Bonneagar Iompair Éireann
Transport Infrastructure Ireland

Introduction to Mass Haul Tools and their role in sustainability

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Arup

TII Standards Roadshow Webinar
31st May 2023

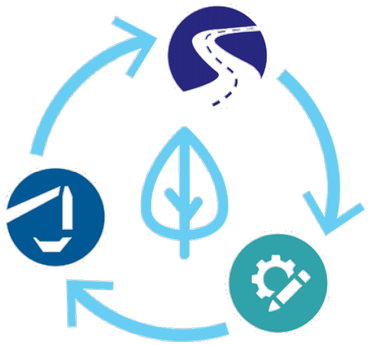
Sustainable Earthworks

Earthworks Design influenced by Sustainability Objectives

Transport Infrastructure Ireland (TII) has a vision to lead in the delivery and operation of sustainable transport.

Appropriate consideration of earthworks during the project planning phases (Phase 2 and Phase 3) can:

- help mitigate ground risks;
- allocate optimal reuse of material;
- reduce potential waste; and
- reduce the need for reactive and less sustainable engineering solutions at subsequent project phases.



Earthworks Analysis & Mass Haul Tools

Excel-based tools for **Phase 2** and **Phase 3** to inform existing process and which helps direct and highlight opportunities for a more sustainable design through optimisation with respects to earthworks.

'Develop sustainable assets and services through innovating and improving the planning, design and construction of the network' …and 'reduce the carbon impact through responsible use of resources, reuse, and repurposing of materials.'

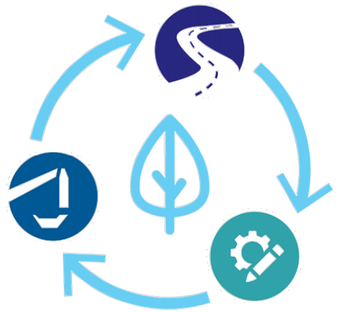
TII Sustainability Implementation Plan

Earthworks Analysis & Mass Haul Tools

Considerations for use of Excel-based Tools on Projects and link with Sustainability Objectives

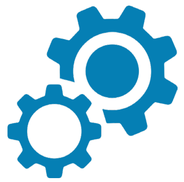
- Tools are intended to act as an integral part of the Phase 2 and Phase 3 design process, providing a structured mechanism to inform on key components at each of these Project Phases

PHASE 2



PHASE 3

Economic



Engineering

Environmental

Cost & Land

Design

EIAR

- Iterative review and identification of source and destination of all material to inform option selection process and justify design during statutory process

Waste Minimisation	Optimal Reuse	Reuse at Highest Value	Sustainable Haulage

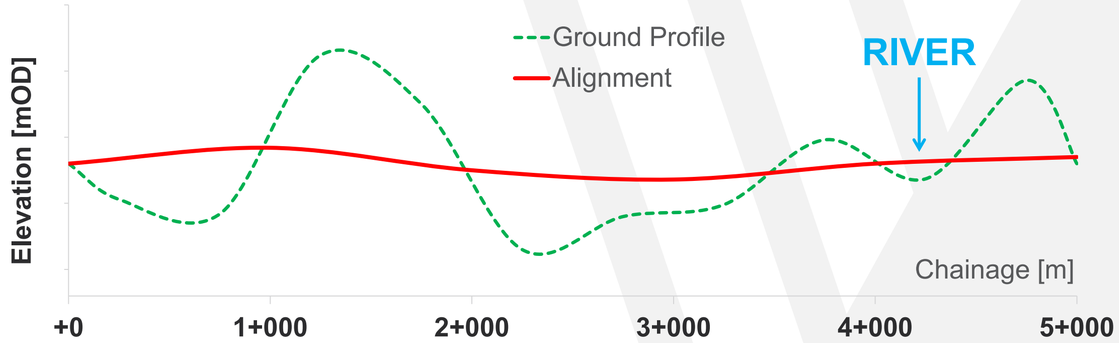
What is Mass Haul?

Basic Definition

Volume of Material ***x*** Transport Distance

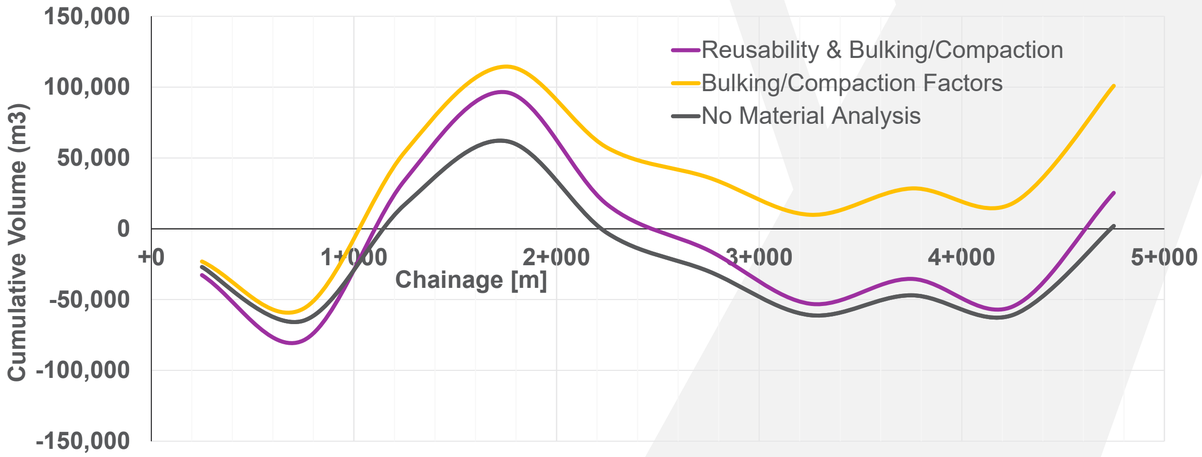
Accurate mass haul is also influenced by the following:

- material classification
- material acceptability
- material value
- bulking / compaction
- source and destination of material
- material handling and construction practices
- haulage constraints
- haulage / extraction equipment
- programme



What is a Mass Haul Diagram?

A **Mass Haul Diagram** is a graphical representation of the material moved and facilitate investigation of material allocation and optimised haulage.



