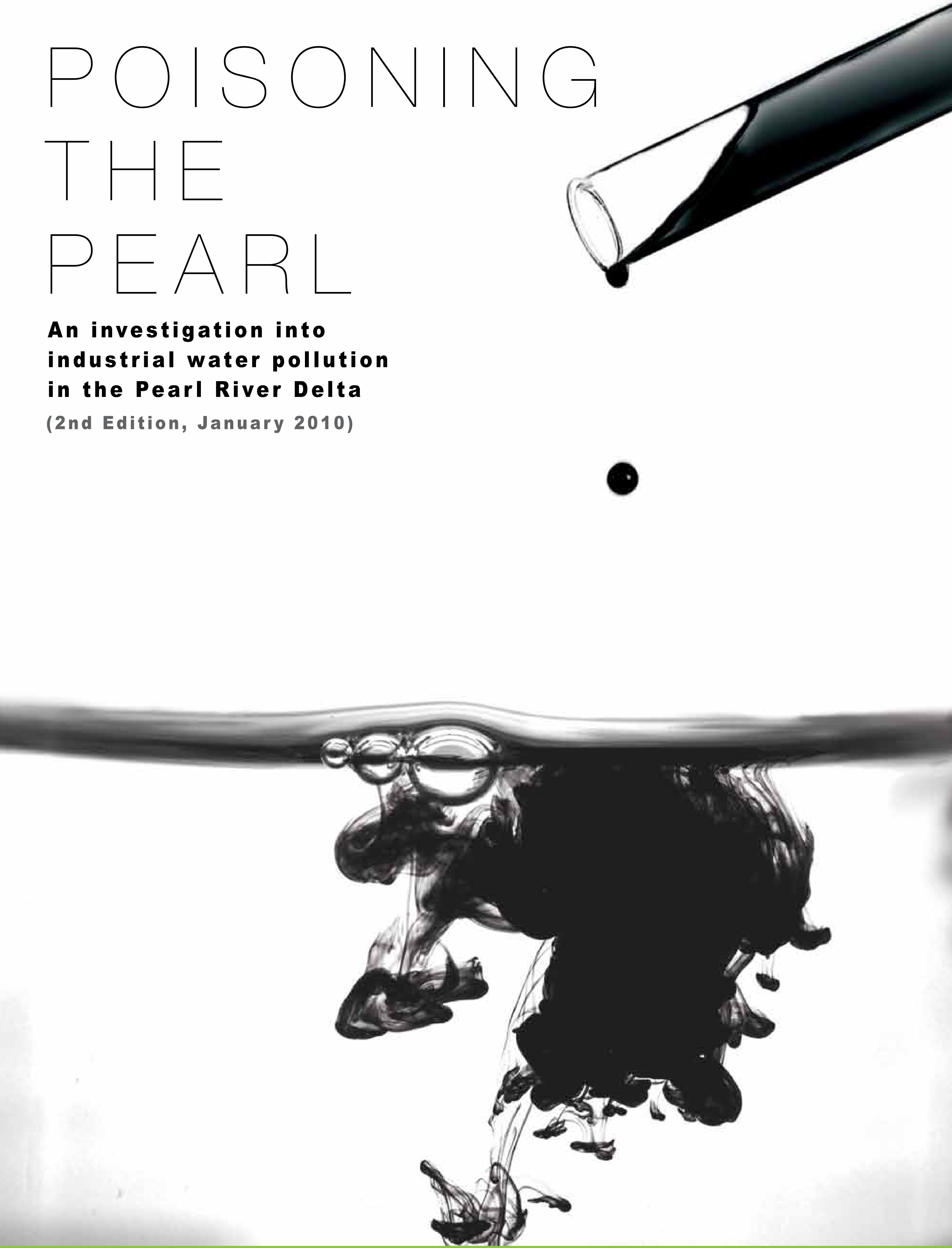
POISONING THE PEARL

An investigation into industrial water pollution in the Pearl River Delta

(2nd Edition, January 2010)



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Why does Greenpeace focus on hazardous chemicals?

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The society we live in is pervaded by tens of thousands of different man-made chemicals. We already know that some of them are hazardous to our health or to the environment; but a far greater number have never even been tested properly, especially under conditions of long-term use and exposure. Even so, we find hazardous man-made chemicals in many everyday products, including clothes, food, detergents, paints, furniture, toys, cosmetics, pharmaceuticals and electronic goods. Some of these are becoming increasingly present in water, air, soil and living organisms as a result of being released during manufacturing, use, and/or disposal.

Not all hazardous chemicals are man-made. Some toxic metals – such as lead, cadmium and mercury – occur naturally in the earth's crust. However, they have only become so widely dispersed in the biosphere – where they can cause widespread toxic effects on both humans and wildlife – because they have been extracted and used by humans.

What are hazardous chemicals?

A hazardous chemical is one that has – at some point during its manufacture, use or disposal – the potential to harm people, other living organisms, or the environment, due to its intrinsic hazardous properties. A hazardous chemical can either be man-made or it may occur naturally in the environment. Hazardous properties include:

- Persistence (chemicals that do not readily break down in the environment as the result of biodegradation or other processes)
- Bio-accumulation (chemicals that can accumulate in organisms, and whose concentration can even increase further along the food chain)
- Carcinogenic properties (chemicals that can cause cancer)
- Mutagenicity (chemicals that have the capacity to induce mutation and genetic defects)
- Toxicity towards the reproductive system (chemicals that can harm the reproductive system, including its development) or the nervous system
- The capability to disrupt endocrine (hormone) systems


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Why are hazardous chemicals such a problem?

Unfortunately, it is very difficult, if not impossible, to remove hazardous chemicals or control the risks they create after they have been released into the environment. The more environmentally persistent chemicals cannot be effectively contained or destroyed using traditional “end-of-pipe” measures, including the processes commonly used in wastewater treatment plants. Instead, they either pass through to the effluent unchanged, or else they accumulate in the treatment plant “sludges”, which then become hazardous wastes themselves. Such persistent chemicals can cause harm over a long period of time . They may even cause harmful impact far away from the place where they were initially released into the environment and long after any controls have been introduced, because they can travel long distances in air or water, and then become re-concentrated to harmful levels through food chains. The social and environmental costs of hazardous chemical exposure – although complex to determine and poorly assessed – are almost certainly extremely high.

The most effective way to address the problems associated with hazardous substances is to ensure that their discharge is rapidly reduced to zero, and ultimately to remove them from commerce by replacing them with less hazardous – preferably non-hazardous – alternatives (the “principle of substitution”). This can be achieved by focusing “upstream” in industrial terms; meaning systematically rethinking and redesigning products and processes in a way that progressively reduces the reliance of industries on hazardous chemicals.

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THE
PEARL

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TABLE OF CONTENTS

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Executive Summary

Industry found discharging hazardous chemicals into South China's Pearl River

The Greenpeace report, *Poisoning the Pearl*, provides a snapshot of industrial water pollution caused by the discharge of hazardous chemicals in the Pearl River Delta (PRD). Our researchers sampled and analysed effluents from the discharge pipes of five manufacturing facilities located in the PRD.

Water pollution is one of China's most severe environmental problems. It affects as much as 70% of the country's rivers, lakes and reservoirs.[1] The pollutants being discharged by industrial facilities into China's water systems contain various hazardous chemicals, including different types of heavy metals and organic pollutants. Often persistent, bio-accumulative and toxic, hazardous chemicals pose a constant, long-term threat to human health and the eco-system into which they are released.

Given its status as China's most industrialised region, it is unsurprising that the PRD suffers from pollution caused by hazardous chemicals. However, serious gaps exist in our knowledge about the problem. For instance, academic studies of hazardous chemical contamination in the area rarely involve direct sampling from industrial sources, so they fail to identify the individual culprits responsible for it. There is also a policy gap regarding the amount of attention the government pays to curbing the discharge of hazardous chemicals into water systems.

Summary of key findings

A total of 25 samples were collected from five manufacturing facilities in the Greater PRD area during June 2009. They included wastewater samples from all the identifiable and accessible discharge points, as well as sediment samples from discharge channels and receiving water bodies.

The five facilities are:

Industrial area / facility	Activity undertaken
Kingboard (Fogang) Industrial Area	Printed circuit board manufacturing
Kingboard (Panyu Nansha) Industrial Area	Printed circuit board manufacturing
Wing Fung P.C. Board Co., Ltd.	Printed circuit board manufacturing
Dasha Industrial Area, Dalingshan Town, Dongguan	Electronics, glass manufacturing, craftwork and printing etc.
Qingyuan Top Dragon Textile Co., Ltd.	Textile manufacturing

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Discharge from industy is one of the major sources of water pollution in China

The key findings of the study can be summarised as follows:

- All the facilities sampled were found to be discharging wastewater containing chemicals with proven or suspected hazardous properties
- For three of the five facilities, samples of discharged wastewater contained concentrations of chemicals which exceeded the limits set by Guangdong provincial effluent standards
- A number of the facilities were found to be discharging various types of organic chemicals, many of them hazardous, which are not currently being monitored or regulated under Guangdong effluent standards

All these facilities sampled must undergo Clean Production Auditing due to their use or release of hazardous materials, according to Article 28 of China's Clean Production Promotion Law, which took effect on January 1st 2003,

The highlights of the specific sampling results are as follows:

Metals

High concentrations of a number of heavy metals that are toxic or potentially toxic were found in many of the wastewater discharges. The levels of individual metals in the wastewater at three sites exceeded the maximum discharge concentrations allowed under Guangdong effluent standards. These were:

- Kingboard (Fogang) Industrial Area, whose effluent had concentrations of beryllium and manganese that were 25 times and 3 times their respective maximum allowable levels
- Wing Fung P.C. Board Co., Ltd., whose effluent had copper at a concentration that exceeded the minimum permissible level by 50 times and the maximum level by 12 times
- Qingyuan Top Dragon Textile Co., Ltd., whose effluent had manganese at a concentration that exceeded the maximum limit

Many of the metals present in the discharged wastewater samples are known to have toxic or potentially toxic effects, particularly in high concentrations. One particular concern is the presence of dissolved copper, as many aquatic organisms are extremely sensitive to this metal, especially in very high concentrations.

The results also provided many other examples of wastewater containing high concentrations of toxic metals. Although these may have been below the regulatory limits, they still indicate that such effluent discharges are significant sources of pollution in the river system.

pH:

The wastewater samples from the following two sites were highly acidic, far above the permissible pH range for discharges (6-9) in the Guangdong effluent standards:

- Kingboard (Fogang) Industrial Area pH = 1
- Dasha Industrial Area, Dalingshan Town, Dongguan pH = 2

Besides themselves being hazardous to aquatic life, highly acidic discharges can greatly increase the water solubility, mobility and toxicity of metals present in wastewater.

Organic chemicals:

Numerous organic chemicals in many different chemical classes were identified in the wastewater samples from the five sites. A lot of these are known for or suspected of having hazardous properties. Foremost among them were:

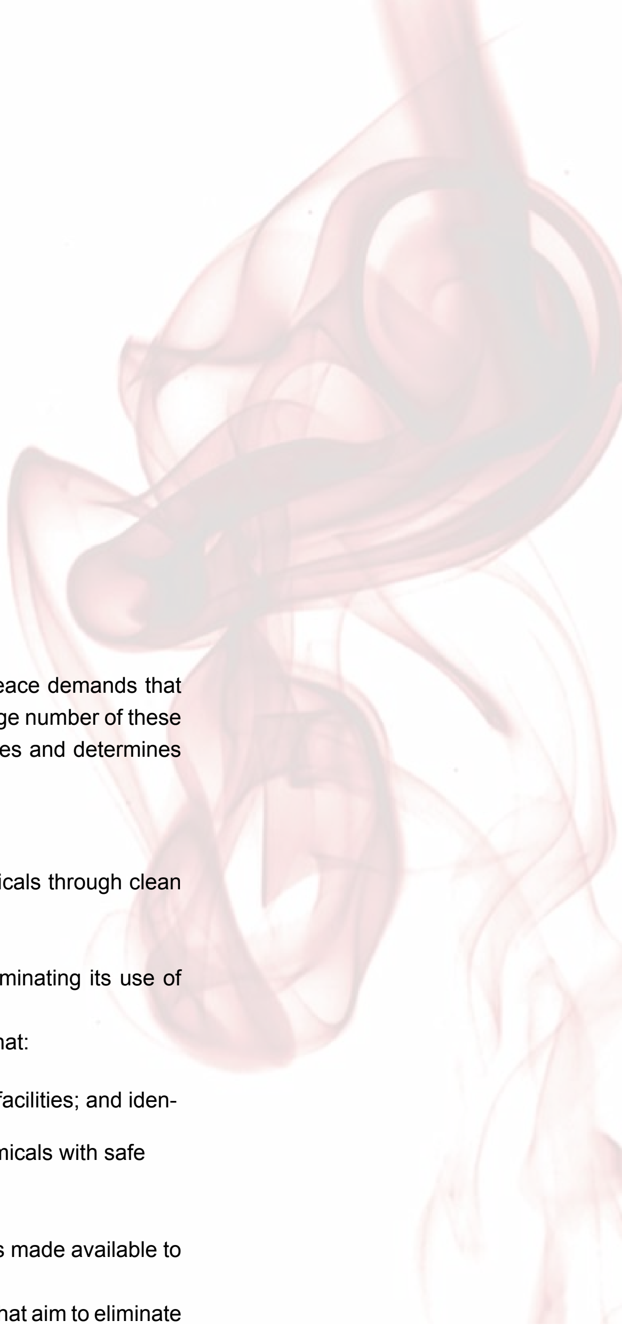
- Brominated compounds, including the brominated flame-retardant tetrabromobisphenol-A (TBBPA), which were found at Kingboard (Fogang) Industrial Area and Kingboard (Panyu Nasha) Industrial Area
- Alkyl phenols (octyl phenol and nonyl phenol), which were found at Kingboard (Fogang) Industrial Area and Qingyuan Top Dragon Textile Co., Ltd.
- Phthalate esters (DEHP, DnBP & DiBP), which were found at Kingboard Panyu Nansha Industrial Area, Wing Fung P.C. Board Co., Ltd., and Dasha Industrial Area, Dalingshan Town, Dongguan
- Bisphenol-A, which was found at Kingboard (Panyu Nansha) Industrial Area
- Dichloromethane, which was found at Dasha Industrial Area, Dalingshan Town, Dongguan

Obviously, the facilities sampled represent only a tiny fraction of all the industrial activity currently taking place in various industrial zones around the Pearl River system, and therefore the wastewater that is being discharged into it. Nonetheless, they illustrate the nature of what is likely to be a much greater problem.

Our vision: a clean production revolution

Greenpeace believes that environmental protection and industrial development are not mutually exclusive. The only way to address the problem of hazardous chemicals identified in this report is for China to kick-start a clean production revolution in the region.

Clean production advocates the redesigning of manufacturing processes and products in order to eliminate toxic chemicals from the entire product and production cycles. It emphasises the prevention of pollution – rather than expensive and often ineffective end-of-pipe treatment – thereby presenting environmentally-friendly and cost-effective solutions to industries. It can be achieved by substituting hazardous chemicals with alternative non-hazardous ones, or by removing the need to use or generate hazardous chemicals. Only when industry starts practising clean production, and the government requiring it, can we finally make the Pearl River and all other rivers in China safe for the environment and human health.



Our demands

To achieve a clean production revolution in the PRD and China as a whole, Greenpeace demands that the following immediate actions be taken, both by companies that are discharging a large number of these hazardous pollutants into the water; and by the government, which regulates industries and determines the direction of China's policy on curbing water pollution.

Industries

Companies must urgently commit to eliminating their discharges[2] of hazardous chemicals through clean production, including:

1. Establishing targets and timelines for progressively reducing and ultimately eliminating its use of hazardous substances, together with intermediate goals.
2. Conducting a full chemical accounting and a clean production / solutions audit that:
    - Examines how, where and why hazardous substances are being used in its facilities; and identifies the hazardous chemicals for prioritised action
    - Evaluates the technical and financial options for substituting hazardous chemicals with safe chemicals in both processes and product design
3. Ensuring that updated information about its releases of hazardous substances is made available to the public, free of charge, at least once a year.[3]
4. Actively supporting the enactment and implementation of government initiatives that aim to eliminate the use and release of hazardous substances by industrial sources.

Government

We urge China's relevant national and local government bodies to commit to the urgent elimination of discharges of hazardous chemicals by:

1. Creating an overall action plan to reduce, restrict and ultimately eliminate the release of hazardous chemicals as a top priority, with a clear timeline.
2. Compiling and regularly updating a list of hazardous chemicals for priority elimination action.
3. Compiling inventories regarding the use and release of hazardous chemicals and creating a register of pollutant release and transfer which is fully open and accessible to the public.
4. Providing environmental protection bureaus (EPBs) with more resources and incentives to strengthen their enforcement of the clean production programmes set out in the Clean Production Promotion Law by:
    - Strengthening Clean Production Auditing of companies that use or release hazardous substances
    - Creating well-funded technical resources and providing ongoing help to enable companies (especially small and medium-scale enterprises) to implement plans to eliminate their use of hazardous chemicals

“They discharge water like this everyday. It is black in colour and pungent when it comes out of the pipe. Our entire village stinks on windy days; you can see foam rising from the discharged water and flying about everywhere, even into our houses. I don’t know whether this factory treats its water at all. All I do know is that what comes out looks and smells like this. We dare not complain, because they (the people linked to the factory) have power. We are mere villagers. What could we possibly do to stop this?”

– Mr. Chan, aged 70, who lives in Le Yuan Cun, next to the Top Dragon Textile Co., Ltd.

1.

Introduction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Water pollution is one of China's most severe environmental problems. It now affects as much as 70% of the country's rivers, lakes, and reservoirs.[4] As the urgency of water-scarcity issues resulting from climate change and rampant water use increases, water pollution is also exacerbating China's already dire water situation. Severe water shortfall is predicted for many regions in China if no actions are taken to tackle the problem.

Industry is a substantial source of water pollution. Among the numerous chemicals released by factories, hazardous chemicals, which includes different types of heavy metals and organic chemicals, are a particular concern. Often persistent, bio-accumulative and toxic (PBT), they pose a constant, long-term threat to human health and the eco-system when they are released into the environment.

