Environmental Management Administration
Ministry of Environment

2024

Environmental Management Administration Annual Report

Design Concept:

The cover design draws inspiration from the Agency's emblem, rooted in the imagery of "blue skies and green lands, pristine mountains and clean waters, and a healthy, sustainable future." It integrates the four major policy pillars—proper household waste management, establishing a high- quality environment, strengthening environmental law enforcement, and preserving soil and water resources—symbolizing our continuous commitment to safeguarding the environment and shaping a shared vision for the future.

This Annual Work Report is the Agency's first comprehensive compilation of yearly achievements. It documents the progress made from the Agency's establishment on 22 August 2023 through 31 December 2024, capturing the starting point and development trajectory of environmental management efforts.

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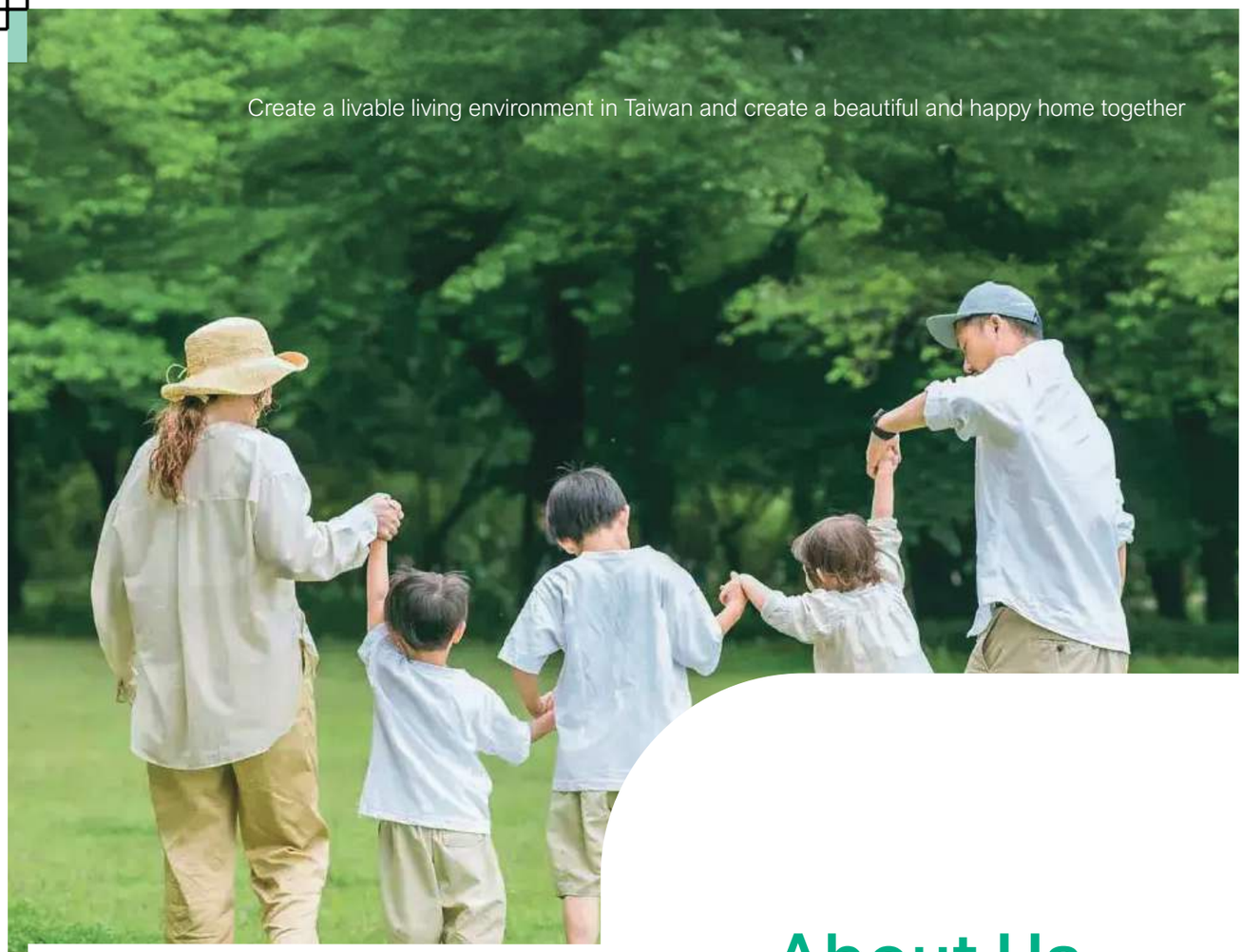

Create a livable living environment in Taiwan and create a beautiful and happy home together

About Us

2024

Environmental Management Administration Annual Report

Organizational Structure and Business Responsibilities

The Environmental Protection Administration of the Executive Yuan underwent organizational restructuring and was successfully upgraded to the Ministry of Environment on August 22, 2023. As part of this transition, the Environmental Inspection Task Force and the Soil and Groundwater Pollution Remediation Fund Management Board (hereinafter referred to as “SGRFMB”) were merged to establish the Environmental Fund Management Board (hereinafter referred to as “the Administration”).

The Administration's core responsibilities encompass six main areas: comprehensive environmental management planning, general waste management, environmental sanitation management, environmental law enforcement, regional environmental management, and soil and groundwater pollution remediation. In addition to enhancing the management of general waste and environmental quality, the Administration prioritizes environmental inspections and technology-based law enforcement, while also introducing initiatives such as regional environmental governance and cross-domain information integration and monitoring (Figure 1).

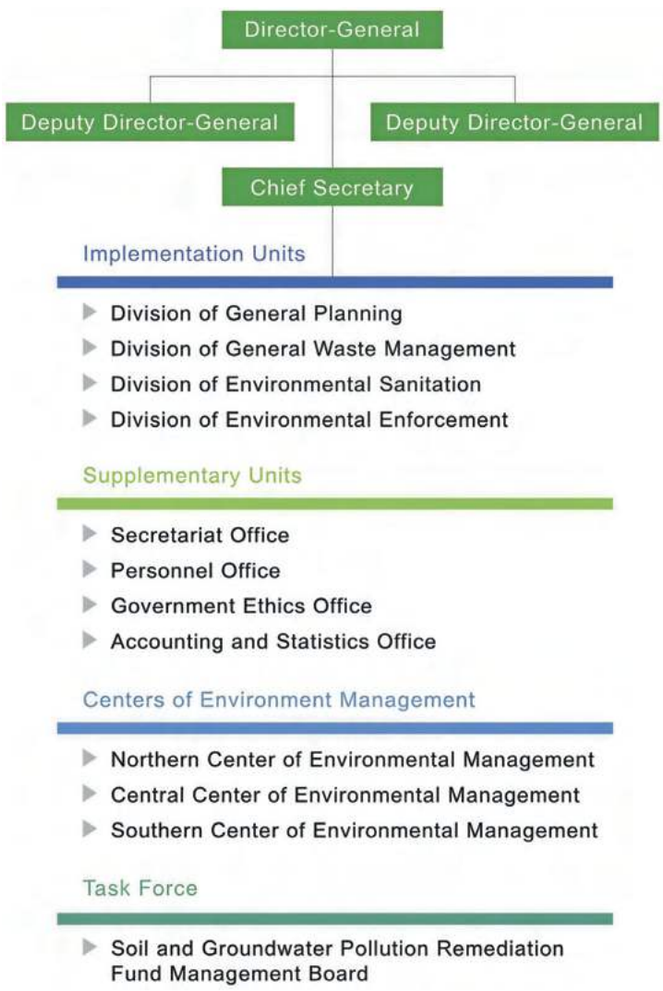

Figure 1
Organizational Structure of the Environmental Management Administration

Policy Vision and Strategic Focus

The mission and strategic development goals of the Administration are centered on ensuring sustainable environmental development. Its policy vision is built upon four main pillars: proper household waste management, establishing a high- quality environment, strengthening environmental law enforcement, and preserving soil and water resources.

Key initiatives include optimizing environmental facilities, transforming landfill sites, improving waste treatment, honoring the ocean, enhancing care for sanitation workers, maintaining environmental hygiene, upgrading public restrooms, advancing environmental technology-based enforcement, promoting soil and water sustainability, and integrating information systems. A total of 25 priority measures are being actively promoted (Figure 2).

Figure 2 Policy Vision of the Environmental Management Administration

Future Vision and Challenges

- Assist local governments in optimizing and establishing waste treatment facilities to properly manage household waste.
- Improve the cleanliness and safety of living environments by enhancing dengue vector source removal, maintaining coastal cleanliness, constructing safe, comfortable, and dignified public restrooms, ensuring rapid post-disaster environmental recovery, and caring for sanitation workers.

- Promote remote digital environmental monitoring and smart decision-making; form cross- sector alliances of professional technical teams to support environmental law enforcement; enhance environmental impact assessment supervision and increase enforcement effectiveness to build a green and happy homeland.
- Foster cross-regional collaboration between central and local governments to promote smart regional governance; utilize technology to assist precise law enforcement; strengthen cooperation between environmental agencies, police, and prosecutors to crack down on illegal activities.
- Achieve zero-lag access to environmental information, enabling immediate feedback and seamless emergency response; strengthen the operational capacity of management centers and ensure joint responses to major incidents.
- Invest administrative resources and implement effective pollution control measures; promote site risk assessments and management.

▲ Group Photo of the Environmental Management Administration

Taoyuan Biomass Energy Center

Sound Management of Municipal Solid Waste

2024

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1 Take Appropriate Measures to Address the Issue of Uncovered Waste Accumulation

From Difficulties to Solutions: Tangible Progress

In recent years, as major waste incineration plants have undergone upgrades, some household waste has been temporarily diverted to landfill sites. By the end of 2023, approximately 840,000 metric tons of exposed garbage had accumulated across 11 counties and cities, including Hsinchu County and Nantou County, posing risks to environmental hygiene and fire safety.

Since 2018, the Board has actively assisted relevant counties and cities in accelerating the cleanup of exposed waste within landfill sites.In 2024, it supported Yunlin County in screening 25,000 tons of waste, and between 2024 and 2025, it continued to assist Nantou County and Penghu County in processing a total of 70,000 tons of exposed waste.These efforts have led to a significant improvement in the environmental sanitation and cleanliness of the sites.

"Mechanical Sorting" and "Baling Technology"

The adoption of mechanical sorting and compression baling technology has enhanced landfill management efficiency and safety:

- **Classified processing improves efficiency**: Combustible and non-combustible materials are separated for treatment, reducing pollution and fire hazards.
- **Compression technology saves space**: Compressing waste reduces its volume by 30–50%, significantly conserving space.

- **Organized management improves safety**: Baled waste is less prone to scattering, reduces odor, and improves site cleanliness and order.

Technological Support from "Drones" and "Thermal Imaging"

The integration of advanced technologies has further improved efficiency and safety in landfill management:

- **UAV modeling**: Drones are used to rapidly generate 3D digital models, allowing for precise mapping of garbage distribution and volume, aiding in cleanup planning and prioritization.
- **Thermal imaging monitoring**: Real-time temperature monitoring helps detect abnormalities early and prevent fire hazards. The Xinfeng Landfill in Hsinchu once faced the risk of fire. Through the use of thermal imaging cameras, abnormalities were detected in time, enabling early warning and immediate cooling measures to prevent the spread of fire incidents.

As of 2024, 22 landfills have been subsidized to accelerate the deployment of technological facilities.

AI-Powered Digital Governance of Landfills: Real-Time Access to the Latest Information.

A 24-hour intelligent management system has been established throughout the country to enhance disaster prevention and monitoring efficiency at landfills using artificial intelligence. This reduces the burden on frontline personnel and improves overall management effectiveness (Figure 3):

- **Nationwide Distribution Map Established**: As of June 2024, a map showing the distribution of exposed waste across the country has been completed. It displays temporary storage volumes and landfill status by city and county.
- **Integrated Monitoring System**: In July 2024, integration of landfill monitoring systems with CCTV was completed, enabling precise control over the volume and distribution of waste on-site.
- **Emergency Response Map Development**: By the end of 2024, a nationwide emergency response map will be finalized, providing real-time data on waste treatment progress and fire alerts, thereby enhancing response capabilities.

Gradual Improvement: Cleanup Plan for Exposed Waste

The Administration has allocated **NT$1.2 billion** to implement a **three-year cleanup plan** in collaboration with local governments, setting clear targets with the aim of **fully resolving the issue of exposed waste by the end of 2026**. Comprehensive support is

being provided to local authorities in areas such as landfill covering, waste sorting and baling, disaster prevention, smart monitoring, and AI-based digital governance:

- **2024**: Clean up **340,000 metric tons**, with priority given to key areas.
- **2025**: A plan was formulated to properly handle and reduce 340,000 tons of exposed waste, further alleviating the pressure on landfills.
- **2026**: The final 410,000 tons of waste were cleared, achieving the overall target.

As of the end of December 2024, the volume of exposed waste has been reduced from **840,000 metric tons** at the end of 2023 to **750,000 metric tons**, indicating steady progress in remediation efforts.

Toward the Future: Enhancing Landfill Operation and Management Efficiency

From **840,000 metric tons** of waste to complete and proper treatment, this challenge requires the **full commitment of both technology and resources**. Looking ahead, the Administration will enhance landfill management by **expanding the application of technology**, **advancing waste classification, compression, and covering operations**, and **strengthening fire prevention and monitoring systems**. These efforts aim to comprehensively improve **management efficiency, safety**, and **environmental quality** at landfill sites.

Figure 3 Taiwan Landfill Uncovered Waste Monitoring System

2 Diversified Food Waste Recycling

Current Status of Diversified Food Waste Recycling

In 2024, the total amount of household food waste recycled across Taiwan reached **50.5 million kilograms** (50,500 metric tons), with a **daily processing volume of 1,384 metric tons**. The recycled food waste was primarily reused through the following methods:

- **Fertilizer production**: High-efficiency composting and traditional composting amounted to 231,000 metric tons, accounting for approximately 45.8%.
- **Animal feed**: Pig feed accounted for **216,000 metric tons**, about **42.8%**.
- **Energy recovery**: Anaerobic digestion to produce biogas for power generation accounted for **48,000 metric tons**, around **9.5%**.
- **Others**: Feeding practices such as raising black soldier flies and poultry (chickens or ducks) accounted for **10,000 metric tons**, approximately **1.9%**.

Food Waste Recycling Approaches

Using black soldier flies to assist in food waste treatment has emerged as an alternative and innovative technology, showcasing an ideal model of ecological circulation. In Taiwan, cleaning teams in five townships and large-scale farming facilities in two counties/cities are utilizing black soldier flies to process food waste. This not only helps reduce carbon emissions, but also brings new vitality to the environmental protection industry.

The Administration is actively promoting diversified approaches to food waste reutilization, including:

- **Composting:**

  The Administration continues to assist local governments in enhancing the performance of composting facilities. Experts and scholars are invited to provide on-site technical guidance, serving as a reference for future facility operations. Support is also provided to help local governments obtain fertilizer registration certificates, thereby improving compost quality and expanding distribution channels.

- **Food Waste-to-Feed:**

  Cooked food waste reused for direct animal feeding must undergo high-temperature treatment, reaching a core temperature above 90°C and be continuously stirred and cooked for at least one hour. These processes must comply with the Animal Industry Act, the Statute for Prevention and Control of Infectious Animal Diseases, and relevant environmental regulations to ensure biosecurity and reduce food loss and waste.

- **Waste-to-Energy:**

  Food waste treated through anaerobic digestion can generate methane, which is then used for power generation and converted into bioenergy. The construction of bioenergy facilities helps reduce reliance on conventional energy sources.

- **Other Methods:**

  Additional reuse options include feeding black soldier flies, earthworms, chickens, ducks, and other technically feasible applications.

Anaerobic Digestion of Food Waste for Power Generation: Contributing to Green Energy

- **Biomass Energy Plant**

  Through promoting **private sector participation in public infrastructure**, biomass energy plants have been established. The **Waipu Green Energy Eco-Park in Taichung** processes up to **30,000 metric tons of food waste per day** and has successfully generated electricity—enough to supply the **annual power consumption of over 1,700 households**.

  The **Taoyuan Biomass Energy Center** has entered its **trial operation phase**, with an annual processing target of **50,000 metric tons** (Figure 4).

Figure 4 Taoyuan Biomass Energy Center

- **Co-digestion of Food Waste and Livestock Wastewater:**

  New Taipei City and the Central Livestock Farm in Pingtung have adopted **co-digestion technology**, combining food waste with livestock wastewater. This approach has **significantly increased biogas production by 1.7 times**. The resulting **digestate** can be used to **promote crop growth**.

- Co-Digestion of Food Waste and Sludge

  A demonstration plant with a daily processing capacity of 100 metric tons is being planned to integrate food waste with other organic waste, further advancing waste-to-energy conversion.

Innovative Resource Recycling: Rearing Black Soldier Flies

Using black soldier flies to process food waste has emerged as an alternative and innovative technology, showcasing a novel approach to resource recycling. Currently, sanitation teams in five townships across Taiwan, along with two counties or cities, have implemented large-scale rearing operations (Figure 5).

Figure 5 black soldier fly larvae

Improvements and Achievements

- Food Waste-to-Bioenergy: Contributing to Green Electricity

  As of 2024, the Waipu Green Energy Park in Taichung, the Taoyuan Biomass Energy Center, and the co-digestion project jointly operated by New Taipei City and the Central Livestock Farm have collectively processed 51,000 metric tons of food waste. These efforts have generated over 6.07 million kilowatt-hours of green electricity, equivalent to a reduction of several thousand metric tons of CO_2 emissions.

- Public-Private Collaboration Creates New Opportunities:

  From local governments to private enterprises, multi-sector cooperation has opened a new chapter in food waste recycling, not only enhancing resource recovery efficiency, but also driving transformation and upgrading of related industries.

Food Waste Reuse and the Development of Regional Circular Economy

In the future, food waste reuse will continue to advance toward greater diversification. As co-digestion technologies mature and biomass energy plants become operational, the efficiency of waste reuse will improve, contributing to a stable supply of green energy. At the same time, innovative approaches such as the use of black soldier flies demonstrate strong potential for both environmental protection and resource value.

The government will collaborate with the private sector to deepen technological research and development, enhance facility infrastructure, and promote regional circular economies. These efforts aim to achieve food waste reduction, energy conversion, and a low-carbon, sustainable future, paving the way for a greener tomorrow.

3 Infrastructure Upgrades for a New Beginning

▲ The Taitung County Waste Incineration Plant was officially commissioned in 2023.

A Waste Bag's Transformative Journey

When we toss a bag of household garbage into the community bin, have we ever wondered what journey lies ahead for it? After collection, this waste is subjected to **high-temperature incineration**, transforming into **clean electricity** that once again powers and brightens our lives.

Currently, **large-scale waste incineration plants across Taiwan** have a **maximum annual processing capacity of 6.81 million metric tons**, generating approximately **3.4 billion kilowatt-hours of electricity**—enough to supply **800,000 households**.

Two Decades On, Incineration Plants Remain Resilient and Are Being Rejuvenated Through Modern Upgrades

Most waste incineration plants in Taiwan have been in operation for over **20 years**. While the equipment remains functional, many facilities face risks of **furnace shutdowns** and the growing need to **comply with stricter pollution control regulations**, making **equipment replacement and upgrades essential**.

The Administration has launched a **nationwide incineration plant upgrade and improvement program** to assist local governments in implementing infrastructure enhancements. The goal is to **restore processing capacity** and **enhance operational efficiency**, including:

- Improving **power generation efficiency**
- Strengthening **air pollution control**
- Promoting **energy conservation and carbon reduction**
- Reducing the volume of **ash and slag for better reuse**

These efforts aim to **extend the service life** of incineration plants and ensure the continued, proper treatment of household waste.

Upgrading Incineration Plants and Launching Diverse Local Facilities Nationwide

To **enhance overall waste treatment efficiency**, a **nationwide incineration plant upgrade program** has been launched. The primary goals are to **restore processing capacity** and **improve pollution control performance**. The program also supports local governments in establishing **self-managed treatment facilities**. As of 2024, **Taiwan's total waste treatment capacity has increased by 270,000 metric tons**.

- **Progress on 24 Existing Incineration Plants:**

  By the end of 2024, among **24 existing incineration plants** nationwide, **10 have completed upgrades**, **6 are undergoing improvement works**, and **8 are in the planning stage**.

- **Significant Pollution Reduction Achievements:**

  The Administration has invested **NT$330 million** to optimize continuous emissions monitoring systems and upgrade air pollution control equipment. Monitoring system efficiency has improved, with **monitoring uptime rising from 85% to 95%**, enabling more effective air quality surveillance.

  Additionally, **15 incineration plants have completed nitrogen oxide (NO2) control upgrades**, with emission concentrations reduced from **87 ppm in 2016** to **63 ppm in 2024**, achieving a **25% reduction**.

- **Establishing an Independent Waste Treatment System in Eastern Taiwan:**

  In the past, **Taitung and Hualien** relied on transporting waste to other municipalities for incineration, which resulted in high and unstable treatment costs. Today, the **Taitung Incineration Plant** and **Hualien DAKA Resource Recycling Center** have officially commenced operations, with daily processing capacities of **300 tons** and **200 tons**, respectively—achieving **self-sufficiency in waste treatment** for the region.

- **Next-Generation Biomass Energy Center Begins Operation:**

  The **Guanyin Biomass Energy Center** in **Taoyuan City** officially began operations at the end of 2023. With a **daily incineration capacity of 660 tons**, it plays a key role in **gradually resolving the issue of accumulated waste in Taoyuan**.

Prospects for the Future

Incineration technology has long been the mainstream method of waste treatment in advanced countries such as Europe, the United States, Japan, and Singapore. Through incineration, waste can be reduced in volume, safely treated, and stabilized, thereby minimizing the need for landfilling.With the ongoing advancement of the incineration plant upgrade program, Taiwan's domestic waste treatment system is expected to become more stable and environmentally sustainable in the future.

- **Enhancing Treatment Capacity:**

  As incineration facilities are upgraded and new plants are gradually commissioned, the nation's overall waste treatment capacity continues to improve. By the end of 2024, with the completion of the Hsinchu County Incineration Plant, Taiwan's total annual treatment capacity will reach 6.89 million metric tons

- By the end of **2027**, with the **completion of the furnace replacement at the Chengxi Plant in Tainan**, the total capacity of **29 incineration plants nationwide** is expected to **exceed 7 million metric tons per year**. The new and upgraded facilities will **enhance operational efficiency** and **ensure stable, long-term operation** (Figure 6).

Figure 6 Incinerator Furnace Bed Upgrades and Enhanced Waste Treatment Efficiency

- Next-Generation Incineration Facilities: Replacing the Old with the New

  Waste is no longer a burden—it is the energy of the future. The government is actively adopting international best practices and advanced technologies to promote the renewal and replacement of aging incineration plants, with the goal of achieving maximum resource circulation, minimal waste generation, and optimal pollution control.

  The Chengxi Plant in Tainan is scheduled to be completed and operational by the end of 2027, while the Chiayi City Plant is planned for commissioning in 2029, both serving as model projects for waste treatment and energy conversion.

  Replacement plans for the Neihu, Wenshan, Houli, and Kaohsiung South District incineration plants are also accelerating, aiming to comprehensively improve waste treatment capacity and lead cities toward a more sustainable future.

- Public Engagement: A Key to Future Waste Policy Implementation

  Public opposition to incineration facilities often stems from misconceptions about secondary pollution. To address this, the government is actively promoting site visits to help residents better understand the actual operations and environmental benefits of incineration plants. In addition, community feedback mechanisms are being implemented to foster neighborly relations, reduce public resistance, and build a harmonious, win-win relationship between plants and communities.

Incineration plants are not merely tools for solving waste problems—they are part of a sustainable lifestyle of the future. Through incineration, garbage is no longer an environmental burden, but a valuable and usable resource. As technologies evolve and policies progress, Taiwan is entering a new era of waste management—one where every bag of trash finds its optimal destination, contributing to cleaner, better urban living.

4 Reusing Incineration Fly Ash: Innovative Thinking for Circular Resource Use

▲ The Kaohsiung Fly Ash Washing Plant was officially commissioned in 2024.

What Is Incineration Fly Ash?

The garbage we throw away, once burned in incinerators, produces **incineration fly ash**—a fine dust captured by the incinerator's **air pollution control devices**, such as **baghouse filters** or **electrostatic precipitators**.

Fly ash has a **complex composition**, containing **heavy metals** and **dioxins**. If not handled properly, it can cause **serious environmental pollution**.

In the past, due to the presence of **chloride salts** and other components that hinder reuse, fly ash could only be **stabilized and then landfilled**. This process consumes landfill space equivalent to **84 standard swimming pools every year**.

With **limited landfill capacity** and increasing difficulty in developing new sites, **managing fly ash has become a major challenge**.

Introducing Washing Technology: Making Fly Ash Clean and Reusable

"Fly Ash Washing" **utilizes** water-washing stabilization technology **to reduce the concentration of** chloride salts **and** hazardous substances **in fly ash. This process makes the fly ash** more stable, safer**, and** more suitable for resource recycling.

Once tested and confirmed to meet regulatory standards, the treated fly ash can be **reused in the production of cement, bricks**, and other **building materials**. It may even serve as a **substitute material for electric arc furnace (EAF) dust** in **high- temperature steel smelting processes**.

Practical applications include the following:

1. Washed fly ash used as a substitute for raw cement materials:

   Muzha Incineration Plant and Beitou Incineration Plant.

2. Washed fly ash used as a substitute for electric arc furnace (EAF) dust in high-temperature steel smelting:

   Muzha Incineration Plant, Beitou Incineration Plant, and Taoyuan Incineration Plant.

3. Washed fly ash used as a substitute for non-structural brick materials:

   Beitou Incineration Plant.

The fly ash washing technology has **significantly reduced the need for landfill disposal**. As of **November 2024**, the total amount of **reused fly ash nationwide exceeded 20,000 metric tons**, with the **reuse rate increasing from less than 2% to 13%**, marking a **notable achievement**.

