Study for Promotion of In-Situ Remediation and Management at Hydrocarbon Contaminated Sites including Gas Station, Korea and Taiwan - II

Dec 2019

Enviro Partners Co., Ltd.

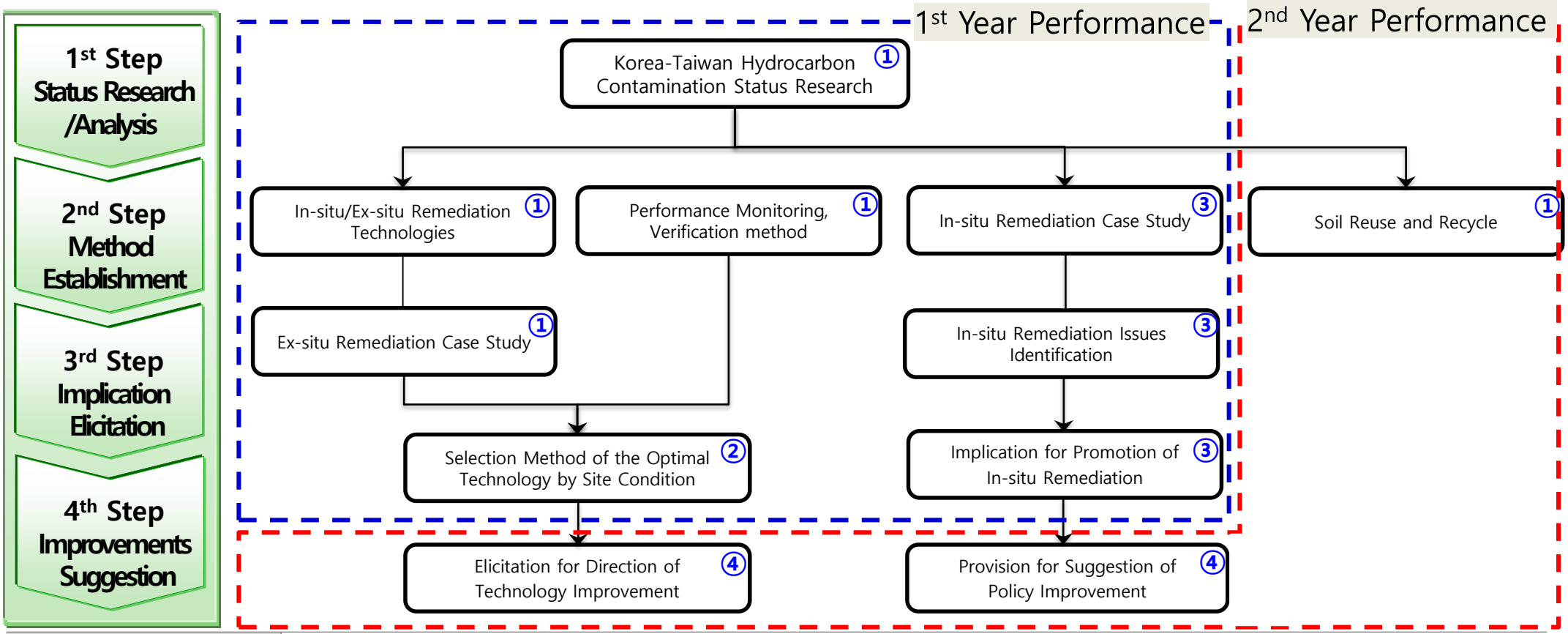
CONTENTS

1. Outline of Study

Study Title	▪ Study for Promotion of In-Situ Remediation and Management at Hydrocarbon Contaminated Sites including Gas Station, Korea and Taiwan _ II
Period	▪ 14th of February 2019 ~ 30th of June 2019
Main Scopes	▪ Elicit suggestion for the improvement of policy and the direction of in-situ remediation technologies in Korea ▪ Comparison for re-use and recycle management system of hydrocarbon contaminated soil in Korea and Taiwan
Contractor	ENVIRO PARTNERS 환경서비스 Environmental Services 환경실사 및 감사 Environmental Assessment and Audit 환경컨설팅 Environmental Consulting 환경영향평가(EIA/EIS), 환경정책자문 Environmental Impact Assesment Environmental Policy Advisory 오염부지관리 Contaminated Site Management 토양지하수 컨설팅, 환경 위해성평가 Soil Groundwater Consulting Environmental Risk Assessement 안전보건 Health and Safety 안전보건 교육, 석면조사 및 철거 Health and Safety Training, Asbestos Survey and Abatement