Southern China's Pearl River Delta (PRD) region is a perfect example of the severity of the country's industrial water pollution. Adjacent to the Hong Kong and Macau special administrative regions, the PRD has emerged as one of the world's most dynamic industrial zones, accounting for more than 10% of China's total GDP in 2007.[5]

The PRD's growth has centred around the Pearl River. With a catchment area of 453,000 km^2, the river is the third longest in China, after the Yangtze and Yellow rivers.[6] Abundant water resources from the Pearl River and its tributaries have long supported the region's industrialisation, to the extent that it is called the "world's factory floor". The Pearl River and its tributaries have also served as a source of drinking water for the region's 47 million inhabitants, with the West River (Xijiang) providing for the needs of the cities of Foshan, Zhaoqing, Jiangmen, Zhongshan and Zhuhai; the North River (Beijiang) serving Guangzhou city; and the East River (Dongjiang) serving the cities of Shenzhen, Dongguan, Huizhou, parts of Guangzhou, and Hong Kong. [7] [8]

However, the water quality of the Pearl River and its tributaries has deteriorated significantly since the region's remarkable economic growth began with the opening up of China's economy in the late 1970s. In 2007, the Ministry of Water Resources designated more than 60% of its waterways as "polluted".[9] These statistics are even more alarming because official figures rarely reflect the contributions of hazardous chemicals to water pollution in the PRD.

Numerous academic reports have demonstrated that the PRD is contaminated with hazardous chemicals, including heavy metals and persistent organic pollutants (POPs). However, studies to date have focused on the broad levels of hazardous chemicals present within the Pearl River system, rather than on attempting to identify and analyse the hazardous chemicals that are being directly discharged into this river system from industrial sources. Pollution by persistent and bio-accumulative hazardous chemicals such as heavy metals and POPs is particularly worrying given that their very nature makes it extremely difficult for the eco-system (and water treatment plants) to neutralise them. The only solution to avoid this 'permanent poisoning' is eliminating the release of the hazardous substances in the first place – i.e. prevention at source through clean production.

Poisoning the Pearl is the result of seven months of fieldwork in the PRD by Greenpeace China, and it aims to provide a snapshot of industrial water pollution resulting from hazardous chemicals. We hope this report will fill a gap in existing knowledge concerning hazardous chemical pollution in the PRD by highlighting the industrial sources responsible for it. We also hope it will serve as a first step in kick-starting a clean production revolution in the PRD.

The underlying premise of clean production is that environmental protection and industrial development are no longer mutually exclusive. Clean production's appeal is that it can help industries to find environmentally-friendly and cost-effective solutions that emphasise precaution and prevention over "end-of-pipe" treatments. However, we are running out of time. As climate change and other pressures make our water resources more scarce, China cannot afford to lose one more cubic metre of water to 'permanent poisoning'. Immediate and firm action needs to be taken to launch a clean production revolution that will prevent industries from releasing the most hazardous chemicals into the PRD and China as a whole.

"People hesitate when they know the vegetables they're about to buy come from our village. Since our farmland is located right next to a huge chemical facility, they think our vegetables must be contaminated."

– Ms. Wang (not her real name), aged 40, who lives in Huangwenyuan Village near the Kingboard Fogang Industrial Area

2.

Greenpeace's investigation in the Pearl River Delta

2. Greenpeace's investigation in the Pearl River Delta

Between February and August 2009, Greenpeace researchers investigated the extent of industrial pollution in the PRD region and its upstream areas. After visiting eight cities and 53 towns and villages and inspecting over 60 facilities in the region, Greenpeace identified five facilities for sampling. Their locations in Guangdong Province and in relation to the PRD area are shown in Figure 1.

A total of 25 samples were collected in June 2009 with documentation. They included wastewater samples from all the identifiable and accessible discharge points emanating from the five sites, as well as sediment samples from discharge channels and receiving water bodies. All the samples were sent to the Greenpeace Research Laboratories (University of Exeter, UK) for analysis, including quantitative analysis for metals and for a range of volatile organic compounds (VOCs), and qualitative analysis for other, semi-volatile (solvent-extractable) organic compounds. All results presented in this report are made according to the samples collected in this sampling programme.

Table 1. The five sampled sites (industrial area or facility)

Industrial area / facility	Activity undertaken
Kingboard (Fogang) Industrial Area[10]	Printed circuit board manufacturing
Kingboard (Panyu Nansha) Industrial Area[11]	Printed circuit board manufacturing
Wing Fung P.C. Board Co., Ltd.	Printed circuit board manufacturing
Dasha Industrial Area, Dalingshan Town, Dongguan	Electronics, glass manufacturing, craftwork and printing etc.
Qingyuan Top Dragon Textile Co., Ltd.	Textile manufacturing

Figure 1. Location of the five facilities in Guangdong Province, showing the boundary of the PRD area

Overview of findings

This section gives an overview of Greenpeace's findings from the sampling analysis. The results indicate that all five facilities are significant point sources for the release of heavy metals and potentially hazardous organic substances into the receiving freshwater environment of the Pearl River basin via their wastewater discharges.

It is important to note that these facilities obviously represent only a small fraction of the total industrial activity in the PRD, and therefore the wastewater that is being created in the various industrial zones of the Pearl River system. Nonetheless, they illustrate the nature of what is likely to be a much greater problem.

The full version of the scientific report (Greenpeace Research Laboratories, the University of Exeter, UK) entitled "Hazardous chemical pollution of the Pearl River: Investigation of chemicals discharged with wastewaters from five industrial facilities in China, 2009'', which includes referenced information on key chemicals identified in the study, can be found on the Greenpeace website (http://www.greenpeace.org/haz-chem-prd-china).

The key findings of this study can be summarised as follows:

- All the facilities sampled were found to be discharging wastewater containing chemicals with proven or suspected hazardous properties
- For three of the five facilities, samples of discharged wastewater contained concentrations of chemicals which exceeded the limits set under Guangdong provincial effluent standards
- A number of the facilities were found to be discharging various types of organic chemicals, many of them hazardous, which are not currently being monitored or regulated under Guangdong effluent standards

All these facilities sampled must undergo Clean Production Auditing due to their use or release of hazardous materials, according to Article 28 of China's Clean Production Promotion Law, which took effect on January 1st 2003.

The key findings concerning specific chemicals can be summarised as follows:

Metals

Many of the wastewater discharges contained various metals that are toxic or potentially toxic in high concentrations. The levels of individual metals in the wastewater samples at three sites exceeded the maximum allowable discharge concentrations under Guangdong effluent standards. These were:

- Kingboard (Fogang) Industrial Area, which had concentrations of beryllium and manganese that were 25 times and 3 times their respective maximum allowable levels
- Wing Fung P.C. Board Co., Ltd., whose effluent had copper at a concentration that exceeded the minimum limit by 50 times and the maximum limit by 12 times
- Qingyuan Top Dragon Textile Co., Ltd., whose effluent had manganese at a concentration that exceeded the maximum limit

The results also provide many other examples of wastewater samples that contained high concentrations of toxic or potentially toxic metals which, although below the regulatory limits, still indicate that these effluent discharges are acting as significant point sources of pollution in the river system.

Below is highlight of a few examples of metals that were found in the sampled facilities and their potential hazards:

Table 2: Examples of toxic metals and their potential hazards

Metal	Potential hazards*	Where Greenpeace found in high concentration
Beryllium	Exposure to dusts/fumes, usually in the workplace, even at very low levels and for short periods of time, can cause beryllium sensitisation and ultimately lead to chronic beryllium disease (CBD), a debilitating lung disease; beryllium and beryllium compounds are recognised as known human carcinogens for workplace exposure to dusts/fumes.	Kingboard (Fogang) Industrial Area
Zinc	Bio-accumulation has possible toxic effects; the symptoms of high doses in humans include pancreatic damage, anaemia and gastrointestinal distress; toxic to a wide range of aquatic plants and animals.	Kingboard (Fogang) Industrial Area
Manganese	Exposure to high levels can lead to multiple symptoms of neurotoxicity, including damage to the brain	Kingboard (Fogang) Industrial Area Qingyuan Top Dragon Textile Co., Ltd.
Copper	Exposure to high levels can lead to bio-accumulation and toxic effects; copper is also toxic to a wide range of aquatic plants and animals, with some negative effects occurring at extremely low levels.	Wing Fung P.C. Board Co., Ltd.

*(*For detailed description of each chemical, please refer to p.16-17)*

2. Greenpeace s investigation in the Pearl River Delta

The graph below highlights some of the highest concentrations of metals found in the facilities sampled and compares them with the maximum permissible limits for the same metals under Guangdong effluent standards:

- **Kingboard (Fogang) Industrial Area:**
  Concentrations of beryllium and manganese were 25 times and 3 times their respective maximum allowable levels
- **Wing Fung P.C. Board Co., Ltd.:**
  Concentrations of copper exceeded the minimum permissible level by 50 times and the maximum level by 12 times
- **Qingyuan Top Dragon Textile Co., Ltd.:**
  Concentrations of manganese exceeded the maximum limit

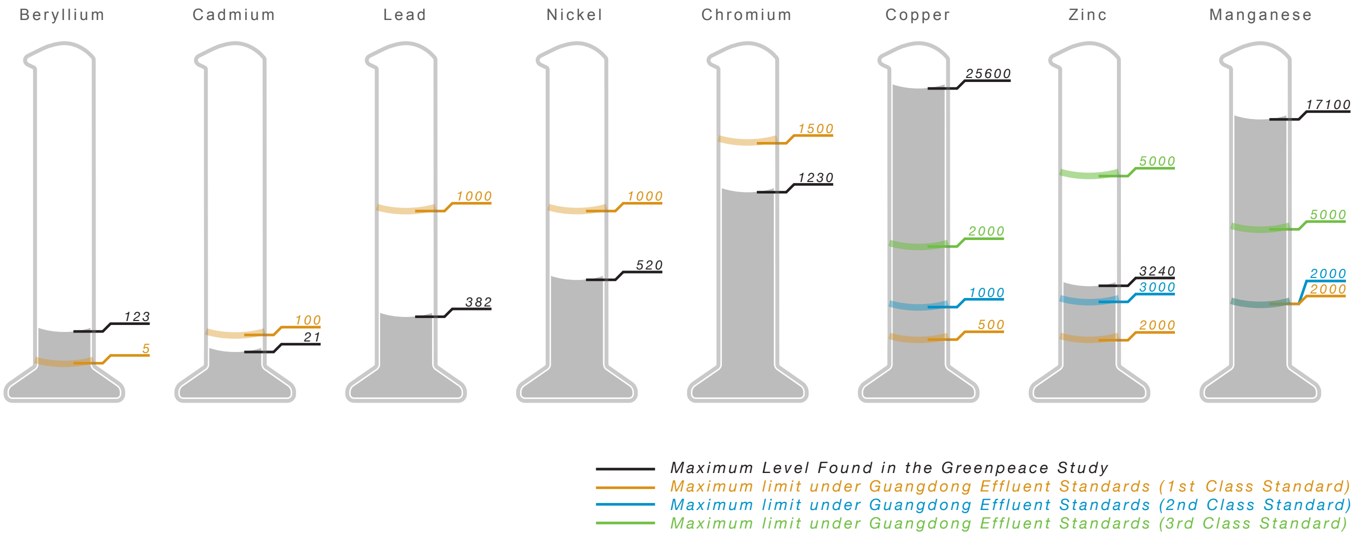


Figure 2: Permissible concentrations in discharged wastewater under Guangdong effluent standards, and the highest level found in this study (Unit = µg/l)

pH

The wastewater samples from two sites were highly acidic, far outside the permissible range for discharges of pH 6-9 under Guangdong effluent standards:

- Kingboard (Fogang) Industrial Area pH = 1
- Dasha Industrial Area, Dalingshan town, Dongguan pH = 2

Besides being hazardous to aquatic life in themselves, highly acidic discharges can greatly increase the water solubility, mobility and therefore the toxicity of metals present in the wastewater.

Organic Chemicals

Numerous organic chemicals from many different chemical classes were identified in wastewater samples from the five sites. A number of them are known to have hazardous properties. Foremost among these hazardous chemicals were the following:

Table 3: Examples of organic pollutants and their potential hazards

Group of Chemicals	**Particular chemicals of concern**	**Potential hazards of the particular chemicals of concern**	**Where Greenpeace found them**
Brominated compounds	Tetrabromobisphenol-A (TBBPA)	TBBPA interferes with endocrine (hormone) systems, with the potential for impacts on the nervous system, immune system, kidney and liver	Kingboard (Fogang Industrial) Area Kingboard (Panyu Nasha) Industrial Area
Alkyl phenols	Octyl phenol and nonyl phenol	Disruption to the endocrine (hormone) systems through ability to mimic natural oestrogen hormones, which may lead to altered sexual development, lower sperm production and increased sperm abnormalities in some organisms	Kingboard (Fogang) Industrial Area Qingyuan Top Dragon Textile Co., Ltd.
Phthalate esters	DEHP, DnBP & DiBP	Some phthalates are toxic to the reproductive development of mammals, including effects on testicular development.	Kingboard (Panyu Nansha) Industrial Area Wing Fung P.C. Board Co., Ltd. Dasha Industrial Area, Dalingshan Town, Dongguan
Other oxygen compounds	Bisphenol-A	A potential endocrine disruptor with impacts on reproductive systems; of great concern in the aquatic environment; widely recognised as a hazardous pollutant	Kingboard (Panyu Nansha) Industrial Area
Chlorinated volatile organic chemicals	Dichloromethane	Harmful if swallowed, inhaled or absorbed through the skin, as it is a possible mutagen and human carcinogen	Dasha Industrial Area, Dalingshan Town, Dongguan

*(*For detailed description of each chemical, please refer to p.16-17)*

2. Greenpeace s investigation in the Pearl River Delta

The graph below showcases the most commonly detected hazardous organic pollutants in the five facilities:

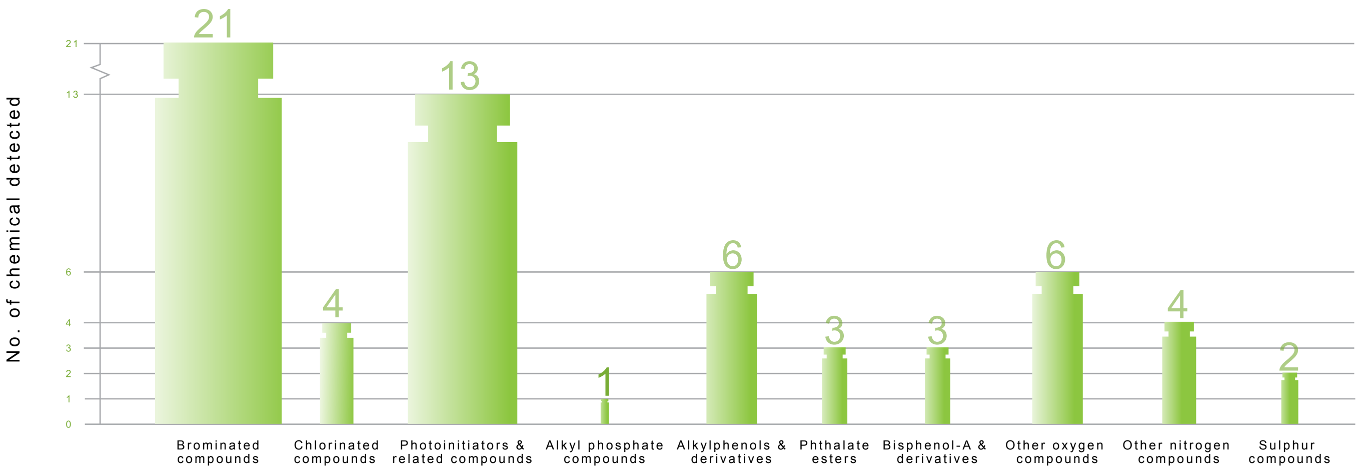


*Figure 3: Detected key organic pollutants from the direct discharge of the five facilities**

*(* Note: Dectected key organic pollutants represent in this graph are the significantly detected organic chemicals found from the 12 wastewater samples. These are most, but not all, organic pollutants identified. Certain chemicals of low significance are not included in this figure)*

Introduction to hazardous chemicals

Acidic discharge (pH)

Acidic wastewater is likely to have a significant impact on aquatic life in the vicinity of the discharge, and it greatly increases the water solubility, mobility and therefore toxicity of metals present in the wastewater.

Alkyl phenols (Organic Chemicals)

The alkyl phenols found in this study are persistent, bio-accumulative and toxic to aquatic life. Exposure to these chemicals can lead to altered sexual development in some organisms.

Octyl phenol (OP), one type of alkyl phenol found in the sample, can cause adverse effects on the reproductive systems, including in mammals. Nonyl phenol (NP) is closely related to OP, and they are well known hormone disrupting chemicals that affect reproductive systems.

Some alkyl phenols are listed as priority hazardous substances under the European Water Framework Directive (WFD).

Beryllium (Metal)

Exposure to beryllium dust/fumes, usually in the workplace, even at very low levels for short periods of time, can lead to chronic beryllium disease (CBD), a debilitating lung disease. Furthermore, workplace dust/fume exposure to beryllium and beryllium compound has been recognised as causing cancer in humans.

Bisphenol-A (Organic Chemical)

Bisphenol-A has long been recognised as a potential endocrine disruptor, and testing has shown it has an impact on reproductive systems and brain development in mammals. It can also disrupt the hormonal system of aquatic organisms.

Because of its toxicity, the Canadian Government has proposed listing Bisphenol-A as a toxic substance under the Canadian Environmental Protection Act. It has banned the advertising, sale and import of polycarbonate baby bottles that uses this chemical.

Copper (Metal)

Copper is widely used in the manufacture of electronic products.

It is an important element for humans and animals in low doses, but exposure to high levels can lead to bio-accumulation and toxic effects.

Many aquatic organisms are extremely sensitive to copper, particularly in soluble forms that are generally far more bio-available and toxic to a wide range of aquatic plants and animals. Some effects occur at extremely low concentrations.

Dichloromethane (Organic Chemical)

Dichloromethane, also known as methylene chloride, is a commonly used industrial solvent, especially in de-greasing and paint-removing applications. It is highly volatile, and inhalation can be a primary route of exposure near industrial facilities.

Dichloromethane is harmful if inhaled or swallowed, and it can irritate and burn the skin. It is a possible mutagen and human carcinogen.

No limit has been set for dichloromethane under Guangdong effluent standards, but there are maximum permitted concentrations for similar chlorinated chemicals of between 30μg/l and 1000μg/l, much lower than the level found (940μg/l).

Manganese (Metal)

Exposure to high levels of manganese can produce toxic effects on the nervous system, including damage to the brain.

Introduction to hazardous chemicals

Photoinitiators and related chemicals (Organic Chemicals)

Photoinitiators are light-sensitive compounds that are used to induce polymerisation or to cure materials. They are used extensively in manufacturing printed circuits.

Industrial developments during the last two decades have promoted fast growth in research and synthesis of these types of chemicals. However, very little information is available publicly concerning the toxicity of these new compounds, not to mention their potential effects on human health and the environment.

Amongst the available information for chemicals found in the sample, there is evidence that thioxanthones, which act as sensitisers for photoinitiators, can cause long term effects in aquatic organisms at relatively low concentrations. Benzophenones, which also act as sensitisers for photoinitiators, have been found to have toxic effects on the livers and kidneys of animals, and they have displayed potential hormone disrupting properties in several tests.

