


Remediation of Mercury Contamination at a Former ChlorAlkali Plant Using Integrated Cap and Containment Technologies

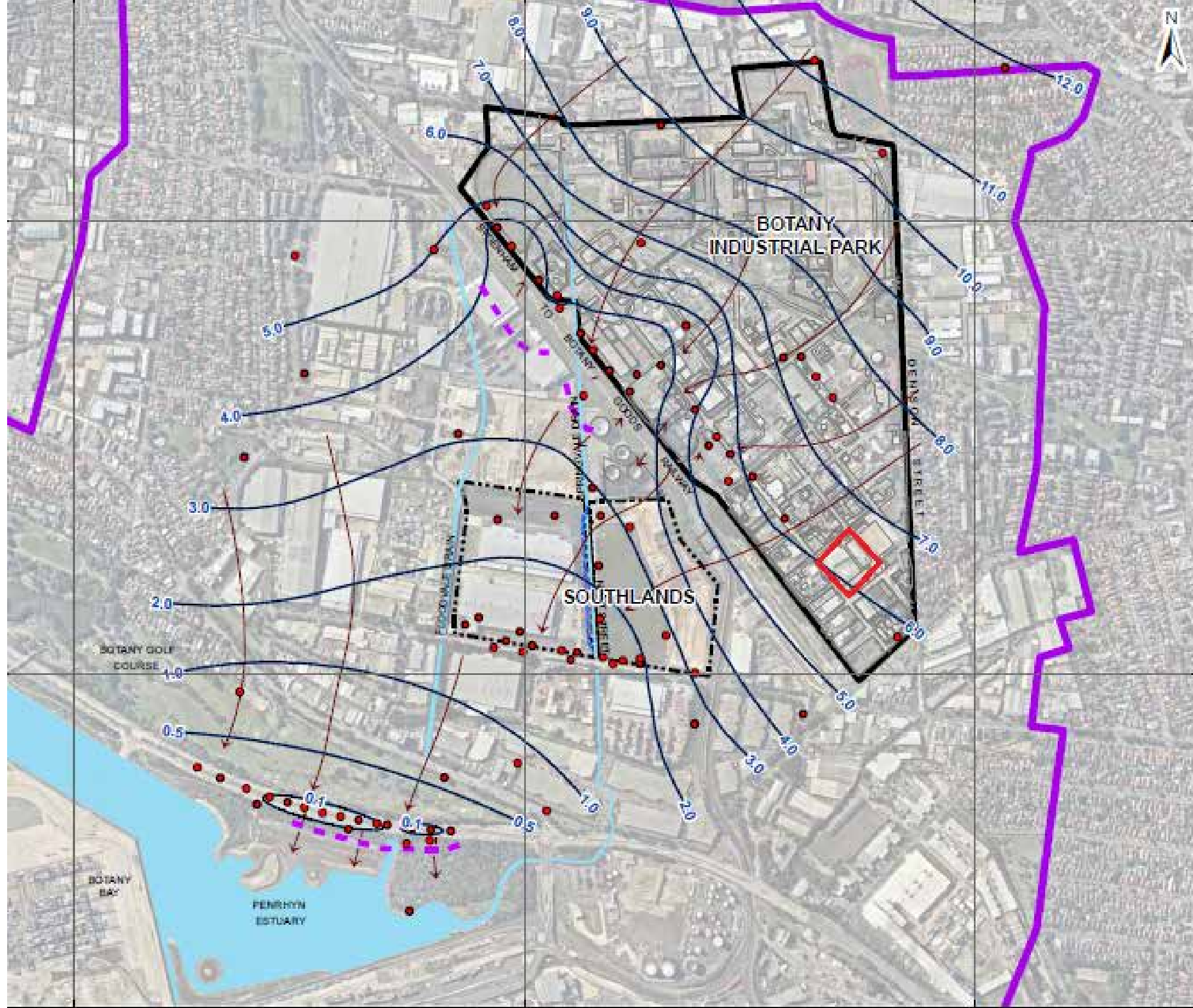
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Background

The site is located on the east coast of Australia, to the south of Sydney in NSW, Australia.



Regional Context



The FCAP site forms part of the 75 ha Botany Industrial Park (BIP) Facility.

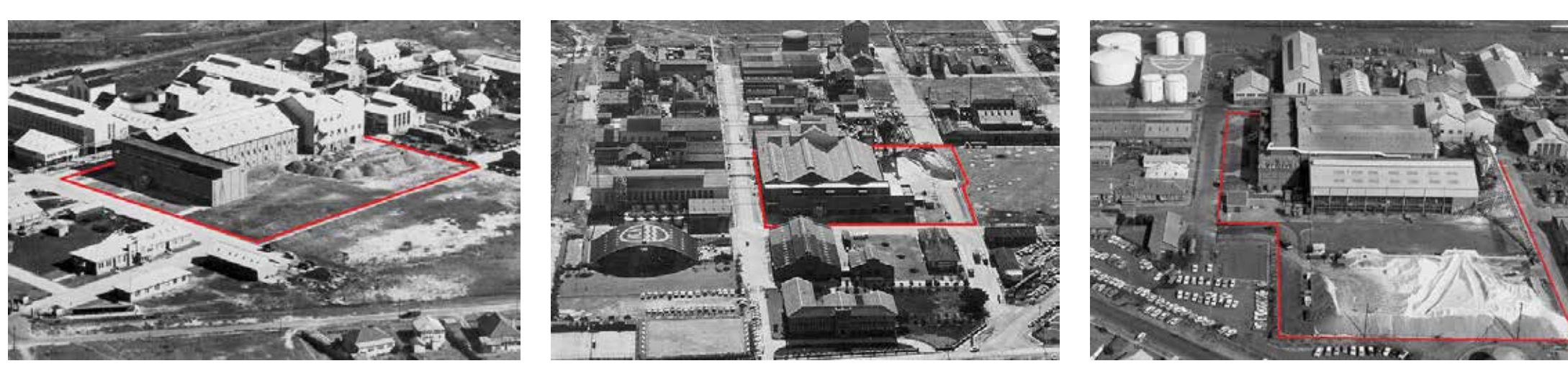
The BIP houses a number of current and former chemical manufacturing businesses