1. Outline of Study

Study Implementation Procedure



STEP 1	• Research on Korea and Taiwan's soil reuse and recycle, compare and analyze the management system between both countries
STEP 2	• Elicit suggestion of technical development after research of Korea-Taiwan in-situ remediation technologies
STEP 3	• Provide suggestion for improvement of in-situ remediation policy through review of in-situ remediation impediment factors

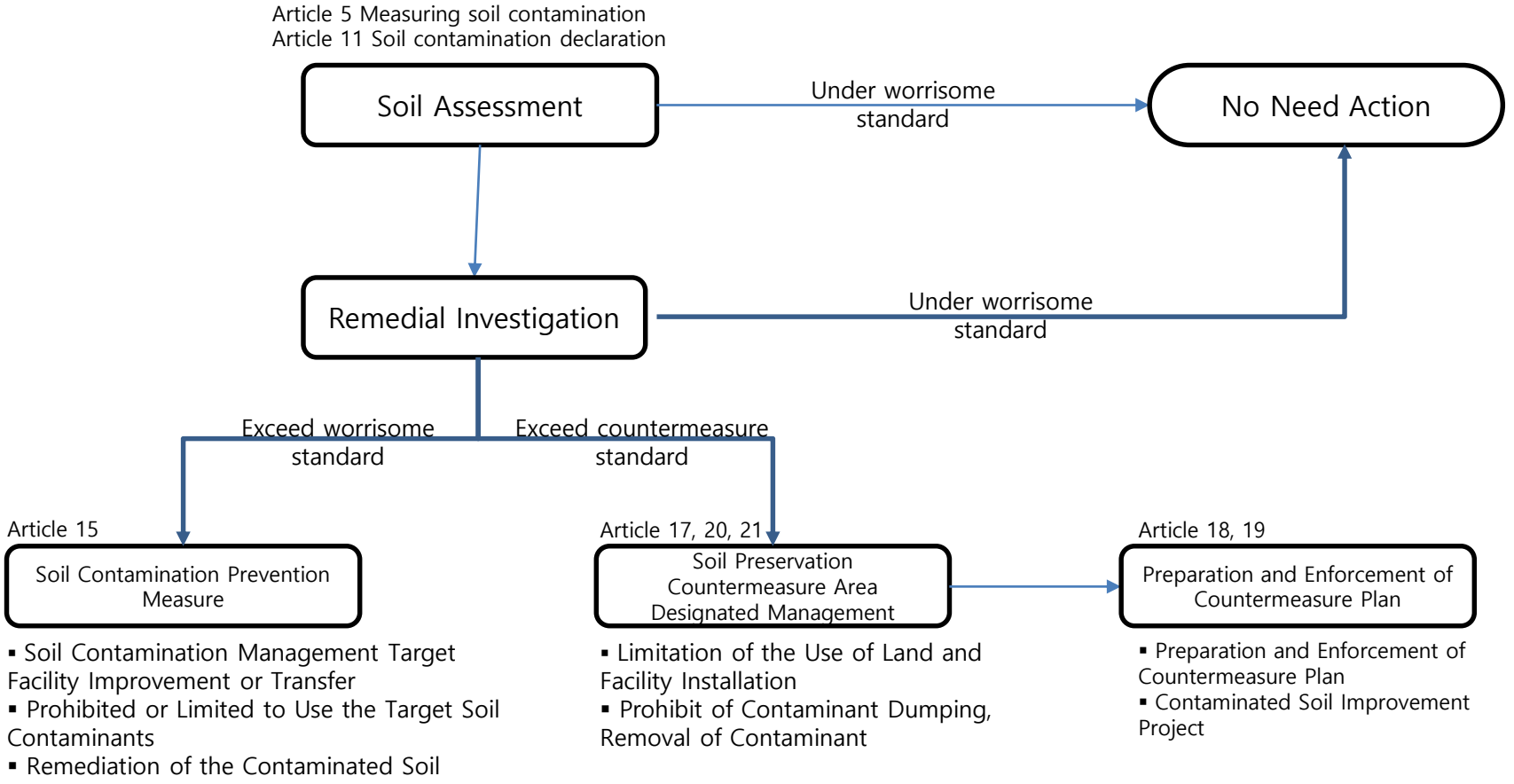
Legal Policies related Contaminated Site