Phthalates (phthalate esters) (Organic Chemical)

Phthalates are primarily used as plasticisers. Substantial concerns exist about their toxic effects on wildlife and humans. Three types were found in the samples.

One type of phthalates, DEHP, which is commonly used to make flexible PVC plastic products, is known to be toxic to the reproductive development of mammals, while another type of phthalates, DnBP has also been reported to have reproductive toxicity. These two phthalates have been identified as ‘substances of very high concern’ under the REACH Regulation in the European Union, and DEHP is listed as priority hazardous substance under European Water Framework Directive (WFD).

TBBPA (Organic Chemical)

Around 210,000 tonnes of TBBPA are used worldwide every year, the largest volume of any brominated flame-retardant (BFR) in the market. Studies show TBBPA may interfere with endocrine (hormone) systems, and have other toxic effects. Furthermore, its degradation can produce bisphenol A, a well-known endocrine disrupter.

Tris (2-ethylhexyl) phosphate (TEHP) (Organic Chemical)

TEHP has been extensively used as a flame retardant and solvent. It has a low acute toxic effect on mammals, and there is evidence that high levels of exposure to it have a carcinogenic effect on animals.

2,4,6-Tribormophenol (2,4,6-TBP) (Organic Chemical)

2,4,6-TBP may affect the nervous system, and have an impact on developing embryos and foetuses in animals. Studies have also shown that it may have disruptive effects on the endocrine system.

Sampled Facilities

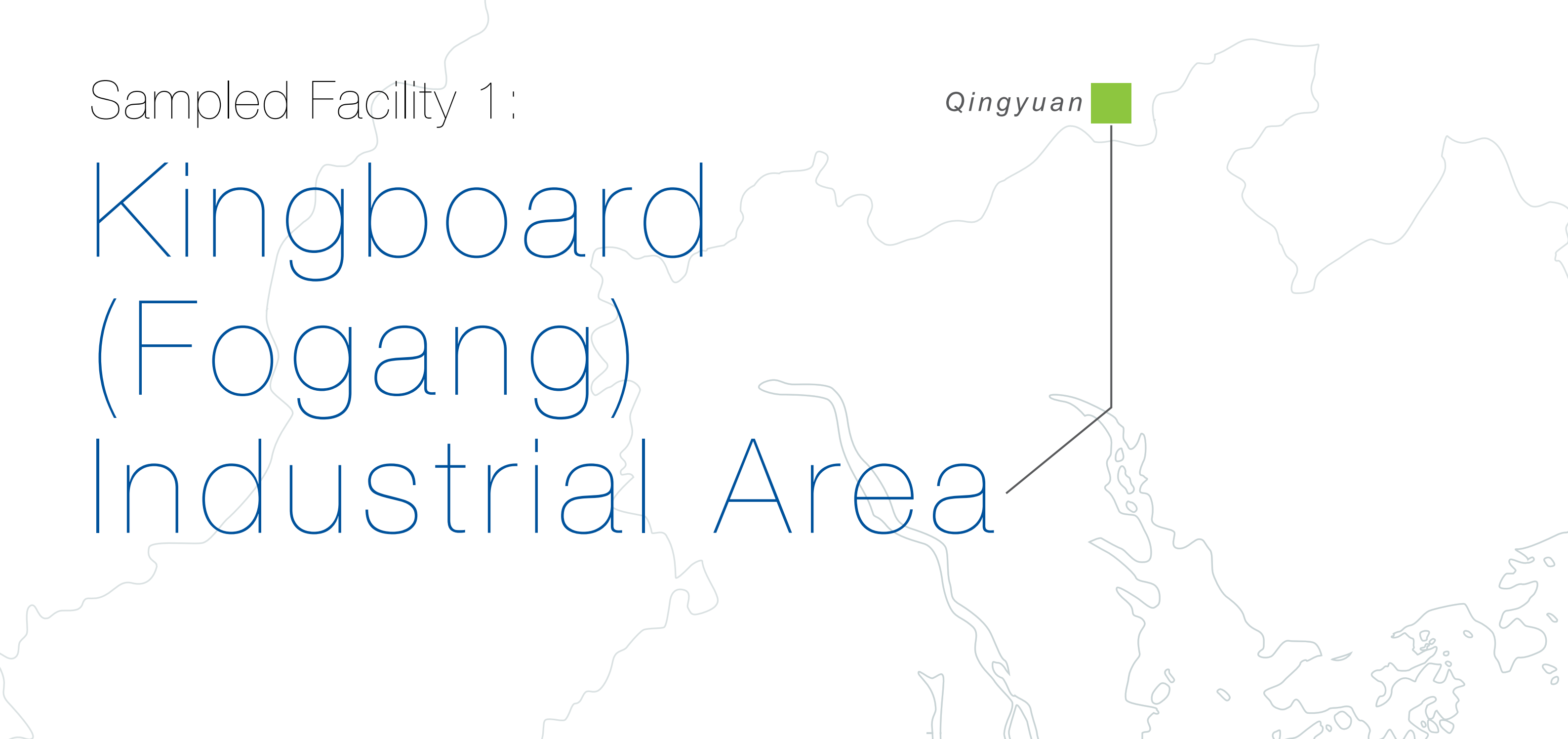
Kingboard (Fogang) Industrial Area

Kingboard (Panyu Nansha) Industrial Area

Wing Fung P.C. Board Co., Ltd.

Dasha Industrial Area, Dalingshan Town, Dongguan

Qingyuan Top Dragon Textile Co., Ltd.



Sampled Facility 1:

Kingboard (Fogang) Industrial Area


River on the west side of the industrial area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Stream on the north side of the industrial area


© Greenpeace/John Novis

Front gate of the production facility within the industrial area

Brief description of the sampling area

This industrial area is part of Kingboard Chemical Group, one of the world's largest producers of laminates and printed circuit boards. The Group manufactures a wide range of products, including chemicals, copper foil, glass fabric, glass yarn, bleached kraft paper, liquid crystal displays and magnetic products.[12]

Kingboard (Fogang) Industrial Area is located in Shijiao Town, Fogang County, Qingyuan City, Guangdong Province.[13] This very large site is situated on the banks of the Pa River (Pajiang), a tributary of the North River (Beijiang) in the Pearl River system. Huangwen Village is situated opposite the industrial area and a small stream flows between the two locations. The Kingboard Chemical Group's corporate website states there are eight factories in the industrial area. All of these facilities make chemicals and components that are used for printed circuit boards manufacturing.

Two discharge pipes were seen in the vicinity of the TECHWISE Shirai (Fogang) Circuits factory, one of the factories in Kingboard (Fogang) Industrial Area. One pipe was the main outfall of TECHWISE's wastewater treatment station. It discharged directly into a small channel that flows into the Pa River. The other was much smaller and concealed, and it was located beneath a wall adjacent to the TECHWISE factory, and it discharged into the same small channel that flows into the Pa River.

Factories situated in the Kingboard (Fogang) Industrial Area

Production Facility		Products
1.	TECHWISE (Qingyuan) Circuits Co., Ltd	Printed Circuit Boards[14]
2.	Kingboard (Fogang) Chemical Co., Ltd	Formalin[15](a saturated solution of formaldehyde)
3.	Kingboard (Fogang) Special Resin Co., Ltd	Polyvinyl Butyral (PVB) Resin[16]
4.	Fogang Kingboard Holdings Limited	Copper Foil[17]
5.	Kingboard (Fogang) Paper Laminates Co., Ltd.	Sheet Paper Laminates[18]
6.	Kingboard (Fogang) Laminates Co., Ltd.	Glass Epoxy Laminates[19]
7.	Kingboard (Fogang) Insulated Material Company Limited	Copper-clad Paper Laminates[20]
8.	QingYuan Chung Shun Century Fiberglass Co., Ltd.	Glass Filaments[21]
All the facilities listed above are subsidiaries of the Kingboard Chemical Group. For more information, please refer to p24.		

Key Findings

Beryllium concentration exceeding permitted level	One water sample had a concentration of beryllium (123 μg/l) that was 25 times the maximum level allowed under Guangdong effluent standards
Manganese concentration exceeding permitted level	One water sample had a concentration of manganese (17100 μg/l) that was three times the maximum level allowed under Guangdong effluent standards
Acidic discharge (pH) outside the permissible range	One of the water samples was highly acidic (pH = 1), which was far outside the permissible pH range (pH = 6-9) under Guangdong effluent standards
Brominated compounds found	Brominated compounds, including flame retardant tetrabromobisphenol-A (TBBPA), were found .
Alkyl phenols and derivatives found	Alkyl phenol and its derivatives, such as octyl phenol and octyl phenol ethoxylates, were found
Photoinitiators and related chemicals found	A number of photoinitiators and related chemicals were found in the samples; there is very little information on the toxicity of these compounds.

For detailed description of each chemical, please refer to p.16-17. Details of sampling result, please refer to Appendix.

Key pollutants present in the wastewater discharge

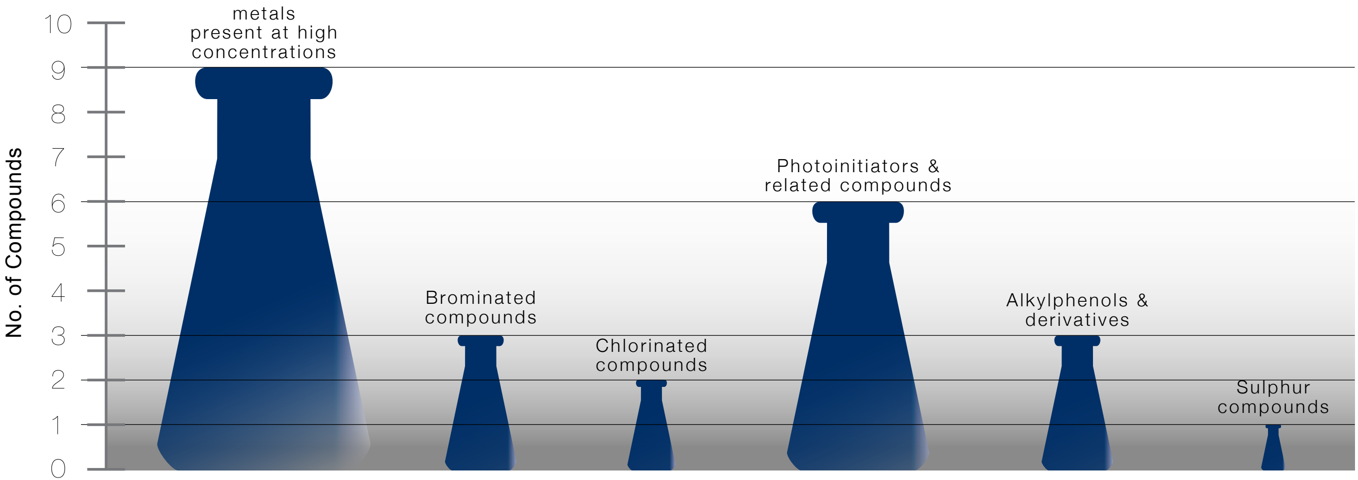


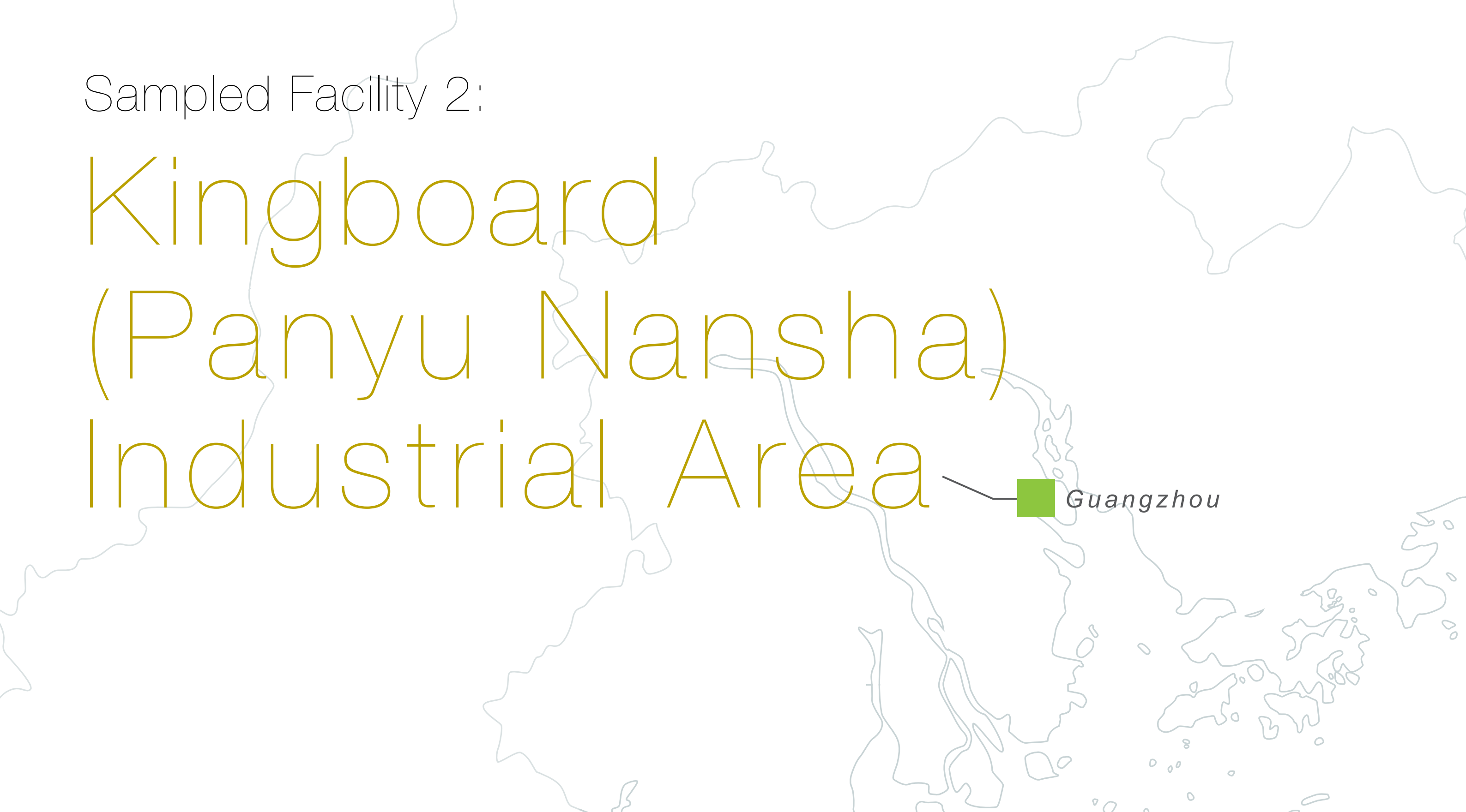
Figure 4: Key pollutants present in the wastewater discharge

Mandatory Clean Production Auditing

Kingboard (Fogang) should undergo Clean Production Auditing under the Clean Production Promotion Law due to its release of hazardous chemicals, including copper and TBBPA. The facility should also come up with methods to reduce and eventually eliminate its use and release of these pollutants.

Sampled Facility 2:

Kingboard (Panyu Nansha) Industrial Area



A discharge outfall connected to the outside wall of the industrial area

Outline of the industrial area

Brief description of the sampling area

The Kingboard (Panyu Nasha) Industrial Area is situated in the Nansha Economic and Technological Development Zone in Panyu, Guangdong Province. Three factories are located inside the area: Kingboard (Panyu Nansha) Petrochemicals, Kingboard New Poly Chemical (Guangzhou), and Guangzhou Chung Shun Century Fibre Glass.

Kingboard Petrochemical manufactures epoxy resins, low and high brominated resins, and tetrabromobisphenol-A (TBBPA), a toxic brominated flame retardant used in the manufacture of brominated resins. Other products include melamine and sulfuric acid amine. Thousands of tonnes of these products are manufactured in the facility every year.[22]

The Kingboard New Poly Chemical facility, a subsidiary of Kingboard Laminates Holdings,[23] manufactures brominated epoxy resins, including TBBPA based resins. It has an annual production capacity of 20,000 tonnes.

Factories situated in the Kingboard (Panyu Nansha) Industrial Area

Production Facility		Products
1.	Kingboard (Panyu Nansha) Petrochemical Company Limited	Epoxy resin, low and high brominated resin, melamine, sulfuric acid amine and tetrabromobisphenol A[24]
2.	Guangzhou Chung Shun Century Fibre Glass Co.	Non-alkali glass yarn and related products[25]
3.	New Poly Chemical (Guangzhou) Co. Ltd	Liquid Epoxy Resins, Propanone, Tetrabromobisphenol A, etc.[26]
All the facilities listed above are subsidiaries of the Kingboard Chemical Group. For more information about the Group, please refer to on p.24.		

Key Findings

Various types of brominated flame retardants found	TBBPA (also found in Kingboard (Fogang)) and 2,4,6-tribormophenol (2,4,6-TBP) found in wastewater discharges.
Phthalates found	Three phthtalates (pthalate esters), DEHP, DnBP and DiBP, were identified
Bisphenol-A found	Both Bisphenol-A and its derivatives were found in discharges
Organophosphorus esters found	Tris(2-ethylhexyl)phosphate or TEHP, a commonly-used flame retardant and solvent, was found
Photoinitiators and related chemicals found	A number of photoinitiators and related chemicals were found in the samples; there is very little information on the toxicity of these compounds.

For detailed description of each chemical, please refer to p.16-17. Details of sampling result, please refer to Appendix.

Key pollutants present in the wastewater discharge

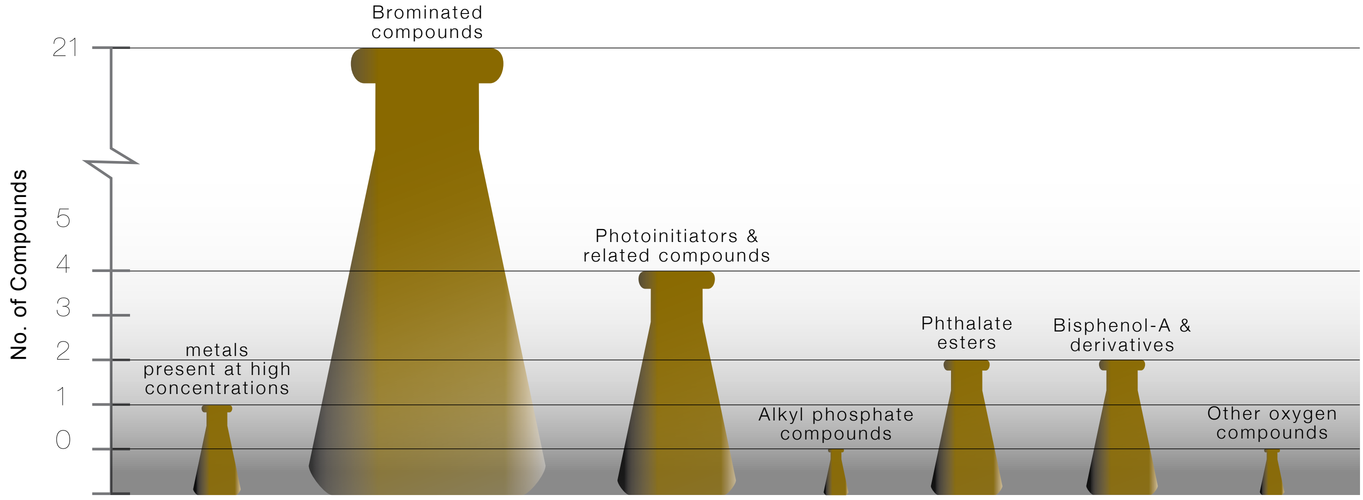


Figure 5: Key pollutants present in the wastewater discharge

Mandatory Clean Production Auditing

Kingboard (Panyu Nansha) should undergo Clean Production Auditing under the Clean Production Promotion Law due to its release of hazardous chemicals, including copper (see Appendix) and TBBPA. It should also come up with methods to reduce and eventually eliminate its use and release of these pollutants.