The FCAP is located in the southern most area of the BIP

Groundwater flows in a south-western direction, towards Penrhyn Estuary of Botany Bay

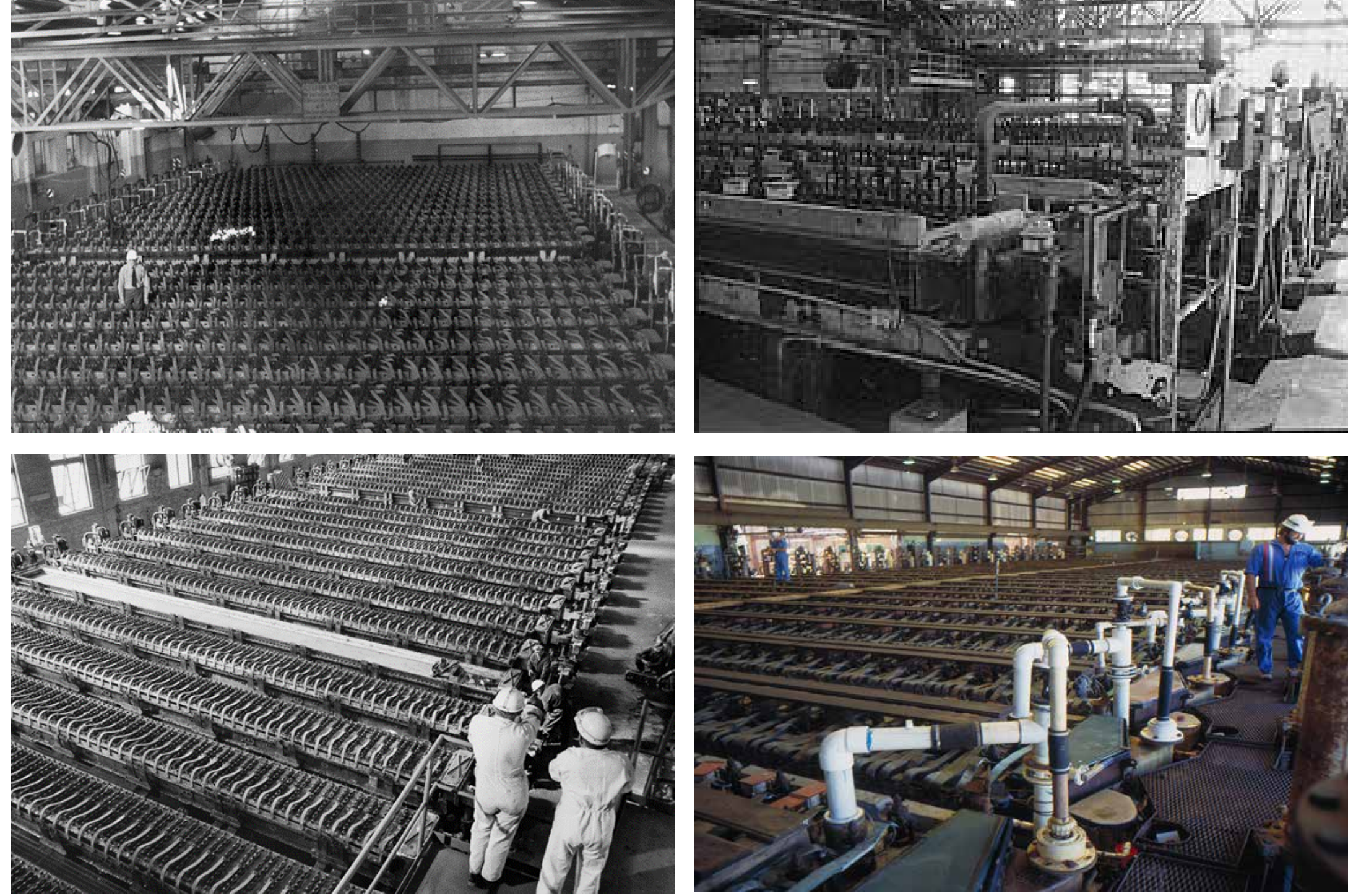
Remediation Planning / Site Preparation / Concept Design (2011 - 2012)

FCAP (Block G) (1942 – 2002)



Site Processes (1942 – 2002)