- **Similarity of Korea and Taiwan dealing regulation matters with directionality and level**

Item	Korea	Taiwan	*Difference*
Contaminated site management standard	• Selects an area with the largest contamination possibility every year, executes environmental site assessments and regular monitoring, manages the worrisome and counter measure standard, and specified as a remediation target site if exceeding the worrisome standard.	• Divides through the monitoring standard and control standard, selects as a regular contamination monitoring target site due to the potential contamination possibility if exceeding the monitoring standard, classifies as a control target site that is a basic site investigation target if it is well managed and exceeds the control standard, and specified as the remediation target site after the target site investigation is conducted.	• **Korea doesn't have a management method other than removing contaminants, while Taiwan monitors the potential contaminated site regularly, prevents early and constantly manages potential contamination.**
Contaminant control range	• Regulates a total of 24 polluted substances of 8 heavy metals, 10 organic matters, organophosphorus compounds, fluorine compound, and cyan compound for the site usage, by each 3 standards from the 2 stages of the worrisome and counter measure standards. There are no soil standards for 8 substances controlled under Persistent Organic Pollutants (POPs) Substances Management Act.	• Regulates as the 2 stages of the monitoring and control standard on about a total of 39 polluted substances of 8 heavy metals, 21 organic compounds, 8 pesticides, and other 2 organic compounds.	• **Korea manages a source that is able to release persistent organic pollutant substances, while Taiwan applies and manages the soil standard, actively manages residual contamination from the past agricultural activities, and the contaminant control range is wider.**
Offsite remediation	• Applies the Soil Environmental Conservation Act and manages it	• Manages the types of contaminated soil as S code from the waste disposal law, and the company that owns the permission of a specific S code is possible to dispose contaminated soil that is under the target code.	• **Taiwan manages contaminated soil to be disposed offsite from the perspective of waste.**
Soil reuse/recycle	• Absence on the specific recycle usage regulation and related standard of remediated soil about soil reuse and recycle.	• Certified soil quality through an analysis method related to when reusing and recycling soil.	• **Taiwan's brick product ratio is higher after soil is remediated.**
Risk Assessment	• Confirm the contaminated site (exceed worrisome standard) through environmental site investigation, etc. • Site remediation is allowed through a risk assessment exceptionally, in principle of a treatment within the remediation standard.(limited in public site)	• Manages through the risk assessment if remediation is difficult to make lower than control site standard due to the geological conditions, the contaminant characteristic, or the remediation technology.	• **Taiwan remediates depending in setting the remedial goal, using the risk assessment results.**

