附錄三、泰國土壤及地下水技術論壇資料

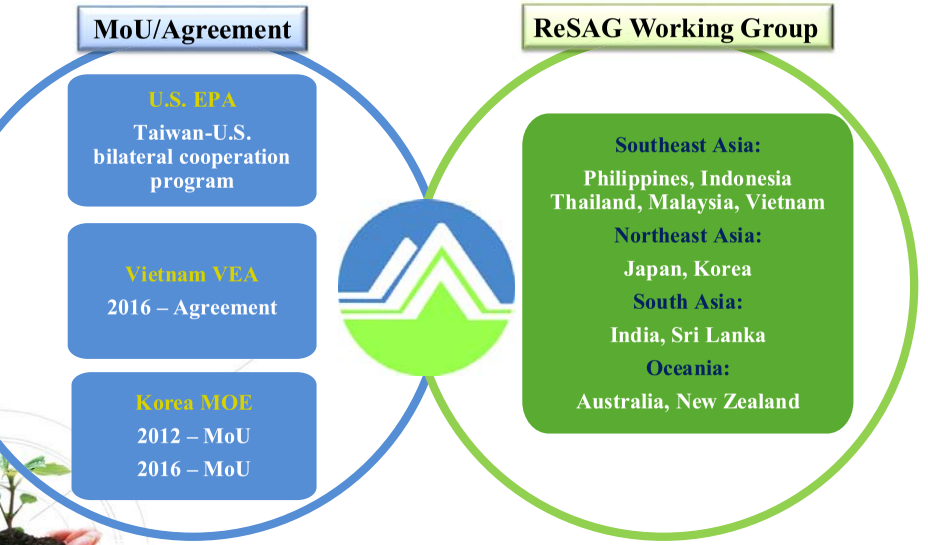
1. Introduction of ReSAG

行政院環境保護署 Environmental Protection Administration Executive Yuan, R.O.C.

Taiwan's Achievements in Promoting Experience Exchange in Soil and Groundwater Pollution Remediation in Asian Pacific Region

Speaker: Dr. Weber Chen
Taiwan EPA
June 21th 2018

2. Important Achievements



Outline

4. Agreement between Taiwan & Vietnam

- First visit to Vietnam Environment Administration in year 2013.
- Participated in Dioxin Conference held by Vietnam Environment Administration.
- Signed Agreement of Technical and Scientific Cooperation in Soil and Groundwater Protection in year 2016.
- Implementation of Agreement of Technical and Scientific Cooperation in Soil and Groundwater Protection in year 2017




3. MOU between Taiwan & Korea

Relationship Establishment	Information Exchange	Cooperation
• 2012 - Taiwan-Korea Conference on Soil and Groundwater Regulatory system • 2012 – Signed MoU for Soil and Groundwater conservation and set up a steering committee	• Participate in remediation technology exchange projects • Conduct regular conference and launch joint research projects • Held Remediation technology forum since 2014	• Both sides invested over 90,000 USD each year to implement cooperative projects • Promotion of mutual assistance project for third party countries

行政院環境保護署
Environmental Protection Administration
Executive Yuan, R.O.C.

Thank you

for listening

3. MOU between Taiwan & Korea (Con't)

University-Industry Collaboration Achievements

- **Comparison of System and Technology of Off-Site Soil Remediation**
- **Comparison of Groundwater Management System**
- **Comparison of Soil and Groundwater Remediation Industry**
- **Experience exchange between Management Strategy, Investigation and Remediation technology of Gas Station**



Ref. : MOU between Taiwan & Korea

Relationship Establishment	Information Exchange	Cooperation
• 2012 - Taiwan-Korea Conference on Soil and Groundwater Regulatory system • 2012 – Signed MoU for Soil and Groundwater conservation and set up a steering committee	• Participate in remediation technology exchange projects • Conduct regular conference and launch joint research projects • Held Remediation technology forum since 2014	• Both sides invested over 90,000 USD each year to implement cooperative projects • Promotion of mutual assistance project for third party countries

Other Important Achievements:

- Held 8 times steering committee meeting since year 2013
- Performed 2 University-Industry Collaboration between countries
- Published 12 papers in both countries academic journals
- Experience exchanged in regulation, management strategies, industry promotion, market mechanisms, technology development and international cooperation mechanisms in soil and groundwater remediation between Korea and Taiwan.

Ref. : Important Achievements

ReSAG is formed

International Workshop: Regulatory Standards of Pollutants and Management System for Soil and Groundwater Pollution — 2011

2012 — International Conference : Green Technology and Phytoremediation for Contaminated Sites

International Workshop: Permeable Reactive Barriers (PRBs) for Contaminated Sites — 2013

2014 — International Conference: Remediation and Management of Soil and Groundwater Contaminated Sites

MoU between Taiwan & Korea

Ref. : Agreement between Taiwan & Vietnam

- First visit to Vietnam Environment Administration in year 2013.
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Early Stage	Middle Stage	Final Stage
• Study, review of environmental legal system • Annual forum on soil and groundwater pollution remediation technology	• Investigation and remediation of pesticide/herbicide and arsenic pollution	• Investigation and remediation of pollution • Agreement renewal based on result




Ref. : Important Achievements

MoU between Taiwan & Korea
Agreement Between Taiwan & Vietnam

International Training Courses: Survey and Remediation of Soil and Groundwater Contaminated Sites — 2015

2016

International Workshop: Contamination Groundwater Characterization & Monitoring — 2017

International Workshop: Remediation Technology of Brownfields

- Over 70 training hours of workshop and Conference.
- Signed MoU with 2 Countries (Vietnam & Korea).
- Held 7 ReSAG Working Group Committee Meeting since 2011.
- Official visit to Thailand, Vietnam, Indonesia, Australia and Korea.

Soil and Groundwater Protection in Taiwan - Policy and Regulations

Hao-Chun Hung

Deputy Director of Comprehensive Planning Section
Soil and Groundwater Remediation Fund Management Board
Environmental Protection Administration, Taiwan

2018.6.21

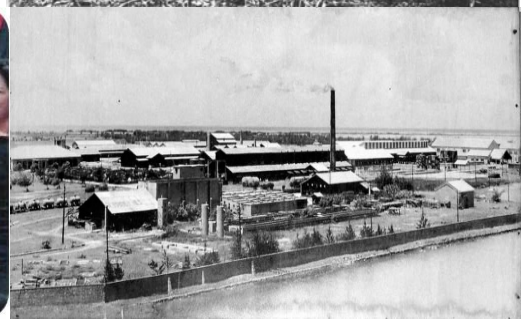
Outline

- Introduction
- Remediation Fund
- Law
- Contaminated Site Remediation
- Achievements
- Conclusion

Introduction

Background

- 1980's~1990's
- Farmland Pollution- Cd rice
- Factory Pollution- RCA, CPDC
- Public Health



- **Soil & Groundwater Pollution Remediation Fund**

SRF History

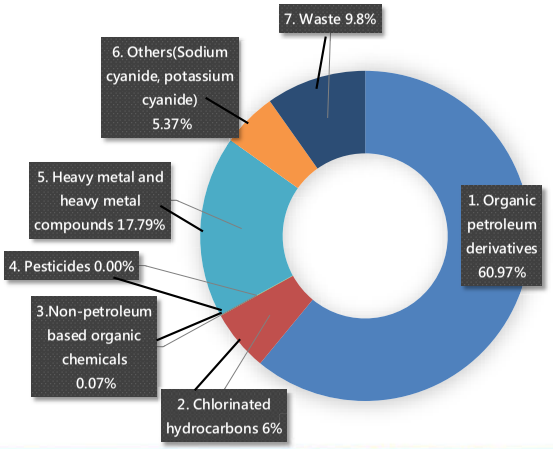
- Soil and Groundwater Pollution Remediation Fund Management Board (SRF) Established Nov.13, 2001.
- Main tasks are to manage the use of fund & to promote the prevention & remediation of soil & groundwater pollution.

The Levy of SRF(1/2)

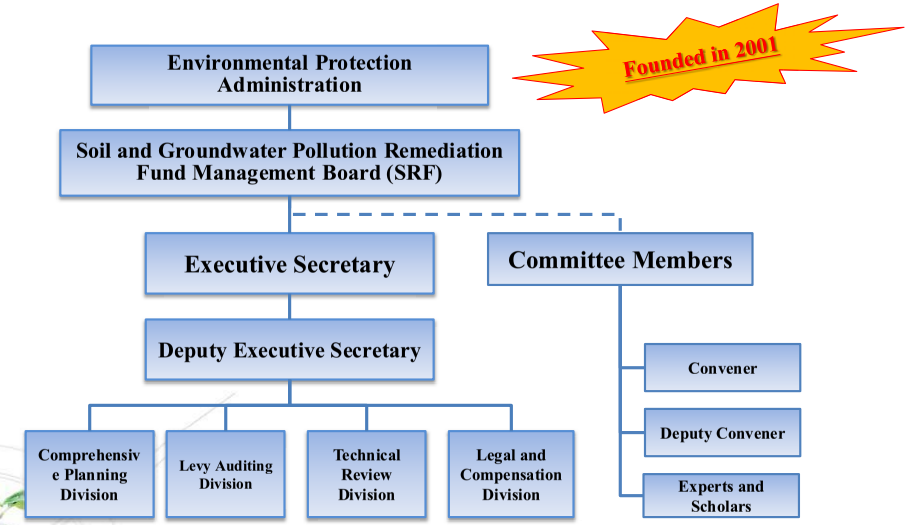
Purpose of SRF

1. Prevent and remediate soil and groundwater pollution and remediation fee associated with unknown polluted sites.
2. Continuation of promoting the implementation of soil and groundwater pollution investigation and remediation and other related issues

Current SRF Levy Ratio



SRF Organiztion Chart



Law

Soil & Groundwater Pollution Remediation Act

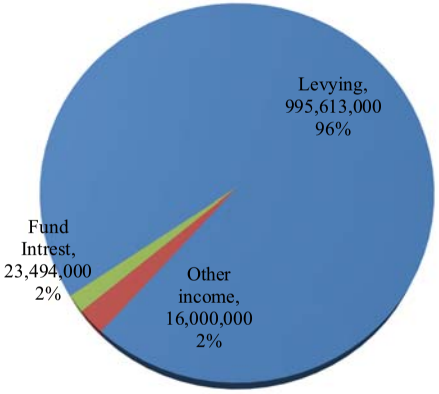
The Levy of SRF(2/2)

8 Major Sources of SRF

1. Remediation Fee Income
2. Polluter(Related) Compensation
3. Land Developer Compensation
4. Central Government Budget
5. Environmental Protection Related Funds
6. Environmental Pollution Fine

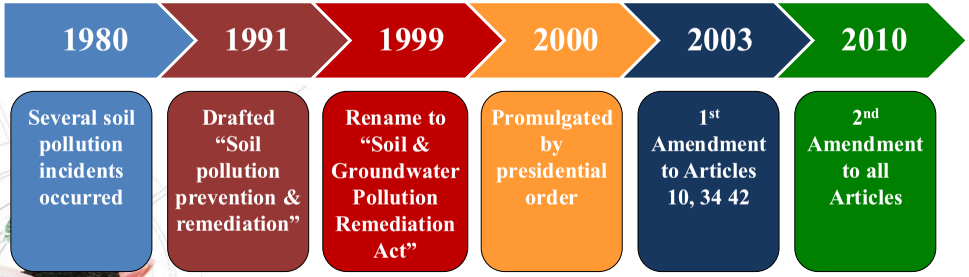
7. Fund Interest

8. Other Related Income

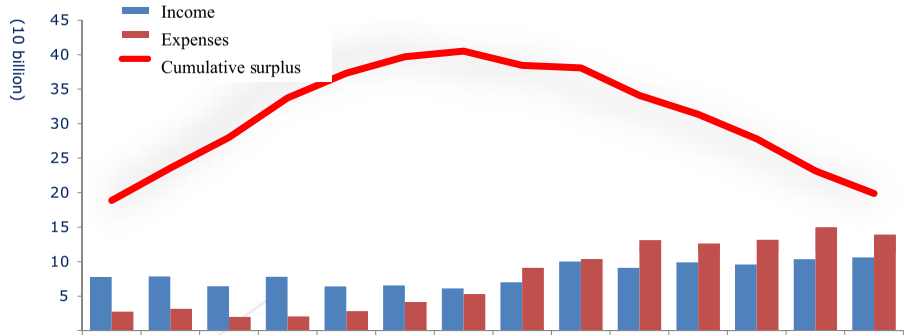


Legislative History of SGPRA

- Soil and groundwater pollution prevention and remediation
- Enhance polluter and manager responsibility
- Monitoring and control standards
- Land management and monitoring responsibility
- Open information, public participation
- Remediation fund



Annual Income and Expense



(year)	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
income	778,115	785,175	642,578	779,510	640,785	656,157	611,546	700,469	1,001,6	909,460	988,632	959,105	1,035,1	1,062,8
expense	276,157	316,488	197,301	206,462	283,074	415,821	529,811	909,227	1,036,6	1,309,2	1,261,8	1,316,5	1,497,5	1,391,2
Cumulative surplus	1,886,2	2,354,9	2,800,2	3,373,2	3,730,9	3,971,3	4,053,0	3,844,2	3,809,2	3,409,5	3,136,2	2,778,8	2,316,3	1,988,0

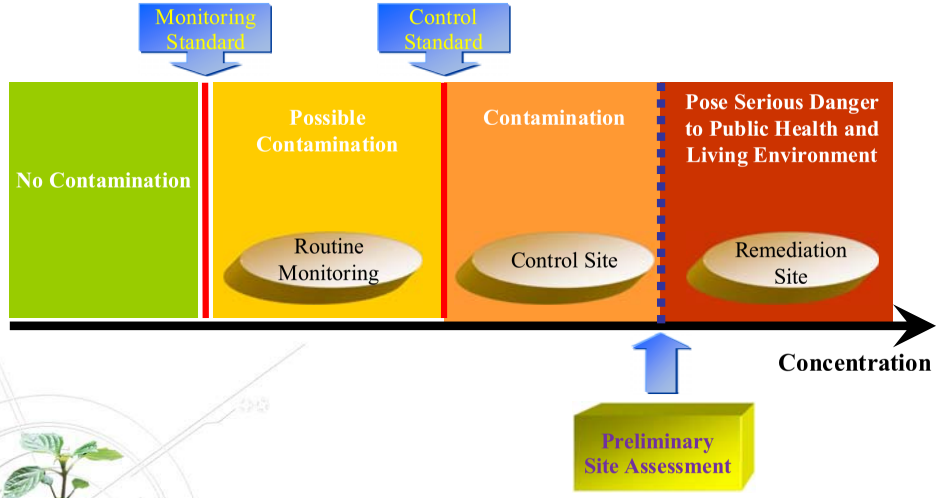
Definition of Polluter(2/2)

Interested Party of the Polluted Land

A person who is not a polluter of the land but is a user, administrator, or owner of the land when the land is declared a pollution remediation site

➢ Failure to demonstrate due diligence as a good manager:
- Shall bear joint payment responsibility with polluter and potential polluter
- Shall be fined when cause land to be publicly declared as control or remediation site

Determination of Soil & Groundwater Contamination



Related Fines

Polluter

- Pay fine if announced as control site or remediation site
- Publicly announce polluter's name and order to receive 4-hr lesson on relevant environmental laws and regulation
- If fail to attend, receive fine per violation until attending

Interested Party of the Polluted Land

Failure to demonstrate due diligence as a good manager:

- Pay fine if announced as control site or remediation site

Definition of Polluter(1/2)

Polluter

A person causing pollution through:
- leaking or discarding of pollutants;
- illegally discharging or injecting pollutants;
- brokering or allowing the leaking, discarding, illegal discharge or injection of pollutants;
- failing to dispose of pollutants pursuant to applicable laws or regulations

Potential Polluter

A person causing pollutants to accumulate in soil or groundwater resulting in pollution due to following:
- discharging, injecting, spreading of pollutants;
- permitting or agreeing to the discharge of wastewater into irrigation and drainage systems or irrigation and water catchment areas

Responsibility -
- Control Site -
  - Investigation, preparing and executing ***pollution control plan***
- Remediation Site -
  - Preparing and executing ***contamination investigation & assessment plan***
  - Preparing and executing ***pollution remediation plan***
- Conducting emergency response measures

Announced Enterprises

Article 8

Land Transfer

- If land used by announced enterprise is transferred, the assignor shall provide and report soil pollution assessment data to competent authority for future reference

Article 9

Business establishment, change or termination

- When following situations applies, announced enterprise shall submit soil pollution assessment data for review:
  - Enterprise establishment, registration, or application for a business license
  - Change of business operator
  - Change of industry category.
  - Change of scope of operating site.
  - Termination of business, cancellation of operating permit or business license, termination of operation, facility closure, or discontinuation of production, manufacturing, or processing

Announced Enterprise –

- Officially announced by central competent authority
- 30 industrial categories

Land Registration & Prohibition of Land Disposal

- Control Site
  - Enter in land register
- Remediation Site
  - Enter in land register
  - Prohibit land disposal

When compulsory auction procedures have been implemented for the land, such procedures may be cancelled

Designated Zones – Regular Monitoring

- Local industry competent authorities shall regularly test and report soil and groundwater quality in accordance with pollution trends in the area
  - Industrial parks
  - Export processing zones
  - Science-based industrial parks
  - Environmental technology parks
  - Agricultural technology parks
  - Other specially designated zones officially announced by the central competent authority

Delineation of Pollution Control Zone and Other Restrictions

Control or Remediation Site

Competent authority shall delineate and publicly announce soil and groundwater pollution control zones

With the exception of control, remediation or other pollution improvement plans

Prohibited Actions

- Leaving pollutants in soil
- Injecting wastewater and sewage into groundwater
- Discharging wastewater and sewage into soil
- Other control activities officially announced by the competent authority

Soil pollution control area

Unless receive approval from central competent authority

Prohibited Land Use Activities

- Development prescribed in the Environmental Impact Assessment Act
- New construction, extension, alteration, renovation, or demolition not required for remediation actions
- Other land use activities that might affect the health and living environment of residents

Investigation by EPA or EPB

- Competent authorities at all levels shall regularly monitor the quality of the soil and groundwater within their jurisdictions.
- Competent authorities at all levels may dispatch personnel bearing identification documents to enter public or private premises for the verification work and may order site users, managers or owners to provide related data.
  - Investigate state and sources of contamination
  - Take samples and install monitoring wells
  - Take agricultural or aqua cultural products
  - Military affairs shall be jointly conducted with local military authorities

Approved Sampling and Measurement

- When, in accordance with this Act, soil, bottom sediment, and groundwater pollution investigation or remediation work is performed, or soil and groundwater pollution test data is provided or submitted, except when approved by the central competent authority, the soil, bottom sediment, and groundwater pollutant testing shall be commissioned to an analysis organization approved by the central competent authority.

Sediment – Regular Monitoring

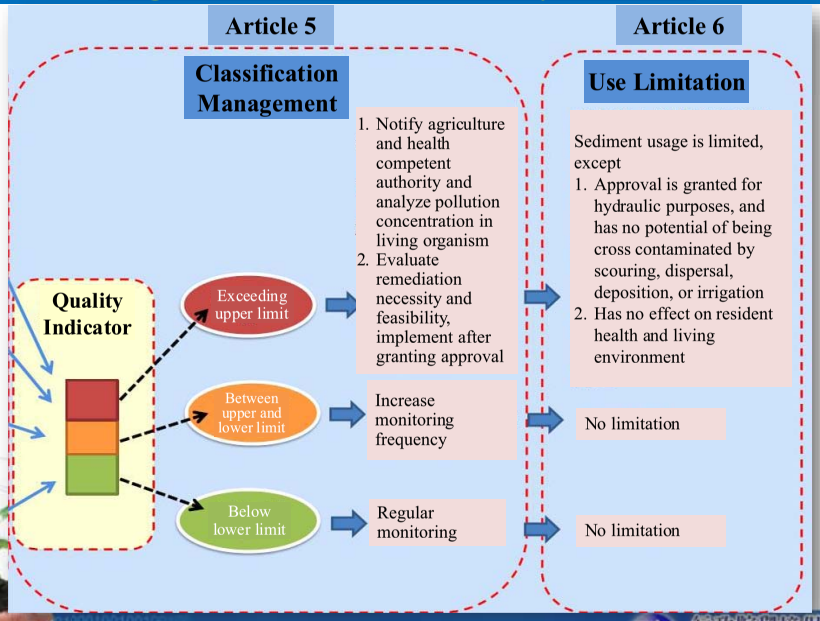
- **The industry competent authorities** in charge of the following water bodies shall regularly test sediment quality, and **submit** the data for future reference

Regular Monitoring

- **Rivers**
- **Irrigation canals**
- **Lakes**
- **Reservoirs**
- **Other surface water bodies specially designated by central competent authority**

→ The central competent authority shall determine classified management and use restrictions based on sediment quality indicators

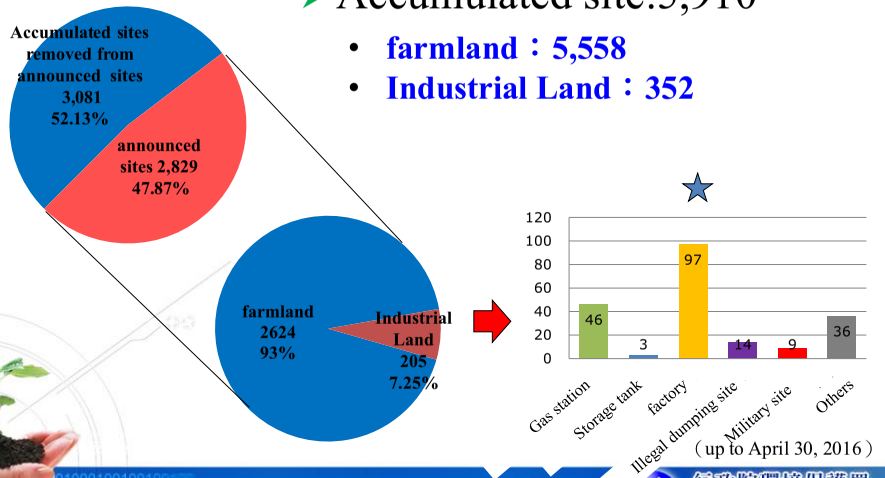
Sediment–Classification Management and Use Limitation Regulation of Sediment Quality Indicator



Contaminated Site Remediation

Remediation (1/2)

- Types of announced sites

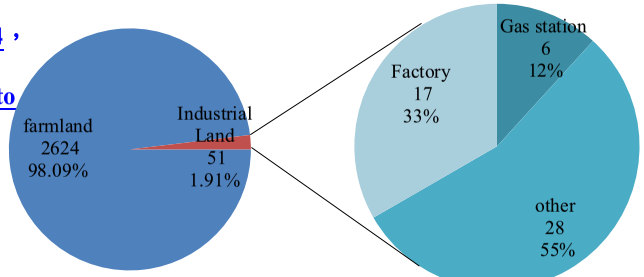


Achievements

Remediation(2/2)

- Promote orphan site remediation

- **farmland site 2,624，budgeted NTD688 million from 2016 to 2019 to accelerate remediation**

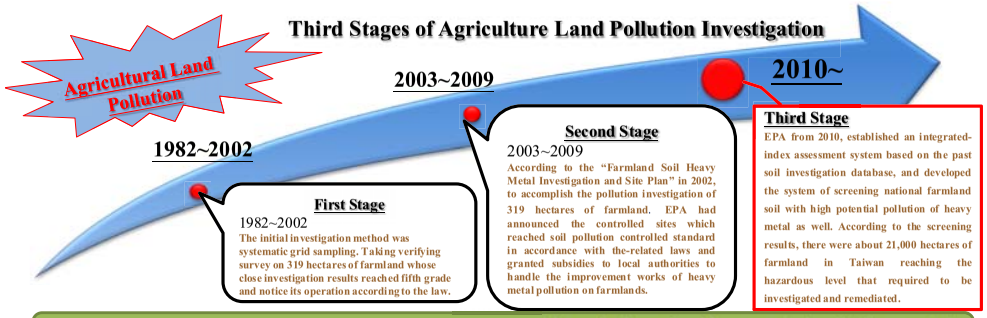


- **Sequenced by the degree of contamination of non-agricultural land 51 sites**

(up to April 30, 2016)

County	Site name	Degree of contamination	Area
臺南市	永康區鹽行段1418等36筆地號土地	7539	41,145
臺南市	臺南市安定區安定段等7筆地號	3779	12,810
苗栗縣	苗栗縣頭份鎮永貞段887地號	3620	20,181
台中市	大里區光正路地下水污染案	2066	50,647
高雄市	高雄市大寮區福德爺廟場址	1455	77,277
⋮	⋮	⋮	⋮

Farmland Pollution



Agriculture Land Investigation Project in 2010：Nation-wide agriculture land heavy metal pollution control and investigation project.

- Create agriculture land potential heavy metal pollution screening mechanism, evaluate the connection between polluted irrigation route and polluted agriculture land and effective administrative management strategy
- Up to August 31 2016, there were 565 hectares of polluted farmlands which had been improved, and therefore had been removed from the controlled list according to the law, so now farmland with soil control is 385 hectares.

Abandoned Factories Pollution

- "Nationwide Abandoned Factory Pollution Investigation Project" started in 2004
- Approximately 120 thousand abandoned factories in Taiwan. Investigated 42 thousand abandoned factories with emphasis on 30 major industries that have the highest pollution potential.
- By the end of 2015, 102 sites were identified as controlled sites and 71 sites have been de-listed

Quality Management for Industrial Parks

The 4-year action program of soil and groundwater quality management for the industrial parks had been promoted since 2011; at the present, the scope is broadened to industrial land and the work is still going on.

Establishing a light classification system of early warning and management

- The monitoring information of 144 designated industrial parks was integrated.
- The status and the measures of administrative control of each industrial park is announced on a regular time schedule.

