Table 4-1: Consequences versus probability assessment

		Consequence			
Probability		**Severe**	**Medium**	**Mild**	**Minor**
	High Likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Low risk	Very low risk
	Low Likelihood	Moderate risk	Low risk	Low risk	Very low risk
	Unlikely	Low risk	Very low risk	Very low risk	Very low risk
	No Linkage	No risk			

Table 4-2: Outline Conceptual Site Model

Source	Pathway	Receptor	Probability	Consequence	Risk Level	Comment	
Made Ground, associated with historical landfill and current earthworks (metals, metalloids, PAH, hydrocarbons) (S01).	Ingestion, inhalation or direct contact (P01)	Site users (R01)	Likely	Medium	Moderate	Made Ground and "inert" landfill materials anticipated to be in some areas across the site and its composition is currently unknown.	Contact with these materials is likely in areas of Public Open Space. Mitigation measures will be required to break the SPR linkage.
	Inhalation of fugitive dust (P01)	Neighbours (R01)	Low likelihood	Medium	Low		The risk of significant generation of dust is likely only during site development process and can therefore be controlled.
	Leaching through unsaturated zone (P06)	Groundwater (R03)	Low likelihood	Medium	Low	The site has not been developed and no contamination is expected to be significant to water bodies.	
	Surface run-off.	Aquatic ecosystems (R08) Surface water (R04)	Low likelihood	Medium	Low		
	Base flow from contaminated groundwater (P11)		Low likelihood	Medium	Low		
	Root uptake (P05)	Soft landscape planting (R05) Habitat Creation Area (R06)	Unlikely	Mild	Very Low	Made Ground is anticipated across some areas of the site. Whilst root uptake is possible in areas of Public Open Space (POS) and Habitat Creation area, the concentrations of metals are not expected to be significantly elevated with regard to plant growth.	
Made Ground below the site associated with	Inhalation of fugitive dust (P01)	Site users (R01)	Likely	Medium to Severe	Moderate to High	Composition of Made Ground / landfill is	Contact with these materials is likely in

Source	Pathway	Receptor	Probability	Consequence	Risk Level	Comment	
historical landfills and current earthworks (asbestos) (S01)						unknown. Therefore, general contamination may be present.	gardens and areas of Public Open Space. Mitigation measures will be required to break the SPR linkage.
		Neighbours (R01)	Low likelihood	Medium to Severe	Moderate		The risk of significant generation of dust is likely only during site development process and can therefore be controlled. Suppression should be included in control measures. If ACM is present on site, works to be undertaken in accordance with CAR 2012.
Made Ground associated with historical landfill and current earthworks hydrocarbons) (S01)	Direct contact (P02)	Water supply pipes (R02)	Low likelihood	Medium	Low	There are landfills in some areas across the site containing unknown fill materials. Landfill noted to accept “inert” materials.	
Ground gases (carbon dioxide and methane) from organic materials in the Made Ground / landfill and earthworks below the site (S02)	Migration, build up and asphyxiation (P03)	Site users (R01)	Likely	Medium to Severe	Moderate to High	Made ground and landfill composition is unknown and significant concentrations of ground gas including carbon dioxide, methane and others may be present. Ground gas monitoring is recommended for the designing mitigation measures if required.	
		Neighbours (R01)		Medium	Moderate		
Ground gases (carbon dioxide and methane) from organic materials in the Made Ground /	Migration, build up and explosion (P03)	Buildings on site (R02)	Likely	Medium to Severe	Moderate to High		
		Buildings on adjacent sites (R02)					