Moving Forward Together: Efforts to Expand the Application of Fly Ash Washing Technology

To **expand the application of fly ash washing technology**, the Administration is working **hand-in-hand with local governments** to gradually implement the **resource recovery of fly ash**:

- Central Government Subsidies:

  The Administration provides **financial support** to assist regions such as **Yilan County** and **Keelung City** in constructing fly ash washing facilities, thereby **alleviating landfill pressure**.

- Local Infrastructure Development:

  The **Bali Plant in New Taipei City** and the **Dafa Plant in Kaohsiung City** have also begun building **fly ash washing treatment facilities**. Each is expected to process over **20,000 metric tons of fly ash per year**, significantly **enhancing local treatment capacity**.

The Future of Fly Ash: Resource Recycling for a Greener Environment

The promotion of fly ash washing technology not only alleviates landfill pressure, but also opens new possibilities for the future:

- Enhancing Treatment Efficiency:

  More washing facilities will be established across various regions, with the goal of continuously increasing the fly ash reuse rate and reducing the need for landfill disposal.

- **Centralized and Efficient Treatment:**

  Facilities such as the Dafa Plant in Kaohsiung City and the Longjing Plant in Taichung City can serve as regional centralized treatment centers, helping to scale up operations and improve efficiency.

- **Diversified Applications:**

  Expanding the use of **fly ash as construction material and industrial raw material** positions it as a **key resource in the circular economy.**

These measures not only **extend the lifespan of landfills** and **reduce the hazardous nature of fly ash**, but also **promote resource circulation** and **create economic value** (Figure 7).

Fly ash was once a major challenge in waste management. Today, through **fly ash washing technology**, it is being transformed into a **valuable resource**. With continued technological advancement, fly ash is no longer just a burden on landfills—it is now **creating win-win value for both the environment and the economy**.

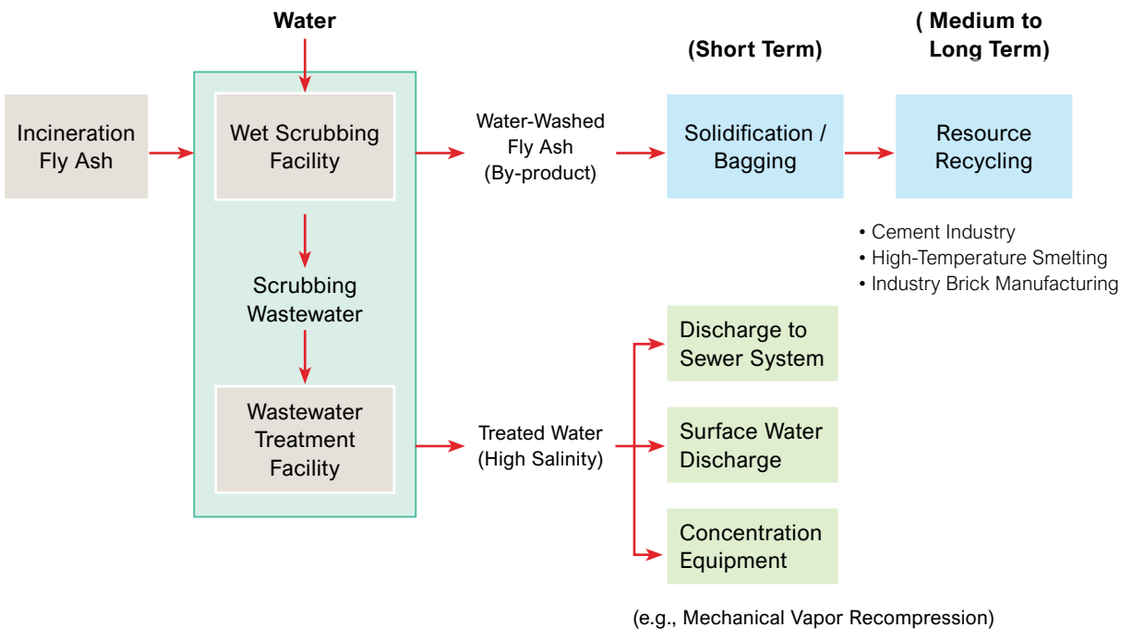


Figure 7 Recycling Process of Washed Incineration Fly Ash

5 Landfill Transformation: Advancing Together Toward Net-Zero

▲ Taipei Energy Hill Landfill Solar Power Plant

Overcoming Challenges: Reuse of Closed Landfills

Who would have imagined that land once sealed off for **waste burial** is now quietly transforming into **power bases for clean energy**? These lands, previously considered **undevelopable due to geological limitations**, were left idle—becoming the **"sleeping corners"** of our natural resources.

With the global movement toward **net-zero carbon emissions**, closed landfills are being **repurposed into solar photovoltaic (PV) fields**, converting sunlight into **stable, renewable electricity** through solar panels. This transformation not only addresses the problem of **idle land use**, but also marks a **new milestone in energy transition and environmental goals**.

Most closed landfill sites are built on **soft, unstable ground**, making them **unsuitable for agriculture or construction**. Additionally, their **scattered distribution** and **small surface area** make it difficult to find practical applications.

How to **reclaim and repurpose** these lands has become a pressing challenge. The installation of **solar PV systems** is emerging as the **best solution**—unlocking their value and turning once-unused spaces into **productive assets for a sustainable future**.

Central-Local Collaboration for a Net-Zero Transition

Working hand-in-hand with local governments, the Administration is promoting the transformation of closed landfills into solar photovoltaic (PV) facilities, with the goal of achieving green energy transition.

Behind every site—from planning to implementation—lies meticulous coordination and effort.

- Policy Initiatives Ensure Effective Transformation:

  To support the 2025 national energy transition goals, central and local governments are collaborating to install solar PV systems on closed landfills, maximizing the use of idle land resources.

- Pingtung and Yunlin Success Cases:

  These two closed landfill sites have been equipped with solar panels, generating 7.12 million kilowatt-hours of electricity annually, enough to meet the yearly electricity needs of 1,900 households.

- Nationwide Progress:

  From 2016 to the present, a total of 48 closed landfill sites across Taiwan have completed solar PV installations, with a total installed capacity of 88.9 MW—equivalent to supplying clean electricity to over 60,000 households.

These transformation projects are only in their early stages, and a **broader vision awaits realization** in the future:

- More Landfills Joining the Green Energy Movement:

  By **2025**, solar PV installations are expected to expand to **103.7 hectares**, with **generation capacity reaching 105 MW**, enabling more closed landfill sites to participate in the **green transition** (Figure 8).

- From Power Plants to Community Spaces:

  Future plans include integrating **environmental parks**, **ecological trails**, and other public amenities, transforming closed landfills into **community activity and recreational areas**.

- Driving Local Economic Growth:

  Revenue from **solar power generation** will be reinvested to support **local development**, not only increasing **land value**, but also serving as a **vital funding source for local infrastructure and construction**.

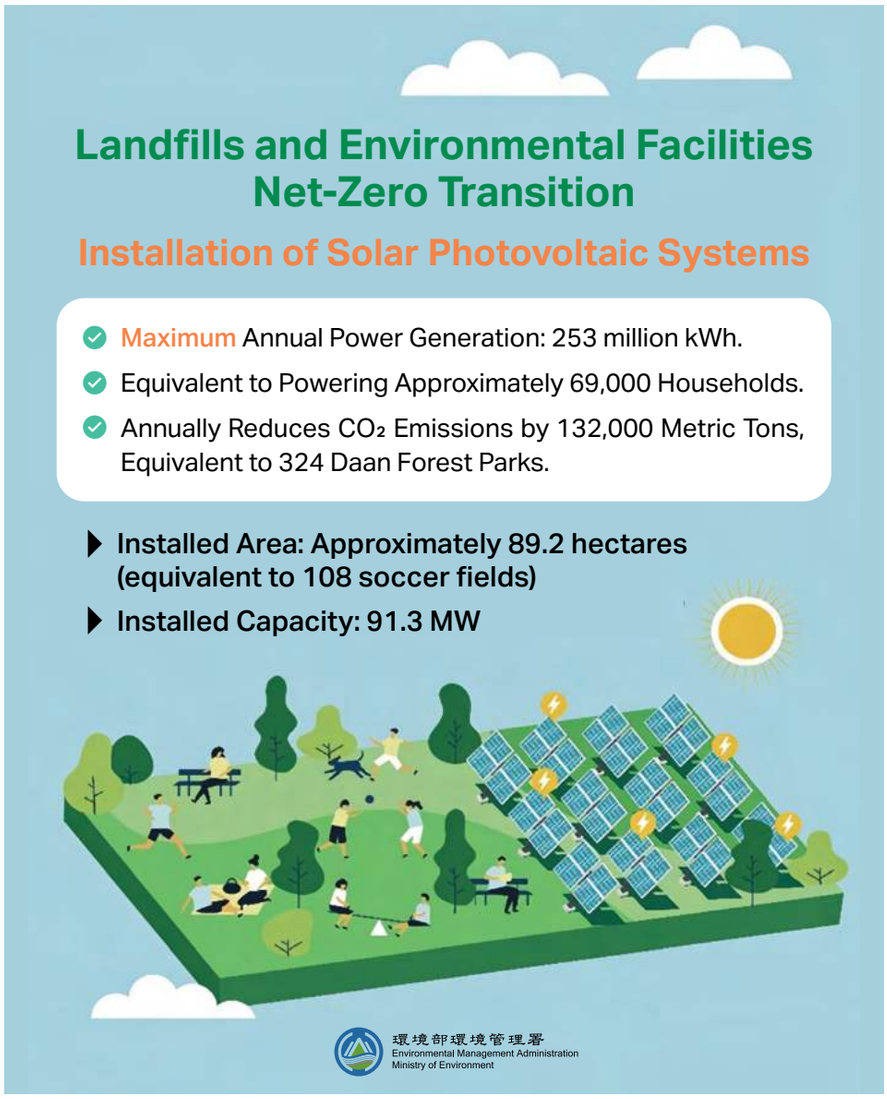


Figure 8 Promotional Materials for Net-Zero Transition of Landfills and Environmental Facilities

Reimagining the Value of Closed Landfills

Once seen as the **end point of waste management**, **closed landfills** are now transforming into **starting points for energy production and community revitalization**. The **green electricity** generated beneath solar panels not only **meets household energy needs**, but also **injects new momentum into local development**

Sound Management of Municipal Solid Waste In the future, as more transformation projects are implemented, **closed landfills will no longer be forgotten lands**, but rather **green exemplars of energy transition and community development**.

With a renewed identity, they will **help create a better future for the environment and the next generation**.

National Model Sanitation Worker

Promoting Environmental Sanitation Management

2024

Environmental Management Administration Annual Report

1 Public Toilet Revamp: A More Convenient Restroom Experience

▲ "Environmental Express" Podcast Episode 20: Creating Comfortable Public Toilets and Promoting Gender-Inclusive Restrooms – featuring Director-General Yen

Creating a Clean, Comfortable, and Accessible Restroom

In daily life, we use the restroom **approximately 6 to 8 times a day**, making **public toilets an essential part of our routine**. This ordinary space is currently undergoing a major transformation. Do you remember how you felt the last time you stepped into a public toilet? Was it clean and comfortable—or was it smelly, outdated, and poorly maintained?

For many, the impression of public toilets remains stuck in the stage of being **"dirty, wet, and smelly."** But with the launch of the **"Quality Public Toilets and Beautiful Environment Promotion Program,"** things are quietly changing.

The goal is to provide a **comfortable, safe, and dignified restroom environment**, while moving toward the **United Nations Sustainable Development Goals (SDGs)**, including:

- **SDG 5**: Gender Equality
- **SDG 6**: Clean Water and Sanitation
- **SDG 11**: Sustainable Cities and Communities

More Than Just a Toilet — A Reflection of the City's Image

How many times have we found ourselves **rushing to find a public restroom**? And when you finally walk in, instead of being hit by a pungent smell, you're greeted with a **fresh, clean atmosphere**—almost like stepping into the **coziest corner of your own home**.

This is the vision of the **"Quality Public Toilets and Beautiful Environment Promotion Program"**: to **enhance the quality of public restrooms nationwide**, striving for.excellence in **both infrastructure and sanitation management**.

How Is the Government Transforming the Face of Public Restrooms?

This transformation has not happened overnight. Since **2019**, the Administration has approved **4,290 public toilet improvement subsidy projects**, with a goal of upgrading **4,000 restrooms nationwide**. The renovated or newly built facilities include those located in **transportation hubs and tourist recreation areas**, ensuring that people can enjoy **cleaner and more comfortable restroom experiences no matter where they are**.

To guide and standardize implementation, the Administration has established a series of regulations, including:

- **Guidelines for Supervision of Public Toilet Construction and Renovation Projects**
- **Review Guidelines for Subsidy Applications for Toilet Projects**
- **Guidelines for the Registration, Maintenance, and Management of Public Toilets**

These documents cover the **entire process—from subsidy review and construction to long-term maintenance and management**—and support **local governments** in conducting **evaluations, inspections, and reporting**.

This reform is not merely about physical renovation; it represents a **major revolution in environmental sanitation and public service**. Across the country, public toilets are advancing toward **higher standards in design, cleanliness, and management**.

On **September 20, 2024**, in celebration of **World Cleanup Day**, the Administration invited **public restroom management and cleaning units** to participate in an event promoting **gender-friendly awareness**. **Minister Peng Chi-Ming** and **Director-General Yen Hsu-Ming** led by example, personally demonstrating **restroom cleaning practices** (Figure 9), and promoting **restroom culture and professional dedication**.

Figure 9
Minister Peng Demonstrating the Cleaning of a Seated Toilet

Minister Peng not only demonstrated the cleaning of **sitting toilets**, but also aimed to **set a positive example**. In addition, a **"Best Public Toilet Awards"** program was organized, selecting outstanding restrooms and cleaning teams across four categories:

- Enterprise-Provided Facilities
- Transportation Hubs
- Tourist and Recreational Areas
- Government-Nominated Facilities

A total of **20 outstanding restrooms**, **4 distinctive restrooms**, and **2 exemplary cleaning units** were recognized and awarded for their contributions.

Innovative Design: From Tradition to the Future

To stimulate innovative design, the Ministry organized a "Public Restroom Design Competition", attracting 24 entries from various sectors. Among them, the modular "Fule Restroom" design stood out, featuring a modern appearance that can be flexibly assembled according to different needs. The designers carefully considered user experience, ensuring that both residents and tourists could enjoy an attractive and efficient restroom environment. These innovative designs not only enhanced restroom functionality but also elevated public restrooms to become part of urban aesthetics, allowing users to enjoy both visual appeal and comfort (Figure 10).

Figure 10
Award-Winning Design – Concept Rendering of the "Fu-Le Toilet"

Public Participation: Ensuring Everyone Has a Voice

You might wonder if such reform efforts are solely driven by the government. In fact, this public restroom revolution is a process of nationwide participation. The Ministry introduced a QR code reporting system that allows citizens to provide instant feedback

on their restroom experience, from cleanliness to equipment malfunctions, ensuring every detail is quickly addressed. In 2024, the system was upgraded to improve five key areas: user-friendliness, coordinate accuracy, positive feedback entry, Google Map-based locating, and facility management registration.

During that year, citizens were encouraged to scan the QR codes to share their restroom experiences, yielding an average satisfaction score of 4.63 out of 5. Out of 12,768 responses, 6,455 included expressions of gratitude toward cleaning staff, showing broad public appreciation. In addition, the Ministry organized the “Outstanding Public Restroom Awards” to encourage competition among facility managers and to raise service standards. More than 1.13 million citizens participated in the voting process, making everyone a part of the movement for change.

Figure 11 Public Restroom Excellence Awards Ceremony

Comfortable, Safe, and Dignified Restrooms

Modern public restroom culture relies not only on hardware improvements but also on the sense of responsibility of every user. The principle of “cleaning up after yourself” is one of the core values of this reform. After using public restrooms, individuals are encouraged to tidy up after themselves or simply say “thank you” to the cleaning staff—small acts that demonstrate civility and enhance the overall experience.

Minister Yen Hsu-Ming also recorded a podcast to promote the idea of “gender-friendly restrooms,” emphasizing that public restrooms are symbols of urban civilization. The restroom revolution is moving toward providing comfort, safety, and dignity. In the future, restrooms will become spaces that are “as clean as home,” where everyone can be both witnesses and participants in this transformation.

2 No Cigarette Butts on the Ground, a Cleaner Environment

As you walk along busy streets, you may easily overlook the small cigarette butts scattered underfoot. Yet these seemingly insignificant items pose a growing and serious threat to both the environment and public health. About 99% of cigarettes on the market use filters, which are primarily made of cellulose acetate—a type of plastic that does not readily decompose in natural environments. Each cigarette butt contains more than 4,000 harmful chemicals, including nicotine, arsenic, and lead, which endanger marine life and human health.

In response to the significant environmental impact of cigarette butts, the Ministry of Environment launched the "*National No-Litter Cigarette Butt Initiative*" in July 2024. The initiative introduced six major strategies: cultural change, source reduction, stricter enforcement, environmental cleanup, public-private collaboration, and strengthened research. The goal is to reduce cigarette butt pollution and create a cleaner, higher-quality living environment.

Shifting Culture: Change Begins with Habits

In June 2024, the Ministry of Environment launched the "Cigarette Butt Reduction & Clean Environment National Alliance", raising awareness about the environmental harm caused by cigarette litter (Figure 12). Through 73 LED billboards, 198 radio stations, social media, news outlets, and garbage truck announcements, the campaign successfully reached over 7.8 million people, laying the foundation for a "No-Litter Cigarette Butt" movement.

Figure 12 Launch of the National Alliance for Reducing Cigarette Butts and Cleaning the Environment

No More Littered Cigarette Butts — It Starts with Us

To reduce cigarette butt litter at the source and provide smokers with proper disposa options after extinguishing cigarettes, the Ministry issued the “Guidelines for Promoting the Installation of Cigarette Butt Receptacles” (Figure 13) in July 2024. The guidelines encourage smokers to dispose of cigarette butts in trash bins or dedicated receptacles instead of discarding them on the ground. By the end of 2024, approximately 10,752 cigarette butt receptacles had been installed nationwide at appropriate locations and are regularly maintained (Figure 14). This not only provides a proper means for disposing of cigarette butts but also reduces cigarette litter in public areas.

Figure 13

Promotional Banner for the “No Cigarette Butts on the Ground” Campaign by the Ministry of Environment

Figure 14

Local governments have installed cigarette butt collection bins in non-smoking-restricted areas

In coordination with the Ministry’s campaign, the Chiayi County Environmental Protection Bureau (EPB) introduced incentive programs to further reduce cigarette litter (Figure 15). A special activity invited residents to collect cigarette butts between June 17 and December 31, 2024. Participants could exchange PET bottles filled with cigarette butts at designated partner stores for shopping discounts. The program successfully recovered approximately 2,386 kilograms of cigarette waste.

Figure 15

Chiayi County No-Litter Cigarette Butt Campaign

Inspections and Penalties: Strengthening Law Enforcement

Enforcement is one of the six key strategies in reducing cigarette butt litter. According to Article 27 of the Waste Disposal Act, violators who discard cigarette butts improperly are subject to inspection and penalties. Cities such as Keelung, Taipei, and New Taipei have raised fines for such violations from NT$1,200 to NT$3,600. In 2024, a total of 76,661 general waste inspections were conducted, of which 27,634 cases—approximately 36%—involved penalties for cigarette butt littering.

Public-Private Collaboration: Joint Participation Across All Sectors

The success of this environmental campaign relies heavily on the active participation of all sectors of society. The Ministry of Environment collaborated with businesses, civic groups, and religious organizations to encourage stores to voluntarily maintain their surroundings and clean up discarded cigarette butts. Many convenience store chains, coffee shops, and other businesses have already taken the initiative to clean the areas around their premises, becoming a bright and welcoming part of city streets.In addition, companies integrated corporate social responsibility (CSR) by promoting environmental values to both employees and customers, further amplifying the campaign's impact. In October 2024, the Junior Chamber International (JCI) and its 153 chapters across Taiwan leveraged youth influence to partner with the Ministry in advancing the No-Litter Cigarette Butt campaign. In November, the Ministry shared the progress of the nationwide initiative with JCI and expressed hope for cleaner streets in the future.

Creative Solutions: Making Environmental Protection More Enjoyable

To make environmental action more appealing, the Ministry launched the "*Reduce Cigarette Butts, Clean the Environment— +N Creative Contest*" in June 2024 (Figure 16), inviting innovative proposals to address the cigarette butt problem. Among the submissions from across the nation, the Gold Award winner, "Bad Luck! Not a Good Day to Litter Cigarette Butts," combined cigarette butt recycling with public awareness efforts. It featured reminder slogans and a reward system for recycling, making environmental action more engaging and fun. These creative ideas not only boosted public participation but also injected fresh vitality into the environmental movement.

Figure 16 Award Ceremony for the Creative Contest

An Environmental Revolution for the Future

From cultural change to strengthened regulations, from corporate collaboration to public participation, this environmental revolution against cigarette butts is quietly reshaping the face of our cities. Each small cigarette butt can pose a serious threat to the natural environment. Yet, when every individual takes responsibility and all sectors of society work together, the streets of the future will be free of cigarette butts.

3 Garbage Truck Upgrades: A New Model for Low-Carbon Transport

The Environmental Challenges of Aging Garbage Trucks

With the growing number of garbage trucks nationwide, many vehicles are now over 15 years old. These aging trucks emit significantly more carbon compared to new low-carbon models, placing a considerable burden on the environment. However, many local governments have not been able to replace these high-emission vehicles quickly enough. Accelerating the phase-out of outdated garbage trucks has therefore become a major challenge in current environmental efforts.

A Proactive Strategy for Fleet Replacement

- **Incorporating into Performance Evaluation:**

  The progress of garbage truck replacement has been included in the *Environmental Protection Performance Evaluation Program* for municipalities and counties. Scores are assigned based on the proportion of old vehicles replaced in each jurisdiction.

- **Increased Subsidies:**

  In 2024, approximately NT$320 million was allocated to assist 20 cities and counties in replacing 175 low-carbon garbage trucks. In addition, local governments earmarked NT$414 million in subsidies to support fleet replacement programs.

- **Launch of Centralized Procurement Contracts:**

  Since 2007, centralized procurement contracts for sealed engine-powered garbage trucks have been introduced. In 2014, electric compression garbage trucks were added, and in 2019, lightweight garbage trucks were incorporated, with the program renamed the "Low-Carbon Garbage Truck Procurement Agreement."

- **Local Implementation Oversight:**
  Continuous supervision ensures that local governments allocate sufficient funding and accelerate the replacement of old vehicles with low-carbon garbage trucks.

Energy Saving and Carbon Reduction: Remarkable Results

Local governments have gradually phased out aging garbage trucks and adopted low-carbon collection models. According to statistics, there are currently 1,550 low-carbon garbage trucks nationwide, accounting for about 28% of the total fleet. Between 2014 and 2024, these vehicles have reduced fuel consumption by approximately 7.71 million liters and cut carbon emissions by 21,400 metric tons, making a significant contribution to environmental protection and carbon reduction (Table 1).

Table 1 Implementation Results of the Low-Carbon Garbage Truck Replacement Program

Item	content
Low-Carbon Garbage Trucks – Total	1,550 vehicles (28% of the national fleet)
Fuel Savings from Replaced Vehicles	Approximately 5.3 million liters
Reduction in Carbon Emissions	Approximately 14,700 metric tons
Subsidy Amount in 2024	~NT$320 million (for 174 low- carbon trucks in 20 counties/cities)
General Subsidies from the DGBAS, Executive Yuan	Approximately NT$414 million (for the garbage truck replacement program)
Inclusion of Low-Carbon Garbage Truck Replacement Progress in Performance Evaluation	Scores Assigned Based on the Proportion of Old Vehicles Replaced
Centralized Procurement Contracts to Accelerate Garbage Truck Replacement	2007 – Engine-powered garbage truck contracts 2014 – Electric compression garbage truck contracts 2019 – Lightweight trucks added; renamed “Low-Carbon Garbage Truck Procurement Agreement

Low-Carbon Waste Collection, Environmental Upgrade

With the government’s continued investment in the replacement of low-carbon garbage trucks, more local governments will be encouraged to adopt such vehicles in the future, moving toward a fully low-carbon waste collection system nationwide. This effort will not only help reduce carbon emissions but also enhance urban cleaning efficiency, making environmental protection an integral part of everyday life for city residents.

4 Caring for Sanitation Crews: Safety and Peace of Mind

Caring for Sanitation Workers: Ensuring Their Hard Work Is No Longer Lonely

Li Ah-Hua is a hardworking sanitation worker who was unfortunately involved in a traffic accident while on duty. His family was able to apply for financial assistance, which safeguarded their livelihood. After his recovery, Li returned to work, deeply experiencing the care and support of society.

Sanitation workers are the guardians of urban environments, working tirelessly and without complaint. However, their jobs often involve significant occupational hazards, particularly traffic accidents and health risks. Ensuring the safety and protection of these dedicated workers has therefore become a pressing issue that must be addressed.

Six Key Measures to Enhance the Welfare and Safety of Sanitation Workers

1. **Extension of Application Deadline for Early Assistance Grants**: In cases where sanitation workers suffer accidental death while on duty, the original requirement to apply within 20 days of the date of death has been removed. Families are now given unlimited time to apply, ensuring they have greater flexibility and support during times of hardship (Figure 17).