Sampled Facility 3:

Wing Fung P.C. Board Co., Ltd.


Front gate of the facility

© Greenpeace / John Novis


A discharge outfall of the facility

Brief description of the sampling area

The Wing Fung P.C. Board facility is located in Jiao Yuan Industrial Zone, Shajing Town, Shenzhen City. It produces multi-layered printed circuit boards.[27] The facility is owned by Jiangmen Glory Faith PCB Co. Ltd, a subsidiary of Kingboard Chemical Holdings Ltd.[28]

The Wing Fung facility discharges wastewater into an open channel via an outfall labelled "Wing Fung Inspection Site". The open channel, which also receives wastewater from the discharge pipes of factories in industrial zones located upstream and downstream of the Wing Fung facility, ultimately flows into tributaries of the Pearl River catchment and ends up at the mouth of the Pearl River.[29]

Company Profile		
Production Facility		Products
1.	Wing Fung P.C. Board Co., Ltd.	Printed circuit boards, mainly used in household appliances, audio-visual products, lighting, digital consumer products, automobiles, computing, electronics, aerospace and military manufacturing.
Wing Fung's holding company is Jiangmen Glory Faith PCB Co. Ltd, which is a subsidiary of the Kingboard Chemical Group. For more information, please refer to p. 24.		

Key Findings

Copper concentrations exceeding permitted levels	Discharged wastewater contained an extremely high concentration of copper (25600 µg/l), which is 12 times higher than the maximum permitted limit under Guangdong effluent standards.
Various brominated compounds found including TBBPA	TBBPA, as well as 10 other brominated compounds were found in wastewater discharge.
Two phthalates found	DiBP and DnBP were identified.
Problematic photoinitiator compounds found	Six photoinitiator related compounds were found in Wing Fung's discharge.

For detailed description of each chemical, please refer to p.16-17. Details of sampling result, please refer to Appendix.

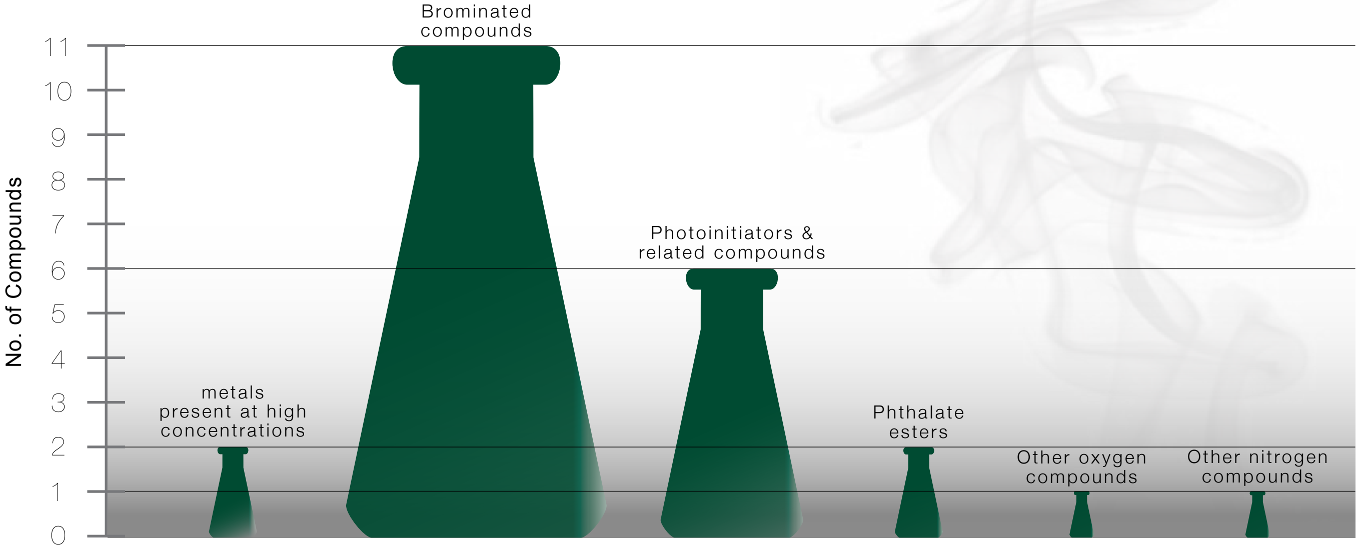

Key pollutants present in the wastewater discharge

Figure 6: Key pollutants present in the wastewater discharge

Mandatory Clean Production Auditing

Wing Fung should undergo Clean Production Auditing under the Clean Production Promotion Law due to its release of hazardous chemicals. These include copper and nickel (see Appendix). The facility should also come up with methods to reduce and eventually eliminate its use and release of these pollutants.

About the Kingboard Chemical Group

- A large electronics materials manufacturer operating more than 60 manufacturing facilities
- Specialises in producing laminates and printed circuit boards[30]
- One of the first foreign companies to manufacture and sell laminates in China. In 2007, the Group became the global leader in rigid laminates, with a market share of approximately 11.8% in terms of production value[31]
- Has two companies listed on the Hong Kong Stock Exchange, namely Kingboard Chemical Holdings Ltd. (HK0148) and Kingboard Laminates (HK1888), with market values of HK$25.48 billion and HK$14.85 billion respectively, as of 14 Oct 2009[32]
- Voted one of the “Forbes 2008 Top 2000 Global Companies”, and ranked fifth in the “Forbes Global Top 200 Small size Enterprises” list for six consecutive years[33]

Sampled Facility 4:

Dasha Industrial Area, Dalingshan Town, Dongguan


The effluent ultimately flows into Tongsha Reservoir


A hidden discharge outfall outside the Industrial Area

Brief description of the sampling area

Dalingshan Town is located in the mid-south of Dongguan City in Guangdong Province. There are over 600 foreign enterprises in the town, making Dalingshan one of the most popular destinations for foreign direct investment in the Pearl River Delta.[34] Dasha Industrial Area in Dalingshan town is comprised of electronics, glass, craftwork and printing factories. It is situated next to a stream of Dongjiang (East River) that ultimately flows into Tongsha Reservoir.[35] Tongsha Reservoir is the largest reservoir in Dongguan City and it was once a source of the city's drinking water. However, heavy pollution has lowered its water quality standard to Grade V so the reservoir's water is now only suitable for general landscape purposes.[36]

Locals have reported that the sampled pipe regularly discharges pungent reddish wastewater into the small river. The soil surrounding the outfall pipe is stained orange and red.

The sampled discharge pipe is a composite pipe, the effluent comes from Dongguan Cheongming Printing Co., Ltd., Dongguan Zhixing Electronic Hardware Co., Ltd. and other wastewater discharge sources in the Dasha Industrial Area.[37]

Key Findings

Acidic discharge with high concentrations of a considerable number of metals found	The discharge wastewater was highly acidic (pH = 2), which is outside the allowable range of pH 6-9, as defined by Guangdong effluent standards. The discharge water contained high concentrations of metals such as chromium, copper, zinc and nickel.
Two phthalates found	Two types of phthalates, DiBP and DnBP, were identified.
Chemicals most likely deriving from photoinitiators found	Three photoinitiator-related compounds were identified, including benzophenone and a thioxanthone derivative, probably due to the use of photoinitiators during certain industrial process (e.g. printing processes or etching of printed circuit boards).
Hazardous chlorinated volatile organic compounds (VOC) found	Dichloromethane, a hazardous chemical commonly used as an industrial solvent, was found in the discharge. However, this compound is not regulated under Guangdong effluent standards.

For detailed description of each chemical, please refer to p.16-17. Details of sampling result, please refer to Appendix.

Key pollutants present in the wastewater discharge

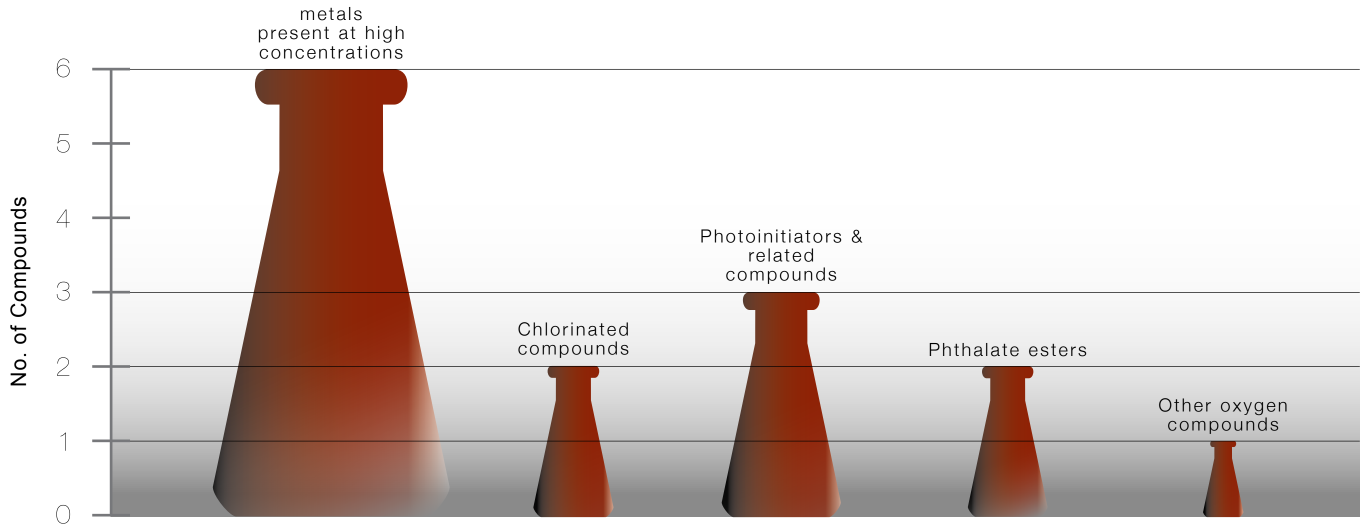


Figure 7: Key pollutants present in the wastewater discharge

Clean Production Auditing in Dasha Industrial Area, Dalingshan Town, Dongguan

Hazardous chemicals are not tested by the Environmental Protection Bureau of Dalingshan District, Dongguan City. The Bureau has not investigated and disclosed the use and release of hazardous chemicals in the Dasha Industrial Area, thus making it hard to trace the source of the chemicals found in the samples.

The industrial facilities in Dasha Industrial Area should undergo clean production auditing, thereby strengthening their control over hazardous chemicals, and taking the first step to eventually eliminate the use and release of hazardous chemicals.

Sampled Facility 5:

Qingyuan Top Dragon Textile Co., Ltd.


© Greenpeace / John Novis

Front door of the facility


A hidden discharge outfall outside the facility

Brief description of the sampling area

The Top Dragon Textile facility is located in Taihe Industrial Zone, Qingxin County, Qingyuan City, Guangdong Province.[38] The facility began operating as a Sino-foreign (Hong Kong) joint venture in 2003, but it was sold to a Shenzhen company and became a private enterprise in 2006.

The facility is situated on the banks of a stream that comes from an ancient scenic spot called the Taihe Ancient Cave Area. A small community called Leyuan village is located next to the factory, with only a wall encircling the latter between them.[39] The stream ultimately flows into the North River (Beijiang), one of the main tributaries of the Pearl River. Wastewater is discharged from Top Dragon via an underground channel which flows into a nearby stream approximately 100 metres from the facility.

Company Profile	
Type of industry:	Textile manufacturing, including sizing, dyeing, weaving and finishing
Manufactured products:	Denim
Holding company:	Qingyuan Top Dragon Textile Co., Ltd.
Stock code on the Hong Kong Stock Exchange:	Not listed
Market value:	No data
Brief background:	According to the Qingyuan City Environmental Protection Bureau, the company was reported in 2008 as having a bad environmental record due to the "improper use of water treatment facilities and pollutants in excess of standards".[40]

Key Findings

Manganese concentration exceeding permitted limits	The highest concentration of manganese in the wastewater samples (5390 µg/l) exceeded the upper limits of Guangdong effluent standards (2000-5000 µg/l).
Chemicals most likely derived from photoinitiators found	Two photoinitiator related compounds were identified, including a benzophenone derivative, which are likely to be the result of using photoinitiators during printing processes.
Alkyl phenols found	Nonyl phenol was detected.
The discharge, via an underground discharge pipe, showed variable discharge practices at different times of the day	Samples were taken from the same discharge pipe twice, once during the daytime and once at night. The data confirmed there is a high degree of variability in the quality of discharged wastewater, depending on the time. For instance, the manganese concentration is higher in wastewater discharged during night time.

For detailed description of each chemical, please refer to p.16-17. Details of sampling result, please refer to Appendix.

Key pollutants present in the wastewater discharge

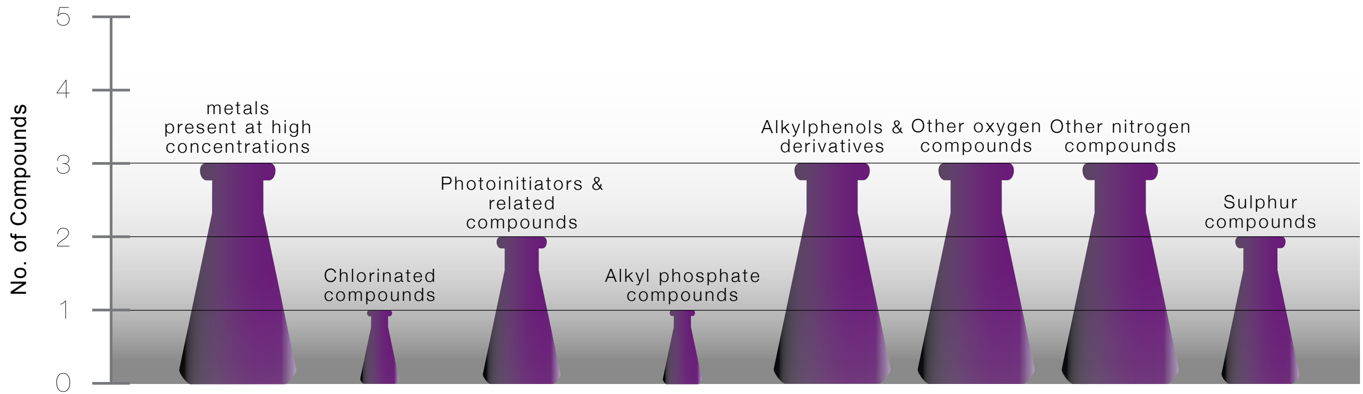


Figure 8: Key pollutants present in the wastewater discharge

Mandatory Clean Production Auditing

Qingyuan Top Dragon should undergo Clean Production Auditing under the Clean Production Promotion Law due to its release of hazardous chemicals, including di-chlorinated benzenes (see Appendix) and alkyl thiols (see Appendix). It should also come up with methods to reduce and eventually eliminate its use and release of these pollutants.

> ”The fish we catch here taste different to how they did in the past. That’s especially true of the fish we catch near those industrial discharge pipes. They always taste strong and soapy like shampoo. So now we spend much less time catching fish around those areas. Instead, we take our boats a lot further away.”
>
> *– Mr. Li, aged 42, a fisherman living in Nansha city, near the Kingboard Nansha Industrial Area*

3.

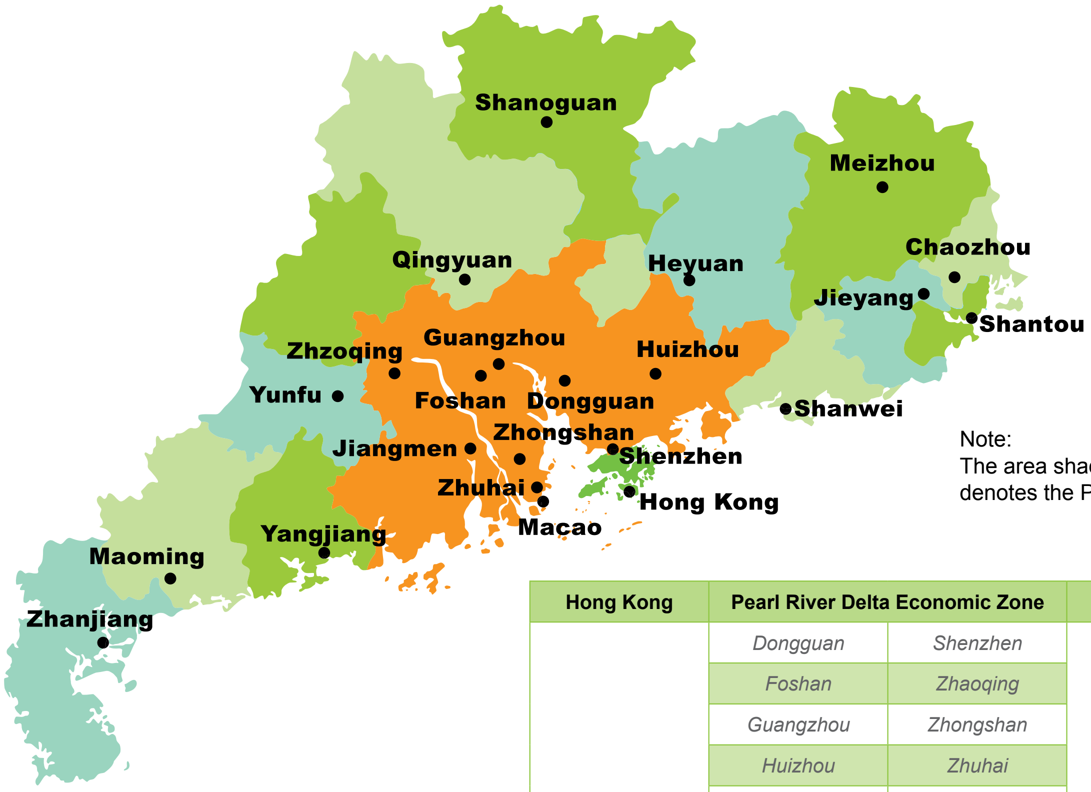
The Pearl River Delta, the "world's factory floor"

3. The Pearl River Delta, the world's factory floor

Water pollution caused by hazardous chemicals from industries like the five cases reported by Greenpeace must be put into the larger context of environmental degradation in the Pearl River Delta (PRD). Often referred to as the "world's factory floor" because of its position as China's main export manufacturing hub, the PRD has experienced more massive economic growth than any other Chinese regions since the opening up of China's economy. Unfortunately, this has come at heavy environmental cost.

