

Former RCA Taoyuan Plant Groundwater Remediation Site Remediation Plan Site Report

整治單位：台灣美國無線電公司

Presenter : TCETVT

2016/03/24



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RCA 場址概況

RCA Site Descriptions



RCA 場址概況-關場前營運狀況

Plant Operation Before Shutdown

- 於1970年設立，廠區佔地約7.2公頃，主要作業為組裝製造電器產品

Former RCA plant was established in 1970. Plant site area 7.2 ha, site property was used for Television sets and related electronics production.

- 奇異公司(GE)於1987年合併美國RCA，並於1988年將產權移給湯姆笙消費電子公司(TCE)

In 1986, General Electric Company (GE) merged with RCA in the U.S. and acquired the plant and property. In 1988, Thomson Consumer Electronics (TCE) acquired RCA from GE.



RCA 場址概況-關場前營運狀況

Plant Operation Before Shutdown

- ❑ 奇異公司(GE)保留半導體業務部門，嗣給Harris公司將其出售營運至1991年

GE retained the solid-state assembly portion of the operations during this period, operating it as GE Solid State Taiwan Ltd. and later sold this operation to Harris Semiconductor Taiwan, Ltd., who operated it until 1991.

- ❑ 1992年10月16日關廠註銷工廠登記證，並賣給宏億建設開發股份有限公司

The plant was closed on October 16, 1992 and sold to Hong-Yi Development and Construction Company (Hong-Yi).



RCA 場址概況-關場前營運狀況

Plant Operation Before Shutdown

□ RCA原桃園廠主要生產線簡述如下:

Former RCA Taoyuan Plant Main Production Line is shown below:

第一廠房：本廠房一樓作為消費者電器部門(CED)運作場所。主要製程為將PC板自插入電子零件、塗上助焊劑、錫接、檢驗、加工、清洗助焊劑、檢驗、測試至完成PC板之組合。

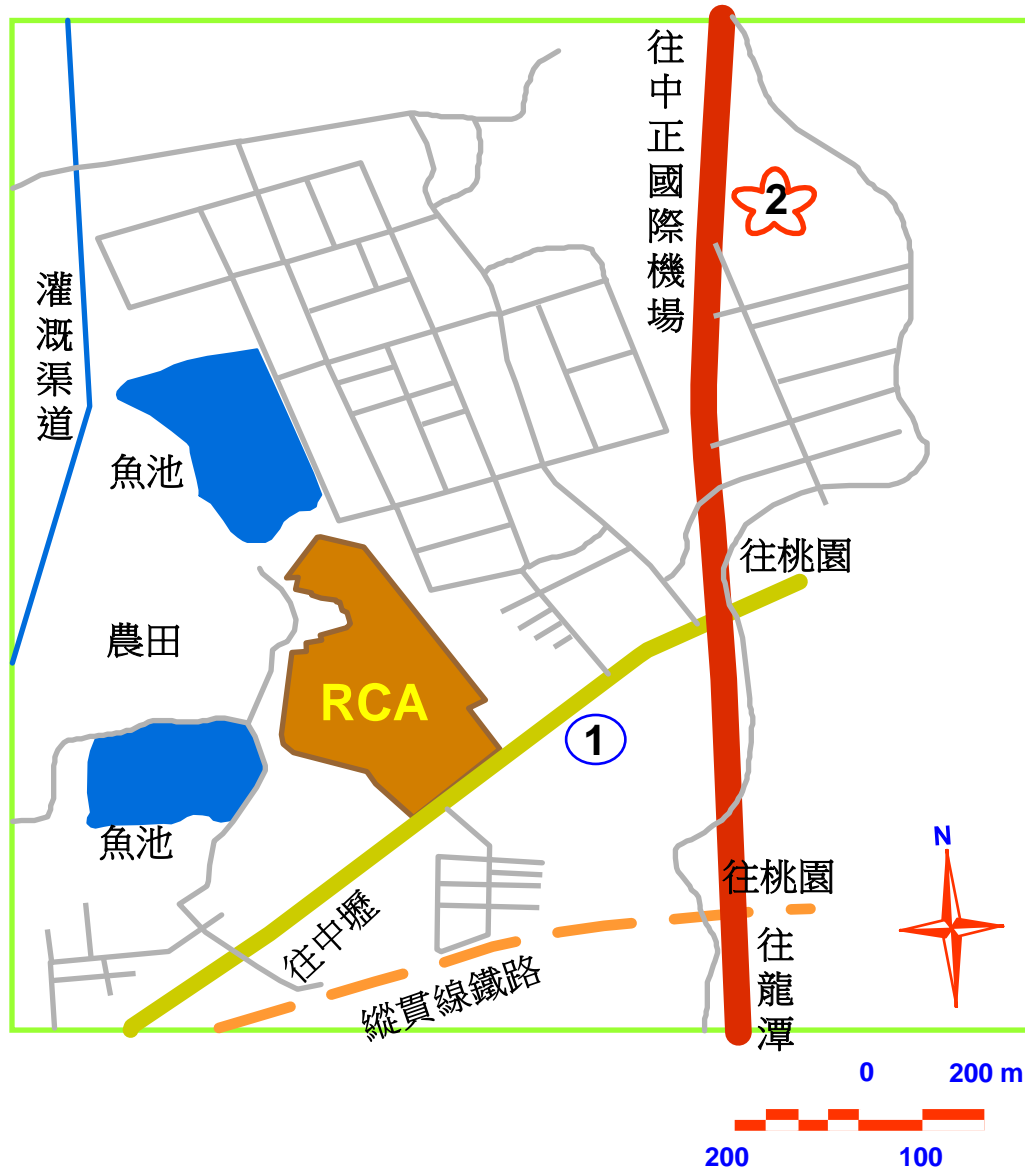
Building I: The first floor operated the CED. Manufacturing procedure includes inserting the main board, applying soldering flux, soldering, examining, processing, washing soldering flux, and testing.