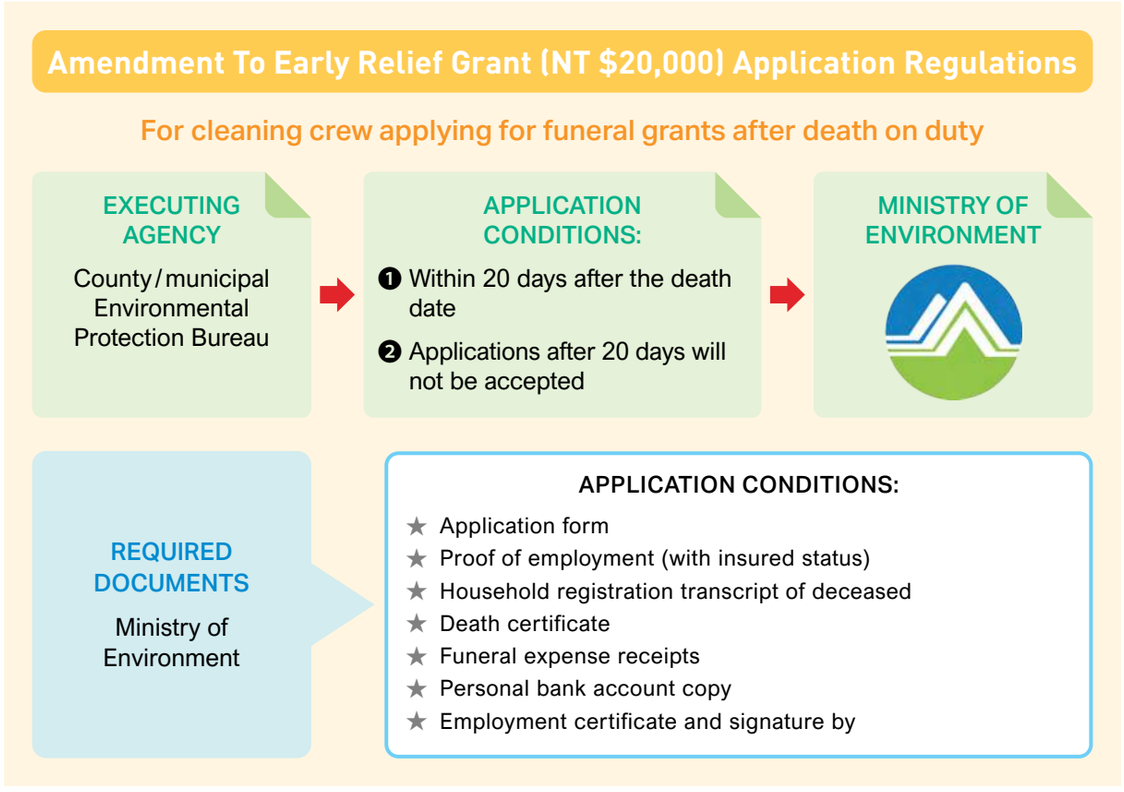


Figure 17 Revised Regulations for Early Assistance Grant Applications

2. **Nationwide Traffic Safety Campaign**: During "Traffic Safety Week," nationwide training sessions were held to raise sanitation workers' awareness of traffic safety and to prevent accidents.

3. **Garbage Truck Maintenance and Health Management**: To ensure the long-term safe operation of garbage trucks while also safeguarding workers' health, the government organized demonstration sessions on vehicle maintenance and repair (Figure 18), as well as on-site health promotion services for sanitation workers (Figure 19).

Figure 18
Guidance on Garbage Truck Front-End Maintenance

Figure 19
On-Site Health Management Services

4. **Improvement Plan for Sanitation Crew Rest Facilities**: Many sanitation crew rest areas face aging infrastructure problems. To enhance the working environment, the Ministry launched a program to improve these facilities, providing workers with safer and more comfortable workplaces (Figure 20).

Figure 20
Improvement of Sanitation Crew Rest Facilities

5. **Increased Safety and Sanitation Bonuses**: To recognize the dedication and hard work of sanitation workers, the Ministry raised both the driver safety bonus and the sanitation performance bonus, further motivating workers to maintain efficiency and safety on the job.

6. **Professional Training and Guidance Workshops**: In 2024, a total of 107 sanitation workers nationwide completed professional training. The Ministry also organized 105 sessions, including occupational safety and health management guidance meetings, on-site operational inspections, health promotion services for smaller sanitation teams (with fewer than 100 members), guidance for agencies with fewer than 200 workers to establish occupational safety and health systems, as well as liaison meetings, observation visits, and workshops on health protection, self- management, major accident prevention, professional skill development, and traffic safety.

5 Together Against Mosquitoes, Keeping Dengue Away

In a community in southern Taiwan, dense clusters of old buildings and numerous vacant houses once made it a hotspot for dengue fever outbreaks. To keep the epidemic under control, government agencies at all levels worked together, with sanitation crews completing the elimination of breeding sources within 24 hours. Public health education was also reinforced, encouraging residents to protect their homes collectively.Ms. Lin shared: "I used to think this was solely the government's responsibility. But now, everyone takes the initiative to remove standing water containers at home. The community has become more united and feels much safer."

The Crisis Is Here! Unveiling the Truth Behind the Spread of Dengue Fever!

In 2024, dengue fever outbreaks surged rapidly across Southeast Asia, and with increasing cross-border travel, the threat to Taiwan continued to grow. The hot and rainy summer climate further fueled the proliferation of mosquito breeding sites, posing significant risks to community health. Reported cases were concentrated in densely populated urban areas and environments prone to water accumulation, underscoring the urgent need for comprehensive environmental management as part of epidemic control efforts.

Eliminate Standing Water, Catch Mosquitoes — Nationwide Action!

In response to the characteristics of the outbreak, the Ministry introduced the "*Ten Enhanced Measures for Dengue Prevention and Control*." These measures include comprehensive health education campaigns, large-scale mobilization for breeding source elimination, coordinated action plans, inspections and evaluations, external audits, stricter checks on vacant land, abandoned houses, and construction sites, as well as equipment and insecticide preparedness. High-risk areas such as vacant houses, empty lots, and aging neighborhoods are inspected one by one. Authorities at all levels, together with residents, are required to carry out the "Inspect, Empty, Clean, and Scrub" actions (Figure 21). Ahead of peak dengue season, nationwide mobilization was launched under the slogan: "Standing Water OUT, Dengue BYE-BYE!"

Education and Public Awareness

Short videos were released online and promoted through social media platforms such as Facebook and Instagram to raise public awareness of mosquito prevention. In coordination with sanitation crew inspections, audio announcements were broadcast on the streets, while prevention manuals were distributed to households, schools, and

Table 2 Local Government Mobilization for Dengue Breeding Site Elimination

County and city	Date	
Taipei City	Apr. 1, 2024	Citywide Breeding Source Elimination Day
New Taipei City	Apr. 8, 2024	New Taipei City Dengue Prevention and Cleanup Campaign
Taoyuan City	Apr. 12, 2024	2024 Taoyuan Fights Dengue: Unite to Safeguard Our Homes
Taichung City	Mar. 30-31, 2024	2024 Citywide Dengue Cleanup Campaign
Tainan City	Mar. 11, 2024	Tainan Epidemic Prevention: A Nation Guided by All
Kaohsiung City	Mar. 20, 2024	2024 Kaohsiung Dengue Prevention Day — Citywide Community Action and Cleanup
Yilan County	Apr. 10, 2024	Dengue Breeding Source Elimination Training and Orientation Session
Hsinchu County	Mar. 26-27, 2024	Joint Breeding Source Cleanup and Awareness Campaign
Miaoli County	Mar. 31, 2024	Nationwide Action: Dengue Breeding Site Cleanup
Changhua County	Mar. 25-27, 2024	“Inspect, Empty, Clean, Scrub” Nationwide Mobilization to Eliminate Dengue Breeding Sources
Nantou County	Mar. 27-29, 2024	Nantou County Dengue Prevention and Breeding Site Cleanup Campaign
Yunlin County	Mar. 29, 2024	Yunlin County Dengue Cleanup Campaign
Chiayi County	Apr. 10, 2024	Chiayi Mobilization: Dengue Breeding Site Cleanup Campaign
Pingtung County	Mar. 26, 2024	Pingtung County Joint Dengue Breeding Source Elimination Campaign
Taitung County	Mar. 26, 2024	“Dragon Mobilization” Dengue Breeding Site Cleanup and Awareness Campaign
Hualien County	Apr. 30, 2024	Training on Dengue Source and Weed Cleanup with Epidemic Drill Briefing
Penghu County	Apr. 3, 2024	Dengue Prevention Knowledge Quiz Event
Keelung City	Apr. 18, 2024	Dengue Breeding Site Cleanup Training
Hsinchu City	Mar. 26, 2024	2024 Hsinchu City Dengue Prevention Kick-off: “Eliminate Breeding Sources, Mobilize Everyone”
Chiayi City	Mar. 30, 2024	Environmental Cleanup Day: Join In Together
Kinmen County	Mar. 30, 2024	Kinmen Dengue Vector Cleanup Awareness Campaign
Lienchiang County	Apr. 8-12, 2024	Lianjiang Dengue Cleanup Mobilization Rally

communities.To further strengthen epidemic prevention, model communities were established in high-risk areas, encouraging neighborhood cooperation, sharing of success stories, and motivating other regions to actively participate in prevention efforts. After each typhoon, the Ministry also issued press releases and used social media to remind the public to carry out the “Inspect, Empty, Clean, and Scrub” routine in their homes and surroundings.

Coordinating Resource Allocation Across Counties and Cities

Regular inspections are conducted on the stockpiles and expiration dates of sanitation equipment, disinfectant machinery, and medical supplies to ensure that, in the event of an outbreak, epidemic prevention resources across counties and cities can be rapidly integrated. These measures strengthen response mechanisms, improve the efficiency and effectiveness of epidemic control, and enhance preparedness and collaboration in handling public health emergencies.

Figure 21 The “Inspect, Empty, Clean, Scrub” Campaign

6 Respect the Ocean, Protect Our Coasts

The Environmental Threat of Marine Debris

Located at the junction of the Eurasian and Philippine Sea plates, Taiwan boasts a diverse coastal landscape: rugged rocky shores in the north, long stretches of sandy beaches and mudflats in the west, magnificent cliffs in the east, and hidden coral reef sanctuaries in the south. Yet, this beautiful coastline is facing severe challenges — increasing pollution, erosion, and declining ecological resources. Most critically, man-made litter poses a growing threat to marine life, gradually undermining the delicate ecological balance of the ocean.

Our coasts need protection. Only through collective action can we preserve this precious blue treasure!

Protecting the Ocean — Honoring the Sea, Setting Sail Together

Since 2020, the Executive Yuan has promoted the "*Salute to the Sea—Coastal Cleanup and Maintenance Program*," which clearly defines management responsibilities and establishes a three-tier cleaning mechanism of "regular cleaning, immediate cleaning, and emergency cleaning." In 2023, the program was continued under the Ministry of Environment's coordination, bringing together 9 ministries and 15 agencies, in collaboration with local governments, to establish a sustainable and effective coastal cleanup system. This ensures that Taiwan's 1,990 kilometers of coastline are "fully managed and fully clean."

The results have been significant: surveys estimate that the total amount of coastal waste decreased from 2,294 metric tons in 2019 to 981 metric tons in 2024—a 57% reduction (Figure 22). This demonstrates the strong commitment of both the government and the public to protecting the ocean. Moving forward, we will continue our efforts to make Taiwan's coastlines a beautiful home where people and nature coexist in harmony.

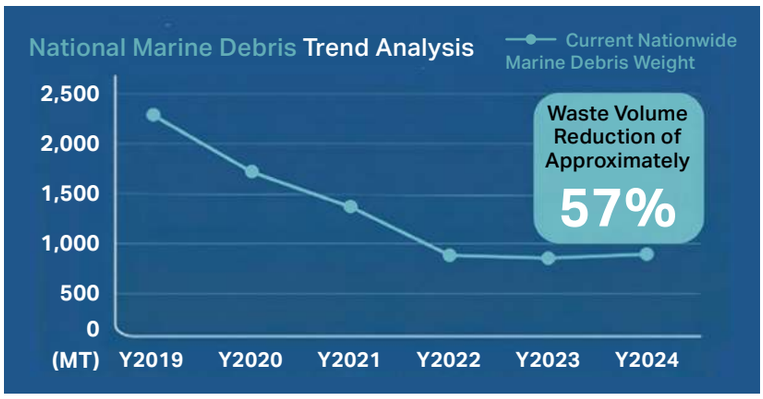


Figure 22
Nationwide Marine Debris Trend Analysis

Taking Action to Maintain Coastal Cleanliness

▲ Director-General Yan of the Environmental Management Administration dives to remove abandoned fishing nets from the seabed.

On September 8, 2024, Minister Peng of the Ministry of Environment, accompanied by Director-General Yen, visited Penghu and personally participated in an underwater cleanup, removing 80 kilograms of discarded fishing nets from the seabed. During the operation, Minister Peng experienced firsthand the difficulties of net removal — in addition to diving skills and equipment, one must also adapt to weather conditions, ocean currents, and the underwater environment. Such tasks cannot be completed in a short time.

However, abandoned fishing nets on the seabed pose a severe threat to marine ecosystems. Protecting the marine environment is an urgent matter that requires immediate and sustained action (Figure 23).

Figure 23

Left: Minister Peng (second from left), Director-General Yan (first from left), and colleagues from the Environmental Management Administration during a coastal inspection and cleanup in Penghu County.

Right: Results of marine environmental protection efforts — removal of abandoned fishing nets from the seabed.

On September 21, 2024, Minister Peng, together with Deputy Minister Wu Chih-Chung of the Ministry of Foreign Affairs and Mr. Filip Grzegorzewski, Head of the European Economic and Trade Office, led colleagues in a coastal cleanup at Bali North Dike in New Taipei City, braving wind and rain. The event coincided with World Cleanup Day and International Coastal Cleanup Day (the third Saturday of September), serving as a concrete action to support coastal cleanliness.

Minister Peng emphasized that Taiwan is not only a partner of the EU in trade and economics but also shares common values on a wide range of issues. With the participation of the European Economic and Trade Office and EU member states, this effort was more than just a single cleanup activity — it was also a call to the public to pay closer attention to climate change and plastic pollution (Figure 24).

Figure 24
Joint Coastal Cleanup with the European Economic and Trade

The Ministry of Environment coordinated 9 ministries, 15 agencies, and 19 local governments to jointly promote coastal cleanup and management under the principles of “regular cleaning,” “immediate cleaning,” and “emergency cleaning,” ensuring that every stretch of coastline is managed and kept clean.

In 2024, a total of 11,291 coastal cleanup events were organized nationwide, with 195,051 participants from the public, businesses, and organizations, collectively removing 3,985 metric tons of coastal waste.

“Salute to the Sea” — Achieving Even Greater Results Together

Through the joint investment of resources and proper division of responsibilities among central ministries, local governments, and civic groups, a cross-sectoral cooperation mechanism has been established to implement coastal cleanup efforts. Together, these efforts advance the “*Salute to the Sea*” policy, ensuring that coastlines remain not only clean and beautiful but also laying a solid foundation for future marine ecological protection. The key achievements of this initiative are as follows:

1. Organizing the “Salute to the Sea” Achievement Forum:

   In 2023, the Ministry of Environment hosted the forum, with Minister without Portfolio Wu Tze-Cheng of the Executive Yuan providing guidance. A total of 200 participants attended, including representatives from 32 government agencies and 16 civic organizations. The forum facilitated the sharing of experiences in coastal cleanup and maintenance, encouraging mutual learning and joint efforts to create cleaner coastlines.

2. Holding a Business Observation Meeting:

   On August 6, 2024, a business observation meeting was held, attended by Minister without Portfolio Chen Chin-Te of the Executive Yuan, the Ministry of Environment, and staff from central agencies and environmental authorities responsible for the “Salute to the Sea” program. A total of 111 participants took part (Figure 25). The itinerary included exchange meetings and field inspections at locations such as Taichung Port and Gaomei Wetlands, strengthening both vertical and horizontal communication among agencies and injecting momentum into coastal protection.

Figure 25 Business Exchange under the “Salute to the Sea” Coastal Cleanup

3. On-Site Inspections of Coastal Cleanliness:

   In line with the evaluation procedures of the “Salute to the Sea” program, five rounds of on-site inspections were conducted in 2024. Senior officials from the Executive Yuan and the Ministry of Environment led teams to Changhua County, Yilan County, Tainan City, Keelung City, and Chiayi County, with a total of 103 participants. These inspections provided a direct understanding of the coastal cleanup and maintenance outcomes achieved by central and local governments.

4. Establishing Evaluation Procedures:

   Under the “Salute to the Sea – Coastal Cleanup and Maintenance Program,” Minister without Portfolio Chen Chin-Te of the Executive Yuan serves as convener, with the Ministry of Environment acting as secretariat to supervise, coordinate, and integrate

cleanup work at all levels of government. To enhance management efficiency, new evaluation procedures were introduced in 2024. Performance is assessed and scored based on criteria including “regular cleaning,” “immediate cleaning,” “emergency cleaning,” “budget execution,” and “other designated tasks.” These measures encourage proactive implementation, innovation, and the strengthening of marine management to ensure sustainable ocean development.

5. Pioneering Public Disclosure of Coastal Cleanliness:

A quarterly evaluation mechanism for coastal environment rapid assessments has been established. The results are submitted to the Executive Yuan, highlighting the 10 cleanest coastlines and the 10 most prone to marine debris accumulation. After reporting to the Executive Yuan, the findings are published on the “Coastal Cleanup Information Platform” website (https://ecolife2.moenv.gov.tw/Coastal/Links).

6. International Coastal Cleanup (ICC):

To monitor the quantity and types of coastal waste, in addition to conducting rapid assessments, the Ministry collaborated with environmental protection agencies from 19 coastal counties and cities to carry out ICC surveys each quarter. These efforts helped establish a national database on the composition of coastal debris, serving as a critical reference for developing waste reduction and management policies.

According to the survey results, the total number of coastal waste items nationwide decreased from 14,870 in 2019 to 6,153 in 2024 — a reduction of about 58.6%. Plastic waste decreased from 8,088 items in 2019 to 3,918 in 2024, a reduction of about 51.6%. Among all categories, “household and recreational waste” was the most prevalent, accounting for 74.9% (including 12 subcategories such as PET bottles and other plastic containers, disposable drinkware such as straws and cups, plastic bags, and other packaging materials). The second largest category was “fishing and recreational angling waste,” accounting for 17.5% (including fishing buoys/floats/boat fenders, nets and ropes, and fishing gear).

7. Applying AI Tools to Detect Coastal Litter Hotspots:

In 2024, the Ministry utilized unmanned aerial vehicles (UAVs) combined with artificial intelligence (AI) image recognition technology to inspect 15 coastal sites, covering a total surveyed area of 13.183 square kilometers. This approach successfully identified, reported, and facilitated the cleanup of over 582 metric tons of waste — marking a major breakthrough in the interpretation and application of coastal debris monitoring.

Through large-scale aerial surveys, UAVs enabled rapid detection of polluted areas along the coastline, allowing for real-time reporting and cleanup, and restoring clean and beautiful coastal scenery for the public.

Smart Inspections for Environmental Law Enforcement

2024

Environmental Management Administration Annual Report

1 Fostering Dialogue with Environmental Engineers: Elevating Certification Standards for Excellence

▲ Group Photo — 2024 Consensus Workshop on Professional Engineer Licensing Documentation

Collaborative Environmental Protection: 2024 Environmental Engineer Fostering Dialogue Gathers 300 Experts Certification Auditing Mechanisms

The Administration launched its first "2024 Professional Engineers' Certification Consensus Workshop for Air, Water, and Soil Pollution Permits" on October 24, 2024, at Taichung Tzu Chi Jing Si Hall. The workshop brought together certifying engineers, county/municipal environmental bureau reviewers, and the Administration's auditors to discuss common certification challenges and legal ambiguities, aiming to reduce disagreements and improve certification quality. Approximately 300 participants from the Ministry of Environment, local environmental agencies, practicing engineers, and engineer associations attended. Recognizing their shared environmental protection mission, participants sought to improve permit and environmental engineering certification systems through professional dialogue, ensuring effective oversight of factories' environmental impacts.

Incorporating Expert Insights: Enhancing Engineer

According to environmental protection regulations, when businesses undergo major process changes or establish new factories, their environmental permit documents must be certified by environmental engineering professionals to ensure that pollutants at every stage of the process can be effectively controlled and reduced. To ensure environmental engineers can fully utilize their professional capabilities, the Administration has established the "Environmental Engineering Professional Certification Rules," requiring

engineers to conduct on-site inspections of pollution control equipment and measures when performing certification duties. The Administration also annually selects and audits certification documents based on the "Standard Operating Procedures for Environmental Protection Professional Certification Audits" to ensure consistency and fairness in auditing. During the consensus workshop, special arrangements were made for engineer associations and audit committee members to discuss these procedures, building consensus across all sectors to improve overall certification quality (Figure 26).

Figure 26
Strategic Meeting on Enhancing the Review Mechanism for Environmental Engineer Certification

Enhancing Review Consistency: Upholding the Integrity of the Permit System

The permitting process for air, water, and soil pollution involves certification by professional engineers, reviews by environmental agencies, and audits—each managed by different authorities. To ensure consistency across government agencies, the consensus workshop invited officials from the Ministry of Environment's Air, Water, and Soil departments to explain relevant regulations and systems.

Practicing engineers shared real-world challenges during certification, with regulatory authorities providing on-the-spot clarifications (Figure 27). The event saw active discussions and received positive feedback afterward.Environmental engineers are key to environmental protection. We hope to continue holding such events to collaboratively address challenges, improve current regulations, and protect the environment for future generations.

Figure 27
Explanation of Engineer Certification, Environmental Agency Review, and Inspection Procedures

2 Uncovering the Deception of Rental Scams Driven by Illegal Waste Dumping

Figure 28 Extensive industrial waste piled up within the facility

Leasing with Caution: Prevent Rental Scams Driven by Illegal Waste Dumping

In Nantou County, renowned for its natural beauty, residents never imagined that a simple land rental could lead to an illegal waste dumping incident, exposing loopholes in land management and the serious environmental threats posed by illegal operators.

The incident occurred in April of a certain year when an elderly couple rented out their long-vacant factory at a low price to what appeared to be a legitimate business. What seemed like a straightforward rental transaction took a sinister turn two months after the contract was signed. When the landlords visited the factory for inspection, they noticed several suspicious signs—the facility was surrounded by black screening nets, pungent odors filled the air, and the tenant was evasive about the factory's purpose, giving vague and shifty responses. Sensing something was wrong, the landlords decided to enter the premises and were shocked to discover massive piles of illegal waste, including unknown liquid waste, mixed plastic waste, bottom ash, and fly ash—both general and hazardous industrial waste (Figure 28).

The landlords immediately reported to environmental authorities and police. Joint investigation revealed that the tenant lacked any legal disposal permits and used the factory rental as a cover for secretly dumping waste—making this a case of "fake rental, real dumping" environmental crime. Cleanup costs were estimated at over 50 million NT dollars, but the tenant had already disappeared and was unable to take responsibility. To

prevent pollution spread and protect surrounding residents' health, the landlords ultimately had to pay out of their own pockets for cleanup and remediation to restore the land. In the end, they not only failed to recover rental payments but also had to pay enormous cleanup costs—truly a case of "losing both the wife and the soldiers"!

Raising Awareness: Preventing Rental Scams and Environmental Crimes

Widespread public attention, prompting the Ministry of Environment to immediately establish stricter rental inspection regulations and advocate for increased public vigilance. Through educational campaigns to raise awareness of such environmental crimes, the Ministry produced "Fake Rental, Real Dumping" infographic cards in 2024 (Figure 29) and a promotional video titled "Be Careful When Renting Out! Preventing Fake Tenancy and Real Dumping" (Figure 30), using related case examples to help people stay alert before renting out factories or land, preventing dumping situations from occurring. The public is reminded not to be tempted by small profits that could lead to significant losses, resulting in enormous cleanup costs in a short time—truly not worth the risk.

Figure 29
Awareness infographic reminding the public to carefully verify rental counterparties.

Figure 30
Public Awareness Video: "Be Cautious When Leasing! Prevent Fake Tenancy and Illegal Dumping"

The Administration once again emphasizes that before renting out factory premises, the public must remember 4 key principles: 1. Proper land management 2. Carefully select tenants 3. Confirm rental purposes 4. Strengthen land inspections.

When residents notice suspicious trucks or vans entering or leaving their neighborhoods, newly formed mounds of soil or piles of garbage, signs of damaged fences, or the presence of unusual odors, these may serve as warning signals. Such occurrences could indicate illegal dumping activities. Residents can immediately report these incidents to the Environmental Complaint Reporting Center (0800-066666, via APP or online, Figure 31) to detect problems early, effectively prevent related criminal activities, and protect the land from being harmed by illegal dumping.

Figure 31 Online System for Environmental Complaint Filing

3 Environmental Agencies, Police, and Prosecutors Unite: Joint Crackdown on Environmental Crimes

▲ Golden Enforcement Award ceremony honoring frontline environmental officers and cross-agency collaboration.

Law Enforcement-ProsecutorsAgency Collaboration in Combating Environmental Crimes

The Administration collaborates with prosecutors, the Third Brigade of the Seventh Special Police Corps, and local environmental agencies to combat environmental crimes. From 2015-2023, joint operations handled 2,230 cases, prosecuted 6,740 individuals, and seized 889 equipment pieces. In 2024, cooperation resulted in 148 cases, 589 prosecutions, and 38 equipment seizures, including cross-county illegal dumping of industrial sludge, construction waste, and landfill materials.

A comprehensive national alliance system is established. Future cooperation will enhance criminal forfeiture applications and mandate environmental restoration by violators to recover national land.

Implementing Advanced Enforcement Strategies and Pollution Prevention Technology Exchange

Enhance inspection capabilities, three "Pollution Prevention Management Factory Exchange Meetings" were held in 2024 at Taiwan International Shipbuilding, Lumosa

Technology, and Chi Mei Corporation. Expert scholars provided training on industrial processes and pollution prevention measures to improve inspectors' professional knowledge.

A "Cross-Domain Professional Technical Alliance" was introduced, involving finance, law, and environmental engineering experts to assist enforcement and calculate illegal profits. Regular consultation meetings with experienced prosecutors facilitate knowledge exchange on environmental crime investigation.

