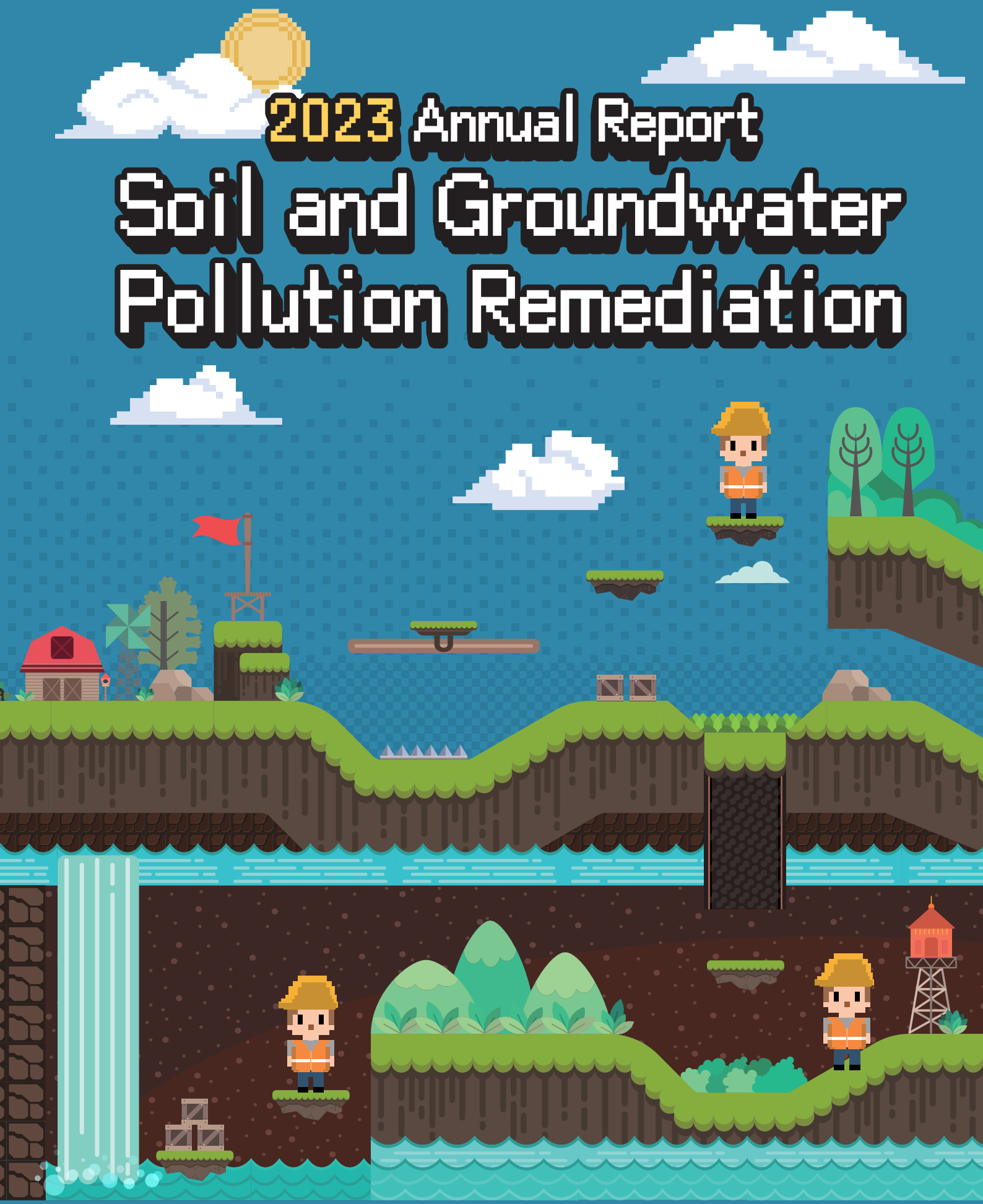
2023 Annual Report
Soil and Groundwater Pollution Remediation



Environmental Management Administration, Ministry of Environment

Soil and Groundwater Pollution Remediation Fund Management Board

"Doctors of the Earth" Six-Part Series

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Part 1: Annual Goals and Health Check Report

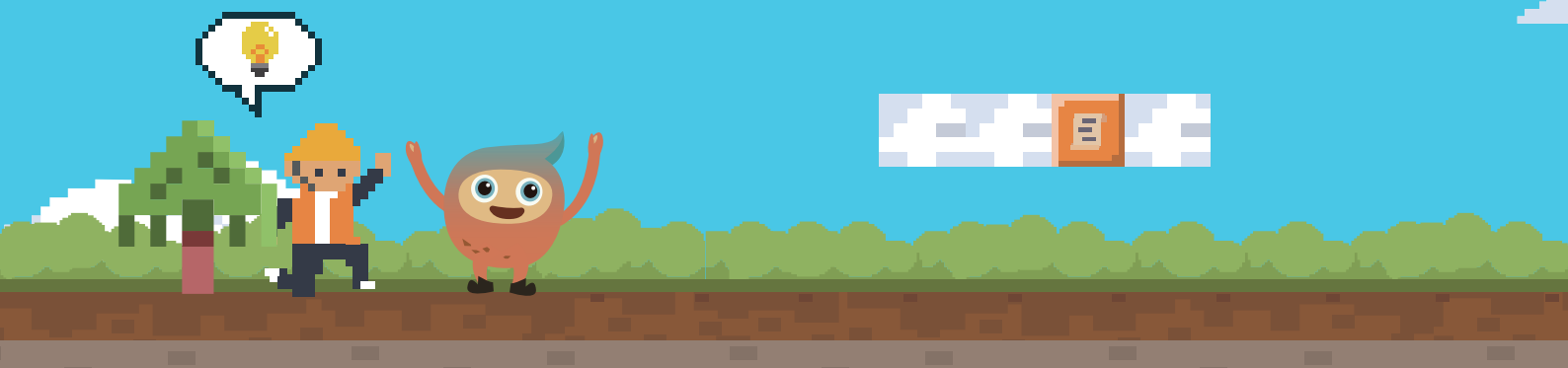
On August 22, 2023, the former Environmental Protection Administration's Environmental Inspection Task Force and the Soil and Groundwater Pollution Remediation Fund Management Committee were merged to form the Environmental Management Administration under the Ministry of Environment, with a vision of sustainable management of soil and water resources.

Sound and Comprehensive Legal System Strengthened Administrative Framework

To enhance the soil and groundwater execution system and promote current policy implementation, two regulatory orders and two administrative rules were amended and announced.

Continuously Conducting Surveys Detecting Potential Pollution Early

The percentage of "Green Light" industrial zones increased from **43%** to **77%**, while "Red, Orange, and Yellow Light" zones with pollution risks decreased from **57%** to **23%.**



Collaborating with All Administrative Teams to Jointly Promote Remediation and Restoration

A total of 163 sites were successfully delisted after remediation efforts were completed.

The remediation site at "Taiwan Metal Mining Corporation and its three abandoned flue areas (partially)" was approved with an alternative remediation target value. This case represents the first instance where appropriate risk management measures were implemented as a tool for site control, in conjunction with zoning for land reuse.

Developing Key Soil and Groundwater Technologies Advancing international cooperation and collaboration

A total of 37 research teams were approved to conduct soil and groundwater pollution remediation research. These included 3 pilot studies, 18 laboratory research projects, and 16 technology test field projects, meeting both domestic remediation needs and international goals for low-carbon sustainability and resource circulation.

Continued international exchange and cooperation with ASEAN, the United States, and Thailand through conferences and collaborative meetings.

The sustainable management of soil and groundwater resources remains the vision, incorporating sustainable fund management. Key policy development priorities will be continuously updated to achieve long-term sustainability in soil and water management.

Part 1: Annual Goals and Health Check Report

The "Ministry of Environment Organization Act" was promulgated on May 24, 2023, by Presidential Order No. 11200043181 (華總一義字第 11200043181 號函), officially transitioning the Environmental Protection Administration (EPA) of the Executive Yuan into the Ministry of Environment. This transformation shifts the focus from "natural resource management" to "proactively addressing global environmental challenges and creating opportunities for Taiwan's transition." The Environmental Management Administration (hereinafter referred to as "EMA") was established by merging the Environmental Inspection Team of the former EPA and the Soil and Groundwater Pollution Remediation Fund Management Board (hereinafter referred to as "SGWR Fund"). This merger is expected to enhance regional environmental governance and enforcement, improve general waste management, refine public health management, and ensure the sustainable management of soil and groundwater resources.

The protection of soil and groundwater is closely intertwined with environmental sustainability and directly impacts the daily lives of the people. To prevent further damage to land ecosystems, the Soil and Groundwater Pollution Remediation Fund Management Board (SGWR Fund), under the Environmental Management Administration (EMA), acts as the "doctor of the land," with deep expertise in land restoration and extensive experience in pollution remediation. To further enhance the management performance of soil and groundwater operations in Taiwan, five governance visions were established: "strengthening the regulatory framework," "preventing soil and groundwater pollution," "remediating contaminated sites," "developing key technologies," and "sustainable fund management." These initiatives are aimed at improving quality of life and encouraging collective efforts to protect the land.

The results of these efforts are categorized based on the five major objectives for 2023, including amendments or establishment of soil and groundwater

regulations, the performance of fund management, site contamination prevention and investigation, integration of efforts across agencies for remediation and revitalization, promotion of domestic and international technologies, and the advancement of international cooperation and domestic advocacy. The related outcomes are as follows:

1.Strengthening the Regulatory Framework and Enhancing the Administrative Management System

(1)To improve the execution system related to soil and groundwater, the Environmental Management Administration (EMA) issued two regulatory orders and amended or established two administrative rules in 2023.

- To promote and develop Taiwan's soil and groundwater pollution remediation technologies, and to strengthen technical capabilities and quality, Taiwan seeks to advance and promote excellent remediation technologies both domestically and internationally. On January 10, 2023, the Environmental Management Administration (EMA) issued the "Guidelines for Application Review and Management of Effectiveness Certification for Soil and Groundwater Pollution Remediation Technologies."

- To accelerate the remediation and improvement of contaminated sites, a credit guarantee mechanism was introduced to help stakeholders of contaminated land secure funding for remediation. As part of this effort, amendments to Articles 4, 6, and 10 of the "Regulations Governing the Revenue, Expenditure, Safekeeping, and Utilization of the Soil and Groundwater Pollution Remediation Fund" were issued on February 13, 2023.

- A guarantee fund was established, incorporating a loan credit guarantee mechanism to help stakeholders of contaminated land obtain the financing needed to implement pollution remediation plans, with interest subsidies provided. On May 19, 2023, the "Guidelines for the Implementation of Loan Credit Guarantees for Soil and Groundwater Pollution Remediation" were issued.

- Given the significant progress in achieving policy goals that encourage fee payers to invest in soil and groundwater pollution prevention equipment and projects, and to further encourage them to purchase environmental liability insurance or related pollution liability insurance to effectively address potential pollution risks, the "Regulations Governing Fees for Soil and Groundwater Pollution Remediation" were amended and issued on December 29, 2023.

2.Continuing Investigations to Detect Potential Pollution Early

(1) In 2023, the Environmental Management Administration (EMA) focused on pollution prevention management, utilizing a rolling management approach to monitor data from 144,000 enterprises nationwide. Based on factors such as business type, pollution sources, and operational characteristics, enterprises were categorized into groups using pollution potential criteria. These groups include: "A. Enhanced Management Group," "B. Self-Management Group," and "C. Review Management Group," to ensure comprehensive management.

(2) In 2023, the proportion of "Green Light" industrial zones increased from 43% to 77%, while the proportion of "Red," "Orange," and "Yellow Light" zones (indicating pollution) decreased from 57% to 23%, showing preliminary success in pollution remediation.

(3) **To quickly identify pollution issues, local Environmental Protection Bureaus required operators of 36 storage systems that reported anomalies to investigate the irregularities and complete** remediation.

3.Coordinating with Administrative Teams at All Levels to Jointly Promote Remediation and Restoration

(1) **Contaminated sites in Taiwan can be categorized into two main types: agricultural land and industrial sites (including factories, gas stations, illegal dumping sites, storage tanks, military bases, and other types of locations). In 2023, a total of 163 sites were de-listed from regulatory oversight.**

(2) **The Environmental Management Administration (EMA) approved a soil remediation goal for the former Taiwan Metal Mining Corporation and its three associated waste flue areas (partially). This was the first case where appropriate risk control measures were integrated with zoned land reuse as a site management tool. Additionally, through technical assistance in the form of guidance, consultation, and feasibility diagnostics, three contaminated sites successfully implemented risk-based management plans this year.**

4.Developing Key Soil and Groundwater Technologies and Enhancing International Cooperation

(1) The "ASEAN Soil and Groundwater Sustainability Forum" was held to promote understanding of ASEAN partners among various sectors in Taiwan. The event brought together the expertise of government, industry, and academia, further expanding opportunities for Taiwan's industries in ASEAN countries.

(2) Grants were provided to academic and civil organizations to conduct research related to soil and groundwater pollution remediation. In 2023, a total of 37 research teams participated, divided into 3 pilot studies, 18 laboratory research projects, and 16 technical field trials. The focus of the funded research includes optimization of remediation processes, sustainable and resilient remediation, remediation technologies that support risk-based criteria, smart pollution monitoring, emerging pollution issues, advanced pollution identification, management of polluted land reuse, and strategies for artificial intelligence application and promotion.

(3) The " 2023 Cross-Disciplinary Soil and Water Technology Industry-Academia Conference" was held, focusing on " technology optimization and industrial upgrading." Four industry-academia cooperation agreements were signed.

(4) The Asia-Pacific Soil and Groundwater Pollution Remediation Working Group held a professional training program for officials. A total of 42 young officials and scholars from Australia, Indonesia, South Korea, the Philippines, Thailand, Vietnam, Sri Lanka, and Japan attended the six-day training in Taiwan.

(5) The "2023 Taiwan-U.S.-Thailand Soil and Groundwater Technology Exchange" was conducted with delegations from Taiwan and the U.S. Environmental Protection Agency (EPA) traveling to Thailand. They shared experiences in site management, pollution investigation, and remediation technologies with local environmental officials. This three-party exchange strengthened close partnerships based on mutual benefit and growth, while exploring opportunities for developing overseas markets.

Part 2:
The Earth Doctors' Prescriptions

In order to strengthen the execution system and current policies related to soil and groundwater, two regulations and two administrative rules were announced, formulated, or amended:

Key points for the application and review of effectiveness certification for soil and groundwater pollution remediation technologies

- Guidelines established in March 2022
- Published on January 10, 2023

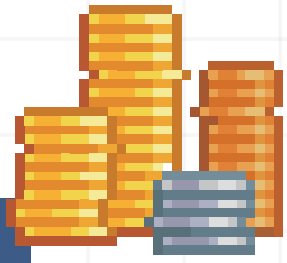
Regulations on the management and utilization of soil and groundwater pollution remediation funds

- Published on June 11, 2001
- Amended on February 13, 2023

Loan Credit

Guidelines for implementing loan credit guarantees for soil and groundwater pollution improvement

- Published on May 19, 2023



Regulations on the collection of soil and groundwater pollution remediation fees

- Published on October 29, 2001
- Amended on December 29, 2023

Part 2: The Earth Doctors' Prescriptions

In 2023, the Ministry issued and amended two regulatory orders and two administrative rules, detailed as follows:

1.Guidelines for Application Review and Management of Effectiveness Certification for Soil and Groundwater Pollution Remediation Technologies

To promote and develop Taiwan's soil and groundwater pollution remediation technologies, strengthen technical capabilities and quality, and facilitate the deep integration and promotion of Taiwan’s outstanding remediation technologies both domestically and internationally, the "Guidelines for Application Review and Management of Effectiveness Certification for Soil and Groundwater Pollution Remediation Technologies" were issued on January 10, 2023. The implementation process is illustrated in Figure 1.

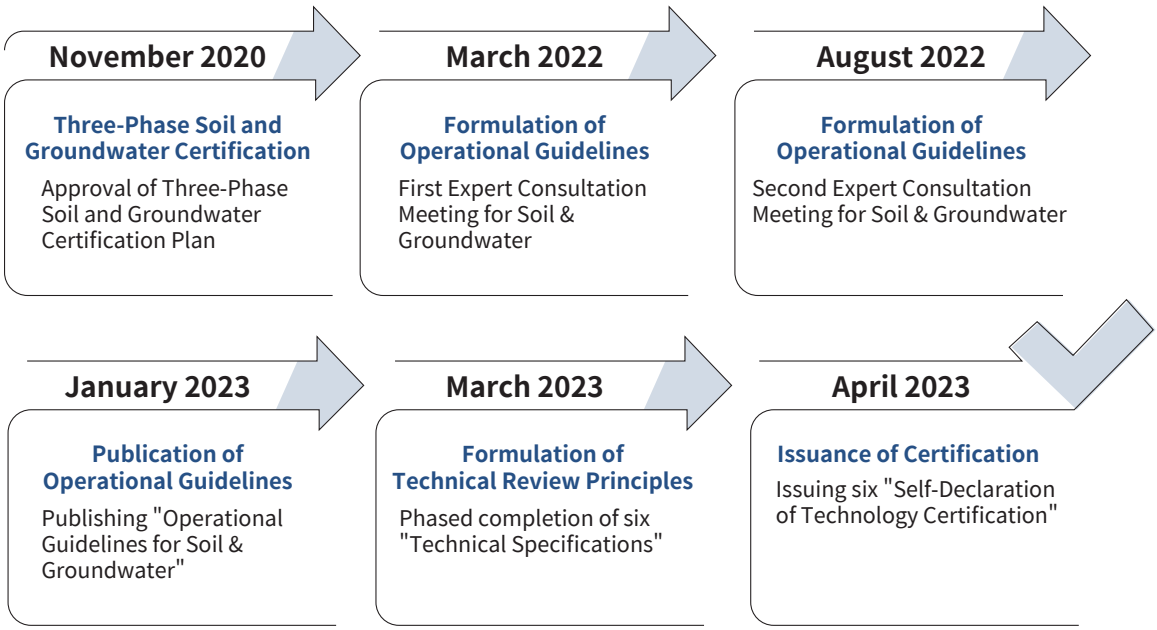


Figure 1: Flowchart of the Application Review and Management Process for Effectiveness Certification of Soil and Groundwater Pollution Remediation Technologies

2.Regulations Governing the Revenue, Expenditure, Safekeeping, and Utilization of the Soil and Groundwater Pollution Remediation Fund

To accelerate the remediation and improvement of contaminated sites, a credit guarantee mechanism was introduced to assist stakeholders of contaminated land in securing funding for remediation, with the goal of fostering public-private partnerships to promote site remediation and improvement. As a result, amendments were issued on February 13, 2023. The revisions included the addition of Subparagraph 12 to Article 4, expanding the use of the fund for credit guarantees, as well as minor adjustments to the wording in Articles 6 and 10.

- The amendments added provisions allowing the fund to be used for loan credit guarantees and interest subsidies related to soil and groundwater pollution remediation goals.
- The fund was also authorized to increase returns by purchasing government bonds, treasury bills, or other short-term securities.
- Surplus from the annual financial statement of the fund must, in accordance with regulations, either be accumulated or remitted to the national treasury.

3.Implementation Guidelines for Loan Credit Guarantees for Soil and Groundwater Pollution Remediation

To accelerate the remediation of soil and groundwater pollution control site and remediation site, and to assist stakeholders of polluted land in implementing soil and groundwater pollution control or remediation plans, the Ministry collaborated with the Small and Medium Enterprise Credit Guarantee Fund to establish a corresponding guarantee fund. A loan credit guarantee

mechanism was introduced to help stakeholders obtain the financing needed for pollution remediation goals, with interest subsidies provided. On May 19, 2023, the "Implementation Guidelines for Loan Credit Guarantees for Soil and Groundwater Pollution Remediation" were issued.

4.Regulations Governing Fees for Soil and Groundwater Pollution Remediation

Significant progress has been made toward encouraging fee payers to invest in soil and groundwater pollution prevention equipment and projects. Additionally, to further incentivize fee payers to purchase environmental liability insurance or related pollution liability insurance to effectively address potential pollution risks, the "Regulations Governing Fees for Soil and Groundwater Pollution Remediation" were amended and issued on December 29, 2023, and will take effect on January 1, 2025. The key points of this amendment are as follows, with the revision process illustrated in Figure 2:

- Refund mechanism transformed into fee discounts: Fee payers who purchase environmental damage liability insurance or related pollution liability insurance will receive a 5% discount on remediation fees in the following year.

- Exemption from reporting if the fee is less than NT$200: Fee payers whose quarterly remediation fees are below NT$200 are not required to submit a report.

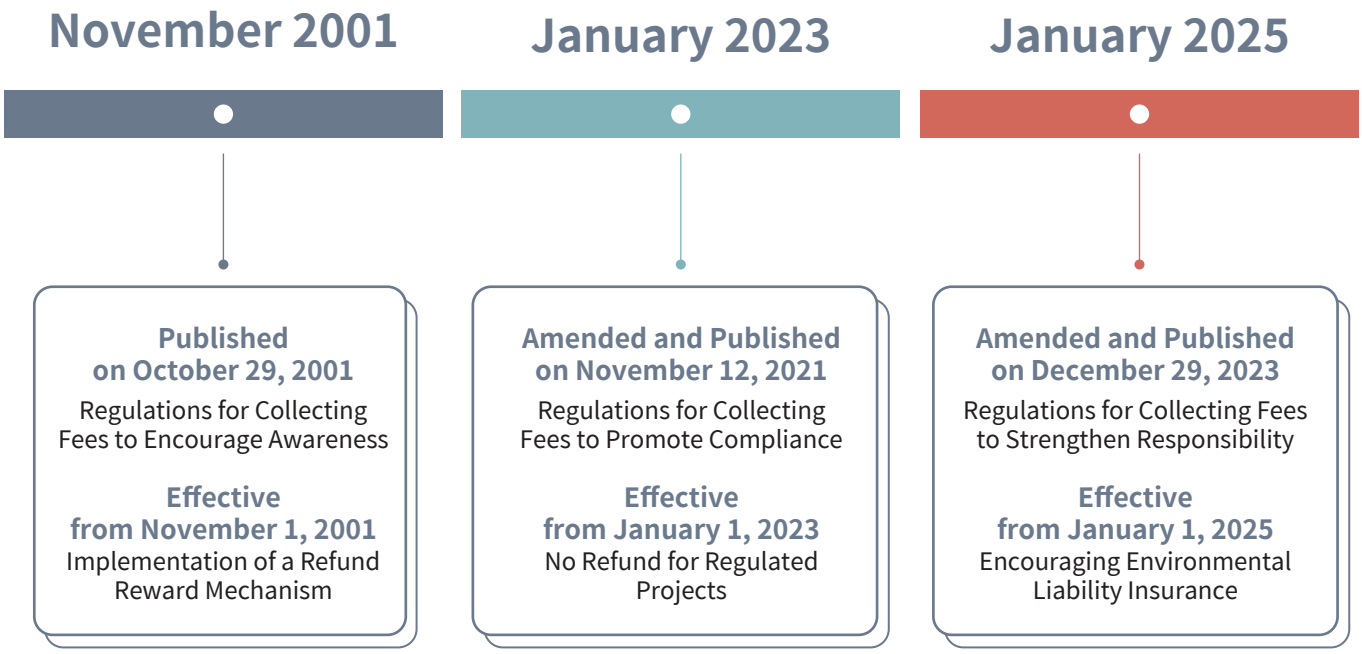


Figure 2: Process Diagram for the Amendments to the Soil and Groundwater Pollution Remediation Fee Regulations

Part 3:
The Earth Doctors' Financial Review

Total revenue: approximately NT$990 million.