Block G Cell Room Floor infrastructure

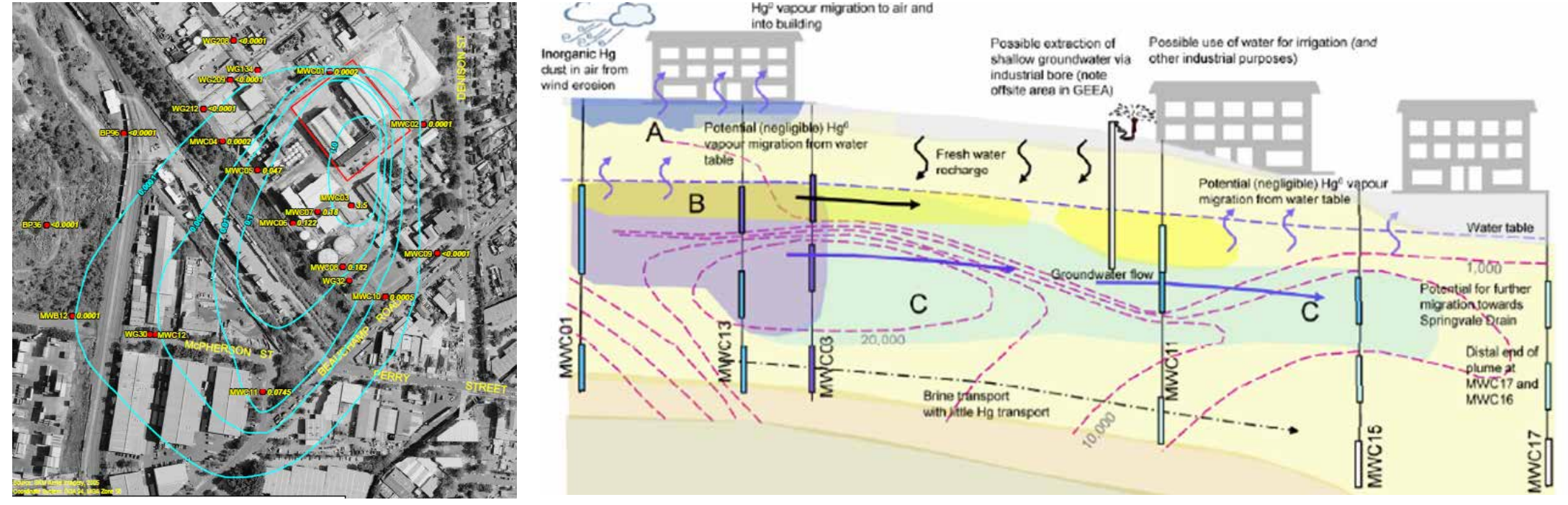


Block G housed a mercury cell electrolysis process which produced chlorine, hydrogen, caustic soda, hydrochloric acid, sodium hypochlorite and ferric chloride.

The mercury cell electrolysis used a Liquid Mercury Cathode.

Losses of mercury to ground were likely to have been high as fugitive process emissions and during equipment maintenance.

Site Characterisation (2006 - 2009)



The site was investigated between 2006 and 2009, following demolition of above ground structures and buildings. A CSM and detailed QRA were completed.

The main risks identified were to on-site workers through inhalation of mercury vapour.

A Management Order (MO) enforced by the NSW EPA, presented a ‘short-list’ of candidate technologies:



- In situ and ex situ thermal treatment;
- Off-site disposal; and
- On-site Cap and Containment.

A Remediation Options Appraisal (ROA) selected ‘On-site Cap and Containment’ on the basis of:

- Remediation technology status;
- Technical feasibility of Implementation;
- Effectiveness in meeting remediation objectives;
- Sustainability (resource consumption, energy use, carbon footprint);
- Potential impacts to human health and environment during implementation;
- Cost.

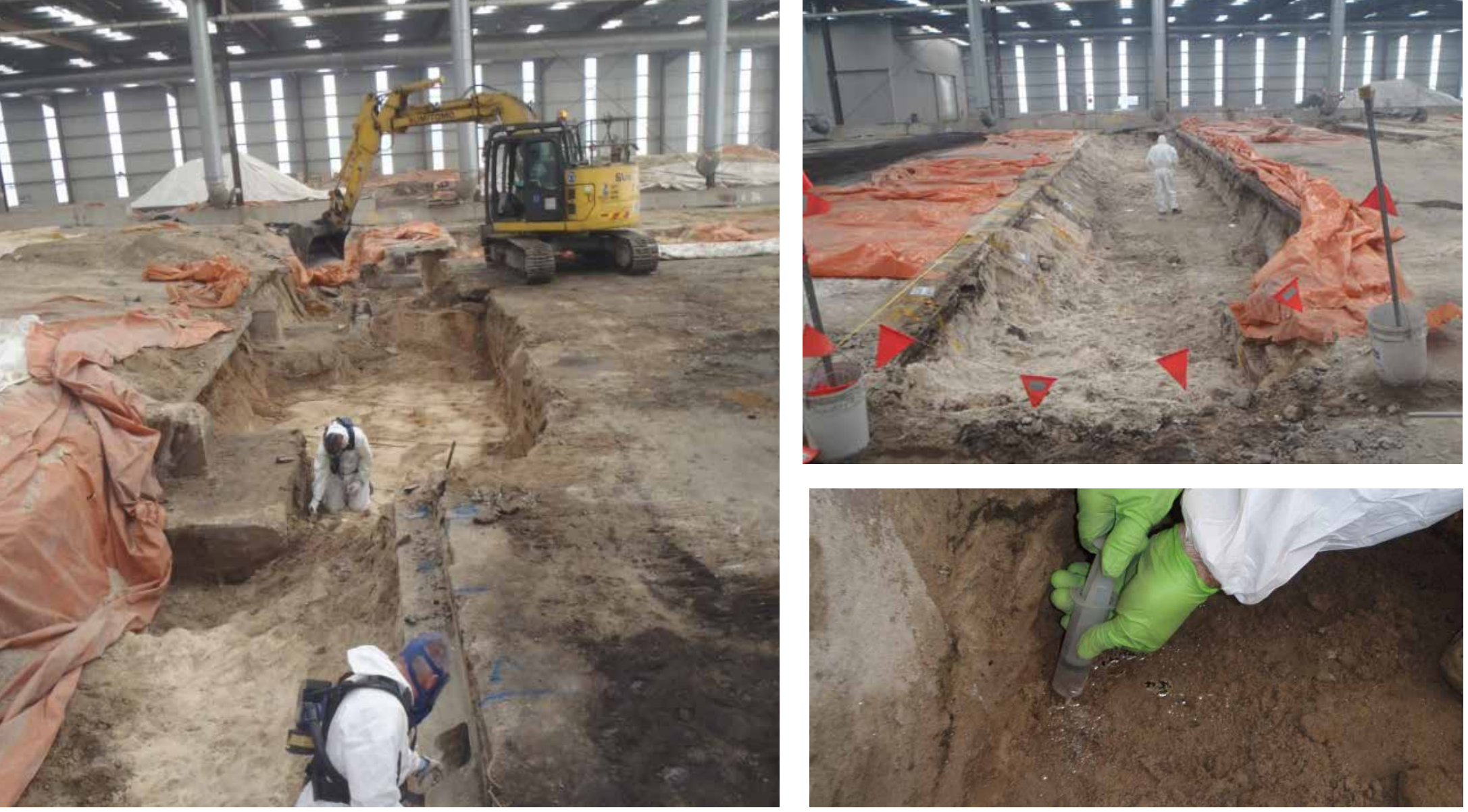
The regulator also enforced targeted source reduction in tandem with the cap and contain strategy.

