MATRIX 2 - GUIDANCE FOR MAIN SITE INVESTIGATION REQUIREMENTS FOR MODERATE RISK (CLASS B = 40% TO 69%) AND HIGH RISK (CLASS A > 70%) FOR UNREGULATED WASTE DISPOSAL SITES.

IMPORTANT NOTE: THIS IS A GENERAL GUIDE TO IDENTIFY SUITABLE SITE INVESTIGATION (SI) METHODS FOR MODERATE & HIGH RISK WASTE SITES, AS IDENTIFIED BY THE EPA COP RISK CLASSIFICATION FROM THE COMPLETED TIER 1 & INITIAL TIER 2 EXPLORATORY INVESTIGATIONS. EACH PHASE OF INVESTIGATION WILL DEVELOP THE CONCEPTUAL SITE MODEL (CSM) AND SHOULD GUIDE THE DESIGN OF THE NEXT PHASE OF INVESTIGATION & ULTIMATELY THE REMEDIATION . THE APPLICATION OF THE INVESTIGATION PROCESS AND METHODOLOGIES SHOULD BE COMPLETED IN ACCORDANCE WITH THE RELEVANT GUIDANCE DOCUMENTS AND STANDARDS AND BE UNDERTAKEN BY EXPERIENCED PRACTITIONERS.

