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The Role of Geology

in the

Successful Delivery of Landfill Sites

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Greenstar

The NTR group

1100 employees

NTR

greenstar

NTRIROADS

IRISH BROADBAND

Airtricity

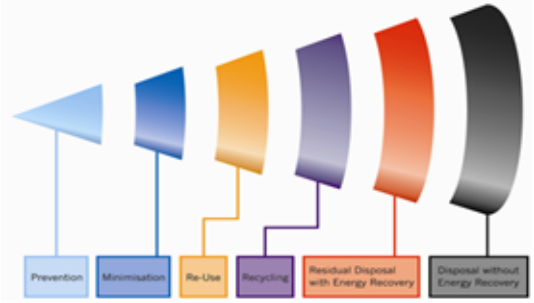
celtic anglian water

MATERIALS RECOVERY LTD

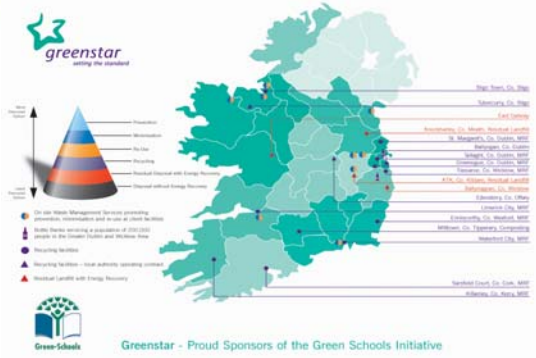
Greenstar – who we are

- Established 1999
- Response to Government Policy "Changing our Ways"
- Irish owned and managed
- 500+ employees in 20 locations
- Ireland's largest waste management company
- Education, Recycling, Composting, Residual Landfill/ energy recovery
- Manages household, commercial and industrial (C&I) waste
- 27,000+ customers nationwide
- €120m+ investment in Irish waste infrastructure to date
- Planned Investment €180m over next 4 years

Greenstar- managing the waste hierarchy



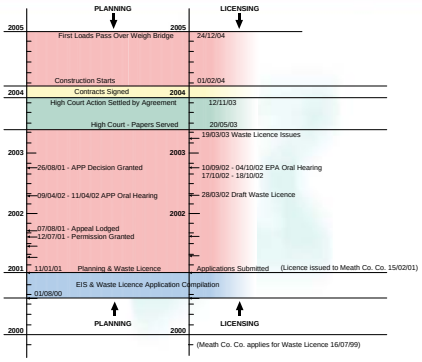
Greenstar – Integrated Waste Management



Role of Geology in Landfill Development & Operations

- Site Selection
- Design
- EIS
- Planning /Licensing
- Judicial Review proceedings
- Construction
- EPA approval to open / liner CQA certification
- Long-term development / operation

Development Timeline – Knockharley, Co. Meath



The Role Of Geology in Landfill Site Selection

- EU Landfill Directive (1999)
  - Location must take into account geological and hydrogeological conditions and groundwater protection zones in the area
  - Can only be authorised if no serious environmental risk
- Groundwater Protection Plans
- GSI Groundwater Protection Responses for Landfills

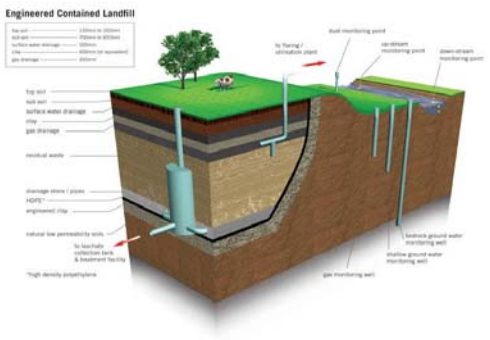
Vulnerability Rating	Source Protection Area		Resource Protection - Aquifer Category					
	Inner	Outer	Regionally Important (R) Rk	Regionally Important (R) Rf /Rg	Locally Important (L) Lm/Lg	Locally Important (L) Ll	Poor Aquifers (P) Pl	Poor Aquifers (P) Pu
Extreme (E)	R4	R4	R4	R4	R3[2]	R2[2]	R2[1]	R2[1]
High (H)	R4	R4	R4	R4	R3[1]	R2[2]	R2[1]	R1
Moderate (M)	R4	R4	R4	R3[1]	R2[2]	R2[1]	R2[1]	R1
Low (L)	R4	R3[2]	R3[1]	R3[1]	R1	R1	R1	R1