Source	Pathway	Receptor	Probability	Consequence	Risk Level	Comment
landfill and earthworks below the site (S02)						
Made Ground, associated with historical mining activities (old clay pit, brick and tile works), possibly including elevated concentrations of metals, metalloids, asbestos fibres, Asbestos Containing Materials, PAH and petroleum hydro-carbons (S03).	Ingestion, inhalation or direct contact (P01)	Site users (R01)	Low Likelihood	Medium	Low	Low likelihood to pose a risk due to the significant time elapsed since these activities took place.
	Inhalation of fugitive dust (P01)	Neighbours (R01)	Low likelihood	Medium	Low	
	Leaching through unsaturated zone (P06)	Groundwater (R03)	Low likelihood	Medium	Low	
	Surface run-off.	Aquatic ecosystems (R08) Surface water (R04)	Low likelihood	Medium	Low	
	Base flow from contaminated groundwater (P11)		Low likelihood	Medium	Low	
	Ingestion, inhalation or direct contact (P01)	Site users (R01)	Low likelihood	Medium	Low	
	Inhalation of fugitive dust (P01)	Neighbours (R01)	Low likelihood	Medium	Low	
Made Ground, associated with earthworks for the construction of A3 (M) in the west boundary on the site, possibly including elevated concentrations of metals, metalloids, asbestos fibres, Asbestos Containing Materials, PAH and petroleum hydrocarbons (S04).	Ingestion, inhalation or direct contact (P01)	Site users (R01)	Low likelihood	Medium	Low	Construction of the A3(M) likely involved excavation of natural soils and is considered unlikely to have a significant impact on the site.
	Inhalation of fugitive dust (P01)	Neighbours (R01)	Low likelihood	Medium	Low	
	Leaching through unsaturated zone (P06)	Groundwater (R03)	Low likelihood	Medium	Low	
	Surface run-off.	Aquatic ecosystems (R08) Surface water (R04)	Low Likelihood	Medium	Low	
Hydrocarbon vapours from potential VOC and petroleum hydrocarbon spillages/leaks from	Ingestion, inhalation or direct contact (P01)	Site users (R01)	No linkage	-	No risk	The tank was located at 110m N off-site and it was only recorded on historical mapping in 1970. It is not considered to pose a risk as there is no pathway between source.
		Neighbours (R01)	No linkage	-	No risk	
	Direct contact	Water supply pipes (R02)	No linkage	-	No risk	

Source	Pathway	Receptor	Probability	Consequence	Risk Level	Comment
unspecified tank located at 110m N of the site. (S05).	Leaching through unsaturated zone.	Groundwater (R03)	No linkage	-	No risk	In terms of migration via leaching to the unsaturated zone, as it lies over London Clay Formation and this comprises generally cohesive soils, of unproductive strata, there is no link between source and receptor; therefore, risk level is considered negligible. Furthermore, the A3(M) is present at low elevation between the former tank and the site.

5 Preliminary development constraints

Based on the Desk Study information presented above, preliminary development constraints with regards to the development of the site, are presented in Table 5-1.

It should be noted that these recommendations are based on the limited data available from the Desk Study and Hydrock's experience. All preliminary development constraint comments are subject to review and change in the light of the site investigation, assessment and design.

Table 5-1: Preliminary development constraints / recommendations

Element	Potential constraint and recommendation
Site Preparation, Earthworks and Groundworks	Topsoil and any organic Made Ground should be removed from beneath all earthworks, buildings and hardstanding areas. This will generate significant volumes of Topsoil, which will need to be accommodated as part of the proposed development. Obstructions are likely in the landfilled area and may require breaking equipment or heavy-duty plant to remove them. Excavations should be readily achievable using standard plant. Excavations are likely to be stable in the short to medium term. However, collapse of excavation faces in the coarse soils is to be anticipated. Water seepages into excavations is possible. However, significant seepages are unlikely and should be adequately controlled by sump pumping. Excavated soils should be suitable for reuse, if required, subject to chemical testing, earthworks testing and testing in accordance with the British Standard for Topsoil. Excavated soils generally should be suitable for reuse, subject to testing and placement in accordance with a suitable Specification. Some management of soils and remediation will be required with regards to the Made Ground (if present).
Foundations	Strip or trench fill foundations may be appropriate across the majority of the site, founding on the firm or stiffer clays of the London Clay Formation, or medium dense and denser coarse soils within Bognor Sand Member. It is currently considered that the Head Deposits are unlikely to be suitable founding strata, though in-situ testing may prove otherwise. If significant Made Ground is present, traditional foundations may not be feasible. Deepening will be required where construction is in close proximity to trees or locally due to low strength soils. If deepening due to trees means that the foundation depth is >2.5m bgl piling or ground improvement may be required.
Floor Slabs	To be confirmed following appropriate ground investigation. However, if the near surface soils are found to be of medium volume change potential or higher, suspended ground floor slabs would be required.