Building Consensus Among Law Enforcement Agencies and Recognizing Outstanding Personnel

"2024 Golden Ring Award Ceremony and Environmental Crime "2024 Golden Ring Award Ceremony and Environmental Crime Investigation Mobilization Rally" To strengthen environmental enforcement consensus, the Administration co-hosted this event with the Taiwan High Prosecutors Office and Forestry Conservation Agency on September 19, 2024. With 259 participants from prosecution offices, police agencies, and environmental authorities, the ceremony recognized outstanding personnel and launched the "Protecting Our Land with Unwavering Determination" mobilization (Figure 32).Executive Yuan Political Deputy Minister Lin Ming-hsin led the ceremony, symbolizing cross-ministerial unity and pledging continued commitment to combat environmental crimes and protect sustainable national development.

Figure 32 "United in Protecting Our Land – Unwavering Commitment" Pledge Ceremony

4 Smart Fencing: Eliminating Illegal Dumping Hideouts

▲ Tracking nighttime illegal waste removal through surveillance equipment.

Persistent Violations and Evasion Tactics by Unscrupulous Operators

Taiwan's economic development has generated various environmental pollution issues, including untreated industrial wastewater and emissions that threaten public health and quality of life. Large-scale construction projects and industrial activities produce massive waste quantities that unscrupulous operators transport across counties to remote areas like farmland and fish ponds, causing environmental contamination and land resource destruction.These operators employ sophisticated evasion tactics including disabling GPS tracking systems, antenna blocking, false reporting, and using unregistered vehicles, significantly complicating enforcement and evidence collection efforts.

Enhancing Waste Management and Monitoring of Clearance Routes

Waste haulers required to install GPS systems under the Waste Management Act often deliberately disable devices or falsify vehicle trajectories, complicating regulatory oversight. To address this issue, the Administration has implemented a "Parallel Monitoring Mechanism" utilizing license plate recognition technology. Remote monitoring equipment is deployed on roads adjacent to dumping hotspots and major cross-county thoroughfares, with recognition data cross-referenced against GPS system records to automatically detect intentional device shutdowns or trajectory irregularities (Figure 33).

Non-registered vehicles frequently observed at illegal dumping sites are subject to source tracking and investigation.

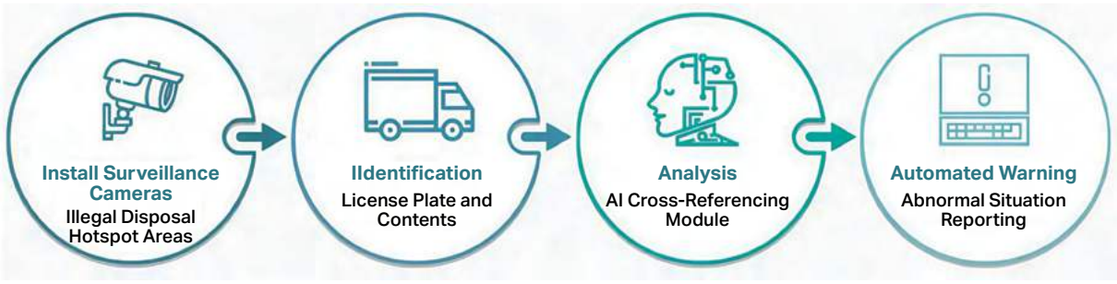


Figure 33 Smart Fence Mechanism for Preventing Illegal Dumping

Previously, many violation patterns involving registered waste transport vehicles could not be determined solely from GPS trajectories. Since establishing the illegal dumping smart fence system as a parallel GPS trajectory comparison mechanism, the system has continuously identified vehicles without trajectories or with severely deviated routes. By detecting abnormal waste transport vehicle patterns, this system not only strengthens oversight of waste haulers but also enables local environmental personnel to proactively identify potentially problematic operators for inspection, preventing illegal waste dumping incidents (Figure 34)

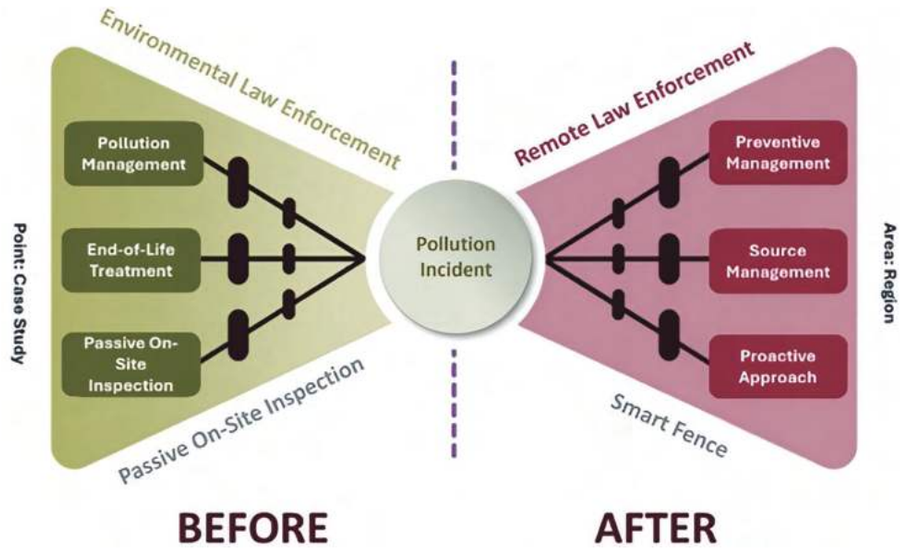


Figure 34 Explanation of Differences in Smart Fence Management

5 Harnessing Big Data for Environmental Governance: Early Warning System for Public Nuisance and Environmental Pollution

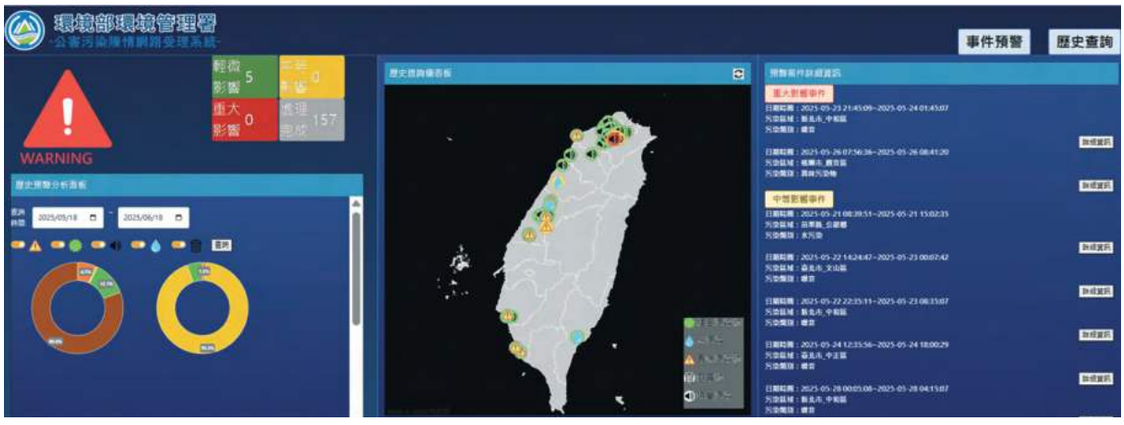
Preventive Measures: The Importance of the Public Nuisance Petition Early Warning System

Have you ever felt concerned about unexplained odors, changes in river water quality, or waste appearing near your residence? In addition to providing multiple complaint channels for public reporting, the Administration has established a "Public Nuisance Pollution Complaint Early Warning System" to promptly identify cases that may be precursors to major pollution incidents. This system enables earlier detection of potential environmental pollution problems and immediate notification to relevant agencies for response, aiming to minimize pollution impacts.

How Big Data Serves as a "Meticulous Observer" in Environmental Protection

Through big data analysis of the public nuisance pollution complaint management system, public reports are analyzed to identify types that may cause major pollution, with corresponding early warning conditions established. When public complaints meet these criteria, the system issues alerts, enabling environmental personnel to respond more promptly and take appropriate measures.

- **Early Warning Conditions**: The system establishes different warning criteria for various pollution types, with continuous adjustment and optimization of these conditions.
- **Tiered Warning Mechanism**: To enable local environmental agencies to handle warning cases more efficiently, the system incorporates a tiered warning mechanism. When multiple warning cases occur, environmental units can prioritize inspection plans according to warning levels, allocating resources to more severe pollution incidents first.



▲ Pollution Alert System Interface Showing Reported Cases and Risk Levels (System Screenshot)

Joint Participation in Protecting Our Environment

The handling of environmental pollution complaints relies not only on government action but also on active public participation. Whenever individuals observe suspected pollution incidents, they can report them at any time through the Public Nuisance Petition System. Each report may serve as a critical clue in identifying major pollution sources. The system consolidates and analyzes incoming data, forwarding it to relevant agencies for follow-up. This process forms a nationwide, participatory environmental monitoring network (Figure 35).

Figure 35 Multiple Channels for Accepting Complaints

Technological progress strengthens environmental protection efforts

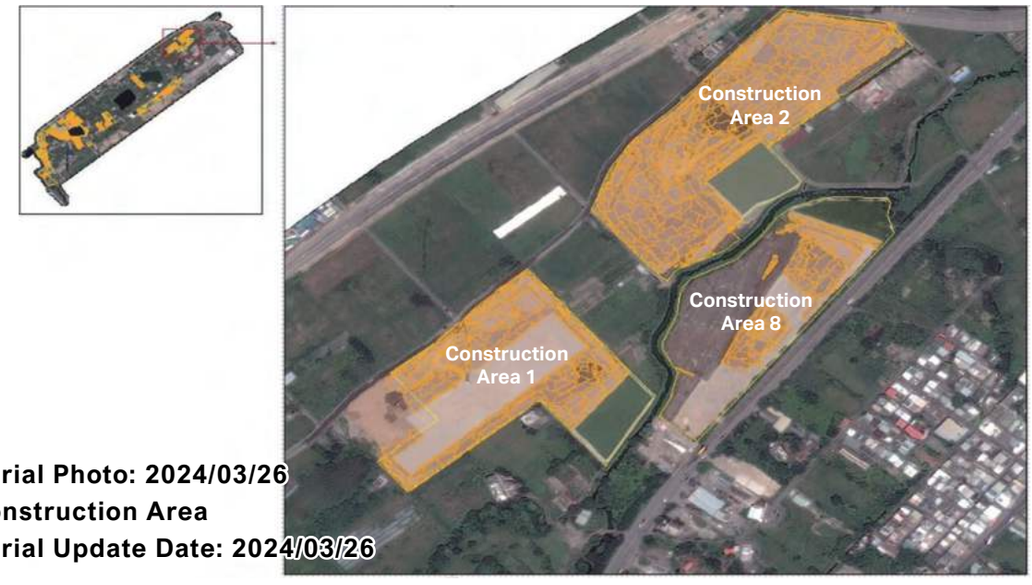
Technological advancement has enhanced environmental protection through intelligent systems, with the public nuisance complaint alert function serving as a key application. This system improves processing efficiency and enables earlier pollution detection and resolution. Through public reporting and rapid response, exposure risks are reduced, ensuring greater public safety and security.

United for a Healthier Future: The Mission and Vision of the Public Nuisance Petition Early Warning System

The "Public Nuisance Pollution Complaint Early Warning System" integrates technology with public participation as a collaborative platform for environmental and health protection. The system utilizes real-time public reports, automated case correlation analysis, and early warning notifications to enable swift government response and prevent pollution escalation.

6 Strengthening Environmental Impact Assessment (EIA) Supervision: New Opportunities Through Cross-Sector Collaboration

Tubo Electrical Engineering Site Locatior



▲ Verified Compliance Imagery of Exposed Ground at Taoyuan Airport Construction Site

Leveraging Technology to Verify Compliance with EIA Commitments ("Taiwan Taoyuan International Airport Third Runway Environmental Impact Statement " Exposed Ground Area Calculation)

Taoyuan International Airport's third runway covers an extensive area, making ground- based observation insufficient for comprehensive assessment of exposed ground distribution and changes. Therefore, 2024 satellite imagery was utilized for remote sensing analysis to precisely calculate exposed ground within the third runway construction zone.

In determining exposed ground, areas where developers have implemented effective dust control measures according to the "Management Regulations for Air Pollution Control Facilities in Construction Projects"—including dust covers, nets, steel plates, concrete, asphalt concrete, aggregate materials, or vegetation—are excluded from the exposed ground category. Remote sensing technology effectively overcomes ground observation limitations and enhances exposed ground management efficiency.

Object-oriented image classification methods were applied to satellite imagery for ground feature analysis and exposed ground interpretation at Taoyuan Airport construction zones. Pixels with similar characteristics were segmented into small area feature objects, with vegetation and water bodies statistically classified, followed by

automated screening of remaining imagery for preliminary exposed ground identification. Different degrees of exposed ground required appropriate manual interpretation—such as agricultural bare soil from farming activities or construction-related aggregate laying, dust nets, and sedimentation ponds—which were reclassified as non-exposed ground to obtain final airport construction zone exposed ground data.

Optimizing the EIA Supervision System: Implementing Tiered Management Systems

The Environmental Impact Assessment Act aims to prevent and reduce environmental impacts from major developments. The Administration implements tiered management based on development type and risk level, actively supervising developers' compliance with EIA commitments. For high-risk projects, expert committees provide professional oversight to strengthen supervision mechanisms. Cross-ministerial cooperation platforms ensure comprehensive joint supervision and inspection across all development cases.

- **Project-Specific and Expert Supervision Committee Meetings**: Given significant public concern over major developments, the Administration convenes expert committees for cases including "Sixth Naphtha Cracker Complex," "Guantang Third LNG Terminal," "Wuxi Niaozuitan Artificial Lake Project," and "Taipei Port Development Plans." Seven meetings were held from November 2023 to December 2024, monitoring compliance with EIA conclusions and commitments.
- **Case-Specific On-Site Supervision**: As of October 2024, 701 development cases are under the Administration's management using tiered supervision based on development characteristics. Priority is given to projects under construction or combined construction-operation phases for field supervision, while operational projects undergo compliance reporting reviews. From November 2023 to December 2024, 551 cases underwent EIA supervision and document review, with 22 penalties issued totaling NT$20.22 million.

EIA Oversight and Coordination: Regulatory Briefings and Interagency Cooperation Meetings

- **EIA Supervision Regulatory Briefings**: Five sessions were conducted across four regions from July 16 to August 21, 2024, with 424 participants. The briefings addressed EIA supervision regulations, case studies, violation patterns, and compliance requirements, urging developers to fulfill EIA commitments.
- **EIA Tracking and Supervision Exchange Forums**: The Administration clarified tracking responsibilities assigned to competent authorities under the EIA Act and requested agencies to review cases for Article 16-2 compliance to facilitate removal from EIA oversight EIA Oversight and Coordination: Regulatory Briefings and Interagency Cooperation Meetings.

Strengthening Regional Environmental Governance

2024

Environmental Management Administration Annual Report

Establishing NGO Partnerships: Jointly Safeguard Northern Taiwan's Environment

Collaborating with Non-Governmental Organizations(NGOs) Address Environmental Pollution

The Administration's Northern Regional Environmental Management Center (Northern Center) focuses on addressing water pollution issues in northern Taiwan, actively collaborating with multiple NGOs including the "Taoyuan Local Alliance," "Taoyuan Coastal Ecological Conservation Association," "Hsinchu County Guanxi Township Environmental Protection Association," "Wilderness Protection Association Taoyuan Branch," and "Taiwan Clean Water Action Alliance" to enhance ecological protection effectiveness.

Establishing an Inter-County Water Environment Coordination Platform

The Administration jointly established a "Taoyuan-Hsinchu Cross-County Water Pollution LINE Group" with environmental organizations to promptly monitor environmental pollution cases in Taoyuan City and Hsinchu County for rapid response. When environmental groups report river issues through the group, immediate contact is made with local environmental bureaus for on-site investigation, maintaining communication channels to track pollution inspection and emergency response progress, with regular liaison meetings held.

In 2024, two Taoyuan algae reef pollution source supervision and control review meetings, one metal surface treatment industry pollution self-management promotional meeting, and four cross-county liaison forums were conducted.

Promoting Self-Regulation in Wastewater Management in Metal Surface Treatment Industries

Metal surface treatment is a key manufacturing industry in Taiwan. As the industry develops, its wastewater contains harmful heavy metals, strong acids, and alkalis, producing hazardous sludge with extremely high treatment costs, leading some operators to illegally discharge waste to reduce expenses. Source separation of wastewater containing different heavy metals would create recoverable sludge value and significantly reduce treatment costs.

To promote new concepts of industrial self-management in pollution control, on May 28, 2024, the Administration convened a "Metal Surface Treatment Pollution Self-Management Promotional Briefing" with participants including the Taiwan Surface Treatment Industry Association, northern region operators, Industrial Technology Research Institute, northern county/municipal environmental bureaus, and Ministry of Environment units (Ethics Office, Water Quality Protection Department, and Atmospheric Environment Department).

The briefing promoted new concepts of industrial self-compliance, encouraging the industry toward clean production milestones and creating environmental sustainability through public-private cooperation (Figure 36, 37).

Figure 36
Director-General Chairs Meeting on Metal Surface Treatment Wastewater Self-Management

Figure 37
Promoting Industry Self-Regulation

Interagency Cooperation to Address Pollution in Taoyuan's Algal Reefs

To protect Taoyuan's water quality and algal reef ecosystem, the Administration established the Taoyuan Algal Reef Pollution Source Inspection and Control Plan. Through cross-departmental collaboration with Taoyuan City Government bureaus and Ministry of Economic Affairs industrial park service centers, we conduct biannual review meetings to assess outcomes. Participating units report on inspection results and industrial self-management effectiveness, while civil environmental groups including the Taoyuan Local Alliance participate to strengthen NGO partnerships for environmental protection (Figure 38).

Progress in Heavy Metal Pollution Remediation in Taoyuan's Rivers and Coastal Areas

The Taoyuan Local Alliance reported that recent field surveys at the Guanxin algal reef area showed wild oyster meat has changed from green to white, indicating improved coastal heavy metal pollution. This is confirmed by Taoyuan City EPB's 2024 Q1-Q3 monitoring showing non-detectable copper concentrations at river estuaries.

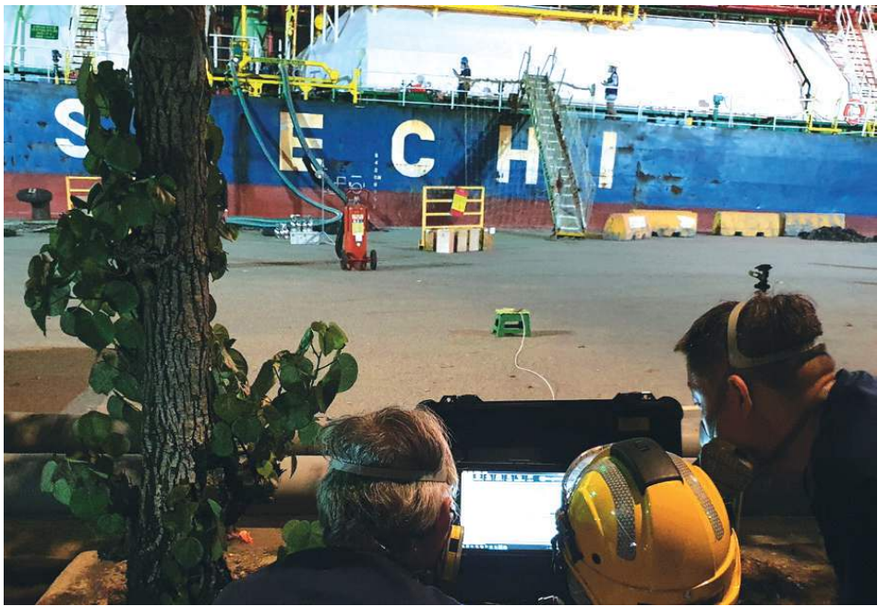
Promoting Environmental Education and Knowledge Exchange

On May 17, 2024, we held the "Environmental Education Consensus Camp" with six civil environmental groups including the Hsinchu County Guanxi Environmental Protection Association. The meeting shared enforcement case studies on water treatment plant pollution and gravel wastewater violations, enhancing groups' understanding of enforcement strategies and strengthening public-private cooperation (Figure 39).

Figure 38
Conducting "Taoyuan Algal Reef Pollution Source Inspection and Control Plan" implementation results review meeting

Figure 39
"2024 Environmental Education Consensus Camp" event

1 Mobilizing Public Engagement: Fight Environmental Violations



Taipei Port Chemical Spill:Equipment Failure CausesAir Pollution

On August 22, 2024, an Indonesian-registered LPG vessel leaked vinyl chloride monomer (VCM) during unloading operations at Taipei Port due to malfunctioned pressure relief equipment, causing air pollution.

Emergency Response:Investigation and Handling of the VCM Leak Incident

On October 18, 2024, an Indonesian vessel with VCM cargo docked at Taipei Port. The crew used only soapy water for pipeline checks, causing VCM leakage and air pollution. Thermal imaging confirmed emissions from the ship's funnel. Prosecutors are investigating potential criminal charges under Taiwan's Criminal Code Article 190-1.

Deferred Prosecution and Environmental Accountability: Follow-up on the Indonesian Vessel Pollution Incident

December 2024: Shilin Prosecutors Office charged Indonesian captain and chief mate with negligent toxic air pollution (Criminal Code Art. 190-1-6). Deferred prosecution granted after ship repairs completed. Fines: Captain NT$3.5M, Chief Mate NT$9.5M. Joint task force established with Ministry of Environment and law enforcement to combat environmental crimes using academic and expert support.

2 Actively supervising the remediation and reorganization of Zhudong Landfill

Central-Local Collaboration to Address Waste Management Challenges

Zhudong Landfill's 10,862 tons of temporary waste (March 2024) has been completely cleared through inter-county coordination. Leachate is regularly treated at processing facilities. Touqian River water quality is monitored continuously, with annual testing for heavy metals, pesticides, and emerging contaminants to ensure safe drinking water.

Utilizing technology to introduce external expert diagnostics and continuously supervise waste cleanup

- **Drone Survey & Waste Disposal**: Aerial drone assessment of exposed waste areas with volume estimation. Coordinated with Chiayi Lucao and Yilan Lize incineration plants, clearing over 17,000 tons. All temporary platform waste removed.
- **Expert Diagnostics**: On-site expert inspections considering waste transfer needs and geographical conditions, providing operational management recommendations for Hsinchu County EPB and Zhudong Township.
- **Regular Supervision**: Ongoing monitoring and site inspections, resolving local issues, coordinating inter-county waste processing capacity, and providing treatment solutions (Figures 40).

Figure 40 Site Conditions Before and After Waste Removal

Enhancing Regional Cooperation and Waste Resilience

Given Hsinchu County's incinerator started operations December 26, 2024, The Administration requested Hsinchu County collaborate with neighboring counties through existing platforms to include their facility in mutual support arrangements, strengthening northern region waste processing resilience.

3 Specialized Oversight and Compliance Assistance for Livestock Wastewater Management

Root Causes of Wastewater Pollution in the Livestock Industry

Yunlin and Changhua Counties are major livestock centers where intensive farming creates water pollution risks. The Xinhuwei, Beigang, and Old Zhuoshui River basins show high levels of suspended solids, ammonia nitrogen, and biochemical oxygen demand. Many livestock operators have inadequate wastewater treatment or illegally bypass/dilute discharge to avoid regulations and reduce costs.

Countermeasures and Strategies: Enforcement and Guidance in Parallel

Since April 2024, the Central Region Environmental Management Center conducted specialized controls on 45 livestock facilities in highly polluted watersheds. Following compliance improvements, annual reductions of 366 tons of organic matter and 184 tons of suspended solids are estimated, significantly reducing environmental burden. The Center held a livestock water pollution prevention meeting with nearly 70 operators to enhance pollution control knowledge and self-management capabilities (Figure 41). Continued inspection and guidance will ensure environmental compliance and improve regional water quality (Figure 42).

Figure 41
Livestock Industry Awareness and Exchange Forum

Figure 42
Identified and intercepted an illegal wastewater dilution mechanism at a livestock farm in Yunlin County

4 Establishing Model Zones for Self-Governed Wastewater Treatment in Collection Areas

Innovative Management Approach: River Water Quality Monitoring and Risk Mitigation Strategies in Central Taiwan

To enhance pollution risk prevention in central Taiwan rivers, The Administration launched an industrial wastewater self-management demonstration zone in 2024. Smart water quality sensors automatically alert businesses in watershed pollution zones when water quality warnings occur, prompting self-inspection and improvements to reduce pollution risks.Taichung's Guangxinglong Drainage and Dali River water gate pollution zones were selected as demonstration areas, with 8 water quality monitoring facilities installed upstream and downstream for comprehensive water quality monitoring and precise watershed tracking (Figure 43).

Figure 43 Diagram of Implementation Method

Establishment of Self-Regulation Mechanism for Collection Area Enterprises: Enhancing Water Quality Monitoring and Rapid Response Capability

The Administration held 2 briefings for industrial self-management mechanisms, inviting wastewater operators and Taichung EPB while establishing dedicated communication channels.When sensors detect water quality abnormalities, LINE alerts are sent to zone businesses for immediate facility inspection, corrections, and group reporting.

Evaluation of Self-Regulation Mechanism Effectiveness: Future Prospects for River Water QualityImprovement

Guangxinglong Drainage pollution zone's abnormal alert rate decreased from 2.01% to 0.18% (91.0% improvement) while Dali River drainage zone improved from 1.19% to 0.24% (79.8% improvement). Sensor implementation significantly enhanced industrial self-management effectiveness, though some monitoring points still show abnormal alerts requiring future optimization through comparative analysis of wastewater treatment operations, continuous review, and encouraging source self-management to ensure river water quality.