Source Reduction (2013)

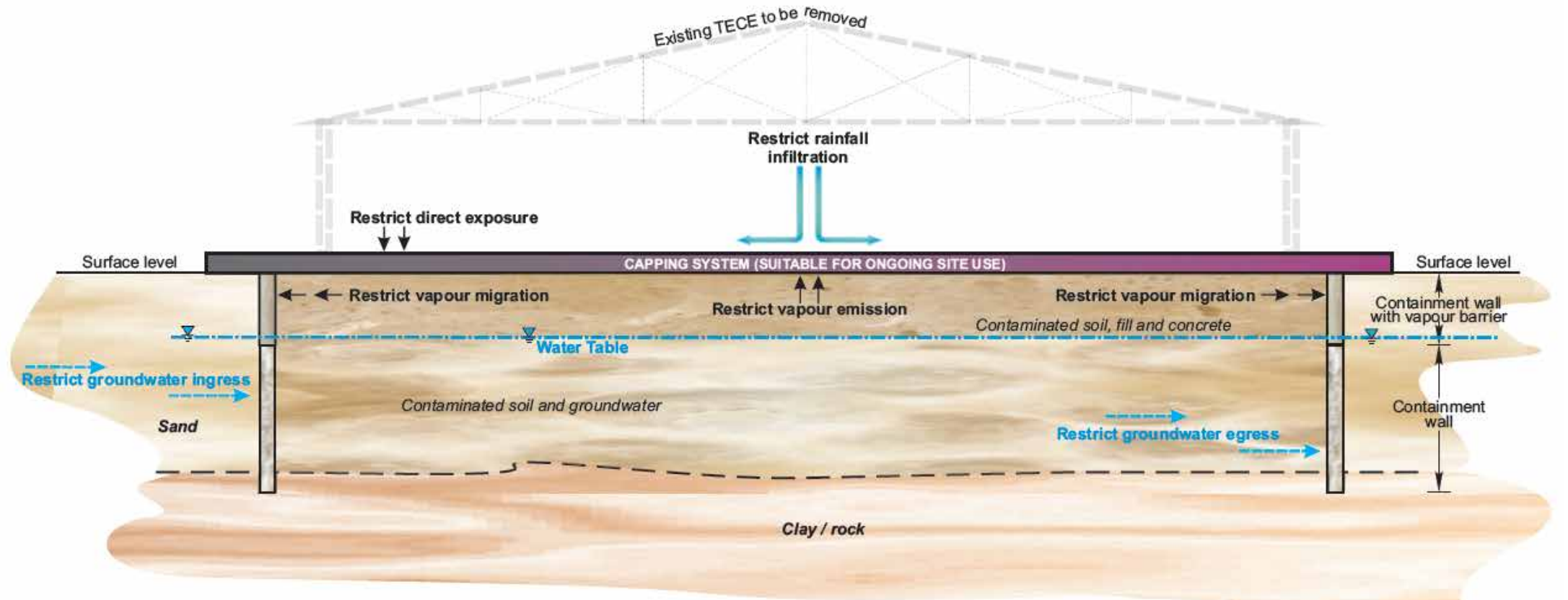


Elemental mercury (as pools or ‘prills’) was recovered where possible.

The sides and bases of the drain alignment excavations were characterized using a Niton XRF Analyzer with confirmatory analysis.



Concept – Integrated Design Remediation Action Plan



Dual Purpose Closed Cut-off Wall

- Hydraulic isolation (1×10^{-9} m/s)
- Lateral vapour emissions
- 25 m deep (clay/rock)

Multi-layered Capping System

- Infiltration
- Drainage landform
- Vertical vapour movement
- Gas venting (contingency)
- Gas monitoring (validation)