Gas Station Pollution

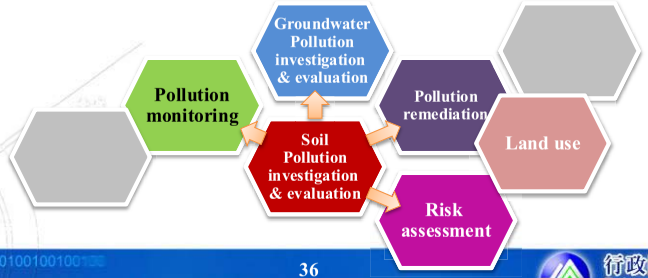
- Starting from 2001, approximately 2,600 gas stations and 10,400 large storage tanks have been investigated for potential soil and groundwater pollution. The extent of gas station pollution in Taiwan has been fully understood with 266 gas stations listed as control polluted sites and 168 gas stations have been de-listed.

Phases	Year	Names of Gas Station Pollution Investigation Projects
Phase I	2001	Groundwater Potential Pollution Source Investigation Project
Phase II	2002~2003	Nation-Wide Gas Stations and Large Storage Tanks (Operated for more than 10 years) Pollution Source Investigation Project
	2003~2004	Gas Stations in Central-North Region(Operated for less than 10 years) Potential Pollution Source Investigation Project
Phase III	2006~2007	Gas Stations Operated for Less Than 10 Years Soil and Groundwater Pollution Investigation Project
Phase IV	2007~2009	Gas Station Soil and Groundwater Pollution Investigation Project (Phase IV)
Phase V	2009~2010	Gas Station Soil and Groundwater Pollution Investigation Project (Phase V)
Phase VI	2010~2011	Gas Station Soil and Groundwater Pollution Investigation Project (Phase VI)
Phase VII	2012~2013	Gas Station Soil and Groundwater Pollution Investigation Project (Phase VII)
Phase VIII	2014~2015	The inspection, consultation and auditing of declaration reports for underground storage tanks project
Phase IX	2015~2016	The inspection, consultation and auditing of declaration reports for underground storage tanks project (Phase II)

Conclusion

Continuously promote policy of soil and groundwater pollution prevention, investigation & remediation

Properly plan and manage the fund incomes and expenses to ensure sustainable operation



Groundwater - Quality Monitoring & Management

Groundwater monitoring well management of 2015

- **Conduct periodic groundwater quality monitoring to understand nationwide background water quality distribution.**
- **453 regional monitoring wells currently.**
- **Modify monitoring frequencies by analyzing water quality trend and propose management plans for specific groundwater quality issues**

Conclusion

Environmental Analysis Laboratory Accreditation, Management and Auditing in Taiwan

Chen , Yuan-Wu
Senior Researcher
EAL, Taiwan EPA

2018 June 21

Curriculum Vitae

EXPERTISE

- **Environmental Analysis Laboratory Accreditation, Management and Auditing**
- **Ultra-trace Persistent Organic Pollutants Analysis**

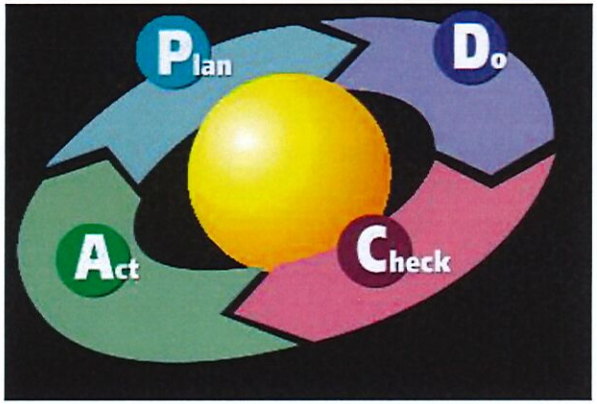
EXPERIENCE

- Research Assistant, EAL, Taiwan EPA, 1993-1998.
- Junior Researcher, EAL, Taiwan EPA, 1998-2006
- Researcher, EAL, Taiwan EPA, July 2006-2010
- Section Director, EAL, Taiwan EPA, 2010-2018
- **Senior Researcher, EAL, Taiwan EPA, 2018-present**
- **Current NATA-approved signatory** for 7.70.04, 7.84.23 (**Determinations of PCDDs and PCDFs in flue gases**)

Chen, Yuan-Wu

What is PDCA?

PDCA (plan–do–check–act) is an iterative four-step management method used in business for the control and continual improvement of processes and products.



Information from **https://en.wikipedia.org/wiki/PDCA**

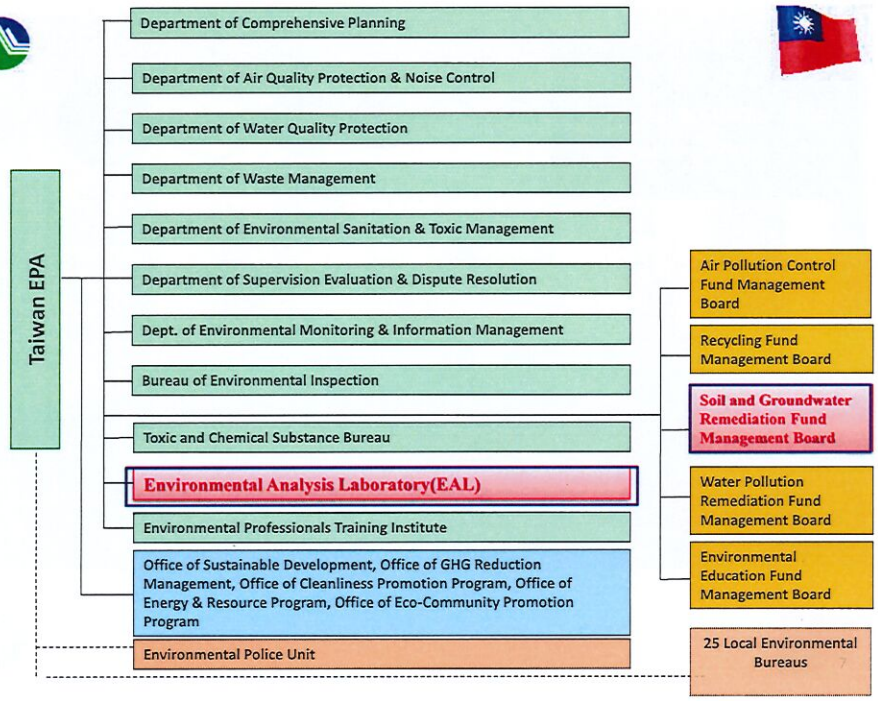
Outline

Brief introduction of EAL

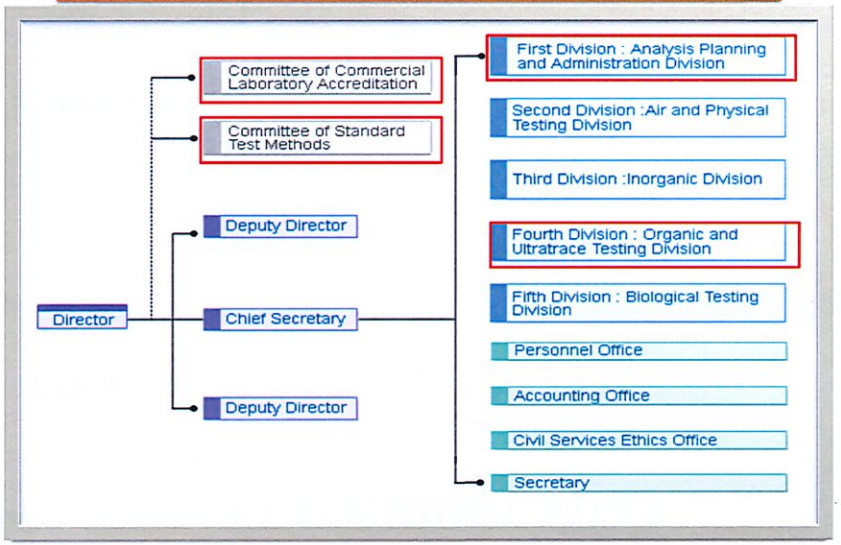
Taiwan EPA Established in 1987

To improve environmental quality, the Taiwan EPA was established in August 1987, setting a milestone in Taiwan's environmental protection efforts.

Our Minister **Lee, Ying-Yuan**



EAL Established in 1990



EAL Mission

To effectively upgrade the quality of national environmental analysis data

To actively enhance the capability of public and private environmental analysis laboratories

To provide support to meet the environmental analysis requirements of all levels of environmental protection authorities in line with the principles of efficiency, quality data, and credibility.

EAL Major Tasks

- Grant Accreditation to Environmental Analysis Laboratories
- Establishment of Standard Environmental Methods
- Implementation of Environmental Data Quality Assurance
- Automation of Laboratory Procedures
- Conducting Environmental Analysis Technology Research
- Promotion of Ultra-trace Testing Capability
- Technological Guidance for Regional Facilities
- Training of Environmental Analysts
- Participation in the International Laboratory Accreditation Program
- Promotion of International collaboration

NATA Accreditation

In May,1994, the EAL applied to NATA (National Association of Testing Authorities, Australia.)

On Jan.31, 1995, the EAL received NATA accreditation .

Up to now, the EAL has extended the scope of accreditation to include air, water, waste and soil analysis.

Establishment of Standard Environmental Methods

Depending on the nature of the pollutants, environmental analysis methods can be classified into ten categories as follows: noise testing, analysis of air, water, drinking water, soil, sediment, wastes, Environmental agents, Toxic chemicals, and Groundwater.

The EAL has established standard environmental methods based on these categories and 604 environmental methods have become standard during recent years.

As unified testing procedures, these standard methods are followed by the accredited laboratories to ensure consistent test data quality.

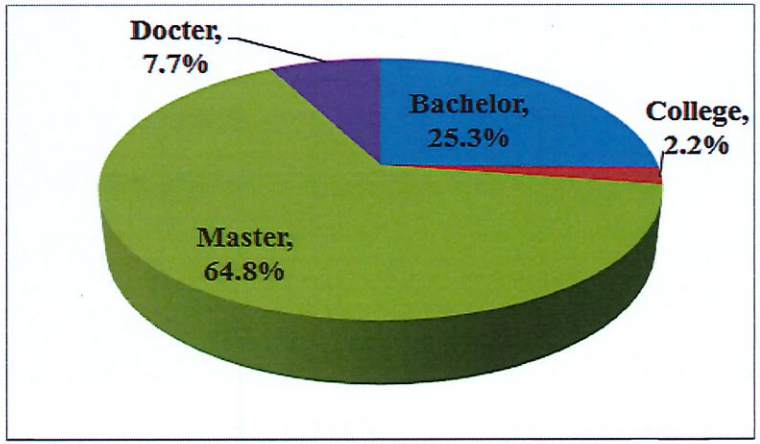
Implementation of Environmental Data Quality Assurance

The EAL ensures that testing data have complied with data quality elements including:

- **Precision**
- **Accuracy**
- **Representativeness**
- **Completeness**
- **Comparability**

Human Resource of EAL

◆Total Employees : 111



Government Employee Reduction Policy:
188→111

Risk Management of EAL

Risk

- Employees in charge of environmental analysis at EAL is **less than 50**
- Employees of Food and Drug Administration (**FDA**) is **more than 1200**

Management

- **Grant Accreditation to Environmental Analysis Laboratories**

Environmental Analysis Laboratory Accreditation

Grant Accreditation to Environmental Analysis Laboratories

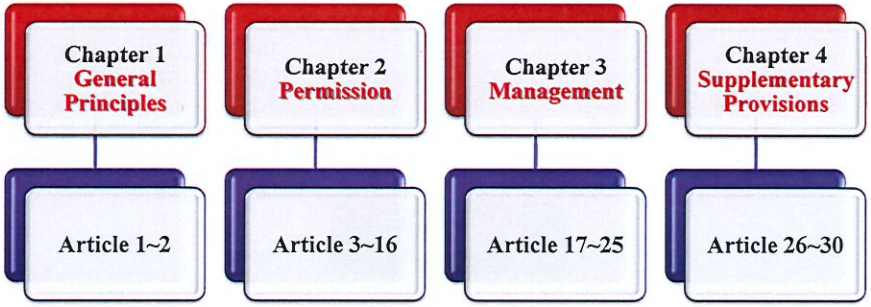
The EAL has been promoting the accreditation of environmental analysis laboratories since 1987.

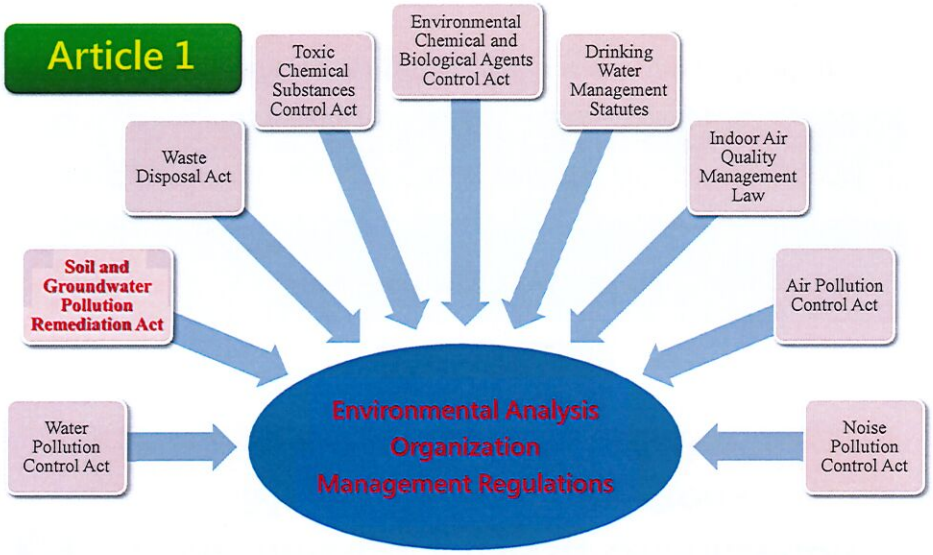
EAL published the "Guideline for the Authorization and Management of Environmental Analysis Laboratories" in 1990.

In November 19, 1997 the latest modified guideline was published as the "Management regulations of Environmental Analysis Laboratories".

A series of basic criteria for an environmental analysis laboratory's QA system has also been formulated according to ISO/IEC 17025 international standards.

Environmental Analysis Organization Management Regulations





Soil and Groundwater Pollution Remediation Act

Article 10

When, in accordance with this Act, soil, bottom sediment, and groundwater pollution investigation or remediation work is performed, or soil and groundwater pollution test data is provided or submitted, except when approved by the central competent authority, **the soil, sediment, and groundwater pollutant testing shall be commissioned to an analysis organization approved by the central competent authority.**

With regard to the analysis organization in the foregoing paragraph, the central competent authority shall determine regulations governing the organization's criteria, facilities, permit application, review, issuance (replacement), revocation, and cancellation, suspension and resumption of business, audit and evaluation procedures, instruments and equipment, test personnel, in-service training, technical evaluation, blind testing, test methods, quality control matters, basic quality system guidelines, test report signing and data submission, implementation of operations, and other binding matters.

The central competent authority shall determine methods and quality control guidelines when soil, sediment, and groundwater pollutant testing is performed as prescribed in Paragraph 1.

Environmental Analysis Organization Management Regulations
-Conditions for Application Labs

Article 4

Be a **non-public enterprise** with paid-in capital of **NT$ 5 million** or more

Be a **public enterprise** or a **government organization other than an environmental protection competent authority**

Be an academic institution at the **public college** level or higher

Personnel requirement

Article 5

Those that apply for analysis organization permits shall possess their own laboratories; each laboratory shall possess dedicated instruments and equipment and **six or more dedicated analysis personnel, including one laboratory manager and quality assurance/quality control personnel**.

Qualifications of the laboratory manager

Article 6

Be a graduate of a **chemistry or environment-related department** of a school at the public or registered private **college-level or higher** or an overseas school at the college-level or higher that is recognized by the Ministry of Education.

Possess analysis experience of **five years** or more related to the analysis category for which they are applying for permission, and provide verification documents. However, those with a relevant **bachelor's degree may deduct two years** of analysis experience; those with a relevant **master's degree may deduct three years** of analysis experience; those with a relevant **doctoral degree may deduct four years** of analysis experience.

Qualifications of the quality assurance/quality control personnel

Article 7

Be a graduate of a **chemistry or environment-related department of a school at the public or registered private college-level or higher** or an overseas school at the college-level or higher that is recognized by the Ministry of Education

Possess analysis experience of **three years** or more related to the analysis category for which they are applying for permission, and provide verification documents. However, those with a relevant **master's degree may deduct one year** of analysis experience; those with a relevant **doctoral degree may deduct two years** of analysis experience.

Qualifications of analysis personnel

Article 8

Be a graduate of a **science, engineering, medical or agricultural department of a school at the public or registered private college-level or higher** or an overseas school at the college-level or higher that is recognized by the Ministry of Education.

Be a graduate of a public or registered private high school or vocational school and possess verification documents demonstrating relevant analysis experience of **three years or more.** However, **chemical analysis, chemical engineering, agricultural chemistry, food science or environmental department graduates may deduct one year** of analysis experience.

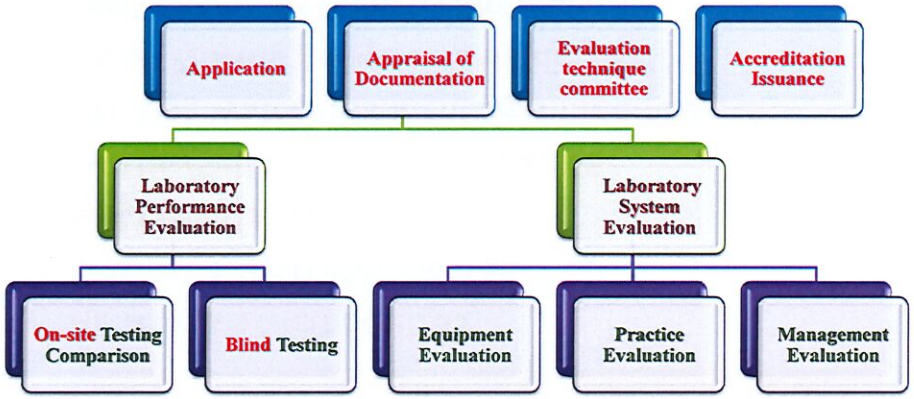
Analysis Categories for Accreditation

Article 12

- Air analysis
- Water quality and water volume analysis
- Drinking water analysis
- Waste analysis
- **Soil analysis**
- Environmental agents analysis
- Toxic chemical substances analysis
- Noise testing
- **Groundwater analysis**
- **Sediment analysis**
- Other analysis categories officially announced

Procedure of Accreditation

Article 13



Evaluation technique committee

Article 14

The central competent authority may establish an **evaluation technique committee** in order to conduct **reviews, evaluations and consultations** for analysis organization permits.

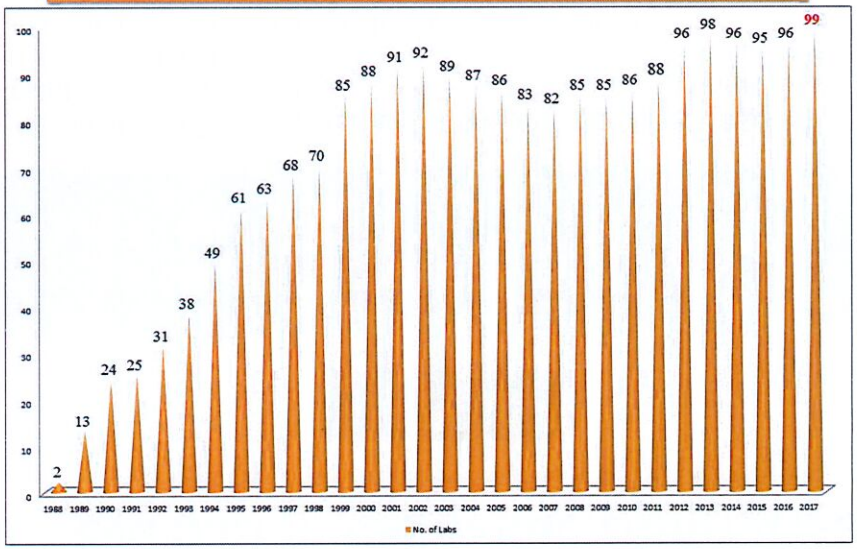
The evaluation committee in the foregoing paragraph shall establish positions for **twenty-one** to **twenty-five committee members**; terms shall be **two years** and committee members may be reappointed after the end of their terms.

NIEA Standard Methods

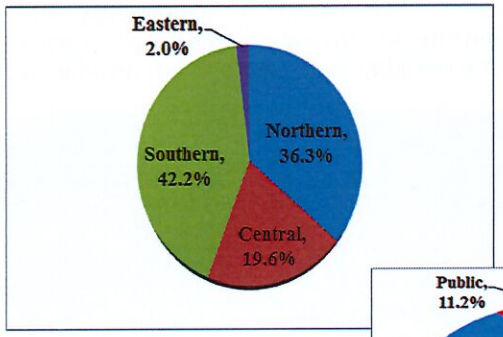
- Air Analysis Methods: 153
- Wastes Analysis Methods: 66
- **Soil Analysis Methods: 25**
- **Wastes/Soil Common Methods: 66**
- Drinking Water Treatment Agent Methods: 25
- **Water Quality Analysis Methods: 167**
- Toxic Chemicals Analysis Methods: 35
- Environmental Agents Analysis Methods: 14
- Environmental Bioanalytical Methods: 53

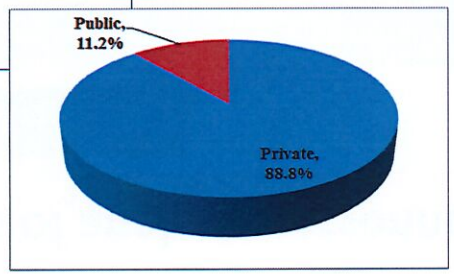
No. of Standard Methods:**604**

Chronology of Number of Labs

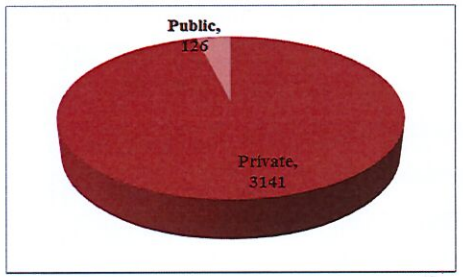


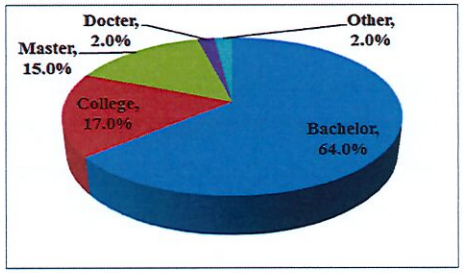
Labs Distribution





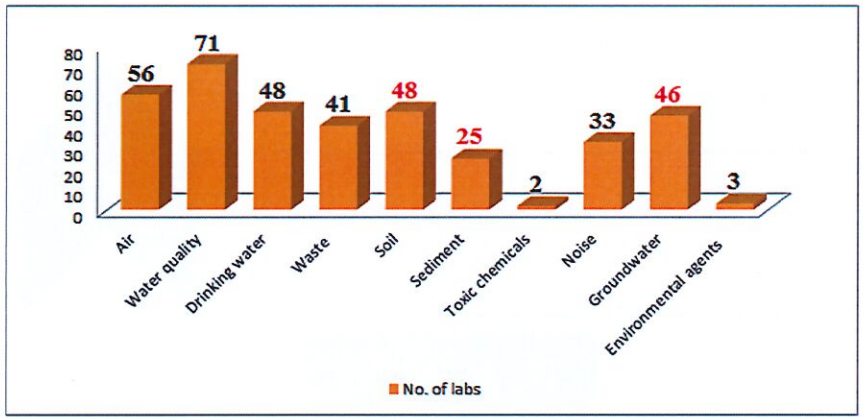
Human Resources



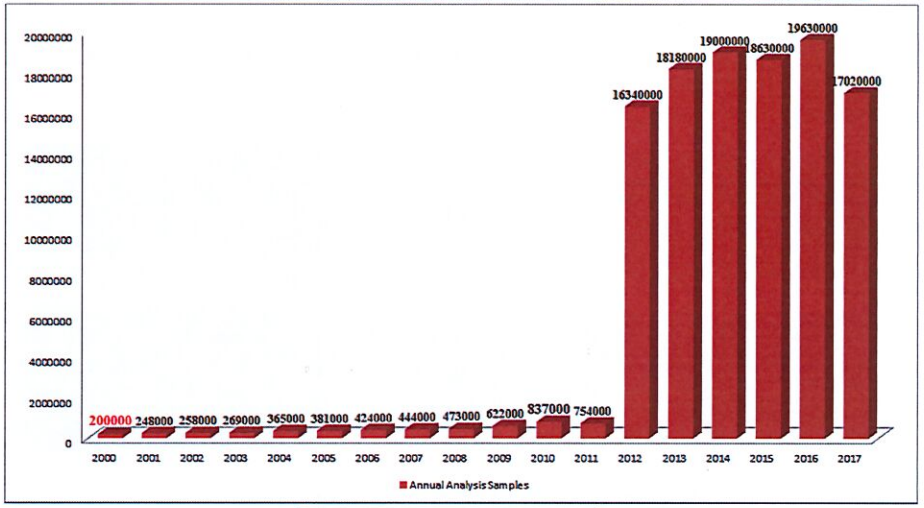


◆Total Employees : 3267

Distribution of Analysis Categories

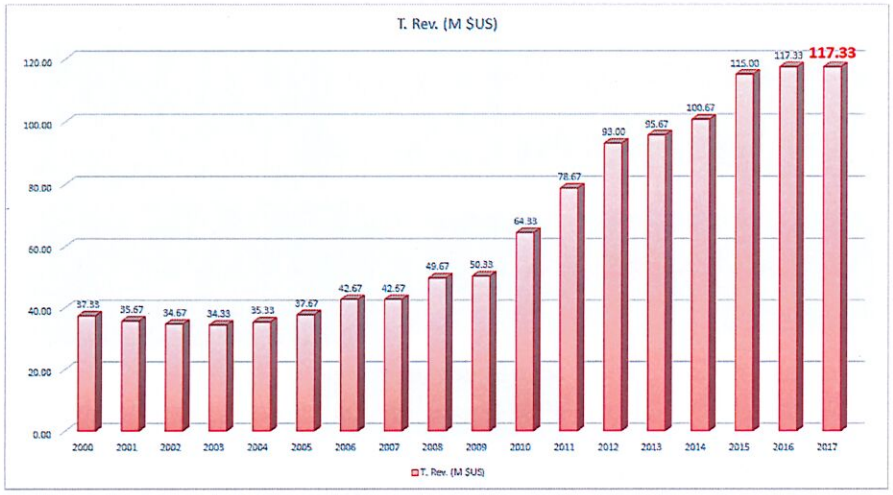


Annual Analysis Samples



> 90%

Annual Total Revenue (M $US)



Environmental Analysis Laboratory Management and Auditing

Data Reporting of Accreditation Labs

Article 17

Quality control data	• prior to **January 31**
A three-month test statistics form	• shall be reported on the **15th day of the January, April, July, and October**
Testing data	• shall be **transmitted via the Internet**

Change Reporting

Article 19

personnel	• <30 days • filled within 30 days.
representative	• <90 days
items recorded on a permit	• <30 days
moving the laboratory	• 15 days in advance • <30 days after completion of the move.