5 Harnessing Smart IoT for Air Quality Enforcement: Precision Detection in Action

Smart Monitoring Unveils Environmental Crisis in Changbin Industrial Park Under the Cover of Darkness

Under cover of darkness, Changhua County's Changbin Industrial Park was shrouded in smoke. The Administration's Central Center and Changhua County EPB conducted surprise nighttime inspections, identifying 2 businesses improperly handling air pollutants that had been releasing untreated smoke and dust during late night hours, causing severe pollution.Using smart air quality sensor IoT data and monitoring, the Center pinpointed abnormal emissions from 2 metal smelting plants. Due to insufficient collection system efficiency, massive particulate-laden smoke escaped from factory entrances and vents like dust storms, covering the night sky (Figure 44).

Figure 44

Left: During nighttime operations, industrial facilities released large volumes of airborne particulate.

Right: The failure to properly capture emissions resulted in widespread smog.

Application of Smart Technology in Environmental Management

The inspection actions are not only a warning to non-compliant operators but also a successful example of collaboration between the Administration and local EPBs. The Administration will continue to leverage technological tools, such as the Smart Air Quality IoT big data system, to conduct precise monitoring and management of pollution sources, while continuously tracking the improvement progress of operators to ensure that air quality is no longer threatened.

6 Tracing the Source: Environmental Crime Case of Illegal Waste Acid Solution Dumping

Environmental Crisis Behind the National Day Holiday: Investigation of Strong Acid Irrigation on Farmland Case

During the National Day long weekend in October 2022, Taichung City EPB discovered a case of unscrupulous operators injecting strong acid into farmland in Qingshui District. The Taichung District Prosecutors Office immediately directed police units, and the Administration established a task force with the EPB. After actively expanding the investigation, source tracing revealed that a waste acid wash solution recycling facility in Taoyuan City had received industrial waste acid wash solutions and, without undergoing approved recycling processes, commissioned illegal operators for external transportation and disposal (Figure 45). This environmental crime case involved disposal sites spanning Taoyuan City, Miaoli County, Taichung City, and Changhua County (Figure 46).

Figure 45
Zhonggang River in Sanwan, Miaoli Turned Red for 3 Kilometers

Figure 46
Top: Prosecutors Inspect a River with Damaged Ecosystem.

Bottom: The Environmental Protection Administration and prosecutors carried out excavation operations at an illegal dumping site in Miaoli County.

Unveiling Criminal Conduct: Task Force Penetrates Defenses to Obtain Crucial Evidence

During investigation, operators fabricated false production records, shipment reports, invoices, forged weighing slips and seals, and falsely reported material usage to evade environmental inspections. Through joint cooperation between the prosecutorial-police-environmental task force and local EPBs, the team traced waste acid sources, penetrated criminal networks, broke through defensive barriers, secured key evidence, and swiftly terminated illegal activities damaging national land and polluting the environment.

Environmental Law Enforcement Results: Criminal Proceeds Seized Exceeding NT$56.09 Million, Illegal Gains Penalized NT$33.75 Million

Enforcement actions serve not only as a deterrent to non-compliant operators but also as a successful example of collaboration between the Administration and local authorities. Moving forward, the Administration will continue leveraging smart air quality IoT big data to enable precise monitoring and management of pollution sources. Additionally, continuous follow- ups will be conducted to track industry improvements and ensure sustained air quality protection.After six months of investigation including site inspections, financial flow analysis, big data comparison, and excavation/testing at disposal sites, the criminal methods were exposed. County EPBs assessed contamination and implemented emergency measures to prevent spread, ordering environmental restoration. Taichung District Prosecutors Office concluded in March 2023, prosecuting 11 individuals under Waste Disposal Act Article 46, with criminal proceeds seized exceeding NT$56.09 million and NT$33.75 million in unlawful gains.

7 Modernizing Landfill Oversight: Shifting from Human-Dependent Operations to Intelligent Automation

The management of expansive landfill sites presents significant challenges. In addition to their remote locations, improper waste classification and spontaneous combustion frequently lead to fires. Such incidents not only destroy on-site equipment and machinery but also generate dense smoke that envelops surrounding communities, often triggering public dissatisfaction and protest.

Trial Implementation of Smart Surveillance for Landfill Sites

In 2024, the Central Region Center launched a pilot project in Miaoli County to establish an Intelligent Monitoring and Control Center for landfill sites. By integrating AI technologies, the initiative aims to transform traditional site management practices.

The AI system provides real-time detection and alerts when smoke or abnormal temperatures are observed, enabling on-site personnel to respond immediately. Additionally, methane gas detectors installed within the site help prevent fire and explosion risks. Smart weighbridge systems and license plate recognition ensure regulatory compliance and operational efficiency. Furthermore, electronic detection systems issue warnings when personnel approach hazardous zones, effectively reducing the risk of accidental collisions.

Toward Nationwide Implementation of Intelligent Landfill Management

This intelligent management system is slated for nationwide expansion to key landfill sites. Through data integration and centralized oversight, AI not only enhances the safety and operational efficiency of landfill management, but also safeguards the quality of life for nearby residents. The initiative marks a pivotal step in Taiwan's transition toward smart environmental governance.

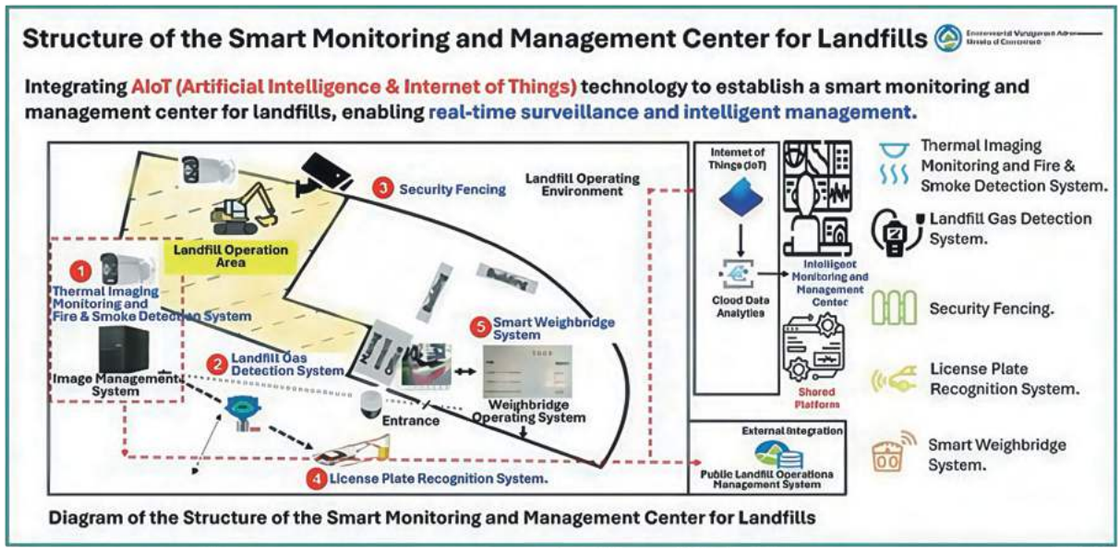
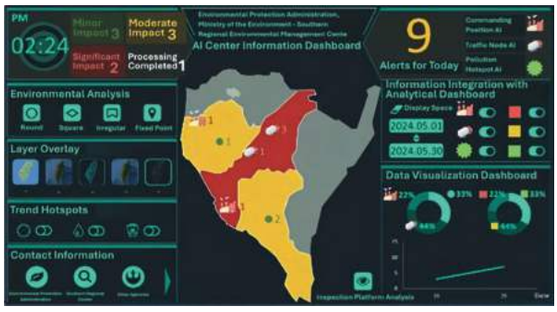


Diagram of the Structure of the Smart Monitoring and Management Center for Landfills

8 Leveraging AI for Inclusive Environmental Governance: Together for a Greener Planet



▲ Dashboard interface of the AI Smart Environmental Co-Governance Platform.

▲ Monitoring screen of the AI Environmental Management System.

Faced with the challenges of vast geographic coverage, a high volume of cases, and evolving patterns of environmental crime, enforcement and inspection efforts must seek innovative solutions under limited manpower. The integration of AI technologies, combined with inter-agency collaboration and autonomous management, is steering environmental governance toward a future that is more responsive and precise.

Complex Challenges: Issues and Constraints in Environmental Management in the Southern Region

The Southern Center oversees over 100,000 regulated enterprises and processes more than 60,000 environmental complaints annually. With limited manpower, a wide jurisdiction, and increasingly complex environmental issues and crimes, it faces growing challenges in effective environmental enforcement.

AI-Driven Governance N+1: Establishing the "Smart Environmental Co-Governance Platform"

With the rapid advancement of artificial intelligence, the Executive Yuan and various ministries have launched initiatives such as the AI Innovation Cabinet and the dual-axis transformation strategy integrating AI, digitalization, and net-zero goals. In alignment with these national efforts, the Southern Regional Center of the Environmental Protection Administration has envisioned leveraging AI to generate "N+1" synergistic benefits, enhancing inspection capacity and environmental enforcement.

To this end, the Center has established the "AI Smart Environmental Co-Governance Platform," built upon three core pillars: AI integration, collaboration with local EPBs, and promotion of autonomous management. The platform encompasses AI applications, manpower and resource coordination, and public-private partnerships. Through this Total Solution approach, the initiative aims to improve enforcement efficiency, strengthen pollution source control, and reduce pollutant emissions—collectively advancing Taiwan's transition toward intelligent environmental governance.

AI Smart Environmental Co-Governance Platform Dashboard

To integrate public concerns with pollution surveillance data, the Environmental Protection Administration has established three elevated vantage points, five key traffic nodes, and seven demonstration sites at known littering hotspots. AI-based image recognition technology (Figure 47) has been deployed and incorporated into an environmental image repository. When incidents such as abnormal chimney emissions, open burning, or illegal waste dumping are detected, the AI Smart Environmental Co-Governance Platform dashboard issues real-time alerts. These alerts, including photos and video evidence, are immediately pushed to partner agencies to initiate appropriate response and remediation measures.

This approach marks a shift from traditional hourly monitoring to time-lapse imaging and now to real-time AI image recognition. By combining remote enforcement with on-site inspections, the system significantly enhances enforcement capacity, advances technical capabilities, and reduces the burden on inspection personnel. During the air pollution season (October to March), the system recorded 32 abnormal smoke alerts, all of which were automatically flagged and relayed to partner agencies for timely response—demonstrating its effectiveness in reducing manpower demands and improving real-time remote monitoring.

Collaborative partnership

Partners were invited to participate in the AI Smart Environmental Co-Governance Platform to jointly promote improvement actions in pollution hotspot areas (Figure 48). The Southern Center utilizes complaint data and micro-sensor pollution hotspot analysis, deploying AI image recognition and odor detection systems at vantage points for continuous monitoring. Additionally, task-based monitoring is conducted using Open-Path Fourier Transform Infrared Spectroscopy (OP-FTIR) to identify suspected pollution hotspots and sources.

Figure 47
Technology-assisted environmental enforcement monitoring.

Figure 48
Strategic planning meeting with partner agencies to address pollution-prone hotspots.

Together with partners, the center has carried out at least 35 inspections and filed 18 cases, resulting in significant pollution improvements. The number of complaints has also decreased by approximately 57% from its peak.

Promotion of Public-Private Partnership and Self-Regulation: A New Model for Intelligent Environmental Governance

Following the lifecycle concept, enterprises implementing self-management from development, operation, emission control to waste disposal can directly benefit the environment. To promote public-private self-regulation, one pilot site was selected to deploy AI image recognition with 3 smart cameras and 2 micro-sensors. The system monitors dust, vehicle dust net coverage, and road surface discoloration. When violations such as dust emissions, uncovered vehicle nets, or unwashed vehicles causing discoloration are detected, automatic alerts prompt immediate corrective actions like activating sprinklers.Since implementation, 13 alerts were issued for dust and uncovered nets, with no further incidents after self-correction, demonstrating the effectiveness and necessity of self-management in improving environmental quality and corporate image (Figures 49, 50).

Figure 49
Execution of joint inspection operations.

Figure 50
Promotion of autonomous management through equipment monitoring activities.

The Future of Smart Governance: Collaborating Toward Pollution and Emission Reduction Goals

The Administration uses scientific instruments and AI to support environmental enforcement. Leveraging the AI Smart Environmental Co-Governance Platform, we will continue working with local governments and partners to promote smart governance, strengthen self-management, and achieve pollution and emission reduction.

9 Strengthening Livestock Wastewater Management and Compliance in the Southern Taiwan

In regions with concentrated livestock activity, the pig farming industry operates at a significant scale. However, the resulting wastewater discharge has long impacted river water quality and the surrounding environment. To address this challenge, the Environmental Protection Administration has integrated monitoring data, targeted investigations, and enhanced inspection efforts to gradually reduce pollution loads. These measures aim to guide water quality management in the livestock sector toward regulatory compliance and sustainable development.

Environmental Challenges of Southern Pig Farms: Daily Wastewater Discharge Equivalent to Tens of Millions of People

According to the Ministry of Agriculture's 2023 statistics, the southern region has approximately 2,250 pig farms raising around 2.45 million pigs, accounting for about 46% of the national total. Considering that one pig produces 4 to 5 times the daily wastewater of one person, the daily pig farm wastewater discharged into rivers in the southern region is equivalent to that of over ten million people (Figure 51).

Figure 51
Livestock Wastewater Discharge Conditions

Targeted Enforcement on Major Polluted River Sections in Southern Taiwan: Committed to Improving Water Quality

To effectively improve river water quality, starting in 2024, the Administration has focused on high-density livestock areas such as the upper Erren River and Wuluo Creek. By analyzing and comparing river water monitoring data with inspection and reporting records, suspected discharge channels are thoroughly investigated to strengthen enforcement efforts (Figure 52).

Figure 52 Livestock Industry Inspections and Sampling Procedures

Enhanced Inspections on the Erren and Wuluo Rivers: Significant Reduction in Ammonia Nitrogen Levels

Most pig farms in the upper Erren River basin are located in remote areas, where some unscrupulous operators illegally discharge untreated wastewater directly into the river, causing severe pollution and odor issues. To combat this, drones and other methods were used to trace pollution sources, resulting in the discovery and fines of three pig farms totaling over NT$1.27 million.

Thanks to the efforts of the Southern Center staff, water quality in the upper Erren River has improved. As of December 2024, the average ammonia nitrogen concentration at the Erceng Bridge monitoring station was 2.1 mg/L, an 80% reduction compared to the 3-year average of 10.2 mg/L (13.6 mg/L in 2021, 5.7 mg/L in 2022, 11.4 mg/L in 2023). At the Guting Bridge station, the 2024 average was 5.5 mg/L, a 35.3% decrease from the 3-year average of 8.5 mg/L (8.4 mg/L in 2021, 6.3 mg/L in 2022, 10.9 mg/L in 2023) (Figure 53).

The enforcement efforts in the Wuluo Creek basin have been effective, reducing ammonia nitrogen concentration by 25%

Sixteen pig farms along the Wuluo River were inspected; 14 exceeded water quality standards. Violations included illegal wastewater discharge and unauthorized dilution, resulting in over NT$1.94 million in fines. One farm was ordered to shut down, and another had its discharge permit revoked.

By December 2024, ammonia nitrogen at Jiuru Bridge averaged 7.4 mg/L — a 25% drop from the three-year average of 9.9 mg/L (2021–2023) (Figure 54).

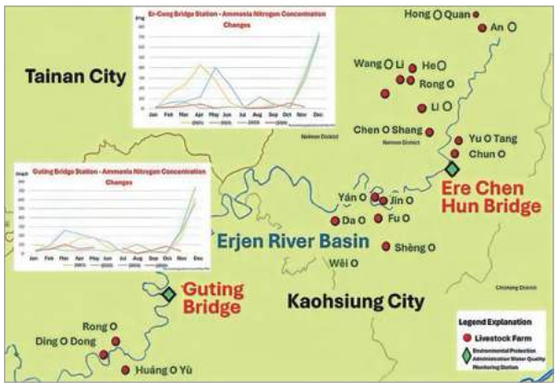


Figure 53
Improvements in Ammonia Nitrogen concentrations at Erleng Bridge and Guting Bridge Monitoring Stations on the Erren River

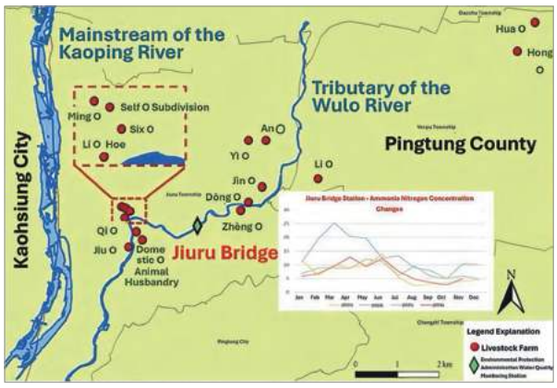


Figure 54
Map of Wuluo River livestock farms and monitoring stations; trend of ammonia nitrogen reduction.

Violation Patterns Highlight Challenges and Improvements in Livestock Wastewater Management

Analysis of livestock industry violations revealed that 57.4% (39 cases) involved effluent exceeding discharge standards, including 12 severe cases exceeding limits by over five times. Additional violations included 3 bypass discharges, 1 dilution case, and 4 due to negligence (11.8% total). As shown in Figure 55, most violations stemmed from non-compliance with permits or poor management. Enforcement actions have since led to notable improvements.

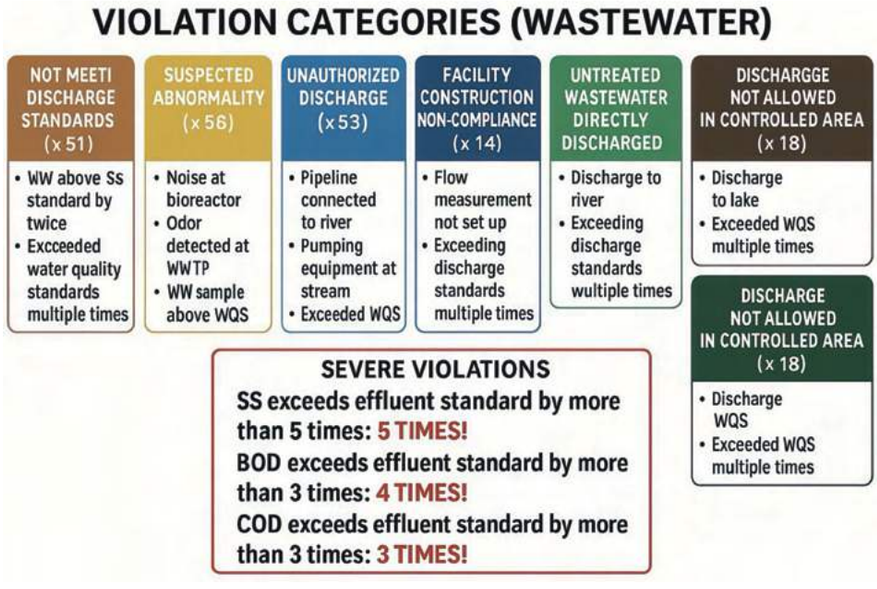


Figure 55 Types of Violations Identified in Livestock Farm Inspections

Preventing soil and groundwater contamination from storage systems

Soil and Sustainable Management of Groundwater

2024

Environmental Management Administration Annual Report

1 Strengthening Source Management: Safeguard Soil and Groundwater Sustainability

Since the promulgation of the “Soil and Groundwater Pollution Remediation Act” , the Ministry of Environment has launched a comprehensive protection initiative to ensure the sustainable use of soil and groundwater resources while safeguarding public health. This initiative spans across agricultural lands, factories, industrial zones, and gas stations, leaving no site unchecked. Through key strategies—such as source control measures—the government aims to prevent pollution from spreading to critical receptors like farmland and groundwater.

Diversified Source Management: High-risk facilities may also adopt self-regulatory management

Promoting self-regulatory prevention management for operators of facilities with high pollution potential. Since 2023, the Administration has implemented a tiered management strategy for soil and groundwater pollution, categorizing operators into three groups (A, B, C) based on management intensity (Figure 56). Each group has specific management protocols implemented through coordinated efforts between local environmental agencies and central authorities. This approach enhances operational autonomy while improving pollution prevention efficiency.

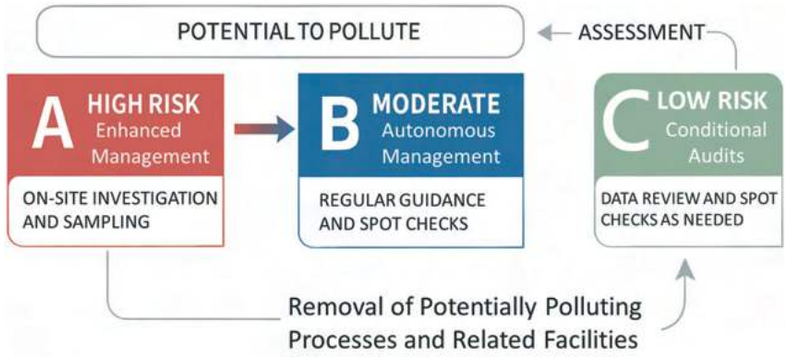


Figure 56 Tiered Pollution Risk Management for Groups A, B, and C

- **By the end of 2024, the tiered management achieved**: Group A (Enhanced Management) - 471 facilities (target: 465), Group B (Self-Management) - 246 facilities (target: 191), and Group C (Review Management) - 251 facilities (target: 246). All groups exceeded 100% target achievement rates (Figure 57). Results showed: Group A had 18 facilities (32.7%) exceeding regulatory standards; Group B had 1,379 of 1,913 facilities (72%) submitting prevention plans, with 904 facilities (66%) passing review; Group C recommended 19 facilities for upgrade to Groups A or B. This tiered management mechanism has demonstrated significant effectiveness in sustainable soil and groundwater management since implementation.

A Group Implementation Results (Enhanced Managementt)			
On-site Inspections		Sampling Tests	
Planned	Actual	Planned	Actual
465	191	52	55

B Group Implementation Results (Self-Management)		
Registered Businesses		Planned
Planned	Actual	Planned
1,913	191	246 (129%)

C Group Implementation Results (Visual Monitoring)	
On-site Checks	
Plannedl	Actual
246	52 (102%)

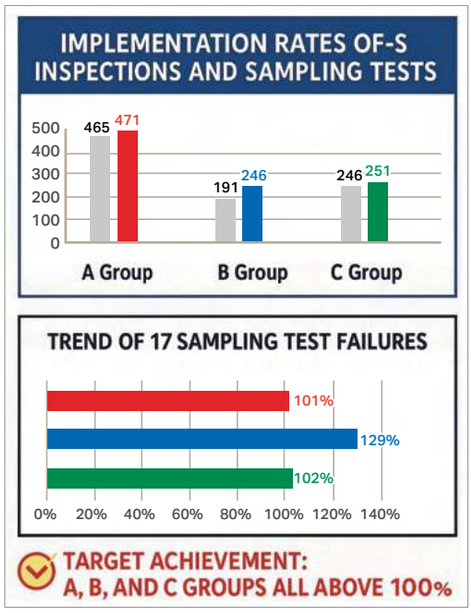


Figure 57 Table of Projected vs. Actual Results for Enterprise-Led Pollution Prevention in 2024

Enhancing Management for Higher Goals

In 2024, improvements were completed including refined tiered adjustment principles, management plan review guidelines, simplified data survey procedures, and streamlined reporting forms to enhance prevention management effectiveness.Key improvements include:

- **Refined tiered adjustment principles**: Group A facilities that pass Phase I site reconnaissance without requiring Phase II investigation and receive approved self-management plans are downgraded to Group B the following year. Groups A and B facilities with confirmed process changes (complete removal of potential processes and related equipment) are downgraded to Group C. Conversely, Groups B and C facilities assessed as having pollution potential are upgraded to Groups A or B. Annual tiered adjustments are communicated through system notifications.
- **Established review guidelines**: Developed comprehensive review criteria and scoring requirements for self-management plans, incorporated into the tiered management manual to ensure consistent evaluation standards across environmental agencies.
- **Optimized Group C procedures**: Enhanced management processes through data screening to exclude facilities not requiring site visits (operations unrelated to soil/groundwater control items, removed processes, office-only use, facilities entirely above 2nd floor), focusing resources on higher-risk facilities. Approximately 6,000 Group C facilities are non-high-risk manufacturing enterprises under Environmental Management System (EMS) monitoring.

- **Simplified reporting procedures**: Implemented automatic data integration from EMS and Industrial Development Administration databases. Raw materials, products, and fuel reporting limited to substances related to soil/groundwater control items only.

To enhance the effectiveness of pollution risk management, the Administration refined its group classification principles, established inspection criteria, and optimized operational procedures. For example, in managing Group C enterprises, environmental bureaus applied data analytics to exclude cases that did not require on-site visits, allowing for more efficient allocation of resources. Figure 58 summarizes the cumulative outcomes of inspections conducted by environmental agencies for Groups A, B, and C in 2023 and 2024.

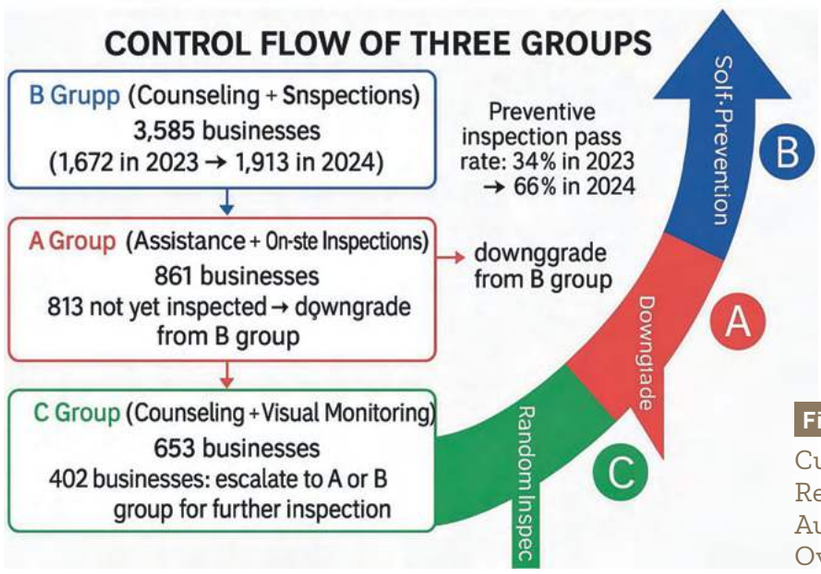


Figure 58
Cumulative Achievement Results of Environmental Authorities 2023-2024 - Overview Diagram

Cumulative results for 2023-2024 show: Group B (3,585 facilities total) achieved plan approval rates increasing from 34% in 2023 to 66% in 2024. Group A (861 facilities total) identified 48 non-compliant facilities for regulatory action, with 813 compliant facilities guided toward Group B reclassification. Group C (653 facilities total) recommended 43 facilities for upgrade to Groups A or B requiring further inspection.