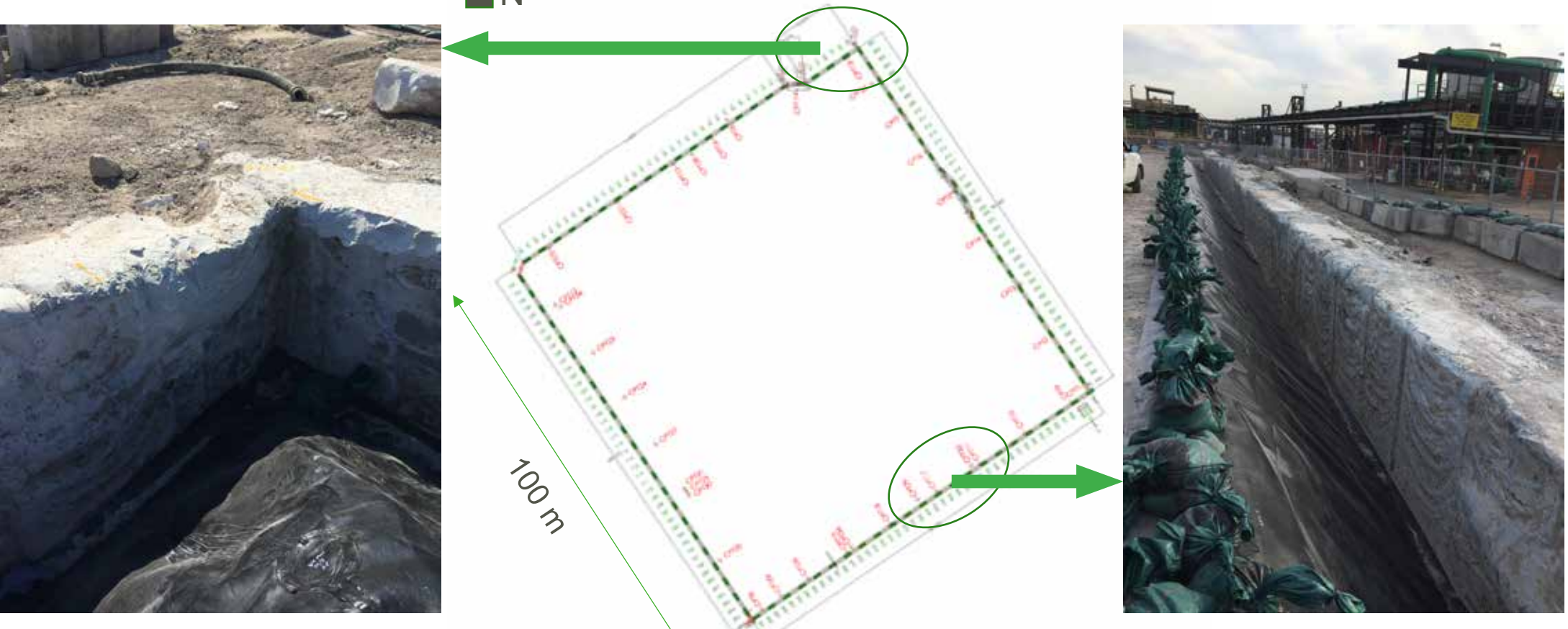

Functional Surface Slab

- Salt stockpile re-location
- Operational platform
- Salt stockpile
- Heavy machinery


Construction – Cut-Off Wall (2015)

The cut-off wall was installed using a Cutter-soil mix installation technology:

- Depth capability (25 m+)
- Target impermeabilities (1×10^{-9} m/s)
- Key-In and panel verticality verification
- Integration with capping system