Auditing of Accreditation Labs

Article 20-21

Regular auditing	• **Blind testing(Proficiency test sample)** • **International Proficiency test project**
Irregular auditing	• Normal or **Abnormal** situation • **Sampling site** auditing • **Lab** auditing

2017 Auditing Project

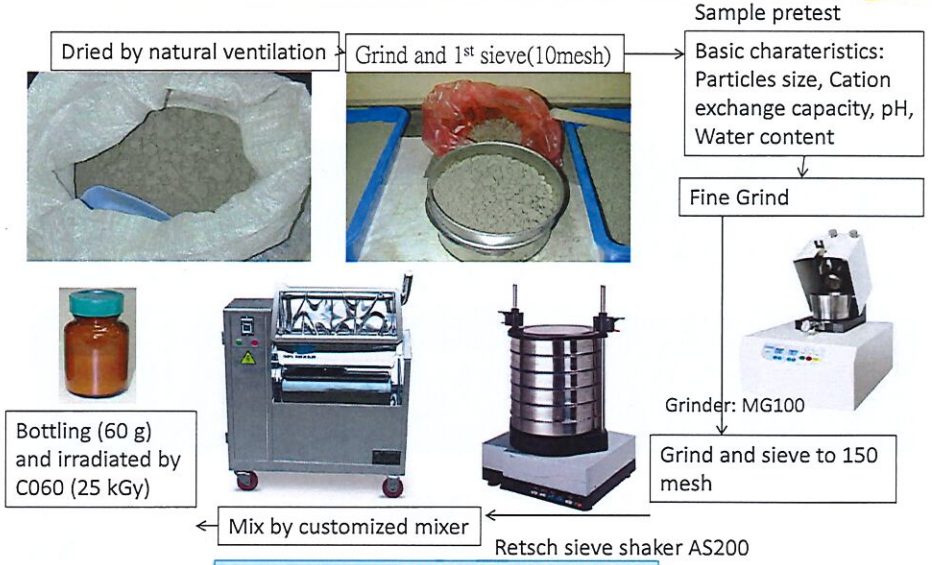
Blind testing	• **299** samples
Sampling site auditing	• **43** times
Lab auditing	• **32** times

for Soil , Sediment and Groundwater Labs

Proficiency test sample project

High quality Dioxin PT sample prepared by EAL

Heavy metal PT sample project



Information from Kai-Hsien Chen Ph. D.

Dioxin Lab Auditing

Information from SGS Dioxin Lab

Training of Accreditation Labs

Article 22

The central competent authority may order an analysis organization to dispatch appropriate or designated analysis personnel to receive on-the-job training.

Penalty regulations

Article 24

- Article 70 of the Air Pollution Control Act
- Article 16 of the Indoor Air Quality Management Law, Article 32
- Paragraph 2 of the Noise Pollution Control Act
- Article 49 of the Water Pollution Control Act
- **Article 42, Paragraph 1, Subparagraph 2 and Paragraph 2 of the Soil and Groundwater Pollution Remediation Act**
- Article 58 of the Waste Disposal Act
- Article 34, Subparagraph 7 of the Toxic Chemical Substances Control Act
- Article 48, Subparagraph 5 of the Environmental Chemical and Biological Agents Control Act
- Article 24 of the Drinking Water Management Statutes

Soil and Groundwater Pollution Remediation Act

Article 42

Those in one of the following circumstances shall be fined NT$50,000 to NT$250,000.

- I. Violation of regulations determined pursuant to Article 10, Paragraph 2 concerning instruments and equipment, test personnel, in-service training, technical evaluation, blind testing, test methods, quality control matters, basic quality system guidelines, test report signing and data submission, and implementation of operations, and other binding matters.

Conclusion

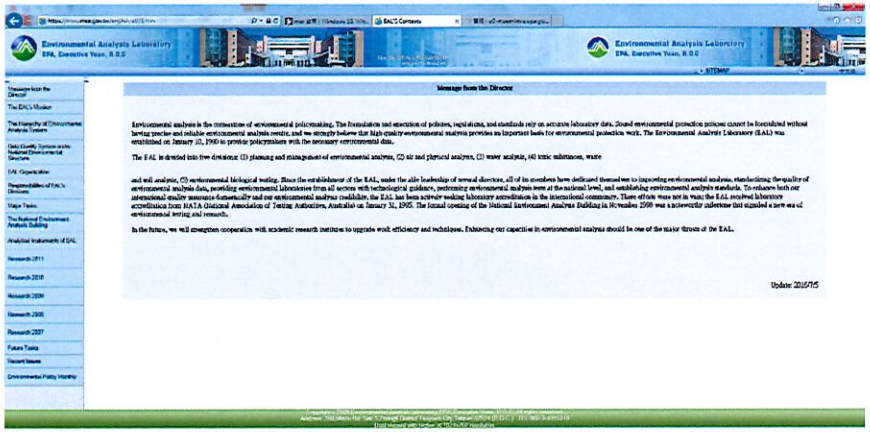
Conclusion

The EAL has been promoting the accreditation of environmental analysis laboratories since 1987.

There are currently 99 accredited laboratories with more than 3200 employees.

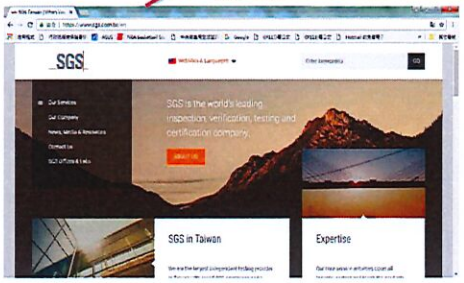
In terms of the number of analyzed samples, accredited laboratories now also account for 90 % of all tested samples in Taiwan.

EAL Website



https://www.niea.gov.tw/english/a001.htm

Our Team Members



Taiwan SGS

Blue Formosa

Thank you for your attention!

e-mail: ywchen@epa.gov.tw

TASGEP

- The Taiwan Association of Soil and Groundwater Environmental Protection (TASGEP) was founded on December 12, 2000. The main objectives of the TASGEP are to fortify the communication of members from different fields including in situ investigators, remediation scientists, legislators, and environmental protectors, to effectively protect soil and groundwater from environment pollution, and to achieve sustainable utilization of environmental resources in Taiwan.

Academia, Research institutes, Government, Consultants, and Industries



TASGEP

- ~60 Corporation Members; 400+ Individual Members
- Annual Conferences (Jan/Feb)
- Bi-lateral Conferences between Taiwan and China
- Training Workshops
- Forum
- International Conferences

Soil and Groundwater Contamination in Taiwan and Southeast Asia: Status and Needs

Tsair-Fuh Lin
Taiwan Association of Soil and Groundwater Environ. Protection, and
Department of Environmental Engineering
Global Water Quality Research Center
Tainan Hydraulics Laboratory
National Cheng Kung University, Taiwan

成功大學 National Cheng Kung University

Tsair-Fuh Lin

財富- rich

Department of Environmental Engineering and
Global Water Quality Research Center
National Cheng Kung University

成功- success

- **Education**
  - PhD in Env Eng, University of California, Berkeley (1995)
- **Experience**
  - President, Taiwan Association of Soil and Groundwater Environ. Protection
  - Distinguished Professor, Department of Environmental Engineering, NCKU
  - Director, Global Water Quality Research Center, NCKU
  - Director, Tainan Hydraulics Laboratory, NCKU
  - Governing Member, International Water Association
- **Contact**

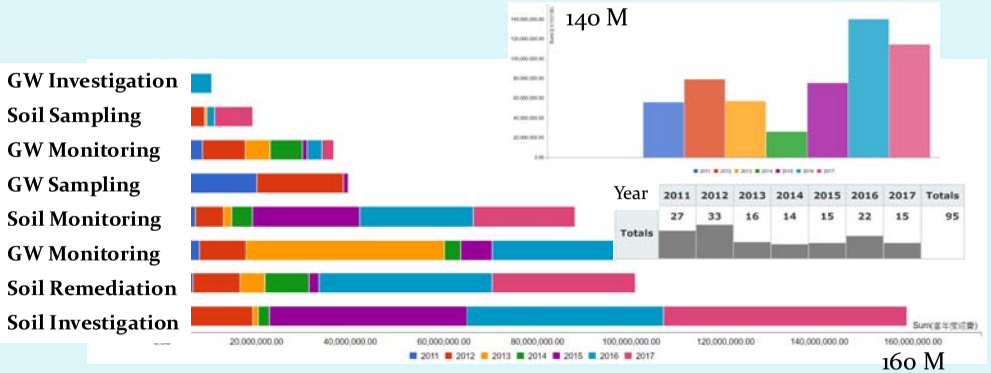
A RICH man teaching in the SUCCESSFUL University

S&GW Research in Taiwan

Journal of Soil and Groundwater Remediation

- A Flagship Journal of TASGEP
- Application Oriented Journal
- English/Chinese

Projects relevant to SGW Supported by TW Government

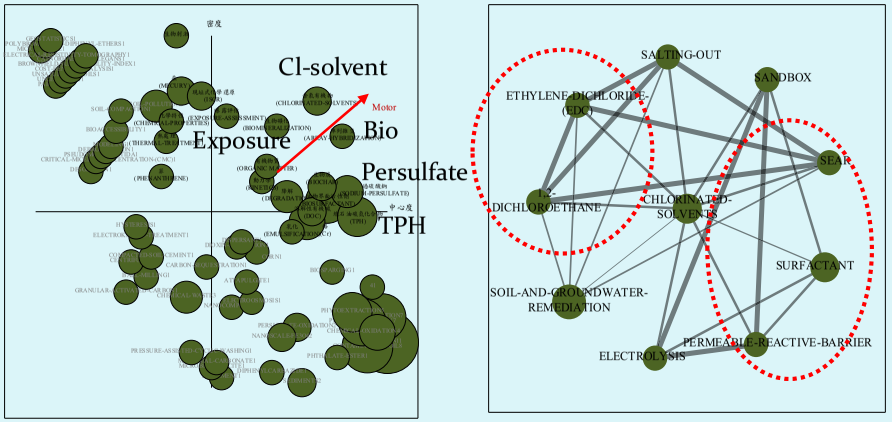


2011-2017, 40-140M/year on Soil and GW Investigation and Remediation
Soil Investigation, Soil Remediation, GW Monitoring, and Soil Monitoring

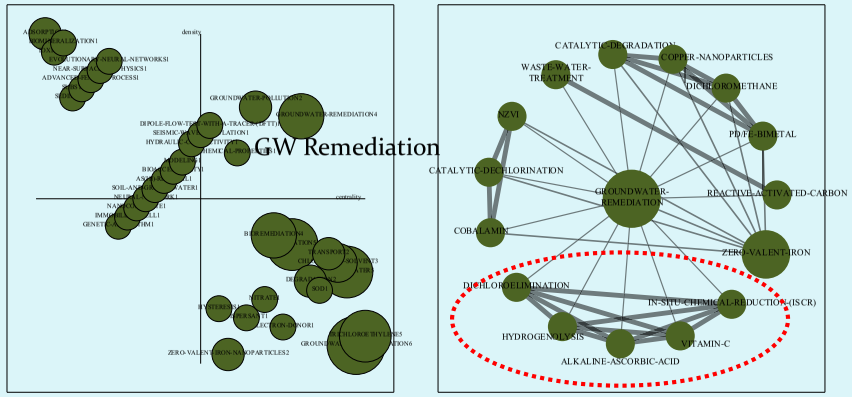
Outlines

- Hot Topics: From Taiwan Research Projects and from Scientific Publications
- Possible Issues: From Outcomes of "International Workshop on Sustainable Soil and Groundwater Protection and Remediation (IWSSGPR) (2015-2017)"
- Asian Market: From US Trade Report (2016)
- Technology Demands: From US Trade Report (2016) and from IWSSGPR (2017)

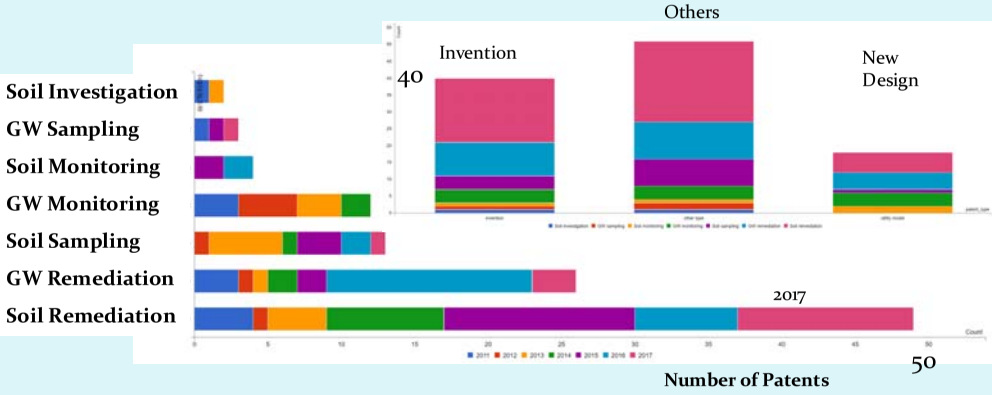
Co-Word Analysis, Soil Remediation (2011-2018, Taiwan, 125 papers)



Co-Word Analysis, Groundwater Remediation (2011-2018, Taiwan, 68 papers)

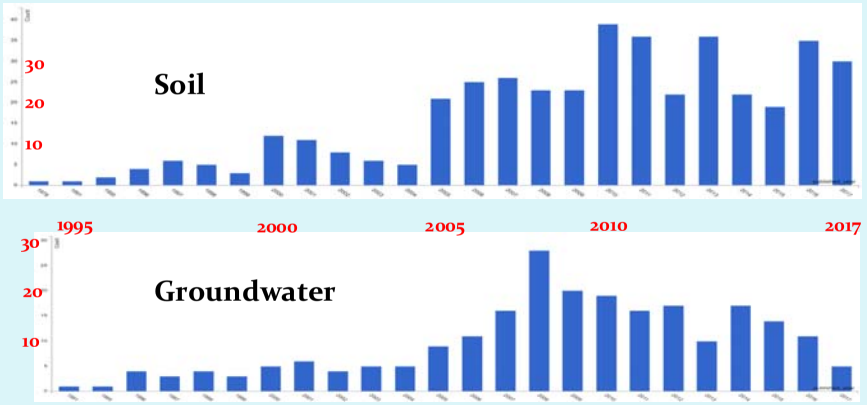


Patents



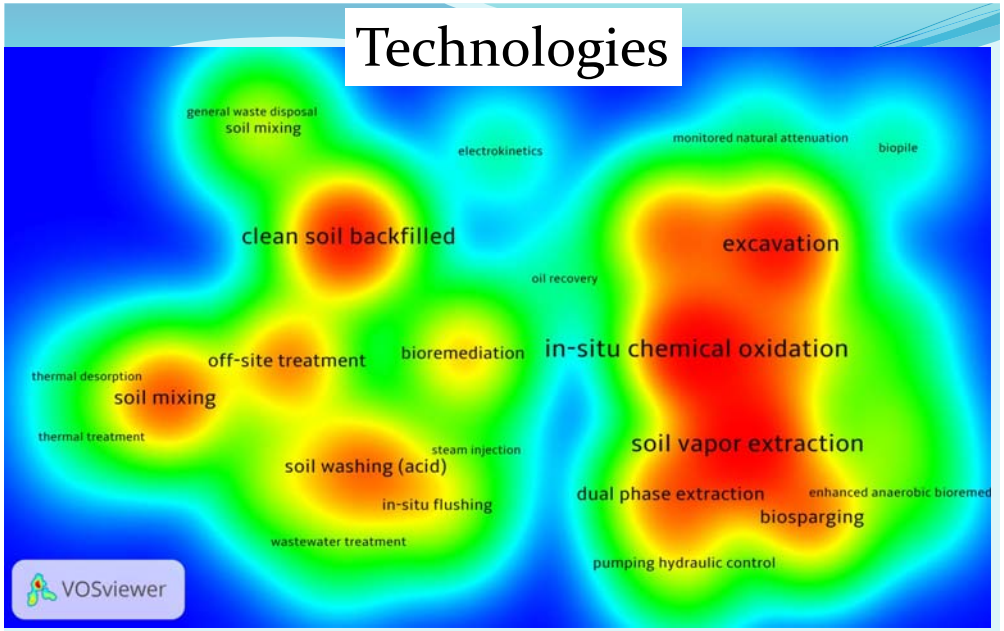
Soil Remediation and GW Remediation

Paper Published (Remediation)



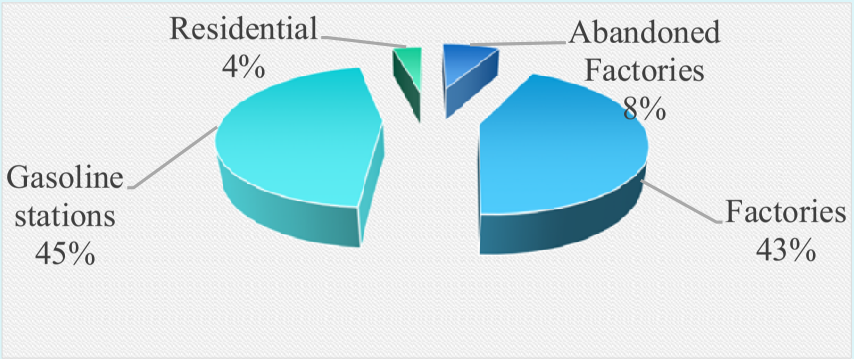
Big Increase from 2005
More Soil than GW 20-50 each year (Soil), and 10-30 each year (GW)

Technologies



- Color: weighing factor, from blue (low), green, yellow, to red (high)
- Distance: cluster intensity, closer meaning stronger link
- Font: frequency

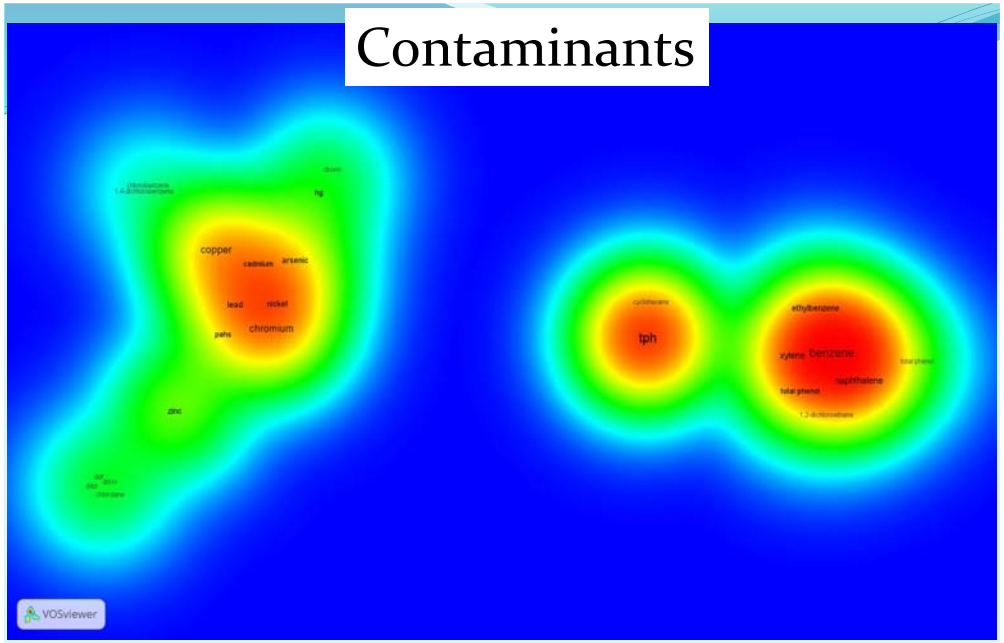
53 Taiwan remediation cases



ASEAN

- ASEAN (Association of Southeast Asian Nations)
- the **seventh** largest economy in the world (USD 2.6 trillion) (2014)
- the **third** largest country by population (622 million)
- The ASEAN Socio-Cultural Community Blueprint (2009-2015)
  - highlights the use of "environmentally sound technologies" to promote sustainable development in the region.

Contaminants



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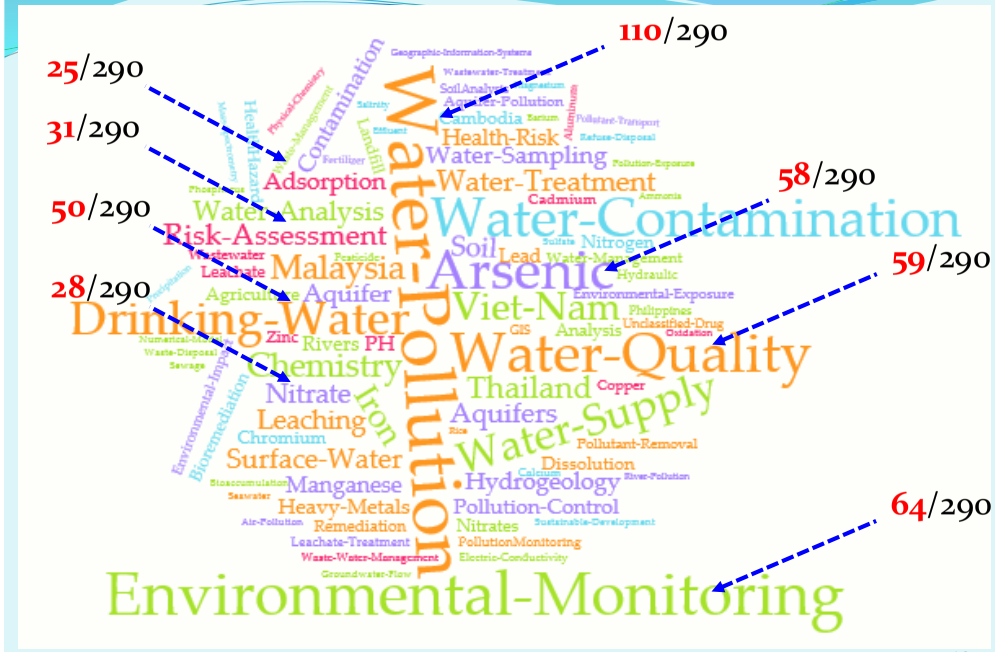
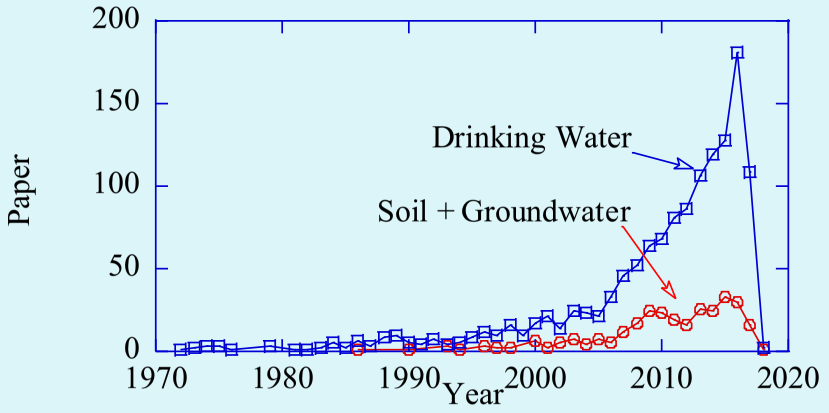


Papers Published (Scopus, 1973-)

