Thailand State of Pollution Report 2016

PCD. No. 06-065 ISBN 978-616-316-403-2
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Pollution Control Department
Ministry of Natural Resources and Environment

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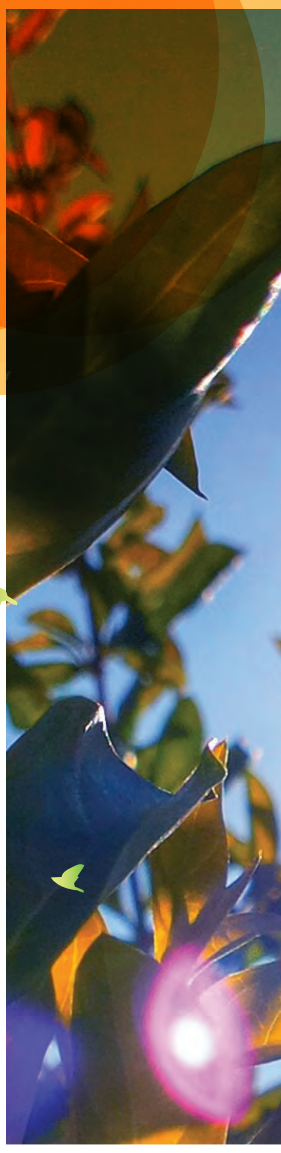

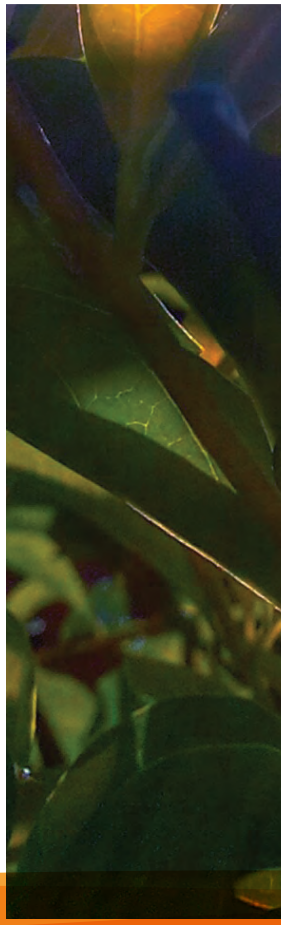

Published 2017

Number 500 Copies

ISBN 978-616-316-403-2

PCD No. 06-065

Produced by

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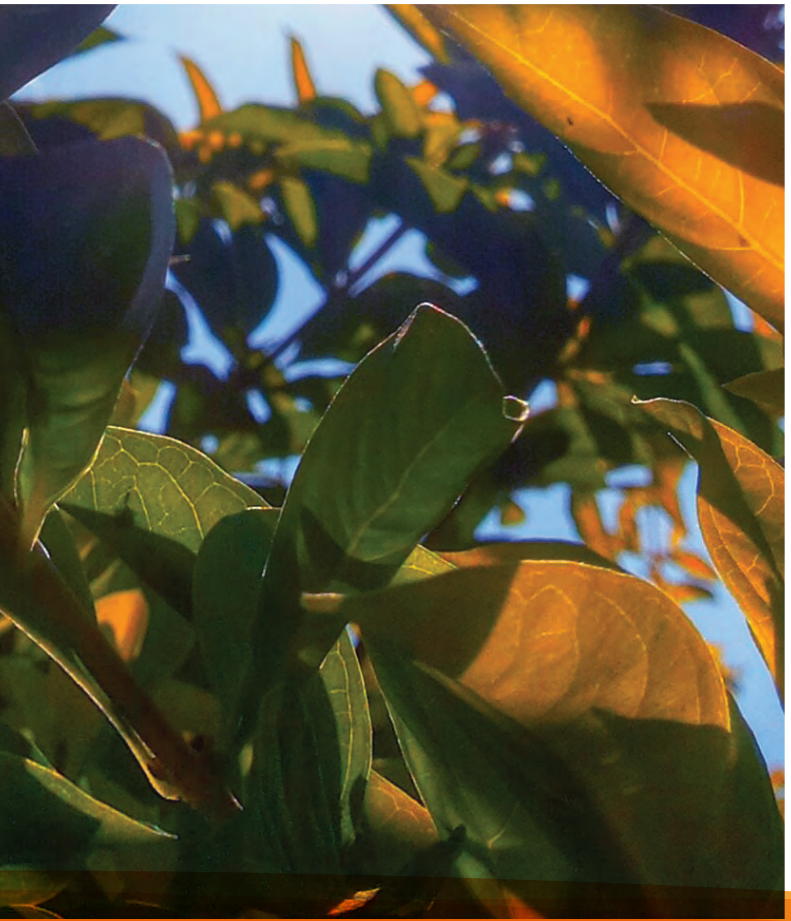


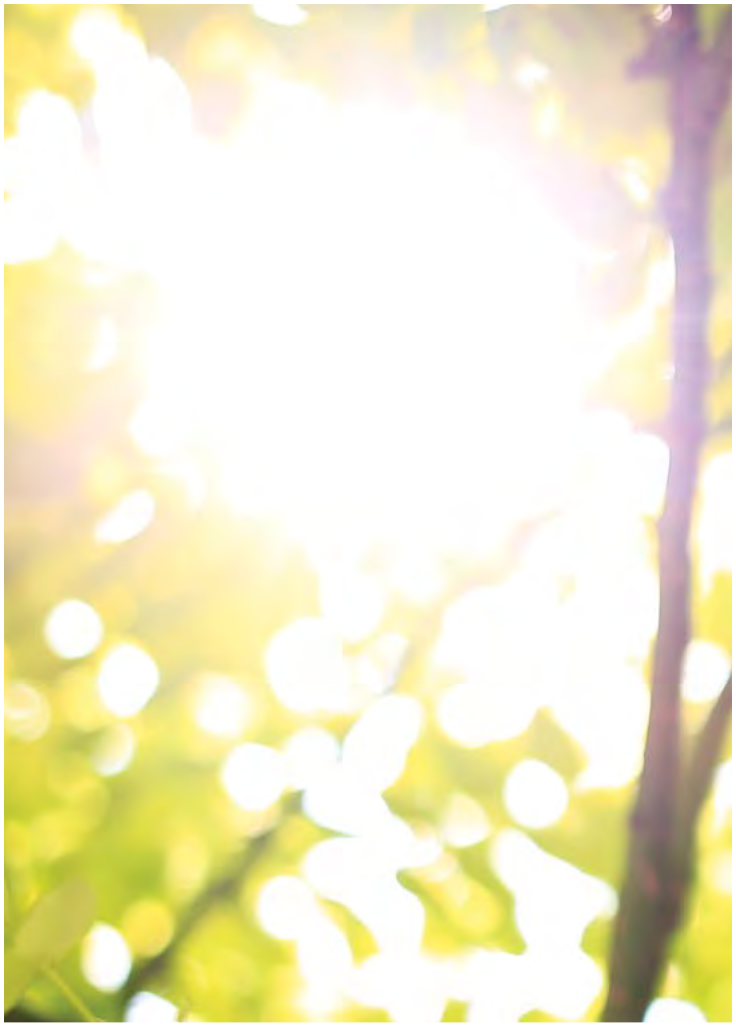

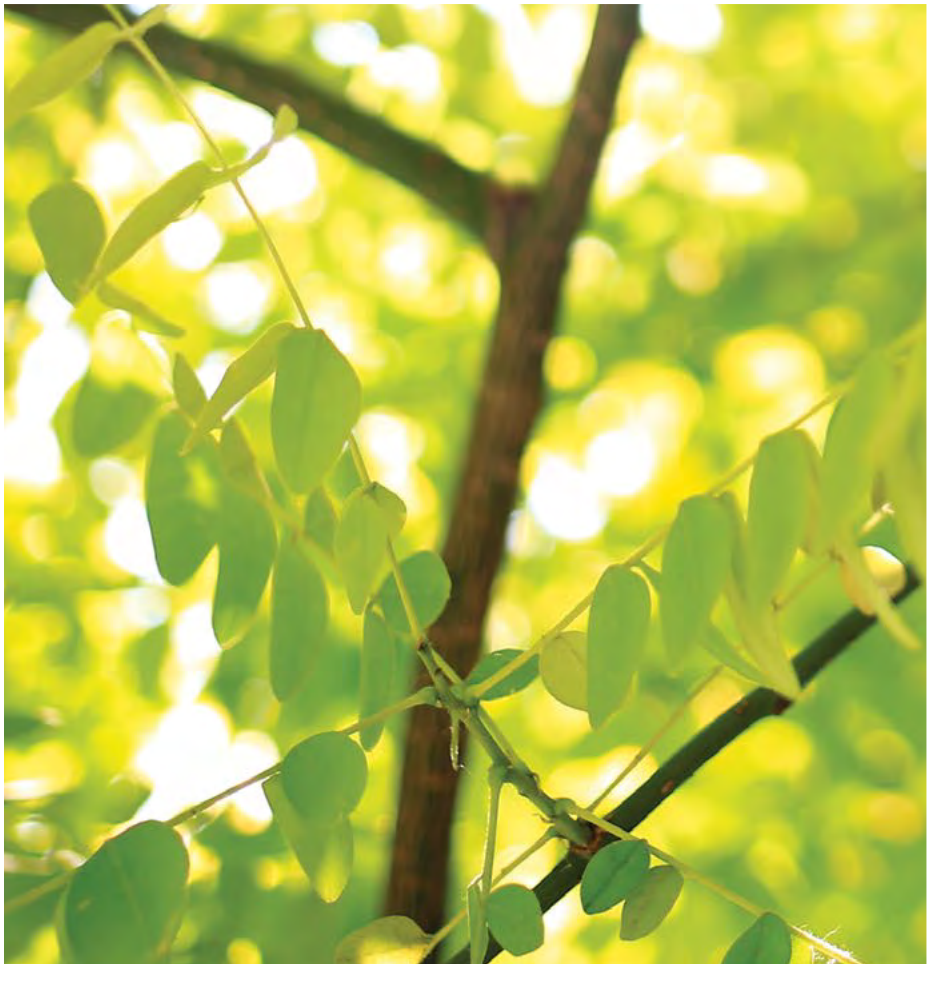


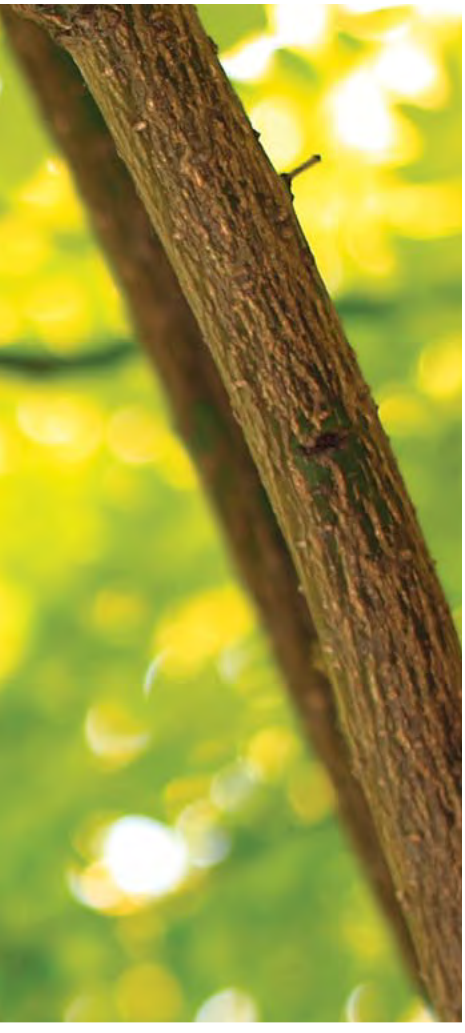

Preface

The information of Thailand's pollution situation in each year signifies that all stakeholders recognize the importance to collaborate in environmental protection. Thailand State of Pollution Report, is prepared in accordance with the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992), Section 53 (9) and is submitted to the Pollution Control Committee and the National Environmental Board, aims to distribute and communicate such information to raise awareness among all stakeholders. This is so that there will be collaboration among all parties to preserve the environment, to mitigate pollution problem, and to use the information provided for environmental planning in order to enhance public's quality of life.

Thailand State of Pollution Report 2016 is consisted of the information on the state of pollution, key factors affecting the state of pollution, the trend of the state of pollution, and the practices being adopted to manage air quality, noise level, surface water quality, coastal water quality, and groundwater quality, municipal solid waste, hazardous waste, infectious waste, and hazardous substances, cases of pollution emergencies and accidents, pollution complaints handling, tools and mechanisms for managing important pollution incidents in 2016, the national environmental budget, and recommendations of policy-making to enhance future pollution management efforts. Additionally, other sectors in order have been listed and praised to inspire to put more efforts in environmental protection collaboration activities.

Lastly, we would like to express our thanks to the Thailand State of Pollution Report Provisional Committee, which is the owner information, the board and advisory board of Pollution Control Committee, and other interested parties for supporting information and recommendation that allows the completion of Thailand State of Pollution Report 2016.

(Mr.Wijarn Simachaya)
Permanent Secretary of the Ministry of Natural Resources and Environment
Chairman of the Pollution Control Committee

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Summary

Thailand State of Pollution 2016

Summary: Thailand State of Pollution Report 2016

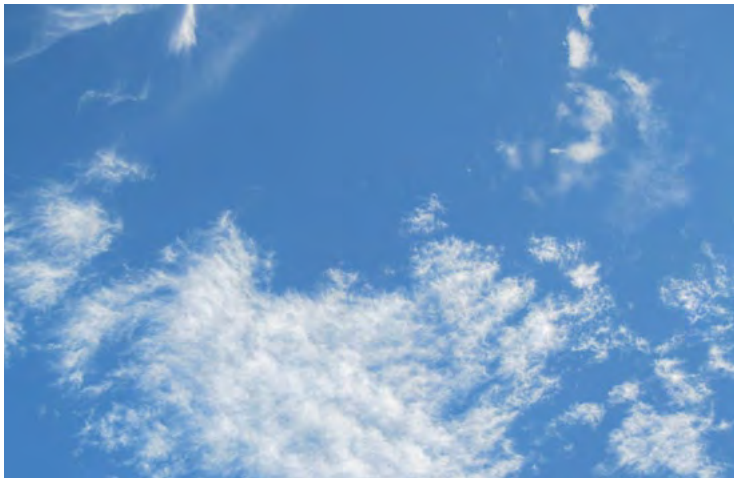
In 2016, Thailand had seen drastic revolutionary changes in all dimensions, from economics, politics, social, education, culture and environment, in order to prepare for the National Strategic Plan aimed towards the development of a sustainable future. In term of the country's Pollution Management, the Government placed great importance and had given extensive support to tackle the problem of pollution from all sides. This is evident in the efforts of Government to push the policy to the National Legislative Assembly on September 12, 2014, pushing for the measures to control air pollution, waste and wastewater generated from production processes and household consumptions. By defining the long term National Development Strategy, or the 20-Year National Strategy (2017-2036), with the vision to create a secure, prosperous and sustainable country, to become a developed country, with the Sufficiency Economy Philosophy. The Government had envisioned the future of Thailand's environment in 2036, economic and social pillars will be developed in an environmental-friendly way, to be a country of green economy, with low carbon dioxide emission, with more green spaces, and with a population with environmental-friendly consumer behavior, to achieve Sustainable Development Goals (SDGs) in 2030. In achieving pollution management goals, such as adopting safe wastewater sanitation system, managing the level of small particles (such as $PM_{2.5}$ and PM_{10}), in city areas, the level of hazardous waste generated per person, hazardous waste sanitation, the overall country's Recycling Rate, and the tons of recycled materials. The 12th National Economic and Social Development Plan (2017-2021), which is also one of the mechanisms for driving the National Strategic Plan, had outlined the strategies related to Pollution Management in the 4th Strategy: Environmental friendly growth for sustainable development. That leads to the changes of the working process of the governmental sector and other sectors in order to align themselves better with Thailand's National Reform Agenda, aimed towards creating a balance between natural resources and the environment, in conjunction with social and economic developments, following the Sufficiency Economy Philosophy.

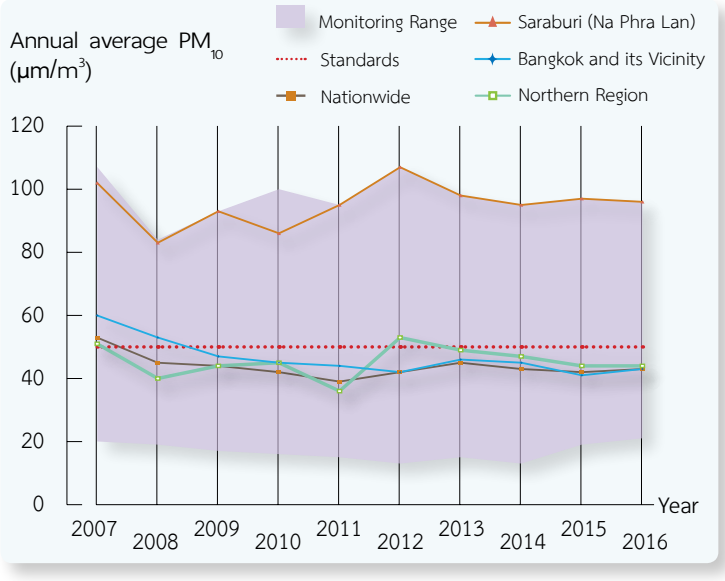
For 2016, Thailand State of Pollution can be concluded as follow:

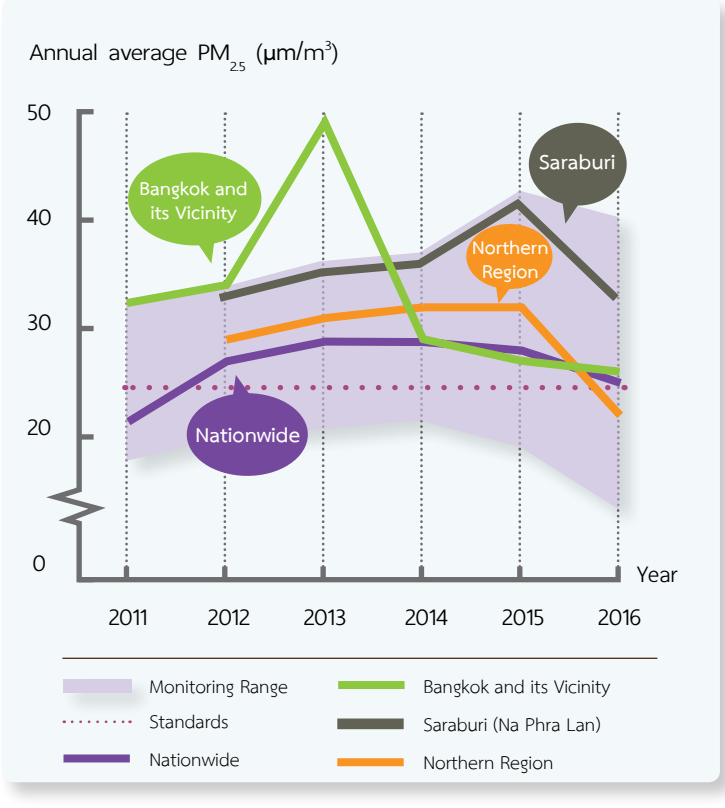
State of Air Quality

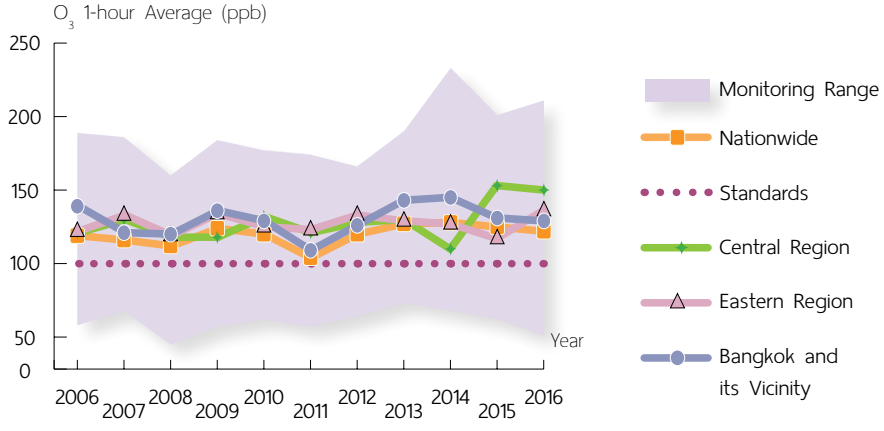
The main pollutants that has been the main problem of Thailand's air quality from 2007-2016 are particles less than or equal to 10 microns (PM_{10}), particles less than or equal to 2.5 microns ($PM_{2.5}$), and ozone (O_3). Since 2008, the annual average of particles less than or equal to 10 microns throughout the whole country, aside from Na Phra Lan Subdistrict, Saraburi, has not exceeded the air quality standards. On the other hand, for particles less than 2.5 microns, which have been monitored from 2011, the annual average has exceeded the air quality standards since 2012, although it is trending downward. The average Ozone for the whole country still exceeds standards, while other pollutants such as Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), and Carbon Monoxide (CO) have always been within the standard range.

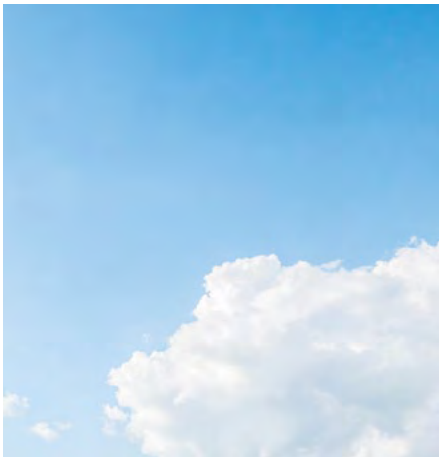
The result of Air Quality Monitoring in 2016 across 31 provinces with Air Quality Monitoring Stations showed that the province with the highest particulate matters exceeding standards is Saraburi in Na Phra Lan Subdistrict (24%), followed by Chiang Rai (10%), Mae Hong Son (7.5%), Chiang Mai (6.9%), and Phayao (6.6%). The pollutants that remain problematic are particles less than or equal to 10 microns (PM_{10}) (with a 2% increase in annual average from 2015), particles less than or equal to 2.5 microns ($PM_{2.5}$) (with a 4% decrease in annual average from 2015), and Ozone (with a 2% decrease in hourly average from 2015). The areas that need immediate remedy for Air Quality Crisis are:











Bangkok: In 2016, the annual average numbers of particulate matters PM_{10} and $PM_{2.5}$ were 43 and 30 µg/m^3 respectively, which is slightly more than the levels measured in 2015, although remaining within the range of annual air quality standards. The 10 years state of air quality (2007-2016) has shown improvement, as a result of air quality and noise level control strategic plans and implementations in Bangkok.

Haze and Smoke in the 9 Upper Northern Region Provinces: From January 1 to April 15, 2016, the total Hot spot in all 9 provinces has decreased by 20% from 2016. The level of particulates in most provinces appears to be decreasing, and the highest level of particulates has decreased from 381 µg/m^3 in 2015 to 317 µg/m^3 from extensive collaborative efforts of all stakeholders to prevent forest fires and resolve the problem of haze and smoke in the area. However, in 2016, the problem occurred at a different timeframe from the previous years due to the long arid weather, with limited rainfall in April and early May. Open burning fires were discovered from after April 15, 2016 onward, causing the particulate levels to exceed standards. This causes the percentage of days exceeding standards to increase from 14% in 2015 to 15% in 2016.

Na Phra Lan Subdistrict, Saraburi: The problem of particulate levels in the atmosphere usually begins during the drought crisis, especially from January to March and from October to December of every year. In 2016, 25.5% of the whole year (89 days from 348 days) showed a particulate matters PM_{10} level that exceeded standards, where the PM_{10} level tends to increase from the evening period until dawn of the next day. One of the factors that causes the problem to intensify is the significantly lower Mixing Height during the drought crisis, especially from 14.00 hrs. onward. It was also discovered that particulate matters were often released from the vents of industrial factories. Particulates were also spread periodically from the crushing processes in stone mills in the Na Phra Lan Subdistrict and the vicinity areas.

Map Ta Phut Subdistrict, Rayong: The main problem in this area is the high concentration of Volatile Organic Compounds (VOCs) in the atmosphere such as Benzene, which had been found to exceed the standards 4 times in 6 monitoring stations, 1,3-butadiene, which had been found to exceed the standards once across 3 stations. Both had shown no changes from the levels recorded in 2015. However, the level of 1,2-dichloroethane had shown improvements from 2015, where it was found to have exceeded standards in 2 of the stations located near the industrial estate.

Noise Level

The monitoring of noise level in the environment is monitored by the Pollution Control Department using 27 automatic monitoring stations in 13 provinces in addition to 16 temporary monitoring stations along the road in Bangkok during 2016 revealed that the average noise level in Bangkok and Bangkok Metropolitan Area measured up to 56.7 dB(A), which is equal to that of 2015. The area besides the roads showed a slight increase in noise level from 2015, from 68.9 dB(A) to 69.2 dB(A), which is within the standard range. However, all temporary stations showed noise levels exceeding standards, with an average value exceeding that of 2015, increasing from 74.2 dB(A) to 75.2 dB(A). The noise level in the other provinces showed a similar value to that of 2015, where in the general area, the average noise level measured up to 57.3 dB(A), with the roadside areas showing a lower value than 2015, decreasing from 63.1 dB(A) to 62.4 dB(A), which is still within the standard range.

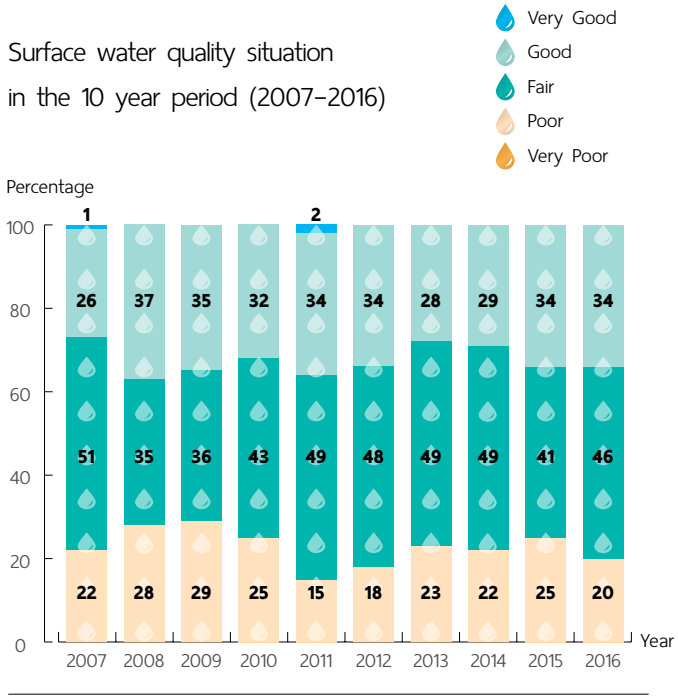
State of Water Quality

Surface Water

The 10-year surface water quality (from 2007 to 2016) remained within the fair quality and had gradually improved over the years. Since 2007, there were no surface water sources rated at very poor quality. There were surface water sources had increased their quality to be at good quality since 2014 , such as the Upper Tha Chin, the Lower Pangrad, and Saiburi. The water sources that had always shown good quality are the Upper Tapi, Trang, Weru, while the surfacewater sources showing continuously deteriorating water quality are the Lower Chao Phraya River, the Lower Tha Chin, Lopburi, Lower Rayong, and Lower Lamtakong, as these are the area where the rivers flow through highly populated urban areas, industrial areas, agricultural areas, and livestock farming areas with no proper water sanitation systems or no effective water management systems.

Currently, the country's main river and surface water sources,totaling 65 sources, showed 46% fair quality, (increased by 41% from 2015), with 34% good quality, and 20% poor quality (decreased by 25% from 2015). The surface water sources in the southern region showed better quality than any other regions in Thailand, while the surface water sources in the central region showed the poorest water quality than any other regions.

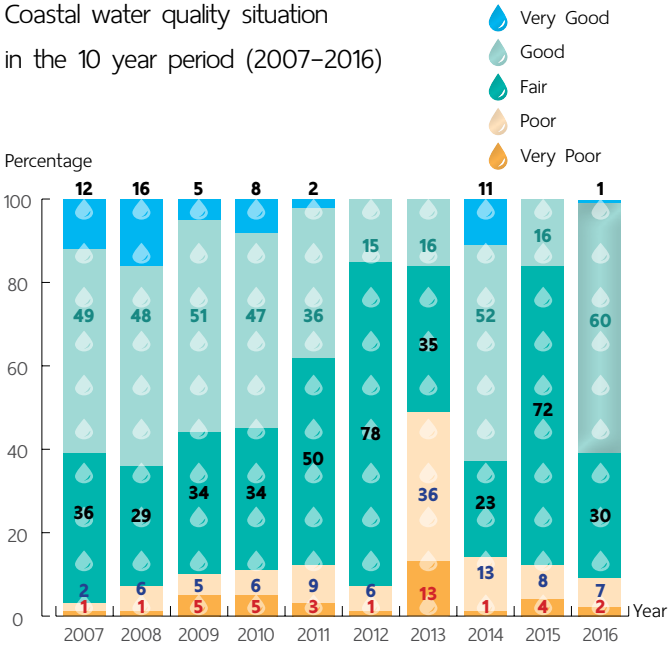
Surface water quality situation
in the 10 year period (2007–2016)



Coastal Water

The coastal water quality in the past 10 years (2007-2016), showed fair quality, with decreasing number of very poor and poor quality areas since 2013, with increasing good quality area. The areas showing poor to very poor water quality are the Bang Pakong River Mouth, the Chao Phraya River Mouth, the Tha Chin River Mouth, the Mae Klong River Mouth and the Inner Bay of Thailand, resulting from the poor water quality from rivers. The coastal water quality in 2016 generally showed 60% good quality (increased by 16% from 2015), 30% fair quality, 7% poor quality, 2% very poor quality (decreased by 3% from 2015), and 1 % very good quality, except in the Inner Bay of Thailand, where the water quality is found to be poor to very poor quality.

Coastal water quality situation
in the 10 year period (2007–2016)



Groundwater

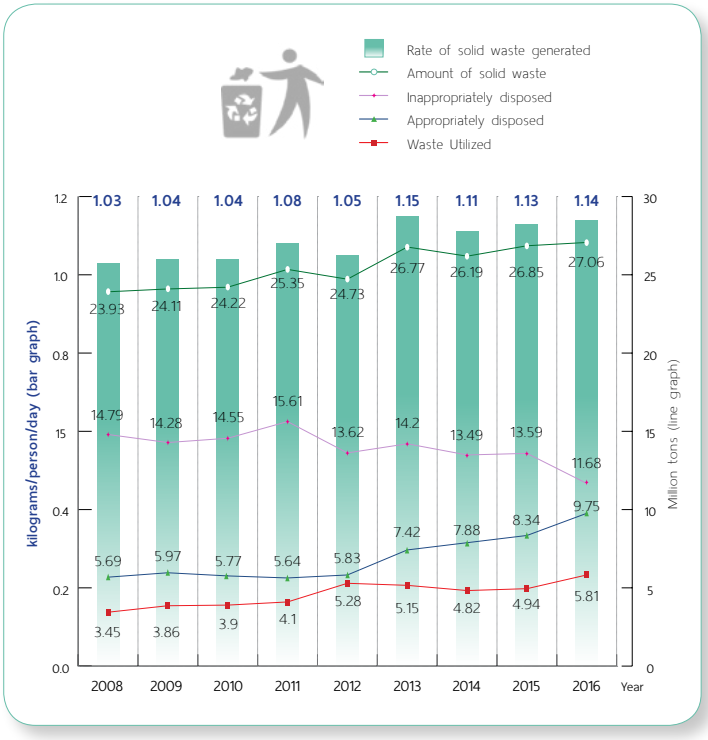
There are a total number of 27 groundwater basins in Thailand. In general, the groundwater quality is marked safe for consumption, which is not different from 2015, with some areas under watched from several activities such as in industrial waste disposal plants in Ratchaburi, areas with illegitimate waste dumping in Cha Choeng Sao, mining areas in Loei, Phichit, Phitsanulok, and Petchabun, in industrial estates in Rayong, and sources of natural gas in Khon Kaen.

State of Waste and Hazardous Waste Condition

Municipal Solid Waste

The number of municipal solid waste in the past 10 years (2008-2016) appeared to be increasing every year, including the amount of waste being generated daily. Since 2014, the amount of municipal solid waste improperly managed had decreased, with increasing number of municipal solid waste being properly managed.

In 2016, 27.06 million tons of municipal solid wastes were produced, which had increased from 2015 (26.85 million tons). The amount of municipal solid waste per capita had increased from 1.13 to 1.14 kg. per person per day. The top 5 provinces with the highest amount of daily municipal solid waste produced were Bangkok, Chon Buri, Nakhon Ratchasima, Samut Prakan, and Khon Kaen. 15.67 million tons of municipal solid wastes (58% of the total wastes produced) were collected for disposal with 9.75% (36% of the total amount of municipal solid waste) being disposed of properly. In the 330 proper waste disposal sites, 6.01 million tons (22% of the total amount of municipal solid waste) had to be transferred to 2,480 improper disposal sites. The remaining 6.29 million tons (23% of total waste) were not collected from both inside and outside service areas. The amount of waste segregation for municipal solid waste recycling had increased to 5.81 million tons (21.5% of total waste), most of which (89.5%) is segregated and recycled by households, the other 10% is sent to junk yards, community recycling centers, recycling banks, and organic farming. The industrial sector recycled about 9.93 million tons of municipal solid wastes, with 5.20 million tons (52%) being traded from within the community and then sent over to industries, and 4.73 million tons (48%) from exchanging wasted materials among producers, importers, and distributors, including the recollection of containers.



Hazardous Waste

In 2016, a total of 3.462 million tons of hazardous wastes were generated, which had increased by 0.017 million tons or 0.49% from 2015. Most hazardous wastes were generated from industries, measured up to 2.8 million tons (80% of the total), where 1.12 million tons (40 % of the total hazardous waste generated) were manageable. 0.606 million tons (18%) of hazardous wastes were generated from the municipal, with 65% were Waste from Electrical and Electronic Equipment (WEEE), and the remaining 35% were generated from households and community. 1,297 tons were collected, with 64 tons (5% of total waste collected) being disposed of. The rest are waiting to be disposed of. 0.056 million tons (2%) were infectious waste, generated from healthcare centers nationwide, totaling 37,962 centers, mostly public and private hospitals, including Infectious Waste Operation rooms in all large healthcare centers. 49,056 tons (88%) of infectious wastes are often eliminated by appropriate private and municipal incinerators.

Hazardous Substances

In 2016, Thailand had imported 7.38 million tons of chemicals from abroad, which had decreased by 1.17 million tons from 2015. These chemicals were used in the industrial sector, the agricultural sector and the public health sector. When considering the top 10 imported agricultural toxic chemicals, it was discovered that the amount imported at 0.16 million tons had increased from 2015 by 0.012 million tons (8%). Likewise, for the top 10 toxic chemicals imported for industrial usage, the amount imported at 3.64 million tons had increased from 2015 by 0.66 million tons (22%). This shows that the level of chemical usage in Thailand is still increasing, and in some cases, is more than necessary.

Emergencies and Pollution Accidents

Emergencies and Pollution Accidents

In 2016, there were a total of 86 emergency cases. 47 of which were emergencies in factories and chemical storage, 26 were in chemical transportation, 6 of which were cases of landfill fires, 2 in illegitimate waste disposal and 5 other cases. The province with the highest number of cases were Rayong, followed by Bangkok, Chon Buri, Samut Prakan, and Samut Sakhon respectively. Most of the sites are industrial estates, areas with many industrial factories, and provinces along the transportation route of toxic chemicals, and oil and gases.

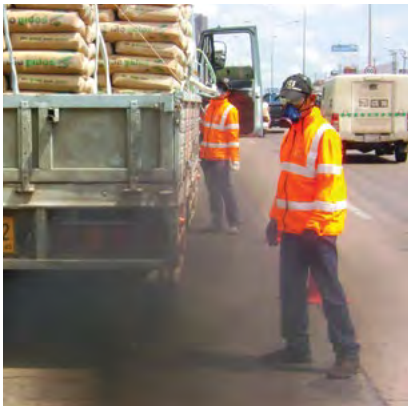
Pollution Complaints

In 2016, there were a total of 10,442 complaint cases, which had decreased by 9% from the previous year. The office that had received the highest number of complaints was the Bangkok Metropolitan Administration Office at 8,093 cases, followed by the Public Service Center, the Office of the Permanent Secretary, the Prime Minister's Office, the Pollution Control Department, the Department of Industrial Works, the Ministry of Natural Resource and Environment, and Damrongdhama Center of Ministry of Interior. 6,101 (59%) of the cases had been resolved, with 4,321 (41%) cases in progress. The sources with the highest number of complaints were from companies, residential areas and buildings, and industrial factories. The province that had received the highest number of complaints was the Bangkok Area and perimeters (90% of all cases), with the main reason being from unregistered or unlicensed businesses, with irresponsible business owners, unconcerned about negative social impact resulting from their business operations. These business owners generally are unconcerned about protecting and mitigating negative impact on the public health of the people living in that community.

Pollution Management

In 2016, tools and mechanisms for key pollution incidents had been developed, which is the 12th National Economic and Social Development Plan (2017-2021), the Environmental Quality Management Plan 2017-2021, the 20-Year Pollution Management Strategy and Pollution Management Plan 2017-2021, the Master Plan on Solid Waste Management (2016-2021), Action Plan to Prevent and Solve Haze Problems in Northern Thailand 2016, the Maintenance of the Cleanliness And Orderliness of the Country Act (No. 2) 2017, and the issuance of related laws on pollution and environmental problems by various Offices such as the Ministry of Natural Resources and Environment, the Ministry of Transport, the Ministry of Industry, totaling 17 issues. Moreover, the Governmental Offices place great importance on engaging the public sector, relaying important news and information, collecting opinions and recommendations, including them in the decision-making process on national projects and strategies, as well as asking for co-operations in following the rules and standards as instituted by the Government. The Governmental Licensing Facilitation Act 2015 also showed the commitment and effort of the Government to service the public sector, increasing the efficiency of Governmental services, while also creating a transparent working produce of Governmental Officers.

On Thailand's Pollution and Environmental Management, an annual budget of THB 13,342 million had been set, which account to 0.49% of the total national budget at THB 2,720,000 million, which is a very small faction, leading to untimely prevention and solutions on the country's environmental problem. However, in 2016, an integrated budgeting system is implementing to serve as a mechanism to drive the operations of Ministries and other Governmental Offices to achieve the goals of Governmental Policies.



The Policy Proposal

In the past year, all related Governmental Offices and stakeholders had collaborated in a communal pollution management efforts in line with the recommendations made. However, there are issues concerning the management process that had to be addressed in order to increase the efficiency of environmental management efforts as follow:

Air Quality and Noise Level Management

1) Speed up the process to define the new standards for controlling the emission of air pollutants from cars to be in-line with the EURO 5/EURO 6 Standards. This is to limit the emission of air pollutants, stimulating the development of new engine technology and the improvement of fuel efficiency, augmenting the standards of cars manufactured in Thailand to be on par with the world's leaders.

2) Results of the vehicle's air pollution emission analysis should be used as the conditions to be met the annual vehicle and motored vehicle registration process, linking the database of the organizations involved with license plate registration, annual vehicle inspection, and all offices related to vehicle prohibition, inspection and traffic regulations.

3) A continuous effort to develop and improve the standards on atmospheric air quality, and the control on the emission of air pollutions from the source of origin, taking into considerations the area's capacity to prepare for the total pollution levels.

Water Quality Management

1) Submitting a proposal to the Thai Government to collect Water Quality Preservation fees from water users (for the community, for agricultural purposes and for industrial purposes), by adding on to the current Water Bill, following the Polluter Pays Principle (PPP), and the Beneficiary Pays Principle (BPP), in other words, "The water usage pays", utilizing the income on this part in the water quality and environment management efforts, as well as developing a public waste water management system.

2) It is suggested that the Maintenance of the Cleanliness And Orderliness of the Country Act B.E. 2560 (2017) should be once again revised to include the issues on Municipal Sewage Management to assign to role of instituting the system for municipal sewage collection and management to local administrative organizations. The Ministry of Interior could designate a budget for such construction directly, and could issue a ministerial order, defining the rate for public wastewater management fee, to be collected in accordance to local ordinance.

3) Consider adjusting relevant laws and regulations to promote the recycling of water in companies or the reuse of recycled water in other businesses and operations.

Waste and Hazardous Waste Management

1) Reorganizing the country's Central Waste Database to make sure that every governmental agencies have access to the same information, and that the database is used in relaying strategic plans and in waste management activities.

2) Speed up the process of issuing the Waste from Electrical and Electronic Equipment (WEEE) Management Act, so that the tool and mechanism for hazardous waste management is available and included in the big picture.

3) Push for measures to reduce the use of plastic bags and foam containers, such as limiting the usage/the availability/the trade of plastic bags in department stores, supermarkets and convenient stores. Prohibiting the use of plastic in certain locations such as national parks, while also reducing the amount of unnecessary plastic usage in commercial products, or limiting the suitable size of plastic containers for product wrapping and containment.

Moreover, in 2016, some Governmental Offices had awarded several stakeholders in the agricultural sector, the industrial sector, the tourism and service sector, and the community with public recognitions for environmental-friendly business operations, serving as a positive incentive to encourage the public and private sectors, including Governmental Offices to become more environmental-friendly. This is so that these stakeholders are involved in environmental protection and preservation processes as well as increased social responsibilities.

Air quality and noise level in Thailand are monitored nationwide, including the monitoring of critical air quality areas, such as the 9 provinces in the Northern Region, Na Phra Lan Subdistrict, Saraburi, Map Ta Phut Subdistrict Pollution Control Zone, Rayong, as well as Bangkok Metropolitan area. The trend analyses of the State of Air Quality and Noise Level, as well as the analyses on the change factors were also conducted to be applied to the planning of preventive measures, and the processes for air quality and noise level management so that the public health will not be affected.

Chapter 1

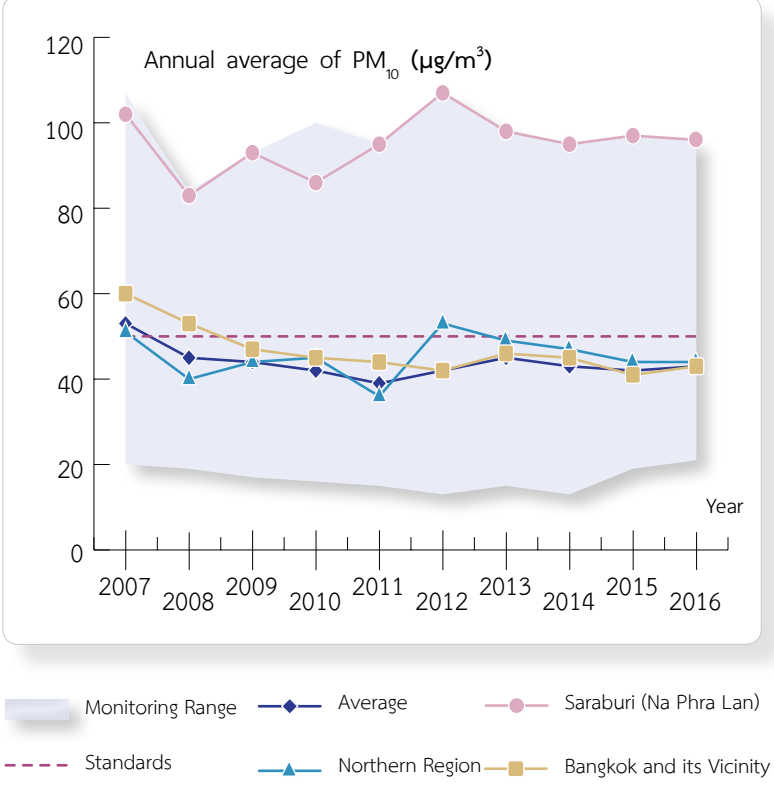
State of Air Quality and Noise Level

State of Air Quality and Noise Level

1.1 Air Quality in the Atmosphere

To monitor air quality, the Pollution Control Department have 63 automatic monitoring stations across the 31 provinces that require continuous monitoring of air quality, particularly in big cities, highly populated areas, industrial zones, and areas with high risk of open burning. The air quality in 2016 had improved. Although the pollutants that remained problematic are particles less than or equal to 10 microns (PM_{10}) and particles less than or equal to 2.5 microns ($PM_{2.5}$), while in the Map Ta Phut Subdistrict, Rayong, the level of Volatile Organic Compounds (1,2-dichloroethane and Chloroform) had been kept within the standard range. However, the 24-hour average of particulates and the 8-hour average of Ozone have exceeded standards in many areas. The monitoring result of air pollutants for each pollutants are as follow:

Figure 1-1 The annual average concentration of PM_{10} in the atmosphere across each area in 2012-2016



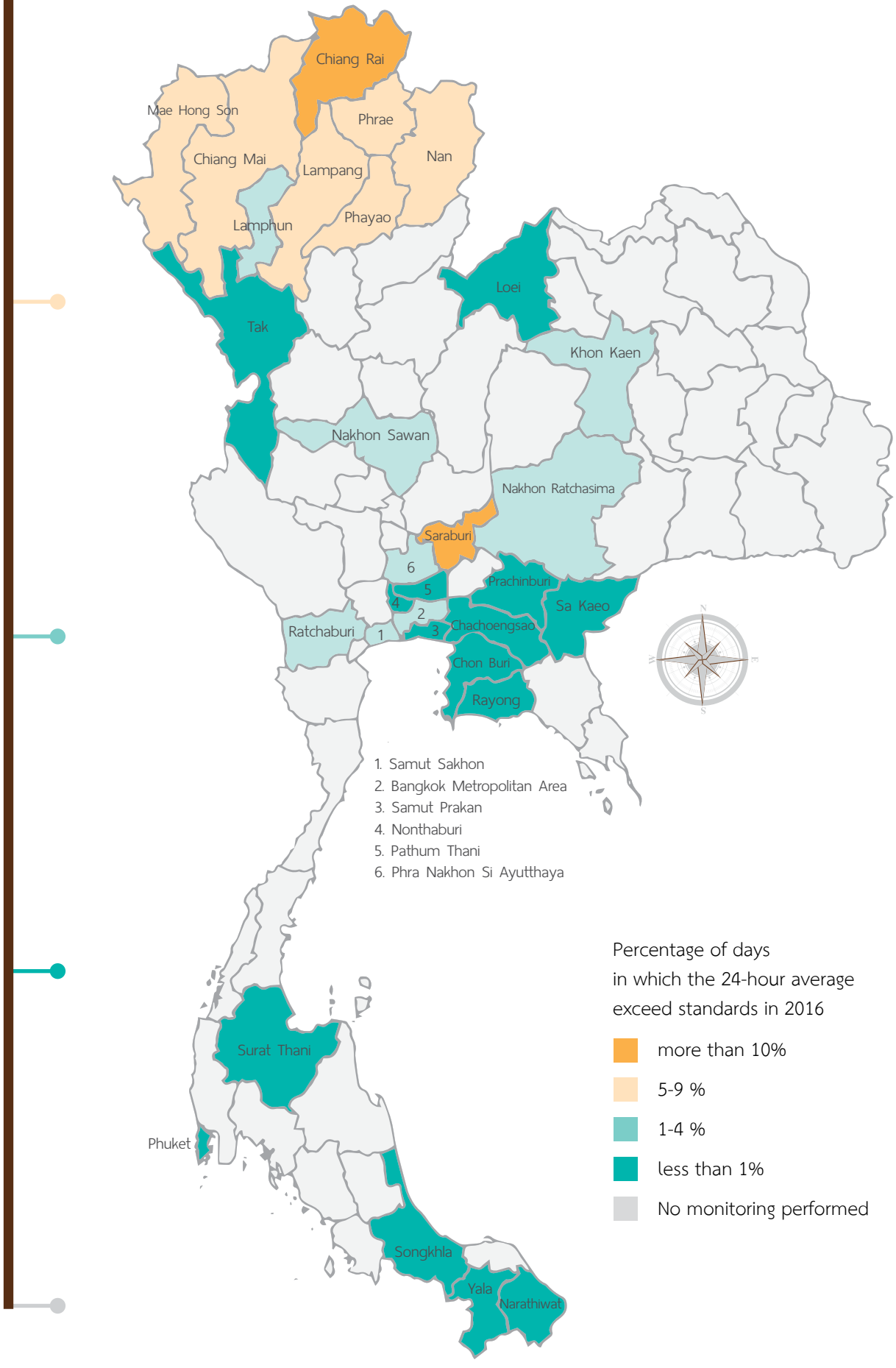
1.1.1 Particles Less Than or Equal to 10 Microns (PM_{10})

The levels of Particles Less Than or Equal to 10 Microns (PM_{10}) had exceeded standards in 21 out of 31 automatically monitored provinces. From calculating the percentage of days in which the 24-hour average exceeded standards, it is found that in most provinces, the percentage of days is less than 5%, with the exception of Chiang Rai and Saraburi going above 10% (Figure 1-2 and Table 1-1). The details of the air quality monitoring results and the standard values are shown in Appendix A.

1) The 24-hour Average was measured to be in the range of 2 – 320 micrograms per cubic meter (µg/m^3), with the highest value of each station averaging at 143 µg/m^3 for the whole country, which had decreased by 9% from 2015.

2) The Annual Average for the whole country is 43 µg/m^3, increased by 2% from 2015. The highest value is measured at 96 µg/m^3 at Na Phra Lan Subdistrict, Chaloem Phra Kiat District, Saraburi (Figure 1-1).

Figure 1-2 The 24-hour average of the amount of particulates exceeding standards in 2016 for each province



1.1.2 Particles Less Than or Equal to 2.5 Microns ($PM_{2.5}$)

12 out of 14 monitored provinces showed values exceeding standard values.

1) The 24-hour Average was measured to be in the range of 2 – 180 µg/m^3, with the highest value of each station averaging at 93 µg/m^3 nationwide, decreased by 18% from 2015.

2) The Annual Average taken nationwide was 27 µg/m^3, which had decreased by 4% from 2015. The highest value at 43 µg/m^3 was taken from the monitoring station on the side of the Din Daeng Road, Din Daeng District, Bangkok (Figure 1-3).

Figure 1-3 The annual average concentration of $PM_{2.5}$ in the atmosphere across each area in 2011-2016

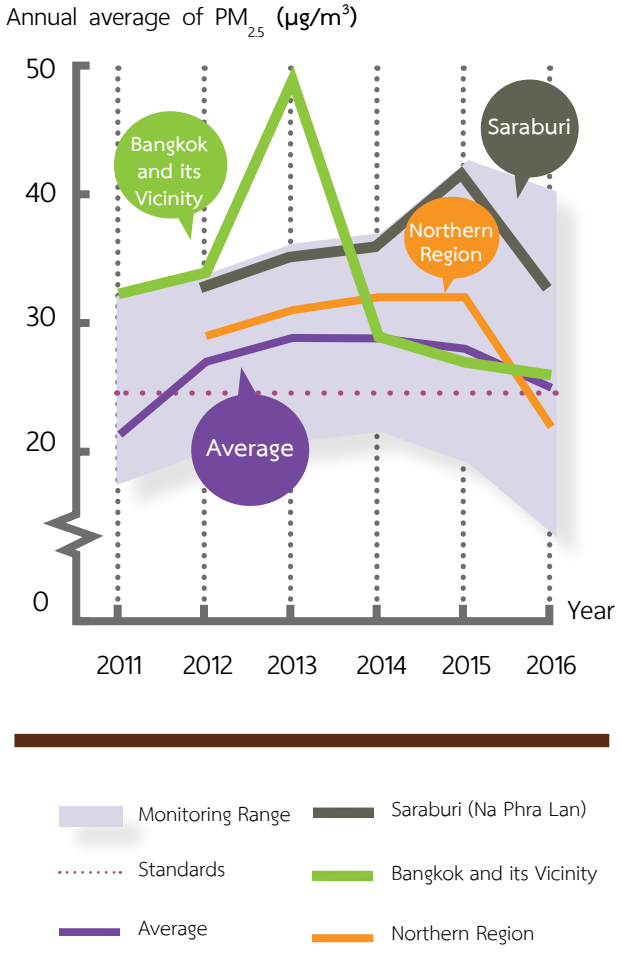


Table 1-1 The summary of monitored particulates in each province, showing the percentage of days that the 24-hour average exceed standards and the highest value for 2016

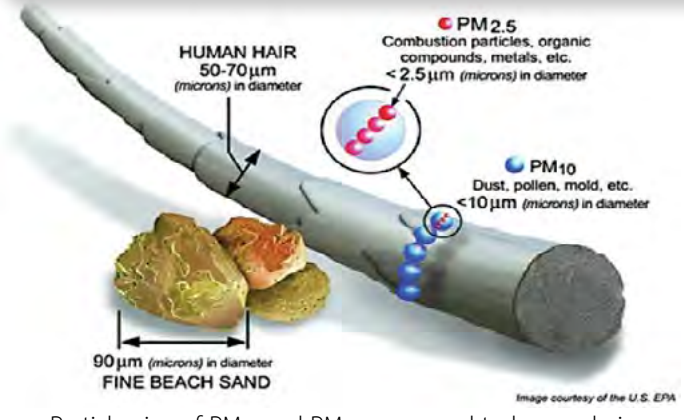
Rank	Provinces	PM_{10}		$PM_{2.5}$	
		Exceeded Standards (%)	Max. (µg/m^3)	Exceeded Standards (%)	Max. (µg/m^3)
1.	Saraburi	24.3	266	10.9†	68†
2.	Chiang Rai	10.1	320	-	-
3.	Mae Hong Son	7.5	285	-	-
4.	Chiang Mai	6.9	209	23.8	144
5.	Phayao	6.6	192	-	-
6.	Nan	6.3	293	19	180
7.	Lampang	6.3	261	20.4	156
8.	Phrae	5.7	172	-	-
9.	Samut Sakhon	3.8	157	16	113
10.	Bangkok	3.8	156	17.2	103
11.	Nakhon Sawan	3.4	175	-	-
12.	Lamphun	3.3	165	-	-
13.	Khon Kaen	2.7	137	34.5	112
14.	Ratchaburi	1.7	167	8.6	136
15.	Nakhon Ratchasima	1.1	143	-	-
16.	Rayong	1.1	128	6.1	82
17.	Phra Nakhon Si Ayutthaya	1	128	-	-
18.	Loei	1	133	-	-
19.	Nonthaburi	0.5	126	-	-
20.	Chon Buri	0.5	150	3.3	85
21.	Samut Prakan†	0.3	131	6.5	69
22.	Chachoengsao	0	108	-	-
23.	Sa Kaeo	0	107	-	-
24.	Narathiwat	0	83	-	-
25.	Surat Thani	0	87	-	-
26.	Phuket	0	85	-	-
27.	Songkhla	0	79	0	47
28.	Yala	0	72	-	-
29.	Prachinburi†	0	104	1	70
30.	Tak†	0	107	0	44

Remark: † Monitoring data obtained is less than 50% of data for the whole year.

Monitoring and Surveillance of PM_{10} and $PM_{2.5}$ in the Atmosphere

Small particles with diameters less than or equal to 10 microns (PM_{10}) and with diameters less than or equal to 2.5 microns ($PM_{2.5}$) are air pollutants that Thailand placed great importance on. As PM_{10} and $PM_{2.5}$ both are very small in size, from various studies, they are discovered that the components of these particles contain chemicals such as sulphates, nitrates, carbonates, germs, heavy metals, and mineral rocks' dusts that can be easily dispersed in the atmosphere, affecting the health and hygiene of humans, increasing the risk of coronary artery diseases, respiratory diseases and cancer.

The monitoring of PM_{10} and $PM_{2.5}$ began in 2011, where the number of monitoring stations for $PM_{2.5}$ had increased to 19 stations across 14 provinces in 2016, to ensure maximum coverage, and a strict implementation of controlling measures to keep the particles level under standards.



Particle size of PM_{10} and $PM_{2.5}$ compared to human hair

Source: United States Environmental Protection Agency, 2003, p.2

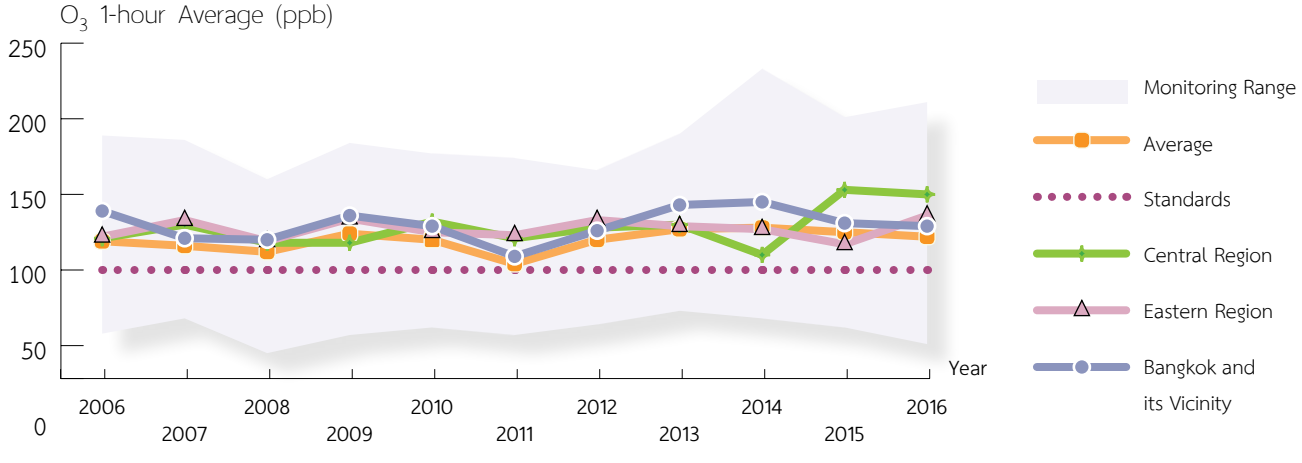
1.1.3 Ozone (O_3)

The monitoring of Ozone is conducted in order to measure the amount of free radicals in the atmosphere. Being exposed to high levels of free radicals can affect the public health by destroying the innate immune system in the lung and thereby increasing the risk of respiratory diseases. In 2016, the level of Ozone had exceeded standards in 24 of the 27 automatically monitored provinces (Figure 1-4).

1) The 1-hour Average's highest value of each station averaged to 122 parts per billion (ppb) nationwide, which had decreased by 2% from 2015. The highest value of 211 ppb was taken at Bang Sao Thong District, Samut Prakan.

2) The 8-hour Average's highest value of each station averaged to 94 ppb nationwide, which had decreased by 3%. The highest value was taken at 152 ppb at Bang Sao Thong Subdistrict, Bang Sao Thong District, Samut Prakan.

Figure 1-4 The monitoring result for Ozone showing each year's highest 1-hour average from 2006-2016 across each area, comparing areas showing high Ozone levels



1.1.4 Nitrogen Dioxide (NO_2)

The levels of Nitrogen Dioxide measured in all areas were found to be within standard range, with the exception of 1 monitoring station in Phuket. The annual average nationwide was measured at 11 ppb, which had decreased by 21% from 2015, with the highest value measured at 34 ppb taken at the road side of Din Daeng Road, Din Daeng District, Bangkok, and the highest 1-hour average measured at 191 ppb taken at Talad Yai Subdistrict, Muang District, Phuket.

1.1.5 Sulphur Dioxid (SO_2)

The levels of Sulphur Dioxide measured in all areas were found to be within standard range, with the annual average measured to be in the range of 1-8 ppb. The nationwide average was measured to be 2 ppb, which had remained constantly from 2015. The highest value was taken at Map Ta Phut Subdistrict, Muang District, Rayong, and the highest 1-hour average of each station was measured to be in the range of 4-115 ppb, with the highest value taken at Map Ta Phut Subdistrict, Muang District, Rayong.

1.1.6 Carbon Monoxide (CO)

The levels of Carbon Monoxide measured in all areas were found to be within standard range, with the highest 1-hour average of each station measured to be in the range of 1.6-8.3 parts per million (ppm), and the 8-hour average of each station measured to be in the range of 1.2-6.1 ppm. The highest value was taken at Wiang Pang Kham Subdistrict, Mae Sai District, Chiang Rai.

1.2 Noise Level

Analyzing the situation and the trend of noise level from 27 automatic continuous monitoring stations along roadside areas and general areas across 13 provinces, in addition to the 16 temporary monitoring stations along the roadside areas of Bangkok, revealed that in 2016, the general conditions of the average annual noise level and in the past 10 years (2007-2016) had not changed much from the past (Figure 1-5 and 1-6). In general areas, the noise levels remained within the standard range. However, the problem persisted along the roadside areas, showing values exceeding standards, particularly in big cities with high traffic congestions such as the Bangkok Metropolitan Area, and Saraburi.

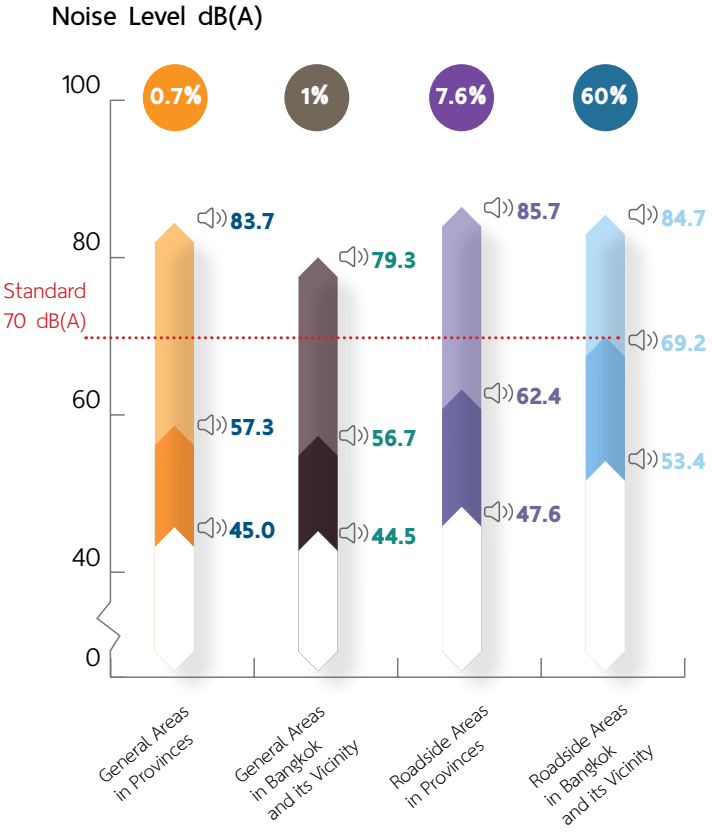
1.2.1 Noise Level in Bangkok Metropolitan Area

1) Roadside Area: The noise level had not changed from 2015, with the 24-hour average of equivalent continuous noise level (L_{eq}) measured to be 69.2 dB(A) (compared to 68.9 dB(A) in 2015). The areas showing everyday noise level exceeding standards are (1) National Housing Authority Public Community Din Daeng, Din Daeng Road (2) Chokchai Police Station, Lat Phrao Road, and (3) Phahurat, Tri Phet Road (The standard for the 24-hour average of equivalent continuous noise level (L_{eq}) is not exceeding 70 dB(A)). The details are shown in Appendix B, Table B-1.

