Assessment and Restoration of the
BP Llandarcy Refinery Landfill

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History of the Llandarcy Refinery

- Commissioned in 1921
- UK’s oldest refinery
- Peak operation as a fuels refinery in 1970s and early 1980s, at which point it was the UK’s largest refinery
- Rationalisations during the mid/late 1980s
- Closure announced in 1997, last lube oil production in June 1998
- Now demolished to grade, except for bitumen plant
- Site now being considered for mixed-use redevelopment as an ‘Urban Village’; an environmentally friendly community with residential, recreational and employment areas
Refinery Site Setting

- Total area of operations approximately 350 ha, divided into 2 key areas:
  - Main site – process operations in the north, Tank Farm area in the south
  - Coastal sites – receiving dock, storage and transfer station; linked to main site by overground/underground pipelines
- Main site situated 3 km inland on complex glacial till sequence, overlying fractured sandstone bedrock, drains into Crymlyn Bog; Wales largest SSSI, European SAC, and RAMSAR site
- Coastal sites situated on dune sands, beachfront next to Swansea Bay
Site Location Plan

Scale: 1 km grid
Landfill History

- Constructed by building semi-circular bund of power station ash into Crymlyn Bog
- Constructed 1939. Principal concept at time of construction was to provide oil containment if storage tanks sustained bomb damage; and several tanks were hit mostly in raids during 1940
- Southern landfill area continued to be used for oil containment and recovery operations, but use of northern area as a licensed disposal site for variety of refinery waste:
  - Pyrophoric waste
  - Fuller’s earth clay (used in lube oil production)
  - Refractory waste (from boiler houses)
  - Tank-bottom sludges
  - Demolition rubble
  - Domestic waste
  - Asbestos graves
Investigations and Assessment

- Site well-known to regulators (UK Environment Agency, Countryside Council for Wales, Neath Port Talbot Council)

- BP proactive in process: Early involvement of EA, CCW, and NPTCBC in agreeing the design and methodology of investigative and assessment programmes before commencing work

- Quantitative Risk Assessment (QRA) at the centre of the process; focus at this time on offsite environmental and ecological receptors:
  - Crymlyn Bog SSSI
  - Local water receiving bodies

- CCW concerns over water balance and nutrient load also considered in parallel programmes of work through numerical modelling of catchment and sampling programme in the bog itself
Generally permeable materials in much of the landfill, ie, ash and rubble

Separation lagoons contaminated around perimeter from oil containment operations

Potential for vanadium contamination attached to sediment to be washed out of lagoon during periods of high recharge; pyrophoric waste and asbestos immobile

Pit containing tank-bottom sludge could act as continuing hydrocarbon source

Surface and groundwater runoff entering separation ponds from refinery likely to be contaminated for a considerable time
Physical Assessment Findings - 2

- Free oil in monitoring wells in landfilled area, up to 2 metres accumulation observed, approximate 1 ha area
- Free oil seepage occurring around perimeter adjacent to bog, currently contained by plywood interceptor, and removed by vacuum trucks
- Oil entering separation lagoon from landfill, and from shallow groundwater from Tank Farm
- Unlike many landfills, no significant gas or landfill leachate issues (except free oil)
Quantitative Risk Assessment

- Offsite free oil discharge considered unacceptable in principle by BP
- Dissolved-phase hydrocarbons modelled from sources in the landfill and at perimeter. Hydrocarbon type generally weathered and of low solubility
- UK EQS standards used as target values where possible
- Limited comparative ecological target criteria for TPH (ie, no EQS for TPH)
- Transport modelling of hydrocarbons in peat undertaken. Suggested attenuation over short distances in peat aquifer; this confirmed by shallow groundwater samples from bog
- Ecological receptors, ie, key plant assemblages, unlikely to be affected
Remedial Strategy - Administrative

- Major phase of work; likely to take several years to complete.
- Early and open discussions with regulators key to agreement of plan – example, CCW has allowed use of SSSI at site boundary to construct oil interception trenches; recognise overall site betterment.
- Understanding from EA on requirements for return of WM licence.
- From site redevelopment perspective, necessary to merge remediation with amenity; form as well as function required.
Remedial Strategy – Outline Design

- Protect open water areas from free oil discharge
  - Isolate Tip area from Main site
  - Intercept oil entering existing separation lagoon from landfill
  - Intercept oil migrating outward to Crymlyn bog
  - Recover free-phase oil from landfilled area

- Sludge/Waste Treatment
  - Excavate and treat tank-bottom sludge pit
  - Treat contaminated materials from separation lagoons
  - Stabilise vanadium lagoon

- Dissolved-Phase Hydrocarbon Flux Control
  - Encourage/construct reedbeds as sustainable and attractive way to reduce dissolved hydrocarbon in runoff; pilot tests completed in 2003

- Amenity Development
  - Landscaping, to improve aspect of area, but also including permeable cap to maintain hydraulic gradients and promote mobility of remaining free-phase oil
Conceptual Remedial Approach