Guangdong Province and the Pearl River Delta Economic Zone

Source: Invest HK (www.investhk.gov.hk)



Note:
The area shaded orange denotes the Pearl River Delta

Hong Kong	Pearl River Delta Economic Zone		Macao
	Dongguan	*Shenzhen*	
	Foshan	*Zhaoqing*	
	Guangzhou	*Zhongshan*	
	Huizhou	*Zhuhai*	
	Jiangmen		
1,100 sq km	*41,698 sq km*		*26 sq km*

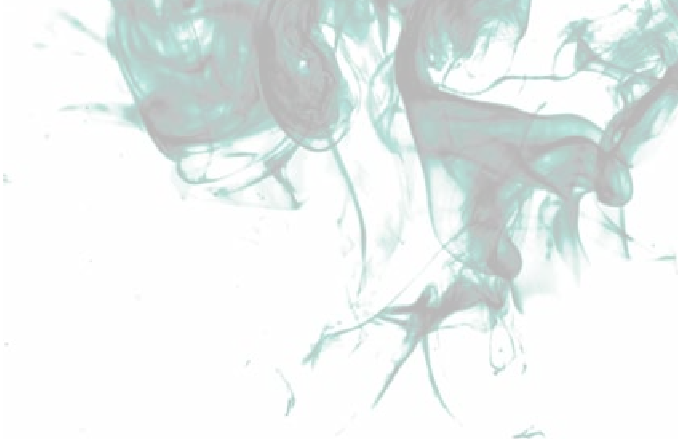
Figure 9: Guangdong Province and the Pearl River Delta Economic Zone

The PRD's economic development

> Since the onset of China's reform programme, the Pearl River Delta Economic Zone has been the fastest-growing portion of the fastest-growing province in the fastest-growing large economy in the world.[41]
>
> — *InvestHK*

Located in the lower reaches of the Pearl River estuary, where the Pearl River flows into the South China Sea, the PRD is one of China's most economically developed regions. It consists of nine prefectures in Guangdong province, namely Guangzhou, Shenzhen, Dongguan, Foshan, Huizhou, Jiangmen, Zhaoqing, Zhongshan and Zhuhai. A population of 47.2 million people inhabit its 41,698-square-km area.[42] The Hong Kong and Macau special administrative regions are adjacent to its south.

The PRD has played a pivotal role in driving China's transition from a planned economy to a market-oriented one. It was one of the country's first regions to open up to foreign investment. Two of China's four original special economic zones (Shenzhen and Zhuhai) are located in the PRD.



Between 1980 and 2006, the PRD’s average economic growth figure (regional GDP) exceeded 16% a year, compared with Mainland China’s average annual economic growth (national GDP) rate of 9.8%.[43] In 2007, the PRD accounted for more than 80% of Guangdong’s GDP and 10.2% of China’s GDP.[44] [45] [46]

Manufacturing has been the mainstay of the PRD’s rapid industrialisation and urbanisation. In 2005, its urbanisation rate was 77.32%, higher than any other regions in China and comparable to the rates in developed countries like the USA and Japan.[47] However, unlike most developed countries, the region’s industrial structure has been characterised by prominent secondary industry and much less-developed tertiary industry. This shows the dominance of manufacturing-based growth over the service sector.

Most products made in the PRD are exported, and the region accounted for 29.1% of China’s total exports in 2007.[48] Foreign capital has played a big role in the PRD, and the region received 17.5% of the country’s Foreign Direct Investment (FDI) during the same year.[49]

The PRD’s main industries

The PRD’s industrialisation began in the early 1980s. To begin with, its main products were labour-intensive consumer goods, such as food and beverages, toys and clothes. However, the relocation of more industrial operations to the region in the mid-1980s, mainly from Hong Kong, accelerated the growth of light industry. This was followed in the early 1990s by heavy industry, especially hi-tech electronic equipment and machinery, chemical products, automobiles, etc.[57]

Hong Kong s relationship with the PRD

Ever since it was first opened up, the PRD economic zone has remained a favourite location for investments by Hong Kong enterprises. Hong Kong is the largest single source of FDI in the PRD and the rest of Mainland China. The following figures illustrate Hong Kong’s economic relationship with the PRD:

- About 64.7% of the total value of FDI in Guangdong province between 1979 and 2005 – accounting for more than US$100 billion -- came from Hong Kong, with most of it going to the PRD[50]
- 70% of investment in Guangdong Province from Hong Kong was invested in manufacturing industries[51]
- About 70% of the total value of investments in “processing and assembly”[52] in Guangdong between 1986 and 2005 came from Hong Kong[53]
- Between 60,000 and 70,000 factories in the PRD were operated by Hong Kong enterprises in 2005[54] [55]
- More than 11 million workers in the PRD were employed by Hong Kong enterprises in 2005[56]

In 2007, Guangdong’s nine “pillar industries”, centred around the PRD, were:[58]

Table 4: Major industries and the Gross output value in Guangdong province

Industries ranked by the value of their output	Gross output value (RMB bn)	Percentage of total gross industrial output value accounted for by enterprises included in the survey (see note B below)
Electronic Information	1,337.7	24.2
Electrical Equipment and Special-Purpose Equipment	850.2	15.4
Petroleum and Chemicals	505.0	9.1
Textiles and Garments	304.4	5.5
Motor Vehicles	257.4	4.7
Food and Beverages	237.5	4.3
Building Materials	221.4	4.0
Logging and Papermaking	131.1	2.4
Medicines	43.2	0.8

Notes:
(A) The figures in value terms are calculated at 2008 prices.
(B) The statistics cover all state-owned and non-state-owned enterprises with an annual sales revenue in excess of RMB5 million.

3. The Pearl River Delta, the world's factory floor

Industrial water pollution in the PRD

Unfortunately, the PRD’s economic growth has come at a huge cost in terms of its environment, including the water quality of the Pearl River and its tributaries, which have visibly deteriorated in recent years. Research conducted by Chinese scientists in 2002 showed that nearly half the River’s urban sections within the region were seriously polluted, and water bodies within the urban zones of Guangzhou, Dongguan and Shenzhen were described as “extremely polluted”.[59] According to a 2002 World Bank study, many reaches of the Pearl River were considered unfit as sources of drinking water, due to pollution.[60] In 2007, the Guangdong Water Resources Department revealed that 7.25 million of the province’s rural population were drinking polluted water.[61]

Domestic and industrial wastewater discharges, urban storm water run-off, and non-point source pollution from agricultural and livestock farm run-off are regarded as the main sources of water pollution in the PRD. In 2007 only about 30% of the total volume of the PRD’s wastewater was treated before it was discharged.[62]

Water scarcity is further increasing pressure on clean water sources. Some studies forecast that – as a result of water pollution and its inefficient use – Guangdong province’s overall water supply will have a shortfall of 3.1 billion cubic metres by 2020 if no measures are taken to address the problem.[63] That equals to about 50% of its demand for water in 2007.[64] The increasing scarcity of water makes it even more imperative to ensure what is available does not become polluted.

Classification of Water Quality in China

Under the Environmental Quality Standard for Surface Water (GB 3838-2002), the MEP uses the following grades to determine water quality in China:

Grade I:	Water sources and national nature preserves
Grade II:	Level I protected area for drinking water supply, suitable habitat for rare species of fish
Grade III:	Level II protected area for drinking water supply, suitable habitat for common species of fish, and swimming zones
Grade IV:	Industrial water supply; suitable for recreation when there is no direct human contact with the water
Grade V:	agricultural water supply and general landscaping

The trend of deteriorating water quality in the PRD is shown by the Guangdong Water Resources Department statistics below. In fact, the PRD’s water quality has been steadily deteriorating since 2001, and more than 60% of its water sources were designated as either Grade IV or Grade V (see Table 5). For these grades, the government uses the general chemical parameter Chemical Oxygen Demand (COD) to determine the level of water pollution. However, it is worth noting that the parameters BOD and COD indicate a general oxygen demand (i.e. the amount of oxygen that could be consumed during the degradation of the material within a sample), and do not provide indication as to what types of chemicals – including hazardous chemicals – are present. The presence of certain toxic and persistent chemicals in water will not significantly affect the COD level, further highlighting the limitation of relying on this type of measurement for water quality. However, they can still provide some reference on the PRD’s desperate water quality situation.

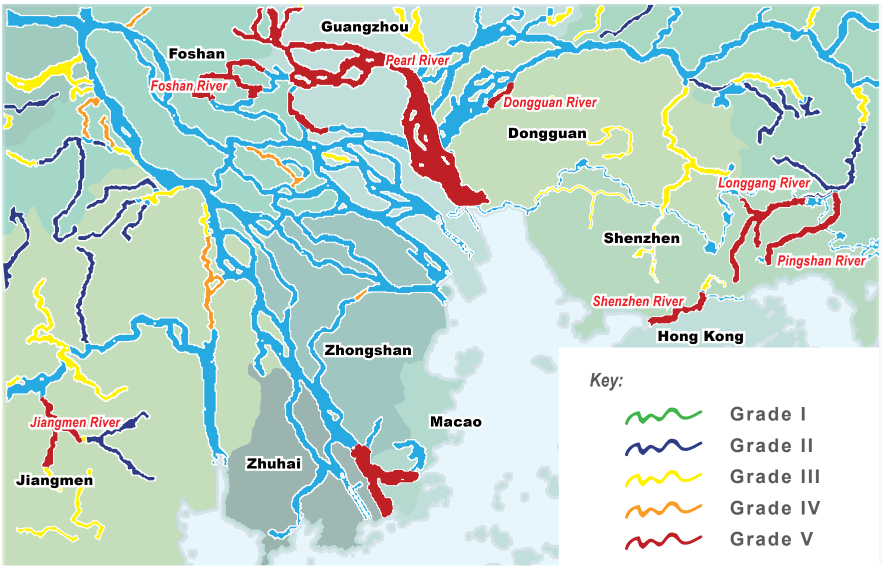


Figure 10: Overview of water quality in the PRD

Source: He M., The Water Household as an Example of Ecology in the Pearl River Delta.[65]

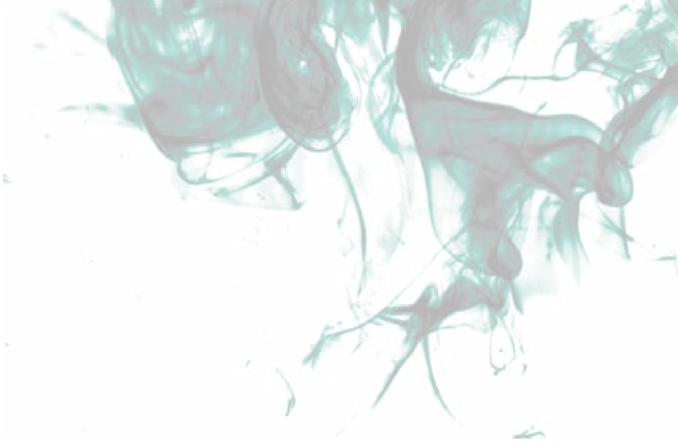


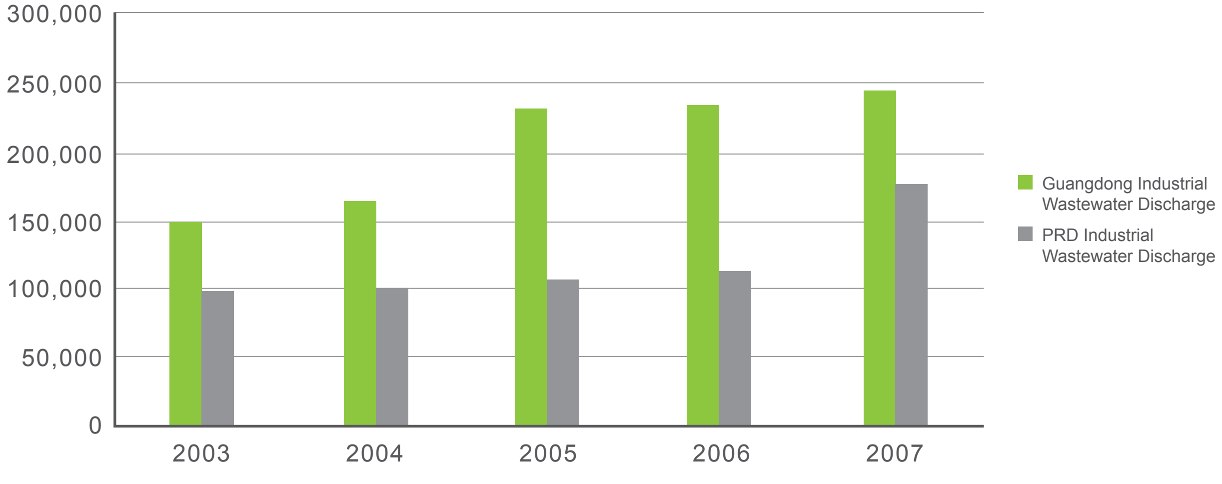
Table 5 : River water quality in the PRD (2000-2007)[66]

Year	Grade I (%)	Grade II (%)	Grade III (%)	Grade IV (%)	Grade V (%)	Below Grade V (%)	% of water session of Grade IV/V/Below V
2000	0	49.68	28.39	0	8.68	13.25	21.92%
2001	N/A	3.45	46.31	9.76	5.21	9.76	24.73%
2002	0	16.90	56.87	2.52	3.78	19.92	26. 22%
2004	0	29.94	20.58	15.72	8.44	25.32	49.48%
2005	0	27.73	17.06	27.73	7.41	20.13	55.27%
2006	3.1	15.18	18.80	12.27	15.65	35.06	62.98%
2007	0	18.11	20.32	11.27	23.53	26.78	61.59%

Source: Ministry of Water Resources China 2000-2007[67]

The volume of industry-generated wastewater being discharged in the PRD has been rising in line with the overall deterioration of water quality. Between 2003 and 2007, industry-generated wastewater increased by 52.1%, from 1.57 billion tonnes to 2.38 billion tonnes, with an annual average increase of 8.74%.[68] In 2007, industry-generated wastewater accounted for 74.8% of all the wastewater discharged in the PRD.[69]

Figure 11: Industrial wastewater discharges in Guangdong province and the PRD (2003-2007)



Sources: 2008 Guangdong Statistical Year Book and 1997-2007 Guangdong Environmental Report

Studies on Hazardous Chemicals in the PRD

The monitoring of pollutants within, and being released to, the Pearl River system, as well as pollution prevention and control measures, have tended to focus on a limited range of pollutant criteria which include levels of nutrients such as nitrogen and phosphorus, fecal bacteria, and general measurements of chemical load such as biological and chemical oxygen demand (BOD & COD)[70]. Although a small number of individual industrial chemicals and chemical groups are addressed, inputs to the river system remain unregulated for the majority of chemicals manufactured, used and released in the Pearl River basin.

Numerous academic studies have demonstrated contamination of the PRD with hazardous chemicals, including heavy metals[71] and persistent organic pollutants.[72] It is highly likely that the chemicals highlighted in these studies are only a few amongst the thousands of chemicals currently used and released to the environment within the river basin.

“I’ve been to many places that were severely affected by water pollution. I can’t find any words to express my sorrow when I see the residents of the entire villages located next to factories are suffering from health problems. They dare not complain because they fear retribution. It also scares me when I see so many people eating food that has been grown in plots next to these sources of pollution. When will we say that ‘enough is enough’? Without clean water, we don’t have a future.”

– Lai Yun, Toxics Campaigner for Greenpeace China

4.

China’s current industrial water pollution policies and problems

4. China s current industrial water pollution policies and problems

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China is making great efforts to curb industrial water pollution and improve the quality of the water in its rivers and lakes. Yet, as Greenpeace investigation found, the problem of industrial water pollution in the Pearl River Delta (PRD) remains severe. This reflects the inadequacies of the country's conventional approach to addressing this issue, and calls for a paradigm shift towards the prevention and elimination of pollution through clean production, an emerging area within China's environmental policy framework.

4.1. The Old Approach: The Water Pollution Control Framework

The existing system for controlling industrial water pollution was created as part of the Water Pollution Control Law, which was enacted in 1984 and amended in 2008. It consists a comprehensive system of ambient quality standards and technology-based effluent standards. The former define the maximum permissible levels of pollutants in a given water body, while the latter set limits to regulate the level of pollutants discharged from discharge pipes. On the national level, five ambient quality standards govern bodies of surface water, groundwater, irrigation water, seawater and fishing water. The effluent standards include a set of industry-specific standards covering 23 industries, as well as an overall Integrated Wastewater Discharge Standard that covers any industry that does not have an industry-specific effluent standard. All the standards are in the form of concentration limits for a list of pollutants.

Both sets of standards were created by the Ministry of Environmental Protection (MEP), China's central environmental agency, as mandated by the Water Pollution Control Law. The Law also gives provincial governments (and governments of directly-administered municipalities (DAMs) and autonomous regions) the power to promulgate provincial standards that are more stringent than the national ones. This means they may choose either to regulate more pollutants or set stricter limits than the national standards. Provincial standards take precedence over national standards in the provinces that enact them.