Roads	Assume an equilibrium design CBR value of 2.5% on natural clays, sand or earthworks fill. If Made ground is left in place a CBR of <2.5% is recommended.
Soakaways	Soakaway drainage is unlikely to be a viable drainage solution in the Head Deposits or London Clay. However, this will depend on the actual clay content of the soil within the Head Deposits (which will dictate infiltration rate) and water levels. Soakaway drainage may be possible within unsaturated granular soils of the Bognor Sand Formation.
Buried Concrete	Assume a Design Sulfate Class DS- 1 and ACEC Class AC-1 (equivalent to Design Chemical Class DC-2 for a 50-year design); however, this will ultimately depend upon the results of testing. Pyritic strata of the Bognor Sand and London Clay Formation may require a higher DS and ACEC design parameters.
Water Supply Pipework	Likely, based on existing data, to be standard pipework but confirmation should be sought from the water supply company, following completion of intrusive works.
Remediation	Significant, pervasive contamination is not anticipated (historical landfill noted as “inert”) and more likely to be in the form of ‘hotspots’ (if present). If so, localised hotspot removal will be required. This material may be able to be treated and reused on site, or will need to be disposed of off-site. Any Asbestos Containing Materials encountered will need to be disposed of off-site. A Materials Management Plan will be required for the earthworks.
Protection from Ground Gases	Radon protective measures are unlikely to be required. The requirement for ground gas protection measures will be confirmed following the ground investigation, installation of boreholes and gas monitoring programme
Waste Disposal	Topsoil is potentially classified as non-hazardous waste. However, this is dependent upon the organic matter in the soil and if >6% organics could be classified as hazardous waste if disposed. Made Ground soils will need to be tested to determine waste classification. Natural uncontaminated soils are likely to be suitable to be disposed of at an inert landfill.

6 Recommendations for Further Work

6.1 Ground Investigation Objectives

In order to confirm the actual risks to receptors and confirm the ground conditions with respect to potential geotechnical and geo-environmental risks, an appropriate intrusive investigation will need to be undertaken. This investigation will need to:

- determine the depth and distribution of Made Ground and natural strata across the site;
- determine the soil strength/density profile beneath the site;
- determine the depth/level of groundwater beneath the site;
- determine the ground gas concentrations beneath the site;
- determine CBRs to inform pavement design;
- assess trench stability, over break potential and 'dig-ability';
- allow soil infiltration rate testing;
- allow sampling for chemical and geotechnical laboratory testing;
- allow soil classification to allow geotechnical characterisation and determine suitability for reuse of soils within earthworks;
- obtain information in terms of Aggressive Chemical Environment for Concrete Class (ACEC Class).

Provision of a detailed UXO risk assessment is recommended prior to any intrusive investigation works.

Following investigation, assessment will be required to:

- update the Ground Model;
- update the Geotechnical Risk Register;
- provide Geotechnical Design recommendations;
- update the Conceptual Site Model (CSM), including identification of plausible pollution linkages;
- undertake generic quantitative risk assessment of potential chemical contaminants to establish 'suitability for use' under the current planning regime;
- discuss potential environmental liabilities associated with land contamination (soil, water and gas); and
- provide outline mitigation recommendations to ensure the site is 'suitable for use'.

6.2 Geotechnical conclusions

The following plausible geotechnical risks are identified.

- Variable Made Ground - settlement or differential settlement of foundations, floor slabs, roads and infrastructure elements.
- Low strength, compressible ground – risk of shear failure and excessive settlement of foundations, roads and infrastructure elements.
- Shrinkage/swelling of clay – settlement/heave of foundations, especially where located within the influence of trees and vegetation.

- Variable lateral and vertical changes in ground conditions – underlying geology may be variable in depth and composition and pose design implications.
- Attack of buried concrete by aggressive ground conditions – the development site may contain Made Ground and potentially sulfate bearing soils.
- Shallow groundwater – surface watercourses are present on the site's southern and eastern boundaries and the site is recorded to be at a moderate to high risk of groundwater flooding. The groundwater conditions are likely to fluctuate seasonally.
- Running sands, loose Made Ground and shallow groundwater, leading to difficulty with excavation due to trench instability.
- Instability of slopes and impact on foundations, floor slabs, roads and infrastructure and construction plant.
- Potential for obstructions and the risk of instability of excavations with the impact on construction staff, vehicles and plant operators.
- Earthworks – Low bearing capacity or settlement of new fill and impact on foundations, floor slabs, roads and infrastructure and construction plant.
- Potential for unforeseen ground conditions and the risks associated with limited data.

These plausible risks require further investigation and assessment (see Section 7).