The Five Countries: Cambodia, Philippines, Malaysia, Thailand, and Vietnam

Drinking Water : 1330 papers

Soil/Groundwater Pollution/Remediation: 290 papers



Contaminants

58	Arsenic
35	Iron
28	Nitrate
24	Manganese
22	
22	
20	
19	
19	
18	
17	Zinc
16	Cadmium
	Copper

Issues/Technologies

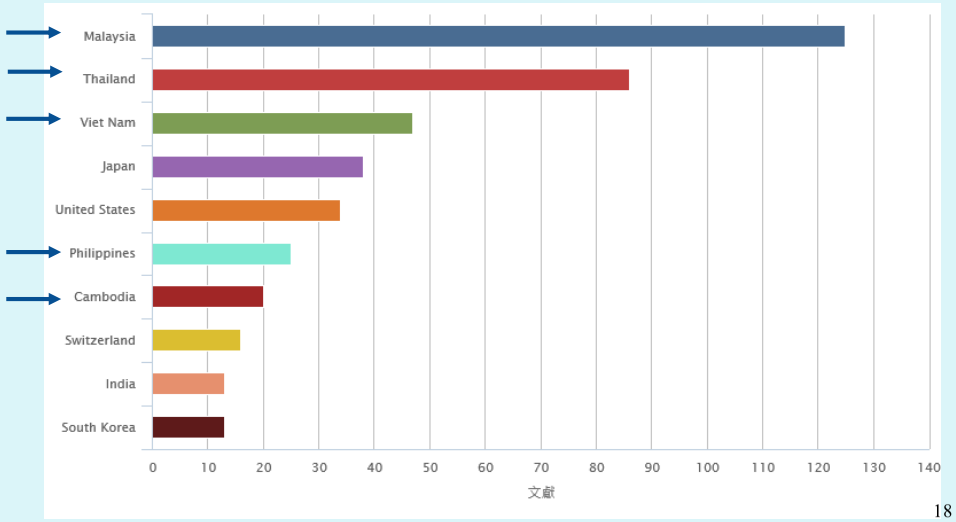
64	Environmental Monitoring
59	Water Quality
50	Drinking Water
40	Soil Pollution
31	Risk Assessment
22	Pollution Control
20	Nonhuman
	ation

Biomolecular Methods (<20)
Site Investigation (<20), Geophysical (<20),
SVE, P&T, Soil vapor extraction, Dual phase extraction,
Chemical washing, Water washing (4), Bioremediation,
Bioventing, Hydraulic control, *In-situ* chemical oxidation,
Steam injection, Pump and treat, Off-site solidification

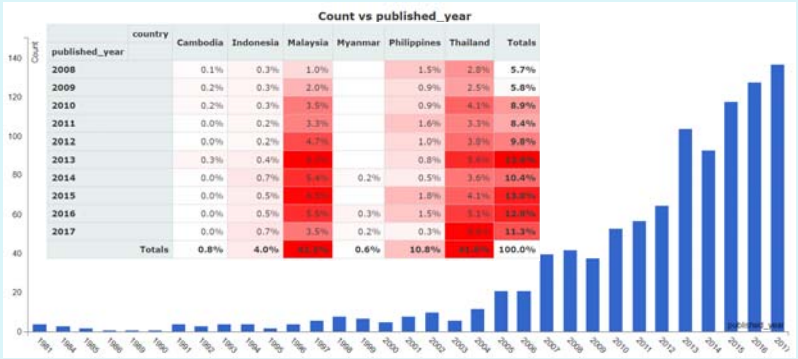
Organic Pollutants, Emerging Contaminants,
BTEX, Chlorinated HCs (< 15)

Papers Published (Scopus, 1973-)

Soil/Groundwater Pollution/Remediation: 290



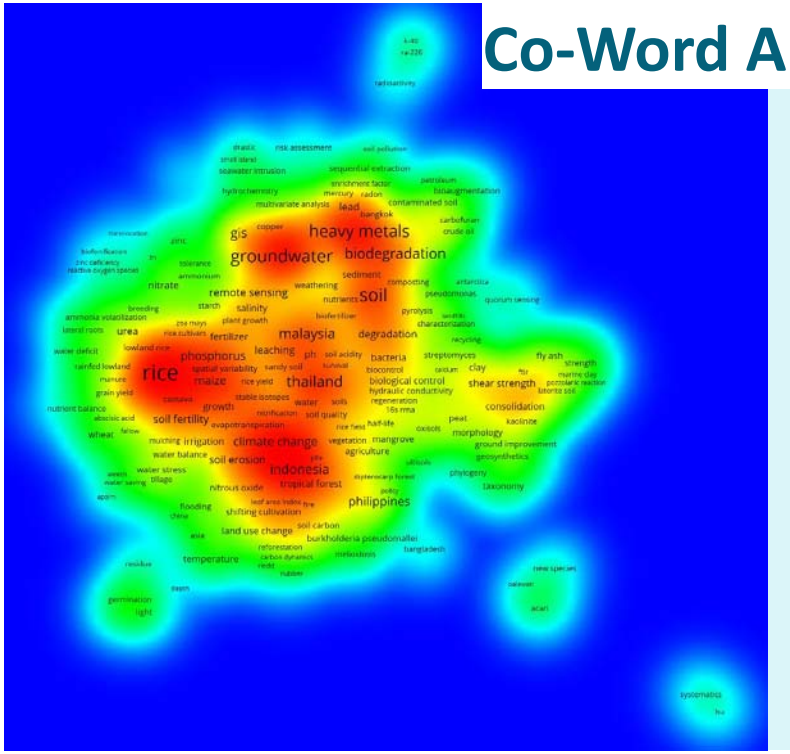
Papers Published (1981-2017) GW and SE Asia



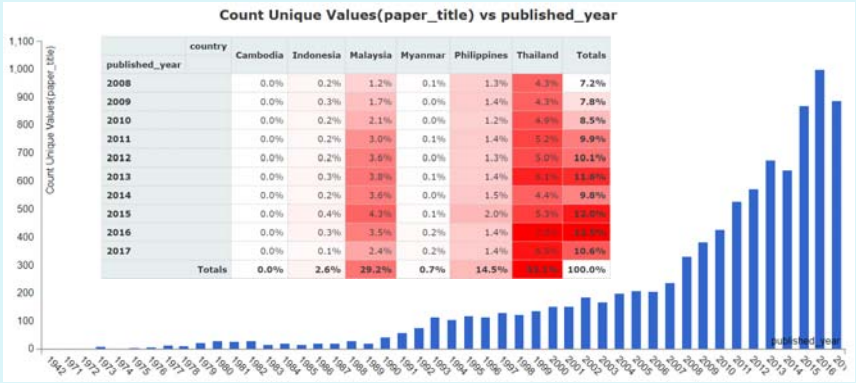
Papers Published by SE Asia Soil and GW Research

- Thailand
- Malaysia
- Myanmar
- Cambodia
- Indonesia
- Philippines
- Viet Nam

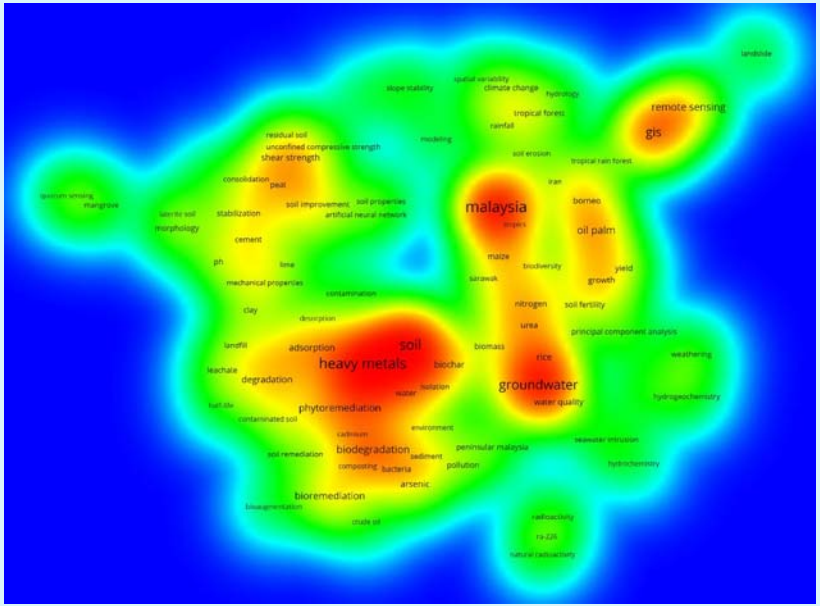
Co-Word Analysis



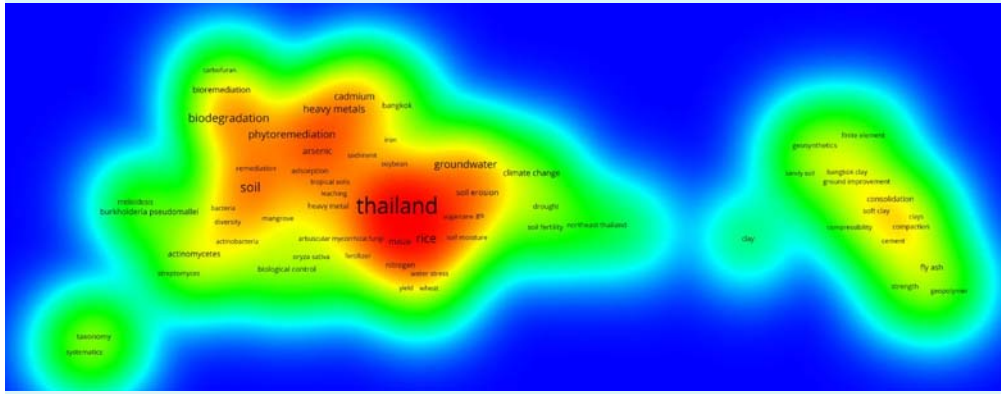
Papers Published (1972-2017) Soil and SE Asia



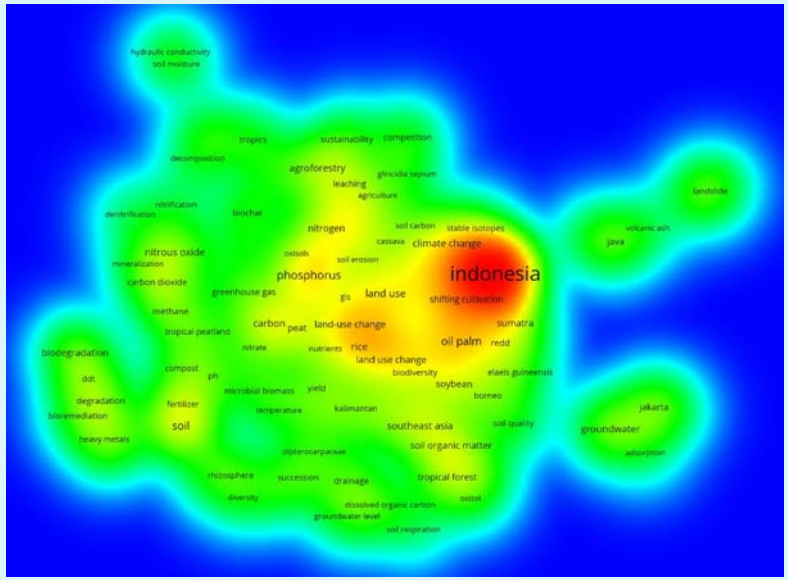
Malaysia



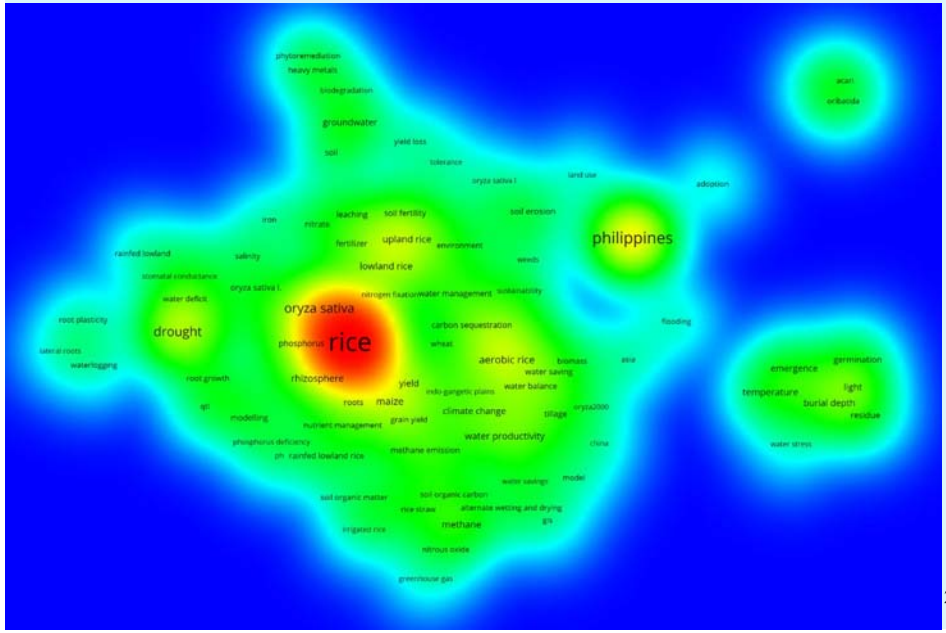
Thailand



Indonesia



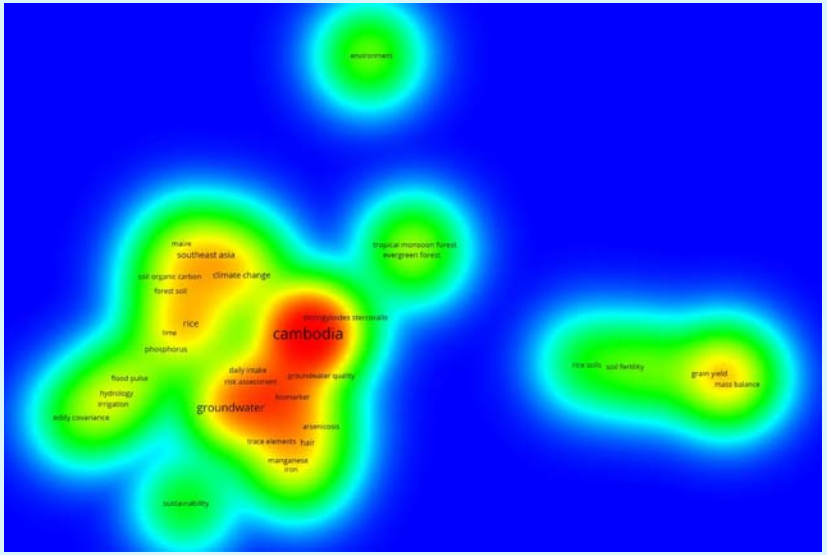
Philippines



International Workshop on Sustainable Soil and Groundwater Protection and Remediation (IWSSGPR)

Country / Year	Thailand	Malaysia	Vietnam	Indonesia	Philippines	Cambodia	Total
2015	2	2	4	8	5	0	21
2016	3	2	6	4	7	1	23
2017	3	3	5	5	10	2	28
Total	8	7	15	17	22	3	72
Percentage	11%	10%	21%	24%	31%	4%	

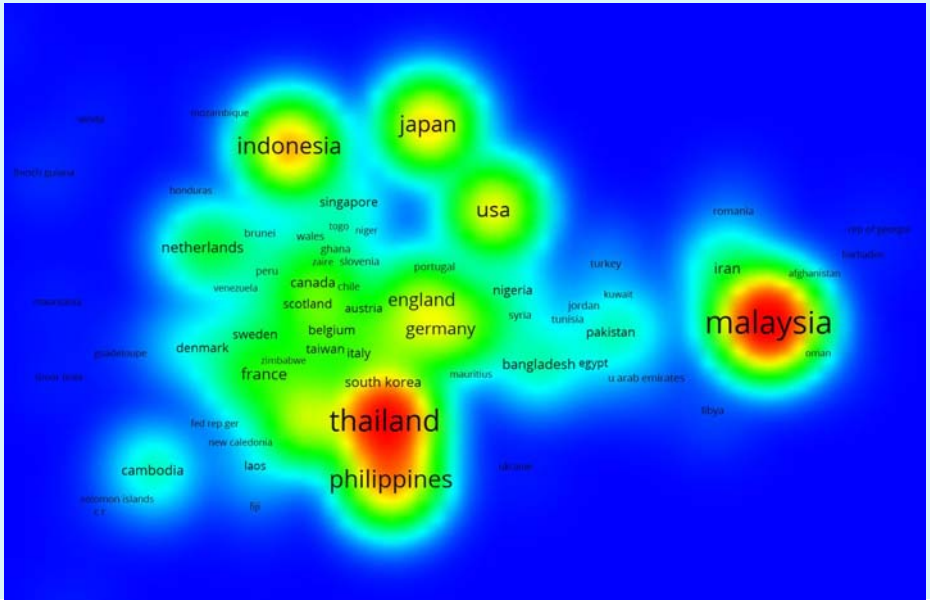
Cambodia



Key Issues suggested by the IWSSGPR participants

- Baseline investigation of soil and groundwater contamination
  - All countries (Monitoring)
- Bioremediation and application in different countries
  - Low cost treatment methods
- Seawater intrusion and land subsidence
  - Vietnam, Philippines, Thailand, Taiwan, India
- Landfill contamination
  - Vietnam, Philippines, Thailand, Indonesia, Malaysia
- Groundwater as drinking water source
  - Thailand (As), Vietnam (As, NH_3, Private Wells), Philippines (Coliform), Malaysia (Fe), India (Nitrate, As, F, Cr. CN, Hg, Dye, Fe, Pesticide, Nitrate, Coliform), Cambodia (As)

Co-Authored Papers



Investigation and Remediation Technologies on Soil Contamination

Site Classification/Contaminants / Investigation Technologies on Soil	Country: Indonesia	Philippines	Thailand	Total
Agricultural	1	4		5
Halogenated SVOCs		3		3
Gas Chromatography/ Mass Spectrometry		2		2
Infrared Spectroscopy		1		1
Halogenated VOCs	1			1
Gas Chromatography/ Mass Spectrometry	1			1
Metals and metalloids		1		1
Unknown		1		1
Battery recycling and disposal	1			1
Metals and metalloids	1			1
Direct Sensing Field-Portable X-Ray Fluorescence	1			1
Gasoline stations	2			2
Fuels	2			2
Gas Chromatography/ Mass Spectrometry	2			2
Landfills, municipal and industrial	1	3	1	5
Halogenated SVOCs		1		1
Gas Chromatography/ Mass Spectrometry		1		1
Halogenated VOCs			1	1
Gas Chromatography/ Mass Spectrometry			1	1
Metals and metalloids	1	2		3
Atomic Absorption Spectroscopy	1	2		3
Metal recycling and automobile salvage		2		2
Metals and metalloids		2		2
Direct Sensing Field-Portable X-Ray Fluorescence		1		1
Inductively Coupled Plasma-Atomic Emission Spectroscopy		1		1
Mining	1	6	4	11
Metals and metalloids	1	6	4	11
Atomic Absorption Spectroscopy	1	2		3
Direct Sensing Field-Portable X-Ray Fluorescence		1		1
Inductively Coupled Plasma-Atomic Emission Spectroscopy		1		1
Unknown		2	4	6
Unknown		2		2
Metals and metalloids		2		2
Atomic Absorption Spectroscopy		1		1
Inductively Coupled Plasma-Atomic Emission Spectroscopy		1		1
Total	6	17	5	28

Site Classification/Contaminants / Remediation technologies on soil	Country: Indonesia	Philippines	Thailand	Total
Agricultural		1		1
Battery recycling and disposal	1			1
Metals and metalloids	1			1
Solidification/Stabilization	1			1
Landfills, municipal and industrial	1	1	1	3
Mining	1	4	4	9
Metals and metalloids	1	4	4	9
Bioremediation		3	1	4
Incineration			1	1
Phytoremediation		1	2	3
Solidification/Stabilization	1			1
Total	5	6	5	16

- Mining is the major site category
- Metals and metalloids are the dominant contaminants

Key Issues suggested by the IWSSGPR participants

- Policy and Laws
  - Bureaucratic issues: Indonesia (Central and Local), Philippines (Multiple agencies at national levels), Malaysia (Peninsula Malaysia, Sarawak, and Sabah; Central and Local government; Multiple Agencies)
  - Needs of laws, regulations, and standards (All)
  - Enforcement
- More Research Funding on Soil and Ground Water (All)
- Environmental Awareness (All)

Remediation Technologies on GW Contaminants

Remediation Technologies (Grwoundwater) / Site Classification/Contaminants	Malaysia	Philippines	Total
(laboratory scale)			1
BTEX (Benzene, Toulene, Ethylbenzene, p-xylene)			1
Ostrich bone wastes as biomaterials for adsorption; uptake experiment using volumetric apparatus (Quantachrome NOVA automated gas sorption analyzer); specific surface area by BET procedure; pore-size analysis using Barrett-Joyner-Halenda method; Spectra by FTIR plus spectrophotometer; XRD analysis by Philips XPERT MPD diffractometer. SEM-EDX using Seron microscope;			1
Barangay Bangkal, Makati City, Philippines			1
LNAPLs			1
Plume extraction by multi-phase extraction (MPE) system			1
Davao and Mindoro, Philippines			1
Arsenic			1
Bituminous fly ash as adsorbent			1
Financial district in the Philippines (Metro Manila)			1
Petroleum Products such as benzene, PAH,			1
Multiphase extraction system used in remediation			1
Kampung teluk, Kelantan		1	1
Iron (Fe)		1	1
Subterrenean Iron Removal		1	1
Landfills, municipal and industrial			3
Metals and metalloids			3
Physical Separation			2
Phytoremediation			1
Petroleum refining and reuse			3
Fuels			3
Multi-Phase Extraction			1
Multi-Phase Extraction			1
Quantachrome NOVA automated gas sorption analyzer			1
Unknown			2
Arsenic			1
Nanozeolites from rice hull ash and chitosan nanoparticles or nanofibers for possible in-situ remediation.			1
Heavy metals			1
Phytoremediation-Tolerant plants for the removal of the contaminants such as metals, radionuclides, organic compounds (aromatic HC, pesticides, explosives and surfactants)			1
Total		1	12	13

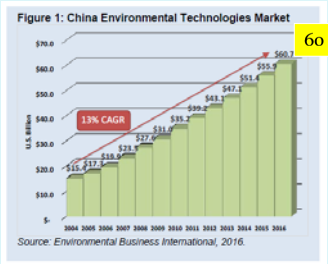
Regions in Thailand	Problem Found
Northern Region	Iron, Fluoride
Central Region	TDS at deep level, Iron, Manganese, Arsenic
Northeastern Region	Iron, Manganese, Sulfate, Chloride, Hardness, TDS
Eastern Region	Chloride, TDS, Iron
Southern Region	Chloride, Hardness due to limestone

- Less information on GW than Soil.