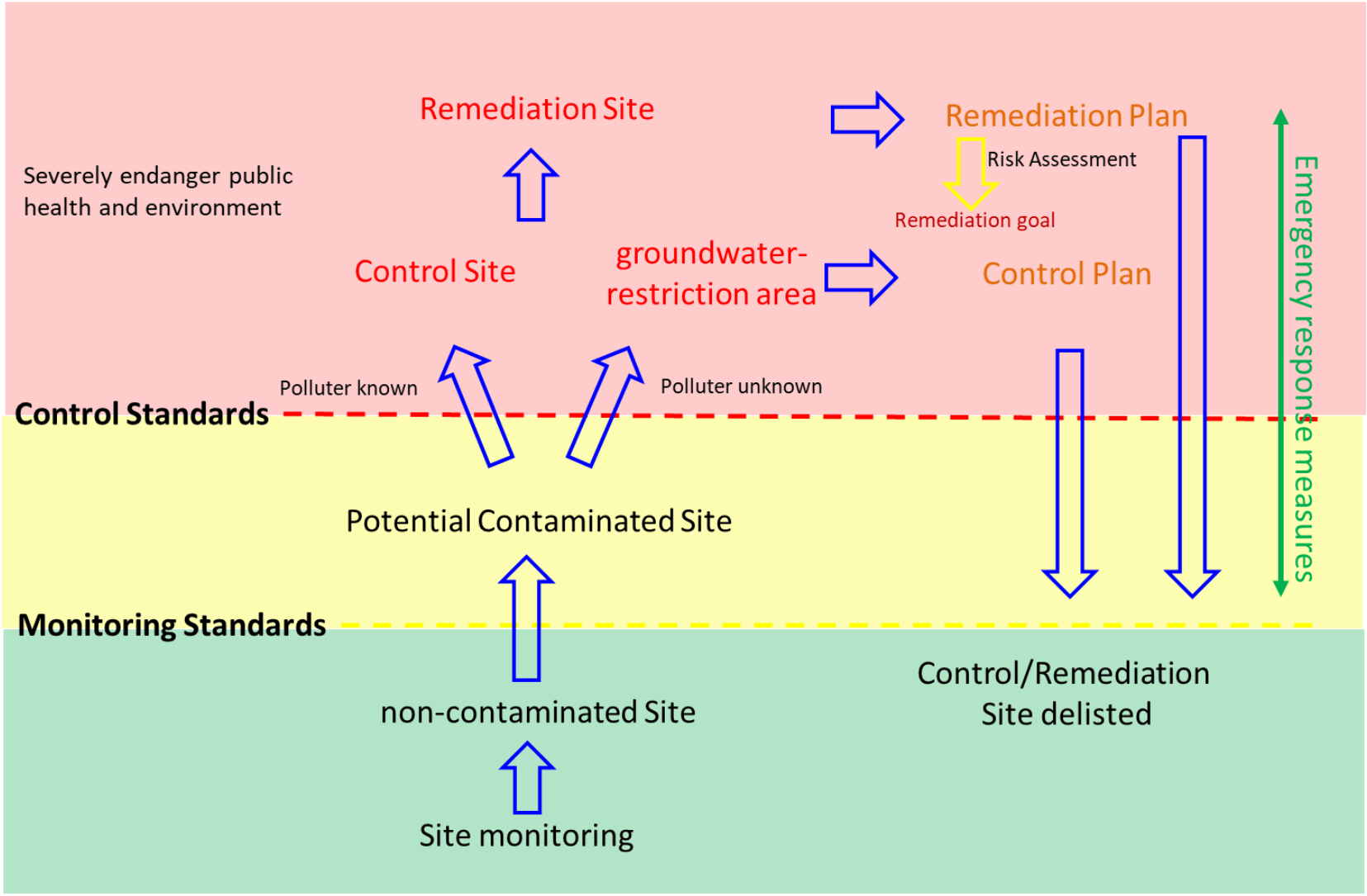
Contaminated Site Management System in Korea

- **Selects an area with the largest contamination possibility every year, executes environmental site assessments and regular monitoring, manages the worrisome and counter measure standard, and specified as a remediation target site if exceeding the worrisome standard.**