2) General Area: The noise level had not changed from the previous year, with the 24-hour average of equivalent continuous noise level (L_{eq}) measured to be 56.7 dB(A). Most of the monitored areas had shown values within the standard range (Appendix B, Table B-2).

3) Roadside Area (Temporary Monitoring Stations): The noise level had increased from 2015, where the 24-hour average of equivalent continuous noise level (L_{eq}) was measured to be 75.2 dB(A) (compared to 74.2 dB(A) in 2015), and it was found that all monitoring stations showed values exceeding standards, where the top 3 highest values taken at (1) Phra Khanong Police Station, Sukhumvit Road Soi 77 (2) Maen Sri Police Booth, Bamrung Muang Road, and (3) Lam Sali Intersection Police Booth, Ramkhamhaeng Road, with the 24-hour average values of equivalent continuous noise level (L_{eq}) of 78.4, 78.2 and 77.7 dB(A) respectively (Appendix B, Table B-3).

Figure 1-5 The 24-hour average values of equivalent continuous noise level (L_{eq}) in 2016



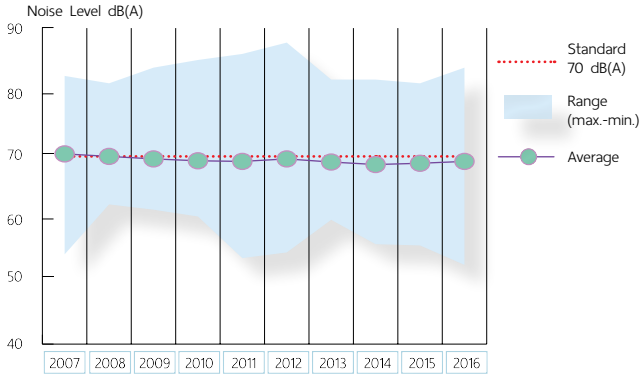
1.2.2 Noise Level in Other Provinces

1) Roadside Area: The noise level in 2015 and 2016 are similar. The 24-hour equivalent continuous noise level (L_{eq}) was at 62.4 dB(A) (compared to 63.1 dB(A) in 2015). The area with higher noise levels than any other areas was the Na Phra Lan Police Station, Chaloem Phra Kiat District, Saraburi, with the highest percentage of days with noise levels exceeding standards (66%), caused by numerous large-sized trucks on the roads (Appendix B, Table B-4).

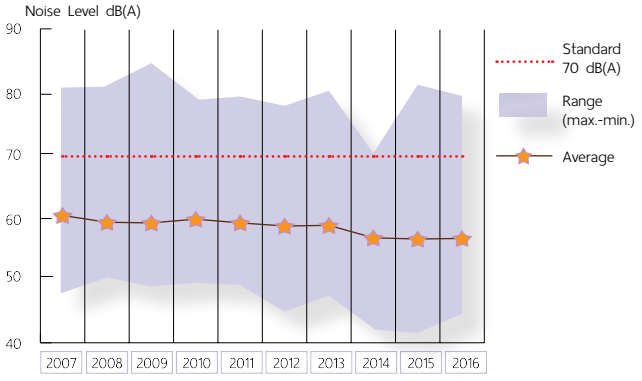
2) General Area: The noise level in 2015 and 2016 are similar. In 2016, the 24-hour equivalent continuous noise level (L_{eq}) was at 57.3 dB(A). (compared to 57.7 dB(A) in 2015). The noise level in all areas appeared to be within the standard range (Appendix B, Table B-5).

Figure 1-6 Comparing the Noise level from 2007 to 2016

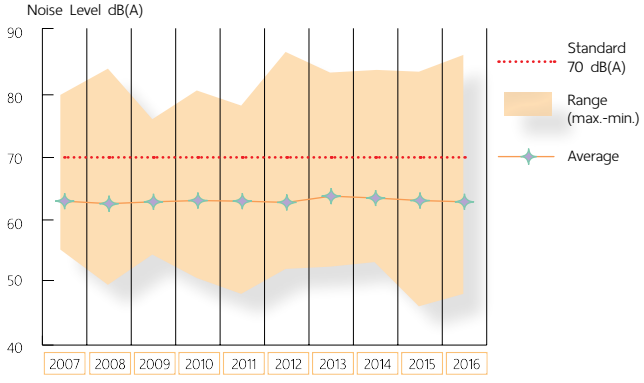
(A) Roadside area in Bangkok and its vicinity



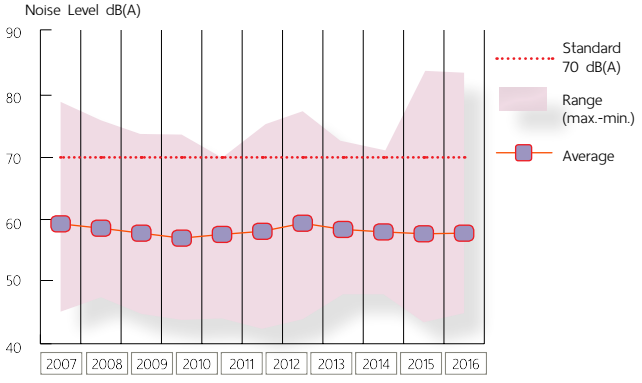
(B) General area in Bangkok and its vicinity



(C) Provincial Roadside Area



(D) Provincial General Area



The Management of Noise Level Impact from the Suvarnabhumi International Airport

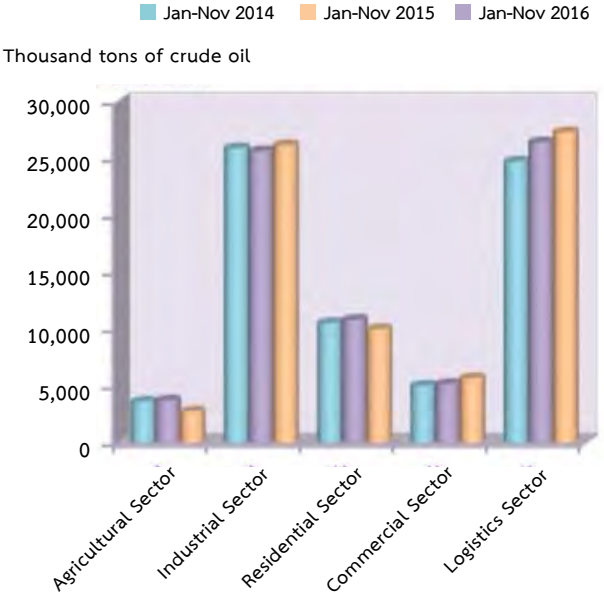
The impact of noise level from the operations of the Suvarnabhumi International Airport, which had been in operation since September 28, 2006, on residential areas within the vicinity of the runway area is more than anticipated in the Environmental Impact Assessment Report. This led to the cabinet resolution in 2006, ordering the Airports of Thailand Public Company Limited (AOT) to resolve the problem, continuously involving technical and academic support organizations in the process, such as the Pollution Control Department, Department of Environmental Quality Promotion. The management of noise level impact in the past include changing the methods of take-off and landing to reduce noise level, changing flight routes to limit the impact of noise levels on the community, creating a noise contour map, where AOT can use as a reference for paying compensation to those affected by noise pollution, extending compensation to those buildings constructed from 2001 until the day that the Suvarnabhumi International Airport begins operations, and monitoring the Noise Exposure Forecast (NEF) to monitor the situation continuously.

As for remedial measures and academic recommendations, recommendations on investigative measures and noise level monitoring measures were made for cases where complaints were filed from buildings outside of the compensated area, which had been applied for use in 2015. Additionally, in 2016, a range of suitable noise level for the airport's vicinity land area usage had been defined, serving as an important tool for relevant organizations to assess the environmental impact of noise level, plan for appropriate land use for areas in the vicinity of the airport, and for city planning of future airport improvement or construction projects, as well considering appropriate measures for future issuance of construction permits and conditions.

1.3 Factors Affecting the Trend of Air Pollution

The main reason for air pollution is pollution source and activities involving the use of coal and liquified petroleum gas (LPG) in cooking processes, the use of fuels such as benzene, diesel, biodiesel, gasohol, etc., for transportation and industrial processes, and electricity production from coal, petroleum, biomass, etc. The air pollutants discovered in each area are identity and their intensity depend on pollution source of each area.

Figure 1-7 Amount of fuel usage in Thailand segregated by sectors (January – November 2016)



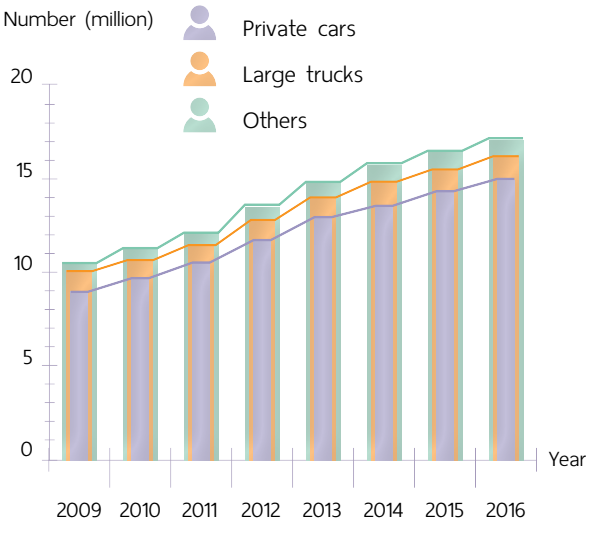
Source: The Department of Alternative Energy Development and Efficiency, Ministry of Energy

1.3.1 The Relationship Between Fuel Usage and Energy on the Source of Air Pollution

The burning of fuel for energy usage give rise to many air pollutants such as dust particles, Ozone, Carbon Monoxide, Nitrogen Dioxide and Sulphur Dioxide. The report on Thailand's Energy Usage from January to November 2016 conducted by Department of Alternative Energy Development and Efficiency, Ministry of Energy, revealed that the logistics and industrial sectors showed a higher energy usage proportion than any other sectors (Figure 1-7).

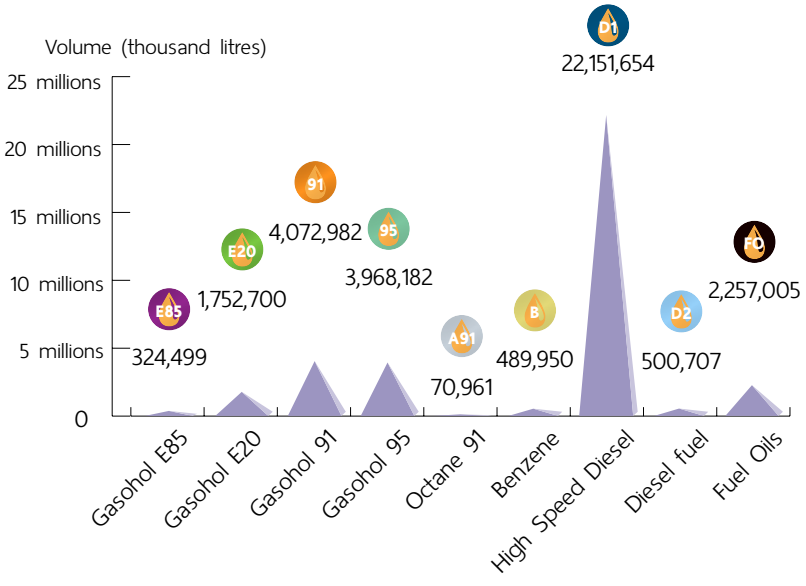
The source of air pollution in cities is mainly from the burning of fuel from vehicles used in land transportation. From the statistics on the cumulative number of registered vehicles nationwide in 2016, it is found that the number had increased from 2015 by 4.1% for personal cars, by 2.4% for large logistic vehicles, and by 2% for other types of vehicles (Figure 1-8), where the cars with the most air pollution emission are diesel engine cars, benzene engine cars older than 8 years, and cars with modified engines, which is in accordance to the sales volume for fuels recorded by Department of Energy Business, showing that the sales volume for automotive diesel is higher than the others (Figure 1-9).

Figure 1-8 Cumulative number of registered vehicles nationwide from 2009-2016



Source: The Department of Land Transport

Figure 1-9 The sales volume of fuel in 2016



Source: Department of Energy Business

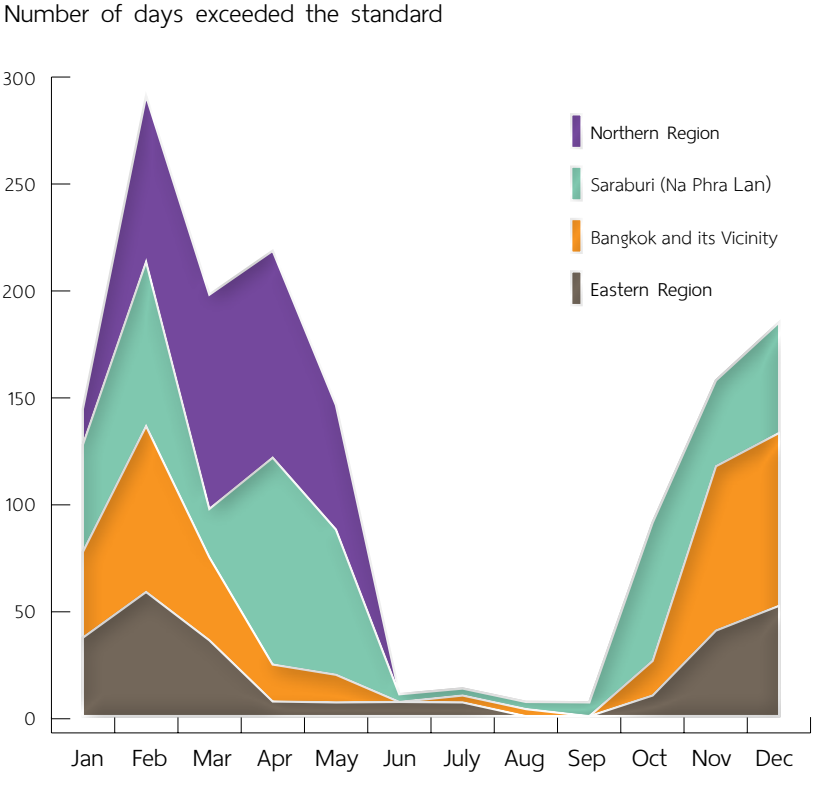
1.3.2 The Period of Time where Air Pollution Problem is Discovered

The main factors causing the amount of air pollutants to gather in the atmosphere are dependent upon the amount emitted from the source and the dispersion of the pollution. Climate condition is considered one of the key factors (Figure 1-10).

During the Monsoon season (May to September), Thailand usually does not face any air pollution problem, as the wind current during the Monsoon season causes the air to flow, and the air pressure during this period also help circulate the air, diluting pollutants into the higher atmospheric levels.

During the beginning and ending of the year (November – April), many areas in Thailand will show a higher level of air pollution than standard values. This is cause from the weak wind and the inversion of air pressure near the surface, causing a higher concentration of pollutants in the area near pollution source, with the exception of the Northern Region, where the problem of air pollution will only occur in the beginning of the year (January – April) due to wide area of open burning during this period.

Figure 1-10 The number of days in which the level of air pollution exceed the standard values on a monthly basis in 2016, comparing between Bangkok Metropolitan Area, the Northern Region, and Na Phra Lan Pollution Control Zone, Saraburi.



1.4 Preventing and Resolving Air Pollution and Noise Level Problems

In 2016, the plan for improving the standards for air pollution emission in new cars, and the standards for the quality of fuel to be in accordance with the EURO 5 and EURO 6 standards had been made to enforce a stricter emission standards in cars. Feasibility studies were conducted with an analysis on the economic impact of the policy, while related Governmental Offices and stakeholders were consulted, while working in parallel with related Offices such as the Traffic Police Division, Department of Land Transport, Bangkok Metropolitan Administration, and Department of Pollution Control to enact the laws concerning on black smoke and noise emission of car engines, and applying the vehicle inspection system to the annual license plate renewal process. This is to ensure that the vehicles are in good quality, equipped with all necessary equipment as required by law, and to ensure that the pollution and noise emission level with contained within standards. The leading party in this case is Department of Land Transport, working together with the private sector in the form of Private Vehicle Inspection Centers, including the inspection of pollution emission in government cars according to the Rules of the Office of the Prime Minister on State Vehicles (No. 4) B.E. 2538 (1995) stating that government cars must be inspected every 6 months, in order to make sure that the pollution emission rate does not exceed standards.

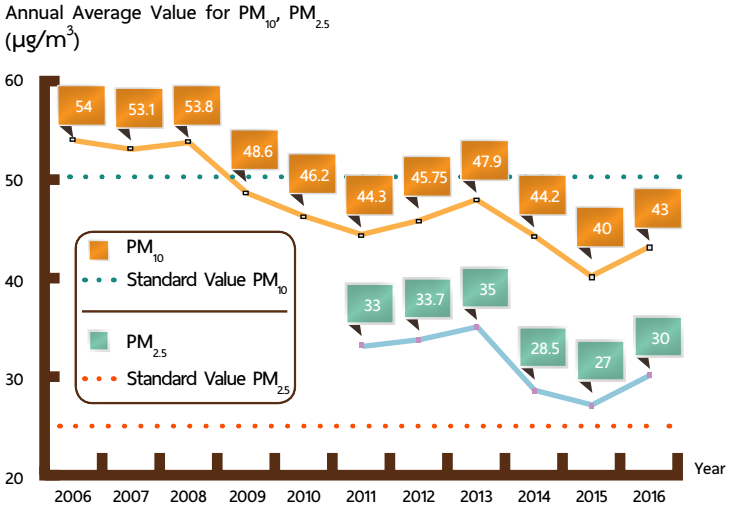
The operation process according the Energy Conservation Plan 2015-2036 is one of the key mechanism to resolve air pollution problems, particularly the measures for energy conservation in the logistic sector, promoting improved fuel efficiency in vehicles, purchasing new energy-conserving cars with low pollution emission rates, lifting or reconsidering governmental subsidies on fuel price, restructuring excise tax on vehicles, developing the basic infrastructure for traffic, public transportation and dual rail trains, improving roads and the efficiency of transportation networks, promoting new technology such as electric cars, including the Alternative Energy Development Plan 2015-2036, where the usage of alternative energy such as biofuel (ethanol, biodiesel, pyrolysis oil, and other alternative fuels) had caused the proportion of alternative energy usage to increase from 12.94% in 2015 to 13.83% in 2016.

As for the Noise Pollution in 2016, Pollution Control Department, in conjunction with National Institute of Metrology, had created an informative package and a user manual for monitoring the level of noise emitted from car engines to be distributed, and to organize trainings to institute understanding among those working in Bangkok Metropolitan Administration, Traffic Police Division, and Department of Land Transport for monitoring and surveillance purposes. Noise level monitoring services are also offered in Private Vehicle Inspection Centers, and ensuring that the monitoring of cars and motorcycles follow the same standards. The website for reporting noise level monitoring from monitoring stations of Pollution Control Department in Bangkok Metropolitan Area had also been developed, where the public is able to access the average noise level for hours through www.pcd.go.th and www.noisemonitor.net.

1.5 The Management of Air Pollution and Noise Level problems in Critical Areas

1.5.1 Bangkok

Figure 1-11 The conditions of particulates in Bangkok from 2006-2016



The air pollution in Bangkok during 2006-2016 had improved, with decreasing PM_{10} and $PM_{2.5}$ levels up until 2015, before starting to increase again in 2016, where the standard annual average value for PM_{10} should not exceed 50 µg/m^3, and the standard annual average value for $PM_{2.5}$ should not exceed 25 µg/m^3. In 2016, it was found that the annual average value for PM_{10} was measured to be 43 µg/m^3, while the annual average value for $PM_{2.5}$ was measured to be 30 µg/m^3 (Figure 1-11), which remained within the annual standard range. The improvement on the overall air quality condition was attributed to the implementation of the Action Plan for Air and Noise Pollution Management in Bangkok in 2012-2016 as follow:

1) To enforcing the law, several organizations are involved such as Department of Land Transport, Bangkok Metropolitan Administration, Metropolitan Police Bureau, Traffic Police Division, Consumer Protection Police Division, Thai Industrial Standards Institute, and Pollution Control Department, detecting and arresting vehicles with pollution emission higher than standards, using extreme measures with Private Vehicle Inspection Centers neglecting pollution emission inspection processes to ensure that standards are being met, arresting vehicle races on public roads, arresting retailers of non-standardized exhaust pipes, monitoring pollution emission of factories and companies.

2) In following relevant laws and regulations, several organizations are involved such as Bangkok Mass Transit Authority, Bangkok Metropolitan Administration, Department of Land Transport, Traffic Police Division, and Pollution Control Department, conducting inspection of the maintenance work of public transportation, to ensure that pollution emission does not exceed standard values by enforcing standard pollution emission levels before providing services along the routes, monitoring the maintenance work of governmental vehicles, especially for the organization involved in controlling pollution emission controls in vehicles, inspecting and controlling construction projects to ensure that the conditions outlined in the EIA report are being met.

3) As for improving the law, several organizations are involved such as the Traffic Police Division, Department of Land Transport, Bangkok Metropolitan Administration, and Pollution Control Department, conducting studies on various measures, leading to the improvement of existing laws, such as increasing the penalty fee for vehicles with black smoke emission level exceeding standards, reducing the lifecycle of taxis, reducing the inspection cycle of cars, and connecting the database for vehicles arrested from having emission levels exceeding standards from various organizations with the annual license registration process of Department of Land Transport.

4) In reducing pollution/reducing the accumulation of pollution from road usage, several organizations are involved such as the Traffic Police Division, Bangkok Metropolitan Administration, and Department of Highways to mitigate traffic congestion problems, which is one of the reasons for accumulative air and noise pollution. Measures were taken to organize parking near bus stops, install no parking signage, control and organize street vendors in designated areas for the convenience of walking along foot passage, reducing the problem of people walking on the roads, and to fix and improve the road surfaces to be in good conditions according to standards, thereby reducing noise level.

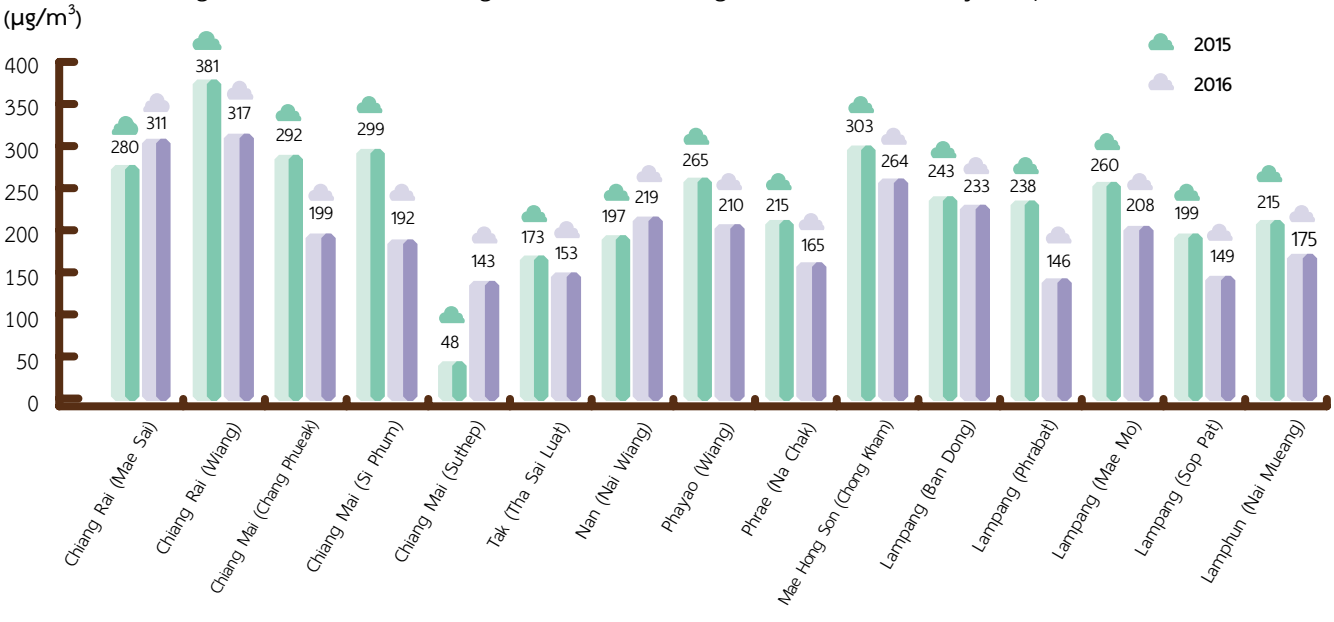
5) In generating collaborative efforts to reduce pollution and personal car usage, several organizations are involved such as the Bangkok Metropolitan Administration, Transport and Traffic Policy Plan Office, Traffic Police Division, National Institute of Metrology, Department of Land Transport, and Department of Environmental Quality Promotion to construct and improve bicycle lanes, promote walking without the use of engines, promote the Car Free Day campaign, and promote the organization of community networks in environmental protection and monitoring, while also increasing the capabilities of officers working on technical air and noise pollution control, protection and mitigation, in accordance with the Enhancement and Conservation of the National Environmental Quality Act B.E. 2535 (1992), and distributing the knowledge and manual for monitoring noise levels in cars, instituting understanding for those operational workers, to use as a guide for monitoring and detecting vehicles with noise levels exceeding standards.

6) In conducting studies, research and development activities, several organizations are involved such as Chulabhorn Research Institute, Department of Highways, and Pollution Control Department in conducting a research on the impact of dust particles ($PM_{2.5}$ and PAHs in $PM_{2.5}$) on the genetic components of the residents in the areas with heavy traffic congestion, studying mathematic simulation models in dealing with Ozone problems, studying the implementation of a diagonal pedestrian crossings, studying noise repellent walls, and creating the standards for new noise mitigated road designs.

1.5.2 Haze and Smoke in the 9 Provinces of Upper Northern Region

The haze and smoke in the 9 provinces of Upper Northern Region of Thailand typically occur in January-April of every year. Thus, the level of particulate matter often rises in the area during those periods. In 2016, the condition appeared to have improved significantly, which is the result of extensive integrated forest fire and smoke control efforts from all parties. As a result, during the critical period of haze and smoke, from January 1 to April 15, 2016 (typically, the haze and smoke crisis will end before the 15th of April in every year), the total heat spots in all 9 provinces has decreased by 20% from 2015, where the levels of particulate matter in most of the provinces had significantly declined with the highest level of particulate matter decreasing from 381 µg/m^3 in 2015 to 317 µg/m^3 (Figure 1-12). However, in 2016, the problem occurred at a different timeframe from the previous years due to the long arid weather, with limited rainfall in April and early May. Open burning fires were discovered from after April 15, 2016 onward, causing the particulate matter levels to exceed standards. This causes the percentage of days exceeding standards to increase from 14% in 2015 to 15% in 2016.

Figure 1-12 The levels of PM_{10} from the monitoring stations across the 9 provinces of Upper Northern Region measured in the highest 24-hour average value from January – April 2016



Measures taken to cope with the haze and smoke problems in the Northern Region in 2016 were as follow:

1) Conducting the Northern Haze Prevention and Mitigation Action Plan 2016, in which the cabinet approved on March 1, 2016, authorizing a central budget of over THB 90 million for the 9 provinces in the Northern Region, implemented by the Ministry of Natural Resource and Environment, and all relevant organizations, particularly the Ministry of Interior, the Border Police, and the local residents in the area, in an integrated prevention and mitigation effort for resolving the haze problems in the Northern Region. Emphasis is placed on a preventive approach, recruiting manpower from all stakeholders, creating a volunteer network for forest fire watch, preparing tools and equipment for monitoring and preventing burning and forest fires in high risk areas, including educating and engaging local communities to raise the awareness on the importance of cooperating with the governmental sector to resolve the problem and control forest fires in the area continuously until the drought season is over in 2016 by refraining from burning forested areas and agricultural area during the crisis period as designated by the province, when burning is prohibited for a specific period. Violators will be prosecuted by law, where the Governor is authorized to apply the Simple Command System.

2) Conducting continuous monitoring to handle haze and smoke conditions after the burning prohibition period as designated by the province, and broadcasting information to create an understanding among community members, discouraging them from starting forest fires and burning agricultural areas, and encouraging them to join the government's network for reducing open burning, implementing crop rotation and adopting a more environmental-friendly approach for agricultural activities. Also implementing non-burning measures in flat areas, expanding on the Royal Project in reducing burning and conserving natural resources, building water weir and growing wet woods, adopting sustainable management of rainforests, in order to resolve the problem in a sustainable manner.

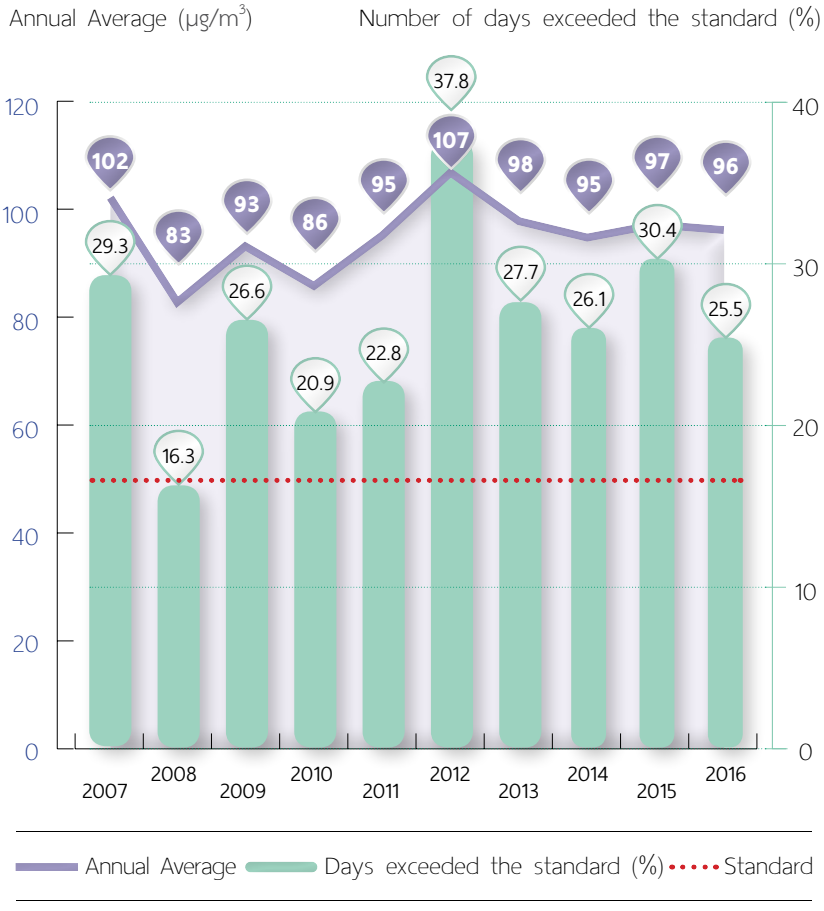
3) Engaging the public in solving the problems of natural resources and the environment through an inclusive process in the form of "Volunteers for the Village's Natural Resources and Environment", in order to monitor and detect forest fires and haze. In 2016, the Ministry of Natural Resource and Environment had named the Doi Suthep-Pui National Park, the Doi Inthanon National park, and the vicinity area as the pilot area for resolving forest fire and haze problems, in accordance with the Pracha Ratch initiatives, while organizing various activities such as the knowledge exchange on fuel management, setting up firebreaks, laying out the plan for forest fire and haze monitoring and detection, growing the volunteer network to cover all high risk areas, and setting up a fund for managing forest fire and haze, giving rise to the volunteer groups for monitoring forest fire and reducing haze in over 100 villages, spread around both national parks and the vicinity areas. 95 funds had also been set up to support the volunteer network. Comparing the statistics of cumulative hotspots in 2016, the Doi Suthep-Pui National Park area showed a 65% decrease, where the Doi Inthanon National Park area showed a 30% decrease, compared to the same period in 2015.

4) Pushing for the movement to sustainably solve the problem of haze and smoke across ASEAN. In 2016, several areas of Thailand located along the borders have been affected by cross-border haze problems, such as in Mae Sai District, Chiang Rai, Chaloem Phra Kiat District, Nan, and Mae Hong Son. Ministry of Natural Resource and Environment had coordinated with the Republic of the Union of Myanmar, requesting cooperation to mitigate and control open burning, while also reporting the situation of cross-border haze and smoke between Tak Province in Thailand and Myawaddy in Myanmar to the Sister City Agreement working group to acknowledge and support the collaborative efforts to prevent and mitigate this cross-border haze problem. Additionally, collaborative efforts on a regional level had been made with the other ASEAN member states to push for the creation of regional level had been made with the other ASEAN member states to push for the creation of the ASEAN Haze-Free Roadmap, aimed towards resolving the cross-border haze problem sustainably, to be approved and implemented as soon as possible so that the ASEAN region can be haze-free within 2020.

1.5.3 Na Phra Lan Subdistrict Area, Saraburi

The problem of particulate matter in the atmosphere in Na Phra Lan Subdistrict area, Chaloem Phra Kiat District, Saraburi usually occurs during the drought season of every year, beginning with the PM_{10} level exceeding standard values consecutively for several days, particularly during January-March, and October-December. According the standards, the 24-hour average level for small particles should not exceed 120 µg/m^3. In 2016, the PM_{10} level appeared to have exceeded standards for a total of 89 days out of the 348 days monitored, which calculated to 74.5% of days where the particle level was kept within standards. The 24-hour averages were found to be within the range of 30 – 266 µg/m^3, where the annual average level of PM_{10} was 96 µg/m^3. In 2015, however, the annual average level was 97 µg/m^3. As such, the conditions in 2016 seemed to have slightly improved in from 2015 (Figure 1-13).

Figure 1-13 The particulate matter conditions (PM_{10}) in the Na Phra Lan Subdistrict, Chaloem Phra Kiat District, Saraburi.



Analyzing the relation between particulate matter problems that occurred in the area, it is found that the level of PM_{10} usually rises in the evening and remain high until dawn of the next day. One of the factors that causes the problem to intensify is the significantly lower Mixing Height during the drought crisis, especially from 14.00 hrs. onward. It was also discovered that particulate matters were often released from the vents of industrial factories. Particulates were also spread periodically from the crushing processes in stone mills in the Na Phra Lan Subdistrict and the vicinity areas.

In 2016, Pollution Control Department Saraburi province, and other parties involved had taken actions measures were taken to prevent and mitigate the problem of particulate matter dispersion and cumulative particles in the area, to prevent serious impact on the public health via the following measures:

1) Strictly regulating and controlling the release of particulate matter from all sources in the area such as roads, industrial factories, and other activities.

2) Inspect and monitor particulate matter from industrial factories in the area and the vicinity area such as cement plants, stone mills, and mineral processing plants.

3) Pushing for local offices and local businesses to clean up roads and effectively vacuum dusts in operational area and public area daily.

4) Monitor the level of particulate matter that exceed standards during the crisis period from October 2016 to April 2017 and coordinate with the offices in-charge to control and resolve the problem, while also requesting for cooperation of the local community to help monitor and report on the problem daily.

However, although all relevant orgnaizations have taken all measures to mitigate the problem, it was found that particulate matter problems had intensified in the early 2016 (Janurary and February), and towards the end of 2016 (November and December), with increasing numbers of consecutive days in which the level of particles exceeded standards. Thus, it is crucial that all parties involved, both from the private and public sector in the area should continue to apply a more effective measure to control and reduce the dispersion of dust particles from the source of origin within the area.

1.5.4 Map Ta Phut Subdistrict, Rayong

In 2016, from the 24-hour average value (monitored value), it was found that the level of Benzene had exceeded standards 4 times in February, July, September and October (Figure 1-14), and the level of 1,3-butadiene had been found to exceed the standards once in August, (Figure 1-15). The 1-year average of Benzene and 1,3-butadiene remained the same from the previous year. From the 10 monitoring stations in the area, the level of benzene had exceeded standards in 6 stations, while the level of 1,3-butadiene had exceeded standards in 3 stations and the level of 1,2-dichloroethane had shown improvements from 2015, where it was found to have exceeded standards in 2 of the stations located near the industrial estate (Figure 1-16).

Figure 1-14 The concentration of Benzene in the atmosphere in the Map Ta Phut Subdistrict Pollution Control Zone, and the areas around Rayong.

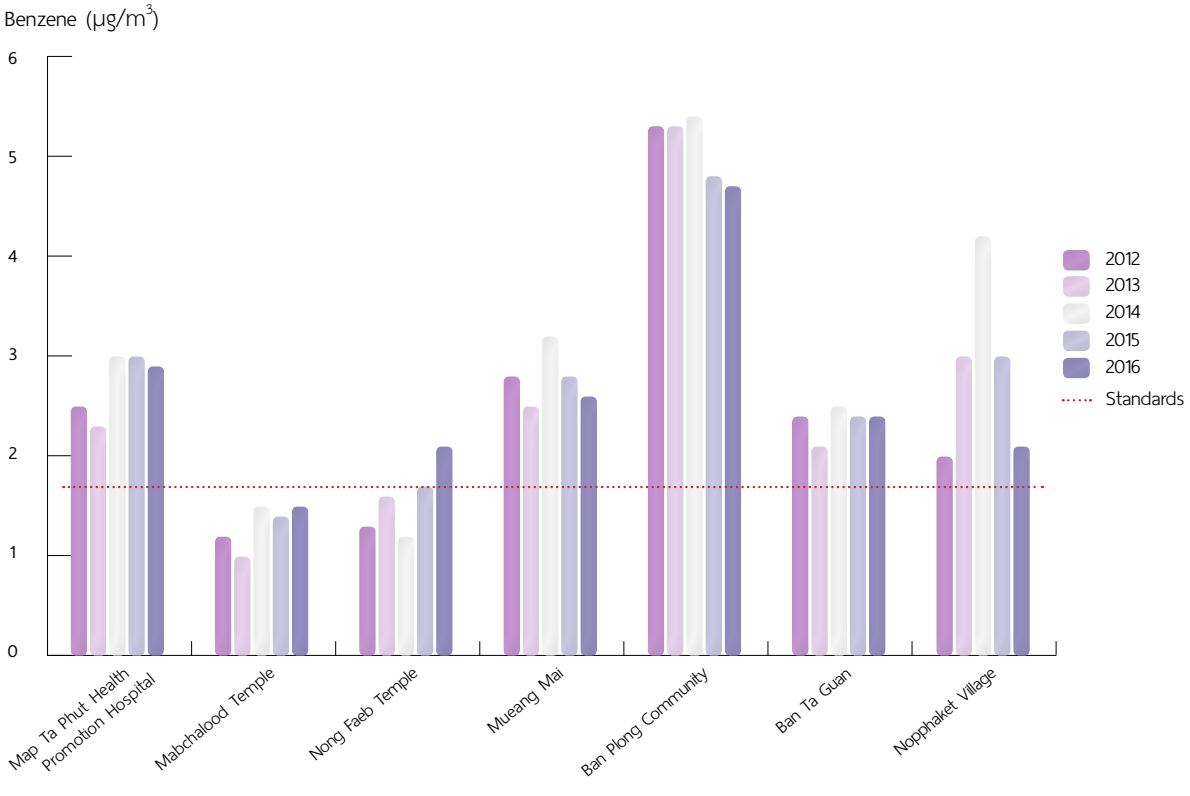


Figure 1-15 The concentration of 1,3-butadiene in the atmosphere in the Map Ta Phut Subdistrict Pollution Control Zone, and the areas around Rayong

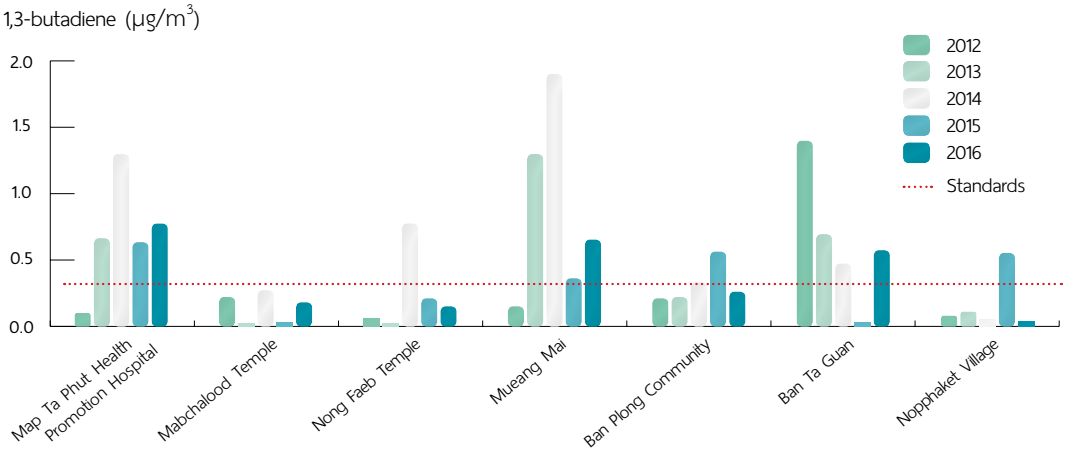
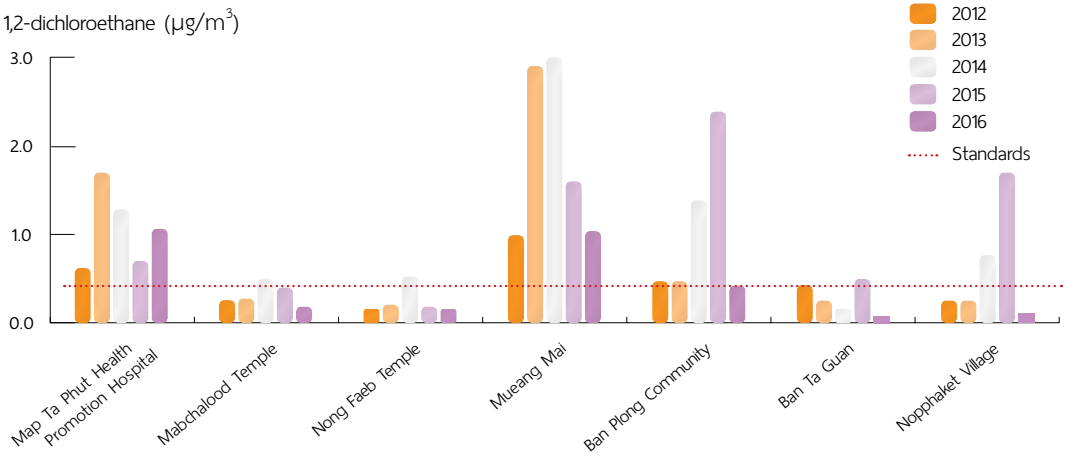


Figure 1-16 The concentration of 1,2-dichloroethane in the atmosphere in the Map Ta Phut Subdistrict Pollution Control Zone, and the areas around Rayong



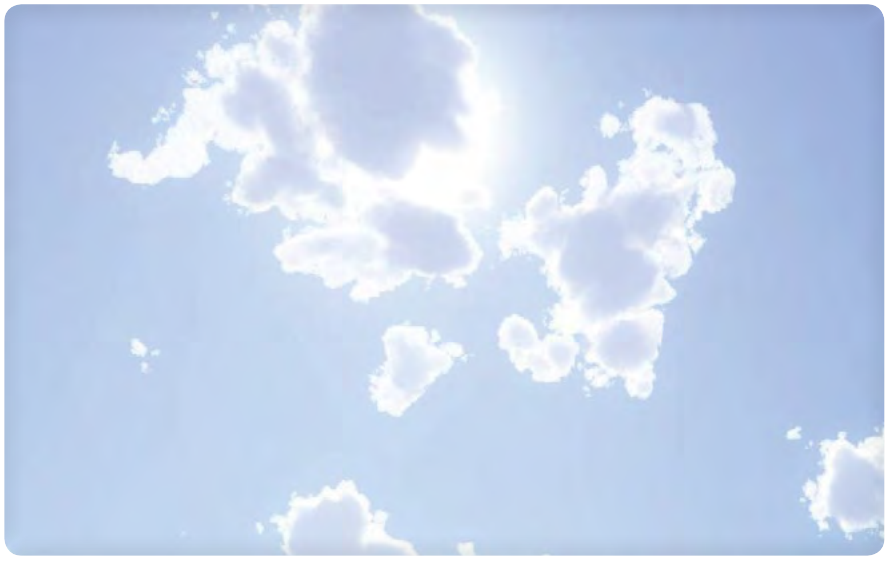
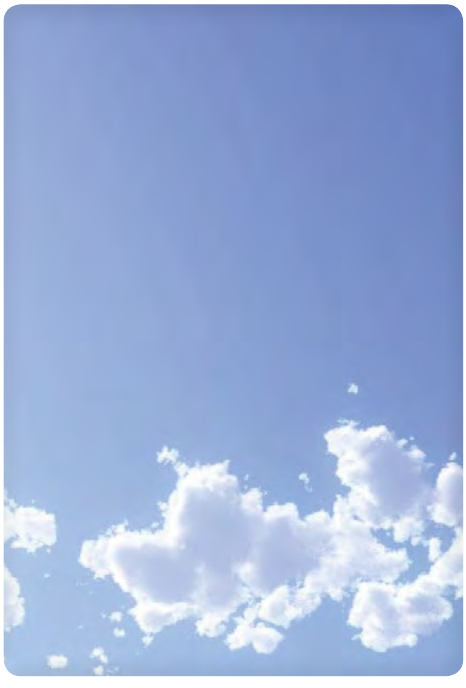
The efforts to mitigate the problem of Volatile Organic Compounds (VOCs) in 2016 had been pushed through the mechanism of the local Environmental Monitoring Subcommittee by the Eastern Seaboard Development Committee, which had assigned the Province of Rayong to appoint "the Subcommittee for the Monitoring and Resolving the Problems of VOCs for the Map Ta Phut Subdistrict, IRPC Industrial Operation Zone, and Rayong's vicinity area". The monitoring subcommittee had then appointed a working committee to support and assist in the operation of the 2 committees below:

1) The Monitoring and Working Committee for Monitoring and Resolving the Problems of VOCs in the Map Ta Phut and the Vicinity Area in Rayong, with the Director Provincial, Offices for Natural Resources and Environment, Rayong, as Chairman and the Director of the Environmental Department as Secretary.

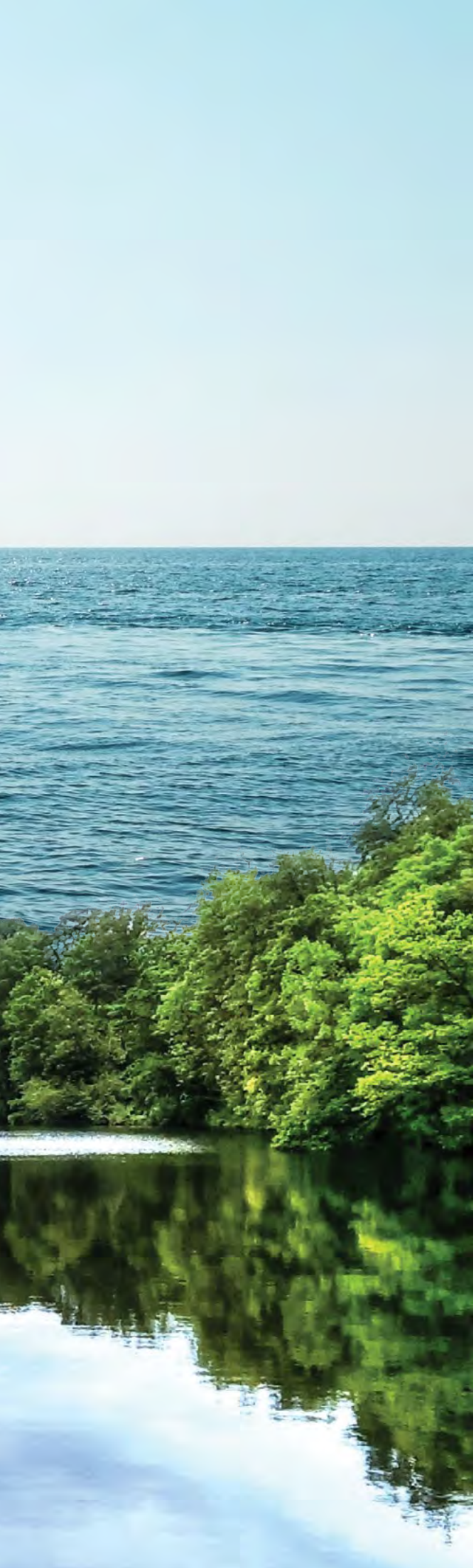
2) Monitoring and Resolving the Problems of VOCs in the IRPC Operation Zone, and Rayong's Vicinity Area, with Rayong Industry Office as the Chairman of the Working Committee and the Head of Industrial Factory Department as Secretary.

From inspecting 24 industrial factories and ports, which is the origin on VOCs (Benzene, 1,3-butadiene and 1,2-dichloroethane), in the Map Ta Phut area, and 7 in the IRPC Operation area, it is found that the industrial factories and the ports in the area had taken complete measures to control the level of VOCs in their production and operation processes, however, a more disciplined and more frequent monitoring process for some of the origin sources related to the targeted compounds is required, for example, fugitive emission of equipment, and chemical transport via cargo ships. Moreover, a more disciplined monitoring process is required for shutdown/turnaround periods.



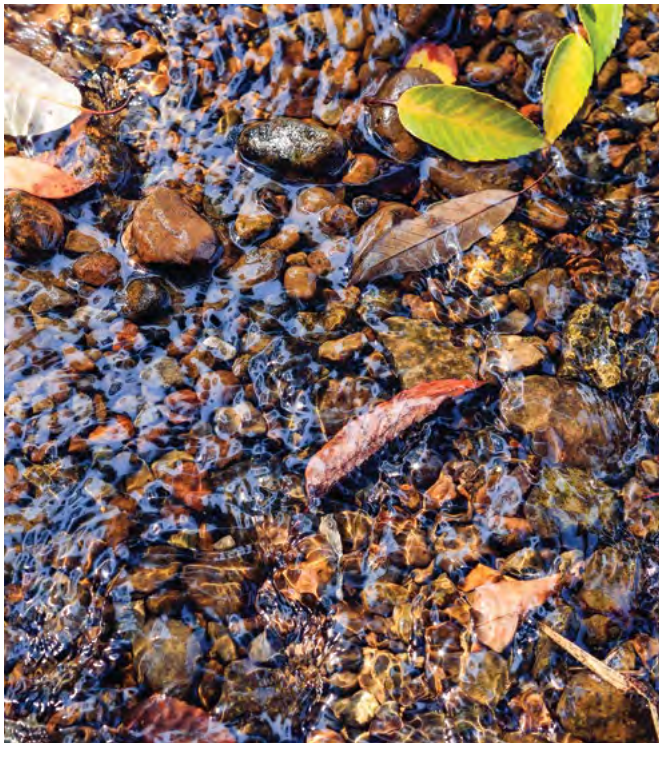
For the state of Thailand water quality, all significant surface water resources across the country, coastal waters in both the Gulf of Thailand and the Andaman Sea, and groundwater basins had been monitored and assessed nationwide in order to analyze the trend and the causes affecting the changes in water quality, as well as to propose recommendations on the water quality management policies and other preventive measures.



Chapter 2

State of Water Quality

State of Water Quality



2.1 Surface Water

The state of water quality across 65 significant surface water sources nationwide measured in 2016 showed that percentage of water quality in the proportion as 34% good quality, 46% fair quality and 20% poor quality (Table 2-1 and Figure 2-1). Compared to 2015, it is found that the overall water quality in 2016 had improved, with the percentage of surface water sources as fair quality increasing from 41% to 46%, and poor quality decreasing from 25% to 20%.

Table 2-1 Surface Water Quality by Region in 2016

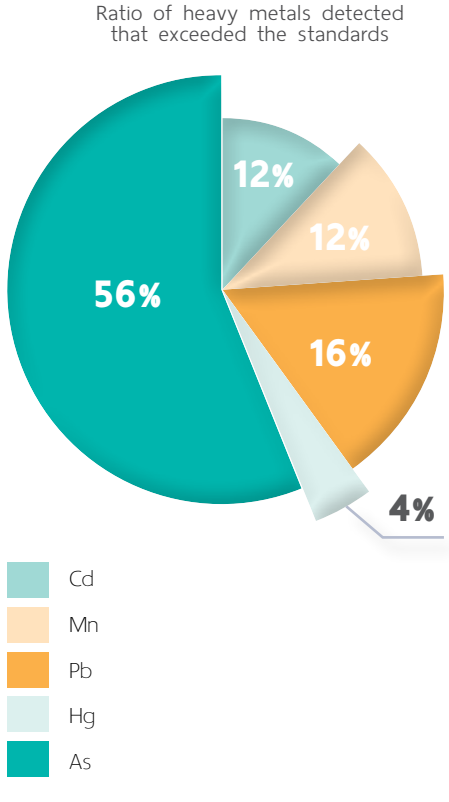
Water Quality (The index WQI[1])	Surface water resources in each region (WQI)					Percentage
	Northern region	Central region	Northeastern region	Eastern region	Southern region	
Excellent (91 – 100)	-	-	-	-	-	0
Good (71 – 90)	Li (75)	Khwae Noi (83) Khwae Yai (80) Upper Phetchaburi (71) Upper Tha Chin ++ (74)	Lam Chee (75) Songkram (83) Loei +(73) Nong Han (80) Oon (83) Mun (71) Upper Lamtakong (72)	Lower Phangrad+(80) Trat (74) Welu (75)	Phum Duang (78) Upper Tapi (80) Upper Pattani+(78) Trang (77) Sai Buri +(75) Lower Pattani+(71) Upper Lang Suan (71)	34
Fair (61 – 70)	Kok (70) Ping (67) Wang -(61) Nan-(67) Yom -(61) Ing -(68) Mae Chang -(62)	Upper Chao Phraya (67) Central Chao Phraya +(67) Central Tha Chin +(65) Mae Klong (70) Pran Buri (70) Pa Sak +(61) Kui Buri (63) Noi (64) Lower Phetchaburi (61)	Phong +(61) Lampao (61) Chi (64) Siew (70)	Chanthaburi -(69) Bang Pakong (65) Prasea (67) Prachinburi (61)	Chumphon (65) Lower Tapi (65) Lower Lang Suan(65) Pak Phanang (62) Thale Luang (66) Songkhla Lake (68)	46
Poor (31 – 60)	Kuang (52) Kwan Phayao -(58) Bueng Braphet (59)	Lower Chao Phraya (41) Lower Tha Chin (47) Sakae Krang (58) Lopburi (51)	Lower Lamtakong (50)	Nakhon Nayok-(59) Upper Rayong(56) Lower Rayong (53) Upper Phangrad(50)	Thale Noi (59)	20
Very poor (0 – 30)	-	-	-	-	-	0

Remark: + Shows water sources that had improved by 1 level compared to 2015 ++ Shows water sources that had improved by 2 levels compared to 2015
- Shows water sources that had deteriorate by 1 level compared to 2015

[1] The Water Quality Index (WQI) indicates the general water quality, derived from 5 water quality parameters, namely Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Total Coliform Bacteria (TCB), Faecal Coliform Bacteria (FCB), and Ammonia – Nitrogen (NH_3-N). The index is between 0 – 100, classifying the quality as excellent (91 – 100), good (71 – 90), fair (61 – 70), poor (31 – 60), and very poor (0 – 30).

Figure 2-1 Thailand Surface Water Quality in 2016

Figure 2-2 Surface water quality monitoring results in the Northern Region compared to the surface water quality standard category 3

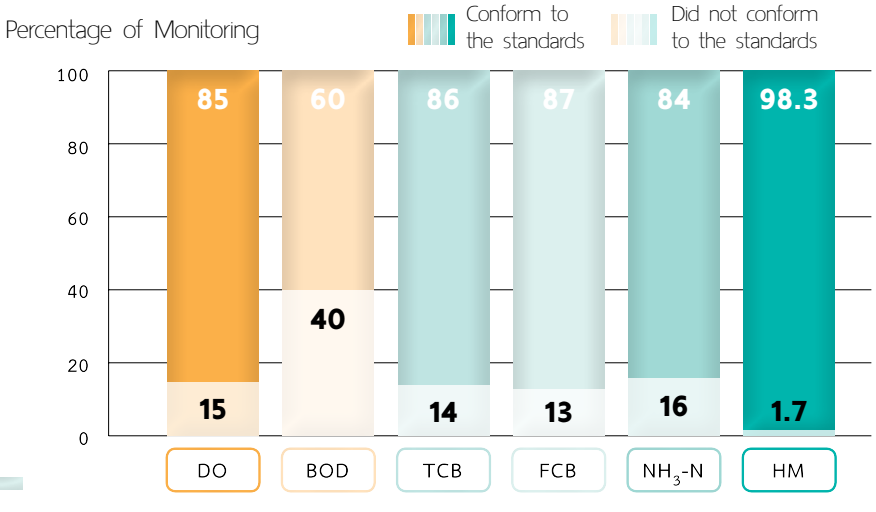


2.1.1 Surface Water Quality by Region

The surface water quality in each region is considered from assessing the percentage of surface water sources with fair quality range upwardly in each region. It is discovered that the southern region showed better surface water quality than any other regions, followed by the northeastern region, the central region, the northern region, and the western region respectively. However, when considering the WQI of surface water sources for poor quality level in each region, it is found that the central region showed a much poorer quality, and lower WQI than other regions. (Table 2-1). And the areas that showed consistently poor quality since 2012 are the Lower Chao Phraya river, Mid-Lower Tha Chin river, Lopburi river, and Sakae Krang river, with the main causes being sewage waste from the communities, agricultural activities, and industries located in the area.

The Northern Region has surface water sources that is 7 sources fair quality, 3 sources poor quality, and 1 of them good quality. For the surface water quality monitoring results, It was found that the highest percentage of parameters could not comply with the surface water quality standard category 3 are the Biochemical Oxygen Demand (BOD). And heavy metal (HM) concentration exceeded the surface water quality standards (1.7% of all monitoring surface water areas) such as Arsenic (As), Lead (Pb), Manganese (Mn), Cadmium (Cd), Mercury (Hg) (Figure 2-2).

The main causes of the problem are the urban community, community along river, tourism and hospitality industry, and agricultural areas (row crops, rice fields, and orchards), mainly monitored in the water quality monitoring stations along the Nan River around Muang District, Pitsanulok, and Muang District, Nan.



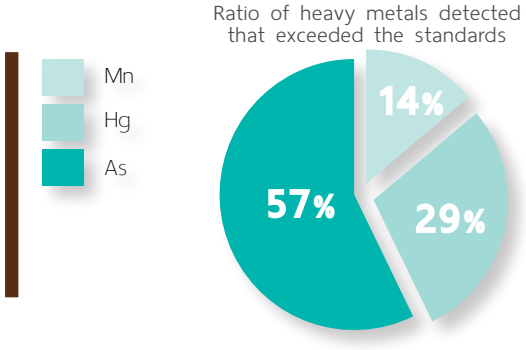
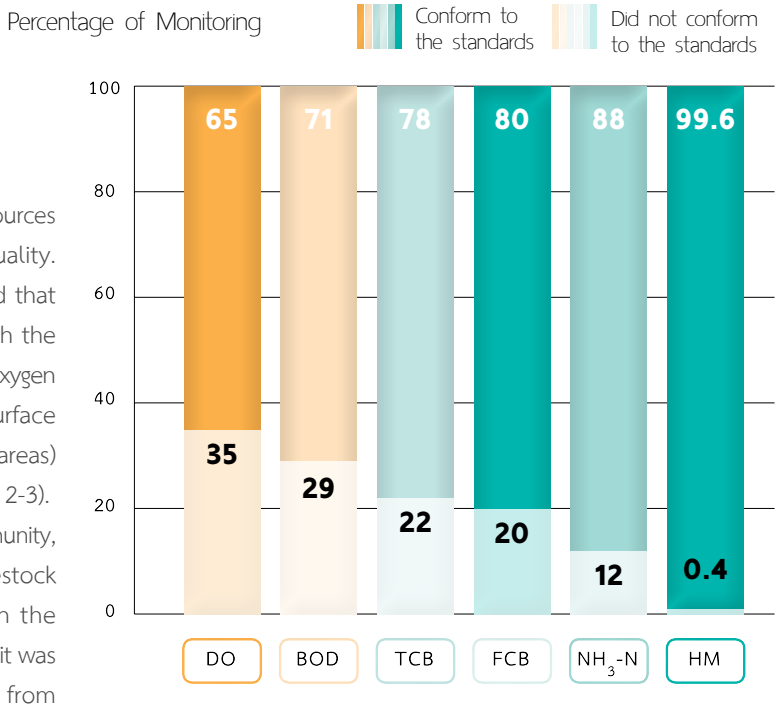


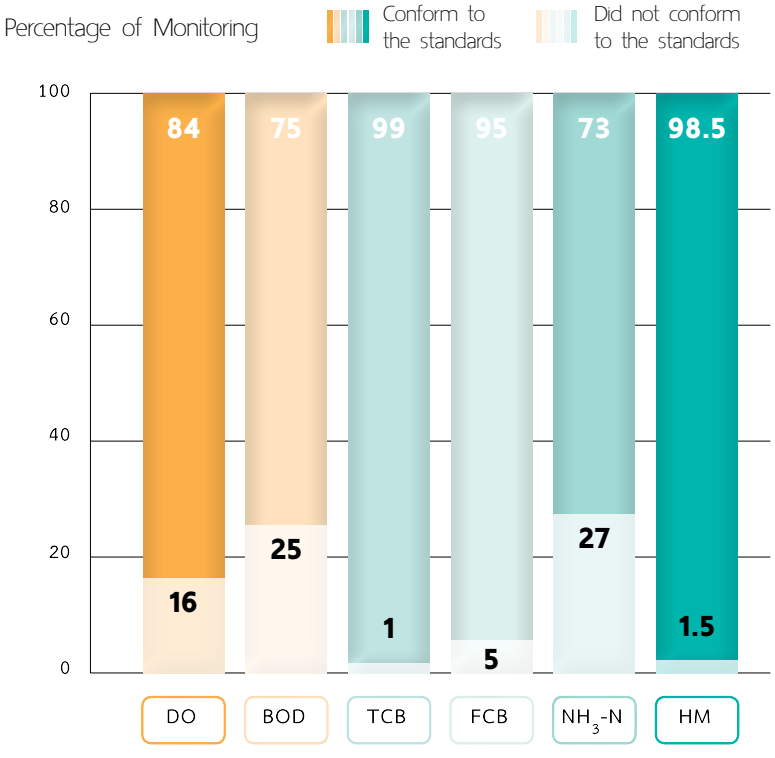
Figure 2-3 Surface water quality monitoring results in the Central Region compared to the surface water quality standard category 3

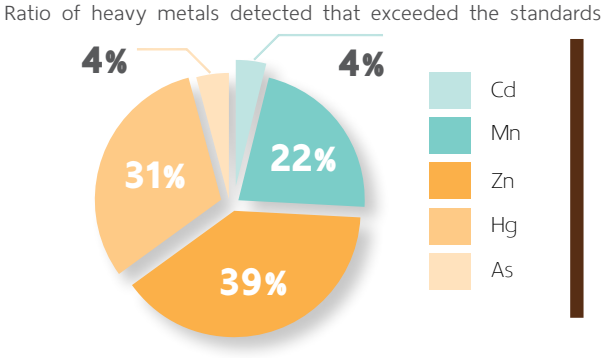


The Central Region has surface water sources that is 9 sources fair quality, 4 sources good quality, and 4 sources poor quality. For the surface water quality monitoring results, it was found that the highest percentage of parameters could not comply with the surface water quality standard category 3 are the Dissolved Oxygen (DO), and Heavy Metal (HM) concentration exceeded the surface water quality standards (0.4% of all monitoring surface water areas) such as Arsenic (As), Manganese (Mn), and Mercury (Hg) (Figure 2-3).