Key Issues suggested by the IWSSGPR participants

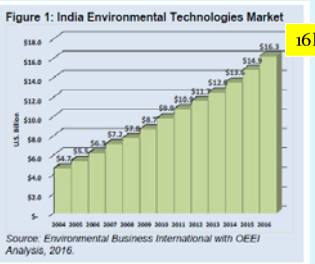
- Potential Contamination
  - Gas Stations (Vietnam, Philippines)
  - **Mining** (Philippines, Indonesia, Thailand, Malaysia, India)
  - Landfill (All)
  - Seawater intrusion (All)
  - Fluoride (India); **Arsenic** (Vietnam, India, Taiwan, Thailand); Nitrate (India); Coliform (Philippines and India); Ammonia (India, Vietnam, Malaysia, and Philippines)

China



60 BU$

India



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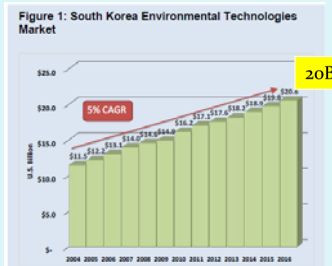
South Korea



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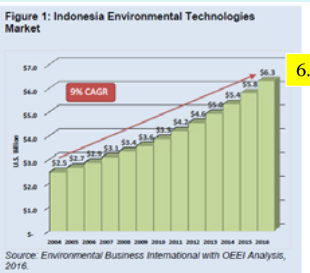
Indonesia



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Possible Collaborations proposed by the IWSSGPR Participants

- Joint Publications
- Joint Workshops
- Student/Researcher Exchanges
- Joint Research Proposals/Projects
- Websites
- Inviting People from Governmental Agencies of SE/S Asian Countries

Appendix 1: Environmental Technologies Top Markets Ranking

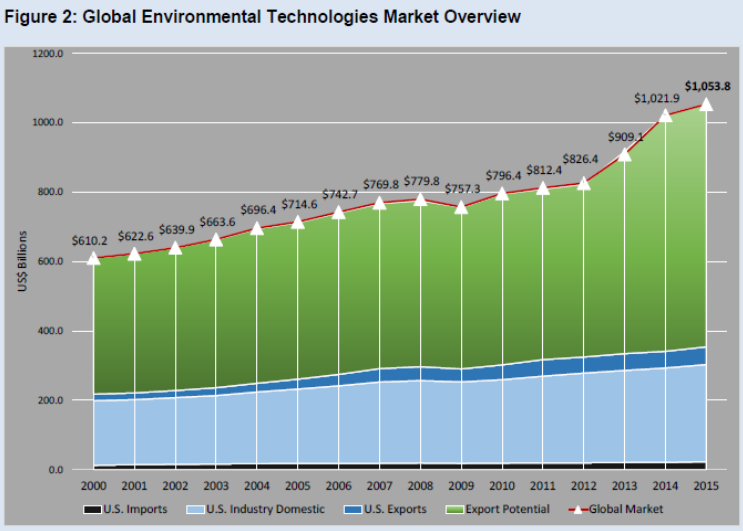
	Water		Air		Waste		Composite Environmental Technologies Score
1	China	44.9	China	47.4	China	7.7	China
2	India	16.3	Mexico	26.3	Indonesia	4.3	Mexico
3	United Arab Emirates	15.8	Korea	18.3	Pakistan	3.7	India
4	Oman	15.3	Turkey	17.4	Brazil	3.6	Brazil
5	Saudi Arabia	12.0	Brazil	15.7	Thailand	3.3	Korea
6	Brazil	10.3	India	12.8	Saudi Arabia	3.0	Saudi Arabia
7	Mexico	9.5	Saudi Arabia	10.9	India	2.7	Indonesia
8	Indonesia	9.3	Indonesia	9.9	Vietnam	2.4	Turkey
9	Poland	8.4	Poland	8.6	Korea	2.1	Poland
10	Korea	6.9	Czech Republic	8.0	Egypt	1.9	United Arab Emirates
11	Thailand	6.6	Vietnam	7.3	Turkey	1.8	Oman
12	Peru	6.5	Kazakhstan	5.9	Malaysia	1.6	Thailand
13	Venezuela	6.1	Algeria	5.3	Mexico	1.4	Vietnam
14	Singapore	5.7	Romania	4.8	Argentina	1.3	Czech Republic
15	Argentina	5.4	Slovakia	4.6	Colombia	0.9	Argentina
16	Chile	4.5	Colombia	4.4	Poland	0.7	Kazakhstan
17	Kazakhstan	4.4	Egypt	4.2	Peru	0.7	Singapore
18	Malaysia	4.2	Argentina	4.1	Netherlands	0.7	Peru
19	Colombia	3.9	Singapore	4.1	Norway	0.6	Venezuela
20	Czech Republic	3.9	Nigeria	3.9	Singapore	0.6	Egypt
21	Republic of South Africa	3.8	Thailand	3.6	Sweden	0.6	Malaysia
22	Vietnam	3.6	Malaysia	3.6	Morocco	0.6	Colombia
23	Egypt	3.4	Venezuela	3.3	Kazakhstan	0.6	Chile
24	Turkey	2.9	Peru	3.1	Chile	0.5	Romania
25	Bangladesh	2.7	Republic of South Africa	2.8	Venezuela	0.5	Algeria
26	Belarus	2.7	Ukraine	2.6	Nigeria	0.4	Pakistan
27	Ghana	2.5	Chile	2.6	Bangladesh	0.4	Republic of South Africa
28	Pakistan	2.5	Dominican Republic	2.5	Hong Kong	0.4	Nigeria
29	Morocco	2.4	Belarus	2.5	Oman	0.3	Slovakia
30	Romania	2.3	Lithuania	2.3	Republic of South Africa	0.3	Bangladesh
31	Nigeria	2.2	Mozambique	2.2	Ecuador	0.3	Belarus
32	Hong Kong	2.0	Bangladesh	2.2	Lithuania	0.3	Ukraine
33	Algeria	1.8	Azerbaijan	2.2	Panama	0.3	Morocco
34	Macedonia	1.7	Hungary	2.2	Estonia	0.3	Azerbaijan
35	Panama	1.7	Ecuador	2.2	Zambia	0.3	Ghana
36	Azerbaijan	1.6	Slovenia	2.1	Tunisia	0.3	Hong Kong
37	Hungary	1.6	Bahrain	2.1	Czech Republic	0.3	Lithuania
38	Ecuador	1.5	Pakistan	2.1	Guatemala	0.2	Ecuador
39	Slovakia	1.5	Philippines	2.0	Bahrain	0.2	Hungary
40	Lithuania	1.4	Zambia	2.0	Jordan	0.2	Dominican Republic
41	Guatemala	1.2	Hong Kong	2.0	Philippines	0.2	Panama
42	Trinidad and Tobago	0.9	Trinidad and Tobago	2.0	Uruguay	0.2	Macedonia
43	Ukraine	0.9	Morocco	2.0	Azerbaijan	0.2	Zambia
44	Kuwait	0.8	Greece	2.0	Ethiopia	0.2	Mozambique
45	Tunisia	0.8	Latvia	1.9	Sri Lanka (Ceylon)	0.2	Philippines
46	Zambia	0.8	Ethiopia	1.9	Paraguay	0.2	Bahrain
47	Greece	0.8	Gabon	1.9	Ukraine	0.2	Slovenia
48	Papua New Guinea	0.7	Tunisia	1.8	Portugal	0.2	Tunisia
49	Philippines	0.7	Qatar	1.8	Ghana	0.2	Trinidad and Tobago
50	Portugal	0.7	Georgia	1.8	New Zealand	0.19	Guatemala

Oman 15.6
Thailand 13.6
Vietnam 12.9
Czech Republic 12.1
Argentina 10.5
Kazakhstan 10.5
Singapore 10.5
Peru 10.2
Venezuela 9.8
Egypt 9.7
Malaysia 9.2
Colombia

Mozambique 1.6
Philippines 1.5
Bahrain 1.5
Slovenia 1.5
Tunisia 1.4
Trinidad and Tobago 1.4
Guatemala 1.2

Global Market

(US 2016 Top Markets Report Environmental Technologies, June 2016)



Thank you!

行政院環境保護署 Environmental Protection Administration Executive Yuan, R.O.C. (Taiwan)
MOST 科技部 Ministry of Science and Technology

US 2016 Top Markets Report Environmental Technologies (June 2016)

Figure 1: Environmental Technologies Top Markets Results

	Water		Air		Waste		Composite Environmental Technologies Score	
1	China	44.9	China	47.4	China	7.7	China	100.0
2	India	16.3	Mexico	26.2	Indonesia	4.2	Mexico	37.1
3	United Arab Emirates	15.8	Korea	18.3	Pakistan	3.7	India	31.7
4	Oman	15.3	Turkey	17.4	Brazil	3.6	Brazil	29.4
5	Saudi Arabia	12.0	Brazil	15.3	Thailand	3.3	Korea	27.3
6	Brazil	10.5	India	12.8	Saudi Arabia	3.0	Saudi Arabia	25.9
7	Mexico	9.5	Saudi Arabia	10.9	India	2.7	Indonesia	23.4
8	Indonesia	9.3	Indonesia	9.9	Vietnam	2.1	Turkey	22.1
9	Poland	8.4	Poland	8.6	Korea	2.1	Poland	17.7
10	Korea	6.9	Czech Republic	8.0	Egypt	1.9	United Arab Emirates	15.8

Key Technologies in Demand (Asia) Soil and Groundwater

India
- Landfill design and engineering
- Hydrological mapping services (GW)
- Monitoring equipment (GW)
- Groundwater recharge technology (GW)

Philippines
- Sanitary landfill systems

Malaysia
- Waste treatment technologies
- Landfill gas recovery systems

Vietnam
- Sanitary landfill design, maintenance and associated technologies
- Brownfield site remediation design and equipment
- Soil contamination testing and monitoring equipment

Thailand
- Sanitary landfill design, maintenance and associated technologies
- Baseline Investigation
- Mining
- Sea Water Intrusion/land subsidence
- Arsenic

(US 2016 Top Markets Report Environmental Technologies, June 2016 and IWSSGPR, 2017)

We need to have a well-designed sampling plan

Planning → Implementation → Assessment

Critical Planning

Where to take Samples

How to collect Samples

How to interpret analysis results

Basic Theoretical Principles & Experiences

Precise Interpretation & Decision Making

Make right decisions

Remediation: Method, Time frame & Cost

The Experiences of Contamination Site Investigation in Taiwan

Chih-Jen Lu

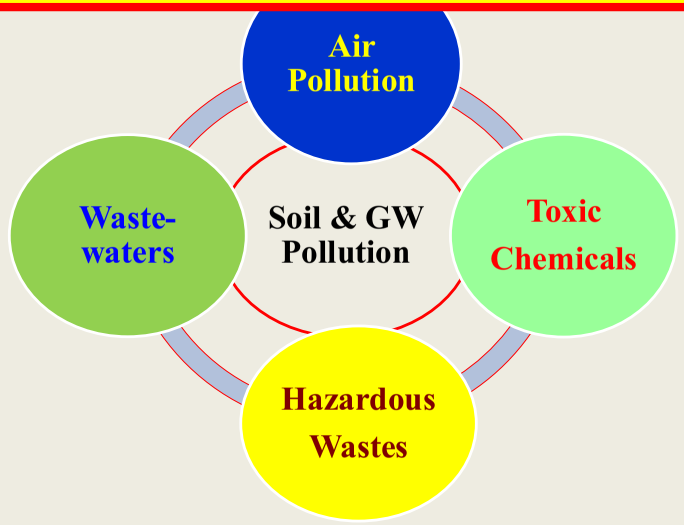
Dept of Environmental Engineering

National Chung Hsing University

Taichung, TAIWAN, ROC

Soil & GW Contamination

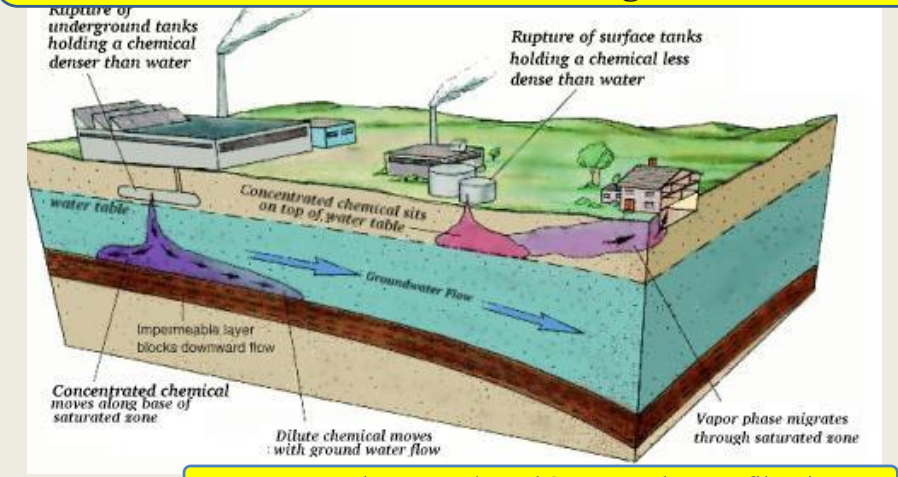
Where were these Chemicals Stored, Operated, Transported & Disposed



Conceptual Site Model (CSM)

Soil & GW Contamination Sources??

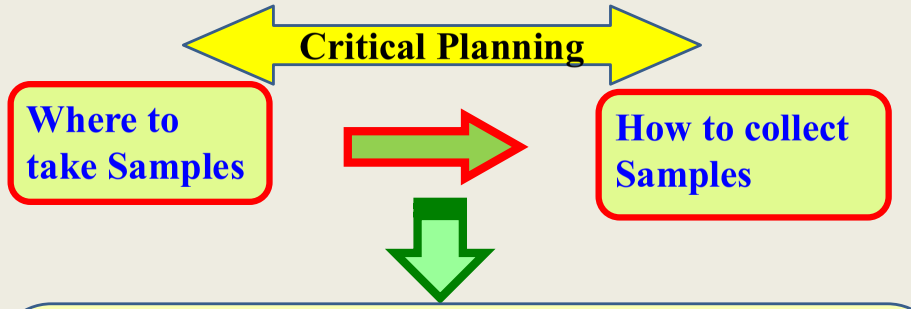
How to find the contamination sources and contaminated area?
How to define the migration pathways
Well Planned Site Investigation



www.google.com.tw/search?q=groundwater+filtration

Sampling Design

- Before the site investigation, we need to ask:
  - How should I design the sampling plan to provide the optimum information for the problem given when the sampling budge is limited
  - Where should I take samples (representative)
  - Does more data mean better data quality



Soil sampling

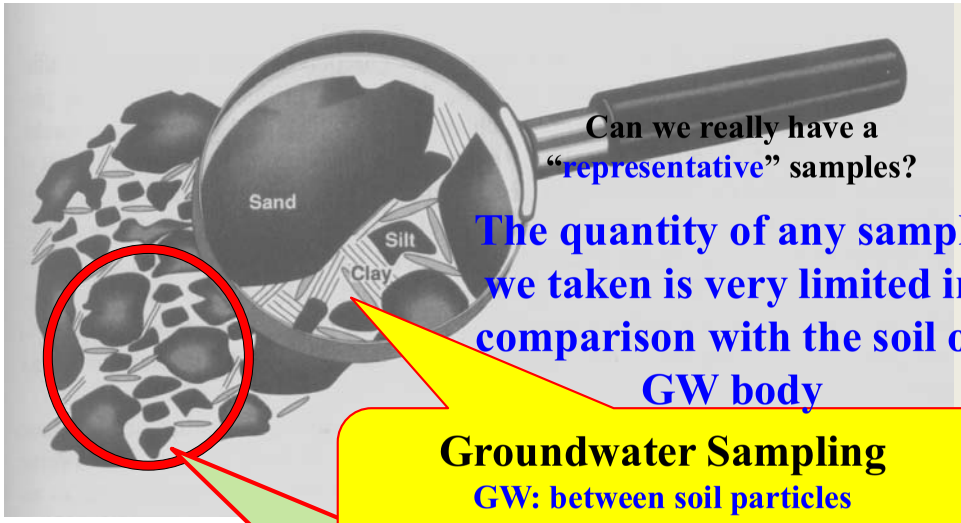
A cost-effective sampling plan should be developed with respect to the historical, industrial, geological, geochemical, meteorological conditions, and also the current or planned land utilization

Site Investigation: Experiences in Taiwan

- Site Investigation
  - Gas Station (UST)
  - Abandoned Manufacturing Factories
  - Military Site
  - Operating Manufacturing Factories
  - Illegal Dumping Site
  - Farmland (rice-paddy land)
  - Sanitary Landfill Site
  - Parks
  - Others (such as: residence area after the industrials being relocated, …)

Sampling Design

- Before the site investigation, we need to ask:
  - How much data do I need to make an acceptable decision
  - How much data do I need to make an adequate estimation about the extent of contamination (to define the contamination area)
  - How much data do I need to have a thorough search for a potential hot spot



Can we really have a "representative" samples?

The quantity of any sample we taken is very limited in comparison with the soil or GW body

Groundwater Sampling

GW: between soil particles

The size distribution of soil particles?

How large the space between these particles?

Soil Sampling

Take samples, Preserved & Pre-treatment, Analysis

Site Investigation

- **Data from Site Investigation**
- To assure the environmental data being properly used to support decisions
  - Adequate quality and usability for their intended and original purpose
  - Managed to reduce potential errors
  - Defensible
  - Convincible

Liability

polluter or potential polluter

Conceptual Site Model

Major Components

1. Who
2. What
3. Where
4. When
5. Why

How

- Contaminated Area
- Contaminated Extent
- Liability
- Risk
- Remediation Processes
- Remediation Time
- Remediation Cost

Error of Sample Heterogeneity

- **Representativeness**
- **Sample heterogeneity is a potential source of error**
  - **Soil is a heterogeneous medium**
  - **Soil exhibits variable properties with lateral distance and with depth**

Heterogeneity

No any single soil sample can be expressed as the "representative sample"

ESA

- The ESA process used by EPA is described as follows:
- (1) Collection information: most data on abandoned factories in Taiwan were either lost or destroyed; thus, before site visiting the investigator must obtain relevant data from the local government of Construction Bureau, Fire Department, and Environmental Protection Bureau.

ESA

- The ESA process used by EPA is described as follows:
- (1) Subsequently, the obtained information and aerial images were used to deduce the factory configuration and the possible contaminated regions on desk in offices.

Aerial Photographs

aerial photographs: an important tool to locate the potential contamination area if the manufacturing factories are not in process during the investigation period

Sampling Design: Conceptual Site Model

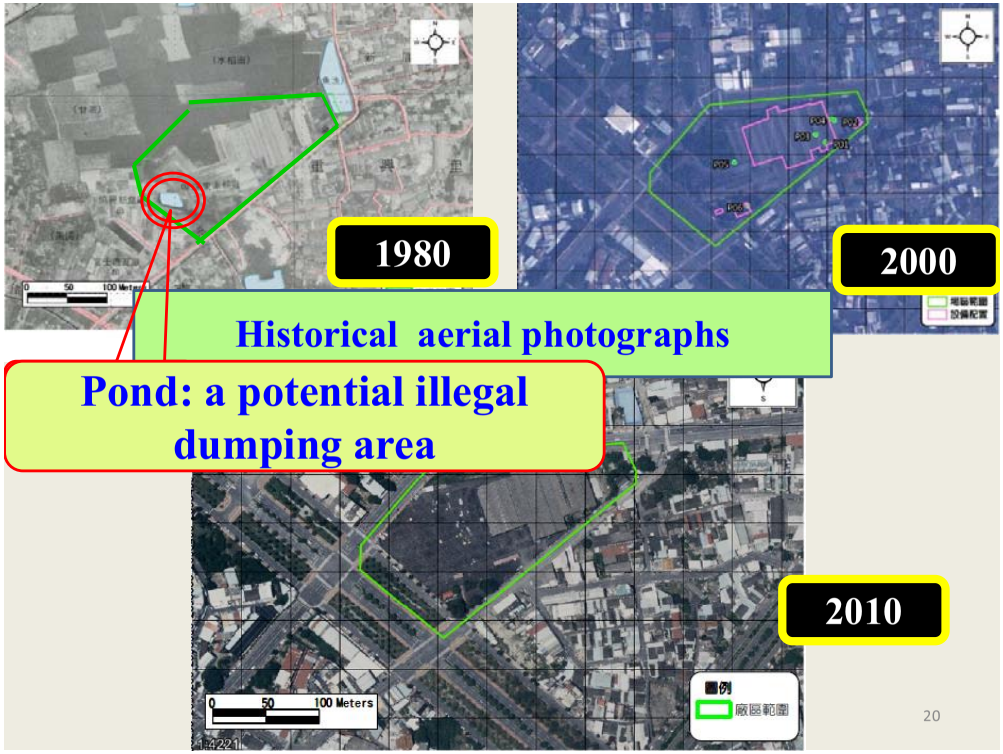
- **Conceptual Site Model**
  - **Contamination sources**
  - **Contaminant releasing pathways**
  - **Contaminant dispersion**
  - **Contaminant migration (extent)**
  - **Contaminant fate (& potential mechanisms)**
  - **Contaminant concentration (spatial & temporal)**
  - **Contaminant & its intermediates (bio & chem)**
  - **Contaminated media & become as the contamination source**
  - **Exposure scenarios (receptors & media)**

Site Investigation: Historical Site Data

- **Historical Site Data**
  - **All efforts should be made to first thoroughly review relevant site information (local and federal officers and relevant files…)**
  - **The historical information generally focuses on events and activities that affected current environment conditions at the site, such as manufacturing process, raw materials, accidents, leakage…**

Site Investigation: Historical Site Data

- **Historical Records** (continued)
  - **Where and how were these chemicals stored & transported**
  - **Are these chemicals still in process, or have been wasted, or have been well stored**
  - **Were these chemicals spilled & spread**
  - **Were any remediation process employed in this site**



Site Investigation: Historical Site Data

- **Historical Site Data**
  - **Therefore, the historical data review examines past and present site operations and disposal practices, providing an overview of known and potential site contaminations**

Site Investigation: Historical Site Data

- **Historical Records**
  - **What industrial activities occurred at this site (manufacturing processes, waste storage, wastewater collection & treatment…)**
  - **What chemicals were used at this site (TPH, Cl-VOC, HM, Pesticides…)**
  - **Where and how were these chemicals used**

- The ESA process used by EPA is described as follows:

- (2) Reconnaissance: part of factories were destroyed and reconstructed or were transferred to other factory, the investigator has to **visit the actual realistic site** to confirm the location of potential pollution sources and other crucial characteristics while recording any abnormalities in soil appearances, waste disposal areas, or any severe leakages

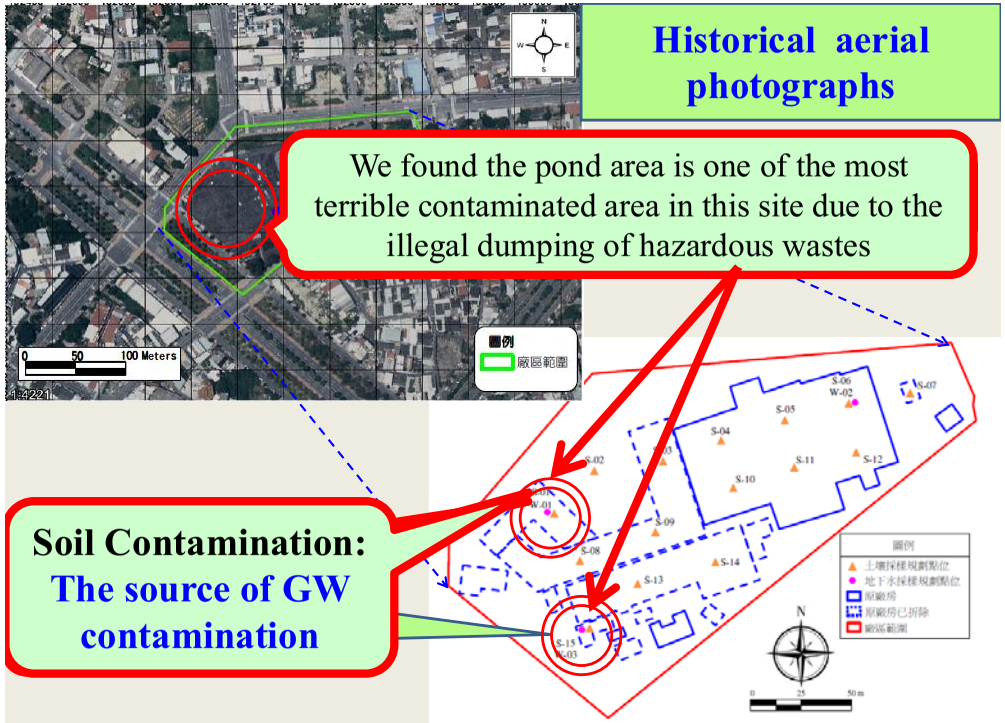
The licensed site investigator must visit the site which has been screened and selected following the established procedures

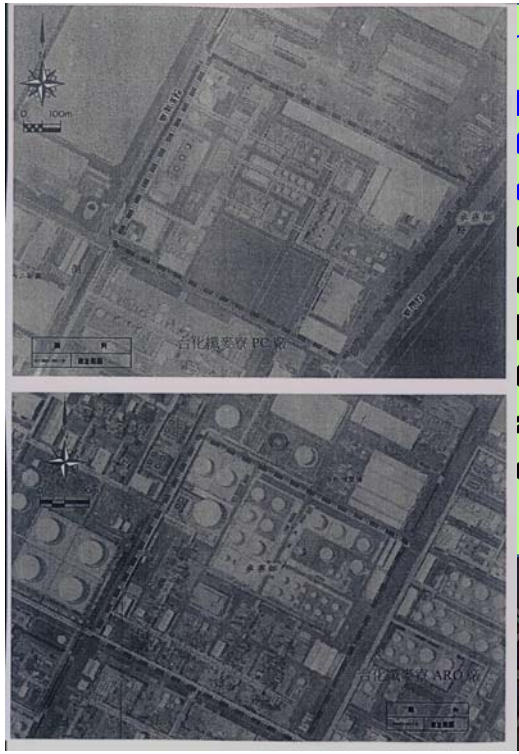
The licensed site investigator must visit the site which has been screened and selected following the established procedures

Historical aerial photographs

We found the pond area is one of the most terrible contaminated area in this site due to the illegal dumping of hazardous wastes

Soil Contamination: The source of GW contamination





The historical aerial photographs were employed to define the potential contaminated area (such as the fuel tanks, piping, WW collection channel, pits, hazardous wastes storage tanks, WW treatment plant, air pollution control equipments, …)

- The ESA process used by EPA is described as follows:
- (3) Interview: the evaluator conducts interviews with relevant responsible persons, **employees**, land owner and users to acquire additional data on factory operations.

The site investigator must visit the site to confirm the location of potential pollution sources and other crucial characteristics while recording any abnormalities in soil appearances, waste disposal areas, or any severe leakages

- The ESA process used by EPA is described as follows:
- (4) **Investigation plan**: the evaluator has to determine potentially highly contaminated regions; subjective assessments were used to distribute sampling points and analyzed items.

Site Investigation: Historical Site Data

- **Historical Records** (continued)
  - **Collect site maps, facility blueprints, historical aerial photographs, storage**

Professional Judgment of Sampling Design

Use of prior knowledge to improve a sampling design to collect the "right" samples to prove the positive of site contamination. Generally, Systematic or Grid Sampling Method was not employed for the investigation of abandoned factories or gas stations.