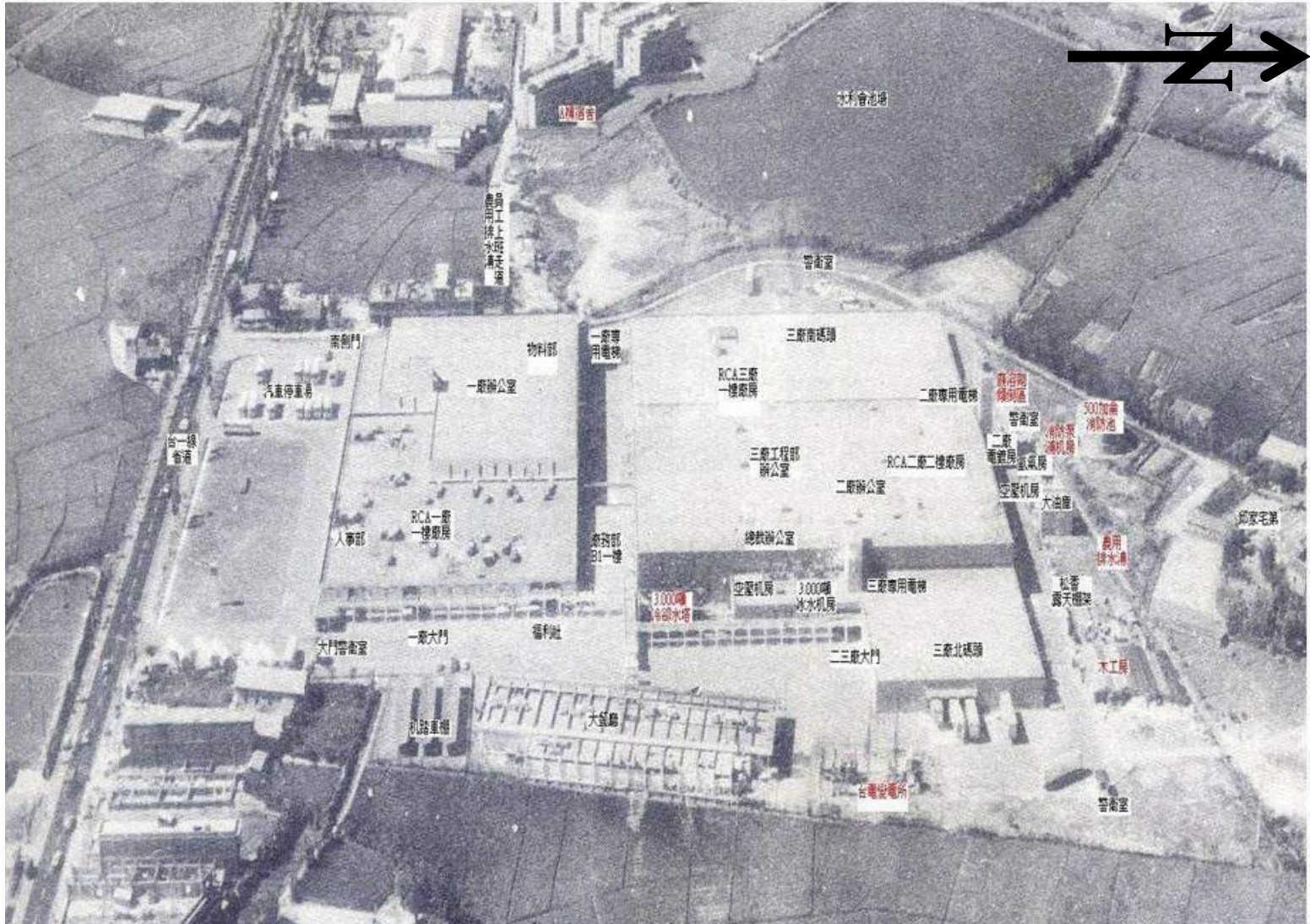
第二廠房：本廠房一樓作為延續第一廠房CED部門後續相關之組成與調整測試至完成主機板。本廠房二樓則供作半導體部門(SSD)之製造用，其為無塵室之印刷線路板製造廠房，作業內容包括基板之裁板、清潔、與焊接上電子零件於基板上。

Building II: The first floor operated the follow-up process, modification, and test of CED. The second floor was the clean room of the SSD. The procedure includes cutting, cleaning, and mounting of electronic chips onto ceramic blocks.



RCA TYP Location







RCA 場址概況-關場後狀況

Plant Operation After Shutdown

- RCA原桃園廠賣給宏億建設公司後，該公司原擬進行用地變更及開發，並於2000年6月提出廠址變更用地開發使用之環境影響說明書。

After the plant was sold to Hong-Yi, Hong-Yi proposed the report to change the use and develop the site in June 2000.

- 廠內主要建築物地上結構物皆由長昌公司委託拆除並回收清運拆除之廢鋼筋，僅留存一處建物做為簡報室。

Onsite main buildings were removed by Chang-Chang Company, except one building remained as briefing room.



RCA 場址概況-場址污染情況

Pollution Results

- 1990年～1997年間曾進行多次場址及附近區域污染調查。

當時場址主要污染物為：

Site contaminatants of concerns from results of previous investigation during 1990~1997 are:

- 四氯乙烷 (PCE)
- 三氯乙烷 (TCE)
- 1,1,1-三氯乙烷 (1,1,1-TCA)
- 1,1-二氯乙烷 (1,1-DCA)
- 1,1-二氯乙烯 (1,1-DCE)
- 順-1,2-二氯乙烯 (cis-1,2-DCE)
- 氯乙烯 (VC)

至2015年6月為止，場內剩下3口監測井VC濃度超過地下水第二類管制標準

Only 3 onsite monitoring wells exhibited VC exceedance of the Control Standard (Class II) in June 2015.



RCA 場址概況-場址污染情況

Pollution Results

□ 依據歷次場址調查結果顯示：

Results of site previous investigation Indicated:

- 場址西北區淺層地下水受VOC污染，濃度在ppm範圍

Shallow groundwater beneath the northwest portion of the Site contained VOCs in the ppm range.

- 場址部份區域土壤受VOCs污染(已於1998年整治完成)

Soil in several areas of the Site contained VOCs (has been removed since 1998).



RCA 場址概況-重要紀事回顧

Major Milestones

- 2002年4月26日桃園縣環保局公告本場址為地下水污染控制場址
TYEPB announced former RCA Taoyuan plant site as the groundwater pollution control site on April 26, 2002.
- 2002年12月2日依桃園縣環保局之要求提出
「台灣美國無線電股份有限公司原桃園廠場址地下水污染控制計畫書」
Requested by the Taoyuan EPB, TCETVT submitted a Pollution Control Plan (PCP) for the former RCA Plant site at December 2 2002.
- 2004年3月19日行政院環保署公告本場址為地下水污染整治場址
EPA announced former RCA Taoyuan plant site as the groundwater pollution remediation site on March 19, 2004.
- 2004年11月9日核定「RCA原桃園廠場址地下水調查及評估計畫
Former RCA Taoyuan Plant Site Groundwater Investigation and Assessment Plan (GIAP)
was approved on November 9, 2004.



RCA 場址概況-重要紀事回顧

Major Milestones

- 2006年8月15日環保局審查會同意本場址適用土污法17條依據風險評估提出可行之整治目標
August 15, 2006, EPB review meeting approved RCA site to apply new remediation goal based on Article 17.

- 2007年3月16日環保局風險評估小組審查會議結論：「本次風險評估報告依業者所提表6.0-1建議整治目標原則認可」
The proposed remediation target was accepted in the conclusion of EPB's Risk Assessment Task Committee at March 16, 2007 meeting.

- 2007年1月15日RCA場址整治推動專案小組委員場址現勘
RCA site Remediation Project Team Committee visited the site on January 15, 2007.



RCA 場址概況-重要紀事回顧

Major Milestones

- 2008年4月16日環保局發函要求依環保署土基會意見：「有關RCA所提之風險評估，雖依既有規範模擬運算，其過程原則同意，惟因採用國外參數條件，考量國內外環境及後續使用習慣之差異頗大，故仍應以地下水污染管制標準為整治目標，經整治工作進行一段時間後，如仍因地質條件、污染物特性或整治技術等因素，無法低於管制標準時，則得依該風險評估結果，再行檢討調整整治目標。」修正風險評估後提送整治計畫書(第五次修正稿)，並召開後續整治計畫書審查會

April 16, 2008, based on EPA's comment, EPB expressed that the risk assessment was approved in principle. If the concentration cannot meet the standards due to geological conditions, pollutants characters, or remediation technologies, remediation target will be modified in accordance with results of Risk Assessment. Remediation Plan (5th revision) was submitted, and Remediation Plan review meeting was held after Risk Assessment was revised.

- 2009年7月20日環保局核定本場址地下水污染整治計畫書
July 20 2009, EPB approved the SGRP.