The main causes of the problem are the urban community, agricultural area (rice fields), aquaculture activities, and livestock farming with improper waste management, particularly in the Lower Chao Phraya River and the Lower Tha Chin River, where it was found that the main cause was the wastewater dischange from factories and the densely industrial estates.

Figure 2-4 Surface water quality monitoring results in the Northeastern Region compared to the surface water quality standard category 3





The Northeastern Region has surface water sources that is 7 sources good quality, 4 sources fair quality and 1 of them poor quality. For the surface water quality monitoring results, it was found that the highest percentage of parameters could not comply with the surface water quality standard category 3 are the Ammonia Level (NH_3-N), and Heavy Metal (HM) concentration exceeded the surface water quality standards (1.5% of all monitoring surface water areas) such as Zinc (Zn), Manganese (Mn), Mercury (Hg), Cadmium (Cd) and Arsenic (As) (Figure 2-4).

The main causes of the problem are the urban community, livestock farming, aquaculture activities, and the soil erosion for agricultural activities such as rice fields, growing tapioca, sugar cane, etc.

The Eastern Region has surface water sources that is 4 sources fair quality, 4 sources poor quality, and 3 sources good quality. For the surface water quality monitoring results, it was found that the highest percentage of parameter could not comply with the surface water quality standard category 3 is the Biochemical Oxygen Demand (BOD) (Figure 2-5).

The main causes of the problem are the urban community, agricultural areas including row crops and orchards, and aquaculture activities, particularly in the Rayong River, Rayong, where the main cause is sewage waste from factories and industrial estates.

Figure 2-5 Surface water quality monitoring results in the Eastern Region compared to the surface water quality standard category 3

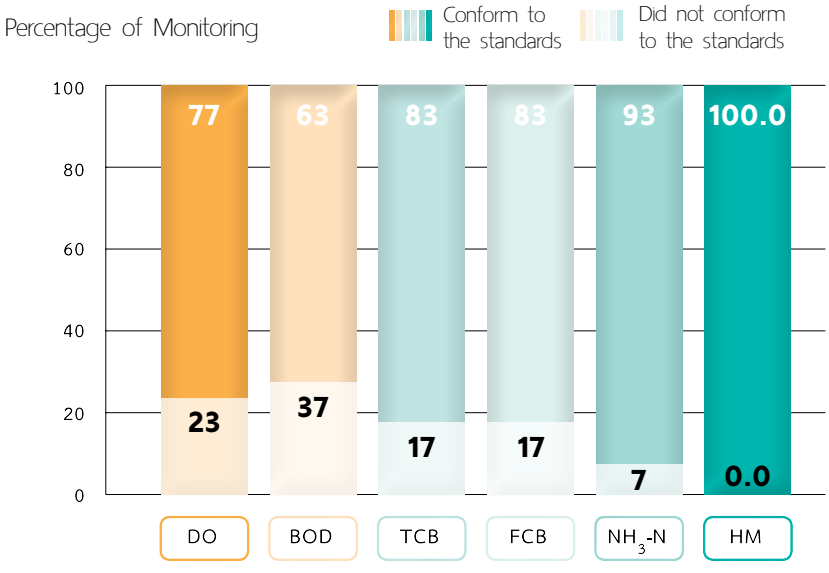
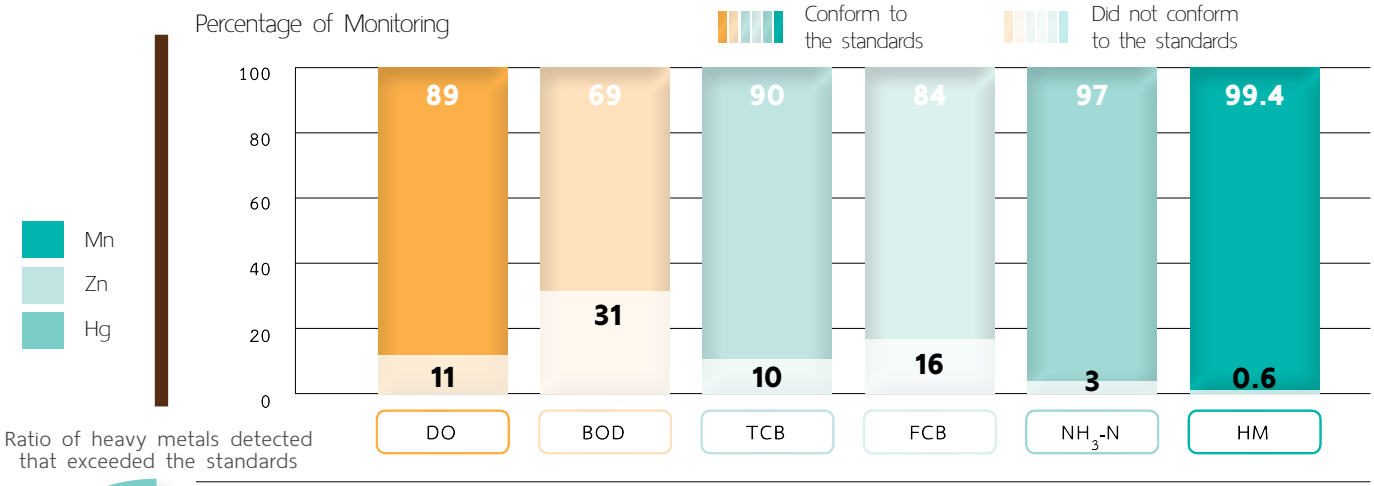
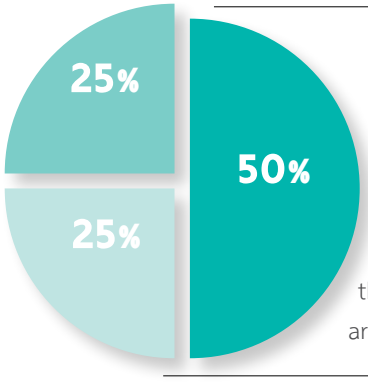


Figure 2-6 Surface water quality monitoring results in the Southern Region compared to the surface water quality standard category 3



Ratio of heavy metals detected that exceeded the standards



The Southern Region has surface water sources that is 7 sources good quality, 6 sources fair quality and 1 of them poor quality. For the surface water quality monitoring results, it was found that the highest percentage of parameters could not comply with the surface water quality standard category 3 are the Biochemical Oxygen Demand (BOD), and Heavy Metal (HM) concentration exceeded the surface water quality standards (0.6% of all monitoring surface water areas) such as Manganese (Mn), Zinc (Zn) and Mercury (Hg) (Figure 2-6).

The main causes of the problem are the community sewage, the fishing port, and agricultural areas such as field rice, aquaculture, and community industrial areas.

As for the results of surface water quality and problematic area of each region, no organochlorine pesticides were detected. The details of the results from surface water quality monitoring of each region, including problematic area are shown in Appendix C, Table C-1 to C-10.

2.1.2 The water quality compared to surface water sources classification

The water quality changing of significant surface water sources in comparison to the water quality classification of 59 surface water sources for the last 5 years ago (2012-2016) showed that the Upper Tapi River and the Lam Chee river are the best water quality. Only 7 surface water sources (12%) remainly stand in their water quality classification, where 6 surface water sources, Trang River, Songkram River, Trat River, Wang River, Phum Duang River, and Loei River, meet the water quality standard category 3, and the Lower Rayong River, meet the water quality standard category 4, as shown in Appendix C, Table C-11.

From analyzing the surface water quality data, the percentage of the main parameters (DO BOD TCB FCB NH_3-N and Heavy Metal (HM)) which do not meet the surface water sources classification during 2012 - 2016 showed that the contamination of heavy metal, not meet with their surface water sources classification approximately 1-2%, while the BOD and DO values exceeding the surface water sources classification are as high as 26-36% and 25-31% respectively. In particularly, BOD, is trending upward from 2013 (Figure 2-7).

The main wastewater sources are generated from industrial sector 17.8 million m³/day, by community sewage 9.6 million m³/day, and agricultural activities 3.9 million m³/day. The important factor of water pollution is untreated wastewater from households, coming from over 24 million households, where only 14.5% entering the wastewater treatment plants, and only 1.4 million m³/day being treated. The overall nationwide 101 plants of municipal wastewater treatment plants, there are 88 plants in used, and operating, which belong to the Local Administrative Organizations 68 plants, The Bangkok Metropolitan Administration 8 plants, and the Wastewater Management Authority 25 plants. The wastewater treatment technology mainly use stabilization ponds, aerated lagoons, and activated sludge systems.

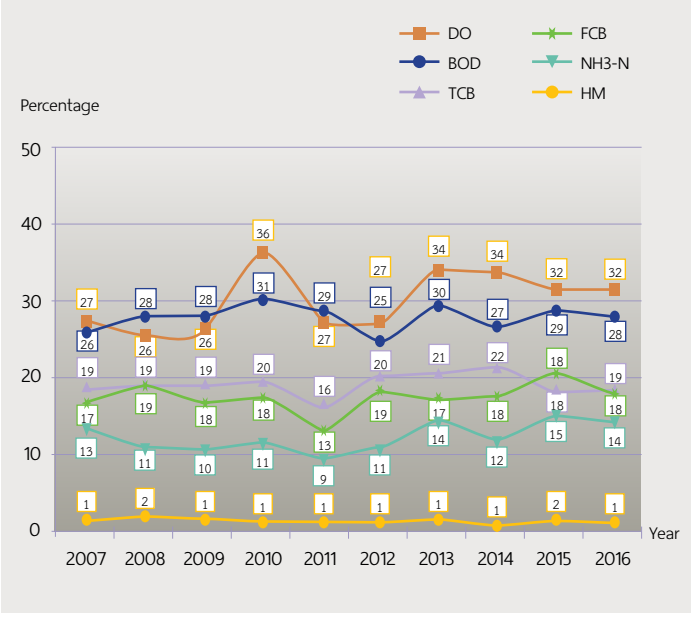
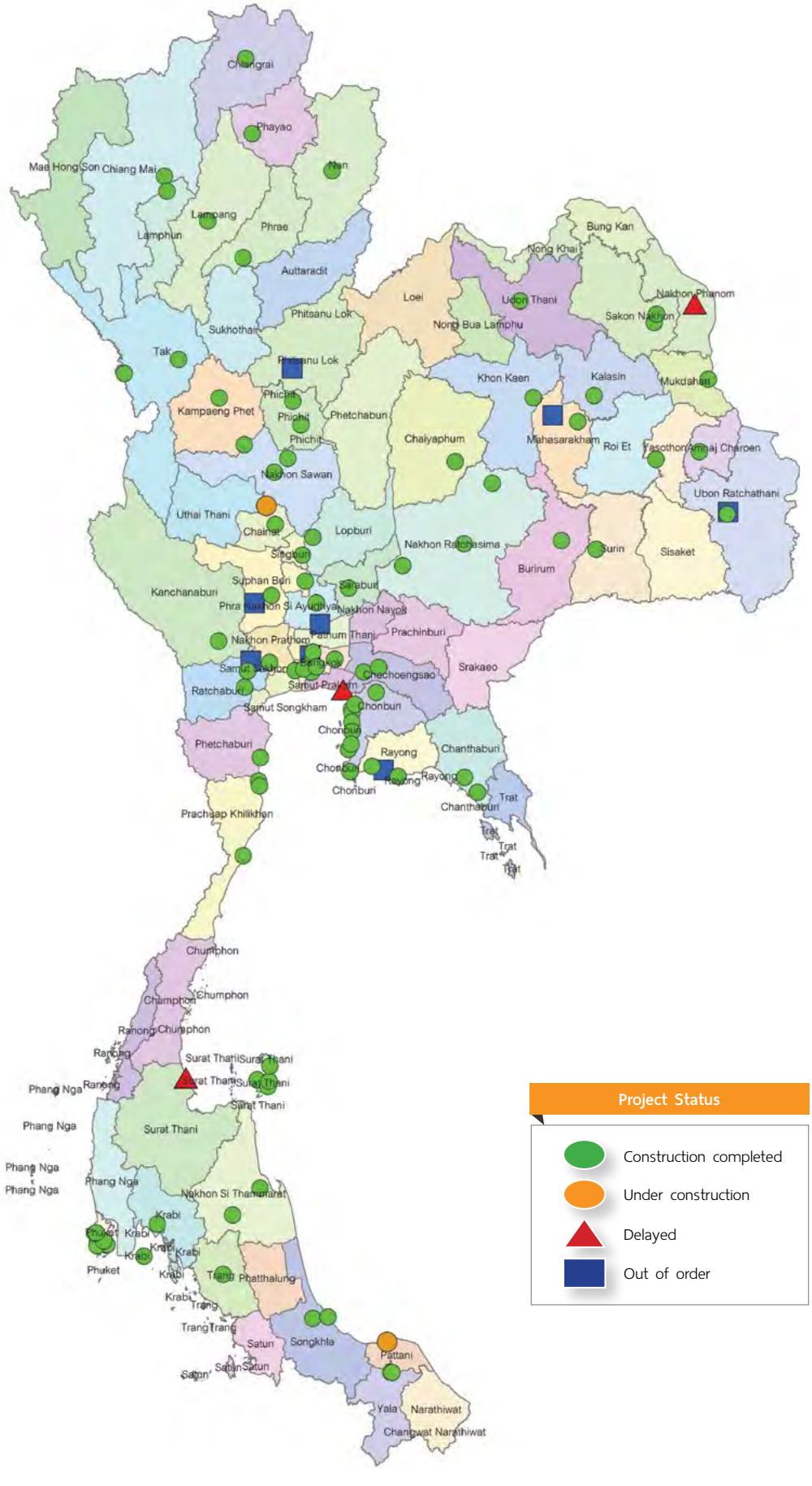


Figure 2-7 The percentage of parameters that do not meet the surface water sources classification 2007-2016

At present, the total capacity for wastewater treatment plants nationwide is only at 2.7 million m³/day, accounting for 28% of the total generated wastewater (Figure 2-8 and Appendix D) because of lack of the Local Administrative Organization's investment budget and the expenditure of operation & maintenance system. There are other wastewater sources such as community businesses, industries, and agricultural activities that do not treat their wastewater effluent or comply with regulatory requirements, for example, many of the pollution sources are along Khlong Saen Saep, 151,799 pig farms with small and medium size nationwide.

Figure 2-8 The total municipal wastewater treatment plants in Thailand



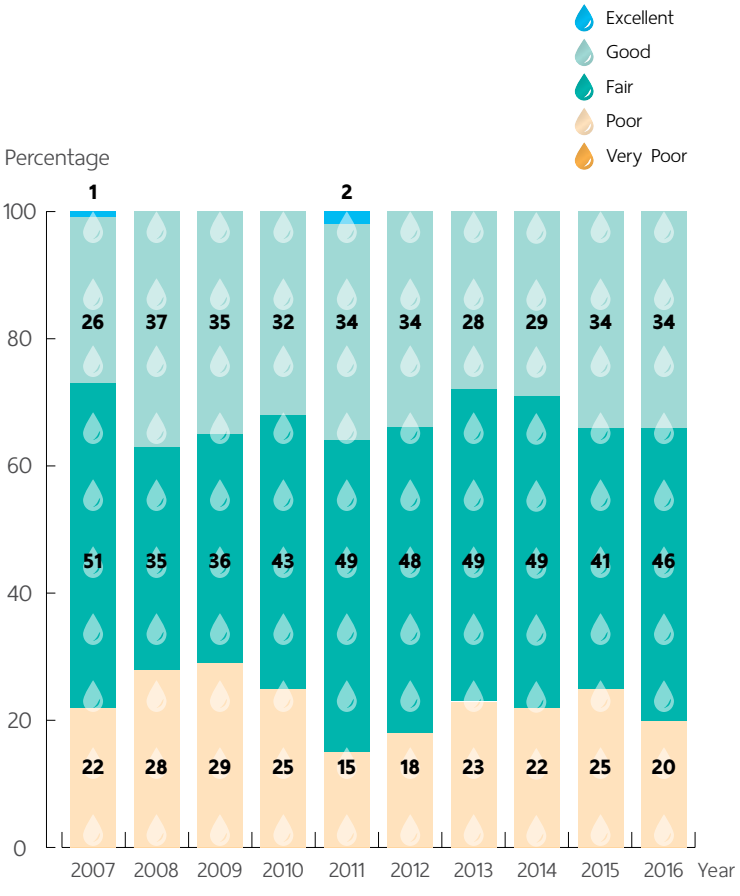
2.1.3 The trend of surface water quality in 10 years period (2007-2016)

In the past 10 years, from 2007 - 2016, the water quality of most of the surface water sources were of fair quality, and at present, the surface water sources of excellent quality have not found in Thailand. However, the trend of surface water quality had slightly improved. From 2007, no discovery the surface water sources of very poor quality, and these have moved towards the better quality in 2013, such as the Upper Tha Chin River, Lower Phang Rad River, and Sai Brui (Figure 2-9).

The surface water sources that have shown consistently good quality are the Upper Tapi River, Trang River, and Welu River. There are 12 surface water sources that had shown deteriorating quality including the Lower Chao Phraya River, Lower Rayong River, Upper Rayong River, Upper Phang Rad River, Welu River, Ping River, Bueng Boraphet Lake, Phong River, Chi River, Lower Lang Suan River, Upper Lang Suan River, and Kui Buri River.

The surface water sources that have shown consistently deteriorating water quality, and requires monitoring and doing action pollution management measures are the Lower Chao Phraya River, the Lower Tha Chin River, Lopburi River, Lower Rayong River, and Lower Lamtakong River, because these rivers flow through highly populated urban community area, as well as industrial areas, agricultural areas, and livestock farming areas, while no effective wastewater treatment and pollution management measures are in place.

Figure 2-9 The trend of surface water quality in 10 years period (2007-2016)



2.2 Coastal Water Quality

In 2016, the state of coastal water quality, along coastline 2,800 kilometers, covering the Gulf of Thailand include the Inner Gulf, the Eastern and Western Gulf, and the Andaman sea coast, had shown the ratio of 1% very good quality, 60% good quality, 30% fair quality, 7% poor quality and 2% very poor quality (Figure 2-4).

Most of the coastal water quality showed proportion of good quality, and Thong Ta Pan Beach (Ko Pha Ngan), Surat Thani is the only one area showing excellent coastal water quality, as a result of local businesses paying attention to protect environment quality and treating wastewater before discharge through environment. However, the coastal water quality in the Inner Gulf of Thailand is found the deteriorated proportion from poor to very poor quality, in particular, coastal water areas with very poor quality such as the Chon Buri Bay, Chon Buri, 12 Thanwa Estuary, in front of the dyeing factory KM.35 at the Chao Phraya Estuary, Samut Prakan, and the Tha Chin Estuary, Samut Sakhon.

Table 2-2 Coastal Water Quality in 2016

Quality	Inner Gulf of Thailand	Eastern Gulf of Thailand	Western Gulf of Thailand	Andaman Coast	Percentage
Excellent (>90 – 100) 1 location	-	-	Surat Thani - Thongtapan Bay (Koh Pha Ngan) (10) +	-	1
Good (>80 – 90) 121 locations	Chon Buri - Bang San (The Tide Hotel) (100) + - Bang Phra (100) + - Koh Sichang (Tha Thewawong) (100) + - Hua Laem Chabang (100) + - Laem Chabang Port (central) (100) + - Laem Chabang Port (500) + - Central Pattaya (10) + + - North Pattaya, (10) + - Koh Lan (Tawaen Beach) (10) + - Koh Lan (pier) (100) + - Chong Samaesan (100) **Phetchaburi** - Chao Samran Beach (10) + - Puek Tian Beach (10) + - Central Cha - Am Beach (Visitor Center) (10) + - Central Cha - Am Beach (Visitor Center) (500) + **Prachuap Khiri Khan** - Hua Hin Beach in Sofitel Hotel (10) + - Hua Hin Beach in Sailom Hotel Hua Hin (10) + - Khao Takiab (10) + - Pran Buri Estuary (500) - Pran Buri Estuary (in front of Evason Resort) (10) + - Pran Buri Estuary (Khao Kalok) (10) + - Sam Phraya Beach (10) + - Ban Bo Nok (100) + - Prachuap Khiri Khan Bay (central) (100) + - South Prachuap Khiri Khan Bay (10) + - Wanakon Beach (10) + + - Ban Tung Pradu (100) + - Ban Krood Beach (10) + - Bang Sapan Estuary (10) + - Manao Bay (10) +	Trat - Koh Chang (Kai Bae Beach) (10) + - Koh Chang (Klong Prao Beach) (10) + - Koh Chang (White Sand beach) (10) + - Koh Chang (Bang Bao Bay) (100) + -Leam Ngob (500) + **Chanthaburi** - Khung Kraben Bay (500) - Leam Sadej Beach(10) **Rayong** - Phangrat Estuary (500) + - Rayong Estuary (500) + - Mae Ram Phueng Beach (10) + - Arboretum (100) + - Sai Kaew Beach (Koh Samet) (100) + - Phai Bay (Koh Samet) (10) - Phai Bay (Koh Samet) (100) + - Tubtim Bay (Koh Samet) (10) - Prao Bay (Koh Samet) (10) - Klang Estuary (500) + - Laem Mae Phim (10) +	Chumphon - Ban Na Tub (100) - Ban Sa Plee (10) - Pharadonphap Beach (10) - Thungwualaen Beach (10) **Surat Thani** - Pum Rieng Estuary (100) + - Don Sak Estuary (500) + - Mae Nam Market (Koh Samui) (10) + - Chaweng Noi Bay (Koh Samui) (10) + - Chaweng Bay (Koh Samui) (10) + - Lamai Beach (Koh Samui) (10) + - Ban Hua Thanon (Koh Samui) (10) + - Ferry Pier (Koh Samui) (100) + - Jetty (Koh Pha Ngan) Cha Lok Lam (100) - Hat Rin Bay (Koh Pha Ngan) (10) - Hat Rin Bay (Koh Pha Ngan) (500) **Nakhon Si Thammarat** - Nai Phlao Beach (10) + - Hin Ngam Beach (10) + - Pak Khlong Tha Sung (500) + - Ban Pak Khlong (100) **Songkhla** - Pak – Rawa floodgate (10) - Maharat Beach (10) + - Thepha Beach (10) - Samila Beach (10)	Ranong - Chan Damri Beach (100) + - Bang Ben Beach (10) + - Praphat Beach (10) + **Phang Nga** - Bang Sak Beach (10) + - Thai Mueang Beach (10) + - Pak Bang Estuary (10) + - Ban Bang Nieng (10) + - Ban Kao Pi Lai (500) + - Ban Koh Ko Kao (10) + - Ban Nam Khem (100) + - Ban Kukkak (10) + **Phuket** - Mai Khao Beach (10) - Nai Yang Beach (10) + - Bang Tao Beach (10) + - Surin Beach (10) - Kamala Beach (10) + - Patong Beach (in front of Patong Beach Hotel) (10) + - Patong Beach (B-lay Tong Phuket) (10) + - Patong Beach (in front of Patong Bay Hotel) (10) - Karon Beach (in front of Phuket Golden Sand Inn) (10) + - Karon Beach (in front of Phuket Academy) (10) - Kata Noi Beach (10) + - Kata Yai beach (10) + - Rawai Beach (Fisherman Village) (100) + - Nai Harn Beach (central) (10) - Makham Bay (500) - Tha Chin Estuary (500) + - Bang Rong Bay (500)	60

Table 2-2 Coastal Water Quality 2016 (Continued)

Quality	Inner Gulf of Thailand	Eastern Gulf of Thailand	Western Gulf of Thailand	Andaman Coast	Percentage
Good (>80 – 90) 121 locations				**Krabi** - Noppharat Thara Beach (10) + - Pilae Beach (Koh Hong) (10) - Leam Tong (Koh Phi Phi) (100) + - Eastern Lo BA Gao Bay (Koh Phi Phi) (10) - Loh Dalum Beach (Koh Phi Phi) (500) + - Loh Dalum Beach, Phi Phi Cabana (Koh Phi Phi) (10) + - Ton Sai Beach, Tonsai Village (Koh Phi Phi) (10) - Ton Sai Beach, Tonsai Village (Koh Phi Phi) (500) - Yao Beach (Koh Phi Phi) (10) + - Maya Bay (100) + - Railay Bay (10) - Khlong nin Beach (Koh Lanta) (10) + - Ban Sriraya (Koh Lanta) (100) + - Ban Bo Muang (Bo Muang Bay) (500) - Thale Waek (10) **Trang** - Pak Meng Beach (500) + - Samran Beach (10) + - Yong Ling Beach (10) + - Yao Beach (10) **Satun** - Ban Pak Bara Beach (500) + - Pak Bara Pier (100) + - Ban Pak Bang (10) +	**60**
Fair (>50 – 80) 61 locations	**Chon Buri** - Ang Sila (pier) (100) - Ang Sila (oyster farm) (500) - Bang San (The Tide Hotel) (10) - Koh Sichang (Sala Atsadang) (100) - Koh Sichang (Tham Phang Beach) (10) - Udom Bay (jetty) (10) - Na Kluea Market (100) - South Pattaya (Cape of Bali Hai) (10) - Jom Tien Beach (10)	**Trat** - Koh Chang (Sakakphet Bay) (100) - Trad Estuary – Laem Sok (Ban Poo) (500) - Leam Ngob (10) - Laem Sok (10) - Pak Klong Yai (100) **Chanthaburi** - Chanthaburi Estuary (500) - Welu Estuary (500) **Rayong** - Prasea Estuary (500) - Nong Fab (100)	**Chumphon** - Chumphon Estuary (500) - Central Sai Ree Beach (10) - Ban Bo Kha (Kor Bay) (10) - Lung Suan Estuary (500) **Surat Thani** - Samret Beach (10) - Tha Khoei Estuary (oyster farm) (100) - Kradae Canal (northern) (500) - Kradae Canal (southern) (500) - Ferry Pier (Don Sak District) (100)	**Ranong** - Bang Rin Canal (100) + **Phang Nga** - Ban Tub Lamu (Navy Base) (100) **Phuket** - Patong Beach (in front of Patong Merrin) (10) - Rawai Beach (central) (10) - Chalong Bay (central) (100) **Krabi** - Nang Bay (10) - Noppharat Thara Beach, (Pak Klong Haeng) (100) –	**30**

Table 2-2 Coastal Water Quality 2016 (Continued)

Quality	Inner Gulf of Thailand	Eastern Gulf of Thailand	Western Gulf of Thailand	Andaman Coast	Percentage
Fair (>50 – 80) 61 locations	**Phetchaburi** - Ban Laem Estuary (northern) (500) + - Ban Laem Estuary (central)) (500) + - Ban Laem Estuary (southern) (500) + - North Cha – Am Beach (in front of Long Beach Hotel) (10) **Prachuap Khiri Khan** - Beach in the area of Klai Kangwon Palace (10) - Hua Hin Jetty (100) - North Prachuap Bay (100) + - Bang Nang Rom Estuary (10) - Whale Estuary (100 - Central, Som Boon Beach (10) -	- Suchada Beach (100) - Fishing pier (Ban Phe Market) (100) - Sai Kaew Beach (Ko Samet) (10) - - Na Dan Pier (Koh Samet) (10) - Tubtim Bay (Koh Samet) (100) - Prao Bay (Koh Samet) (500)	- Ferry Pier (seatran) (100) - Lamai Beach (Koh Samui) (500) - Ferry Pier (Koh Pha Ngan) (100) - **Nakhon Si Thammarat** - Khanom Electricity (100) - Pak Phanang Estuary (500) **Songkhla** - Songkhla Lake Estuary (500)	- Ban Sala Dan (Koh lanta) (10) - Loh Dalum Beach (Koh Phi Phi) (Central Western) (10) - Khlong Dao Beach (10) **Trang** - (Central) Chao Mai Beach (Chao Mai National Park) (10) **Satun** - Bang Tung Rin (100)	30
Poor (>25 – 50) 14 locations	**Chon Buri** - Chon Buri Bay (500) - Sri Racha (Koh Loy) (100) - Laem Chabang Port (the end) (100) + - Sattahip Pier (100) **Chachoengsao** - Bang Pakong Estuary (500) **Bangkok** - Bang Khun Thian (500) + **Samut Songkhram** - Mae Klong Estuary (100) - - Mae Klong Estuary (500) - **Phetchaburi** - Ban Bang Taboon Estuary (North) (500) - Ban Bang Taboon Estuary (Central) (500) + - Ban Bang Taboon Estuary (South) (500)	**Rayong** - Phayun Beach (10)	**Surat Thani** - Tha Khoei Estuary (Tha Chang) (500) - Tapi Estuary (500) -	-	7
Vey Poor (0 – 25) 5 locations	**Chon Buri** - Chon Buri Bay (100) - **Samut Prakan** - 12 Thanwa Estuary (100) - In front of the dyeing factory KM.35 (100) - Chao Phraya Estuary (100) **Samut Sakhon** - Tha Chin Estuary (100) -	-	-	-	2

Remark:

- Data from 202 sample collection points, collected twice per year, conducted once during the dry season (March – April), and once during the rainy season (June – July), using the Marine Water Quality Index: MWQI.
- The values in () shows the distance from shore (meters).
  - \+ Shows water sources that had improved by 1 level compared to 2015
  - ++ Shows water sources that had improved by 2 levels compared to 2015
  - \- Shows water sources that had deteriorate by 1 level compared to 2015

Marine Water Quality Index: MWQI

A tool developed by the Pollution Control Department for assessing the marine water quality with values in the range of 0 – 100 as such:

- From 0 - 25 = Very poor
- From < 25 - 50 = Poor
- From < 50 - 80 = Fair
- From < 80 - 90 = Good
- From < 90 - 100 = Excellent

The MWQI is calculated from the coastal water quality data across 8 parameters: Dissolved Oxygen (DO), Total Coliform Bacteria (TCB), Phosphate – Phosphorus (PO_4^{3-}-P), Nitrate – Nitrogen (NO_3^- – N), Temperature (Temp.), Suspended Solids (SS), Acidity – Alkalinity (pH) and Ammonia – Nitrogen (NH_3-N). However, if the level of pesticides and toxic elements such as Mercury (Hg), Cadmium (Cd), Total Chromium (Total Cr), Chromium Hexavalent (Cr^{6+}), Lead (Pb), Copper (Cu), Cyanide (CN^-) and PCBs are found to be exceeding the Marine Water Quality Standards, the MWQI will be recorded as "0" immediately.

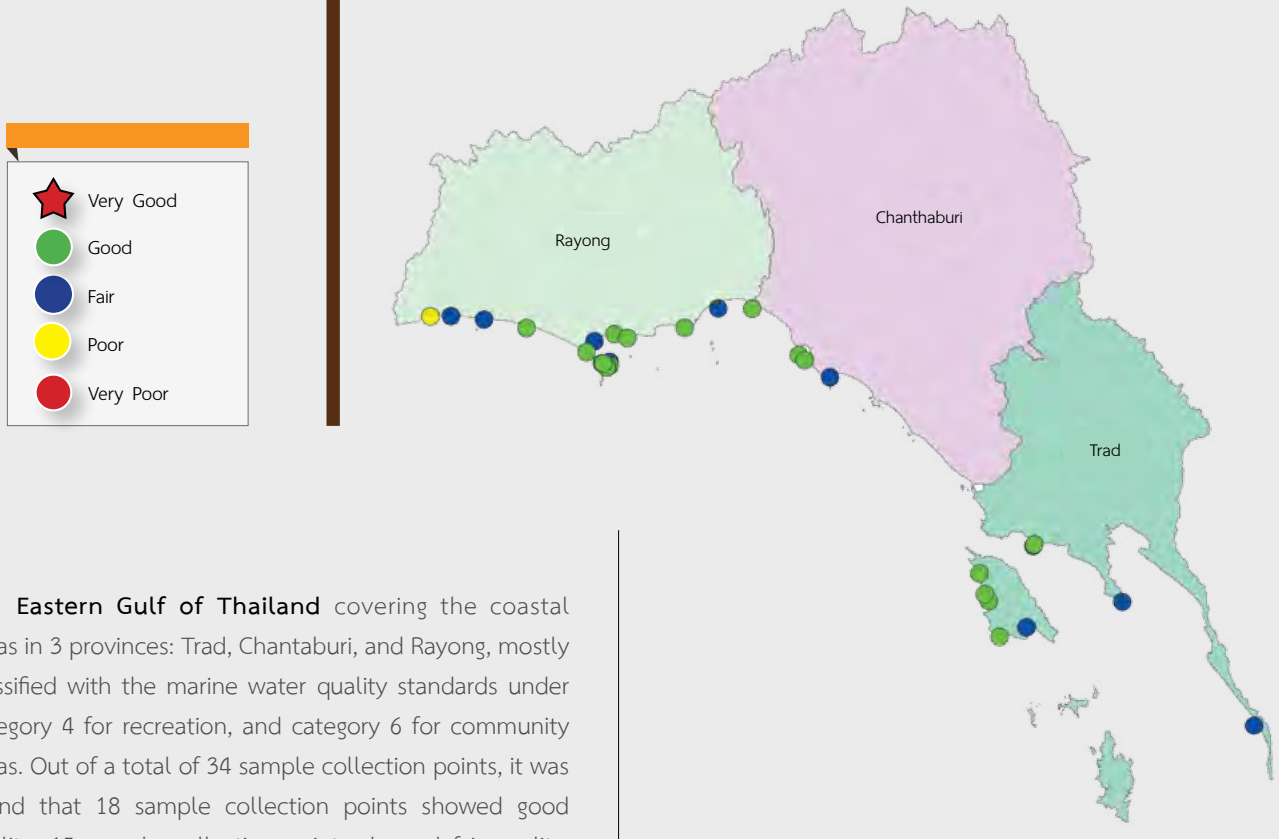
2.2.1 Coastal Water Quality by Area

When considering the water quality by area of both the Gulf of Thailand and the Andaman Sea, it was found that along the coast of the Gulf of Thailand, particularly the coastal water quality in the Inner Gulf of Thailand and the Eastern Gulf of Thailand, to be of poor quality, because these areas affected pollution sources draining and inland wastes discharge from communities, industries, and agricultural areas into the sea. Mainly along river estuaries faced with the coastal water problems, such as the Bang Pakong Estuary, Ta Chin Estuary, Chao Phraya Estuary, Bang Khun Tian, Mae Klong Estuary, and the Chantaburi Estuary. Moreover, in Samut Prakarn, Rayong and Chon Buri, industrial wastes such as the paint, plastic, rubber, cement, metal, battery, food and pharmaceutical industries were also being dumped, causing the problem of deteriorating water quality in those areas.

In the Andaman Sea coastline, the problematic areas had discovered along the beaches and island in the tourism areas where have a large number of tourists, and a lot of marine recreations, including the waste discharge from pollution sources to the sea as communities, hotel and residential areas, and restaurants. The data from 2016 revealed that the number of tourists visiting in the 25 marine national parks are as high as 5.6 million people, and the marine national parks with the highest tourist visits are Hat Noppharat Thara-Mu Koh Phi, Ao Phang Nga, are Mu Koh Similan. Thus, it is important these areas along the Andaman Sea are carefully monitored as no suitable environmental management measures were in place, and can potentially affect the environment and the wellbeing of the tourists.

The details of the coastal water quality by area are as follow:

Figure 2-10 Coastal Water Quality in the Eastern Gulf of Thailand



Eastern Gulf of Thailand covering the coastal areas in 3 provinces: Trad, Chantaburi, and Rayong, mostly classified with the marine water quality standards under category 4 for recreation, and category 6 for community areas. Out of a total of 34 sample collection points, it was found that 18 sample collection points showed good quality, 15 sample collection points showed fair quality, and 1 showed poor quality (Figure 2-10). The parameters that did not meet the marine water quality standard are:

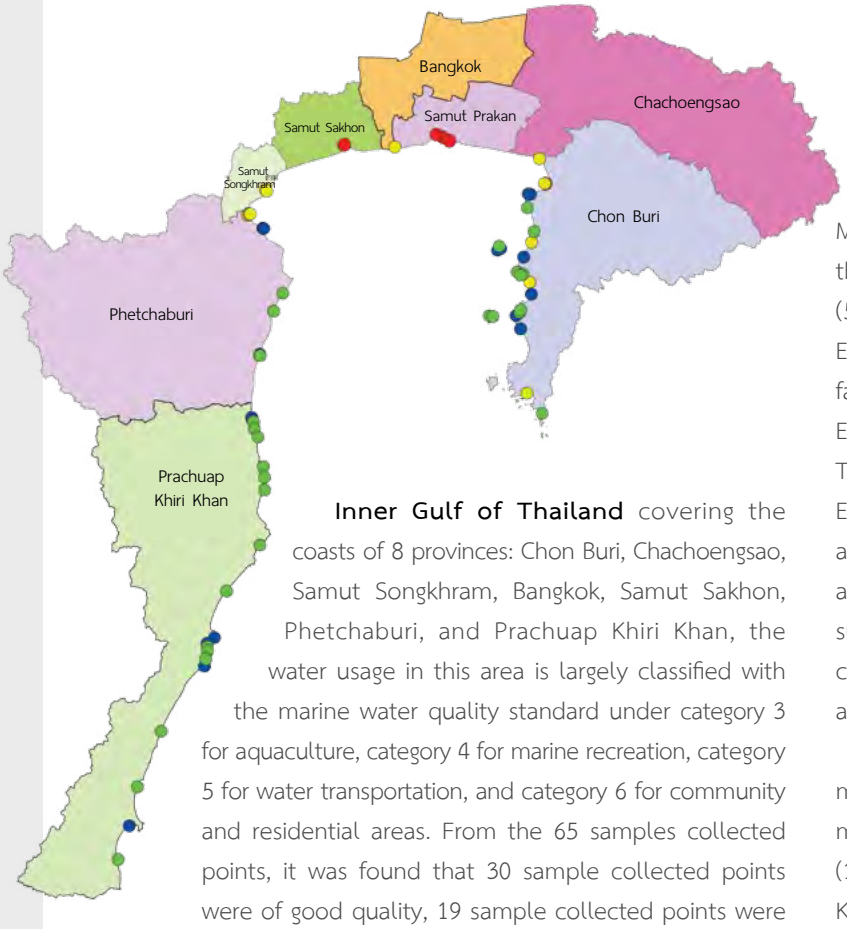
- ***Phosphate*** – Phosphorus in the Ban Nong Fab (100 meters radius), Rayong, potentially caused by the Chemical Fertilizer Factories in the area; in the Hat Suchada (100 meters radius), Hat Sai Kaew (Koh Samet), Hat Payoon in Rayong, caused by wastewater discharge from community areas, and activities that involve the usage of products containing phosphate, such as detergents and cleaning agents from households.

- ***Nitrate*** – Nitrogen around the Trat-Laem Sok Estuary area (Ban Pu) (500 meters radius), Trat, Chantaburi Estuary (500 meters radius), Welu Estuary (500 meters radius), Chantaburi may have been caused by the chemical fertilizer industries within the area, and agricultural activities utilizing chemical fertilizers. In the Koh Chang area (Ao Salakphet) (100 meters radius), Trat, Na Dan Pier (Koh Samet), Rayong, because these are community areas, several nutrients are discovered, which are the main sources of nitrate in the community sewage and food wastes.

- ***Total Coliform Bacteria*** are discovered in the Pak Khlong Yai area (100 meters radius), Trat, the Prasae Estuary (500 meters radius), Hat Suchada (100 meters radius), Pramong Pier (Talad Ban Pae) (100 meters radius), Hat Sai Kaew (Koh Samet), Na Dan Pier (Koh Samet), Ao Tub Tim (Koh Samet) (100 meters radius), Rayong, which are all tourist destinations, where a lot of communal activities occur along the coastlines.

- ***From analyzing the sediments' quality,*** it is found that the heavy metals level exceeding the standard of Coastal Water Sedimentary Quality are Chromium, Copper, Zinc, and Lead. In the Trat-Laem Sok Estuary (Ban Pu) (500 meters radius), Trat, and Hat Suchada (100 meters radius), Rayong areas, accumulations occur in the sediments, which is influenced by the factories in the area, such as the metal lathe and welding factories, petrochemical refineries, recycling plants and waste landfills, etc.

Figure 2-11 Coastal Water Quality in the Inner Gulf of Thailand



Inner Gulf of Thailand covering the coasts of 8 provinces: Chon Buri, Chachoengsao, Samut Songkhram, Bangkok, Samut Sakhon, Phetchaburi, and Prachuap Khiri Khan, the water usage in this area is largely classified with the marine water quality standard under category 3 for aquaculture, category 4 for marine recreation, category 5 for water transportation, and category 6 for community and residential areas. From the 65 samples collected points, it was found that 30 sample collected points were of good quality, 19 sample collected points were fair quality, 11 sample collected points were poor quality, and 5 were very poor quality (Figure 2-11). The Inner Gulf of Thailand are the mouth of 4 main rivers: Mae Klong River, Ta Chin River, Bangpakong River, and Chao Phraya River, which are the main reasons why the coastal water quality in this area does not meet standards. The parameters that does not meet the standards are:

- ***Dissolved Oxygen*** in the Chao Phraya Estuary (100 meters radius), Samut Prakarn, the Ta Chin Estuary (100 meters radius), Samut Sakorn, Mae Klong Estuary (500 meters radius), Samut Songkram, Bang Ta Boon Estuary (Upper, Mid, and Lower) (500 meters radius), Phetchaburi, which can be derived from the accumulation of organic matters from the community area and agricultural activities, causing the bacteria to utilize oxygen for decomposing organic matters, causing the amount of dissolved oxygen to reduce.

- ***Phosphate-Phosphorus*** was discovered in the Koh Si Chang area (Hat Tham Phang), Chonburi, Chonburi Bay (100 meters radius), the Laem Chabang Port (Lower) (100 meters radius), Chonburi, the Bang Pakong Estuary (500 meters radius), Chachoengsao, the Mae Klong Estuary (100 meters radius), Samut Songkram, the Bang Taboon Estuary (Upper, Central and Lower) (500 meters radius), Phetchaburi, the 12 Thanwa Estuary (100 meters radius), in front of the dyeing factories at KM.35 (100 meters radius), the Chao Phraya Estuary (100 meters radius), Samut Prakarn, Bang Khun Tien (500 meters radius), Bangkok, and the Tha Chin Estuary (100 meters radius), Samut Sakorn, as these areas are tourist destination for marine environment, as well as residential and community area. Thus, the substances found were derived from the release of chemicals with phosphate into the water sources, such as the drainage from clothes washing activities.

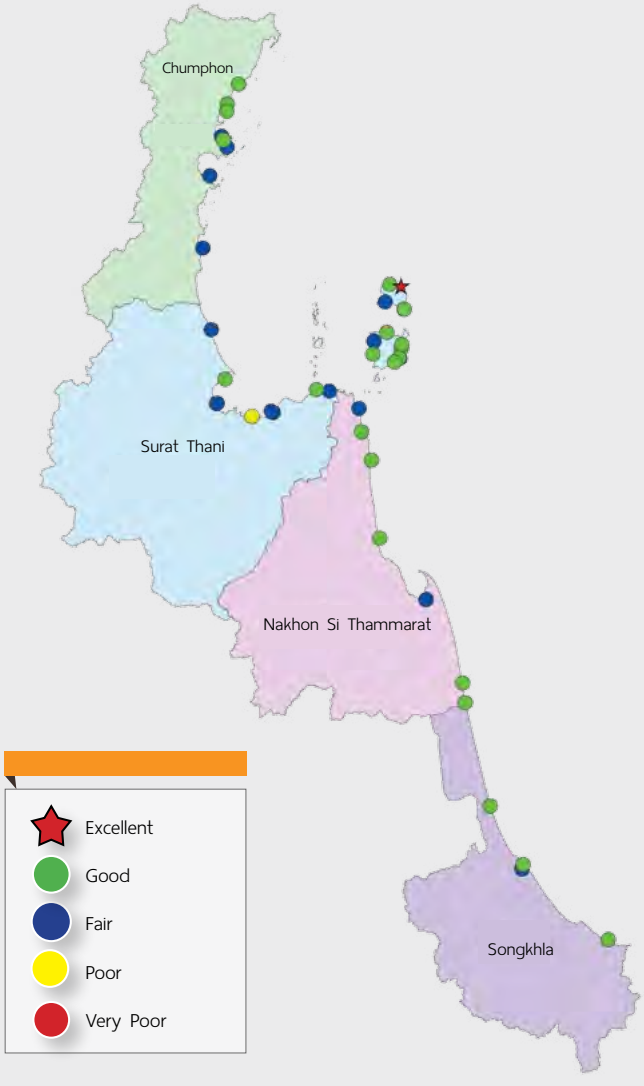
- ***Nitrate-Nitrogen*** found in the Chonburi Bay (100 meters radius), Chonburi, Bang Pakong Estuary (500 meters radius), Chachoengsao, the 12 Thanwa Estuary (100 meters radius), in front of the dyeing factory at KM.35 (100 meters radius), the Chao Phraya Estuary (100 meters radius), Samut Prakarn, may be derived from the textile manufacturing areas, as well as plastics and chemicals. Those found in the Bang Khun Tien area (500 meters radius), Bangkok, the Mae Klong Estuary (100 meters radius), Samut Songkram, the Bang Taboon Estuary (Upper and Lower) (500 meters radius), Phetchaburi, which are all residential and community area, which is the source of waste water from wastes and food wastes, which is the cause of the accumulation of nitrates.

- ***Total Coliform Bacteria*** in the Mae Klong Estuary area (100 meters radius and 500 meters radius), Samut Songkram, Chonburi Bay (100 meters and 500 meters radius), Laem Chabang Port (Lower) (100 meters radius), Sattahip Port (100 meters radius), Chonburi, 12 Thanwa Estuary (100 meters radius), in front of the dyeing factory KM.35 (100 meters radius), the Chao Phraya Estuary (100 meters radius), Samut Prakarn, Bang Khun Tien (500 meters radius), Bangkok, and the Tha Chin Estuary (100 meters radius), Samut Sakorn was mainly derived from the community and residential area along the coastline, as well as livestock farming.

- ***Copper*** measured up to 12.5 µg/L (should not exceed 8 µg/L according to standards), and Lead is measured up to 10.6 µg/L (should not exceed 8.5 µg/L according to standards) in the Chao Phraya Estuary (100 meters radius), Samut Prakarn, which is likely due to the area is where textile factories, fiber manufacturing plants, and fabricdyeing factories are located, as well as metal processing plants.

- ***The qualities of sediments in the Inner Gulf of Thailand*** showed that there are heavy metals that does not meet the sediment qualities standards for coastal soils, such as Chromium, Copper, Zinc, Lead, which were found in the Bang Pakong Estuary areas, in Chachoengsao, and the Chonburi Bay, Chonburi, which may had been influenced by the accumulation of sediments contaminated by heavy metals over a long period of time from metal production factories, such as iron smelting plants, shipyards, ship painting docks, chemical factories, and paper mills, which are scattered across the Bang Pakong Estuary area. The sediments from the Bang Pakong Estuary area can be carried over by the current to accumulate in the Chonburi Bay, causing heavy metal contaminations to occur in both areas.

Figure 2-12 Coastal Water Quality in the Western Gulf of Thailand



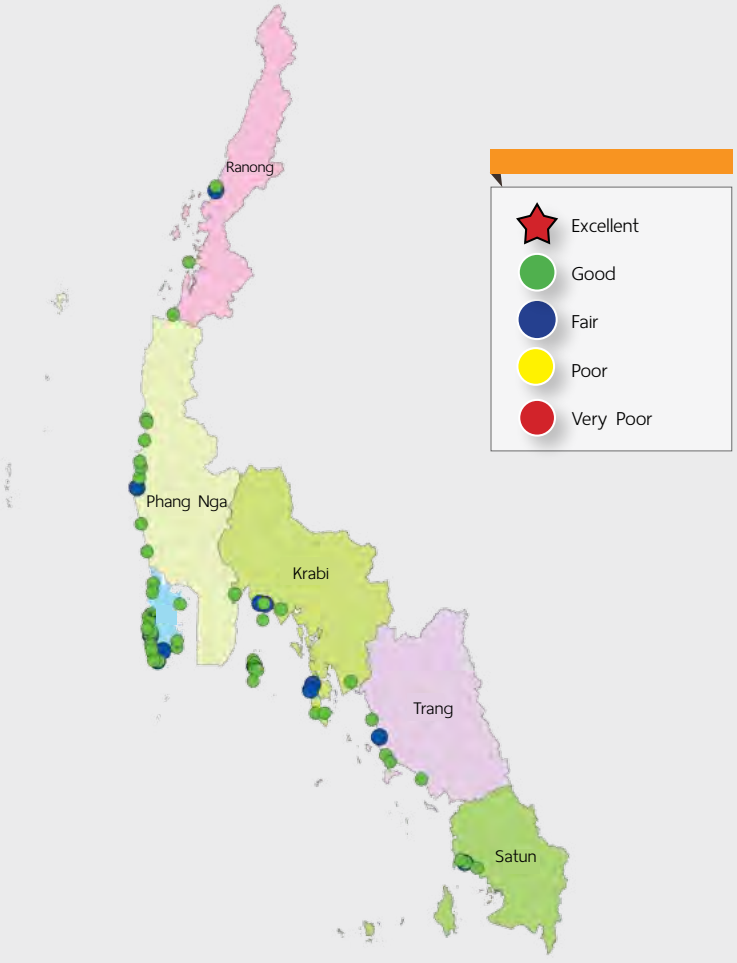
Western Gulf of Thailand covering the coasts of 4 provinces: Surat Thani, Nakorn Sri Thammarat, Chumphon, and Songkhla, the Western Gulf of Thailand is mainly classified with the marine water quality standard, under category 4 for marine recreation, and category 6, for community area. Out of 41 sample collected points, 1 sample collected points was found to be of excellent quality, 23 sample collected points were good quality, 15 sample collected points fair quality, and 2 sample collected points poor quality (Figure 2-12). The parameters that exceeded standards are:

- ***Phosphate-Phosphorus,*** in Hat Lamai area (Koh Samui) (500 meters radius), the Ferry Port (Koh Pha Ngan) (100 meters radius), Tha Koey Estuary, Ampur Tha Chang (500 meters radius), Surat Thani, Pak Panang Estuary (500 meters radius), Nakorn Sri Thammarat, which these areas are community area, where products containing phosphates, such as determents are heavily used, as well as being hot tourist spots.

- ***Nitrate-Nitrogen,*** Ta Pi Estuary (500 meters radius), Hat Lamai (Koh Samui), Surat Thani, Thale Sab Songkhla Estuary (500 meters radius), Songkhla, which are all community area, where nitrates are produced from municipal wastewater and other solid wastes.

- ***Total Coliform Bacteria*** are found in the Chumphon Estuary area (500 meters radius), Mid-Hat Sai Ri, Lang Suan Estuary (500 meters radius), Chumphon, Tha Koey Estuary, Ampur Tha Chang (500 meters radius), Ta Pi Estuary (500 meters radius), Surat Thani, Kanhom Electric Plant (100 meters radius), Nakorn Si Thammarat, Thale Sab Songkhla Estuary (500 meters radius), Songkhla, as these are community area with highly concentrated usage of coastal areas, as well as having many marine recreational activities from being tourist spots.

Figure 2-13 Coastal Water Quality on the Andaman Coast



Andaman Coast covering the coasts of 6 provinces: Ranong, Pang Nga, Phuket, Krabi, Trang, and Satun, these areas are mainly classified with the marine water quality standard under category 4 for marine recreation and category 6 for community areas. The Andaman coastal areas are mainly tourism beaches and islands, and from 62 sample collected points, 50 sample collected points were found to be in good quality, and 12 found to be fair quality (Figure 2-13). The parameters found to be exceeding standards are:

- ***Phosphate-Phosphorus*** in the Hat Patong area (in front of Patong Merlin), Hat Patong (in front of Patong Beach Hotel), Phuket, due to marine recreational activities and residential activities in the area.

- ***Nitrate-Nitrogen*** in the Khlong Bang Rin area (100 meters radius), Ranong, Hat Rawai (Mid-Section), Phuket, Ban Thung Rin (100 meters radius), Satun, which are all community area with residential activities along the coastline, including marine recreational activities from tourist destinations, generating food wastes.

- ***Total Coliform Bacteria*** in the Hat Rawai area (Mid-Section), Chalong Bay (Mid-Section) (100 meters radius), Phuket, Nang Bay, Ban Sala Dan (Ko Lanta), Krabi, due to the areas being community areas with high residential activities, including marine coastal recreational activities.

Coastal Incidents from Oil Spill, Oil Slick, Tar Balls, and Red Tides

In 2016, there were a total of 13 Oil Spill, Oil Slick, Tar Balls, and Red Tides occurrences along the Gulf of Thailand. With Chonburi having the highest coastal incidents mainly caused by oil spill from shipwreck, illegal oil discharge of cargo ships, and unknown sources. In that same year, 25 Red Tides were also discovered and reported back by network in the areas. Out of the 25 discoveries, 22 incidents were discovered along the coast of the Gulf of Thailand, mainly in Chonburi area, and 3 incidents were discovered on the Andaman Coast, all in Phuket. The main cause was the wastewater discharge from land to sea. This calls for the need of wastewater management facility, pre-treating wastewater from residents, businesses, hotels, livestock farms, and factories with high efficiency.

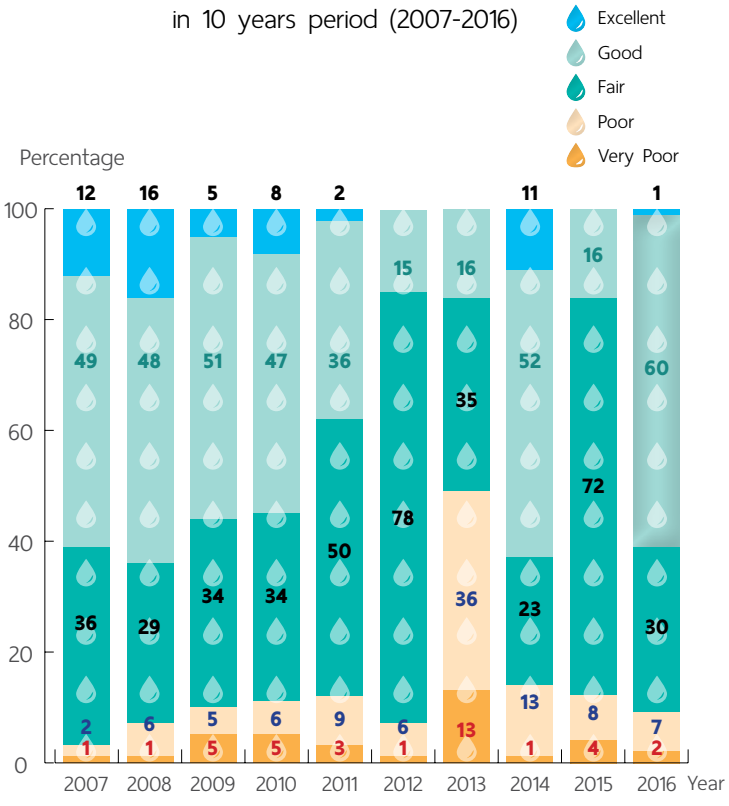
Source: The Department of Marine and Coastal Resources

2.2.2 Coastal Water Quality Trend in 10 years period (2007-2016)

From 2007-2016, the coastal water quality is mainly found to be in fair quality. The trend also showed that the coastal water quality in the poor to very poor-quality range are improving from 2013 onwards, with an increasing number of good quality, increasing from 16% in 2015 to 60% in 2016 (Figure 2-14).

The main parameters indicating the coastal water quality problems from 2007-2016 are: Total Coliform Bacteria, Phosphate-Phosphorus, and Nitrate-Nitrogen levels, and the areas where the water quality were found to be of poor to very poor quality are the Inner Gulf of Thailand areas and the estuaries areas of the Bang Pakong River, the Chao Phraya River, the Tha Chin River, and the Mae Klong River, which is caused consequentially from the poor surface water quality of the significant rivers.

Figure 2-14 Nationwide Coastal Water Quality Trend in 10 years period (2007-2016)



2.3 Groundwater Quality

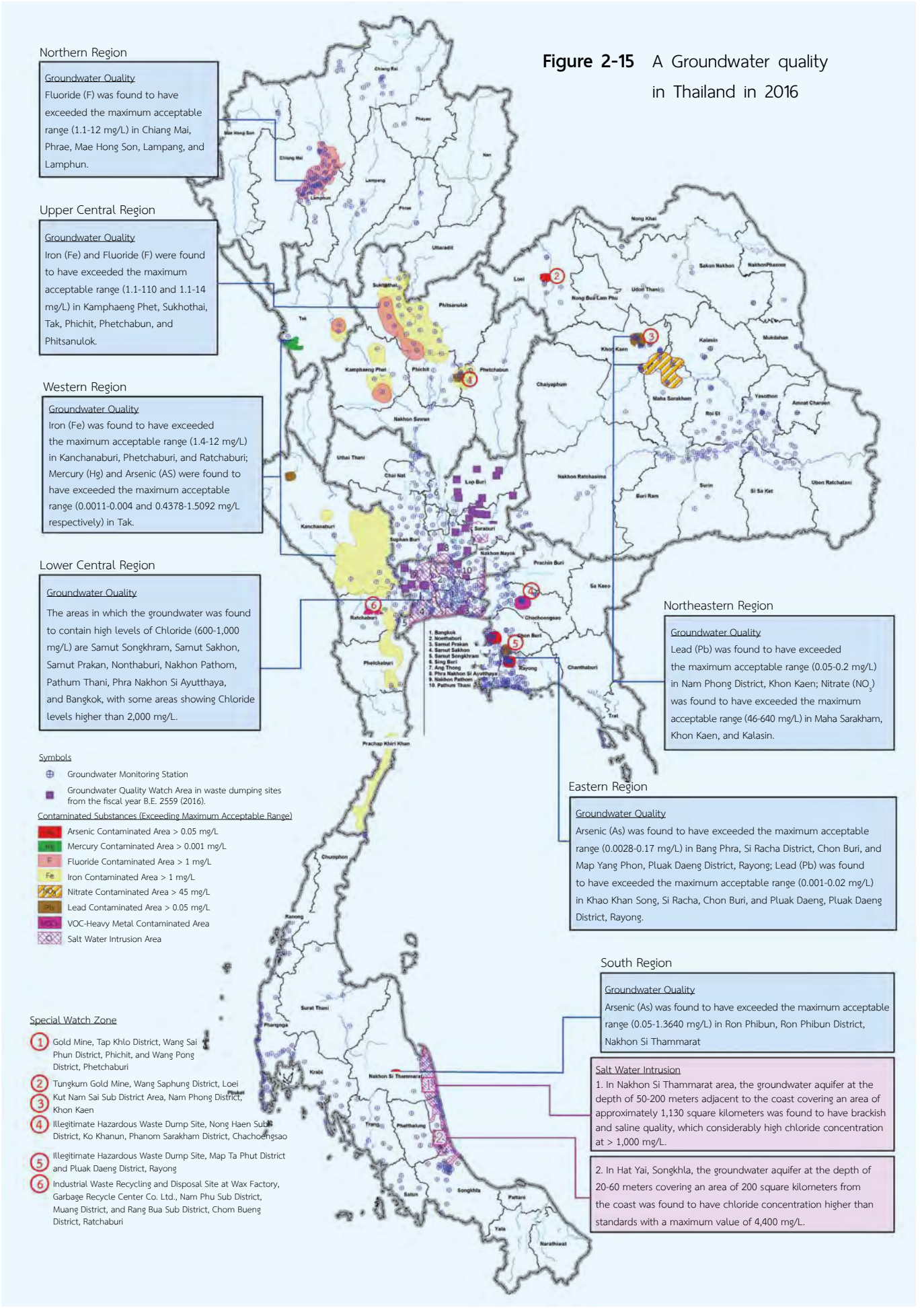
2.3.1 General Area

There are a total of 27 groundwater basins in Thailand. The Department of Groundwater Resources has 864 groundwater observation stations, which consisted of 1,524 wells (Table 2-3), which are mainly used for monitoring the change in groundwater level and the groundwater quality. From conducting data analysis, it is found that the overview of groundwater quality meet the groundwater standard for consumption according to the Groundwater Act B.E. 2520 (1977). Naturally, the groundwater basins are located in between layers of sediments and hard rock, and thus contain certain minerals dissolved in the groundwater, affecting the water quality, causing the mineral levels to exceed the level governed by grondwater standards for consumption, such as Iron element, generally found in all areas, fluoride element, generally found along fault lines and near hot springs, and chloride element causing saline water, generally found in coastal areas, and rock salt sources in the Northeastern area (Figure 2-15).

Table 2-3 Showing the numbers of permanent groundwater observation stations in each basin in 2016

Region	No.	Groundwater	Permanent monitoring station in 2016	
			No. of stations	No. of ponds
North	1	Phrae	3	4
	2	Nan	-	-
	3	Mae Hong Son	2	4
	4	Lampang	6	9
	5	Fang	4	9
	6	Chiang Rai, Phayao	16	25
	7	Chaing Mai, Lamphun	53	98
	Total		**84**	**149**
Central	8	Upper Chao Phraya	47	82
	9	Phetchabun	2	2
	10	Lower Chao Phraya	208	501
	11	Tak	3	6
	12	Kanchanaburi	5	6
	13	Phetchaburi, Prachuap Khiri Khan	5	9
	Total		**270**	**606**
North East	14	Loei	9	10
	15	Udon Thani, Sakon Nakhon	24	24
	16	Nakhon Ratchasima, Ubon Ratchathani	158	208
	Total		**191**	**242**
East	17	Prachin Buri, Sa Kaeo	24	35
	18	Chanthaburi, Trat	6	10
	19	Rayong	103	153
	20	Chonburi	48	65
	Total		**181**	**263**
South	21	Surat Thani	9	10
	22	Ranong, Satun	71	130
	23	Nakhon Si Thammarat, Phatthalung	32	57
	24	Hat Yai	26	67
	25	Narathiwat	-	-
	26	Chana	-	-
	27	Pattani	-	-
	Total		**138**	**264**
	Overall		864	1,524

Figure 2-15 A Groundwater quality in Thailand in 2016



2.3.2 Groundwater Quality Monitoring Areas

1) Waste Recycling and Incineration Plants in Wax Garbage Recycle Center Co., Ltd.

The company conducts waste management operations, recycling and incinerating wastes and solvents, where some systems still not up to standards. And wastewater discharge flow down the natural creek (Huay Nam Phu), causing surface water and groundwater contamination, affecting the public wellbeing, preventing civilians from unusable water from that sources.