This systematic approach aims to progressively reduce Group A facilities, enhance Group B self-management capabilities, and maintain Group C monitoring to achieve national soil pollution reduction goals.

Comprehensive Deployment: Multi-Faceted Control of Storage Systems

With rapid industrial growth and increasing transportation, energy storage has become economically essential. Nationwide, 8,400 sites operate 22,000 storage systems, averaging 2.6 tanks per site, creating soil and groundwater contamination risks. Environmental agencies implemented regulations requiring pollution prevention facilities

and regular monitoring. As of end-2024, 8,419 active systems include 3,216 underground and 5,203 above-ground tanks, with 84% storing gasoline and diesel (Figure 59).

From September 2023 to December 2024, agencies identified 32 systems with abnormal reports. Local bureaus required operator investigations, confirming no contamination. Since 2022, monitoring expanded to 5,196 above-ground tank operators for baseline data collection.

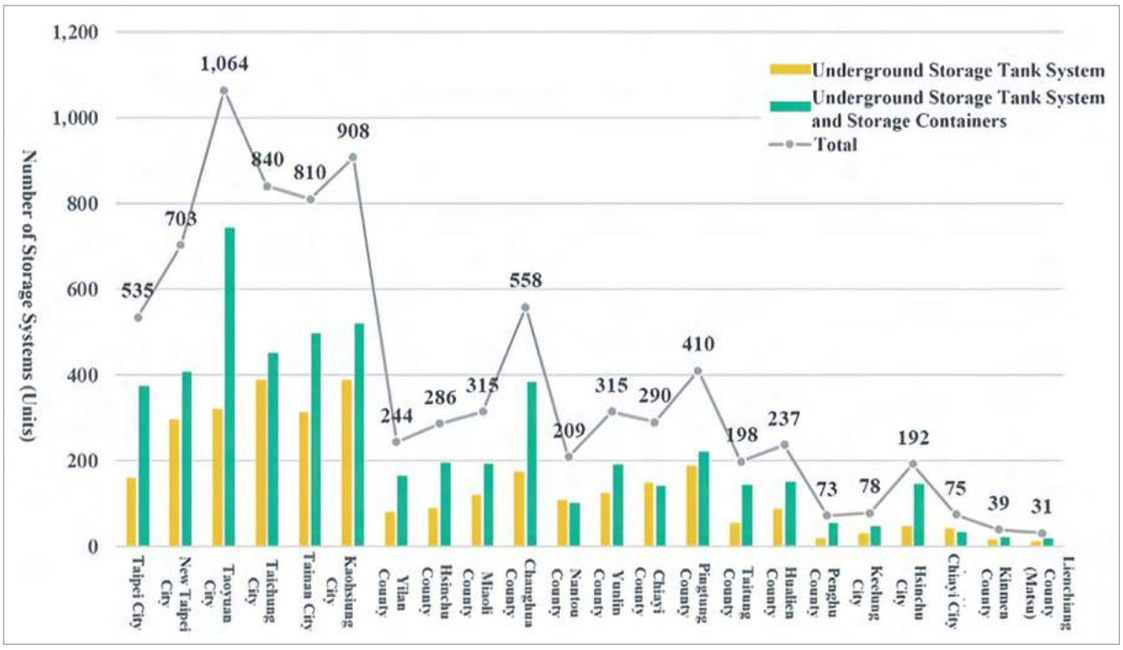


Figure 59 Nationwide Distribution Statistics of Storage Systems

Table 3 Status of Monitoring, Reporting, and Tracking Management of Storage Systems

Monitoring Period	Reported Cases	Monitoring and Reporting Management	
		Abnormal Reports	Confirmed Pollution Cases
Sep. to Dec. 2023	3,233	6	0
Jan. to Apr. 2024	3,239	4	0
May to Aug. 2024	3,243	15	0
Sep. to Dec. 2024	3,243	7	0
Total Cases	12,958	32	0

2 Advancing Site Remediation Strategies: Support Soil and Water Sustainability

According to the "Soil and Groundwater Pollution Remediation Act," listed sites must complete pollution remediation and pass verification before delisting. Each site requires comprehensive consideration of pollution characteristics, hydrogeological conditions, funding, timeline, and future land use, plus assessment of potential environmental and health risks.When pollution verification finds contaminant concentrations meeting control standards, site control procedures are initiated. Control types include pollution control sites, remediation sites, time- limited improvement sites, and groundwater use restriction areas, following the pollution site determination process (Figure 60).

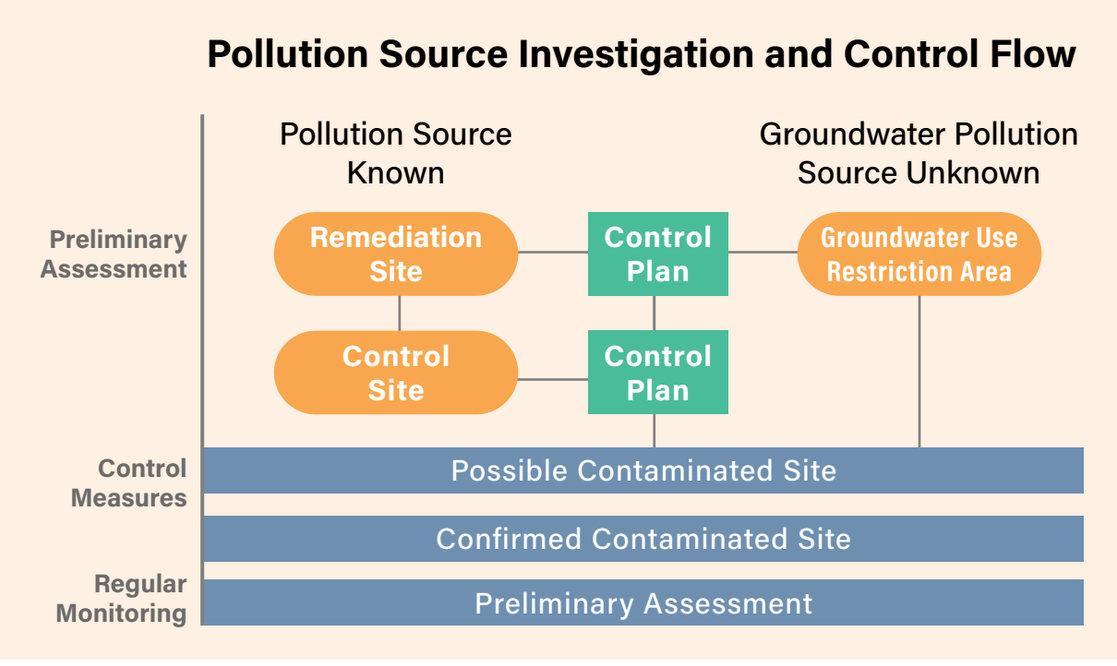
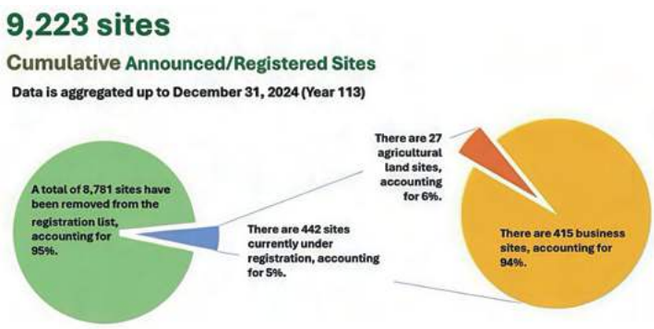


Figure 60 Pollution Site Determination Process

Comprehensive Pollution Assessment, Precision Management, and Future Regulatory Feedback Mechanism

As of end-2024, 9,223 sites were cumulatively listed across all contamination types, with 8,781 delisted and 422 remaining under management (27 agricultural, 415 industrial sites, primarily factories) (Figure 61).

The Administration tracks contaminated sites precisely to develop effective management strategies and established guidelines for pollution control plans and site improvement procedures to provide clear frameworks for responsible parties and authoritie.



Factory Site Categories	Number of Sites	Proportion
Gas Stations	22	5.3%
Storage Tanks	10	2.41%
Factory	254	61.2%
Illegal Dumping Sites	16	3.86%
Military Factory Sites	10	2.41%
Other	103	24.82%
Total Count	415	100%

Figure 61 Proportion of Regulated and Deregulated Sites in 2024

From Assessment to Remediation: Step by Step in Restoring Land Value

In restoring land vitality, some cases involve responsible parties failing to initiate remediation, stalled improvement progress, or unknown groundwater pollution sources.

In 2023, the Administration identified 146 sites requiring accelerated remediation. A full-scale analysis was carried out to confirm the responsible parties, assess the extent and severity of pollution, and develop remediation methods and implementation plans, with the ultimate goal of delisting the sites and restoring land use.

To address these challenges, the Administration developed a dual-track strategy: central demonstration execution and local collaborative advancement. Through central-local cooperation, this aims to strengthen remediation effectiveness, restore land value, and achieve sustainable resource utilization (Figure 62).

To ensure proper resource allocation, the Administration begins by clarifying legal responsibility for site pollution, establishing a solid foundation for remediation work. For sites completing environmental assessment, pollution characteristics, economic benefits, and current land use are analyzed to plan appropriate measures under improvement management strategies. These plans include substantive pollution remediation, natural attenuation, groundwater pollution management, risk control, and land reuse options. In 2024, 60 sites completed environmental assessment and 3 sites completed pollution volume confirmation surveys, enabling evaluation of remediation methods, funding, and timelines to accelerate comprehensive improvement of all 146 sites.

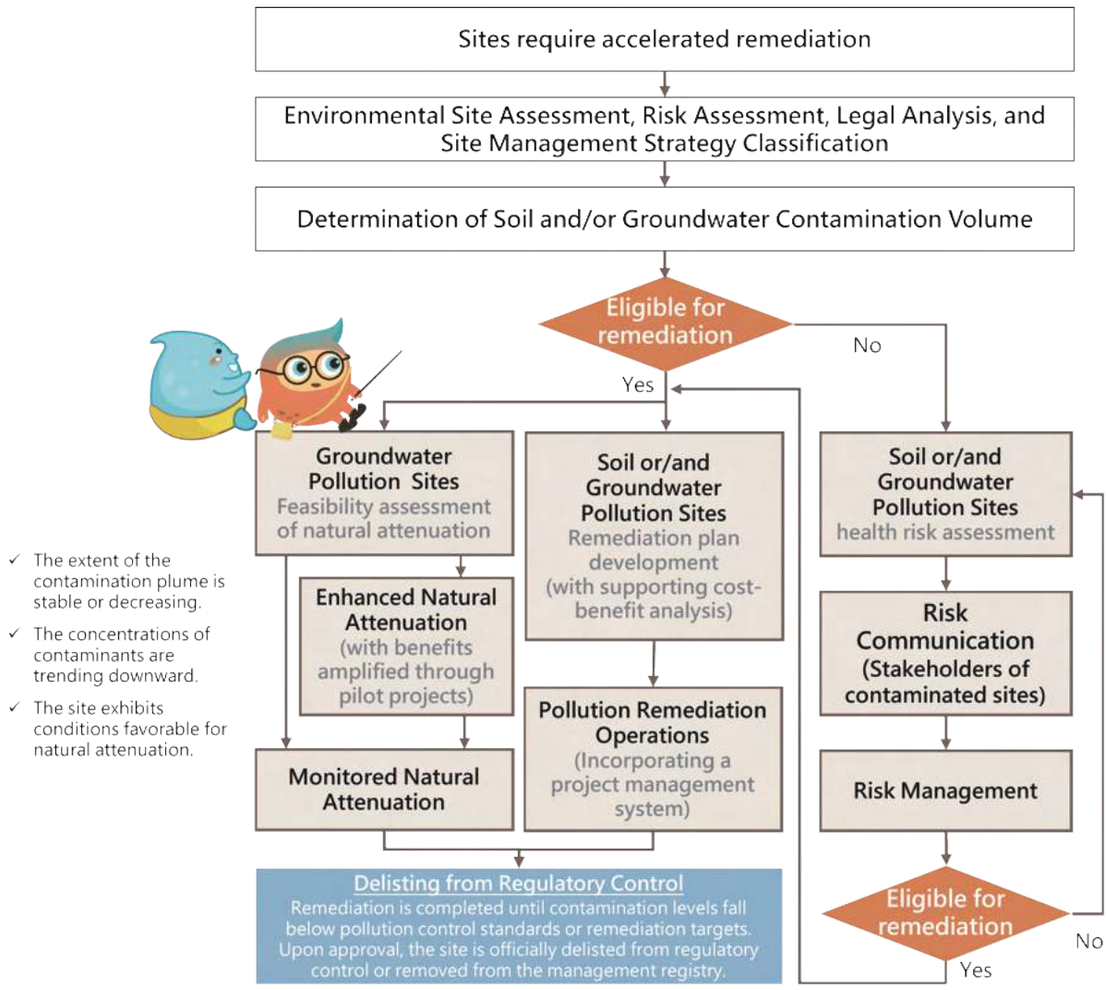


Figure 62 Accelerated Site Improvement Management Strategy Process

In February 2024, the Administration established subsidy mechanisms for accelerated site improvement, with Kaohsiung and Pingtung pioneering remediation plans. Operating principles for risk management were established in April, with Nantou and Tainan implementing risk control measures.For unknown groundwater pollution sources, four tiered management approaches were established. Four project plans were approved in 2024, reducing listed sites from 34 to 29, with three areas achieving partial delisting and value restoration.

Each remediated site represents sustainable resource utilization. Through central-local dual-track strategies, more lands are recovering from pollution, safeguarding sustainable soil and groundwater resources.

3 Strengthening Risk Control for Sustainable Land Reuse

Land Rebirth Through Risk Management: The Path to Transforming Contaminated Sites

Listed sites pose environmental and health risks before pollution removal yet carry regeneration hope. Each contaminated site has unique stories connecting past, present, and future, requiring proactive strategies. Effective management has become urgent. The Administration strengthens risk control measures, embedding risk assessment into site management to prevent pollution spread and ensure acceptable risk levels.

Each site differs, requiring customized treatment solutions considering pollutant characteristics, geographical conditions, and future land reuse planning. Risk management measures must be flexible to ensure effective control and protect residents' health.

The "Former Lilac Copper Smelter" soil pollution site couldn't achieve complete remediation below control standards due to geological conditions and pollutant characteristics. The pollution perpetrator proposed customized remediation targets based on risk assessment. The former EPA approved site remediation targets on August 26, 2022, with procedures currently executed according to New Taipei City EPB's approved remediation plans.

The "Former Taiwan Metal Mining Corporation and Associated Three Waste Flue Areas" site features unique mining history with water curtain caves and waste flues as preserved cultural assets. The pollution perpetrator proposed zoned land revitalization planning with remediation targets based on risk assessment. After review by the Administration's case team, approval was completed on September 14, 2023. Remediation plan display concluded by end-2024, with execution expected to begin in February 2025. The plan includes low-intensity use of partial areas, preserving original landscape and cultural features, with future tourist trails (Figure 63), regenerating this land as recreation and learning space.

These remediation processes exemplify successful risk control implementation. As plans progress, formerly contaminated lands gradually recover vitality, establishing foundations for future development. More contaminated sites will transform from hazardous labels into symbols of hope and vitality.

Revitalizing Contaminated Land: Creating New Opportunities for Sustainable Land Use

Nantou County's Dagang Section contaminated land recovered through inter- agency cooperation, with lots 106-107 successfully delisted in early 2024 as a sustainable reuse benchmark (Figure 64). The Administration collaborated with National Property

Administration and Nantou County to establish an organic waste resource recovery center via public-private partnerships.

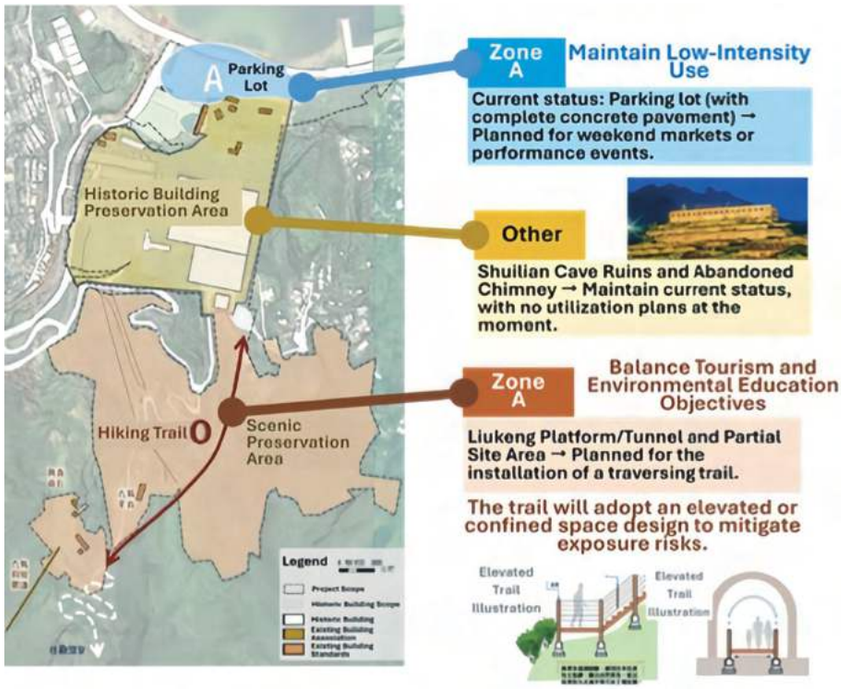


Figure 63 Land Use Planning for the Taijin Contaminated Site Remediation

Figure 64 Groundbreaking and Blessing Ceremony for the Remediation of the Dagang Section Contaminated Site in Nantou County

The integrated approach completed remediation in one year, saving NT$50 million while planning a waste center to process food waste and organic sludge. This strengthens central Taiwan's disposal capacity, achieves net-zero emissions, and generates revenue for the remediation fund. Commercial investment begins in 2025, driving regional sustainable development.

Establishing a Revenue Reinvestment Mechanism to Sustain the Remediation Fund

In contaminated land governance and revitalization, ensuring effective resource utilization and sustainable fund management remains a major environmental challenge. As contaminated land issues intensify, achieving continuous and expanded remediation effectiveness has become a focal concern.

To address this challenge, the Administration studied domestic and international success cases and proposed a "revenue return mechanism," establishing calculation principles for sites requiring accelerated improvement to return land development revenue to the soil and groundwater pollution remediation fund. This mechanism combines contaminated land improvement and reuse plans with land development revenue, creating more possibilities for contaminated land remediation through development-stage revenue returns.

Contaminated land governance requires substantial funding, and the remediation fund requires sustainable mechanisms to ensure resource continuity. The Administration designed a site-specific revenue return mechanism where local governments receiving fund subsidies must sign administrative contracts with contaminated land stakeholders, agreeing to regular revenue returns to support initial pollution improvement investments, achieving fund sustainability. Three-party cooperation model for contaminated land revitalization.

To flexibly accommodate diverse land development models, the revenue recovery mechanism has been adjusted accordingly. For sites with high profit potential—such as those involving urban planning changes, non-urban zoning adjustments, or industrial land use—a higher recovery ratio is applied. Conversely, for lands designated for cultural heritage preservation, landscape conservation, or public interest purposes, a lower recovery ratio is adopted to ensure fair and efficient resource allocation.

Building on the model established in the Dagang section of Nantou County, the Administration has initiated discussions and implementation of the revenue recovery mechanism in collaboration with environmental bureaus of municipalities and counties. Currently, the Administration is working closely with local governments to accelerate site pollution remediation and actively promote related projects. Moving forward, it will continue to accumulate experience, refine administrative contract details, and strengthen coordination between central and local authorities to advance innovative approaches to contaminated land management. Through the revenue recovery mechanism, the Administration aims to mobilize greater resources, expand the scope of remediation, and achieve large-scale land restoration—laying a solid foundation for a green and sustainable future. This effort represents not only the regeneration of land, but also a commitment to environmental responsibility and the well-being of future generations.

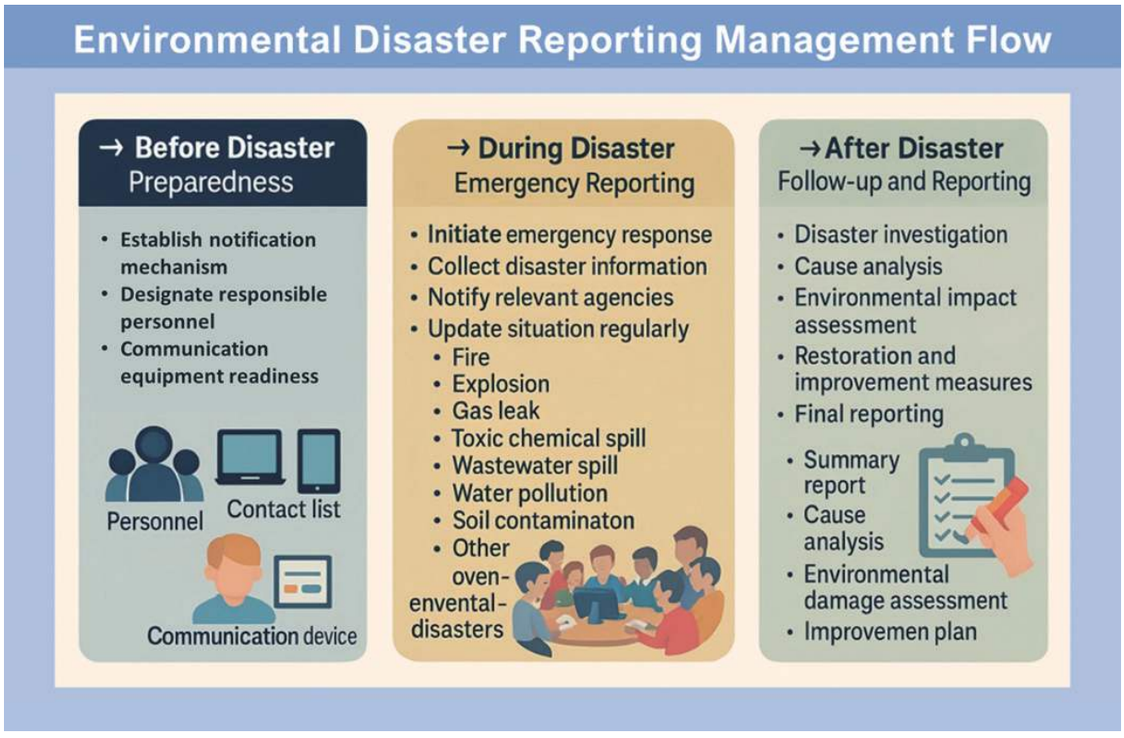
Rescue troops are being deployed in shifts to continue post-disaster recovery efforts.
(Photo courtesy of the Ministry of National Defense)

Establishment and Promotion of Disaster Response Mechanisms

2024

Environmental Management Administration Annual Report

1 Disaster Response and Environmental Restoration Mobilization



Disaster Response Responsibilities and Division of Labor

As the national disaster prevention and response contact point for all environmental protection units, the Administration has established an Emergency Response Task Force to effectively and promptly carry out disaster prevention and response operations. We have also developed a disaster response mechanism that utilizes the Environmental Disaster Management Information System to oversee pre-disaster resource preparation, disaster reporting, and requests for assistance. Furthermore, we have implemented a comprehensive operational mechanism covering post-disaster resource allocation through to environmental restoration. The Administration actively conducts nationwide training and drills to prepare for every challenge, ensuring readiness to complete critical post-disaster tasks such as environmental cleanup, disinfection, drinking water quality inspection and control, and the coordination of portable toilet deployment.

Central–Local Government Cooperation in Disaster Response and Recovery

Pre-Disaster Preparedness Measures

To ensure adequate disaster preparedness, official notices are issued in advance to all environmental protection agencies nationwide, requiring them to complete resource

preparations. Once typhoon or flood disasters occur, multiple communication channels—including instant messaging apps, text messages, and phone calls—are immediately used to notify agencies to expedite the preparation process.

To strengthen the capacity of environmental protection personnel in responding to disasters, annual nationwide training programs are conducted, enabling staff to understand emergency response procedures and become proficient in the use of the "Environmental Disaster Management Information System" (Figure 65). In addition, to validate training outcomes, an annual online "National Multi-Hazard System Operation Drill" is carried out, simulating combined earthquake and typhoon disaster scenarios. This ensures that agencies are more familiar with response and recovery operations.

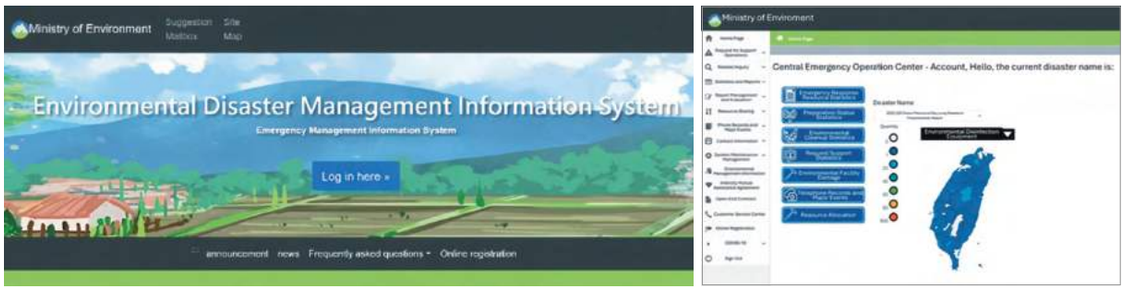


Figure 65 Environmental Disaster Management Information System

Disaster Response Actions

Upon receiving a Level 1 activation notice from the Central Emergency Operation Center of the Executive Yuan, the disaster response mechanism is immediately activated. Senior officials of the Ministry at Grade 12 or above are stationed at the Central Emergency Operation Center to coordinate real-time responses. At the same time, the Administration establishes response teams at both the Taipei and Taichung offices, with staff stationed on-site. Local environmental protection agencies are notified to commence response operations, and real-time updates on disaster-affected areas and the coordination of disaster response resources are initiated to support post-disaster recovery efforts (Figure 66).