RCA 場址概況-重要紀事回顧

Major Milestones

- ❑ 2009年10月26日環保署同意核備本場址地下水污染整治計畫書
October 26 2009, EPA agreed the EPB approved SGRP.
- ❑ 2010年5月至2012年8月監督單位為恆逸工程股份有限公司
From May 2010 to August 2012, Heng-Yi Engineering Co. Ltd. served as the supervision company.
- ❑ 2011年8月16日桃園市政府公告核定「台灣美國無線電股份有限公司(RCA)原桃園廠地下水污染整治場址污染整治計畫變更計畫」，延長6個月，至2012年2月15日。
August 16, 2011, TYG approved 6-month extension of “Former RCA Taoyuan Plant Groundwater Remediation Site Remediation Plan Amendment” due on February 15, 2012.
- ❑ 2012年1月13日台灣美國無線電股份有限公司申請延長整治時間六個月(但並未核准)。
TCETVT applied for 6-month extension on January 13, 2012. (had not been approved)



RCA 場址概況-重要紀事回顧

Major Milestones

- 2013年6月24日桃園縣政府公告核定「台灣美國無線電股份有限公司(RCA)原桃園廠地下水污染整治場址污染整治計畫第二次變更計畫」，延長24個月，至2015年6月23日。

On June 24, 2013, TYG approved 24-month extension of “Former RCA Taoyuan Plant Groundwater Remediation Site Remediation Plan 2nd Amendment” due on June 23, 2015.

- 2013年10月至2015年10月監督單位為艾奕康工程顧問股份有限公司
From October 2013 to October 2015, AECOME Engineering Consulting Co. Ltd. serves as the supervision company.

- 整合第二次變更計畫相關整治經驗後，於「台灣美國無線電股份有限公司(RCA)原桃園廠地下水污染整治場址污染整治計畫第三次變更計畫」，提出申請延長，以完成地下水整治工作。

Extral extension of “Former RCA Taoyuan Plant Groundwater Remediation Site Remediation Plan 3rd Amendment” was proposed to complete groundwater remediation successfully.



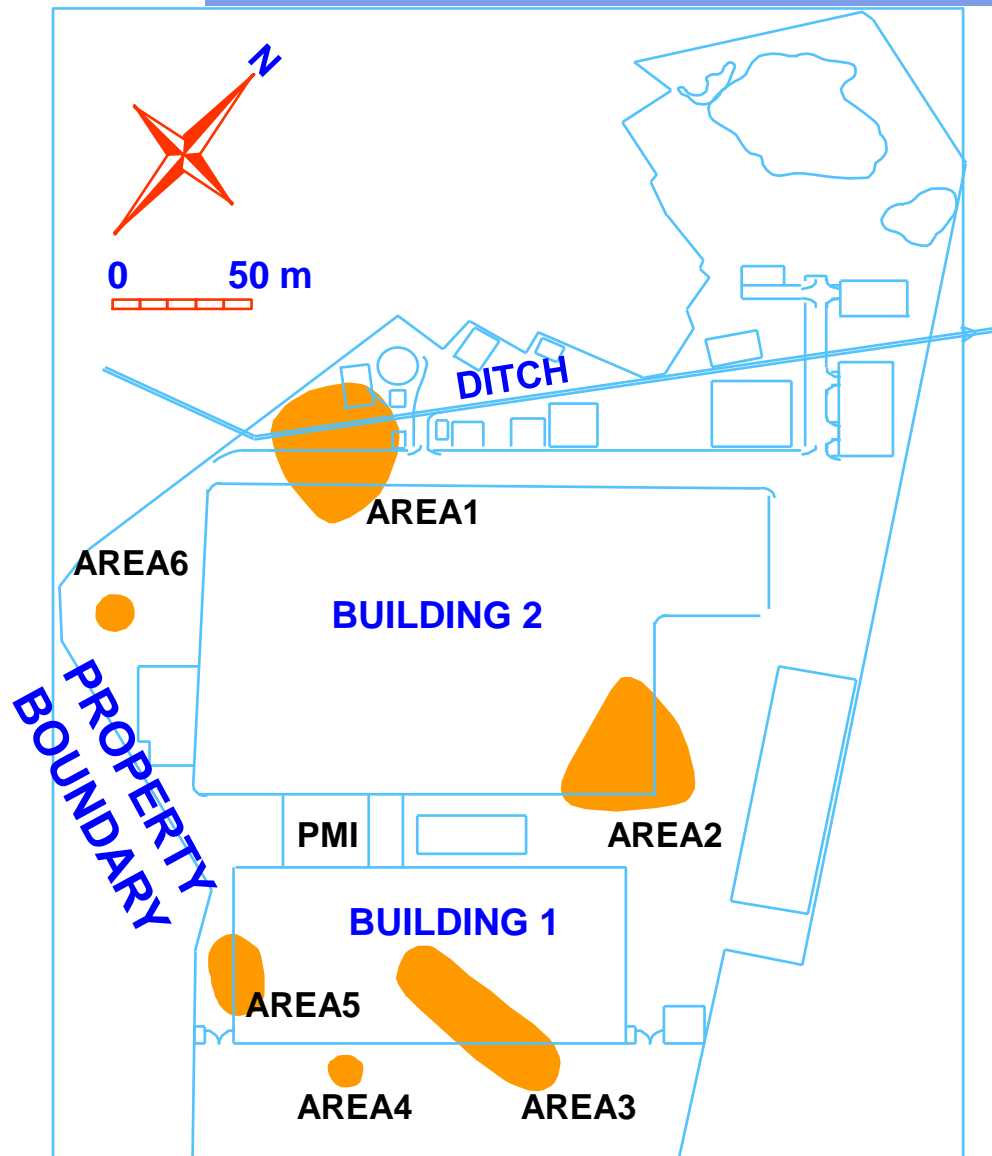
RCA 場址概況-場址地下水整治目標值

Remediation Target

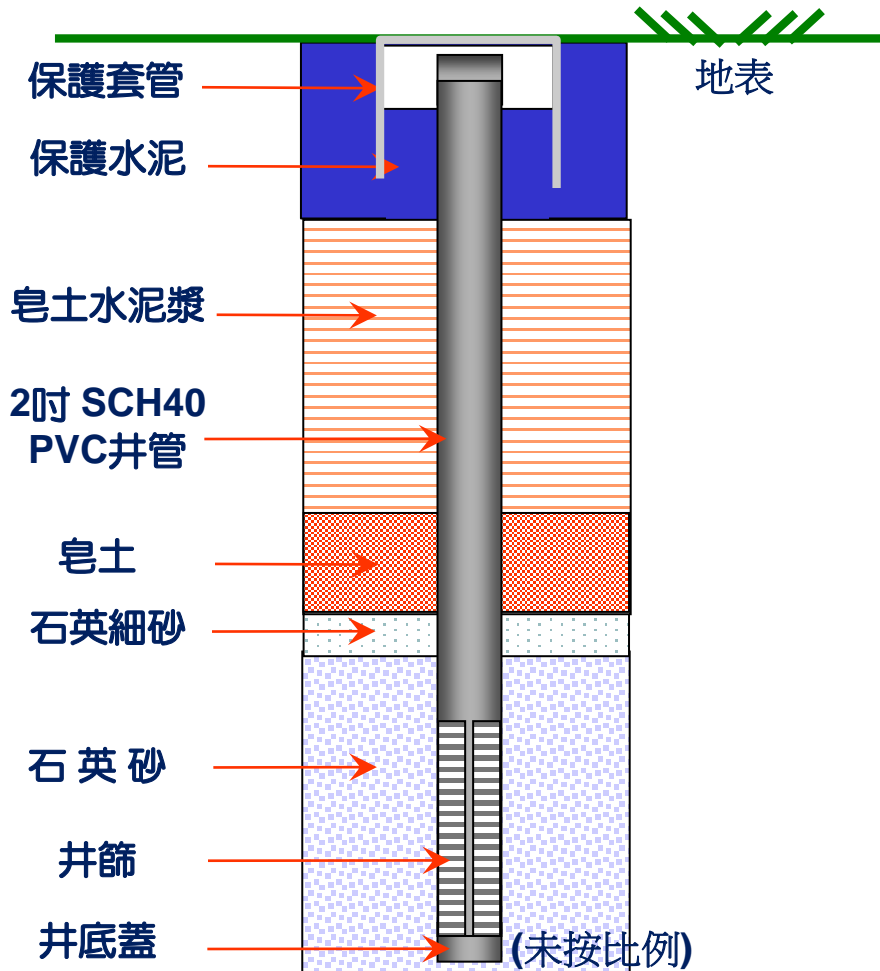
單位Unit: (mg/L)