The Department of Groundwater Resources collaborated with the Pollution Control Department, the Ratchaburi Provincial Office of Natural Resources and Environment and the Nam Phu Sub District Administration Organization to monitor the groundwater quality from 2013 to present, and found that the level of Nickel concentration exceeded the Groundwater Quality Standard (Standards require that the Nickel level not exceed 0.02 mg/L). The values in 2016 appeared to be higher than in 2015, and VOCs were also discovered, such as Vinyl Chloride, Benzene, where the values exceed the standard in shallow wellsowned by civilians. Vinyl Chloride Concentration appeared to be increasing, while Benzene Concentration recorded in June 2016 appeared to be decreasing compared to previously recorded values in the same year, decreasing from 5.3 µg/L to 3.4 µg/L (Figure 2-16).

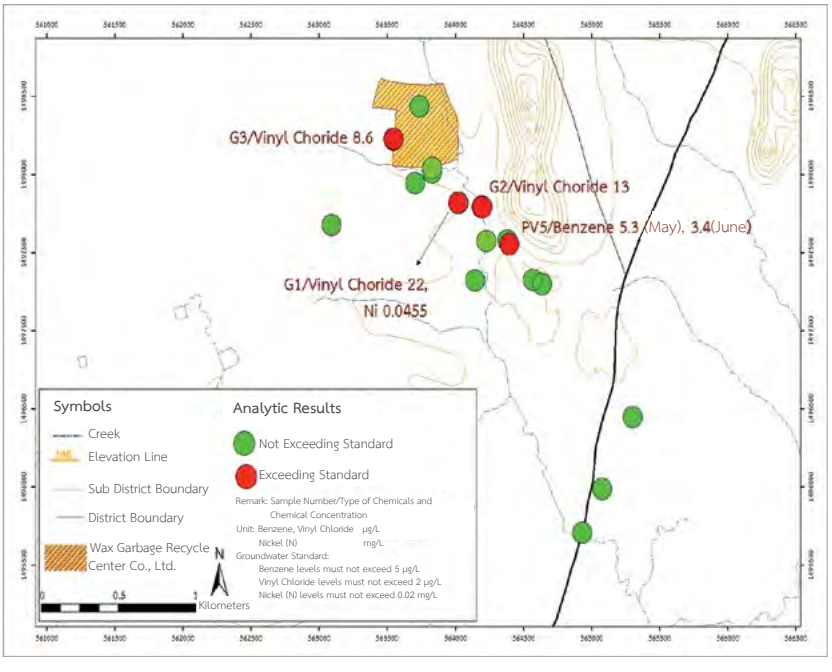


Figure 2-16 Monitoring Results from groundwater samples in the area near Wax Garbage Recycle Center Co., Ltd., Nam Phu Sub district, Ampur Muang, and Rang Bua Sub district, Ampur Jom Bung, Ratchaburi in 2016

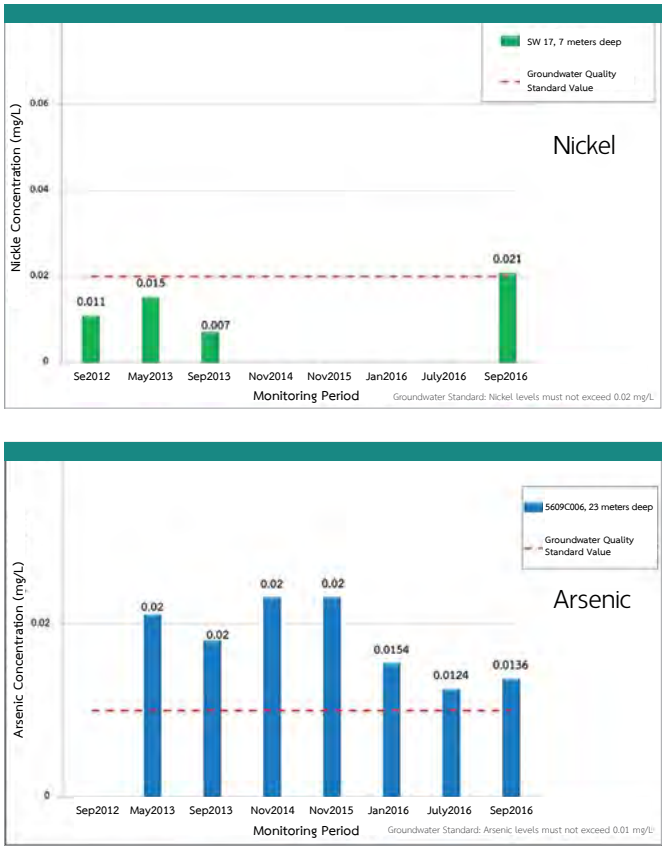
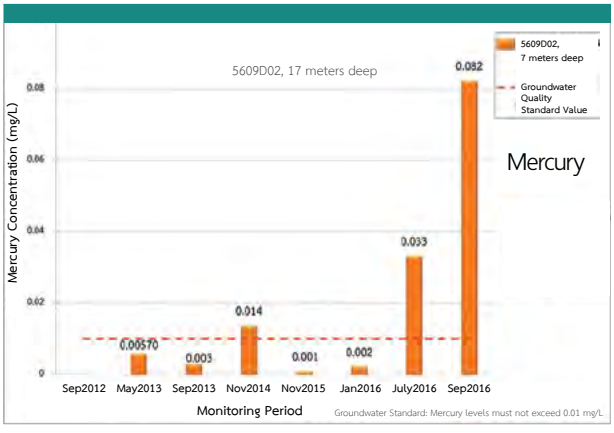


Figure 2-17 Comparing the concentration levels of nickel, mercury and arsenic from 2012-2016



2) Areas with illegal industrial waste dumping, near Nong Nan Sub district, Ampur Phanom Sarakram, Chachoengsao

On 21 August 2012, villagers in the Nong Nan Sub district, Ampur Phanom Sarakram, Chachoengsao filed in a complaint to the Prime Minister concerning the illegal dumping of hazardous waste by the factories in the Nong Nan Sub district, Ampur Phanom Sarakram, Chachoengsao, causing villagers to be affected by the bad odor, and poor water quality, causing them to not be able to use the water from the surface water and groundwater sources in the area.

The Department of Groundwater Resources investigated on the pollution and contamination of the water sources. From 2012 to present, it was found that the heavy metal concentration, such as arsenic, mercury, and nickel (Figure 2-17) exceeded the Groundwater Quality Standard. The concentration of Mercury and Nickel appeared to be trending upward, while the arsenic concentration appeared to be declining. However, from 2012-2014, Phenol was discovered, and found to be exceeding the Drinking Water standard declared by WHO in 1958, which stated that the acceptable level of Phenol should not exceed 0.0001 mg/L to be safe for drinking. However, today, it is discovered that the level of phenols lies within the range of 0.00014-0.00025 mg/L, which does not exceed the standard governed by WHO 1958 (Table 2-4).

Table 2-4 The level of Phenols discovered in 2016

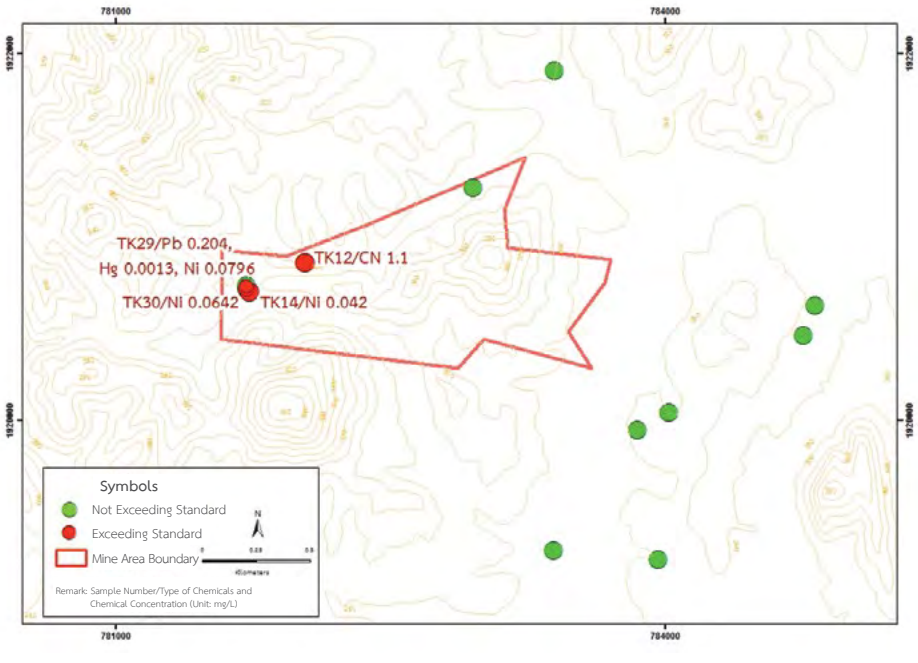
No.	Location	Depth	Type	Level of Phenols discovered in 2016
1	Pig farm	7	Shallow well	4-Nitrophenol discovered 0.00025 mg/l
2	Nong Nae Witthaya School	92	Groundwater well	2,4,6-Trichlorophenol discovered 0.00024 mg/l
3	Cassava farmland	34	Observation pond	Phenol discovered 0.00014 mg/l

3) The Gold Mine Area, Thung Kam Co., Ltd., Wang Sa Pung District, Loei

The Thung Kam Co. Ltd. had been operating a gold mine in 2006, Khao Luang Sub district, Wang Sa Pung District, Loei. Data from the Pollution Control Department in 2010 showed that the natural creek (Huay Nam Huay) in the area were contaminated by cyanide, showing values exceeding standards by more than 10 times, causing the civilians in this area have rash system on their body, and the water sources to be inaccessible for public consumption. Moreover, cadmium and arsenic contamination had also been discovered, and the gold mine has ceased operations from 2014 to present.

The Department of Groundwater Resources collaborated with the Department of Primary Industries and Mines, and Pollution Control Department to monitor the groundwater quality in the mine area from 2011 to present (Figure 2-18) and discovered that the concentration of arsenic, nickel, mercury, lead and cyanide exceed the Groundwater Quality Standards. The concentration of heavy metals monitoring were found to be both increasing and decreasing. This may be influenced by the level of precipitation in the area. Outside of the 3-kilometer radius from the mine, the concentration of lead was found to exceed the level governed by the Groundwater Quality Standard in January B.E. 2557 (2014), however, today, the lead concentration had decreased, and no longer exceed the Groundwater Quality Standard.

Figure 2-18 Monitoring results from the groundwater sample in the gold mine by the Thung Kam Co., Ltd., Khao Luang Sub District, Wang Sa Pung District, Loei, in 2016



4) Areas within the vicinity of the gold mine by Akara Resources Public Co. Ltd., Thap Khlo District, Wang Sai Phun District, Phichit, Noen Maprang District, Phitsanulok, and Wang Pong District, Phetchabun

From the complaints filed on the groundwater quality by the communities surrounding the gold mine concerning chemical contaminations such as cyanide, arsenic, manganese, and cadmium, the hypothesis is that these contaminations may have been derived from the gold and ore separation process, causing the cyanide used in the process to seep through the ground, eventually contaminating the groundwater sources, causing it to be unsafe for consumption.

In 2016, the Department of Groundwater Resources had been monitoring the conditions of groundwater contamination in the area, where the samples had been collected 2 times from 56 wells in December 2015, and from 52 wells in May 2016. From analyzing the groundwater quality and comparing them to the Groundwater Quality Standard, heavy metals such as manganese, arsenic and lead were discovered in the groundwater (Table 2-5).

Figure 2-19 The level of arsenic and lead in the monitoring wells exceeding Groundwater Quality Standard

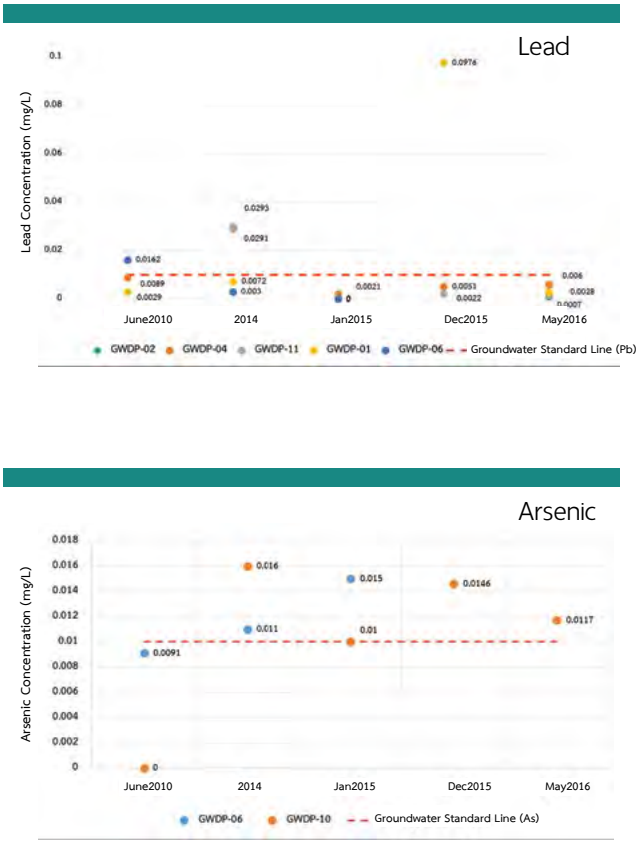


Table 2-5 The level of heavy metals exceeding the Groundwater Quality Standard in 2016

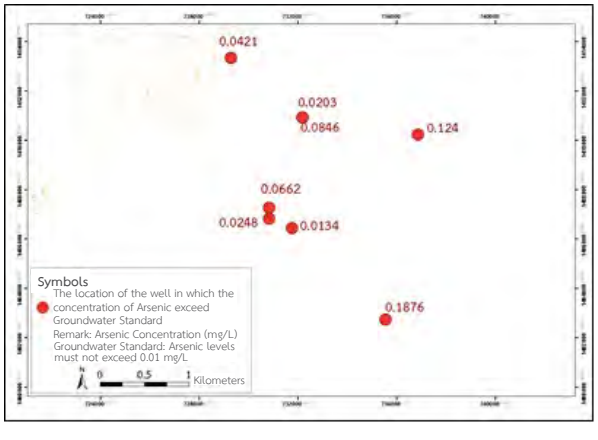
Heavy Metal	Unit	Standard	December 2015	May 2016
Manganese	mg/l	Must not exceed 0.5	0.6 - 3.9	0.6 - 2.1
Arsenic	mg/l	Must not exceed 0.01	0.0146	0.0117
Lead	mg/l	Must not exceed 0.01	0.0976	Not exceed standard

From monitoring the groundwater quality in area near the gold mine in 2010 and 2014-2016, it was found that the highest level of arsenic concentration was 0.016 mg/L in 2014, which was recorded from a monitoring well 6 kilometers south of the gold mine. The highest level of lead concentration was recorded to be 0.0976 mg/L, and was recorded in 2015, however, today, the lead concentration level appeared to have decreased and no longer exceed the Groundwater Quality Standard (Figure 2-19). As for level of cyanide, which was recorded once in January 2015, it was found that the concentration of cyanide is very low, and does not exceed the Groundwater Quality Standard. Today, the Department of Groundwater Resources had been conducting the monitoring of groundwater quality in the area near the gold mine twice a year to increase the confidence of the civilians living in that area.

5) Areas near the Map Ta Phut Industrial Estate, Ampur Muang, and Map Yang Phon Sub district, Pluak Daeng District, Rayong

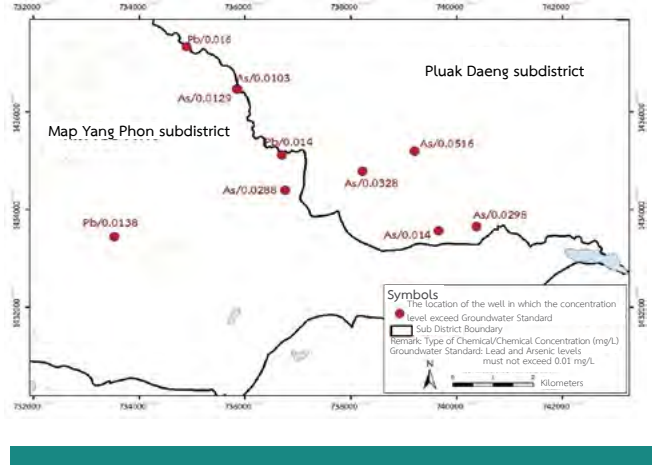
The Department of Groundwater Resources collaborated with the Pollution Control Department, the Department of Environmental Quality, Environment Resource Plan and Policy Center, and the Map Ta Phut Industrial Estate Office to monitor and watch the groundwater quality in the Map Ta Phut Industrial Estate and its vicinity area from 2014 to present (Figure 2-20). It was found that the concentration of arsenic lies within the range of 0.012-0.1876 mg/L, which exceed that Groundwater Quality Standard (which states that arsenic levels should not exceed 0.01 mg/L), and is trending upward particularly in the area near the landfill. VOCs such as benzene, carbon tetrachloride, dichloromethane, ethylbenzene, styrene, toluene, trichloroethylene and xylene were also discovered, although not exceeding the Groundwater Quality Standard.

Figure 2-20 The location where arsenic levels exceed the Groundwater Quality Standard in the Map Ta Phut Industrial Estate, Ampur Muang, Rayong, 2016



The Map Yang Phon Sub district area, Pluak Daeng District, Rayong, had been carefully watched and monitored since 2014 to present. In 2016, the concentration of lead and arsenic in that area were found to have exceeded standards in both shallow wells and groundwater wells, where the lead concentration were found to be in the range of 0.0138-0.016 mg/L, which were higher than the previous year. The highest concentration level of arsenic was found to be 0.0516 mg/L, which the standard had decreased from 2014 (with the highest value of 0.081 mg/L) (Figure 2-21), and appeared to be directly related to the level of seasonal levels of high and low tides. In solving the problem of groundwater contamination in the industrial estate and vicinity areas, well-cleaning had been applied, as well as capping up and closing unused wells. Groundwater observation stations had also been constructed in the Eastern Region to watch and monitor groundwater levels and groundwater qualities.

Figure 2-21 The location where arsenic and lead concentration exceed standards in the Map Yang Phon Sub District, Pluak Daeng District, Rayong, 2016



6) Sinphuhorm Natural Gas Field Project, Kut Nam Sai Sub district, Nam Phong District, Khon Kaen

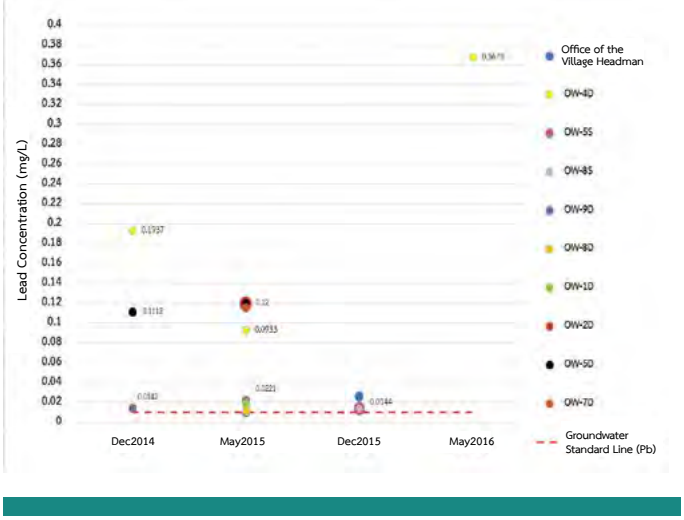
In 2014, the Regional Environmental Office (Region 10), Khon Kaen had monitored the groundwater quality in the area near the Sinphuhorm Natural Gas Field Project, Kut Nam Sai Sub district, and in the Muang Whan Sub district, Nam Phong District, Khon Kaen, and found that the concentration of lead had exceeded the Groundwater Quality Standard.

In 2015-2016, the Department of Groundwater Resources had monitored and watched for groundwater contamination in the Kut Nam Sai Sub district area, Nam Phong District, Khon Kaen, and found that the heavy metals such as lead, manganese, nickel, arsenic, and selenium appeared to be exceeding standards (Table 2-6).

Table 2-6 The heavy metals with values exceeding Groundwater Quality Standard in the area near the Sinphuhorm Natural Gas Field Project, Nam Kut Sai Sub district, Nam Phong District, Khon Kaen

Heavy Metal	Standard	2015 (70 wells)		2016 (67 wells)	
		1st time	2nd time	1st time	2nd time
Lead (Pb) (mg/l)	Must not exceed 0.01 (mg/l)	0.0104 - 0.1937	0.0102 – 0.12	0.0142 - 0.0258	0.3678
Manganese (Mn) (mg/l)	Must not exceed 0.5 (mg/l)	0.7 – 2.2	0.6 – 2.6	0.6 – 5.7	1.2 – 4.7
Nickel (Ni) (mg/l)	Must not exceed 0.02 (mg/l)	Not exceed standard	0.0941	0.0258 – 0.0423	Not exceed standard
Arsenic (As) (mg/l)	Must not exceed 0.01 (mg/l)	Not exceed standard	0.15	Not exceed standard	Not exceed standard
Selenium (Se) (mg/l)	Must not exceed 0.01 (mg/l)	Not exceed standard	0.0144	Not exceed standard	Not exceed standard

Figure 2-22 The concentration of lead in the groundwater observation well values exceeding the Groundwater Quality Standard



From monitoring the groundwater quality in the area around the Gas Extraction Plant and the Nam Phong Paper Mill in 2015-2016, it was found that in 2015, the level of lead exceeded standards in 8 wells around the Gas Extraction Plant, with values in the range of 0.0102 – 0.1937 mg/L, and in 2016, the lead levels exceeding standards were discovered in 4 wells around the Gas Extraction Plant and 3 kilometers southeast of the Gas Extraction Plant, with values in the range of 0.0142 – 0.3678 mg/L (Figure 2-22). However, the number of wells with values exceeding standards appeared to be decreasing. The investigation and monitoring had been conducted twice a year in the monitoring well, and the consumption well in the area around the Gas Extraction Plant and the Nam Phong Paper Mill, Nam Phong District, Khon Kaen, to watch for lead contamination in the groundwater sources.

2.4 Measures to Rehabilitate Water Pollution from Various Sources

2.4.1 Wastewater from public sector

1) Law enforcement with water pollution sources more strictly, while also providing guidance and recommendations for wastewater treatment at the point source meet the standards before discharge into environment, particularly in the Khlong Saen Saeb area, and the Ta Chin and Chao Phraya Rivers.

Local Administration Organization	Province
1) Hat Yai City Municipality	Songkhla
2) Songkhla City Municipality	
3) Pattaya City	Chon Buri
4) Bang Sare Subdistrict Municipality	
5) Saen Suk Municipality	
6) Tha Rae Subdistrict Municipality	Sakon Nakhon
7) Patong Municipality	Phuket
8) Karon Subdistrict Municipality	
9) Hua Hin Municipality	Prachuap Khiri Khan
10) Ban Phae Subdistrict Municipality	Rayong
11) Buri Ram Municipality	Buri Ram
12) Udon Thani City Municipality	Udon Thani
13) Krabi Municipality	Krabi
14) Mae Sot City Municipality	Tak
15) Mukdahan Municipality	Mukdahan
16) Kosum Phisai Subdistrict Municipality (Hua Khwang) (Unpaid Wastewater Treatment Fee after the wastewater treatment system is damaged. and not available)	Maha Sarakham

2) Pushing Local Administration Organizations to collect wastewater management fee to apply to the operation of wastewater treatment systems. Currently, wastewater management fees are collected in only 16 places.

3) Providing guidance and recommendations on how to improve the efficiency of the existing waste water treatment systems to be aligned with standards.

4) Putting in place the policy for the Beneficiary Pays Principle for wastewater management, wastewater management fee to the water supply bill, and using the collected amount to run waste water management operations.

5) Improving the wastewater discharge standards, particularly at the 10 pollution sources (buildings, hotels, accommodations, bath houses, massage and body sauna, public and private hospitals and clinics, private and public schools and universities, department stores, markets and restaurants), and appropriate land allocation, currently.

6) Putting in place the guideline for reusing treated wastewater from municipal wastewater treatment plants that does not need additional quality improvement efforts, such as reusing water for golf courses, for cleaning the streets, for watering plants, etc., or reusing the water after applying simple quality improvement methods before reuse, such as for fruit trees and decorative plants, for fire control, or for cleaning the lavatory and bathrooms.

7) Managing wastewater and solid wastes problems in 11 pilot tourism areas, promoting tourists and entrepreneurs treated wastewater at the point sources before discharge into the sea, providing wastewater treatment systems in tourism areas adequately, and controlling amount at tourists suitable with capacity of marine tourism areas.

Model of Tourism Area	Province
1) Koh Samet	Rayong
2) Khao Yai National Park	Nakhon Ratchasima, Saraburi, Prachin Buri, Nakhon Nayok
3) Phu Thap Boek	Phetchabun
4) Doi Inthanon National Park	Chiang Mai
5) Tarutao National Park	Satun
6) Pattaya City and Ko Lan	Chon Buri
7) Erawan National Park	Kanchanaburi
8) Ko Chang National Park	Trat
9) Phu Kradueng National Park	Loei
10) Thanbok Khoranee National Park	Krabi
11) Ko Phi Phi	

Driving the Rehabilitation of Khlong Saen Saep

The government places great importance on the rehabilitation efforts of Khlong Saen Saep to restore clean water and to set the best practice areas, for other pollution rehabilitation efforts. This driving is a collaboration between various government sectors, such as the Ministry of Transport, the Ministry of Interior, Bangkok Metropolitan Administration, the Marine Department, the Pollution Control Department, the Royal Irrigation Department, the Department of Industrial Works, the Public Relations Department, and Industrial Estate Authority of Thailand, and had divided the operations into 3 urgent phases as follow:

Phase 1 For the year 2017-2021, the operation start from Khlong Saen Saep, in which converge on Khlong Phadung Krung Kasem (Phan Fa Lilat Bridge) to Wat Bamphen Nuea (approximately 20 kilometers), where the water quality is considered to be poor, the main activities that must be completed are installation more sewage collection pipeline in Huay Khwang area, and along the Witthayu Road Khlong Tan Road, to collect approximately 24,000 m^3/day of wastewater into the wastewater treatement plant at Din Daeng; constructing 2 wastewater treatment plants to handle wastewater influent about 509,000 m^3/day, according to the Bangkok Metropolitan Administration plan, monitoring the wastewater effluent quality and enforce law and regulations concerning pollution sources strictly, and building public awareness among the people and entrepreneurs.

Phase 2 For the year 2022-2026, start from Wat Bamphen Nuea to the end of Nong Chok District (approximately 25.5 kilometers), where the water quality is considered to be fair, the main activities that must be completed are contraction 2 wastewater treatment plan to handle wastewater influent about 205,000 m^3/day according to the Bangkok Metropolitan Administration plan, monitoring the wastewater effluent quality and enforce law and regulations concerning pollution sources strictly, and building public awareness among the people and entrepreneurs.

Phase 3 For the year 2027-2031, start from Chachoengsao Province to the connecting point with the Bang Pakong River (approximately 26.5 kilometers), where the water quality is considered fair to good, the main activites that must be completed are assistance in technical information and knowledge, and building public awareness among the people and entrepreneurs.

Monitoring the pollution sources along Khlong Saen Saep in 2016, it is found that 62 pollution sources (49% of total), be legal operation, and 65 pollution sources not meet the standards (51% of total).

2.4.2 Wastewater from Industries Sector

1) Improving the standards of wastewater discharge from industies, industrial estates and industrial zones in accordance with the National Environmental Quality Act B.E. 2535 (1992), to be applicable and appropriate to the area and the current conditions.

2) Collecting and revising the data for the development of a standard specific to industrial wastewater, to be aligned with the current pollution situation such as producing fresh water from sea water reverse-osmosis plants, leather factories, flour factories, paper mill and fibers factories, petrochemical industries and fabric dyeing industries.

3) Collaborating with relevant government sector to fix the problems of overlapping regulations on industrial wastewater discharge, including 1) the overlapping of wastewater standards, 2) the environmental reporting, 3) obtaining a permit for discharge industrial wastewater into the environment, and 4) controlling and monitoring industrial operations for law enforcement pollution source more effective.

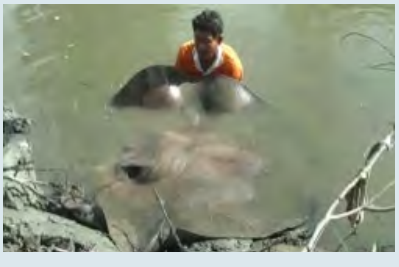
4) Fixing the problem of water quality, particularly in the area with continuous pollution contamination areas such as the Clity Creek Rehabilitation in Kanchanabri, controlling the VOCs in groundwater in the Map Ta Phut Industrial Estate, Rayong, and resolving the contamination problem in the gold mines in Loei and Phichit.

5) Setting up a guideline for reusing treated industrial wastewater in agriculture, target industries such as the food industries, vegetable oil or animal fat industries, flour industries, distillery slop industries, ethanol and rubber industries.

6) Following the Ministerial Regulation on Soil and Groundwater Contamination Control in Factory Area B.E. 2559 (2016), under the Factory Act B.E. 2535 (1992) to control soil and groundwater contamination and preserving the environment in factories, while also reducing the affect on the public health both inside and outside of the factories.

Dying of Giant Freshwater Stingray in the Mae Klong River

From the end of September 2016 to the beginning of October 2016, 43 dead Giant Freshwater stingrays were found in the Bang Khon Tee District and the Ampawa District, Samut Sakorn. Scientific investigations yielded that the cause of the stingrays' deaths was due to the high concentration of free ammonia from distillery slop leakage, which is poisonous to the stingrays and other freshwater animals, particularly during the times, underwater had low dissolved oxygen, or appeared the nonaerobic condition when there is no air underwater. Supporting documents are currently being gathered in order to file for a fine charged towards the pollution owner of the leakage source area.



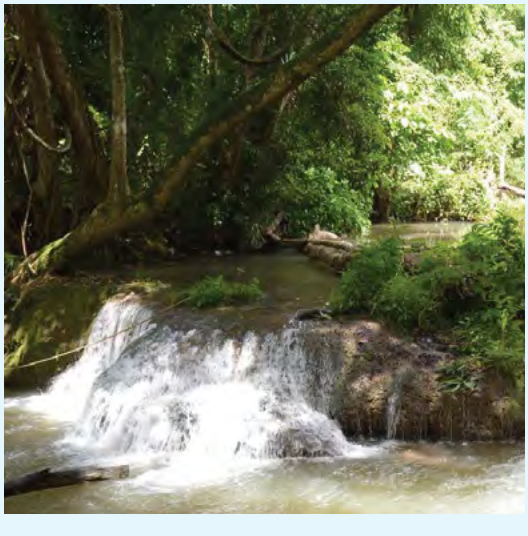
The Rehabilitation of the Clity Creek Lead Contamination in Kanchanaburi province

The problem of lead (Pb) contamination in the Clity Creek and the vicinity area in Thong Pha Phum District, Kanchanaburi was caused by lead-contaminated effluent discharge from tailing sediment pool in the Lead Concentrates (Thailand) Co., Ltd.'s into the Clity Creek in 1998, causing massive lead contamination exceeded the standard in the environment such as water, sediments, freshwater animals, directly affecting those who lived around the area to not be able to use those resources.

The crisis caused the villagers in the area to file a lawsuit against the Pollution Control Department to the Central Administrative Court on 23 February 2004, and the High Administrative Court had issued an order on 10 January 2013 to the Pollution Control Department to determine the plan, methodology and operations to remedy and monitor water samples, soil samples, vegetation and freshwater animals in the Clity Creek throughout every season, at least once per seasons, until the lead level was discovered not exceed standard for at least one year. The order was made public announcement to the villagers, and the 22 villagers who filed the lawsuit was compensated.

The Pollution Control Department have collaborated with relevant government organizations such as the Department of Disease Control, the Department of Health, the Department of Water Resources, the Royal Forest Department, and the Department of National Park, Wildlife and Plant Conservation set up the plan to remediate the problem of lead contamination in the Clity Creek in the second phase from 2016-2021, containing 5 operating plans as follows, the remediation plan for the Clity Creek in the Ore Processing Plant and the vicinity area, the environmental quality monitoring plan, the health surveillance, the socio-economic plan, and the implementation follow-up plan. The 5 operating plans were approved by the Pollution Control Committee, and the National Environment Board, and in 2017, the Pollution Control Department will act accordingly to the plan, and will coordinate the efforts of all relevant government organizations, following the plans.

Following the meeting of the Clity Creek Lead Contamination Remediation Subcommittee No. 1/2560 on 15 February 2017, the Department of National Park, Wildlife, and Plan Conservation and the Provincial Offices for Natural Resources and Environment Kanchanaburi had been assigned to follow up on the land usage permit in their designated areas, the Department of Water Resources had been assigned to consult with the Department of Groundwater Resources in developing the mountain water supply system in conjunction with groundwater system, and the Pollution Control Department had been assigned to consult with relevant government organizations to formulate a longterm plan (20 years) to remedy the Clity Creek lead contamination problem that accord with the national strategic plan and to formulate flagship projects/activities in every 5 years period, setting up an implementation budget with targets and plans clearly, including to cooperate on the bureau of the budget to request for implementation budgets in the future.



2.4.3 Wastewater from Agricultural Sector

1) Setting up a guideline for reusing treated wastewater from pig farms to increase the yields of non-food agricultural produces such as rubber and napier grass.

2) Developing agricultural activities in the area to adopt Good Agricultural Practice (GAP) and developing agricultural products such as rice, vegetables, chicken, pig, and shrimp to be aligned with the standards for environmental quality management, and adopting zero waste practices.

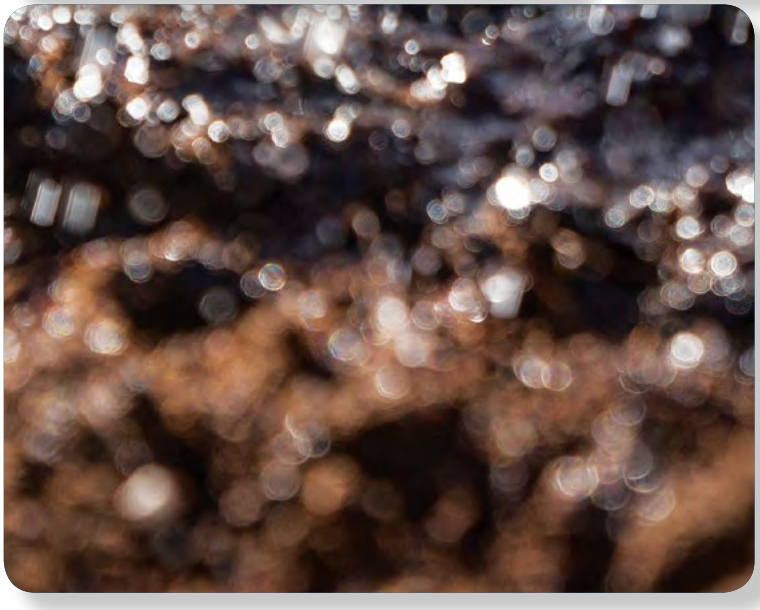
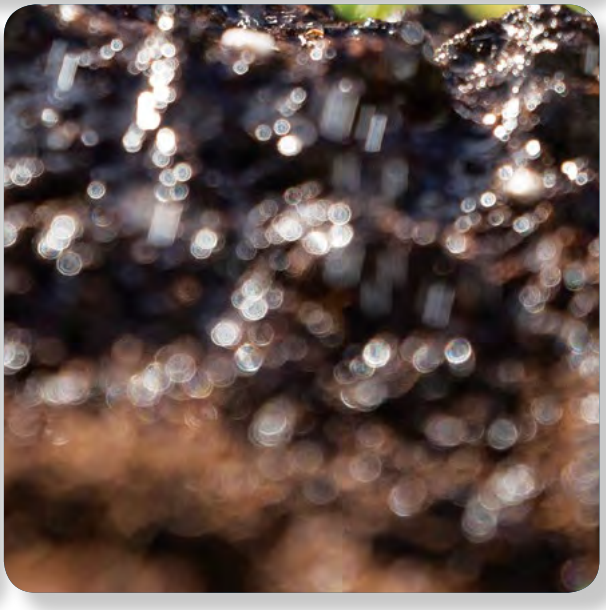
3) Developing the capacity building for the pig farm owners in the Tha Chin area, reducing the amount of wastewater discharge into natural water sources, or promoting zero waste farms by relaying the knowledge and skills on wastewater treatment methods, and wastewater and waste utilization.

4) Supporting the construction of wastewater treatment systems to produce biogas in small and medium pig farms because most of the pig farm size in the area are small to medium scale, and does not have a proper wastewater management and and waste management systems. Many of the wastes in these farms contain valuable nutrients that could be used in place of chemical fertilizers for plants. To provide this support, the government will be sponsoring the investment for farmers, targeting 15 provinces in 25 water basins, totaling 30 farms.

5) Initiating the Environmentally Friendly Farm Project to promote and institute a conscience for zero waste and non-pollution farming systems, while also outlining the health and hygiene systems for pig farming, developing the capacities building for farmers to apply the concepts and practices to solve environmental issues over 100 farms nationwide joining the project.





Following the National Roadmap on municipal solid waste management, the municipal solid waste and hazardous waste efforts from 2014 resulted in a more systematic mean of municipal solid waste and hazardous waste. Local offices were able to manage municipal solid wastes and hazardous wastes more effectively, with accumulated wastes in waste incineration areas being increasingly managed. And to increase the capabilities and productiveness in municipal solid waste and hazardous waste management, the masterplan on the National Municipal Solid Waste Management (2016-2021) and the Thailand Zero Waste Action Plan based on the practicipatory State Principle had been established, while also increasing the level of enforcement on the management of Waste of Electrical and Electronic Equipment (WEEE) and the control and management of chemical substances in Thailand through national regulations and international agreements.

Chapter 3

State of Waste and Hazardous Substances

State of Waste and Hazardous Substances

3.1 Municipal Solid Waste

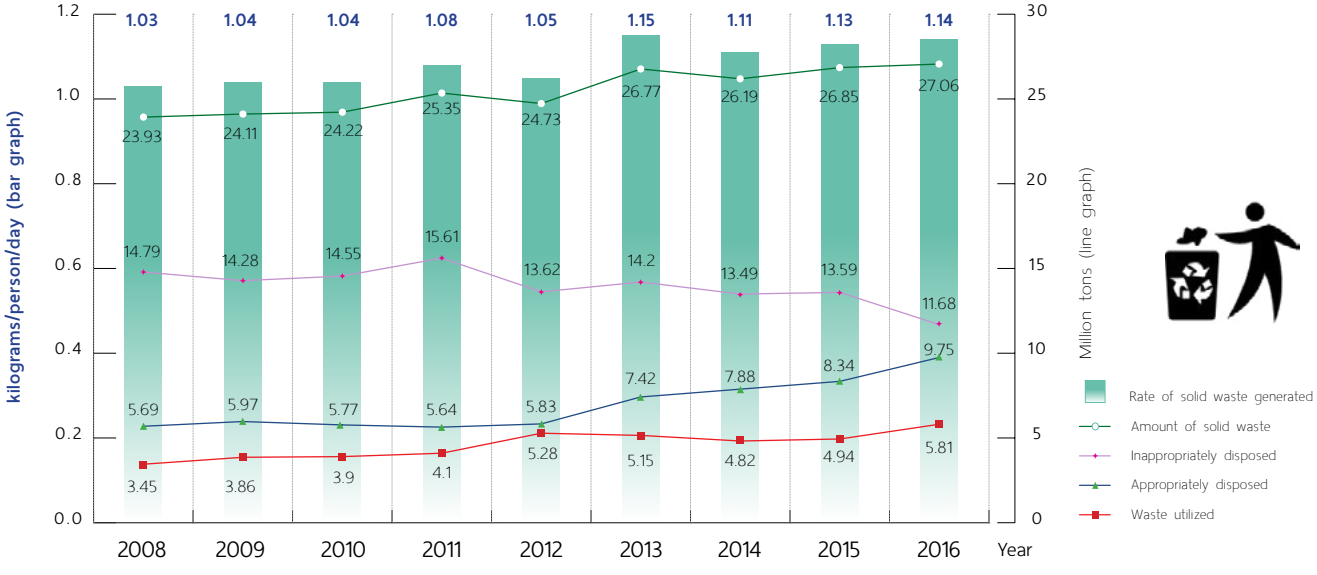
3.1.1 The Amount of Municipal Solid Waste and Municipal Solid Waste Management

From various investigations conducted by questionnaires and field investigation, it was found that in 2016, Municipal Solid Wastes were discovered at 7,777 Local Administration Organizations nationwide, totaling 27.06 million tons or 74,130 tons/day. The amount of waste generated per person on average had increased from 1.13 to 1.14 kg/person/day. The proportion of Municipal Solid Waste generated in Bangkok was 4.21 million tons (16%), with 11.16 million tons (41%) generated in Pattaya, and 11.69 million tons (43%) in Sub District Administrative Organizations. The top 5 provinces with the highest municipal solid waste generated are Bangkok, Chon Buri, Nakhon Ratchasima, Samut Prakan, and Khon Kaen. Moreover, it is found that there is an accumulation of old wastes in municipal waste management facilities nationwide that had not been managed, totaling 9.96 million tons. The amount of municipal solid waste per province is shown in Appendix E.

The factors affecting municipal solid waste generation are economic growth, growth of the tourism industry, urbanization, population growth, workforce influx from the ASEAN Community (AC) , and irresponsible and wasteful usage of resources.

The amount of Municipal Solid Waste had increased slightly in 2016 from 2015 due to the population growth, and the beginning of economic recovery. This improvement is due to the rising trend if a more effective waste management, including proper disposal and reuse of municipal solid wastes, resulting in a positive change. In 2016, more municipal solid wastes had been properly collected and stored in municipal solid waste management facilities, causing the amount of municipal solid wastes that had been properly disposed to increase, totaling 9.75 million tons. When compared to 2015 (8.34 million tons/year), it was found that the amount of municipal solid wastes that had been properly disposed had increased by 16.91%. As for the usage of municipal solid waste in 2016 compared to 2015, it was found that the amount of waste reuse had increased by 17.61%, this is due to the trend in reusing and reducing wastes at the source of waste from promotional activities to institute a conscience for waste reuse, reduce and recycle during 2016 (Figure 3-1).

Figure 3-1 The Rate of Waste Generation, the Amount of Municipal Solid Waste Generated, the Reuse of Wastes, and the Amount of Properly Disposed and Improperly Disposed Wastes in 2008-2016



Today, there are only 4,711 Local Administrative Organizations that currently collect municipal solid wastes for disposal, where out of these locations, a total of 21.05 million tons of wastes were generated, equivalent to 57,663 tons/day (78% of the nationwide municipal solid wastes generated), out of this amount, 15.76 million tons (58% of the nationwide municipal solid wastes generated) were collected for disposal, equivalent to 43,173 tons/day, 9.75 million tons were properly disposed of, equivalent to 26,721 tons/day (36% of the nationwide municipal solid wastes generated), with the remaining 6.01 million tons, or 16,452 tons/day (22% of the nationwide municipal solid wastes generated) being disposed of improperly, such as by open burning, and by illegal dumping in old pits or abandoned sites. This is mainly found in small Local Administrative Organizations. Analyses yielded that the reason why municipal solid waste management efforts are not fully utilized to their capacity is due to the low capacity, capability and readiness of Local Administrative Organizations in managing municipal solid waste in the area. Municipal Waste Management sites are also non-operable due to resistance from the civilians. Moreover, there were a total of 6.29 million tons of municipal solid wastes (23% of the nationwide municipal solid wastes generated) that had not been collected both in the serviced areas and outside the serviced areas (Figure 3-2).

Figure 3-2 Diagram of the Flow of Municipal Solid Waste in 2016

The 15.76 million tons of municipal solid wastes collected for disposal will be transported to a total of 2,810 municipal solid waste disposal site nationwide, consisting of 330 proper disposal sites, such as sanitary landfill, engineer landfill, control dump of less than 50 tons/day, incinerators with emission control systems, Waste to Energy (WTE) processes, compost processes, Mechanical and Biological Waste Treatment (MBT) processes, and integrated disposal processes (Table 3-1). There were a total of 2,480 improper waste disposal sites such as open dumping, control dump of more than 50 tons/day, open burning, or using incinerators without emission control systems.

In 2016, the number of proper municipal solid waste disposal sites had decreased from the previous year (from 448 sites in 2015) because some disposal sites are unable to operate waste disposal in an appropriate manner. There had been an increase in the number of open dump sites, especially in small landfills or village-scale landfills. Meanwhile, some municipal solid waste disposal sites had ceased operations, while the number of municipal waste control dump sites of less than 50 tons/day had decreased. This change is caused by the amount of municipal solid waste generated had exceeded the capacity of waste disposal sites, while local administrative offices also lack the manpower and the budget to cope with such problem

Table 3-1 Proper Municipal Solid Waste Disposal Sites in Operation 2016

Type	Public sites Amount (sites)	Private sites Amount (sites)
Sanitary Landfills / Engineered Landfills	84	8
Controlled dumps with a capacity of less than 50 tons/day	129	73
Incinerators with air pollution control system	1	6
Incinerators with the capicity of less than 10 tons/day and having an emission control system (cyclones)	12	-
Sorting systems, compost, and correct landfill systems	9	3
Mechanical biological treatment systems	4	1
Total	**239**	**91**

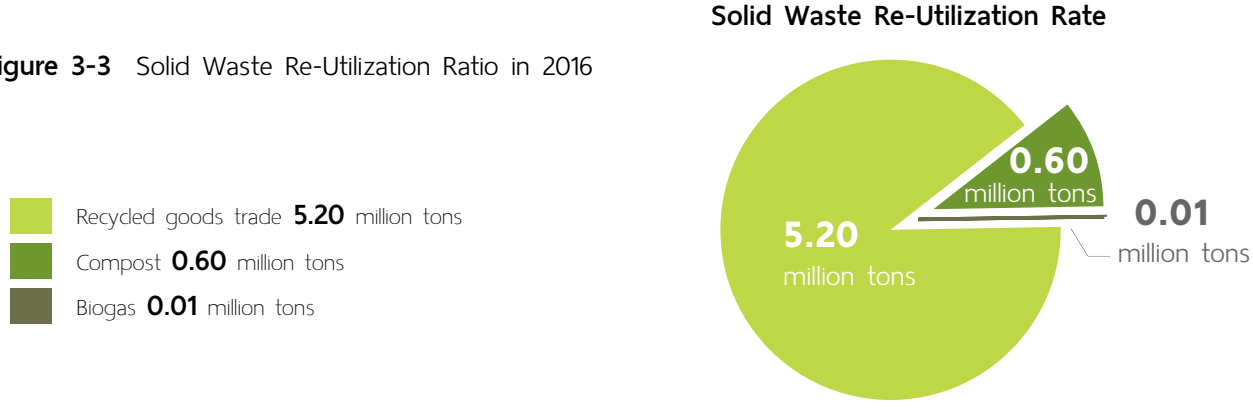
3.1.2 Waste Sorting and Utilization

1) **Municipal Solid Waste Sorting and Utilization**

In 2016, 5.81 million tons or 21.47% of the total waste generated had been recycled (Figure 3-3) as follow:

- **Utilization of Recycled Waste:** Approximately 5.20 million tons (89.50%) of wastes are recyclable waste, sorted from households, the source of origin. Most are glass, paper, plastic, metal, and aluminum, which are valuable wastes. After having sorted these valuable wastes out of the pool of wastes, the recyclable wastes will be sold to junk yards, the community recycling plant, or the waste recycling bank to be sent back into the manufacturing process. Some may be reused as materials for invention, or reused milk cartons, water bottles, reused plastic bags, and even car tires being reused as plant pots.
- **Utilization of Organic Waste:** Approximately 0.60 million tons (10.33%) of the wastes remaining after being sorted at the source are organic wast es from food wastes, vegetables, and fruits. Only a small portion of these wastes can be reused. The reuse of organic wastes can be found in fresh markets or department stores, where organic wastes are reused as organic fertilizers, or compost for soil supplements for agricultural purposes. Some of these organic wastes can also be reused as animal feeds.
- **Utilization of Municipal Solid Waste in Biogas:** Approximately 0.01 million tons (0.17%) had been processed into biogas as a replacement energy source.

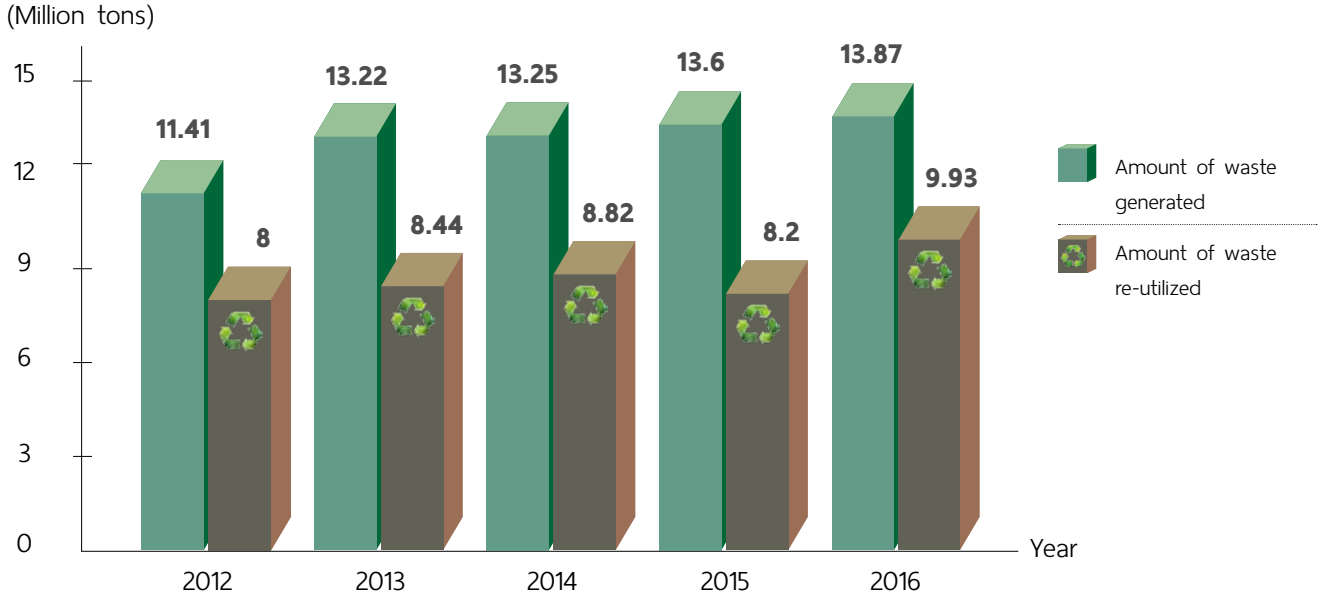
Figure 3-3 Solid Waste Re-Utilization Ratio in 2016



2) Utilization of Recyclable Industrial Waste

In 2016, it was estimated that there were 13.87 million tons of recyclable materials in the industrial sector such as glass, paper, plastic, metal, aluminum, and rubber, with approximately 9.93 million tons or 71.59% (Figure 3-4) being reused or used as an alternative energy source. Today, the amount of materials being reused depends on the country's economics. Support from the government is a key factor to help the industrial sector and the private sector to reuse and recycle wastes. Such support can be in the form of tax incentives, export promotion, promotion of recycled or eco-friendly products, which can be used as incentives for the industrial sector to reuse and recycle their wastes, to reduce the consumption of resources, and to reduce the cost of waste disposals.

Figure 3-4 The Amount of Industrial Waste being Utilized in 2012-2016

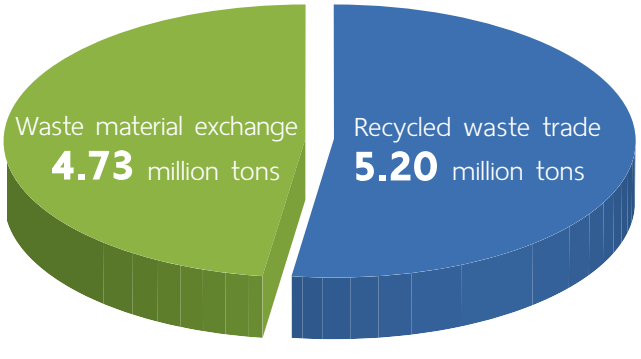


Source: Information gathered from the Office of Industrial Economics, Research and Development Center for Thai Rubber Industry, Thai Rubber Research Institute, Thai Pulp and Paper Industries Association, Iron and Steel Institute of Thailand, and Federation of Thai Industries, with additional data provided by Pollution Control Department.

Remark: The process of data and information collection is part of estimation process for the utilization of industrial waste.

Out of about 9.93 million tons of the recyclable industrial wastes that had been reused 5.20 million tons (52%) were repurchased from the community, the other 4.73 million tons (48%) were traded in the waste exchange system among manufacturers, importers, and distributors, and were also traded in the deposit-refund systems (Figure 3-5 and Table 3-2).

Figure 3-5 The Utilization of Recyclable Industrial Waste



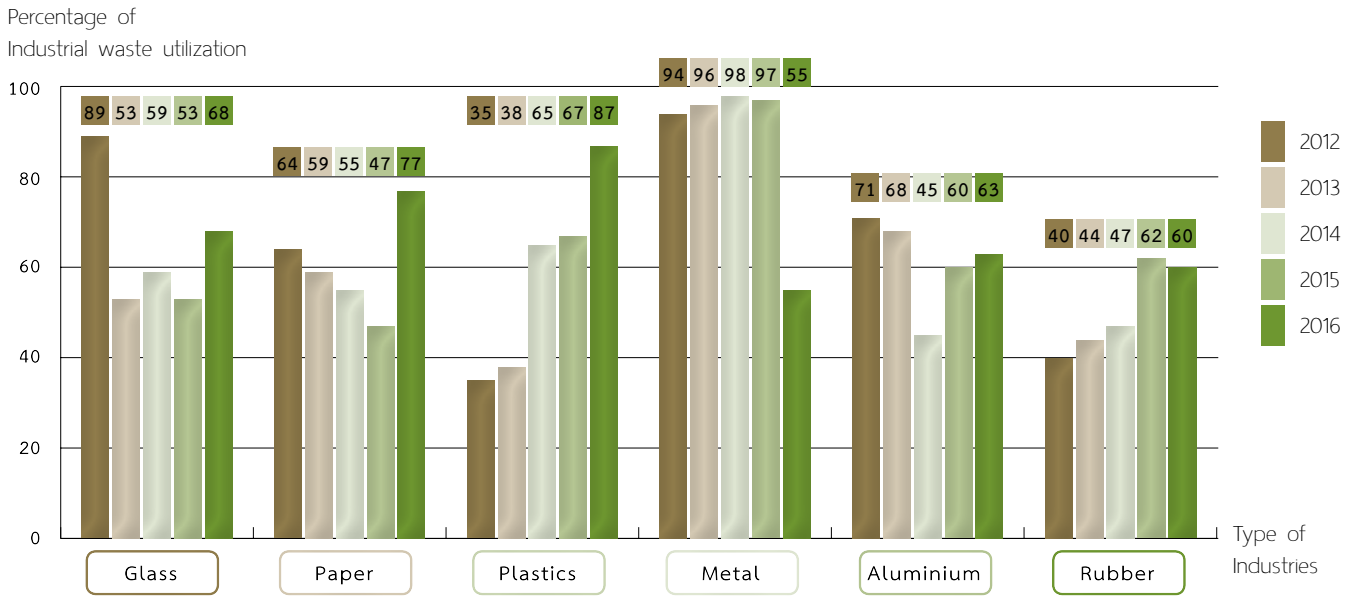
From the data gathered on the utilization of recyclable industrial waste, it was discovered that the rate at which every industry recycled their wastes was stable. The growth of the glass, plastic and aluminum industries had slightly increased. By promoting the reuse of different types of wastes, the amount of resource consumption is also reduced, which in turn help cut down the cost of waste disposal. The effort to promote waste reutilization should be done in various ways, and should run in parallel, such as promoting the reduction of usage, promoting reutilization, promoting the invention of recycled materials, promoting the research and development of new technology for waste recycling, promoting the market for recycled products, promoting tax incentives for the manufacturing process of recycled and reused materials.

Table 3-2 The Amount of Utilization of Municipal Solid Waste

Type	Amount of waste generated (tons)	Amount utilized		Total		Method
		Trade in communities (tons)	Trade and exchange between industies (tons)	Tons	Percentage	
Glass	2,415,842	640,000	767,000	1,407,000	58	Recycling
	-	-	250,000	250,000	10	Reuse
Paper	4,079,363	1,440,000	1,720,000	3,160,000	77	Recycling
Plastic	3,072,000	2,240,000	430,000	2,670,000	87	Recycling
Steel/Metal	3,025,563	480,000	1,175,000	1,655,000	55	Recycling
Aluminium	780,000	288,000	202,000	490,000	63	Recycling
Rubber	505,063	112,000	109,000	221,000	44	Recycling
	-	-	80,000	80,000	16	Reuse
Total	**13,877,831**	**5,200,000**	**4,733,000**	**9,933,000**		

From the ratio of recycled industrial waste during 2012-2016 (Figure 3-6), it is evident that the amount of recycled materials had increased. This is owed to the fact that community trades had increased, which in-turn is passed on to the industrial sector, all resulting from the trending economic growth in 2016 due to various economic stimuli by the government to promote equal income spread, boosting domestic consumption. This results in an increase in the purchase of plastic containers, as well as other packaging materials, which constitutes to the increase in re-utilization of glass, paper, plastic and aluminum from 53%, 47%, 67% and 60% in 2015 to 68%, 77%, 87%, and 63% respectively. As for the metal industry, the government unleash several mega projects such as the construction of the Mass Rapid Transit Rail System, which caused an increase in the import of metal from foreign countries in order to serve the foreseeable increase in domestic demands, causing a steady level of domestic metal production, while metal import increase due to lower prices. This causes a reduction in the reutilization of metal in manufacturing processes at only 55% compared to 2015.

Figure 3-6 The proportion of industrial waste utilization in 2012-2016



"Wastes in the Sea of Thailand"

Previously, there had been many articles on how Asian countries are among one of the world's top countries with the most plastic wastes in the sea, including China, Indonesia, Philippines, Vietnam, Sri Lanka, and Thailand, with China topping the chart as number one in the world for the amount of plastic wastes in the sea, and Thailand in 6th place (0.15-0.41 million tons/year). This caused concerns over the effect of plastic wastes on marine resources and the coasts of Thailand as such: 1) Inflicting change on the ecosystem, causing a spread of foreign species of plants and animals, causing the number of local aquatic animal to decrease, 2) causing damage to ships and fishery equipment, 3) ruining beautiful sceneries, damaging tourist site values, and 4) affecting the environment, the health and well-being of marine animals and humans, which could be harmed from wastes along the coasts, or from ingesting wastes, damaging the digestive tract, or receiving toxic substances from the wastes. There are 2 types of effect on the health and well-being of living organisms from the wastes, one is body-related, and the other is ingestion, which could disturb the digestive system, as well as being affected by the small toxic substances called "Microplastic" (plastic pieces smaller than 5 millimeters), which could accumulate inside marine animals causing toxic residuals. This could affect their growth cycle, and could potentially be accumulated in humans who then consume these animals.

From the information provided by the Department of Marine and Coastal Resources, who had conducted investigations from the collection of coastal wastes during 2009-2015, over a distance of 531 kilometers, with 420,817 wastes collected, weighing 73,234 kilograms. The highest amount of wastes are generated from coastal recreational activities (from plastic bags, bottle caps, glass bottles, etc.), generating up to 277,619 pieces of wastes, which is 66% of the total wastes collected, followed by wastes generated from water activities such as fishery, boating, fishing boats, and other activities related to ships and boats (such as ropes, fishing nets, etc.), generating up to 67,073 pieces of wastes, which is 16% of the total wastes collected.

The main sources of wastes in the sea of Thailand are coastal and land activities such as in industrial area, community area, households, and businesses along the coasts, where there are waste dumps on land, washed over to the sea, and some marine activities, such as cargo ship transport, recreational cruises, tourist boats, and fishing ships, are killing aquatic animals. Certain types of wastes, such as plastic bags and water bottles, that are dumped into the sea are covering up coral reefs, causing the deterioration of coral reefs. Thus, the Pollution Control Department had collaborated with relevant parties to resolve the problems of wastes in the sea, adopting the 3R concept of Reduce, Reuse, and Recycle. All stakeholders from the government, the people, and the private sectors were involved in a collaborative effort to fix the problems of plastic wastes affecting the environment.

3.2 Hazardous Waste

Hazardous wastes include hazardous waste from the community, hazardous wastes from industries, and infectious wastes. In 2016, it was estimated that 3.462 million tons of hazardous wastes were generated nationwide, increased by 0.017 million tons or 0.49% from 2015. Most of the hazardous wastes generated were from industrial activities at 2.8 million tons (80%), with 0.606 million tons (18%) from the community (including Waste from Electrical and Electronic Equipment), and 0.056 million tons (2%) infectious wastes (Table 3-3).

Table 3-3 The amount of hazardous wastes by type of origin from 2015-2016

Source	2015	2016	Net change	Percentage
	million tons	million tons	up - down	up - down
Industry	2.8	2.8*	-	-
Municipal	0.591	0.606**	+0.015	+2.54
Infectious waste	0.054	0.056***	+0.002	+3.30
Total	**3.445**	**3.462**	**+0.017**	**+0.49**

Source: * Information from the Department of Industrial Works
** Information from the Pollution Control Department
*** Information from the Department of Health
Remark: Calculated from the data of actual hazardous waste generated.

3.2.1 Household Hazardous Waste

From investigation and estimates conducted, approximately 606,319 tons were generated, an increase of 2.54% from 2015, most of which were Waste from Electrical and Electronic Equipment (WEEE) accounting for 393,070 tons or 65% of total, with around 213,249 tons or 35% of other types of community hazardous wastes such as batteries, chemical containers, spray bottles, etc.

As for efforts in managing Household Hazardous Waste, several problems and challenges were faced such as the Local Administrative Organization does not have a waste sorting system in place, and therefore, wastes were collected and transported collectively with general municipal solid wastes, the lack in regulatory guidelines for sorting hazardous wastes from municipal solid wastes, many areas does not have a storage site for hazardous wastes to be transported and disposed of properly, additionally, some community hazardous wastes and wastes from electrical and electronic equipment were recycled inappropriately, causing damaging environmental impact.

3.2.2 Hazardous Industrial Waste

The amount of industrial wastes (both hazardous and non-hazardous waste) were estimated at 37.4 million tons nationwide from both within and outside of industrial estate areas. Out of which, 2.8 million tons (7.49%) were hazardous wastes, and 34.6 million tons (92.51%) were non-hazardous wastes.

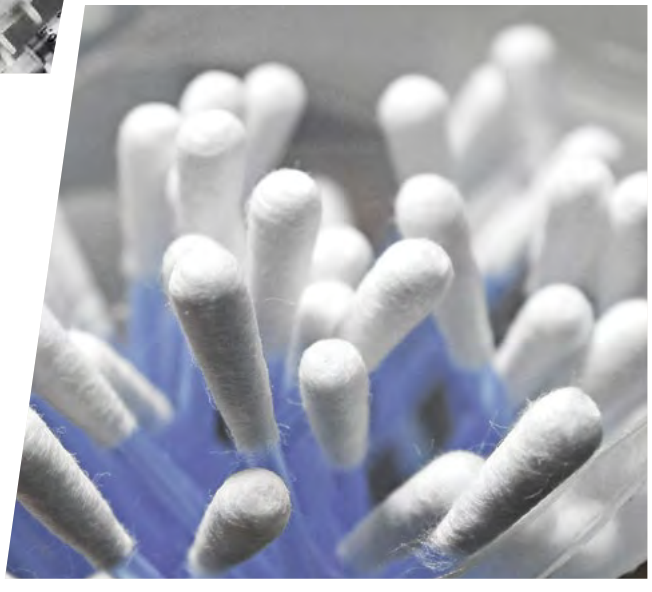
The amount of both hazardous and non-hazardous industrial wastes reported electronically to be transported out of the factories to be disposed of revealed that 1.12 million tons or 40% of hazardous wastes generated could be managed and 15.22 million tons or 44% of non-hazardous wastes generated could be managed by the measures summarized in Table 3-4.