6.3 Geoenvironmental conclusions

Based on historical and current land uses, it is unlikely that the site would be classified as Contaminated Land under Part 2A of the EPA 1990.

The overall risk from land contamination at the site is considered to be low with some specific moderate and potentially high risks for the current development. The site is largely Greenfield historically; however, historical landfills and current earthworks / construction works indicate contamination may exist. This would need to be confirmed by appropriate intrusive investigation, testing and assessment of the results of the investigation.

The possible pollutant linkages (for risk levels of moderate or greater) on an unremediated redeveloped site, as determined by the desk study and walk-over, are summarised in Table 6-1:

Table 6-1: Possible Contaminant Linkages (for Risk Levels of Moderate or Greater)

Source(s)	Receptor(s)
Made Ground, associated with historical landfills and current earthworks/ construction works, possibly including elevated concentrations of metals, metalloids, asbestos fibres, Asbestos Containing Materials, PAH and petroleum hydrocarbons (S01).	Site users Neighbours
Ground gases (carbon dioxide and methane) from organic materials in the Made Ground / landfill and Earthworks (S02).	Site Users Neighbours Buildings

These possible pollutant linkages require further investigation and assessment (see recommendations below).

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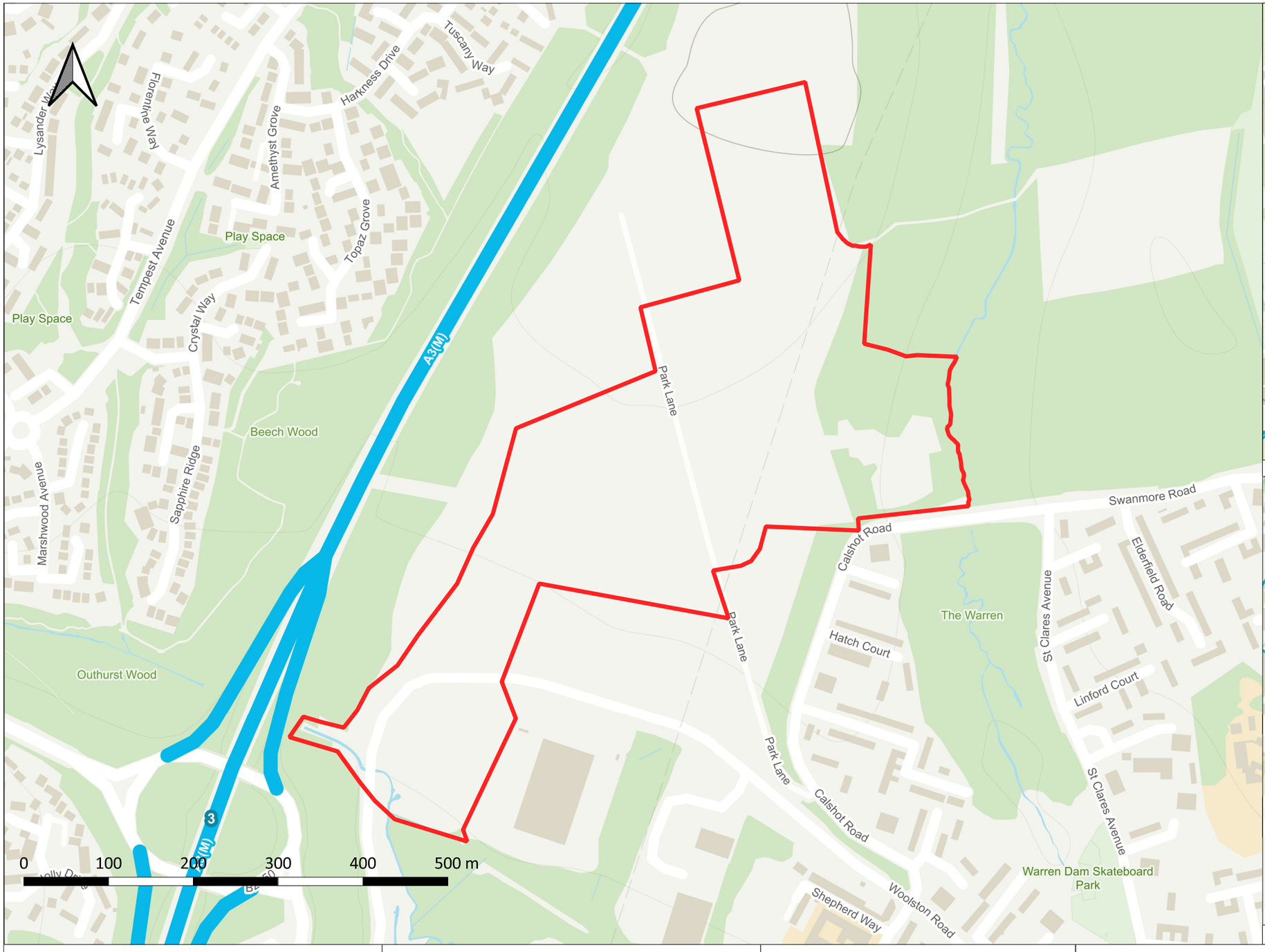
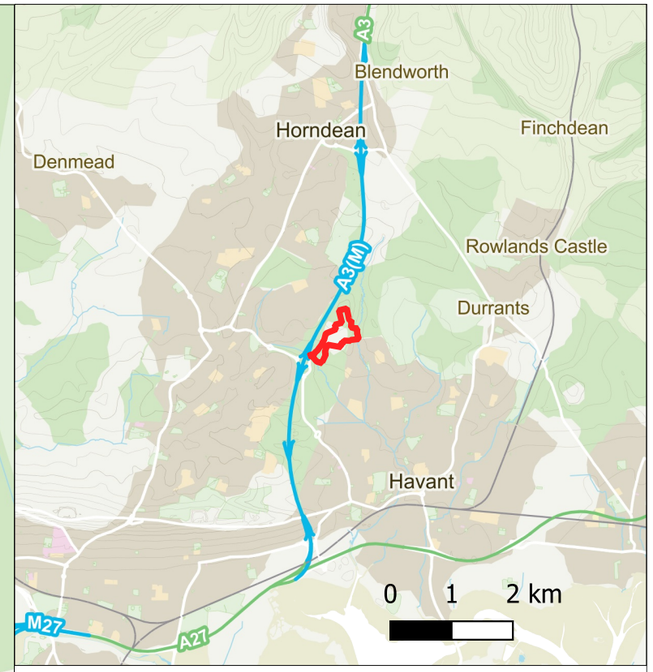
Appendices