Earthworks Analysis & Mass Haul Tools

Excel-based tools providing semi-automated and structured process to undertake Earthworks and Mass Haul

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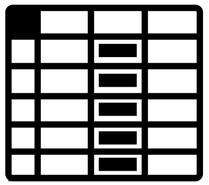
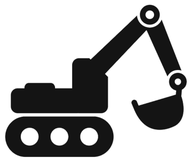
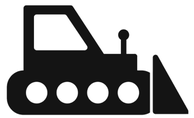


Geometry & Volumetric Data



Earthworks Volumes



Reusability, Classification
& Material Analysis

Constraints, Material Deposition
Areas & Borrow Areas

Import, Export & Haulage Evaluation

Mass Haul Diagrams

Summary

Earthworks Analysis & Mass Haul Tools

Excel-based tools providing semi-automated and structured process to undertake Earthworks and Mass Haul

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	Topsoil	General Fill	Selected Fill	Capping	Subbase	Total
Haulage Deficit (m³)	26,700	72,563	236,044	155,085	118,607	
Haulage Surplus (m³)	15,631	317,329	0	31,202	5,395	

Topsoil

Chainage To		FORWARD MOVEMENT To the 1st Next Fill Section Gradient	Constraints	Volume	Distance	To the 2nd Next Fill Section Gradient	Constraints	Volume	Distance	BACKWARD MOVEMENT To the 1st Next Fill Section Gradient	Constraints	Volume	Distance	To the 2nd Next Fill Section Gradient	Constraints	Volume	Distance
50	CUT	0.27%	YES	164	320	0.55%	YES	1381	1820								
450	FILL																
700	CUT	0.63%	NO	23	1175												
2800	FILL																
3200	CUT	-0.72%	NO	462	525					-0.74%	NO	462	1250				
3850	FILL																
			YES	541	500					0.86%	NO	541	500				
			NO	172	450					0.07%	YES	172	450				
			YES	5263	975					-0.50%	NO	1498	775	-0.29%	YES	3899	1675
			NO	36	200					-0.65%	YES	36	575				
			NO	1626	450					-1.22%	NO	832	300				
			NO	695	650					0.10%	NO	695	400				

Excel-based tools
with supporting **User Guide**

Mass Haul Diagrams

Summary

Exploring Optimisation Opportunities

Linked with Sustainability Objectives

- Iterative review and identification of source and destination of all material to inform option selection process and justify design during statutory process

Waste Minimisation

- Avoid off-site disposal through investigation of alternative use / destination

Optimal Material Reuse

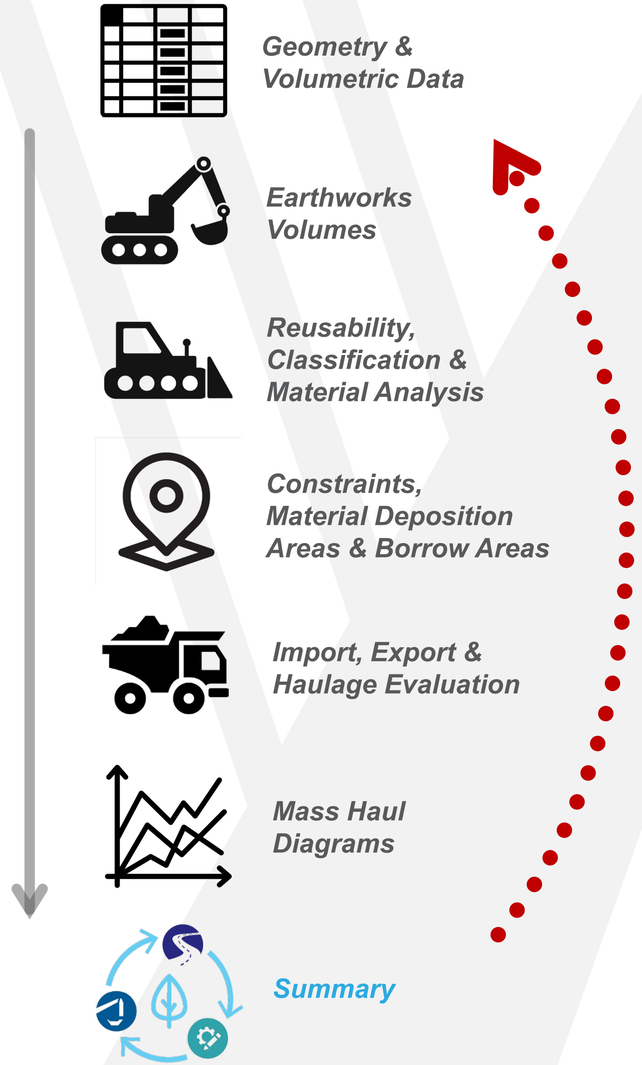
- Structured consideration of material reuse potential
- Encourage localised balances through identification of movements beyond nearby earthworks area

Reuse of Material at Highest Value

- Breakdown allocation and haulage of different material designations

Sustainable Haulage

- Identification of haulage constraints or long haulage distances which could result in unsustainable haulage / construction practices
- Review gradient characteristics of proposed movements