Remediation fee collection income

97.77%

Other sources of revenue

1.02%

Property income

1.21%

0.56%

Equipment replacement

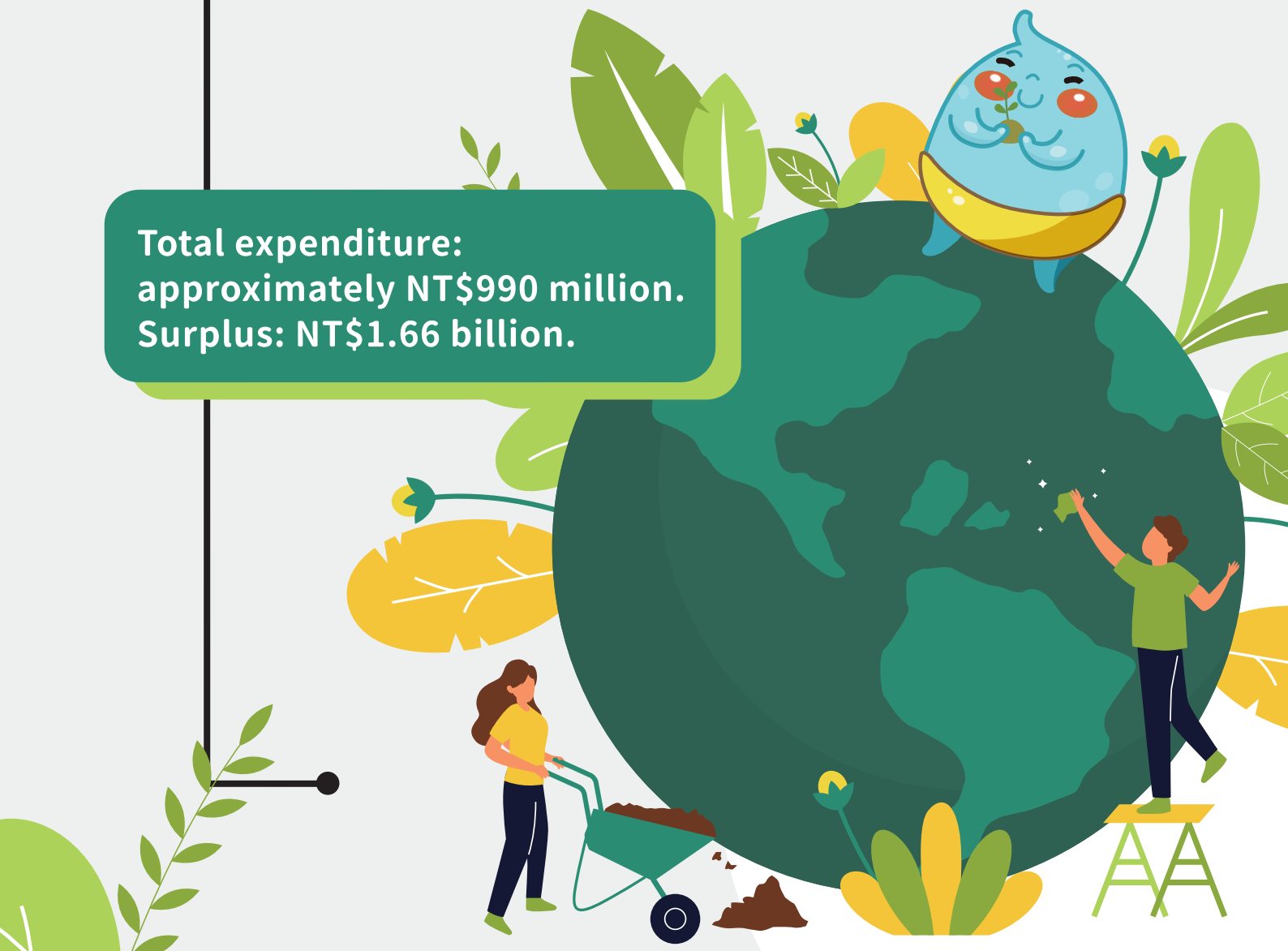
91.93%

Soil and groundwater pollution remediation-related work

General administrative management

7.51%

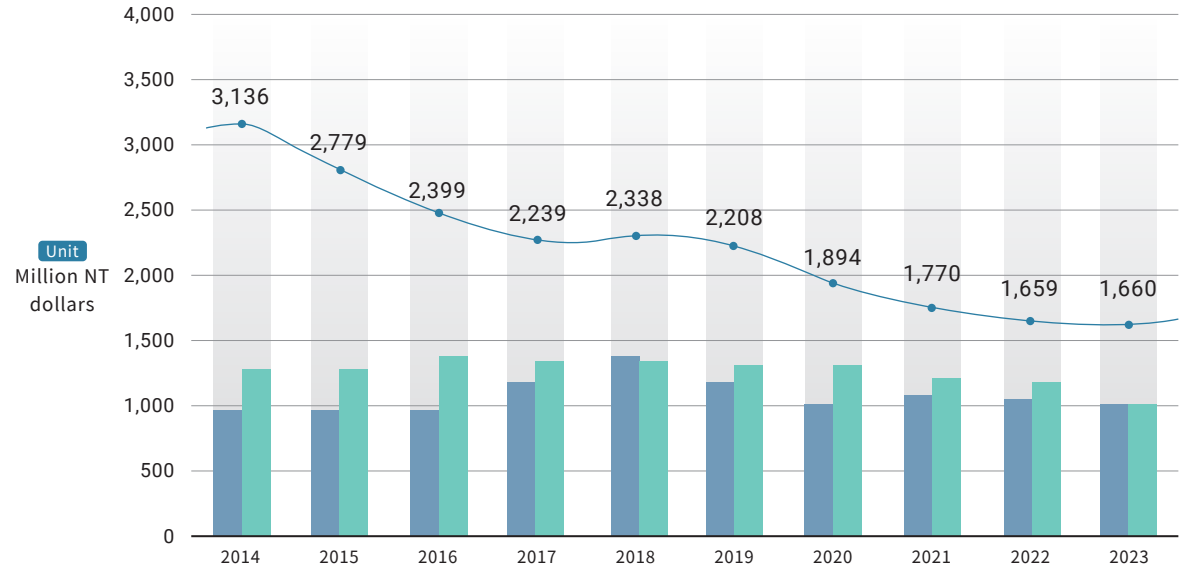
Total expenditure: approximately NT$990 million. Surplus: NT$1.66 billion.



Part 3: The Earth Doctors' Financial Review

The Soil and Groundwater Pollution Remediation Fund (SGWR Fund) was established in 2000 (Year 89 in the ROC calendar) to address the urgency of responding to and managing contaminated soil and groundwater sites. Taking into account Taiwan's socio-economic and environmental conditions, and referencing the U.S. Superfund system, the SGWR Fund was created. According to Article 28 of the Soil and Groundwater Pollution Remediation Act, remediation fees are collected from manufacturers and importers based on the quantity and import volume of designated substances. These remediation fees align with the core principles of the Soil and Groundwater Pollution Remediation Act and the Basic Environmental Act, while also promoting corporate social responsibility within the industry.

The SGWR Fund’s budget is the primary financial source for the operations of the Soil and Groundwater Pollution Remediation Fund Management Board under the Environmental Management Administration (EMA). In 2023, the SGWR Fund had revenues of over NT$990 million and expenditures of over NT$990 million, with an accumulated surplus of nearly NT$1.66 billion, as shown in Figure 3.



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Fund Income	989	959	989	1,179	1,357	1,178	999	1,087	1,052	999
Fund Expenditure	1,262	1,317	1,369	1,339	1,257	1,308	1,313	1,211	1,164	998
Cumulative Surplus	3,136	2,779	2,399	2,239	2,338	2,208	1,894	1,770	1,659	1,660

Figure 3: Revenue, Expenditures, and Accumulated Surplus of the Soil and Groundwater Pollution Remediation Fund Over the Past 10 Years

1.Sources of SGWR Fund Revenue

According to Article 29 of the Soil and Groundwater Pollution Remediation Act, the SGWR Fund has eight main sources of revenue, as listed below:plans, the Ministry collaborated with the Small and Medium Enterprise Credit Guarantee Fund to establish a corresponding guarantee fund. A loan credit guarantee

- Revenue from soil and groundwater pollution remediation fees.
- Payments made by polluters, Person Potentially Responsible for Pollution, or stakeholders of contaminated land as per Articles 43 and 44.
- Payments made by land developers in accordance with Paragraph 3, Article 51.
- Income generated from the interest of the fund.
- Appropriations from the central competent authority through the budget process.
- Allocations from other environmental protection-related funds.
- A portion of fines and administrative penalties related to environmental pollution.
- Other related income.

In 2023, the SGWR Fund's revenue exceeded NT$990 million, with the primary source being remediation fee collections, amounting to over NT$970 million, which accounted for 97.77% of the total annual revenue, as shown in Figure 4.

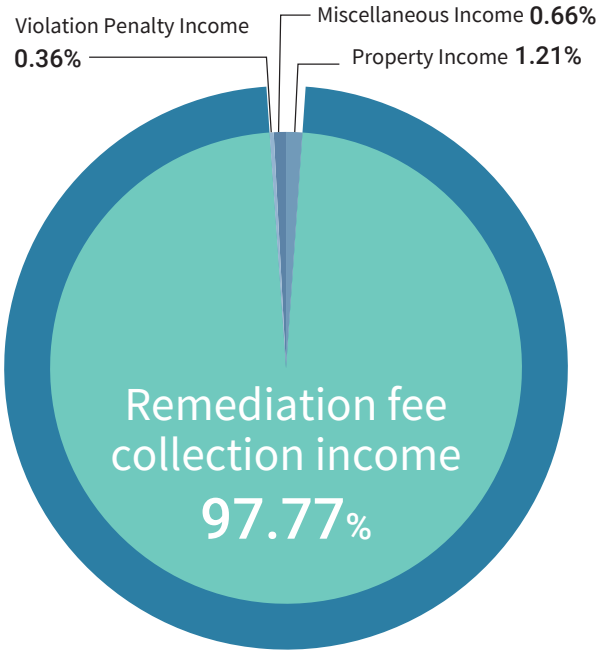


Figure 4: SGWR Fund Revenue for 2023

(1) Actual Amount of Remediation Fees Collected in 2023

The new Regulations Governing Fees for Soil and Groundwater Pollution Remediation took effect on July 1, 2017. Since the implementation of the new system, the average quarterly actual collected amount has been approximately NT$245 million. In 2023, the total collected remediation fees amounted to approximately NT$976 million.

(2) Export Refunds

Considering the risks involved in manufacturing and transportation, a provision was established allowing for an export refund if imported materials are not fully used and are exported in their original state. The recent number of applications for export refunds and the approved refund amounts are shown in Table 1.

Table 1: Statistics on Approved Export Refund Amounts and Number of Approved Cases from 2014 to 2023

Unit: NT$1,000

Approved Year	Number of Applications	Approved Refund Amount
103	40	251
104	28	88
105	39	247
106	35	190
107	43	204
108	43	328
109	37	103
110	48	356
111	38	467
112	43	761

Note: Statistics are based on the actual approval date of each application case, not categorized by the corresponding quarter.

(3)Insurance and Project Refunds

In 2023, there were 38 applications for insurance refunds and 21 applications for project refunds from the previous year (2022). As shown in Table 2, the number of applications and the actual approved refund amounts have remained stable in recent years, indicating a certain level of effectiveness in pollution prevention.

Table 2: Statistics on Approved Insurance and Project Refund Amounts and Number of Approved Cases from 2013 to 2022

Unit: NT$1,000

Approved Year	Total Number of Applications	Number of Insurance Applications	Number of Project Refund Applications	Approved Refund Amount
102	75	38	37	137,715
103	67	40	27	134,643
104	66	40	26	134,339
105	67	40	27	116,624
106	65	42	23	146,398
107	66	41	25	144,701
108	63	39	24	147,279
109	61	40	21	136,963
110	60	40	20	141,424
111	59	38	21	161,402

Note: Applications for insurance or project refunds for the previous year are submitted between June and July each year.

(4)Compensation Revenue

From 2001 (Year 90 in the ROC calendar) to the end of 2023, the SGWR Fund sought approximately NT$563 million in compensation for expenses advanced by the fund. Over the past three years, through innovative scientific technologies and collaboration mechanisms between environmental inspectors and law enforcement, polluters have been tracked down. Compensation for remediation costs of agricultural land totaled approximately NT$65 million (with the total agricultural site remediation claim amounting to over NT$190 million). Additionally, compensation for the pollution remediation site of industrial, mainly from the China Petrochemical Development Corporation (CPDC) An-Shun Site, totaled approximately NT$350 million (with the total industrial site remediation claim amounting to over NT$370 million). In total, these claims represent about 60% of the overall compensation amount. The current status of compensation is illustrated in Figure 5.

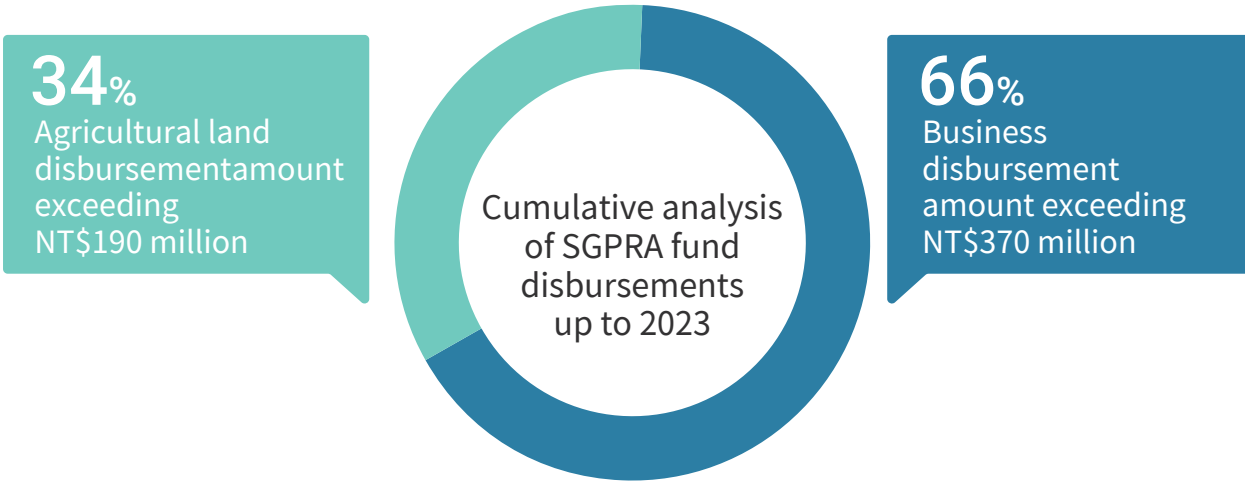


Figure 5: Analysis of SGWR Fund Advanced Expenses Accumulated through 2023

2.SGWR Fund Expenditures

In 2023, the SGWR Fund's expenditures exceeded NT$990 million. Of this, over NT$910 million was allocated to soil and groundwater pollution remediation-related work, accounting for approximately 91.93% of total expenditures. The remaining NT$80 million was used to cover expenses for the construction of administrative support information systems, shared data centers, renovation of the Ministry's new conference center, staff salaries, utilities, and maintaining the normal operation of the committee's internal affairs, which accounted for 8.07% of total expenditures, as shown in Figure 6.

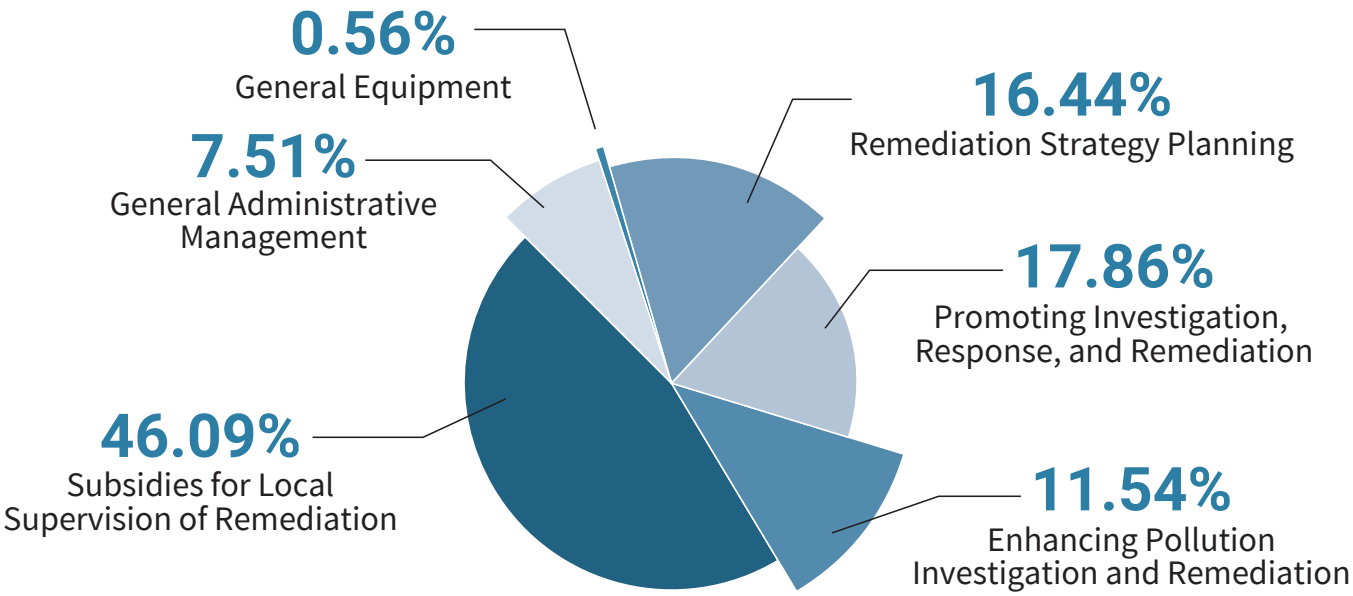


Figure 6: SGWR Fund Expenditures for 2023

Part 4:
Graded Management of Earth's Health Check

163 sites were delisted in 2023.

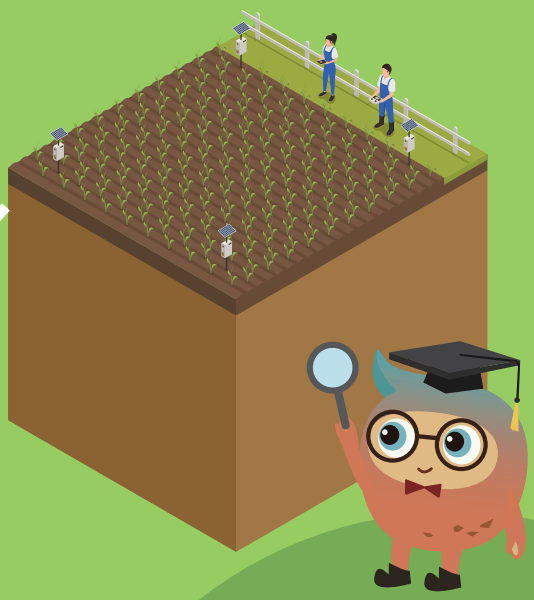
A total of **12** enterprises with off-site treatment and reuse permits under the S-class code.

3 sites integrated risk management measures to execute pollution remediation.

Improvement

The "Former Taiwan Metal Mining Corporation and its Three Abandoned Flues (Partial Area)" became the first case to propose a zonal land revitalization plan and set new remediation targets in accordance with the "Principles for Zonal Remediation and Land Use of Contaminated Sites."

Pollution prevention and management



1,209.30 hectares

Agricultural land have been remediated.

18 counties and cities

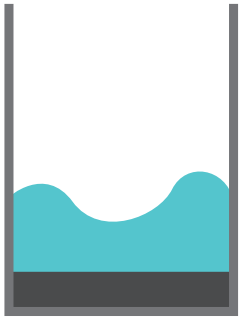
Agricultural sites were fully delisted.

501

Completion of regular sediment quality monitoring reports.

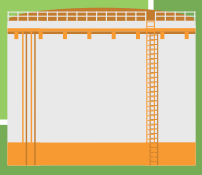
94.9%

Submission rate of waterbody sediment quality data records.



36 abnormal cases of storage systems were tracked and managed; after verification by the EPB, no pollution was confirmed.

A total of **390** on-site inspections for assessments and investigations under Articles 8 and 9 were carried out.



Over **140,000** enterprises were categorized into tiered management groups, including:

- Intensive management group
- Self management group
- Review management group

The number of industrial zones classified as "green light"

62 → 166

accounting for **77%**

Approximately 92.1% of regional groundwater quality samples were below the monitoring standard.

Part 4: Graded Management of Earth's Health Check

In 2023, nationwide efforts in soil and groundwater pollution prevention and management operations included reporting and investigations across various types of sites. The business outcomes covered agricultural land investigations, groundwater quality monitoring, sediment quality monitoring and management, and statistical data reporting from various types of business units. Based on these preventive measures, combined with the current regulatory framework, the report presents data on listed and de-listed contaminated sites as well as key remediation goals completed in 2023. These include the following major sites: "A.B.C. Machine Industry Co., Ltd." in New Taipei City, "CPC Corporation, Taiwan - Exploration and Production Business Division, Tiezhenshan Oil Field" in Miaoli County, "KHS Musical Instrument Co., Ltd. Guoling No. 1 Plant" in Taoyuan City, "Rising Glory Technology Co., Ltd. No. 2 Plant" in Taoyuan City, "Ching Luen Chan Industrial Co., Ltd." in Changhua County, "Formosa Oil (Asia Pacific) Corporation Hu-Kou Northbound Gas Station" in Hsinchu County, and "Mech-President Corporation Fengshan No. 2 Gas Station" in Kaohsiung City.