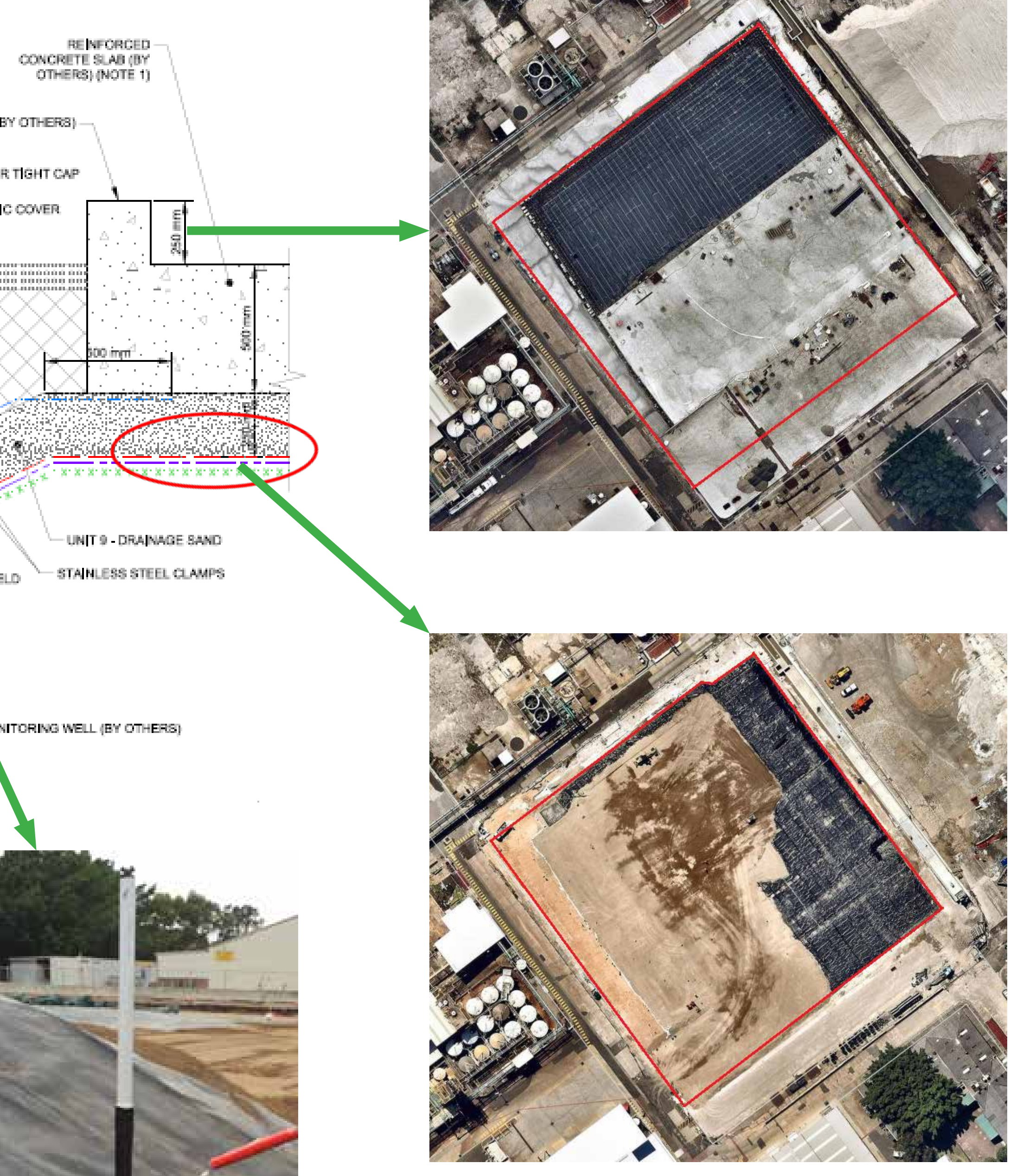
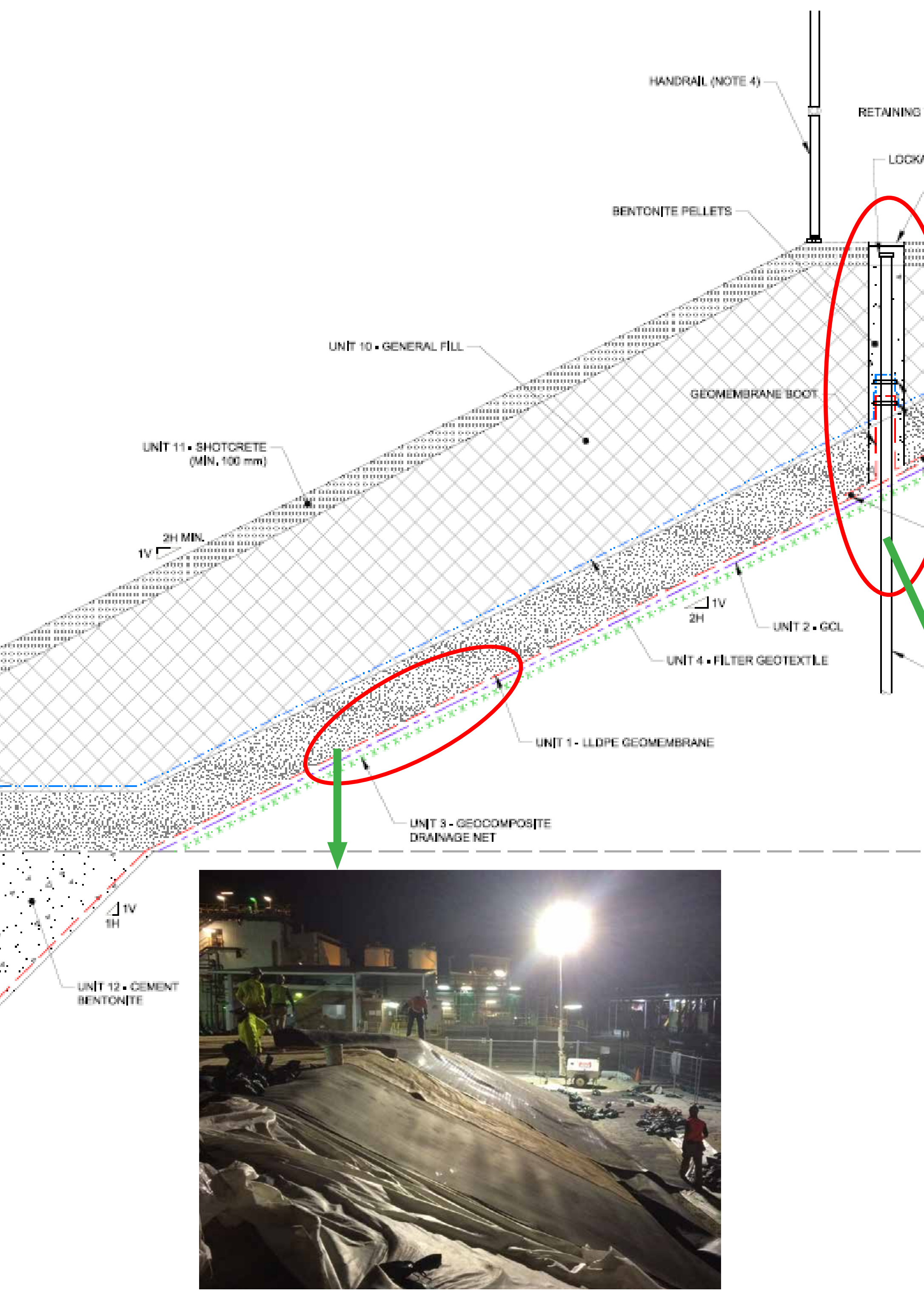


Cutter-soil mix technology was used to install 188 contiguous soil bentonite panels. The panels were installed in a counter clockwise direction, creating a closed continuous cut-off system. The soil bentonite mix was batched on site.