Table 3-4 The amount of industrial wastes (both hazardous and non-hazardous) authorized for disposal by various measures.

Method of Management	Hazardous Level			
	Non-hazardous (million tons/year)	Percentage	Hazardous (million tons/year)	Percentage
Processed and reused	5.07	33.3	0.16	14
Waste-to-energy	3.97	26.1	0.34	29.8
Processed and used as materials	4.48	29.4	0.25	21.9
Treated	0.90	5.9	0.05	4.4
Disposed	0.54	3.5	0.28	24.6
Shipped overseas for management	0.27	1.8	0.06	5.3
Total	**15.23**	**100**	**1.14**	**100**

Remark: The amount of industrial wastes (both hazardous and non-hazardous) generated nationwide by province.

Source: The Department of Industrial Works 2016; data from January – December 2016



3.2.3 Infectious Waste

It was estimated that the amount of infectious wastes generated in 2016 was 55,646 tons, which had increased from 2015 by 1,778 tons (3.3%), out of which, 31,601 tons (56.79%) were generated from the public hospitals, 9.486 tons (17.05%) were generated from private hospitals, 10,691 tons (19.21%) were generated from clinics, 3,544 tons (6.37%) were generated from Sub District Health Centers, 321 tons (0.58%) were generated from animal clinics, and 3.2 tons (0.01%) were generated from hazardous pathogen laboratories. Most infectious wastes were generated from public and private hospitals, including hazardous pathogen laboratories located in large healthcare centers.

Managing infectious wastes often involves transporting infectious wastes to be disposed of at waste incinerators owned by private parties or local administrative organizations, with a total of 49,056 tons (88%) being disposed of. 14,016 tons were incinerated at 6 incinerators owned by Local Administrative Organization, 35,040 tons were incinerated at 5 privately owned incinerators. However, existing infectious waste incinerators have no air quality monitoring system to abide with existing regulations, and the 6,590 tons (12%) infectious wastes unaccounted for may be disposed of privately by the hospitals' own incinerators or by other means.

From the data obtained from Department of Health, there was a total of 37,962 health centers generating infectious wastes, out of which 1,068 were public hospitals, 343 were private hospitals, 23,054 were clinics, 9,777 were sub district health centers, 2,522 were animal clinics and 1,198 were hazardous pathogen laboratories. Out of the 953 public hospitals under the Ministry of Public Health, 880 hospitals or 92.34% were able to meet the legal requirements for disposing of infectious wastes while the remaining 7.66% were still unable to meet the requirements.

Most of the infectious wastes generated at hospitals were disposed of at incinerators owned by private parties or by Local Administrative Organization. However, many small health centers, which makes up a large proportion of all health centers, faced challenges in waste collection, transportation and disposal, as only a small amount of infectious wastes were generated at each location per day. Additionally, the process of waste collection for infectious waste had to follow certain procedures and guidelines, causing difficulties in the collection and disposal of infectious wastes at each location with extremely high costs. As a result, many small health centers deliver their wastes to public hospitals in their network to be disposed of collectively, while some may also be disposed of collectively with general municipal solid wastes.

3.3 Hazardous Substances

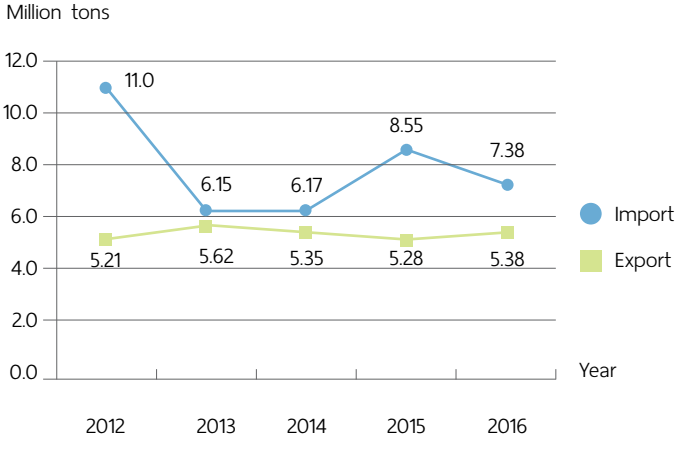
The economic growth and competitiveness of both the domestic and international market called for the application of new technologies to develop industrial, agricultural, and healthcare capacity, and hazardous substances are a part of this development. For example, methanol is used in industrial activities to dissolve and mix fossil fuels, the agricultural sector sees an increasing usage of chemicals in pesticides to increase crop yields, and phenols are heavily used in healthcare for pharmaceutical industries, for anti-bacterial substances and cleaning agents, etc. The usage of such hazardous substances can cause inevitable effects, both positive and negative, to the public health and well-being, the environment, and the economy.

The control and management measures of hazardous substances in Thailand involve following the Hazardous Substances Act B.E. 2535 (1992), which controls the manufacturing, the import, export and possession of hazardous substances. Relevant offices will consider which substances should be controlled, divided by the need to control such substances, following the 4th National Strategic Plan on Chemical Management (2012-2021), which is aimed towards a high-efficiency chemical management plan.

Moreover, Thailand also follows various international conventions concerning chemical substances such as the Rotterdam Convention, the Stockholm Convention, and the Minamata Convention, as well as taking part in driving various collaborative associations such as driving the consensus of the Health Assembly on food security in response to the problems and challenges of the usage of hazardous substances.

In 2016, Thailand had imported 7.38 million tons of chemicals, which had decreased by 1.17 million tons (13.68%) from 2015, and had exported more chemicals than in 2015, increasing from 5.28 million tons in 2015 to 5.38 million tons (1.89%).

Figure 3-7 The amount of Thailand's chemical import and export from 2012-2016



Source: Import-Export statistics, the Customs Department
(Data from January – December 2016)

3.3.1 Agrochemicals

Agrochemicals are under the responsibility of the Department of Agriculture, under the Hazardous Substances Act B.E. 2535 (1992). The Agrochemicals import data from 2016 revealed a total of 160,824.163 tons, which had increased by 11,323.416 tons from 2015, equating 8%. The highest imported hazardous substances are herbicide at 78%, insecticide at 10% and fungicide at 8%, where the type and amount of Agrochemicals imported during 2012-2016 is presented in Table 3-5.

Table 3-5 The type and amount of agricultural hazardous substances imported in 2012-2016

Rank	Type of chemical	Import Total (tons)				
		2012	2013	2014	2015	2016
1	Herbicide[1]	106,860.024	137,048.869	117,645.359	119,971.879	125,596.274
2	Insecticide[2]	16,796.966	21,485.943	13,911.544	12,927.521	16,062.069
3	Fungicide[3]	6,967.199	10,350.010	10,988.225	11,088.374	12,915.972
4	Plant growth regulator[4]	2,374.631	1,390.307	1,600.430	2,242.581	2,708.208
5	Fumigants[5]	945.361	1,249.481	1,480.959	1,384.395	1,331.432
6	Acaricide[6]	199.593	1,000.261	1,296.700	1,395.320	1,693.234
7	Mollussicide[7]	233.389	149.064	212.046	205.018	206.000
8	Rodenticide[8]	0.010	0.000	135.600	243.600	173.900
9	Microbial Pesticides[9]	103.090	153.015	106.021	42.058	137.074
10	Nematocide[10]	0.004	0.006	0.065	0.001	0
Total		**134,480.267**	**172,826.956**	**147,376.949**	**149,500.747**	**160,824.163**

Remark:

1. Herbicide, such as Paraquat Dichloride, Glyphosate Isopropylammonium
2. Insecticide, such as Chlorpyrifos, Carbosulfan
3. Fungicide, such as Mancozeb, Propineb
4. Plant Growth Regulator, such as Paclobutrazol, Ethephon
5. Fumigants, such as Aluminum Phosphide, Methyl Bromide
6. Acaricide, such as Pyriben, Amitraz
7. Mollussicide, such as Metaldehyde, Niclosamide-Olamine
8. Rodenticide, such as Zinc Phosphide
9. Microbial Pesticides, such as Bacillus Thuringiensis, Bacillus Subtilis
10. Nematocide, such as Oxamyl

Source: Office of Agricultural Regulation, Department of Agriculture 2016

Figure 3-8 The amount of agrochemicals imported in 2012-2016

The data on the amount of agrochemicals imported from 2012-2016 (Figure 3-8) revealed that the state of chemical usage in Thailand's agricultural activities is increasing. However, all parties involved, both public and private, are continually promoting organic agricultural practices, such as developing a guideline for managing the risks from Organophosphate chemicals in herbicides in the Upper Northern Region by interactive research activities.

Environmental Problem Caused by Growing Bananas in Chiang Rai Province

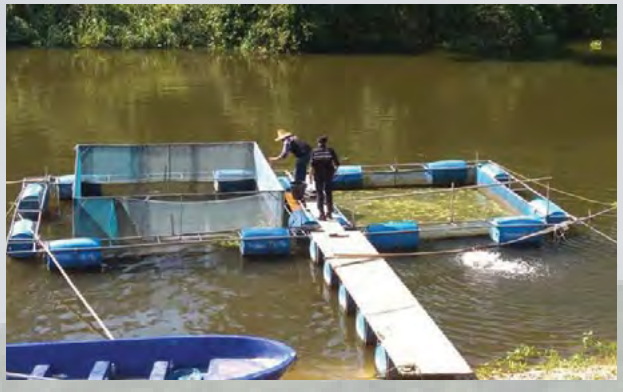
In the Phaya Mengrai District, Chiang Rai Province, a group of Chinese investors had leased 2,700 rais of lands to grow bananas for exporting to China (currently growing bananas in over 1,000 rais), using the Brazilian Green Banana shoots from China, which takes around 9-10 months to grow per batch. Three main chemical groups were used in several processes, from growing the trees to harvesting, and distributing, such as the group for nourishing the trees and fruits, the group for pest's removal, and the group for controlling growth and yield. Utilizing these groups of chemicals raised concerns among the public and media, including governmental offices, particularly on the effect these chemicals may have on the environment as seen in the news for what happened in the Lao People's Democratic Republic, where the area resides along the two banks of the Ing River. And Chiang Rai's main water sources cut through several districts before converging into the Mekong River at Chiang khong District in Chiang Rai Province.

Today, the trending level of environmental impact does not appear to be as feared, where Search Results Regional Environmental Office 1 (Chiang Mai) had conducted continuous field investigations to watch out for any environmental impact. The 2 investigations conducted so far revealed that the water quality of the Ing River remains within standard values, and is of good-fair quality. The levels of heavy metals and residual chemicals of agricultural activities (pesticides) are also within standard range. The water quality in the area around the banana plantation, however, appeared to be of poor quality, with levels of heavy metals and arsenic higher than standard values.

Resolving the Problem of Chemical Contamination from Agricultural Activities in Nan Province

On 5-6 July, 2016, the Thai PBS Television Station, reported in their evening news "Plikpom Khao", the result of a study conducted by Naresuan University on the chemical contamination of Nan Province's water sources and environment revealing chemical contamination from the use of insecticides to include Chlorpyrifos, Glyphosate, Atrazine, and Paraquat in samples collected. The study also revealed the effects these chemicals had on the health and well-being of residents in the area. In resolving the problem of chemical contamination from agricultural activities in the area, efforts made by various offices in the province and the central administration was integrated as follow:

1. Nan Province had established the Committee for the Development of People's Quality of Life to cope with the problem of chemical contamination in Nan, which is composed of the Board of Directors, the Academic Committee, the Committee for Avoiding and Reducing the Usage of Agricultural Chemicals, the Committee for Driving Social Values for Environmentally-Friendly Agricultural Activities, and the Communication Committee, in order to define the guidelines for the utilization of chemicals in agricultural activities in the Nan Province.



2. Ministry of Natural Resource and Environment in conjunction with Ministry of Agriculture and Cooperatives had tackled the problem of agricultural chemical contamination in Nan as follow:

- Examining 10 samples of chemical contaminations from agricultural activities in the environment during 7-10 August 2016 revealed 14.09 µg/L of chlorpyrifos in the mountain water supply (the World Health Organization set the limit at 100 µg/L), 7.42 – 21.17 µg/L of atrazine and 34.57 – 157.36 µg/L of chlorpyrifos in the surface water, in which Thailand still has no standards for.

- Preparing to make recommendations for resolving problems from agricultural chemical pollution for both provincial area level in Nan and at a policy level to the subcommittee for agricultural activity environmental management under the Committee for Pollution Control to be approved of.

3. Ministry of Public Health had analyzed the level of chemical contamination from agricultural activities in the community's water supply and bottled drinking water produced in the community and found that the values does not exceed World Health Organization's safety levels.

3.3.2 Hazardous Industrial Chemicals

Hazardous Industrial Chemicals are under the surveillance of the Department of Industrial Works, under the Hazardous Substances Act B.E. 2535 (1992). From the data retrieved in 2016, it was discovered that a total of 3,639,001 tons of hazardous wastes were imported for industrial uses, which was 659,603.01 tons or 22% more than the previous year. The top 3 hazardous substances imported for industrial use are 1) Methanol at 21%, 2) Sulfuric Acid at 20%, and 3) Sodium Hydroxide at 16%. The list of names and amounts of the top 10 hazardous substances imported for industrial use is shown in Table 3-6.

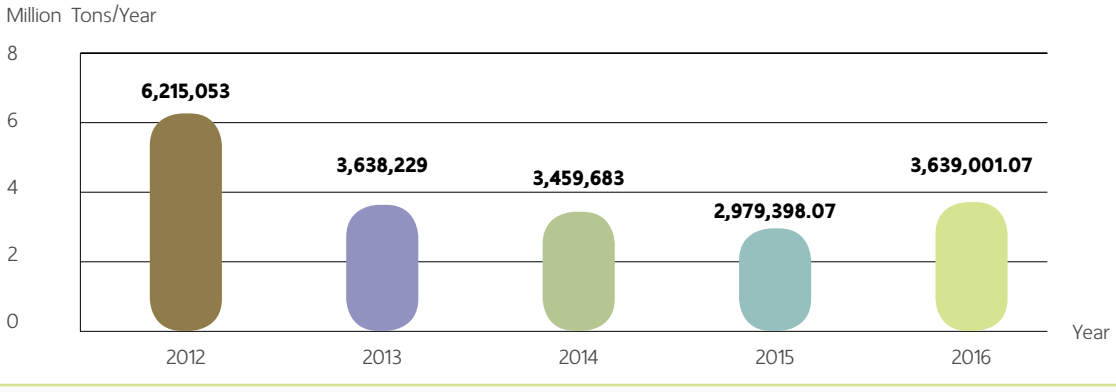
Table 3-6 The list of names and amounts of the top 10 hazardous substances imported for industrial use 2016

Rank	Name	Hazadous Substance Category	Amount (tons)
1	Methanol or Methyl Alcohol	1	780,389.25
2	Sulfuric Acid	3	731,933.94
3	Sodium Hydroxide	1	573,586.92
4	Ethylene Dichloride or 1,2-Dichloroethane	3	551,296.95
5	Ammonia Anhydrous	3	429,236.71
6	Styrene	2	215,346.25
7	Acetic Acid	3	113,754.94
8	Phenol	2	91,002.40
9	O-Phosphoric Acid	1	88,205.75
10	Nitric Acid	2	64,247.96
Total			**3,639,001.07**

Mark: The Hazardous Substances Act B.E. 2535 (1992) states the following:
Hazardous Substance Category 1 No registration required, but import into the Kingdom of Thailand must be reported.
Hazardous Substance Category 2 Hazardous substance registration is required and but import into the Kingdom of Thailand must be reported.
Hazardous Substance Category 3 Hazardous substance registration is required, hazardous substance license is required and an import license must be obtained before import is permitted.
Hazardous Substance Category 4 Production, import, export or to have in possession is prohibited.
Source: The Department of Industrial Works (information as of January-December 2016)

Considering the statistics of the top 10 hazardous substances imported for industrial use during 2012-2016, it was found that import began to decrease in 2013, and had increased in 2016 (Figure 3-9).

Figure 3-9 Import of Industrial Hazardous Substances 2012-2016



3.4 Waste and Hazardous Substances Management

3.4.1 Municipal Solid Waste Management

In 2016, a collaboration with the governmental offices was established to promote activities related to developing a more efficient municipal waste management procedures yielding the following:

1) Promoting provincial parties to solve the problem by providing a guideline for closing down municipal solid waste disposal site, improving them into control pit, and providing the budget for improving disposal sites that does not meet standards. Driving the private parties engagement, particularly on turning waste to energy, and driving related governmental offices to strictly enforce the law on private parties who does not strictly follow the academic guidelines such as the Phraeksa Landfill in Samut Prakarn.

2) Promoting the reduction and sorting of wastes generated by Local Administrative Organizations and households, as well as various sources. Promoting Local Administrative Organizations to collect sorted wastes, applying appropriate technology for the various sizes of local administrative organizations, and promoting integrated waste management. Allowing the private parties to take part in investing and managing the whole system, while also engaging the people in the project. In 2016, a collaborative effort between the public and private parties was established to promote activities related to developing a more efficient municipal waste management procedures as a role model for waste sorting from the source of origin. In the future, there may be opportunities for investment in large waste management system covering provincial or regional areas, such as the Center for Recycled Waste Sorting, the Center for Biomass Fertilizers, or the Center for Recycling Industry. Several efforts had been made to promote the management of municipal solid wastes by local administrative organizations across the country to communicate to the people, instituting an understanding on how to properly manage municipality solid waste, plastic, foam, wastes in tourist areas, and defining an active strategy, outlining the 3R strategy, the law, and any relevant regulations in order to increase the capacity and efficiency of recycling wastes as much as possible before the final stage of disposal.

3) In driving the law, many governmental offices had driven the law and regulations concerning the management of municipal waste, hazardous waste, infectious waste, and industrial hazardous wastes. For instance, Ministry of National Resources and the Environment had proposed a draft of the Waste from Electrical and Electronic Equipment (WEEE) Management Act B.E. .... which states that the manufacturer and the importer of electrical and electronic equipment are responsible for proper management of wastes generated from such equipment. Ministry of Interior had made adjustments to the draft of the Maintenance of the Cleanliness and Orderliness of the Country Act B.E. .... in order to solve the problem of community waste management, while Ministry of Industry had acted upon the measures for preventing and resolving the problem of illegitimate waste disposal, and the management of industrial hazardous waste and infectious waste.

4) In establishing a discipline among the Thai citizens, Ministry of Natural Resources and the Environment had made a Memorandum of Understanding with 16 business organizations for their cooperation to not distribute plastic bags to their customers on the 15th and 30th of each month, which continued continually from 15 August 2016 to 4 December 2016, which coincides with Thailand's Environmental Day for 2016. As a result, there had been a reduction of over 166 million plastic bags usage. Efforts to support the Ministry of Education had also been made to consult schools on how to manage wastes and to build discipline and consciousness among Thai youths, creating environmental conservation curriculum with contents concerning the management of municipal solid wastes.

"Waste-Free Thailand" on the way of "Pracharath" or "3R Pracharath"

Ministry of Natural Resources and the Environment, in conjunction with Ministry of Interior and other related offices had together drive and support the management of waste from the source of origin, which is to apply the 3R policy to reduce the amount of waste generation at the source. The main focus is to reduce wastes generated by households, while also promoting waste sorting at source of origin, and how to create added-value from waste processing or reutilization. This is to reduce the amount of wastes entering the waste management system, and to increase the rate of proper waste management across 76 provinces. As a result, 1,297 tons of hazardous waste were collected, 64 tons (5%) were sent for disposal, with 1,233 tons (95%) waiting to be disposed. Asides from focusing on waste reduction and waste sorting at the source of origin, the efforts are also focused around creating a more efficient procedure for waste collection in order to lead to proper as per academic guideline, including promoting the engagement of private parties via investing to construct and manage the process of waste processing, turning waste into biomass and energy, as well as producing organic fertilizers in order to be environmentally-friendly in the future. This is to incorporate the sense of responsibility and the sense of engagement in managing municipal solid wastes by related parties, including the people as part of those who are responsible for generating and managing wastes in the way of **"Pracharath".**

The "Do Good for Dad" Activity, Promoting Waste Sorting at the Waste Management and Environmental Department at Volunteers for DAD

The "Do Good for Dad" activity to promote waste sorting was started from the collaboration of 3 parties, Bangkok Metropolitan Administration, Thammasat University, and Ministry of Natural Resources and the Environment, acting under the Waste Management and Environmental Department of Volunteers for DAD. The Bangkok Metropolitan Administration was in charge of the waste management around Sanam Luang area, Thammasat University was in charge of the registration process and assigning queues for the volunteers, and the Ministry of Natural Resources and the Environment was in charge of educating and managing the volunteer teams.

The goal of this activity is to create an understanding around waste sorting among the people who came over to pay respect to the late King Bhumibol Adulyadej so that they can be easily reutilized, leaving the least amount of waste for disposal. Moreover, the people can also use this knowledge obtained and apply it to their daily life, while also pass-on this know-how to others. On the 100th Day in Remembrance of the Demise of His Majesty King Bhumibol Adulyadej, a total of 33,235 people, averaging 307 people per day had volunteered to work on waste management in the area, which increases to 540 people per day on holidays.

From the statistics of the amount of waste in Sanam Luang area, it was found that the amount of waste had increased in the beginning when people were given entry into the Royal Ceremony to pay respect to the late King Bhumibol Adulyadej from 18 October 2016 to 5 November 2016, where the amount of waste averaged 65.08 tons per day on weekdays, and 120.33 tons per day on weekends (data from the Phra Nakhon District Office, Bangkok). Today, it is found that the amount of waste is decreasing, with only 34.30 tons/day daily average (data obtained on 5 November 2016 – 21 March 2017), which is a result of the efforts to promote waste sorting before disposal. The line of food and drink distribution in the area had also been reorganized, changing the food containers from plastics into biodegradable containers, causing the amount of foam containers to decrease.

Moreover, several organizations such as the Thailand Environment Institute, the Regional Environmental Office 1-6, and Suan Dusit Rajabhat University had provided academic support and educators to provide knowledge on waste sorting to volunteers, which is a good way to engage all stakeholders in solving this problem.

3.4.2 Hazardous Waste Management

1) Driving the draft of the Waste from Electrical and Electronic Equipment (WEEE) Management Act B.E. .... as a law to govern the management of electrical and electronic equipment in a systematic manner by adopting the concept of Extended Producer Responsibility (EPR) in constitute a return, collection, and storage system, as well as transportation, recycling, and disposal of products. This should be done in an academically correct way in order to be environmentally safe. It is currently being under consideration of the cabinet, before being proposed to the National Legislative Assembly.

2) Laying out a guideline in order to prepare for the enforcement of the Waste from Electrical and Electronic Equipment (WEEE) Management Act, such as establishing a coordination center and spread the knowledge and information on managing WEEE, pinpointing the location of the waste return center for WEEE, developing the registration system and relevant database in order to control, monitor and analyze various activities to make sure that the law is being reinforced, and to be used as a reference for outlining strategies or policies to support the management of WEEE. Creating and spreading the knowledge and information on how to properly manage WEEE, applicable to all relevant stakeholders, broadcasting the details of the Waste from Electrical and Electronic Equipment (WEEE) Management Act and actionable guidelines for all stakeholders to abide to the law.

3) Creating measures for the preventing and solving the problems of illegitimate industrial hazardous waste and infectious waste disposal for 2017-2021 in order to prevent and solve the problems of illegitimate industrial hazardous waste and infectious waste disposal more efficiently, which had already been approved by the National Environmental Board in Meeting No. 5/2016 on 28 December 2016, which include several important measures such as bringing the people generating industrial hazardous waste and infectious waste into the Industrial Hazardous Waste and Infectious Waste Management System, pushing for a system to control and monitor the transportation of industrial hazardous waste and infectious waste, promoting effective industrial hazardous waste and infectious waste to mitigate the problem of illegitimate waste disposal.

4) Creating a master plan for the management of infectious waste for 2016-2021 under the control of the Public Health Board by having the Department of Health as the main facilitator to appropriately manage infectious waste and setting up a database system for infectious wastes to support an efficient waste management system.

5) Creating a 5-year plan for managing industrial waste (2015-2019) by the Department of Industrial Works (approved by the Cabinet on 26 May 2016). In 2016, under the plan for industrial waste management, the Department of Industrial Works had made an adjustment to the law, declaring that all trucks transporting the 40 types of hazardous wastes listed in the Hazardous Substances Act B.E. 2535 (1992) must install a Global Positioning System (GPS), with a management system to support the GPS system for monitor and control, as well as launching a program to create a database or monitoring the transport of industrial waste with GPS functionality to monitor the driver and the vehicle, as well as calculating the route for transporting industrial waste from the origin to the destination in order to prevent illegitimate waste disposal.

3.4.3 Controlling and Managing Hazardous Substances

1) Thailand has measures to control highly toxic and hazardous chemicals, which is stated in the Hazardous Substances Act B.E. 2535 (1992), that governs the production, the import, export and the possession of such substances. The governing authority will continually update the list of substances to be controlled, where recently, by the announcement of the Ministry of Industry, the List of Hazardous Substances (No. 3) B.E. 2559 (2016) had been updated on 12 January 2017 to include 1 additional substance, Formaldehyde or Methanol, in List No. 4.1, and 8 additional substances in the List No. 5.1 to include: 1) Cresol or Methyl Phenol, 2) HFC-245eb, 3) HFC-338mcc, 4) HFC-388mee, 5) HFC-356ffa, 6) HFO-1234yf, 7) HFO-1234ze, and 8) HFO-1336mzz-Z.

2) The 4th National Strategic Plan on Chemical Management (2012-2021), created by the National Committee on Strategy Development for Chemical Management, had created a strategic plan, an indicator, and the goal of this national strategic plan as follow: "By 2021, social and environment is safe by effective management of chemicals in accordance with national development and participation from all sectors." In 2016, there had been some key actions following the middle stage of the strategic plan (2016-2018), under the 4th National Strategic Plan on Chemical Management, such as to study the process of adding the database of chemical mixtures into Thailand's Chemical Database No. 2 (Chemical Mixtures), mitigate the effects of herbicides and pesticides by agricultural communities, study the process of pharmaceutical waste management, prepare for the approval of the Minamata Convention on mercury, and the implementation plan as required by the Convention, increase the efficiency of chemical management under the middle stage of the strategic plan (2016-2017), initiate the protection of health and environment in the chemical risk zone, and to provide knowledge and offer training in order to develop the capabilities of the officers, to safeguard chemical usage, develop mechanics and tools, and conduct researches on how to manage chemicals.

3) Controlling and managing hazardous substances under international conventions with the Pollution Control Department acting as a coordinator for relevant conventions as follow:

3.1) The Stockholm Convention on managing accumulative toxic substances over a long period of time, in 2016, actions had been taken with the approval of the subcommittee to place the POPs (HCBD, PCNs, and the PCP's Esters) under the governance of the Hazardous Substances Act B.E. 2535 (1992) and the Pollution Control Department, as the Convention's secretariat, had prepared the proposal for controlling such substances, with additional information, to the Department of Industrial Works, in order to present to the Committee for Hazardous Substances for consideration.

3.2) The Rotterdam Convention on the process for reporting in advance the international trade of hazardous chemicals and chemicals in certain herbicides and pesticides, in 2016, the subcommittee had given their approval for the control of Short-Chain Chlorinated Parafins (SCCPs) as Hazardous Substances Category 2 under the Hazardous Substances Act B.E. 2535 (1992). As such, the Department of Pollution Control, as the Convention's secretariat, is compiling documents and information for the Department of Industrial Works to present to the Committee for Hazardous Substances for consideration.

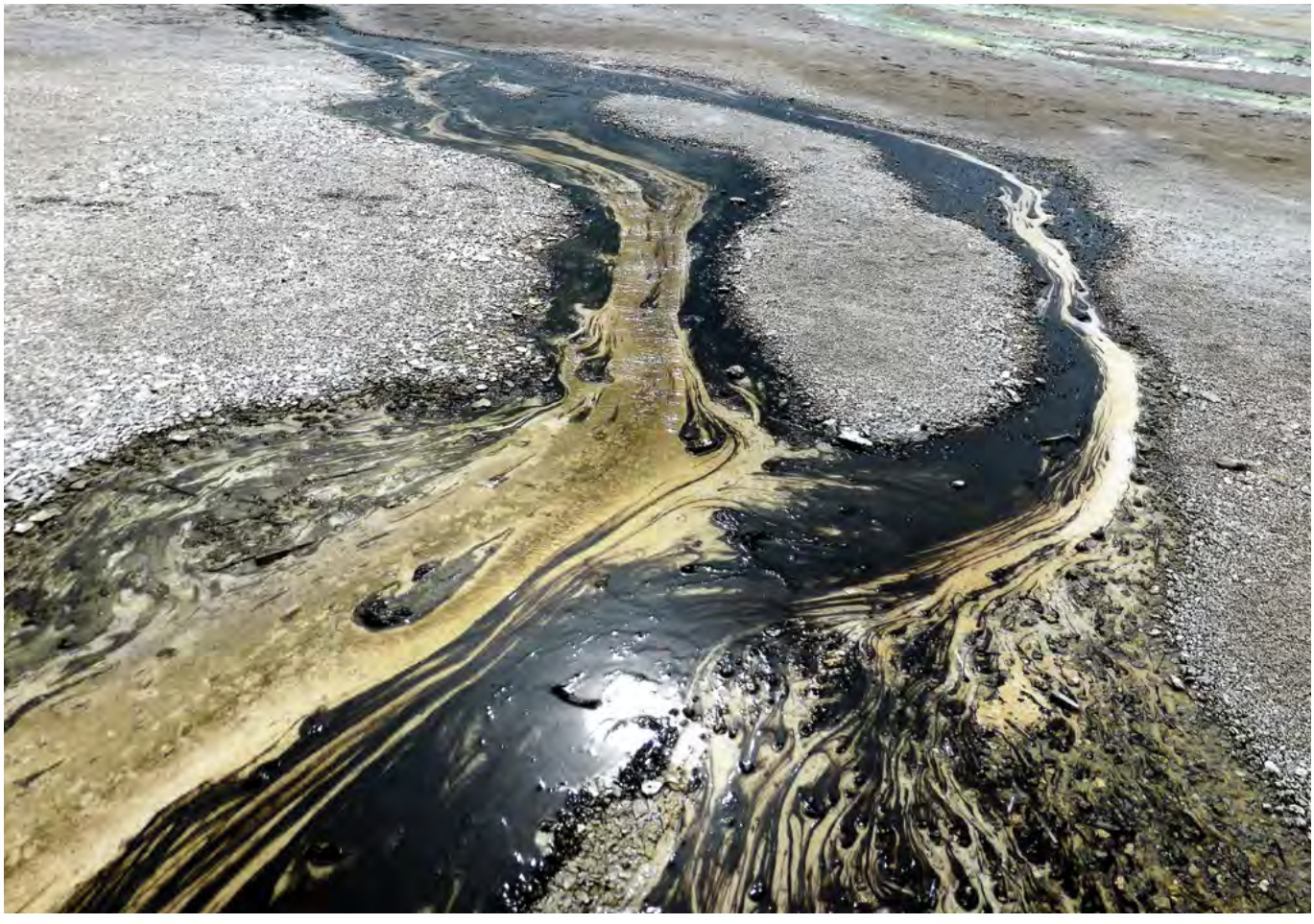
3.3) The Minamata Convention on Mercury; after conducting an analysis of Thailand's readiness for the implementation of the Minamata Convention, and from conducting a public forum, it was determined that Thailand should join in as a member of the Minamata Convention, in 2016, information was gathered for the accession of the Minamata Convention, and had requested for the approval of the subcommittee to implement the Minamata Convention. The subcommittee had given their approval, and had called for the implementation of the Convention under existing laws to support any implementation or actions required by the convention. The subcommittee had also requested for the approval of the accession of the Convention from the National Environmental Board and the Cabinet.

In 2016, relevant offices had resolved the problems of filing of complaints about environmental emergencies and accidents, by monitoring the causes of the problem, proposing ways to remedy the problem, and monitoring the source of pollution. There had also been the enforcement of laws to mitigate the hardship of the people from the problem of pollution continually.

Chapter 4

Emergencies and Pollution Accidents

Emergencies and Pollution Accidents



4.1 Emergencies and Pollution Accidents

There was a total of 86 occurrences of pollution accidents in 2016 (Table 4-1). Analyses revealed that most accidents occurred in industrial activities, chemical transportation, and in chemical storage. The provinces with the highest number of accidents were Rayong (14 times), Bangkok (10 times), Chon Buri (7 times), Samut Prakan (6 times), and Samut Sakhon (6 times). The site of accidents has often been industrial estate areas, where there was a large number of factories, and was provinces within the logistic routes of hazardous substances and petroleum. Examples of some of the types of accidents that occurred are shown in Table 4-2 and Figure 4-1.

Table 4-1 Pollution Accident Occurrences in 2016

Province	Types of causes/activities						
	industrial activities	chemical storage	chemical transport	illegitimate waste disposal	landfill fire	other	Total (cases)
Rayong	11	1	2	-	-	-	14
Bangkok	2	1	4	-	-	3	10
Chon Buri	2	2	3	-	-	-	7
Samut Prakan	3	1	2	-	-	-	6
Samut Sakhon	5	1	-	-	-	-	6
Phra Nakhon Si Ayutthaya	2	1	1	-	1	-	5
Prachinburi	3	-	-	-	2	-	5
Chachoengsao	-	-	2	2	-	-	4
Nakhon Pathom	2	-	1	-	-	-	3
Nakhon Ratchasima	-	-	3	-	-	-	3
Pathum Thani	2	-	-	-	-	-	2
Khon Kaen	1	-	-	-	-	1	2
Lamphun	-	-	2	-	-	-	2
Tak	-	-	-	-	1	1	2
Ratchaburi	-	1	-	-	-	-	1
Buri Ram	-	-	1	-	-	-	1
Sa Kaew	-	-	-	-	1	-	1
Phitsanulok	-	-	-	-	1	-	1
Trat	1	-	-	-	-	-	1
Surat Thani	1	-	-	-	-	-	1
Yala	1	-	-	-	-	-	1
Narathiwat	1	-	-	-	-	-	1
Nong Bua Lam Phu	1	-	-	-	-	-	1
Saraburi	-	1	-	-	-	-	1
Chanthaburi	-	-	1	-	-	-	1
Maha Sarakham	-	-	1	-	-	-	1
Nan	-	-	1	-	-	-	1
Uttaradit	-	-	1	-	-	-	1
Ubon Ratchathani	-	-	1	-	-	-	1
Total	**38**	**9**	**26**	**2**	**6**	**5**	**86**

Source: Information gathered from the Department of Disaster Prevention and Mitigation, the Department of Disease Control, and the Department of Pollution Control.

Table 4-2 Cases of Pollution Emergencies and Accidents by Type of Causes in 2016

Type	Details of Event
Industrial Activities	• Fire in factories, mostly in plastic factories, and paint mixing factories, where there is a high risk of fire hazard, explosion and fire of oil container and oil pipeline within petrochemical factories in Rayong and Samut Prakan. • The leakage of chemicals caused by the leakage of ammonia and chlorine used as coolants in frozen seafood factories.
Chemical Transport	• Oil transport truck tipping over in the Phaisan Sub District, Buri Ram Province, with over 10,000 L of benzene spilling into the public water source, causing the death of the fishes in the Phrik Creek over a distance of 8 kilometers. • The derailing of the oil transport train owned by PTT Public Company near the Nong Lom Railway Station, Lamphun, causing over 134,000 L of diesel to spill over, covering the Railway Station's floor, which had already been cleaned up. • The toluene transport truck tipping over, spilling into the sewage at the 18th kilometer of Bangna-Trad Road, with a small, controllable about of chemical entering the water source. • The formic acid transport truck tipping over on the Industrial Ring Road Bridge. • Leakage on the surface of Suksawat Exit on the elevated toll road, where the incident had been fixed by covering the road with sand, absorbing the chemicals and applying white cement before being transported for disposal.
Chemical Storage	• The fire of agricultural chemical storage warehouse in Ratchaburi and Samut Prakan. • The fire of a storage warehouse for recycled rubber and ready-made rubber in the Ban Bueng District area, Chon Buri. • The fire of the storage for the industrial waste of the General Environmental Conservation Public Company Limited, located in the Map Ta Phut Industrial Estate, Rayong.
Illegitimate Waste Disposal	• The illegitimate wastewater release into the public canal from a bicycle manufacturing factory in Chachoengsao. • Illegitimate waste disposal in the dirt pit of Moo 5, Ko Khanun, Phanom Sarakram, where acidic wastes were being transported from acidic vinegar manufacturing factories located in the industrial estate 304, Si Maha Phot District, Prachinburi, which consequentially were illegitimately disposed off in dirt pits.

Table 4-2 Cases of Pollution Emergencies and Accidents by Type of Causes in 2016 (continued)

Type	Details of Event
Landfill Fire	• In the Bang Rakam Subdistrict, Nakhon Luang District, Phra Nakhon Si Ayutthaya, which is a site withholding wastes from several offices in the area.
Other	• The leakage of fire extinguisher chemicals (pyrogen) occurred when staffs were changing the fire extinguishing system in the basement level of the headquarter of Siam Commercial Bank (Ratchayothin Road), causing the death of 8 people from suffocation and 7 injuries. • Antibacterial chemicals in swimming pools owned by the Khon Kaen Local Organization, which causes a spread of chemical vapors while mixing soda ash lite with water, causing 13 injuries from inhaling toxic gases. • The explosion caused by urea fertilizers used in the agricultural activities of longan orchards in the Baan Mae Yuab area, Ko Taphao, Tak, which were urea imported from China in a total of 2 bags of 100 kg per bag. Officers were able to control the fire with no injuries or life casualties. • A suspicious metal container with the radiation sign was left in an abandoned building in Soi Phahonyothin 24, Chatuchak, Bangkok. Officers from the Office of Atoms for Peace went in to investigate, and discovered that the container was an expired container for Iridium 192 (IR-192). The investigation was conducted using a radiation sensor, and did not discover any radiation leakage. The officers then collected the container to store at a safe zone.

Figure 4-1 Photos of Pollution Accidents

The explosion of the PTT Phenol plant in Rayong Province

Figure 4-1 Photos of Pollution Accidents (Continued)

Pyrogen leakage in the headquarter of Siam Commercial Bank (Ratchayothin Road) causing the death of staffs

Oil transport train tipping over at Nong Lom Railway Station in Lamphun Province

Illegitimate disposal of Iridium 192 container

The Pollution Control Department and all related offices in the network responsible for the management of chemical accidents had coordinated cooperation of various parties in monitoring and proposing academic recommendations to respond and settle any accidents quickly and efficiently, and controlling the impact in a limited area, as well as analyzing the situation to lay out the plan for collection, coordinate the remediation of the contamination to mitigate the effect on the environment and the community, including keeping watch of any environmental impact as necessary.

4.2 Pollution Complaints

The rapid growth and expansion of the economics, the society, and technology in urban areas, including business conduct with no concern for social and environmental responsibilities had inflicted inevitable effects of pollution on the people. Thus, filing complaints become the immediate reaction by the people when affected by pollution in order to communicate to the governmental offices, asking for rapid remediation to mitigate their distress. The government places great importance in trying to resolve any public distress, and therefore set up various channels for complaint services such as the public service center, a hotline, postal complaint filings, as well as electronic channels such as through email and website.

In 2016, the statistics of pollution complaints from various responsible offices such as the Bangkok Metropolitan Administration, the Department of Industrial Works, the Pollution Control Department, and the Public Service Center by the Office of the Permanent Secretary, Prime Minister Office, reported a total of 10,422 complaints, which had decreased by 9% from the previous year (Figure 4-2 and Figure 4-3).

The type of pollution problems that had received the amount of complaints in 2016 from all offices was air pollution (bad stench, dust and smoke), apart from Bangkok, whose most popular complaints were noise level and vibration. The Public Service Center, Office of the Permanent Secretary, Prime Minister Office had received the highest complaints on municipal solid wastes, sewage wastes, and hazardous wastes (Figure 4-3).

Figure 4-2 Statistics on Pollution Complaints in 2012-2016

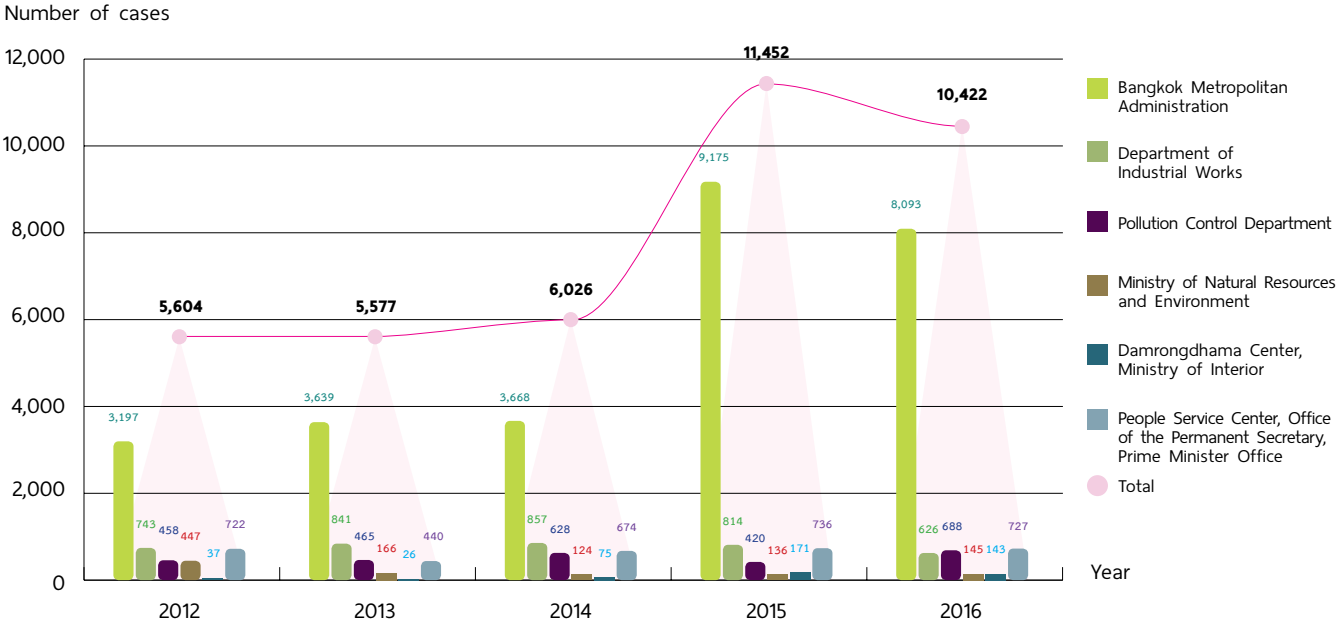
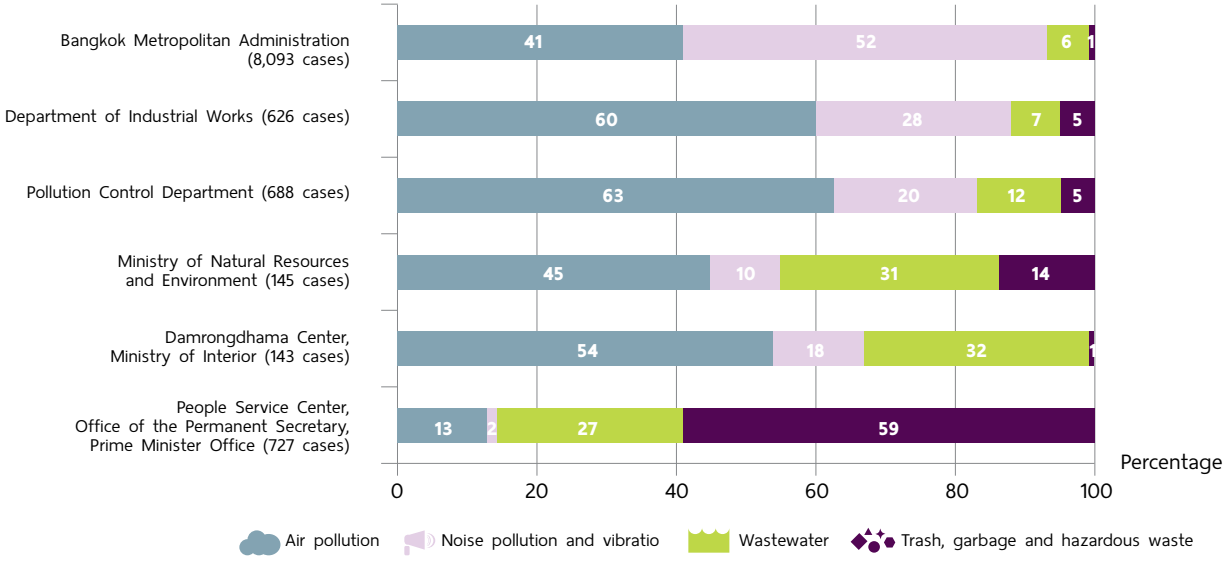


Figure 4-3 Proportion of the type of pollution problem in which complaints had been filed in 2016

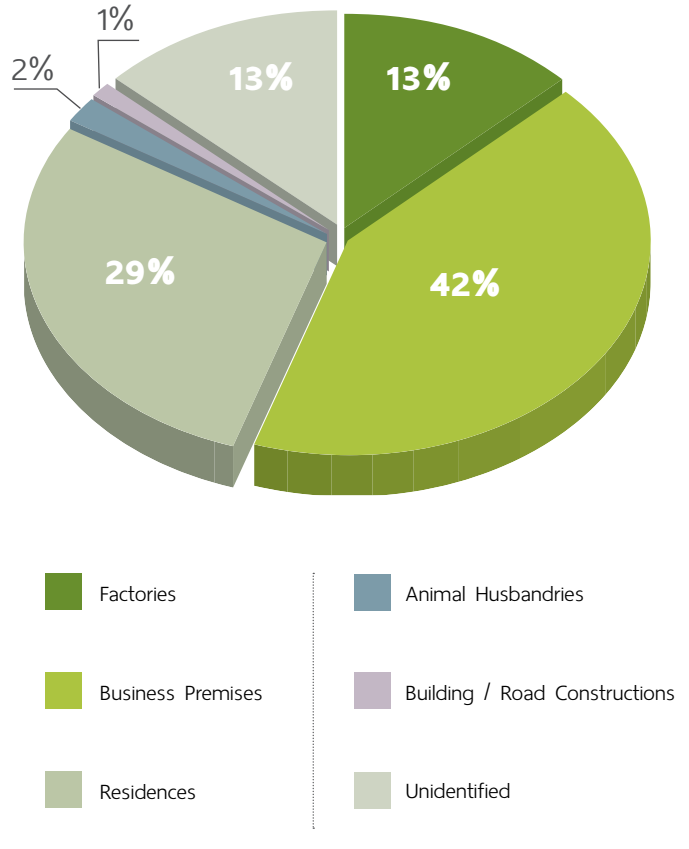


The statistics of pollution complaints filed in 2016 showed that the office with the highest number of complaints filed was the Bangkok Metropolitan Administration at 8,093 complaints, followed by the Public Service Center, Office of the Permanent Secretary, Prime Minister Office at 727 complaints, the Pollution Control Department at 688 complaints, the Department of Industrial Works at 626 complaints, the Ministry of Natural Resources and the Environment at 145 complaints, and the Damrongdhama Center, Ministry of Interior at 143 complaints respectively. The offices responsible had taken appropriate measures to investigate and resolve the pollution problems accordingly, and had managed to resolve 6,101 complaints (59%), leaving 4,321 complaints in the process (41%) (Table 4-3). For the overall picture of the sources of the problems, the top 3 sources were businesses (42%), residential area/building (29%), and industrial factories (13%) respectively (Figure 4-4).

Table 4-3 The progress report on resolving pollution complaints in 2016

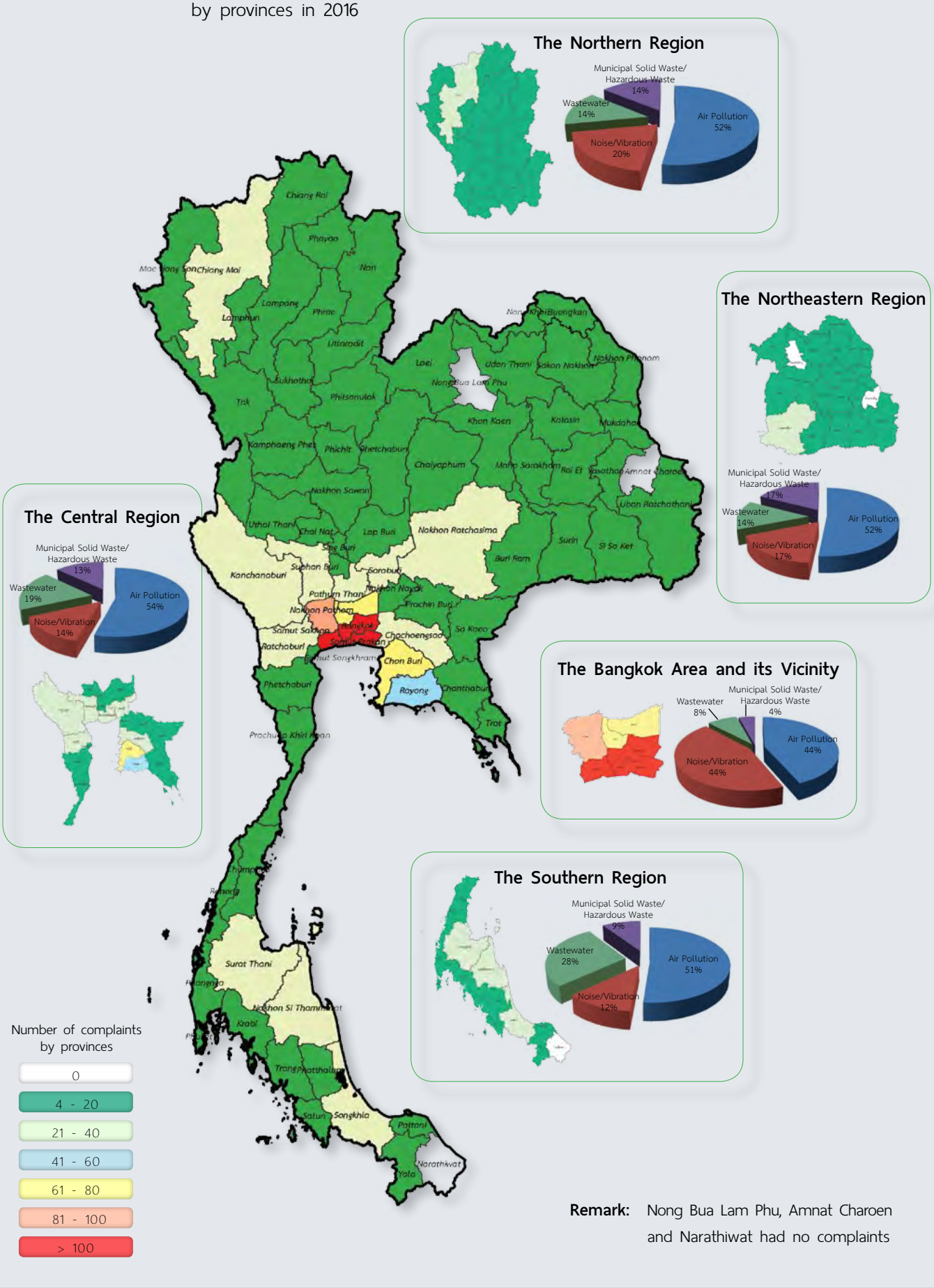
Agency	Number of cases	Operation results			
		Completed		Ongoing	
		Number	Percentage	Number	Percentage
Bangkok Metropolitan Administration	8,093	4,298	53	3,795	47
Department of Industrial Works	626	472	75	154	25
Pollution Control Department	688	550	80	138	20
Ministry of Natural Resources and Environment	145	29	20	116	80
Damrongdhama Center, Ministry of Interior	143	104	73	39	27
People Service Center, Office of the Permanent Secretary, Prime Minister Office	727	648	89	79	11
Total	**10,422**	**6,101**	**59**	**4,321**	**41**

Figure 4-4 The source of pollution with filed complaints in 2016



As for the information on pollution complaints by province, the province with the highest number of complaints was Bangkok at 9,385 complaints, which accounted for 90% of the total complaints filed, due to the Bangkok Area and perimeters being the central of Thailand's economic development, with numerous industrial activities, businesses, and urbanization (Figure 4-5).

Figure 4-5 The map of Thailand showing the number of pollution complaints by provinces in 2016



Remark: Nong Bua Lam Phu, Amnat Charoen and Narathiwat had no complaints

When considering pollution complaints by region, the distribution of the pollution complaints filed in each area was found to be as follow:

The Bangkok Area and its Vicinity	**Areas with high pollution complaints:** Bangkok, Samut Sakhon, Samut Prakan **Problem with the most complaints:** noise level and vibration
The Central Region	**Areas with high pollution complaints:** Chon Buri, Rayong, Phra Nakhon Si Ayutthaya **Problem with the most complaints:** air pollution
The Northern Region	**Areas with high pollution complaints:** Chiang Mai, Petchabun, Phitsanulok **Problem with the most complaints:** air pollution
The Northeastern Region	**Areas with high pollution complaints:** Nakhon Ratchasima, Khon Kaen, Buri Ram **Problem with the most complaints:** air pollution
The Southern Region	**Areas with high pollution complaints:** Nakorn Si Thammarat, Surat Thani, Songkhla **Problem with the most complaints:** air pollution

From analyzing the factors affecting the complaints filed, it was discovered that the pollution problem is mainly caused by unregistered businesses, resulting in unmonitored business operations and therefore a lack of information to thoroughly monitor the impact. Moreover, business owners often lack the sense of social impact responsibility, and does not place much importance on preventing and reducing negative impact to the health and well-being of the residents in the area. This causes substantial negative social impact to the people in the area, as well as the environment. Moreover, due to the various complaint system, the people can more conveniently file complaints and report to the responsible offices to be able to respond and resolve the problem promptly. However, in compiling the statistics on the pollution complaints, it was discovered that there are many overlapping data from several offices, as some people file multiple complaints to different offices in the same case.

In 2016, new tools and mechanisms were introduced to increase the efficiency of the country's pollution management, particularly monetary supports by means of integration will drive the collaboration of the governmental offices closer to the targeted goal. By applying strategic tools in issuing various laws and regulations to support the work of the government, in addition to compliment offices and organizations with good pollution management practices, the various stakeholder parties will be inspired to take better care of the environment.

Chapter 5

Pollution Management

Pollution Management

5.1 Important Pollution Management Tools and Mechanisms in 2016

5.1.1 The 12th National Economic and Social Development Plan (2017-2021)

The Office of the National Committee for Economic and Social Development had created the 12th National Economic and Social Development Plan (2017-2021) to prepare and install the necessary infrastructure to advance Thailand into a developed country with stability, prosperity, and sustainability by following the Sufficiency Economy Philosophy. On 13 September 2016, the Cabinet had approved the 12th National Economic and Social Development Plan, which contains 10 strategies with 2 strategies on pollution management, which is the 4th strategy on an environmentally-friendly growth for sustainable development, and the 9th strategy on the development of the various regions, the cities, and economic areas, with the goal of conserving and restoring natural resources and the environment in order to sustain an environmentally-friendly growth and the people's good quality of life. There are several key indicators that must be met such as at least 75% of the municipal solid waste must be treated properly and be reutilized, at least 30% of hazardous wastes in the community must be properly disposed of, all hazardous industrial wastes must be treated properly, restoring the surface water sources to good quality, and resolving the smoke and haze crisis and the problem of air quality in industrial areas and large cities.

5.1.2 Pollution Management Plan for (2017-2021)

The Ministry of Natural Resources and the Environment had created the Pollution Management Plan for (2017-2021) as a framework for defining the direction of the country's development goal for natural resources and the environment. On 21 September 2016, the National Environmental Board had given its approval of this plan, containing 4 strategies, 2 out of which are strategies on pollution management: 1) the 2nd strategy on managing good quality environment that is protected, rehabilitated and restored. This strategy focuses on the importance of preventing environmental problems at the source of origin, reducing waste generation at all stage, promoting recycling and waste reutilization, and creating a central management system for waste management, in addition to increasing the responsibility of producers to take part in their own product manufacturing process, managing any product waste efficiently. 2) The 3rd strategy, which focuses on increasing the efficiency of the usage of natural resources in a worthy and sustainable manner, in order to ascertain that all stakeholders are utilizing natural resources valuably, efficiently, and mitigating any potential environmental impact in order to allow for economic development on the bases of sustainable bio-resources.

5.1.3 The 20-Year Pollution Management Strategy and the Pollution Management Plan 2017-2021

The Ministry of Natural Resources and the Environment had created the 20-Year Pollution Management Strategy and the Pollution Management Plan 2017-2021 as a framework for defining the direction of the country's pollution management to be in-line with the roadmap for the country's development, and changing the domestic and international context. This is also to provide a guideline for promoting the engagement of all stakeholders in the country's development on the aspect of pollution management with a definite goal and direction. On 28 December 2016, the National Environmental Board had given its approval to the 20-Year Pollution Management Strategy, with goals in 3 phrases: Phase 1, in the first 5 years, is to improve the pollution management system, Phase 2, in year 10-15, is to produce and consume environmentally-friendly products on a daily-life basis, and Phase 3, in 20 years, to gear the country towards the direction of becoming a low carbon and zero waste society. The first 5 years is known as the Pollution Management Plan 2017-2021, which include 3 strategies: the 1st Strategy involves the prevention and reduction of pollution generation at the source of origin, with the goal of promoting business owners to use national resources responsibly and valuably, generating the least amount of pollutants, and adopting an environmentally conservative behavior, the 2nd Strategy involves increasing the efficiency of waste management and disposal, controlling pollution generated at source of origin, with the goal of reducing the release of pollution from the source of origin into the environment, and the 3rd Strategy, which involves the development of the pollution management system with the goal of improving the pollution management system to be more efficient. There are several environmental network members driving the effort for pollution management, which could cope with laws and regulations concerning commerce, investment, and the environment in the global stage.

5.1.4 The Master Plan on National Solid Waste Management (2016-2021)

The Ministry of Natural Resources and the Environment had created the Master Plan on Solid Waste Management (2016-2021). May 3rd, 2016 the Cabinet had given its approval, with the goal to reduce the generation of municipal solid waste or hazardous waste at the source of origin. By applying the 3Rs Strategy to reduce, reuse and recycle wastes at the source of origin will help reduce the manufacturing cost as well as reduce the amount of municipal solid waste. This is so that the waste management process of municipal solid waste is conducted in a sustainable way, promoting the disposal of municipal solid waste and hazardous waste at the central point, utilizing integrated technology and converting waste into energy in an appropriate way, which will also increase the sense of responsibility and engagement of all stakeholders in order to collaborate for the management of municipal solid waste and hazardous waste.

5.1.5 The Action Plan to Prevent and Solve Haze Problems in Northern Thailand 2016

The Ministry of Natural Resources and the Environment, in conjunction with the Ministry of Agriculture and Cooperatives, the Ministry of Interior, the Ministry of Public Health, the Ministry of Defence, the Ministry of Transport, the Ministry of Education, the Ministry of Foreign Affairs, the Ministry of Energy, and the Prime Minister's Office had created an action plan to prevent and solve haze problems in the northern region in 2016. March 1st, 2016 the Cabinet had given its approval for the action plan in order to provide a guideline for a preventive approach, preventing the burning and spread of fire beyond control, and to limit any potential casualty by gathering forces and resources from all parties, including the volunteer network, tools and equipment, in order to watch out for and prevent open burning and forest fires in high risk areas. This also includes educating the people and approaching communities to promote the engagement of the people and to ask for cooperation to help reduce open burning during the crisis period in 2016. Strict law enforcement will also be applied during haze and smoke crisis period, and any one not abiding by the law will be dealt with appropriately by adopting the "Single Command" approach with the governors of each province holding full authority. There are 9 targeted areas including Chiang Rai, Chiang Mai, Lamphun, Lampang, Phrae, Nan, Phayao, Mae Hong Son, and Tak.

พระราชบัญญัติ

ลมเด็จพระเจ้าอยู่หัวมหาวชิราลงกรณ บดินทรเทพยวรางกูร

5.1.6 The Maintenance of the Cleanliness And Orderliness of the Country Act (No. 2) B.E. 2560 (2017)

The Ministry of Interior had created the Maintenance of the Cleanliness And Orderliness of the Country Act (No. 2) B.E. 2560 (2017), which had been approved by the Cabinet on January 12th, 2016 declaring that the collection and disposal of sewage waste and municipal solid waste come under the responsibility of the local administrative office in each area. The Minister of Interior is to issue a ministerial regulation as follow: 1) set up specific fee for sewage and municipal solid waste management, 2) assigning the responsibility and the authority of Local Administrative Organizations concerning waste collection, transport and disposal, 3) those who wishes to conduct businesses around sewage and waste collection, transportation and disposal must apply for a license from the local administrator, 4) the Department of Local Administration has the duty to propose, advise and support the Local Administrative Organizations to conduct a plan for the Waste Management Project to be in-line with the provincial development plan, set up a budget for local administrative organization requiring budget support drawn from the National Budget, state the penalty under criminal law for those who conduct unauthorized business operations around waste collection, transportation and disposal, as well as for those who does not abide by the local law. This Act has been announced in the Royal Thai Government Gazette No. 134 Section 5A on 15 January 2560 (2017), and is effective from 16 January 2560 (2017) onward.

5.1.7 The Laws on Pollution as Announced in the Royal Thai Government Gazette B.E. 2559 (2016)

There are 17 subordinate legislations involved with pollution that had been announced in 2016 by various government offices as follow (Appendix F)

1) The Ministry of Natural Resources and the Environment

There are 11 subordinate legislations that had been issued by virtue of the Enhancement and Conservation of National Environmental and Quality Act B.E. 2535 (1992) as follow:

- Defining the area boundaries and the measures for environmental protection in Khura Buri District, Takua Pa District, Thai Mueang District, Thap Put District, Mueang Phang Nga District, Takua Thung District, and Ko Yao District in Phang Nga, B.E. 2559 (2016), where the area boundaries defined will have the responsibility to abide by the guidelines as stated by the law (No. 133 Special Section 76D, 31 March B.E. 2559 (2016))

- Defining the area boundaries and the measures for environmental protection in Ao Luek District, Mueang Krabi District, Nuea Khlong District, Khlong Thom District, and Ko Lanta District, Krabi, B.E. 2559 (2016), where the area boundaries defined will have the responsibility to abide by the guidelines as stated by the law (No. 133 Special Section 76D, 31 March B.E. 2559 (2016))

- Defining the type, the size, and the procedures for related projects or businesses that may be creating severe impact on the community both in environmental quality, natural resources, and health, in which case the government, state enterprises, or the private sectors must conduct an Environmental Impact Assessment Report (No. 4) B.E. 2559 (2016), in order to declare the type and size of the projects or business operations that must conduct such report, as well as the guidelines for the practice, as well as the instruction for writing the report that must be delivered by all parties (No. 133 Special Section 93 D, 22 April B.E. 2559 (2016)).