Figure 66 Central Disaster Response Center Meeting

Environmental Recovery Actions in Disaster Response

Following typhoons, heavy rainfall, or earthquakes, the Administration continues to urge local environmental agencies to strengthen preparedness efforts. This includes enhancing post-disaster environmental cleanup, disinfection, and sampling for drinking water quality control, as well as assisting with the deployment of necessary equipment and other environmental emergency measures. The Administration also supervises local governments in assessing damage to environmental infrastructure and, in accordance with the Disaster Prevention and Protection Act, provides guidance and subsidies to support recovery and reconstruction. Additionally, it assists local authorities in carrying out post-disaster cleanup, disinfection, and disease prevention tasks to reduce the risk of mosquito-borne diseases such as dengue fever (Figure 67).

Figure 67 Disaster Response and Environmental Recovery

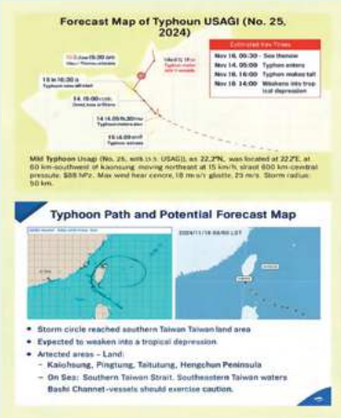
Disaster Events and Response Actions Undertaken in 2024

In 2024, Taiwan experienced multiple disaster events, including the April 3 Hualien earthquake and four typhoons—Kaimi, Sandu'er, Khanun, and Tembin. These events left widespread environmental damage in their wake. In response, local environmental protection agencies swiftly initiated recovery operations, working around the clock to remove fallen trees, clear post-disaster waste, and carry out disinfection efforts. These actions aimed to restore urban cleanliness and environmental hygiene as quickly as possible, helping residents return to normal life. (Table 4)

Table 4 Overview of Disaster Response and Recovery in 2024

Name	Date	Responses	Recovery
0403 Hualien Earthquake	April 3, 2024	A magnitude 7.2 earthquake struck Hualien County, causing severe damage to numerous buildings and facilities. The Hualien County EPB immediately set up mobile toilets, carried out water spraying at demolition sites, and cleaned the roads around temporary storage areas. The Administration promptly conducted disaster inspections and assisted the Hualien County EPB in post-disaster environmental cleanup, disinfection operations, and the repair of food waste	 Post-Disaster Cleaning  Post-Disaster Cleaning
Typhoon Gaemi	July 23, 2024	Typhoon Koinu made landfall in Yilan County, bringing strong winds and heavy rain that disrupted transportation in Hualien and caused severe flooding from Yunlin to Kaohsiung. The Administration quickly notified local environmental agencies to report affected areas and jointly carry out recovery work. Taichung City EPB supported Changhua with equipment and personnel, while New Taipei and Hsinchu EPBs assisted Chiayi, showcasing effective cooperation and mutual support.	  

Name	Date	Responses	Recovery
Typhoon Krathon	September 30, 2024	Typhoon Krathon struck Kaohsiung, causing severe damage in southern Taiwan, and later triggered landslides, flooding, and ground collapses in New Taipei and Keelung. On October 6, Premier Cho, Minister Peng, and Director-General Yen inspected landslide damage and incinerator operations, with the Ministry of Environment providing urgent financial support as needed.	   Premiere Cho's inspection
Typhoon Kong-rey	October 30, 2024	Typhoon Kong-rey struck Taitung, the first winter landfall in 57 years, causing landslides in eastern counties and toppling thousands of trees in Taipei and New Taipei. The Administration is monitoring recovery and providing support.	 Damaged Recycling Facility, Dawu Township, Taitung County  Minister Peng visits Hsinchu sanitation staff

Responses	Recovery	Responses	Recovery
Typhoon Usagi	November 30, 2024	Although Typhoon Usagi did not make landfall, it brought heavy rain to eastern and southern Taiwan, causing flooding in parts of Pingtung and Taitung. The Administration continues to monitor and provide support.	 Forecast Track of Typhoon Usagi

2 Strengthening Disaster Response Coordination to Rapidly Complete Post-Disaster Cleanup

Environmental Ministry Principles for Enhancing Disaster Response Resource Deployment

Due to environmental warming and climate change, the frequency and severity of environmental disasters have increased in recent years. To integrate relevant response resources, enhance disaster response effectiveness, and support affected counties and cities through a spirit of mutual assistance, the Ministry accelerates post-disaster environmental restoration. Through practical drills and exercises, the efficiency of emergency mobilization and disaster response capabilities of both central and local disaster response systems is evaluated, and resource deployment management issues are addressed.

2024 Disaster Response Coordination Drill

In 2024, the Administration and the Hsinchu City EPB held the "Environmental Disaster Recovery and Disinfection Mobilization Exercise." A tabletop drill took place on July 22 with 12 agencies and 85 participants, followed by a full-scale field drill on September 27 involving 18 special vehicles, 8 disinfection machines, and 75 personnel. This first large-scale exercise simulated the full process from disaster to recovery, enhancing central–local joint response capacity (Figure 68).

Figure 68 2024 Ministry of Environment Post-Disaster Recovery and Environmental Disinfection Coordination Drill

Disaster Coordination and On-Site Assessment of Affected Areas

After Typhoon Haikui, the environment was severely damaged. The Administration coordinated with the Kaohsiung City EPB to dispatch 41 vehicles and 100 personnel to assist in a five-day environmental cleanup operation, rapidly completing post-disaster

recovery (Figure 69). Following the Hualien earthquake on April 3, 2024, Deputy Director Liu led a team on April 6, 2024, to inspect the disaster site in Hualien County (Figure 70), supervising the disposal of general waste such as garbage and sludge. During Typhoon Gaemi on July 23, the Administration, adhering to the principle of regional mutual aid, coordinated the Taichung City EPB to dispatch 1 grapple truck, 2 disinfection vehicles, and 3 electric sprayers to Changhua County to assist in environmental cleanup, swiftly completing post-disaster recovery. Additionally, we facilitated the deployment of resources from Hsinchu City (1 grapple truck, 1 loader [Bobcat]) and New Taipei City (3 grapple trucks, 10 loaders [Bobcat], 10 small trucks, 32 personnel) to jointly support the post-disaster cleanup and recovery efforts in Chiayi County.

Figure 69

Deployment of Environmental Bureau's Clamshell Trucks for Disaster Cleanup

Figure 70

Deputy Director-General Liu of the Administration visited disaster-affected areas in Hualien County

3 Rapid Response to Post-Typhoon Haikui Cleanup

On August 27, 2023, Typhoon Haikui severely impacted the Taitung area, causing fallen roadside trees, blocked traffic, and clogged drainage channels. The Administration immediately provided subsidies to the Taitung County EPB to assist in post- disaster cleanup and restoration. The funds were used to hire cleaning personnel, rent emergency waste collection vehicles—including grapple trucks, dump trucks, and excavators—and manage construction debris, damaged furniture, and difficult-to-handle recyclable materials. On September 6, the Southern Regional Center of the Administration, together with the Taitung County EPB, carried out cleanup operations in the most severely affected Donghe Township (Figure 71).

The Kaohsiung City EPB urgently dispatched 20 grapple trucks and 10 dump trucks to the site, while the military rapidly removed fallen trees and cleared blocked roads, swiftly restoring urban order. This collaboration between central and local authorities demonstrated highly efficient disaster response and provided rapid assistance to residents in the affected areas (Figure 72).

Figure 71
Southern Regional Center inspects post-disaster cleanup in Taitung

Figure 72
Kaohsiung EPB and the Military Assisting Post-Disaster Recovery in Taitung

Preventing Disease-Carrying Mosquito Breeding After Typhoons: Community Health Protection

After Typhoon Haikui, residual standing water became breeding grounds for disease-carrying mosquitoes, potentially triggering dengue fever outbreaks. The Administration reminded the public to regularly inspect and remove standing water containers during post-rain environmental cleanup, following the “Inspect, Empty, Clean, Scrub” principle. Mosquito breeding not only affects community hygiene but also challenges epidemic prevention efforts. Therefore, it is essential to mobilize the entire community to maintain cleanliness indoors and outdoors to prevent mosquito

proliferation. The Administration continues to monitor the progress of post-disaster restoration in Taitung, assisting local governments in strengthening environmental management and public health awareness, helping residents return to normal life and rebuild their communities. At the same time, the public is encouraged to actively participate in community cleanup and disease prevention efforts.

Post-Typhoon Krathon: Supporting Environmental Restoration in Affected Counties and Cities , Interdepartmental Disaster Response: Accelerated Clearance of Major Roads in Kaohsiung

On October 3, 2024, Typhoon Krathon made landfall in Kaohsiung, toppling trees and blocking major roads. The city government quickly launched disaster response with military support, mobilizing over 1,000 personnel and 164 vehicles to restore traffic. The Administration coordinated support from multiple local EPBs, while 35 additional teams from other counties and cities assisted. Central and local governments, together with civil groups, worked efficiently to restore safe and normal living conditions (Figure 73).

Figure 73 Local Governments Preparing and Coordinating Post-Disaster Recovery in Kaohsiung (Taoyuan City, Chiayi County, Taichung City, and Tainan City)

Full-Scale Park and Green Space Cleanup: Rapid Restoration of Public Areas

After Typhoon Krathon, many trees in Kaohsiung's parks and green spaces were toppled. The Kaohsiung City Government prioritized the removal of large fallen trees and branches within parks to quickly restore their recreational functions. In the early stages of disaster response, effortsfocused on clearing trees along main roads, gradually addressing secondary roads and major parks, and restoring public facilities and landscaped areas. Meanwhile, military personnel worked closely with local teams to upright large trees within park areas. The Public Works Bureau fully mobilized all available resources to support the restoration work.

The Kaohsiung City Government mobilized personnel and equipment to remove post-typhoon debris and fallen branches, ensuring that urban parks were quickly restored to a clean and safe environment. This allowed citizens to promptly enjoy secure and friendly recreational spaces, gradually restoring the city's aesthetic.

Slope Collapse at Keelung EPB: Premier Cho Visits Disaster Site

Typhoon Krathon brought Keelung its heaviest rainfall in 70 years, causing a ground collapse behind the EPB cleaning team's office and vehicle damage. On October 6, Premier Cho, Minister Peng, Director-General Yen, legislators, and local officials inspected the disaster site to assess the damage firsthand, demonstrating a strong commitment to post-disaster recovery efforts.

Premier Cho stated that fortunately, the damage sustained by the Keelung EPB's cleaning team did not result in any casualties. He expressed gratitude to the city's EPB for its prompt and effective emergency response. One of the most urgent tasks now is the rapid deployment of cleaning vehicles to support waste removal and ensure that residents' daily lives remain unaffected. The central and local governments will work together to replenish the fleet of cleaning vehicles and assist in repairing access roads to and from the cleaning team's facility.

Accompanied by Director Ma, Minister of Environment Dr. Peng Chi-Ming, Director-General Yen Hsu-Ming, and Legislator Wang Cheng-Hsu inspected the waste incineration operations at the Tianwaitian Incinerator in Keelung City (Figure 74). Minister Peng stated: (1) Thanks to the EPB's effective response, Typhoon Krathon did not disrupt the normal operations of the Tianwaitian Incinerator. (2) The Ministry of Environment will assist with slope repairs along the access road to the incinerator and urges relevant agencies to promptly restore damaged water pipelines to ensure continued operation. (3) For specialized vehicles—such as mobile toilet trucks, sewage transport vehicles, street washers, and cleaning trucks—the Ministry will help coordinate vehicle deployment

based on actual needs during the repair period. If any vehicles are damaged beyond use, the Ministry will provide subsidies for replacement as necessary. (4) Regarding funding for post-typhoon reconstruction, the Keelung City Government is advised to first utilize its disaster preparedness fund. If additional resources are needed, the Ministry will provide emergency assistance based on actual requirements.

Figure 74

Minister Peng, Director-General Yen, and Legislator Wang inspect the Tianwaitian Incinerator, Keelung

4 Post-Storm Waste Cleanup and Facility Restoration

Coordinated Central-Local Efforts to Accelerate Post-Typhoon Waste Removal in Lanyu Following Typhoon Koinu

In October 2023, Typhoon Koinu severely impacted Lanyu Township, Taitung County, generating an estimated 1,600 tons of post-disaster waste. The waste was temporarily stored at a construction soil storage site owned by Taipower. However, due to transportation difficulties to the remote island and limited on-site removal capacity, cleanup progressed slowly. The Administration provided funding for waste removal, aiming to have all post-disaster waste classified, packaged, and transported back to the main island by May 31, 2024. The Administration dispatched personnel on January 30, March 7, and April 29, 2024, to supervise local efforts to accelerate Lanyu's post-disaster waste removal. Additionally, on February 1, 2024, Director Shih Bingxin of the Southern Regional Center met with Taitung City Mayor Chen Mingfeng and EPB Director Guo Jiancheng to discuss the transportation and disposal of Lanyu's post-disaster waste (Figure 75). In total, approximately 771 tons of garbage and 300 tons of recyclable materials were transported back to Taiwan via specialized vessels.

Figure 75 On-site inspection of Lanyu waste storage and meeting with Taitung City Mayor and County EPB Director to discuss assistance

Typhoon Gaemi Disaster Response: Assisting Environmental Facility Restoration

The Nansi Sanitary Landfill in Tainan City was damaged by Typhoon Gaemi on July 25, 2024. The external access road collapsed, posing risks to road users and vehicles, and parts of the site's retaining walls were also damaged. On August 30, 2024, personnel from our Southern Regional Center conducted an on-site inspection, identifying cracks in some retaining walls and tilting fences atop the walls. The Administration urged the proper use of subsidy funds to carry out restoration and improvement work. For the post-disaster restoration of the Nansi Sanitary Landfill, the Administration assisted in securing subsidies

from the Public Construction Commission Executive Yuan. On October 8, 2024, approval was granted for NT$38.73 million to carry out disaster reconstruction works (Figure 76).

Figure 76 Collapsed Access Road and Damaged Retaining Wall Nansi Sanitary Landfill, Tainan City

The Jinfeng Township Landfill in Taitung County was damaged by the September 18, 2022, Chishang Earthquake, which caused displacement and cracking in the existing retaining walls. The original restoration funding request was NT$8,729,000. Considering the funding was slightly insufficient, the Administration assisted in securing additional subsidies from the Public Construction Commission Executive Yuan, bringing the total approved amount to NT$11,852,000 for reconstruction works. Furthermore, in 2024, Typhoons Krathon and Kong-rey struck, causing additional damage to the Jinfeng Township Landfill. On November 21, 2024, personnel from our Southern Regional Center conducted an on- site inspection of the damage. To expedite restoration, an additional subsidy of NT$2,688,488 was approved to assist local authorities in quickly restoring the landfill (Figure 77).

Figure 77 Jinfeng Township Landfill, Taitung County: Damaged Landfill Surface and Access Roads

5 Post-Typhoon Beach Inspection and Restoration

Immediate Coastal Waste Removal After Typhoons

After typhoon season, large amounts of debris often accumulate along coastlines, threatening the environment and ecology. To address this, the government enforces an “emergency cleanup” mechanism requiring waste removal within seven days. Local authorities inspect, assess, and mobilize resources, with support from volunteers and civic groups. Despite heavy debris from Typhoons Gaemi, Krathon, and Kong-rey in 2024, coordinated efforts kept waste under control and minimized ecological impact, while encouraging public participation in beach cleanups. In southern Taiwan, our Southern Regional Center continues post-typhoon inspections. Following Typhoons Krathon and Kong-rey, 19 polluted sites were reported through the Coastal Cleanup Information Platform, ensuring timely cleanup and accountability (Figure 78).

Figure 78 Coastline inspection and cleanup after typhoon

Multi-Ministry Cooperation for Clean Coastlines and Source Waste Reduction

While post-typhoon coastal cleanup has shown significant results, reducing waste at the source remains the long-term solution. From 2020 to 2024, the Ministry of Environment and the Water Resources Agency under the Ministry of Economic Affairs removed approximately 45,000 tons of riverine debris, preventing garbage from entering the ocean. The Fisheries Agency under the Ministry of Agriculture has promoted improved floating devices, replacing 97% of polystyrene buoys, and piloted recycling programs for discarded fishing nets, effectively reducing marine waste. The Environmental Protection Administration has also implemented multiple plastic reduction policies, including restrictions on single-use plastics and promotion of reusable cups, gradually reducing overall waste generation. Through policy and technology measures, the amount of debris remaining on coastlines has decreased, with residual coastal garbage reduced by about 60% since 2019.

Emergency Response and Post-Disaster Environmental Cleanup Subsidies

Following earthquakes and typhoon disasters in Taiwan, the Administration has provided emergency response funding subsidies to expedite environmental restoration, cleanup, and disinfection efforts—helping residents return to normal life as quickly as possible. To support local governments in rebuilding affected communities, a total of 13 subsidy cases have been approved, amounting to NT$59,671,716. (Table 5)

Table 5 Subsidies Provided by the Administration to Local Governments for Post-Disaster Recovery (2023–2024)

Disaster Event	Local Governments	Subsidy Cases	Subsidy Amounts (unit: NT$)
Typhoon Koinu	Taitung County	Emergency subsidy for Typhoon Koinu	1,000,000
		Lanyu emergency subsidy	1,000,000
0403 Hualien Earthquake	Hualien County	Post-earthquake cleanup plan	3,600,000
		Post-earthquake cleanup (construction waste temporary site – 2nd zone)	2,925,000
		Post-earthquake cleanup and disinfection plan	1,904,985
Typhoon Gaemi	Hualien County	Cleanup and disinfection plan	1,548,700
	Kaohsiung City	Post-disaster cleanup project	7,602,816
	Tainan City	Recovery plan – manpower and equipment rental	8,991,905
Typhoon Krathon	Taitung County	Post-disaster cleanup project	2,655,435
	Pingtung County	Post-disaster cleanup project	1,855,770
	Kaohsiung City	Post-disaster cleanup project	17,575,000
Typhoon Kong-rey	Taitung County	Post-disaster cleanup project	7,107,120
	Hualien County	Cleanup and disinfection plan	1,904,985
Total			59,671,716

AI intelligent system business management and environmental conservation green economy.

Information and AI Digital Development

2024

Environmental Management Administration Annual Report

1 Multi-Layered Cybersecurity Protection – Creating a Safe Service Environment for Environmental Management

Cybersecurity Challenges Cannot Be Ignored

As our daily lives increasingly rely on the internet—from mobile payments and online applications to various government services—the importance of cybersecurity has grown exponentially. To ensure everyone can enjoy safer and more reliable online services, the Administration actively implements both technical and educational measures. We have introduced AI-powered intelligent traffic optimization technologies and, through proactive monitoring and training, are creating a "smart, secure, and stable" service environment.

Technical Measures – Building Comprehensive Cybersecurity Protection

Multi-Layered Cybersecurity Architecture for Full-Scale Information Security Upgrades

To respond to rapidly evolving cyber threats, the Administration has fully implemented a multi-layered cybersecurity protection architecture, which includes:

1. **Upgrading firewall systems and optimizing network architecture**: Blocks malicious intrusions and enhances protection of critical systems.
2. **Enhancing malicious email filtering and establishing a 24/7 Security Operations Center (SOC)**: Monitors continuously and intercepts potential threats in real time.
3. **Implementing a Vulnerability Alert and Notification System (VANS)**: Provides real-time monitoring of system weaknesses and rapid patching of vulnerabilities.

Through these measures, the risk of data breaches and unauthorized access is significantly reduced, ensuring internal data is more complete and secure. Citizens can use the services provided by the Administration with greater confidence and peace of mind (Figure 79).

AI-Powered Intelligent Traffic Optimization Technology – Smoother Network Performance

Have you ever experienced slow or lagging internet? By implementing AI- powered intelligent traffic optimization technology, the Administration effectively addresses previous issues of network bandwidth overload, making network services more stable and seamless. This automated AI system can intelligently allocate network resources, preventing network congestion and ensuring the smooth operation of all public services

provided. This AI-driven, automated management requires no human intervention, allowing resources to be used more efficiently. Citizens can enjoy faster, more stable public services when using the Administration's systems, enhancing both user experience and daily convenience!

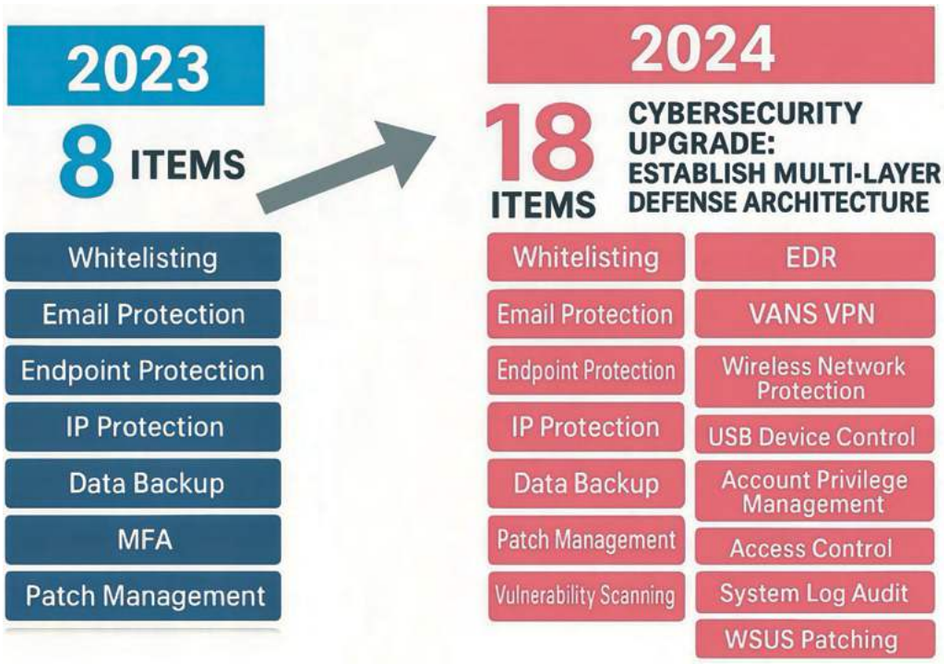


Figure 79 Cybersecurity Protection Diagram of the Administration

Education – Embedding Cybersecurity Awareness in Daily Practices

To truly integrate cybersecurity protection into every business system and each employee's daily tasks, the Administration has innovatively launched the "Autonomous Cybersecurity Drill and Inspection Approach" (Figure 80), which includes:

- **Autonomous Checklists**: Establishing 9 main categories and 48 detailed items, such as account password management and website content maintenance, allowing each unit to self-assess whether they meet the standards.
- **Random inspection with Rewards**: Conducting unannounced checks periodically whil e encouraging units that implement excellent measures, motivating everyone to maintain strong cybersecurity practices. Through the principle of "self-check, random inspection, and rewards", the Administration moves beyond a passive model of "top-down directives and bottom-up execution."

Every individual actively participates, cultivating cybersecurity awareness in their daily work. As a result, citizens'data and the services provided enjoy stronger security protection.