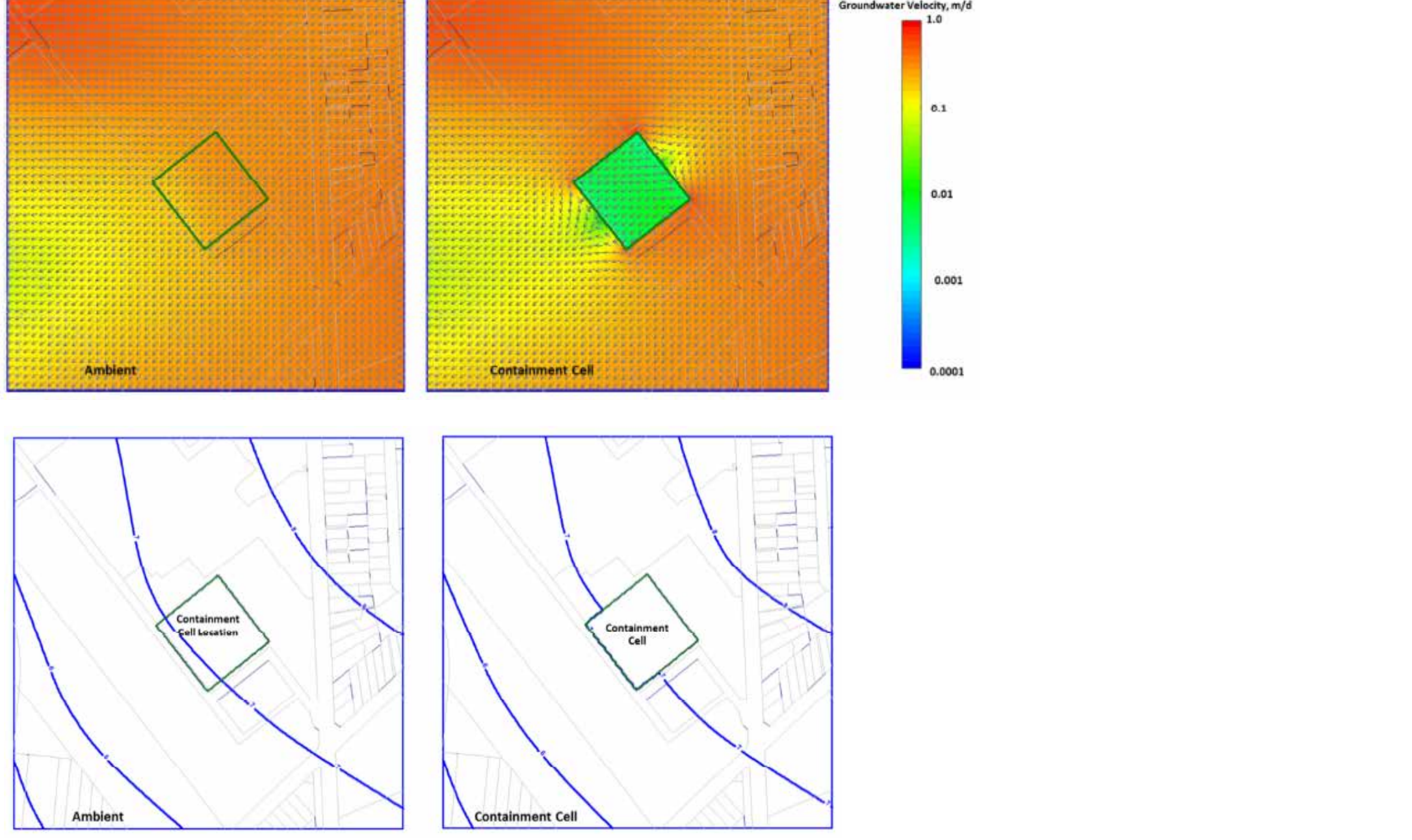


Capping System Design and Installation

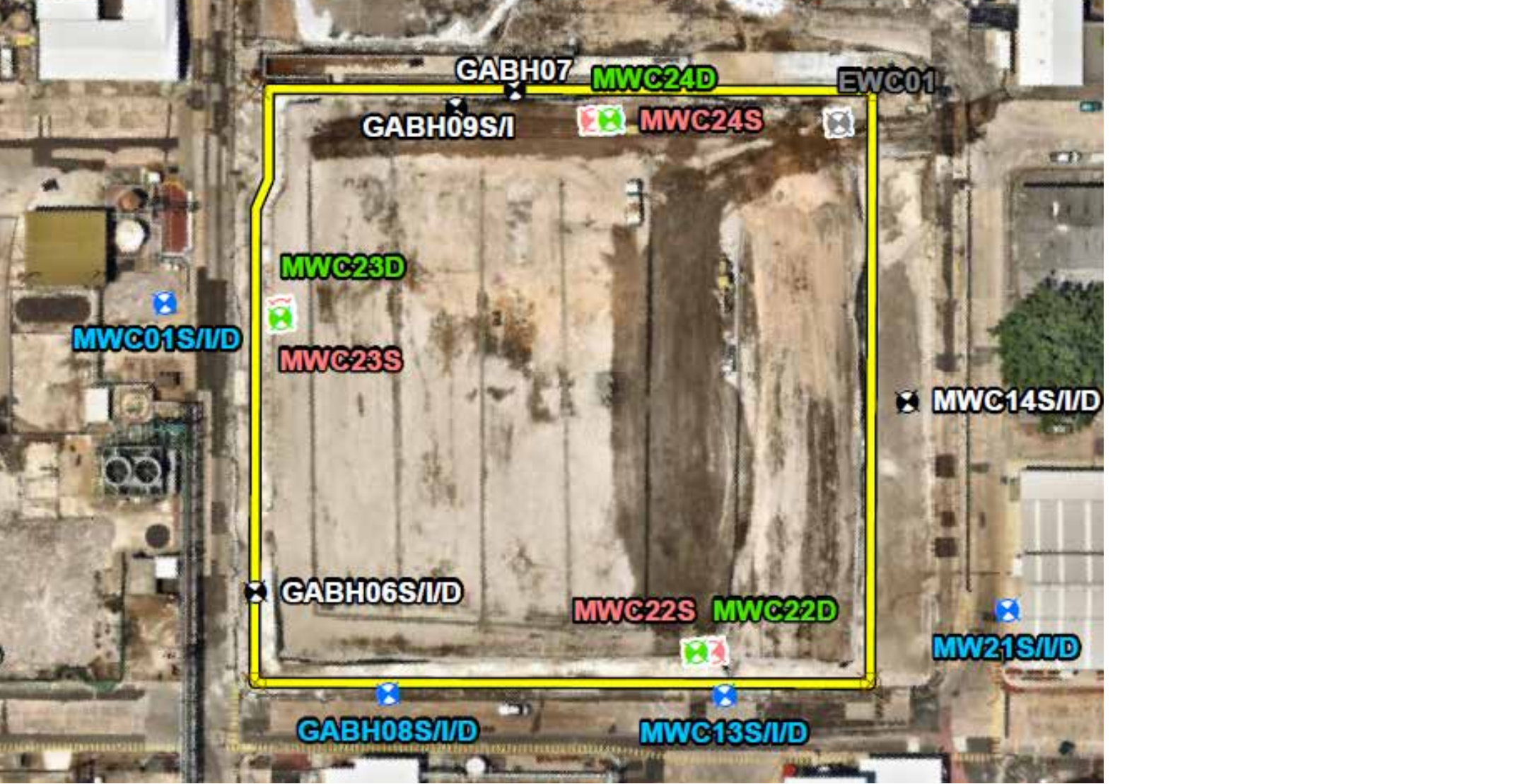
A multilayered capping system incorporated a vapour barrier, contingency vapour collection system, a vapour monitoring system.