Professional Judgment: Abandoned Factories

Professional Judgment

Use of prior knowledge to improve a sampling design

Professional judgment is clearly used in judgmental sampling but can also be used to improve statistical sampling designs, such as in defining the boundaries of sampling strata

These experience help us to improve the accuracy of sampling with the limited budget

Judgmental Sampling: Abandoned Factories

Judgmental Sampling

If we have enough data about the abandoned factory, generally we do not employ the "Systematic and Grid Sampling". We rely on our "trained" engineers taking the right samples from the right spot (the hot spot)

Easily to meet schedule within the limited budget

Professional Judgment: Abandoned Factories

Professional Judgment

Appropriate for situations

The ability to directly choose sampling locations in areas of interest provides a high degree of control over sampling costs

Can provide a sample to "prove the positive"

Then, we need "enough" data to define the extent and range of the contamination

Judgmental Sampling: Abandoned Factories

- **Judgmental Sampling Design**
  - **selection of sampling units is based on professional judgment**
  - **Results depend entirely on the validity and accuracy of professional judgment**
  - **Inferences are based on professional judgment not on statistical scientific theory**

In Taiwan, we have accumulated abundant and reliable experiences about the site investigation of gas station, fuel tank, abandoned factories and the processing factories

Top 10 types of Potentially Highly Contaminated Abandoned Factories in Taiwan

Leather, Fur & Related Products Manufacturing

Leather: VOC, SVOC, preserves, Cr, HM-contained dye…

Wood and Bamboo Products Manufacturing

Wood Products: Cl-Aromatics (PCP), TPH, Cr…

Priority List of 21 types of Potentially Highly Contaminated Abandoned Factories in Taiwan

No.	Industry	No.	Industry
1	Leather, Fur & Related Products Manufacturing	12	Plastic Products Manufacturing
2	Wood and Bamboo Products Manufacturing	13	Basic Metal Manufacturing
3	Basic Chemical Material Manufacturing	14	Metal Surface Treating
4	Petrochemicals Manufacturing	15	Metal Heat Treating
5	Fertilizers Manufacturing	16	Computers, Electronic & Optic Prod. Manufacturing
6	Man-made Fibers Manufacturing	17	Electronic Parts & Components Manufacturing
7	Synthetic Resin and Plastic Materials Manufacturing	18	Electrical Equipment Manufacturing
8	Synthetic Rubber Manufacturing	19	Electricity Supply
9	Varnishes, Lacquers, Dyes, Pigments Manufacturing	20	Waste Collection
10	Pesticides and Herbicides Manufacturing	21	Waste Treatment and Disposal
11	Petroleum and Coal Products Manufacturing		

Top 10 types of Potentially Highly Contaminated Abandoned Factories in Taiwan

Basic Chemical Material Manufacturing

Chemical Industries: Cl-VOC, Cl-Aromatics, HM-contained Catalysts…

Petrochemicals Manufacturing

Petrochemicals: TPH, Aliphatics, Aromatics, Cl-Aliphatics, Cl-Aromatics, …

Abandoned Factories in Taiwan

Top 10 types of Potentially Highly Contaminated Abandoned Factories in Taiwan

Leather, Fur & Related Products Manufacturing
Wood and Bamboo Products Manufacturing
Basic Chemical Material Manufacturing
Petrochemicals Manufacturing
Fertilizers Manufacturing
Man-made Fibers Manufacturing
Synthetic Resin and Plastic Materials Manufacturing
Synthetic Rubber Manufacturing
Varnishes, Lacquers, Dyes, Pigments Manufacturing
Pesticides and Herbicides Manufacturing

The Major Contaminated Regions in the Abandoned Factory Investigations

- Manufacturing area
- Wastewater treatment facilities
- Open space
- Storage tank and pipeline area
- Waste disposal region
- Material storage area
- Boiler room, drying room, chimney area, and dust collection area
- Storage pond
- Other (cracked pavements or electrical room)

Top 10 types of Potentially Highly Contaminated Abandoned Factories in Taiwan

Pesticides and Herbicides Manufacturing

Pesticides Industries: Cl-Aromatics (Cl-phenols, Cl-Benzenes), Dioxin, HM (Arsenic), …

The Major Contaminants in the Abandoned Factory Investigations

- Heavy metal
- Total petroleum hydrocarbons
- Polychlorinated biphenyls
- Volatile organic compounds
- Dioxin
- Pesticide
- Total phenolic compounds (phenols)

The results of 220 pre-screened abandoned factories investigation

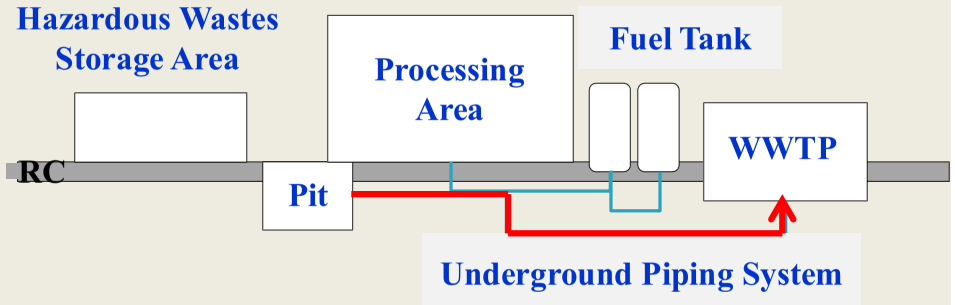
Item	Soil Contamination	GW Contamination
Type of Pollutant		
• Heavy metal	80	5 (Cr)
• Total petroleum Hydrocarbons	22	0
• Polychlorinated biphenyls	6	0
• Volatile organic compounds	2	9
• Dioxin	1	0
• Pesticide	1	0
• Total phenolic Compounds	-	1

HM: Soil Contamination

Cl-VOC: GW Contamination

Leakage of chemicals or fuel storage tank

Soil & GW contamination resulted from the leakage of the hazardous wastes storage tank (drum)



Soil Sampling (hot spot):
Processing Area, Wastewater Piping, Fuel Piping, WW Collection pit, Hazardous Wastes Storage Area, Fuel Tank, Chemical Storage Tank, WW treatment Plant, Air Pollution Control Area, et al.

Leakage of underground piping

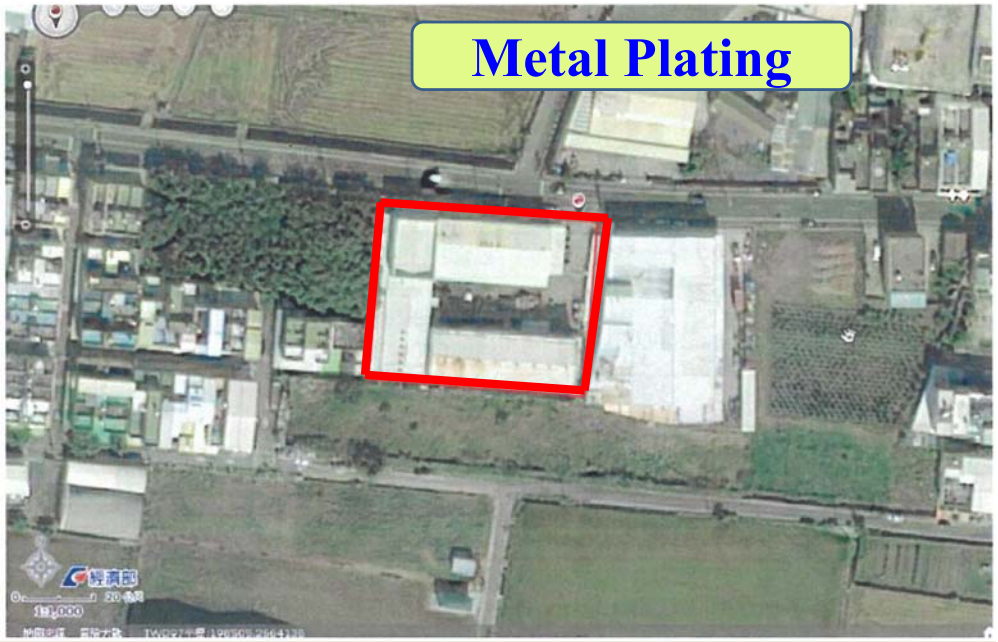
Potential Contaminated Area

Processing area & Wastes (Chemicals) storage area

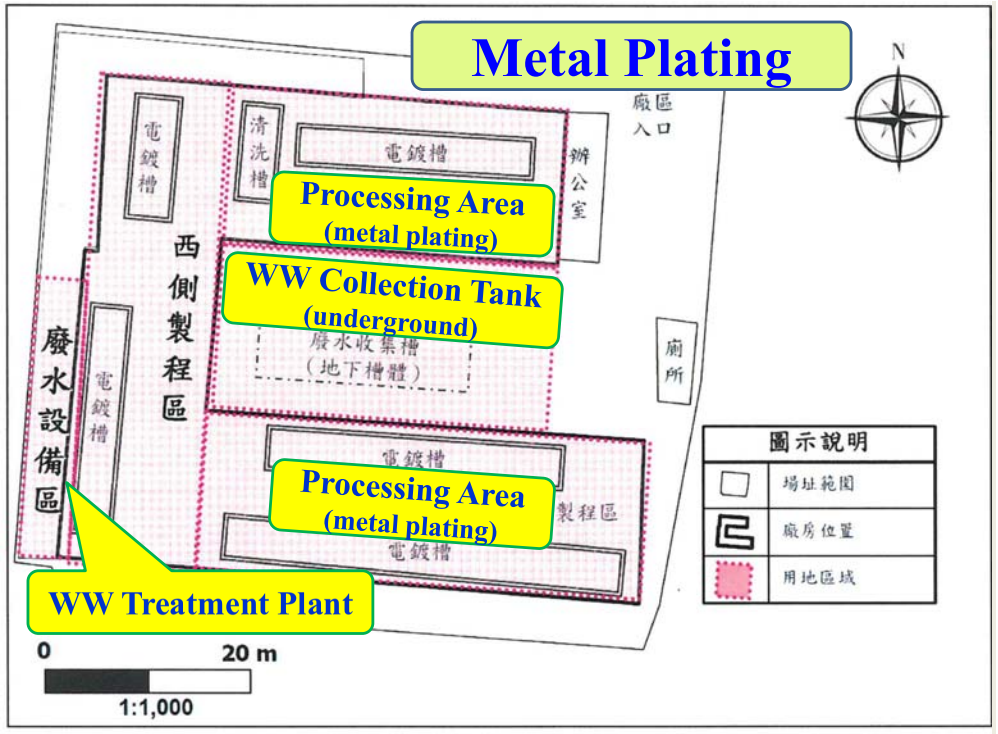
Soil & GW contamination resulted from the leakage of the chemical storage tank (drum)

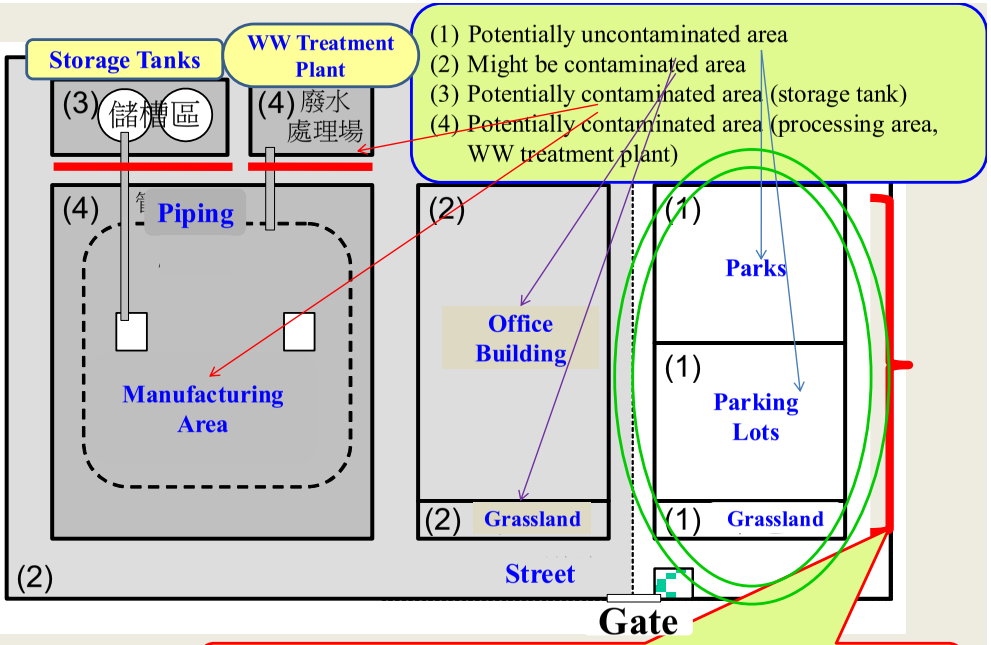
Potential contaminated area: hazardous wastes storage area & recycle processing area (TPH, Cl-VOC, …)

For soil sampling, WW collection channel & pits are the potential contaminated hot spot due to leakages from the cracked RC channel or PU pavement

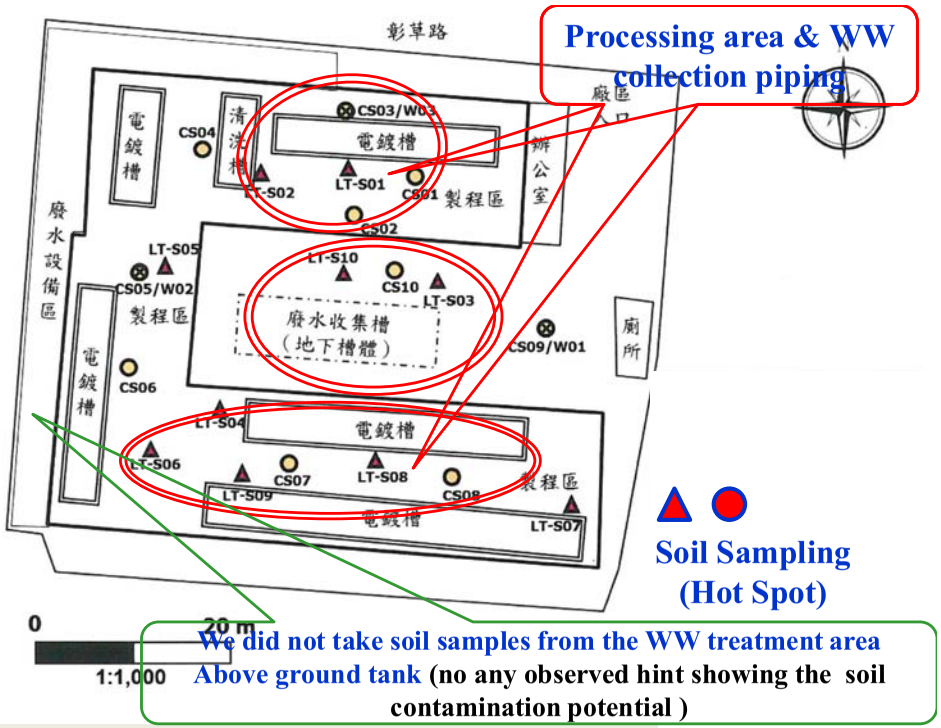


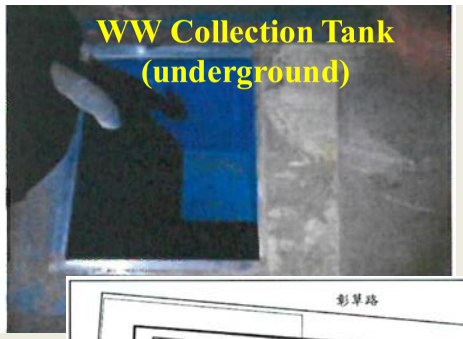
Soil & GW contamination resulted from the leakage of the WWTP and the collection system (pit & Piping)

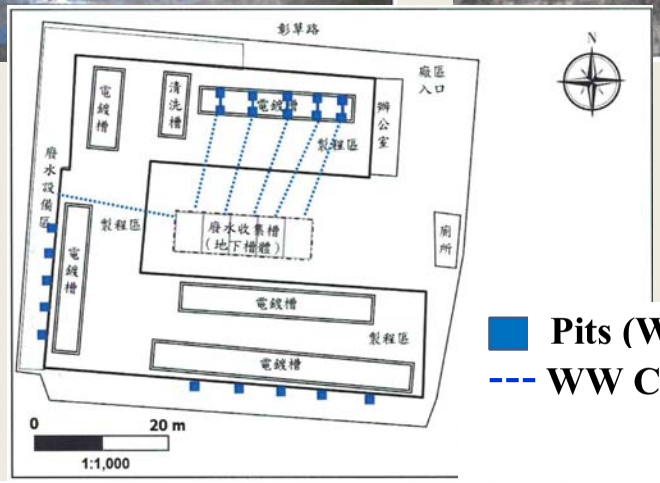




Site Investigation Data: In comparison with the Aerial Photographs (potential illegal dumping area)

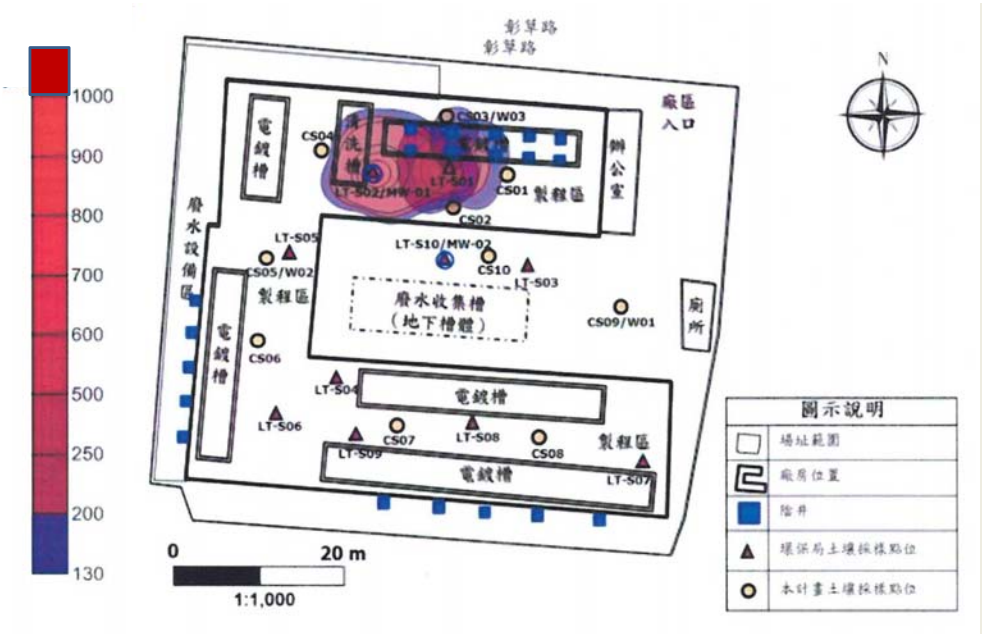






Pits (WW Collection)

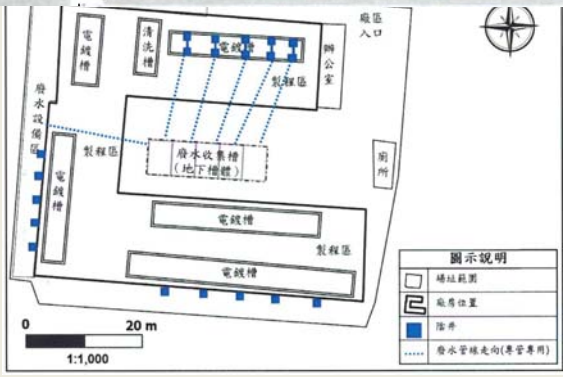
--- WW Collection Piping



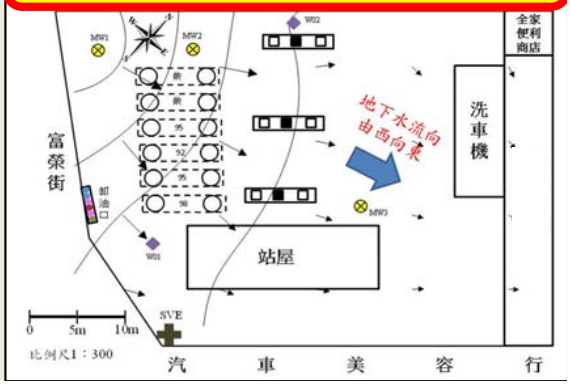
Contaminant: Ni (Soil & GW)

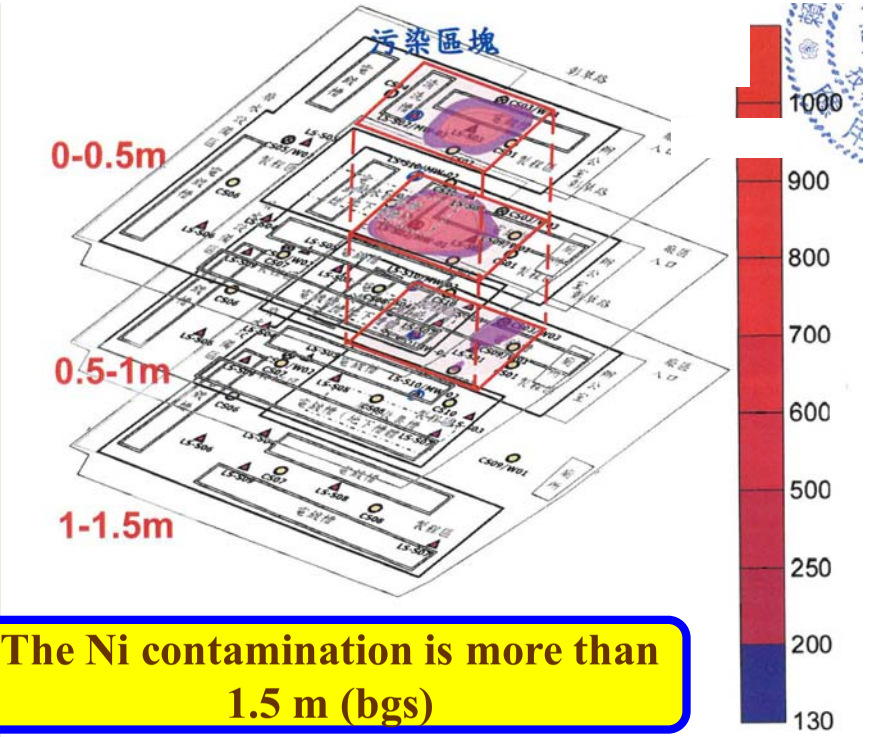
Processing Area (metal plating)

WW Treatment Plant (above ground)

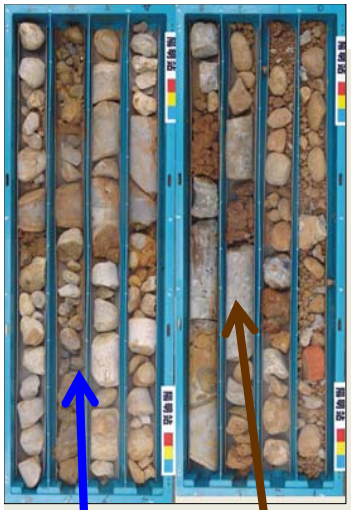


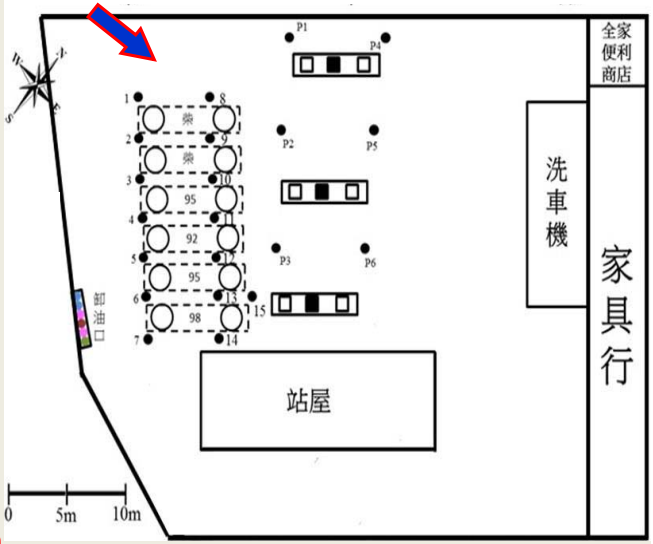
Gas Station



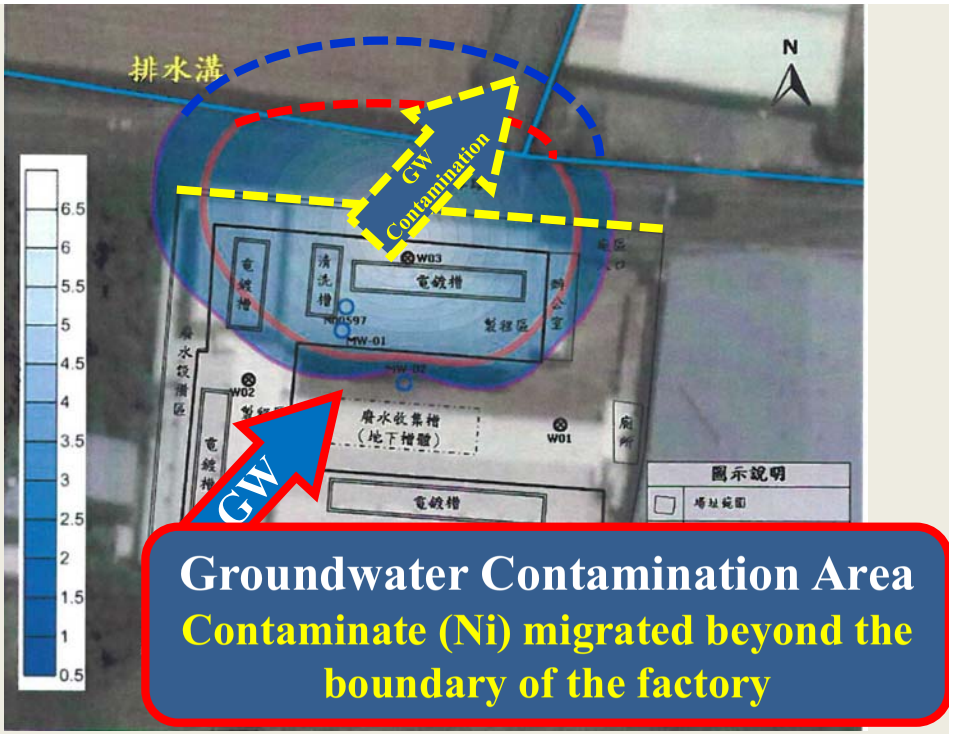


The Ni contamination is more than 1.5 m (bgs)





High & Low Permeability



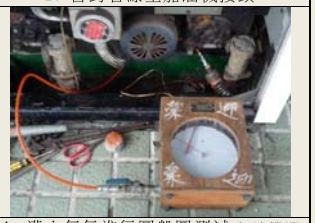
Groundwater Contamination Area

Contaminate (Ni) migrated beyond the boundary of the factory

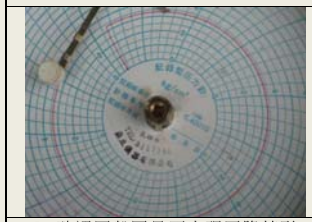
1．將輸油管線油品卸回油槽

2．盲封管線至加油機接頭

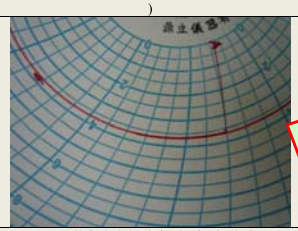
3．灌入氮氣進行圓盤圖測試(油槽端)



4．灌入氮氣進行圓盤圖測試(加油機端)