- Defining the standard values for smoke released from mechanic boats using compression-ignition engines to be announced that the smoke released shall not exceed the standard values (No. 133 Special Section 129 D, 6 June B.E. 2559 (2016)).

- Defining the standard for controlling waste water release from factories, industrial estates and industrial activities areas, in order to improve the standard for controlling industrial waste water release to be more applicable (No. 133 Special Section 129 D, 6 June B.E 2559 (2016)).

- Defining the guideline, the procedures, practice, and framework for conducting the preliminary environmental impact assessment report in protected areas such as Khura Buri District, Takua Pa District, Thai Mueang District, Thap Put District, Mueang Phang Nga District, Takua Thung District, and Ko Yao District in Phang Nga, B.E. 2559 (2016), in order to be announced and enforced in those areas (No. 133 Special Section 146 D, 30 June B.E. 2559 (2016))

- Defining the guideline, the procedures, practice, and framework for conducting the preliminary environmental impact assessment report in protected areas such as in Ao Luek District, Mueang Krabi District, Nuea Khlong District, Khlong Thom District, and Ko Lanta District, Krabi, B.E. 2559 (2016) in order to be announced and enforced in those areas (No. 133 Special Section 146 D, 30 June B.E. 2559 (2016)).

- Extending the period in which the announcement issued by the Ministry of Natural Resources and the Environment on defining the boundary for environmental protection in Bang Lamung District and Sattahip District, Chonburi, B.E. 2553 (2010) by 2 years from 31 July B.E. 2559 (2016) onwards (No. 133 Special Section 167 D, 28 July B.E. 2559 (2016)).

- Extending the period in which the announcement issued by the Ministry of Natural Resources and the Environment on defining the boundary for environmental protection in Phuket, B.E. 2553 (2010) by 2 years from 31 July B.E. 2559 (2016) onwards (No. 133 Special Section 167 D, 28 July B.E. 2559 (2016)).

- Extending the period in which the announcement issued by the Ministry of Natural Resources and the Environment on defining the boundary for environmental protection in Ban Laem District, Mueang Phetchaburi District, Tha Yang District, and Cha-Am District, Phetchaburi, Hua Hin District and Pran Buri District, Prachuap Khiri Khan, B.E. 2553 (2010) by 2 years from 31 July B.E. 2559 (2016) onwards (No. 133 Special Section 167 D, 28 July B.E. 2559 (2016)).

- Defining the type and size of projects or business that is obligated to conduct the environmental impact assessment report, as well as the guideline, the procedures, the regulations and the framework for conducting the report No. 9 (B.E. 2559 (2016)), adding on to the announcement by the Ministry of Natural Resources and the Environment on defining the type and size of projects or business that is obligated to conduct the environmental impact assessment report as well as the guideline, the procedures, the regulations and the framework for conducting the report on 24 April B.E. 2555 (2012) to be more applicable (No. 133 Special Section 274 D, 29 November B.E. 2559 (2016)).

There is 1 subordinate legislation that had been issued by virtue of the Industrial Products Standards Act, B.E. 2511 (1968) as follow:

- The Order of the Pollution Control Department on the guideline for inspecting industrial products B.E. 2558 (2015) to accommodate the practice of the announcement of the Ministry of Industry following the Industrial Products Standards Act, B.E. 2511 (1968) (No. 133 Special Section 1 D, 5 January B.E. 2559 (2016)).

2) The Ministry of Transport

There are 2 subordinate legislation that had been issued by virtue of the Navigation in the Thai Waters Act, B.E. 2456 (1913), as follow:

- Regulations for boat inspection, defining the guideline, procedures and conditions for issuing licenses on pollution from sewage waste B.E. 2559 (2016), in order to define the guideline, procedures and conditions for issuing licenses on pollution from sewage waste (No. 133 Section 99 A, 30 November B.E. 2559 (2016))

- Regulations for boat inspection, defining the guidelines and conditions for boat inspection to prevent pollution from waste, B.E. 2559 (2016) to provide the guideline for boat inspection to prevent pollution from waste (No. 133 Section 99 A, 30 November B.E 2559 (2016)).

3) The Ministry of Industry

There are 3 subordinate legislation that had been issued by virtue of the Factory Act, B.E. 2535 (1992), as follow:

- The ministerial regulations controlling soil and groundwater contamination inside factory areas B.E. 2559 (2016) to protect personal security and the quality of the environment, where the owner of all 12 types of factories must conduct a quality assessment and management of soil and groundwater contamination, to keep the values within the standard range for soil and ground water contamination (No. 133 Section 38 A, 29 April B.E. 2559 (2016)).

- The ministerial regulations No. 25 (B.E. 2559 (2016)) issued by virtue of the Factory Act, B.E. 2535 (1992) to define the guidelines for the prohibition of the construction or expansion of the category 3 factories of certain type or size in the proximity of a public water source, or within the proximity of unsuitable location or environment. Authority is also given to the Minister to issue an order for the category 3 factories of certain type or size to provide appropriate environment in order to prevent problems concerning security and the environment (No. 133 Section 113 A, 30 December B.E. 2559 (2016))

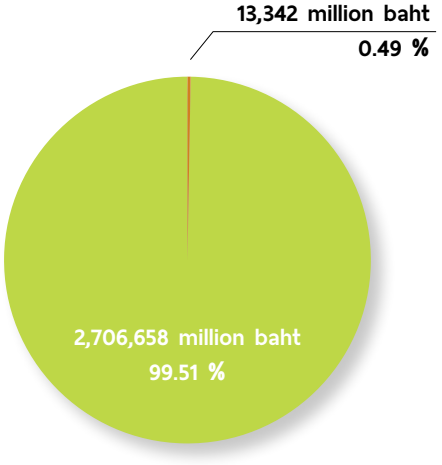
- The announcement of the Department of Industrial Works on the type of report on the type and amount of pollutants released from factories, B.E. 2559 (2016), to define the type of reports for the release of pollutants from factories in order to monitor the release of pollutants from factories (No. 133 Special Section 48 D, 25 February B.E. 2559 (2016)).

5.1.8 The Engagement of the People

Today, the public sector place great importance on engaging the people with the activities run by the government, by providing a channel for the people to report facts, comments, and recommendations, as well as engaging them in the decision making process of various policies, planning, projects, and works, in order to provide the government with valuable insights to further develop various governmental activities through various channels such as conducting a survey, setting up public forum, opening up websites to collect comments and opinions, setting up working committees with members from the public, etc. Efforts had also been made to promote the people to join in collaborative networks to watch out for and report any clues or activities in their local areas, which provide an opportunity for the people to be more engaged in the process, increasing the public confidence that their contributions, opinions and needs were accounted for in the government's working process. Moreover, the government had issued the Licensing Facilitation Act B.E. 2558 (2015) as a mean to provide a more convenience public service to the people, increasing the efficiency of governmental service works, as well increasing the transparency of the officers' working process, while also keeping the public involved in the government's work process.

5.2 Budget for Pollution Management

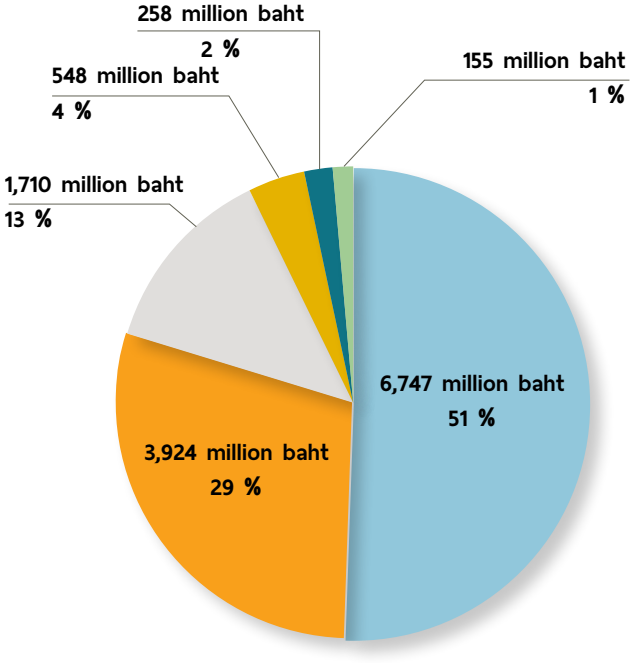
The total National Budget allocated for 2016 was 2,720,000 million baht, where 13,342 million baht was allocated for the country's management of pollution and the environment, which is 0.49% of the total national budget, increased by 0.13% from 2015 (2015 at 0.36%) under the strategy for national budget allocation, which include 6 strategies as follow: 1) the strategy for the management of natural resources and the at 6,747 million baht, 2) the strategy for management with efficiency and good governance at 3,924 million baht, 3) the strategy for education, health, virtue, ethics and quality of life at 1,710 million baht, 4) the strategy for restoring confidence and mobilizing the establishment of good foundation for the country at 548 million baht, 5) the strategy for the development of economic growth with stability and sustainability at 258 million baht, and 6) the strategy for the development of science, technology and at 155 million baht (Figure 5-1), where the allocation of such budget will be used for the prevention, control, and solving pollution problem by various offices, both from the central government, the local administration, and the engagement of both the public and private sectors and communities.



▼ Management of natural resources and environment budget

Figure 5-1 The proportion of environmental budget allocation under the National Budget Allocation Strategy 2016

Source : Collected from the documents on the annual budget allocation for the Fiscal Year 2016, the Bureau of the Budget, the Prime Minister's Office

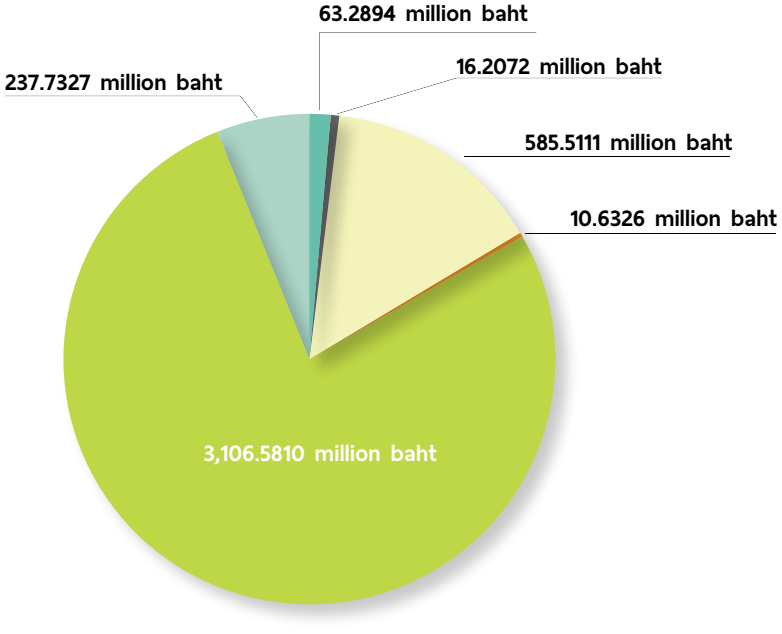


1) Management of natural resources and environment strategy
2) Good governance management strategy
3) Education, public health, virtue, ethics, and quality of life strategy
4) Restoring confidence and mobilizing the establishment of good foundations for the country budget strategy
5) Building sustainable and fair economic growth strategy
6) Development of science, technology and innovation strategy

The Fiscal Year 2016 was the year where the budget allocation was starting to be considered in an integrated manner, to drive the work and efforts of various offices and ministries to be in line of the governmental policy. An integrated plan had been set to support 19 urgent key policies, with 6 integrated plans related to the management of pollution and the environment, with a total budget of 4,019.954 million baht (Figure 5-2), which is divided across various offices according the strategic budget allocation plan for the Fiscal Year 2016 as follow:

▲ The work plan for preparing Thailand's readiness for AEC	63.2894	million baht budget
▲ The work plan for the promotion of Research and Development	16.2072	million baht budget
▲ The work plan for the Management of Waste and the Environment	585.5111	million baht budget
▲ The work plan for IT and Communication Development	10.6326	million baht budget
▲ The work plan for Water Resource Management	237.7327	million baht budget
▲ The integrated plan for promoting the distribution of power to local administrative organizations to manage the provincial environmental quality	3,106.5810	million baht budget

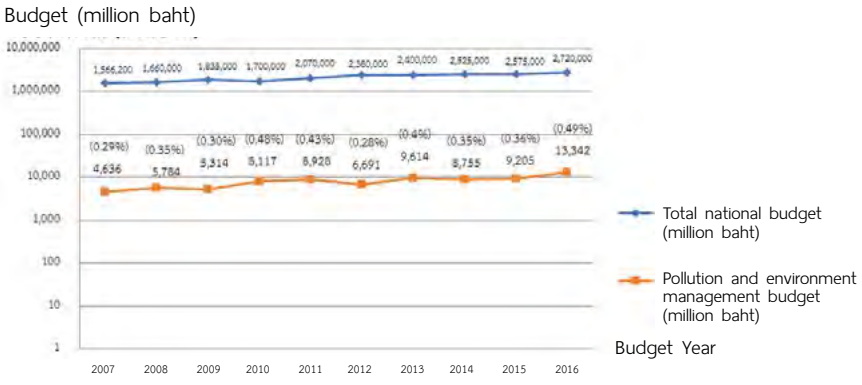
Figure 5-2 The proportion of expenses for the Fiscal Year 2016 related to the management of pollution and the environment divided by integrated work plan



Source : a collection of budget and expenses documents for the fiscal year 2016, the Bureau of Budget, Prime Minister's Office

In the past 10 years, from the fiscal year 2007-2016, the total national budget had increased from 1,566,200 million baht to 2,720,000 million baht, increased by 74%, however, the proportion of budget allocation for the country's management of pollution and the environment had been quite stable at 0.28 – 0.49%, or an average of 0.37% of the total national budget, which is still a small portion (Figure 5-3), while the country's problem of pollution and the environment is deteriorating with greater severity. As a result, efforts to the resolve the problem cannot be carried out promptly.

Figure 5-3 The budget for the management of pollution and the environment compared to the national total budget for the fiscal year 2007-2016

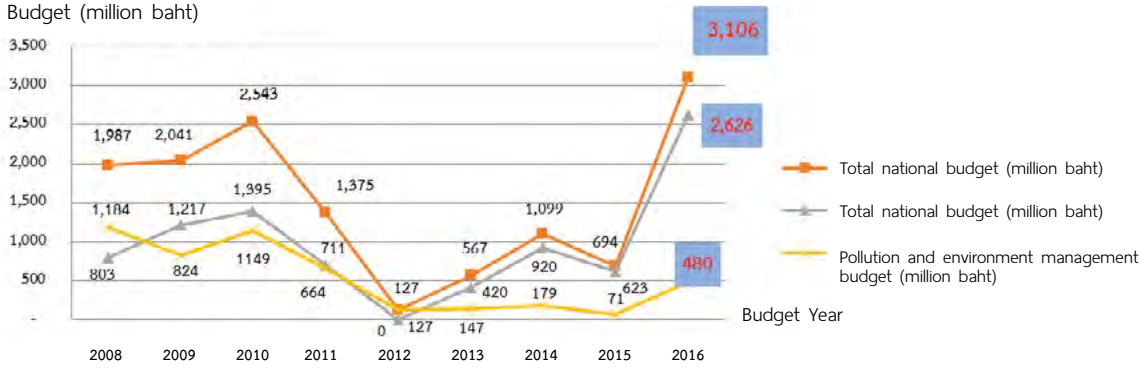


Source : a collection of the budget and expense documents from the fiscal year B.E 2559 (2016), the Bureau of Budget, Prime Minister's Office

The budget allocated as subsidies to local administrative organizations to conduct waste and sewage management projects according to the provincial action plan for environmental quality management was 3,106 million baht, in which 2,626 million baht was divided across 73 projects related to waste management, and 480 million baht was divided across 23 projects related to sewage management.

From the fiscal year 2008-2016, a total of 13,539 million baht budget was allocated towards the management of municipal solid waste and sewage, under the provincial action plan for environmental quality management. Out of which, 8,715 million baht was allocated towards waste management projects, and 4,825 million baht was allocated towards sewage management. During the fiscal year 2008-2016, the budget allocation in this area had increased, and decreased during the fiscal year 2011-2012, before gradually increasing in 2013-2014, and decreased again in 2015. The budget allocation increased to its highest in the fiscal year 2016, with the influence of the roadmap for the management of municipal solid waste and hazardous waste, which had been approved by the National Council for Peace and Order on August 26th 2014, which had considered the allocation of (additional) budget through the action plan for provincial environmental quality management 2016 (Figure 5-4).

Figure 5-4 The budget for the management of waste and sewage under the action plan for provincial environmental quality management 2008-2016



Source: a collection of budget and expenses documents from the fiscal year 2016, the Bureau of Budget, Prime Minister's Office

5.3 The Policy Proposal

The overall picture of the country's state of pollution in 2016 for each type of pollution had begun to improve, with various stakeholder parties giving their cooperation to follow the policy proposal made in 2015. In managing pollution problem, in water pollution, air pollution, hazardous waste, and hazardous substances, the key points can be summarized as follow:

Air Pollution Management: aimed towards resolving the problem of air pollution in crisis area by controlling values to be within standard values. The government and the Ministry of Energy had promoted the usage of eco-friendly vehicles and eco-friendly fuel. However, the amount of car usage are still high, which affect traffic conditions, resulting in air pollution in some area. As such, driving various supportive measures in other areas still could not yield tangible results, such as utilizing the result of pollution monitoring activities and applying it to the annual license plate renewal, defining the vehicle usage lifetime, and excising tax on old car. For controlling air pollution from the industrial sector, measures are being drafted to consider pollution loading, particularly with VOCs in industrial areas, including the measures to support the development plan and governmental policy, such as the measure to control polluted air from waste power plant, particulate matters ($PM_{2.5}$), and measures to accommodate the reception of cross-border pollution from logistic activities.

Water Quality Management: running campaigns to promote the community and business owners residing along the waterfront to help safeguard the water sources, not dumping waste or sewage into the water source. However, this campaign had yet to succeed. Only a few number of new water treatment plants had been installed as local administrative organizations lack the budget to build and maintain the system effectively, which also include collecting fees for waste water treatment. Many businesses also does not treat waste water before releasing it back into the environment, however, there had been support provided with issued guidelines and regulations to allow for the reutilization of treated water, particularly the reutilization of industrial waste water in the agriculture sector. Data had been collected to revise and improve the quality of water sources, including the standards for waste water, taking into consideration the amount of nutrients (Nitrate and Phosphate), in order to prevent the spread of water hyacinth and other water weeds, including the red sea phenomena.

Management of Municipal Solid Wasate, Hazardous Waste, and Hazardous Substances Today, all stakeholders are using the masterplan for the national waste management (B.E. 2559 – 2564) (2016 – 2021), which is the main framework for implementation, causing a more effective mean of managing waste at the source of origin, from reducing and sorting waste down to waste collection, transportation and disposal. The Maintenance of the Cleanliness And Orderliness of the Country Act (No. 2) B.E. 2560 (2017) had also been issued, giving local administrative organizations the authority to assume the role of waste management. The Ministry of Interior is also allowed to set up a budget and issue ministerial legislations to set and collect waste management fees. However, the issuance of the Act for the Management of Waste from Electrical and Electronic Equipment (WEEE) and from other products to increase the efficiency of the management of hazardous wastes in communities is still progressing slowly, as well as the issuance of the guidelines for managing municipal solid waste and hazardous waste to make sure that all conducts of waste management are proper conducts and follow the academic guideline. For managing and controlling hazardous chemicals under the Stockholm Convention on the long-term accumulation of pollutants in 2016, 3 types of pollution that shall be controlled by the Hazardous Substances Act B.E. 2535 (1992) had been added (HCBD, PCNs and the Esters of PCP).

Spatial Pollution Management: preventive and remediation measures had been set for illegitimate disposal and management of hazard industrial waste and infectious waste for B.E. 2560-2564 (2017-2021), and had been proposed to the National Environmental Board, targeting high risk area and activities. In preparing for the development area outlined by the governmental policy, such as the special economic zone along the borders, where rules will be applied for the control of hazardous waste import-export. However, these rules had still yet to take into consideration the various types and number of factories or businesses that would emerge in vicinity areas, as well as the combined waste collection of local administrative organization. From analyzing the state of pollution, the challenges, and the key factors affecting the implementation pollution management measures in the past, the following policy proposal for pollution management had been made for the year 2017:

5.3.1 Management of Air Quality and Noise Level

1) Accelerate the definition of control standards for the release of air pollution from new cars to meet the EURO 5/EURO 6 standard sooner, so that less air pollution will be released from cars, which would help control the amount of air pollution from the increasing number of cars owned each year, which also affect traffic conditions, and thus, contributing to the air pollution problem in some area. This would also create a positive impact on the development of car engine technology and fuel efficiency, uplifting the standard of cars manufactured in Thailand to be among the world's leading manufacturers.

2) Incorporating the results from monitoring vehicles' pollution values as a condition for cars' and motorcycles' annual license plate renewal, and placing more importance on car maintenance efforts throughout the usage lifecycle, and creating a linked database system between the annual license plate renewal authority, and the annual car inspection office, as well as any organization authorized to conduct car inspection, detection, and prohibition.

3) Carry on continuous efforts in improving the atmospheric air quality standards, and the standard for controlling the release of pollution from the source of origin, taking into consideration the capacity for accommodating pollutants in each area, or the accumulative amount of pollution.

5.3.2 Water Quality Management

1) Submit a proposal to the government to collect water conservation fee from all users, by incorporating the fee into the water bill. Such fees will be collected from community activities, agricultural activities, and industrial activities, where water is used for their benefit, and in which waste water is generated by incorporating the Polluter Pays Principle (PPP), and the Beneficiary Pays Principle (BPP) or, "the water user pays". Part of the income on this part will be used towards effective management of water and the environment, including the construction of a central water treatment system.

2) The Maintenance of the Cleanliness And Orderliness of the Country Act B.E. 2560 (2017) should be revised and improved to include the management of municipal waste water, to assign the local administrative organization the role of setting up the collection and treatment of municipal waste water in a collective manner. The Ministry of Interior can set up a budget for the construction directly, and can issue a ministerial legislation on setting a central water treatment service fee to issue a local ordinance for fee collection, which will overall increase the efficiency of waste water management.

3) Consider adjusting the law or the regulations related to the recycling of water from businesses, or the reutilization of treated water in an alternative business activity.

5.3.3 Management of Municipal Solid Waste and Hazardous Waste

1) Set up a new central database for the country's municipal solid waste to make sure that all offices have access to the same information to be used for the planning and implementation of municipal solid waste management.

2) Accelerate the issuance of the Act for the Management of Waste from Electrical and Electronic Equipment (WEEE) and other products so that the tools and mechanisms for the overall hazardous waste management become available.

3) Pushing for the measures to reduce the use of plastic bags and foam containers, which contribute to both surface waste problem, waste problems in both surface water and the sea, inflicting negative environmental impact, affecting both human, animals, the ecosystem, and the beautiful landscape in the area, particularly in natural tourist sites, as these are non-biodegradable materials that often accumulate in the environment for a long period of time. The efforts to control the usage of these materials may include limiting the amount of usage, the amount of service provided, and the amount of trade of plastic bags in department stores, supermarkets, and convenience stores, issuing a rule to restrict the usage of plastics in certain areas such as in national parks, as well as reducing unnecessary use of plastics in packaging or limited the size of containers to be suitable for use.

In 2016, several stakeholders in different fields had been rewarded by the governmental office to inspire and promote the people, the public sector and private sector to become more environmentally-friendly in their conducts and operations, as well as taking a more engaging part in taking care of the environment in conjunction with a sense of responsibility from business owners as follow:

1. Agriculture Sector

1.1 The Open-Burning Free Community Award by the Department of Agricultural Extension, to stimulate the consciousness of farmers to refrain from open burning in agricultural areas.

1.2 The Eco-Friendly Farm Award by the Department of Livestock Development to promote eco-friendly livestock farming practices that does not cause environmental pollution.

2. Community Sector

2.1 The Zero Waste Community and the Zero Waste School Award by the Department of Environmental Quality Promotion to promote the community, schools, and local administrative organizations to reduce and sort wastes generated from source to be reused by adopting the 3R concept.

2.2 The Volunteer for Natural Resources and Environmental Management by the Department of Environmental Quality Promotion to create the best volunteer network for municipal waste management and a rising star at the national level.

2.3 The Care for Global Warming Municipal Award by the Thailand Greenhouse Gas Management Organization (Public Organization) for stimulating the local administrative organization to reduce greenhouse gases and to move closer towards becoming a Low-Carbon City.

3. Tourism Sector

3.1 The Thailand Tourism Awards by the Tourism Authority of Thailand to promote business owners and Tourist Sites Management to use natural resources efficiently and valuably, and to adopt good environmental management practices.

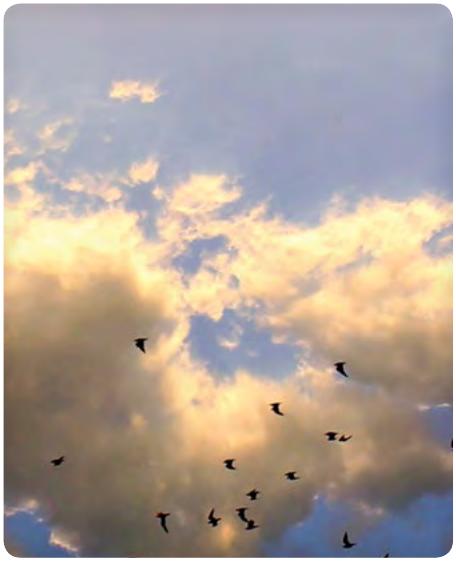
3.2 The Environmental-Friendly Service Award for Green Hotel at Gold Class Level by the Department of Environmental Quality Promotion to enhance the service standard and the hospitality business operation to be more environmentally friendly.

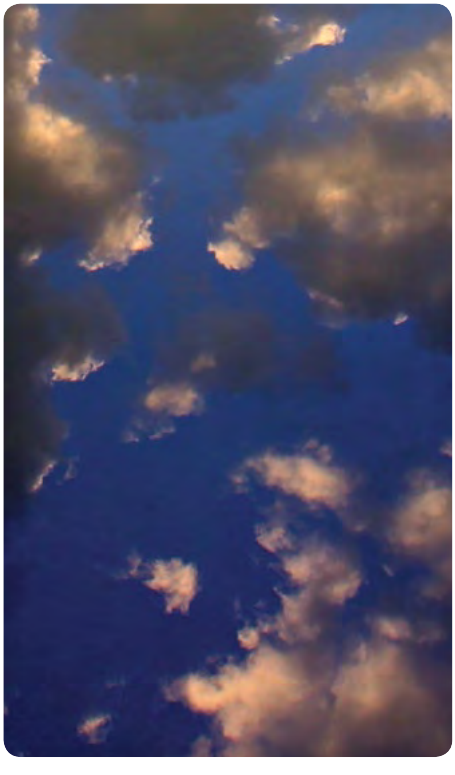
4. Industrial Sector

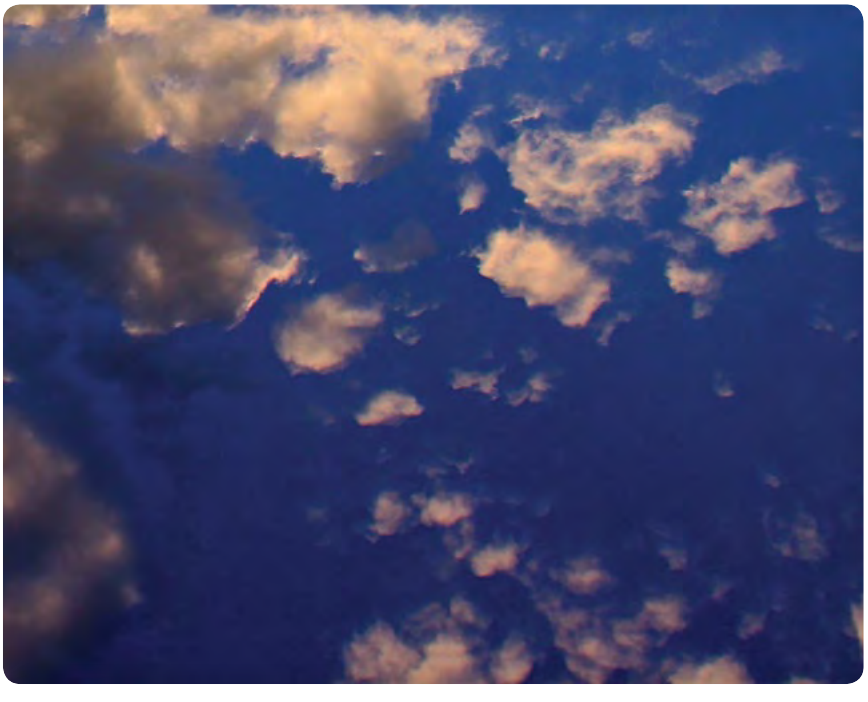
4.1 Giving awards to promote business owners to put in place good environmental management practice, adopting an environmentally friendly production process, and to promote business partners and trade partners to adopt the Green Industry Process as follow:

- The Best Industry Award by the Ministry of Industry
- The Level 5 Green Industry Award by the Department of Industrial Works
- The Eco-Industrial Estate and Good Environmental Governance (White Flag Green Star), by the Industrial Estate Authority of Thailand

4.2 The EIA Monitoring Award, given to business owners who follows the environmental measures outlined in the EIA Report, who acts as a role model for other business owners, by the Office of Natural Resources and Environmental Policy and Planning, for example in transportation projects, petrochemical, energy, industry, mines, and for public service and residential areas.







Appendix

Appendix A

Air Quality

Monitoring Results

Table A-1 Air quality from air monitoring stations in general areas of Bangkok by station, 2016

Station	Sulfur Dioxide (SO_2)				Nitrogen Dioxide (NO_2)				Carbon Monoxide (CO)							Ozone (O_3)						Particules less than or equal to 10 micrometers indiameter (PM_{10})				Particules less than or equal to 2.5 micrometers indiameter ($PM_{2.5}$)			
	1-hour average (ppb)			Average	1-hour average (ppb)			Average	1-hour average (ppm)			8-hour average (ppm)			Average	1-hour average (ppb)		8-hour average (ppm)		Day > std.	Average	24-hour average (µm/m3)			Average	24-hour average (µm/m3)			Average
	Max	Min	Time > std.*	1 Year	Max	Min	Time > std.	1 Year	Max	Min	Time > std.	Max	Min	Time > std.	1 Year	Max	Min	Max	Min		1 Year	Max	Min	Time > std.	1 Year	Max	Min	Time > std.	1 Year
Hiran Ruchi, Thon Buri District	16	0	0/5397	1	78	0	0/1138	17	4.80	0.00	0/3621	3.30	0.00	0/3558	0.56	102	0	79	0	1/152	17	98	16	0/198	40	#	#	#	#
Samae Dam, Bang Khun Thian District	#	#	#	#	124	0	0/7106	16	3.10	0.00	0/7201	1.81	0.00	0/7509	0.47	135	0	115	0	13/316	20	152	10	2/314	42	#	#	#	#
Bang Na, Bang Na District	16	0	0/4436	2	86	0	0/4702	13	2.50	0.00	0/5182	1.91	0.09	0/5421	0.51	130	0	96	0	7/217	16	85	15	0/222	38	75	9	16/190	28
Khlong Chan, Bang Kapi District	#	#	#	#	96	0	0/7737	19	#	#	#	#	#	#	#	150	0	114	1	27/318	27	118	11	0/307	38	#	#	#	#
Din Daeng, Din Daeng District	15	0	0/6015	2	118	3	0/5812	26	3.90	0.00	0/6462	2.80	0.04	0/6727	0.96	152	1	104	1	10/257	17	107	9	0/303	33	#	#	#	#
Chong Nonsi, Yan Nawa District	12	0	0/4409	1	111	4	0/5011	27	3.60	0.00	0/6244	2.86	0.00	0/6496	0.70	123	0	82	0	7/210	15	116	12	0/277	42	#	#	#	#
Sam Sen Nai, Phaya Thai District	#	#	#	#	92	0	0/8332	16	2.70	0.00	0/8364	1.91	0.15	0/8726	0.75	133	0	100	0	14/366	21	108	14	0/359	36	64	8	5/348	23
Wang Thonglang, Wang Thonglang District	16	0	0/7654	2	105	0	0/7643	16	#	#	#	#	#	#	#	151	0	112	0	32/343	23	120	12	0/330	38	95	5	33/318	27
Standards	300			40	170			30	30			9			-	100		70			-	120			50	50			25

Remarks
* : *Number of times pollution exeeded the standard / Number of times pollution measurement performed*
\# : *No monitoring performed*

Table A-2 Air quality from air monitoring stations in roadside areas of Bangkok by station, 2016

Station	Sulfur Dioxide (SO_2)				Nitrogen Dioxide (NO_2)				Carbon Monoxide (CO)							Ozone (O_3)						Particules less than or equal to 10 micrometers indiameter (PM_{10})				Particules less than or equal to 2.5 micrometers indiameter ($PM_{2.5}$)			
	1-hour average (ppb)			Average	1-hour average (ppb)			Average	1-hour average (ppm)			8-hour average (ppm)			Average	1-hour average (ppb)		8-hour average (ppm)		Day > std.	Average	24-hour average (µm/m3)			Average	24-hour average (µm/m3)			Average
	Max	Min	Time > std.*	1 Year	Max	Min	Time > std.	1 Year	Max	Min	Time > std.	Max	Min	Time > std.	1 Year	Max	Min	Max	Min		1 Year	Max	Min	Time > std.	1 Year	Max	Min	Time > std.	1 Year
Rama IV Rd., Pathum Wan District	#	#	#	#	#	#	#	#	3.70	0.40	0/4699	3.03	0.60	0/4684	1.39	#	#	#	#	#	#	131	50	2/76	79	#	#	#	#
Intharaphithak Rd., Thon Buri District	21	0	0/4384	2	106	0	0/4381	19	4.30	0.00	0/4264	2.73	0.00	0/4429	0.83	96	0	70	0	0/227	15	106	10	0/214	41	81	9	22/188	29
Ladprao Rd., Wang Thonglang District	18	0	0/1659	3	N/A	N/A	N/A	N/A	4.30	0.20	0/288	2.83	0.53	0/296	1.89	62	2	54	3	0/72	15	34	12	0/72	21	#	#	#	#
Din Daeng Rd., Din Daeng District	18	0	0/6741	1	111	5	0/6144	34	5.10	0.00	0/6669	3.34	0.00	0/6860	1.12	115	0	60	0	2/290	10	156	26	11/308	62	103	20	37/134	43
Standards	300			40	170			30	30			9			-	100		70			-	120			50	50			25

Remarks
* : *Number of times pollution exeeded the standard / Number of times pollution measurement performed*
\# : *No monitoring performed*
N/A : *Not functioning properly*

Table A-3 Air quality from air monitoring stations in Bangkok and its vicinity, 2016

Province	Station	Sulfur Dioxide (SO_2)				Nitrogen Dioxide (NO_2)				Carbon Monoxide (CO)							Ozone (O_3)						Particules less than or equal to 10 micrometers indiameter (PM_{10})				Particules less than or equal to 2.5 micrometers indiameter ($PM_{2.5}$)			
		1-hour average (ppb)			Average	1-hour average (ppb)			Average	1-hour average (ppm)			8-hour average (ppm)			Average	1-hour average (ppb)		8-hour average (ppm)		Day > std.	Average	24-hour average (µm/m3)			Average	24-hour average (µm/m3)			Average
		Max	Min	Time > std.*	1 Year	Max	Min	Time > std.	1 Year	Max	Min	Time > std.	Max	Min	Time > std.	1 Year	Max	Min	Max	Min		1 Year	Max	Min	Time > std.	1 Year	Max	Min	Time > std.	1 Year
Samut Prakan	Song Khanong, Phra Pradaeng District	23	0	0/3972	3	80	0	0/3787	14	2.20	0.00	0/3974	1.73	0.00	0/4149	0.54	121	0	88	0	10/174	21	102	18	0/170	46	69	8	11/168	25
	Bang Prong, Muang District	22	0	0/3780	7	161	0	0/6386	20	4.50	0.00	0/7132	1.75	0.00	0/7131	0.44	158	0	132	4	32/290	31	84	11	0/121	33	#	#	#	#
	Talat, Phra Pradaeng District	27	0	0/7661	4	123	0	0/8393	13	4.80	0.00	0/8331	1.91	0.00	0/8725	0.47	174	0	102	0	33/359	23	105	12	0/366	34	#	#	#	#
	Talat, Muang District	33	0	0/6138	5	107	1	0/5018	26	3.20	0.00	0/5925	2.50	0.10	0/6100	0.91	81	0	61	2	0/77	15	115	26	0/240	53	#	#	#	#
	Bang Sao Thong, Bang Sao Thong District	19	0	0/3128	1	131	0	0/3800	18	3.35	0.00	0/5124	3.07	0.00	0/5314	0.60	211	0	152	1	68/346	31	131	13	0/331	40	#	#	#	#
Pathum Thani	Khlong Nueng, Khlong Luang District	12	0	0/2026	2	131	1	0/2234	25	1.90	0.10	0/1644	1.64	0.10	0/1699	0.81	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	#	#	#	#
Samut Sakhon	Om Noi, Krathum Baen District	115	1	0/8350	8	100	0	0/8191	11	3.10	0.20	0/6851	2.44	0.28	0/7117	0.93	107	0	89	2	13/346	18	117	11	0/322	36	#	#	#	#
	Maha Chai, Muang District	39	0	0/5407	3	168	0	0/5427	9	#	#	#	#	#	#	#	120	0	103	0	13/260	22	157	11	13/284	50	113	4	33/206	33
Nonthaburi	Bang Kruai, Bang Kruai District	14	0	0/6622	2	88	0	0/8261	14	3.90	0.00	0/8026	2.34	0.00	0/8243	0.62	147	0	105	0	15/210	27	110	19	0/365	41	#	#	#	#
	Bang Phut, Pak Kret District	28	0	0/8110	3	62	0	0/5427	18	2.80	0.10	0/8055	2.41	0.16	0/8401	0.56	109	0	78	1	2/217	19	126	25	2/317	56	#	#	#	#
	Standards	300			40	170			30	30			9			-	100		70			-	120			50	50			25

Remarks
* : *Number of times pollution exeeded the standard / Number of times pollution measurement performed*
\# : *No monitoring performed*
N/A : *Not functioning properly*

Table A-4 Air quality in provincial areas by monitoring station, 2016

Region	Station	Sulfur Dioxide (SO_2)				Nitrogen Dioxide (NO_2)				Carbon Monoxide (CO)							Ozone (O_3)						Particules less than or equal to 10 micrometers indiameter (PM_{10})				Particules less than or equal to 2.5 micrometers indiameter ($PM_{2.5}$)			
		1-hour average (ppb)			Average	1-hour average (ppb)			Average	1-hour average (ppm)			8-hour average (ppm)			Average	1-hour average (ppb)		8-hour average (ppm)		Day > std.	Average	24-hour average (µm/m3)			Average	24-hour average (µm/m3)			Average
		Max	Min	Time > std.*	1 Year	Max	Min	Time > std.	1 Year	Max	Min	Time > std.	Max	Min	Time > std.	1 Year	Max	Min	Max	Min		1 Year	Max	Min	Time > std.	1 Year	Max	Min	Time > std.	1 Year
North	Chang Phueak, Muang District, Chiang Mai	0	0	0/7574	1	71	0	0/7305	9	4.10	0.00	0/3738	3.62	0.07	0/3889	0.50	120	0	102	1	62/339	25	187	4	11/319	47	48	11	0/170	24
	Si Phum, Muang District, Chiang Mai	4	0	0/8366	1	98	0	0/8357	19	5.30	0.00	0/8365	3.05	0.44	0/8703	1.04	#	#	#	#	#	#	209	10	25/360	52	144	6	86/357	32
	Phra Bat, Muang District, Lampang	13	0	0/8326	2	69	0	0/8262	7	2.30	0.00	0/8321	1.61	0.10	0/8713	0.62	120	1	98	2	82/366	27	151	8	19/351	47	#	#	#	#
	Sop Pat, Mae Mo District, Lampang	35	0	0/8205	1	60	0	0/7791	4	3.53	0.23	0/8315	2.64	0.24	0/8658	0.77	105	2	90	2	48/366	24	158	8	7/357	41	#	#	#	#
	Ban Dong, Mae Mo District, Lampang	45	1	0/8172	1	67	0	0/8102	6	#	#	#	#	#	#	#	122	5	104	5	82/361	28	261	7	14/350	49	#	#	#	#
	Mae Mo, Mae Mo District, Lampang	34	0	0/8294	1	88	0	0/8190	4	#	#	#	#	#	#	#	131	5	105	7	77/365	33	189	10	18/357	49	156	5	74/362	29
	Wiang, Muang District, Chiang Rai	#	#	#	#	#	#	#	#	4.80	0.00	0/8204	1.94	0.00	0/8554	0.41	102	0	81	0	16/362	19	288	2	20/355	44	#	#	#	#
	Wiang Phang Kham, Muang District, Chiang Rai	#	#	#	#	#	#	#	#	8.30	0.00	0/4787	6.14	0.00	0/4839	1.23	#	#	#	#	#	#	320	12	36/331	57	#	#	#	#
	Chong Kham, Muang District, Mae Hong Son	#	#	#	#	#	#	#	#	7.70	0.00	0/8030	1.67	0.00	0/8325	0.44	94	0	79	0	6/361	17	285	7	25/332	42	#	#	#	#
	Nai Wiang, Muang District, Nan	10	0	0/7793	1	62	0	0/8313	4	0.20	0.00	0/8343	1.84	0.08	0/8695	0.55	109	0	86	0	34/362	23	204	7	13/255	43	#	#	#	#
	Huai Kon, Muang District, Nan	79	0	0/8051	1	17	0	0/8057	1	2.40	0.00	0/8043	2.14	0.00	0/8364	0.31	104	0	92	0	24/343	17	293	6	21/348	39	180	2	51/269	27
	Nai Mueang, Muang District, Lamphun	10	0	0/7724	2	51	0	0/7878	6	5.60	0.00	0/7818	3.47	0.00	0/8080	0.52	105	0	90	0	39/342	25	165	9	12/359	43	#	#	#	#
	Na Chak, Muang District, Phrae	30	0	0/7796	1	70	0	0/8038	8	4.20	0.00	0/7981	2.81	0.00	0/8334	0.33	135	0	113	0	82/354	29	172	5	20/350	48	#	#	#	#
	Wiang, Muang District, Phayao	19	0	0/8007	1	63	0	0/8142	7	5.10	0.00	0/8127	3.63	0.00	0/8440	0.36	112	0	95	0	48/356	26	192	0	23/349	43	#	#	#	#
	Mae Pa, Mae Sot District, Tak	#	#	#	#	33	0	0/4887	4	4.90	0	0/4859	2.90	0	0/5026	0.41	51	0	48	1	0/214	13	107	4	0/198	33	44	2	0/187	12
North East	Nai Mueang, Muang District, Khon Kaen	7	0	0/4826	2	89	0	0/4847	8	4.00	0.00	0/4526	1.78	0.00	0/4708	0.63	136	0	96	1	58/218	17	137	7	6/225	53	112	11	78/226	43
	Nai Mueang, Muang District, Nakhon Ratchasima	19	0	0/6963	3	101	0	0/7130	18	4.40	0.00	0/6508	2.56	0.00	0/6747	0.82	108	0	83	1	12/319	22	143	21	3/282	55	#	#	#	#
	Na An, Muang District, Loei	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	133	13	3/293	44	#	#	#	#
Central	Pratu Chai, Phra Nakhon Si Ayutthaya District, Phra Nakhon Si Ayutthaya	22	0	0/7267	1	40	0	0/5633	7	2.40	0.00	0/5585	2.29	0.05	0/5766	0.75	140	0	115	1	78/332	28	128	7	3/288	42	#	#	#	#
	Na Phra Lan, Chaloem Phra Kiat District, Saraburi	8	0	0/8129	1	93	0	0/8148	16	4.90	0.00	0/7590	2.34	0.00	0/7903	0.64	156	0	131	1	71/359	23	266	30	89/348	96	68	12	10/92	35

Table A-4 Air quality in provincial areas by monitoring station, 2016 (Continued)

Region	Station	Sulfur Dioxide (SO_2)				Nitrogen Dioxide (NO_2)				Carbon Monoxide (CO)							Ozone (O_3)						Particules less than or equal to 10 micrometers indiameter (PM_{10})				Particules less than or equal to 2.5 micrometers indiameter (PM_{25})			
		1-hour average (ppb)			Average	1-hour average (ppb)			Average	1-hour average (ppm)			8-hour average (ppm)			Average	1-hour average (ppb)		8-hour average (ppm)		Day > std.	Average	24-hour average (µm/m3)			Average	24-hour average (µm/m3)			Average
		Max	Min	Time > std.*	1 Year	Max	Min	Time > std.	1 Year	Max	Min	Time > std.	Max	Min	Time > std.	1 Year	Max	Min	Max	Min		1 Year	Max	Min	Time > std.	1 Year	Max	Min	Time > std.	1 Year
Central	Pak Phrieo, Muang District, Saraburi	#	#	#	#	92	3	0/8308	18	#	#	#	#	#	#	#	164	3	116	4	76/365	29	148	14	4/355	53	#	#	#	#
	Na Mueang, Muang District, Ratchaburi	16	0	0/7996	1	77	0	0/8277	6	2.00	0.00	0/8277	1.49	0.07	0/8617	0.49	166	0	131	0	29/364	23	167	13	6/351	44	136	5	31/339	27
	Pak Nam Pho, Muang District, Nakhon Sawan	17	0	0/8100	2	63	0	0/8058	12	5.20	0.00	0/8056	2.34	0.03	0/8390	0.86	126	2	106	5	74/365	34	175	14	12/358	50	#	#	#	#
	Pluak Daeng, Pluak Daeng District, Rayong	25	0	0/8176	1	69	0	0/7775	8	#	#	#	#	#	#	#	110	0	79	0	4/363	20	128	13	3/355	45	#	#	#	#
	Map Ta Phut, Muang District, Rayong	115	0	0/7735	7	82	0	0/8028	13	7.40	0.00	0/8159	4.18	0.03	0/8480	0.44	127	0	86	0	10/344	25	105	12	0/351	36	#	#	#	#
	Tha Pradu, Muang District, Rayong	22	0	0/8337	2	83	0	0/8075	9	3.10	0.00	0/8295	2.19	0.00	0/8667	0.82	128	1	110	2	23/366	24	106	8	0/354	33	82	5	21/347	23
	Huai Pong, Muang District, Rayong	54	0	0/7449	5	103	0	0/6775	9	3.40	0.00	0/7637	1.95	0.00	0/7847	0.40	163	0	131	0	34/336	29	126	14	1/315	38	#	#	#	#
	Noen Phra, Muang District, Rayong	47	0	0/8241	4	70	0	0/8353	11	1.60	0.00	0/8350	1.24	0.10	0/8689	0.53	110	0	93	2	5/362	27	105	15	0/359	39	#	#	#	#
	Thung Sukhla, Si Racha District, Chon Buri	78	0	0/8318	2	95	0	0/8350	13	#	#	#	#	#	#	#	124	0	98	0	31/366	29	144	10	1/355	39	85	4	10/364	19
	Bo Win, Si Racha District, Chon Buri	#	#	#	#	122	0	0/7717	14	#	#	#	#	#	#	#	137	0	112	3	20/354	28	128	14	2/338	44	#	#	#	#
	Ban Suan, Muang District, Chon Buri	#	#	#	#	103	0	0/8303	13	3.20	0.10	0/8368	2.79	0.10	0/8729	0.57	179	0	135	1	26/366	26	150	13	1/363	40	#	#	#	#
	Wang Yen, Plaeng Yao District, Chachoengsao	76	0	0/7951	2	66	0	0/7847	9	#	#	#	#	#	#	#	194	0	89	0	20/358	23	108	12	0/330	38	#	#	#	#
	Aranyaprathet, Aranyaprathet District, Sa Kaew	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	107	14	0/297	36	#	#	#	#
	Tha Tum, Si Maha Phot District, Prachin Buri	68	0	0/4828	2	36	0	0/4844	5	#	#	#	#	#	#	#	92	0	65	0	0/213	20	104	11	0/210	31	70	3	2/194	18
South	Makham Tia, Muang District, Surat Thani	8	0	0/8262	1	32	0	0/8235	2	2.40	0.00	0/8276	1.16	0.04	0/8658	0.30	79	0	74	1	1/365	18	87	9	0/340	32	#	#	#	#
	Talat Yai, Muang District, Phuket	33	0	0/6794	2	191	0	0	10	1.90	0.00	0/8061	1.30	0.00	0/8400	0.50	73	0	65	0	0/362	20	85	5	0/323	26	#	#	#	#
	Hat Yai, Hat Yai District, Songkhla	34	0	0/7163	3	102	0	0/7830	9	4.30	0.00	0/6730	2.15	0.00	0/6845	0.55	106	0	86	0	6/356	24	79	18	0/348	42	47	6	0/312	19
	Bang Nak, Muang District, Narathiwat	#	#	#	#	#	#	#	#	2.60	0.00	0/8205	1.27	0.00	0/8552	0.43	#	#	#	#	#	#	83	10	0/312	32	#	#	#	#
	Sateng, Muang District, Yala	#	#	#	#	#	#	#	#	1.89	0.00	0/7054	1.36	0.00	0/7361	0.4	#	#	#	#	#	#	72	4	0/316	30	#	#	#	#
	Standards	300			40	170			30	30			9			-	100		70			-	120			50	50			25

Remarks
* : *Number of times pollution exeeded the standard / Number of times pollution measurement performed*
\# : *No monitoring performed*

Appendix B

Noise Level

Monitoring Result

Table 1 24-hour average noise levels (L_{eq}) measured at roadside monitoring stations in Bangkok and its Vicinity in 2016

Monitoring station	Noise Level (dBA)		Number of days noise exceeded standard/ Number of monitoring days (Percentage)
	Min – Max	Average*	
Phahurat, Tree Petch Road, Phra Nakhon District	71.7 – 75.1	73.5	337/337 (100)
Din Daeng National Housing Authority, Din Daeng District	71.2 – 84.6	73.2	362/362 (100)
Chok Chai Police Station, Ladprao Road, Bang Kapi District	70.4 – 73.6	71.5	198/198 (100)
Thonburi Power Sub-Station, Inthara Phithak Road	68.5 – 74.6	71.0	183/199 (92)
Huai Khwang, National Housing Stadium, Pracha Songkhro Road, Huai Khwang	59.2 – 84.7	68.7	97/278 (35)
Road and Transit Division of Samut Sakhon, Petchkasem Road, Aom Noi, Krathum Baen District	53.4 – 67.2	62.6	0/297 (0)
Electricity Generating Authority of Thailand, Bang Kruai District	61.2 – 70.4	63.9	1/29 (0)
Standards	**70**		

Remark: * refers to the mean value of 24-hour average noise levels (L_{eq}) measured in 1 year

Table 2 24-hour average noise levels (L_{eq}) measured at general monitoring stations in Bangkok and its vicinity in 2016

Monitoring station	Noise Level (dBA)		Number of days noise exceeded standard/ Number of monitoring days (Percentage)
	Min – Max	Average*	
Nonsi Witthaya School, Nag Linchee Road, Yananwa District	53.5 – 77.1	60.7	12/297 (4)
Bodindecha (Sing Singhaseni) School	52.2 – 79.3	57.7	5/358 (1)
Sukhothai Thammathirat Open University, Chaengwattana Road, Pak Kret District	54.5 – 70.0	58.6	0/366 (0)
Bangkok University, Rangsit Campus, Klong Luang District	48.3 – 67.3	52.7	0/310 (0)
Klongchan National Housing Authority, Sukha Phiban 1 Road, Bang Kapi District	44.5 – 62.8	53.6	0/351 (0)
Standards	**70**		

Remark: * refers to the mean value of 24-hour average noise levels (L_{eq}) measured in 1 year

Table 3 24-hour average noise levels (L_{eq}) measured at temporary roadside monitoring stations in Bangkok in 2016

	Monitoring station	Date Range	Noise Level (dBA)		Number of days noise exceeded standard/ Number of monitoring days (Percentage)
			Min – Max	Average*	
1	Mansri Police Station, Bamrungmuang Road	3-9 Feb 2016	76.1 - 84.9	78.2	7/7(100)
2	Office of Atoms for Peace, Vibhavadi Rangsit Road	11 - 17 June 2016	73.0 - 74.6	73.6	7/7(100)
3	Victory Monument Police Station, Dokya Bookstore	27 Jan. - 2 Feb 2016	75.5 - 84.9	77.2	7/7(100)
4	Royal Forest Department, Phahonyothin Road, Chatuchak District	22 - 28 Apr 2016	73.9 - 74.8	74.4	7/7(100)
5	Bansomdejchaopraya Rajabhat University Police Station, Itsaraphap Road	15 – 21 Oct 2015	74.8 - 76.2	75.6	7/7(100)
6	Kaset Intersection Police Station, Phahonyothin Road	4 - 10 May 2016	72.4 - 75.5	73.4	7/7(100)
7	Suk Sawat - Phracha Uthid Junction, Police Station	30 Oct - 5 Nov 2015	76.1 - 76.8	76.6	7/7(100
8	Phrakanong Police Station, Sukumvit 77	4 - 10 Feb 2016	78.2 - 78.6	78.4	7/7(100)
9	Rama IX Junction Police Station, Rama IX Road	8 - 14 Jan 2016	74.2 - 76.2	75.3	7/7(100)
10	M.C.O.T. Junction Police Station, Rama IX Road	7 - 13 Jan 2016	76.4 - 77.6	77.1	7/7(100)
11	Khlong Toei Junction Police Station, At Narong Road	2 - 8 Dec 2015	72.4 - 75.1	74.0	7/7(100)
12	Lam Salee Junction Police Station, Ramkhamhaeng Road	19 - 25 Jan 2016	76.2 - 78.3	77.7	7/7(100)
13	Department of Land Transport, Phahonyothin Road	17-23 Feb 2016	70.5 - 71.3	71.0	7/7(100)
14	The Meteorological Department Sukumvit Road, Bang Na District	5 - 11 Nov 2015	75.5 - 76.2	76.0	7/7(100)
15	Sathu Pradit Junction Police Station, Rama III Road	6 - 12 Nov 2015	69.3 - 70.3	69.9	3/7(43)
16	Keakkai Junction Police Station, Samsen Road	31 Mar - 6 Apr 2016	74.3 - 75.3	74.8	7/7(100)
17	Department of Land Transport, Phahonyothin Road	17-23 Feb 2016	70.5 - 71.3	71.0	7/7(100)

Remarks: 1. Standard Noise Level has the 24-hours Noise Level (L_{eq}) of less than 70 dBA
2. Continuously monitored for 1 week, the microphone was located 3-5 meters away from the road

Table 4 24-hour average noise levels (L_{eq}) measured at roadside monitoring stations in other provinces in 2016

Province	Monitoring station	Noise Level (dBA)		Number of days noise exceeded standard/ Number of monitoring days (Percentage)
		Min – Max	Average*	
Saraburi	Na Phra Lan Police Station, Chaloem Phra Kiat District	53.9 – 72.4	68.7	182/276 (66)
Nakhon Ratchasima	Wastewater Pump Station, Nakhon Ratchasima City Municipality	63.3 – 75.0	66.4	31/326 (10)
Rayong	Rayong Provincial Agricultural Extension Office, Muang District	61.7 – 67.2	64.1	0/310 (0)
Khon Kaen	Department of Water Resources Office 4, Muang District	54.5 – 85.7	60.7	5/355 (1)
Chiang Mai	Yupparaj Wittayalai School, Muang District	59.3 – 70.0	63.2	0/352 (0)
Rayong	Map Ta Phut Health Promoting Hospital, Muang District	58.8 – 71.9	62.6	1/316 (0)
Phuket	Phuket Health Centre, Muang District	59.8 – 82.8	62.3	6/364 (2)
Chon Buri	Kasetsart University, Si Racha Campus	54.7 – 72.8	60.2	1/270 (0)
Songkhla	Hat Yai City Municipality, Hat Yai District	47.6 – 76.8	57.4	9/343 (3)
Chon Buri	Khao Hin Health Promotional Office, Bo Win, Si Racha District	50.9 – 64.5	8.7	0/192 (6)
Standards		70		

*Remark: * refers to the mean value of 24-hour average noise levels (Leq) measured in 1 year*

Table 5 24-hour average noise levels (L_{eq}) measured at general monitoring stations in general areas in other provinces in 2016

Province	Monitoring station	Noise Level (dBA)		Number of days noise exceeded standard/ Number of monitoring days (Percentage)
		Min – Max	Average*	
Chon Buri	Regional Environmental Office 13 Chonburi, Muang District	49.4 – 65.5	54.6	0/210 (0)
Lampang	Lampang Meteorological Center, Muang District	52.9 – 65.5	56.5	0/251 (0)
Saraburi	Fire Station (Khao Noi), Muang District	50.9 – 83.7	61.4	5/221 (2)
Saraburi	Wat Tham Si Wilai, Chaloem Phra Kiat District	48.6 – 73.0	55.2	1/240 (0)
Saraburi	Na Phra Lan Municipality, Chaloem Phra Kiat District	45.2 – 70.4	57.8	1/288 (0)
Chiang Mai	Chiang Mai City Hall, Muang District	45.0 – 79.0	58.3	3/228 (0)
	Standards	70		

*Remark: * refers to the mean value of 24-hour average noise levels (Leq) measured in 1 year*

Appendix C

Water Quality
Monitoring Results

Table C-1 Water quality index and areas with water quality problems in the northern region

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Ping	3	4.2 – 13.6 6.2 100%(60/60)	0.8 – 2.8 1.4 82%(49/60)	170 - 50,000 5,400 83%(50/60)	<18 - 13,000 1,150 87%(52/60)	ND - 0.42 0.03 100%(60/60)	TCB Saen To Bridge, Khanu Woralaksaburi,(Aug.), Ban Wang Yang(Aug.,Nov.), Kamphaeng Phet Bridge(Feb.) Muang, Kamphaeng Phet, Wat Tha Ta Khro (Nov.), Kittikachorn Bridge (Feb.,Aug.,Nov.), Sapan Kwaen(Nov.[3]) Muang, Tak. Cho Lae, Mae Taeng, Chiang Mai (May) FCB Saen To Bridge(Nov.), Kamphaeng Phet Bridge(Feb.), In front of Wat Tha Ta Khro(Feb.[4]), Kittikachorn Bridge (Aug.[4],Nov.), Sapan Kwaen(Feb.) Muang, Ban Tak(May,Aug.) Tak
Wang	3	2.0 – 11.4 6.5 86%(19/22)	0.8 - 7.2 1.3 59%(13/22)	330 - 92,000 8,200 73%(16/22)	78 – 54,000 1,800 68%(15/22)	ND – 1.20 0.34 68%(15/22)	BOD Yang Dam, Lampang City Municipality(Mar.,May[2]), Soi River Confluence, Chae Hom(Nov.) Lampang TCB Ban Wang Man Bridge, Samngao, Tak(Nov.), Soi River Confluence, Chae Hom(Aug.[3]), Yang Dam, Lampang City Municipality (May[3],Aug.[3]), Setu Wari Bridge(May,Aug.) Muang, Lampang FCB Thongsawat Bridge, Thoen(Nov.), Yang Dam, Lampang City Municipality(Mar.,May[4],Aug.,Nov.), Setu Wari Bridge(Aug.,May) Lampang NH_3 Thongsawat Bridge, Thoen(May,Aug.), Som Prap Raw Water Pumping Station, Som Prap(Aug.),Yang Dam, Lampang City Municipality(May,Aug.[5]), Setu Wari Bridge(May), Soi River Confluence, Chae Hom(Aug.) Lampang
Yom	3	3.0 - 10.2 6.2 92%(44/48)	0.6 – 13.9 1.8 56%(27/48)	78 - 92,000 5,400 81%(39/48)	<18 - 17,000 595 88%(42/48)	ND – 6.23 0.30 83%(40/48)	BOD Pho Thale(May), Sam Ngam(May) Phichit, Phra Ruang Bridge (Feb.,Jun.[2],Nov.), Ban Wang Hin Phatthana Bridge(Jun.,Nov.) Muang, Sawan Khalok(Jun.,Nov.), Si Satchanalai(Nov.) Sukhothai, Wang Chin(Nov.), Ban Nam Khong(Nov.) Ban Nam Khong, PhraeTCB Pho Thale(May), Phra Ruang Bridge(Jun.[3],Aug.), Pak Khwae,Muang(Jun.[3]), Sawan Khalok(Jun.), Wang Chin(Aug.), Ban Nam Khong (Aug.), Ban Maha Pho(Aug.) Muang, Phrae, Chiang Muan(Jun.[3]) Phayao FCB Pho Thale(May), Phra Ruang Bridge(Jun.,Aug.), Pak Khwae (Feb.,Jun.[4]), Sawan Khalok(Jun.) NH_3 Phra Ruang Bridge (Jun.[5]), Ban Wang Hin Phatthana Bridge(Jun.), Sawan Khalok(Jun.), Wang Chin, Phrae(Aug.), Ban Nam Khong (Aug.), Ban Maha Pho(Aug.), Song, Phrae(Aug.), Chiang Muan, Phayao(Aug.)
Nan	3	2.6 – 8.4 6.2 98%(55/56)	0.4 – 3.6 1.6 68%(38/56)	210 - 160,000 4,900 93%(52/56)	20 - 9,200 405 95%(53/56)	ND - 0.50 0.20 100%(56/56)	TCB Ban Don Si Soem, Nai Wiang(May), Pumping Station, San (Feb.,May[3],Aug.) Muang, Nan FCB Ban Don Si Soem, Nai Wiang(May), Pumping Station, San(Feb.,May[4]) Muang, Nan
Kok	2	6.1 - 8.1 7.1 100%(20/20)	0.4 - 1.3 0.7 100%(20/20)	330 - 54,000 6,200 40%(8/20)	92 - 11,000 2,100 30%(6/20)	0.05 - 0.32 0.13 100%(20/20)	TCB Mae Chan(May,Aug.), Mae Faluang Bridge(Aug.[3]) Muang, Chiang Rai FCB National Peacekeeping Council Bridge No. 97, Ban Tha Khao Plueak (May,Aug.), Nua Muang Chiang Rai Bridge(Jan.,Mar.,Aug.), Mae Faluang Bridge(May[4],Aug.) Muang, Chiang Rai
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] The areas that have the lowest level of DO [2] The areas that have the highest level of BOD [3] The areas that have the highest level of TCB [4] The areas that have the highest level of FCB [5] The areas that have the highest level of NH3-N NH3-N ND (non – detected) = 0.01

Table C-1 Water quality index and areas with water quality problems in the northern region (Continued)

