Evolution of a Conceptual Site Model for the Botany Chlorinated Hydrocarbon 'Mega-Site' Clean-Up Project

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Evolution of the CSM

1989-1990 – initial CSM:
- 'Stage 1' investigations by EPA and ICI (now Orica)
- Initial understanding of groundwater / surface water impacts 1
- **Objective:** Gave direction to 'Stage 2' detailed investigations

1996 – 'Stage 2' CSM:
- Detailed / technical CSM
- Developed fundamental understanding of hydrogeology, plumes and exposure pathways. 2
- **Objective:** Gave direction to subsequent source investigations and initial remediation strategies (administrative controls, containment, mitigate impacts to Springvale Drain)

2000s – updated CSMs:
- Technical 'source-pathway-receptor' model
- **Objective:** Consolidation of site information:
  - Source zone characterisation 3
  - Quarterly monitoring (air, groundwater, surface water) 4
  - Modelling, remedial trials and risk assessments
- Supported stakeholder engagement (Strategy Workshops)

2017 – '17-Compartment' CSM:
- Adapted "14-Compartment Model" (Vanderkooy *et al* 2014)^ – focus on phase/zone transfer pathways 5
- Added "Receiving Environment" - processes within Penrhyn Estuary and Springvale Drain 6
- Site setting (sand aquifer with low-K zones) and contaminant characteristics suited to model (4 to 6 OoM range of COPC migration potential / concentrations / mass transfer)
- **Objective:** Better explain the more significant reductions in plume mass/conc. since GTP operation commenced in 2004.
- **Objective:** Aimed at a broader audience and support 7 development of long-term management strategies

Increasing knowledge

Changing project objectives

'17-Compartment' CSM

CSM Structure 5

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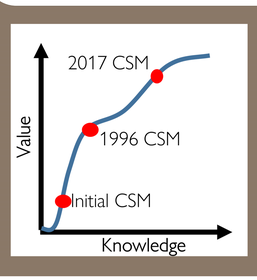
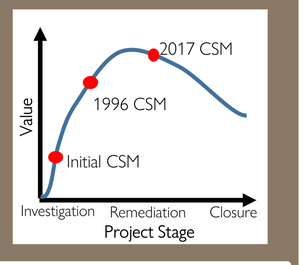
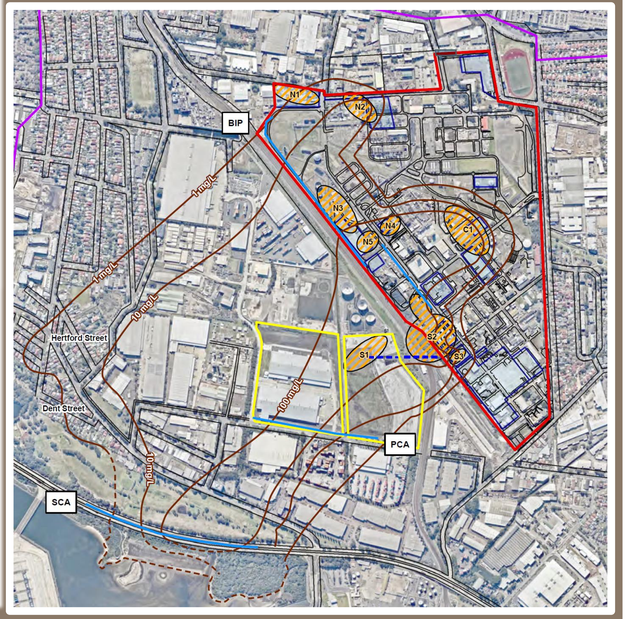
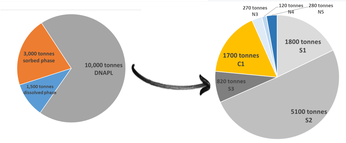
	Source Zone		Plume		Receiving Environment
	Peat/Clay	Botany Sands	Botany Sands	Peat/Clay	
Vapour					
DNAPL			N/A	N/A	N/A
Aqueous					
Sorbed					





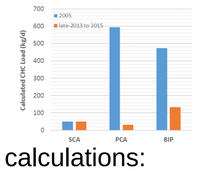


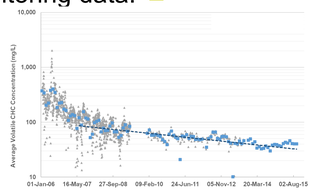
Key aspects:
- CHC mass balance:



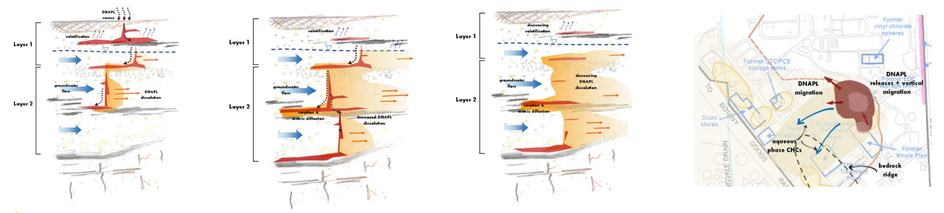
- Interrogation of 10 years' GTP abstraction and monitoring data: 7

	Estimated CHC Load (Golder, 2014b) (mg/L)	Calculated CHC Mass Load (Golder, 2014b) (kg/day)	Calculated CHC Mass Load (JBS&G, 2015b) (kg/day)	Estimated CHC Load (Golder, 2014b) (mg/L)	Calculated CHC Mass Load (Golder, 2014b) (kg/day)	Calculated CHC Mass Load (JBS&G, 2015b) (kg/day)	Average Measured CHC Concentration (mg/L) (refer to GTP9 (mg/L)	Average Calculated CHC Mass Load (JBS&G, 2015b) (kg/day)
	Jun 2005			Sep 2013			Nov 2013 – Aug 2015	
First Street	53	109	27	15	30	50	-	-
Second Street	461	365	214	71	56	61	-	-
Total BIP	166	474	279	30	86	116	34 (range 24-54 mg/L)	130

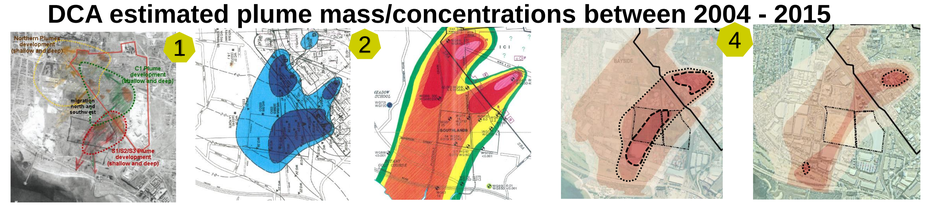




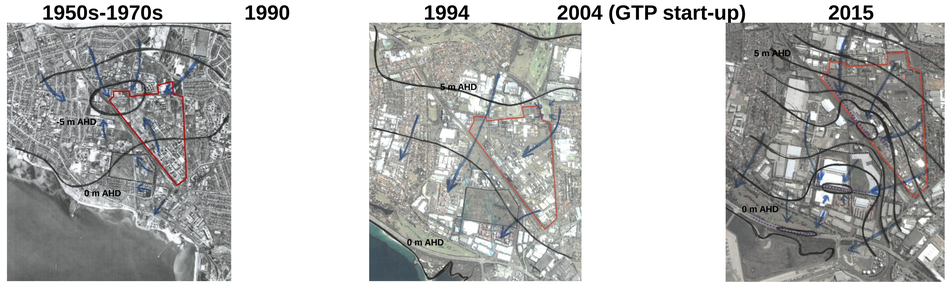
- Modelling and 1st-order decay calculations:
- Source zone evolution 3



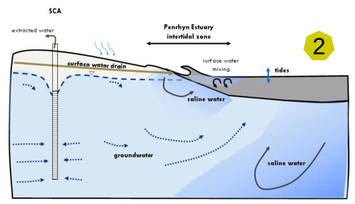
- Model of historical flow regime and plume evolution – **1 OoM decrease in 1,2-DCA estimated plume mass/concentrations between 2004 - 2015**

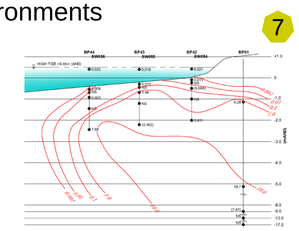


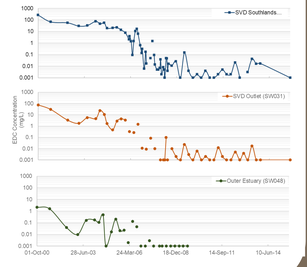
1,2-DCA (dotted line >100 mg/L; dashed line >1000 mg/L)



- Monitoring of receiving environments







- Sorption and degradation terms ……?

Lessons Learned:
1. Compartment model is appropriate for complex 'mega-sites' under similar natural settings
2. Simplifies complex phase interactions → has helped prioritise future investigations and development of long-term management strategies
3. Incorporation of degradation terms requires consideration.
4. Add 'Receiving Environment'
5. Fit-for-purpose CSM – focus on objective

^Vanderkooy M., M. McMaster, G. Wealthall, M.A. Seyedabbasi, Sale, T.C., C.J. Newell (2014) User's Guide for 14-Compartment Model, prepared for the Strategic Environmental Research and Development (SERDP) Program, July 2014.

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