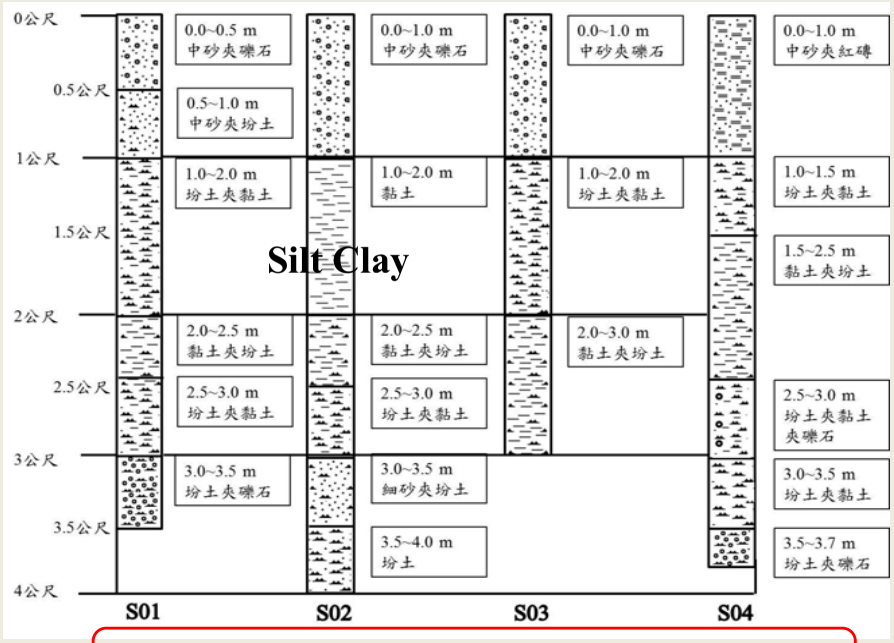


5．確認圓盤圖是否出現壓降情形

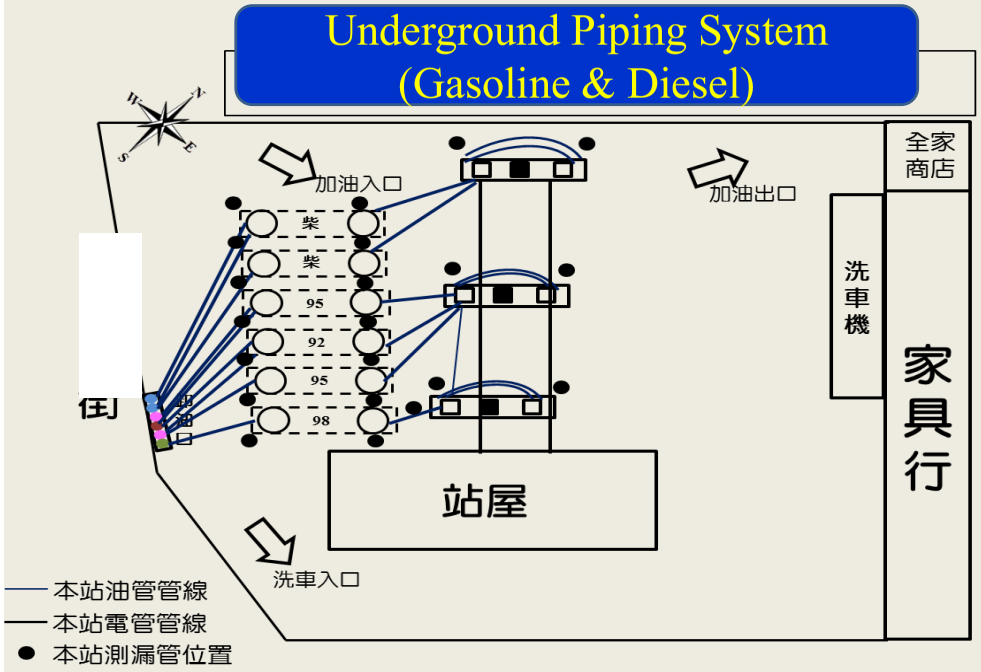


6．測試完畢覆寫密合度良好

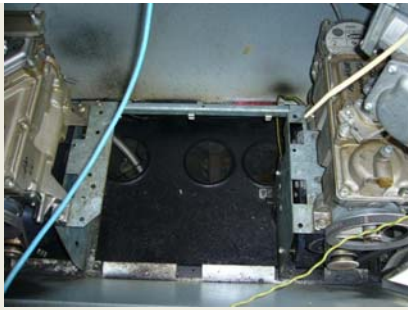
No piping or tank leakage was detected



The TPH contaminated area is limited

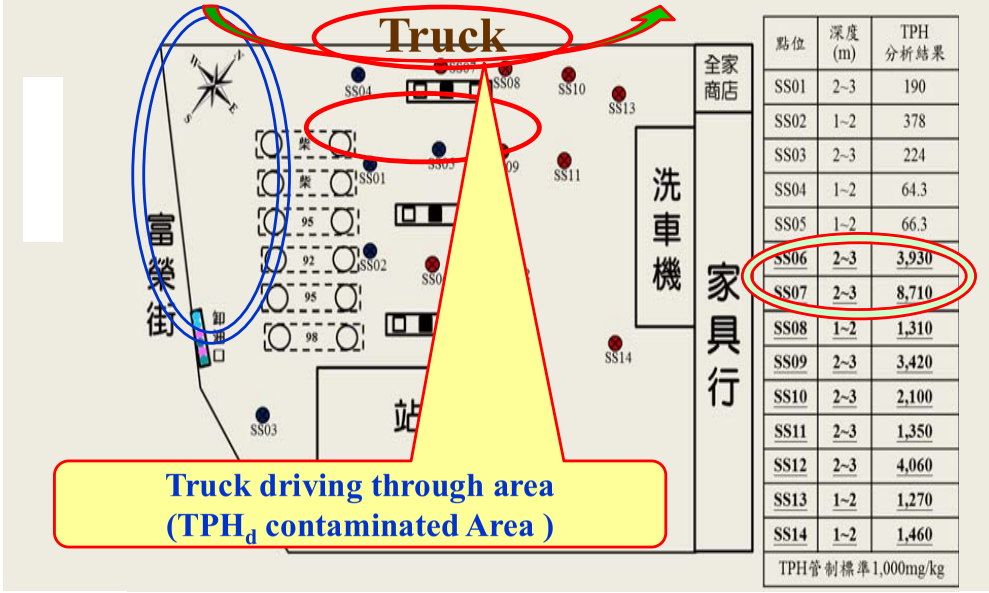


Gas Station: Site Investigation
Potential Contamination Area



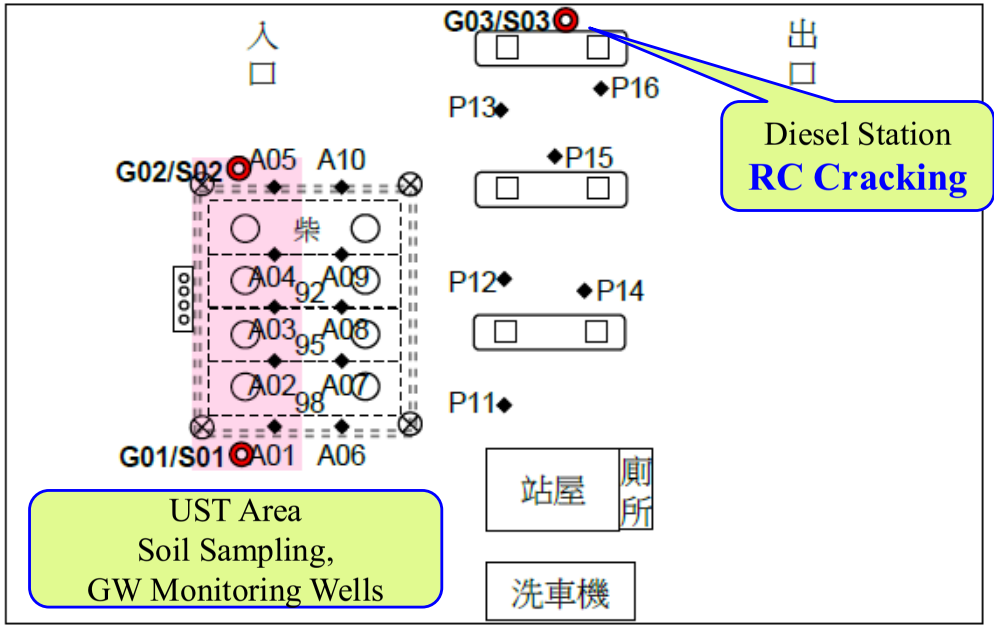
Before the soil sampling or well installing, data review (the underground piping system) and trial plow are critical procedures to prevent to cut the operating gasoline pipe
Unfortunately, in this case we cut an operating gasoline piping

UST: a RC secondary containment was equipped
In UST area, no soil sample was collected (RC dual deck)



點位	深度 (m)	TPH 分析結果
SS01	2~3	190
SS02	1~2	378
SS03	2~3	224
SS04	1~2	64.3
SS05	1~2	66.3
SS06	2~3	3,930
SS07	2~3	8,710
SS08	1~2	1,310
SS09	2~3	3,420
SS10	2~3	2,100
SS11	2~3	1,350
SS12	2~3	4,060
SS13	1~2	1,270
SS14	1~2	1,460
TPH管制標準1,000mg/kg		

Truck driving through area
(TPH_d contaminated Area)

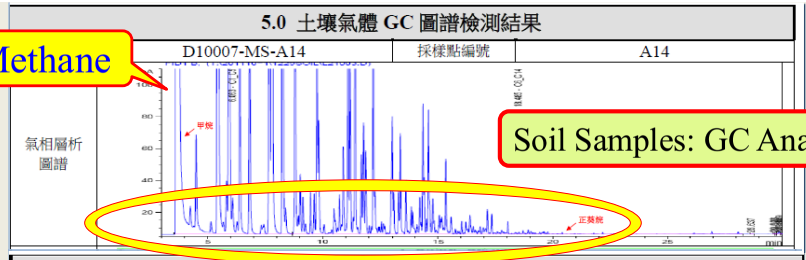


Diesel Station
RC Cracking

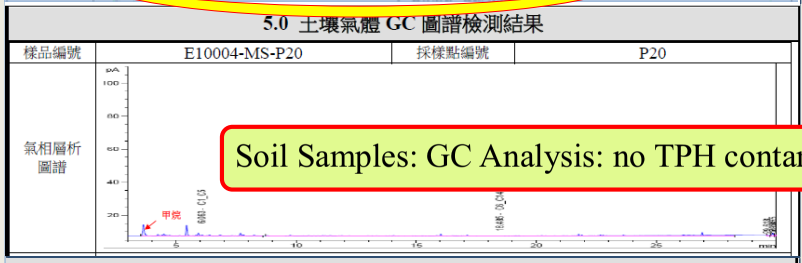
UST Area
Soil Sampling,
GW Monitoring Wells

Gas Station
Monitoring Well & GW Sampling

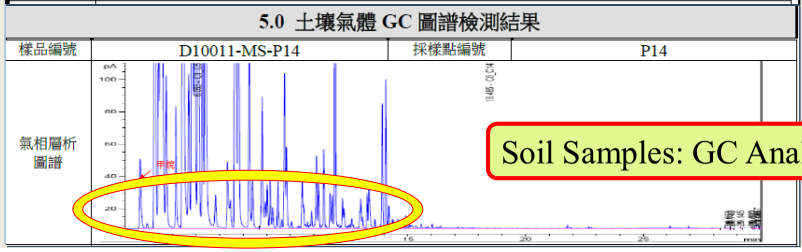
Methane



Soil Samples: GC Analysis



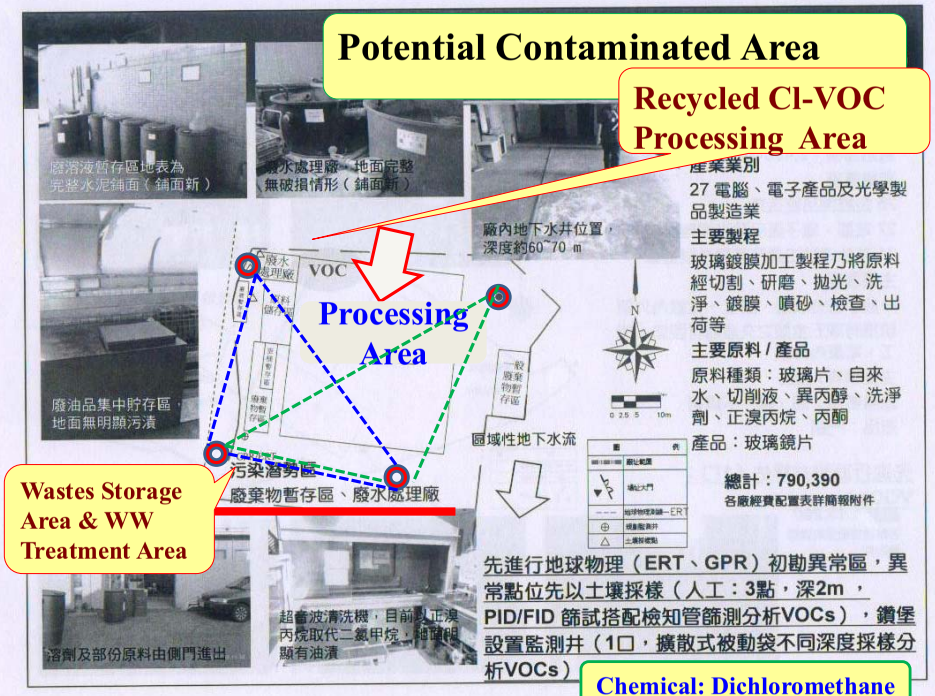
Soil Samples: GC Analysis: no TPH contamination



Soil Samples: GC Analysis

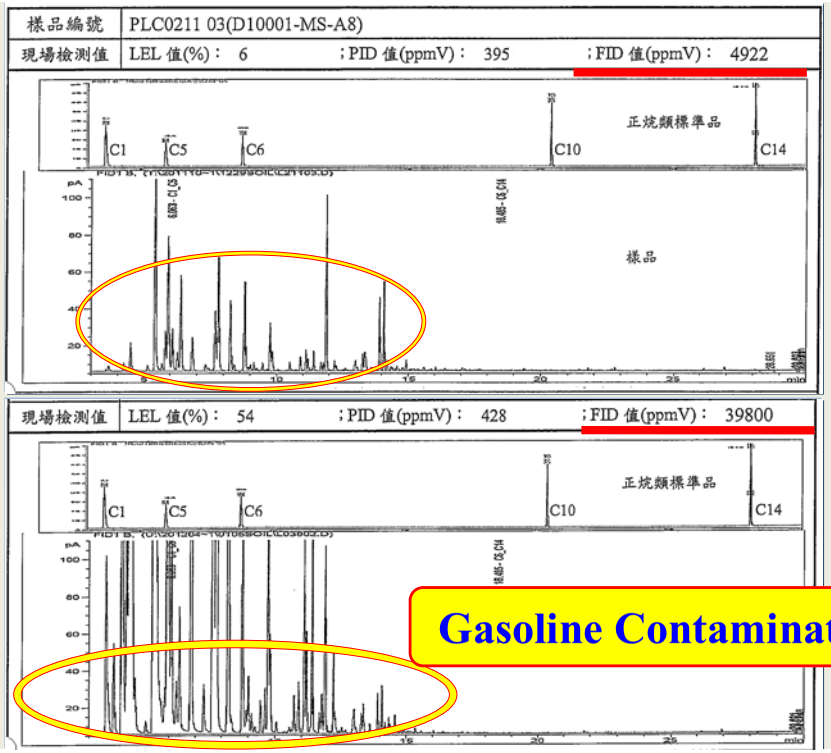
Potential Contaminated Area

Recycled Cl-VOC Processing Area



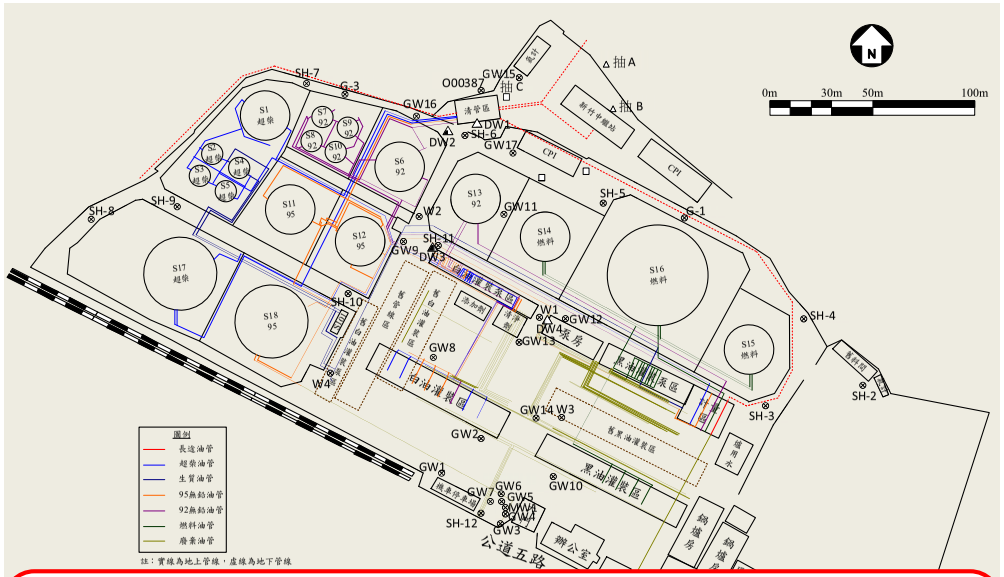
Wastes Storage Area & WW Treatment Area

Chemical: Dichloromethane

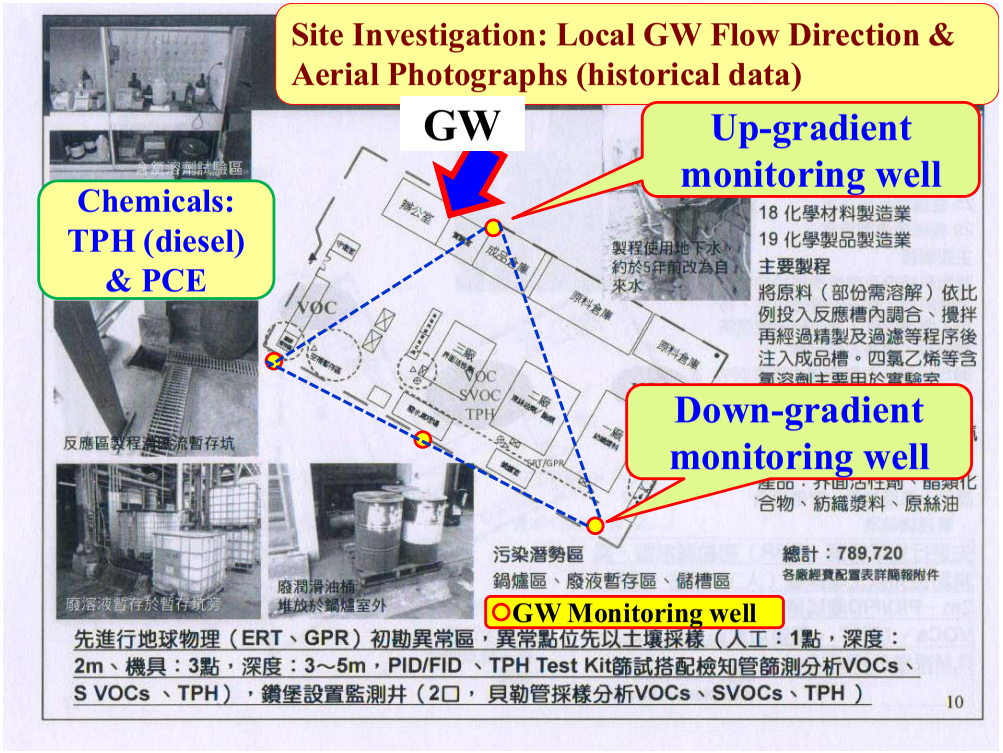


Gasoline Contamination

Generally, we did not set monitoring wells inside the deck area with RC pavement.

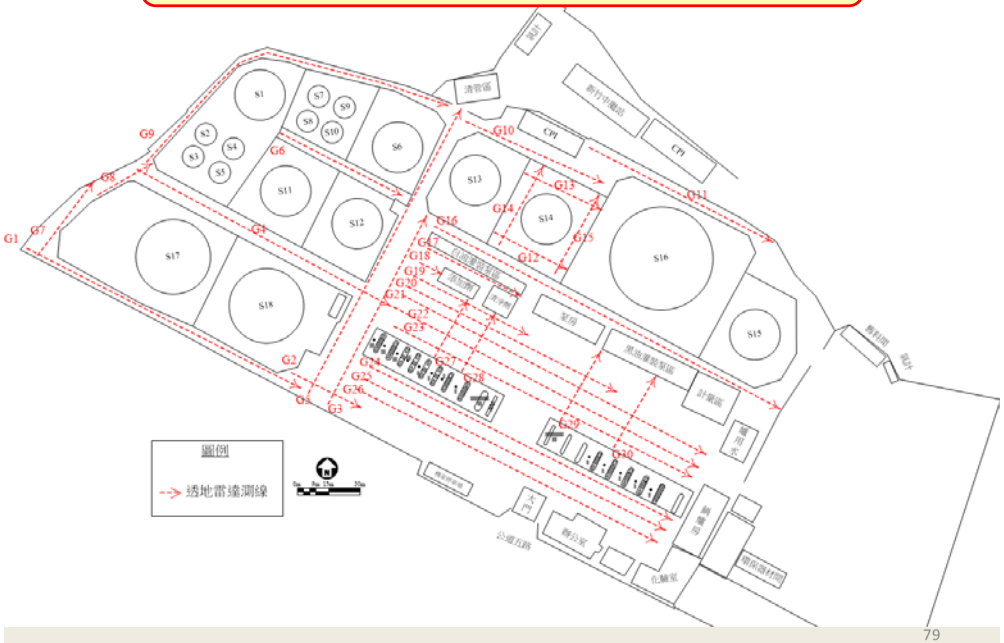


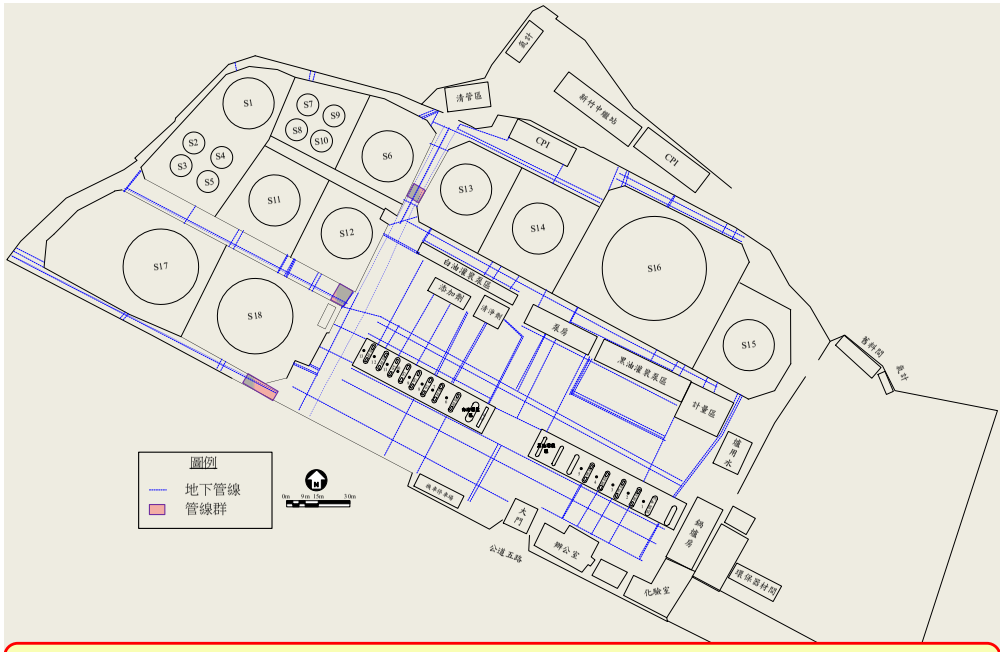
There are many petroleum piping in the subsurface within the fuel tank site. However, the piping diagram is not so reliable. It is a serious concern when we want to take soil samples in the petroleum tank site.