Besides ambient quality standards and effluent standards, the State Council has also adopted a Total Emissions Control (TEC) approach since the start of China's 9th Five Year Plan (1996-2000).[73] This aims to tackle severe water pollution problems on a regional and national level. The TEC policy imposes a national cap on target pollutants in the form of an annual tonnage, and it allocates a cap to local governments, which in turn allocate it to individual companies. The TEC approach moves beyond controlling the concentration of pollutants to controlling the total amount of pollutants discharged by industrial facilities, since effluent standards often cannot control an increase in the total pollution load resulting from continuous infusion of wastewater that meets concentration limits. There is currently a national TEC cap on Chemical Oxygen Demand (COD), while sub-national governments have promulgated local caps for other pollutants. For instance, municipalities in the PRD region, such as Shenzhen, have placed TEC caps on pollutants that go beyond COD.[74]

The Structure of Water Pollution Standards in China

National Level Standards

1. Ambient Quality Standards

- Surface Water Quality Standard
- Groundwater Quality Standard
- Seawater Quality Standard
- Irrigation Water Quality Standard
- Fishing Water Quality Standard

2. Effluent Standards

— Industry-specific effluent standards

- Pulp and paper industry
- Ship and shipbuilding industry
- Offshore oil development industry
- Textile industry
- Meat-processing industry
- Synthetic ammonia industry
- Iron and steel industry
- Industries that use aerospace propellants
- Military industry
- Phosphate fertiliser industry
- Caustic soda industry
- PVC-related industry

— Integrated Wastewater Discharge Standard
(All industries not listed above)

Sub-national Level Standards

Provincial Ambient Quality Standards
Provincial Effluent Standards
(e.g. the Wastewater Discharge Standard of Guangdong Province)

4.1.1 Implementation of the Industrial Water Pollution Control System

While local governments are responsible for abiding by the ambient water quality standards set for their jurisdictions, industries are responsible for abiding by technology-based effluent standards and TEC caps allocated by the government. The Water Pollution Control Law stipulates that companies must design and install water-pollution control equipment simultaneously with the construction of their main production facilities. They must also ensure that their pollution-control equipment runs simultaneously with their production processes, and that it meets relevant effluent standards (the so-called “Three Synchronisations Requirement,”).[75]

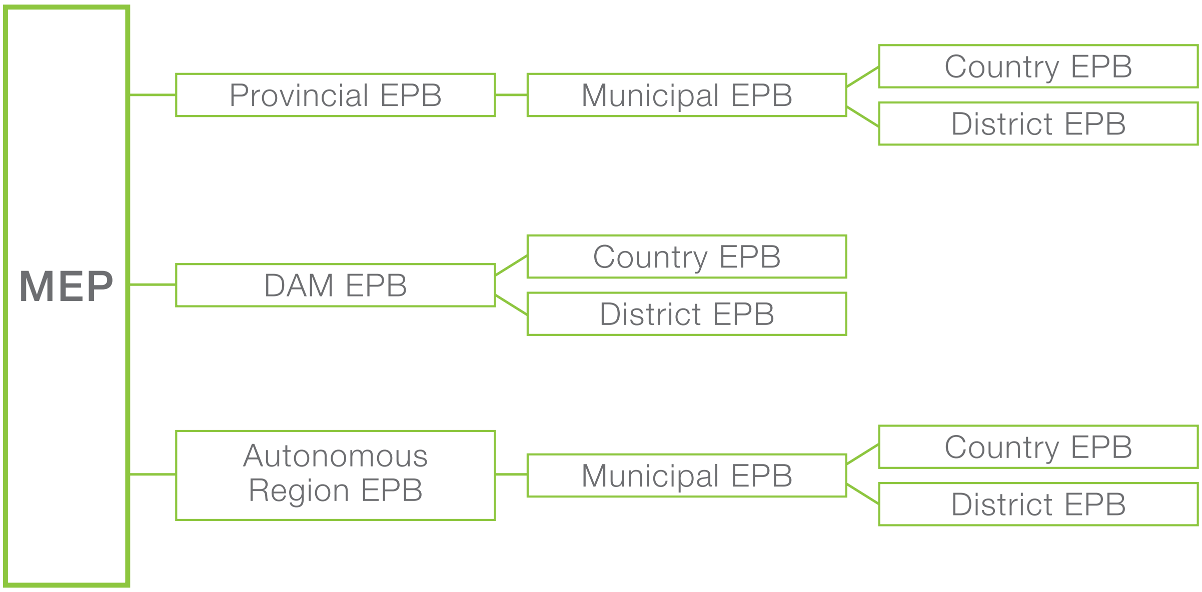
If the pollutants in a company’s effluents exceed standard limits, or if its annual discharge of a single pollutant exceeds the TEC cap allocated to it, the Environmental Protection Bureaus (EPBs) at provincial, municipal and county levels, who are the enforcers of these standards, are authorised to order the company to reduce the level of effluents to compliance level by modifying their operations. A fine will also be imposed if effluent standards or TEC caps are exceeded.

EPBs on the provincial level (including those in DAMs and autonomous regions), prefecture and municipal level, and county level, are responsible for controlling water pollution within their own jurisdictions. Their major industrial water pollution control responsibilities include:

- Monitoring the release of pollutants from industries
- Initiating legal action against non-compliant industrial facilities
- Levying fees for pollution discharges
- Collecting and reporting data on pollution by industrial facilities

Greenpeace co-organized the International Conference on Public Participation in Environmental Protection with the Center for Environmental Education & Communications of Ministry of Environmental Protection of China, April 2008

Figure 12: Structure of the Environmental Protection Authority



4.1.2 Loopholes in the Current Industrial Water Pollution Control System

Although it is comprehensive, the current pollution control system of effluent standards and TEC caps has not yet brought industrial water pollution – especially pollution by hazardous chemicals – under control. There are several key reasons as to why such system under-performs:

4. China's current industrial water pollution policies and problems

1. It does not adequately address hazardous pollutants

Unlike conventional pollutants, which are often discharged in large quantities, many hazardous pollutants, such as heavy metals and organic pollutants, only exist in trace amounts in the water. Even so, they can be much more hazardous to both aquatic life and human health, causing mortality, and increased risk of cancer, mutation, or reproductive problems. The process of bio-accumulation, which allows hazardous chemicals to build up in living organisms and become more concentrated as they move up the food chain, also makes them problematic even when released at very low levels. A great number of these chemicals also persist in the environment, and, unlike conventional pollutants, they are not easily biodegraded. The pollution of hazardous, bio-accumulative chemicals is almost irreversible.

Although hazardous pollutants pose serious threat to water bodies, China's policies on industrial water pollution still place emphasis on conventional pollutants, such as COD and Suspended Solids. For instance, COD was the only water pollutant to be capped at national level in the most recent 11th National Five Year Plan.[76] Even the China's most comprehensive national effluent standard, the Integrated Wastewater Discharge Standard,[77] sets effluent limits for 69 pollutants/pollution indicators, but fails to include many highly hazardous pollutants, such as certain PAHs (e.g. benzo(a) anthracene), which are widely found in Chinese rivers,[78] as well as dichloromethane and octyl phenol, which were found in this investigation.

Guangdong Province's effluent standards

Guangdong province's Provincial Wastewater Discharge Standard is more stringent than the national Integrated Waste Water Discharge Standard. It sets effluent standards for five more pollutants/pollution indicators than the national one.[79] The Total Emissions Control (TEC) approach used in cities like Shenzhen - which places a cap on target pollutants – go beyond COD.[80] These examples show that the PRD does sometimes implements tighter and stronger regulations than those on the national level. Nevertheless, the gap between what is being regulated and what is actually released into the water is still large. For example, dichloromethane and octyl phenol, both of which are highly hazardous chemicals found in industrial effluents in the PRD region, are not regulated under Guangdong's provincial effluent standard.

2. Existing standards are inadequately enforced

The enforcement of existing effluent standards and TEC caps is often weak at the local level, and the absence of systems to disclose pollution information means there is a lack of public scrutiny to hold the polluters accountable. As an OECD study on environmental compliance in China concluded[81]. "A wide gap exists between what EPBs are authorised to apply and what they actually do when enterprises violate environmental rules". The weaknesses in local environmental law enforcement are illustrated by the following facts:

- Many companies only operate their water pollution control equipment when they expect inspection visits to save cost
- A large percentage of small and medium-sized enterprises are not inspected, due to the EPBs' lack of capacity and resources
- Industry-related departments in local governments often interfere with the enforcement of environmental laws to ensure the uninterrupted generation of revenue or employment

3. Intrinsic problems associated with the "pollution control" approach must be recognised

Last, but not least, technology-based effluent standards – the conventional approach to controlling industrial water pollution in China – have intrinsic weaknesses when it comes to controlling hazardous pollutants. They require waste streams to meet the permissible pollution levels set by regulators. And they are often strongly associated (although not explicitly) with "end-of-pipe" technologies that tend to cause a complete or partial shift of many pollutants from one medium to another. Pollution-control measures, such as filters and scrubbers, often aim to capture or concentrate hazardous substances, while subsequent treatments involving chemical, physical or biological methods simply change their form.

For example, discharging hazardous pollutants into the sewage system for subsequent treatment at municipal wastewater treatment facilities often simply results in concentrating many hazardous chemicals into sewage sludge. That is because wastewater treatment plants are only designed to treat organic biological waste, not hazardous chemicals. In fact, many hazardous substances can never be degraded by these kinds of processes. The resulting sewage sludge is therefore contaminated, and it is usually incinerated or disposed in landfills, thereby creating other types of hazardous releases into the environment.

The use of technology-based effluent standards for highly hazardous pollutants also fails to create the need for processes to be reformulated in a way that eliminates hazardous substances. Instead, it focuses on meeting legal emission limits established by national laws, which were set with end-of-pipe technology constraints in mind. In this way, it is more a pollution control technique for hazardous chemicals, rather than the pollution prevention approach that Greenpeace advocates.

4.2 The New Approach: the Clean Production Framework

The inadequacies of the "end-of-pipe" approach to pollution control call for a paradigm shift away from the existing legal/policy framework for addressing industrial water pollution, especially where hazardous chemicals are

concerned. This does not mean we should completely abandon the pollution control approach, as it plays an important role in controlling conventional, non-hazardous pollutants. However, it is clear that by itself it is not enough to tackle persistent hazardous chemicals.

There are already indications that China is moving towards a new approach to preventing and eliminating pollution. One such example is the Clean Production Promotion Law, enacted in 2002. Although it is still relatively new and subject to further improvements, this Law incorporates promising elements that may guide China towards a new approach to hazardous chemical pollution.

4.2.1 A More Holistic Legal Framework

Article 1 of the Clean Production Promotion Law[82] emphasises the concept of preventing pollution by stating:

> *This Law is enacted in order to promote cleaner production, increase the efficiency of the utilisation rate of resources, reduce and avoid the generation of pollutants, protect and improve environments, ensure the health of human beings and promote the sustainable development of the economy and society.*

This is further specified in Article 19:

> *Enterprises in the course of technological upgrades shall adopt the following cleaner production measures: Adopting toxin-free, non-hazardous or low-toxin and low-harm raw materials to replace toxic and hazardous raw materials.*

It also takes into account the need to address pollution throughout the lifecycle of a product, not just “treating” pollution at the end of a discharge pipe. This holistic approach is illustrated by the Law’s definition of “clean production” in Article 2, which refers to the key elements of “design improvement”, “implementation of advanced processes, technologies and equipment” and “reduced pollution at source”. In Article 20, it reinforces the holistic, lifecycle approach to pollution by mandating that “when products and packaging are designed, their influences on mankind and natural environments during their lifecycle must be considered and priority accorded to selecting toxin-free, non-hazardous, easily degraded and easily recycled options”.

In addition, Article 31 incorporates the principle of public participation, with a provision that requires industries to disclose information about the pollution they cause, thereby encouraging greater public scrutiny and pressure on them to reduce it.

4.2.2 Implementation Programmes under the Clean Production Promotion Law

The Clean Production Promotion Law creates a number of implementation mechanisms to promote clean production in China.

Some of these are:

- **Clean Production Auditing**

The Law mandates that two types of companies – those that exceed effluent standards or TEC caps and those that use or release hazardous materials – undergo Clean Production Auditing (Article 28). This diagnostic process examines production processes in their entirety, in order to identify reasons for energy inefficiency and high pollution levels. It also proposes options for reducing energy use and waste streams, including the generation and release of hazardous materials.

Clean Production Auditing must be completed by a certain deadline, and a Clean Production Auditing Report containing implementation plans must be submitted to relevant government departments.

- **Disclosure of Environmental Information**

The Law also requires companies that exceed effluent standards or TEC caps to publish information about their discharges of major pollutants on a regular basis, and to submit to public supervision (Article 31). This provision serves as the legal basis for the MEPs’ recent move to promulgate Measures on Environmental Information Disclosure,[83]which set out more detailed rules concerning the release of information about pollution by companies.

- **Industry-Specific Clean Production Requirements**

In addition, the Law contains industry-specific clean production requirements. For instance, companies that manufacture large electromechanical equipment are required to put labels on their products listing the materials that were used in their production (Article 21); whereas the agricultural sector is forbidden to use hazardous waste as a fertiliser or for building up fields (Article 22).

Although the Clean Production Promotion Law contains some promising elements, it is still relatively new and needs improvement. For example, its criteria for selecting hazardous chemicals for Clean Production Auditing purposes need clarifying. And its requirement for disclosing pollution information only applies to companies that have exceeded effluent standards or TEC caps, not those which use or release hazardous chemicals. Even for the former, the implementation of Measures on Environmental Information Disclosure[84] is still weak, as a recent Greenpeace assessment demonstrated. [85]More importantly, clean production programs still have not been used as major policy tools to combat water pollution in China, compared to conventional pollution control programs.

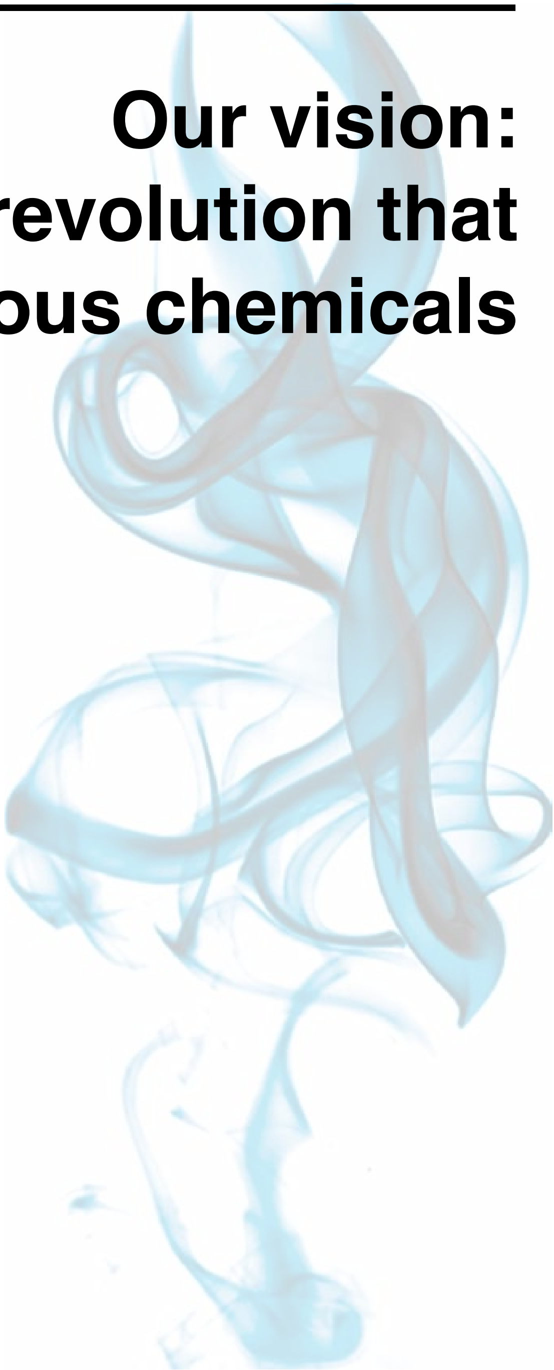
But despite its imperfections, the Clean Production Promotion Law embodies some important principles and elements that Chinese policymakers can further explore and refine in the future. With the political will and the right tools, they will be able to go beyond the current water pollution control approach and start off a clean production revolution in China.

“Sampling polluted water is not easy; even when taking samples for a few hours, the sheer stench of the water makes the task uncomfortable. Now, I cannot imagine how villagers live around this pollution for years and decades, without having any channels to complain. ”

– Chan Yue Fai,
Campaign Manager of Greenpeace China

5.

Our vision: A clean production revolution that eliminates hazardous chemicals



5. Our vision: A clean production revolution that eliminates hazardous chemicals

5.1 The Vision

Greenpeace advocates the clean production approach to hazardous chemicals, which focuses on precaution, prevention and reduction at source.

Clean production advocates the redesigning of manufacturing processes and products in order to eliminate toxic chemicals from the entire product and production cycles. It emphasises the prevention of pollution – rather than expensive and often ineffective end-of-pipe treatment – thereby presenting environmentally-friendly and cost-effective solutions to industries. It can be achieved by substituting hazardous chemicals with alternative non-hazardous ones, or by removing the need to use or generate hazardous chemicals.

When we use the term "clean production", we mean the elimination of any emissions of hazardous chemicals that may reach the environment, either directly or indirectly (e.g. via contamination of air or soil, or release via manufactured products).

The concept of clean production is a major departure from the conventional "end-of-pipe" approach to controlling pollution (the old water pollution control approach mentioned above) in the sense that:

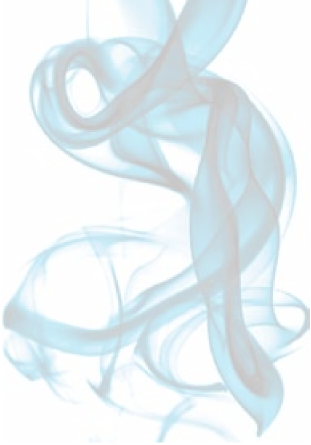
- It is based on **the Precautionary Principle.**
  Instead of initiating regulatory action after the damage is done, the precautionary principle requires actions to remove the possibility of damage to the environment before it occurs. It also recognises that limitations and uncertainties exist in scientific knowledge. In other words, if an assessment of available scientific information gives rise to concerns about the possibility of adverse effects, then measures should be taken regardless of scientific uncertainties.

- It is based on **the Preventative Principle.**
  It is cheaper and more effective to prevent environmental damage rather than trying to manage or "cure" it afterwards. Prevention involves substituting hazardous materials and substances with safer ones. When hazardous substances are still being used, every possible measure must be taken to prevent any accidental or intentional release until safer alternatives are developed and implemented.

- It is based on **the Holistic Principle.**
  Rather than "treating" the waste stream once hazardous chemicals are released, clean production adopts an integrated approach that takes into account the entire life cycle of a chemical or product. One example is to change the manufacturing process to stop the use of hazardous chemicals rather than redirecting hazardous chemicals to a wastewater treatment plant that is incapable of adequately treating them. The latter approach simply transfers the chemicals into the wastewater treatment plant's sludge, thereby generating a new stream of hazardous waste.

- It is based on **the Public Participation Principle.**
  Public participation is an effective tool in driving corporations towards clean production practices. Public access to industry-held environmental risk data – in this case the types and amounts of materials that enterprises use and release into the environment during manufacturing processes – has been closely correlated to reductions in pollutant emissions. Increased public knowledge on environmental risks encourages better enforcement of existing pollution control regulations as well as innovative solutions to reduce and eventually eliminate hazardous emissions from source, even in the absence of existing regulations.