Contaminated Site Management System in Taiwan

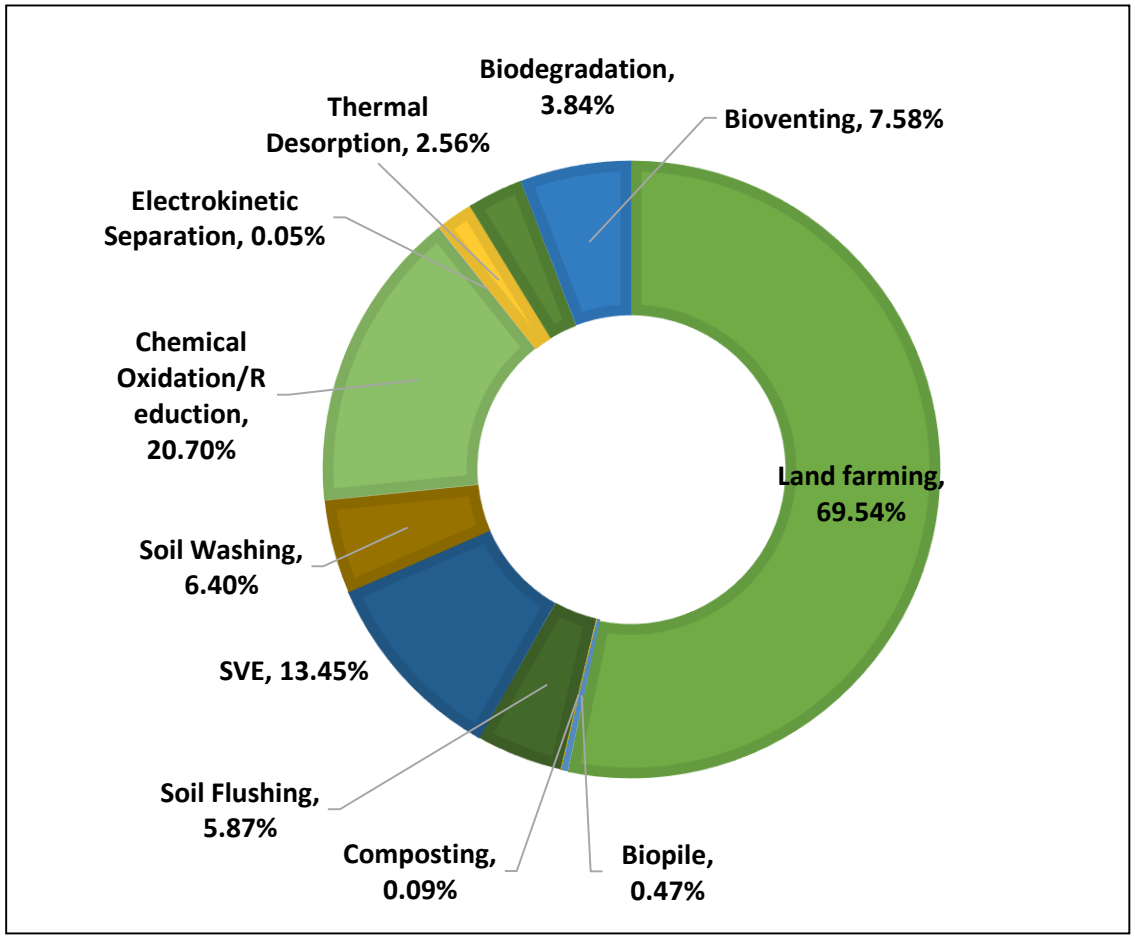
- **Taiwan identifies potential contaminated sites, monitors the sites regularly, and actively implements the concept of preventing early and constantly managing potential contamination.**