				TIER 2: MAIN INVESTIGATION					TIER 2 PROBE AND/OR BOREHOLE SAMPLING					TIER 2 SPECIALIST SURVEYS			
				The selection of site investigation techniques should be focused on what SPR Linkage is being examined & the site/ground conditions - in some cases a combination of techniques may be required and/or additional trial pitting considered necessary													
SPR LINKAGE	**SOURCE**	**PATHWAY**	**RECEPTOR**	**SHALLOW PROBES/HAND AUGERS**	**GEOPHYSICS/ INFRA RED SURVEYS**	**WINDOW SAMPLING**	**CABLE PERCUSSION BORING**	**AIR ROTARY OPEN OR CORED HOLE**	**GAS SAMPLING**	**LEACHATE SAMPLING**	**SOIL SAMPLING**	**SURFACE WATER SAMPLING**	**GROUNDWATER SAMPLING**	**PUMPING TEST**	**ECOLOGICAL SURVEYS**	**SURFACE WATER SURVEYS**	**ODOUR/DUST or ASBESTOS SURVEYS**
				Manual or mechanical installation of temporary probes for gas monitoring to typically 2m BGL & use of landfill gas analyser and/or PID to determine concentrations - may give limited soil profile and strength information.	Range of techniques for waste extent, depth, plumes & anomalies; can be influenced by power cables, unsuitable ground conditions, poor interpretation. Needs ground proofing.	Competitor/terrier rig shallow soil sampling, permeability testing & standpipe installation for GW monitoring & gas taps: Ground conditions can limit depth.	Also called Shell & Auger (S&A) drilling - deeper soil sampling, permeability testing & standpipe installation for GW monitoring & gas taps. The need for both shallow and deep monitoring boreholes should be considered. Can be limited by boulders/ obstructions. No bedrock penetration.	Bedrock drilling, chip sampling & standpipe installation for GW monitoring permeability testing & gas taps. Very limited subsoil or waste sampling. The need for both shallow and deep monitoring boreholes should be considered. Coring used for geotech logging, rock quality/fracture logging.	Field gas meters primarily used, more specific Gas Sampling using bags, Gresham Tubes can be completed where relevant, etc.	Sampling liquid from boreholes in waste area giving data on List 1 & List 2 substances contamination - Parameters to be considered as per Table C.2 of EPA Landfill Monitoring Manual 2003.	Soil sampling to assess permeability potential of surrounding materials (leachate or gas pathway assessment). Further soil for contamination/leachate potential assessment may be required. Also soil assessment potential for local material to be used for remediation/capping. Detailed borehole logs with well installation information should be completed.	List 1 & List 2 substances contamination assessment in SW & seepage locations. Sampling applied for surface water abstractions from shallow dug wells and surface water sources, (SPR 6). Parameters to be considered as per Table C.2 of EPA Landfill Monitoring Manual 2003.	List 1 & List 2 substances contamination assessment GW flow direction. Parameters to be considered as per Table C.2 of EPA Landfill Monitoring Manual 2003.	Enables improved GW sampling for List 1 & List 2 substances contamination assessment, relevant water standards & GW flow regime & direction to be assessed. (Pumping well depth will vary - Involvement of hydrogeologist or groundwater specialist recommended for this element of work, e.g. well locations, well design, depth and guidance on pumping test).	Habitat Directive (Appropriate Assessment Screening) Statement required, (as per Article 6(3) of Habitat Directive (92/43/EEC), other surveys include surface water Q Rating, or site specific surveys for sites with potential ecological significance - surveys should be risk specific and undertaken in the right season under the right conditions.	water levels, flow rates, assimilative capacity, hydrology studies	Only required if odours, dust and asbestos are identified as potential problem during Tier 1 and Tier 2 works
SPR 1	LEACHATE	Vertical & Horizontal Groundwater to Surface Water Drainage/Runoff	Surface Water Body	**N**	**S**	**R/S**	**R/S**	**R/S**	**N**	**R**	**R**	**R**	**R/S**	**S**	**S**	**R**	**N**
SPR 2	LEACHATE	Vertical & Horizontal Groundwater to Surface Water Drainage/Runoff	Surface Water Body Protected Area (SWDTE)	**N**	**S**	**R/S**	**R/S**	**R/S**	**N**	**R**	**R**	**R**	**R/S**	**S**	**R**	**R**	**N**
SPR 3	LEACHATE	Vertical & Horizontal Groundwater Migration	Human Presence (Private Well)	**N**	**S**	**N**	**R/S**	**R/S**	**N**	**S**	**S**	**N**	**R**	**S**	**N**	**N**	**N**
SPR 4	LEACHATE	Vertical & Horizontal Groundwater Migration	Groundwater Protected area (GWDTE)	**N**	**S**	**N**	**R/S**	**R/S**	**N**	**S**	**S**	**S**	**R**	**S**	**R**	**N**	**N**
SPR 5	LEACHATE	Vertical & Horizontal Groundwater Migration	Aquifer Category	**N**	**S**	**N**	**S**	**R**	**N**	**R**	**R**	**N**	**R**	**R/S**	**N**	**N**	**N**
SPR 6	LEACHATE	Vertical & Horizontal Groundwater Migration	Public Supply (Well) (includes Group Water Schemes)	**N**	**S**	**N**	**S**	**R**	**N**	**R**	**R**	**S**	**R**	**R/S**	**N**	**N**	**N**
SPR 7	LEACHATE	Vertical & Horizontal Groundwater Migration	Surface Water Body	**N**	**S**	**S**	**R/S**	**R/S**	**N**	**R**	**R**	**R**	**R**	**S**	**S**	**R**	**N**
SPR 8	LEACHATE	Surface Water Drainage/Runoff	Surface Water Body	**N**	**S**	**R/S**	**R/S**	**N**	**N**	**R**	**R**	**R**	**N**	**N**	**S**	**R**	**N**
SPR 9	LEACHATE	Surface Water Drainage/Runoff	Surface Water Body Protected Area (SWDTE)	**N**	**S**	**R/S**	**R/S**	**N**	**N**	**R**	**R**	**R**	**N**	**N**	**R**	**R**	**N**
SPR 10	LANDFILL GAS	Lateral Migration (Subsoil)	Human Presence	**R**	**S**	**S**	**S**	**S**	**R/S**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**S**
SPR 11	LANDFILL GAS	Vertical Migration (Subsoil)	Human Presence	**R**	**S**	**S**	**S**	**S**	**R/S**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**S**