Exploring Optimisation Opportunities

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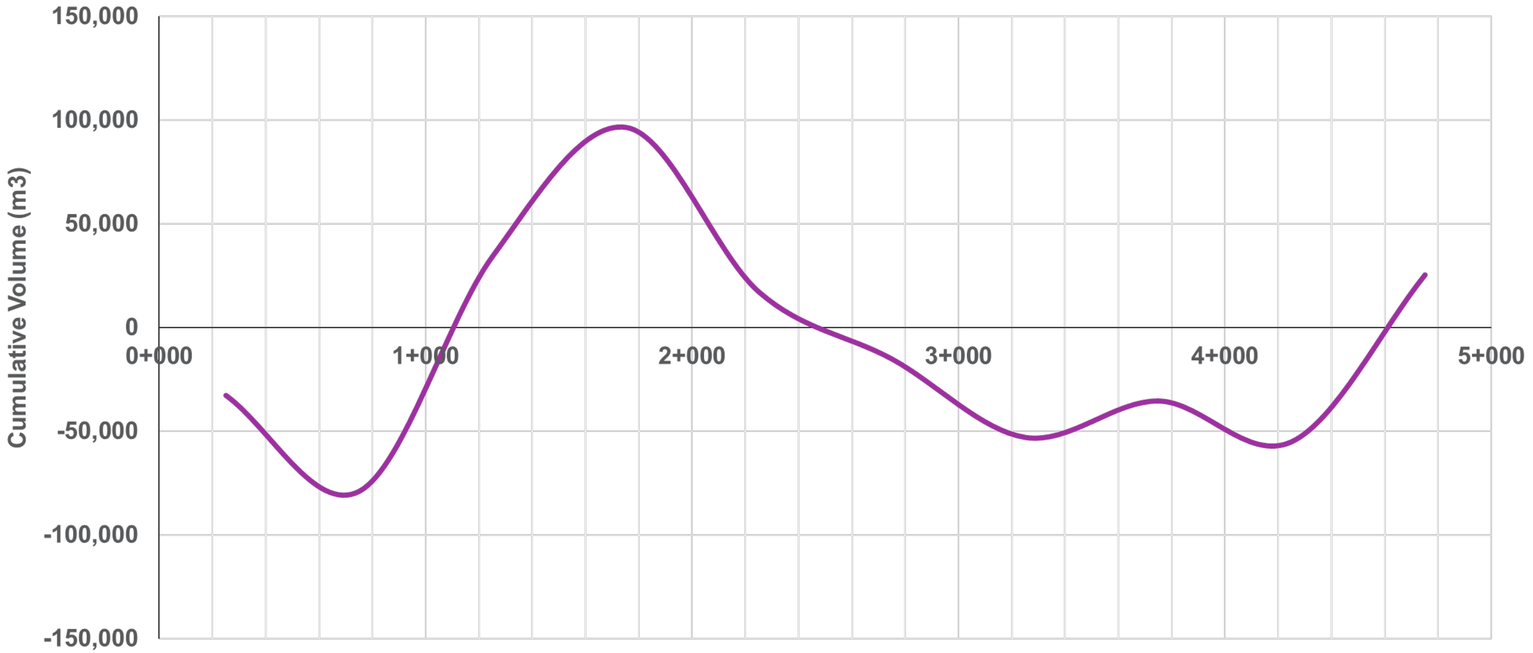
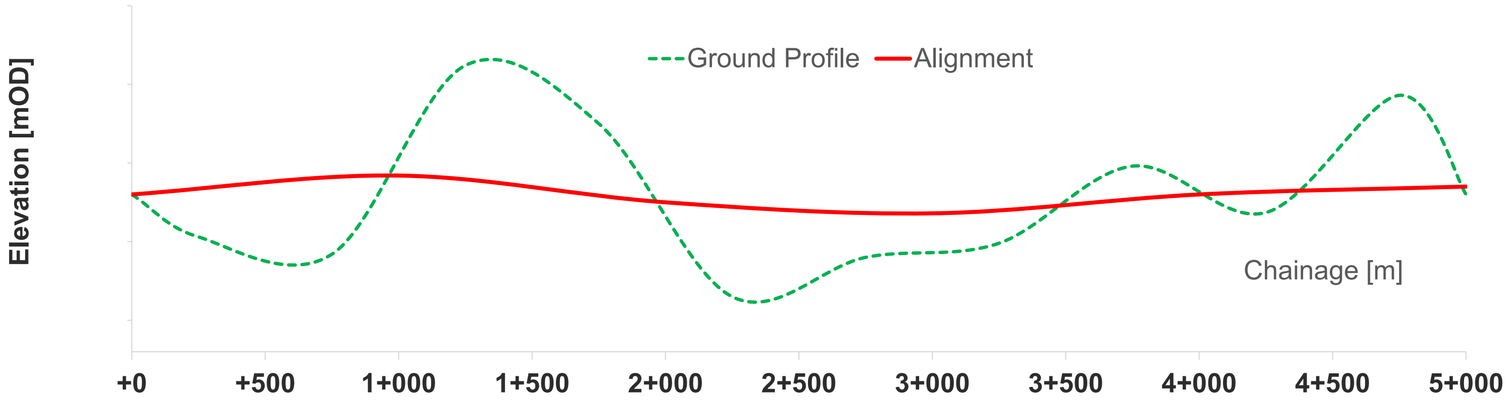
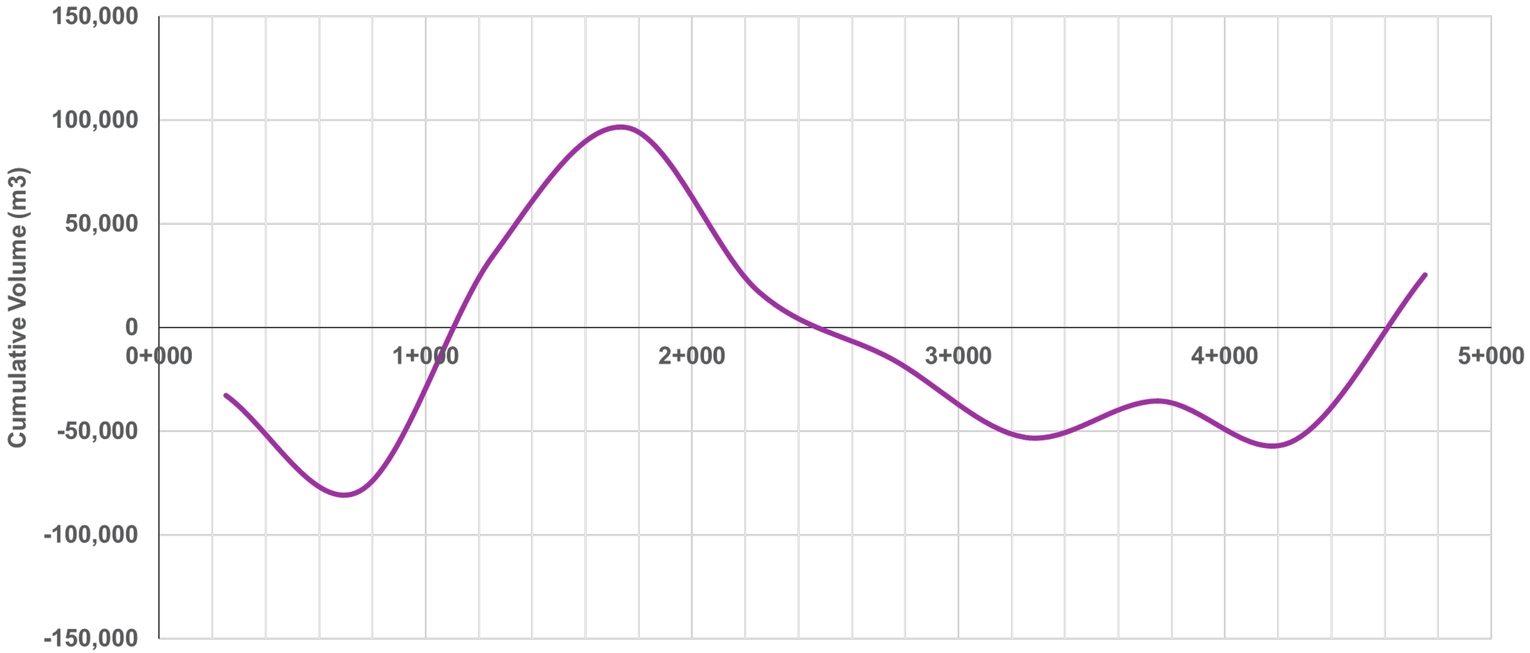