化學物質 Chemicals	第二類地下水污染管制標準 EPA GW Pollution Control Standards
1,1-二氯乙烷 1,1-Dichloroethane	8.5
1,1-二氯乙烯 1,1-Dichloroethylene	0.07
1,1,1-三氯乙烷 1,1,1-Trichloroethylene	2.0
順1,2-二氯乙烯 cis-1,2-Dichloroethylene	0.7
四氯乙烯 Tetrachloroethylene	0.05
三氯乙烯 Trichloroethylene	0.05
氯乙烯 Vinyl chloride	0.02

Soil Gas Survey



Groundwater Monitoring Wells



平臺式



隱藏式



Groundwater Sampling (1/2)



Groundwater Sampling (2/2)

貝勒管採樣



微洗井採樣



被動式採樣袋





Groundwater Flow Direction





歷年整治情形

Remediation Phases



密閉式開挖：VOC濃度高，工作人員安全防護嚴謹。



開挖深度：6.1 m

地下水面：5.8 m





開挖之污染土壤在二號廠房內曝氣。



抽氣及處理系統



地下水處理系統



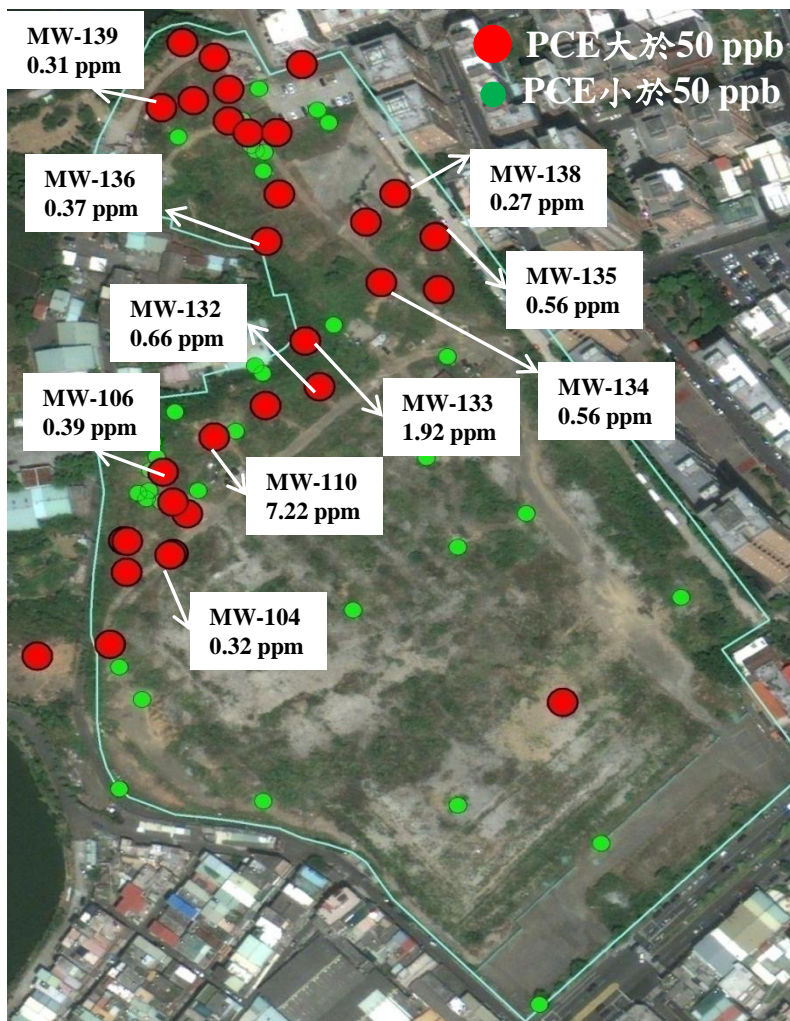
Enhanced Anaerobic Bioremediation



歷年整治情形-原生污染物整治成效

Remediation Performance of Parent Products

2007年12月全面整治前場內PCE濃度分佈



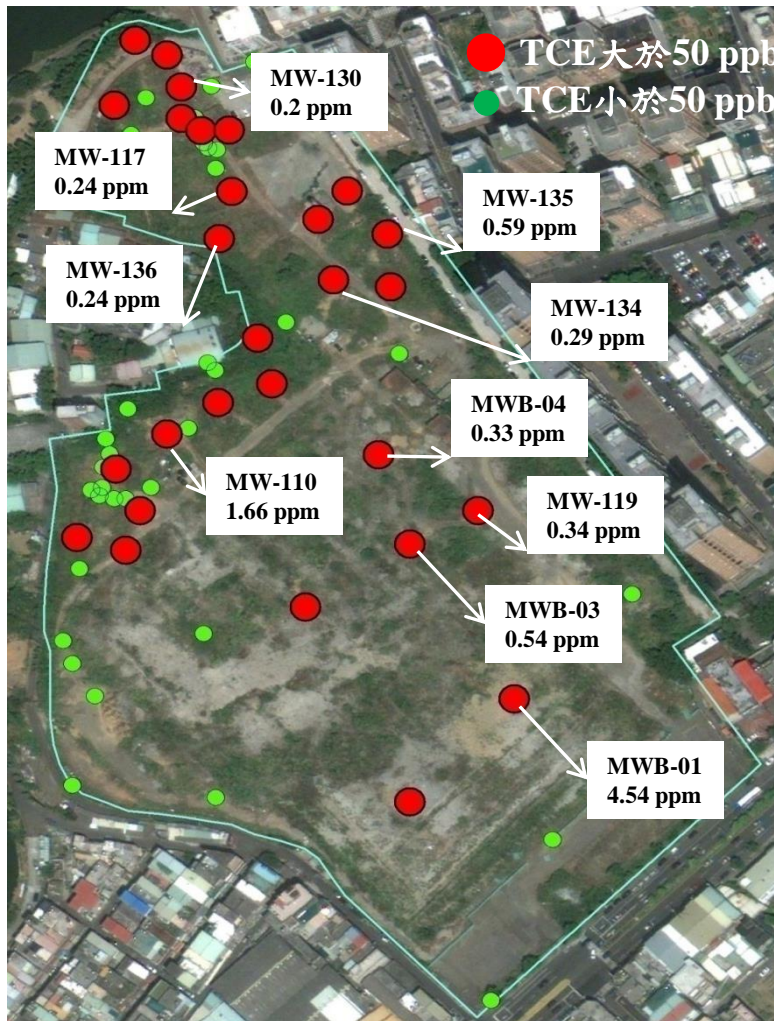
- 紅色圓圈為2007年12月超出第二類地下水管制標準之點位，共31口監測井測出PCE超標，經全面整治後，自2012年9月開始PCE濃度均低於管制標準。

Location of exceedances (December 2007) of the Control Standards (Class II) is in red. 31 monitoring wells exhibited PCE exceedance. With full-scale remediation, PCE has met the Control Standard since September 2012.