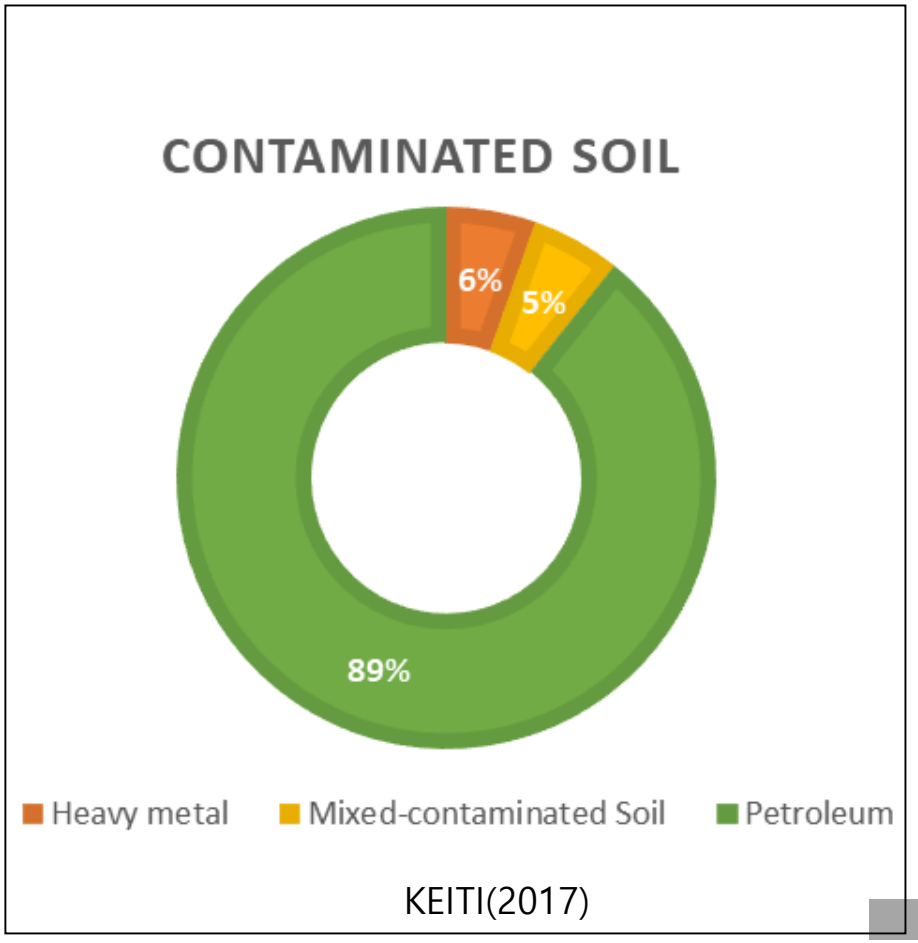


3. Korea-Taiwan Soil Remediation Technologies

Soil Remediation Technology Application Status in Korea

- **Land farming 69%(1,468), Chemical Oxidation/Reduction 20%(437), SVE 13%(248) is applied in order, in the case of hydrocarbon contaminated soil site(total 2,111).**
- **Hydrocarbon contamination ratio is the highest as hydrocarbon contamination is 89%(2,111), mixed contamination 5%(126), heavy metals 6%(128).**





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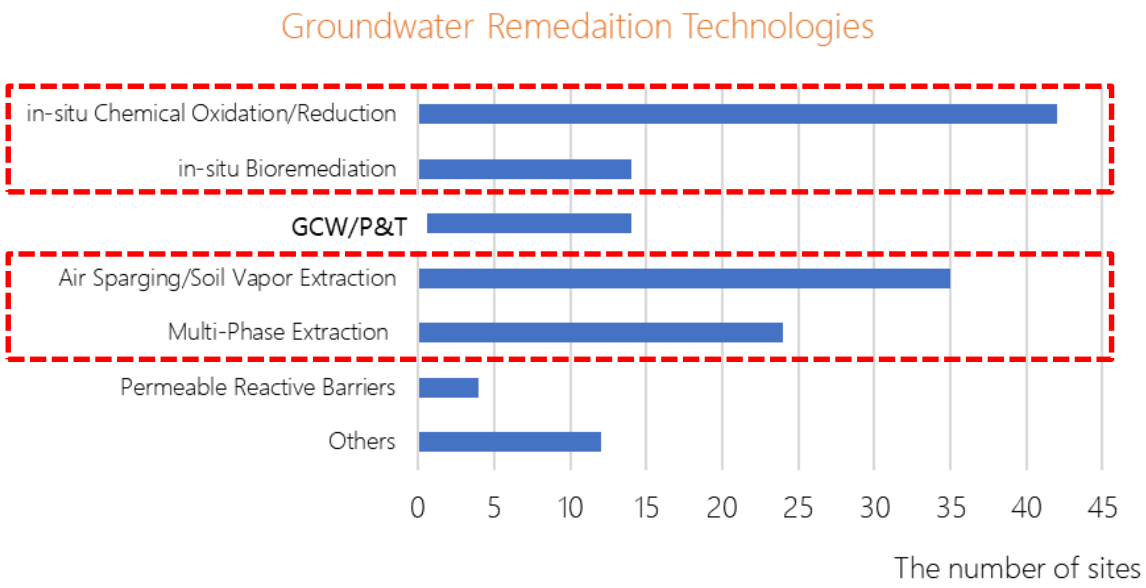
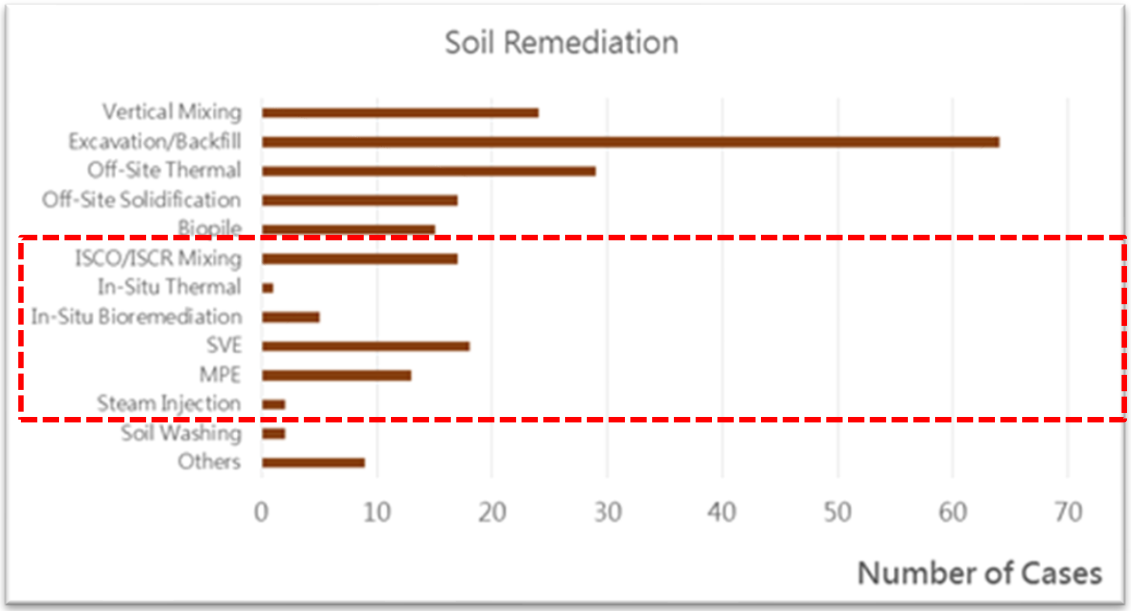
2. Status of Contaminated Site Management in Korea and Taiwan