Numerical Modeling / Validation Approach

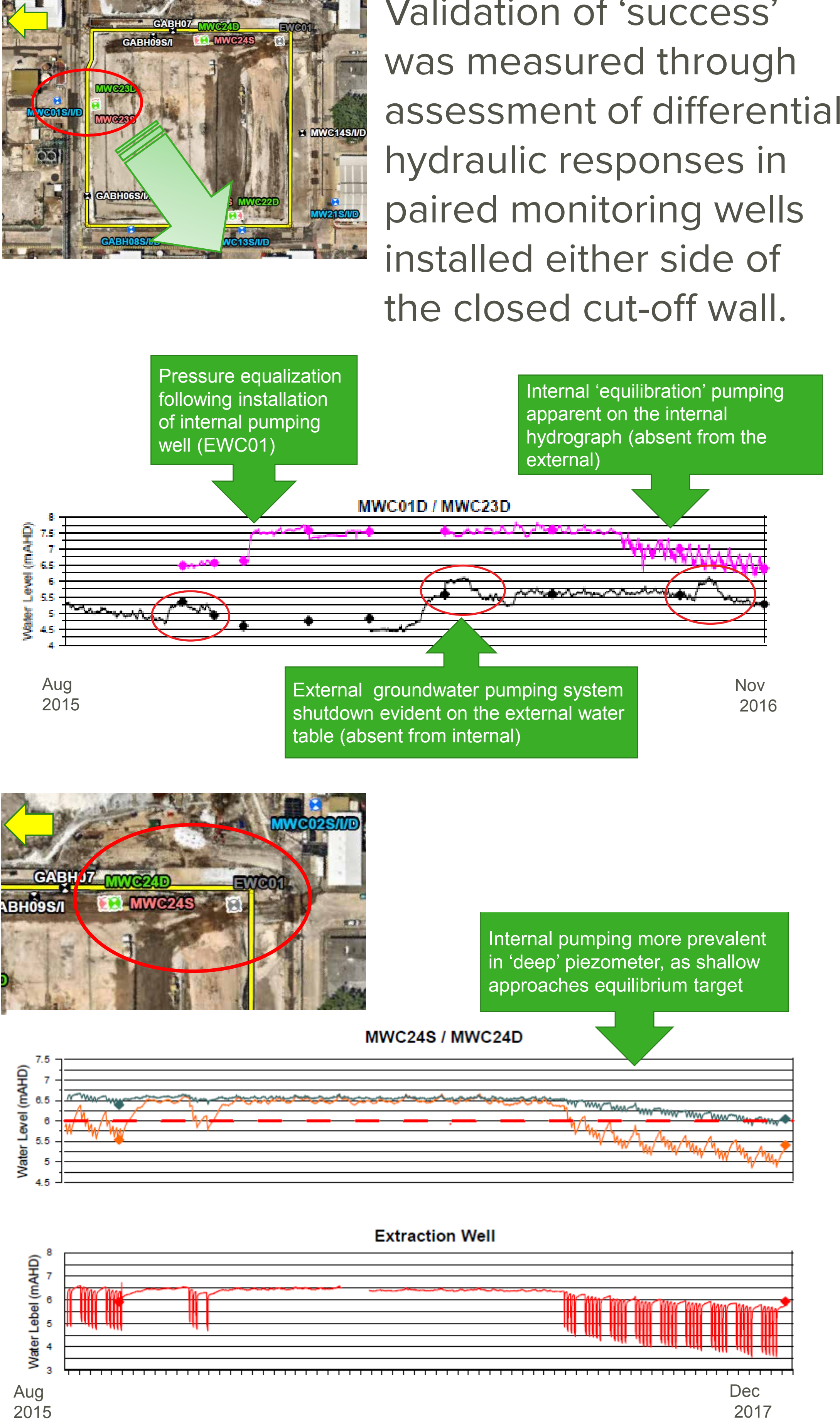


A numerical model prepared by A.D.Laase predicted a range of hydraulic head redistribution patterns and regional behaviours.



A series of paired shallow and deep monitoring wells was designed and installed to compare hydraulic head either side of the closed cutoff wall structure.

Hydraulic Validation



Validation of ‘success’ was measured through assessment of differential hydraulic responses in paired monitoring wells installed either side of the closed cut-off wall.

Pressure equalization following installation of internal pumping well (EW001)


Internal ‘equilibration’ pumping apparent on the internal hydrograph (absent from the external)

External groundwater pumping system shutdown evident on the external water table (absent from internal)

Internal pumping more prevalent in ‘deep’ piezometer, as shallow approaches equilibrium target

Extraction Well

Remediation Outcomes



- Sustained evidence of predicted patterns in hydraulic head redistribution
- Site rendered suitable for the industrial/ commercial land use