歷年整治情形-原生污染物整治成效

Remediation Performance of Parent Products

2007年12月全面整治前場內TCE濃度分佈

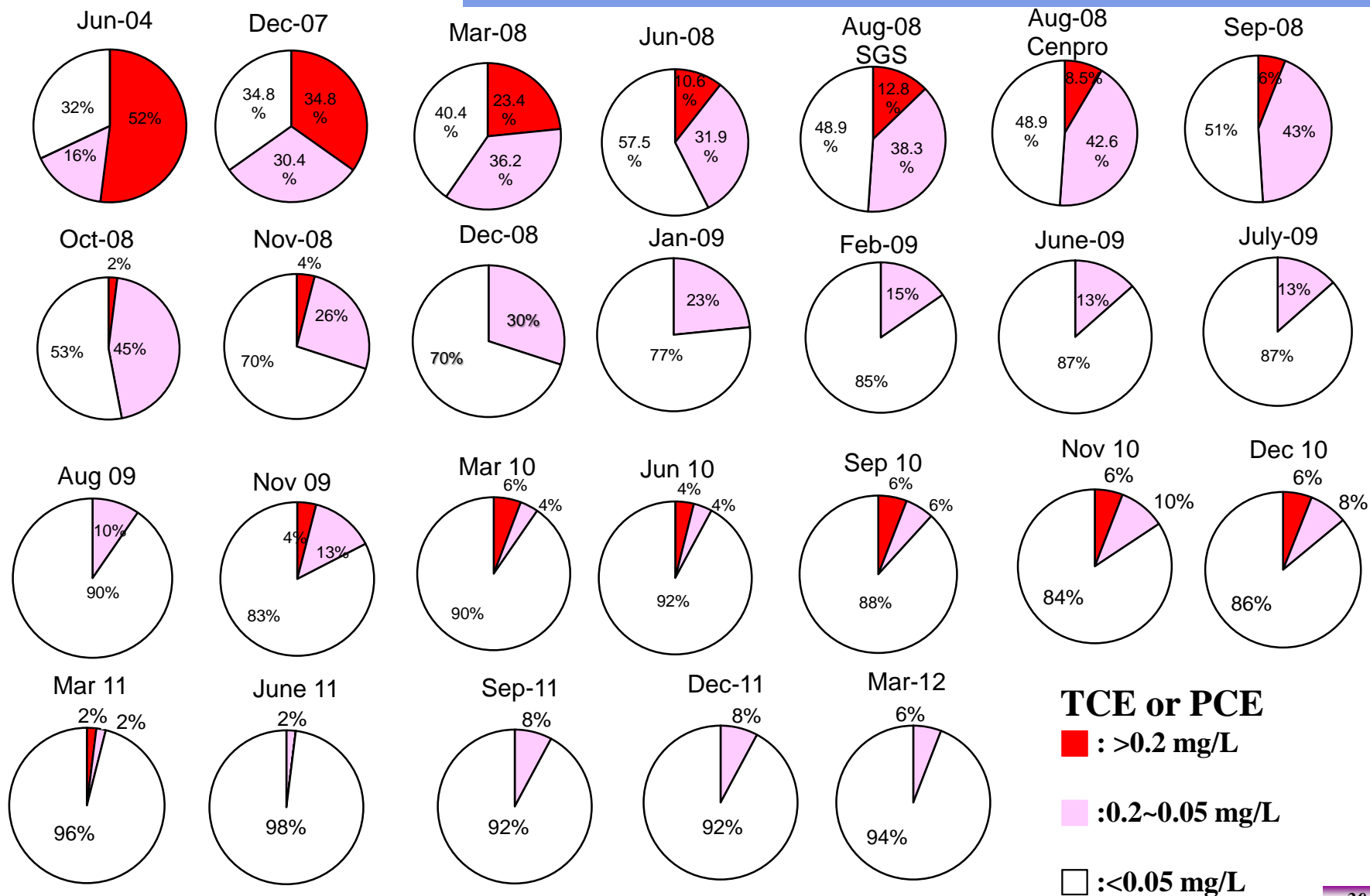


- 紅色圓圈為2007年12月超出第二類地下水管制標準之點位，共28口監測井測出TCE超標，經全面整治後，自2015年6月開始TCE濃度已低於管制標準。

Location of exceedances (December 2007) of the Control Standards (Class II) is in red. 28 monitoring wells exhibited TCE exceedance. With full-scale remediation, TCE has met the Control Standard since June 2015.

歷年整治情形-原生污染物整治成效 (51wells)

Remediation Performance of Parent Products (51 wells)





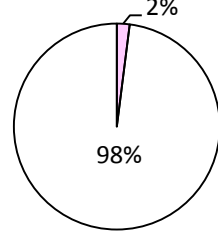
歷年整治情形-原生污染物整治成效 (51 wells) Remediation Performance of Parent Products (51 wells)

TCE or PCE

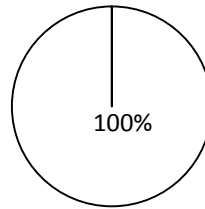
■ :0.2~0.05 mg/L

□ :>0.05 mg/L

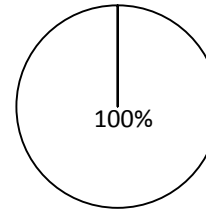
Jan-12



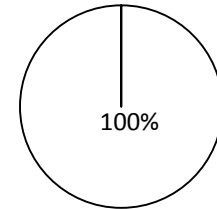
Sep-2012



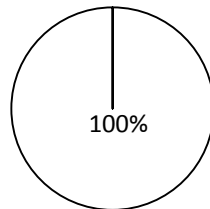
Mar-2013



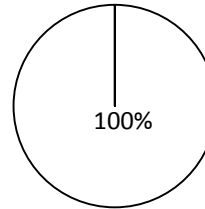
June-2013



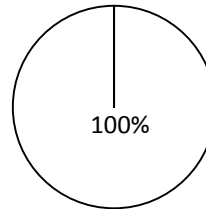
Sep-2013



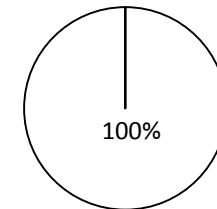
Dec-2013



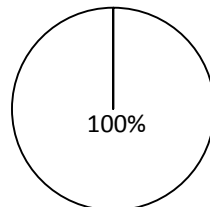
Mar-2014



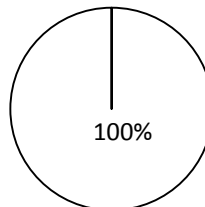
June-2014



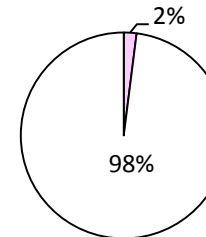
Sep-2014



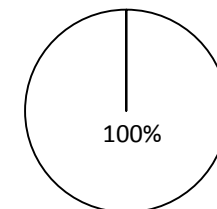
Dec-2014



Mar-2015



June-2015





目前整治情形-ERD 灌注系統

ERD Injection System

- 加強型還原脫氯反應(enhanced reductive dechlorination)，係經由灌注糖蜜以營造地下水成為厭氧環境，以利脫鹵球菌種生長，並降解含氯有機物。

Enhanced reductive dechlorination applies molasses injection to establish anaerobic environment in groundwater, facilitating the growth of DHC and the degradation of CVOCs.