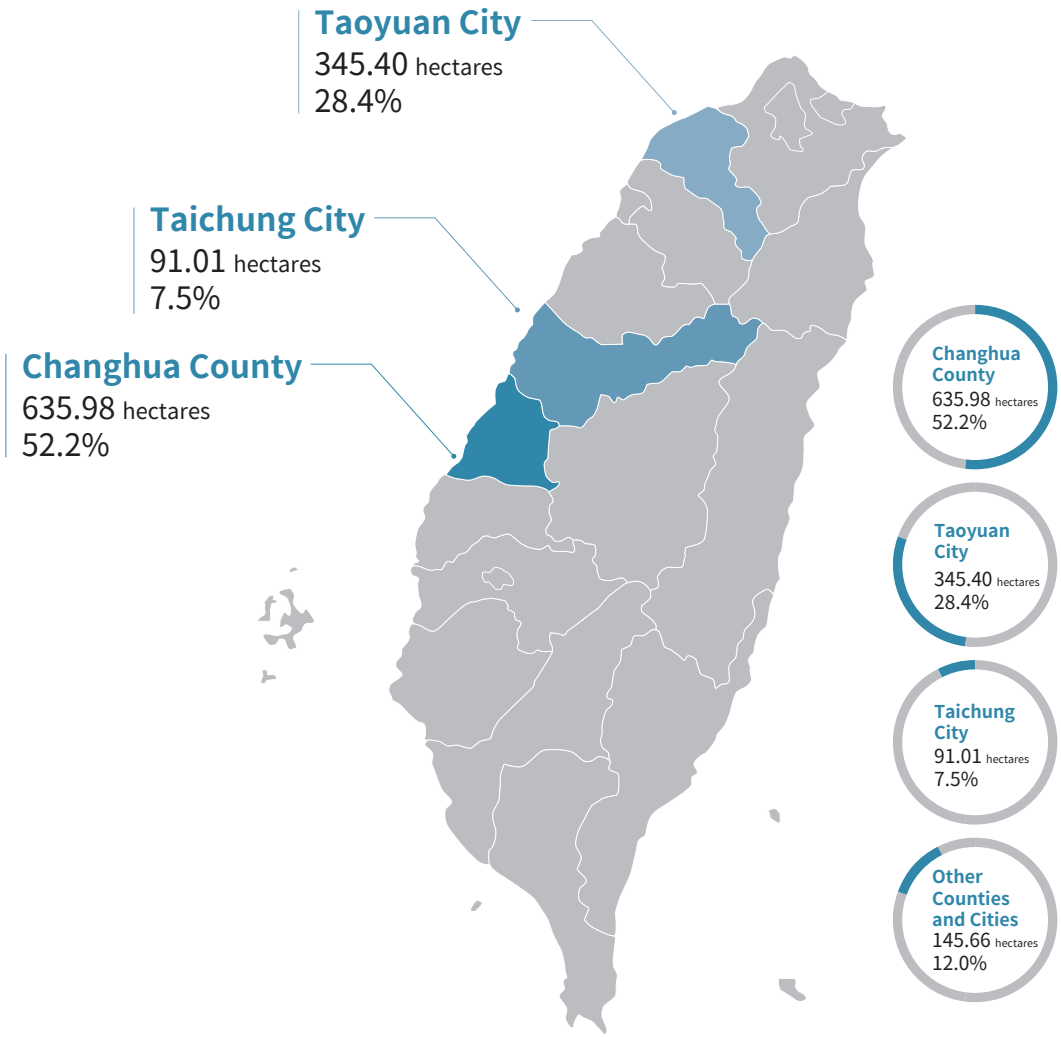
In addition, recent efforts have focused on promoting the off-site soil treatment system, site risk management, and land reuse, with the goal of achieving the effective utilization of land resources.

1.Investigation and Reporting Statistics

To ensure the sustainable use of soil and groundwater resources and to protect public health, the Environmental Management Administration (EMA) has conducted investigations and remediation efforts related to pollution potential in agricultural land, factories, industrial zones, gas stations, storage systems, and designated business land since the enactment of the Soil and Groundwater Pollution Remediation Act.

(1)Agricultural Land

As of the end of 2023, a total of approximately 1,218.05 hectares of polluted agricultural land (including controlled sites and sites with deadlines for improvement) have been listed, as shown in Figure 7 and Table 3. The total budget for agricultural land soil improvement reached approximately NT$2.3 billion, including approximately NT$330 million for fallow compensation, around NT$1.8 billion for pollution remediation, and approximately NT$180 million for removal and destruction costs.



Note: Statistical data is as of December 2023, with data extracted on March 27, 2024.

Figure 7: Cumulative Percentage of Controlled and Improvement Deadline Agricultural Sites in Taiwan

Table 3: Status of Controlled and Improvement Deadline Agricultural Sites in Taiwan (as of 2023)

Counties/Cities	Area of Sites Under Regulation (hectares)	Area of Delisted Sites (hectares)	Cumulative Area of Listed Sites (hectares)
解 Keelung City	-	-	-
解 Taipei City	-	4.89	4.89
New Taipei City	0.64	4.16	4.80
Taoyuan City	3.99	341.41	345.40
解 Hsinchu City	-	36.20	36.20
解 Hsinchu County	-	0.36	0.36
解 Miaoli County	-	7.96	7.96
解 Taichung City	-	91.01	91.01
Changhua County	2.89	633.09	635.98
解 Nantou County	-	0.58	0.58
解 Yunlin County	-	10.33	10.33
解 Chiayi City	-	4.60	4.60
解 Chiayi County	-	7.30	7.30
Tainan City	1.23	28.82	30.05
解 Kaohsiung City	-	10.37	10.37
解 Pingtung County	-	14.35	14.35
解 Yilan County	-	13.50	13.50
解 Hualien County	-	0.18	0.18
解 Taitung County	-	-	-
解 Penghu County	-	-	-
解 Kinmen County	-	0.16	0.16
解 Lienchiang County	-	-	-
Total	8.75	1,209.27	1,218.02

Note 1: Statistical data is as of December 2023, with data extracted on March 27, 2024.

Note 2: Sorted by geographic location: North, Central, South, and East.

Note 3: An asterisk 解 indicates that all sites in the respective county or city have been delisted.

i.Environmental Protection and Food Safety

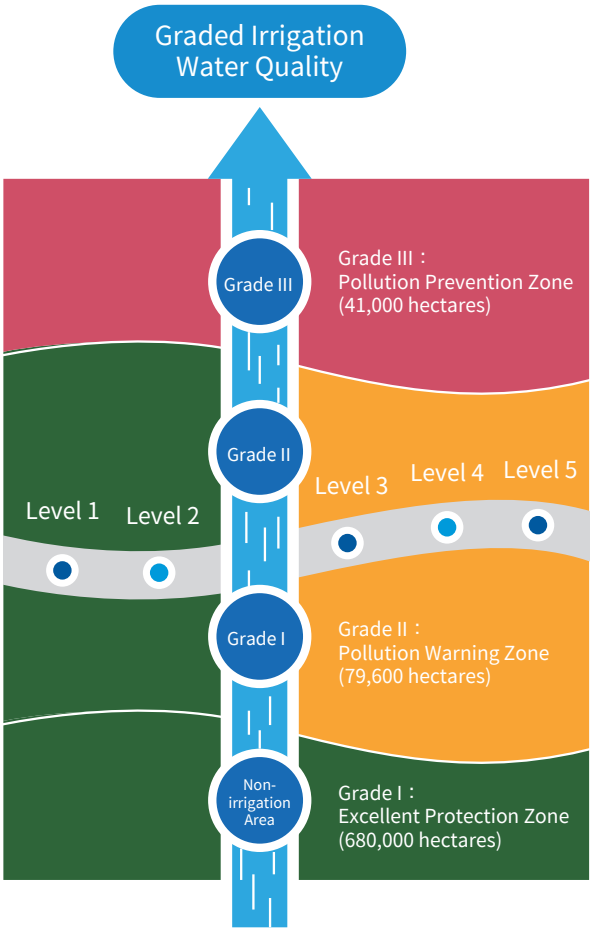
In collaboration with the Agriculture and Food Agency of the Ministry of Agriculture, the Environmental Management Administration (EMA) completed 494 soil sampling and analysis operations on agricultural land in 2023. The results showed that heavy metal concentrations in the soil of agricultural land did not exceed the standards for soil pollution control in edible crop farmland.

ii.Regular Monitoring and Pollution Early Warning

For agricultural land where past investigations revealed heavy metal concentrations higher than the soil pollution monitoring standards for edible crop farmland but below the regulatory standards, soil monitoring was carried out in accordance with Article 6 of the Soil and Groundwater Pollution Remediation Act. In 2023, a total of 381 samples were analyzed, with 23 samples exceeding the soil pollution control standards for edible crop farmland, resulting in a pollution detection rate of 6%. These 23 cases were distributed as follows: 16 in Taoyuan City (copper), 5 in Changhua County (chromium, copper, nickel), and 1 each in Chiayi County and Yilan County (arsenic). Of the 23 cases, 2 (in Chiayi and Yilan Counties) were found to be within groundwater arsenic concentration potential zones and have been addressed by the local Environmental Protection Bureaus according to arsenic pollution determination and treatment principles. The remaining 21 cases have been included in remediation plans, with 16 cases in Taoyuan City and 2 in Changhua County completed and de-listed by the end of 2023. The remaining 3 cases in Changhua County are expected to be fully remediated by the end of 2024.

iii.Regular Preventive Monitoring of Agricultural Soil and Irrigation Water

To effectively utilize monitoring resources and prevent pollution, the Environmental Management Administration (EMA) implemented a system based on the grading of high-pollution-potential agricultural land (PN value) and the evaluation framework for agricultural water and soil resources zoning by the Ministry of Agriculture. Using data from the Agricultural Research Institute's 1992 survey of 130,000 agricultural topsoil samples (PN values) as the basis for the classification of agricultural soil pollution potential, irrigation channels with high pollution potential (Level III channels) were identified as key indicators of continuous pollutant accumulation. The framework for assessing agricultural land pollution potential is shown in Figure 8, which categorizes areas into Pollution Prevention Zones, Pollution Warning Zones, and High-Protection Zones. Since 2023, new key preventive measures for agricultural land pollution have been introduced, including soil and irrigation water monitoring with different densities across the various zones to assess the status of agricultural land annually.



Note: Statistical data is as of December 2023

Figure 8: Agricultural Land Pollution Potential Zoning Evaluation Framework

Currently, a total of 1,673 agricultural soil monitoring samples have been collected nationwide, along with continuous monitoring at 88 irrigation

stations per month and 771 single-point irrigation water quality tests. The compliance rate for agricultural soil monitoring was 99.3%, and the compliance rate for heavy metals in irrigation water samples was 98.3%. The actual protected irrigation area covered approximately 130,000 hectares, accounting for 16% of Taiwan's total agricultural land area of 800,000 hectares.

(2) Groundwater Quality Monitoring

To establish long-term nationwide groundwater quality data and monitor groundwater conditions, the Environmental Management Administration (EMA) has set up over 460 regional groundwater monitoring wells for background water quality investigations. In addition to conducting regular annual water quality monitoring and well management operations, in 2023, the EMA also conducted water quality investigations and studies on groundwater-related concerns, and continuously reviewed groundwater pollution control and monitoring standards. Based on these findings, the EMA has proposed groundwater quality protection policies for Taiwan.

Comparing the 2023 regional groundwater monitoring data with the Category 2 groundwater pollution monitoring standards, approximately 92.1% of the samples were below the groundwater pollution monitoring standards. Additionally, for 23 volatile organic compounds (VOCs), the compliance rate with groundwater pollution control standards was 100%.

(3)Regular Sediment Quality Monitoring and Reporting

To monitor sediment quality and pollution potential in specific surface water bodies in Taiwan, sediment quality management has been incorporated into the Soil and Groundwater Pollution Remediation Act since 2010. The Environmental Management Administration (EMA) has established several sub-regulations and administrative guidelines, as shown in Figure 9. Since 2014, all responsible authorities are required to perform sediment quality testing of the water bodies under their jurisdiction at least once every

five years. The first round of sediment quality testing and reporting (2014-2018) has been completed, with a 100% submission rate, covering 473 water bodies. For the second round (2019-2023), a total of 528 water bodies are scheduled for testing, including 83 rivers, 93 lakes and reservoirs, and 352 irrigation channels.

As of 2023, the responsible authorities have submitted 525 sediment sampling plans for approval, with a submission rate of 99.4%. Additionally, 501 water bodies have completed sediment quality reporting, with a reporting rate of 94.9%. The statistical data is shown in Table 4. For water bodies with sediment quality exceeding the regulatory limits, the EMA continues to investigate the causes to ensure sediment and ecological quality. Relevant measures are implemented by the responsible authorities in accordance with the classification and use restrictions of sediment quality indicators.

- Responsible authorities should conduct periodic testing of sediment quality in water bodies under their jurisdiction at least once every five years
- Gradual establishment of necessary supporting laws, administrative regulations, and guidelines

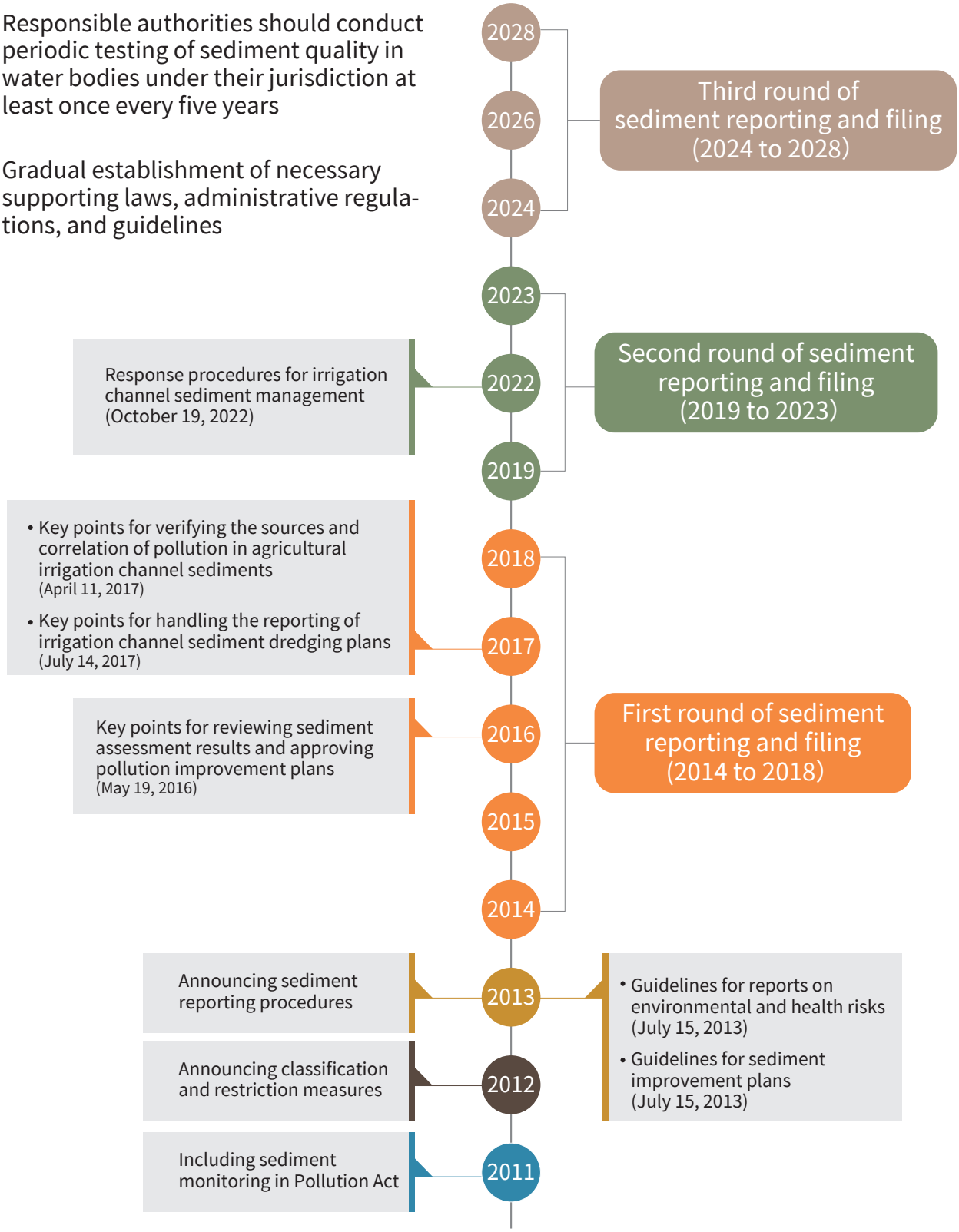


Figure 9: Timeline of Sediment Quality Management Initiative

Table 4: Overview of Sediment Quality Data for Water Bodies

		Rivers	Lakes and Reservoirs	Irrigation Channels (including voluntary reporting)	Total
First Round Reporting (2014-2018)	Number of Reported Water Bodies	83	91	345	519
	Below Lower Limit (Note 1)	10 (12.0%)	18 (19.8%)	144 (41.7%)	172 (33.1%)
	Above Lower Limit but Below Upper Limit (Note 2)	56 (67.5%)	65 (71.4%)	149 (43.2%)	270 (52.0%)
	Above Upper Limit (Note 3)	17 (20.5%)	8 (8.80%)	52 (15.1%)	77 (14.8%)
		Expected Reports			Total
		Rivers	Lakes and Reservoirs	Irrigation Channels	
Second Round Reporting (2019-2023)	Expected Number of Water Bodies	83	93	352	528
	Number of Reported Water Bodies	66	83	352	501
	Below Lower Limit (Note 1)	5 (7.58%)	13 (15.7%)	93 (26.4%)	111 (22.2%)
	Above Lower Limit but Below Upper Limit (Note 2)	37 (56.1%)	58 (69.9%)	189 (53.7%)	283 (56.7%)
	Above Upper Limit (Note 3)	24 (36.4%)	12 (14.5%)	70 (19.9%)	106 (21.2%)

Notes:

1.Sampling points where all sediment quality indicator concentrations are below the lower limit, or where no representative sediment can be sampled, are counted as "sampling points below the lower limit."

2.Sampling points where sediment quality indicator concentrations are below the upper limit but at least one item exceeds the lower limit are counted as "sampling points above the lower limit but below the upper limit."

3.Sampling points where any sediment quality indicator concentration exceeds the upper limit are counted as "sampling points above the upper limit."

4.The sediment quality data in this table includes water bodies with increased monitoring frequency and voluntary reporting.

(4)Businesses

i.Businesses

Since 2004, the Environmental Management Administration (EMA) has implemented five phases of the Chlorinated Plan, three phases of the High-Pollution-Potential Factory Investigation Plan, and the High-Pollution-Potential Business Investigation and Prevention Management Plan. A total of 965 factories with high-pollution-potential processes have been inspected on-site. Based on a systematic screening mechanism, pollution investigations were conducted on 232 factories, and 142 were confirmed to have soil and/or groundwater contamination exceeding regulatory standards. The results have been handed over to local Environmental Protection Bureaus for further regulatory actions.

Since 2022, the EMA has focused on pollution prevention management, adopting a rolling management approach and maintaining data on 144,000 businesses nationwide. By promoting self-prevention management among businesses, the EMA has developed a stratified and grouped management method. Businesses are categorized based on pollution potential factors such as business type, pollution source, and operational characteristics, and grouped into "A. Enhanced Management Group," "B. Self-Management Group," and "C. Inspection Group." Each year, businesses are further classified into groups, and those with soil and groundwater pollution potential undergo on-site inspections, investigations, and preventive management to enhance overall effectiveness and intensity. The principles for the stratified and grouped management of businesses are shown in Figure 10.

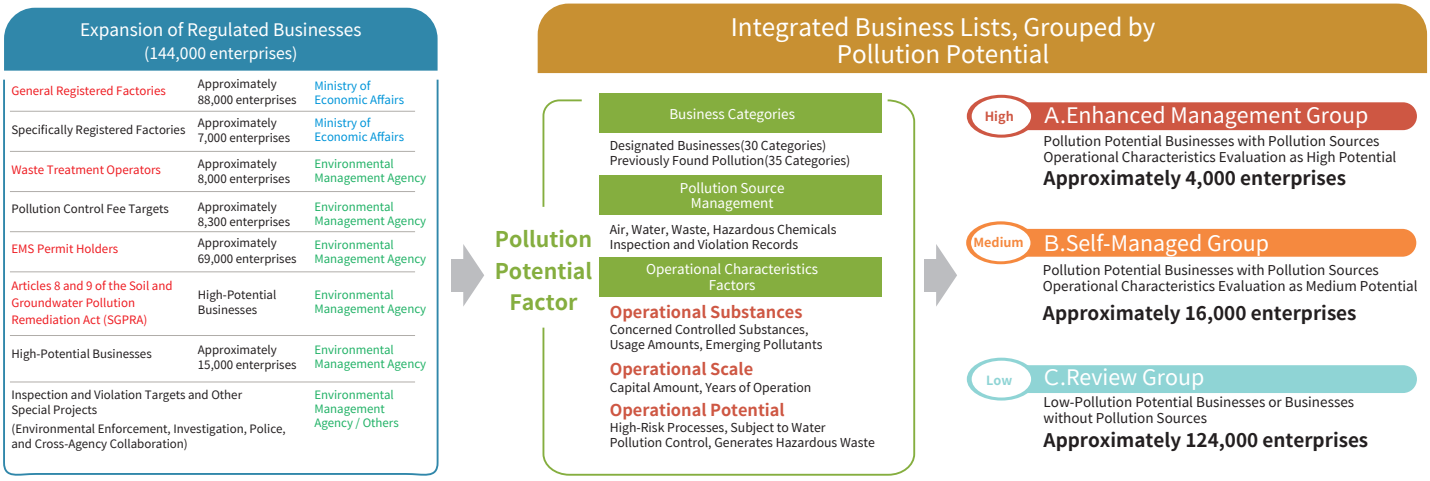


Figure 10: Principles of Stratified and Grouped Management for Businesses

a.Pollution Prevention Management for Business Groups

- Enhanced Management Group (approximately 4,000 businesses):

  This group consists of businesses with high pollution potential and registered pollution sources, with operational characteristics evaluated as high-risk. The local Environmental Protection Bureaus conduct "on-site inspection and prevention management pre-briefings" to explain the "Business Self-Pollution Prevention Management Plan" to the businesses. According to the "Stratified and Grouped Management Process and Inspection Plan," on-site inspections and prevention management activities are carried out to assist businesses in identifying key areas for soil and groundwater pollution prevention and provide substantial prevention or improvement recommendations. For businesses with a pollution potential score of REC $\geq$ 8, on-site investigations and verification work are conducted to strengthen land quality monitoring and pollution early warning and response management.

- Self-Management Group (approximately 16,000 businesses):

  This group consists of businesses with pollution potential and registered pollution sources, with operational characteristics evaluated as medium-risk. The local Environmental Protection Bureaus hold "Self-Prevention Management Briefings" to explain the "Business Self-Pollution Prevention Management Plan" to the businesses. Through the "Stratified and Grouped Management Process and Inspection Plan," businesses are encouraged to enhance their awareness of self-pollution prevention and monitoring, promoting the implementation of self-prevention management operations.

- Inspection Group (approximately 124,000 businesses):

  This group consists of businesses that are not considered to have pollution potential or do not have registered pollution sources. The primary work involves verifying the accuracy of submitted data and, if necessary, conducting on-site inspections to compare with existing records. Additionally, inspection and enforcement records or abnormal incident reports are compiled to provide suggestions for adjusting the grouping list. The Environmental Management Administration (EMA) regularly reviews and updates the management data for these businesses, adopting a rolling review approach.

b. Develop Regulatory Procedures and Business Prevention Management Plans, and Establish a Division of Responsibilities to Strengthen Pollution Prevention Effectiveness

The "Stratified and Grouped Management Process and Inspection Plan" and the "Business Self-Pollution Prevention Management Plan" have been developed to guide the Environmental Protection Bureaus in their supervisory roles and provide businesses with a reference for self-management operations. The Environmental Management Administration (EMA) collaborates with the Environmental Protection Bureaus to conduct

on-site operations, collecting feedback from businesses on management strategies, their willingness to cooperate, and any implementation challenges. This feedback serves as a basis for adjusting management strategies.

c.Inter-agency Integration of Pollution Prevention Strategies for High-Pollution-Potential Businesses to Enhance Pollution Prevention Capabilities

The pollution prevention management work of various responsible agencies, including the Industrial Development Bureau, the Industrial Park Management Bureau, the Energy Bureau, the National Science and Technology Council, the Ministry of Agriculture, and the Economic Development Bureau, has been integrated to establish the "Business Land Pollution Prevention Management Strategy." Under this strategy, a division of responsibilities is defined to promote self-pollution prevention management among businesses. Guidance and regular tracking are also provided to improve the effectiveness of business land pollution prevention efforts.

d.Optimize Systems and Strengthen the Land History System

The functionality of the existing "Business Land Pollution Investigation and Prevention Management System" is continuously maintained and optimized. Through the collaboration between central and local authorities, the system is regularly updated with nationwide business information and pollution potential maps. The land history system is further enhanced to comprehensively document the land use history, facilitating multi-dimensional management across time and space for tracking pollution potential and implementing preventive management for factories.

ii.Industrial Zones

To monitor the soil and groundwater quality in specific areas, Article 6, Paragraph 3 of the Soil and Groundwater Pollution Remediation Act assigns responsibility to the competent authorities of designated areas such as industrial parks and technology industrial parks (formerly export processing zones) to conduct regular monitoring based on the pollution potential within the zone. As of the end of 2023, a total of 215 industrial zones had been designated nationwide. The largest proportion, 94 zones (44%), are privately-operated industrial zones, as shown in Figure 11.