Autonomous Inspection Approach – Bringing Cybersecurity Closer to Everyday Work

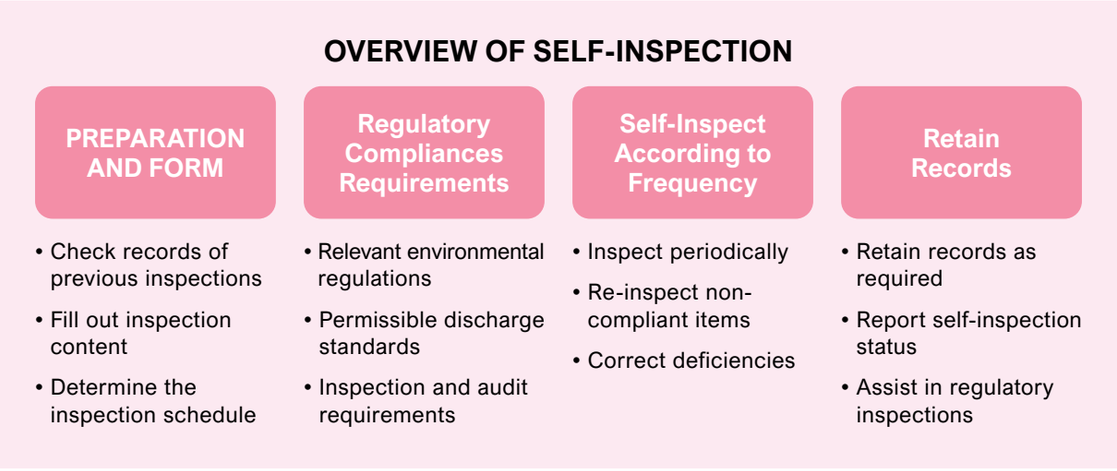
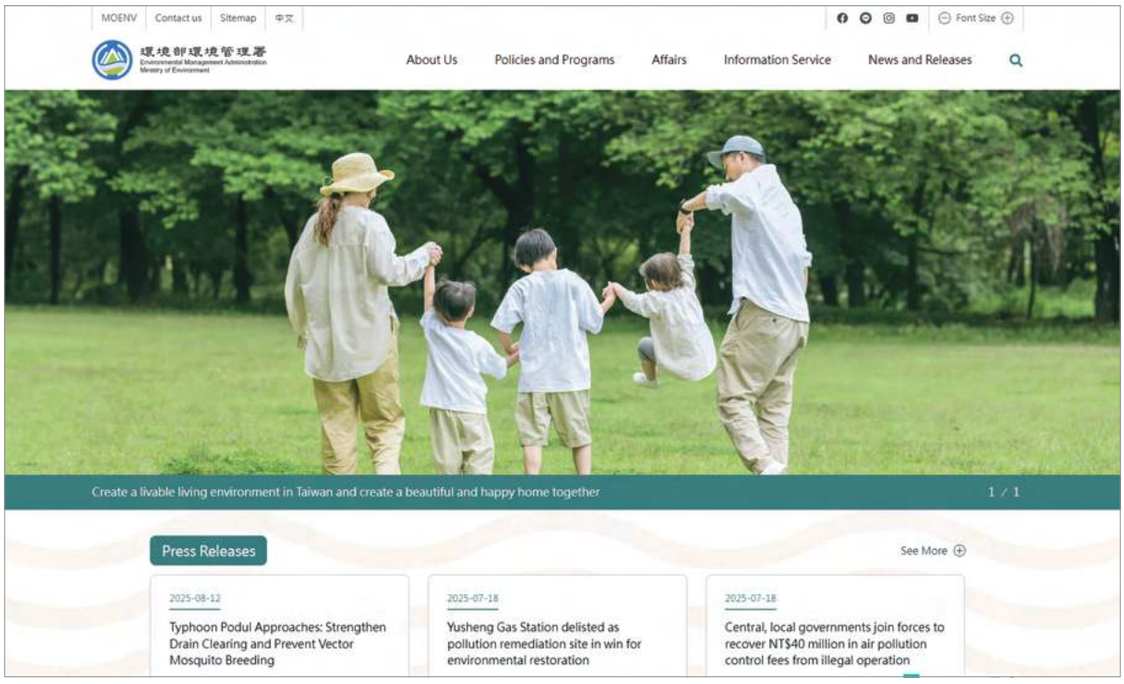


Figure 80 Overview of the Autonomous Inspection Mechanism and Checklist

Collaborating to Build a Safe and Intelligent New Era

Facing the rapid changes of the digital age and ever-evolving cyber threats, the Administration recognizes that cybersecurity protection and smart governance must be continuously optimized. In the future, the Administration will build on existing achievements to explore more advanced technologies and management models, while continuing to conduct diversified educational training and promotional activities. This ensures that both staff and citizens can cultivate cybersecurity awareness in daily life, gradually achieving the goal of “safe, convenient, intelligent, and sustainable” services.

2 New Official Website Launched – More User-Friendly Services



▲ The new official website highlights key policy themes and provides access to frequently used public information services.

The Official Website Plays a Vital Role

The official website serves as the public-facing gateway of a government agency. For government institutions, it is a platform for policy promotion and showcasing achievements; for the public, it is a channel for quickly accessing essential information and services. Beyond being a bridge for interaction between the government and citizens, the website also functions as a formal avenue for responding to public discourse and plays a key role in enhancing overall policy effectiveness and administrative efficiency.

In the past, the Administration's official website was jointly hosted with the Ministry of Environment. Its rigid design and limited layout made it difficult to effectively present the Administration's wide range of services and information. As a result, the site contained relatively little content and struggled to attract public engagement, leading to a vicious cycle of low traffic. To address this issue, the Administration launched a new standalone website in 2024. The redesigned site features a more user-friendly interface, improved visual appeal, and a stronger focus on user experience. Through this new platform, the Administration demonstrates its unwavering commitment to environmental issues.

Curated Themes Highlighting the Administration's Core Responsibilities

The Administration's scope of work is diverse and closely intertwined with everyday life. It ranges from addressing urgent public toilet needs, managing household waste disposal, and maintaining environmental cleanliness, to responding to illegal wastewater discharge or dumping by unscrupulous operators. Whether it's waiting for garbage collection or safeguarding the cleanliness of coastal areas, these responsibilities directly impact the well-being and quality of life of the public.

To make it easier for the public to understand and access the Administration's services, the newly launched official website replaces rigid and technical language with clear, reader-friendly terms. It also incorporates relevant photos and charts to enhance comprehension. Centered around the theme of "Refined Explanations, Integrated Outcomes" (Figure 81), the site presents 64 key service topics. Related information—such as frequently asked questions and popular services—is consolidated within the main service sections to reduce unnecessary searching and clicking. By simply navigating to the relevant section, users can quickly obtain clear and detailed information on the services they care about.

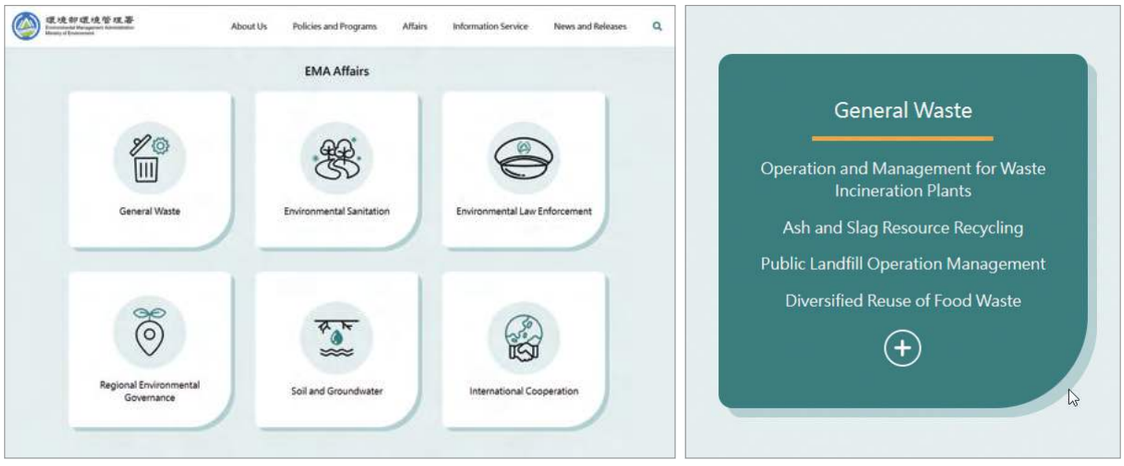


Figure 81 New Website Design: Key Service Sections

Clear at a Glance: Intuitive Presentation of Complex Data

In the past, if someone wanted to know the processing capacity of waste incineration plants across the country, they had to download one report after another, making it difficult to gauge whether each plant had sufficient capacity. Or, if they wanted to know the annual number of pollution complaints handled by the Administration and the main categories of pollution, they might not know where to find accurate information. The new official website transforms these overwhelming datasets into intuitive and visually

appealing charts (Figure 82). Beyond showcasing the Administration's operational achievements, it allows every user interested in environmental issues to access relevant information easily. The new website thus serves as a platform that is transparent, open, and user-friendly.

Figure 82 New Website Design: Visualized information

Achieve More with Less Effort – Quickly Access to the Administration's Services

The Administration operates multiple online service systems for the public, businesses, and government units to support and implement its work. However, these systems were previously scattered across different platforms. Users often did not know which keywords to use when searching for relevant services, making it difficult to find information and sometimes creating a negative perception.

To address these challenges, the new official website offers a comprehensive solution. It highlights frequently used services from the Administration's online systems (Figure 83)—such as public restroom search, pollution complaint reporting, and beach cleanup applications—by placing them prominently on the homepage so users can quickly find what they need. The site also reviews all service-oriented systems provided by the Administration, adding clear introductions and service highlights. These systems are organized into four major categories: Environmental Sanitation, Environmental Enforcement, Waste Management, and Soil & Groundwater. Serving as a unified entry point to the Administration's service platforms (Figure 84), the new website integrates relevant information in a one-stop format, making it significantly more convenient for the public to access and use.

Figure 83 New Official Website Homepage Popular Services Section

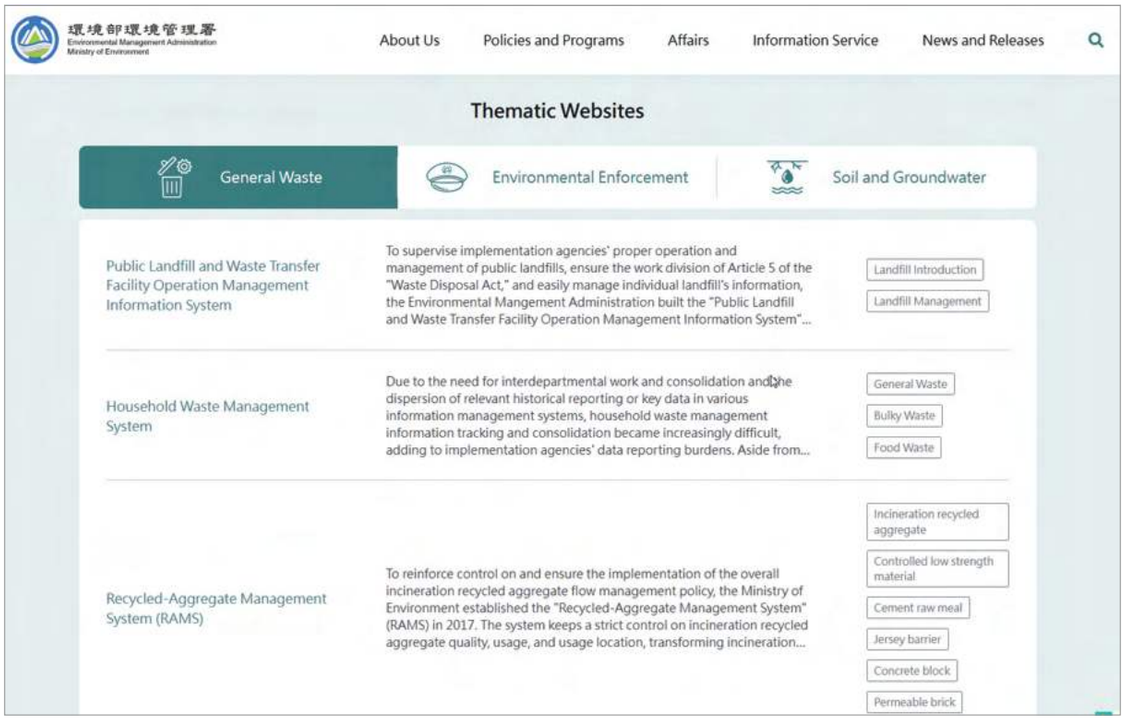


Figure 84 New Official Website Homepage: Business Systems Section

Future Outlook – Continued Enhancements to the New Website

To provide the public with a higher-quality browsing experience, the Administration values the experience and feedback of every website user, continuously updating and optimizing content to present accurate information. Beyond this, the Administration aims to advance the official website toward AI-driven intelligence and a low-carbon platform, further aligning with international standards and showcasing Taiwan's efforts and achievements in environmental protection and management to the world.

Stainable Develop and International Cooperation

2024

Environmental Management Administration Annual Report

1 International Technical Exchange: Innovation Begins with Observation

Environmental pollution knows no borders; its impacts easily transcend regions and nations, making it a global concern with significant challenges in management and mitigation. Different countries, based on their unique environmental conditions and societal needs, design tailored environmental policies, showcasing diverse and innovative governance approaches. As pollution generates varied impacts across countries and regions, exchanging and cooperating on environmental technologies and experiences has become an indispensable trend. Guided by the mission of environmental sustainability, the Administration continuously learns from countries with advanced technologies and policies, while also promoting Taiwan's expertise in soil and groundwater remediation to countries in need. This mutual learning approach strengthens Taiwan's environmental management policies and contributes to international environmental exchange.

Between 2023 and 2024, the Administration sent personnel to the United States, South Korea, Thailand, and other countries to study environmental management policies and technologies, including waste management and environmental enforcement. We also organized international seminars, technical forums, and training courses to implement knowledge exchange, absorb global practices, and evaluate the applicability of international technologies within Taiwan's context. These efforts aim to deepen international cooperation and enhance Taiwan's environmental governance capacity.

International Collaboration and Technical Exchange: Pioneering a New Era in Environmental Governanc

To strengthen international exchange and expertise, the Administration sent personnel to the United States, South Korea, Thailand, and other countries between 2023 and 2024 to study waste management and environmental enforcement practices. We also organized international seminars with keynote speeches and demonstrations to promote knowledge exchange. In June 2024, we co-hosted the "International Workshop on Emerging Contaminants and Remediation Practices" with the U.S. EPA (Figure 85), attracting over 200 participants from industry, government, and academia, and fostering exchanges with experts from Australia. Through the Asia-Pacific Soil and Groundwater Remediation Action Group (ReSAG), established in 2011, the Administration has strengthened Taiwan's role as a regional hub. ReSAG has trained 145 officials and promoted cooperation across 10 member countries, with the June 2024 forum further advancing regional collaboration.

On technological innovation, the Administration has promoted the Soil and Groundwater Remediation Technology Certification System, certifying 35 technologies

and adding 4 new ones for remediation contractors. At the November 2024 event, we awarded “Remediation Technology Certificates” and “Self-Declared Technology Effectiveness Certificates,” recognizing industry contributions and fostering more opportunities for international collaboration.

Figure 85 Hosting the 2024 Taiwan–U.S. International Workshop on Soil and Groundwater Remediation Technologies.

Leveraging Technology to Identify Pollution Sources

The Administration visited Washington, D.C., and Denver in the United States to engage with the U.S. Environmental Protection Agency (EPA) and related environmental agencies, focusing on the application and development of technology in environmental enforcement. By learning from these advanced practices, we aim to enhance Taiwan’s environmental enforcement efficiency and provide critical tools for inspections and regulatory actions. Enforcement Systems: The U.S. EPA shared inspection procedures for air and water pollution, prompting in-depth exchanges on differences in enforcement practices, challenges in execution, and cultural considerations. We also reviewed the U.S. Environmental Enforcement and Compliance Online Platform, which integrates nationwide industrial environmental reporting data and provides robust analytical capabilities. This system allows rapid identification of potential violations and demonstrates how systematic data analysis can uncover discrepancies in industrial wastewater reporting, generating lists of potentially noncompliant facilities. Technological Innovations: The U.S. EPA showcased the Geospatial Measurement of Air Pollution (GMAP) technology, which combines air pollution monitoring instruments, spatial modeling, and mobile vehicle equipment (Figure 86). This system maps air pollution concentrations along travel routes

and visualizes pollutant dispersion, enabling early response to industrial emissions and minimizing environmental impacts. Such advanced technological applications provide valuable reference for Taiwan to strengthen real-time monitoring and data-driven environmental enforcement.

Figure 86

U.S. EPA presents GMAP-based air pollution monitoring systems; Administration personnel engage in field visit and technical exchange.

Waste Management and Resource Circularity Strategies under Climate Change Adaptation

To learn about neighboring countries' climate adaptation strategies, the Administration joined a study tour in Korea on waste management and resource circulation, visiting several MOE facilities to see how policy and innovation support sustainable development (Figure 87). Korea showcased technologies such as advanced incineration gas treatment, solar panel recycling at Jincheon, and biogas applications to enhance energy recovery from organic waste.

Figure 87

Visit to the Jincheon Solar Panel Recycling Center in Seoul to observe South Korea's module recycling technologies.

In January 2024, South Korea enacted the *Circular Economy Transition Act*, introducing life-cycle product management and economic incentives such as waste bag fees and incineration taxes to promote recycling and reduction. It also advanced energy recovery facility upgrades and strengthened the EPR system for plastics and solar modules.

Taiwan-US Technical Exchange and Policy Insights

To deepen exchanges with other countries on environmental protection and technology- based law enforcement, on June 26, 2024, the Administration participated in the "Asia-Pacific Soil and Groundwater Remediation Working Group" (ReSAG) technical forum, and on June 27–28, in the "2024 Taiwan–U.S. Soil and Groundwater Technology Exchange International Workshop." During these events, the Administration introduced its innovative measures to strengthen waste management and track waste flow, specifically the "Introducing the AI Geofencing for Combating Illegal Dumping." (Figure 88)

Figure 88

Demonstrating the smart geofencing strategy for managing mping to participants of the Taiwan–U.S. technology exchange.

Establishing ReSAG: The Core Engine of Asia-Pacific Cooperation

Since 2011, Taiwan has played a leading role in soil and groundwater pollution remediation cooperation in the Asia-Pacific region by establishing the Asia-Pacific Soil and Groundwater Remediation Working Group (ReSAG). This collaborative platform, composed of 12 member countries, has become a central engine for regional environmental governance. To enhance regional environmental management capabilities, the Administration has conducted two professional training courses since 2023 for officials to share Taiwan's remediation experience. In June 2024, a technical forum was held, facilitating technical exchanges among 10 member countries (Figure 89). These efforts not only cultivated 145 Asia-Pacific officials as environmental governance "seeds" but also solidified Taiwan's leadership in soil and groundwater protection.

Figure 89 ReSAG's Inaugural Technical Forum, focusing on waste and emerging pollutant management.

Applying Drone Technology to Pollution Surveys for Precise Risk Assessment

In November 2023, Deputy Director-General Liu Ruixiang led a delegation of 21 experts from industry, government, and academia to Thailand, marking a new milestone in bilateral cooperation. The Taiwanese expert team conducted joint field investigations with officials from Thailand's Ministry of Industry and Ministry of Natural Resources and Environment at two major contaminated sites (Figure 90). During the site visits, drone technology emerged as a key highlight, enabling rapid identification of abnormal terrain through aerial imagery and facilitating precise risk assessment recommendations. This initiative significantly strengthened the foundation for future collaboration between both parties.

Figure 90

Deputy Director-General Liu joins Thai and U.S. counterparts in inspecting a major contamination site in Rayong, Thailand

From Workshops to Competitions: Planting the Seeds of Environmental Protection

By promoting international exchanges on soil and groundwater environmental protection between Taiwan and ASEAN countries, the Administration has established a partnership platform with ASEAN nations and showcased highlights of Taiwan's achievements in soil and groundwater pollution investigation and remediation.

Additionally, through organizing the "Taiwan and International Students Soil and Groundwater Technology and Strategy Workshop" (Figure 91) and the "Soil and Groundwater Remediation Research Competition and Awards Ceremony," the Administration cultivates talent, raises awareness of environmental protection, and strengthens close ties between Taiwanese and ASEAN academic institutions. These efforts also provide opportunities for Taiwanese companies to enter the ASEAN soil and groundwater remediation market, opening new possibilities for sustainable environmental development.

Figure 91 Soil and Groundwater Technology Exchange—Enhancing Regional Environmental Cooperation with ASEAN Nations.

Certification Sparks Innovation; International Collaboration Scales Up

To provide reliable remediation tools for contaminated sites, the Administration has advanced the three-phase Soil and Groundwater Remediation Technology Certification System. To date, 35 technologies have been certified and 9 granted self-declared effectiveness certificates, fostering innovation and credibility in environmental

governance. In 2024, four new methods—dual-phase extraction, enhanced in-situ anaerobic bioremediation, surfactant flushing, and bioremediation agents—were added, broadening options for remediation contractors. (Table 6)

Table 6

Statistics on the Issuance of "Contaminated Site Remediation Technology Certificates" and "Self-Declaration of Remediation Technology Effectiveness Certificates" Stainable Develop and International Cooperation

Pollution Type		2023	2024
		Numbers Issued	Numbers Issued
Contaminated Site Remediation Technology Certificates	Total Petroleum Hydrocarbons	11	2
	Chlorinated Organic Compounds	5	3
	Volatile Organic Compounds	6	7
	Heavy Metals	-	1
Self-Declaration of Remediation Technology Effectiveness Certificates	Soil Washing	3	-
	Soil Vapor Extraction	1	1
	Biopile Method	2	-
	In Situ Chemical Oxidation/Reduction	-	1
	In Situ Thermal Treatment	-	1

As technologies continue to advance, evaluation standards and effectiveness parameters have also expanded. In 2024, four new remediation methods were incorporated into the certification framework: dual-phase extraction, enhanced in-situ anaerobic bioremediation, surfactant flushing, and bioremediation agents. These additions offer the remediation industry a broader range of technical options. By extending the scope of eligible technologies for the "Self-Declaration of Technical Effectiveness" certification, Taiwan has not only diversified its contaminated site remediation strategies but also injected fresh momentum into environmental governance.

Against this backdrop, the Administration held a milestone achievement presentation on November 28, 2024, bringing together experts and representatives from industry, academia, and research institutions to witness Taiwan's latest progress in remediation technology certification. During the event, Deputy Director-General Liu Ruixiang personally presented the "Remediation Technology Certification for Contaminated Sites" and the "Self-Declaration of Technical Effectiveness" certificates (Figure 92), recognizing companies that have made outstanding contributions in technological innovation and practical application. Certified companies also shared real-world implementation cases, further promoting experience exchange and collaboration opportunities within the industry.

Figure 92 Certification ceremony group photo with Deputy Director-General Liu, Professor Ya-Ben Wang, and award recipients.

However, these efforts extend beyond domestic initiatives. On August 29, 2024, a new chapter in international technical exchange was opened as delegations from Taiwan, the Philippines, and Japan convened for the Environmental Technology Verification (ETV) Exchange Meeting (Figure 93). The three parties engaged in in-depth discussions and explored the development of mutual recognition mechanisms. This meeting fostered meaningful dialogue on ETV standards and laid a solid foundation for Taiwan's verification system to align with international practices. It also created multiple opportunities for collaboration. As these partnerships deepen, Taiwan's soil and groundwater remediation technologies are poised to play a more influential role across the Asia-Pacific region.

Figure 93 Taiwan, Philippines, and Japan experts discuss ETV mutual recognition and regional cooperation.

Looking Ahead: Promoting Environmental Sustainability and Strengthening International Cooperation and Technical Exchange

The Administration will continue to align with international trends, optimize the technology certification system, and strengthen cooperation with Asia-Pacific partner countries. It aims to further promote Taiwan's environmental technologies and experiences globally, advance sustainable environmental development, and make greater contributions to international environmental cooperation.

Fostering Sustainability via Education and Capacity Building

Sustainable development requires not only technological advancement and policy implementation, but also a strong foundation in education. By fostering environmentally friendly values and influencing individual behavior, the likelihood of pollution can be significantly reduced. To this end, the Administration continues to organize soil and groundwater awareness activities targeting youth, families, educators, and the general public. These efforts aim to deepen public concern for local soil and groundwater issues, embedding environmental protection values from the ground up and extending them across generations.

2 Parent – Child Learning: Introducing Soil and Water from an Early Age

In 2024, the Administration organized two soil and groundwater environmental education events for families, titled “Expert-Led Soil and Water Fun Workshops,” designed to teach children and parents about soil and groundwater health and protection through engaging, hands-on activities. A total of 24 families, comprising 78 participants, joined these events. Local crops such as rice and red dragon fruit were incorporated into the activities, allowing children and parents to experience practical interactions with the environment and understand the close connection between the environment and daily life (Figure 94).

Interactive Q&A Led by Environmental Education Instructors

Parent–child families participate in rice planting experiences

Figure 94 Outcomes of Soil and Groundwater Environmental Education Promotion Activities

3 Learning Through Play: Soil and Water Protection Begins with Board Games

The Administration launched the board game Land Defender, which cleverly combines educational content on soil and water protection with fun gameplay. Through game cards, players learn not only about the causes of pollution but also about different remediation techniques, while developing basic knowledge and awareness of soil and groundwater protection. From May to October 2024, the Administration conducted 12 training sessions and in-class teaching experiences using the board game for teachers and students in elementary schools and above. These activities aimed to expand the use of this educational tool. Teachers not only learned how to integrate the board game into their lessons but also personally experienced this interactive and challenging learning approach (Figure 95).

Figure 95 Educator training (left) and classroom board game activity on soil and groundwater (right).

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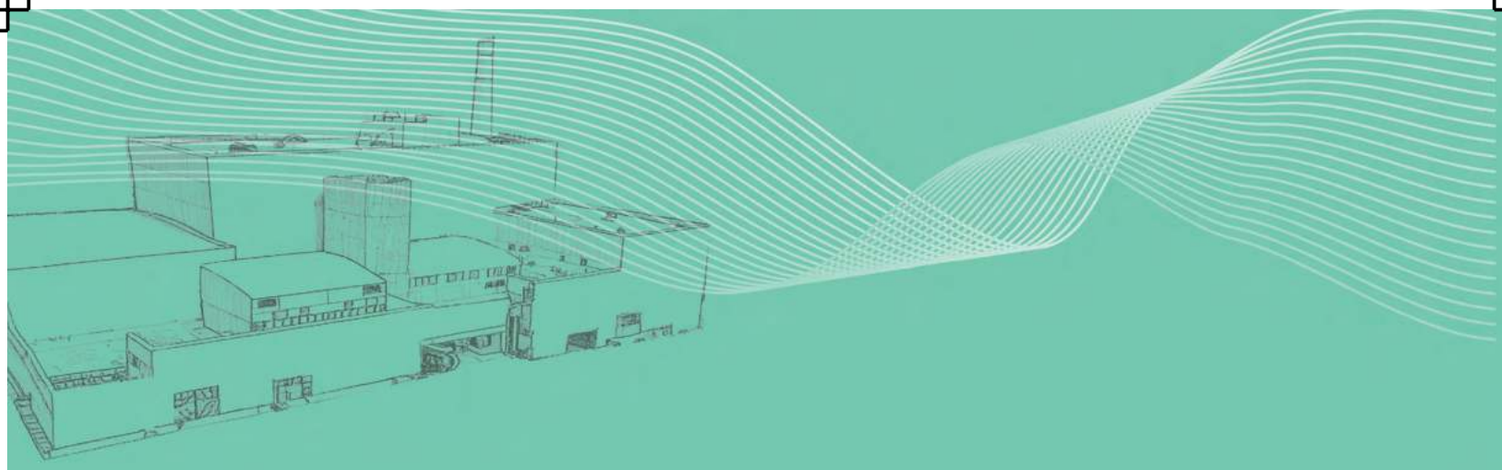

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