- 本場址地下水ERD處理系統設有196口注入井，能輸送糖蜜溶液送至地下含水層以建立厭氧區域處理地下水CVOC污染，並於2014年6月經環保局同意乳酸鈉溶液注入以加強整治之效率。

In this site, ERD system contains 196 injection wells which are able to transmit molasses solution to groundwater aquifer for establishing anaerobic environment in groundwater and removing CVOC pollution. In June 2014, EPB approved sodium lactate injection for the remediation.



目前整治情形-查核點時間與查核項目

Check Point and Check Item

Month	Total Number of Monitoring Wells	Total Number of Monitoring Wells Non-Compliant for PCE	Expected Number of Monitoring Wells Non-Compliant for Daughter Products	Total Number of Monitoring Wells Non-Compliant for Daughter Products
June 2013	51	0	3	5
September 2013	51	0	2	10
December 2013	51	0	1	10
March 2014	51	0	0	7
June 2014	51	0	6	6
September 2014	51	0	3	3
December 2014	51	0	2	5
March 2015	51	0	1	9
June 2015	51	0	0	3

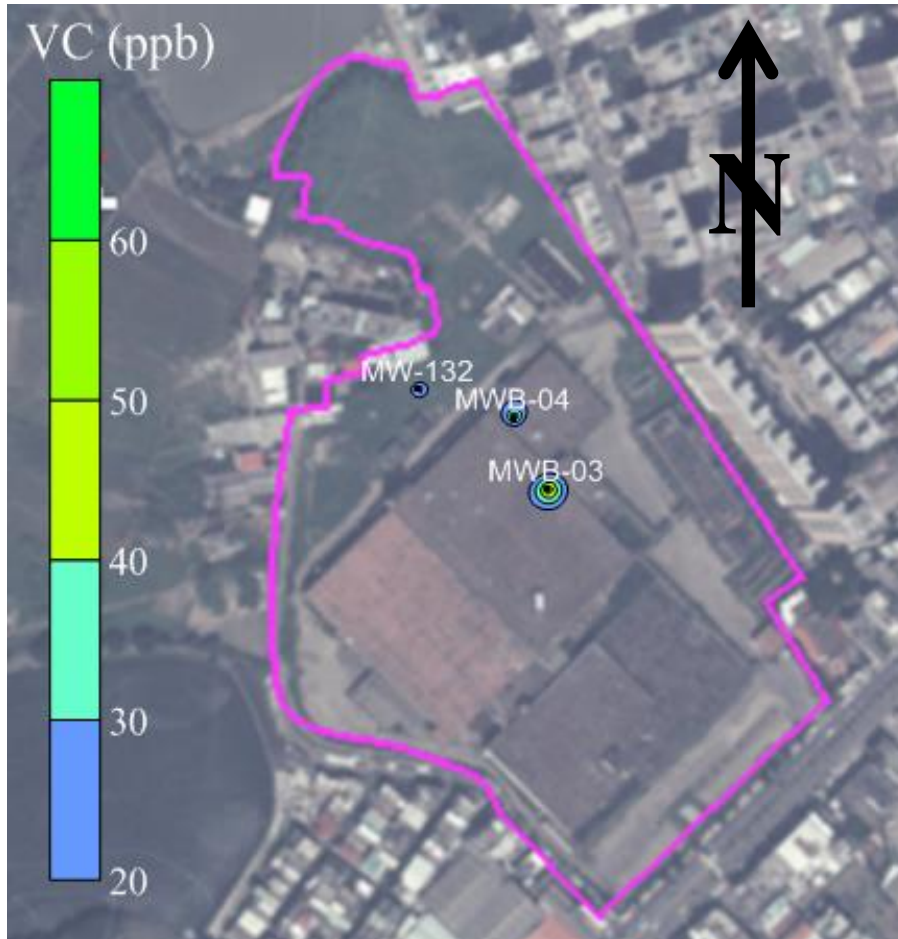
❖ 與原先預期0口衍生物不合格數不符，2015年第2季共3口監測井VC超過管制標準

In 2015 2Q, 3 monitoring wells exhibited VC exceedance. The results were not consistent with our expectation.



目前整治情形-2015年6月場內採樣結果

June 2015 Sampling Results



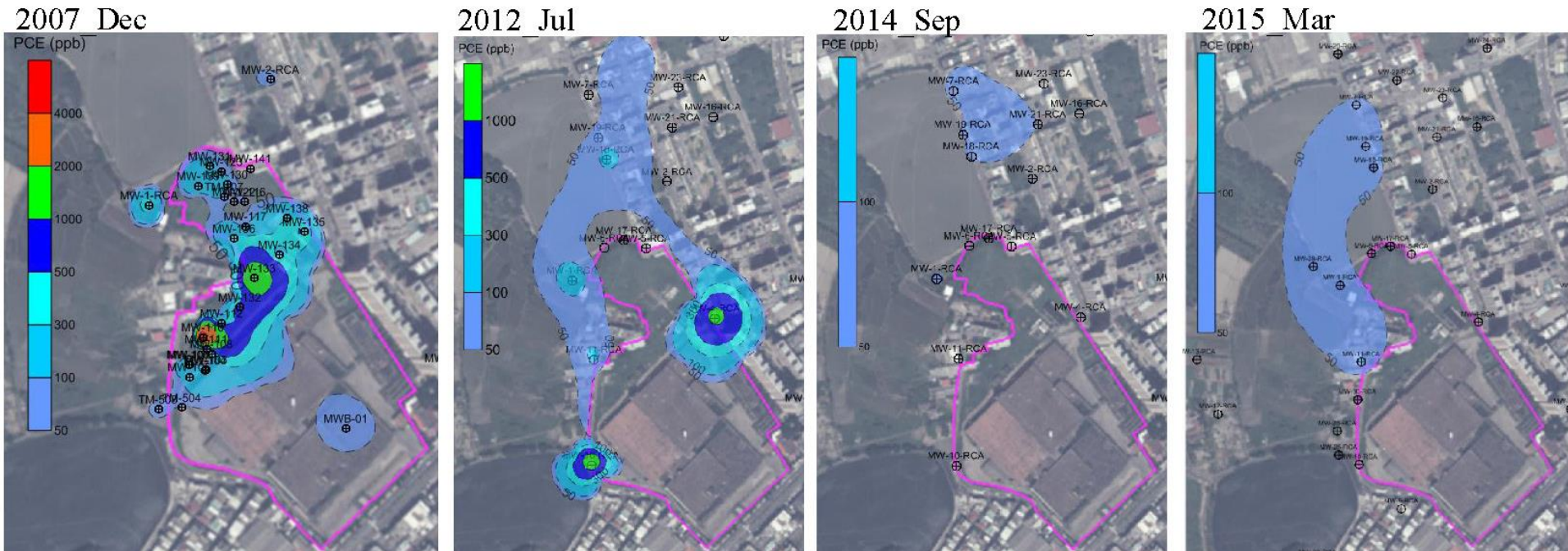
□ VC: MW-132 (38.2 ppb)
MWB-03 (60.1 ppb)
MWB-04 (44.9 ppb)

(經過糖蜜與乳酸鈉灌注後，
2015年6月採樣剩3口監測井VC
濃度超標。)

(With molasses and sodium lactate
injections, only 3 monitoring wells
exhibited VC exceedance in June 2015.)