The site investigation of an abandoned Fuel Tank Site

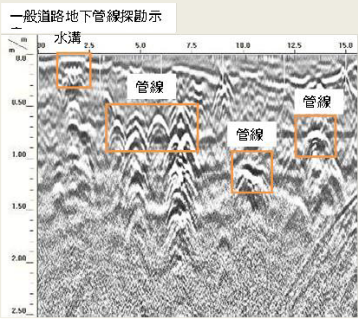
GPR Arrangement (red line)

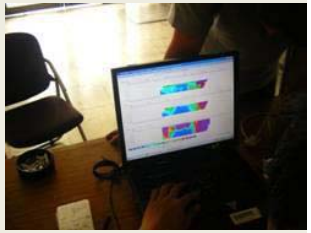




The distribution of underground piping (blue line)

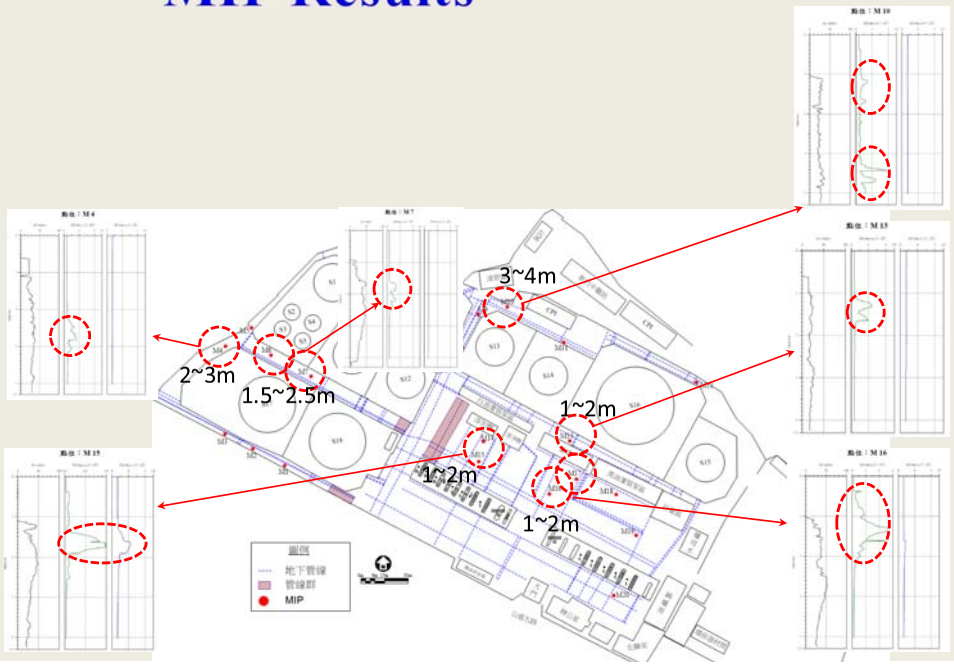
A GPR (ground penetration radar) was employed to "see" the distribution of different piping system before soil sampling

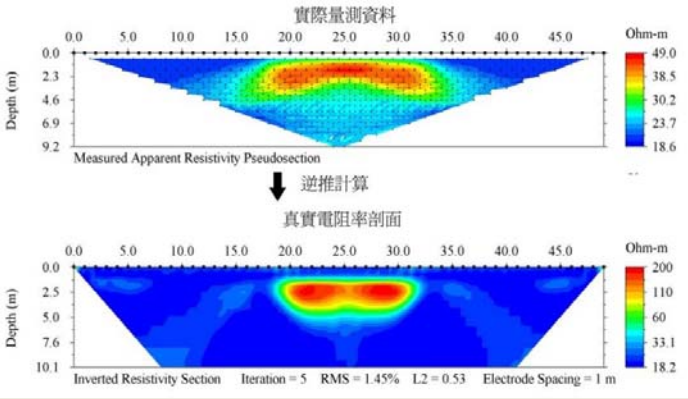




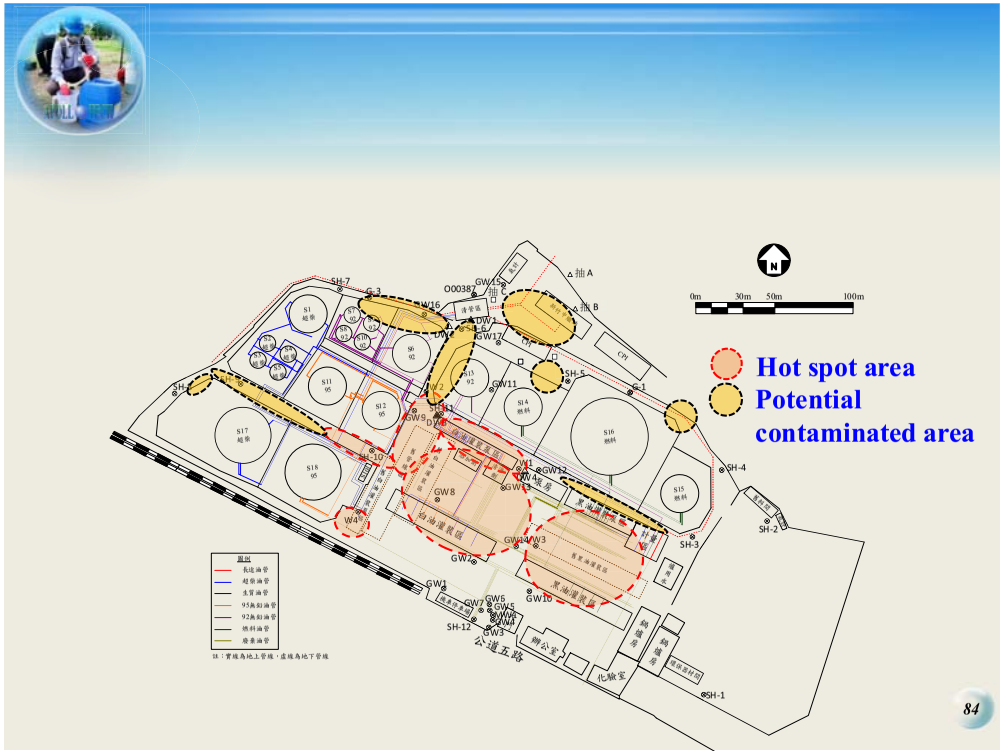
Located the distribution of underground piping

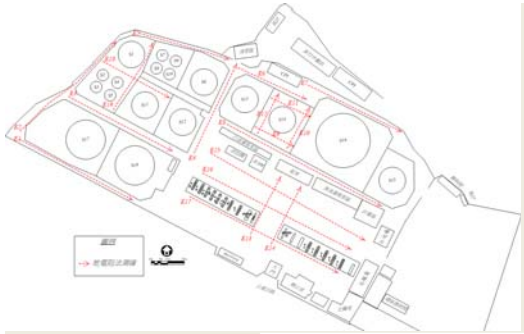
MIP Results

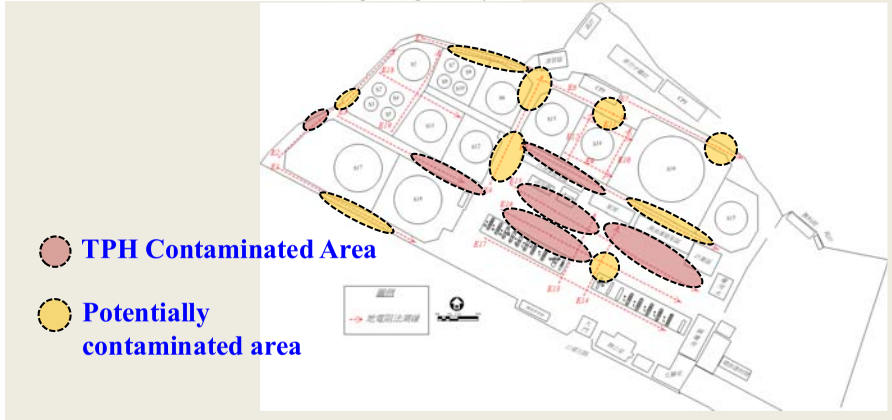




An ERT (Electrical Resistivity Tomography) system was employed to pre-screen the hot spot

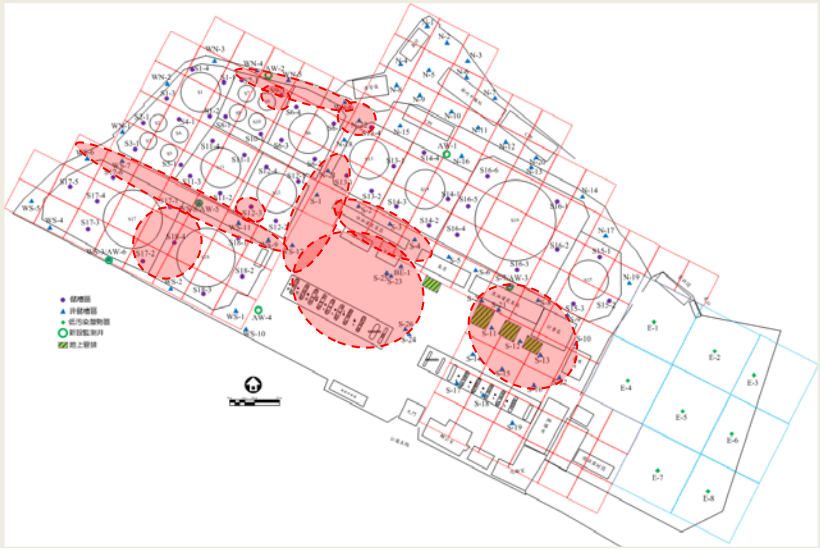




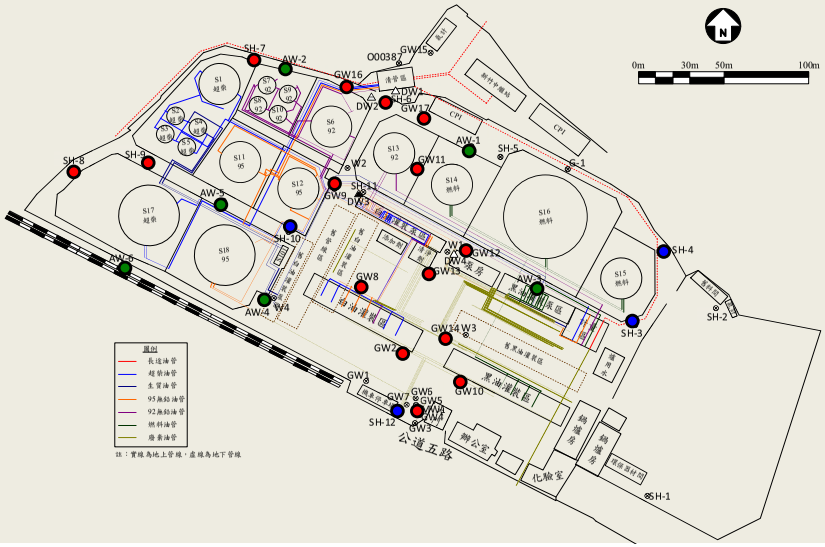


Soil: Contamination Area

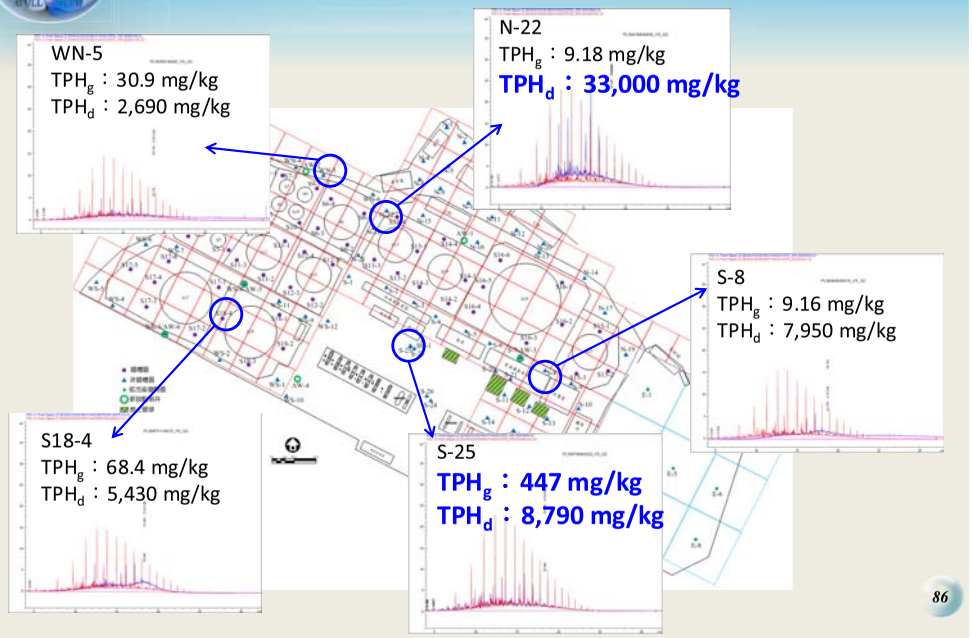
Totally, 126 soil samples were collected and analyzed



GW Monitoring Well



TPH Analysis (TPH_g & TPH_d)



污染範圍推估

- 「含氯運作(表面清洗)」區的
  距離半徑10公尺處，深度約為

Existing Boundary of Factory
TCE Contaminated area very close t
the boundary
It is necessary to have monitoring we
outside the boundary

地下水流向

監測井	MW101066-04 (Q00241)	
濃度(mg/L)	環保署分析	佳美採樣分析
DCA	<0.0078	0.00033
1,1,-DCE	<0.0026	未檢出
cis-DCE	<0.00162	未檢出
TCE	0.0120	0.00060

濃度(mg/L)	
DCA	未檢出
1,1,-DCE	未檢出
cis-DCE	0.0347
TCE	0.0039

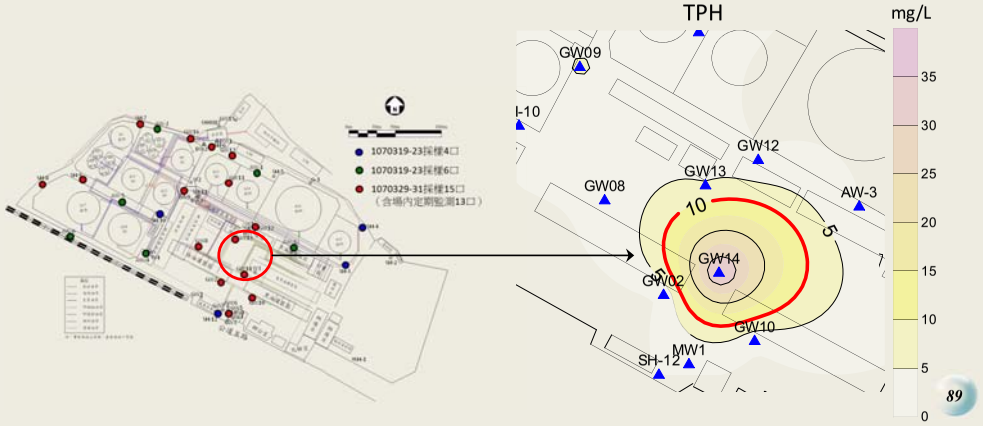
監測井	MW101066-01 (Q00240)	
濃度(mg/L)	環保署分析	佳美採樣分析
DCA	1.60	3.17
1,1,-DCE	0.644	1.34
cis-DCE	15.8	16.8
TCE	361	526

Down-gradient MW
At the boundary

38

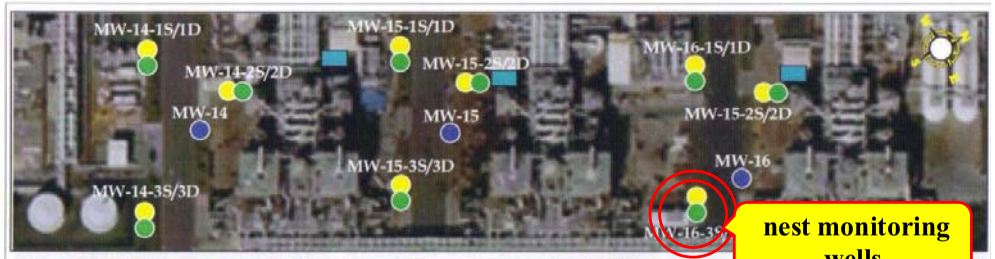
The confirmed GW Contamination area

(one of the hot spot of soil contamination)



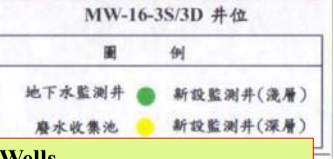
89

Military Site
TPH, TNT, DNT, HM …

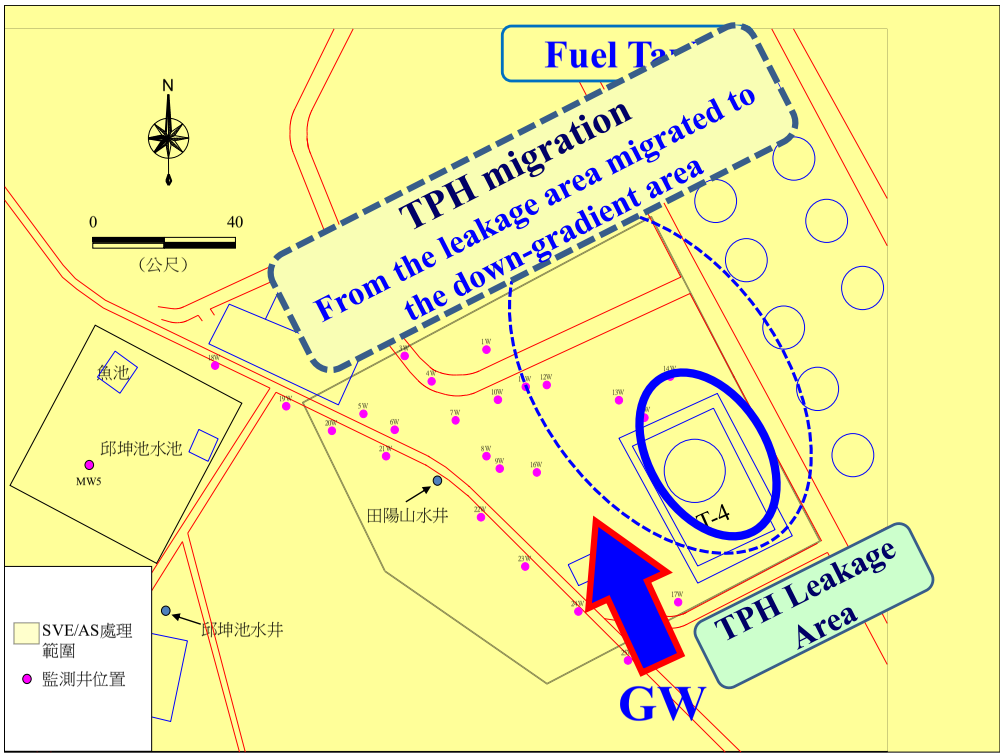


nest monitoring wells

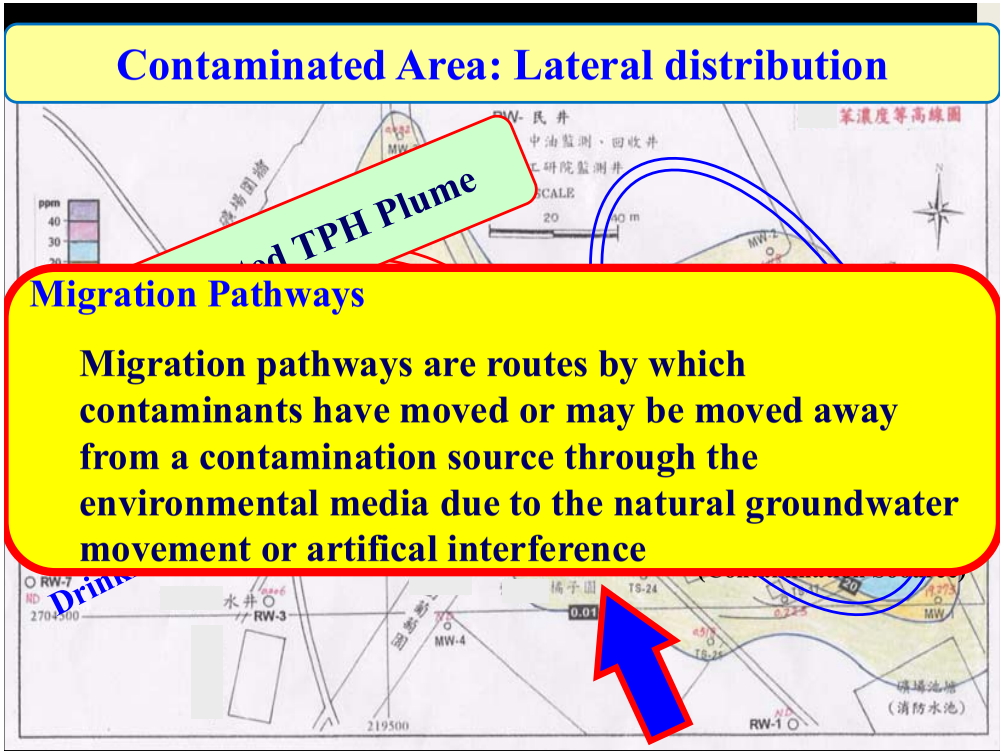
We need to find a proper location to install monitoring wells
Site Investigation: detect the underground pipes

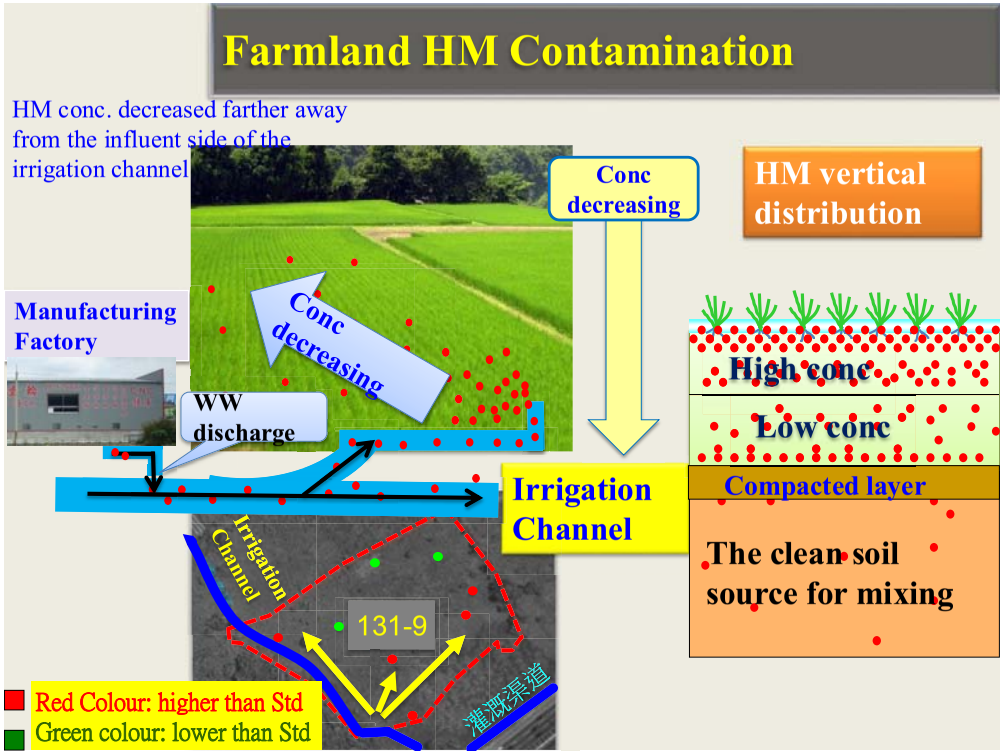


WW Collection Pits
Shallow & Deep Monitoring Wells
(nest monitoring wells)


Fuel Ta
TPH migration
From the leakage area migrated to the down-gradient area
N
0
40
（公尺）
魚池
邱坤池水池
MW5
田陽山水井
T-4
邱坤池水井
SVE/AS處理範圍
監測井位置
TPH Leakage Area
GW


W00079
W00080
MW2A
W00077
MW03
MW01
MW02
【圖例】
赤山掩埋場
赤山-舊掩埋面
赤山-新掩埋面
赤山掩埋場監測井
Sanitary Landfill Sites
GW Contamination: TOC, NH3-N, NO3-N, HM, TDS, EC, Cl-, SO4=, BTEX…


Contaminated Area: Lateral distribution
TPH Plume
Migration Pathways
Migration pathways are routes by which contaminants have moved or may be moved away from a contamination source through the environmental media due to the natural groundwater movement or artifical interference
RW-7
RW-3
MW-4
RW-1
TS-24
219500


Farmland HM Contamination
HM conc. decreased farther away from the influent side of the irrigation channel
Conc decreasing
HM vertical distribution
Manufacturing Factory
WW discharge
Conc decreasing
Irrigation Channel
High conc
Low conc
Compacted layer
The clean soil source for mixing
Irrigation Channel
131-9
灌溉渠道
Red Colour: higher than Std
Green colour: lower than Std

Summary

- Taiwan EPA initiated a multitude of soil and groundwater investigations on abandoned factories, establishing short-, mid-, and long-term goals for 120,000 closed factories.

Summary

- Taiwan EPA has developed a GIS system platform, integrating the major elements of environmental risk assessment (i.e., pollution potential, environmental transmission, and exposure risk…) to establish a simple risk assessment screening mechanism for abandoned factories.

Summary

- Taiwan EPA has screened 42,000 potentially highly contaminated factories, formulated standard operating procedures and technical methods for investigating the soil and groundwater contamination of abandoned factories.

Summary

- This system is employed to assess the soil and GW contamination potential. After the screening process with this system, site investigation is then planned and implemented.

Results of Site Investigation

The Major Contaminants in the Abandoned Factory Investigations

- **Heavy metal**
- **Total petroleum hydrocarbons**
- **Polychlorinated biphenyls**
- **Volatile organic compounds**
- **Dioxin**
- **Pesticide**
- **Total phenolic compounds (phenols)**

Summary

- Taiwan EPA has found that about 60% of the investigated factories were detected soil and/or GW contamination.

The contaminated regions in the abandoned factory investigations

Item	Soil Contamination	GW Contamination
Manufacturing area	**60**	**9**
Waste water treatment facilities	24	4
Open space	**23**	**3**
Storage tank and pipeline area	13	1
Waste disposal region	12	0
Material storage area	8	2
Boiler room, drying room, chimney area, and dust collection area	8	0
Storage pond	6	0
Other (cracked pavements or electrical room	9	0

Results of Site Investigation

Top 10 industrials of Soil & GW Contamination

1. **Leather, Fur & Related Products Manufacturing**
2. **Wood and Bamboo Products Manufacturing**
3. **Basic Chemical Material Manufacturing**
4. **Petrochemicals Manufacturing**
5. **Fertilizers Manufacturing**
6. **Man-made Fibers Manufacturing**
7. **Synthetic Resin and Plastic Materials Manufacturing**
8. **Synthetic Rubber Manufacturing**
9. **Varnishes, Lacquers, Dyes, Pigments Manufacturing**
10. **Pesticides and Herbicides Manufacturing**

Summary

- According to the investigation experience this screening system was also employed to investigate the operating manufacturing factories (especially the potential Cl-VOC contaminated site), military site, petroleum tank site, et al.

Thank You

for

Your Attentions