- *Geometry & Volumetric Data*
- *Earthworks Volumes*
- *Reusability, Classification & Material Analysis*
- *Constraints, Material Deposition Areas & Borrow Areas*
- *Import, Export & Haulage Evaluation*
- *Mass Haul Diagrams*
- ***Summary***

Exploring Optimisation Opportunities

Linked with Sustainability Objectives



Earthworks Balance Summary		General Fill	Select Fill	(U1) Unacceptable	
Total Volume (m^3)	Bulked Cut	225,114	82,446	29,352	Total
	Uncompacted Fill	198,030	118,080	#N/A	
	MDAs	0	#N/A	0	
	Borrow Pits	0	0	0	
	Export	0	0	0	
	Import	0	0	#N/A	
	Balance	27,084	-35,634	29,352	20,802

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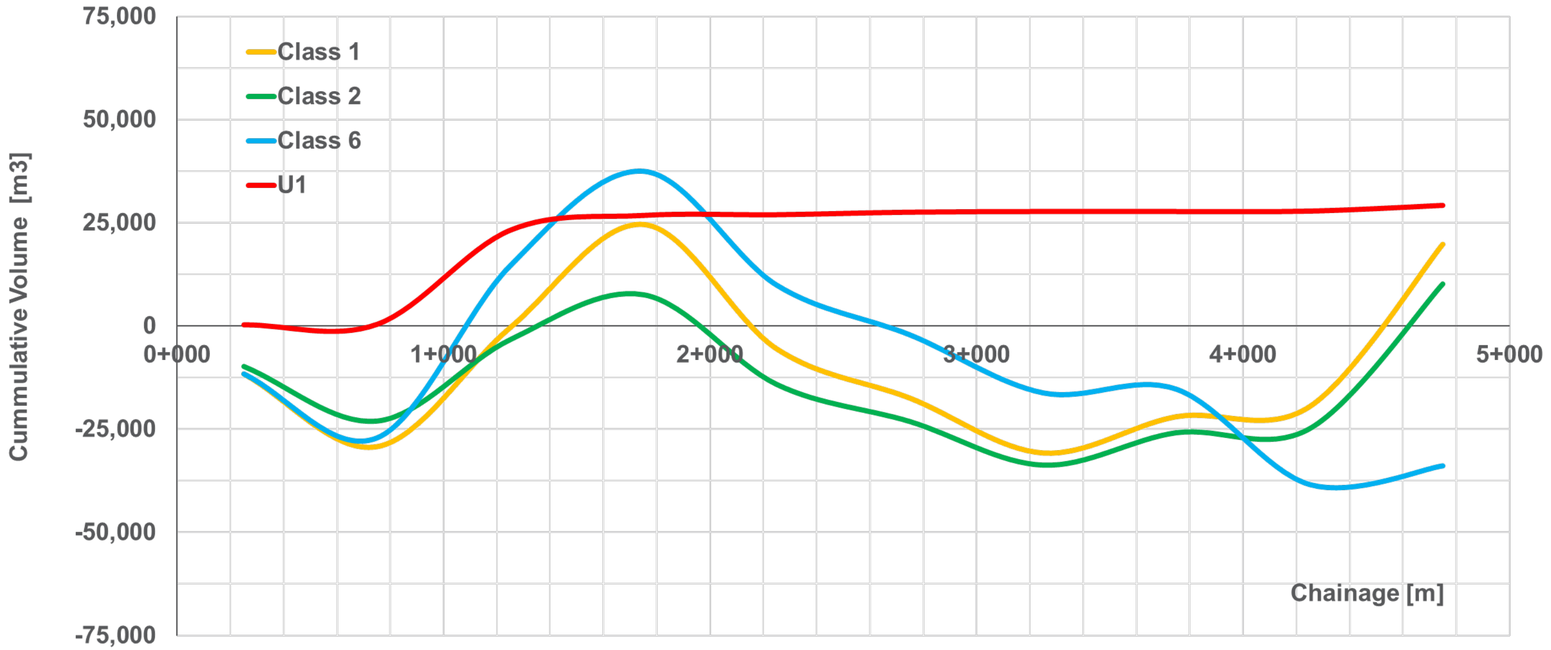

Detailed Mass Haul Diagrams

The tool provides a series of Mass Haul Diagrams per material designation, which can be used in conjunction with the Summary tab, which provides tabulated direction of optimisation opportunities.

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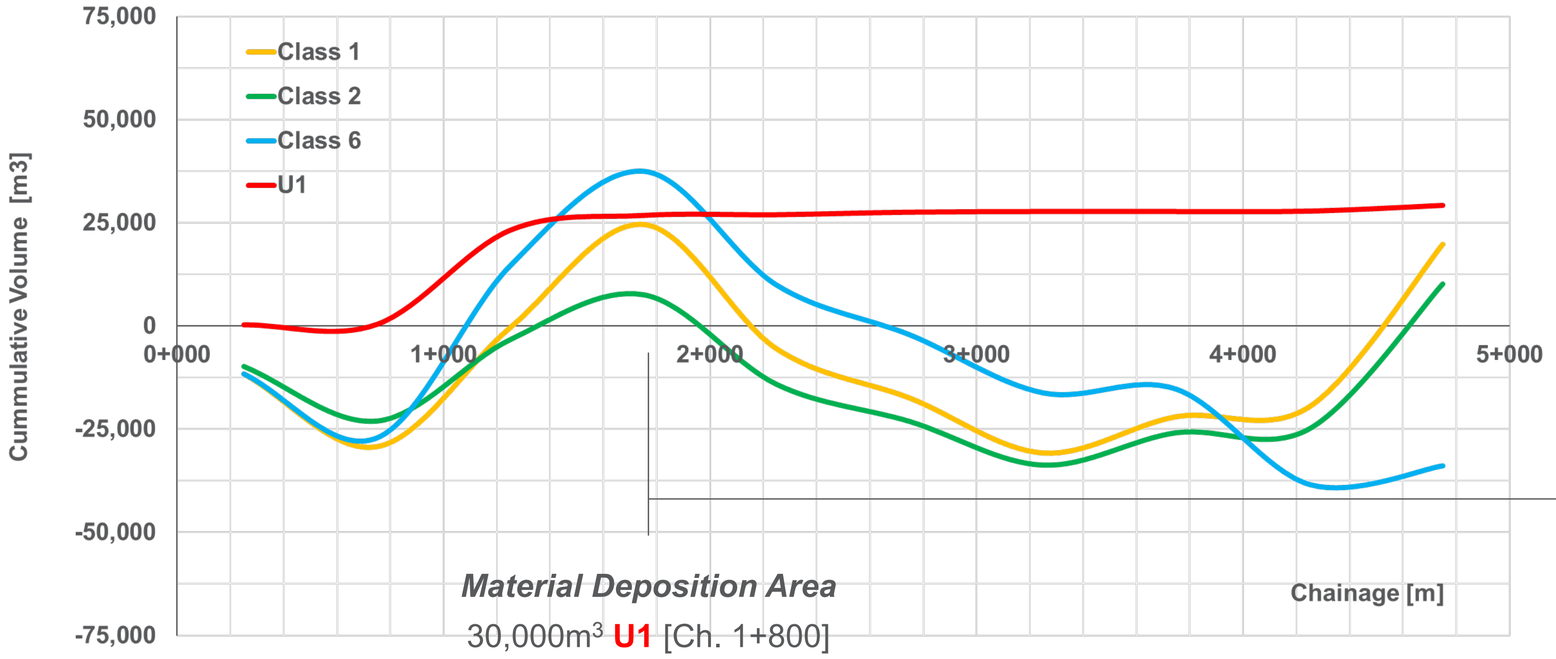