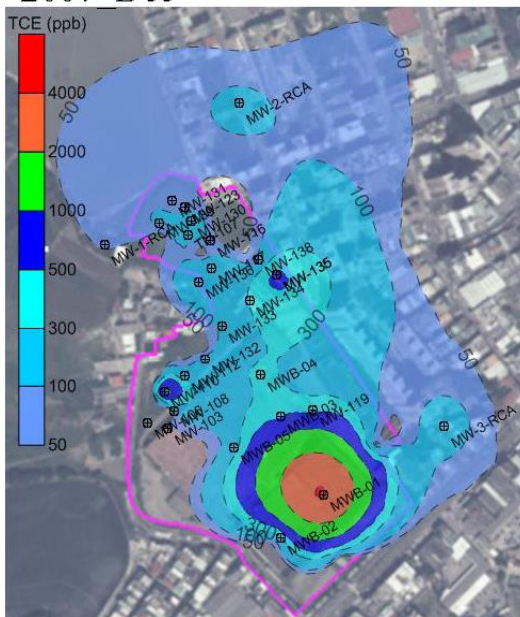
PCE Plume



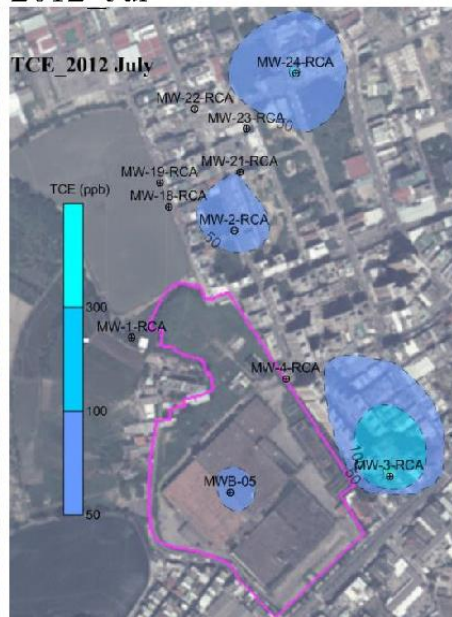


TCE Plume

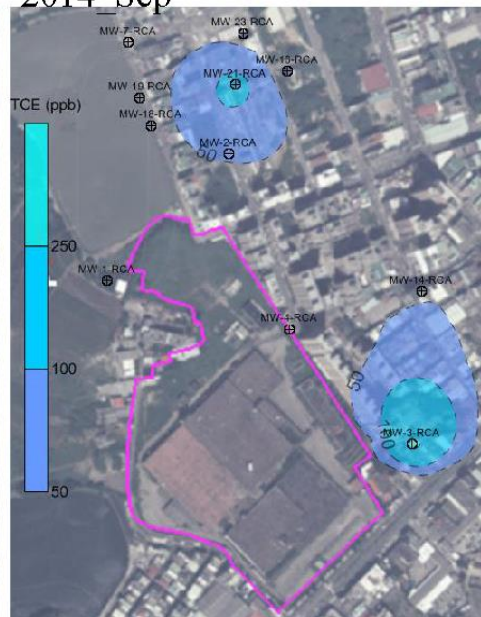
2007 Dec



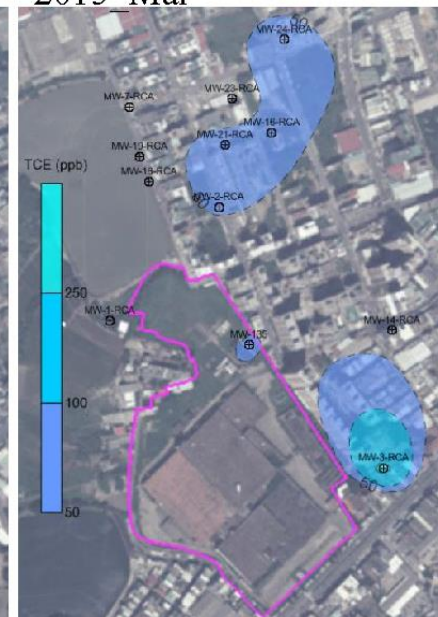
2012 Jul



2014 Sep



2015 Mar





整治計畫展延說明

Remediation Plan Extension Descriptions



整治計畫展延說明

Extension Description

- 文獻指出國外過去有許多地下水遭受含氯溶劑污染場址整治多年到最後仍然會發生拖尾(Tailing)或濃度回升(Rebound)的現象，導致整治所需期程延長。

Some references indicate that tailing or rebound occurs in many overseas groundwater sites polluted by chlorinated solvents after years remediation, resulting in extension of remediation.

- 由於場址地下水污染物質為含氯溶劑，且本場址之地質水文較為複雜，以致地下水污染整治計畫無法於整治期限內達到低於第二類地下水管制標準之目標。爰依土壤及地下水污染整治法第22條再次提出申請展延整治計畫。

The characters of chlorinated pollutants in the site are particular, and the site hydrogeology is complicated, so the groundwater concentrations could not reach the Groundwater Control Standard (Class II) within the remediation period. In accordance with Groundwater Pollution Remediation Act Article 22, we request for the authority's approval extension of remediation.

整治計畫展延說明-目前整治工法

Current Remediation Technology

❖ Traditional Gravity or Pressure Injection

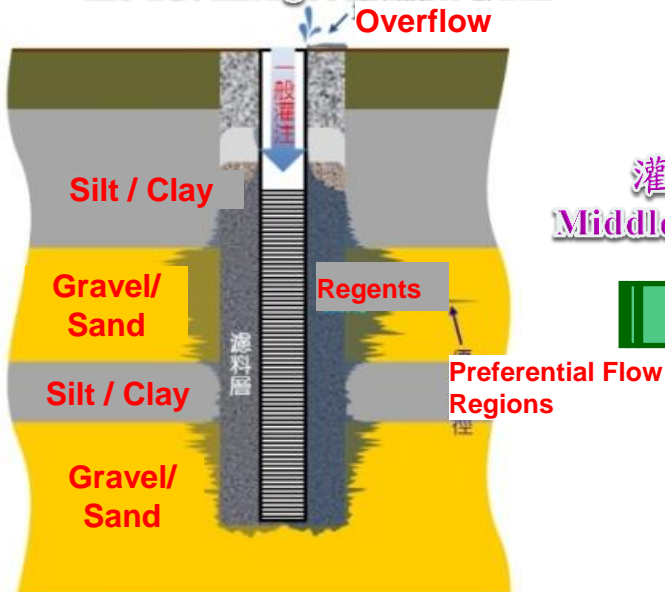
→ 遭遇坩黏土層或整治後期（產生大量生物膜），藥劑不易消散而累積於灌注井內，或沿灌注井與地層間細縫溢流至地表

In clay layers or the late stage of remediation period (producing great amount of biofilms), reagents easily accumulate in injection wells or flow out to the surface along the pores within layers.