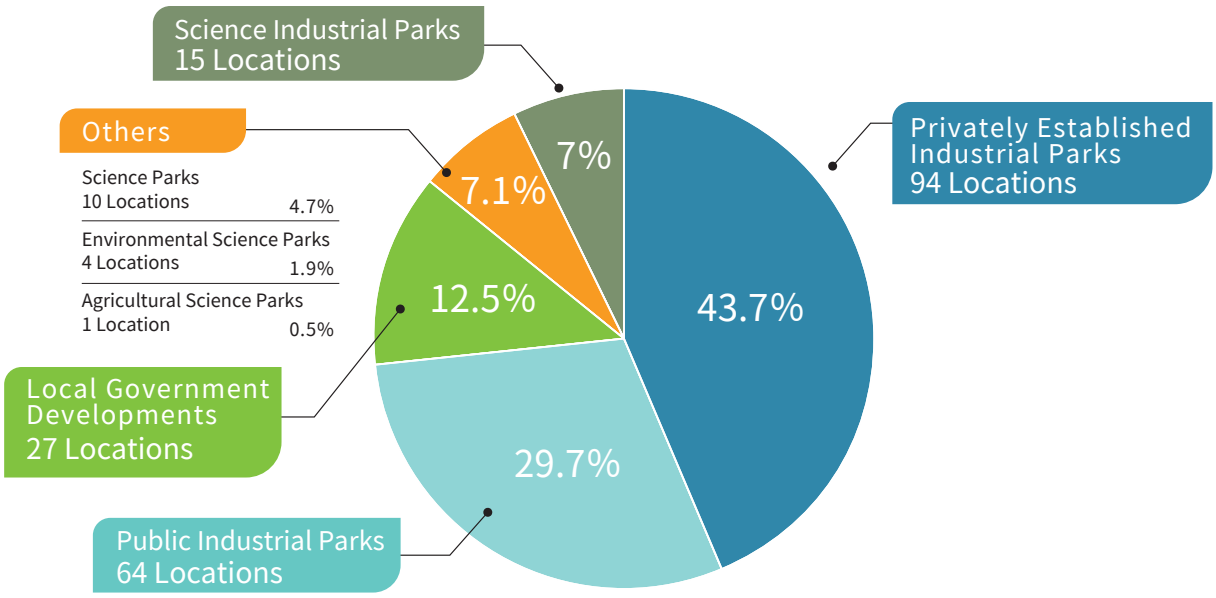


Figure 11: Statistics on the Number of Various Types of Industrial Zones

a. Implementation of Filing Operations within Industrial Zones

As of the end of 2023, the filing rate of reports submitted to local authorities for the 215 designated industrial zones nationwide reached 99.1%. Over the past decade (2014-2023), the filing rate has gradually increased from 80%. The Environmental Management Administration Ministry of Environment (MOENV) will continue to monitor and track the status of report submissions.

b.Implementation of Perimeter Early Warning Monitoring Well Networks

For industrial zones with higher pollution potential, classified as "red" or "orange" zones, pollution investigation, verification, and administrative control work have been prioritized both inside and outside the zones. Additionally, perimeter early warning monitoring well networks have been established in 23 industrial zones. As of the end of 2023, a total of 247 early warning monitoring wells have been installed to protect sensitive receptors outside the zones.

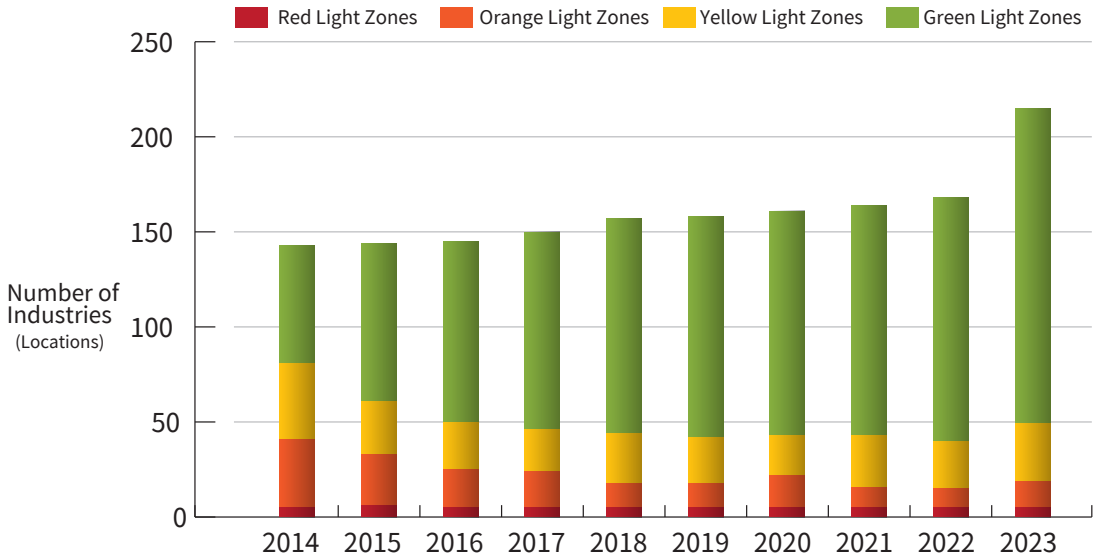
c.Investigation, Control, and Pollution Response Management

As of the end of 2023, based on the combined investigation results of the MOENV and local Environmental Protection Bureaus, along with data submitted by the responsible authorities, 38 industrial zones have shown abnormal soil and groundwater monitoring results. According to the verification results, 91 pollution sites within the industrial zones have been officially announced (including 23 remediation sites, 52 control sites, and 16 sites of Groundwater Pollution Use Restriction Zone). Control and remediation work is currently being carried out in accordance with regulations.

d. Classification by light management system

The nationwide light classification early-warning and management system for designated industrial zones categorizes zones into red, orange, yellow, and green warning levels. Over the past decade (2014-2023), the number of green-zoned industrial zones has increased from 62 to 166, while the number of red, orange, and yellow-zoned industrial zones (indicating pollution) has decreased from 81 to 49. The historical distribution of warning levels for industrial zones across Taiwan is shown in Figure 12. For industrial zones currently classified as red or orange, which have higher pollution potential, the Environmental Protection Bureaus are conducting pollution investigations, while responsible authorities in each industrial

zone are actively enhancing quality management and pollution response efforts, improving the overall management mechanism of industrial zones.



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
	5	6	5	5	5	5	5	5	5	5
	36	27	20	19	13	13	17	11	10	14
	40	28	25	22	26	24	21	27	25	30
	62	83	95	104	113	116	118	121	128	166

Figure 12: Current Distribution and Historical Changes of Warning Levels for Industrial Zones in Taiwan

iii.Storage Systems

According to data from the Environmental Management Administration (EMA), as of the end of 2023, there were a total of 8,397 operational storage systems nationwide. Of these, 3,201 were underground storage tank systems, and 5,196 were aboveground storage tanks and containers, with gasoline and diesel being the primary stored substances (accounting for about 68% of all businesses). The distribution of storage systems across counties and cities is shown in Figure 13. In 2023, a total of 36 storage systems reported anomalies, and the Environmental Protection Bureaus required operators to clarify and resolve the issues. All cases were confirmed to have no pollution.

To regulate aboveground storage systems for gasoline, diesel, and fuel oil, the EMA completed the inclusion of these systems under management in 2022. In 2023, 35 large gasoline and diesel storage tanks began regular monitoring and reporting, and by 2025, an additional 300 small and medium-sized gasoline and diesel storage tanks will be added for monitoring and reporting.

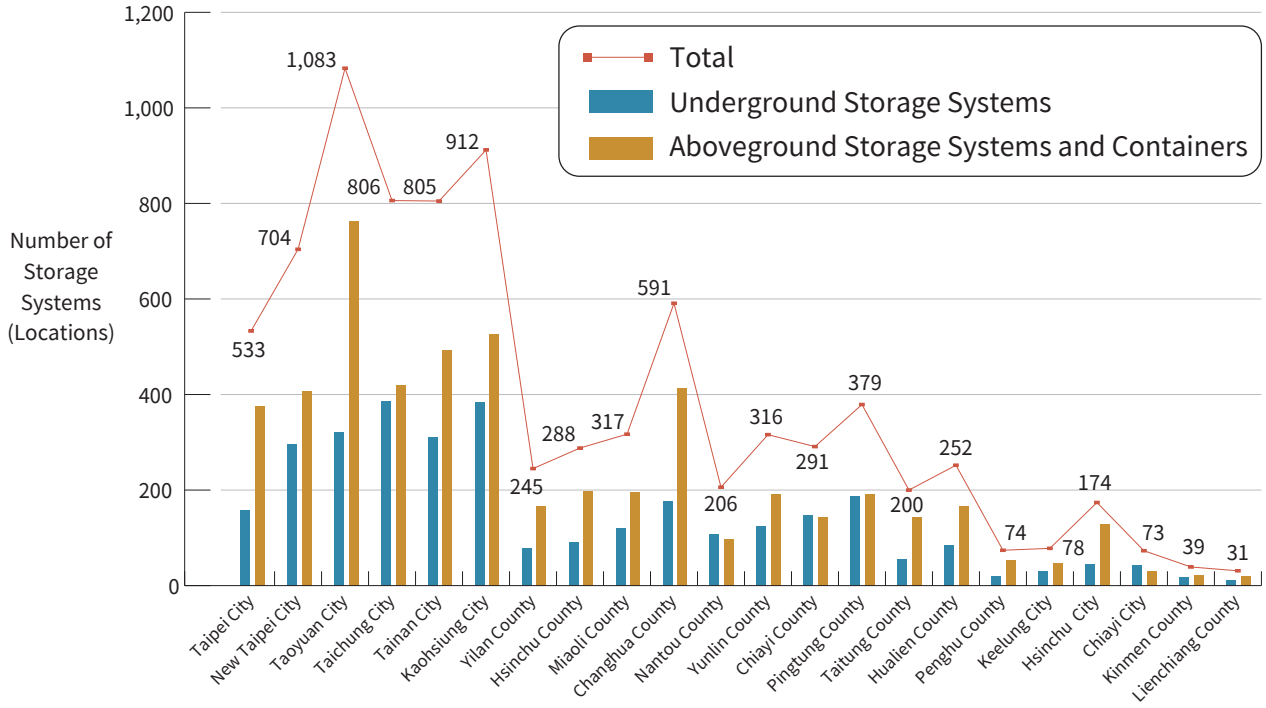


Figure 13: Statistical Distribution of Storage Systems Across Counties and Cities Nationwide

iv.Management of Designated Business Lands

To uphold fairness and justice and ensure the safety of land transactions, the Environmental Management Administration (EMA) established Articles 8 and 9 of the Soil and Groundwater Pollution Remediation Act, which took effect on January 1, 2005. These articles require landowners and designated businesses to provide soil pollution assessment and testing data before land transfers, establishment, modification, or closure of businesses. This ensures the safety and quality of the land being used by businesses. Since 2011, the

EMA has announced several sub-regulations under the authority of Article 9, Paragraph 2 of the Act, such as the "Fee Standards for Review of Soil Pollution Assessment and Testing Data," "Management Regulations for Soil Pollution Assessment and Testing Operations," and "Regulations for the Management of Soil Pollution Assessment Personnel." The timeline for the implementation of Articles 8 and 9 of the Soil and Groundwater Pollution Remediation Act is shown in Figure 14.

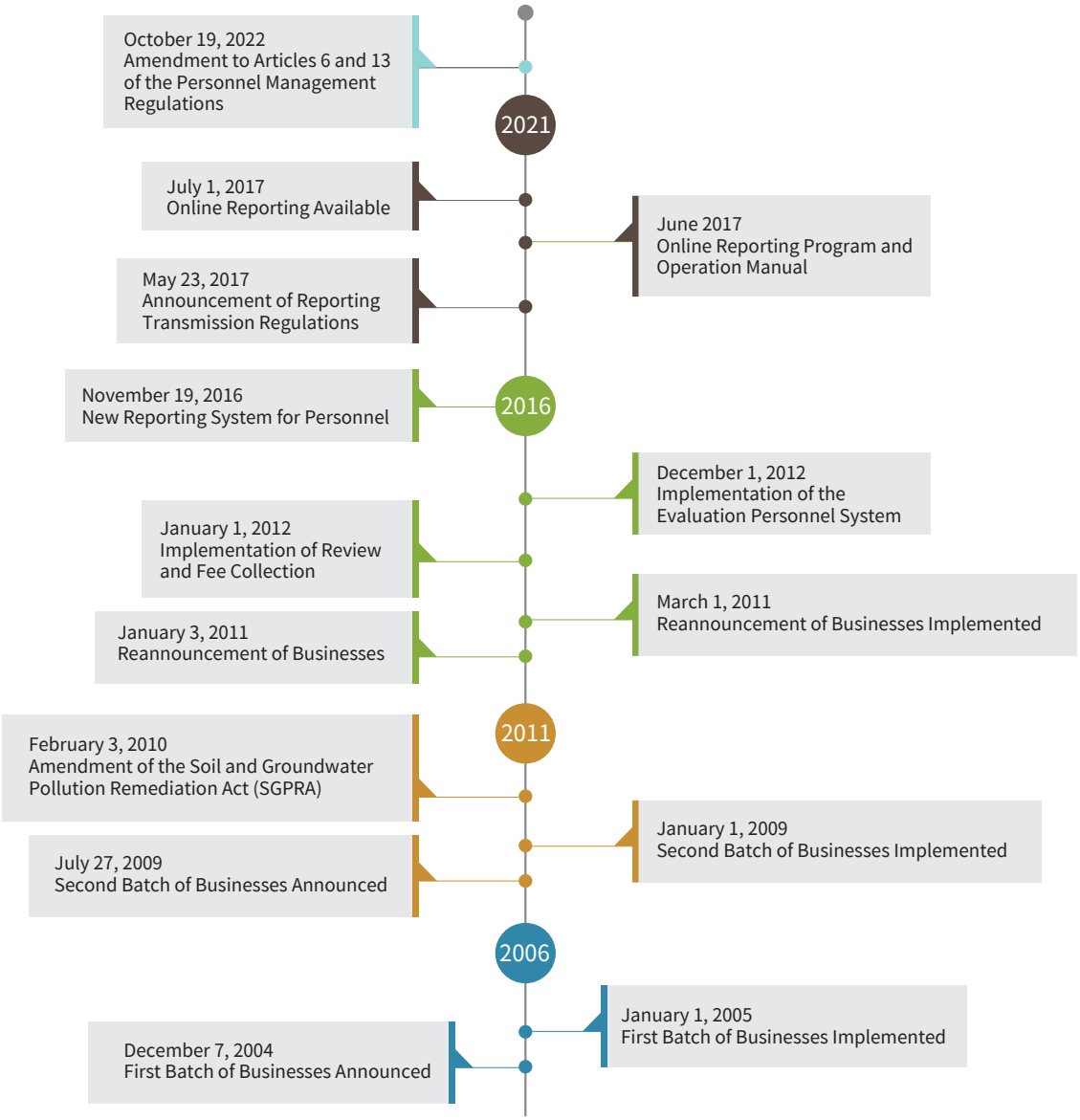
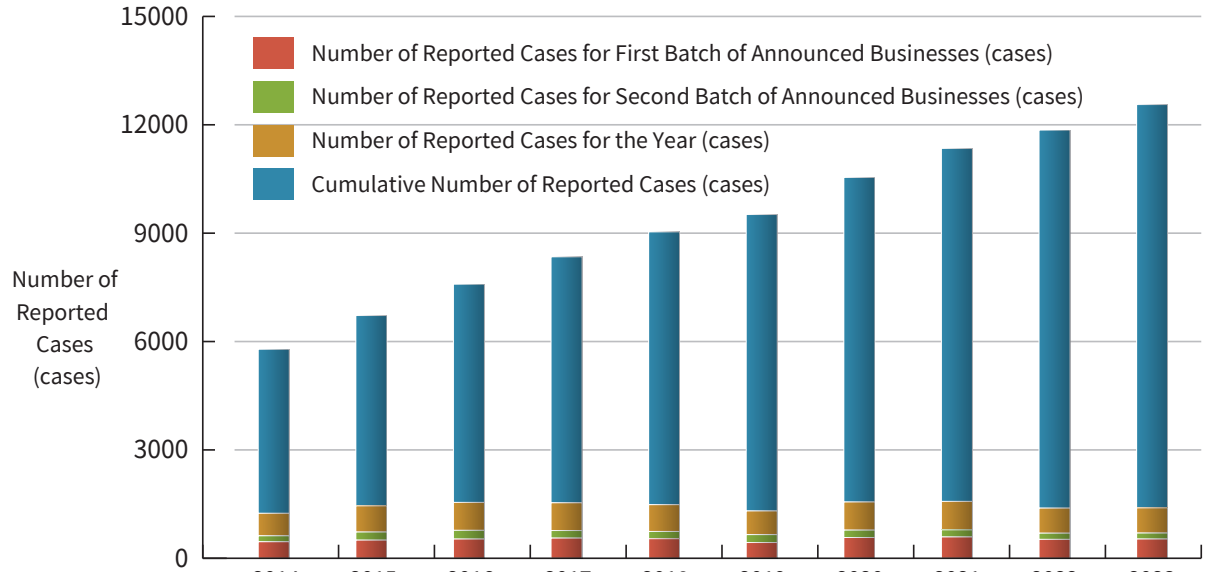


Figure 14: Implementation Timeline for Articles 8 and 9 of the Soil and Groundwater Pollution Remediation Act

Since the implementation of the regulation on January 1, 2005, more than 11,164 cases have been reported, as shown in Figure 15. To ensure that assessment personnel adhere to the regulations for conducting assessments, investigations, and sampling supervision under Articles 8 and 9 of the Soil and Groundwater Pollution Remediation Act, the Environmental Management Administration (EMA) and local Environmental Protection Bureaus have continued to conduct on-site inspections. In 2023, a total of 390 inspections were carried out, representing approximately 56% of the cases reported that year, ensuring the quality of assessment, investigation, and testing operations. To further enhance the review and filing operations of the Environmental Protection Bureaus, the EMA held one workshop and two regulatory briefings in 2023. These events facilitated exchanges of opinions with the Environmental Protection Bureaus, sharing experiences and practices to align operational principles and ensure the quality of implementation, reporting, and review, while protecting the rights of both the public and businesses. Through the regulatory briefings, the public was also informed about the soil pollution assessment and testing system for designated business lands, encouraging greater attention to land quality and safeguarding both land transactions and the rights of all parties.



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of Reported Cases for First Batch of Announced Businesses (cases)	458	502	532	558	542	436	575	590	523	533
Number of Reported Cases for Second Batch of Announced Businesses (cases)	164	224	241	210	200	219	204	197	171	165
Number of Reported Cases for the Year (cases)	622	726	773	768	742	655	779	787	694	698
Cumulative Number of Reported Cases (cases)	4,542	5,268	6,041	6,809	7,551	8,206	8,985	9,772	10,466	11,164

Figure 15: Statistics on Cases Reported Under Articles 8 and 9 of the Soil and Groundwater Pollution Remediation Act

2.National Statistics on Polluted Sites

When the Environmental Management Administration (EMA) and local Environmental Protection Bureaus conduct investigations on soil and groundwater pollution, and the concentration of pollutants is found to meet regulatory standards, the site is subjected to pollution site management procedures. The types of control include sites for Sites with a Limited Correction Period, Soil and Groundwater Pollution Control Site (hereinafter referred to as Control Site), Soil and Groundwater Pollution Remediation Site (hereinafter referred to as Remediation Site), and Groundwater Pollution Use Restriction Zone. The process for determining polluted sites is shown in Figure 16. The EMA monitors the number and area of Contaminated Site to establish and implement more effective site management strategies.

