

Subject Material Densities and Bulking

Date 9 January 2015

Job No/Ref

234376 TN-P2-CE-011 Rev 0

## Densities and Bulking Factors for Earthworks Materials Generated on Site

Extractive Material Group	Material	Bank Density (t/m <sup>3</sup> )	Source of Density Value	Temp Stockpile Bulking Factor	Overall Earthworks Factor
1	Topsoil	1.50	literature	1.05	1.05
2	Subsoil	2.09	Ground Investigation	1.10	1.10
2	Glacial Till	2.09	Ground Investigation	1.10	1.10
N/A	Existing Drilling Platform	2.00	Assumed	N/A	1.00
3	Inert Site Won Rock (Sandstone)	2.21	Ground Investigation	N/A	1.20
3	Inert Site Won Rock (Mudstone Siltstone)	2.39	FWS Email of 09 Jan 2015	N/A	1.15
4	Non-Hazardous Non Inert retained on site	2.57	Weighted average based on FWS email of 08 Jan 2015	N/A	1.15
5	Non-Hazardous Non Inert disposed of off site	2.70	FWS Email of 08 Jan 2015	1.25	N/A
6	Non-Hazardous Non Inert disposed of off site	2.70	FWS Email of 08 Jan 2015	1.25	N/A
7	Non-Hazardous Non Inert disposed of off site	2.34	FWS Email of 08 Jan 2016	1.25	N/A
7	Non Product Grade Polyhalite disposed of off site	2.76	FWS Email of 08 Jan 2015	1.5	N/A
8	Halite	2.16	FWS Email of 08 Jan 2015	1.4	N/A
9	Polyhalite Product	2.76	FWS Email of 08 Jan 2015	N/A	N/A

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**Placed Densities for Imported Materials**

Material	Placed Density (t/m <sup>3</sup> )	Source of Density Value
Type 1 Sub-base	2.1 tonnes/m <sup>3</sup>	Measured value, previous Arup project
Type 3 Sub-base	2.0 tonnes/m <sup>3</sup>	Assumed based on density of type 1 taking into account higher void ratio of type 3
Sand	2.1 tonnes/m <sup>3</sup>	Literature

**Definitions**

Bank Density	In-situ Bulk Density of undisturbed rock or soil, in the ground, prior to excavation
Bank Volume	Volume occupied by undisturbed soil or rock in the ground prior to excavation
Temporary Stockpile Bulking Factor	Change in volume between bank volume and volume of the same mass of material placed in temporary stockpile
Stockpile Volume	Volume occupied by material placed in temporary stockpile (= Bank Volume x Temporary Stockpile Bulking Factor)
Overall Earthworks Bulking Factor	Change in volume between bank volume and volume of the same mass of material placed within permanent earthwork bunds.
Mound Volume	Volume occupied by material placed in permanent earthworks mounds (Bank Volume x Overall Earthworks Bulking Factor)
Placed Density	Bulk Density of imported earthworks material as placed within the permanent works

**Calculation of vehicle movements, import and export of earthworks materials**

Imported material	The number of loads imported is calculated as (volume of material required x placed density)/26.3 assuming 70% of trucks are articulated tippers and 30% rigid bodied tippers
Exported material	The number of loads exported is calculated as (bank volume x bank density)/20 assuming all trucks are rigid bodied tippers

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