- Matrix integrated into EPA Manual on Site Selection (1996)

The Role Of Geology in Landfill Site Selection

Greenstar Site	Overburden Depth	Overburden Type	Resource Protection Category	GSI Response Level	EPA Licence No.	Opening
KTK, Kilcullen Co. Kildare	to 25m	Sand / Gravel / Clay	Pu	R1 / R2[1]	81-2	Oct-98
Knockharley, Co. Meath	to 21m	Boulder Clay	Pu	R1	146-1	Dec-04
Connaught Regional Landfill, Co. Galway	to 10m	Peat and Boulder Clay	Ll	R2[2]	178-1	Jan-06
Ballynagran, Co. Wicklow	to 25m	Boulder Clay	Pl, Ll	R1 / R2[1]	165-1	Jan-07
Usk, Co Kildare	to 11m	Sand / Gravel and Boulder Clay	Pu	R2[1]	168-1	Oct-08
Annaskinnan, Co. Westmeath	to 20m	Sand/Gravel / Clay	Ll	R2[2]	153-1	N/A
Ballyguyroe, Co. Cork	to 30m	Clay / Peat	Ll	R1	157-1	N/A

Modern Engineered Landfill



The Role Of Geology in Landfill Design

- EU Landfill Directive (1999)
  - Inert landfills - mineral geological barrier equivalent to 1 metre of 1 X 10^{-7}
  - Non Hazardous Landfills – 1 metre of 1 X 10^{-9} m/s plus bottom liner
  - Hazardous Landfills – 5 metres of 1 X 10^{-9} m/s plus bottom liner
  - Artificially established geological barrier no less than 0.5m thick
  - Substratum sufficiently stable to prevent settlement damage to liner
- EPA Licence Conditions
- EPA Manual Landfill Site Design
  - Construction specifications / guidelines
  - Construction Quality Assurance
- BAT Guidance Note Landfill Activities
- Liner design
  - Engineered Clay
  - Bentonite Enhanced Soil (BES)
- Materials Balance
  - Road construction, embankments, landscaping, drainage, daily cover

The Role Of Geology in Landfill Construction

- Site Investigation / Materials Balance
- Bill of Quantities
- IEI Conditions of Contract – Clause 12
- Liner Construction & Placement
  - Window of Acceptability – MC, DD, triaxial tests
  - Clay screening – Grading, MC
  - BES batching – Grading, MC, bentonite content
  - Insitu testing – cores, triaxial tests, NDM, SRT
- Traffic / Dust / Noise / Neighbours
- Quality Assurance – Construction Quality Assurance (CQA)
- Programme & Costs

Summary

At best Geology can shorten the timeline and costs of a landfill development project

At worst, Geology can make a landfill development project fail.

Knockharley Landfill, Co Meath

Connaught Regional Landfill – East Galway

Connaught Regional Landfill – BES Batching

Connaught Regional Landfill – BES Placing

Connaught Regional Landfill – HDPE / BES

Connaught Regional Landfill – Drainage

Knockharley Landfill - Roadworks

Knockharley – Clay / HDPE liner

Knockharley – Clay / HDPE liner

Knockharley – Clay / HDPE liner

Liner CQA – NDM testing

Knockharley Cells 1-4

Knockharley – Leachate Drainage Blanket

Controlled landfilling into lined cells

Knockharley Restoration Plan