Material Deposition Areas

Explore areas within LMA where a beneficial use case could be achieved/enhanced through the provision of material, which would also reduce need for off-site disposal.

- *Geometry & Volumetric Data*
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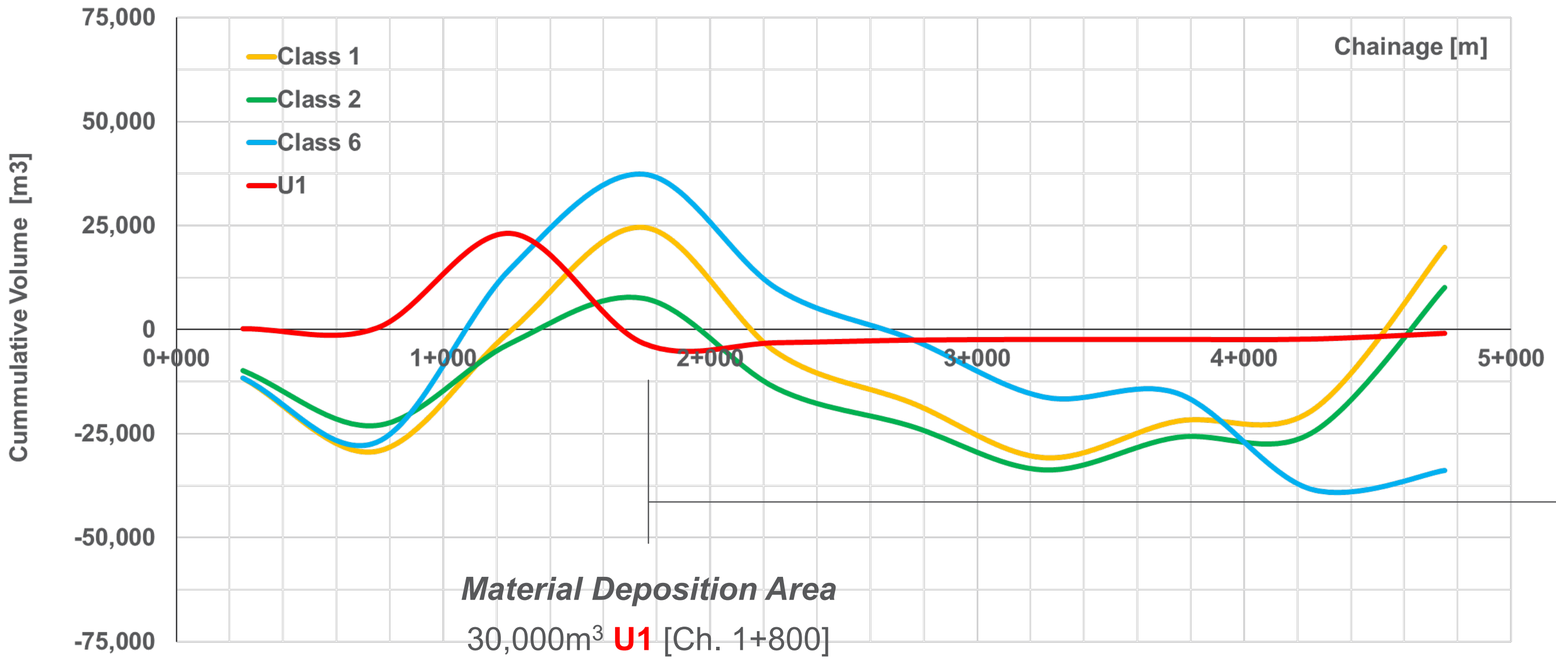

Material Deposition Area

30,000m^3 **U1** [Ch. 1+800]

