we will develop tools, information and policies that will help promote full elimination—not just elimination in product but also in production processes if applicable.

   The team will ensure that appropriate tools and communications are completed for each targeted analyte. Tools and policies we will pursue include, but are not limited to:

   - Communications to relevant suppliers reinforcing our policy to avoid specific substances
   - Lists of resources that will help suppliers identify "positive" formulations
   - Guidebooks that help diagnose where to find substances that are ubiquitous and hard to eliminate (such as APEOs)

   Phase out activities will likely be similar across different chemical classes. We will ensure appropriate tools and communications are completed for the targeted analytes.

   For some new chemicals being considered for action, we may invest in research to identify viable alternatives and additional information on both use and substitution potential in the supply chain. For example, while all ZDHC brands have committed to phase out of long-chain perfluorinated chemicals, we are researching alternatives for water, stain and oil repellency performance requirements. Research like this is intended to lead to quality product performance and lower environmental impact.

   Current water quality standards focus on general water quality parameters and heavy metals. A common discharge standard with a more comprehensive set of water quality parameters would help create common expectation of what "good" looks like across the supply chain. This approach warrants further exploration.[7]

Chemical Management and Information Improvement Opportunity

To promote better chemicals management, there are a number of actions the ZDHC members will undertake to enable high performance in this area. Three areas will be targeted: a best practices pilot study, chemicals management training and disclosure/information exchange.

- **Best Practices Pilot Project.** Best practices for chemicals management, treatment and water stewardship have been established. However, there is no clear value proposition and proven outcomes from implementing these best practices. The team will work with key experts and stakeholders to develop a chemicals management best practice pilot project.

  Best practices will be outlined and the pilot project set up to monitor the business case as well as effluent performance.

7 *While complete elimination is possible for many substances, limits are helpful for others due to their ubiquity and natural occurrence.*

- **Develop and Implement Chemicals Management Training.** The ZDHC team is working with industry partners to develop chemicals management training for suppliers and eventually for other supply chain partners and brands. The team will offer the first training sessions in the Fall 2013. This training will provide a consistent platform for ZDHC supply chain partners, tailored to all who have a role in handling chemicals, not just managers or those overseeing activities. Providing these resources through a common industry platform should reduce duplication of effort, promote common effort and the reduce burden on supply chain partners.
- **Disclosure and Information Exchange.** Information exchange is another area of focus for the ZDHC team. Other industries and coalitions have examined similar issues (for example, the electronics industry). ZDHC will partner with stakeholders to learn about existing systems and solutions and apply those to the textile industry. This work is still developing and requires extensive partnership with the chemical industry, apparel and footwear industry and policy groups.

Committed to transparency, we will continue to share information and results as we implement these projects and tasks. We will provide deliverables and communications on our website (www.roadmaptozero.com) and through webinars with stakeholders. We look forward to continually learning more about how to improve environmental performance across our supply chain and encourage you to participate and contribute to this programme to eliminate hazardous chemical discharges throughout our supply chain.