Source & Pathway & Receptor Parameters Targeted for CSM & Risk Screening & Remediation.				waste type, footprint, soil type, thickness, strength. Suitable for gas monitoring and gas migration potential.	waste type/volume, waste footprint, depth to bedrock, groundwater vulnerability, horizontal pathway - plume migration.	waste type, groundwater vulnerability/level, gas migration potential,	waste type, groundwater vulnerability/level, groundwater sampling, flow direction & resource potential, horizontal pathway, gas migration potential.	groundwater vulnerability/level & flow direction & resource potential, groundwater sampling, horizontal pathway, gas migration potential.	waste type, landfill gas migration, concentrations and flow potential	waste type, leachate quality, leachate concentrations and possible gas migration potential.	soil type, permeability, leachate & gas migration potential, ground vulnerability, horizontal pathway. May also assist in assessing re-use of material for remediation.	surface water receptor and pathway information.	groundwater receptor and horizontal pathway information.	assessment of aquifer status, permeability, groundwater resource potential, flow direction, horizontal pathway	Define ecologically designated areas and sensitive receptors - then look at linkages regarding surface water pathways etc	surface water pathway/receptor	Air Pathway/Receptors
General comments regarding techniques & COP Section Reference - Note: the development of the CSM and design of the site investigation should involve an experienced SI practitioner.				Gas monitoring should be considered if trial pit phase identifies gas potential, thin/no capping and human presence exists. Section 5.5.2 of COP.	Geophysics should be considered for areas where extent of waste is unclear and where shallow plumes may be impacting on surface waters. Advantage of covering large areas and is not intrusive. Needs ground proofing. Section 5.5.1.2 of COP.	Window sampling option should be considered for shallow boreholes in ground without obstructions (as identified from Trial Pit Survey). Use boreholes for sampling, water/leachate & gas monitoring.	S&A drilling can be completed after or instead of window sampling phase especially if deeper depth required. Use boreholes for sampling, water/leachate & gas monitoring. Section 5.5.2 of COP.	Aquifer category work based on GSI well survey data & rotary drilling. Recommend minimum of three GW level locations are available for flow direction calculation - use of data loggers to confirm levels and/or possible linkage. Core drilling rarely used unless RQD needed. Design and proper grouting of wells is important. Use boreholes for sampling, water/leachate & gas monitoring. Section 5.5.2 of COP.	Should be considered once landfill gas identified as risk to receptors. Complete as per best practice and relevant guidelines. Refer to EPA Landfill Monitoring Guidelines, 2nd Edition 2003, especially Section 7.	Characterises waste type and leachate source/contamination potential. Complete as per best practice and relevant guidelines. Section 5.5.3 of COP. Refer to EPA Landfill Monitoring Guidelines, 2nd Edition 2003, especially Section 6. Leachate characteristics can be compared to parameters in EPA Landfill Design Document 2000 - Sections 7.1 & 7.2	Characterises soil type and if contamination present, characterises geology and permeability. Refer to relevant guidelines and Standards. Section 5.5.3 of COP. Leachate characteristics can be compared to parameters in EPA Landfill Design Document 2000 - Sections 7.1 & 7.2	should be completed as per best practice and relevant guidelines. Refer to EPA Landfill Monitoring Guidelines, 2nd Edition 2003, especially Section 4.	should be completed as per best practice and relevant guidelines. Refer to EPA Landfill Monitoring Guidelines, 2nd Edition 2003, especially Section 5.	Generally step test to assess well pumping capability, allow groundwater quality assessment using on-site meters and quality sampling should be followed by longer CRT test to determine aquifer characteristics and potential linkages. Level loggers should be used.	should be considered for SACs/SPA, wetlands and surface waters - if surface water body is part of salmonoid (Q Index) or marine catchment then ecology survey's should be considered. Consultation with NPWS may be required. Where applicable use existing data from EPA/OPW or local authority sources. Refer to Section 5.5.1.3 and Appendix 4 of COP.	catchment surveys, V-Notch weirs, flow studies should all be considered Consultation with relevant fisheries board may be beneficial.	Standard dust jars or specific odour surveys should be considered. Complete as per best practice and relevant guidelines. Refer to EPA Landfill Monitoring Guidelines, 2nd Edition 2003, especially Sections 8 and 10.