Appendix A Drawings





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KEY PLAN

Site Boundary

NOTES

REVISIONS

P01	FIRST ISSUE EXAMPLE			
	DRAWN BY YP	CHECKED BY AJ	APPROVED BY AJ	03/06/2021
REV.	REVISION NOTES/COMMENTS			
	DRAWN BY YP	CHECKED BY AJ	APPROVED BY AJ	03/06/2021

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TITLE
Site Location Plan

HYDROCK PROJECT NO.
19453-GELO

SCALE @ A3
1:1

CLIENT
Portsmouth City Council

PURPOSE OF ISSUE
SUITABLE FOR INFORMATION

STATUS
S2

PROJECT
DUNSBURY PARK, PORTSMOUTH

DRAWING NO.
19453-HYD-XX-XX-DR-GE-1001

REVISION
P01

Appendix B Field reconnaissance photographs

Stantec Hydrock Limited
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Figure 1: Looking W from entrance to Plot 400

Figure 2: Looking N from entrance to Plot 400

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Figure 3: Looking S towards Fitzwygram Way

Figure 4: Historic / unfinished service runs at plot entrance

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Figure 5: Looking W along lower plateau with Plot 500 in distance. Note empty IBC

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Figure 6: Looking E along lower level of plot

Figure 7: Looking NE, note 3m high soil bund

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Figure 8: Monitoring well at base of soil bund

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Figure 9: Looking S over soil bund towards Plot 4

Figure 10: Looking S parallel to E boundary of plot. Note developed Plot 500 to immediate right.

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Figure 11: Looking N along boundary in northern stockpile area

Figure 12: Looking S fromnorthern stockpile area

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Figure 13: Looking SE across soil stockpiles. Note extensive revegetation

Figure 14: Ponding water between soil stockpiles

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Figure 15: Looking S along eastern boundary

Figure 16: Heras fencing and pea gravel stockpile along eastern boundary

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Figure 17: Disturbed possibly burnt area outside boundary fencing

Figure 18: Possible service trace

Appendix C Historical Ordnance Survey Maps