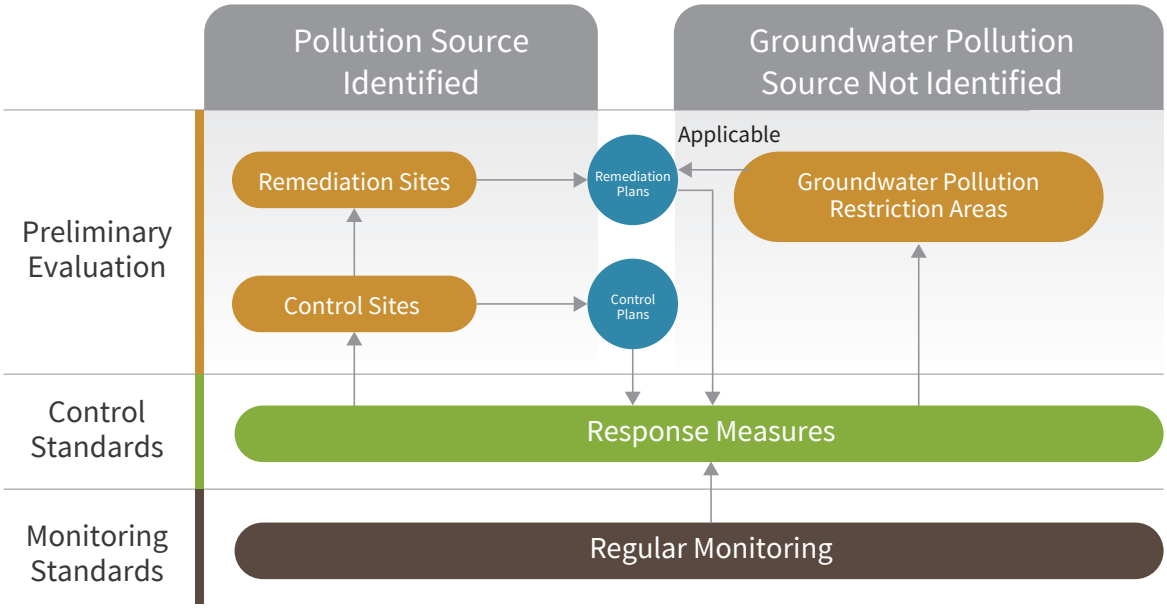
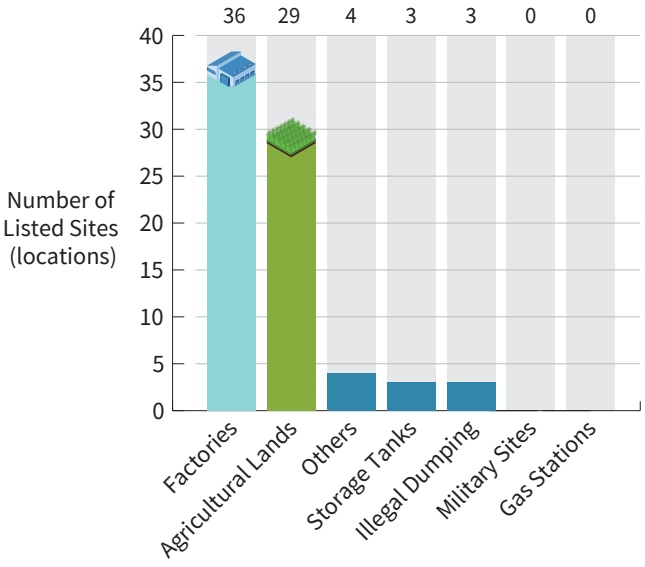


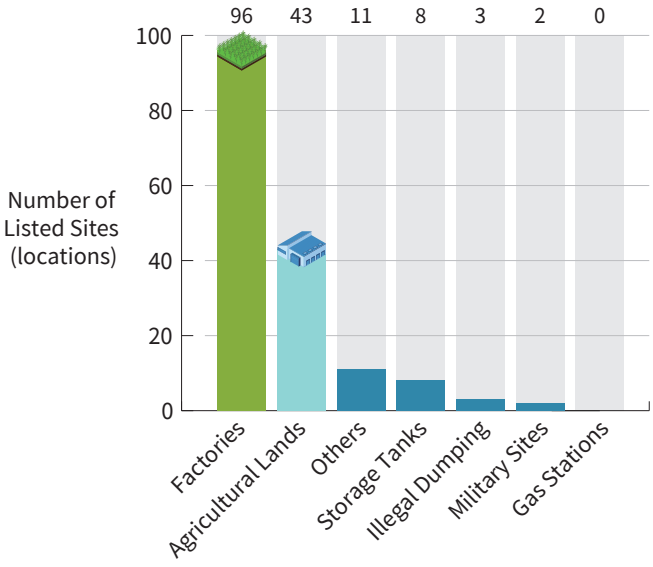
Figure 16: Process for Determining Polluted Sites

In 2023, a total of 75 sites were listed under various categories (including sites for scheduled improvements, control, remediation, and groundwater use restriction areas), with factories accounting for the highest number at 36, followed by agricultural land with 29, other sites with 4, storage tanks and illegal dumping sites with 3 each. The statistics on the number of listed polluted sites by category are shown in Figure 17. In contrast, a total of 163 sites were delisted, with agricultural land accounting for the most at 96, followed by factories with 43, other sites with 11, gas stations with 8, storage tanks with 3, and military bases with 2. The statistics on delisted sites by category are shown in Figure 18. The consolidated information on the number of listed and delisted sites by category in 2023 is shown in Table 5.



Note: Statistical data is as of December 2023, retrieved on January 16, 2024.

Figure 17: Statistics on the Number of Listed Polluted Sites by Category for 2023



Note: Statistical data is as of December 2023, retrieved on January 16, 2024.

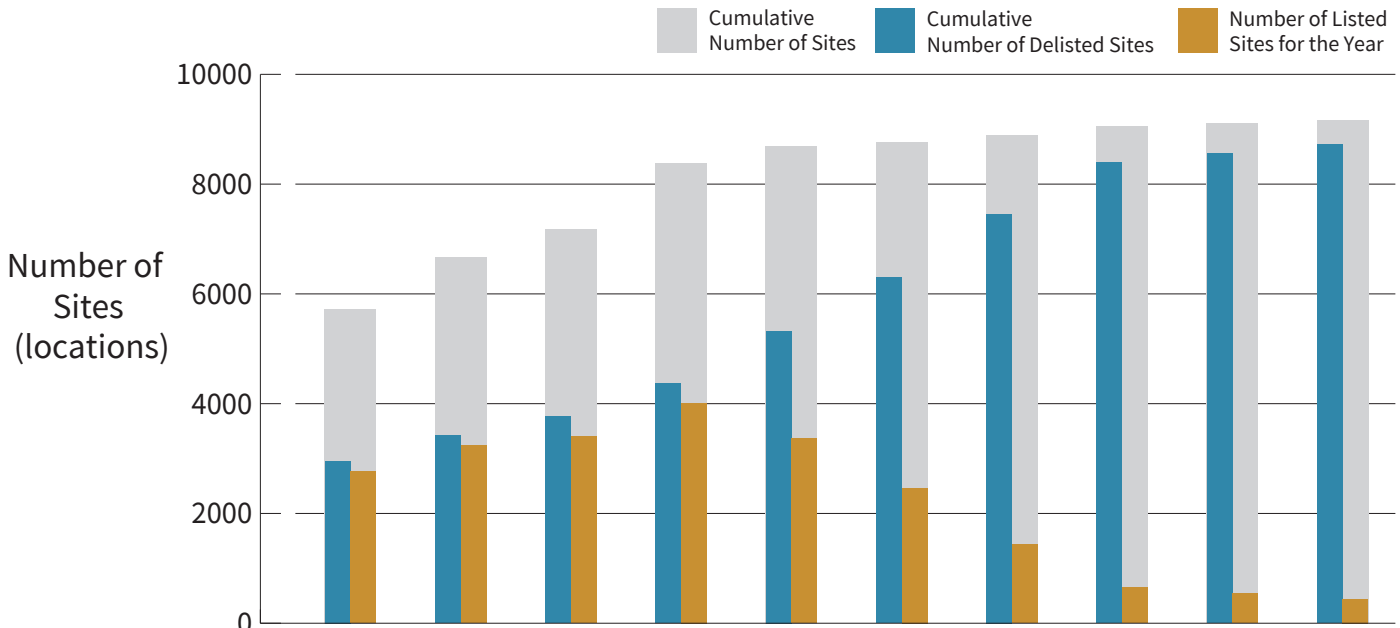
Figure 18: Statistics on the Number of Delisted Polluted Sites by Category for 2023

Table 5: Summary of the Number of Sites by Management Category in 2023

Listed Site Types	Listed Sites		Delisted Sites	
	Quantity (locations)	Area (hectares)	Quantity (locations)	Area (hectares)
Sites for Scheduled Improvements	40	10.35	36	44.68
Control Sites	29	12.20	111	55.34
Remediation Sites	5	32.94	8	5.25
Groundwater Pollution Restriction Areas	1	0.58	8	8.74

(1)Historical Statistical Analysis

A comparison of the site management status over the years shows that by the end of 2023, a total of 9,163 sites had been listed, while a cumulative total of 8,720 sites had been delisted. Summarizing the cumulative number of listed and delisted sites over the years, as well as the number of sites currently listed, the number of sites under management has gradually decreased since 2017. Meanwhile, the cumulative number of delisted sites has increased annually since 2014, although the growth rate slowed in 2021 (with an average of 635 sites delisted per year from 2014 to 2023). The cumulative changes over the years are shown in Figure 19.



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cumulative Number of Sites	5,722	6,660	7,170	8,383	8,692	8,762	8,889	9,050	9,100	9,163
Cumulative Number of Delisted Sites	2,957	3,422	3,769	4,372	5,323	6,301	7,457	8,396	8,556	8,720
Number of Listed Sites for the Year	2,765	3,238	3,401	4,011	3,369	2,461	1,432	654	544	443

Note: Statistical data is as of December 2023, retrieved on January 16, 2024.

Figure 19: Cumulative Changes in Site Management Over the Years

(2)Delisting Results of Remediated Sites

i.A.B.C. Machine Industry Co., Ltd." in New Taipei City

a.Pollution Origin

A.B.C. Machine Industry Co., Ltd. (hereafter referred to as A.B.C. Company) was investigated by the Environmental Protection Administration (EPA) in 2015 under the "High-Pollution Potential Operating Factories Soil and Groundwater Pollution Potential Investigation Demonstration Project." The investigation found that the chromium concentration in the soil reached a maximum of 8,380 mg/kg, exceeding the Soil Pollution Control Standard (250 mg/kg). Following verification by the New Taipei City Environmental Protection Bureau under the "2017 New Taipei City Soil and Groundwater Management and Emergency Response Plan," the maximum concentrations of chromium, copper, and zinc in the soil were 14,300 mg/kg, 4,050 mg/kg, and 2,130 mg/kg, respectively—exceeding the Soil Pollution Control Standards (chromium 250 mg/kg, copper 400 mg/kg, zinc 2,000 mg/kg). Additionally, the maximum concentration of chromium in the groundwater was 8.76 mg/L—35 times the Groundwater Pollution Control Standard (chromium 0.5 mg/L). The EPB publicly designated the site as a Soil and Groundwater Pollution Control Site on October 18, 2017, and the Ministry of Environment announced it as a Soil and Groundwater Remediation Site on June 19, 2018.

b.Remediation Process and Results

(a)The pollution was primarily located on the northern and southern sides of the site. The polluted areas on the northern side were consistent with the temporary plating storage tank in the old electroplating area and the machinery processing area. On the southern side, the polluted areas were near the wastewater collection tank. The source of the pollution was determined to be from the old electroplating process area and the wastewater collection tank.

(b) The remediation work was carried out by the polluter in accordance with the control plan approved by the New Taipei City EPB on November 25, 2020. The soil remediation utilized the ex-situ soil replacement method, and groundwater was treated using in-situ extraction combined with oxidation-reduction processes. The total project duration was 30 months.

(c) To ensure that the pollution source had been fully removed, all existing factory buildings and processing facilities were dismantled, leaving only the guardhouse and part of the office area. This significantly reduces the likelihood of future pollution. Additionally, three standard wells and one simple well were installed around the site to confirm that the remediation efforts did not cause the spread of groundwater pollutants.

(d) The remediation completion report submitted by A.B.C. Company was approved on September 13, 2023. The EPB conducted remediation verification from September 27-28, 2023. The results showed that the concentrations of soil and groundwater pollutants were below the Soil and Groundwater Pollution Control Standards. Consequently, the Ministry of Environment publicly announced the delisting of the site as a Soil and Groundwater Pollution Remediation Site on November 27, 2023, in accordance with Article 26, Paragraph 2 of the Soil and Groundwater Pollution Remediation Act.

ii."CPC Corporation, Taiwan - Exploration and Production Business Division, Tiezhenshan Oil Field" in Miaoli County

a.Origin of Pollution

In February 2019, a pollution incident occurred at CPC Corporation, Taiwan's Exploration and Production Business Division, Tiezhenshan Oil Field (hereafter referred to as the Tiezhenshan Oil Field). The Miaoli County Environmental Protection Bureau (EPB) confirmed that total petroleum hydrocarbons (TPH) and benzene in the soil, as well as TPH, benzene, toluene, dichloromethane, and naphthalene in the groundwater, exceeded pollution control standards. The initial evaluation score (TOL) for the site reached 4,033.62 points. Consequently, the Ministry of Environment announced the site as a Soil and Groundwater pollution Remediation Site on August 30, 2019. CPC Corporation submitted a Pollution Prevention and Emergency Response measures (hereafter referred to as the Emergency Plan) on July 4, 2019, which was approved by the Miaoli County EPB on September 9, 2019. The plan was executed according to the approved content, and a first modification of the Emergency Plan was submitted on August 26, 2020, and approved by the EPB on October 15, 2020. The report on the first modification of the Emergency Plan was submitted and approved in October 2021.

On November 1, 2019, CPC Corporation submitted a Soil and Groundwater Pollution Investigation and Assessment Plan (hereafter referred to as the Assessment Plan), which was approved by the EPB on December 25, 2019. The implementation was carried out as per the approval, and a final report was submitted on September 9, 2020. The EPB approved the report on November 17, 2020, and requested the submission of a remediation plan. CPC Corporation submitted the remediation plan on February 18, 2021, which was approved by the EPB on June 29, 2021, with the execution period ending on December 31, 2022.

b.Remediation Process and Results

(a)The main pollutant at the site was condensate oil (light oil), and the geological conditions mainly consisted of gravel layers. The remediation unit employed appropriate remediation technologies, including biopile treatment, soil vapor extraction (SVE), dual-phase extraction (DPE), air sparging (AS), and biosparging (BS).

(b)The pollution leakage point was located near a valve box next to the small oil-water separation (API) tank on-site. The pollution extended to a depth of about 2 meters underground and was found in clay soil, which easily adsorbed TPH, creating a persistent pollution source. The contaminated soil in the leak source area was fully removed using the ex-situ soil replacement method. The contaminated soil was then transported to a newly established bioremediation facility, equipped with SVE air extraction devices at the bottom for aeration, where the soil was regularly turned, watered, monitored, and supplemented with nutrients to confirm the bioremediation effectiveness.

(c)Considering the hilly terrain and the characteristics of the light oil pollutant, in-situ remediation methods were adopted to minimize disturbance to the site. These methods included the installation of dual-phase extraction wells, soil vapor extraction wells, and air sparging wells to physically remove the contaminated groundwater and soil vapor from the leak source. Additionally, the injection of oxygen into the groundwater accelerated the microbial degradation of the pollutants.

(d)The remediation completion report for Tiezhenshan Oil Field was submitted in October 2022. The sampling results from the soil and groundwater at the site, verified by the EPB, showed that pollutant concentrations were below the Soil and Groundwater Pollution Control Standards. Consequently, the Ministry of Environment publicly

announced the delisting of the site as a remediation site on October 6, 2023, in accordance with Article 26, Paragraph 2 of the Soil and Groundwater Pollution Remediation Act.

iii."KHS Musical Instrument Co., Ltd. Guoling No. 1 Plant" in Taoyuan City

a.Origin of Pollution

The site of KHS Musical Instrument Co., Ltd. Guoling No. 1 Plant (hereafter referred to as KHS) was investigated in 2010 as part of the Soil and Groundwater Chlorinated Organic Solvent Pollution Investigation and Verification Project (Phase II). The investigation revealed that the concentrations of trichloroethylene (TCE) and cis-1,2-dichloroethylene in the groundwater exceeded the Class 2 Groundwater Pollution Control Standards. On May 12, 2011, the Taoyuan City Government issued an official letter (府環水字第 1000701420 號), announcing KHS as a groundwater pollution control site and designating it as a groundwater pollution control area. Subsequently, on December 14, 2011, the Ministry of Environment announced KHS as a groundwater pollution remediation site (環署土字第 1000109914 號).

b.Remediation Process and Results

(a)Historically, trichloroethylene was used for cleaning purposes, and the potential pollution source was likely the result of leakage from improper handling of waste liquid filtering, distillation, and reuse operations in the trichloroethylene storage area. Once trichloroethylene pollution was discovered, the suspected pollution source operations were immediately halted, and the waste storage area was relocated.

(b)The remediation work was divided into two phases. In the first phase (pilot test), nutrients were added to stimulate microbial metabolism, accelerating the removal of pollutants. The effectiveness of microbial degradation was confirmed, and based on the experimental data, adjustments were made for the full-scale remediation plan. In the second phase, a concentrated injection method was applied in high-

pollution areas to reduce pollutant concentrations using emulsified zero-valent iron (EZVI), complemented by continuous injections of EOS (a bioremediation solution) to enhance the degradation efficiency of EZVI.

(c) Verification sampling was conducted on May 26, June 14, and July 13, 2023. The results showed that all pollutants were below the groundwater pollution control and monitoring standards. Therefore, on October 6, 2023, the Ministry of Environment announced the delisting of KHS Musical Instrument Co., Ltd. Guoling No. 1 Plant as a groundwater pollution remediation site (環部管字第 1127113500 號).

iv."Rising Glory Technology Co., Ltd. No. 2 Plant" in Taoyuan City

a.Origin of Pollution

Rising Glory Technology Co., Ltd. (hereafter referred to as Rising Glory) is an operational metal product manufacturing factory. The main processes include degreasing metal parts with dichloromethane (now discontinued), cleaning with hydrochloric acid, followed by electroplating. In 2017, the Ministry of Environment conducted the "Investigation and Control Project of Pollution Sources in High-Pollution Potential Industrial Zones (Phase V)" to assess soil and groundwater contamination at the site. The results revealed that the concentration of dichloromethane in the groundwater near the wastewater discharge outlet exceeded the Class 2 Groundwater Pollution Control Standards. The Taoyuan City Government declared the site a pollution control area in accordance with the Soil and Groundwater Pollution Remediation Act. Subsequently, on September 25, 2018, the Ministry of Environment designated Rising Glory as a groundwater pollution remediation site (環署土字第 1070076993 號).

b.Remediation Process and Results

(a)Rising Glory employed a "Pollution Treatment Technology Screening Matrix" to conduct a preliminary screening for remediation technologies

suitable for chlorinated solvent contamination. The technology selection was based on the site's operational characteristics, groundwater contamination conditions, and hydrogeological factors to identify the most appropriate remediation methods.

(b) From November 2018 to the present, four rounds of onsite monitoring and two rounds of offsite monitoring have been conducted. The long-term monitoring results indicated that dichloromethane concentrations had been below the Class 2 Groundwater Pollution Monitoring Standards since December 2019, with no signs of rebound. Based on the feasibility assessment of natural attenuation at the site, monitored natural attenuation (MNA) was determined to be the most suitable remediation approach. The MNA method involved Regular monitoring to track fluctuations in dichloromethane levels in the groundwater and ensure that the pollutant concentration met remediation goals.

(c) On April 25, 2023, Rising Glory conducted verification sampling, and the results confirmed that all pollutants were below the groundwater pollution control and monitoring standards. Therefore, on June 26, 2023, the Ministry of Environment issued an official announcement (環署土字第 1121073315 號) to delist Rising Glory Technology Co., Ltd. No. 2 Plant as a groundwater pollution remediation site.

v."Ching Luen Chan Industrial Co., Ltd." in Changhua County

a.Origin of Pollution

Ching Luen Chan Industrial Co., Ltd. (hereafter referred to as Ching Luen Chan) began operations in 1980, engaging in metal surface treatment, specifically electroplating metal hardware components. The facility has since ceased operations. During its operational period, soil pollution likely resulted from leakage of electroplating tanks and raw materials, with inadequate pollution containment. On April 17, 2013, the Ministry

of Environment carried out sampling as part of the "2011-2012 Soil and Groundwater Pollution Incident Response Investigation, Verification, and Technical Support Project." The analysis revealed that nickel and chromium levels in the soil exceeded the soil pollution control standards. Consequently, on January 5, 2016, the Ministry of Environment officially designated the site as a soil pollution remediation site.

b.Remediation Process and Results

(a)On April 19, 2019, the Changhua County Environmental Protection Bureau approved Ching Luen Chan's soil remediation plan. After completing the remediation work and self-verification, Ching Luen Chan submitted the remediation completion report on October 14, 2021. The primary remediation technologies used were excavation and tilling methods. However, during a verification inspection on November 8, 2021, the bureau found that chromium and nickel concentrations in the soil still exceeded the soil pollution control standards.

(b)On February 11, 2022, Ching Luen Chan submitted a first amendment to the soil remediation plan, which was approved by the Changhua County Environmental Protection Bureau on October 13, 2022. After completing the remediation work and self-verification, Ching Luen Chan submitted the amended remediation completion report on January 13, 2023. The primary remediation technique used in this phase was soil inversion and dilution.

(c)On April 14, 2023, the Changhua County Environmental Protection Bureau conducted a verification inspection of the completed soil remediation. The results showed that chromium concentrations in the soil were within the soil pollution control standards. Subsequently, the Ministry of Environment announced the delisting of the remediation site on June 7, 2023.

vi."Formosa Oil (Asia Pacific) Corporation Hu-Kou Northbound Gas Station" in Hsinchu County

a.Origin of Pollution

The Environmental Protection Administration (EPA) conducted an investigation in 2014 under the "Underground Storage System Network Declaration Data Verification, Consultation, and Cross-Checking Project." The results revealed that benzene and total petroleum hydrocarbons (TPH) in the soil at the Formosa Oil (Asia Pacific) Corporation Hu-Kou Northbound Gas Station exceeded soil pollution control standards. Additionally, benzene, TPH, and methyl tert-butyl ether (MTBE) in the groundwater exceeded groundwater pollution control standards. Consequently, on April 14, 2015, the Hsinchu County Environmental Protection Bureau officially designated the site as a soil and groundwater pollution control site and demarcated the area as a soil and groundwater pollution control area. Following a preliminary evaluation and review, the Ministry of Environment announced on November 9, 2015, that the site was designated as a soil and groundwater pollution remediation site.

b.Remediation Process and Results

(a)On January 26, 2018, the Hsinchu County Environmental Protection Bureau approved the "Soil and Groundwater Pollution Remediation Plan," and Formosa Oil (Asia Pacific) Corporation proceeded with the remediation work based on the approved plan. The original plan's execution period was set for 18 months.

(b)During the remediation process, new pollution evidence was discovered, leading to the submission of a first amendment to the remediation plan, which was approved by the Environmental Protection Bureau on December 11, 2019, with an execution period of 10 months. Following the first verification, a few points at the site still did not meet the improvement targets, prompting a second amendment. This was

approved on January 13, 2022, with an execution period of 6 months.

(c) On July 12, 2022, Formosa Oil (Asia Pacific) Corporation submitted the remediation completion report for the second amended plan to the Hsinchu County Environmental Protection Bureau for review and verification. The verification results indicated that both soil and groundwater testing items were below the Soil and Groundwater Pollution Control Standards. Consequently, on April 14, 2023, the Ministry of Environment officially delisted the site as a remediation site.

vii."Mech-President Corporation Fengshan No. 2 Gas Station" in Kaohsiung

a.Pollution Origin

The Fengshan No. 2 Gas Station of Mech-President Corporation (hereafter referred to as Fengshan No. 2 Gas Station) was established in October 2000. Initially operated by Hongqi Construction Co., Ltd. (hereafter referred to as Hongqi Company), it was leased to Mech-President Corporation in September 2005 and operated by them until May 2012. Since August 2012, Hongqi Company has resumed operations. The current fuel products in use include 92 Unleaded Gasoline, 95 Unleaded Gasoline, and Super Diesel. The Environmental Protection Administration (EPA) conducted soil and groundwater pollution verification under the "Gas Station Soil and Groundwater Pollution Investigation Project (Phase IV) (Group B)" in March and October 2008. The test results indicated that Total Petroleum Hydrocarbons (TPH) in the soil exceeded the Soil Pollution Control Standard, and benzene, toluene, and naphthalene in groundwater exceeded the Second Class Groundwater Pollution Control Standard (0.05 mg/L). The former Kaohsiung County Government designated the site as a Soil and Groundwater Pollution Control Site on January 19, 2009.