Provisional Guidance on Minimum Extent of Testing/Sampling - (sampling totals will depend on the type of risk identified, size of site, extent & volume of waste, ground conditions, variability of the waste material, etc..)				Number of probes will depend on extent of survey and depth of probes. Location bias should be towards end of site with potential receptors.	Will depend on the nature and extent of the waste and type of survey being undertaken. Needs to be site specific assessment scoped and completed by experienced and qualified contractors.	Number of probes will depend on survey area, ground conditions and depth of completion. If suitable ground exists typically two to three five metre deep boreholes are possible per day. Location bias should be towards end of site with potential receptors.	Number of boreholes will depend on survey area, ground conditions and depth of completion. Location bias should be towards end of site with potential receptors.	Number of boreholes will depend on extent of waste and location of receptors. Completion rate will be impacted by ground conditions, installations and grouting. Location bias should be towards end of site with potential receptors. The need for both deep and shallow monitoring boreholes should be considered - review by qualified hydrogeologist recommended.	Should be used at trial pit stage and with monitoring boreholes. Will depend on extent and nature of gases and receptors. Should be decided on a site specific basis.	Should take into account data already available from previous investigations, and will depend on the nature and composition of the waste and number of investigation points. Full screen testing as per Table C.2 of EPA Landfill Monitoring Manual 2003, indicator parameters include pH, Conductivity, Temp, BOD, Ammonia, Chloride, Sulphate, Sodium and Potassium.	Will depend on the variability of site and geology. Ground variability will require more sampling. In-situ permeability and strength (SPT) tests and soil assessment for remediation use should be considered.	Sample upstream and down stream locations as per Table C.2 of EPA Landfill Monitoring Manual 2003. Basic indicator parameters include pH, Conductivity, Temp, BOD, Dissolved Oxygen, Suspended Solids, Ammonia, Chloride, Sulphate, Sodium and Potassium.	Sample at all borehole locations. Full screen as per Table C.2 of EPA Landfill Monitoring Manual 2003. Basic indicator parameters include pH, Conductivity, Temp, BOD, Ammonia, Chloride, Sulphate, Sodium and Potassium. Sampling on at least two occasions for indicator parameters and any elevated parameters identified in the initial sampling.	Pumping tests are important for assessing aquifer status, pathways and confirming linkages and should be completed if possible. If pumped groundwater is found to be contaminated during the step test then disposal management needs to be allowed for - drilling of pump test well outside landfill footprint and between any potentil receptor is recommended.	Quantified on a site specific basis. For moderate and high risk sites the functional and habitat value should be assessed and species or habitat specific surveys may be required.	Quantified on a site specific basis.	Quantified on a site specific basis.
MODERATE RISK SITES				initial one day probe survey should be considered for moderate gas risk sites.	Less coverage and survey densities would be expected for moderate risk sites when compared to high risk sites.	Minimum of one to two days drilling should be considered.	Minimum of three to five locations should be considered. Depending on site specific conditions, such as site size.	Minimum of three locations with one down gradient borehole required for moderate risk sites.	Less gas monitoring locations would be expected to be monitored for moderate risk sites when compared to high risk sites.	A minimum of one full suite at two locations and indicator parameters at a minimum of two or three other locations. Additional monitoring may be required depending on site conditions.	Number of samples should be determined by the site specific requirements.	Full suite on up stream and down stream locations at least once and indicator parameters on at least one other occasion.	Full suite on up gradient and nearest down gradient borehole at least once and indicator parameters at all other relevant groundwater locations.	Step test and 24 hour test should be initially considered.	After ecological screening the need for more detailed surveys should be determined by the site specific requirements.	Quantified on a site specific basis. In general moderate risk sites would be expected to require a less extensive scope of works to be completed.	Quantified on a site specific basis. In general moderate risk sites would be expected to require a less extensive scope of works to be completed.
HIGH RISK SITES				initial two day probe survey should be considered for high gas risk sites.		Minimum of two to three days should be considered.	Minimum five locations should be considered. Depending on site specific conditions, such as site size.	Minimum of three boreholes, with one downgradient, are required for high risk sites, but more should be considered if necessary, i.e large sites.		A minimum of one full suite at three locations and indicator parameters at all other suitable locations. Additional monitoring may be required depending on site conditions.		Full suite on up and down stream locations at least twice and indicator parameters at any other relevant surface locations on at least two other occasions.	Full suite on up gradient and at least two down gradient boreholes and indicator parameters at all other relevant groundwater locations at least twice.	Step test and 72 hour test should be considered.			

AFTER TIER 2 MAIN INVESTIGATION, REFINE CONCEPTUAL SITE MODEL, CONFIRM RISK CLASSIFICATION & PROGRESS TO TIER 3 QRA & REMEDIATION PHASE. (NOTE THAT FOCUS SHOULD BE ON USING ACQUIRED DATA FOR TIER 3 RISK ASSESSMENT RATHER THAN CHANGING ORIGINAL SCORING MATRIX).

R = Recommended technique assuming site conditions allow.

S = Should be considered but is dependent on site suitability for that methodology.

N = Not recommended, but may occasionally be suitable.

RQD = Rock Quality Designation
CSM = Conceptual Site Model
NPWS = National Parks and Wildlife Service
BGL = Below Ground Level
SI = Site Investigation
GW - Groundwater
GSI = Geological Survey Of Ireland
CRT = Constant Rate Test
QRA = Quantitative Risk Assessment

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Prepared by White Young Green on behalf of the OEE