It is important to note that while the wider concept of clean production takes into account the life cycle of all material flows, including the judicious use of renewable energy and materials, material reuse and recycling etc., this report focuses on one particular aspect of clean production, which is the elimination of hazardous chemicals.



5.2 The International Shift to Clean Production

The “clean production” concept emerged in the 1980s, when the attention of regulators in developed countries began to turn increasingly towards preventing the generation of hazardous emissions and wastes could be prevented in the first place. In 1990, the United States Environmental Protection Agency (EPA) established ‘pollution prevention’, also known as source reduction, as the country’s overriding environmental policy.

To this end, the US Pollution Prevention Act of 1990[86] established a clear definition of pollution prevention:

> *Pollution prevention or source reduction is any practice which reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal… Source reduction includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials and hazardous chemicals, and improvements in housekeeping, maintenance, training, or inventory*

Pollution prevention is a key step leading towards clean production and the elimination of hazardous chemicals. Besides the US Pollution Prevention Act, the concept is also embodied in several other international environmental policies and laws, including:

- The 1992 HELCOM (Baltic Sea) Ministerial Declaration
- The 1998 (North-East Atlantic) OSPAR Ministerial Declaration
- The 19/5 Helsinki Convention Recommendation from 1998[87]
- The Cessation Commitment in the EU Water Framework Directive published in 2000[88]
- The Substitution Principle of the Stockholm (POPs) Convention in 2001
- The Substitution Principle in the EU Chemical Registration and Evaluation Legislation published in 2006

5.3 Key Elements of a Clean Production Revolution

The key elements for achieving the vision of clean production involve simultaneous actions by both governments and companies. Foremost, it requires governments to recognise the gravity and urgency of hazardous chemical-induced pollution. It also requires governments to commit to the elimination of hazardous chemicals with specific legislation and government plans that have clear timelines and goals.

Planning for the elimination of hazardous chemicals via clean production begins with the establishment of a list of hazardous chemicals for prioritised action, and a publicly-available database covering discharges, emissions and losses of hazardous chemicals. It also involves immediate actions on the ground, including stronger implementation of programmes that aim at reducing and eliminating the release of hazardous chemicals, actions such as those which are outlined in the Clean Production Promotion Law.

Companies should not wait for the government to act first. Instead, they should recognise their own responsibility and publicly commit themselves to eliminating hazardous chemicals in their production processes and product designs, as well as announcing their own goals and objectives in this area. They should also initiate a dynamic process that constantly assesses their production processes and identifies opportunities to eliminate the use of hazardous chemicals. Once such opportunities are identified, they should actively implement clean production options with a degree of transparency that allows for public and government scrutiny.

China should no longer continue to solely depend on the current pollution control approach, which focuses heavily on “end-of-pipe” solutions. The situation requires Chinese policymakers to go beyond the “end-of-pipe” mentality and embrace the precautionary clean production approach.

China’s current Clean Production Promotion Law, which endorses important principles such as pollution prevention and environmental information disclosure, is a significant starting point. Nevertheless, to achieve the ultimate goal of eliminating hazardous chemicals, it will need to be strengthened and supplemented significantly.

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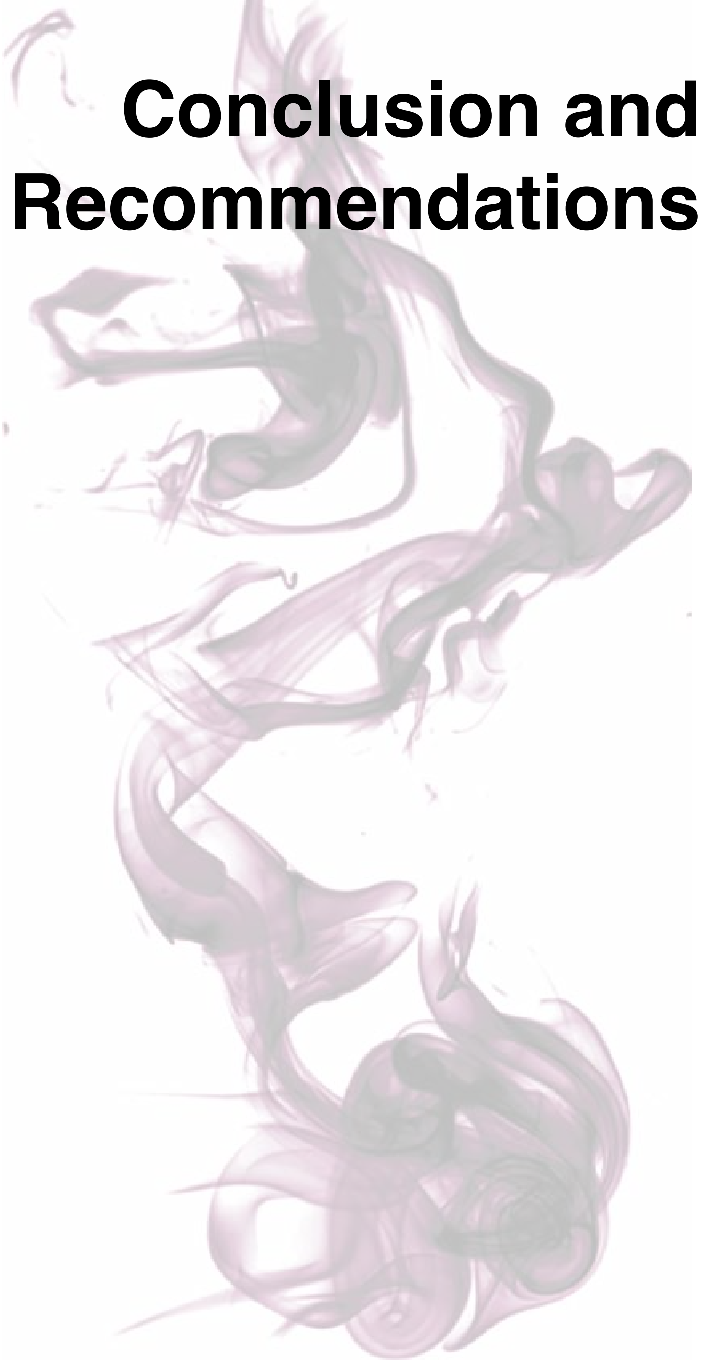
> “Greenpeace uses field visits and in-depth research to expose the culprits of industrial water pollution and works with experts to showcase best industry and legislative practices. Our goal is to make China’s rivers free of hazardous chemicals.”
>
> *– Greenpeace*

6.

Conclusion and Recommendations



6. Conclusion and recommendations

Hazardous chemical pollution in the PRD, as identified in this report, requires immediate actions by companies that are discharging a large number of hazardous pollutants into the water, and by the government, which regulates industries and determines the direction of China's water pollution control policy.

Greenpeace demands that companies urgently commit to eliminating their discharges[89] of hazardous chemicals through clean production, including the following steps:

1. Establishing targets and timelines for progressively reducing and ultimately eliminating its use of hazardous substances, together with intermediate goals.
2. Conducting a full chemical accounting and a clean production / solutions audit that:

    - Examines how, where and why hazardous substances are being used in its facilities; and identifies the hazardous chemicals for prioritised action
    - Evaluates the technical and financial options for substituting hazardous chemicals with safe chemicals in both processes and product design

3. Ensuring that updated information about its releases of hazardous substances is made available to the public, free of charge, at least once a year.[90]
4. Actively supporting the enactment and implementation of government initiatives that aim to eliminate the use and release of hazardous substances by industrial sources.

The urgent problem of industrial water pollution in the PRD region, and in China as a whole, requires the country's governments to commit to the urgent elimination of discharges of hazardous chemicals, through:

1. Creating an overall action plan to reduce, restrict and ultimately eliminate the release of hazardous chemicals as a top priority, with a clear timeline.
2. Compiling and regularly updating a list of hazardous chemicals for priority elimination action.
3. Compiling inventories regarding the use and release of hazardous chemicals and creating a register of pollutant release and transfer which is fully open and accessible to the public.
4. Providing environmental protection bureaus (EPBs) with more resources and incentives to strengthen their enforcement of the clean production programmes set out in the Clean Production Promotion Law by:

    - Strengthening Clean Production Auditing of companies that use or release hazardous substances
    - Creating well-funded technical resources and providing ongoing help to enable companies (especially small and medium-scale enterprises) to implement plans to eliminate their use of hazardous chemicals

7.

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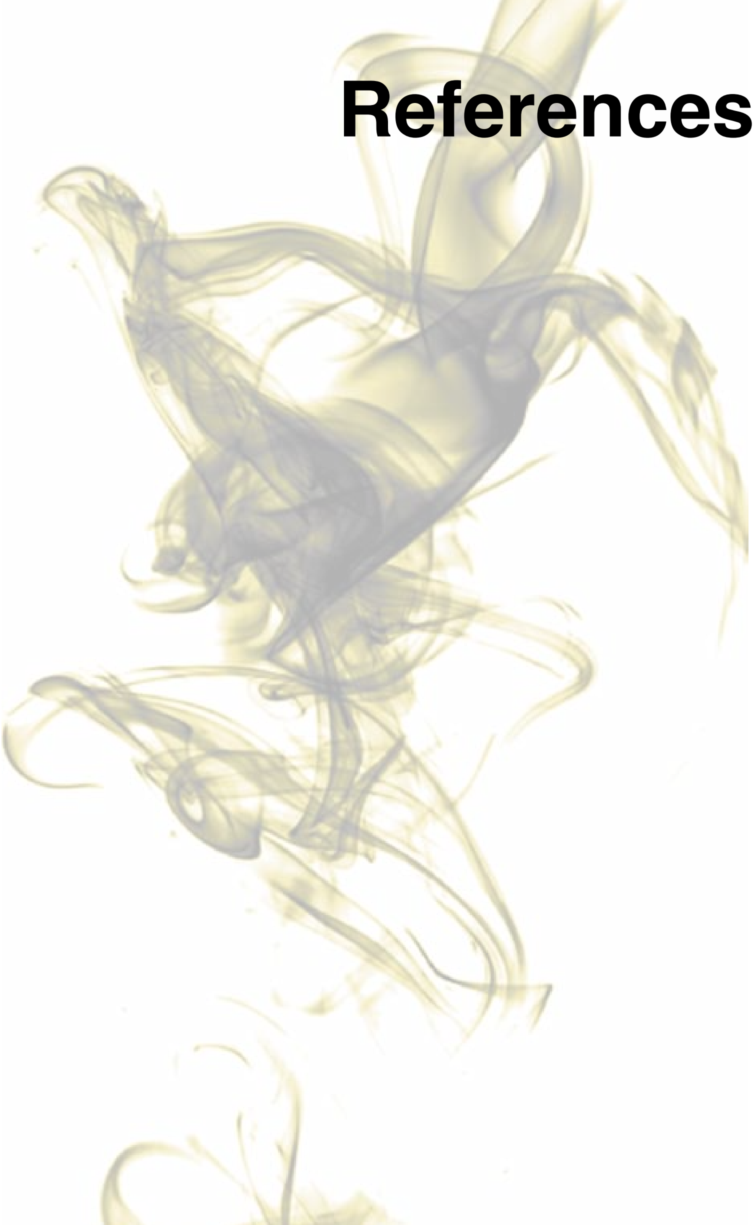

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Chau, K.W. (2006) Persistent organic pollution characterization of sediments in Pearl River estuary. Chemosphere 64(9): 1545–1549
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87 The Recommendation reads "RECOMMENDS … that the Governments of the Contracting Parties ... with regard to hazardous sub stances ...make every endeavour to move towards the target of the cessation of discharges, emissions and losses of hazardous sub stances, ... by the year 2020,"

88 Article 16.6 of the EU Water Framework Directive: "For the priority substances, the Commission shall submit proposals of controls for… the cessation or phasing-out of discharges, emissions and losses of the substances as identified in accordance with paragraph 3 [priority hazardous substances], including an appropriate timetable for doing so. The timetable shall not exceed 20 years.."

89 "Discharges" means all discharges, emissions and losses that may reach water sources, either directly or indirectly (e.g. via contamination of the air or soil, or released via products).

90 See the Greenpeace report *Silent Giants: an investigation into corporate environmental information disclosure in China* for more details

Appendix

Appendix - Detailed Sampling results of the five sites investigated by Greenpeace

1. Kingboard (Fogang) Industrial Area

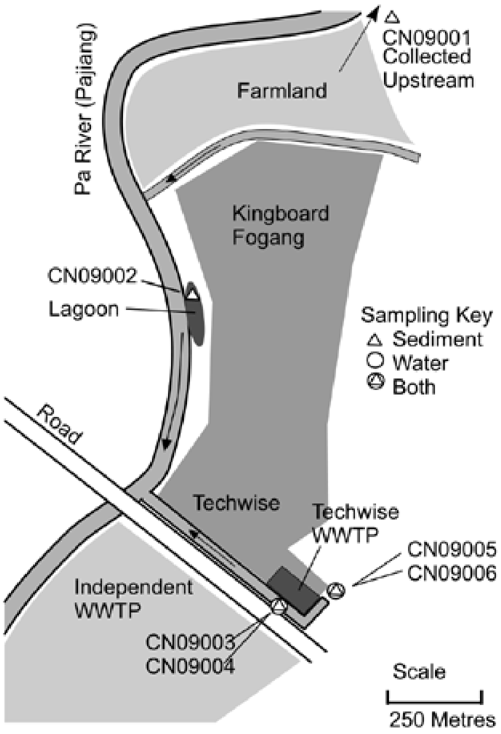

Figure 1. Map of the Kingboard (Fogang) Industrial Area, including the TECHWISE facility, showing the locations from which samples of wastewater and sediment were collected

Table 1a. Description of samples collected from the vicinity of the Kingboard (Fogang) Industrial Area in Qingyuan City, Guangdong Province, China, 2009

Sample	Type	Description
CN09003	wastewater	Discharge pipe outside the wastewater treatment plant of TECHWise, into an open channel (as CN09004)
CN09004	sediment	Sediment & plant material collected from below the discharge pipe outside the wastewater treatment plant of TECHWise (as CN09003)
CN09005	wastewater	Milky white wastewater collected from a concealed pipe that passes underneath the perimeter wall of TECH-Wise and discharges into the open channel upstream of the main outfall (as CN09006)
CN09006	sediment	Collected from the open channel 0.5 m downstream of the discharge via a concealed pipe that passes underneath the perimeter wall of TECHWise (as CN09005)
CN09001	sediment	Collected from the Pa River, approximately 1km upstream of the Kingboard (Fogang) Industrial Area
CN09002	sediment	Collected from a stagnant water lagoon adjacent to the Kingboard (Fogang) Industrial Area. The lagoon is upstream of the outfalls and is connected to the Pa River

Sample	CN09003	CN09005	CN09004	CN09006	CN09002	CN09001
Type	Wastewater		Sediment			
Brief description	WWTP pipe	concealed pipe	WWTP pipe	concealed pipe	lagoon	upstream
pH	6	1	-	-	-	-
METAL	(μg/l)	(μg/l)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Antimony	<50	<50	<20	<20	<20	<20
Arsenic	<50	<50	<20	131	28	<20
Beryllium	<5	123(a)	<0.5	21.0	31.5	2.7
Cadmium	<5	21	3.0	1.7	2.3	3.3
Chromium	<20	1230	44	112	32	10
Chromium (VI)	<50	<50	-	-	-	-
Cobalt	<20	103	25	9	45	11
Copper	246	63(a)	30500	85	30300	82
Lead	<50	382(b)	97	698	78	109
Manganese	50	17100(a)	28	12	4	4
Mercury	<2	<2	<0.2	0.7	0.5	0.2
Nickel	39	31	328	4	33	16
Selenium	<200	<200	<30	<30	<30	<30
Thallium	<20	<20	<10	<10	<10	<10
Tin	<100	10100(a)	26300	716	<10	<10
Vanadium	<20	402	40	47	30	37
Zinc	30(a)	3240	160	202	523	743
Organic compound isolated	65	71	44	42	24	12
No. Reliably identified (% of total)	24 (37%)	17 (24%)	11 (25%)	16 (38%)	22 (92%)	10 (83%)
Brominated compounds						
Tetrabromobisphenol A	1	1				
Deca-BDE (a PBDE)					1	1
Other PBDEs					5	
Other bromine compounds		2	1	2	1	
Chlorinated compounds						
Pentachloro benzene			(1)			
Dichloro benzenes		(2)				
Photoinitiators & related compounds						
Quantacure ITX	1					
Diphenylethanone deriv.	1					
Phenylethanone derivative	3					
Coumarin deriv	1					
Alkylphenols & derivatives						
Octyl phenol	1					
Octyl phenol ethoxylates	2					
Other oxygen compounds						
Alkyl fatty acid	1					
Benzoic acid ester				1		
Benzoic acid derivatives				1		
Alkyl aldehyde	1					
Sulphur compounds						
Alkyl thiols	1					
Sulphur				1		
Hydrocarbons						
PAHs				3		
Alkyl benzenes	2			1		
Aliphatic hydrocarbons	9	12	9	7	15	9

Table 1b. Organic chemicals identified, and concentrations of metals and metalloids, in samples of wastewater and sediment associated with the Kingboard (Fogang) Industrial Area in Qingyuan City, Guangdong Province, China, 2009. (..) signifies compounds identified at trace levels using a selective SIM method. For wastewater samples, concentrations are given for whole (unfiltered) samples, dissolved concentrations accounted for greater than 75% of the whole sample concentration unless otherwise indicated; 50-75%(a), 25-50%(b)

2. *Kingboard (Panyu Nansha) Industrial Area*

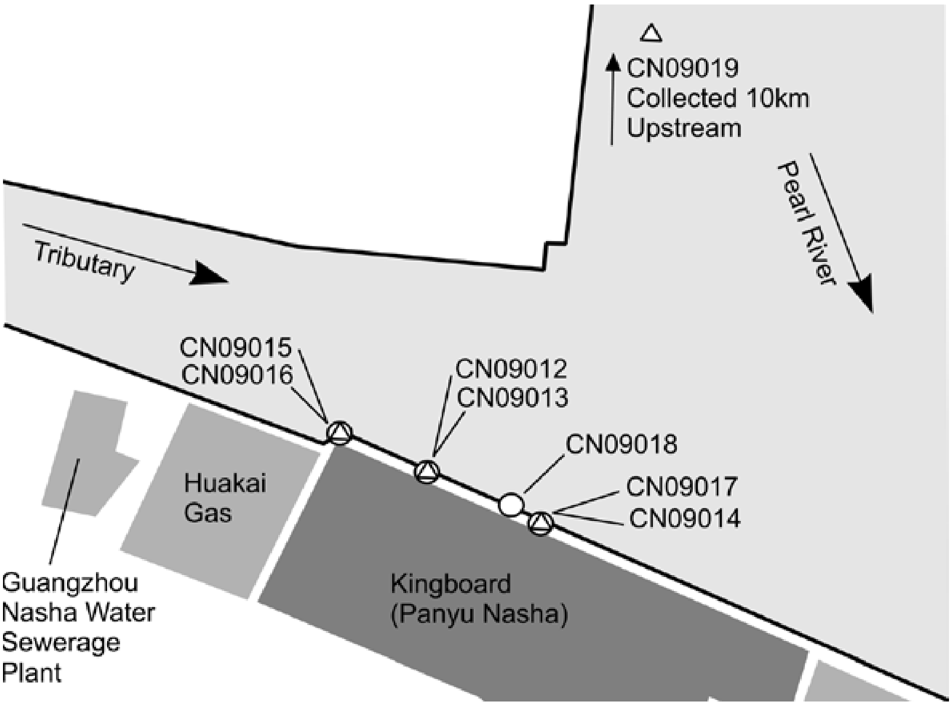

Figure 2. Sketch map of the Kingboard (Panyu Nansha) Industrial Area showing the locations from which samples were collected