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Kuang	3	0.0 - 8.9 4.0 45%(15/33)	0.5 – 8.4 2.0 46%(16/35)	490 - >160,000 16,000 63%(22/35)	40 - 92,000 1,700 71%(25/35)	0.06 – 4.36 0.58 43%(15/35)	DO In front of the Guang River's weir and sand sluice 1(Jan.,Mar.[1],Jun.,Aug.),Tha Nang Bridge(Jan.,Mar.[1]), the bridge under the northern industrial estate sewage outlet (Jun.), In front of Wang Thong Dam (Jun.) Muang, Lamphun, San Sai, Chiang Mai (Jan.,Mar.) BOD In front of the Guang River's weir and sand sluice 2, Lamphun (Mar.,Jun.), In front of the Guang River's weir and sand sluice 1 (Jan.,Mar.,Jun.,Aug.), Tha Nang Bridge(Jan.,Mar.), the bridge under the northern industrial estate sewage outlet(Jun.), In front of Wang Thong Dam(Mar.[2]), San Sai (Mar.,Jun.) TCB In front of the Guang River's weir and sand sluice 2(Jan.), In front of the Guang River's weir and sand sluice 1(Mar.,Aug.), Tha Nang Bridge (Mar.,Jun.[3],Aug.), the bridge under the northern industrial estate sewage outlet(Jun.), In front of Wang Thong Dam (Mar.,Jun.), San Sai(Mar.,Jun.), Doi Saket, Chiang Mai(Aug.) FCB In front of the Guang River's weir and sand sluice 2(Jun.), In front of the Guang River's weir and sand sluice 1(Mar.,Jun.), Tha Nang Bridge(Mar.,Jun.[4]), the bridge under the northern industrial estate sewage outlet(Jun.), In front of Wang Thong Dam(Mar.,Jun.,Aug.), San Sai(Jun.) NH_3 In front of the Guang River's weir and sand sluice 2(Jun.), In front of the Guang River's weir and sand sluice 1(Jan.,Mar.[5],Jun.,Aug.), Tha Nang Bridge(Jan.,Mar.,Jun.,Aug.), the bridge under the northern industrial estate sewage outlet(Jan.,Jun.), In front of Wang Thong Dam (Jan.,Mar.,Jun.,Aug.), San Sai(Jun.)
Li	2	4.3 - 9.9 6.6 76%(13/17)	0.5 – 3.8 0.9 76%(13/17)	330 - 9,200 1,700 88%(15/17)	<18 - 1,100 330 94%(16/17)	0.05 - 0.81 0.10 94%(16/17)	NH_3 Ban San Wilai Bridge, Mae Tuen, Li, Lamphun(May.[5])
Ing	2	0.0 - 8.6 7.0 59%(10/17)	0.9 – 6.9 1.4 53%(9/17)	45 - 54,000 1,300 82%(14/17)	<18 – 16,000 92 88%(15/17)	ND – 1.21 0.17 88%(15/17)	DO Muang, Phayao(Aug.[1]) BOD Chun, Phayao(Nov.[2]), Muang, Phayao(Jun.) TCB Chiang Khong, Chiang Rai(Aug.[3]) FCB Muang, Phayao(Jun.[4]) NH_3 Chun, Phayao(Aug.), Muang, Phayao(Aug.[5])
Mae Chan	2	0.8 – 10.5 3.7 33%(4/12)	0.5 – 9.0 1.7 50%(6/12)	40 ->16,000 1,350 83%(10/12)	20 –16,000 124 75%(9/12)	ND – 1.16 0.41 67%(8/12)	DO Ko Kha, Lampang(May[1]) BOD Ko Kha(Aug.), Ban Nam Thong Dam(May), Ban Hua Suea Dam(May[2]) Mae Tha, Lampang FCB Ban Nam Thong Dam (Feb.[4]), Ban Hua Suea Dam(May) NH_3 Ban Nam Thong Dam(Aug.), Ban Hua Suea Dam(May,Aug.), Mae Moh, Lampang(Aug.[5])
Kwan Phayao	-	2.8 – 9.0 7.0 100%(24/24)	2.1 – 8.3 3.8 67%(16/24)	<18 - 16,000 1,300 100%(24/24)	<18 - 1,700 94 100%(24/24)	ND – 1.21 0.51 50%(12/24)	BOD Bridge in front of Inland Fisheries Station(Mar.,Aug.), In front of King Ngam Meuang Monument(Jun.,Aug.), In front of Phayao Waterworks Authority (Aug.), Khun Dej Bridge, Ing Estuary(Jun.[2],Nov.), Midl Kwan Phayao(Aug.) Muang, Phayao NH_3 Bridge in front of Inland Fisheries Station(Jun.,Aug.), In front of King Ngam Meuang Monument (Jun.,Aug.),In front of Phayao Waterworks Authority(Jun.,Aug.), Khun Dej Bridge, Ing Estuary(Jun.[5],Aug.), Mid Kwan Phayao (Jun.,Aug.), Mouth of Mae Sai Canal Estuary(Jun.,Aug.) Muang, Phayao
Bueng Boraphet	-	0.6 – 8.0 4.6 79%(15/19)	1.7 – 18.9 4.0 53%(10/19)	80 – 8,000 2,300 100%(19/19)	23 – 2,300 200 100%(19/19)	ND - <0.03 0.01 100%(19/19)	DO Ban Rung Chig(Aug.[1]), Ban Puak Sung(Aug.), Ban Noen Rakhang(Nov.), Ban Nong Duk(Aug.) BOD Ban Rung Chig (May.,Aug.), Ban Puak Sung (May.,Aug.), Ban Tha Din Daeng(Feb.,Aug.), Ban Nong Duk(Feb.,May[2],Aug.)
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions) *Water sources that had not been categorized will be compared to the Water Quality Standard Category 3*

[1] The areas that have the lowest level of DO [2] The areas that have the highest level of BOD [3] The areas that have the highest level of TCB [4] The areas that have the highest level of FCB [5] The areas that have the highest level of NH3-N NH3-N ND (non – detected) = 0.01

Table C-2 Heavy metal monitoring results and problematic areas in the Northern Region

Parameter	The range of Min - Max (mg/l)	The Standard of Surface Water Quality (mg/l)	Areas that Exceed the Standard / Problematic Areas
Cd 1.8%(3/169)*	ND– 0.011	≤0.005 , ≤0.05	Nan River Nai Muang, Muang, Phitsanulok(Feb._0.006,May_0.011**) Yom River Song, Phrae(Jun._0.01)
Total Cr	ND – 0.025	≤0.05***	Not found
Mn 1.8%(3/169)*	ND – 1.95	≤1.0	Bueng Boraphet Ban Rung Chig(Aug._1.1), Ban Nong Duk(Aug._1.95**) Nan River San, Muang, Nan(May_1.59)
Ni	ND – 0.088	≤0.1	Not found
Pb 2.4%(4/169)*	ND – 0.145	≤0.05	Nan River Wat Sawang Arom, Tha Thong, Muang, Phitsanulok(Feb._0.052), Nai Muang, Muang, Phichit[2](Feb._0.051,May_0.118), San, Muang, Nan[2] (May_0.145**)
Zn	ND – 0.945	≤1.0	Not found
Cu	ND – 0.015	≤0.1	Not found
Hg 1%(1/102)*	<0.0005– 0.004	≤0.002	Bueng Boraphet Ban Nong Duk(Feb._0.004**)
As 8.9%(14/158)*	ND – 0.026	≤0.01	Kwan Phayao In front of Phayao Waterworks Authority, Muang, Phayao (Aug._0.011) Kuang River In front of Wang Thong Dam, Mueang Nga, Muang, Lamphun (Mar._0.017) Nan River Taphan Hin, Phicit[2](Feb._0.012), Tha Luang Muang, Phichit[2] (Feb._0.014), Nai Muang, Muang, Phichit[2] (Feb._0.014), Phom Phiram, Phitsanulok[2] (Feb._0.016), Phichai, Uttaradit(Feb._0.016), Pattana Pak Neua 13th Bridge, Muang, Uttaradit[2](Feb._0.015), Ngiu Ngam, Muang, Uttaradit[2] (Feb._0.019), Nai Wiang, Muang, Nan[2](Feb._0.026**), San, Muang, Nan[2] (Feb._0.022), Tha Wang Pha, Nan[2](Feb._0.02) Yom River Pho Taele, Phichit[2](Feb._0.018), Sam Ngam, Phichit(Feb._0.026**)

Remarks

- *The standard value of Cd below 0.005 mg/l applies where water hardness does not exceed 100 mg/l*
- *The standard value of Cd below 0.05 mg/l applies where water hardness exceeds 100 mg/l*
- ** Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that does not meet standards / Number of all monitoring sessions)*
- ***Maximum value*
- **** Is the standard value of hexavalent Cr, but the analysis result was Total Cr*
- *[2] The monitoring station did not meet the heavy metal standards in 2015 and 2016*
- *ND = non-detected (non-detected)*

Cd	=	*0.00006*	*mg/l*	*Zn*	=	*0.004*	*mg/l*
Total Cr	=	*0.00013*	*mg/l*	*Cu*	=	*0.002*	*mg/l*
Mn	=	*0.1*	*mg/l*	*Hg*	=	*0.0005*	*mg/l*
Ni	=	*0.004*	*mg/l*	*As*	=	*0.0003*	*mg/l*
Pb	=	*0.00013*	*mg/l*				

Table C-3 Water quality index and areas with water quality problems in the central region

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Upper Chao Phraya	2	2.8 - 8.2 5.3 32%(9/28)	0.4 - 2.7 1.3 64%(18/28)	780 - 30,000 7,450 46%(13/28)	<180 - 11,000 1,100 43%(12/28)	ND - 0.30 0.10 100%(28/28)	TCB Muang, Sing Buri(Aug.), Phayuhakhiri, Nakhon Sawan(May,Aug.[3]), Muang, Nakhon Sawan(Feb.,May[3],Aug.) FCB Muang, Ang Thong(Aug.), Phayuhakhiri, Nakhon Sawan(May), Muang, Nakhon Sawan(May[4])
Central Chao Phraya	3	2.2 - 7.4 4.1 55%(11/20)	0.5 - 2.6 1.1 95%(19/20)	1,300 - 35,000 4,900 85%(17/20)	200 - 11,000 1,015 85%(17/20)	ND - 0.56 0.20 95%(19/20)	TCB Muang, Nonthaburi(Aug.[3]), Muang, Pathum Thani(May), Pomphet, Phra Nakhon Si Ayutthaya(May[3]) FCB Muang, Nonthaburi(May,Nov.), Pomphet, Phra Nakhon Si Ayutthay(May[4]) NH_3 Muang, Nonthaburi(Nov.[5])
Lower Chao Phraya	4	1.1 - 4.7 1.9 42%(10/24)	1.3 - 6.8 4.9 42%(10/24)	780 - >160,000 24,000 42%(10/24)	<180 - 160,000 7,900 21%(5/24)	0.1 - 1.50 0.51 46%(11/24)	DO Muang, Samut Prakan(May,Aug.,Nov.), Phra Pradaeng, Samut Prakan (Feb.,Nov.), Khlong Toei, Bangkok(Feb.[1],May,Nov.), Krung Thep Bridge, Bangkok (Feb.,Aug.), Phra Phuttha Yodfa Bridge, Bangkok(Feb.,May), Rama VI Bridge, Nonthaburi(Feb.,Aug.[1]) BOD Muang, Samut Prakan (May,Aug.), Phra Pradaeng (May,Aug.,Nov.), Khlong Toei(Feb.,May[2],Aug.,Nov.), Krung Thep Bridge(Feb.,May), Phra Phuttha Yodfa Bridge(Feb.,May), Rama VI Bridge(May) TCB Muang, Samut Prakan(May), Phra Pradaeng(May,Aug.,Nov.), Khlong Toei (Aug.,Nov.), Krung Thep Bridge(Feb.,Nov.[3]), Phra Phuttha Yodfa Bridge (Feb.,May[3],Aug.,Nov.), Rama VI Bridge(Feb.,Nov.[3]) FCB Muang, Samut Prakan(May,Aug.), Phra Pradaeng(May,Aug.,Nov.), Khlong Toei(Feb.,May,Aug.,Nov.), Krung Thep Bridge(Feb.,May,Aug.,Nov.[4]), Phra Phuttha Yodfa Bridge(Feb.,May,Nov.), Rama VI Bridge(Feb.,May,Nov.) NH_3 Muang, Samut Prakan(May,Aug.), Phra Pradaeng(Feb.,May,Aug.[5],Nov.), Khlong Toei(Feb.,May,Aug.,Nov.), Krung Thep Bridge (Feb.,May), Phra Phuttha Yodfa Bridge(May)
Upper Tha Chin	2	4.5 - 8.7 5.5 38%(6/16)	0.4 - 2.1 1.1 88%(14/16)	450 – 35,000 3,500 75%(12/16)	110 – 3,500 1,200 44%(7/16)	0.00 – 0.18 0.01 100%(16/16)	TCB Hanka, Chai Nat(Nov.[3])
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] *The areas that have the lowest level of DO* [2] *The areas that have the highest level of BOD* [3] *The areas that have the highest level of TCB* [4] *The areas that have the highest level of FCB* [5] *The areas that have the highest level of NH3-N* *NH3-N ND (non – detected) = 0.01*

Table C-3 Water quality index and areas with water quality problems in the central region (Continued)

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Central Tha Chin	3	2.3 - 6.6 4.5 67%(8/12)	0.8 - 2.9 1.6 83%(10/12)	1,300 - 24,000 7,300 83%(10/12)	200 – 13,000 1,400 83%(10/12)	<0.01 - 0.56 0.14 92%(11/12)	TCB Thai Muang, Muang, Suphan Buri(Feb.[3],May[3]) FCB Thai Muang(Feb.,May[4]) NH_3 Thai Muang(Feb.[5])
Lower Tha Chin	4	0.8 - 5.5 2.8 71%(20/28)	1.4 - 11.1 2.7 54%(15/28)	1,700 – 540,000 13,000 57%(16/28)	330 – 540,000 4,750 46%(13/28)	<0.01 - 1.57 0.71 32%(9/28)	DO Wat Siri Mongkhon(Nov.) Muang, Krathumbaen(Nov.) Samut Sakhon, In front of Wat Thian Dat, Ban Tha Mai(Feb.,Nov.[1]), Wat Bang Chang Nuea (Aug.,Nov.), Pho Kaeo Bridge, Ban Thakham(Nov.) Sam Phran, Nakhon Chaisi (Nov.) Nakhon Pathom BOD Tha Chin Estuary(May,Aug.), Wat Siri Mongkhon (Feb.,May,Aug.) Muang, Krathumbaen(Feb.,May) Samut Sakhon, In front of Wat Thian Dat,(Feb.,May[2]), Wat Bang Chang Nuea(Feb.,May), Pho Kaeo Bridge(Feb.,May) Nakhon Pathom TCB Tha Chin Estuary(Aug.,Nov.), Wat Siri Mongkhon(Aug.,Nov.) Muang, Krathumbaen(Aug.,Nov.) Samut Sakhon, In front of WatThian Dat(Feb.,May[3],Aug.), Wat Bang Chang Nuea(May.,Nov.), Pho Kaeo Bridge(May) Nakhon Pathom FCB Tha Chin Estuary(Aug.,Nov.), Wat Siri Mongkhon(Aug.,Nov.) Muang, Krathumbaen(May.,Aug.,Nov.) Samut Sakhon, In front of Wat Thian Dat,(Feb.,May.[4],Aug.,Nov.), Wat Bang Chang Nuea(May.,Nov.), Pho Kaeo Bridge(May.,Nov.) Nakhon Pathom NH_3 Tha Chin Estuary(May.,Aug.,Nov.), Wat Siri Mongkhon(Feb.,May,Aug.,Nov.) Muang, Krathumbaen(Feb.,Aug.,Nov.) Samut Sakhon, In front of Wat Thian Dat (Feb.[5],May,Aug.,Nov.), Wat Bang Chang Nuea(Feb.,May,Nov.), Pho Kaeo Bridge (Feb.,May) Nakhon Pathom
Mae Klong	3	2.6 - 7.4 5.4 90%(36/40)	0.6 - 2.5 1.4 95%(38/40)	130 – 79,000 4,900 90%(36/40)	20 - 4,900 490 95%(38/40)	ND - 0.38 0.09 100%(40/40)	TCB Mae Klong Estuary(Nov.) Muang, Samut Songkhram, Muang(Aug.) Photharam(Aug.[3],Nov.) Ratchaburi FCB Photharam(Aug.[4],Nov.[4]) Ratchaburi
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] The areas that have the lowest level of DO [2] The areas that have the highest level of BOD [3] The areas that have the highest level of TCB [4] The areas that have the highest level of FCB [5] The areas that have the highest level of NH3-N NH3-N ND (non – detected) = 0.01

Table C-3 Water quality index and areas with water quality problems in the central region (Continued)

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Upper Phetchaburi	2	1.2 - 6.8 4.6 50%(4/8)	0.8 - 1.9 0.9 75%(6/8)	230 - 7,900 1,300 88%(7/8)	<18 – 790 57 100%(8/8)	ND - 0.36 0.14 100%(8/8)	DO Thai Kaeng Krachan Dam, Kaeng Krachan, Phetchaburi(Jun.[1])
Lower Phetchaburi	3	2.2 - 6.0 5.1 69%(11/16)	0.8 - 7.0 1.4 81%(13/16)	2,300 - 49,000 15,000 56%(9/16)	330 - 22,000 2,300 75%(12/16)	0.03 - 1.13 0.25 81%(13/16)	BOD Ban Laem Estuary, Ban Laem, Phetchaburi(Nov.[2]) TCB Bridge before entering Ban Laem, Ban Laem, Phetchaburi(Jun.,Aug.), Klong Krasae (Mar.,Jun.,Nov.[3]), Ton Mamuang(Mar.,Aug.) Muang, Phetchaburi FCB Bridge before entering Ban Laem, Phetchaburi(Mar.,Nov.), Klong Krasae(Nov.[4]), Ton Mamuang(Nov.)Muang, Phetchaburi NH_3 Estuary(Jun.[5]), Bridge before entering Ban Laem, Ban Laem, Phetchaburi(Mar.,Aug.)
Kwae Yai	2	2.8 - 7.4 5.4 35%(7/20)	0.5 - 1.7 1.2 90%(18/20)	45 - 7,900 690 95%(19/20)	<18 – 490 94 100%(20/20)	ND - 0.31 0.12 100%(20/20)	-
Kwae Noi	2	3.2 - 8.1 5.4 45%(9/20)	0.5 - 1.5 0.7 100%(20/20)	310 - 22,000 2,000 90%(18/20)	20 - 4,900 330 95%(19/20)	ND - 0.19 0.02 100%(20/20)	TCB Thong Phaphum, Kanchanaburi(May[3]) FCB Muang, Kanchanaburi (Nov.[4])
Pasak	3	2.0 - 9.0 5.0 72%(31/43)	0.9 - 5.7 2.1 49%(21/43)	220 - 160,000 7,900 84%(36/43)	110 - 24,000 1,300 77%(33/43)	ND - 5.93 0.16 93%(40/43)	BOD Muang(Feb.[2]) Saraburi, Chai Badan, Lop Buri(May), Nong Phai(May), Muang,(Feb.), Lhomsak(May) Phetchabun TCB Nakhon Luang(Aug.), Tha Ruea(Feb.,Aug.,Nov.) Phra Nakhon Si Ayutthaya, Chai Badan, Lop Buri (May), Muang,(Aug.), Lhomsak(May[3]) Phetchabun FCB Nakhon Luang (Nov.), Tha Ruea(Feb.) Phra Nakhon Si Ayutthaya, Muang(May,Nov.) Saraburi, Chai Badan, Lop Buri(May,Nov.), Nong Phai(May), Muang(Aug.[4]), Lhomsak(May,Aug.) Phetchabun NH^3 Tha Ruea(Nov.) Phra Nakhon Si Ayutthaya, Wichian Buri(May[5]), Muang(May) Phetchabun
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] *The areas that have the lowest level of DO* [2] *The areas that have the highest level of BOD* [3] *The areas that have the highest level of TCB* [4] *The areas that have the highest level of FCB* [5] *The areas that have the highest level of NH3-N* *NH3-N ND (non – detected) = 0.01*

Table C-3 Water quality index and areas with water quality problems in the central region (Continued)

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Lopburi	3	0.1 - 6.4 3.5 50%(9/18)	0.6 - 5.2 2.4 44%(8/18)	400 - 160,000 16,500 56%(10/18)	180 - 54,000 2,500 56%(10/18)	ND - 2.13 0.25 89%(16/18)	DO Ban Phraek, Phra Nakhon Si Ayutthaya(Aug.), Muang(Jul.), Tha Wung(Jul.) Lopburi, Muang, Sing Buri(May.,Aug.[1]) BOD Muang(Feb.,May,Jul.), Tha Wung (Feb.,May[2],Jul.) Lopburi TCB Muang(May), Ban Phraek(Aug.) Phra Nakhon Si Ayutthaya, Muang(Feb.[3],May,Jul.[3]), Tha Wung(May[3],Jul.[3]) Lopburi, Muang, Sing Buri(May[3]) FCB Muang(May), Ban Phraek(Nov.) Phra Nakhon Si Ayutthaya, Muang(Feb.,May,Jul.), Tha Wung(Feb.,May,Jul.[4]) Lopburi NH_3 Muang (Nov.) Phra Nakhon Si Ayutthaya, Tha Wung(May[5]) Lopburi
Noi	3	1.6 - 6.8 4.1 55%(11/20)	0.5 - 2.4 1.0 95%(19/20)	450 - 54,000 9,450 65%(13/20)	<180 - 35,000 730 95%(19/20)	ND - 0.40 0.17 100%(20/20)	DO Phak Hai, Phra Nakhon Si Ayutthaya(Aug.), Pho Thong, Ang Thong (Aug.[1]) TCB Phak Hai, Phra Nakhon Si Ayutthaya(Feb.,Aug.,Nov.), Pho Thong, Ang Thong (Feb.,Nov.[3]), Bang Rachan, Sing Buri(Aug.), Muang, Chai Nat(Nov.) FCB Pho Thong, Ang Thong(Nov.[4])
Sakaekrang	3	1.6 - 5.0 3.1 33%(4/12)	1.5 - 3.9 2.7 17%(2/12)	300 - 90,000 4,000 83%(10/12)	50 - 28,000 550 83%(10/12)	ND - 0.03 ND 100%(12/12)	DO Thai Muang Bridge(Jun.[1]) Muang, Uthai Thani TCB Thai Muang Bridge (Jun.[3],Aug.), FCB Thai Muang Bridge(Jun.[4],Aug.)
Pranburi	2	1.0 – 6.7 5.2 20%(4/20)	0.6 – 4.4 1.5 65%(13/20)	230 - 49,000 1,700 85%(17/20)	<18 - 3,300 190 90%(18/20)	ND - 0.51 0.14 95%(19/20)	DO Ban Rong Sup, Khao Noi, Pranburi, Prachuap Khiri Khan(Mar.,Jun.[1],Nov.) BOD Ban Rong Sup, Khao Noi(Nov.[2]) TCB Ban Rong Sup, Khao Noi(Nov.[3]) NH_3 Ban Rong Sup, Khao Noi,(Aug.[5])
Kuiburi	3	2.6 - 7.5 3.7 50%(4/8)	0.8 - 8.9 1.0 75%(6/8)	78 - 22,000 2,300 88%(7/8)	20 – 1,300 154 100%(8/8)	ND - 2.95 0.18 88%(7/8)	BOD Kuiburi Estuary, Moo 1, Ban Pak Khlong Klieow, Bo Nok, Muang, Prachuap Khiri Khan(Jun.,Aug.[2]) TCB Moo 2, Kuiburi, Kuiburi, Prachuap Khiri Khan(Jun.[3]) NH_3 Kuiburi Estuary(Aug.[5])
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] The areas that have the lowest level of DO [2] The areas that have the highest level of BOD [3] The areas that have the highest level of TCB [4] The areas that have the highest level of FCB [5] The areas that have the highest level of NH3-N NH3-N ND (non – detected) = 0.01

Table C-4 Heavy Metal Monitoring Results and Problematic Areas in the Central Region

Parameter	The range of Min - Max (mg/l)	The Standard of Surface Water Quality (mg/l)	Areas that Exceed the Standard / Problematic Areas
Cd	ND - 0.001	≤0.005 ,≤0.05	Not found
Total Cr	ND - 0.023	≤0.05***	Not found
Mn 0.6%(1/181)*	ND – 1.57	≤1.0	Pasak River Thai Muang, Muang, Phetchabun(Aug._1.57**)
Ni	ND – 0.097	≤0.1	Not found
Pb	ND – 0.014	≤0.05	Not found
Zn	ND – 0.70	≤1.0	Not found
Cu	ND – 0.011	≤0.1	Not found
Hg 1.2%(2/169)*	<0.0005 – 0.011	≤0.002	Mae Klong Banpong, Ratchaburi(Nov._0.0021) Pranburi River Moo 5, Ban Plai Nam, Khao Noi, Pran Buri, Prachuap Khiri Khan(Nov._0.011**)
As 2.4%(4/169)*	ND – 0.016	≤0.01	Kwae Yai Rim Nam Nah Muang Rd., Ban Nuea, Muang, Kanchanaburi (Aug._0.016**), Wat Thung Lat Ya, Moo 1, Lat Ya, Muang, Kanchanaburi (Aug._0.015) Pranburi River Pranburi Estuary, Moo 2, Pak Nam Pran Buri Municipality, Pran Buri, Prachuap Khiri Khan(Mar._0.011), Moo 5, Ban Plai Nam, Khao Noi, Pran Buri, Prachuap Khiri Khan[2](Mar._0.014)

Remarks

- *The standard value of Cd below 0.005 mg/l applies where water hardness does not exceed 100 mg/l*
- *The standard value of Cd below 0.05 mg/l applies where water hardness exceeds 100 mg/l*
- ** Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that does not meet standards / Number of all monitoring sessions)*
- ***Maximum value*
- **** Is the standard value of hexavalent Cr, but the analysis result was Total Cr*
- *[2] The monitoring station did not meet the heavy metal standards in 2015 and 2016*
- *ND = non-detected (non-detected)*

Cd	=	*0.00006*	*mg/l*	*Zn*	=	*0.004*	*mg/l*
Total Cr	=	*0.00013*	*mg/l*	*Cu*	=	*0.002*	*mg/l*
Mn	=	*0.1*	*mg/l*	*Hg*	=	*0.0005*	*mg/l*
Ni	=	*0.004*	*mg/l*	*As*	=	*0.0003*	*mg/l*
Pb	=	*0.00013*	*mg/l*				

Table C-5 Water Quality Index and Problematic Areas in the Northeastern Region

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Phong	3	0.3 - 11.8 3.5 44%(23/52)	0.3 - 3.5 1.5 75%(39/52)	18 - 9,200 790 100%(52/52)	<18 - 2,400 195 100%(52/52)	ND - 2.27 0.57 44%(23/52)	DO Khok Si(Aug.), Ban Nong Hin(May) Muang, Nong Wai Dam(May,Aug.), Nam Phong Pumping Station(May[1],Aug.), 100-metre Under Huai Chod Lake estuary(Aug.), 100-metre Above Huai Chod Lake estuary(Jun.,Aug.) Nam Phong, Ban Kham Bon, Khok Sung(Jun.,Aug.), Ubonrat, Khon Kaen NH_3 Phra Lap (Aug.,Nov.), Khok Si(Nov.), Ban Nong Hin(Nov.) Muang, Ban Tha Maduea (Aug.,Nov.), Tha Mao-Wang Chai Bridge(Feb.[5],Nov.), Ban Kut Nam Sai Noi(Nov.), Chao Pu Thung Thiaw Shrine(Feb.,Nov.), Nong Wai Dam(Feb.,May,Aug.,Nov.), Nam Phong Pumping Station(May.,Aug.,Nov.), 100-metre Under Huai Chod Lake estuary(Jun.,Aug.,Nov.), 100-metre Above Huai Chod Lake estuary, Nam Phong(Jun.,Aug.,Nov.), Khok Sung(Jun.,Aug.,Nov.), Ban Bo Nok Kao (Jun.,Nov.) Ubonrat, Khon Kaen
Chi	3	1.3 - 9.5 5.8 88%(42/48)	0.1 - 7.3 1.4 73%(35/48)	<18 - ≥16,000 495 100%(48/48)	18 - ≥16,000 130 96%(46/48)	0.07 - 1.23 0.52 48%(23/48)	DO Ban Tha Tum(Jun.[1]), Wat Ban Din Dam(Jun.) Muang, Maha Sarakham BOD Maha Chanaphai(Aug.[2]), Muang,(Aug.) Yasothon, Selaphum, Roi Et(Feb.), Ban Kaeng Kham Bridge connecting Chaiyaphum and Nakhon Ratchasima (Aug.) FCB Wat Ban Din Dam(Aug.), Ban Tha Phra, Muang, Khon Kaen (Aug.[4]) NH_3 Warin Chamrap(May[5],Aug.), Khueang Nai(Feb.,May,Aug.,Nov.) Ubon Ratchathani, Maha Chanaphai(Feb.,May,Aug.), Muang,(Feb.,May,Aug.) Yasothon, Selaphum, Roi Et(Feb.,May,Aug.,Nov.), Ban Tha Tum(Jun.,Dec.), Ban Din Dam(Jun.,Dec.) Muang, Maha Sarakham, Muang, Khon Kaen(Dec.), Ban Kaeng Kham Bridge connecting Chaiyaphum and Nakhon Ratchasima (Deb.,Jun.), Ban Khwao, Chaiyaphum(Feb.,Jun.)
Mun	3	2.0 - 8.5 5.7 94%(68/72)	0.1 - 5.9 1.5 69%(50/72)	20 - >160,900 1,100 97%(70/72)	<20 - >160,900 170 94%(68/72)	ND – 2.40 0.10 82%(59/72)	BOD Chum Phuang(Nov.), Phimai(Feb.[2]) Nakhon Ratchasima TCB Phibun Mangsahan, Ubon Ratchathani(May,Nov.[3]) FCB Phibun Mangsahan (Nov.[4]), Tha Tum Surin(May), Satuek, Buri Ram(May,Aug.) NH_3 Ban Tha Phae, Khong Chiam(May.,Aug.), Under Pak Mun Dam, Ban Hua Heo(Feb.,May), Above Pak Mun Dam, Ban Hua Heo(May) Khong Chiam, Phibun Mangsahan (May,Aug.), Hat Wat Tai(May), Democracy Bridge(May), Hat Khu Duea(May) Muang, Chi - Mun junction, Ban Tha Khon Mai Yung, Warin Chamrap (May,Aug.) Ubon Ratchathani, The Bridge links between Khu Mueang and Phutthaisong, Buri Ram(May[5])
Standard for water resources category 2		≥ 6.0	≤1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] The areas that have the lowest level of DO [2] The areas that have the highest level of BOD [3] The areas that have the highest level of TCB [4] The areas that have the highest level of FCB [5] The areas that have the highest level of NH3-N *NH3-N ND (non – detected) = 0.01*

Table C-5 Water Quality Index and Problematic Areas in the Northeastern Region (Continued)

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Songkhram	3	5.4 - 9.6 6.6 100%(20/20)	0.3 - 2.0 1.0 100%(20/20)	<30 – 2,400 230 100%(20/20)	<30 – 930 120 100%(20/20)	ND – 0.30 0.15 100%(20/20)	-
Upper Lam Takhong	3	2.2 - 10.8 6.5 85%(17/20)	0.3 - 4.8 1.6 65%(13/20)	<20 - ≥16,000 1,050 100%(20/20)	<20 – ≥16,000 75 90%(18/20)	ND – 0.60 ND 95%(19/20)	BOD Ban Kut Chanuan, Mittraphap,(Nov.), Lam Takhong Pumping Station (Nov.) Si Khiu, Nong Sarai(Nov[2]) Pak Chong, Nakhon Ratchasima FCB Ordnance Dept. Bridge(Aug.[4]), Nong Sarai(Aug.[4]) Pak Chong, Nakhon Ratchasima NH_3 Khanong Phra(May[5]) Pak Chong, Nakhon Ratchasima
Lower Lam Takhong	4	1.2 - 6.8 2.6 75%(6/8)	2.7 - 6.1 4.4 50%(4/8)	5,000 – ≥16,000 16,000 100%(8/8)	<20 – ≥16,000 16,000 38%(3/8)	ND – 2.10 ND 88%(7/8)	DO Wat Samakkhi Community, Nai Muang(Feb.,May[1]) Muang, Nakhon Ratchasima BOD Ban Yong Yang, Pa Nao(Feb.,Aug.[2]), Wat Samakkhi Community(May,Aug.) Muang, Nakhon Ratchasima FCB Ban Yong Yang, Pa Nao(May[4],Aug.[4],Nov.[4]), Wat Samakkhi Community(Aug.[4],Nov.[4]) Muang, Nakhon Ratchasima NH_3 Wat Samakkhi Community(May[5])
Lam Paw	2	0.9 - 8.8 4.9 20%(4/20)	0.9 - 4.4 1.6 45%(9/20)	130 - 3,500 640 100%(20/20)	45 – 790 150 100%(20/20)	0.18 - 3.06 0.81 40%(8/20)	DO Rong Kham, Kalasin(Jun.[1]) BOD Kamalasai, Kalasin(Jun.[2]) NH_3 Rong Kham (Feb.), Kamalasai(Feb.,Jun.[5],Dec.), Ban Don Sanuan(Feb.,Jun.,Dec.), Bridge of Lam Paw River(Feb.,Jun.,Dec.), Under Lam Paw Dam(Feb.,Jun.) Muang, Kalasin
Siao	3	4.5 - 8.5 6.5 70%(14/20)	0.3 - 6.4 1.8 45%(9/20)	14 - 4,900 410 100%(20/20)	7 – 330 78 100%(20/20)	ND - 1.23 0.37 60%(12/20)	BOD Suwannaphum, Roi Et(May[2]) NH_3 Suwannaphum(Feb.,May[5],Aug.), Kaset Wisai(Feb.,May,Aug.) Roi Et, Borabu, Maha Sarakham(Jun.,Aug.)
Loei	3	4.8 - 10.4 6.8 100%(20/20)	1.0 - 2.7 1.5 90%(18/20)	150 - 24,000 1,415 90%(18/20)	<30 - 24,000 230 95%(19/20)	ND - 1.12 0.20 90%(18/20)	TCB Ban Mai, Muang, Loei(Feb.[3]), Wang Saphung, Wang Saphung, Loei(Feb.[3]) FCB Ban Mai, Muang, Loei(Feb.[4]) NH_3 Ban Mai, Muang, Loei(Feb.[5],Jun.)
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] The areas that have the lowest level of DO [2] The areas that have the highest level of BOD [3] The areas that have the highest level of TCB [4] The areas that have the highest level of FCB [5] The areas that have the highest level of NH3-N NH3-N ND (non – detected) = 0.01

Table C-5 Water Quality Index and Problematic Areas in the Northeastern Region (Continued)

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Un	3	4.0 – 8.3 5.7 44%(7/16)	1.0 - 1.8 1.3 88(14/16)	<30 – 2,400 430 100%(16/16)	<30 – 230 36 100%(16/16)	ND - 0.28 0.12 100%(16/16)	-
Lam Chi	3	4.5 - 8.5 6.7 55%(11/20)	0.1 – 5.2 1.7 40%(8/20)	40 - ≥16,000 315 85%(17/20)	<20 – ≥16,000 80 90%(18/20)	ND – 0.10 ND 100%(20/20)	BOD Muang, Surin(Aug.[2]), Sung Noen, Krasang, Buri Ram(Aug.[2]) FCB Nong Teng(Feb.), Sung Noen(Feb.[4]) Krasang, Buri Ram
Nong Han	-	3.8 - 9.7 7.8 96%(27/28)	0.4 - 4.3 1.0 82%(23/28)	<30 – 430 36 100%(28/28)	<30 – 430 30 100%(28/28)	ND - 1.03 0.17 89%(25/28)	BOD Ku Mak Seu Wastewater Treatment(May[2],Nov.) Sakon Nakhon NH_3 Ku Mak Seu Wastewater Treatment(Feb.,May,Aug.[5])
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] The areas that have the lowest level of DO [2] The areas that have the highest level of BOD [3] The areas that have the highest level of TCB [4] The areas that have the highest level of FCB [5] The areas that have the highest level of NH3-N NH3-N ND (non – detected) = 0.01

Table C-6 Heavy Metal Monitoring Results and Problematic Areas in the Northeastern Region

Parameter	The range of Min - Max (mg/l)	The Standard of Surface Water Quality (mg/l)	Areas that Exceed the Standard / Problematic Areas
Cd 0.6%(1/180)*	ND – 4.75	≤0.005, ≤0.05	Chi River Warin Chamrap, Ubon Ratchathani(Aug._0.006**)
Total Cr	ND - 0.009	≤0.05***	Not found
Mn 2.8%(5/180)*	ND – 4.75	≤1.0	Chi River Ban Tha Tum, Muang, Maha Sarakham(Jun._4.75**) Lam Paw River Kamalasai(Jun._1.4) ,Ban Don Sanuan, Muang, (Jun._1.31) Kalasin Siao River Rasi Salai, Si Sa Ket(May_2.11, Aug._2.11)
Ni	ND – 0.02	≤0.1	Not found
Pb	ND – 0.02	≤0.05	Not found
Zn 5.0%(9/180)*	ND – 3.84	≤1.0	Chi River Krapho, Tha Tum, Surin(Nov._3.84**) Lower Lam Takhong Nai Mueang, Muang, Nakhon Ratchasima (May_1.72, Aug._1.72) Upper Lam Takhong Lam Takong Dam, Sikhio(May_1.32, Aug._1.32), Ordnance Dept., Pak Chong(May_1.75, Aug._1.75) Nakhon Ratchasima Mun River Phimai, Nakhon Ratchasima(May_1.67, Aug._1.67)
Cu	ND – 0.068	≤0.1	Not found
Hg 5.2%(7/135)*	<0.0005 – 0.01	≤0.002	Lower Lam Takhong Nai Mueang, Muang, Nakhon Ratchasima(Feb._0.0028) Loei River Chiang Khan(Feb._0.0033), Ban Na An(Nov._0.01**) Muang, Loei Mun River Mueang Khong, Rasi Salai, Si Sa Ket(Nov._0.0027), Phimai, Nakhon Ratchasima (Feb._0.004) Phong Nam Phong Pumping Station, Nam Phong, Khon Kaen(Nov._0.0032) Nong Han Pak Nam Phung, Sakon Nakhon(Nov._0.0054)
As 0.6%(1/180)*	ND – 0.011	≤0.01	Chi River Sela Phum, Roi Et(Aug._0.011**)

Remarks

- *The standard value of Cd below 0.005 mg/l applies where water hardness does not exceed 100 mg/l*
- *The standard value of Cd below 0.05 mg/l applies where water hardness exceeds 100 mg/l*
- ** Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that does not meet standards / Number of all monitoring sessions)*
- ***Maximum value*
- **** Is the standard value of hexavalent Cr, but the analysis result was Total Cr*
- *[2] The monitoring station did not meet the heavy metal standards in 2015 and 2016*
- *ND = non-detected (non-detected)*

Cd	=	*0.00006 mg/l*	*Zn*	=	*0.004*	*mg/l*
Total Cr	=	*0.00013 mg/l*	*Cu*	=	*0.002*	*mg/l*
Mn	=	*0.1 mg/l*	*Hg*	=	*0.0005*	*mg/l*
Ni	=	*0.004 mg/l*	*As*	=	*0.0003*	*mg/l*
Pb	=	*0.00013 mg/l*				

Table C-7 Water Quality Index and Problematic Areas in the Eastern Region

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Bang Prakong	3	1.2 – 7.3 4.3 67%(35/52)	0.4 – 3.3 1.4 75(39/52)	130 - 54,000 3,500 92%(48/52)	45 - 35,000 1,045 88%(46/52)	0.03 – 1.48 0.18 90%(47/52)	DO Ton Nam Bang Prakong, Ban Srang, Prachin Buri(May[1]), TCB Bang Prakong Estuary(Aug.), Bang Prakong Bridge(Aug.) Bang Prakong, Pier(Aug.[3]), Wat Hua Sai (Nov.) Bang Khla, Chachoengsao FCB Bang Prakong Bridge(Aug.), BY PASS Bridge, Ban Phoe(Aug.), Bang Phra Bridge(Nov.), Chachoengsao Bridge(Aug.), Muang, Chachoengsao, Pier(Aug.[4]), Wat Hua Sai(Feb.) Bang Khla, Chachoengsao NH_3 Bang Prakong Estuary(Feb.), Bang Prakong Bridge(Nov.), BY PASS Bridge (Nov.), Wat Sai Chon Na Rangsi, Muang(Nov.), Pier(Nov.[5]) Chachoengsao
Prachin Buri	2	1.0 – 8.0 4.1 25%(5/20)	1.0 - 4.5 2.5 5%(1/20)	170 - 35,000 4,050 55%(11/20)	78 - 28,000 1,300 45%(9/20)	0.03 - 0.43 0.08 100%(20/20)	DO Ban Bang Taen, Ban Srang(May[1]), Muang(May) Prachin Buri BOD Kabin Buri, Prachin Buri(May[2]) TCB Ban Srang Bridge, Ban Srang, Prachin Buri(Nov.[3]) FCB Ban Srang Bridge(Nov.[4]), Bridge near Prachin Buri Highway District, Muang (May), Tha Prachum Bridge, Si Maha Phot (May) Prachin Buri
Nakhon Nayok	3	1.0 – 7.2 3.3 40%(8/20)	1.0 – 5.0 2.6 35%(7/20)	230 - 92,000 3,500 95%(19/20)	130 - 4,900 1,100 95%(19/20)	0.03 - 0.50 0.19 100%(20/20)	DO Nakhon Nayok Estuary, Ban Srang, Prachin Buri(May[1]), Sampharng Ongkharak, Ongkharak(Jul.[1]), Wat Amphawan, Banna(Jul.[1],Nov.) Nakhon Nayok BOD Sampharng Ongkharak (Nov.),Banna(Nov.[2]) TCB Nakhon Nayok Bridge, Muang, Nakhon Nayok(May.[3]) FCB Banna(Nov.[4])
Trat	3	3.8 – 10.6 6.4 94%(15/16)	0.4 – 15.2 1.1 88%(14/16)	45 - 24,000 1,245 88%(14/16)	18 – 24,000 410 94%(15/16)	<0.03 - 0.28 0.03 100%(16/16)	BOD Pak Nam Ban Dan Kao(May), Tha Phae Bridge(May[2]) Muang, Trat TCB Pak Nam Ban Dan Kao(May[3]), Tha Phae Bridge(Nov.) Muang, Trat FCB Pak Nam Ban Dan Kao(May[4])
Chanthaburi	3	3.8 – 14.5 6.9 97%(31/32)	0.2 - 11.2 1.1 75%(24/32)	20 - >160,000 4,450 75%(24/32)	<18 - >160,000 640 78%(25/32)	<0.03 – 2.16 0.10 94%(30/32)	BOD Bridge in front of Wat Ang Hin, Ko Khwang(Feb.[2]), Behind KP Grand Hotel Bridge(Feb.,May) Muang, Chanthaburi TCB Wat Ang Hin Bridge, Ko Khwang (May[3],Aug.,Nov.), Behind KP Grand Hotel Bridge(Feb.,May[3],Nov.), Tha Luang Bridge(Feb.,May[3]) Muang, Chanthaburi FCB Immigration office, Ban Thachalab, Muang, Chanthaburi(Nov.), Bridge in front of Wat Ang Hin, Ko Khwang (May.,Nov.), Behind KP Grand Hotel Bridge(May[4],Nov.), Tha Luang Bridge (Feb.,May) NH_3 Behind KP Grand Hotel Bridge(May[5]), Tha Luang Bridge(May) Muang, Chanthaburi
Standard for water resources category 2		≥6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] *The areas that have the lowest level of DO* [2] *The areas that have the highest level of BOD* [3] *The areas that have the highest level of TCB* [4] *The areas that have the highest level of FCB* [5] *The areas that have the highest level of NH3-N* *NH3-N ND (non – detected) = 0.01*

Table C-7 Water Quality Index and Problematic Areas in the Eastern Region (Continued)

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Upper Rayong	3	1.7 – 7.4 4.5 50%(4/8)	1.4 – 4.5 2.2 38%(3/8)	790 - >160,000 9,250 75%(6/8)	140 - >160,000 5,450 50%(4/8)	<0.03 – 0.90 0.38 88%(7/8)	DO Bridge at Ban Khai, Rayong(Nov.[1]) BOD Wat Lahan Rai Sangkaram Bridge, Ban Khai, Rayong(Feb.[2]) TCB Bridge(Feb.), Wat Lahan Rai Sangkaram Bridge(Aug.[3]) Ban Khai, Rayong FCB Bridge(Feb.,May,Aug.), Wat Lahan Rai Sangkaram Bridge, (Aug.[4]) Ban Khai, Rayong NH_3 Bridge at Ban Khai, Rayong(Nov.[5])
Lower Rayong	4	1.4 – 18.9 4.5 94%(15/16)	0.9 – 10.0 2.3 88%(14/16)	3,500 - >160,000 39,000 38%(6/16)	780 - >160,000 6,350 50%(8/16)	0.06 - 1.37 0.39 75%(12/16)	DO Peampongsanta Bridge, Muang, Rayong(Nov.[1]) BOD Thetsaban 8 Bridge, Ban Pak Khlong(Aug.[2]), Chalermchai Bridge(Aug.) Muang, Rayong TCB Thetsaban 8 Bridge, Ban Pak Khlong(May.[3],Aug.), Chalermchai Bridge (May.,Aug.), Peampongsanta Bridge(Feb.,May.[3],Aug.[3],Nov.[3]), Chanthaburi-Rayong Bridge(May.[3],Aug.) Muang, Rayong FCB Thetsaban 8 Bridge, Ban Pak Khlong (May,Aug.), Chalermchai Bridge(May), Peampongsanta Bridge(Feb.,May,Aug.,Nov.[4]), Chanthaburi-Rayong Bridge(May) Muang, Rayong NH_3 Chalermchai Bridge (May),Peampongsanta Bridge(Feb.,May,Nov.[5])
Pra Sae	3	3.9 - 8.3 5.9 95%(19/20)	0.9 – 3.7 1.9 55%(11/20)	170 - >160,000 3,500 85%(17/20)	<18 - 92,000 865 90%(18/20)	<0.03 - 0.36 0.08 100%(20/20)	TCB Pra Sae Estuary(Nov.), Thale Noi-Tha Kra Pak Bridge(Aug.), Ban Pho Thong Bridge(Feb.[3]) Klaeng, Rayong FCB Pra Sae Estuary(Nov.), Ban Pho Thong Bridge(Feb.[4]) Klaeng, Rayong
Upper Phang Rat	3	5.4 – 9.6 7.0 100%(8/8)	1.4 – 9.8 4.3 13%(1/8)	1,700 - >160,000 32,500 50%(4/8)	330 - 160,000 2,300 63%(5/8)	0.03 – 0.73 0.13 75%(6/8)	BOD Wat Yan Sue, Moo 4, Ban Yan Sue, (Feb.,May), Na Yaiarm Bridge, Moo 1 Sukhumvit Rd.(Feb.,May[2]) Na Yaiarm, Na Yaiarm, Chanthaburi TCB Wat Yan Sue(May), Na Yaiarm Bridge(Feb.[3],May[3],Nov.) FCB Na Yaiarm Bridge (Feb.,May[4],Aug.) NH_3 Wat Yan Sue(May[5]), Na Yaiarm Bridge,(Feb.)
Lower Phang Rat	2	4.7 - 7.1 5.8 38%(3/8)	0.6 - 1.9 0.9 88%(7/8)	130 – 3,500 815 100%(8/8)	20 - 1,300 225 88%(7/8)	<0.03 - 0.28 0.11 100%(8/8)	-
Welu	2	3.6 – 7.7 5.4 36%(10/28)	0.2 - 2.9 1.3 75%(21/28)	<18 - >160,000 465 71%(20/28)	<18 – 22,000 33 79%(22/28)	<0.03 -2.55 0.11 93%(26/28)	TCB Moo 2, Ban Laem Peta(May[3]), Ban Laem Ngun, Moo 3(May), Wan Yao Canal Estuary, Moo 8(May[3]) Khlung, Chanthaburi FCB Moo 2, Ban Laem Peta(May), Jai Jam Bridge, Moo 7, Ban Tha Chot, Saen Tung, Khoa Saming, Trat(May), Ban Laem Ngun, Moo 3(May), Wan Yao Estuary, Moo 8 (May[4]) Khlung, Chanthaburi NH_3 Jai Jam Bridge (May), Pa Nom Pick Canal Estuary (May[5]) Khoa Saming, Trat
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] The areas that have the lowest level of DO [2] The areas that have the highest level of BOD [3] The areas that have the highest level of TCB [4] The areas that have the highest level of FCB [5] The areas that have the highest level of NH3-N NH3-N ND (non – detected) = 0.01

Table C-8 Heavy Metal Monitoring Results and Problematic Areas in the Eastern Region

Parameter	The range of Min - Max (mg/l)	The Standard of Surface Water Quality (mg/l)	Areas that Exceed the Standard / Problematic Areas
Cd	ND – 0.0030	≤0.005 , ≤0.05	Not found
Total Cr	ND – 0.0227	≤0.05***	Found Areas that Exceed the Standard / Problematic Areas
Mn	0.1 – 0.950	≤1.0	Not found
Ni	ND – 0.017	≤0.1	Not found
Pb	ND – 0.010	≤0.05	Not found
Zn	ND – 0.040	≤1.0	Not found
Cu	ND – 0.017	≤0.1	Not found
Hg	0.00 – 0.002	≤0.002	Not found
As	<0.01 – 0.010	≤0.01	Not found

Remarks

- *The standard value of Cd below 0.005 mg/l applies where water hardness does not exceed 100 mg/l*
- *The standard value of Cd below 0.05 mg/l applies where water hardness exceeds 100 mg/l*
- ** Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that does not meet standards / Number of all monitoring sessions)*
- ***Maximum value*
- **** Is the standard value of hexavalent Cr, but the analysis result was Total Cr*
- *[2] The monitoring station did not meet the heavy metal standards in 2015 and 2016*
- *ND = non-detected (non-detected)*

Cd	=	*0.00006*	*mg/l*	*Zn*	=	*0.004*	*mg/l*
Total Cr	=	*0.00013*	*mg/l*	*Cu*	=	*0.002*	*mg/l*
Mn	=	*0.1*	*mg/l*	*Hg*	=	*0.0005*	*mg/l*
Ni	=	*0.004*	*mg/l*	*As*	=	*0.0003*	*mg/l*
Pb	=	*0.00013*	*mg/l*				

Table C-9 Water Quality Index and Problematic Areas in the Southern Region

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Upper Tapi	2	7.6 -9.1 7.9 100%(4/4)	0.2 – 1.0 0.5 100%(4/4)	490 - 9,200 4,450 50%(2/4)	130 – 1,700 790 75%(3/4)	<0.05 – <0.05 <0.05 100%(4/4)	-
Lower Tapi	3	4.5 - 8.5 6.4 100%(24/24)	0.6 – 3.7 1.4 71%(17/24)	490 - 160,000 8,100 75%(18/24)	45 - 160,000 1,700 71%(17/24)	<0.05 – <0.05 <0.05 100%(24/24)	TCB Tha Thong Pier, Ban Pak Nam(Aug), Ban Don Pier(Feb.[3],Aug.,Dec.) Muang, Surat Thani, Phun Phin, Surat Thani(Aug.[3]), Chawang, Nakhon Si Thammarat(Nov.) FCB Tha Thong Pier, Ban Pak Nam(Aug.,Dec.), Ban Don Pier(Feb.[4],May,Aug.,Dec.) Muang, Surat Thani, Phun Phin(Aug.) Surat Thani
Phum Duang	3	4.8 – 8.0 6.4 100%(16/16)	0.3 – 3.8 1.1 88%(14/16)	40 - 24,000 2,850 94%(15/16)	4.0 – 2,400 330 100%(16/16)	<0.05 – <0.05 <0.05 100%(16/16	TCB Khiri Rat Nikhom, Surat Thani(Aug.[3])
Pak Phanang	3	2.8 – 8.1 6.1 93%(26/28)	0.8 - 6.5 2.4 39%(11/28)	230 - 160,000 8,100 89%(25/28)	78 - 17,000 790 79%(22/28)	<0.05 – <0.05 <0.05 100%(28/28)	BOD Estuary(May[2],Aug.), Ferry Pier(May,Aug.), U Thok Vibhaja Prasid Barrage (May) Pak Phanang, Nakhon Si Thammarat TCB Ferry Pier, Pak Phanang, Nakhon Si Thammarat (Feb.,Aug.), Tha Samet, Cha-uat, Nakhon Si Thammarat (Aug.[3]) FCB Ferry Pier(May,Aug.,Nov.), Tha Samet, Cha-uat, Nakhon Si Thammarat(May,Aug.[4],Nov.)
Chumphon	3	2.6 – 7.7 6.9 92%(11/12)	0.9 – 3.8 1.5 67%(8/12)	790 - >160,000 15,500 58%(7/12)	170 - 92,000 3,500 67%(8/12)	<0.05 – <0.05 <0.05 100%(12/12)	TCB Chumphon Estuary, Moo 9, Ban Don Song(May[3],Aug.,Nov.), Moo 4, Pak Nam Rd., Tha Yang(Aug.,Nov.) Muang, Chumphon FCB Chumphon Estuary, Moo 9, Ban Don Song(May[4],Aug.,Nov.), Moo 4, Pak Nam Rd., Tha Yang (Aug.) Muang, Chumphon
Upper Lang Suan	2	7.2 – 8.5 7.9 100%(8/8)	0.8 – 2.2 1.1 75%(6/8)	330 - 35,000 12,600 25%(2/8)	49 - 5,400 1,750 38%(3/8)	<0.05 – <0.05 <0.05 100%(8/8)	TCB Khan Ngoen, Lang Suan, Chumphon(Feb.[3],Aug.) FCB Khan Ngoen, Lang Suan, Chumphon(Aug.[4]), Wat Pang Wan, Moo 5, Ban Ton Pong, Pang Wan, Phato, Chumphon(Aug.)
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] *The areas that have the lowest level of DO* [2] *The areas that have the highest level of BOD* [3] *The areas that have the highest level of TCB* [4] *The areas that have the highest level of FCB* [5] *The areas that have the highest level of NH3-N* *NH3-N ND (non – detected) = 0.01*

Table C-9 Water Quality Index and Problematic Areas in the Southern Region (Continued)

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Lower Lang Suan	3	4.9 - 7.9 7.5 100%(8/8)	0.4 – 3.2 1.6 63%(5/8)	490 - 54,000 16,500 75%(6/8)	490 - 9,200 3,150 88%(7/8)	<0.05 – <0.05 <0.05 100%(8/8)	TCB Estuary, Bang Maphrao(Aug.[3]), Laem Sai(Nov.) Lang Suan, Chumphon FCB Laem Sai, Lang Suan, Chumphon(May[4])
Trang	3	2.9 - 7.4 5.8 80%(16/20)	0.4 – 2.0 0.8 100%(20/20)	40 - 35,000 1,070 95%(19/20)	40 – 7,900 185 85%(17/20)	<0.10 – 0.29 0.10 100%(20/20)	TCB PWA Huai Yot Pumping Station, Huai Yot, Trang(Dec.[3]) FCB Estuary, Kantang, Trang(Feb.,Aug.,Dec.[4])
Upper Pattani	2	5.0 – 8.2 6.1 58%(7/12)	0.5 – 2.0 1.4 58%(7/12)	330 - 5,400 865 92%(11/12)	68 - 3,500 490 75%(9/12)	<0.005 – 0.19 0.02 100%(12/12)	-
Lower Pattani	3	4.8 – 7.2 6.1 100%(8/8)	0.7 – 2.0 1.4 100%(8/8)	790 - 16,000 5,450 100%(8/8)	61 - 16,000 795 63%(5/8)	0.01 – 0.28 0.13 100%(8/8)	FCB Pak Nam Pattani, Bana, Muang Pattani(May[4],Aug.,Nov.)
Sai Buri	3	3.5 - 8.0 6.7 94%(15/16)	0.5 - 2.0 1.2 100%(16/16)	330 – 16,000 1,300 100%(16/16)	23 – 5,400 595 88%(14/16)	<0.005 – 0.20 0.05 100%(16/16)	FCB Pak Nam, Sai Buri, Pattani(Nov.[4]), Moo 1, Kayu Boko, Raman, Yala(Aug.[4])
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] The areas that have the lowest level of DO [2] The areas that have the highest level of BOD [3] The areas that have the highest level of TCB [4] The areas that have the highest level of FCB [5] The areas that have the highest level of NH3-N NH3-N ND (non – detected) = 0.01

Table C-9 Water Quality Index and Problematic Areas in the Southern Region (Continued)

Water Resource	Types of Water Resources	Min - Max, Median, and Percentage*					Areas With Water Quality Problems
		DO (mg/l)	BOD (mg/l)	TCB (MPN/100 ml)	FCB (MPN/100 ml)	NH3-N (mg/l)	
Thale Noi	-	1.6 - 6.1 4.9 92%(11/12)	0.7 – 11.4 4.3 42%(5/12)	23 - 9,200 895 100%(12/12)	20 - 2,400 199 100%(12/12)	<0.005 – 0.78 0.13. 83%(10/12)	DO Nang Riam Canal, Khuan Khanun, Phatthalung(Nov.[1]) BOD Ban Thale Noi, Pra Nang Tung(Feb.,May,Nov.[2]), Mid Thale Noi(Feb.), Nang Riam Canal (Feb.,May,Nov.) Khuan Khanun, Phatthalung NH_3 Ban Thale Noi, Pra Nang Tung, Khuan Khanun, Phatthalung(Aug.,Nov.[5])
Thale Luang	-	3.6 – 6.9 5.8 100%(20/20)	0.7 – 5.6 2.5 75%(15/20)	20 - 16,000 640 100%(20/20)	20 - 16,000 280 85%(17/20)	<0.005 – 0.30 0.06 100%(20/20)	BOD Ban Rong Canal's Estuary(Feb.,May,Aug.,Nov.), Mid Thale Luang (Feb.[2]) Ranot, Songkhla FCB Ban Rong Canal's Estuary, Ranot, Songkhla (Nov.[4]), Lam Pa Canal's Estuary, Muang, Phatthalung(Nov.), Pak Phayun, Pak Phayun, Phatthalung(Aug.[4])
Songkhla Lake	-	0.0 - 7.4 5.3 68%(19/28)	0.8 – 27.9 2.0 54%(15/28)	<1.8 - 160,000 185 96%(27/28)	<1.8 - 160,000 45 89%(25/28)	<0.005 – 9.75 0.04 82%(23/28)	DO Samrong Canal's Estuary (Aug.[1],Nov.), Songkhla Lake's Estuary(Feb.) Muang,Songkhla BOD Phawong Canal's Estuary, Hat Yai(Aug.,Nov.), Ko Yor Bridge, Ko Yor(Aug.), Samrong Canal's Estuary(Aug.[2],Nov.), Songkhla Lake's Estuary, Muang,(Feb.) Songkhla TCB Samrong Canal's Estuary, Muang, Songkhla(Aug.[3]) FCB Samrong Canal's Estuary, Muang(Aug.[4],Nov.),Au Tapao Canal's Estuary, Rattaphum(Nov.)Songkhla NH_3 Au Tapao Canal's Estuary, Rattaphum(Aug.,Nov.), Samrong Canal's Estuary Muang, (Aug.[5],Nov.), Phawong Canal's Estuary, Hat Yai (Nov.) Songkhla
Standard for water resources category 2		≥ 6.0	≤ 1.5	≤ 5,000	≤ 1,000	≤ 0.5	For problematic water quality, the following will be considered: DO less than 2.0 mg/l, BOD more than 4.0 mg/l, TCB more than 20,000 MPN/100 ml, FCB more than 4,000 MPN/100 ml, NH_3 more than 0.5 mg/l
Standard for water resources category 3		≥ 4.0	≤ 2.0	≤ 20,000	≤ 4,000	≤ 0.5	
Standard for water resources category 4		≥ 2.0	≤ 4.0	-	-	≤ 0.5	

Remarks * Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that did not meet standards / Number of all monitoring sessions)

[1] The areas that have the lowest level of DO [2] The areas that have the highest level of BOD [3] The areas that have the highest level of TCB [4] The areas that have the highest level of FCB [5] The areas that have the highest level of NH3-N NH3-N ND (non – detected) = 0.01

Table C-10 Heavy Metal Monitoring Results and Problematic Areas in the Southern Region

Parameter	The range of Min - Max (mg/l)	The Standard of Surface Water Quality (mg/l)	Areas that Exceed the Standard / Problematic Areas
Cd	<0.001 – 0.009	≤0.005 , ≤0.05	Not found
Total Cr	<0.001– 0.038	≤0.05***	Not found
Mn 2.6%(2/77)	<0.004 – 2.4	≤1.0	Thale Noi, Ban Thale Noi, Khuan Khanun, Phatthalung(Nov_1.25), Nang Riam Canal, Khuan Khanun, Phatthalung(Nov_2.4**)
Ni	0.001 – 0.070	≤0.1	Not found
Pb	<0.001 – 0.014	0.05	Not found
Zn 1.3%(1/78)	0.014 – 2.038	≤1.0	Thale Luang Lam Pa Canal's Estuary, Muang, Phatthalung(Feb_2.038**)
Cu	<0.001 – 0.005	≤0.1	Not found
Hg 1.3%(1/78)	<0.0005 – 0.002	≤0.002	Pak Phanang River Pak Phanang Fang Tawan-ok, Pak Phanang, Nakhon Si Thammarat(Nov_0.0024**)
As	0.001 – 0.010	≤0.01	Not found

Remarks

- *The standard value of Cd below 0.005 mg/l applies where water hardness does not exceed 100 mg/l*
- *The standard value of Cd below 0.05 mg/l applies where water hardness exceeds 100 mg/l*
- ** Percentage of monitoring sessions that exceeded standards (Number of monitoring sessions that does not meet standards / Number of all monitoring sessions)*
- ***Maximum value*
- **** Is the standard value of hexavalent Cr, but the analysis result was Total Cr*
- *[2] The monitoring station did not meet the heavy metal standards in 2015 and 2016*
- *ND = non-detected (non-detected)*

Cd	=	*0.00006*	*mg/l*	*Zn*	=	*0.004*	*mg/l*
Total Cr	=	*0.00013*	*mg/l*	*Cu*	=	*0.002*	*mg/l*
Mn	=	*0.1*	*mg/l*	*Hg*	=	*0.0005*	*mg/l*
Ni	=	*0.004*	*mg/l*	*As*	=	*0.0003*	*mg/l*
Pb	=	*0.00013*	*mg/l*				

Table C-11 Water qualitied compared with the classified water quality standard by water source.