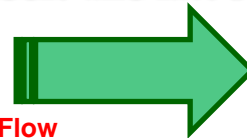
→ 因坩黏土與生物膜造成藥劑無法有效接觸污染區

The silty clay and biofilms cause ineffective contact between the reagents and polluted areas

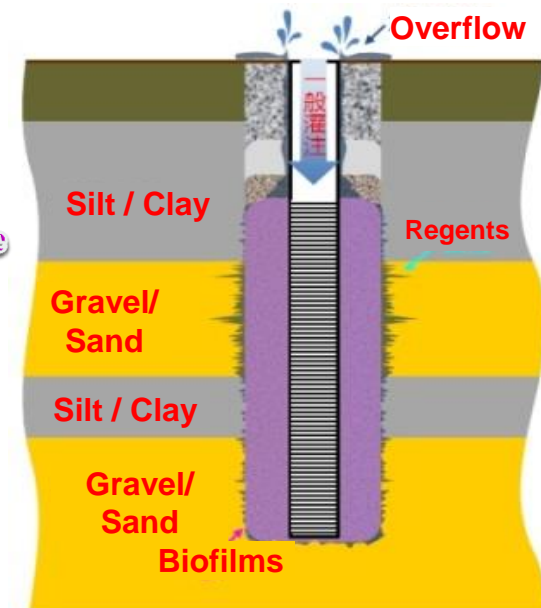
藥劑灌注初期由優勢流徑傳遞
In the initial period, solution flows along the advantageous flow path



灌注中後期
Middle and late stage



Biofilms 阻塞縮限傳輸途徑
Blocks of biofilm limits the transition path



整治計畫展延說明-現場灌注情形

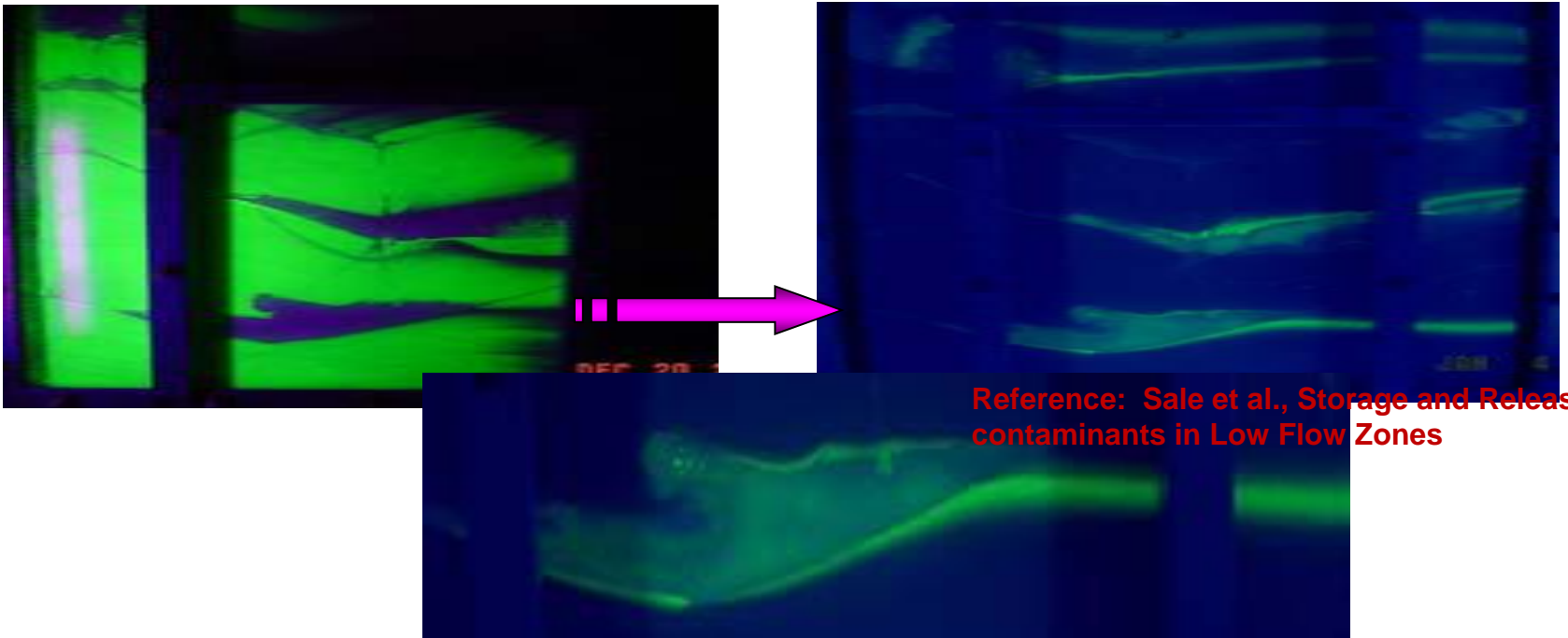
Site Injection Situations



整治計畫展延說明-高 / 低 K 區污染傳輸

Pollution Transition in High/Low K Value Areas

- ❖ 污染團（**螢光綠**）初始進入砂層或高 K 區，溶質尚未進入黏土或低 K 區（**藍色**）
Initially, plumes (**Light Green**) flow into the sand layer or high K value areas. The solutes have not diffused into the clay layer or low K value area (**Blue**).
- ❖ **前進擴散 (Forward Diffusion)**：污染團經長期接觸擴散入黏土（**螢光綠**），砂層中污染團已流出或清除（**藍色**）
Forward Diffusion: with long-term contact, plumes diffuse into the clay layer (**Light Green**). Plumes in the sand layer are removed or flow out (**Blue**).
- ❖ **反向擴散 (Back Diffusion)**：黏土中之溶質回擴再次污染已乾淨之砂層，造成整治場址常見的**濃度穿透曲線之拖尾效應 (Tailing) 或濃度回升 (Rebound)** 現象
Back Diffusion: back diffusion of solutes in the clay layer again pollutes the clean sand layer, causing **Tailing or Rebound**.





整治計畫展延說明-場址面臨問題與因應策略

Challenges and Countermeasures

Current Situations

Aquifer consisted of gravel and silty clay. Solutes diffuses into silty clay due to pollution which has existed for many years.

Clay layer and biofilms limit remediation transition radius of current injection system.

DCE and VC concentration at partial monitoring wells accumulate or increase.

The efficacy of molasses and sodium lactate cannot sustain long, so injection cost longer. In addition, concentration may increase after wells are sealed.

Under continuous decrease of pollution concentration, remediation is conservatively expected to be complete in 3years.

Conceptual Plan

Conducting multi-depth investigation on precise pollution distribution in gravel layers and clay layers

Applying the transition remediation technology which can remove the pollution in gravel and clay layers effectively in short-circuiting and increasing areas.

Focusing on monitoring wells whose DCE > 20 ppb

Using the long-term and anaerobic bioremediation solution which can degrade VC effectively in enhanced remediation areas.

Proposing a 3-year extension plan in accordance with current pollution situations



結論

Summary

- 目前部分監測井出現污染物濃度上升與短流現象，針對這些特定區域監測井TCETVT將使用新式灌注公法並搭配新型之生物整治藥劑以加強藥劑傳輸效果，解決短流及污染物因反擴散現象造成濃度上升之現象，其餘監測井則使用既有灌注系統進行乳酸鈉灌注作業。

Pollutants concentrations in certain wells have increased, and short-circuiting occurred. TCETVT will conduct new injection method with the new bioremediation reagents to strengthen the transmission of reagents and address short-circuiting and increase of concentration caused by back diffusion of pollutants. Sodium lactate can be injected into other monitoring wells using existing injection system.



感謝聆聽
敬請指教

Thank You for Listening