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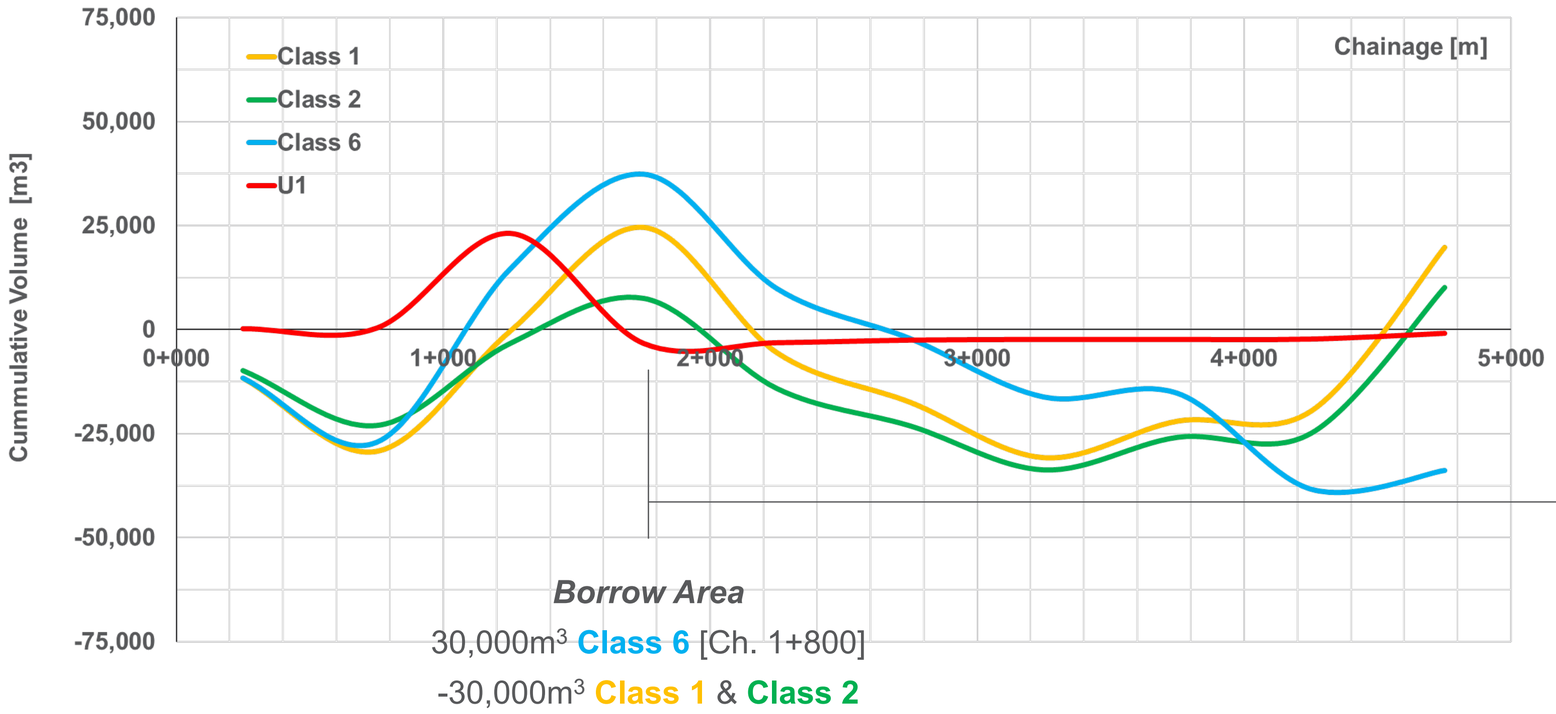

Borrow Area

30,000m^3 **Class 6** [Ch. 1+800]

-30,000m^3 **Class 1** & **Class 2**

Borrow Areas

Explore areas where valuable material could be acquired within LMA to reduce/avoid the need for import from off-site natural resources.

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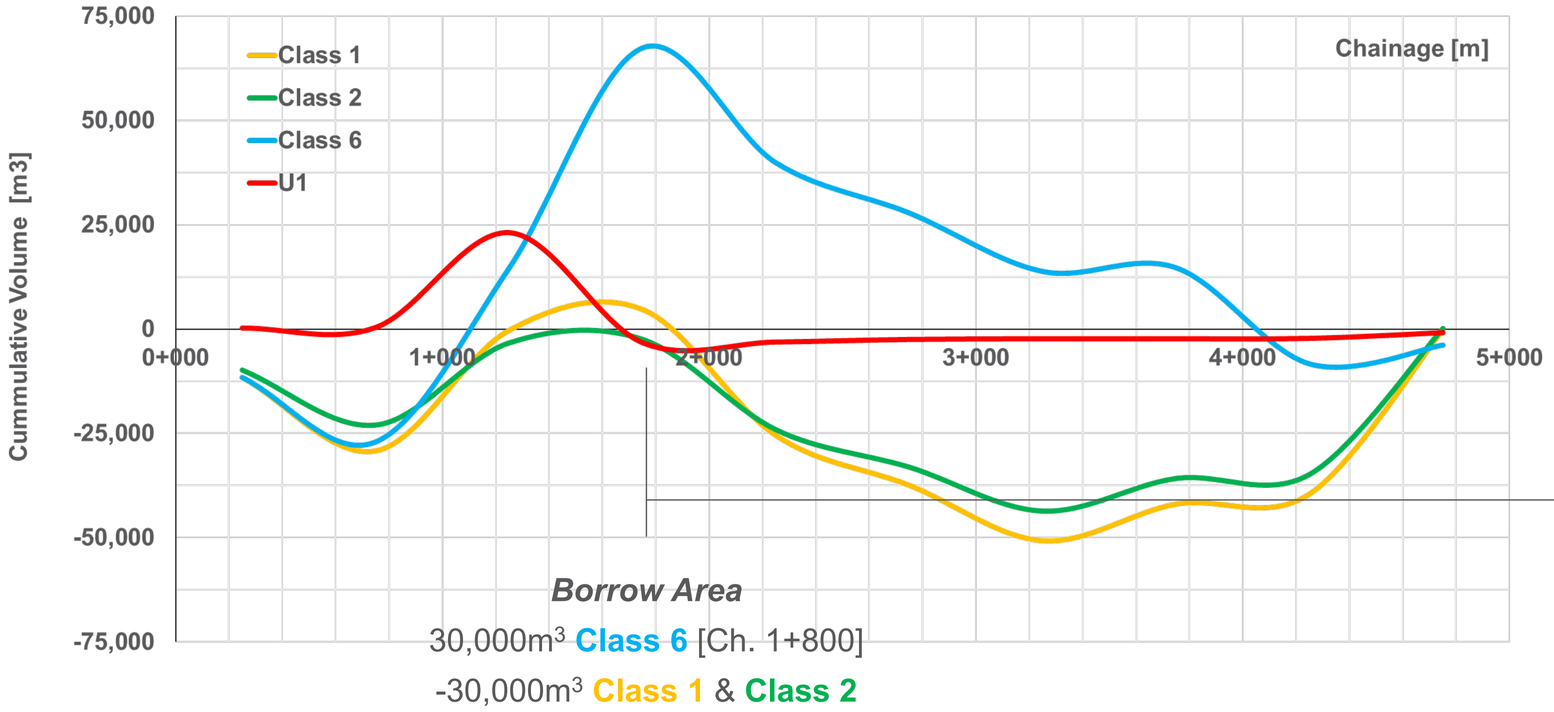