Table 2a. Description of samples collected from the vicinity of the Kingboard (Panyu Nansha) Industrial Area in the Nansha Economic and Technological Development Area, Panyu, Guangdong Province, China, 2009

Sample	Type	Description
CN09012	wastewater	Outfall 1: discharged *via* a large concrete pipe (as CN09013)
CN09013	sediment	Outfall 1: from point of wastewater discharge *via* large concrete pipe (as CN09012)
CN09015	wastewater	Outfall 2: discharged *via* a large concrete pipe adjacent to a security post (as CN09016)
CN09016	sediment	Outfall 2: shallow channel between the discharge pipe and the main river (as CN09015)
CN09017	wastewater	Outfall 3: discharged *via* a smaller concrete pipe (as CN09014)
CN09014	sediment	Outfall 3: from point of wastewater discharge *via* smaller pipe (as CN09017)
CN09018	wastewater	Outfall 4: milky white liquid discharged *via* a small concrete pipe through perimeter wall of the facility. No sediment present at this location
CN09019	sediment	Control: From the Pearl River approximately 10km upstream of the Kingboard facility

Sample	**CN09012**	**CN09015**	**CN09017**	**CN09018**	**CN09019**	**CN09013**	**CN09016**	**CN09014**
Brief description	Wastewater				Sediment			
Type	outfall 1 large pipe	outfall 2 large pipe	outfall 3 pipe	outfall 4 small pipe	Pearl River Upstream	outfall 1 large pipe	outfall 2 large pipe	outfall 3 pipe
pH	8	7	7	6	-	-	-	-
METAL	(µg/l)	(µg/l)	(µg/l)	(µg/l)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Antimony	<50	<50	<50	<50	<20	<20	<20	<20
Arsenic	<50	<50	<50	<50	24	<20	22	23
Beryllium	<5	<5	<5	<5	2.0	1.5	0.8	0.7
Cadmium	<5	<5	<5	<5	1.0	1.0	<1.0	<1.0
Chromium	<20	<20	<20	<20	69	54	55	20
Chromium (VI)	<50	<50	<50	<50	-	-	-	-
Cobalt	<20	<20	<20	<20	17	11	7	5
Copper	43	<20	<20	<20	72	56	59	13
Lead	<50	<50	<50	<50	58	42	43	18
Manganese	150	$319^{(a)}$	563	257	6	7	6	2
Mercury	<2	<2	<2	<2	<0.2	0.7	0.7	0.2
Nickel	<20	<20	<20	97	43	49	57	13
Selenium	<200	<200	<200	<200	<30	<30	<30	<30
Thallium	<20	<20	<20	<20	<10	<10	<10	<10
Tin	<100	<100	<100	<100	<10	<10	<10	<10
Vanadium	<20	<20	<20	<20	55	67	58	16
Zinc	$292^{(b)}$	41	$197^{(c)}$	$1370^{(c)}$	197	179	183	144
Organic compound isolated	10	34	99	125	9	9	22	33
No. Reliably identified (% of total)	6 (60%)	16 (47%)	59 (59%)	52 (42%)	7 (78%)	7 (78%)	18 (82%)	19 (58%)
Brominated compounds								
Tetrabromobisphenol A	1	1	1					
Deca-BDE (a PBDE)					1	1	1	1
Tri-bromophenol			1					
Other bromine compounds	1	3	19	3		3	1	8
Alkyl phosphate compounds								
Tris(2-ethylhexyl)phosphate			1					
Photoinitiators & related compounds								
Anthraquinone derivative			1					1
Benzoquinone derivative			2					
Naphthalenedione derivativ			1					
Decadiene-dione derivative			1					
Phthalate esters								
DiBP/DnBP	2							
DEHP	1							1
Fatty acids and derivatives								
Acids			1	12				
Esters			1	8				
Amides				2				
Nitriles				1				
Aldehyde				1				
Thiol			1	1				
Alkene alcohol				1				
Other oxygen compounds								
Bisphenol-A			1					
Bisphenol-A derivatives			2					1
Dioctyl /diphenyl ether				1		1		1
Hydrocarbons								
PAHs			2					
Alkyl benzenes			6	1				2
Aliphatic hydrocarbons	1	12	18	21	6	2	16	4

Table 2b. Organic chemicals identified, and concentrations of volatile organic chemicals (VOC), metals and metalloids, in samples of wastewater and sediment associated with the Kingboard (Panyu Nansha) Industrial Area in Panyu, Guangdong Province, China, 2009. For wastewater samples, concentrations are given for whole (unfiltered) samples, dissolved concentrations accounted for greater than 75% of the whole sample concentration unless otherwise indicated; 50-75%$^{(a)}$, 25-50%$^{(b)}$, <25%$^{(c)}$

3. Wing Fung P.C. Board Co., Ltd.

Table 3a. Description of samples collected from the vicinity of the Wing Fung P.C. Board facility in the Jiao Yuan Industrial Zone, Shenzhen, China, 2009

Sample	Type	Description
CN09028	wastewater	Collected at point of discharge from the Wing Fung facility into a communal channel
CN09029	sediment	Wastewater channel, at the point of wastewater discharge from the Wing Fung facility
CN09026	sediment	Wastewater channel, 10m upstream of the discharge from the Wing Fung facility

Sample	**CN09028**	**CN09029**	**CN09026**
Type	Wastewater	Sediment	
Brief description	discharge	by discharge	upstream
pH	8	-	-
METAL	**(µg/l)**	**(mg/kg)**	**(mg/kg)**
Antimony	<50	<20	<20
Arsenic	<50	<20	<20
Beryllium	<5	<0.5	<0.5
Cadmium	<5	<1.0	<1.0
Chromium	<20	111	147
Chromium (VI)	<50	-	-
Cobalt	<20	7	6
Copper	25600	2480	380
Lead	<50	28	22
Manganese	140	2	1
Mercury	<2	<0.2	<0.2
Nickel	520	72	46
Selenium	<200	<30	<30
Thallium	<20	<10	<10
Tin	<100	203	86
Vanadium	<20	25	15
Zinc	31(a)	587	456
Organic compound isolated	60	31	44
No. Reliably identified (% of total)	28 (47%)	26 (84%)	44 (100%)
Brominated compounds			
Deca-BDE (a PBDE)		1	1
Other PBDEs		7	15
Other bromine compounds	10		
Photoinitiators & related compounds			
Diphenylethandione	1		
Diphenylethanone deriv.	1		
Phenylethanone derivative	1		
Quantacure ITX	1		
Benzophenone	1		
Coumarin derivative	1		
Phthalate esters			
DiBP/DnBP	2		
Other Oxygen compounds			
Benzoic acid and esters	2		
Benzoic acid thiol	1		
Alkyl alcohols	1		
Nitrogen compounds			
N-Formyl morpholine	1		
Hydrocarbons			
PAHs	1		3
Alkyl benzenes	1	1	1
Alkenyl benzene		1	1
Aliphatic hydrocarbons	2	15	21
Natural sesquiterpenoid		1	2

Table 3b. Organic chemicals identified, and concentrations of metals and metalloids, in samples of wastewater and sediment associated with the Wing Fung P.C. Board Co., Ltd. facility in Shenzhen, China, 2009. For wastewater samples, concentrations are given for whole (unfiltered) samples, dissolved concentration accounted for greater than 75% of the whole sample concentration unless otherwise indicated; 50-75%(a)

4. Dasha Industrial Area, Dalingshan Town, Dongguan

Table 4a. Description of samples collected from the vicinity of the Dasha Industrial Area, Dalingshan Town, Dongguan, Guangdong Province, China, 2009

Sample	Type	Description
CN09021	wastewater	Discharged from Dasha Industrial Area, Dalingshan Town, Dongguan *via* a pipe at the rear of the facility
CN09020	sediment	Wastewater channel immediately below the discharge pipe. This channel has been formed due to the flow of wastewater

Sample	**CN09021**	**CN09020**
Type	Wastewater	Sediment
Brief description	pipe	below pipe
pH	2	-
METAL	**(µg/l)**	**(mg/kg)**
Antimony	<50	<20
Arsenic	<50	<20
Beryllium	<5	<0.5
Cadmium	<5	<1.0
Chromium	1080	213
Chromium (VI)	<50	-
Cobalt	<20	4
Copper	1680	163
Lead	122	38
Manganese	673	1
Mercury	<2	0.2
Nickel	448	29
Selenium	<200	<30
Thallium	<20	<10
Tin	<100	21
Vanadium	<20	45
Zinc	1230	179
Chlorinated volatile organic chemicals		
Methane, dichloro-	940	-
Ethene, trichloro-	8.8	-
Other organic compounds isolated	37	19
No. Reliably identified (% of total)	17 (46%)	19 (100%)
Photoinitiators & related compounds		
Quantacure ITX	1	
Benzophenone	1	
Tetrahydro naphthalenedione deriv.	1	
Phthalate esters		
DiBP/DnBP	2	
Fatty acids and derivatives		
Acids	1	
Esters	2	
Other oxygen compounds		
Alkyl-enone	1	
Hydrocarbons		
PAHs	1	3
Alkyl benzenes	2	
Aliphatic hydrocarbons	5	16

Table 5b. Organic chemicals identified, and concentrations of metals and metalloids, in samples of wastewater and sediment associated with the Dasha Industrial Area, Dalingshan Town, in Dongguan, Guangdong Province, China, 2009. For wastewater sample, concentrations are given for whole (unfiltered) samples, dissolved concentration accounted for greater than 75% of the whole sample concentration

5. *QingYuan Top Dragon Textile Co., Ltd*

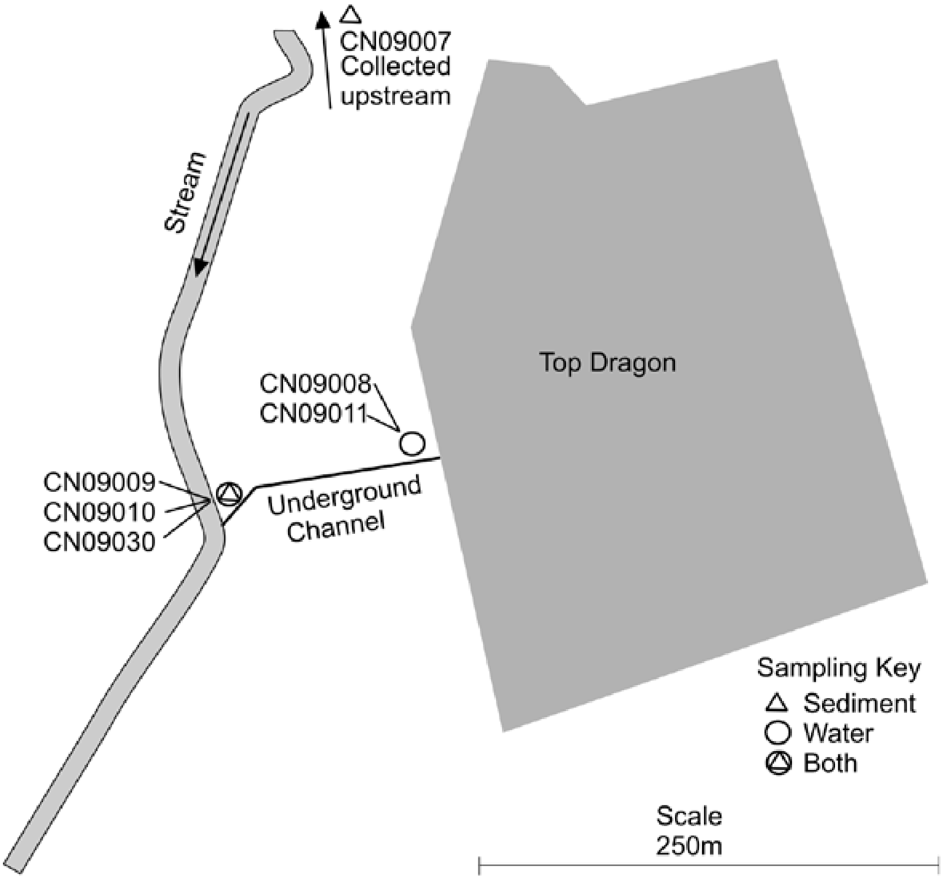

Figure 4. Sketch map of the Top Dragon facility showing the locations from which samples were collected

Table 5a. Description of samples collected from the vicinity of the Top Dragon facility in the Taihe Industry Zone, Qingxin, Qingyuan in Guangdong Province, China, 2009

Sample	Type	Description	Date / Time
CN09008	wastewater	From a wastewater outfall into an underground channel, collected *via* a hatch located just outside the Top Dragon wastewater treatment facility. Channel flows approximately 100m underground before entering a stream, see CN09009 & CN09030	01-06-09 11pm
CN09011	wastewater		02-06-09 11am
CN09009	wastewater	From the outfall of the underground channel, where it flows into a stream approx. 100m from the Top Dragon facility (as CN09010)	02-06-09 10am
CN09030	wastewater		05-06-09 4 pm
CN09010	sediment	From the outfall of the underground channel, where it flows into a stream approx. 100m from the Top Dragon facility (as CN09009 & CN09030)	
CN09007	sediment	Receiving stream, approximately 0.5km upstream of the underground channel outfall	

Sample	**CN09011**	**CN09008**	**CN09009**	**CN09030**	**CN09010**	**CN09007**
Type	Wastewater				Sediment	
Brief description	channel start, *via* hatch		channel outfall		channel	stream,
	11am	**11pm**	**10 am**	**4 pm**	**outfall**	**upstream**
pH	8	7	7	6	-	-
METAL	**(µg/l)**	**(µg/l)**	**(µg/l)**	**(µg/l)**	**(mg/kg)**	**(mg/kg)**
Antimony	<50	<50	<50	<50	<20	<20
Arsenic	<50	<50	<50	<50	<20	<20
Beryllium	<5	<5	<5	<5	<0.5	<0.5
Cadmium	<5	<5	<5	<5	1.3	<1.0
Chromium	<20	<20	<20	<20	94	8
Chromium (VI)	<50	<50	<50	<50	-	-
Cobalt	<20	<20	<20	<20	17	4
Copper	<20	<20	<20	<20	41	4
Lead	<50	<50	<50	<50	19	<5
Manganese	978	5930	1110	163	10	1
Mercury	<2	<2	<2	<2	<0.2	<0.2
Nickel	27	40	29	<20	58	8
Selenium	<200	<200	<200	<200	<30	<30
Thallium	<20	<20	<20	<20	<10	<10
Tin	<100	<100	<100	<100	<10	<10
Vanadium	<20	<20	<20	62(a)	22	9
Zinc	12	34(b)	14	90	138	38
Organic compound isolated	59	34	33	12	19	16
No. Reliably identified (% of total)	20 (34 %)	15 (44%)	10 (30%)	5 (42%)	7 (37%)	4 (25%)
Chlorinated compounds						
Di-chlorinated benzenes		(1)				
Alkyl phosphate compounds						
Tris(2-ethylhexyl)phosphate		1	1			
Photoinitiators & related compounds						
Benzoquinone derivative	1					
Tetrahydro naphthalenedione derivative	1					
Alkylphenols & derivatives						
Nonyl phenols	3					
Fatty acids and derivatives						
Acids	2	3	1			
hydroxy ester derivatives	2					
Other oxygen compounds						
Furanone derivative		1				
Cyclodecanone derivative		1				
Alkyl alcohols	1		1			
Other nitrogen or sulphur compounds						
Indole	1			1		
Amine; N-methyl aniline	1	1	1	1		
Amide; formanilide		1	1			
Alkyl thiols	1					
Sulphur			1	1	1	
Hydrocarbons						
Alkyl benzenes	1		1			
Aliphatic hydrocarbons	6	6	3	2	6	4

Table 4b. Organic chemicals identified, and concentrations of metals and metalloids, in samples of wastewater and sediment associated with the Top Dragon Textile facility in the Taihe Industry Zone, Guangdong Province, China, 2009. (..) signifies compounds identified at trace levels using a selective SIM method. For wastewater samples, concentrations are given for whole (unfiltered) samples, dissolved concentration accounted for greater than 75% of the whole sample concentration unless otherwise indicated; 50-75%(a), 25-50%(b)

Greenpeace China s Clean Water Campaign

Greenpeace's clean water campaign aims to eliminate the most hazardous chemicals threatening China's rivers and lakes. Greenpeace calls on the government and industry to protect China´s precious water resources by committing to eliminate discharges of the most hazardous substances through clean production.

In order to achieve this, Greenpeace monitors the environmental performance of companies and their factories, visits local victims of water pollution, and samples water in the Yangtze, Yellow and Pearl River Delta regions. We use extensive field visits and in-depth research to expose the culprits of industrial water pollution, and work with experts to showcase best industry and legislative practices.

Greenpeace stands for positive change through action to defend the natural world and promote peace. We are a non-profit organisation with a presence in 40 countries. To maintain its independence, Greenpeace does not accept donations from governments or corporations but relies on contributions from individual supporters and foundation grants.

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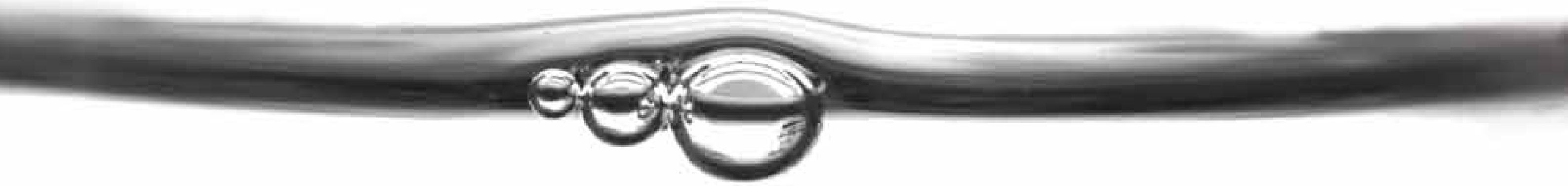

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