The former Kaohsiung County Government conducted a preliminary assessment under the "Preliminary Evaluation Measures for Soil and Groundwater Pollution Control Sites" (hereafter referred to as the Preliminary Evaluation Measures). The results showed that the P-value total score was 74 points, exceeding 20 points, thereby meeting the criteria stipulated in Article 2, Paragraph 1, Subparagraphs 1 and 2 of the Preliminary Evaluation Measures. Based on this, the Ministry of Environment designated the site as a Soil and Groundwater Pollution Remediation Site. on April 20, 2009.

b.Remediation Process and Results

(a)Mech-President Corporation conducted supplemental investigations from June 2009 to April 2010. The results showed that Benzene, Toluene, Ethylbenzene, and Xylene (BTEX) and TPH in the soil were below control standards, but groundwater samples near the underground storage tank (UST) showed benzene exceeding the control standards on the northern side, while benzene, toluene, naphthalene, and TPHd exceeded the control standards on the southern side. The investigation and remediation plans were filed in June 2010 and approved in August 2011. The remediation work, originally planned for 25 months until September 2013, included Pump and Treat (P&T), Soil Vapor Extraction (SVE), In Situ Chemical Oxidation (ISCO), and Biosparging. Due to the discovery of new contamination, the addition of soil excavation, and changes to subcontractors, four amendment plans were submitted. Kaohsiung City Environmental Protection Bureau (EPB) approved the fourth amendment on September 10, 2021, extending the remediation period to September 2023.

(b) Mech-President Corporation submitted a final report in February 2022, but the Kaohsiung City EPB held a review meeting in April 2022, deciding that "the groundwater parameters remain unstable, and residual oxidant was detected. Please conduct another groundwater validation after the water quality stabilizes and include the results in the revised version of the report." Following a second groundwater validation, Mech-President Corporation submitted a revised report in July 2022, which was approved by the Kaohsiung City EPB in August 2022.

(c) Kaohsiung City EPB conducted soil and groundwater verification from September to November 2022. The results indicated that the concentration of pollutants in both soil and groundwater were below the Soil and Groundwater Pollution Control Standards. The Ministry of Environment officially lifted the pollution remediation designation for the site on January 4, 2023.

3.Management of Off-Site Contaminated Soil Treatment

Due to the rapid increase in the number of contaminated sites in Taiwan and the stricter control measures and penalties following amendments to the Soil and Groundwater Pollution Remediation Act (SGPRA), the demand for off-site treatment of contaminated soil has steadily risen. This is particularly relevant for sites where on-site remediation is not feasible due to limitations such as site size, remediation timeline, available technology, or budget constraints. In 2014, a decision was made to integrate the reporting and management of off-site soil treatment into the waste management framework under the Waste Disposal Act. By utilizing the well-established mechanisms for transporting and treating industrial waste, this management framework effectively regulates the handling of off-site contaminated soil and ensures the proper conduct of treatment operations. Continuous revisions to related regulations have been implemented to support and improve the process.

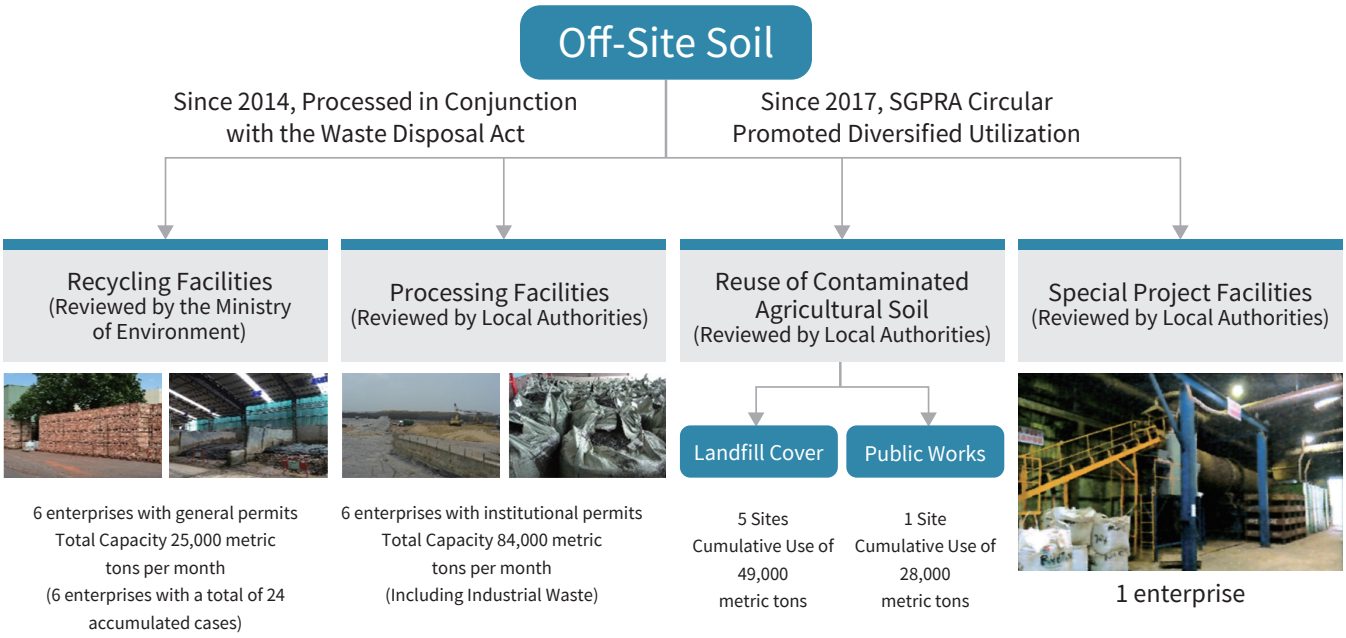
(1)Off-site treatment of contaminated soil regulated under industrial waste management practices

To effectively manage the handling and flow of off-site contaminated soil, a treatment plan must be submitted for review and approval before the soil can be removed from the site. During transportation, online manifests are required, and vehicles must be equipped with real-time tracking systems, including GPS capabilities, driving record functions, and communication systems. The soil must be transported to licensed and approved treatment or recycling facilities for proper handling.

(2)Expanding recycling channels for off-site contaminated soil and establishing guidelines for permit reviews

By the end of 2023, there were 12 approved facilities for off-site soil treatment and recycling, identified with the S-code designation. These include 6 recycling facilities and 6 treatment facilities, with a total monthly capacity of 109,000 metric tons. Additionally, under the SGPRA, five landfill sites (including the Ministry of Economic Affairs' Central Region Industrial Waste Treatment Center and four public landfills in Taoyuan City) have accepted contaminated agricultural soil for use as landfill cover, with a cumulative total of approximately 49,000 metric tons. One public works project in Changhua County has reused contaminated agricultural soil for engineering purposes, with a cumulative total of approximately 28,000 metric tons. There is also one off-site soil project facility in Taoyuan City, as illustrated in Figure 20.

Furthermore, a comprehensive guideline has been established to ensure consistency in the review of permits for contaminated soil treatment and recycling. This handbook serves to standardize the review process, ensuring fairness and adherence to high regulatory standards.



Note: Data as of December 2023.

Figure 20: Implementation Status of Off-Site Management Framework

4.Site Risk Management

Continuing the past risk assessment systems and concepts, the Environmental Management Administration (EMA) has formulated site conditions and practices suitable for risk management measures based on previous results. By conducting on-site interviews and providing guidance, the EMA has deeply implemented risk management for contaminated sites. Additionally, the EMA assists local authorities in reviewing risk assessments for contaminated sites and ensures the transparency of this information by making it available on online platforms.

(1)Promoting and Implementing Risk Management at Contaminated Sites

To accelerate the promotion and implementation of risk assessment concepts in the management of contaminated sites, the EMA has established a guidance team composed of experts and scholars. The team identified sites eligible for risk management measures, focusing on controlled sites, remediated sites, or groundwater use-restricted areas. As of September 30, 2022, a total of 415 sites had been selected. The selection process involved evaluating land ownership, pollution responsibility, sensitive areas, and sites already undergoing remediation goals. The selection workflow for the guidance site

list is shown in Figure 21. Among the 44 selected sites, further classifications were made based on the clarity of polluter responsibility, whether remediation had been conducted, and the type of landowner, resulting in three groups: priority, recommended, and maintained improvement groups. To expedite the remediation of contaminated sites and encourage responsible parties to actively engage in remediation efforts, the EMA continues to promote long-term risk management of contaminated sites. In 2023, three sites successfully applied risk management measures alongside traditional remediation methods, effectively controlling the pollution and preventing further spread.

Figure 21: Workflow for Selecting the Guidance Site List

(2)Assisting in the Review of Risk Assessments for Contaminated Sites and Ensuring Transparency

The "Taiwan Metal Mining Co., Ltd. and its Associated Three Exhaust Duct Areas (Partially)" soil and groundwater contamination Pollution Remediation Site submitted an application for zonal land revitalization and alternative remediation targets, in accordance with the "Principles for Zonal Remediation and Land Use of Contaminated Sites." On September 14, 2023, the EMA approved

the remediation target values for the site. The land-use planning for the Taiwan Metal Pollution Remediation Site is illustrated in Figure 22.

Similarly, the "Former Liyue Copper Refinery" soil Pollution Remediation Site applied for alternative remediation target values based on a risk assessment, meeting the criteria under Article 24, Paragraph 2 of the Soil and Groundwater Pollution Remediation Act. The EMA approved the remediation target values on August 26, 2022, and will continue to oversee the site's supervisory management tasks as required. To enhance the transparency of risk assessment operations and decision-making, the EMA has built and publicly disclosed the relevant information for the "Former Liyue Copper Refinery" soil remediation site through the "Soil and Groundwater Risk Analysis Information System." This allows the public to clearly understand the risk assessment process and data used, as shown in Figure 23.

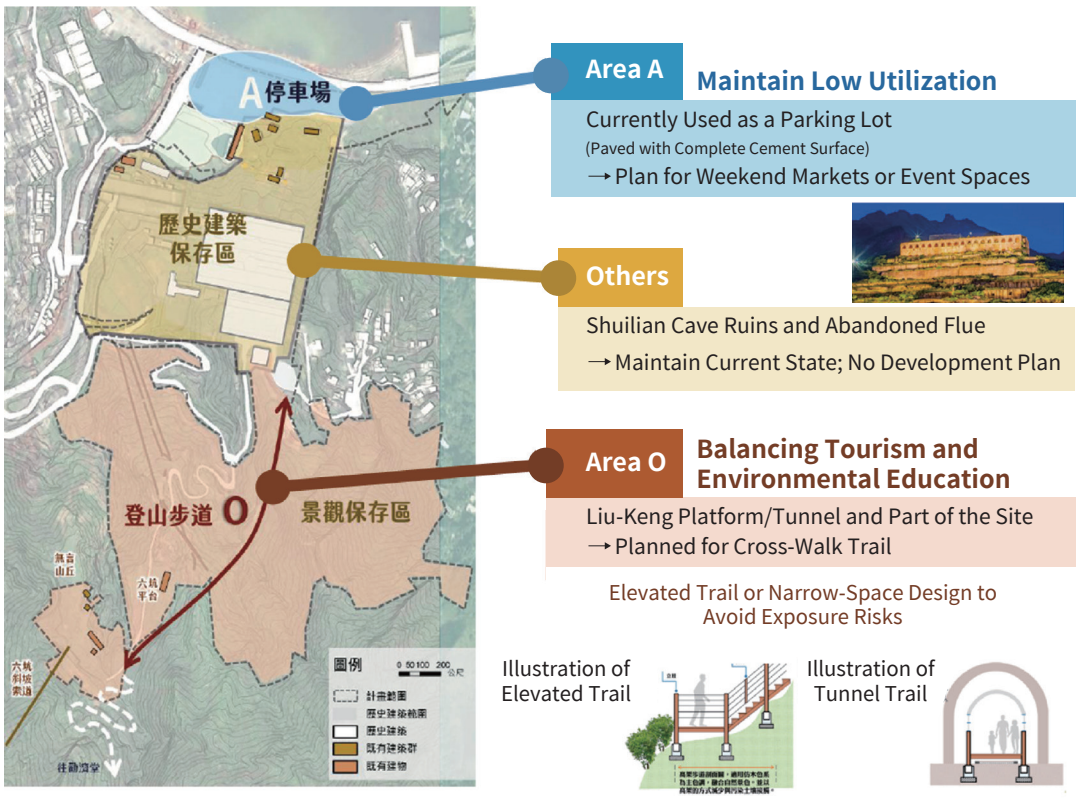


Figure 22. Land-Use Planning for the Taiwan Metal Pollution Remediation Site

Figure 23: Illustration of Information Disclosure in the Risk Analysis Information System

5.Management System for the Reuse of Contaminated Land

In response to the practical conditions at certain sites in Taiwan, where large-scale remediation efforts and extensive regulatory controls have rendered land unusable for long periods, the Environmental Management Administration (EMA) has planned a system for zonal remediation and utilization. The goal is to balance environmental protection with local development. This section outlines the current system and progress in promoting land reuse.

(1)Prioritizing the Promotion of National (Public) Contaminated Sites

Taiwan, being densely populated, faces high demand for land use. Contaminated land often loses its utility and value due to the extensive costs and time required for remediation, which may discourage responsible parties from conducting necessary clean-ups, leaving the land abandoned and increasing environmental risks. Therefore, the goal of sustainably reusing soil and groundwater resources while regenerating the value of contaminated land is crucial for Taiwan's urban development. Based on brownfield redevelopment

strategies from advanced nations, the Environmental Protection Administration (EPA) published the "Guidelines for Zonal Remediation and Land Use of Contaminated Sites" on May 25, 2021, and developed a phased strategy for implementation. In the short term, the central government will lead by establishing demonstration cases. In the medium term, local governments will be encouraged to seek cooperation with central authorities, and in the long term, commercial public-private partnerships will be promoted to expedite the remediation of contaminated sites.

Since 2022, the EMA has focused on national and public contaminated sites, engaging in discussions with land management units to find solutions. Of the 83 national and public sites currently under regulatory control, 50 are undergoing remediation, and 33 require accelerated improvement. After excluding 11 operational factories, roads, and sites with designated uses, 22 sites were prioritized for remediation and reuse feasibility studies (Figure 24). The analysis covered the feasibility of revitalizing contaminated land or adopting risk control measures. Below are the key outcomes of this initiative.

i.11 Demonstration Cases Have Been Successfully Promoted:

a. Based on the consensus of unified government efforts and professional division of labor, the policy for the "Nantou County Dagang Section Pollution Control Site" was established as a demonstration case. A cross-departmental cooperation model was built, organizing a project team to jointly promote pollution remediation and land reuse. Initial remediation was funded by the Soil and Groundwater Pollution Remediation Fund (SGPRF), with future plans for constructing public environmental facilities on the land. The future revenue from the land will be returned to the SGPRF, achieving sustainable use of soil and groundwater resources, regenerating land value, and meeting both environmental and local development goals.

b.In 2023, funds were allocated for investigation and evaluation to assist the Water Resources Agency's Third River Management Office in assessing contamination at 10 sites in the Jincheng Section of Houli District, Taichung. After coordination meetings, the Third River Management Office submitted a pollution control plan, which was approved by the Taichung Environmental Protection Bureau on November 15, 2023, and the pollution remediation work is now underway.

ii.Ongoing Efforts to Promote 11 Sites:

a.In 2023, the EMA allocated funds for investigation and assessment related to five contaminated sites, including the Dawanwan Section of Jiayizi Pit in Linkou District, New Taipei City; Plot No. 1340 (partially) in Jiuqing Section, Jiuru Township, Pingtung County; Ronghua Section and Xinghua Section in Changzhi Township, Pingtung County; and Jia'an Section in Houbi District, Tainan City. The contamination volume has been confirmed, and in 2024, the EPA will continue to convene meetings with local Environmental Protection Bureaus to discuss subsequent remediation and cooperation plans.

b.The remaining six sites, limited by factors such as being designated as water conservation areas, are currently under review to determine whether remediation, risk management, or ecological restoration through vegetation would be the most appropriate approach. Discussions with land managers on the direction of future efforts are ongoing.

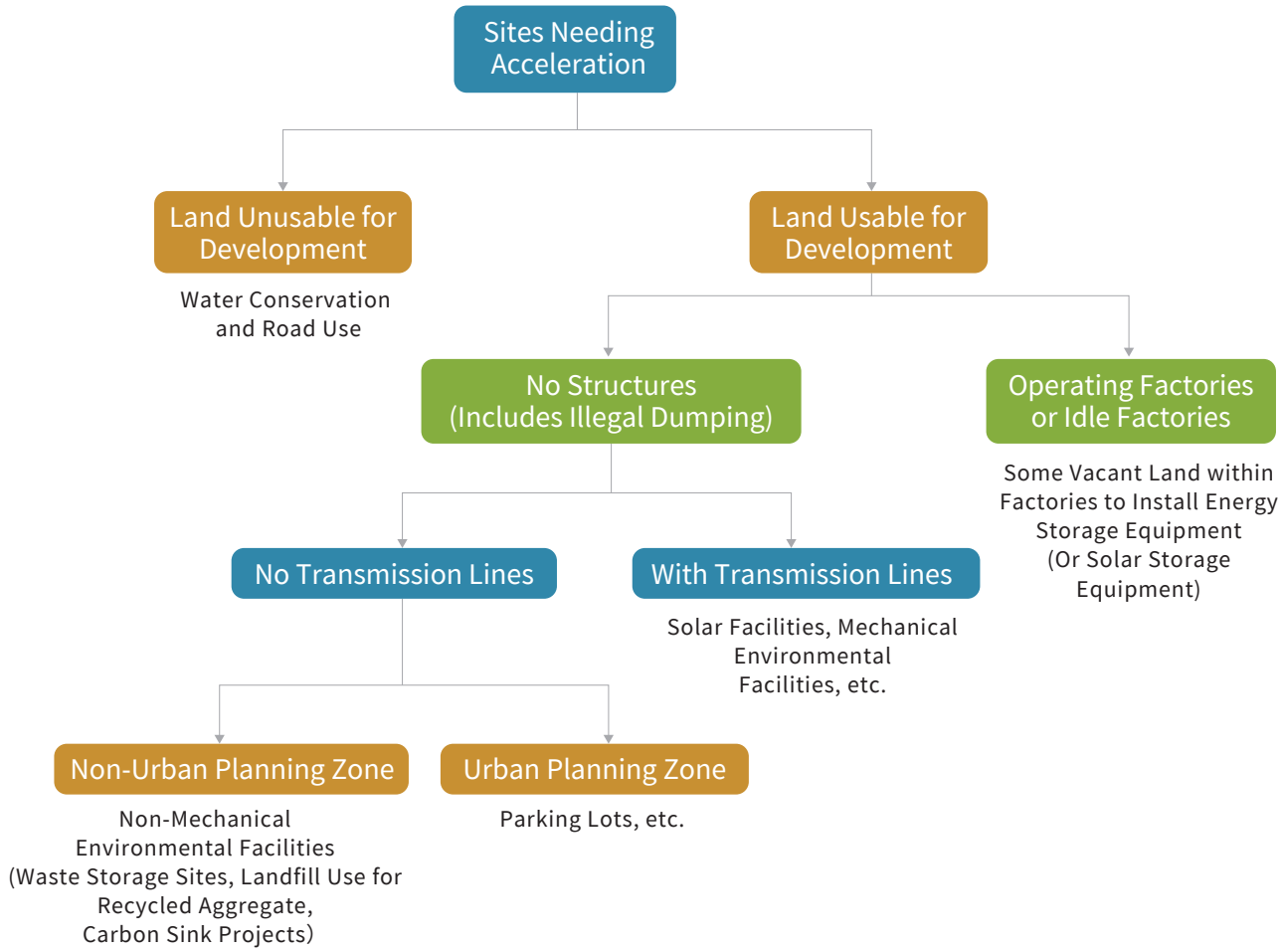


Figure 24: Feasibility Assessment Directions for Revitalization of Contaminated Land

(2)Results of Demonstration Projects for National and Publicly Owned Contaminated Sites

In promoting the demonstration project for the “Nantou County Dagang Section Pollution Control Site,” six meetings for discussion and on-site inspections were held in 2023, jointly advancing the remediation work. A supplemental investigation was completed, and with the use of relevant rapid screening tools, high-concentration contaminated soil was treated off-site, while low-concentration contaminated soil was remediated using an on-site pile-turning and aeration method. This saved approximately NT$40 million in remediation costs and shortened the remediation period by more than two

years. The Nantou County Environmental Protection Bureau (EPB) will conduct verification work in 2024, after which the site will be deregulated. The on-site remediation process is shown in Figure 25.

On November 16, 2023, the Nantou County EPB commissioned the "Preliminary Work Plan for the Nantou County Organic Waste Resource Center BOT Project." This project will assist in planning the promotion of the Organic Waste Resource Center through a public-private partnership (PPP) model. The plan will include feasibility assessments, preliminary planning, and the announcement of tenders. The facility is designed to process 100 tons of organic kitchen waste per day, addressing the county's waste disposal needs while stimulating the local economy and creating job opportunities. This case will also serve as a reference for other national and publicly owned contaminated sites.

The EMA will continue this cross-ministry cooperative model, integrating the policy needs of central government ministries and local governments to prioritize the remediation of national and publicly owned contaminated sites. By utilizing the Soil and Groundwater Pollution Remediation Fund, the EMA aims to jointly invest in pollution remediation and develop public environmental facilities to promote sustainable land use.

Figure 25: On-Site Remediation Operations at Dagang Section, Nantou

(3)Enhancing the Regulatory Framework for Contaminated Land Revitalization

To improve the existing regulatory framework for revitalizing contaminated land and strengthen supporting measures, three expert consultation meetings were held in 2023. These meetings drew on successful international case studies to analyze the feasibility of establishing "trust accounts for contaminated site funds," ensuring that remediation efforts continue even as development and utilization generate revenue. The aim is to strengthen the management mechanism for phased and zonal improvements on contaminated sites, especially those integrating development or utilization efforts (Figure 26). Additionally, a draft of guidelines for simultaneous remediation and land reuse was developed, along with the "Contaminated Site Land Reuse Planning Guide," intended for use by local Environmental Protection Bureaus.

On a practical level, efforts included establishing the Nantou Dagang Section as a demonstration case and holding 20 consultations, site inspections, briefings, and discussions. These activities were designed to thoroughly understand the conditions at each site and help land stakeholders plan remediation and reuse pathways. Furthermore, the compilation of the "National and Publicly Owned Contaminated Land Revitalization Handbook" provides guidance to responsible parties. The initiative was complemented by a results-sharing seminar and case study collection to promote further efforts. These steps gradually encourage other ministries and local governments to seek cooperation with central authorities and integrate contaminated land reuse with initiatives like net-zero carbon emissions, regional revitalization, and technical validation.

By encouraging local governments and land stakeholders to actively seek third-party developers and engage in public-private commercial cooperation via administrative contracts, the goal is to accelerate the remediation and reuse of contaminated land.