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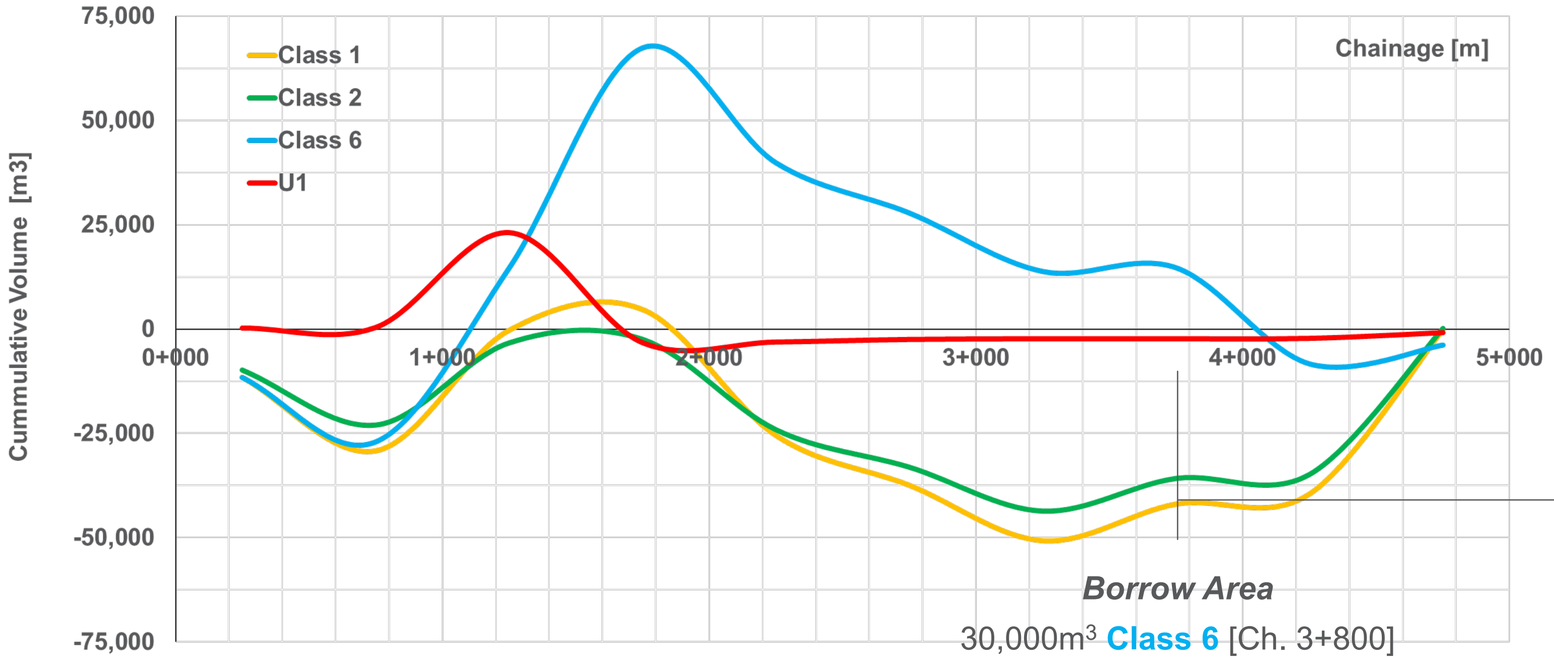

Borrow Area

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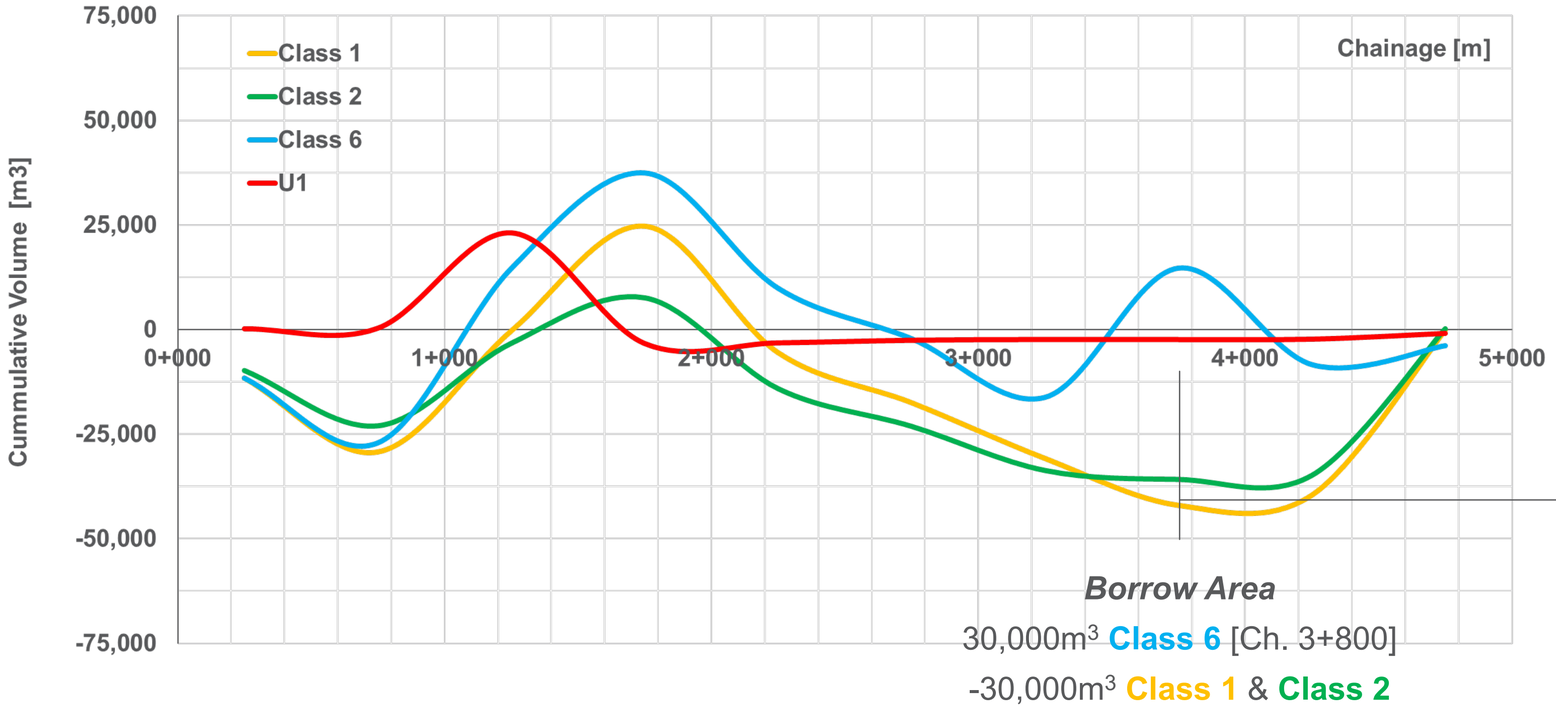

Borrow Area

30,000m³ **Class 6** [Ch. 3+800]

-30,000m³ **Class 1** & **Class 2**

Chainage			Forward Movement				Backward Movement			
			FWD Movement #1 & #2				BWD Movement #1 & #2			
From	To	Section Status	Gradient	Constraint	Volume	Distance	Gradient	Constraint	Volume	Distance
-	-	-	%	-	m³	m	%	-	m³	m
0	1000	FILL								
1000	2000	CUT	0.00%	NO	30800	1250	0.00%	NO	30800	1000
2000	3500	FILL								
3500	4000	CUT	0.00%	NO	8313	500	0.00%	NO	22419	1000
4000	4500	FILL								
4500	5000	CUT								