Soil and Groundwater Remediation Technologies Application Status in Taiwan





- For groundwater remediation
  - Over 90% employ *in-situ* remed iation technologies
  - ISCO and AS/SVE are the most used ones
- For soil remediation
  - *In-situ* technologies are less used (~20%)
  - Partly due to the timely closure demand
  - Integration or treatment train concept is frequently applied

In-situ thermal remediation is one of the technology gaps in the inventory

4. Impediment Factors of In-situ Remediation

	Impediment Factors	Implications
Technical Factors	•Limited application of solidification, such as, the contaminant's vitrification, and soil contamination source blockage and shielding technologies	•Provide an institution to develop and apply Korean solidification and stabilization technology
	•There is much difference between the modelling result and the actual contaminated soil volume.	•Development of contaminated extent and amount estimation modelling technology
	•Impossible to inject in balance of air and oxidants due to the soil's heterogeneity.	•Needs an accurate contamination modelling technique
	•The permeability coefficient is low or forming fluid flow is impossible in clay.	•Needs to provide a remediation verification method that considers soil characteristics etc.
	•A contamination reduction due to advection rather than a mix of contaminants and oxidants that use low pressure injection method.	•Development for oxidants and contamination behavior technology
	•A subsurface settlement due to an excessive amount of air and oxidants for expansion and an excessive pumping	•Development of injection technology and oxidant
Institutional Factors	•Management of a separate law and regulation on the condition of linking soil contamination and groundwater contamination	•Provision of soil and groundwater integrated management method
	•Remediation period is maximum 4 years	•Flexible remediation period based on soil properties and contaminants
	•Verification at remediation completion	•Needs post management after completion of remediation
	•Standardized guideline for sample collection points and methods	•Provision of guideline to estimate sampling points and sample quantity by in-situ remediation methods
	•Regulations absence on impossible sample collection points	•Sampling method
	•Analysis error for the surrounding environment	•Provision of quality management method such as analytical quality management, verification sample sealing, etc.
	•Risk assessment : Only applied to public properties	•Increase of target sites after provision of verification and post management methods based on the risk assessment

Thank You for Listening

THANK YOU

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