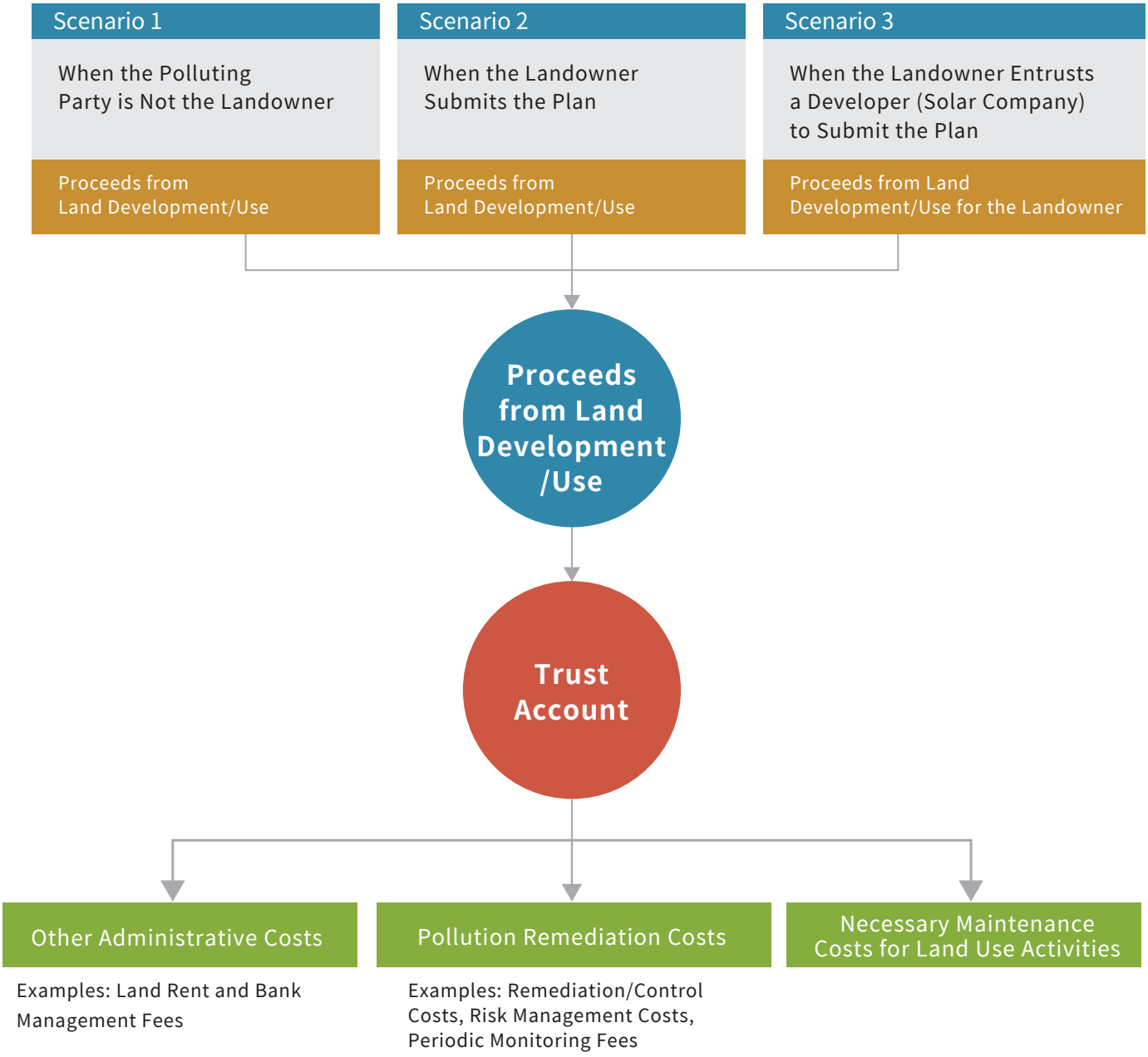


Figure 26: Income and Expenditure Diagram for the Contaminated Site Remediation Trust Account

Part 5:
Advocacy for New Knowledge in Earth Information

Green Sustainable Resilience Remediation International Conference

Taiwan-U.S.-Thailand Soil and Groundwater Technology Exchange

Air English Classroom

ASEAN Sustainable Soil and Groundwater Forum

APWG Soil and Groundwater Pollution Remediation Professional Training Course

Soil and Groundwater Cross-Domain Technology Academia-Industry Presentation and Technology Matching Conference

Results of County and Municipal Innovative Local Initiatives

Soil and Groundwater Environmental Education Promotion Activities

Soil and Groundwater Protection Board Game

'Clean Soil, Clear Water' Event Series on Facebook and Instagram

Creative Short Film Contest for Soil and Groundwater Protection

Youth Training Camp on Soil and Groundwater Pollution Remediation

Part 5: Advocacy for New Knowledge in Earth Information

This part outlines the domestic technical development achievements in soil and groundwater for 2023, as well as the results of international cooperation and outreach efforts. These include the promotion of Green and Sustainable Remediation (GSR) , technology trials and policy implementation, the execution and application of subsidized research and pilot test projects, international soil and groundwater seminars, and the outcomes of domestic educational campaigns and innovative initiatives led by the Environmental Protection Bureau.

1. Technical Development Achievements

To continuously enhance domestic capabilities in soil and groundwater pollution investigation and remediation, and to support the promotion of environmental protection technologies within Taiwan's industry, the Environmental Protection Agency (EPA) has incorporated the concept of Green and Sustainable Remediation (GSR) into its technical development. This approach addresses economic, social, and environmental aspects to drive the advancement of soil and groundwater technologies in Taiwan. Key initiatives include the three-stage certification and verification system for pollution sites, the development and testing of GSR technologies, as well as subsidized research and pilot test projects. These efforts have significantly improved Taiwan's technical standards and quality. The technical development achievements for 2023 are as follows:

(1)Pollution Site Remediation Moving Toward Green and Sustainable Resilient Remediation

Pollution site remediation can have varying degrees of impact on the environment, society, and the economy. To mitigate these impacts, since 2018, the EPA has encouraged regulated pollution sites to include GSR

assessments or best management practices in their control/remediation plans or progress reports, following guidelines set forth by the agency. From 2018 onwards, 10-20% of sites each year have incorporated GSR into their remediation goals. In 2023, this number reached its highest, with 61 sites including or updating GSR assessments in their control or remediation plans, and 49 sites reporting best management practices related to GSR in regular reports. This demonstrates the increasing adoption of green and sustainable remediation concepts by site operators.

Meanwhile, climate change and natural disasters may cause both short- and long-term impacts on pollution sites, affecting remediation progress and outcomes, and potentially posing risks to community safety and economic development. According to the EPA's 2022 assessment, 427 regulated pollution sites, covering an area of 899 hectares, are located in flood-prone or historically affected areas, accounting for 79.4% of all regulated sites. Additionally, 53 sites are at risk of landslides, and 47 sites may be affected by saltwater intrusion and groundwater salinization, highlighting the vulnerability of pollution sites to natural disasters, as illustrated in Figure 27.

To help site operators address the future impacts of climate change and natural disasters while maintaining remediation effectiveness and reducing the environmental, social, and economic impacts of remediation processes, the EPA expanded Taiwan's GSR implementation framework in 2023. The framework now includes resilient remediation, which will be continuously adjusted based on practical needs. The current implementation framework is shown in Figure 28. A climate risk assessment methodology for pollution sites has also been developed (Figure 29) to support decision-makers in executing effective and resilient remediation plans.

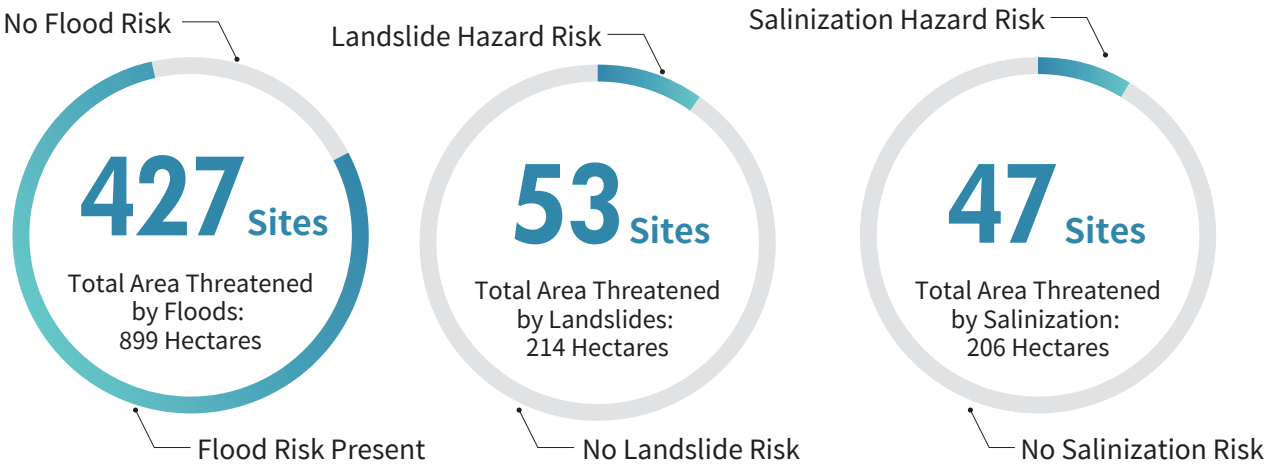


Figure 27: Statistics on the Number and Area of Regulated Pollution Sites in Taiwan Threatened by Natural Disasters

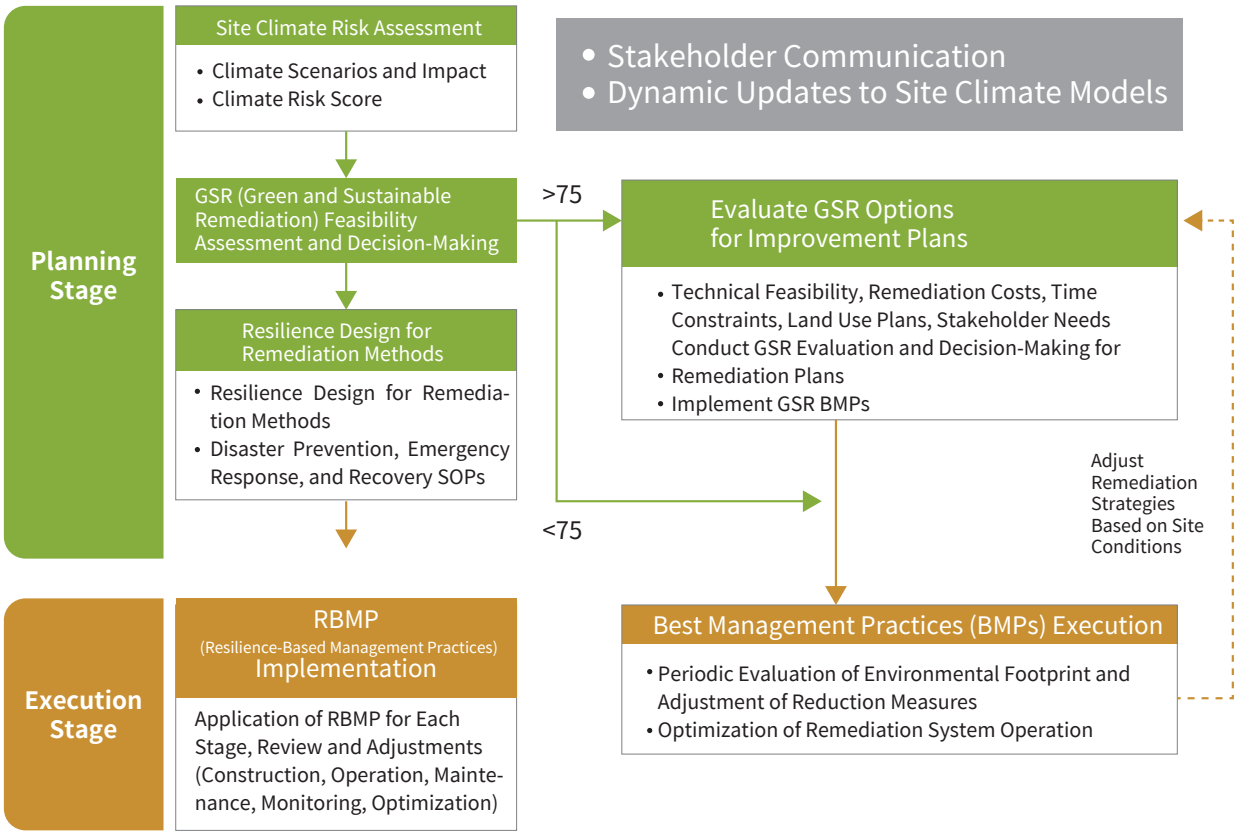


Figure 28: Implementation Framework of Green,Sustainable and Resilient Remediation

Figure 29: Climate Disaster Risk Assessment Procedures for Pollution Sites

To enhance the acceptance and incentive for implementing GSR, the EPA launched the first GSR Excellence Award selection event in August 2023. After a three-month evaluation process conducted by experts, six outstanding units with distinct features were selected from 11 participating units. On November 8, a recognition ceremony (Figure 30) was held in conjunction with the International Conference on Green and Sustainable Resilient Remediation. Through this recognition event, the EPA continues to encourage pollution site operators to adopt GSR practices, ensuring the protection of soil and groundwater quality.

Figure 30: GSR Excellence Award Ceremony and International Conference on Green and Sustainable Resilient Remediation

(2)Three-Stage Certification and Verification System for Soil and Groundwater Remediation Technologies

To provide reliable and practical soil and groundwater remediation technologies for pollution sites in Taiwan, and to support the promotion and deepening of domestic and international adoption of Taiwan's outstanding remediation companies and technologies, the EPA has planned a three-stage approach. This involves implementing different systems to gradually promote certification related to soil and groundwater remediation technologies, with the goal of achieving the desired outcomes. The three-stage certification system for soil and groundwater remediation technologies is shown in Figure 31.

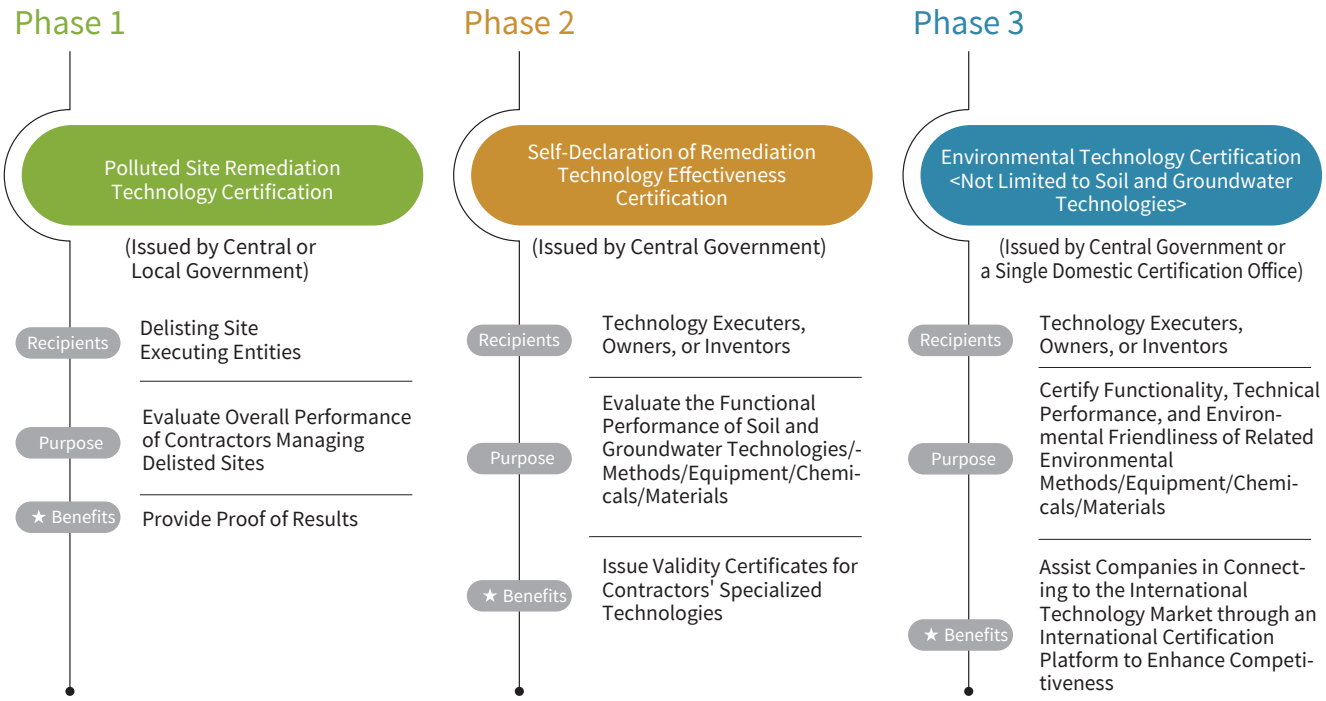


Figure 31: Three-Phase Certification System for Soil and Groundwater Pollution Remediation Technologies

(3) Subsidized Research and Pilot Test Projects

To promote the practical application of technologies and enhance the effectiveness of industry-academia collaboration, the "Soil and Groundwater Pollution Remediation Fund Subsidized Research and Pilot Test Projects" has been implemented since 2010. With the philosophy of "Strengthening Academia, Benefiting Industry," the initiative encourages academic institutions to conduct innovative research and development in areas such as soil and groundwater pollution investigation, assessment, and remediation activation. Furthermore, it actively facilitates industry-academia partnerships, where technological applications are tested in real-world environments to optimize local technologies and accelerate the resolution of domestic pollution remediation challenges.

i.Advancing Technology and Policy Towards Low-Carbon and Sustainability

In 2023, a total of 37 promising technologies were approved for research and development, including 3 pioneer projects, 18 research projects, and 16 pilot test projects. The focus of the R&D efforts includes optimizing remediation processes, promoting sustainable and resilient remediation, supporting risk-based remediation technologies, smart contamination monitoring, addressing emerging contamination issues, advanced contaminant forensics, managing and promoting the revitalizion of contaminated land, and the application and promotion of artificial intelligence. The goal is to apply the results of these R&D efforts to optimize technology, reduce carbon emissions from remediation activities, and improve overall remediation effectiveness to meet domestic technical needs.

On the administrative side, efforts are being made to integrate risk management and contaminated land revitalization into contaminated site management to ensure the effective reuse of contaminated land. In alignment with international trends, continued attention is being paid to emerging contamination issues, fully supporting the key policy objectives.

To date, the administration has supported a total of 385 projects, resulting in the publication of 217 articles in international journals, the acquisition of 52 patents, the transfer of 5 technologies, and the training of over 800 professionals. It is estimated that these efforts generate 488 job opportunities annually.

ii.Optimizing Remediation Technologies and Partnering with Industries for Upgrades

Embracing the spirit of "Protecting the Environment, Ensuring Taiwan's Sustainability," the Environmental Management Administration, Ministry of Environment (EMA) launched its first industry-academia collaboration results for soil and groundwater. On September 13, 2023, the "2023 Soil and Water Cross-Disciplinary Technology Industry-Academia Presentation and Technology Matchmaking Event" was held at the Public Administration and Business Education Center of National Chengchi University, attracting over 200 professionals from academia, industry, and the general public.

The event centered at the theme of "Technology Optimization and Industry Upgrade," resulting in the signing of four industry-academia cooperation agreements. By fostering cooperation between the government, industry, and academia, the event established a new model of collaboration for the development of soil and groundwater technologies. This collaborative approach aims to drive cross-disciplinary technological efforts and tackles the challenges of soil and groundwater pollution through concrete actions. An overview of the event is shown in Figure 32.

In addition to oral presentations of promising technologies, the event featured exhibitions of soil and groundwater remediation technologies, showcasing equipment and materials, as well as posters and visual demonstration of innovative technological achievements. The event also included an online virtual exhibition, offering the public a variety of ways to experience the event , further amplifying Taiwan's technical capacity in soil and groundwater to the globe.

Witnessing the Signing of Four Industry Cooperation Letters of Intent

Director Hsu-Ming Yen of the EMA posing for a group photo with industry and academia experts of intent.

Figure 32: 2023 Soil and Groundwater Cross-Disciplinary Technology Industry-Academia Presentation and Technology Matchmaking Event

2.International Cooperation and Exchange

In 2023, the Environmental Management Administration (EMA) promoted international cooperation on soil and groundwater pollution remediation through various activities under the International Cooperation Program. These efforts facilitated environmental information exchanges between Taiwan, the United States, and Asia-Pacific countries, seeking new opportunities for international collaboration. The program also assisted Southeast Asian countries in enhancing their soil and groundwater pollution remediation technologies, thereby strengthening Taiwan's contribution to global environmental protection. Ultimately, these initiatives aim to establish Taiwan as a hub for soil and groundwater information exchange in the Asia-Pacific region.

(1)Professional Training Courses by the Asia-Pacific Soil and Groundwater Pollution Remediation Working Group

The Asia-Pacific Soil and Groundwater Pollution Remediation Working Group, an international regional cooperation platform advocated by the Environmental Management Administration (EMA), was established in 2011. It

now includes 12 member countries, aiming to promote regional cooperation and share Taiwan's technical expertise and experience in soil and groundwater environmental protection. To strengthen Taiwan's contributions to regional environmental protection and lay the groundwork for future official cooperation with member countries, the EMA regularly conducts professional training courses for young officials from these countries.

From December 4 to 9, 2023, the EMA organized the 4th training event at National Cheng Kung University in Tainan. This was the first training course held for officials since the pandemic, and participation from the member countries was enthusiastic. The course combined both theoretical and practical aspects, including site visits. Participants were impressed by Taiwan's management policies, technical capabilities, and engineering expertise in soil and groundwater environmental protection, providing valuable references for future practical applications. An overview of the event is shown in Figure 33.

Opening group photo

Vice Minister Shen (center) and Deputy DG Liu (third from left)

Workshop session

Figure 33: Results of the Professional Training Course by the Asia-Pacific Soil and Groundwater Pollution Remediation Working Group

(2)ASEAN Soil and Groundwater Sustainability Forum

On January 6, 2023, the Environmental Management Administration (EMA) successfully held the ASEAN Soil and Groundwater Sustainability Forum at the Chang Yung-Fa Foundation International Conference Center. The event invited representatives from the East Java Environmental Protection Agency of Indonesia, scholars from Indonesia and Vietnam, as well as local environmental authorities, industry representatives, academics, and both foreign and local graduate students studying in Taiwan. Together, they discussed Taiwan's and ASEAN countries' soil and groundwater environmental policies, shared environmental governance experiences, and sparked innovative ideas. The event also included an award ceremony for the "Sustainable Innovation in Soil and Groundwater Remediation Research Competition," as shown in Figure 34.

The forum focused on the soil and groundwater protection challenges faced by Indonesia and Vietnam, Taiwan's legislative process for the Soil and Groundwater Pollution Remediation Act, management strategies, technical developments, and international alignment. It helped broaden understanding of ASEAN partners across different sectors in Taiwan and encouraged collaboration between industry, government, and academia. The event also provided an opportunity for Taiwan's industries to explore potential involvement in ASEAN countries. Additionally, the "Sustainable Innovation in Soil and Groundwater Remediation Research Competition" aimed to foster foreign talent from ASEAN countries by using "Sustainable Innovation in Soil and Groundwater" as the central theme. The competition was designed to inspire new ideas and encourage participants to apply their knowledge in improving or solving environmental problems in their home countries, pushing soil and groundwater towards sustainable development goals, as shown in Figure 35.

Figure 34: Group Photo from the Award Ceremony for the "Sustainable Innovation in Soil and Groundwater Remediation Research Competition"

Figure 35: Group Photo of Industry, Government, and Academia Representatives at the "ASEAN Soil and Groundwater Sustainability Forum"

(3)Deepening Taiwan-U.S. Partnership

Since 2005, the Environmental Protection Administration (EPA) of Taiwan and the U.S. Environmental Protection Agency (EPA) have established a strong foundation in the field of soil and groundwater pollution remediation. In 2023, the Environmental Management Administration (EMA) of Taiwan extended this bilateral cooperation to include a member of the "Asia-Pacific Soil and Groundwater Pollution Remediation Working Group" (Thailand), marking the first Taiwan-U.S.-Thailand tripartite cooperation. Representatives from the EMA and the U.S. EPA jointly traveled to Thailand to assist in addressing issues related to contaminated site management. This initiative aims to further deepen the Taiwan-U.S. environmental partnership while enhancing Taiwan’s engagement with countries in the New Southbound Policy, creating valuable opportunities for Taiwan's environmental diplomacy.