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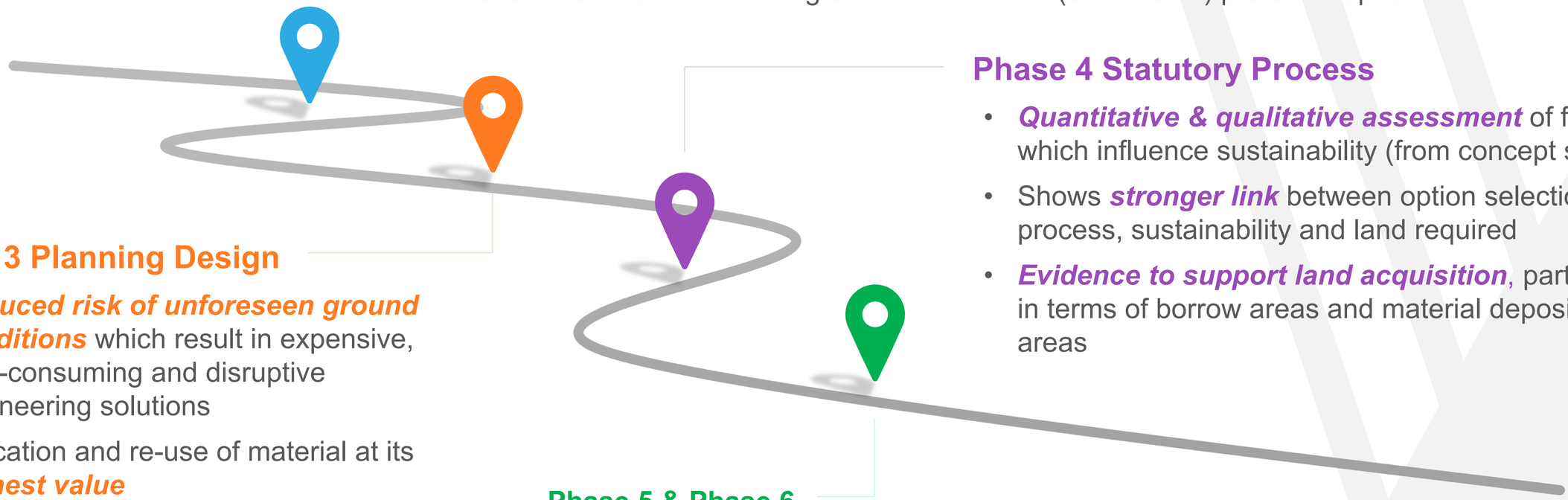
Why consider Mass Haul?

Phase 2 Option Selection Process

- More ***considered comparison*** of options in terms of earthworks
- Optimised earthworks design when options at their ***most flexible***
- Facilitate ***identification of deposition and/or borrow areas*** much earlier in the process
- Increased likelihood of achieving a ***more balanced*** (earthworks) preferred option



Phase 3 Planning Design

- ***Reduced risk of unforeseen ground conditions*** which result in expensive, time-consuming and disruptive engineering solutions
- Allocation and re-use of material at its ***highest value***
- ***Reduces reactive design*** to deal with unbalanced preferred option

Phase 4 Statutory Process

- ***Quantitative & qualitative assessment*** of factors which influence sustainability (from concept stage)
- Shows ***stronger link*** between option selection process, sustainability and land required
- ***Evidence to support land acquisition***, particularly in terms of borrow areas and material deposition areas

Phase 5 & Phase 6

- ***Greater cost certainty*** in terms of earthworks quantities and movement
- Optimised earthworks will likely result in ***less reliance on natural / scarce resources***
- ***Localised balances*** which reduce works & cost from long/unsustainable haulage
- ***Reduction in claim costs and programme overrun*** due to improved consideration of material movements and allocation e.g. sourcing acceptable, disposal of unacceptable

Release, Feedback & Training

Open Release

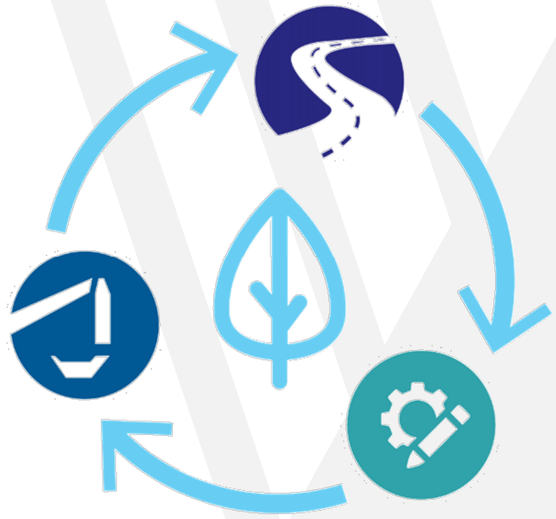
- Excel-based Tools & User Guide were released on 7th December 2022 and are currently available to all interested parties.
- Please submit a request to **earthworks@tii.ie**
- Each user is currently required to fill out a brief access form.

Feedback Form

- A Feedback Form is currently being finalised for issue to all who have accessed and/or used the Excel-based Tools to date.
- Encourage all to provide feedback either through the Feedback Form or send separately to **earthworks@tii.ie**

Training

- In-person training will be made available via a one day workshop.
- Training will include a more in-depth review of the Excel-based tools, with on-screen examples and facility for question & answer.

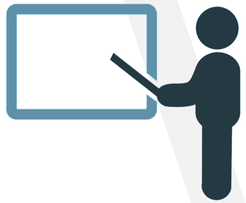


Release, Feedback & Training

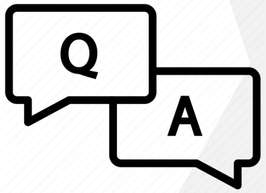
Proposed Training Agenda

Agenda	Description
Principles of Sustainability & Mass Haul	Overview of the principles of sustainability associated with earthworks, and review of key principles associated with Mass Haul.
Step-by-Step of Excel-based Tools	Summary of each tab within the Excel-based tools and the User Guide.
Optimisation Worked Examples	Live tutorial of inputs and exploration of opportunities for optimisation.
Ground Investigation Objectives, Design & Management	Overview of principles related to ground investigation at Phase 2 and Phase 3, how the data can inform aspects of the tools and review of key considerations of ground investigation at these early phases.

In-Person Training



On-Screen Tutorials



Q&A Sessions

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Thank you