Water source classified as category 2 for water conservation for aquatic life, fishery, swimming and water sport (20 water sources)

No.	Water Resource	Parameters not meeting standard	Areas With Water Quality Problems	Main Source of Pollution
1	Upper Tapi	TCB	Phipun, Nakhon Si Thammarat	- Agricultural Area (Rubber Plantation)
2	Lam Chi	DO, BOD	Tha Tum, Muang, Surin	- Mahout Community - Surin Municipality
3	Kwae Noi	DO	Muang, Sai Yok, Thong Phaphum, Kanchanaburi	- Kanchanaburi Municipality - Tourism Activities Shops Restaurant in Sai Yok Waterfall Area
4	Welu	DO	Khoa Saming, Trat Khlung, Chanthaburi	- Aquaculture (Shrimp Cage Farming, Shellfish Cage Farming) - Fisherman Community - Khlung Municipality
5	Un	DO, BOD	Si Songkhram, Nakhon Phanom Phannanikhom, Sakon Nakon	- Riverside Community - Agricultural Area (Rice)
6	Mae Chan	DO, BOD	Mae Tha, Lampang	- Agricultural Area - Nam Cho Municipality - Na Khua Municipality
7	Ing	DO, BOD	Chun, Muang, Phayao	- Agricultural Area (Rice) - Phayao Municipality
8	Upper Phetchaburi	DO	Mostly, at the rear end of the dam, the DO is lower than the specified standard value, where water drainage occurs at the lower level of the dam.	-
9	Kwae Yai	DO	- Muang, Kanchanaburi - Mostly, at the rear end of the dam, the DO is lower than the specified standard value, where water drainage occurs at the lower level of the dam.	- Rafting business, such as Tourist Raft, Restaurant Raft, Transport Raft - Kanchanaburi Municipality
10	Li	DO, BOD,TCB, FCB	Wiang Nong Long, Li, Lamphun	- Agricultural Area (Orchard)
11	Upper Pattani	DO, BOD, TCB, FCB	Muang, Ban Nang Sata, Yala	- Yala Municipality - Bannang Sata Municipality - Livestock (Cattle, Goat)
12	Lower Phang Rat	DO, BOD, TCB, FCB	Chang Kham, Na Yaiarm, Chanthaburi	- Aquaculture (Shrimp Cage Farming, Shellfish Cage Farming) - Agricultural Area (Rice) - Fisherman Community
13	Upper Lang Suan	BOD, TCB, FCB	Lang Suan, Phato, Chumphon	- Community
14	Kok	TCB, FCB	Mae Chan, Muang, Chiang Rai	- Agricultural Area (Rice) - Chiang Rai Municipality
15	Pranburi	DO, BOD, TCB	Pak Nam to Phet Kasem Rd., Ban Rong Sup, Khao Noi, Pran Buri, Prachuap Khiri Khan	- Khao Noi Municipality - Fisherman Community
16	Siao	DO, BOD, NH_3-N	Kaset Wisai, Kaset Wisai, Roi Et Borabu, Maha Sarakham	- Agricultural Area (Rice) - Livestock (Pig, Chicken) - Kaset Wisai, Suwannaphum Municipality
17	Lam Paw	DO, BOD,TCB, NH_3-N	Rong Kham, Muang, Kalasin	- Kalasin Municipality - Chai Nat Municipality - Agricultural Area (Rice)
18	Upper Chao Phraya	DO, BOD, TCB, FCB	Muang, Chai Nat Phayuha Khiri, Muang, Nakhon Sawan	- Nakhon Sawan Municipality - Agricultural Area (Rice)
19	Prachin Buri	DO, BOD, TCB, FCB	Ban Sang, Muang, Srimahapho, Prachin Buri	- Agricultural Area (Rice) - Fish Cage Farming - Prachin Buri Municipality - Industrial Plants
20	Upper Tha Chin	DO, BOD, TCB, FCB	Muang, Sam Chuk, Suphan Buri Hanka, Chai Nat	- Agricultural Area (Rice) - Suphan Buri Municipality - Sam Chuk Municipality

Table C-11 Water qualitied compared with the classified water quality standard by water source. (Continued)

Water sources classified as Category 3 for agricultural activities (35 sources)

No.	Water Resource	Parameters not meeting standard	Areas With Water Quality Problems	Main Source of Pollution
1	Trang	-	-	Meet the quality standard by water source
2	Songkhram	-	-	Meet the quality standard by water source
3	Trat	-	-	Meet the quality standard by water source
4	Wang	-	-	Meet the quality standard by water source
5	Phum Duang	-	-	Meet the quality standard by water source
6	Loei	-	-	Meet the quality standard by water source
7	Upper Lam Takhong	BOD	Si Khiu, Pak Chong, Nakhon Ratchasima	- Pak Chong Municipality - Sikhio Municipality - Hotel and Resort Business
8	Sai Buri	FCB	Sai Buri, Pattani	- Taluban Municipality - Aquaculture (Fish Cage Farming) - Fisherman's Pier - pealing and cleaning of seafood - Livestock (Cattle, Goat)
9	Mun	BOD	Chokchai, Nakhon Ratchasima Phibun Mangsahan, Muang, Ubon Ratchathani Satuk, Buri Ram	- Ubon Ratchathani Municipality - Phibun Mangsahan Municipality - Satuk Municipality - Chokchai Municipality
10	Chanthaburi	TCB, FCB	Muang, Chanthaburi	- Aquaculture (Shrimp Farming) - Agricultural Area (Rice)
11	Pra Sae	BOD	Thung Khwai Kin, Klang, Rayong	- Klang Municipality - Aquaculture (Shrimp Farming)
12	Lower Pattani	TCB,FCB	Muang, Pattani	- Fisherman's Pier - Pattani Municipality - Seafood Pealing and Cleaning Industry
13	Yom	BOD, As	Pho Thale, Pho Prathap Chang, Sam Ngam, Phichit	- Agricultural Area (Rice) - Sam Ngam, Phichit Community
14	Mae Klong	DO	Muang, Samut Songkhram	- Samut Songkhram Municipality
15	Nan	BOD, As, Pb, Cd	Taphan Hin, Muang, Phichit Muang, Phitsanulok Phichai, Uttaradit Muang, Tha Wangpha, Nan	- Agricultural Area (Rice) - Taphan Hin, Phichit Community - Muang, Phitsanulok Community - Tha Wangpha, Nan Community
16	Kuiburi	DO, BOD	Muang, Prachuap Khiri Khan	- Prachuap Khiri Khan Municipality
17	Ping	BOD, FCB	Muang, Banphot Phisai, Nakhon Sawan Khanu Woralaksaburi, Kamphaeng Phet	- Agricultural Area (Rice) - Riverside Community - Hotel and Resort Business in Nakhon Sawan Municipality
18	Pak Phanang	BOD	Pak Phanang, Chian Yai, Nakhon Si Thammarat	- Pak Phanang Municipality - Agricultural Area (Rice) - Fish Market Business - Industrial Plants in the area such as Fishmeal Factory - Water in Phru Khuan Khreng
19	Lower Tapi	BOD, FCB	Muang, Surat Thani	- Surat Thani Municipality
20	Lower Lang Suan	FCB	Bang Maphrao, Laem Sai, Lang Suan, Chumphon	- Pak Nam Municipality - Fisherman's Pier

Table C-11 Water qualitied compared with the classified water quality standard by water source. (Continued)

Water sources classified as Category 3 for agricultural activities (35 sources) (Continued)

No.	Water Resource	Parameters not meeting standard	Areas With Water Quality Problems	Main Source of Pollution
21	Chi	BOD, NH_3-N	Khuang Nai, Ubon Ratchathani; Maha Chana Chai, Muang, Yasothon; Sela Phum, Roi Et; Ban Khwao, Chaiyaphum	- Yasothon Municipality - Agricultural Area (Rice)
22	Bang Prakong	DO, BOD, Saltiness	Bang Pakong, Ban Phoe Muang, Bang Khla, Chachoengsao Ban Srang, Prachin Buri	- Agricultural Area (Rice) - Aquaculture (Shrimp Farming, Sea Bass Farming) - Chachoengsao Municipality - Industrial Plants and Industrial Estates
23	Phong	DO, NH_3-N	Muang, Nam Phong, Ubonrat, Khon Kaen	- Khon Kaen Municipality - Agricultural Area (Rice) - Aquaculture (Fish Cage Farming)
24	Chumphon	BOD, TCB, FCB	Muang, Chumphon	- Chumphon, Pak Nam Municipality - Fish Market - Seafood Processing Plant
25	Noi	DO	Bang Sai, Phak Hai, Phra Nakhon Si Ayutthaya	- Agricultural Area (Rice) - Phak Hai Municipality
26	Central Chao Phraya	DO	Muang, Nonthaburi Muang, Sam Khok, Pathum Thani	- Nonthaburi City Municipality - Pathum Thani Municipality - Agricultural Area (Rice)
27	Nakhon Nayok	DO, BOD	Ban Srang, Prachin Buri Ongkharak, Ban Na, Muang, Nakhon Nayok	- Agricultural Area (Rice) - Aquaculture (Fish Cage Farming) - Industrial Plants such as Paper Mill - Nakhon Nayok Municipality
28	Kuang	DO, BOD, TCB, FCB, NH_3-N	Muang, Lamphun	- Lamphun Municipality - Industrial
29	Pasak	BOD, TCB	Tharua, Phra Nakhon Si Ayutthaya Muang, Kengkoi, Saraburi Chai Badan, Lop Buri Wichian Buri, Nong Phai, Muang, Lhomsak, Phetchabun	- Agricultural Area (Rice) - Aquaculture (Fish Cage Farming) - Saraburi Municipality - Phetchabun Municipality - Cement Factory, Feed Mill Factory
30	Sakaekrang	DO, BOD	Muang, Uthai Thani	- Uthai Thani Municipality - Agricultural Area (Rice) - Aquaculture (Fish Cage Farming)
31	Lower Phetchaburi	DO, BOD, TCB, FCB	Ban Laem, Muang, Phetchaburi	- Phetchaburi Municipality
32	Upper Rayong	DO, BOD, TCB, FCB, NH_3-N	Bankhai, Rayong	- Agricultural Area (Rice) - Bankhai Municipality - Industrial Plants and Industrial Estates
33	Lopburi	DO, BOD, TCB, FCB	Muang, Ban Phreak, Phra Nakhon Si Ayutthaya Muang, Tha Wung, Lop Buri Muang, Sing Buri	- Agricultural Area (Rice) - Phra Nakhon Si Ayutthaya Municipality - Lop Buri Municipality - Sing Buri Municipality
34	Upper Phang Rat	BOD, TCB, FCB, NH_3-N	Na Yai Am, Na Yaiarm, Chanthaburi	- Na Yaiarm Municipality - Industrial Plants
35	Central Tha Chin	DO, BOD, TCB, FCB	Bang Len, Nakhon Pathom Song Phi Nong, Suphan Buri	- Suphan Buri Municipality - Agricultural Area (Rice) - Aquaculture (Fresh Water Shrimp, Catfish, Snake-Head Fish)

Table C-11 Water qualitied compared with the classified water quality standard by water source. (Continued)

Water sources classified as Category 4 for industrial activities (4 sources)

No.	Water Resource	Parameters not meeting standard	Areas With Water Quality Problems	Main Source of Pollution
1	Lower Rayong	Meet the quality standard by water source Category 4		
2	Lower Lam Takhong	DO, BOD	Muang, Nakhon Ratchasima	- Nakhon Ratchasima Municipality
3	Lower Chao Phraya	DO, BOD, NH_3-N	Muang, Samut prakarn to Bang Krui, Nonthaburi	- Samut prakarn Municipality - Phra Pradaeng Municipality - Bangkok - Bang Kruai Municipality - Industrial Plants
4	Lower Tha Chin	DO ,BOD, NH_3-N	Muang, Samut Sakhon to Nakhon Chaisi, Nakhon Pathom	- Samut Sakhon Municipality - Om Noi Municipality - Krathum Baen Municipality - Rai Khing Municipality - Sam Phran Municipality

Remark: *The water quality standard for surface water is classified into 5 categories as follow:*
Category 1 For Ecosystem Conservation and Natural Reproduction of Living Things
Category 2 Conservation for aquatic life, fishery, swimming, and water sports
Category 3 For agricultural activities
Category 4 For industrial activities
Category 5 For transportation

Appendix D

The Community Sewage Treatment Systems Nationwide

Table D-1 The 101 community sewage treatment systems nationwide

No.	Regional	Municipality	Province	Type	Water treatment capacity (m^3/day)	Status	Construction Budget Source	Cost (Million Baht)	The Operation Office	Collection Fee
1	North	Chiang Rai Muni.	Chiang Rai	AL	27,200	Running	PWD	529	DLA	None
2	North	Chiang Mai Muni.	Chiang Mai	AL	55,000	Running	PWD	490	WMA	None
3	North	Lamphun Muni.	Lamphun	AS (SBR)	10,000	Running	PDP	583	DLA	None
4	North	Phayao Muni.	Phayao	SP	9,700	Running	PWD	200	WMA	None
5	North	Sukhothai Thani Muni.	Sukhothai	SP	8,400	Running	PDP	277	DLA	None
6	North	Lampang Muni.	Lampang	SP	24,600	Running	PDP	615	WMA	None
7	North	Phichit Muni.	Phichit	AL	12,000	Running	PWD	180	DLA	None
8	North	Nan Muni.	Nan	SP	8,259	Running	PDP	475	DLA	None
9	North	Phitsanulok Muni.	Phitsanulok	SP	25,000	Out of Order	PWD + PDP	623	-	None
10	North	Taphan Hin Muni.	Phichit	SP	7,600	Running	PDP	120	DLA	None
11	North	Chum Saeng Muni.	Nakhon Sawan	SP	1,650	Running	PDP	36	DLA	None
12	North	Tak Muni.	Tak	SP	5,400	Running	PDP	66	DLA/WMA	None
13	North	Mae Sot Muni.	Tak	SP	11,000	Running	PDP	305	WMA	Yes
14	North	Kamphaeng Phet Muni.	Kamphaeng Phet	SP	13,500	Running	PDP	230	WMA	None
15	North	Salok Bat Muni.	Kamphaeng Phet	SP	500	Running	PWD	10	DLA	None
16	North	Uthai Thani Muni.	Uthai Thani	SP	9,000	Under construction	PDP	489	-	None
17	North	Nakhon Sawan Muni.	Nakhon Sawan	AS (MSBR)	36,000	Running	PDP	716	DLA	None
18	North East	Sakon Nakhon Muni.	Sakon Nakhon	SP+ wetland	16,200	Running	Dept. of Fisheries + PWD	586	DLA	None
19	North East	Tha Rae Muni.	Sakon Nakhon	SP+ wetland	2,054	Running	Environmental Fund	61	DLA	Yes
20	North East	Udon Thani Muni.	Udon Thani	SP	46,950	Running	PDP	738	WMA	None / has been issued
21	North East	Nakhon Phanom Muni.	Nakhon Phanom	SP	8,600	Postponed	PDP	369	-	None
22	North East	Khon Kaen Muni.	Khon Kaen	AL	78,000	Running	PDP	1,083	DLA	None
23	North East	Kosum Phisai Muni.	Maha Sarakham	SP	1,500	Out of Order	Environmental Fund	21	DLA	Yes
24	North East	Maha Sarakham Muni.	Maha Sarakham	SP	4,200	Running	PDP	168	DLA	None
25	North East	Chaiyaphum Muni.	Chaiyaphum	SP	6,000	Running	PDP	56	DLA	None

Table D-1 The 101 community sewage treatment systems nationwide (Continued)

No.	Regional	Municipality	Province	Type	Water treatment capacity (m^3/day)	Status	Construction Budget Source	Cost (Million Baht)	The Operation Office	Collection Fee
26	North East	Kalasin Muni.	Kalasin	AL	14,400	Running	PDP	187	DLA	None
27	North East	Nakhon Ratchasima Muni.	Nakhon Ratchasima	SP+AS	70,000	Running	PWD+PDP	1,421	DLA	None
28	North East	Pak Chong Muni.	Nakhon Ratchasima	SP	12,000	Running	PDP	248	WMA	None
29	North East	Bua Yai Muni	Nakhon Ratchasima	SP	3,000	Running	DOPA + MNRE	29	DLA	None
30	North East	Buri Ram Muni.	Buri Ram	AL	13,000	Running	PWD	249	DLA	Yes
31	North East	Surin Muni.	Surin	SP	13,597	Running	PDP	361	DLA	None
32	North East	Ubon Ratchathani Muni.	Ubon Ratchathani	AL	22,000	Out of Order	PWD	370	DLA	None
33	North East	Warin Chamrap Muni.	Ubon Ratchathani	SP	22,000.	Running	PDP	391	DLA	None
34	North East	Yasothon Muni.	Yasothon	SP	7,246	Running	PDP	502	DLA	None
35	North East	Amnat Charoen Muni.	Amnat Charoen	SP	12,819	Running	PDP	672	WMA	None
36	North East	Mukdahan Muni.	Mukdahan	SP	8,500	Running	Fund	204	WMA	None / has been issued
37	East	Chon Buri (PAO)	Chon Buri	OD	22,500	Running	PWD	565	hiring a private party to operate	Yes
38	East	Phanat Nikhom Muni.	Chon Buri	SP	5,000	Running	PWD	30	DLA	None
39	East	Si Racha Muni.	Chon Buri	OD	18,000	Running	PWD	325	WMA	Yes / has been issued
40	East	Laem Chabang Muni.	Chon Buri	OD	25,000	Running	PWD	115	DLA	None
41	East	Pattaya (Soi Wat Boonkanchana Ram)	Chon Buri	AS	20,000	Running	PWD	359	hiring a private party to operate	Yes
42	East	Pattaya (Soi Wat Nong Yai)	Chon Buri	AS	65,000	Running	PDP (Fund)	1,787	hiring a private party to operate	Yes
43	East	Saen Suk Muni. (South)	Chon Buri	OD	9,000	Running	PWD	816	DLA	Yes
44	East	Saen Suk Muni. (North)	Chon Buri	OD	14,000	Running	PWD	817	DLA	Yes
45	East	Bang Sare Muni.	Chon Buri	SP	5,400	Running	PWD	16	WMA	Yes
46	East	Rayong Muni.	Rayong	AL	41,000	Out of Order	PDP	319	DLA	None
47	East	Ban Phe Muni.	Rayong	OD	8,000	Running	PWD	230	WMA	Yes
48	East	Map Ta Phut Muni.	Rayong	AL	15,000	Running	PWD	287	DLA	None

Table D-1 The 101 community sewage treatment systems nationwide (Continued)

No.	Regional	Municipality	Province	Type	Water treatment capacity (m^3/day)	Status	Construction Budget Source	Cost (Million Baht)	The Operation Office	Collection Fee
49	East	Chanthaburi Muni.	Chanthaburi	SP	17,000	Running	PWD	299	DLA	None
50	East	Khlung Muni.	Chanthaburi	SP	4,500	Running	PDP	128	DLA	None
51	East	Chachoengsao Muni.	Chachoengsao	OD	24,000	Running	PWD	240	DLA	None
52	East	Bang Khla Muni.	Chachoengsao	SP	5,000	Running	PDP	274	DLA	Yes
53	South	Ban Tai (SAO) (Ko Phangan)	Surat Thani	CW	200	Running	TAT	10	DLA	None
54	South	Ko Samui Muni. (Lamai Beach)	Surat Thani	OD	8,650	Running	PWD	420	hiring a private party to operate	None
55	South	Ko Samui (Nathon)	Surat Thani	OD	2,400	Running	PWD	421	hiring a private party to operate	None
56	South	Ko Samui (Chaweng Beach)	Surat Thani	OD	6,000	Running	PWD	422	hiring a private party to operate	None
57	South	Chumphon Muni.	Chumphon	SP	12,000	Postponed	PWD	200	-	None
58	South	Nakhon Si Thammarat Muni.	Nakhon Si Thammarat	SP+CW	33,700	Running	PDP	765	DLA	None
59	South	Thung Song Muni.	Nakhon Si Thammarat	AS (Fix film)	10,000	Running	PDP	257	DLA	None
60	South	Patong Muni.	Phuket	OD	23,250	Running	PWD + PDP (Fund)	616	hiring a private party to operate	None / has been issued
61	South	Phuket Muni.	Phuket	OD	36,000	Running	PWD + MNRE	912	hiring a private party to operate	None
62	South	Karon Muni.	Phuket	AS	6,000	Running	PDP	177	hiring a private party to operate	Yes
63	South	Kathu Muni.	Phuket	OD	6,100	Running	PDP	280	hiring a private party to operate	None
64	South	Trang Muni.	Trang	AL	22,000	Running	PWD	481	DLA	None
65	South	Ao Nang (SAO)	Krabi	AS+CW	400	Running	Denmark's Government Subsidies	28	DLA	None
66	South	Krabi Muni.	Krabi	AL	12,000	Running	PWD	200	WMA	None
67	South	Hat Yai Muni.	Songkhla	SP+CW	138,000	Running	PDP (Fund)	1,784	hiring a private party to operate	Yes
68	South	Songkhla Muni.	Songkhla	AL	35,000	Running	PWD	513	WMA	Yes
69	South	Pattani Muni.	Pattani	SP	27,000	Under construction	PWD	348	-	None
70	South	Yala Muni. (Swamp behind rubber plantation)	Yala	SP	3,200	Running	PDP	58	DLA	None

Table D-1 The 101 community sewage treatment systems nationwide (Continued)

No.	Regional	Municipality	Province	Type	Water treatment capacity (m^3/day)	Status	Construction Budget Source	Cost (Million Baht)	The Operation Office	Collection Fee
71	South	Yala Muni. (Wat Yala Thammaram Area)	Yala	AL	4,600	Running	PDP	59	DLA	None
72	Central	Nakhon Pathom Muni.	Nakhon Pathom	SP	25,000	-	PWD	219	DLA	None
73	Central	Chai Nat Muni.	Chai Nat	AL	5,800	Running	PWD	204	DLA	None
74	Central	U Thong Muni.	Suphan Buri	SP	6,000	Out of Order	PWD	136	DLA	None
75	Central	Suphan Buri Muni	Suphan Buri	SP	12,500	Running	PWD	363	DLA	None
76	Central	Nonthaburi Muni.	Nonthaburi	OD	38,500	Running	PWD	617	DLA	None
77	Central	Sing Buri Muni.	Sing Buri	SP	4,500	Running	PWD	250	DLA	None
78	Central	Ang Thong Muni.	Ang Thong	AL	8,200	Running	PWD	179	DLA	None
79	Central	Phra Nakhon Si Ayutthaya Muni.	Phra Nakhon Si Ayutthaya	OD	24,000	Running	PWD	497	DLA	None
80	Central	Pra Intaracha Muni.	Phra Nakhon Si Ayutthaya	AS	4,500	Out of Order	PDP	148	DLA	None
81	Central	Pathum Thani Muni.	Pathum Thani	OD	11,000	Out of Order	PWD	340	hiring a private party to run	None
82	Central	Ban Mi Muni.	Lop Buri	SP	1,000	Running	DOPA	-	DLA	None
83	Central	Saraburi Muni.	Saraburi	OD	24,000	Running	PWD	377	DLA	None
84	Central	Ratchaburi Muni.	Ratchaburi	SP	20,000	Running	PWD	364	DLA	None
85	Central	Ban Pong Muni.	Ratchaburi	SP	8,400	Running	PWD	83	DLA	None
86	Central	Photharam Muni.	Ratchaburi	OD	4,000	Running	PWD	56	DLA	None
87	Central	Kanchanaburi Muni.	Kanchanaburi	OD	24,000	Running	PWD	574	DLA	None
88	Central	Phetchaburi Muni.	Phetchaburi	SP	10,000	Running	RDPB	118	DLA and RDPB	None
89	Central	Cha-am Muni.	Phetchaburi	AL	17,000	Running	PWD	360	hiring a private party to operate	None
90	Central	Prachuap Khiri Khan Muni.	Prachuap Khiri Khan	AL	8,000	Running	PWD	200	DLA	None
91	Central	Hua Hin Muni. Phase 1	Prachuap Khiri Khan	RBC	8,000	Running	PWD + PDP (Fund)	53	DLA	Yes
92	Central	Hua Hin Muni. Phase 2	Prachuap Khiri Khan	OD	8,500	Running	PWD + PDP (Fund)	310	DLA	Yes
93	Central	Khlong Dan Muni.	Samut Prakan	AS	525,000	Canceled	Loan + PDP /(Fund)	22,950	-	-
94	Central	BKK (Si Phraya)	Bangkok	AS	30,000	Running	BKK	464	hiring a private party to operate	None / has been issued

Table D-1 The 101 community sewage treatment systems nationwide (Continued)

No.	Regional	Municipality	Province	Type	Water treatment capacity (m^3/day)	Status	Construction Budget Source	Cost (Million Baht)	The Operation Office	Collection Fee
95	Central	BKK (Chong Nonsi)	Bangkok	AS	200,000	Running	BKK + AGSOE	4,552	BKK	None / has been issued
96	Central	BKK (Rattanakosin)	Bangkok	AS	40,000	Running	AGSOE	883	BKK	None / has been issued
97	Central	BKK (Thung Khru)	Bangkok	AS	65,000	Running	BKK + AGSOE	1,760	BKK	None / has been issued
98	Central	BKK (Nong Khaem)	Bangkok	AS	157,000	Running	BKK + AGSOE	2,348	BKK	None / has been issued
99	Central	BKK (Chatuchak)	Bangkok	AS	150,000	Running	BKK + AGSOE	3,482	BKK	None / has been issued
100	Central	BKK (Din Daeng)	Bangkok	AS	350,000	Running	BKK	6,382	BKK	None / has been issued
101	Central	BKK (Bang Sue)	Bangkok	AS	120,000	Running	BKK	4,732	BKK	None / has been issued

Remarks :
1. AL *Aerated Lagoon: AL*
2. SP *Stabilization Pond: SP*
3. CW *Constructed Wetland: CW*
4. RBC *Rotating Biological Contactor: RBC*
5. AS *Activated Sludge: AS*
   - 5.1 OD *Oxidation Ditch: OD*
   - 5.2 SBR *Sequencing Batch Reactor: SBR*
   - 5.3 MSBR *Membrane sequencing batch reactor: MSBR*

Appendix E

The Amount of Municipal Solid Waste by Province

Table E-1 The amount of municipal solid waste by province

Regional Environmental Office	Province	Amount of solid waste residual (ton)	Amount of solid waste generated (ton/year)	Service Area									Non-Service Area				Amount of solid waste utilized (ton/year) (1)+ (2)+ (3)
				the number of local administrative office providing service (no. of locations)	the amount of waste generated in the service area of local administrative office (ton/year)	the amount of waste collected for disposal (ton/year)	the amount of waste being reutilized (ton/year) (1)	the amount of waste outside of service area (ton/year)	the amount of waste being unproperly disposed (ton/year)	the amount of waste properly disposed (ton/year)	reutilization of waste (ton/year) (2)	disposal of waste (ton/year) (by Landfill Compost Incinerator, etc.)	the number of local administrative office not providing service (no. of locations)	the amount of waste generated outside the service area of local administrative office (ton/year)	the amount of waste being reutilized (ton/year) (3)	the amount of waste being unproperly disposed (ton/year)	
Regional	Chiang Mai	42,978.96	605,351.16	149	485,773.54	320,194.19	165,579.35	0.00	67,192.77	253,001.41	456.25	252,545.16	61	119,577.63	25,875.68	93,701.95	191,911.28
Environmental	Chiang Rai	13,276.95	401,671.89	62	195,913.52	155,378.33	40,535.18	0.00	54,435.85	100,942.49	784.75	100,157.74	81	205,758.37	30,341.64	175,416.73	71,661.58
Office 1	Lamphun	131.28	146,974.96	31	86,436.16	56,931.63	22,075.88	7,428.65	7,440.24	49,491.39	0.00	49,491.39	26.00	60,538.80	9,186.13	51,352.67	31,262.01
(Chiang Mai)	Mae Hong Son	533.22	56,798.79	25	33,542.56	24,538.60	9,003.96	0.00	7,873.61	16,664.98	0.00	16,664.98	24	23,256.23	5,581.49	17,674.73	14,585.46
Total	4	56,920.41	1,210,796.79	267.00	801,665.77	557,042.75	237,194.37	7,428.65	136,942.47	420,100.27	1,241.00	418,859.27	192.00	409,131.03	70,984.95	338,146.08	309,420.32
Regional	Lampang	43,316.68	301,211.50	76	252,343.80	221,358.95	30,984.85	0.00	129,700.29	91,658.66	0.00	91,658.66	27	48,867.69	2,394.40	46,473.29	33,379.25
Environmental	Phayao	29,041.64	176,879.55	37	115,665.73	84,669.05	30,996.68	0.00	44,672.35	39,996.70	0.00	39,996.70	34	61,213.82	29,269.02	31,944.80	60,265.70
Office 2	Phrae	23,142.60	158,156.21	76	145,570.38	114,241.35	31,329.03	0.00	106,149.30	8,092.05	0.00	8,092.05	7.00	12,585.83	1,113.25	11,472.58	32,442.28
(Lampang)	Sukhothai	24,274.20	209,097.59	56	144,778.89	78,411.59	66,367.30	0.00	22,012.78	56,398.81	13,133.62	43,265.19	34	64,318.70	48,239.03	16,079.68	127,739.95
Total	4	119,775.12	845,344.85	245.00	658,358.81	498,680.95	159,677.86	-	302,534.72	196,146.22	13,133.62	183,012.60	102.00	186,986.04	81,015.69	105,970.35	253,827.18
Regional	Phitsanulok	6,817.20	326,149.57	33	170,000.36	108,748.10	59,157.16	2,095.10	57,611.60	51,136.50	0.00	51,136.50	69	156,149.21	9,322.10	146,827.11	68,479.26
Environmental	Nan	9,241.95	166,450.88	45	91,540.10	43,851.47	44,637.24	3,051.40	20,181.22	23,670.25	0.00	23,670.25	54	74,910.78	9,426.13	65,484.65	54,063.36
Office 3	Phichit	18,169.65	201,290.72	43	106,248.37	52,111.05	51,374.27	2,763.05	28,999.25	23,111.80	0.00	23,111.80	58.00	95,042.35	5,714.81	89,327.54	57,089.08
(Phitsanulok)	Uttaradit	4,734.76	164,387.22	46	106,902.30	63,197.20	43,548.15	156.95	36,872.30	26,324.90	0.00	26,324.90	33.00	57,484.93	2,303.15	55,181.78	45,851.30
Total	4	38,963.56	858,278.39	167.00	474,691.13	267,907.81	198,716.82	8,066.50	143,664.37	124,243.45	-	124,243.45	214.00	383,587.26	26,766.18	356,821.08	225,483.00
Regional	Nakhon Sawan	11,109	369,669.36	75.00	239,503.74	140,175.62	82,903.12	16,425.00	38,076.80	102,098.82	182.50	101,916.32	67.00	130,165.63	-	130,165.63	83,085.62
Environmental	Tak	79,592	230,081.36	46.00	178,081.11	135,371.20	42,709.91	-	109,127.70	26,243.50	-	26,243.50	22.00	52,000.25	-	52,000.25	42,709.91
Office 4	Kamphaeng Phet	6,119	245,275.74	48.00	149,899.24	78,577.20	47,779.54	23,542.50	23,290.65	55,286.55	127.75	55,158.80	41.00	95,376.50	14.60	95,361.90	47,921.89
(Nakhon Sawan)	Uthai Thani	1,296	117,511.40	26.00	52,657.59	31,875.45	20,782.14	-	6,022.50	25,852.95	25.55	25,827.40	37.00	64,853.82	-	64,853.82	20,807.69
Total	4	98,115.75	962,537.87	195.00	620,141.67	385,999.47	194,174.70	39,967.50	176,517.65	209,481.82	335.80	209,146.02	167.00	342,396.20	14.60	342,381.60	194,525.10
Regional	Nakhon Pathom	141,384.67	424,761.30	107.00	413,671.50	371,134.98	42,536.52	-	133,974.30	237,160.68	-	237,160.68	9.00	11,089.80	29.28	11,060.52	42,565.80
Environmental	Suphan Buri	92,366.62	286,277.88	74.00	174,311.16	123,001.62	50,211.54	1,098.00	74,876.28	48,125.34	3,265.82	44,859.52	52.00	111,966.72	5,292.36	106,674.36	58,769.72
Office 5	Chai Nat	20,012.94	130,153.26	42.00	105,719.10	56,378.64	49,340.46	-	24,112.08	32,266.56	-	32,266.56	16.00	24,434.16	-	24,434.16	49,340.46
(Nakhon Pathom)	Samut Sakhon	279,825.00	343,227.48	35.00	339,867.60	302,096.40	37,771.20	-	148,558.67	153,537.73	3,641.70	149,896.03	2.00	3,359.88	-	3,359.88	41,412.90
Total	4	533,589.23	1,184,419.92	258.00	1,033,569.36	852,611.64	179,859.72	1,098.00	381,521.33	471,090.31	6,907.52	464,182.79	79.00	150,850.56	5,321.64	145,528.92	192,088.88

Table E-1 The amount of municipal solid waste by province (Continued)

Regional Environmental Office	Province	Amount of solid waste residual (ton)	Amount of solid waste generated (ton/year)	Service Area									Non-Service Area				Amount of solid waste utilized (ton/year) (1)+ (2)+ (3)
				the number of local administrative office providing service (no. of locations)	the amount of waste generated in the service area of local administrative office (ton/year)	the amount of waste collected for disposal (ton/year)	the amount of waste being reutilized (ton/year) (1)	the amount of waste outside of service area (ton/year)	the amount of waste being unproperly disposed (ton/year)	the amount of waste properly disposed (ton/year)	reutilization of waste (ton/year) (2)	disposal of waste (ton/year) (by Landfill Compost Incinerator, etc.)	the number of local administrative office not providing service (no. of locations)	the amount of waste generated outside the service area of local administrative office (ton/year)	the amount of waste being reutilized (ton/year) (3)	the amount of waste being unproperly disposed (ton/year)	
Regional Environmental Office 6 (Nonthaburi)	Nonthaburi	-	612,918.95	45.00	612,918.95	434,078.81	178,840.15	-	-	434,078.81	-	434,078.81	-	-	-	-	178,840.15
	Samut Prakan	616,143.00	862,217.60	48.00	862,217.60	753,104.50	109,113.10	-	33,032.50	720,072.00	-	720,072.00	-	-	-	-	109,113.10
	Pathum Thani	82,912.25	611,736.52	63.00	610,264.43	530,567.65	79,696.78	-	471,970.55	58,597.10	-	58,597.10	1.00	1,472.09	-	1,472.09	79,696.78
	Phra Nakhon Si Ayutthaya	642,565.96	420,870.11	120.00	380,031.01	291,244.45	88,786.56	-	227,497.20	63,747.25	-	63,747.25	37.00	40,839.11	3,544.56	37,294.54	92,331.12
	Ang Thong	-	104,202.93	47.00	82,726.08	39,447.01	43,279.07	-	365.00	39,082.01	-	39,082.01	16.00	21,476.86	-	21,476.86	43,279.07
	Sing Buri	28,138.31	89,195.07	23.00	64,625.27	50,307.95	14,317.32	-	50,307.95	-	-	-	19.00	24,569.80	2,687.68	21,882.12	17,005.00
Total	6	1,369,759.52	2,701,141.19	346.00	2,612,783.34	2,098,750.37	514,032.97	-	783,173.20	1,315,577.17	-	1,315,577.17	73.00	88,357.85	6,232.24	82,125.61	520,265.22
Regional Environmental Office 7 (Saraburi)	Saraburi	93,481	272,684.20	90	247,057.55	186,584.35	60,473.20	-	51,158.40	135,425.95	313.90	135,112.05	18	25,626.65	-	25,626.65	60,787.10
	Phetchabun	134,693	346,739.05	83	257,383.40	173,601.30	75,974.75	7,807.35	131,067.85	42,533.45	-	42,533.45	44	89,355.65	547.50	88,808.15	76,522.25
	Lop Buri	125,622	336,033.60	72	261,548.05	211,714.60	49,833.45	-	197,413.90	14,300.70	-	14,300.70	53	74,485.55	1,879.75	72,605.80	51,713.20
	Nakhon Nayok	75,000	87,315.30	27	60,768.85	47,402.55	13,366.30	-	21,535.00	25,867.55	-	25,867.55	18	26,546.45	-	26,546.45	13,366.30
	Prachin Buri	216,965	188,241.45	45	140,298.70	104,163.70	35,470.70	664.30	76,394.50	27,769.20	-	27,769.20	24	47,942.75	-	47,942.75	35,470.70
Total	5	645,761.20	1,231,013.60	317.00	967,056.55	723,466.50	235,118.40	8,471.65	477,569.65	245,896.85	313.90	245,582.95	157.00	263,957.05	2,427.25	261,529.80	237,859.55
Regional Environmental Office 8 (Ratchaburi)	Ratchaburi	143,660	326,991.87	73.00	246,718.75	171,710.60	75,006.38	1.77	63,469.85	108,240.75	-	108,240.75	38.00	80,273.12	1,768.43	78,504.70	76,774.80
	Kanchanaburi	222,948	308,516.62	72.00	206,745.65	148,741.15	57,702.31	302.20	139,908.15	8,833.00	-	8,833.00	49.00	101,770.96	4,109.17	97,661.79	61,811.48
	Samut Songkhram	-	70,787.82	34.00	70,022.88	53,854.66	16,168.22	-	52,916.61	938.05	-	938.05	1.00	764.94	-	764.94	16,168.22
	Phetchaburi	356,925	204,055.79	51.00	160,314.38	127,260.90	33,053.48	-	71,704.25	55,556.65	-	55,556.65	33.00	43,741.42	288.35	43,453.07	33,341.83
	Prachuap Khiri Khan	285,197	212,152.40	40.00	171,590.20	128,334.00	31,708.32	11,547.89	26,009.90	102,324.10	146.00	102,178.10	20.00	40,562.20	594.95	39,967.25	32,449.27
Total	5	1,008,729.79	1,122,504.50	270.00	855,391.86	629,901.31	213,638.70	11,851.86	354,008.76	275,892.55	146.00	275,746.55	141.00	267,112.64	6,760.90	260,351.75	220,545.59
Regional Environmental Office 9 (Udonthani)	Udon Thani	17,203	592,041	147	516,270	262,015	254,255	-	150,668	111,347	10,950	100,397	33	75,771	62	75,709	265,267
	Nong Khai	12,058	130,438	66	130,004	92,805	37,200	-	44,957	47,848	4,745	43,103	1	434	-	434	41,945
	Loei	56,836	230,043	76	191,580	120,216	71,363	-	112,186	8,030	730	7,300	24	38,463	-	38,463	72,093
	Nakhon Phanom	42,786	243,710	69	177,297	82,486	94,810	-	71,905	10,581	365	10,216	34	66,413	210	66,203	95,385
	Sakon Nakhon	4,511	411,640	67	233,982	92,590	141,392	-	52,637	39,953	-	39,953	73	177,658	3,077	174,581	144,469
	Bueng Kan	10,334	144,778	53	132,687	69,259	63,429	-	63,036	6,223	-	6,223	6	12,090	403	11,687	63,832
Total	6	143,727.81	1,752,649.71	478.00	1,381,820.76	719,371.20	662,449.56	-	495,388.95	223,982.25	16,790.00	207,192.25	171.00	370,828.95	3,752.28	367,076.67	682,991.84

Table E-1 The amount of municipal solid waste by province (Continued)

Regional Environmental Office	Province	Amount of solid waste residual (ton)	Amount of solid waste generated (ton/year)	Service Area									Non-Service Area				Amount of solid waste utilized (ton/year) (1)+ (2)+ (3)
				the number of local administrative office providing service (no. of locations)	the amount of waste generated in the service area of local administrative office (ton/year)	the amount of waste collected for disposal (ton/year)	the amount of waste being reutilized (ton/year) (1)	the amount of waste outside of service area (ton/year)	the amount of waste being unproperly disposed (ton/year)	the amount of waste properly disposed (ton/year)	reutilization of waste (ton/year) (2)	disposal of waste (ton/year) (by Landfill Compost Incinerator, etc.)	the number of local administrative office not providing service (no. of locations)	the amount of waste generated outside the service area of local administrative office (ton/year)	the amount of waste being reutilized (ton/year) (3)	the amount of waste being unproperly disposed (ton/year)	
Regional Environmental Office 10 (Khon Kaen)	Khon Kaen	754,904.00	710,298.01	176.00	607,663.44	402,770.20	204,893.24	-	334,179.40	68,590.80	-	68,590.80	48.00	102,634.57	-	102,634.57	204,893.24
	Kalasin	17,433.00	357,256.78	99.00	260,674.47	130,279.45	129,289.07	1,105.95	84,194.55	46,084.90	3,744.90	42,340.00	51.00	96,582.31	5,354.55	91,227.76	138,388.52
	Chaiyaphum	84,010.00	392,108.17	95.00	270,992.65	167,656.82	100,876.84	2,458.99	167,656.82	-	-	-	47.00	121,115.52	35,561.95	85,553.57	136,438.79
	Maha Sarakham	142,252.00	332,456.71	62.00	177,494.60	86,399.15	87,890.75	3,204.70	76,650.00	9,749.15	-	9,749.15	79.00	154,962.12	16,998.05	137,964.07	104,888.80
	Nong Bua Lam Phu	20,561.60	180,323.37	48.00	141,459.78	64,736.40	76,723.38	-	47,566.80	17,169.60	-	17,169.60	20.00	38,863.59	5,150.15	33,713.44	81,873.53
Total	5	1,019,160.60	1,972,443.03	480.00	1,458,284.93	851,842.02	599,673.27	6,769.64	710,247.57	141,594.45	3,744.90	137,849.55	245.00	514,158.10	63,064.70	451,093.40	666,482.87
Regional Environmental Office 11 (Nakhon Ratchasima)	Nakhon Ratchasima	227,492.30	897,289.38	151.00	474,838.77	381,398.29	73,714.41	19,726.07	157,950.93	223,447.36	-	223,447.36	182.00	422,450.61	154,476.40	267,974.21	228,190.80
	Surin	2,754.39	481,612.05	21.00	83,644.60	49,652.70	20,649.92	13,341.99	18,288.25	31,364.45	-	31,364.45	151.00	397,967.45	53,182.67	344,784.78	73,832.58
	Buri Ram	26,157.29	583,123.98	71.00	254,731.65	143,004.97	85,240.10	26,486.58	77,586.61	65,418.36	438.37	64,979.99	137.00	328,392.33	10,561.04	317,831.29	96,239.50
	Si Sa Ket	33,398.78	512,185.32	45.00	133,829.98	75,779.93	41,547.86	16,502.18	40,078.06	35,701.87	1,136.37	34,565.50	171.00	378,355.34	5,495.76	372,859.58	48,179.99
Total	4	289,802.75	2,474,210.73	288.00	947,045.01	649,835.90	221,152.28	76,056.83	293,903.86	355,932.04	1,574.73	354,357.30	641.00	1,527,165.72	223,715.87	1,303,449.85	446,442.89
Regional Environmental Office 12 (Ubon Ratchathani)	Ubon Ratchathani	18,634.20	540,827.07	102.00	334,264.08	278,746.12	53,196.56	2,321.40	65,746.72	212,999.40	24,644.80	188,354.60	136.00	206,562.99	61,228.75	145,334.24	139,070.11
	Amnat Charoen	44,155.50	73,730.00	36.00	62,685.10	55,746.45	6,938.65	-	13,647.35	42,099.10	11,705.55	30,393.55	27.00	11,044.90	6,445.90	4,599.00	25,090.10
	Yasothon	46,400.00	85,044.64	61.00	65,653.50	56,963.88	7,256.20	1,433.42	37,292.05	19,671.83	591.30	19,080.53	26.00	19,391.14	149.65	19,241.49	7,997.15
	Mukdahan	4,126.50	65,685.40	25.00	48,373.45	42,526.15	5,672.10	175.20	6,267.05	36,259.10	10,373.30	25,885.80	29.00	17,311.95	6,164.85	11,147.10	22,210.25
	Roi Et	124,954.70	339,603.45	73.00	146,788.40	127,490.85	18,319.35	978.20	125,961.50	1,529.35	69.35	1,460.00	130.00	192,815.05	40,463.90	152,351.15	58,852.60
Total	5	238,270.90	1,104,890.55	297.00	657,764.53	561,473.45	91,382.86	4,908.22	248,914.67	312,558.78	47,384.30	265,174.48	348.00	447,126.02	114,453.05	332,672.97	253,220.21
Regional Environmental Office 13 (Chonburi)	Chon Buri+Pattaya	398,936	956,195.98	92	940,595.88	875,299.20	30,076.00	35,220.68	444,964.20	430,335.00	80,117.50	350,217.50	6	15,600.10	-	15,600.10	110,193.50
	Rayong	221,900	327,361.28	66	325,901.28	288,510.60	15,297.15	22,093.53	104,138.15	184,372.45	6,453.20	177,919.25	1	1,460.00	-	1,460.00	21,750.35
	Chanthaburi	52,721	201,020.10	62	168,907.40	125,414.00	6,883.90	36,609.50	37,974.60	87,439.40	-	87,439.40	19	32,112.70	1,573.15	30,539.55	8,457.05
	Trat	86,305	99,173.21	33	83,826.37	56,015.54	22,335.83	5,475.00	35,879.50	20,136.04	-	20,136.04	10	15,346.84	182.50	15,164.34	22,518.33
	Chachoengsao	1,242,000	274,158.80	74	208,900.45	194,552.30	4,529.65	9,818.50	192,362.30	2,190.00	-	2,190.00	34	65,258.35	-	65,258.35	4,529.65
	Sa Kaeo	142,054	138,947.91	32	77,737.70	65,970.10	4,872.75	6,894.85	56,224.60	9,745.50	-	9,745.50	33	61,210.21	3,219.30	57,990.91	8,092.05
Total	6	2,143,916.00	1,996,857.27	359.00	1,805,869.08	1,605,761.74	83,995.28	116,112.06	871,543.35	734,218.39	86,570.70	647,647.69	103.00	190,988.20	4,974.95	186,013.25	175,540.93

Table E-1 The amount of municipal solid waste by province (Continued)

Regional Environmental Office	Province	Amount of solid waste residual (ton)	Amount of solid waste generated (ton/year)	Service Area									Non-Service Area				Amount of solid waste utilized (ton/year) (1)+ (2)+ (3)
				the number of local administrative office providing service (no. of locations)	the amount of waste generated in the service area of local administrative office (ton/year)	the amount of waste collected for disposal (ton/year)	the amount of waste being reutilized (ton/year) (1)	the amount of waste outside of service area (ton/year)	the amount of waste being unproperly disposed (ton/year)	the amount of waste properly disposed (ton/year)	reutilization of waste (ton/year) (2)	disposal of waste (ton/year) (by Landfill Compost Incinerator, etc.)	the number of local administrative office not providing service (no. of locations)	the amount of waste generated outside the service area of local administrative office (ton/year)	the amount of waste being reutilized (ton/year) (3)	the amount of waste being unproperly disposed (ton/year)	
Regional Environmental Office 14 (Surat Thani)	Surat Thani	263,499.30	377,504.90	77.00	262,982.50	204,965.75	58,016.75	-	109,463.50	95,502.25	-	95,502.25	60.00	114,522.40	-	114,522.40	58,016.75
	Chumphon	51,672.75	134,637.55	47.00	72,762.75	60,845.50	11,917.25	-	45,771.00	15,074.50	-	15,074.50	31.00	61,874.80	-	61,874.80	11,917.25
	Nakhon Si Thammarat	1,093,053.33	368,388.38	117.00	209,564.75	176,397.20	33,167.55	-	143,116.50	33,280.70	-	33,280.70	67.00	158,823.63	-	158,823.63	33,167.55
	Ranong	18,291.30	68,174.70	17.00	46,161.55	28,762.00	17,399.55	-	28,762.00	-	-	-	13.00	22,013.15	-	22,013.15	17,399.55
Total	4	1,426,516.68	948,705.53	258.00	591,471.55	470,970.45	120,501.10	-	327,113.00	143,857.45	-	143,857.45	171.00	357,233.98	-	357,233.98	120,501.10
Regional Environmental Office 15 (Phuket)	Phuket	-	321,159.44	18.00	321,159.44	289,043.50	32,115.94	-	-	289,043.50	-	289,043.50	-	-	-	-	32,115.94
	Phangnga	193,962.00	103,390.82	46.00	97,126.95	67,400.90	29,726.05	-	37,835.90	29,565.00	1,205.32	28,359.68	5.00	6,263.87	1.15	6,262.72	30,932.52
	Krabi	192,975.00	197,494.20	45.00	157,902.65	108,434.20	49,468.45	-	50,311.60	58,122.60	547.50	57,575.10	16.00	39,591.55	-	39,591.55	50,015.95
	Trang	80,407.50	240,745.59	63.00	176,092.59	83,087.79	91,555.75	1,449.05	37,838.74	45,249.05	2,536.75	42,712.30	36.00	64,653.00	35.99	64,617.01	94,128.49
	Satun	18,448.35	108,594.80	34.00	96,137.35	41,427.50	54,709.85	-	19,929.00	21,498.50	-	21,498.50	7.00	12,457.45	-	12,457.45	54,709.85
Total	5	485,792.85	971,384.85	206.00	848,418.99	589,393.89	257,576.05	1,449.05	145,915.24	443,478.65	4,289.57	439,189.08	64.00	122,965.86	37.14	122,928.73	261,902.76
Regional Environmental Office 16 (Songkhla)	Songkhla	147,645.06	592,976.99	78.00	480,957.74	275,477.13	205,480.60	-	29,630.70	245,846.43	-	245,846.43	62.00	112,019.26	-	112,019.26	205,480.60
	Narathiwat	59,242.85	272,994.51	43.00	167,909.89	59,257.75	108,652.14	-	27,809.35	31,448.40	-	31,448.40	45.00	105,084.62	730.00	104,354.62	109,382.14
	Yala	14,718.00	217,788.47	46.00	183,651.16	96,721.35	86,929.81	-	4,595.35	92,126.00	-	92,126.00	17.00	34,137.30	-	34,137.30	86,929.81
	Phatthalung	67,052.19	191,340.91	48.00	129,442.33	62,269.00	67,173.33	-	49,494.00	12,775.00	-	12,775.00	25.00	61,898.58	3,139.00	58,759.58	70,312.33
	Pattani	49,108.10	236,539.50	64.00	162,138.13	74,676.12	87,462.01	-	44,556.32	30,119.80	-	30,119.80	49.00	74,401.37	2,737.50	71,663.87	90,199.51
Total	5	337,766.20	1,511,640.38	279.00	1,124,099.25	568,401.35	555,697.90	-	156,085.72	412,315.63	-	412,315.63	198.00	387,541.13	6,606.50	380,934.63	562,304.40
Total 76 Provinces	76	9,956,568.36	22,848,819.17	4,710.00	16,838,432.58	12,031,410.77	4,524,841.85	282,179.95	6,005,044.50	6,026,366.28	182,432.05	5,843,934.23	3,066.00	6,010,386.59	616,127.94	5,394,258.65	5,323,401.84
	Bangkok	-	4,208,450.00	1.00	4,208,450.00	3,726,650.00	481,800.00	-	-	3,726,650.00		3,726,650.00		-			481,800.00
Total 77 Provinces	77	9,956,568.36	27,057,269.17	4,711.00	21,046,882.58	15,758,060.77	5,006,641.85	282,179.95	6,005,044.50	9,753,016.28	182,432.05	9,570,584.23	3,066.00	6,010,386.59	616,127.94	5,394,258.65	5,805,201.84

Appendix F

Laws and Regulations related to pollution announced in the Royal Gazette in Act B.E. 2559 (2016)

Laws and Regulations related to pollution announced in the Royal Gazette in Act B.E. 2559 (2016)

No.	Topic	Key Details	Government Gazette	Effective Date
The Enhancement and Conservation of National Environmental and Quality Act B.E. 2535 (1992)				
1.	Notification of the Ministry of Natural Resources and the Environment on defining the boundary areas for environmental protection in Khura Buri District, Takua Pa District, Thai Mueang District, Thap Put District, Mueang Phang Nga District, Takua Thung District, and Ko Yao District in Phang Nga, B.E. 2559 (2016)	To define the boundary areas for environmental protection in Khura Buri District, Takua Pa District, Thai Mueang District, Thap Put District, Mueang Phang Nga District, Takua Thung District, and Ko Yao District in Phang Nga, where the stated area has the duty to abide by the rules and regulations outlined in this Act.	No. 133 Special Section 76 D, 31 March, B.E. 2559 (2016)	This notification shall come into force from the day following the date of publication in the Royal Gazette.
2.	Notification of the Ministry of Natural Resources and the Environment on defining the boundary areas for environmental protection in Ao Luek District, Mueang Krabi District, Nuea Khlong District, Khlong Thom District, and Ko Lanta District, Krabi, B.E. 2559 (2016)	To define the boundary areas for environmental protection in Ao Luek District, Mueang Krabi District, Nuea Khlong District, Khlong Thom District, and Ko Lanta District, Krabi where the stated area has the duty to abide by the rules and regulations outlined in this Act.	No. 133 Special Section 76 D, 31 March, B.E. 2559 (2016)	This notification shall come into force from the day following the date of publication in the Royal Gazette.
3.	Notification of the Ministry of Natural Resources and the Environment on defining the type, the size, and the procedures for related projects or businesses that may be creating severe impact on the community both in environmental quality, natural resources, and health, in which case the government, state enterprises, or the private sectors must conduct an Environmental Impact Assessment Report B.E. 2553 (2010) (No. 4) B.E. 2559 (2016)	To define the type and size of the projects or businesses that must conduct the Environmental Impact Assessment Report, and the guideline, the procedures, practice, and framework for conducting the the report on the environmental and health impact analysis, for which the government, state enterprise or private sector will be operating.	No. 133 Special Section 93 D, 22 April B.E. 2559 (2016)	This notification shall come into force from the day following the date of publication in the Royal Gazette
4.	Notification of the Ministry of Natural Resources and the Environment on Defining the standard values for smoke released from mechanic boats using compression-ignition engines.	To define the standard values for smoke released from mechanic boats using compression-ignition engines so as to not exceed the standard values.	No. 133 Special Section 129 D, 6 June B.E. 2559 (2016)	One year after the date of publication in the Royal Gazette.
5.	Notification of the Ministry of Natural Resources and the Environment on defining the standard for controlling waste water release from factories, industrial estates and industrial activities areas, to improve the standard for controlling industrial waste water release to be more applicable.	To improve the standard for controlling industrial waste water release from factories, industrial estates and industrial activities areas to be more applicable.	No. 133 Special Section 129 D, 6 June B.E. 2559 (2016)	One year after the date of publication in the Royal Gazette.

Laws and Regulations related to pollution announced in the Royal Gazette in Act B.E. 2559 (2016)

No.	Topic	Key Details	Government Gazette	Effective Date
6.	Notification of the Ministry of Natural Resources and the Environment on defining the guideline, the procedures, practice, and framework for conducting the preliminary environmental impact assessment report in protected areas such as Khura Buri District, Takua Pa District, Thai Mueang District, Thap Put District, Mueang Phang Nga District, Takua Thung District, and Ko Yao District in Phang Nga, B.E. 2559 (2016)	To announce the guideline, the procedures, practice, and framework for conducting the preliminary environmental impact assessment report in protected areas such as Khura Buri District, Takua Pa District, Thai Mueang District, Thap Put District, Mueang Phang Nga District, Takua Thung District, and Ko Yao District in Phang Nga, where the stated area must follow the guidelines outlined in this Act.	No. 133 Special Section 146 D, 30 June B.E. 2559 (2016)	Enforced the day after the date of publication in the Royal Gazette.
7.	Notification of the Ministry of Natural Resources and the Environment on defining the guideline, the procedures, practice, and framework for conducting the preliminary environmental impact assessment report in protected areas such as in Ao Luek District, Mueang Krabi District, Nuea Khlong District, Khlong Thom District, and Ko Lanta District, Krabi, B.E. 2559 (2016)	To announce the guideline, the procedures, practice, and framework for conducting the preliminary environmental impact assessment report in protected areas such as in Ao Luek District, Mueang Krabi District, Nuea Khlong District, Khlong Thom District, and Ko Lanta District, Krabi, where the stated area must follow the guidelines outlined in this Act.	No. 133 Special Section 146 D, 30 June B.E. 2559 (2016)	Enforced the day after the date of publication in the Royal Gazette.
8.	Notification of the Ministry of Natural Resources and the Environment on extending the period in which the announcement issued by the Ministry of Natural Resources and the Environment on defining the boundary for environmental protection in Bang Lamung District and Sattahip District, Chonburi, B.E. 2553 (2010)	To extend the period for environmental protection measures in Bang Lamung District and Sattahip District, Chonburi by 2 years from 31 January 2016 onwards.	No. 133 Special Section 167 D, 28 July B.E. 2559 (2016)	Enforced the day after the date of publication in the Royal Gazette.
9.	Notification of the Ministry of Natural Resources and the Environment on extending the period in which the announcement issued by the Ministry of Natural Resources and the Environment on defining the boundary for environmental protection in Phuket, B.E. 2553 (2010)	To extend the period for environmental protection measures in Phuket by 2 years from 31 January 2016 onwards.	No. 133 Special Section 167 D, 28 July B.E. 2559 (2016)	Enforced the day after the date of publication in the Royal Gazette.

Laws and Regulations related to pollution announced in the Royal Gazette in Act B.E. 2559 (2016)

No.	Topic	Key Details	Government Gazette	Effective Date
The Enhancement and Conservation of National Environmental and Quality Act B.E. 2535 (1992)				
10.	Notification of the Ministry of Natural Resources and the Environment on Extending the period in which the announcement issued by the Ministry of Natural Resources and the Environment on defining the boundary for environmental protection in Ban Laem District, Mueang Phetchaburi District, Tha Yang District, and Cha-Am District, Phetchaburi, Hua Hin District and Pran Buri District, Prachuap Khiri Khan, B.E. 2553 (2010)	To extend the period for environmental protection measures in Ban Laem District, Mueang Phetchaburi District, Tha Yang District, and Cha-Am District, Phetchaburi, Hua Hin District and Pran Buri District, Prachuap Khiri Khan by 2 years from 31 January 2016 onwards.	No. 133 Special Section 167 D, 28 July B.E. 2559 (2016)	Enforced the day after the date of publication in the Royal Gazette.
11.	Notification of the Ministry of Natural Resources and the Environment on defining the type and size of projects or business that is obligated to conduct the environmental impact assessment report, as well as the guideline, the procedures, the regulations and the framework for conducting the report No. 9, B.E. 2559 (2016)	To adjust the announcement of the Ministry of Natural Resources and the Environment on defining the type and size of projects or business that is obligated to conduct the environmental impact assessment report, as well as the guideline, the procedures, the regulations and the framework for conducting the report on 24 April 2012 to be more appropriate.	No. 133 Special Section 274 D, 29 November B.E. 2559 (2016)	Enforced the day after the date of publication in the Royal Gazette.
The Navigation in the Thai Waters Act B.E. 2456 (1913)				
1.	Regulations for boat inspection, defining the guideline, procedures and conditions for issuing licenses on pollution from sewage waste, B.E. 2559 (2016)	To define the guideline, procedures and conditions for issuing licenses on pollution from sewage waste.	No. 133 Section 99 A, 30 November B.E. 2559 (2016)	60 days from the date of publication in the Royal Gazette
2.	Regulations for boat inspection, defining the guidelines and conditions for boat inspection to prevent pollution from waste, B.E. 2559 (2016)	To define the guidelines and conditions for boat inspection to prevent pollution from waste.	No. 133 Section 99 A, 30 November B.E. 2559 (2016)	60 days from the date of publication in the Royal Gazette
The Factory Act B.E. 2535 (1992)				
1.	Notification of the Department of Industrial Works on the type of report on the type and amount of pollutants released from factories, B.E. 2559 (2016)	To define the type of reports for the release of pollutants from factories in order to monitor the release of pollutants from factories.	No. 133 Special Section 48 D, 25 February B.E. 2559 (2016)	Enforced the day after the date of publication in the Royal Gazette.
2.	The ministerial regulations controlling soil and groundwater contamination inside factory areas, B.E. 2559 (2016)	To protect personal security and the quality of the environment, where the owner of all 12 types of factories must conduct a quality assessment and management of soil and groundwater contamination, to keep the values within the standard range for soil and ground water contamination.	No. 133 Section 38 A, 29 April B.E. 2559 (2016)	180 days after the date of publication in the Royal Gazette and onwards.

Laws and Regulations related to pollution announced in the Royal Gazette in Act B.E. 2559 (2016)

No.	Topic	Key Details	Government Gazette	Effective Date
The Factory Act B.E. 2535 (1992) (Continued)				
3.	The ministerial regulations No. 25, B.E. 2559 (2016) issued by virtue of the Factory Act, B.E. 2535 (1992)	To define the guidelines for the prohibition of the construction or expansion of the category 3 factories of certain type or size in the proximity of a public water source, or within the proximity of unsuitable location or environment. Authority is also given to the Minister to issue an order for the category 3 factories of certain type or size to provide appropriate environment in order to prevent problems concerning security and the environment. Thus, the need for this regulation.	No. 133 Section 113 A, 30 December B.E. 2559 (2016)	Enforced the day after the date of publication in the Royal Gazette.
The Industrial Products Standards Act B.E. 2511 (1968)				
1.	The Order of the Department of Pollution Control on the guideline for inspecting industrial products, B.E. 2558 (2015)	As the Ministry of Industry had made an announcement of the Industrial Products Standards Act, B.E. 2511 (1968), the Department of Pollution Control is in charge of the inspection of industrial product, and therefore this order is announced to accommodate this procedure.	No. 133 Special Section 1 D, 5 January B.E. 2559 (2016)	Enforced the day after the date of publication in the Royal Gazette.

Appendix G

List of Glossary

List of Glossary

Abbreviation	English
As	Arsenic
AS	Activated Sludge
AL	Aerated Lagoon
BOD	Biochemical Oxygen Demand
Cd	Cadmium
Cl	Chloride
CN^-	Cyanide
CO	Carbon Monoxide
Cr	Chromium
Cr^{6+}	Hexavalent Chromium
Cu	Copper
CW	Constructed Wetland
dBA	Decibel A
DO	Dissolved Oxygen
EPR	Extended Producer Responsibility
FCB	Fecal Coliform Bacteria
Fe	Iron
Hg	Mercury
HM	Heavy Metal
L_{eq}	Equivalent Continuous Sound Pressure Level
mg/l	Milligrams per Liter
ml	Milliter
Mn	Manganese
MPN	Most Probable Number
MPT	Mechanical and Biological Waste Treatment
MWQI	Marine Water Quality Index
MSBR	Membrane Sequencing Batch Reactor
ND	Non-detected
NH_3	Ammonia
NH_3-N	Ammonia - Nitrogen
Ni	Nickel
Non-TH	Non-carbonate Hardness as $CaCo_3$

Abbreviation	English
NO_x	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_3-N	Nitrate - Nitrogen
O_3	Ozone
OD	Oxidation Ditch
PAHs	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCBs	Polychlorinated Biphenyls
pH	Potential of Hydrogen Ion
PM_{10}	Particulate Matter 10 Micron
$PM_{2.5}$	Particulate Matter 2.5 Micron
PO_4-P	Phosphate - Phosphorus
ppb	Part per Billion
ppm	Part per Million
ppt	Part per Thousand
RBC	Rotating Biological Contactor
SBR	Sequencing Batch Reactor
SO_2	Sulphur Dioxide
SP	Stabilization Pond: SP
SS	Suspended Solid
Std.	Standard
TCB	Total Coliform Bacteria
TDS	Total Dissolve Solid
Temp.	Temperature
Total Cr	Total Chromium
TSP	Total Suspended Particulate Matter
VOCs	Volatile Organic Compounds
WEEE	Waste from Electrical and Electronic Equipments
WQI	Water Quality Index
WTE	Waste to Energy
Zn	Zinc
$\mu g/m^3$	Microgram per Cubic Metre

Appendix H

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the Thailand State of Pollution Report Working Group 2016

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