Breaking Ground

White Young Green

The Role of Geology in the Successful Reclamation of Contaminated Land
by
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Consulting

- Civil
- Structural
- Mechanical
- Electrical
- Rail
- Transportation
- Highways
- Environmental
- Project Management
- Health & Safety
- Management Services

www.wyg.com thinking beyond construction

Causes of Contamination

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- Our industrial past
  - Town gas works
  - Industrial works
  - Railway land
- Current activities
  - Fuel and chemical storage
  - Power stations and Scrap yards
  - Asbestos Containing Materials
  - Poor Environmental Management
- Land filling
- Radon

Suggested Temporal Changes in Value Caused by Land Contamination

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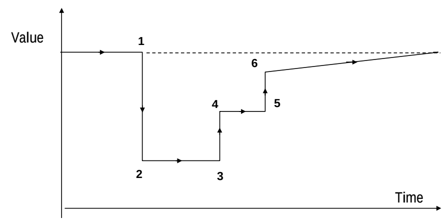

KEY :

1-2 Effect of the discovery of the contamination
2-3 Delay before site investigation works are completed
3-4 Effect of completion of site investigation works
4-5 Delay before remedial works are completed
5-6 Effect of completion of remedial works

(A Brown and Pleasant Land)

Environmental Investigation Procedures

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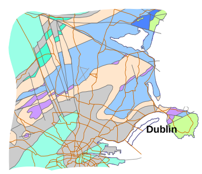

Phased Approach

Define objectives Desk study Sampling plan and strategy	Phase I
On-site sampling Chemical analysis Site assessment report	Phase II
Risk assessment Remediation system design and implementation	Phase III
Monitoring and validation	Phase IV

Research – Check Historical Maps

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Developing an
Environmental Profile
of the
Site and its Environs

Site Walkover

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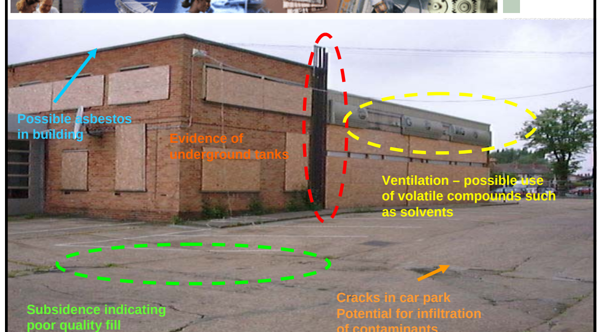


Phase 2 Site Investigation

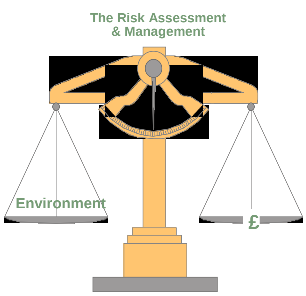
- Phase 2 targets high risk areas identified in Phase 1
- Investigation Geophysics, trial pits, boreholes
- Soil, Water and Gas Sampling
- On site sample screening
- Laboratory Analysis
- Site Survey
- Hydraulic tests

Phase 2 Data Objectives

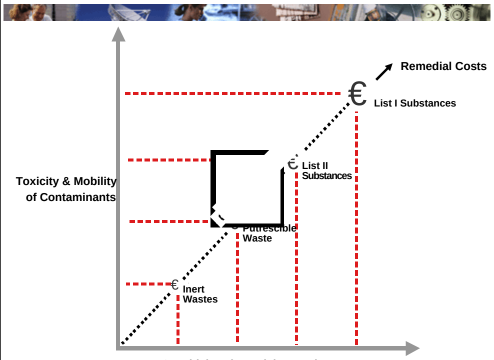
- Refine Conceptual Model
- Delineate contamination extent (lateral & vertical)
- Identify Pollutant Linkages (Source – Pathway – Receptor)
- Risk estimation using Guideline Values
- Sufficient information for additional assessment (I.e modeling, QRA, remedial design)

Risk Assessment

- Site specific conceptual model
- Risks to humans
- Risks to the environment
- Source
- Plausible pathway
- Receptor
- Risk = exposure x toxicity
- Risk based corrective action



Model



PHASE 1 – DESK STUDY

- Desk top study: Timber Yard
  Paint Factory
  Transport Yard
- Preliminary Site Investigations:
  Drilling
  Contamination type
  Geology
  Hydrogeology
  Initial Quantitative Risk Assessment

PHASE 2 - SITE INVESTIGATION

- Site Investigations included:
  - 56 boreholes (20m * 20m grid)
  - 21 groundwater monitoring wells
  - DNAPL observed
- Analytical findings:
  - Soil: BTEX, TPH, PAH
  - Groundwater: BTEX, TPH, PAH, Phenol
  - DNAPL Identified: Creosote

Dublin Stratigraphy – Contaminant Pathways

STRATIGRAPHY	DISTRIBUTION	MAIN CHARACTERISTICS	SIGNIFICANCE TO CONTAMINATION
FILL	Approx. 40% of Dublin area	General Fill Material (not compacted), varying thickness	Poor Aquifer Often little attenuation capacity. Significant Source and Pathway
ALLUVIAL & ESTUARINE DEPOSITS	Floodplains of Main Rivers (Liffey, Dodder, Tolka, Camack)	Soft silts and clays Generally <3-4m thick	Poor Aquifer Varied permeability. Potential Pathway
GRAVELS	Floodplains of Main Rivers (Liffey, Dodder, Tolka, Camack)	Fluvial Gravels with interspersed silt layers. 1 – 20m thick. Permeability range: $10^{-2} – 10^{-5}$m/s	Minor Aquifer Potential Moderate to lower permeability zones. Significant Pathway
BOULDER CLAYS	Widespread	Upper weatherized brown Boulder Clay and lower black boulder clay Varying thickness Permeability range: $10^{-9} –10^{-11}$m/s	Poor Aquifer Restricts downward migration to bedrock. Can contain water bearing lenses
LIMESTONE BEDROCK	Widespread	Basinal limestone with interbedded shales and mudstones ('CALP')	Aquifer Shale and mudstone layers restrict movement. Some movement through fissures/fractures. Pathway

QUANTITATIVE RISK ASSESSMENT

- SOURCE: Groundwater and Soil (Hydrocarbon contamination)
- PATHWAY:
  - Air: Indoor & Outdoor Inhalation
  - Soil: Ingestion & Dermal Contact
  - Groundwater: Lateral migration to River Liffey; Vertical migration to bedrock; Ingestion & Dermal Contact
- RECEPTOR: Site users; River Liffey

Excavation and Off-site Disposal and WWT


- Top 3m of soil removed across site
- 34 shipments over 11 month period
- 70k tonnes of contaminated soil excavated
- Soil treated in Germany and Holland
- WWTP regulated by EPA to DCC Standards
- >8k m3 of water treated

In-situ Soil Stabilisation

CUT OFF WALL BARRIER
- Cement/ bentonite mix
- Keyed into boulder clay
- 1×10^{-9} m/s permeability

SOIL STABILISATION
- Cement/bentonite/binding agent mix
- Leachability testing

MONITORING

- Noise
- Dust Deposition
- Air Quality
- Groundwater
- Groundwater levels
- Waste water from the treatment plant
- Meteorological Data
- Odour


THE SITE TODAY

- EPA Licence surrender: October 2005
- 02 Head Quarters
- Quality Hotel
- Office Block
- Apartment Block

Conclusion

- Think source-pathway-target
- Importance of accurate geological and hydrogeological model
- Geologists have mixture of skills required to manage remediation projects
- Turn a perceived liability into an asset