(4)2023 Taiwan-U.S.-Thailand Soil and Groundwater Technical Exchange

Starting on November 26, 2023, the EMA led a delegation of experts from Taiwan's industry, government, and academia to Thailand, in collaboration with U.S. EPA experts, for a six-day "2023 Taiwan-U.S.-Thailand Soil and Groundwater Technical Exchange."

During this exchange, representatives from Taiwan and the U.S. EPA, along with officials from Thailand’s environmental authorities, shared experiences in contaminated site management, pollution investigation, and remediation technologies. This tripartite collaboration, under the principles of mutual benefit and shared growth, further strengthened the close partnership and explored potential business opportunities in overseas markets. The face-to-face technical exchange and site investigation provided practical assistance to Thailand’s efforts in contaminated site management and allowed a deeper understanding of Thailand's pollution remediation and environmental industry needs.

In response to the contaminated sites raised by Thailand, the Taiwanese delegation, alongside officials from Thailand's Ministry of Industry and Ministry of Natural Resources and Environment, conducted on-site

investigations. Working with Thailand's Department of Groundwater Resources, the team used rapid screening tools to test multiple groundwater quality parameters. Drones were deployed for aerial surveys to capture high-altitude panoramic images, assisting in the assessment of landform changes over the years and identifying abnormal areas or impacts near the sites. During the summary meeting, the Taiwanese delegation, based on their extensive practical experience, presented a report with detailed suggestions for follow-up actions and measures, which earned high praise and appreciation from the Thai officials.

This technical exchange achieved many tangible results through the collaborative efforts of experts from industry, government, and academia. It not only deepened the partnership based on mutual benefit and growth but also created numerous opportunities for future cooperation. This tripartite exchange serves as a model for promoting Taiwan's contaminated site management systems and pollution investigation/remediation technologies to other Asia-Pacific partner countries. The results of the event are shown in Figure 36.


Taiwan-US-Thailand exchange group photo


Industry, government, academic group photo


Site inspection in Rayong with Thai Ministry of Industry and US delegation


Joint interview with Thai Ministry of Industry and US delegation by Thai media

Figure 36: Results of the "2023 Taiwan-U.S.-Thailand Soil and Groundwater Technical Exchange"

3. Domestic Advocacy Activities

In 2023, the Environmental Management Administration (EMA) organized the "Cool Knowledge You Didn't Know" creative short film competition on soil and groundwater protection. This event attracted many participants, including students, who used creative filming and presentation techniques to enhance the fun and visibility of important knowledge about soil and groundwater protection, sparking new ideas on these issues.

In addition, several soil and groundwater environmental education promotion activities were held, such as "Lucky and Prosperous Adventures with A-Bolo" (好運旺旺來~阿菠蘿的冒險), "Vibrant Green Onion Harvest in Sansing" (蔥滿活力 ~ 三星採蔥趣), "The Secrets of Earthworms: Soil Engineers" (土壤工程師 ~ 蚓土的秘密), and "Little Sweet Potato Farmer: The Treasures Underground" (小小地瓜農 ~ 地底下的寶藏). These activities provided hands-on experiences to help participants understand the importance of soil and groundwater in daily life. Furthermore, the first set of soil and groundwater protection board games was introduced into schools, enriching the variety of soil and groundwater advocacy programs.

(1) "Cool Knowledge You Didn't Know" Soil and Groundwater Protection Creative Short Film Competition

As global awareness of environmental issues continues to grow, many environmental concepts and activities have become familiar to the public. Soil and groundwater, which are closely tied to our daily lives, should be a focus of concern alongside the rising environmental consciousness. The internet, being universally accessible across demographics and age groups, along with social media and video platforms, has become a primary means of information exchange today. Through the browsing, clicking, and sharing of short videos, everyone can become both an information distributor and receiver. By utilizing creative filming and presentation techniques, this competition aims to enhance the appeal and visibility of important knowledge regarding soil and groundwater protection, sparking new ideas and interest in these topics.

A total of 89 entries participated in the short film competition, with 36 submissions in the social category and 53 in the campus category. After a two-stage review by five judges, 43 works were awarded prizes (23 from the social category and 20 from the campus category). On November 20, the awards ceremony and a networking event showcasing the winning works were held at the Center for Public and Business Administration Education (NCCU CPBAE). The results of the event are shown in Figure 37.

Tea Party Before the Award Ceremony		
Student Work Exchange		
Group Photo of Winning Teams		
Group Photo with All Participants		

Figure 37: Results of the Soil and Groundwater Protection Creative Short Film Competition

(2)Nurturing Talent for the Soil and Groundwater Industry: Practical Skills for Future Professionals

To help current students and recent graduates understand the development and future prospects of Taiwan's soil and groundwater industry, and to enhance their willingness to enter related fields while equipping them with the necessary professional skills, a five-day, four-night "2023 < 坐才 > Youth Training Camp for Soil and Groundwater Pollution Remediation" was held from February 6 to 10 at the Kaohsiung International Conference Center. The program primarily targeted third-year university students majoring in environmental engineering, while also promoting international exchange by welcoming international students to participate. The goal was to raise the visibility of Taiwan's soil and groundwater talent pool and foster collaboration, while also encouraging international interaction among participants.

The event featured a diverse and rich array of activities, ranging from foundational theory to technical research and on-site observation. The curriculum covered the entire life cycle of soil and groundwater, incorporating sustainable resource management concepts in the context of climate change. Industry experts provided lectures to help students gain deeper insights into the current status of Taiwan’s soil and groundwater industry, its technological development, and future employment opportunities. Practical on-site observation activities allowed participants to understand the actual processes involved in site investigation and remediation, and to grasp the significant resources and manpower required to address environmental pollution. This immersive, practical learning experience helped participants better appreciate the value and strengths of Taiwan's soil and groundwater industry, and inspired them to consider joining the field while enhancing the industry's competitiveness.

At the end of the program, case studies were provided for group discussions, simulating the investigation and remediation planning for various types of pollution. These exercises promoted critical thinking,

discussion, and organizational skills among participants. Through this training, students gained a deeper understanding of the soil and groundwater industry, effectively supporting the development of Taiwan's environmental protection industry and preparing future leaders. The results of the event are shown in Figure 38.

Opening Group Photo

Classroom Learning Scene

Closing Group Photo

Figure 38: Results of the 2023 < 坐才 > Youth Training Camp for Soil and Groundwater Pollution Remediation

(3) Innovative Local Initiatives by County and City Governments

To strengthen public awareness of soil and groundwater prevention, local Environmental Protection Bureaus across various counties and cities have incorporated regional characteristics into their advocacy activities. By organizing diverse and innovative promotional events, they have attracted public attention while integrating the unique local culture and traditions. This approach connects participants emotionally with the land and helps them learn about the importance of sustainable soil and groundwater management. The results of these initiatives have been published in the dedicated advocacy results section on the Soil and Groundwater Pollution Remediation website. The results are shown in Figure 39.

Online Promotional Zone for Soil and Groundwater Remediation

Keelung City	Hsinchu County	Chiayi County
		
Why is the Little Drop Crying? Children's Play	Hakka Language Picture Book Electronic Audiobook	Where Does the Arsenic Come From? Taiwanese Short Film

Figure 39: Results of Innovative Initiatives by Local Environmental Protection Bureaus in Counties and Cities

(4)Soil and Groundwater Environmental Education Promotion Activities

Environmental education should take root at an early age, as children are like young seedlings absorbing knowledge and growing. Encouraging them to actively care for and pay attention to their environment helps foster future guardians of the environment, reducing the likelihood of future pollution incidents. Connecting with nature is a critical aspect of environmental education. Before the start of this event, environmental educators provided

basic knowledge about soil and groundwater, as well as the importance of crops, through interactive lectures. These sessions included Q&A to reinforce understanding and hands-on activities that helped participants grasp the significance of soil and groundwater in daily life, how human activities can coexist with the environment in a sustainable way, and the harm caused by soil and groundwater pollution. This approach increased awareness of the importance of the land.

A total of 46 parent-child families, comprising 139 participants, took part in the four sessions. Feedback through surveys and learning questionnaires indicated that all parents were willing to participate in similar activities again. The high level of engagement from the children was evident, and many parents expressed hope that the event would be held again next year. Through close interaction with nature and hands-on experiences, participants gained a deeper understanding of the importance of soil and groundwater. Relevant event information is shown in Table 6, and the results of the event are presented in Figure 40.

Table 6: Information on Soil and Groundwater Environmental Education Promotion Activities

Activity Name	Location	Activity Overview
Lucky and Prosperous Adventures with A-Bolo (好運旺旺來 ~ 阿菠蘿的冒險)	Puyu Pineapple Farm (No. 196, Heshan Rd., Dashu District, Kaohsiung City)	Focused on pineapple cultivation, participants learned about crop growth and connected with the land and nature.
Vibrant Green Onion Harvest in Sansing (蔥滿活力 ~ 三星採蔥趣)	Green Onion Baby Experience Farm (No. 79, Section 3, Dade Rd., Sanxing Township, Yilan County)	Through an ecological experience in the Sansing Green Onion fields, participants learned how healthy soil is essential for growing delicious crops.
The Secrets of Earthworms: Soil Engineers (土壤工程師 ~ 蚓土的秘密)	Cien Shelter Leisure Farm (No. 40, Ln. 61, Guangfu Rd., Erlin Township, Changhua County)	Participants learned how natural farming methods restore the vitality of the land and engaged in hands-on DIY earthworm potted plant activities to experience the soil firsthand.
Little Sweet Potato Farmer: The Treasures Underground (小小地瓜農 ~ 地底下的寶藏)	Wang Wang Sweet Potato Farm (No. 74, Liugu Linkou, Jinshan District, New Taipei City)	Participants dug sweet potatoes and experienced traditional kilns, learning about the importance of healthy soil for food production.

Opening Introduction to Soil and Groundwater Knowledge

Park Tour

Group Photo

Hands-on Experience

Figure 40: Results of the Soil and Groundwater Environmental Education Promotion Activities

(5)Soil and Groundwater Protection Board Game

i.Teacher Empowerment Training

In alignment with the environmental education focus of the 2019 Curriculum Guidelines, the Environmental Protection Administration (EPA) organized teacher empowerment training centered around the first board game on soil and groundwater protection published by the EPA—"Land Defender." The training aimed to assist educators in using the board game to teach topics related to soil and groundwater, thereby enhancing students' correct understanding and basic knowledge of soil and groundwater environmental protection.

The teacher empowerment training was held on May 31, June 7, and June 14, with a total of 109 participants, including elementary and middle school teachers, Ministry of Education-certified environmental educators, and seed teachers specializing in soil and groundwater pollution education from local Environmental Protection Bureaus.

The course began with an ice-breaking game, where participants were grouped according to their target teaching audience. Through interactive games, participants introduced themselves, creating a lively atmosphere and fostering connections to facilitate the board game sessions. The training continued with an introduction to the functions of soil and groundwater, using real-life examples of soil and groundwater pollution incidents in Taiwan and their impact on daily life, including current remediation methods.

After experiencing the board game, each group discussed their gameplay experience, feelings about the game, key factors for winning, and suggestions for improvement. The discussion outcomes were compiled into posters and shared with all participants during a collaborative learning session. The process of creating and presenting the posters not only served as a record of the discussions but also helped focus conclusions. Through playing the game, engaging in discussions, and creating posters, participants learned how to use the board game to convey knowledge about soil and groundwater. The results of the training are shown in Figure 41.

Soil and Groundwater Protection Board Game Experience

Group Discussion and Poster Creation

Sharing Session and Group Photo

Figure 41: Results of the Teacher Empowerment Training for the Soil and Groundwater Protection Board Game

ii.In-Class Teaching Experience with the Board Game

By June 2023, a total of seven in-class teaching sessions using the board game had been completed, involving 162 students. The sessions began with an introduction to soil and groundwater, explaining the various roles that healthy soil and groundwater play in daily life. The long time required for soil and groundwater to accumulate was emphasized, along with the potential impacts of depleting these vital resources. Students were then guided through the board game, learning the rules and playing it in practice. A model lesson plan for using the board game in the classroom was developed, and the game was gradually promoted through teacher recommendations.

After the game, worksheets were used to help students recall the gameplay and reinforce their knowledge. For example, students were asked to select the "most memorable card" and carefully read its content. The "pollution card" (which pollutes nine pieces of land at once) was used to explain the spread and severity of soil and groundwater pollution, while the remediation cards helped students learn about methods such as "plowing techniques" and "topsoil replacement." Additionally, the concept of "paying coins to use remediation cards" was introduced to prompt students to think about the time and money required to restore land, making them understand that remediation is difficult and involves various methods. The game enabled students to better grasp the knowledge being conveyed through an engaging experience. The results of the activity are shown in Figure 42.

Opening Explanation on the Importance of Soil and Groundwater

Students Playing the Board Game

Filling out Learning Sheets After the Board Game

Interactive Q&A with Students

Figure 42: Results of the In-Class Teaching Experience with the Soil and Groundwater Protection Board Game

iii.Board Game Application Mechanism

To provide more learning resources for organizations interested in topics such as environmental protection, environmental education, and soil and groundwater, the Environmental Protection Administration (EPA) has developed the "Soil and Groundwater Protection Board Game Teaching Tool Application Mechanism." This mechanism aims to assist users in promoting knowledge and awareness of soil and groundwater through interactive learning via the board game. The application process includes the method of application, review mechanisms, relevant regulations, form completion, and details on shipping and returning the materials, ensuring a systematic and digitalized management of the board game distribution.

As of November 2023, there have been 24 applications for experience sessions, 8 cases of borrowing the game, and 17 cases of distribution requests. The application process remains open for further submissions. The application process is illustrated in Figure 43.

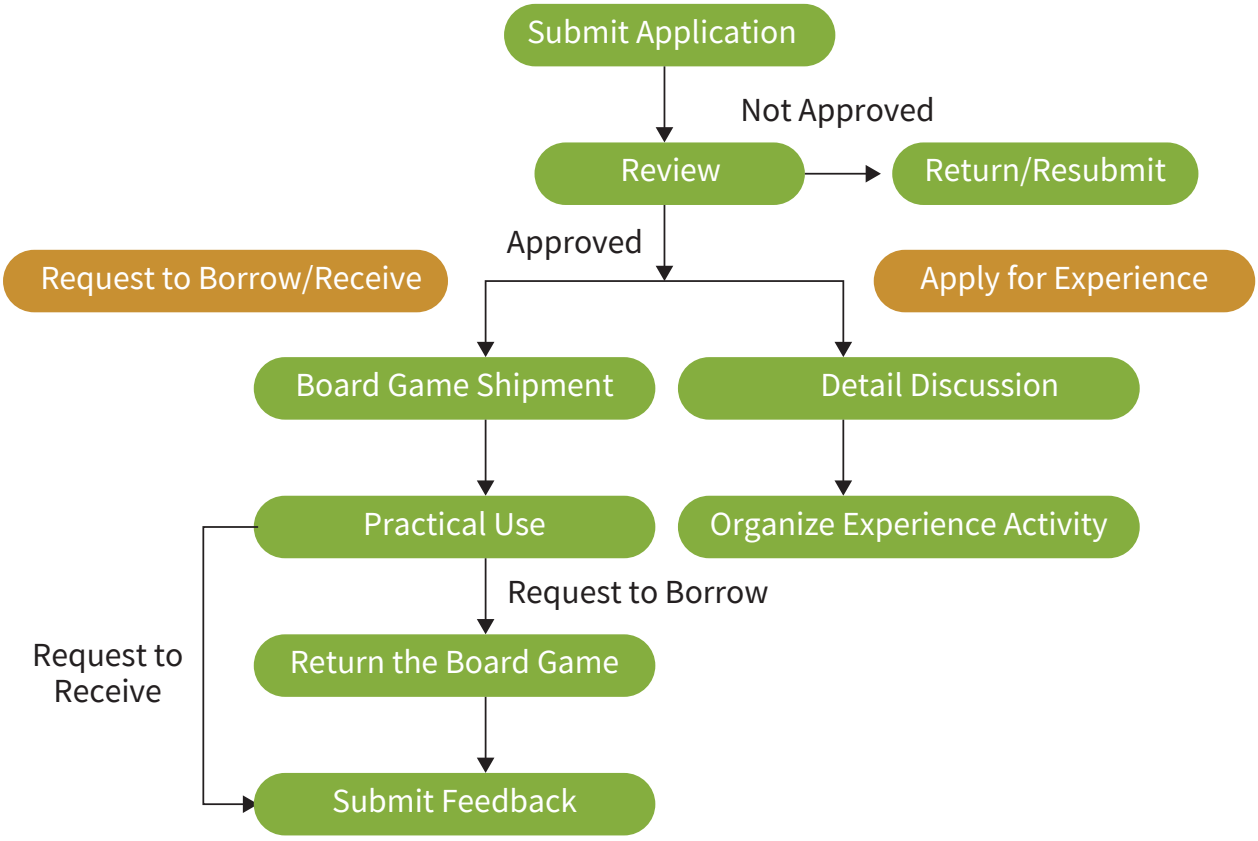


Figure 43: Application Process for the Soil and Groundwater Protection Board Game Teaching Tool

(6)Multimedia Advocacy

The soil we walk on and the groundwater we drink can be difficult to detect when contaminated. Pollution may enter the food chain, continuously affecting aquatic life and human health. Over time, this not only impacts ecosystems but also poses long-term health risks to humans. However, environmental issues often seem abstract and complex to the public. For environmental protection to be sustainable, awareness must extend beyond a small group of concerned individuals. Fortunately, the rise of the internet provides an effective and timely channel for communication and interaction with the public. It has become a useful tool for promoting policies, gradually enhancing public awareness of soil and groundwater protection, and expanding the advocacy efforts on these important environmental topics.

i.Managing the "Clean Soil and Water" (土淨水清) Facebook and Instagram Accounts

Four major themes were developed to create engaging content for these platforms. Through regular posts and interactive activities with followers, the goal was to increase reach and boost page traffic. From March to December 2023, a total of 128 posts were made across Facebook and Instagram. Additionally, one event per month was held on both platforms from August to October, totaling six events. These social media posts reached a combined audience of 361,137 people. As of November 15, 2023, the number of Facebook followers increased by 1,045, and Instagram followers increased by 339. The results of these efforts are shown in Figure 44.

Instagram Post

Facebook Post

Figure 44: Results of the Multimedia Advocacy Efforts

ii.Production of Chinese and English Educational Materials

In line with the promotion of bilingual education, the Environmental Management Administration (EMA) collaborated with Studio Classroom to create Chinese and English teaching materials. These materials serve as a medium for introducing scientific knowledge about groundwater. The content begins by explaining the sources, functions, and sources of pollution for groundwater, and ties in Taiwan's frequent water shortages to emphasize the importance of groundwater in the country. It also highlights the challenges of detecting and cleaning up groundwater pollution, explaining how the government monitors groundwater quality and has established early warning systems to safeguard this vital resource.

A total of 210,000 copies of the bilingual educational materials were published in the magazine on September 15, 2023 (October issue), and the teaching videos were promoted through television, radio, and online media platforms. These multimedia learning channels allow students to improve their English while gaining a deeper understanding of soil and groundwater knowledge. A sample of the materials and video footage is shown in Figure 45, and the multimedia learning platforms are summarized in Table 7.

Teaching Materials

Screenshots fromEducational Videos

Figure 45: Sample of Studio Classroom Print and Multimedia Content

Table 7: Summary of Multimedia Learning Platforms for Studio Classroom

Media Platform	Results
Magazine	Circulation: 210,000 copies
Television	Taiwan: 6 channels including CTS Educational and Cultural Channel; Overseas: 2 channels in the U.S. and Canada
Radio	Broadcast on 10 stations including Han Sheng Radio
Official Website	85,218 page views
Facebook	12,135 people reached
LINE TV	36,857 views
YouTube	7,566 views

Part 6:
A Sustainable Earth

1 Sound and Comprehensive Legal System Strengthened Administrative Framework

- Safeguarding Agricultural Land and Food Safety, Continuing the Promotion of Tiered and Zonal Management
- Improving Sediment Protection and Water Quality
- Promoting Channels for Off-Site Soil Reuse
- Improving Tiered Warning System for Zones
- Managing Storage Systems with Environmental Monitoring

2 Ongoing Surveys to Detect Pollution Early

- Planning Policies and Improving Self-Prevention
- Monitoring Groundwater for Management Decisions

Promoting Accelerated Site Improvement

3 Collaborating to Promote Remediation and Restoration

Strengthening Digital Management and Data Application

Introducing Risk Assessment for Polluted Lands

Promoting Zonal Improvement for Polluted Sites

4 Promoting International Exchange and Cooperation

Fostering International Exchanges

Promoting Green Remediation and Net-Zero Adaptation

Promoting Soil and Groundwater Technology Integration

5 Ensuring Sustainable Fund Management

Simplifying Fee System and Procedures

Part 6: A Sustainable Earth

Over the years, the Environmental Management Administration, Ministry of Environment (EMA) has actively completed remediation at numerous pollution sites. Moving forward, the focus will shift to pollution prevention and management, fostering horizontal collaboration with other government agencies, including those responsible for environmental protection, agriculture, and the economy. This aims to promote industrial development in the soil and groundwater sector and expand investment in localized technology research and development. Additionally, the EMA will organize international visits and seminars to align Taiwan's soil and groundwater pollution remediation efforts with global standards. To achieve this, the EMA has developed a medium- to long-term work plan with 15 key initiatives, as outlined below:

1. **Accelerate comprehensive site remediation management.**
2. **Protect agricultural land and food safety by continuing the graded and zoned management system.**
3. **Develop business management policies to enhance corporate self-regulation and prevention.**
4. **Strengthen the tiered signal management system in industrial zones.**
5. **Diversify storage system management and promote self-monitoring of environmental conditions.**
6. **Monitor groundwater quality to support groundwater management decision-making and analysis.**
7. **Enhance sediment protection systems to improve water quality management.**
8. **Introduce risk assessment management to revitalize polluted land.**
9. **Strengthen the digitization of operations and improve the diversified application of data.**
10. **Promote regional site remediation and land-use mechanisms.**

11. **Expand avenues for off-site reuse of polluted soil.**
12. **Actively refine the fee system and implement simplified administrative procedures for public convenience.**
13. **Promote green and resilient remediation efforts to achieve net-zero adaptation.**
14. **Link soil and groundwater technology development with promotion and collaboration.**
15. **Foster international exchanges.**

2023 Annual Report on Soil and Groundwater Pollution Remediation

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This design skillfully integrates the outcomes of soil and groundwater pollution remediation with retro video game visual elements, capturing public attention. The pixel art and layered scenes not only evoke nostalgia for classic video games but also symbolize the concept of environmental protection. From the vibrant greenery on the surface to the deep layers of remediation underground, the design conveys a clear message: through technology and sustained efforts, we can systematically address pollution and restore the health of the natural environment. This visually compelling fusion effectively communicates essential environmental information to the public in an innovative and engaging manner.